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DOE/EIS-0136 Volume 1

FINAL
ENVIRONMENTAL IMPACT STATEMENT

SPECIAL ISOTOPE SEPARATION PROJECT

IDAHO NATIONAL ENGINEERING LABORATORY
IDAHO FALLS, IDAHO

November 1988

U.S. DEPARTMENT OF ENERGY

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U.S. DEPARTMENT OF ENERGY

COVER SHEET

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ABSTRACT: The purpose of this Final Environmental Impact Statement (EIS) is to provide environmental input into a U.S. Department of Energy (DOE) decision on the proposed construction and operation of a Special Isotope Separation (SIS) Project using the Atomic Vapor Laser Isotope Separation (AVLIS) process technology and on the selection of a site for such a project. The SIS Project would provide DOE with the capability of segregating the isotopes of DOE-owned plutonium into specific isotopic concentrations. This capability is needed to provide a contingency, flexibility, and technological diversity in DOE's production of weapon-grade plutonium for national defense.

The alternatives considered in detail in this EIS include (1) constructing and operating the SIS Project at the Idaho National Engineering Laboratory (INEL) near Idaho Falls, Idaho (the Preferred Alternative); (2) constructing and operating the SIS Project at the Hanford Site near Richland, Washington; (3) constructing and operating the SIS Project at the Savannah River Plant (SRP) near Aiken, South Carolina; and (4) No Action, or not constructing and operating the SIS Project.

This EIS includes discussion of the SIS facilities and processes; the environmental consequences of constructing and operating the facilities at the alternative sites for routine operations and accidental conditions; and the environmental consequences of No Action.

FOREWORD

The purpose of this Final Environmental Impact Statement (EIS) is to provide environmental input into a U.S. Department of Energy (DOE) decision on the proposed construction and operation of a Special Isotope Separation (SIS) Project using the Atomic Vapor Laser Isotope Separation (AVLIS) process and on the selection of a site for such a project. The SIS Project is needed by DOE to provide a prudent level of contingency, flexibility, and technological diversity in DOE's existing production complex for ensuring that approved needs for defense nuclear materials can be met.

The SIS Project would process DOE fuel-grade plutonium into weapon-grade plutonium* using the AVLIS and supporting chemical processes. The AVLIS process uses precisely tuned visible laser light to selectively ionize, or excite, specific plutonium isotopes in a vapor stream. The ionized plutonium isotopes are then separated from the plutonium isotope of interest. Chemical processes are required to (1) prepare the AVLIS plutonium feed for processing, remove americium-241, and cast plutonium metal into forms that meet AVLIS processing requirements; (2) recover and, if required, purify the AVLIS plutonium product; and (3) recover and process the AVLIS separated by-products.

The SIS Project would require the construction and operation of a Laser Support Facility, which would house the laser system, and a Plutonium Processing Building. Construction and operation of the SIS Project would not modify (i.e., require changes or modification in operation) existing DOE nuclear material production facilities; the SIS Project would be integrated with existing support and waste management facilities at the selected site. Construction and operation of the SIS Project would be conducted in accordance with all applicable laws and regulations intended to protect the environment and the safety and health of workers and the public.

The DOE fuel-grade plutonium that would be processed by the SIS Project would consist entirely of DOE-owned plutonium. Feedstock for the SIS facility would not be from commercial reactor spent fuel that is precluded by law or from fuel precluded by DOE policy. The fuel-grade plutonium to be processed includes processed N-Reactor fuel and scrap plutonium currently located at the Hanford Site and a small quantity of scrap plutonium currently at the Savannah River Plant (SRP) which would be transported to the selected site. An additional potential source of fuel-grade plutonium for SIS processing is the DOE-owned plutonium within the Fast Flux Test Facility (FFTF) fuel at the Hanford Site. Currently, DOE is preparing an Environmental Assessment (EA) analyzing the feasibility and environmental impacts of various fuel-decladding techniques that could be used to recover DOE-owned plutonium in the spent fuel from the FFTF. The Final EIS has been

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*"Weapon-grade" plutonium is defined as plutonium-239 nominally containing 6-percent plutonium-240. In this document the term "fuel grade" is used to refer to plutonium containing greater than 6-percent plutonium-240.

modified to include the cumulative risk of transporting all FFTF fuel to the SIS facility from the Hanford Site--the preferred location for the decladding activity. While no other DOE-owned fuel-grade material is currently available to the SIS facility, it is possible that future DOE initiatives could provide feedstock for the SIS facility. Such sources could fall within the bounding analysis of this Final EIS, which has been expanded in response to public comments to analyze impacts of operating the SIS for a full-throughput capacity 30-year mission. While the EIS attempts to bound the impacts by assuming maximum annual processing throughput, year-to-year requirements for weapon-grade material may not require that weapon-grade material be produced at the rated capacity. When and if additional feed materials are identified for processing at the SIS facility, the Proposed Action would be reviewed in light of the analyses presented in the Final EIS to determine the need for additional National Environmental Policy Act (NEPA) review.

After SIS processing, weapon-grade plutonium would be transported to DOE's Rocky Flats Plant, near Denver, Colorado; the by-product material would be stored on an interim basis at the location of the SIS Project. The by-product would be primarily plutonium-239 and 240, with lesser quantities of plutonium-238, 241, and 242. The by-product material would be stored in a storage vault until such time as DOE evaluates its potential applicability for other possible missions. If no missions are identified for the by-product material, it would be rendered into a form that would meet the Waste Acceptance Criteria for, and be transported to, the Waste Isolation Pilot Plant (WIPP) near Carlsbad, New Mexico. Storage of the by-product material in the storage vault would not exceed the design life of the storage vault (i.e., 30 years for a new Stand-Alone Storage Vault). To bound the environmental impacts, the transport of by-product to the WIPP has been analyzed in the Final EIS.

Within this Final EIS, all annual consequences are based on the maximum SIS throughput or processing rate as well as the maximum quantities of SIS materials (feed, products, and wastes) that could be handled, generated, and transported in a single year to bound the reasonably foreseeable routine and accidental consequences of SIS operation. The presentation of annual environmental consequences is consistent with current regulatory standards [e.g., the U.S. Environmental Protection Agency's (EPA's) National Emission Standards for Hazardous Air Pollutants (NESHAP)] and DOE Orders. It is also consistent with the DOE Defense Program's practice of establishing production goals at its facilities commensurate with annually approved requirements for defense nuclear materials. To bound (i.e., determine the maximum) potential cumulative consequences over the design life of the facility, an analysis of cumulative consequences of SIS operation for 30 years has been conducted in this Final EIS.

The DOE's Preferred Alternative considered in this Final EIS is to construct and operate the SIS Project at the Idaho National Engineering Laboratory (INEL) near Idaho Falls, Idaho. The alternatives to this Proposed Action, which are also addressed in this EIS, are to construct and operate the SIS Project at the Hanford Site near Richland, Washington; construct and operate the SIS Project at the SRP near Aiken, South Carolina; and take No Action, or not construct and operate the SIS Project.

The DOE has prepared this Final EIS in compliance with the requirements of NEPA. Copies of this Final EIS were distributed to interested agencies, organizations, and individuals.

Public hearings were held on the Draft EIS. The transcripts from these hearings, accompanying exhibits, and written comments submitted to DOE are available to the public upon request as supplemental volumes (Volumes 3 through 6) to the Final EIS. Volume 2 of the Final EIS contains DOE's responses to all comments received on the Draft EIS. In addition, a summary of the issues and concerns identified by the comments and a discussion regarding how comments are addressed in the Final EIS have been included in Volume 1 and Volume 2.

The most noteworthy changes/enhancements in the Final EIS with respect to the Draft EIS made in response to the comments are as follows:

- The clarification of the need for the SIS Project
- The incorporation of recently available on-going design data as well as adoption of potential laser and process modifications previously discussed in the Draft EIS
- The reflection of recent design changes ensuring the separation of process and nonprocess liquid waste streams to ensure that only nonradioactive and nonhazardous liquid effluents would be discharged to a new Idaho Chemical Processing Plant (ICPP) percolation pond
- The inclusion of an expanded discussion on the number of construction and operational workers associated with the SIS Project and the potential socioeconomic impacts of these workforces
- The inclusion of transuranic (TRU) wastes, SIS by-product, and onsite low-level waste (LLW), in the analysis of the transport of SIS materials, including the cumulative risk from all shipments over the 30-year facility design life
- The recalculation of facility accident consequences based on continuing safety analysis studies and the reexamination of potential release fractions
- The extension of an impact analysis to include the cumulative quantities of wastes and risks for 1 year (annual) and 30 years (facility design life).

The Final EIS has been structured to conform as closely as possible to the format described in the Council on Environmental Quality (CEQ) Regulation 40 CFR Parts 1502.1 through 1502.18. The first volume contains the main body of the Final EIS and additional detailed information in appendixes. Vertical lines in the margins of Volume 1 indicate where revisions or additions were made to the Draft EIS. Volume 2 contains a summary of all comments received on the Draft EIS and DOE's responses to these comments as well as all written questions that were submitted at the public hearings. Volumes 3 through 6, which are available on request, contain reproductions of all the comments received. Copies of Volumes 3 through 6 have also been placed in libraries and reading rooms to improve accessibility to the public.

Volumes 1 and 2 of the Final EIS have been sent to those who commented on the Draft EIS and to those who received the Draft EIS, are available to members of the public, and have been filed with the EPA. A notice of availability of the Final EIS has been published by EPA in the Federal Register. DOE will make its decision on whether to construct and operate the SIS Project and on the selection of a site, if the SIS Project is to be constructed and operated, not earlier than 30 days after publication of the EPA notice of availability. DOE will document its decision in a publicly available Record of Decision.

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SUMMARY

In accordance with Section 102(2)(C) of the National Environmental Policy Act (NEPA) of 1969, as amended, this Environmental Impact Statement (EIS) addresses the potential environmental consequences of constructing and operating a Special Isotope Separation (SIS) Project. This EIS was prepared in accordance with the Council on Environmental Quality (CEQ) regulations for implementing the procedural provisions of NEPA (40 CFR 1500-1508) and the U.S. Department of Energy's (DOE) NEPA guidelines (52 FR 47662, December 15, 1987).

This Final EIS was prepared based on six public hearings, which were held at the request of interested organizations and individuals. The transcripts and accompanying exhibits from these hearings are available to the public as supplemental volumes (Volumes 3 through 6) to the Final EIS. Accompanying this Final EIS are DOE's responses to written comments received on the Draft EIS (Volume 2). Also included is a summary of the issues and concerns identified by the comments and how these are addressed in the Final EIS.

Volumes 1 and 2 of the Final EIS have been sent to those who commented on the Draft EIS and to those who received the Draft EIS, are available to members of the public, and have been filed with the U.S. Environmental Protection Agency (EPA). A notice of availability of the Final EIS has been published by EPA in the Federal Register. DOE will make its decision on whether to construct and operate the SIS Project and the selection of a site, if the SIS Project is to be constructed and operated, not earlier than 30 days after publication of the notice of availability. DOE will document its decision in a publicly available Record of Decision.

SUMMARY OF COMMENTS AND RESPONSES ON THE DRAFT EIS

During the 60-day public comment period on the Draft EIS, more than 1400 individuals and organizations provided DOE with comments and approximately 13,775 individuals signed petitions on its proposal to construct and operate the SIS Project. Approximately 58 percent of the individuals and organizations providing comments (i.e., about 810 commentors) were opposed to locating the SIS Project at the Idaho National Engineering Laboratory (INEL) or the DOE proposal to construct and operate the SIS Project (i.e., they supported No Action). Of the petitions received from the individuals and organizations providing comments, about 94 percent of the total number of names on the petitions (i.e., about 12,940) supported the DOE's Preferred Alternative of locating the SIS Project at the INEL. Only three commentors of the approximately 1400 providing comments identified a preference for locating or not locating the SIS Project at either the Hanford Site or the Savannah River Plant (SRP).

Numerous comments were submitted during the review period on the Draft EIS supporting the construction and operation of the SIS Project at the preferred location of the INEL and/or the need for the facility. Selected topics raised in support of the Preferred Alternative were centered on: Economic and Employment Benefits, Potential High-Technology Spinoffs, Project's Need for National Defense, Excellent INEL Safety Record, Existing

Infrastructure to Support Project, Labor/Management Relationship, and Openness of and Access to INEL Management.

DOE also received numerous comments on a wide range of topics, in written statements, letters, and oral testimony that opposed the Preferred Alternative of constructing and operating the SIS Project at the INEL. The following lists the main issues.

1. Need and Justification for the SIS Project
2. SIS Feed Material and Period of Operation
3. Geologic Hazards
4. Waste and Waste Management
5. Atmospheric Emissions
6. Facility Accidents
7. Transportation Safety
8. Emergency Preparedness
9. Health Effects
10. Socioeconomics
11. NEPA Process
12. INEL Mission
13. Independent Monitoring

For each of the topics listed above which did not support the Preferred Alternative, the following pages list the topic, specific comments under the topic, and a summary of DOE's response to the specific comments.

1. Nonsupportive Statements and Comments on Need and Justification for the SIS Project

- The SIS Project and the weapon-grade plutonium it would produce are not needed because (1) there are already enough plutonium and nuclear weapons, (2) reductions in nuclear weapons resulting from arms agreements would provide additional quantities of plutonium, and (3) plutonium, unlike tritium, does not have to be replaced.

- The SIS Project is contrary to efforts to reduce nuclear weapons.

- Construction and operation of the SIS Project would violate the Nuclear Non-Proliferation Treaty or would increase the potential proliferation risk.

- The Secretary of Energy stated that the nation is "awash" in plutonium.

- Other alternatives [blending, weapons recycling, restarting N-Reactor, and the Atomic Vapor Laser Isotope Separation (AVLIS) demonstration facility at the Lawrence Livermore National Laboratory (LLNL)] would provide the redundancy and flexibility DOE requires for plutonium production, and enriched uranium or fuel-grade plutonium rather than weapon-grade plutonium could be used directly in nuclear weapons.

- The EIS should have a classified appendix that supports the need for the Project.

DOE Summary Responses to the Previous Comments:

The national policy on nuclear weapons, their deployment, and their number is a policy decision which is made by the President of the United States and approved through the authorization and appropriation process of the United States Congress. Although DOE and the Department of Defense provide input to the President through the National Security Council on this national policy and implement such policy, approval of the policy is the responsibility of the President and the United States Congress. The quantities of weapon-grade plutonium from retired nuclear weapons and those dismantled as a result of nuclear weapon agreements are included in an annually prepared document known as the Nuclear Weapons Stockpile Memorandum (NWSM), and are accounted for in the determination of any new weapon-grade plutonium required for national defense. Plutonium, unlike tritium, does not decay rapidly; however, modernization programs approved by the President and Congress require replacing older warheads that used uranium enriched in the isotope uranium-235 with new warheads that use weapon-grade plutonium.

The SIS Project is needed by DOE to provide a prudent level of contingency, flexibility, and technological diversity, given the current age of and limitations on existing production facilities and reactor-based issues which have impacted the nation's capability to produce plutonium. It is not being proposed to satisfy a specific requirement for the production of new weapon-grade plutonium. Both the President and the United States Congress, as reflected by approved authorizations and appropriations, have supported the need for the contingency, flexibility, and technological diversity that the SIS Project would provide.

The United States will continue to pursue verifiable agreements to reduce nuclear weapons while maintaining the capability of producing special nuclear materials for national defense. Until verifiable agreements have been reached to eliminate nuclear weapons, the capability of producing special nuclear materials for national defense must be maintained as an integral part of the nation's nuclear deterrence policy.

Construction and operation of the SIS Project would not violate the Treaty on the Non-Proliferation of Nuclear Weapons or increase the potential proliferation risk. The SIS facility, like all United States facilities engaged in the production of special nuclear materials for national defense, would not be a candidate for International Atomic Energy Agency (IAEA) inspection, and sensitive nuclear technology would not be available to assist a foreign country in the design or operation of a facility for producing nuclear weapon material. All information contained within this EIS and its publicly available support documents has been reviewed to exclude sensitive nuclear technology and classified information.

Energy Secretary Herrington's statement that the nation is "awash in plutonium" was made during budget deliberations early in 1988. Secretary Herrington (in later testimony before the Senate Committee on Armed Services Subcommittee on Strategic Forces and Nuclear Deterrence) characterized his earlier comment as an "overstatement" and clarified the issue by stating that adequate supplies of plutonium are available in the short term, but over the longer term (i.e., by 1995) there is no assurance that plutonium needs can be met. It is important to note that a New Production Reactor would have the primary mission of tritium production and would not provide a technologically diverse source of weapon-grade plutonium. Such diversity is required as reflected in the need statement for the SIS Project.

Blending of fuel-grade plutonium with plutonium of higher-than-weapon-grade purity is entirely dependent on the existing SRP production reactors that were constructed in the early 1950s. The reactors at the SRP are currently the subject of several safety concerns and are also the nation's only source of tritium production. Although the N-Reactor could be restarted, the years of potential future operation are limited by the distortion of the reactor's graphite moderator. Recycling of weapon-grade plutonium from retired weapons has occurred and will continue to occur, and recovered material is accounted for in the need for new weapon-grade plutonium; however, recycling and recovery of material from weapons cannot provide a source of new weapon-grade plutonium and is dependent on approved schedules for retirements and uncertainties with respect to future agreements on nuclear weapons. The SIS demonstration facility at LLNL has been designed to demonstrate the AVLIS technology and system capabilities and is unsuitable for production. While fuel-grade plutonium or enriched uranium could be used directly in nuclear weapons, such use is contrary to the currently approved modernization programs for nuclear weapons. Potential national emergencies that might require the use of any of these alternatives are speculative and not within the scope of this EIS.

A discussion of the need and underlying purpose for which DOE is proposing the project was presented in Section 1.1.1 of the Draft EIS, in accordance with CEQ's regulations (40 CFR 1502.13), and has been expanded in the Final EIS in response to comments received. The SIS Project is not being proposed to meet identified requirements for weapon-grade plutonium, but rather is being proposed to provide a prudent level of contingency, flexibility, and technological diversity. A classified appendix on supply capability is, therefore, not considered to be needed.

2. Nonsupportive Statements and Comments on SIS Feed Material and Period of Operation

- DOE plans to use commercial spent fuel as a feed for the SIS Project.
- Sufficient feed material does not exist to justify the cost and operation of the SIS Project.
- The Draft EIS did not assess the environmental impacts of the processing of the Fast Flux Test Facility (FFTF) fuel.
- Impacts should be assessed for the 30-year life of the facility.

DOE Summary Responses to the Previous Comments:

DOE has not considered nor does it plan to use commercial spent fuel precluded by law as feed for the SIS Project. Current law (Hart-Simpson-Mitchell Amendment) prohibits the recovering of plutonium from spent U.S. commercial fuel for use in weapons. DOE complies with the law and has no intention of requesting Congress to change the law. The Draft EIS clearly identified in its "Foreword" that sources of SIS feed material would not include plutonium derived from such spent commercial fuel.

DOE has identified an initial quantity of feed material that would result in only several years of SIS operation (currently estimated as 8-10 years in contrast to the 6-8 years as previously reported), if the SIS Project were operated at maximum throughput capacity. This includes DOE-owned, Defense Program origin material in the FFTF located at the Hanford Site, were it to become available. Additional sources of DOE-owned feed material, but not including plutonium derived from spent commercial fuel precluded by law, may be available depending on additional DOE production initiatives and the limitations on existing production facilities. DOE believes that the feed material currently identified provides, without relying on the availability of material from the FFTF, a sufficient basis to proceed with the SIS Project to provide a prudent level of contingency, flexibility, and technological diversity. The specific quantities of fuel-grade material available are classified; however, Chapter 1 of the EIS has been updated to state that the current quantities identified provide for only several years (currently estimated as 8-10 years) of SIS operation assuming full throughput capacity.

Currently, DOE is preparing an Environmental Assessment (EA) analyzing the feasibility and environmental impacts of various fuel-decladding techniques that could be used to recover DOE-owned plutonium in the spent fuel from the FFTF. The Foreword to the Final EIS has been modified to reflect this consideration. The annual impacts of potentially transporting the processed FFTF fuel would be the same as those for transporting N-Reactor fuel-grade plutonium to SIS facilities. Section 4.5.1 and the Summary of the Final EIS have been modified to include the cumulative risk of transporting all FFTF fuel to the SIS facility from the Hanford Site, the preferred location for the decladding activity. However, it should be noted that in addition to its potential use as feed for SIS, the FFTF spent fuel could be blended to produce weapon-grade plutonium, and a decision to build the SIS Project does not foreclose options concerning use of FFTF fuel.

Consistent with current regulatory standards [e.g., the U.S. Environmental Protection Agency's (EPA's) National Emission Standards for Hazardous Air Pollutants (NESHAP)] and DOE Defense Program's practice of establishing production goals at its facilities commensurate with annually approved requirements for defense nuclear materials, the Draft EIS presented the potential environmental consequences of the SIS Project based on its maximum annual throughput or process rate. To bound (i.e., determine the maximum) potential cumulative consequences over the design life of the facility, an analysis of cumulative consequences of SIS operation for 30 years has been included in this Final EIS.

3. Nonsupportive Statements and Comments on Geologic Hazards

- The INEL area is geologically active and therefore unsuitable as a location for the SIS Project.

- The Draft EIS underestimated the frequency of volcanic activity on the Snake River Plain.

- Data suggest that volcanic eruptions could occur.

- The Draft EIS presented an unrealistically low estimate of the probability of the occurrence of high-magnitude earthquakes in the INEL area.

- The INEL should be designated as a seismic risk Zone 3 (major damage) area rather than a Zone 2 (moderate damage) area.

DOE Summary Responses to the Previous Comments:

Chapter 3 of the Final EIS has been expanded to include a detailed discussion of seismic and volcanic hazards in the INEL region. Although the Eastern Snake River Plain has a geologic history of volcanic activity, the potential threat from volcanic eruptions is considered low. During a period of eruptive activity at a particular fissure eruption zone, the interval between eruptions (once eruptions have begun) may be 2000 to 3000 years. The interval between the major eruptive cycles measured on the INEL is between 80,000 and 225,000 years.

Chapter 3 of the Final EIS has also been expanded to discuss predictions of future earthquake activity along potential faults (Arco and Howe segments) with magnitudes of 7.3 to 7.5 with a recurrence interval of approximately 30,000 years. Anticipated accelerations resulting from this postulated event indicate that the Design-Basis Earthquake (DBE) standards used for the Plutonium Processing Building and By-Product Storage Vault are appropriate and would not be exceeded.

The Uniform Building Code seismic zone map is frequently updated, normally every 3 years, based on new or additional earthquake data. In light of the 1983 Mt. Borah earthquake and other data, the area included in Zone 3 in the 1987 version of the map was expanded over the 1981 version. However, the INEL is still in Zone 2B, consistent with the data recorded from the 1983 Mt. Borah earthquake. Another approach of seismic hazard zoning is even more useful, as it takes into account earthquake frequency. The map developed for this approach shows the SIS site in the lowest zone of earthquake potential, based on historic data (Keller, E.A., 1987, Environmental Geology, 5th ed., Merrill Publishing Co., p. 157).

4. Nonsupportive Statements and Comments on Waste and Waste Management

- The availability and disposal capacity of the Waste Isolation Pilot Plant (WIPP) are uncertain and the Draft EIS did not assess alternatives if the WIPP is not available. The INEL would become a de facto storage location in the event that the WIPP is unavailable.

- Long-term storage of radioactive waste at the INEL is unacceptable.

- The INEL has already contaminated the Snake River Plain aquifer and is a candidate Superfund site.

- Storage of radioactive waste at the INEL poses a threat to the Snake River Plain aquifer.

DOE Summary Responses to the Previous Comments:

DOE plans to transport all stored and newly generated transuranic (TRU) waste to the WIPP in New Mexico, as stated in its Record of Decision prepared on the Final EIS for the WIPP (DOE/EIS-0026). DOE is currently working with the National Academy of Sciences (NAS) to address experimentation and research activities supporting the performance assessment being conducted to demonstrate compliance with EPA disposal standards for TRU waste (40 CFR 191). In addition, the WIPP will comply with all applicable requirements of the Resource Conservation and Recovery Act (RCRA). DOE is currently working with the EPA and the State of New Mexico to resolve uncertainties regarding the procedures for obtaining a RCRA permit for the WIPP.

Recent discussions on the storage capacity limitations of TRU waste at the WIPP have been focused on the amount of TRU waste that would be initially received by the WIPP for experimental purposes to support performance assessment studies prior to a decision to make the WIPP fully operational as a disposal facility. These discussions are unrelated to the design capacity for TRU waste emplacement at the WIPP. Reports of the WIPP's leaking involve the intertwining of two separate issues: (1) water that ran down the walls of shafts, before grouting was completed, from water-bearing strata in the rocks overlying the salt beds; and (2) brine migration within the salt beds themselves. With respect to water from overlying strata, the flow has been eliminated by grouting the shaft walls above the salt to seal off the water. When the facility is decommissioned, the shafts will be entirely backfilled and sealed at several locations with engineered materials designed to minimize any leakage. Inflow from this source will then be inconsequential. With respect to brine migration within the salt beds, actual measurements to date indicate that brine migration can be absorbed by backfill materials, preventing the accumulation of liquids. The amount of brine migration is less than originally contained in the salt mined out of the room. DOE will continue to coordinate with the NAS to resolve and conduct those studies required to initiate operations at the WIPP.

In the unlikely event that the WIPP performance assessment indicates that the WIPP is unsuitable for the disposal of TRU waste, DOE would undertake studies and evaluations to determine acceptable alternatives. These alternatives would be covered by a separate NEPA review as DOE would be faced with a general issue regarding disposal of TRU wastes from several sources, of which the TRU waste generated by SIS would be a small part. In summary, assessments of alternatives to the WIPP as part of the SIS Project are not considered appropriate, as (1) DOE has received no evidence, nor has it been made aware of any scientific study which negates continuing to plan for the disposal of TRU waste at the WIPP, and (2) the WIPP has been and would continue to be the subject of a separate NEPA review, as part of an independent decision-making process.

If the SIS Project were located at the INEL, the only radioactive wastes that would be stored or disposed of at the INEL would be low-level radioactive waste (LLW) and mixed wastes. The maximum amount of LLW that would be generated by the SIS Project and disposed of at the INEL would represent less than 1 percent of the quantities currently being disposed of at the INEL. A bounding (i.e., using extremely conservative assumptions) analysis of LLW included in the Draft EIS and Final EIS clearly indicates that the disposal of SIS-generated LLW would not result in contamination (i.e., concentration above drinking water standards) of the Snake River Plain aquifer beneath the disposal area. While the quantities of SIS-generated mixed waste that would be stored at the INEL represent a greater percentage of total mixed wastes (i.e., about 15 percent), all mixed waste would be stored in a facility meeting RCRA requirements. All storage facilities for mixed waste are subject to inspection by the EPA to ensure that storage practices are being followed which prevent potential contamination of ground water.

In addition to LLW and mixed waste, SIS by-product material, which is highly radioactive but not considered a waste, would be stored onsite in a specially designed storage vault. The storage vault is designed to contain canisters of the by-product material without releasing radioactive material.

Currently, only three sites at the INEL require corrective action under RCRA: the Test Reactor Area (TRA) Warm Waste Pond, Test Area North (TAN) ground water, and the Radioactive Waste Management Complex (RWMC). The Final EIS in Section 3.1.4.4 includes an expanded discussion of these three sites. Studies and corrective action plans for each of these sites are being prepared. In all cases, those practices which resulted in the need to undertake corrective action have been stopped or changed (e.g., the use of chromate-based algicide and corrosion inhibitors for the TRA Warm Waste Pond, which resulted in chromium being detected in perched ground water underneath the pond, was stopped after 1970). The construction and operation of the SIS Project would not affect the implementation of any required corrective action.

The primary source of radionuclide contamination in the Snake River Plain aquifer resulted from the previous practice of using an injection well. This practice, similar to those which resulted in hazardous contamination, has been stopped. DOE is planning to plug the well with cement in 1989 (this process is called abandonment in legal terms) and will meet the requirements set forth in the State of Idaho <u>Rules and Regulations for Construction and Use of Injection Wells</u> published in August of 1984.

Storage of SIS-generated radioactive waste and by-product would not pose a threat to the Snake River Plain aquifer, and corrective actions are being implemented to protect ground-water resources.

5. Nonsupportive Statements and Comments on Atmospheric Emissions

   - Releases of Freon to the environment pose an unacceptable environmental and health risk, and recycling/reuse/substitution should be considered.

   - The cumulative impact of radioactive releases into the environment on humans and the environment was not adequately assessed.

- The INEL has already contaminated wildlife and the EIS should assess the radioactive impacts on wildlife.

- The EIS should state that a Prevention of Significant Deterioration (PSD) permit will be required prior to the operation of the SIS Project.

DOE Summary Responses to the Previous Comments:

Section 4.1.2.2 of the Final EIS has been modified to include the estimated number of skin cancers that could potentially result from the emissions of Freon resulting from the refurbishment of laser electronic packages in the SIS. SIS emissions of Freon would represent only about 0.006 percent of the consumption of Freon in the United States (approximately 6.7×10^8 pound per year) and would result in an annual calculated increase in the risk of a fatal skin cancer to an individual in the United States of only about 2.7×10^{-12}. On-going engineering development is being pursued to further reduce Freon emissions through the use of chiller and condensate systems to reduce evaporation and vapor recovery systems for recycling Freon. In addition, the SIS Project personnel are working with commercial Freon manufacturers to identify and/or develop substitute dielectric coolants that will have no adverse impact on the environment. These potential substitutes are being evaluated and will be used when available.

Releases of radioactivity to the atmosphere from DOE facilities must comply with the EPA's NESHAP. The NESHAP standard is an annual standard applicable to the cumulative atmospheric releases of radioactive emissions from all sources at a particular DOE facility (e.g., the INEL). Sections 4.5.1.4 and 4.5.2 of the Final EIS discuss the cumulative radiological impacts (i.e., from the SIS Project, authorized projects, and existing facilities) and compare them to this standard. An analysis of accumulated releases and of risks of radioactive releases has been included in Section 4.5.1 of the Final EIS for 30 years (facility design lifetime).

The concentrations of radioactive materials in the wildlife near the Idaho Chemical Processing Plant (ICPP) have been studied. Although data indicate some levels of contamination in wildlife species, the levels of contamination are extremely low [e.g., using the highest cesium concentrations in pronghorn antelope collected within 10 kilometers (6 miles) of the ICPP, the resultant exposure was 10 percent of that from naturally occurring potassium-40 in their bodies and less than 2 percent of that from natural external sources in their surrounding environment]. The atmospheric emissions of radioactivity from the SIS Project would be less than 5.3×10^{-8} percent of the applicable EPA standards, and would not pose any radiological risk or threat to wildlife.

Section 5.4 of the Final EIS has been modified to include a brief discussion of 40 CFR 82 concerning stratospheric ozone protection, and Section 5.6.3 has also been modified to indicate that a PSD permit for the SIS Project is being developed, including any regulated emission for which there is not an EPA de minimis level under Idaho's PSD regulations.

6. Nonsupportive Statements and Comments on Facility Accidents

- Since the SIS Project is a unique facility and has yet to be demonstrated, designs or design criteria do not exist upon which to adequately assess safety.
- The Draft EIS did not sufficiently consider propagating accidents or externally initiated accidents.
- Assumptions used in the Draft EIS accident analysis were not conservative, and an independent analysis indicates that accident consequences would exceed Nuclear Regulatory Commission (NRC) standards.
- The costs of accidents such as losses in the value of agricultural products sold and to the tourism and recreation industries were not identified in the Draft EIS.
- The Draft EIS did not include a worst-case accident as required by NEPA.

DOE Summary Responses to the Previous Comments:

The AVLIS technology represents a new technology but one that has been demonstrated experimentally to verify the analytical design models at each step. Other systems and processes such as pyrochemical and aqueous processing, waste handling, and plutonium processing utilize proven technologies that are used in other DOE Defense Program facilities. While it is true, based on preliminary designs and safety evaluations, that not all values used can be precisely defined, bounding values (e.g., maximum quantities available for release) were used in the EIS to determine the upper range of potential environmental consequences. NEPA requires the assessment of potential environmental consequences early within the planning process for a project; preparation of an EIS after completion of a final design for a project would not allow or provide the opportunity for incorporation of environmental considerations into the potential implementation of the project.

The Draft EIS and the Final EIS discuss the potential environmental consequences from a DBE followed by fire, which is an externally initiated natural phenomenon. Other externally initiated natural phenomena such as tornado, tornado-driven missiles, and snow load would have lower consequences and were therefore not presented in the EIS. Propagating accidents (one accident which results from the consequence of a preceding accidental event) are normally considered to be those accidents which are initiated by a sequence of events that lead to an accidental release of radioactive material. The EIS addresses quantities of plutonium at risk (the amount of plutonium which could be dispersed as a result of a hypothetical accident) that maximize the potential release and consequences independent of whether the accident is initiated by a single event or a series of events. Whether the accident is of a propagating nature or not, it would not affect the maximum quantities of plutonium at risk.

Assumptions used in the Draft EIS, with two exceptions, were representative and/or conservative for the SIS Project. The major conservative assumptions include postulating releases based on maximum quantities of plutonium at risk; using degraded high-efficiency particulate air (HEPA) filter efficiencies (i.e., down to 0-percent efficiency); and postulating accident scenarios which do not take credit for engineered safety features and administrative controls. With respect to the assumptions made in the Draft EIS, two assumptions were either not representative or conservative and have therefore been revised for this Final EIS. These two assumptions were (1) the inclusion of a plateout reduction factor of 2 (a factor accounting for the fallout of plutonium in ductwork was inadvertently used) and (2) the quantities of plutonium at risk for the design-basis fire in a single area and uncontrolled chemical reaction events. For the Final EIS, the plateout reduction factor of 2 has not been used and the quantities of plutonium at risk for the design-basis fire in a single area and the uncontrolled chemical reaction have been increased. While the revisions resulting from these two changes result in higher calculated consequences for postulated accidents, the releases still do not result in any projected cases of early offsite fatalities or any early offsite injuries, and the calculated offsite maximum individual dose for locating the SIS Project at the INEL for the postulated severe accident with complete loss of filter efficiency is 0.28 rem to the whole body, or a small fraction of the NRC's siting criteria of 25 rem to the whole body (10 CFR 100) for commercial reactors.

Although an independent analysis of the potential consequences of the SIS Project was submitted as part of the comments received on the Draft EIS, the analysis provided was flawed with respect to several assumptions, the most significant of which was the utilization of inventories and source terms based on a pressurized water reactor. The processes, sources of dispersion energy, and quantities of plutonium that would be used at the SIS Project are much different from those of a reactor or other nuclear industry facilities and cannot be compared either directly or indirectly with respect to source terms or release fractions. The independent analysis was therefore considered as not providing "credible scientific evidence" and was not discussed in the Final EIS.

For those accidents considered in the EIS, including the postulated severe accident with complete loss of HEPA filtration, the resulting releases of radioactivity are not of sufficient magnitude to require costs for mitigation including costs of evacuation, milk and crop disposal, decontamination, and land-use prohibition. Potential economic costs, including economic losses to agriculture and tourism, were therefore not presented.

The severe facility accident presented in the EIS is considered to be a bounding impact analysis meeting the criteria set forth in CEQ regulations for implementing the procedural provisions of NEPA, as amended (40 CFR 1502.22). As stated in the Draft EIS, for the postulated severe accident to occur, five conditions are assumed: (1) facility-wide fire must in some fashion occur; (2) the building fire suppression system, which will be Design-Basis Accident (DBA) qualified, is assumed to be not effective; (3) the final filtration systems, including fire protection systems, both of which will be DBA-qualified, are not effective; (4) no mitigative action (such as immediately placing plutonium into protected storage upon detection of a fire) is taken; and (5) no response is made by the ICPP fire brigade and INEL fire department. The severe accident has an estimated probability of occurrence of less than 1×10^{-6} per year. (Note: estimated probabilities of the occurrence of accidents have been presented in the Final EIS to emphasize the remote chances of occurrence. Inclusion of these probabilities is not a CEQ requirement.) While other potential accident scenarios can be postulated, it is not believed that an accident, which is based on "credible scientific evidence" as required by 40 CFR 1502.22, can be postulated that would result in higher consequences.

7. Nonsupportive Statements and Comments on Transportation Safety

- The SIS Project would dramatically increase the number of local shipments required for plutonium.
- The Draft EIS did not adequately identify/assess many problems associated with the DOE transport containers.
- The transportation analysis within the Draft EIS did not contain a sensitivity analysis of the input parameters such as stop times, used nonconservative assumptions such as national accident statistics, and did not utilize route and location-specific accident data.
- The transportation analysis in the Draft EIS did not discuss the impacts of the transport of SIS-generated by-product material.

DOE Summary Responses to the Previous Comments:

The SIS Project would not dramatically increase the number of plutonium shipments. Although the number of shipments is classified, the Final EIS on the transportation of radioactive material by air and other modes (NUREG-0170) indicates that in 1975 more than 4200 packages of plutonium were transported by truck in Type B containers nationwide. The number of plutonium packages transported in Type B containers associated with the SIS Project would comprise only a very small fraction of those indicated in the referenced document.

Certified or approved Type B shipping containers would be used for the transport of feed, product, and by-product to and from the SIS Project; the TRUPACT II will be used for the shipment of TRU waste (in drums) and potentially by-product (in Type B containers) to the WIPP. Extensive testing of the Type B container presently in use by DOE (the model 1518 6M) is described in references that have been added to the Final EIS. The inner and outer containers of each Type B container are individually leak-tested during fabrication, and must be inspected prior to each shipment. The TRUPACT II is currently undergoing NRC certification tests.

An analysis of the sensitivity of RADTRAN risk calculations to variations in parameters was performed in 1986 for a sample truck transport case (SAND85-1001) by Sandia National Laboratories. The stop times used in the analysis presented in the Draft EIS and the Final EIS are based on actual operational requirements for safe secure transport (SST) shipments. The reference provided for this assumption was a personal communication with a DOE individual knowledgeable about SST requirements. The requirements are classified. The decreased stop time results in a decrease in incident-free risk, but has no effect on accident risk calculations.

The transportation impact assessment in the Draft EIS and the Final EIS uses both route-specific and national average transportation data. The route-specific data include total distance, adjacent population, and fraction of the route on various types of roads (e.g., rural, urban, or suburban). The road-type fractions are combined with national average truck accident data for each road type. The national average data used in the analysis described in the Draft EIS and the Final EIS provide the most representative risk estimates for cross-country routes to which they were applied. Sandia National Laboratories has conducted a number of tests to demonstrate the validity of this conclusion. Data included in the Final EIS in Appendix A, Section A.3, indicate that the national average combination-truck accident rate on interstate highways is about 3.1×10^{-7} accident per kilometer. The average for only those states through which representative SIS shipments would pass is 3.2×10^{-7} accident per kilometer. State average accident rates along the nine separate representative routes for SIS shipments range from 2.0×10^{-7} to 4×10^{-7} accident per kilometer. These rates are for all property-damage accidents involving combination trucks and are much higher than the rates for severe accidents. The limited variability in accident rate supports the use of national average data for SIS shipments.

The transport analysis presented in the Draft EIS did not include the impacts of the transport of by-product material to the WIPP, as the Draft EIS indicated that the by-product material may be a resource applicable for other possible DOE missions. Although DOE intends to evaluate the usefulness of the by-product material for other possible missions, the analysis of SIS materials transport contained in this Final EIS has been modified to analyze the potential consequences of the transport of by-product material. The transport of all SIS-generated TRU waste for each of the potential SIS locations has also been included in the Final EIS. Inclusion of the transport of by-product materials and SIS-generated TRU waste to the WIPP results in higher routine and accident risks (e.g., for locating the SIS Project at the INEL, the annual radiological dose under routine conditions to the population sharing the road and residing along the transport routes increases from 0.2 person-rem to 12 person-rem, and the annual radiological risk of a latent cancer fatality and genetic effect increases from 4.4×10^{-5} to 4.9×10^{-3}, respectively).

8. Nonsupportive Statements and Comments on Emergency Preparedness

   - The Draft EIS did not discuss the emergency preparedness plans that would be required in the event of a facility or transport accident.

   - In the event of an accident, local and state agencies are inadequately trained and do not have sufficient resources.

   - Local officials have not been informed of the types and quantities of hazardous materials for which they must be prepared pursuant to Title III of the Superfund Amendments and Reauthorization Act (SARA).

DOE Summary Responses to the Previous Comments:

Section 4.6 of the Final EIS has been expanded in its discussion of the responsibilities of DOE, the State of Idaho, and local counties for emergency preparedness response to potential offsite incidents, including those involved in the transport of materials. As stated in the Draft EIS and Final EIS, it is the responsibility of state and local emergency planning agencies to develop adequate emergency response plans that cover all natural and man-made disasters. The DOE Idaho Operations Office has provided the DOE-Idaho Emergency Planning, Preparedness, and Response Plan to the state and local agencies to assist them in developing plans as they relate to the INEL. DOE is willing to assist these agencies by reviewing existing plans as they interact with the INEL and is also willing to enter into negotiations to establish a stronger Memorandum of Understanding to delineate areas where assistance can be provided to the state and local response agencies by DOE and DOE emergency response teams.

The responsibility for training of state and local emergency response personnel also rests with the state and local agencies. To assist the state and local personnel, DOE has provided training to these groups on several occasions, as exemplified by training conducted by the DOE Albuquerque Operations Office on TRU waste shipments. Each year since 1983, the State of Idaho has participated in site-wide emergency preparedness exercises. During each of the previous years, DOE has also exercised its interface with one of the local Idaho counties to minimize the impact on the budgets of local emergency response planning agencies.

DOE has provided the State of Idaho with data on the quantities and types of hazardous materials used at the INEL in compliance with Title III of SARA. Information on hazardous materials associated with the SIS Project will also be provided where applicable as part of the on-going SARA Title III reporting process. Acknowledgment of this requirement has been included in Table 5-1 of the Final EIS.

9. Nonsupportive Statements and Comments on Health Effects

   - Plutonium is one of the most deadly materials known to man and is pyrophoric.
   - The Draft EIS underestimates the potential health effects from radioactive releases.
   - The use of the National Academy of Sciences Committee on the Biological Effects of Ionizing Radiation (BEIR) III Report is outdated because of the issuance of BEIR IV.
   - The EIS should discuss the results of existing health effects studies and the reported high number of cancers around the INEL and use these as a basis for the assessment of potential impacts.

DOE Summary Responses to the Previous Comments:

Plutonium is recognized as an extremely hazardous material; however, in recognition of its hazards, design safety features and extensive controls are used to provide the highest level of safety to reduce potential health, safety, and environmental impacts. The pyrophoric character of plutonium has been fully considered in the design of the SIS Project.

The potential radiological dose and health effects (fatal cancers and genetic effects) presented in the Draft EIS and the Final EIS are based on scientifically accepted methods and studies. The health effects presented in the Draft EIS and the Final EIS are calculated using risk estimators based on the BEIR III Report. As discussed in Appendix A of the Draft EIS, by assuming all radiation from the SIS Project to be high-linear-energy-transfer (LET) radiation and using risk estimators associated with the linear extrapolation model, the number of health effects presented is conservative. At the low levels of radiation associated with the SIS Project, it is plausible that the potential health effects could be zero because the extrapolated potential cancer risks associated with the SIS Project were based on cancer risks for higher dose rates than those projected for the SIS Project.

Although the BEIR IV Report has been issued since the preparation of the Draft EIS, its primary focus is on health effects from radon. All of the health risk estimators for transuranics provided in the BEIR IV Report for fatal lung and liver cancers and for genetic effects are less than those presented for high-LET radiation based on the data presented in the BEIR III Report.

Counties surrounding the INEL demonstrate lower, not higher, cancer rates, based on the Idaho Tumor Registry, than do those in more remote locations. The small population and small number of specific cancer cases result in large statistical variations in yearly rates without any associated significance. Some investigators have selectively separated apparent increases in specific cancers without noting the overall low averages and the statistical variability to be expected. The EIS calculates potential health effects on the basis of widely accepted scientific information and does not utilize local health effects data because of their lack of statistical and control validity.

10. Nonsupportive Statements and Comments on Socioeconomics

- The potential economic gains (or number of jobs) do not outweigh the potential risks or costs of the Project, and personnel and financial resources should be put to a more productive or beneficial use.

- The Draft EIS did not assess impacts of the SIS Project on agriculture or tourism/recreation.

- The beneficial impacts of the SIS Project on the economy are overstated, and most of the workers for the Project will either be from out of state or will only receive low-paying service jobs.

- The EIS does not assess the impact of shutting down the SIS Project or the boom-bust impacts that would be associated with it.

- The Draft EIS was wholly inadequate with respect to assessment of socioeconomic impacts by not providing a detailed assessment of impacts to local communities and services and should have used an impact model.

DOE Summary Responses to the Previous Comments:

The objective of an EIS is to assess the potential environmental consequences of the Proposed Action and the reasonable alternatives to the Proposed Action, including No Action. The EIS provides a basis upon which the responsible Federal official weighs the potential environmental consequences and risks in relation to the need to proceed with the project. The basis for the responsible Federal official's determination and reasons for proceeding or not proceeding are published in a publicly available Record of Decision. The use of personnel and financial resources for other Federal actions, including impacts on the Federal budget, is not within the scope of this EIS. The CEQ's regulations regarding the procedural provisions of NEPA exclude requests for appropriations.

The Final EIS in Chapter 3 and Appendix B includes indicators of the importance of agriculture and tourism/recreation to the economy in areas of the alternative locations for the SIS Project. The results of a recent study of travelers in Idaho, prepared by the University of Idaho, have also been referenced in the Final EIS. No adverse impacts from the SIS Project to either the tourism/recreation or agriculture sectors of the economy are expected to occur, as all releases are significantly below all applicable standards. Even in the event of an extremely unlikely severe facility accident, the release is not of sufficient magnitude to require offsite cleanup or mitigation including decontamination and destruction of milk and food crops. Based on the survey conducted by the University of Idaho in April 1988 of Idaho travelers, which indicates that about 33 percent of those coming to Idaho come to visit friends and relatives, the construction and operation of the SIS Project may have a small beneficial impact on the tourism industry in Idaho because of the employment opportunities associated with the Project.

The beneficial impacts associated with the SIS Project that were identified in the Draft EIS were the indirect employment opportunities associated with direct employment for the SIS Project and employee contributions to taxes. The beneficial impacts presented at best are understated, as they do not include induced employment opportunities that would arise from indirect and direct employment opportunities, direct and indirect expenditures for materials and services associated with the construction and operation of the SIS Project, or taxable revenues derived from the purchases of materials and services.

As discussed in the section entitled "SIS Feed Material and Period of Operation," DOE has identified an initial quantity of feed material that would result in only several years (currently estimated as 8-10 years) of SIS operation if the SIS Project were to be operated at maximum throughput capacity. Additional sources of DOE-owned feed material may be available but depend on future DOE production initiatives and the limitations on existing production facilities. Since the Proposed Action being considered in this EIS is the construction and operation of the SIS Project and the period of future operation is dependent on both the need for weapon-grade plutonium and the quantities of feed material that may be available in the future, a specific assessment of shutdown impacts is not included. It is highly unlikely, however, that in the event the SIS Project were to be stopped, a "boom-bust" scenario would result, as total employment associated with the SIS Project would be only a small percentage of total INEL employment.

The Draft EIS referenced several specific documents that contained an extensive discussion of the regional infrastructure surrounding the INEL, the Hanford Site, and the SRP. The employment associated with the construction and operation of the SIS Project at the three alternative locations comprises only a very small percentage of existing employment at each of the regions and, as contained in the referenced documents, each region has an adequate infrastructure to absorb additional growth. The Final EIS provides an amplified discussion of existing infrastructure based on these referenced documents. The use of a socioeconomic impact model for the assessment of potential socioeconomic impacts is not considered appropriate because of the relatively small size of the workforce associated with the SIS Project as well as the existing infrastructure's abilities to accommodate additional growth.

11. Nonsupportive Statements and Comments on the NEPA Process

- The Draft EIS was inadequate and should be reissued.
- DOE mismanaged the hearing process, causing the citizens to miss the opportunity to submit verbal testimony, and refused to hold hearings in other locations as requested.
- The Draft EIS included an unprecedented disclaimer denying DOE's responsibility for the Draft EIS.
- The Draft EIS did not assess the moral consequences or psychological effects associated with the SIS Project.

DOE Summary Responses to the Previous Comments:

The Draft EIS was reviewed by the EPA in accordance with its responsibilities under NEPA. The EPA rating system concerning adequacy has three Categories: 1-adequate, 2-insufficient information, and 3-inadequate. The Draft EIS was given a rating of category 2 "with environmental concerns" which basically means that additional information, as specified by the EPA, needs to be incorporated in the Final EIS to fully address environmental impacts. EPA specifically requested that additional information on the accident analysis be included.

While a number of specific issues and concerns were raised on the Draft EIS as identified in the specific comments and responses, none of the issues or concerns have identified new reasonable alternatives requiring assessment or have directly resulted in a significant change in the analysis of the potential environmental consequences. DOE believes that it has fulfilled its obligations under NEPA for the preparation of a Draft EIS. Accordingly, DOE has determined that the Draft EIS does not need to be reissued.

Implementing regulations for NEPA require Federal agencies to encourage public input on a Draft EIS but do not require Federal agencies to conduct public hearings. For the SIS Project, however, DOE concluded that public hearings were appropriate. Three public hearings were originally scheduled, one each in Boise, Twin Falls, and Idaho Falls, Idaho. The decision to schedule hearings at these locations was based in part on the level of public participation from the alternative sites with respect to the EIS scoping process and in part on the proximity of areas to the INEL that would most likely be affected by the Project and their accessibility for the conduct of public hearings.

Because 504 persons preregistered to speak at the scheduled hearings, DOE investigated extending each of the scheduled hearings and announced extensions of each of the hearings at the originally scheduled locations to accommodate those persons who preregistered. A review of the individuals who provided oral testimony at the hearings indicates that only a limited number of individuals providing oral testimony did not also provide written comments as part of the public hearing record or directly to DOE. Every individual and organization had the opportunity to provide written comments directly to DOE. Because of this fact, DOE does not consider that it abrogated its responsibilities for public participation under NEPA when preregistered individuals or organizations could not provide oral testimony at the desired time.

Inclusion of the disclaimer in the Draft EIS was an error. Disclaimers are generally required by DOE to be included in technical reports prepared by DOE's contractors but are not included in reports prepared in compliance with NEPA. The DOE has no intention of asserting such a disclaimer with respect to its responsibilities under NEPA nor for this Final EIS. Recognizing that the disclaimer was an oversight, the Hearing Officer very early in the public hearings stated for the record that DOE considered the disclaimer's inclusion to be incorrect. The extensive public outreach program and publicity generated by DOE's seeking input from the public on the Draft EIS indicate DOE's responsibility for the Draft EIS.

Several commentors on the Draft EIS were concerned with the potential moral or psychological impacts of the potential construction and operation of the SIS Project or the potential use of nuclear weapons. While DOE is sympathetic to these concerns, moral and psychological impacts are not within the scope of the NEPA process and accordingly are not included in the Final EIS for the proposed SIS Project.

12. Nonsupportive Statement and Comment on the INEL Mission

- Locating the SIS Project at the INEL would change the INEL's mission or image from peaceful uses of the atom.

DOE Summary Response to the Previous Comment:

The first facilities at the INEL reflected both defense-related and non-defense-related activities. The percentage of the total effort dedicated to defense or non-defense activities at the INEL has changed in the past and will continue to change in the future. The ICPP, which is adjacent to the proposed location of the SIS Project at the INEL, has the mission of recovering uranium-235 from spent Government-owned fuel for use in defense programs. The SIS Project, while adding a new defense mission to the INEL, would not change the character/image of the INEL, as INEL's activities encompass both defense-related and non-defense-related activities.

13. Nonsupportive Statement and Comment on Independent Monitoring

- Independent monitoring should be performed by Idaho.

DOE Summary Response to the Previous Comment:

The State of Idaho has a working agreement with DOE whereby Idaho may obtain monitoring samples collected by the DOE or the U.S. Geological Survey (USGS) onsite or offsite. In addition, DOE, in consultation with the state, is establishing a contract with Idaho State University (ISU) to provide independent verification of the monitoring program at the INEL. The DOE will fund the contract, and the University will furnish the results simultaneously to the state and DOE. The data will be fully available to the regulatory bodies of the state and to the public.

NEED FOR AND PURPOSE OF SIS PROJECT

DOE, in accordance with the Atomic Energy Act of 1954, as amended, is responsible for developing and maintaining a capability to produce all SNM required for the defense programs of the United States. DOE's production of nuclear materials for national defense is based on the NWSM, the document by which the President approves the production and retirement of nuclear weapons, and on the subsequent authorization and appropriation of funds by Congress.

The SIS Project is needed by DOE to provide a prudent level of contingency, technological diversity, and flexibility in DOE's production complex for ensuring that approved needs for nuclear defense materials are met. The SIS Project would support this DOE mission by providing a reactor-independent plutonium isotope separation facility for purification of DOE-owned feedstocks of fuel-grade material into weapon-grade plutonium. These feedstocks include neither commercial fuel precluded by law nor fuel precluded by DOE policy. This capability would provide a contingent supply of weapon-grade plutonium in the event that the present source of material becomes unavailable for unanticipated reasons or in the event that the demand for plutonium increases beyond present projections.

At present, weapon-grade plutonium is produced at the SRP in South Carolina using three reactors (i.e., P-, K-, and L-Reactors). Another former supply of weapon-grade plutonium, the N-Reactor at the Hanford Site in Washington, has been placed in cold-standby. The reactors at the SRP are also the nation's only source of tritium which, because of its radioactive decay rate, is the highest priority for production by these reactors. Plutonium is only produced at the SRP after the tritium requirements have been met.

Providing the required production capacity and capability has been increasingly difficult in recent years. To produce or be able to produce nuclear materials for national security needs, the following criteria are considered essential:

- Contingent capacity, or contingency. It is fundamental that plutonium production capability be available when needed. The current production reactors are more than 30 years old and are nearing the end of their useful lives; therefore a prudent level of backup capacity must be provided.

- Technological diversity. While reactors have been and will remain the ultimate source of new plutonium, reactor-based issues, such as those which have disrupted defense material production in the past, must not be permitted to compromise national security. A reactor-independent technology is required for backup production capability during those periods when reactor production may not be available.

- Flexibility in facility utilization in case approved production requirements rapidly increase or other plutonium capacity is diverted to tritium production. Weapons material requirements often vary substantially from year to year as new requirements are identified. Redundant capacity that can be quickly activated is not currently available in the complex.

An SIS Plant is the only available option which meets all these criteria. In response to the above needs, SIS would (1) have the capability of providing weapon-grade plutonium at a time when no other capability may be available; (2) provide a reactor-independent technology and therefore not be vulnerable to reactor issues that include generic concerns which could conceivably impact even newly constructed reactors; and (3) provide a capability that can be activated rapidly. No other option or set of options can sufficiently meet all these criteria.

THE SIS PROJECT

The SIS Project would use the AVLIS process to separate the isotopes of plutonium to produce plutonium meeting specific isotopic concentrations. The AVLIS process relies on the differences in the unique light-absorption characteristics of each plutonium isotope. When specific plutonium isotopes absorb light of the correct energy, the isotopes become positively charged (ionized). The positively charged isotopes can then be separated from other isotopes by attracting the ionized isotopes by application of a small electric field.

The AVLIS process consists of two basic systems, a laser system and a separator system. The laser system provides the source of precisely tuned, monochromatic, visible laser-light beams for the selective photoionization of the undesired plutonium isotopes. The separator system forms a directed vapor stream of plutonium through electron beam vaporization of plutonium metal feed, and, after selective photoionization, collects the nonionized, or neutral, plutonium isotopes on a product collector and the ionized, or positively charged, isotopes on by-product collectors.

The SIS Project would require the construction of (1) a Laser Support Facility (LSF) consisting of a Laser Support Building (LSB), a Dye Pump

Building (DPB), and a Load Center Building (LCB); and (2) a Plutonium Processing Building (PPB). The SIS Project would also require either the use of an existing vault or the construction of a new vault for the interim storage of SIS-generated by-product material at the selected site. The SIS-generated by-product material, consisting principally of plutonium-239 and 240, with lesser quantities of plutonium-238, 241, and 242, would be stored until such time as DOE evaluates the applicability of the material for other potential missions (i.e., the by-product material would be treated as a potential resource). If no mission is identified for the by-product material, it would be rendered into a form that would meet the Waste Acceptance Criteria for the WIPP, and would be transported to the WIPP and appropriately managed as a TRU waste.

The LSB would contain the laser system for the generation of the precisely tuned, multi-wavelength light beams for selective photoionization. The laser system would use copper vapor lasers that convert electrical energy into fixed-wavelength green and yellow light. The light from the copper vapor lasers would then be used to excite, or pump, dye lasers that provide the source of the precisely tuned light beams. After amplification, the dye-laser light beams would be transported to separator units in the PPB through a beam tube.

In support of the laser system, the DPB would contain the equipment to supply an alcohol/dye mixture to the dye lasers, and the LCB would contain the electrical equipment to provide power for the equipment in the LSB.

The portion of the PPB that would contain plutonium would be a Category I structure. Category I structures are those whose continued integrity and/or operability are essential to achieve and maintain a safe condition during those accidents which could result in potentially significant offsite consequences. The PPB would contain the AVLIS separator system and the balance-of-plant (BOP) processes. The separator system would consist of four separator lines, each enclosed within a glove box. In each glove box would be independent separator units enclosed in vacuum chambers. Based on current design, the BOP processes would consist of the following:

1. Prepare plutonium metal as feed for AVLIS processing by converting plutonium oxide to metal through direct oxide reduction (DOR), removing americium-241 through a molten-salt-extraction (MSE) process, and casting the plutonium metal into suitable forms for processing;

2. Process the plutonium product (primarily plutonium-239) captured by the product collectors by reacting the product with hydrogen to form a hydride powder, heating the powder to decompose the hydride and provide a solid-metal button, purifying the resulting metal button by electrorefining as necessary, and packaging the plutonium product buttons for shipment;

3. Process the by-product material captured on the by-product extractors by oxidizing the by-product material to form a stable plutonium oxide and packaging the oxide by-product for storage in a vault;

4. Process salts by metal scrubbing, recover the plutonium from scrub metal and scrap materials by oxidation, dissolution, ion exchange, oxalate precipitation and finally, decomposition of the oxalate intermediate to recyclable plutonium dioxide; and

5. Process airborne, liquid, and solid wastes to forms meeting all applicable environmental, health, and safety standards.

All plutonium processing in the PPB would be conducted in glove boxes. Exhausts from plutonium processing glove boxes would be passed through three stages of testable HEPA filters.

If a new storage vault for SIS-generated by-product material is required, it would also be a Category I structure. By-product material stored in the vault would be placed in sealed containers on storage pallets. The pallets would be placed in racks designed to remain in place during a DBE.

Construction of the SIS Project would require land for the new facilities as well as a peak workforce of 788 personnel (about 440 construction and 348 operating personnel) that would occur during the construction period. Construction would generate atmospheric emissions, liquid effluents, and solid wastes typical of those for construction of any major industrial facilities. All atmospheric emissions and liquid effluents would be well below environmental standards, and mitigative measures would be taken for fugitive-dust suppression and erosion and spill control.

Operation of the SIS Project would require an operating workforce of about 750 personnel and would, as a result of normal operations, generate radioactive and nonradioactive atmospheric emissions, nonradioactive and nonhazardous liquid effluents, and solid wastes including TRU waste, LLW, and hazardous and mixed (i.e., radioactive waste having hazardous characteristics) wastes. Normal nonradioactive atmospheric emissions would be below applicable PSD de minimis levels. All solid wastes would be handled and managed in accordance with applicable environmental requirements including the requirements of the RCRA, as amended, for hazardous and mixed wastes.

During operation of the SIS facilities, accidents could occur that would result in atmospheric emissions of radioactivity. The postulated accidents involving SIS facilities that have the greatest potential for offsite consequences involve the PPB and include a postulated single-process-area fire, a DBE followed by a fire, a nuclear criticality, and an uncontrolled chemical reaction. The potential accidents not involving the SIS facilities that would have the greatest potential for offsite consequences would be the transport of SIS feed, product, by-product, and TRU waste.

PROPOSED ACTION AND ALTERNATIVES

The DOE's Proposed Action and Preferred Alternative is to construct and operate the SIS Project at DOE's INEL near Idaho Falls, Idaho. The alternatives to this action are to construct and operate the SIS Project at the Hanford Site near Richland, Washington; construct and operate the SIS

Project at the SRP near Aiken, South Carolina; and take No Action, or not construct the SIS Project.

CONSTRUCT AND OPERATE THE SIS PROJECT AT THE IDAHO NATIONAL ENGINEERING LABORATORY (PREFERRED ALTERNATIVE)

The proposed SIS Project site at the INEL is located within the existing security fence of the ICPP in the south-central portion of the approximately 2300-square-kilometer (890-square-mile) INEL. The site is about 14 kilometers (9 miles) from the nearest INEL boundary. No humans permanently reside on the INEL, and no population center larger than 5000 persons is located within a 60-kilometer (37-mile) radius of the ICPP. The estimated 1980 population within an 80-kilometer (50-mile) radius of the SIS Project site was about 110,270 persons and is forecast by the year 2010 to be about 230,129 persons, based on 1970 to 1980 population increases, or 151,922 persons based on Bureau of Economic Analysis projections.

The vegetation community at the INEL consists primarily of sagebrush with other shrubs, grasses, and forbs. The sagebrush community supports a diverse wildlife population characteristic of open Western desert rangelands. Endangered species occasionally observed on the INEL site are the bald eagle and the peregrine falcon.

Construction of the SIS Project at the INEL would directly impact a total of about 0.2 square kilometer (49.8 acres) of land area. Land area for construction of a transmission line (0.05 square kilometer or 11.2 acres) and for use as a borrow area would also be involved. During construction, plant and animal habitats associated with a sagebrush vegetation community would be lost or displaced from areas not previously disturbed. Approximately 92 percent of the previously undisturbed land area (i.e., areas outside the ICPP area) would not be affected by operation and would be planted with a protective cover and would eventually revert to a sagebrush vegetation community through natural plant succession. No known critical habitats or known habitats for rare or endangered species would be directly impacted. No historic sites would be directly impacted by construction.

A large in-migrating construction workforce for the project is not expected due to the availability of construction workers in the surrounding INEL region. Construction employment would have a beneficial economic impact in the region and would create indirect employment opportunities as well as contributions to the regional tax base. The projected number of in-migrating construction workers (116 personnel) is not expected to adversely impact the local infrastructure, as there is adequate capacity for continued growth.

During normal operation, atmospheric emissions of radioactive materials would not measurably increase radiation doses to the population surrounding the INEL. The calculated whole-body doses from SIS operation to a hypothetical individual residing at the nearest INEL boundary and the collective whole-body dose to the offsite population within an 80-kilometer (50-mile) radius of the INEL would be 1.3×10^{-8} millirem and 2.3×10^{-8} person-rem per year (based on a population of 230,129 persons). Calculated annual health effects to the population are 2.5×10^{-12} genetic disorder and 3.5×10^{-11} latent cancer fatality. The normal atmospheric emissions of radioactivity when added to those from present and planned INEL emissions would be well below the EPA's NESHAP of 25 and 75 millirem to the whole body and critical organ, respectively.

Normal operation of the SIS Project would also generate atmospheric emissions of nonradioactive materials. These emissions would consist of (1) argon, helium, hydrogen, nitrogen, and water vapor, which are not regulated pursuant to the Clean Air Act, as amended; (2) organic vapors that include Freon R-11 and R-113; and (3) nonradioactive process emissions and incremental atmospheric emissions from the burning of coal for steam generation that are below PSD de minimis levels. Emissions of Freon would result in a negligible increase in the risk of skin cancer; substitutes will be used when available.

Service waste and treated sanitary effluents would be discharged to the soil column through one or more new percolation ponds, which would be constructed as part of improvements to the ICPP waste management system, and infiltration beds. Service waste discharges would primarily consist of process steam condensate and cooling tower blowdown. All liquid waste streams would be monitored prior to discharge to ensure that the discharge would be nonhazardous and nonradioactive as defined by 40 CFR 261 and Chapter XI of DOE Order 5480.1, would comply with the current draft revision of DOE Order 5480.1B (Chapter XI), and would be nonhazardous as defined by the RCRA.

Solid wastes generated annually as a result of SIS operations would represent a small increment in relation to the amount of these wastes currently being received and managed at the INEL. All solid radioactive wastes would be handled as part of ongoing waste management activities at the INEL. Hazardous wastes would be handled in accordance with all RCRA requirements and would be transported to a RCRA-approved treatment, storage, disposal (TSD) facility as with currently generated hazardous waste. TRU waste is planned to be packaged, certified, and transported to the WIPP near Carlsbad, New Mexico. LLW would be disposed of at the INEL at the RWMC as with currently generated LLW. Mixed wastes would either be stored at the INEL in a RCRA-approved storage facility, as with currently generated mixed wastes, or would be transported to an approved TSD facility.

During SIS operations, fuel-grade plutonium (i.e., processed N-Reactor fuel and scrap) from DOE's Hanford Site and a small quantity of fuel-grade plutonium (i.e., scrap) from the SRP would be transported to the INEL, and plutonium metal product would be transported to Rocky Flats. By-product material, which would be treated as a potential resource until DOE evaluates its potential applicability for other missions, would be stored in a new Stand-Alone Storage Vault that would be constructed near the PPB. Feed and product materials would be transported in Type B containers certified by the NRC or approved for use by the U.S. Department of Transportation (DOT), aboard SSTs operated by DOE couriers. The TRU waste and potentially the by-product material that could be rendered into a form for emplacement at the planned WIPP would be transported by truck in a TRUPACT II cask. The annual radiological dose to the population sharing the roads with the SST and trucks transporting TRU waste and those living near the roads for (1) transporting feed from the Hanford Site and SRP to the INEL, (2) transporting product from the INEL to Rocky Flats, (3) transporting LLW onsite, and (4) transporting TRU waste and potentially by-product to the WIPP was calculated to be less than 12 person-rem, resulting in 3.5×10^{-3} latent cancer fatality and 1.6×10^{-3} genetic disorder.

For postulated SIS facility accidents, there are no cases of early offsite fatalities and no early offsite injuries. The highest dose at the site boundary to an organ of an individual and the highest offsite whole-body dose from an accident in which the filtration system would function at full efficiency are 2.7 millirem to the thyroid and 0.5 millirem to the whole body, both as a consequence of a postulated nuclear criticality accident. For accidents other than the criticality accident, the highest dose to an organ to the bone surface is .007 millirem from a postulated DBE and fire. The numbers of latent cancer fatalities and genetic disorders for these accidents range from 1.2×10^{-8} to 7.3×10^{-6} latent cancer fatality and 1.1×10^{-8} to 6.7×10^{-6} genetic disorder, conditional upon the occurrence of the particular accident. In addition to the above cases with full filter efficiency, a spectrum of filter efficiencies down to zero was considered. The maximum whole-body dose to an individual at the site boundary from the extreme case with 0-percent filter efficiency is 2.8×10^{-1} rem (280 millirem), which is a small fraction of the 25-rem criterion used by the NRC in the siting of a commercial power reactor (10 CFR 100). None of these facility accidents, including the postulated severe accident with complete loss of filters, results in an offsite release that would require costs for offsite mitigation.

For postulated accidents involving the transport of all SIS materials (i.e., feed, product, potentially by-product, TRU waste, and onsite LLW), the radiological risk per year of health effects was calculated to be 1.3×10^{-4} latent cancer fatality and 5.9×10^{-5} genetic disorder.

During construction and operation of the SIS Project, potential impacts could occur to INEL workers. Construction workers would be exposed to elevated background levels of radiation from gamma radiation in the vicinity of the SIS site and from inhalation of radionuclides emitted to the atmosphere from current INEL operations and earthwork activities. The estimated construction dose of about 30 millirem would be significantly below the DOE occupational exposure standard of 5000 millirem (5 rem). During operation of the SIS Project, workers within the ICPP area and other INEL areas would be exposed to normal radiological releases from the SIS facilities. The committed whole-body dose to a worker at the main processing building in the ICPP area was calculated to be 3×10^{-5} millirem, which is significantly below the DOE occupational exposure standard. Worker exposures to radioactive, hazardous, and/or toxic materials within the SIS facilities would be limited, in compliance with all applicable occupational safety requirements, and maintained at as-low-as-reasonably-achievable (ALARA) levels.

As a result of postulated accidents, high exposures, injuries, and fatalities could occur to SIS workers. INEL workers external to (i.e., outside of) the SIS facilities would be exposed to the atmospheric emissions of the postulated accident release. The highest whole-body dose to a worker at the main processing building in the ICPP area, assuming filter efficiency degraded to 0 percent and no evacuation, was calculated to be 6.5 rem (6500 millirem). Within the SIS facilities, potential fatalities might occur to workers within a few feet of the postulated criticality event or to workers in proximity to an explosion. Administrative controls are expected to limit the number of SIS operating personnel in areas of high potential exposure.

CONSTRUCT AND OPERATE THE SIS PROJECT AT THE HANFORD SITE

Construction of the SIS Project at the Hanford Site would affect a sagebrush vegetative community similar to the vegetative community and wildlife habitats found at the INEL. Previous planning for locating the SIS Project at the Hanford Site using a design of the SIS Project that has since undergone revision indicated that construction of the SIS Project might involve less land area for facilities than the present designs for locating the SIS Project at the INEL, while more land area would be affected temporarily by the construction of a transmission line. Because of the elevation of the proposed SIS Project site above a potential Probable Maximum Flood (PMF), less SIS site grading at the Hanford Site could be anticipated than at the INEL, as well as fewer emissions and effluents associated with grading.

Construction of the SIS Project at the Hanford Site would not affect known critical habitats or known habitats for rare or endangered species. No known historic sites would be directly impacted by construction. A large in-migrating construction workforce for the project is not expected because of the availability of construction workers formerly involved in the construction of commercial nuclear power plants at the Hanford Site. Construction of the SIS Project at the Hanford Site would provide job opportunities at a time when many jobs have been lost due to suspension of the characterization studies for a geologic repository for commercial nuclear wastes, and due to the placement of N-Reactor in cold-standby status.

During normal operation, atmospheric emissions of radioactive materials would not measurably increase radiation doses to the population surrounding the Hanford Site. The calculated annual whole-body dose to a hypothetical maximum individual from normal atmospheric emissions of radioactivity would be 7.3×10^{-9} millirem and the calculated collective annual whole-body dose to the offsite population surrounding the Hanford Site would be 1.4×10^{-7} person-rem based on a year-2010 population of 709,147 persons, or 9.7×10^{-8} person-rem for a year-2010 population of 500,000 persons. Calculated annual health effects to the population are 1.5×10^{-11} genetic disorder and 2.2×10^{-10} latent cancer fatality. The normal SIS atmospheric emissions of radioactivity when added to present and planned Hanford Site emissions would be well below EPA's NESHAP. Compared to locating the SIS Project at the INEL, the calculated dose to the hypothetical maximum individual at the Hanford Site is lower because of the greater distance from the SIS site to the nearest Hanford Site boundary, and the calculated collective dose to the offsite population surrounding the Hanford Site is higher because of the larger population surrounding the Hanford Site (i.e., for both the high and low year-2010 population forecasts). Nonradiological emissions during operation would be similar to those estimated if the SIS were located at the INEL and would be below PSD de minimis levels. Substitutes for Freon will be used when available.

Only nonradioactive and nonhazardous liquid effluents would be discharged to the soil column. Sanitary waste water would be treated through use of a septic tank and discharged to a tile field. Service waste water would also be discharged to a tile field. Solid wastes generated during SIS operation would be handled in the same manner as at the INEL (i.e., hazardous wastes transported to an approved TSD facility, LLW disposed of by shallow ground burial, mixed wastes stored or transported to an approved TSD facility, and TRU waste transported to the WIPP). All applicable requirements and standards would be met as previously discussed for locating the SIS Project at the INEL.

During SIS operations, shipments of plutonium product from the SIS would be routinely transported from the Hanford Site to DOE's Rocky Flats Plant in Colorado. The fuel-grade plutonium at the Hanford Site that would be processed by the SIS Project would only be transported onsite, compared to transporting the fuel-grade plutonium to the INEL if the SIS Project were located at the INEL. Only a small quantity of fuel-grade plutonium scrap from the SRP would be transported to the Hanford Site. TRU waste and potentially by-product material rendered into a form for emplacement at the WIPP would be transported by truck in a TRUPACT II cask. The annual radiological dose to the population from routine shipments of SIS materials (i.e., feed, product, by-product, TRU waste, and onsite LLW) was calculated to be less than 16 person-rem, resulting in 4.4×10^{-3} latent cancer fatality and 2.0×10^{-3} genetic disorder.

For postulated facility accidents, there are no cases of early offsite fatalities and no early offsite injuries. The highest dose at the site boundary to an organ and the highest offsite whole-body dose from an accident in which there would be full filter efficiency are 1.8 millirem to the thyroid and 0.3 millirem, respectively, both as a consequence of the postulated nuclear criticality accident. For accidents other than the criticality accident, the highest dose to an organ is .005 millirem to the bone surface from a postulated DBE and fire. The numbers of latent cancer fatalities and genetic disorders for the accidents considered range from 3.1×10^{-7} to 2.8×10^{-4} latent cancer fatality and 2.8×10^{-7} to 2.4×10^{-4} genetic disorder. The primary differences in the calculated facility accident consequences of locating the SIS Project at the Hanford Site versus locating it at the INEL are that site-boundary doses for the Hanford Site would be lower than at the INEL and offsite societal consequences (i.e., population doses and health effects) would be higher than those at the INEL. The lower site-boundary doses are attributable to the longer distance from the proposed SIS Project site to the Hanford Site boundary compared to that at the INEL. The higher offsite societal consequences (i.e., population doses and health effects) at Hanford are due to the larger population estimated to reside within an 80-kilometer (50-mile) radius of the SIS Project at the Hanford Site compared to the 80-kilometer (50-mile) population surrounding the project at the INEL.

Locating the SIS Project at the Hanford Site would not require significant offsite shipments of fuel-grade plutonium, but would result in greater distances in the shipment of TRU waste, product, and potentially by-product. The calculated annual radiological risk of health effects in the event of a transport accident is slightly higher than that for locating the SIS Project at the INEL, or 1.6 x 10^{-4} latent cancer fatality and 7.5 x 10^{-5} genetic disorder.

During construction and operation of the SIS Project, potential impacts could occur to Hanford Site workers. The potential impacts to Hanford Site workers would not differ significantly from those discussed for the INEL, except for construction-worker exposures, as the SIS facility and its releases during normal and accident events would be the same as that for locating the SIS Project at the INEL. The construction-worker exposure for locating the SIS Project at the Hanford Site is calculated to result in a dose of about 2 millirem compared to a 30-millirem dose to a construction worker at the INEL, almost entirely due to differences measured in external radiation.

CONSTRUCT AND OPERATE THE SIS PROJECT AT THE SAVANNAH RIVER PLANT

Construction of the SIS Project at the SRP would affect vegetative communities of monotypic stands of loblolly pine and admixtures of hardwoods. Unlike locating the SIS Project at either the INEL or the Hanford Site, the reference SIS site at the SRP is not located within an existing operating area because of land area availability; therefore, the reference site area, which is not considered to have been disturbed by prior operations (although it has been logged) would be lost, and wildlife would be permanently lost or displaced. Because of the reference site's elevation above a PMF, less grading and fewer construction emissions and effluents associated with grading are expected compared to the SIS site at the INEL. All other potential environmental consequences of constructing the SIS Project at the SRP would be similar to those for constructing the SIS Project at the INEL.

Compared to locating the SIS Project at the INEL, the calculated annual whole-body dose to a hypothetical maximum individual from routine radiological releases to the atmosphere is slightly lower (i.e., 8.9 x 10^{-9} millirem) at the SRP because of meteorological dispersion characteristics, and the calculated annual collective whole-body dose to the offsite population surrounding the SRP (i.e., 2.0 x 10^{-7} person-rem based on comparably projected year-2010 populations) is greater at the SRP because of the larger population surrounding the SRP. Calculated health effects to the population would be 3.2 x 10^{-10} latent cancer fatality and 2.3 x 10^{-11} genetic disorder. Nonradiological emissions during operation would be similar to those emitted if the SIS Project were located at the INEL and would be below PSD de minimis levels. Nonradioactive and nonhazardous liquid effluents would be discharged to a stream in accordance with National Pollutant Discharge Elimination System (NPDES) permit limitations.

Hazardous and mixed wastes would either be stored or disposed of at the SRP in new storage or disposal facilities meeting all RCRA requirements. LLW would either be disposed of or stored onsite. TRU waste would be transported to the WIPP.

During SIS operations, shipments of fuel-grade plutonium would routinely be transported between the Hanford Site and the SRP, and plutonium product would be transported from the SRP to DOE's Rocky Flats Plant. The annual radiological dose to the population from routine shipments of SIS material (feed, product, potentially by-product, TRU waste, and onsite LLW) was calculated to be less than 19 person-rem, resulting in 5.3×10^{-3} latent cancer fatality and 2.4×10^{-3} genetic disorder.

For postulated facility accidents, there are no cases of early offsite fatalities and no early offsite injuries. The highest dose at the site boundary to an organ and the highest offsite whole-body dose from an accident in which there would be full filter efficiency are 5.1 millirem to the thyroid and 0.8 millirem, respectively, both as a consequence of the postulated nuclear criticality accident. For accidents other than the criticality accident, the highest dose to an organ is .005 millirem to the bone surface from a postulated DBE and fire. The numbers of latent cancer fatalities and genetic effects for the accidents considered range from 4.3×10^{-7} to 5.9×10^{-4} latent cancer fatality and 3.9×10^{-7} to 5.4×10^{-4} genetic disorder. The primary difference in the calculated accident consequences of locating the SIS Project at the SRP versus locating it at the INEL is that offsite societal consequences (i.e., population doses and health effects) of locating the SIS Project at the SRP would be higher than at the INEL because of the larger forecast year-2010 population residing within an 80-kilometer (50-mile) radius of the SRP. Although the SIS Project site at the SRP is closer to the SRP boundary compared to the site at the INEL, the SRP site-boundary doses are only slightly higher than those of the INEL because of different meteorological dispersion characteristics.

Because of the longer distances associated with the transport of SIS materials compared to locating the SIS Project at the INEL, the calculated annual radiological risk of health effects in the event of a transport accident is larger, or 2.9×10^{-4} latent cancer fatality and 1.3×10^{-4} genetic disorder.

During construction and operation of the SIS Project, potential impacts could occur to SRP workers. The potential impacts to SRP workers would not differ significantly from those discussed for the INEL, except for construction-worker exposures, as the SIS facility and its releases during normal and accident events would be the same as that for locating the SIS Project at the INEL. The construction-worker exposure for locating the SIS Project at the SRP is calculated to result in a dose of about 15 millirem compared to a 30-millirem dose to a construction worker at the INEL, almost entirely due to differences measured in external radiation.

NO ACTION

The No-Action Alternative is not to construct and operate the SIS Project. If the SIS Project is not constructed and operated, the flexibility, contingency, and technological diversity in the production of weapon-grade plutonium that would be provided by the SIS Project would not be achieved. The operation of DOE's nuclear materials production complex for weapon-grade plutonium would continue to be delineated on an annual basis. The No-Action Alternative would not result in changes to continuing operations at the Hanford Site, the SRP, or any other DOE site. Blending fuel-grade plutonium with newly produced plutonium of higher-than-weapon-grade purity will continue to provide an option for the production of weapon-grade plutonium irrespective of whether the SIS Project is constructed and operated.

ALTERNATIVES CONSIDERED BUT NOT EVALUATED IN DETAIL

In proposing to proceed with the SIS Project commensurate with its responsibility for maintaining the capability to produce the nuclear materials required for national defense, DOE has previously considered technology alternatives for plutonium isotopic separation and other weapon-grade plutonium production alternatives. Based on a Technical Readiness Review and an Environmental Assessment and Finding of No Significant Impact (FONSI) of the AVLIS and Molecular Laser Isotope Separation (MLIS) technologies, DOE has concluded that the AVLIS process should be the technology for the proposed SIS.

The production alternatives considered were increased blending, use of a new fuel lattice in the reactors at the SRP, restart of the N-Reactor at the Hanford Site, construction and operation of a New Production Reactor (NPR), and conversion of the Washington Nuclear Project Unit 1 (WNP-1), which is located within the Hanford Site, to a DOE production reactor. Alternatives not involving new weapon-grade sources (i.e., weapon recycle and enhanced scrap recovery) were also considered. The production of weapon-grade plutonium by blending requires the production of new plutonium, of a higher purity than weapon-grade plutonium, to blend with fuel-grade plutonium. Increased blending by producing plutonium with a plutonium-240 content of less than 3 percent, or "super blending," would require excessively high throughput (i.e., more frequent changing of targets) in the production reactors at the SRP to control the buildup of plutonium-240 in the irradiated targets. The more frequent changes in the targets would lead to increased reactor downtime, resulting in a reduction in the quantities of material produced and in the need for additional reactor availability to compensate for the loss of material. Increased blending through greater SRP production of new plutonium with a plutonium-240 content of 3 percent would similarly require greater production reactor availability. Because increased blending, either through "super blending" or greater production, would require additional SRP reactor availability, which is limited both by the higher priority need for the production of tritium and by current or potential operational constraints, it is not considered a reasonable alternative to SIS.

Currently, the SRP reactors use a Mark-16-31 lattice for plutonium production. The implementation of this initiative is not considered to be a reasonable alternative to the SIS Project because, similar to blending, implementation would not significantly alter the current dependency on reactor availability. Also, the production complex requires the flexibility to use these reactors for tritium production while still maintaining plutonium production capacity.

In the past, another source of new weapon-grade plutonium was the N-Reactor at the Hanford Site. During 1987, this reactor was placed in stand-down for the application of safety modifications. Later, prior to its restart, this reactor was placed in cold-standby because of sufficient near-term plutonium supply and the high cost of continuing to operate the reactor. The N-Reactor has a limited service life that is governed by distortion of the graphite moderator and is potentially subject to problems of aging similar to those of the SRP reactors. The restart of the

N-Reactor, while possible, does not meet the requirement of technological diversity, nor does it promise a reliable contingency supply for the period of most-needed performance.

Studies have also been performed with respect to the construction and operation of an NPR and the potential conversion of WNP-1 to a DOE production reactor. Implementation of either initiative was considered unreasonable because neither would provide the flexibility and technological diversity of a reactor-independent source as represented by the SIS Project. Currently, new reactor capacity has been planned to meet long-term tritium needs and would not be operated until after the year 2000.

None of the alternatives discussed above are technologically diverse from reactor-based plutonium production. In addition, flexibility in meeting potential requirements for rapid increases in plutonium production is not provided by these alternatives.

The nation's stockpile of weapon-grade plutonium physically resides either in the weapons or in inventories associated with manufacture, processing, and storage. When warheads are returned, the material can be reclaimed; however, the numbers and frequencies of return are determined based on national security considerations. During the chemical and physical processing of both new and returned material, scrap is generated. Evaluations of need for new weapon-grade plutonium fully consider the availability of material from returns and scrap. While accelerated processing of these materials can relieve short-term shortages, it adds no weapon-grade material to the stockpile. The recovery and recycling of existing weapon-grade plutonium from retired weapons as well as the acceleration of scrap recovery are, therefore, not reasonable alternatives to the SIS Project because they provide no contingency source material.

COMPARISON OF THE PROPOSED ACTION AND ALTERNATIVES

Each of the alternatives, except No Action, would provide the needed contingency and flexibility in the DOE defense nuclear materials production complex for approved needs for weapon-grade plutonium. No Action, while continuing to provide weapon-grade plutonium, would not meet the same needs as represented by the SIS Project.

The emissions and effluents resulting from SIS construction and operation would be within all applicable environmental standards. The major differences in the expected environmental consequences between the construction and operation of the SIS Project at the INEL (the preferred location) compared to the other locations considered are primarily related to the different geographic settings/locations (e.g., the different distances involved in the transport of materials, different distances of the location of the SIS relative to the nearest INEL/Hanford Site/SRP boundaries, and the estimated population surrounding each of the alternative sites).

Compared to locating the SIS Project at the INEL, the construction and operation of the SIS Project at the Hanford Site would involve the loss or displacement of similar vegetation communities and ecological habitats, and potentially a smaller amount of land area for SIS facilities. Locating the

SIS Project at the SRP would affect a more diverse ecosystem of monotypic pine and admixtures of hardwoods.

Construction of the SIS Project at each of the three alternative locations is not expected to result in major socioeconomic impacts because of the availability of construction workers in each of the three surrounding regions. Socioeconomic impacts resulting from in-migrating operating workers are also expected to be small as the number of in-migrating workers would constitute a small percentage of the average annual increase in population in the regions surrounding the alternative sites. Economic benefits as a result of the construction and operation of the SIS Project are expected to be similar for each of the alternative sites.

The INEL, with the smallest population surrounding the proposed SIS Project site, has a calculated collective whole-body dose to the surrounding population that is slightly less than the other two sites for normal operating releases. The calculated maximum individual dose for locating the SIS Project at the INEL is slightly higher than for locating the project at either the SRP or the Hanford Site, because of differences in the distance from the SIS Project to the nearest site boundary and meteorological dispersion characteristics. Calculated consequences of postulated SIS facility accidents generally parallel the differences in consequences from normal operating releases (i.e., mean site-boundary doses for locating the SIS Project at the INEL and the SRP are higher than for locating the SIS Project at the Hanford Site, and the offsite societal consequences for locating the SIS Project at the INEL are less than those for locating the SIS Project at the Hanford Site and the SRP).

Because of the semiarid climate at the INEL, water required for construction and operation would be withdrawn from ground water, and liquid effluents meeting all applicable standards including safe drinking water standards for radioactivity would be discharged to the soil column. The Hanford Site, lying in a similar semiarid climate but close to the Columbia River, would meet SIS water requirements through the withdrawal of water from the Columbia River and would discharge treated liquid effluents to the soil column. The SRP, lying within the less arid climate of the southeastern United States, would withdraw ground water for meeting SIS water requirements, but would discharge liquid effluents to an onsite stream.

Another geographic difference between the INEL and the other potential sites for the SIS Project is the location of each of the sites relative to the origins and destinations of SIS shipments of feed, product, by-product, and TRU waste. Because locating the SIS Project at the INEL would involve fewer annual shipment-kilometers of TRU waste and potentially by-product than would locating the SIS Project at either the Hanford Site or SRP, this alternative has lower calculated routine exposures and risk in the event of a transport accident.

The impacts from the construction and operation of the SIS Project at the INEL, the Hanford Site, or the SRP would not measurably increase the existing or planned cumulative impacts at these locations. The effective dose equivalent and highest organ dose from SIS operation, when added to the existing radiological doses as a result of on-going operations at any of the alternative sites, would be well below NESHAP requirements. Annual generation of SIS solid wastes, including low-level radioactive, TRU, mixed, and hazardous wastes, would comprise only a small percentage of the same categories of waste currently being generated, received, and managed at each of the alternative sites. Nonradioactive atmospheric emissions resulting from SIS operation, which would be below PSD de minimis levels, would also not measurably increase the total amount of nonradioactive emissions from current operations at each of the SIS alternative locations. Nonradioactive and nonhazardous SIS liquid effluent discharges would neither increase nor accentuate potential water-quality impacts, and the cumulative withdrawal of water, whether from surface water or ground water, would be well within the capabilities of the existing water resources at each of the alternative sites.

Table S-1 provides a summary comparison of each of the alternatives and their environmental consequences based on the maximum annual production capability of the SIS Project. Table S-2 provides a summary of environmental consequences of 30 years of SIS operation at each of the alternative locations.

Table S-1. Consequences of the Proposed Action (PA), Alternatives, and Continuation of Present Practice

Category	Proposed Action (PA) and Preferred Alternative--construct and operate SIS Project at the INEL	Construct and operate SIS Project at the Hanford Site	Construct and operate SIS Project at the SRP	No Action--continuation of present practice
PROGRAMMATIC IMPACTS				
Need	Would provide DOE with needed contingency, flexibility, and technological diversity in the DOE nuclear materials production complex.	Same as PA.	Same as PA.	Would continue to provide plutonium but would not provide needed contingency, flexibility, and technological diversity.
CONSTRUCTION IMPACTS				
Land area required	26.9 acres within the ICPP area and about 34.1 acres outside existing ICPP area, of which 11.2 acres would be temporarily disturbed for a substation distribution line, and additional acreage for borrow area.	18 acres within the 200-East Area and 29 acres outside 200-East Area, of which 25 acres would be temporarily disturbed for a transmission line, and additional acreage for borrow area.	20 acres outside existing F-Area and additional acreage for borrow area and other support facilities.	Not applicable--facilities currently in place and operating.
Socioeconomic impacts	No large in-migrating construction workforce or major adverse impacts expected; beneficial impacts would include a stable INEL workforce, indirect job opportunities,	Same as PA. No large in-migrating construction workforce or major adverse impacts expected; beneficial economic impacts similar to those for PA.	Same as PA. No large in-migrating construction workforce or major adverse impacts expected; beneficial economic impacts similar to those for PA.	Not applicable--facilities currently in place and operating.

Table S-1. Consequences of the Proposed Action (PA), Alternatives, and Continuation of Present Practice (continued)

Category	Proposed Action (PA) and Preferred Alternative--construct and operate SIS Project at the INEL	Construct and operate SIS Project at the Hanford Site	Construct and operate SIS Project at the SRP	No Action--continuation of present practice
		CONSTRUCTION IMPACTS (continued)		
Socioeconomic impacts (continued)	and contributions to tax base.			
Ecological habitat	Habitats and wildlife associated with sagebrush vegetation community would be lost or displaced; successional recovery of all but 2.9 acres outside ICPP area and minor areas for transmission line; no critical habitats, wetland habitats, or habitats for rare or endangered species would be affected.	Same as PA, except a smaller amount of acreage (i.e., about 9 acres) might be affected during construction.	Habitats and wildlife associated with 20 acres of pine and admixtures of hardwoods would be lost; no wetlands impacted.	Not applicable--facilities currently in place and operating.
Effluents and emissions	Typical of those associated with a large construction project; effluents and emissions would be well below applicable environmental standards, and mitigative measures would be	Same as PA.	Same as PA.	Not applicable--facilities currently in place and operating.

Table S-1. Consequences of the Proposed Action (PA), Alternatives, and Continuation of Present Practice (continued)

Category	Proposed Action (PA) and Preferred Alternative--construct and operate SIS Project at the INEL	Construct and operate SIS Project at the Hanford Site	Construct and operate SIS Project at the SRP	No Action--continuation of present practice
	CONSTRUCTION IMPACTS (continued)			
Effluents and emissions (continued)	implemented for fugitive dust, erosion, and spills.			
Archeologic/ historic resources	No sites would be impacted. Periodic inspections of excavations and excavated material will determine whether frequency of paleontological finds requires mitigation.	Same as PA.	Same as PA.	Not applicable--facilities currently in place and operating.
	ROUTINE NONRADIOLOGICAL OPERATIONAL IMPACTS			
Socioeconomic impacts	Potential in-migrating operating personnel would be a small percentage of average population increases; no significant impacts to community facilities; beneficial impacts would include indirect job opportunities and contributions to local tax base.	In-migrating operating personnel would be a small percentage of average population increases; no significant impacts to community facilities; beneficial economic impacts are expected to be similar to those for PA.	In-migrating operating personnel would be a small percentage of average population increases; no significant impacts to community facilities; beneficial economic impacts are expected to be similar to those for PA.	Not applicable--facilities currently in place and operating.

Table S-1. Consequences of the Proposed Action (PA), Alternatives, and Continuation of Present Practice (continued)

Category	Proposed Action (PA) and Preferred Alternative--construct and operate SIS Project at the INEL	Construct and operate SIS Project at the Hanford Site	Construct and operate SIS Project at the SRP	No Action--continuation of present practice
ROUTINE NONRADIOLOGICAL OPERATIONAL IMPACTS (continued)				
Atmospheric emissions	Additional burning of coal for steam generation and nonradiological process emissions would be well below PSD de minimis levels; Freon emissions would be below PSD de minimis levels for volatile organic compounds; on-going studies examining Freon emission reduction measures; substitute coolants to be used when available.	Same as PA.	Same as PA.	Atmospheric emissions within air quality permit limitations would continue.
Liquid effluents	Only nonhazardous and nonradioactive liquid effluents would be discharged to new percolation pond(s); sanitary effluents would be treated by existing ICPP Sewage Treatment Plant.	Same as PA, except service wastes would be discharged to a tile field and sanitary waste water would be treated through use of a septic tank.	Same as PA, except service wastes and treated sanitary waste water would be discharged to surface water (Four Mile Creek) in accordance with applicable permit requirements.	Liquid effluents associated with current practice would continue; improvements to existing facilities would continue to be undertaken to comply with permit requirements.

Table S-1. Consequences of the Proposed Action (PA), Alternatives, and Continuation of Present Practice (continued)

Category	Proposed Action (PA) and Preferred Alternative--construct and operate SIS Project at the INEL	Construct and operate SIS Project at the Hanford Site	Construct and operate SIS Project at the SRP	No Action--continuation of present practice
ROUTINE NONRADIOLOGICAL OPERATIONAL IMPACTS (continued)				
Nonhazardous solid waste	Nonradioactive and nonhazardous solid waste would be disposed of in onsite sanitary landfill.	Same as PA.	Same as PA.	Nonradioactive and nonhazardous waste generated as a result of current practice would continue to be disposed of in sanitary landfills.
Hazardous waste	Hazardous wastes would be handled in accordance with applicable RCRA requirements, and would be transported to an approved RCRA TSD facility.	Same as PA.	Hazardous wastes would be stored or disposed of on the site in new facilities meeting RCRA requirements.	Hazardous wastes associated with current practice would continue to be generated; improvements to existing facilities and new TSD facilities would be implemented to comply with RCRA requirements.
ROUTINE RADIOLOGICAL OPERATIONAL IMPACTS				
Atmospheric emissions[a]	Small quantities would be released to atmosphere, resulting in negligible offsite increases; calculated	Same as PA, except calculated annual whole-body doses to maximum individual	Same as PA, except calculated annual whole-body doses to maximum individual	Annual radiological consequences of current practice would continue; doses to

Table S-1. Consequences of the Proposed Action (PA), Alternatives, and Continuation of Present Practice (continued)

Category	Proposed Action (PA) and Preferred Alternative--construct and operate SIS Project at the INEL	Construct and operate SIS Project at the Hanford Site	Construct and operate SIS Project at the SRP	No Action--continuation of present practice
	ROUTINE RADIOLOGICAL OPERATIONAL IMPACTS (continued)			
Atmospheric emissions[a] (continued)	annual increase in whole-body dose to maximum individual and surrounding population would be 1.3×10^{-8} millirem and 2.3×10^{-8} person-rem, respectively; calculated population health effects of 2.5×10^{-12} genetic disorder and 3.5×10^{-11} latent cancer fatality; atmospheric emissions in combination with other emissions would be well below NESHAP standards.	and surrounding population would be 7.3×10^{-9} millirem and 1.4×10^{-7} person-rem, respectively; and slightly higher health effects.	and surrounding population would be 8.9×10^{-9} millirem and 2.0×10^{-7} person-rem, respectively, and slightly higher health effects.	maximum individuals and populations from existing operations are a small fraction of background radiation and are well below NESHAP standards.
Solid waste	Radioactive solid wastes that would be generated include LLW, TRU waste, and mixed waste; TRU waste would be certified and transported to the planned WIPP; LLW would be disposed of in existing land burial facility; mixed waste would either	Same as PA.	LLW would be disposed of onsite and mixed wastes would either be stored or disposed of on the site in RCRA-approved facilities; TRU waste would be certified and transported to the planned WIPP.	LLW, TRU waste, and mixed waste associated with current practice would continue to be generated and managed in the same manner as for the SIS Project; high-level radioactive waste would also

Table S-1. Consequences of the Proposed Action (PA), Alternatives, and Continuation of Present Practice (continued)

Category	Proposed Action (PA) and Preferred Alternative--construct and operate SIS Project at the INEL	Construct and operate SIS Project at the Hanford Site	Construct and operate SIS Project at the SRP	No Action--continuation of present practice
	ROUTINE RADIOLOGICAL OPERATIONAL IMPACTS (continued)			
Solid waste (continued)	be stored in RCRA-permitted storage facilities separate from hazardous waste or transported to approved TSD facility. Quantities generated would be a small percentage of the quantities currently managed and would result in small exposures.			be generated that would be immobilized at the SRP and the Hanford Site.
Routine transport of materials	All materials would be transported in accordance with appropriate DOE, DOT, and EPA requirements. Annual offsite shipments of SIS feed, product, potentially by-product, and TRU waste and on-site shipments of LLW would result in less than 12 person-rem and 3.5×10^{-3} latent cancer fatality and 1.6×10^{-3} genetic disorder.	Compared to PA, only a few shipments of feed from the SRP would occur, while the transport of TRU waste and potentially by-product would occur over a longer distance. Annual offsite shipments of SIS materials would result in less than 16 person-rem, and slightly higher health effects.	Compared to PA, feed, product, TRU waste, and potentially by-product would be transported longer distances. Annual offsite shipments of SIS material would result in less than 19 person-rem, and slightly higher health effects.	Materials would continue to be transported on and off the site in accordance with appropriate requirements. Radiological exposures for shipments of radioactive materials would continue to be below applicable DOE and DOT criteria and standards.

Table S-1. Consequences of the Proposed Action (PA), Alternatives, and Continuation of Present Practice (continued)

Category	Proposed Action (PA) and Preferred Alternative--construct and operate SIS Project at the INEL	Construct and operate SIS Project at the Hanford Site	Construct and operate SIS Project at the SRP	No Action--continuation of present practice
		ACCIDENTS		
SIS facility accidents[b]	For all accidents considered, there would be no offsite cases of early fatalities or injuries. For the accidents in which the filtration system would function as designed, the highest dose at the INEL site boundary to an organ would be 2.7 millirem to the thyroid and the highest whole-body dose would be 0.5 millirem, both from the postulated criticality accident. The numbers of potential offsite latent cancer fatalities and genetic disorders for Design-Basis Accidents having the highest consequences range from 1.2 x 10^{-8} to 7.3 x 10^{-6} cancer fatality and 1.1 x 10^{-8} to 6.7 x 10^{-6} genetic disorder. In addition to the above cases with full	For all accidents considered, there would be no offsite cases of early fatalities or injuries. For the accidents in which the filtration system would function as designed, site-boundary doses would be lower than PA (e.g., 1.8 millirem to the thyroid from the postulated criticality accident) and offsite societal consequences would be higher than PA (e.g., number of offsite latent cancer fatalities for accidents ranges from 3.0 x 10^{-7} to 2.8 x 10^{-4}). Although a full spectrum of filter efficiency calculations has not been done for the Hanford Site, the whole-body and	For all accidents considered, there would be no offsite cases of early fatalities or injuries. For the accidents in which the filtration system would function as designed, site-boundary doses would be higher than PA (e.g., 5.1 millirem to the thyroid from the postulated criticality accident) and offsite societal consequences would be higher than PA (e.g., number of offsite latent cancer fatalities for accidents ranges from 4.3 x 10^{-7} to 5.9 x 10^{-4}). Although a full spectrum of filter efficiency calculations has not been done for the SRP, the whole-body and	SIS accidents not directly comparable to continuation of current practice.

Table S-1. Consequences of the Proposed Action (PA), Alternatives, and Continuation of Present Practice (continued)

Category	Proposed Action (PA) and Preferred Alternative--construct and operate SIS Project at the INEL	Construct and operate SIS Project at the Hanford Site	Construct and operate SIS Project at the SRP	No Action--continuation of present practice
		ACCIDENTS (continued)		
SIS facility accidents[b] (continued)	filter efficiencies, a full spectrum of filter efficiencies down to zero was considered. The maximum whole-body dose at the site boundary from the extreme case with zero filter efficiency is 2.8×10^{-1} rem and the maximum dose to the bone surface 3.6×10^{0} rem.	bone-surface doses calculated at the INEL boundary approximate the doses at the Hanford Site boundary because the distances are reasonably close.	bone-surface doses calculated at the INEL boundary approximate the doses at the SRP boundary because the distances are reasonably close.	
Transport of SIS feed, product, and by-product	Annual radiological risk for transport of all SIS radioactive materials would be 1.3×10^{-4} latent cancer fatality and 5.9×10^{-5} genetic disorder; annual nonradiological risk of a fatality would be 1.8×10^{-2}.	Annual radiological risk would be higher than PA, or 1.6×10^{-4} latent cancer fatality and 7.5×10^{-5} genetic disorder; annual nonradiological risk of a fatality would also be higher than PA, or 2.2×10^{-2}.	Annual radiological risk would be higher than PA, or 2.9×10^{-4} latent cancer fatality and 1.3×10^{-4} genetic disorder; annual nonradiological risk of a fatality would also be higher than PA, or 2.1×10^{-2}.	Compared to PA, annual risk of current practice would be higher because of longer distances associated with feed shipments for blending and product shipments.

Table S-1. Consequences of the Proposed Action (PA), Alternatives, and Continuation of Present Practice (continued)

Category	Proposed Action (PA) and Preferred Alternative--construct and operate SIS Project at the INEL	Construct and operate SIS Project at the Hanford Site	Construct and operate SIS Project at the SRP	No Action--continuation of present practice
		OTHER IMPACTS		
Occupational safety	Construction-worker exposure of about 30 millirem per year would be well within exposure limits for uncontrolled areas; operation exposures would be kept to ALARA levels and below permissible DOE standards; injuries, exposures, and fatalities could potentially occur as a result of accidents; the routine dose to an ICPP worker (i.e., less than 3.0×10^{-8} rem) and doses as a result of postulated accidents, including those filtration systems degraded to 90 percent, would both be below the DOE standard of 5 rem; for the severe accident with 0-percent filtration, the calculated dose is 6.5 rem.	Construction-worker exposure of about 2 millirem would be well within exposure limits and below those expected for PA; operational exposures would be kept to ALARA levels and below permissible DOE standards; routine and accident doses to on-site workers would be similar to those for the INEL, including that as a result of a severe accident.	Construction-worker exposure of about 15 millirem would be well within exposure limits and below those expected for PA; operational exposures would be kept to ALARA levels and below permissible DOE standards; routine and accident doses to on-site workers would be similar to those for the INEL, including that as a result of a severe accident.	Facilities are currently in place and no construction-worker impacts would occur; worker exposures kept to ALARA levels and below permissible DOE standards.

Table S-1. Consequences of the Proposed Action (PA), Alternatives, and Continuation of Present Practice (continued)

Category	Proposed Action (PA) and Preferred Alternative--construct and operate SIS Project at the INEL	Construct and operate SIS Project at the Hanford Site	Construct and operate SIS Project at the SRP	No Action--continuation of present practice
		OTHER IMPACTS (continued)		
Resource impacts	Ground-water withdrawals would be an insignificant percentage of annual discharge of Snake River Plain aquifer; no significant use of scarce or strategic material would be required for construction and operation.	Surface-water withdrawals would be an insignificant percentage of annual average flow of Columbia River; use of scarce or strategic material would be same as for PA.	Ground-water withdrawals would be an insignificant percentage of current SRP ground-water withdrawals; use of scarce or strategic material would be same as for PA.	Surface- and ground-water withdrawals would continue and would be a small percentage of the capability of ground- and surface-water resources; scarce or strategic material would not be required for continuing current practice.

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[a] Collective (i.e., population) doses presented use a forecast year-2010 population based on a population growth rate for each of the areas as experienced between 1970 and 1980. Collective doses based on local estimates of population for the year 2010 are: INEL, 1.5 x 10^{-8} person-rem; Hanford Site, 9.7 x 10^{-8} person-rem; SRP, 1.4 x 10^{-7} person-rem.

[b] The ranges of potential offsite latent cancer fatalities using year-2010 local population estimates are: INEL, 7.9 x 10^{-9} to 4.8 x 10^{-6}; Hanford Site, 1.9 x 10^{-7} to 1.8 x 10^{-4}; SRP, 2.8 x 10^{-7} to 3.9 x 10^{-4}.

Table S-2. Consequences of 30 Years of SIS Project Operations at the Alternative Sites

Category	Proposed Action (PA) and Preferred Alternative--construct and operate SIS Project at the INEL	Construct and operate SIS Project at the Hanford Site	Construct and operate SIS Project at the SRP
	ROUTINE NONRADIOLOGICAL OPERATIONAL IMPACTS		
Socioeconomic impacts	Workforce would contribute to stabilizing workforce and benefits to regional economy.	Same as for PA.	Same as for PA.
Atmospheric emissions	Nonradiological emissions would continue to be below annual standards; substitute coolants expected to be available for Freon emissions. Less than 2160 metric tons of SO_2, particulates, NO_x, CO, and organic vapors emitted.	Same as for PA.	Same as for PA.
Liquid effluents	Only nonradioactive and nonhazardous liquid effluents would be discharged to percolation pond(s). Total SIS liquid discharges would approximate 7.2×10^8 liters of treated sanitary effluent and 7.8×10^7 liters of nonradioactive and nonhazardous process steam condensate and cooling tower blowdown to service waste system.	Same as for PA except discharges would be to tile fields.	Same as for PA except discharges would be to a stream (i.e., Four Mile Creek).

Table S-2. Consequences of 30 Years of SIS Project Operations at the Alternative Sites (continued)

Category	Proposed Action (PA) and Preferred Alternative--construct and operate SIS Project at the INEL	Construct and operate SIS Project at the Hanford Site	Construct and operate SIS Project at the SRP
ROUTINE NONRADIOLOGICAL OPERATIONAL IMPACTS (continued)			
Nonhazardous solid waste	Total amount of nonhazardous waste would be less than 27,000 metric tons, which would be disposed of in an onsite sanitary landfill.	Same as for PA.	Same as for PA.
Hazardous waste	Would continue to be handled in accordance with applicable RCRA requirements and would be transported offsite to an approved RCRA TSD facility. Total amount requiring handling, management, and offsite transport less than 990,000 liters.	Same as for PA.	Hazardous waste would be stored or disposed of onsite in compliance with RCRA. Quantity same as for PA.
ROUTINE RADIOLOGICAL OPERATIONAL IMPACTS			
Atmospheric emissions	Maximum accumulated whole-body dose of 4.0×10^{-7} millirem and accumulated whole-body dose to surrounding population of less than 6.8×10^{-7} person-rem. Total calculated health effects to population of 7.5×10^{-11} genetic disorder and 1.1×10^{-9} latent cancer fatality.	Maximum accumulated individual whole-body dose of 2.2×10^{-7} millirem and accumulated whole-body dose to surrounding population of less than 4.2×10^{-6} person-rem. Total calculated health effects to population of 4.5×10^{-10} genetic disorder and 6.6×10^{-9} latent cancer fatality.	Maximum accumulated individual whole-body dose of 2.7×10^{-7} millirem and accumulated whole-body dose to surrounding population of less than 6.1×10^{-6} person-rem. Total calculated health effects to population of 6.9×10^{-10} genetic disorder and 9.6×10^{-9} latent cancer fatality.

Table S-2. Consequences of 30 Years of SIS Project Operations at the Alternative Sites (continued)

Category	Proposed Action (PA) and Preferred Alternative--construct and operate SIS Project at the INEL	Construct and operate SIS Project at the Hanford Site	Construct and operate SIS Project at the SRP
	ROUTINE RADIOLOGICAL OPERATIONAL IMPACTS (continued)		
Solid waste	Total quantities of radioactive waste generated would be: LLW, less than 900 metric tons; TRU waste, less than 12,000 metric tons; mixed waste, less than 300 metric tons. All wastes managed and stored or disposed of as listed in Table S-1.	Same as PA. All wastes managed and stored or disposed of as listed in Table S-1.	Same as PA. All wastes managed and stored or disposed of as listed in Table S-1.
Routine transport of materials	Routine transport of radioactive materials would result in an accumulated exposure of less than 360 person-rem. Total calculated health effects to population of 4.8×10^{-2} genetic disorder and 1.1×10^{-1} cancer fatality.	Routine transport of radioactive materials would result in an accumulated exposure of less than 480 person-rem. Total calculated health effects to population of 6×10^{-1} genetic disorder and 1.2×10^{-1} cancer fatality.	Routine transport of radioactive materials would result in an accumulated exposure of less than 570 person-rem. Total calculated health effects to population of 7.2×10^{-1} genetic disorder and 1.6×10^{-1} cancer fatality.
SIS facility accidents[a]	Risk of offsite genetic disorder and cancer fatality for design-basis accident having highest consequence would be less than 5.7×10^{-7} for a genetic disorder and 6.3×10^{-7} for a latent cancer fatality; because of the extremely low probability of occurrence of the postulated severe accident, the risk to the offsite population would not significantly increase.	Risk of genetic disorder and offsite cancer fatality would be less than 1.5×10^{-6} for a genetic disorder and 1.6×10^{-6} for a latent cancer fatality; postulated severe accident would not significantly increase risk.	Risk of genetic disorder and offsite cancer fatality would be less than 2.2×10^{-6} for a genetic disorder and 2.3×10^{-6} for a latent cancer fatality; postulated severe accident would not significantly increase risk.

Table S-2. Consequences of 30 Years of SIS Project Operations at the Alternative Sites (continued)

Category	Proposed Action (PA) and Preferred Alternative--construct and operate SIS Project at the INEL	Construct and operate SIS Project at the Hanford Site	Construct and operate SIS Project at the SRP
	ROUTINE RADIOLOGICAL OPERATIONAL IMPACTS (continued)		
Transport accidents[a]	Radiological risk of a single health effect from the transport of feed, product, (potentially) by-product, TRU waste, and onsite transport of LLW, less than 1.8×10^{-3} genetic disorder and 3.9×10^{-3} latent cancer fatality.	Radiological risk of a single health effect from the transport of feed, product, (potentially) by-product, TRU waste, and onsite transport of LLW, less than 2.3×10^{-3} genetic disorder and 4.8×10^{-3} latent cancer fatality.	Radiological risk of a single health effect from the transport of feed, product, (potentially) by-product, TRU waste, and onsite transport of LLW, less than 3.9×10^{-3} genetic disorder 8.7×10^{-3} latent cancer fatality.
Occupational safety	Accumulated whole-body dose to a worker in ICPP would be about 9.0×10^{-7} millirem.	Same as for PA.	Same as for PA.
Resource impacts	Less than 30 times the quantities of materials and energy required for annual operation; no significant use of scarce or strategic material required.	Same as for PA.	Same as for PA.

[a] Risks are the product of the consequences (i.e., potential cancer fatalities), the annual probability of the occurrence of the accident, and the number of years of operation.

1 NEED AND PURPOSE

The U.S. Department of Energy (DOE), in accordance with the Atomic Energy Act of 1954, as amended, is responsible for developing and maintaining a capability to produce all special nuclear material (SNM) required for the Defense Programs of the United States and for supporting related research and development programs. DOE's production of SNM is based on the Nuclear Weapons Stockpile Memorandum (NWSM), the document by which the President approves the production and retirement of nuclear weapons, and on the subsequent authorization and appropriation of funds by Congress.

The Special Isotope Separation (SIS) Project is needed by DOE to provide a prudent level of contingency, technological diversity, and flexibility in DOE's production complex for ensuring that approved needs for nuclear defense materials are met. The SIS Project would support this DOE mission by providing a reactor-independent plutonium isotope separation facility for purification of otherwise unusable DOE-owned feedstocks of fuel-grade material. These feedstocks include neither commercial fuel precluded by law nor fuel precluded by DOE policy. The SIS facility would use the technology of selective photoexcitation/ionization and electrostatic separation of vaporized plutonium isotopes, referred to as the Atomic Vapor Laser Isotope Separation (AVLIS) technique, which is being demonstrated at the Lawrence Livermore National Laboratory (LLNL).

As required by the regulations of the Council on Environmental Quality (CEQ) (40 CFR 1502.13), the following sections briefly discuss the underlying purpose and need for the SIS. The discussion on the need for the SIS Project is necessarily qualitative because quantitative defense material requirements, inventories, and production capacities are classified in accordance with the law. However, the need for this facility is based on providing contingency, technological diversity, and flexibility which are currently unavailable and which can be adequately discussed in the unclassified presentation that follows.

1.1 NEED

DOE's production of nuclear materials for national defense programs is based on the NWSM. In this memorandum, the Secretaries of Defense and Energy jointly recommend to the President the size and composition of the nuclear weapons stockpile that they believe is required to defend the United States. The approval of the NWSM by the President and the subsequent authorization and appropriation of funds by Congress constitute the legal authority and mandate for DOE to produce the specified types and quantities of nuclear defense materials and weapons and to maintain the facilities and capabilities to do so. The quantities of materials produced, the capacities of various facilities for producing these materials, and the national policy on nuclear weapons and their deployment involve various aspects of national security and are beyond the scope of this Environmental Impact Statement (EIS). The NWSM is classified (Secret/Restricted Data).

The annually updated NWSM requires that DOE take the necessary steps to provide the needed capacity and capability for nuclear materials and weapon production throughout the document's planning and projection periods (10 years). The nuclear materials referred to are tritium, highly enriched uranium, and plutonium. The SIS Plant will deal only with the production of plutonium. The SIS Production Plant would provide a capability for obtaining plutonium used in the weapons program by purifying fuel-grade plutonium. This capability would provide a contingent supply of weapon-grade plutonium* if the present source of material becomes unavailable for unanticipated reasons or if the demand for plutonium increases beyond present projections.

At present, weapon-grade plutonium is produced at the Savannah River Plant (SRP) in South Carolina using three reactors (i.e., P-, K-, and L-Reactors). Another former producer of weapon-grade plutonium, the N-Reactor at the Hanford Site in Washington, has been placed in cold-standby. The reactors at SRP are also the nation's only source of tritium which because of its radioactive decay rate is the highest priority for production by these reactors. Plutonium is only produced at the SRP after tritium requirements have been met.

The nuclear materials production requirements described above comprise an on-going mandate. Providing the required production capacity and capability has been increasingly difficult in recent years. To produce or be able to produce nuclear materials for the national security, the following criteria are considered essential:

- Contingent capacity, or contingency. It is fundamental that plutonium production capability be available when needed. The current production reactors are more than 30 years old and are nearing the end of their useful lives; therefore, a prudent level of backup capacity must be provided.

- Technological diversity. While reactors have been and will remain the ultimate source of new plutonium, reactor-based issues, such as those which have disrupted defense material production in the past, must not be permitted to compromise national security. A reactor-independent technology is required for backup production capability during those periods when reactor production may not be available.

- Flexibility in facility utilization in case approved production requirements rapidly increase or other plutonium capacity is diverted to tritium production. Weapons material requirements often vary substantially from year to year as new requirements are identified. Redundant capacity that can be quickly activated is not currently available in the complex.

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*Weapon-grade plutonium is defined as plutonium-239 nominally containing 6-percent plutonium-240. The term "fuel-grade" is used in this document to refer to plutonium containing greater than 6-percent plutonium-240.

An SIS Plant is the only available option that meets all these criteria. In response to the above needs, SIS would (1) have the capability of providing weapon-grade plutonium at a time when no other capability may be available; (2) provide a reactor-independent technology and, therefore, not be vulnerable to reactor issues that include generic concerns which could conceivably impact even newly constructed reactors; and (3) provide a capability that can be activated rapidly. No other option or set of options can sufficiently meet all of these criteria. Alternatives considered are more fully discussed in Section 2.5.2 of this EIS.

1.1.1 Need for SIS Project

As the Federal agency responsible for the production of nuclear defense materials, DOE is required to develop and maintain the capabilities necessary to produce plutonium. Plutonium is one of the fissionable materials used in nuclear weapons. For this application, the isotopic composition of the plutonium must meet specific weapon-grade plutonium requirements.

As noted above, DOE requires contingency in production capability, technological diversity, and flexibility in its production complex to ensure continued availability of plutonium production capacity. These concepts are discussed below:

> Contingency capacity within the DOE defense nuclear materials production complex is essential to ensuring that the needs for weapon-grade plutonium are met without being dependent or reliant on any single facility. The age of the present complex requires that a prudent level of contingent production capability be initiated now so that future approved requirements for nuclear defense materials can be met. SIS would provide this contingency capacity.
>
> Technological diversity, as represented by the SIS Project's ability to provide a reactor-independent source of weapon-grade plutonium, would lessen DOE's total dependency on its production reactors. Specifically, the SIS can produce weapon-grade plutonium from fuel-grade plutonium without being dependent on reactor availability to produce plutonium directly by blending through the production of higher-than-weapon-grade-purity plutonium. Such availability has been limited by generic issues related to reactor safety and operability.
>
> Flexibility in the DOE production complex would be provided by the SIS Project capability to provide an alternative source of weapon-grade plutonium when there are competing demands for tritium and plutonium production from the same production reactors or when approved plutonium demand requirements increase rapidly.

Currently, DOE can produce weapon-grade plutonium only by operating the three reactors at the SRP, when they are not fully dedicated to tritium production. SRP reactors produce weapon-grade plutonium or plutonium that is of a higher purity than weapon-grade (i.e., plutonium having a 3-percent plutonium-240 content) for use in a process referred to as blending. In blending, this newly produced plutonium of higher than weapon-grade purity is mixed with fuel-grade plutonium.

The near-term DOE weapon-grade plutonium production capability--by direct reactor production and blending--is entirely dependent on the continued availability of DOE's existing production reactors. The availability of the reactors at the SRP, which began operation in the early 1950s, is limited by the higher priority need for production of tritium and by operational constraints on their availability and power levels. For example, the SRP reactors have operated in a constrained mode, at nominally 50 percent power or less, since fiscal year (FY) 1987 and are expected to continue to operate in this mode during the near term. Future operational constraints could further limit production reactor availability.

N-Reactor, which operated up to and during 1986, was placed in a stand-down condition in 1987 while safety modifications were implemented. In February 1988, DOE announced that N-Reactor was being placed in cold-standby and would not be restarted immediately. DOE's decision not to restart N-Reactor was based on a sufficient near-term supply of weapon-grade plutonium and the high cost of continuing to operate the facility. The N-Reactor also has a limited service life that is governed by distortion of the graphite moderator. DOE is currently assessing the feasibility of modifying the N-Reactor for potential production of tritium, which may at some point make the reactor unavailable as a plutonium source.

The nation's stockpile of weapon-grade plutonium physically resides either in weapons or in inventories associated with manufacture, processing, and storage. When warheads are returned, the material can be reclaimed; however, the numbers and frequencies of return are determined based on national security considerations. During the chemical and physical processing of both new and returned material, scrap is generated. Evaluations of need for new weapon-grade plutonium fully consider the availability of material from returns and scrap. While accelerated processing of these materials can relieve short-term shortages, it adds no weapon-grade material to the stockpile. The recovery and recycling of existing weapon-grade plutonium from retired weapons and the acceleration of scrap recovery are, therefore, not reasonable alternatives to the SIS Project because they provide no contingency source of material.

The length of operation and the quantity of material to be processed by the SIS Project would be dependent on (1) the availability of DOE-owned feed material, and (2) the level of operation (i.e., fraction of full SIS production capacity). The latter would be determined annually commensurate with approved requirements for nuclear defense materials. Currently, DOE has identified a quantity of feed material that would result in several years (8 to 10) of SIS operation at full throughput capacity. Additional sources of DOE-owned feed material, which do not include spent fuel from commercial reactors precluded by law, may be available in the future, depending on other DOE production initiatives and the limitations on existing production facilities. Being highly modularized, the AVLIS technology would allow the SIS Project to be expanded if ever required. Such expansion would be the subject of a separate National Environmental Policy Act (NEPA) review.

1.1.2 Relationship to Other Actions

Currently, DOE is preparing an Environmental Assessment (EA) analyzing the feasibility and environmental impacts of various fuel-decladding/processing techniques that could be used to recover DOE-owned plutonium in the spent fuel from the Fast Flux Test Facility (FFTF) at the Hanford Site. Methods currently being assessed assume the decladding of FFTF fuel and the subsequent chemical processing of the decladded fuel at the Hanford Site. The annual impacts of potentially transporting the processed FFTF fuel would be the same as those for transporting N-Reactor fuel-grade plutonium to SIS facilities. While the implementation of a fuel-decladding activity for FFTF fuel would provide a significant source of feed material for SIS processing, the availability of this material is not a prerequisite in DOE's decision on whether to proceed with the SIS Project.

As proposed and assessed in this EIS, the SIS Project would not modify existing DOE nuclear materials production facilities; instead, it would be integrated with existing support and waste management facilities at the selected site. Construction and operation of the SIS Project at any of the alternative sites considered in this EIS would involve neither major changes to the proposed SIS Project nor changes to other DOE facilities for the production of weapon-grade plutonium.

The DOE has recently announced its intention to add New Production Reactor (NPR) capacity to provide a long-term, reliable source of tritium. The NPR would be designed to replace the Savannah River reactors as the primary source of tritium but would be capable of producing weapon-grade plutonium should excess capacity remain after accomplishment of the primary mission. Prior to this (i.e., from the year 1995 to the year 2005), SIS would constitute the sole contingency capability for weapon-grade plutonium. Subsequently, SIS would afford flexibility in utilization of NPR and would ensure, through technological diversity, against supply interruptions stemming from potential generic reactor problems.

Operation of the SIS Project has the potential capability of fulfilling other isotopic separation missions. Examples of potential additional isotopic separation missions that would use DOE-owned feed materials are (1) the isotopic purification of existing weapon-grade plutonium to reduce radiation hazards to personnel in the DOE and Department of Defense (DOD) environments; (2) the cleanup of plutonium-238 for space power applications; (3) the isotopic purification of other plutonium isotopes for weapon research and demonstration programs; and (4) the isotopic purification of highly enriched uranium from the Idaho Chemical Processing Plant (ICPP) to reduce potential radiation hazards and to better utilize these existing uranium resources. The DOE is not formally proposing nor has it approved other missions for the SIS Project as part of its proposal to proceed with the construction and operation of the SIS Project. Prior to proceeding with any other potential missions, the appropriate environmental, technical, and safety evaluations would be performed to ascertain the feasibility of using the facilities as well as any needed modifications, and any change in the proposed use of the SIS Project to produce weapon-grade plutonium from DOE-owned sources of fuel-grade plutonium would be fully subject to the requirements of NEPA.

1.1.3 Proposed Action and Alternatives

The DOE's Preferred Alternative (Proposed Action) considered in this EIS is to construct and operate the SIS Project at the INEL near Idaho Falls, Idaho. The identification of this Preferred Alternative is based on the findings of a site evaluation team in 1986 (DOE, 1986) as discussed in Section 1.1.4. The alternatives are to (1) construct and operate the SIS Project at the Hanford Site; (2) construct and operate the SIS Project at the SRP; and (3) take No Action. If constructed and operated, the SIS Plant would produce weapon-grade plutonium from DOE's present and future inventories of fuel-grade plutonium. After SIS processing, weapon-grade plutonium would be transported from the selected site to DOE's Rocky Flats Plant; by-product material (primarily plutonium-239 and 240, with lesser quantities of plutonium-238, 241, and 242) would be stored in a vault at the location of the SIS Plant on an interim basis until DOE evaluates its applicability to other possible missions. If no further missions are identified, the by-product material would be rendered into a form that would meet acceptance criteria and would be transferred to the Waste Isolation Pilot Plant (WIPP), once this facility is ready to emplace material. The potential environmental consequences of transporting this by-product material to the WIPP have been identified in the EIS even though a decision has not been made regarding the applicability of by-product material to additional missions.

Chapter 2 of this EIS describes the Proposed Action and alternatives, including the No-Action Alternative and those alternatives considered but determined not to be reasonable alternatives to the SIS Project and eliminated from detailed consideration. Chapter 3 discusses the affected environments at each of the alternative sites. Chapters 4 and 5 discuss the potential environmental consequences of the alternatives and the regulatory requirements and guidelines applicable to the construction and operation of the proposed SIS Project, respectively.

1.1.4 History

In FY 1980, Congress appropriated initial funding for research into the application of AVLIS technology for separation of plutonium isotopes. Later, in accordance with the Conference Report for FY 1986 Energy and Water Development Appropriations Act (Public Law 99-141), DOE reviewed the ALVIS process being developed by LLNL and the Molecular Laser Isotope Separation (MLIS) process under development at the Los Alamos National Laboratory (LANL). The purpose of this review was to establish the readiness of these two processes for deployment and to select the most suitable process for a possible production facility. In March 1986, DOE prepared an Environmental Assessment (DOE, 1986d) to evaluate the differences in potential environmental impacts between the AVLIS and MLIS technologies. DOE's Finding of No Significant Impact (FONSI), issued in April 1986, concluded that although there are quantitative and qualitative differences between the processes, no significantly different environmental impacts exist between the two processes (DOE, 1986e). DOE further determined that the selection of the SIS process for the purpose of focusing continued development, demonstration, and design of a potential production plant was not a major

Federal action significantly affecting the environment. As a result of this review, DOE selected the AVLIS process as the preferred technology for SIS.

As a followup to the technical readiness review conducted in early 1986, DOE initiated a decision-making process to identify a preferred site for SIS Plant design consideration. A site evaluation team was appointed within DOE to provide an SIS Project-independent technical evaluation of production and/or reactor fuel processing sites. The site evaluation team, composed of DOE technical experts, made its evaluation on the basis of a 3-month analysis. The evaluation team advised that the INEL would provide diversification of plutonium processing sites and a favorable labor climate. In making its evaluation, the team examined available support facilities and other criteria, including project cost and schedule; environmental, safety, and health impacts; human resources and workload; and socioeconomic considerations (DOE, 1986f).

Documents that are used as reference documents for this EIS (see section entitled "References") and that provide additional information on the background and potential environmental consequences of the SIS Project have been placed for public inspection in the SIS Public Reading Room of the INEL Technical Library, University Place, 1776 Science Center Drive, Idaho Falls, Idaho, the DOE Public Reading Rooms in Aiken, South Carolina, Richland, Washington, and the Freedom of Information Reading Room in Washington, D.C.

2 PROPOSED ACTION AND ALTERNATIVES

This chapter describes the Proposed Action and alternatives considered by the U.S. Department of Energy (DOE). The Proposed Action and DOE's Preferred Alternative is the construction and operation of the Special Isotope Separation (SIS) Project using the Atomic Vapor Laser Isotope Separation (AVLIS) process at the Idaho National Engineering Laboratory (INEL) near Idaho Falls, Idaho (Section 2.1). The alternatives to this Proposed Action are to construct and operate the SIS Project at the Hanford Site near Richland, Washington (Section 2.2); construct and operate the SIS Project at the Savannah River Plant (SRP) near Aiken, South Carolina (Section 2.3); and take No Action, or not construct and operate the SIS Project (Section 2.4). No major modifications in the design or processes of the proposed SIS Project would be required for constructing and operating the SIS Project if located at any of the alternative sites. Blending, as described in more detail for the No-Action Alternative, would continue to be practiced by DOE in all cases.

Section 2.5 of this chapter discusses other options that DOE has considered but that are not addressed in detail in this Environmental Impact Statement (EIS). Section 2.6 presents a comparison of the environmental consequences of the Proposed Action and the alternatives considered.

The information presented in this chapter has been updated since the issuance of the Draft EIS to reflect the most currently available design and safety analysis data and analyses. As a result of the on-going design process, changes to the proposed SIS Project include the adoption of the potential laser and process modifications discussed in the Draft EIS. As discussed in the Draft EIS, the adoption of the potential laser modifications, referred to in this Final EIS as the Auxiliary Laser Subsystem, would employ a dye (LD700) similar in structure to those used in the dye-laser subsystem. Adoption of the potential process modifications, while resulting in 200 metric tons (220 tons) of additional transuranic (TRU) waste, would result in employing a reliable and proven nitric acid system for recovery and purification of plutonium which DOE is currently using at other facilities. In addition to adoption of the modifications noted above, the design of the SIS process liquid waste system has been modified such that process and nonprocess (i.e., cooling tower blowdown and steam condensate) have been segregated to ensure that only nonhazardous and nonradioactive liquid effluents would be discharged.

2.1 CONSTRUCT AND OPERATE THE SIS PROJECT AT THE INEL

The proposed site of the SIS Project at DOE's INEL was selected from among several candidate sites that included a stand-alone or new site that would be established at the INEL, the Idaho Chemical Processing Plant (ICPP), the Test Reactor Area (TRA), and Test Area North (TAN). Each of these candidate sites was reviewed and evaluated on the basis of several criteria, including:

- Applicability of technical experience within the operating areas for plutonium handling
- Safeguard and security infrastructure
- Availability of support facilities and utilities
- Operational compatibility
- Operational and construction costs
- Environmental factors (i.e., seismicity, flooding, use of previously undisturbed areas, and the availability of environmental data to support impact analyses).

On the basis of these evaluation criteria, a new stand-alone area would impact previously undisturbed areas, result in significantly greater operational and construction costs (i.e., more than one-fourth the cost of the SIS Project), and was judged not to be superior for any of the other criteria evaluated. With respect to locating the SIS Project at the TAN, TRA, or ICPP, each of the areas was evaluated to be equal to one another with respect to environmental factors and the availability of support facilities and utilities. The ICPP area was evaluated as the most suitable considering (1) the applicability of technical expertise with respect to processing and management of DOE-owned fuels; (2) safeguards and security infrastructure, including a recently upgraded personnel exclusion zone and security area for the protection of Category I amounts of nuclear material; (3) operational compatibility; and (4) operational and construction cost savings with respect to infrastructure (e.g., roads, warehousing, maintenance shops, fire protection, etc.) and security and safeguard improvements that would be required at either the TRA or TAN areas. The preferred INEL site of locating the SIS Project within the ICPP area was included as part of the INEL presentation to the site evaluation team. Based on the presentation of this team, the Energy Systems Acquisition Board designated the INEL as the preferred location for the SIS Project.

The SIS Project site is located within the northern portion of the fenced area of the ICPP (Figure 2-1). The major facilities to be constructed as part of the SIS Project include a Laser Support Building (LSB) to house the main laser equipment; a Plutonium Processing Building (PPB) to house the separator lines, mainstream processes in support of the separator lines, and sidestream processing for recoverable quantities of plutonium; and a storage vault that would be used for SIS-generated by-product material. Figure 2-2 displays a plot plan of the SIS facilities at the INEL site. The SIS Project would be integrated with other INEL facilities that would provide steam, water, and other utilities for the proposed project as well as waste management of low-level radioactive waste (LLW), TRU, hazardous, mixed, sanitary, service, and nonradioactive and nonhazardous solid wastes.

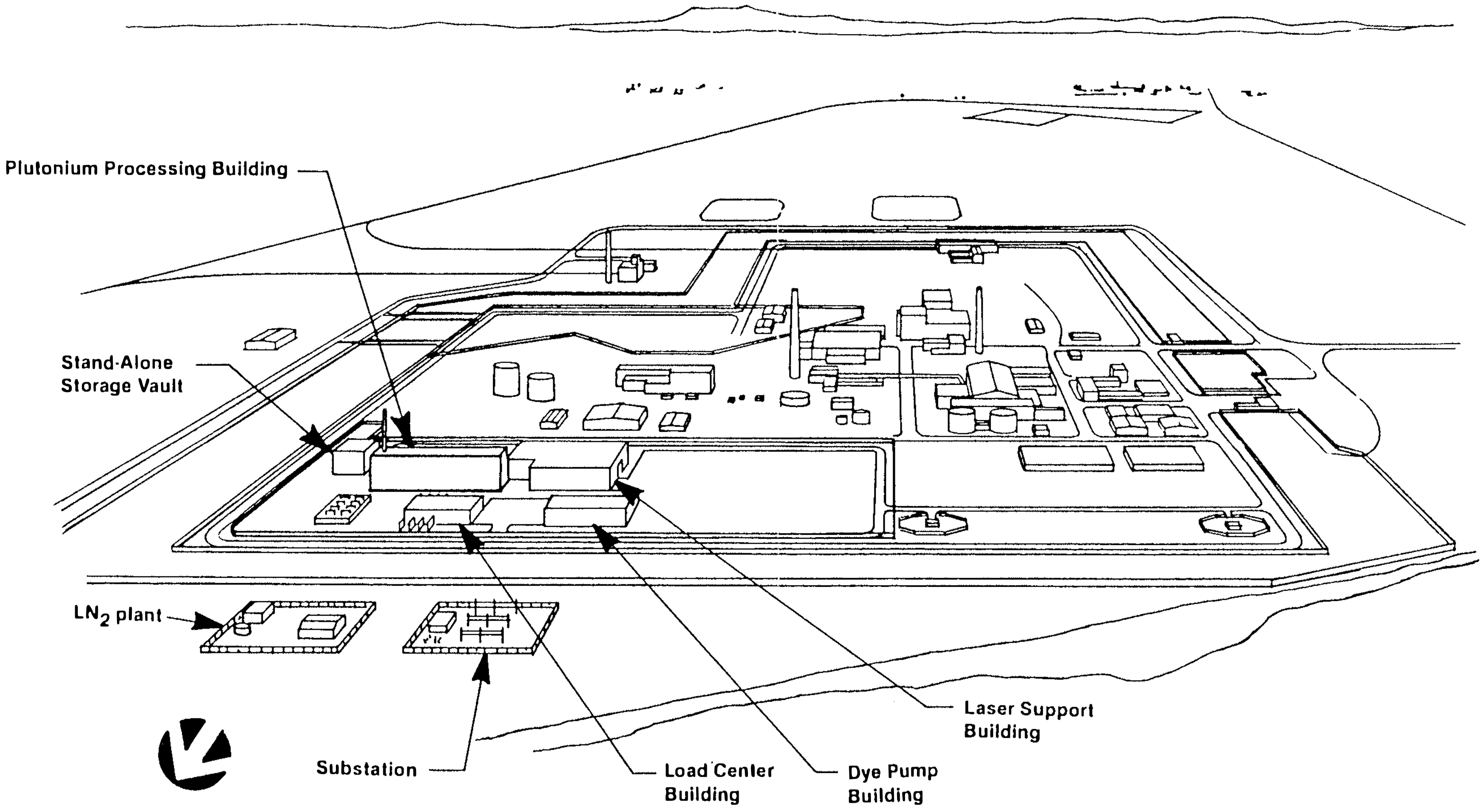


Figure 2-1. SIS Site at the INEL.

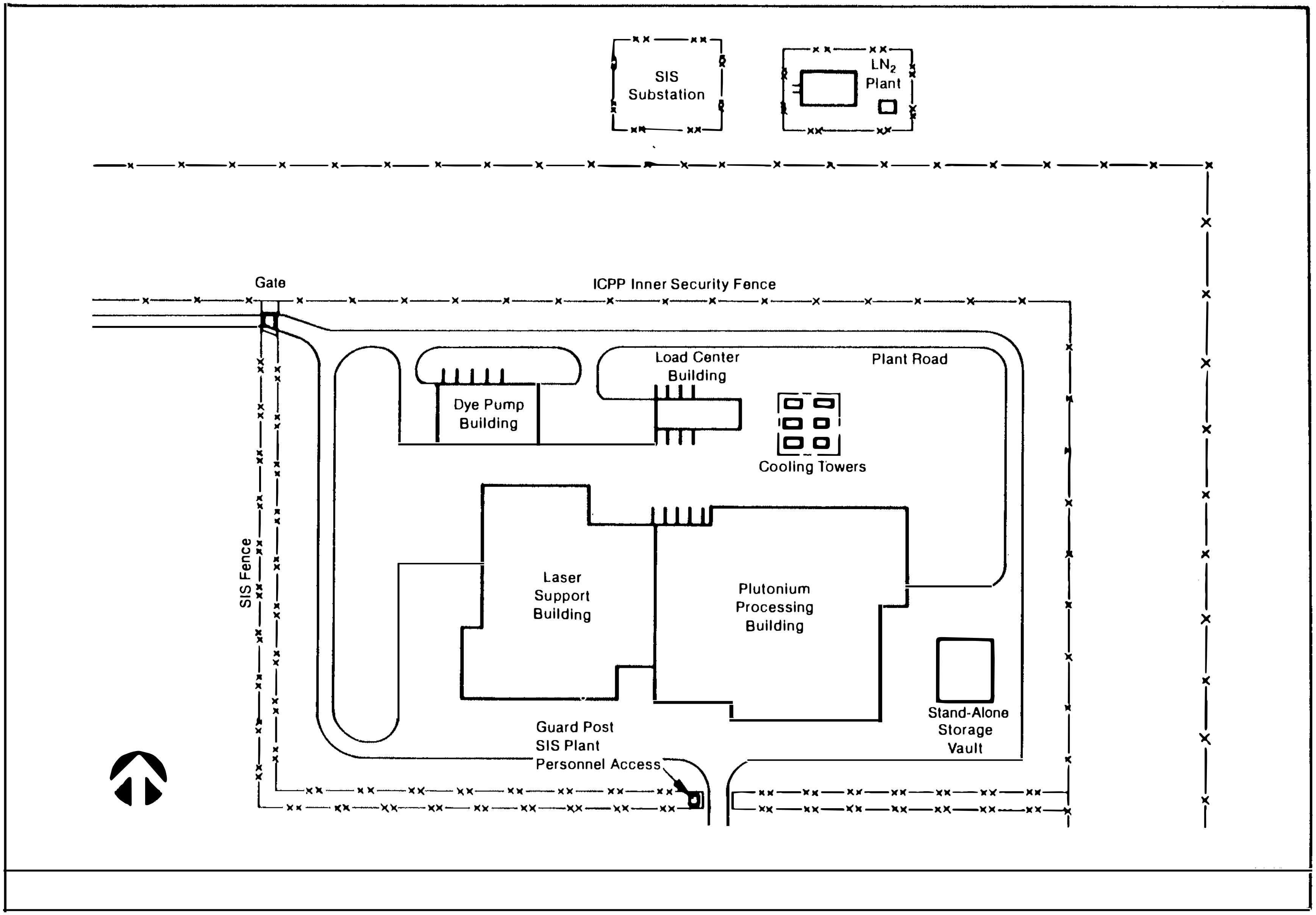


Figure 2-2. SIS Plot Plan.

The following sections describe the basic processes, facilities, effluents, and resource requirements associated with the construction and operation of the proposed SIS Project. The description of the processes, facilities, effluents, and resource requirements is based on definitive designs as completed by September 1988.

2.1.1 Process Descriptions

The basic process elements of the SIS Project are illustrated in Figure 2-3. Plutonium feed would be chemically processed to prepare the plutonium as feed to the AVLIS process. These initial process steps would include reduction of plutonium oxide to elemental plutonium, extraction of americium from plutonium metal, and casting of plutonium metal into a suitable feed form for the AVLIS process separator system.

The AVLIS process would perform the isotopic separation of the plutonium feed into a product stream meeting required isotopic specifications and into a plutonium by-product stream. The physical separation of the plutonium isotopes in the feed involves the interaction of laser-light beams and a plutonium vapor stream in the separator units of the AVLIS process. Plutonium enriched in the desired plutonium isotope is captured on product collectors, and undesirable plutonium isotopes are captured on by-product extractors in the separator units.

The separator system product collectors would be processed to recover the desired enriched plutonium. The product stream may then pass through an electrorefining (ER) process, if required, to meet chemical purity specifications. The separator system by-product extractors would be processed to recover and convert the plutonium by-product to a stable plutonium oxide. The final product would be packaged and transported off the site, and the final by-product would be packaged and stored in a new Stand-Alone Storage Vault.

The by-product material that would be stored in the Stand-Alone Storage Vault would be primarily plutonium-239 and 240 with lesser quantities of plutonium-238, 241, and 242. The by-product material would be stored on an interim basis until such time as DOE evaluates the potential applicability of the by-product material for other possible DOE Defense Program missions. If no missions are identified for the by-product material, it would be rendered into a form that would meet waste emplacement/acceptance criteria and be transported to the WIPP for emplacement. The risks of transporting SIS by-product material are analyzed in Chapter 4. Storage of the by-product material in the storage vault would not exceed the design-life of the storage vault (i.e., 30 years for a new Stand-Alone Storage Vault).

The AVLIS and balance-of-plant (BOP) processes for the conversion of fuel-grade plutonium oxide into weapon-grade plutonium are discussed in the following sections.

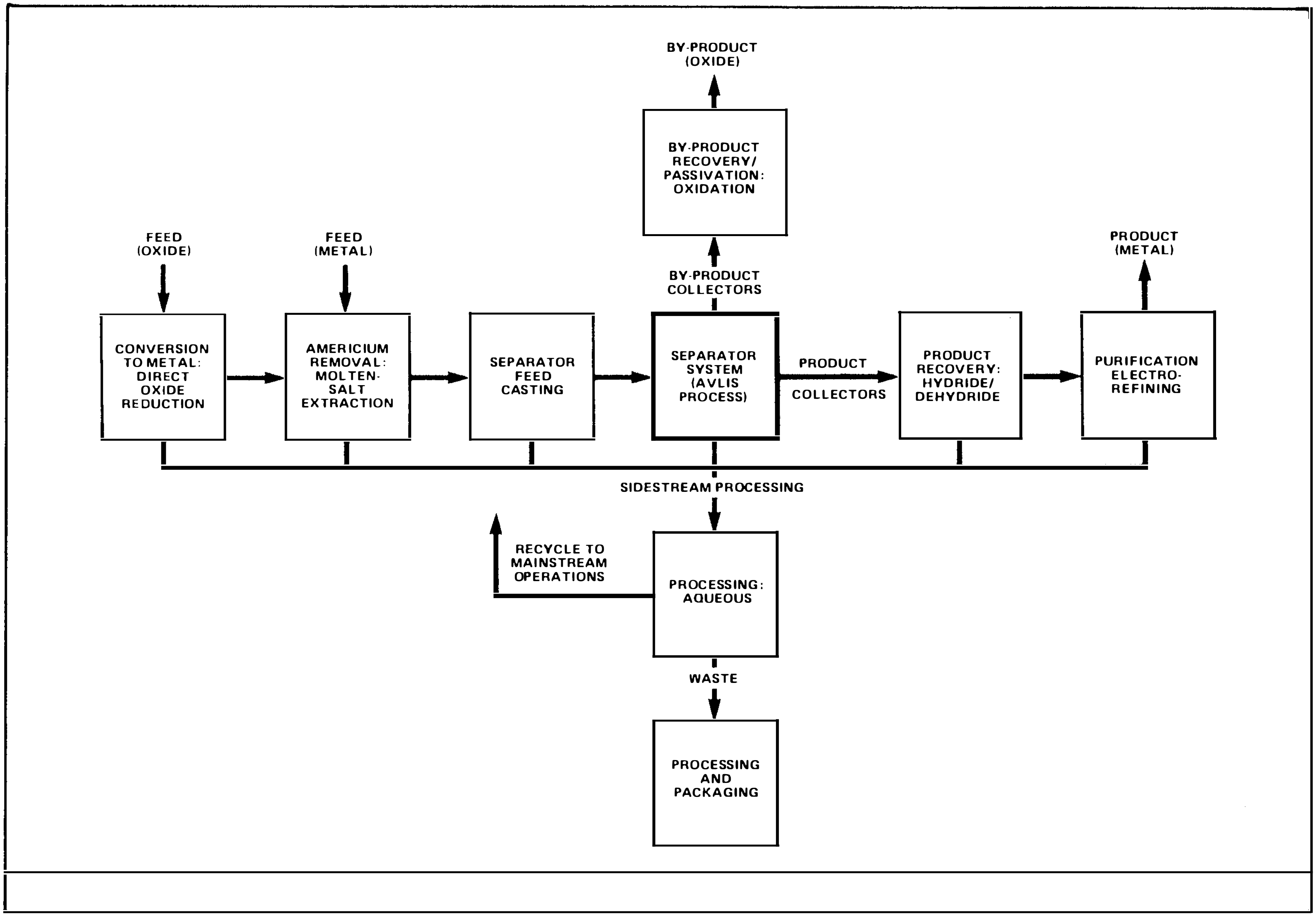


Figure 2-3. Plutonium Processing Flow Diagram.

2.1.1.1 AVLIS Process

The electron energy states of any atom are very precisely defined and depend on the mass of the atom. These electron energy states give rise to light-absorption characteristics that are unique to each isotope. When an electron absorbs light of the correct or matching energy, the electron can become free of the forces that bind it to the atom. The loss of the electron leaves the atom with a net positive charge (ion), which can be separated from the neutral atoms in a vapor stream by the application of an electric field. The AVLIS process relies on the differences in light absorption of the individual plutonium isotopes to achieve separation.

As illustrated in Figure 2-4, the AVLIS process contains two basic systems: the laser system, housed in the LSB, and the separator system, housed in the PPB. The initial step in the AVLIS process is the electron-beam vaporization of the plutonium metal feed in the separator system to form a directed stream of nonionized atomic vapor. The laser system would provide the precisely tuned, monochromatic visible laser-light beams for the photoionization of selected plutonium isotopes (i.e., plutonium-238, 240, and 241) in the vapor stream. The ionized plutonium isotopes are removed at the by-product extractors by an applied electric field in the separator system. The neutral vapor stream, enriched in the desired plutonium isotope (plutonium-239), deposits on the product collector.

Separator System

The SIS Project would contain four separator lines within the PPB, each of which would be housed in a large glove box, called a line box (Figure 2-5). Within each line box would be four separator units. The line box would be separated horizontally by a stainless-steel membrane, creating an upper and lower chamber. The upper chamber would house the vacuum chambers, an interconnecting beam pipe, and an overhead hoist. The lower chamber of the line box would contain the separator transport and handling systems. The atmosphere in both chambers would be nitrogen.

Separator units, in which the laser light and plutonium vapor would interact to provide the separation of plutonium isotopes, would consist of a feeder mechanism, vaporizer assembly, product collector, and by-product extractors. Individual separator units would be moved into and out of the lower chamber of the line box by a transfer cart on a conveyor system. Associated utilities, such as cooling systems, power supplies, vacuum pumps, and instrumentation and control (I&C), would be connected after the separator unit is within the vacuum chamber.

Once the separator units are in place within the vacuum chambers and utilities are connected, the isotopic separation process would be initiated. The vaporizer assembly would produce a stream of plutonium vapor. The laser light would photoionize selected plutonium isotopes. The by-product extractors would electrostatically remove and trap the photoionized isotopes from the vapor stream, and the product collector would capture the remaining vapor enriched in plutonium-239.

Each separator line would be supported by a series of three glove boxes: the separator storage box (SSB); the disassembly box (DB); and the

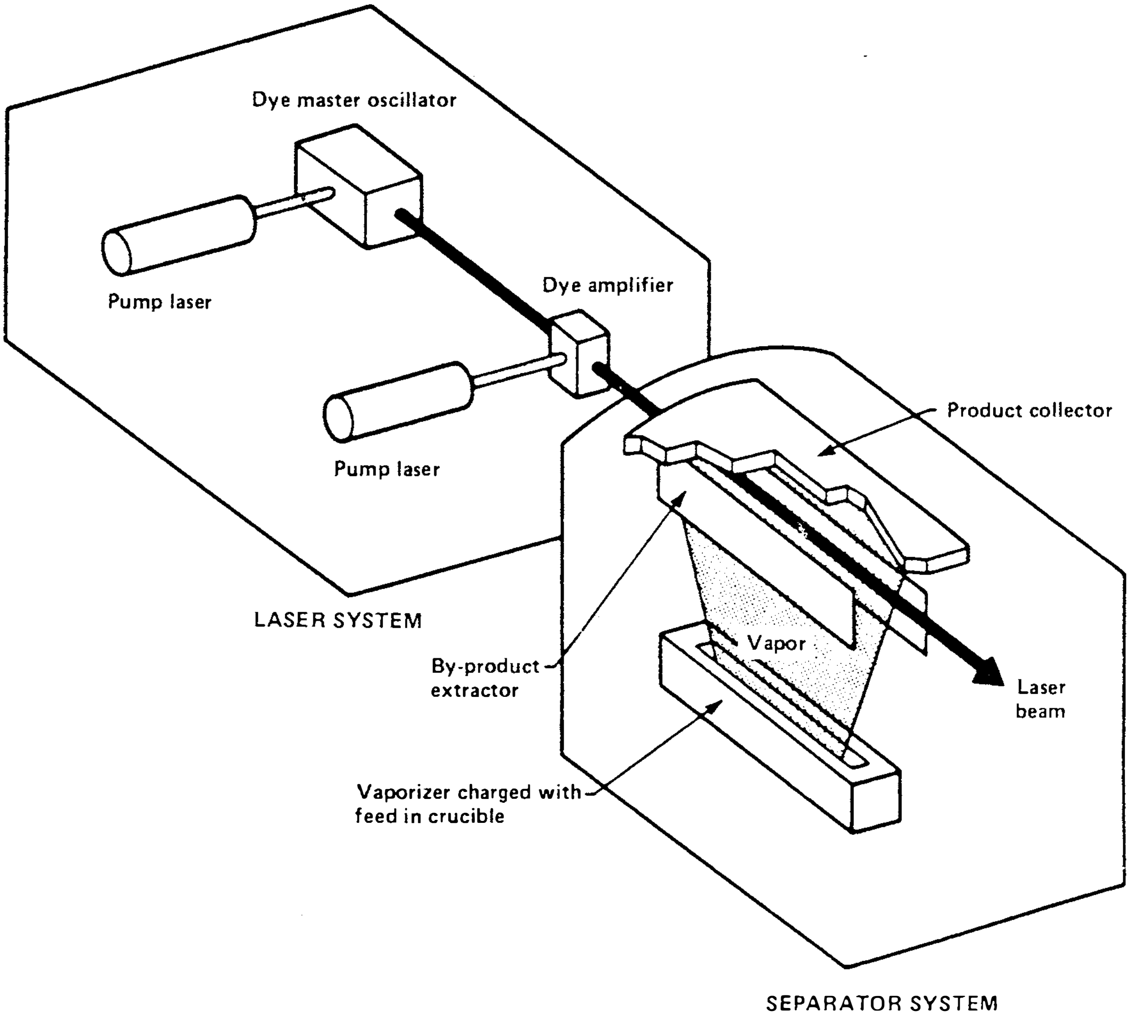


Figure 2-4. AVLIS Process Diagram.

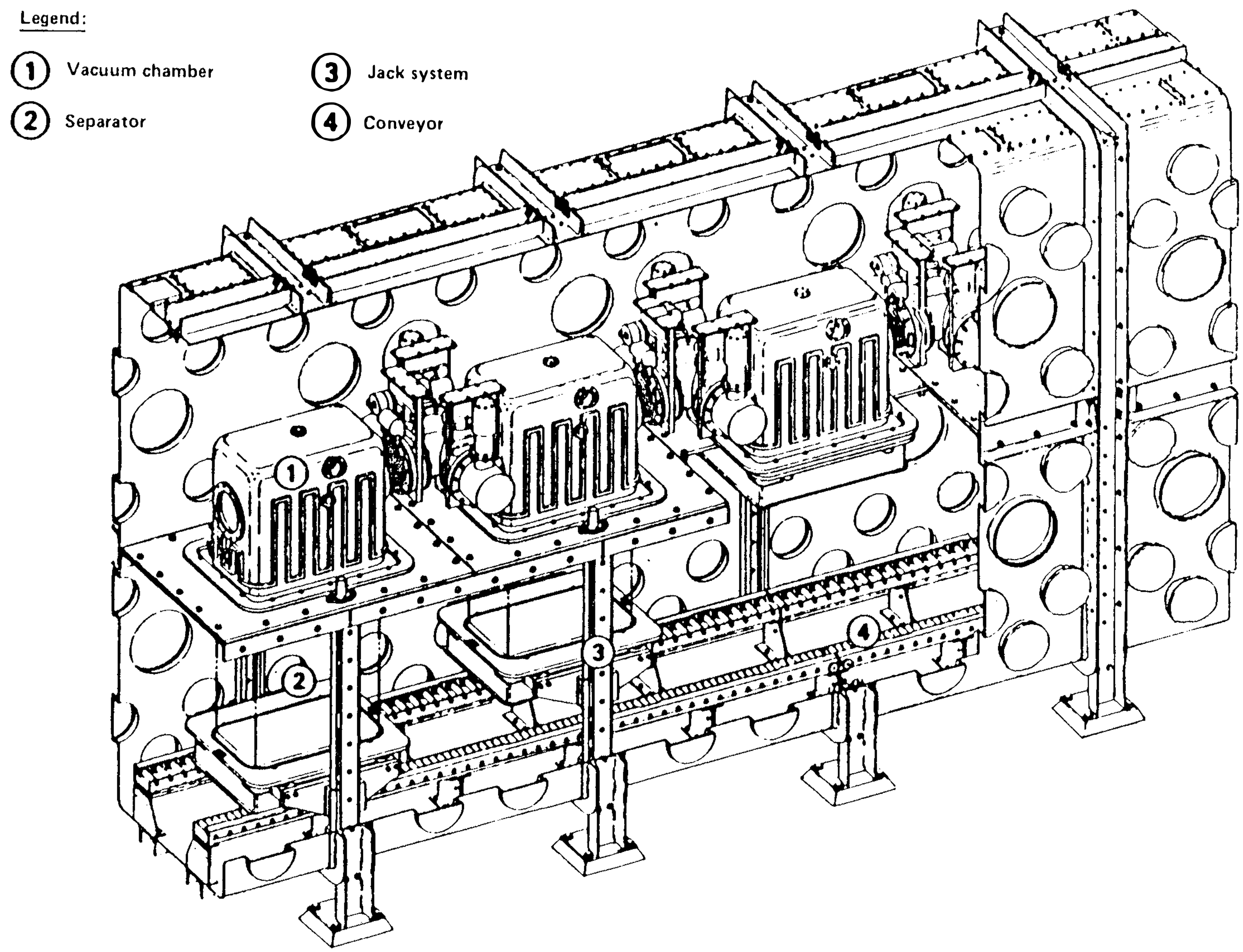


Figure 2-5. Separator Line Box.

assembly, resupply, and maintenance (ARM) box. The SSB contains vacuum chambers for the storage of used and refurbished separators. Following an operational cycle, used separators would be transferred, one at a time, from the separator line box to the SSB and replaced by refurbished units. Used separators in the SSB would be transferred to the DB for disassembly. Disassembled parts would either be transferred to chemical processing or transferred from the DB to the ARM to be made ready for reuse. After operations are completed on the parts in the ARM box and the separators reassembled, the separators would be transferred to the SSB to await return to the line box. All of these operations would be performed in a nitrogen atmosphere.

Laser System

The laser system (Figure 2-6) located in the LSB would supply tuned, multi-wavelength light beams that selectively photoionize selected plutonium isotopes. The laser system would comprise the subsystems needed to convert incoming electric power into process light and deliver that light to the plutonium separators in the PPB. The laser and electro-optical system would contain five major subsystems: the copper-laser subsystem, the dye-laser subsystem, the ALS, the beam-combination and optical transport subsystem, and the I&C subsystem. Because of their capability to be "tuned" to precise color values (and hence energy levels) and their high efficiency, dye lasers would be used to generate the multiple process wavelengths. However, the dye lasers must be optically excited, since they cannot be electrically excited directly. Copper lasers would be used to convert electrical energy into fixed-wavelength green and yellow light, which would then be used to excite (pump) the dye lasers. After amplification, the output from the dye-laser chains would be combined optically and transported to the separator units in the PPB through underground evacuated beam tubes.

Copper-Laser Subsystem

Copper lasers are devices that employ a dilute vapor of metallic copper in neon gas as their active medium. Electrical energy excites and heats the medium to produce a discharge of fixed-wavelength green and yellow light. Generically, copper lasers are in the category of gas-discharge lasers. For the SIS Project two copper-laser subsystems would be employed, one to provide optical power to the dye-laser amplifiers, and one to provide light to the dye master oscillators.

The copper-laser subsystem providing light to the dye-laser amplifiers would be composed of copper-laser chains, each consisting of an oscillator and three amplifiers. The oscillator package in each chain would contain two small-bore copper lasers. The output of the oscillator package would be a single, low-power beam that has precisely controlled spatial characteristics. Amplifiers consisting of large-bore copper lasers are used to increase the laser power for pumping or energizing the dye lasers.

Beams from the multiple copper-laser chains would be used in parallel to provide the required pulse repetition frequency (process) and total power to the dye-laser system. The output of these chains would contain both green and yellow light that would be split by an optical system. Each color

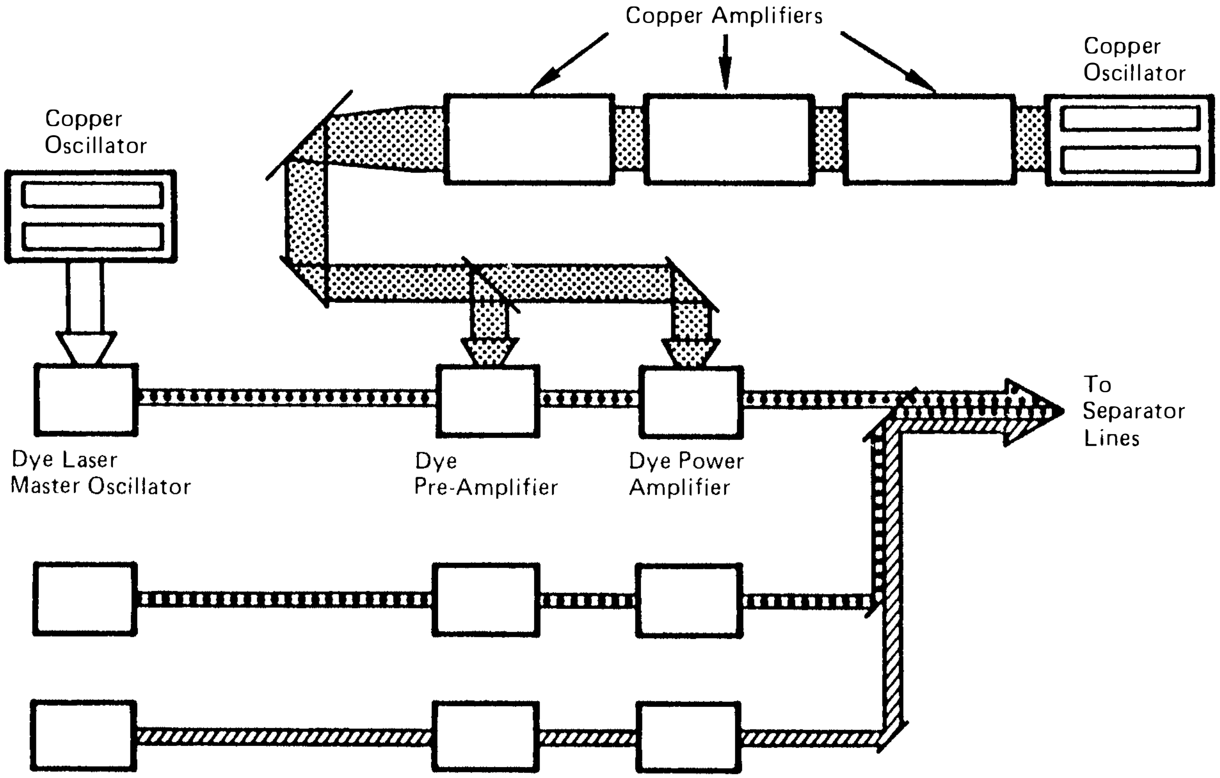


Figure 2-6. Basic Laser System Architecture.

would then be used to pump separate dye chains for optimum utilization of the copper-laser light.

The copper-laser subsystem providing light to the dye-laser master oscillators would not require copper-laser amplifier chains, as the dye-laser master oscillators require relatively low optical pumping power. The copper-laser subsystem providing light to the dye-laser master oscillators would consist of a number of copper oscillators whose outputs would be multiplexed for repetition rate and power.

Copper lasers convert only a fraction of the input electrical power to laser light. As a result, a large portion of this energy is converted to heat. A low-conductivity cooling-water system would remove this heat from the copper lasers. To prevent structural damage to the copper lasers, emergency cooling water would also be provided from the raw water supply in the event of failure of the primary system. Electronics for both the oscillators and amplifiers would be immersed in a closed-loop Freon system for cooling and for preventing high-voltage breakdown.

Dye-Laser Subsystem

The dye-laser subsystem would generate laser beams with the precise spatial and spectral properties required for photoionization of undesired plutonium isotopes. The basic components of the dye-laser subsystem are the waveform generator, the wavelength acquisition and stabilization unit, and the dye-laser power amplifiers.

The waveform generator consists of a number of dye master oscillators that generate the basic wavelength signals required by the process. These low-power signals would be actively controlled by a wavelength acquisition and stabilization unit by using an absolute wavelength reference standard.

To increase the power of the signal from the waveform generator to that required by the process, a number of dye-laser amplifiers, pumped by increasing amounts of copper-laser power, would be used. These amplifiers would consist of a flow channel through which dye solution is circulated. Light from the copper lasers would excite the dye molecules, providing energy for the process beam.

The dye-recirculation system, housed in the Dye Pump Building (DPB), would supply the dye solutions to the dye lasers. These colored solutions would be generated from different dyes, initially in powdered form, and then dissolved in ethanol to a controlled concentration. The dyes are chemically distinct but have similar physical properties.

The four dyes presently planned for use in the SIS Plant are R4, R6, Rhodamine 6G (R6G), and P6F. The first three of these dyes are basic dyes of the xanthene series and are prepared and purified as tetrafluoroborate compounds. P6F is produced as a perchlorate salt. In these forms, all dyes have been evaluated for mutagenicity using Ames/*Salmonella* microsome test procedure. In all tests there was no indication of mutagenic behavior (SRI, 1987a,b; Webbles and Felton, 1985).

The first two dyes, R4 and R6, which are members of the xanthene series, have been synthesized (i.e., produced from a molecule) for the SIS mission; P6F is a commercially available laser dye also known as LD700. R6G is a well-established commercial dye developed over 50 years ago that is now prepared in various forms and with various purities in quantities exceeding 100 tons per year. This dye is used extensively for coloring drugs for internal use, mouthwashes, lipsticks, toothpastes, soaps, and lacquers and in pigments for printing ink, cosmetics, crayons, pastels, and leather and paper dyes.

Over the years, several investigators have tested R6G, which had a variety of generally unknown chemical purities and compositions, for mutagenicity. Two in vitro studies in the 1970s produced negative results for mutagenicity (Kada, Tutikawa, and Sadais, 1972; Au and Hsu, 1979). Earlier work in Japan produced tumors in rats from repeated injections (average of 100 injections), but the test dosages (an average of nearly 100 milligrams for a 200-gram rat) and control on the tests and materials were not consistent with presently accepted testing procedures (Umeda, 1956). A study on the biological effects of dyes on living tissue indicates that repeated injections of toxic substances may generate tumors by the trauma rather than by chemical carcinogenesis (Gangolli et al., 1972). Nestmann et al. (1979) published results that indicated positive mutagenic activity, but in response to discussions with the authors Webbles and Felton (1985), Nestmann indicated that impurities could be responsible for his results. The workers in Webbles and Felton (1985) attempted to reproduce Nestmann's results with R4, R6, P6F, and R6G but were unable to do so with the SIS dyes.

Although the evidence for mutagenicity of properly purified R6G is weak, it has been identified, on the basis of the earlier tests, as a possible animal carcinogen. This identification is to be contrasted with two more serious categories of (1) human carcinogen, or (2) positive mutagenic activity in two or more mammals.

The National Toxicology Program is presently performing a comprehensive cancer bioassay program that will include R6G in the survey. Results from this work will not be available for a year or more. All dyes used in the SIS Project will be handled as if possible carcinogens in operation and as hazardous wastes with respect to disposal.

Auxiliary Laser Subsystem

During definitive design, modifications are being made to the laser system to enhance photoionization performance. The ALS is a krypton-ion-pumped dye-laser system. The dye used in this system (approximately 0.1 percent of the total mass) is P6F, also known as LD700 (see dye-laser subsystem discussion). The dye solvent would be ethylene glycol with a small amount of benzyl alcohol.

Beam-Combination and Optical-Transport Subsystem

The beam-combination and optical-transport subsystem has two primary parts, one for pump light and the other for process light, or tunable visible light. For pump light, the copper-laser beam-combination and transport optics would combine and distribute the light from many copper-laser chains. For process light, the dye-laser beam-combination and transport optics would transport the tunable visible light within the LSB. The separate process light beams would be combined for transport to the PPB through underground evacuated beam tubes. Once in the PPB, the process light would be formatted and propagated by the separator system optics throughout the plutonium vapor region.

Laser Instrumentation and Control Subsystem

The laser I&C subsystem would measure all parameters and directly control all laser functions. Local control would be provided at required workstations, while an integrated supervisory level of the system would permit assumption of control during normal operations. A management information level would provide trend information (Section 2.1.2.3 contains additional details).

2.1.1.2 Balance-of-Plant Processes

The BOP processes in the PPB would serve several key functions. Mainstream processes in support of the AVLIS separators would provide the requisite feed to the separator, the recovery of plutonium from the separator components, and the purification (as required) of the enriched product. These unit operations would generate sidestreams containing recoverable quantities of plutonium. Chemical processing of these sidestreams would recover the plutonium. Finally, waste processing would convert the various gaseous, liquid, and solid waste streams and nonserviceable components into forms suitable for disposal. The following sections briefly describe the mainstream and sidestream processes. Section 2.1.5.1 discusses waste streams, waste processing, and the resulting operational atmospheric emissions, liquid effluents, and solid wastes.

Mainstream Processes

The mainstream unit operations (Figure 2-3) would consist of metal conversion, americium removal, feed casting, plutonium recovery, product purification, and by-product processing.

Metal Conversion

In metal conversion, plutonium oxide is heated, or calcined, to remove residual absorbed water and volatile materials and then reduced to plutonium metal through direct oxide reduction (DOR), a one-step conversion process in which plutonium oxide reacts with calcium metal to produce plutonium metal. A molten-salt mixture dissolves the reaction product, CaO, allowing coalescence of the plutonium metal. The reaction would take place in a special tilt-pour furnace (similar to a small crucible that is heated electrically) designed for pyrochemical operations. The salt would then be separated from the plutonium metal and processed for plutonium recovery. The plutonium metal would be transferred to the next process step (americium removal).

Americium Removal

The decay of plutonium-241 results in the formation of americium-241, which is an alpha emitter. Since most of the feed metal is expected to exceed an upper limit of americium-241 in the plutonium for feed to the separators, a molten-salt extraction (MSE) process would be used for americium removal. In MSE, plutonium metal would be contacted with a molten salt mixture containing a small amount of $PuCl_3$, which would be supplied from a sidestream. The $PuCl_3$ selectively oxidizes the americium (Am) to $AmCl_3$, and after cooling, the $AmCl_3$ containing salt is separated from the plutonium metal (button). The separated salt would then be processed to recover plutonium, and the plutonium button sent to feed casting.

Feed Casting

In feed casting, plutonium metal would be cast from MSE metal buttons and chemically pure recycled material. The metal buttons would first be cast into an ingot where volatile impurities would be removed. Each ingot would then be weighed and assayed. When needed, the plutonium ingot would be remelted and cast into feed forms meeting separator requirements. Residues from casting would be recycled.

Plutonium Product Recovery

The plutonium product deposited on the product collector would be recovered by reacting it with hydrogen and collecting the resultant hydride powder. The powder would then be heated to decompose the hydride, providing a solid-metal button product. The product metal may then be purified via electrorefining (ER), if required, or packaged for shipment.

Product Purification

Plutonium metal product from the hydriding operation would be chemically purified, as required, by an ER process. In ER, metal feed would be placed in an anode cup and electrochemically dissolved in a molten-salt electrolyte containing $PuCl_3$. Pure plutonium metal would be deposited at the cathode. At the completion of the run, the anode and salt would be recycled for scrap recovery, and the product metal would be cast into buttons and packaged for shipment or blended with other less pure plutonium metal prior to packaging and shipment.

By-Product Extractor Processing

At the conclusion of a separator operating cycle, the by-product extractors would be removed and the plutonium metal oxidized to a stable plutonium oxide. This oxide, consisting principally of plutonium-239 and 240, would be stored on an interim basis in a new Stand-Alone Storage Vault at the INEL.

Sidestream Processes

Scrap containing recoverable plutonium would be generated from the AVLIS separator components, and scrap and salts would be generated from the mainstream BOP operations. The plutonium would be recovered and purified using various sidestream process operations and recycled to the mainstream processes.

AVLIS separator components would be processed for plutonium recovery by oxidizing or hydriding the plutonium from component surfaces. Hydrides would be converted to the oxide prior to sidestream processing. Chlorination of plutonium hydride has not been adopted as either an optional or supplemental process to dehydriding.

In sidestream processing, a salt scrub operation, calcium and/or magnesium-zinc alloy would be used to extract plutonium from spent ER and DOR salts, respectively. The scrubbed salt would then be treated as a waste stream, while the plutonium contained in the scrub metal or alloy would be recovered in the nitric acid system. A nitric acid system for scrap recovery would consist of the following operations: (1) nitric acid dissolution, (2) ion-exchange purification, (3) precipitation of the plutonium as an oxalate, (4) calcination of the oxalate to plutonium oxide, and (5) oxidation of in-box generated combustible scrap (e.g., cheesecloth and filter paper). The plutonium oxide would be recycled to Metal Conversion.

The nitric acid system for recovery and purification of plutonium also represents a supplemental capability for americium removal from the feedstock and a general chemical purification capability for off-specification feedstocks.

2.1.2 Facilities Description

The SIS facilities and key interfaces are shown in Figure 2-7. As shown, the project is segregated into three distinct facilities: the PPB, the Laser Support Facility (LSF), and a Stand-Alone Storage Vault. The portion of the PPB that would contain plutonium and the Stand-Alone Storage Vault would be Category I facilities as defined by DOE-Idaho Architectural Engineering (A-E) Standards and constructed in accordance with DOE Order 6430.1A. Category I facilities are those facilities whose continued integrity and/or operability are essential to achieve and maintain a safe condition during accidents that could result in potentially significant offsite consequences.

The PPB would house the separator lines, support processes, process storage vault, analytical laboratory, change room and maintenance facilities, and emergency power systems. The LSF would include the LSB, DPB, and the Load Center Building (LCB).

Vehicular access to the SIS facilities would be from existing ICPP area roads. Personnel access to the SIS facilities would be through the existing ICPP badgehouse and the SIS guardpost. Parking would be provided outside the ICPP perimeter fence.

A minimum 61-meter-wide (200-foot-wide) isolation zone, fenced on its inner and outer boundaries to create an area for security intrusion detection and observation, surrounds the ICPP site. Double security fencing

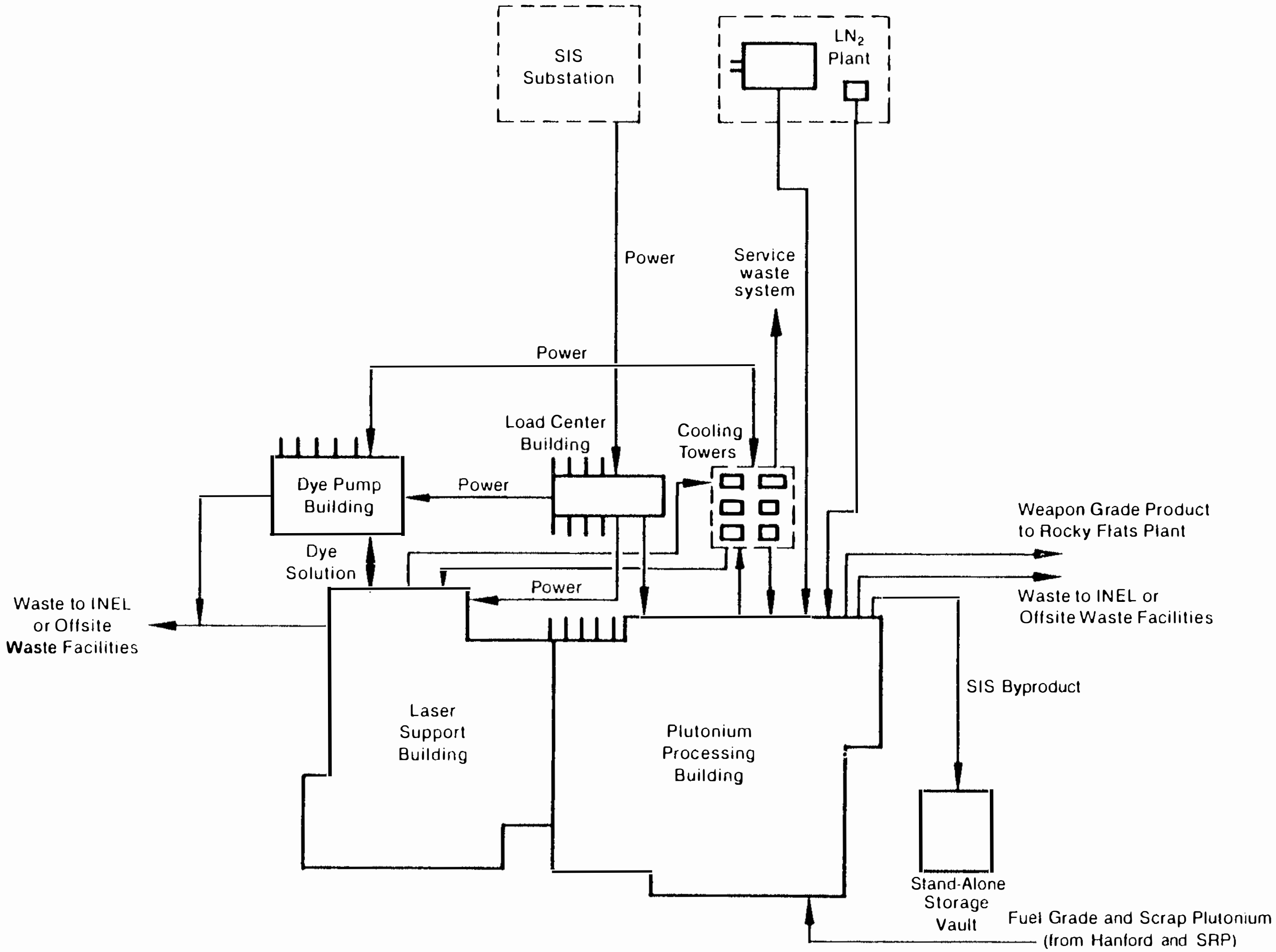


Figure 2-7. SIS Facilities and Key Interfaces.

meeting INEL standards would enclose the SIS facilities within the ICPP secured area.

Road access and walkways would be included as needed to service the area. Permanent access to the site would be provided by a paved road inside the SIS protected area from the southern entrance gate. The road and accompanying aprons would provide paved access to all buildings, loading docks, and required services for tank trucks, safe secure transport (SST) vehicles, tractor-trailer rigs, and mobile cranes within the SIS site. Drainage ditches would be provided where required.

A new electrical substation would provide two complete and independent electrical feeders to the SIS facilities. Both feeders would be capable of independently supplying the entire facility load. The substation would be constructed in accordance with American National Standards Institute (ANSI) Standard C2, the National Electrical Code (NEC), and the Factory Mutual Handbook of Industrial Loss Prevention. The substation would be protected from lightning transients and would be equipped with a redundant transformer, switchgear, and power distribution systems for high reliability. Loss of either transformer would cause an automatic switch to the other unit. The substation would also meet requirements to withstand high winds and seismic criteria for Uniform Building Code (UBC) Zone 2B earthquakes.

The SIS substation would receive power from the redundant INEL 138-kilovolt loop transmission system. This loop system is carried on wood-pole H-frame structures and protected by two overhead ground wires.

The SIS substation would have two stepdown power transformers, one connected on either side of a single 138-kilovolt oil circuit breaker. This connection would provide a redundant double-end feed to the substation and would permit full-capacity operation even if one section of the loop or one transformer is out of service. No fluids containing polychlorinated biphenyl (PCB) would be used in the transformers or in any of the other electrical equipment. The 138/13.8-kilovolt power transformers would feed 13.8-kilovolt switchgear housed in the LCB.

A liquid nitrogen plant would also be constructed outside the ICPP security fence. The plant would have sufficient capacity to service the demand for glove-box inerting atmospheres and would provide liquid nitrogen required for selected process operations in the PPB. Piping will be installed to interconnect the nitrogen plant to the PPB.

2.1.2.1 Plutonium Processing Building

The PPB design would provide an optimal arrangement for process operations, maintenance, safeguards, security, safety, and radiation shielding. Functions and activities are described below.

Administrative Functions

During definitive design, all the Administration Building functions described in the Draft EIS have been incorporated in the LSB and PPB so the Administration Building no longer exists as a separate building.

Plutonium Processing Building

The PPB would be a multistory facility with a small basement housing drain tanks, a first (ground) floor housing operating and support areas, and a second level housing heating, ventilation, and air conditioning (HVAC) units and support functions.

The portion of the PPB that would contain plutonium will be a Category I structure. The Category I portion of the PPB structure would be constructed of reinforced concrete with vibration isolation foundations for the separators and optics. The roof slab, exterior walls, and exterior openings/penetrations would be designed to resist tornadoes, missiles, and vertical and horizontal loads from earthquake, wind, and dead and live loads. The design would ensure that failure of any contiguous structures would not compromise the structural integrity of the Category I structure. Penetrations through the Category I boundary for venting or other functions would be minimized. The portions of the PPB that would not be Category I would be designed in accordance with DOE Order 6430.1A and DOE-Idaho A-E Standards. Alarmed and monitored emergency exits would be provided to allow egress from the PPB in an emergency. Exterior doors would meet the same requirements for withstanding forces as the walls.

Operating areas in the PPB would be on the first (ground) level. They include the separator lines, separator support, mainline pyrochemical processes, sidestream processes, Material and Process Control Laboratory (MPCL), storage vault, and shipping and receiving. Building services and support process areas would also be on this level and would include emergency generators and maintenance shops in the Category I structure, with change rooms, access control, and the PPB electrical load center outside the Category I structure.

The second level would house the HVAC systems and various support equipment. The facility air handling cascade units and exhaust systems are housed within the Category I structure, with supply air handling units, chemical mixing and storage, and mechanical and electrical separator support areas outside the Category I structure.

Glove boxes would be designed to minimize the potential for release of radioactive material and to protect building personnel from contamination under normal and abnormal conditions. Glove boxes would be shielded to reduce exposure levels to operators and other facility personnel to levels compatible with the overall radiation protection requirements in accordance with DOE Order 6430.1A. Partition walls that encircle groupings of glove boxes would provide additional radiation shielding. Glove penetrations would be provided to allow operating personnel access to all interior surfaces and equipment. Additional accessories, such as filters, access ports, airlocks, I&C, and utility service connections, would be selectively provided for each glove box.

In glove boxes where combustible gases are used, combustible concentrations would be avoided by providing gas-composition monitoring and controls, off-gas recombiners, and adequate ventilation flow with appropriate safety, alarm, and shutdown equipment. All glove boxes containing significant quantities of plutonium would be equipped with criticality drains or limited-volume water systems to limit the level of water that could accumulate on the floor of a glove box in abnormal situations.

Glove boxes would be capable of maintaining reduced-pressure atmospheres of inert gas or air. Positive overpressure-protection instruments, alarms, and controls would be used to limit the flow of gas into a glove box.

Glove-box systems would be arranged to provide efficient use of space, material flow, and personnel access to equipment. Gaslocks would be used to isolate selected glove-box atmospheres where high-purity inert gas (nitrogen or argon) is required. Process material transfer between groupings of glove boxes would be accomplished through overhead transfer systems and a stacker/retriever (S/R) located in the process storage vault. Some of these glove boxes (primarily pyrochemical glove boxes) would interface with the process storage vault through a gaslock and a transfer station. Some wet process glove boxes would not require an interface with the vault. Since chlorides and nitrates would be handled in wet chemical glove boxes, these glove boxes would be connected to the exhaust spray and off-gas scrubber systems through piping connections.

The process storage vault would be sized to temporarily store plutonium feed, in-process materials, product, by-product, residues, and archive samples, and would be maintained in a nitrogen atmosphere. All plutonium stored in the vault would be placed in sealed containers on specially designed storage pallets. The pallets would be placed in geometrically safe (for criticality concern) racks designed to remain in place during a seismic event.

The material and process control and certification support for the PPB would be supplied by the MPCL located in the PPB. Samples for analysis would be transferred from the originating glove boxes in the process area to a sample-receiving and nondestructive assay (NDA) glove box in the sample preparation room, and from this glove box to the MPCL. Temporary storage of samples would be provided in the sample preparation and storage glove box.

The MPCL would have direct access to the process storage vault for permanent storage of both archive samples and the NDA calibration standards. In addition, a means would be provided to transport laboratory solid residues to the aqueous recovery glove box.

The arrangement of the glove boxes in the MPCL would be based on time-and-motion and/or queuing studies that would optimize their location in terms of sample flow, analysis required, throughput, prevention of cross-contamination, and radiation exposure. The glove boxes would be connected by a pneumatic transfer system to facilitate the movement of samples (or sample aliquots) between boxes. Any sample transfers between wet and dry atmospheres would be made through an isolation airlock.

The PPB structure would have a truck loading dock opposite a tornado- and missile-resistant entrance into the PPB. Bottled gases required by the PPB would be stored in an isolated covered area adjacent to the PPB.

Services and Utilities

To ensure the confinement of processed material and to maintain a high level of plant availability, special emphasis will be placed on the design of services and utilities for the PPB. The following sections provide a brief description of the major mechanical and electrical systems of the PPB.

Mechanical Systems

Heating, ventilation, and air conditioning. The HVAC system of the PPB would be designed in accordance with DOE Order 6430.1A and DOE-Idaho A-E Standards for conditioning and controlling air commensurate with levels recommended for comfort and process requirements, for maintaining pressure differentials between zones of differing contamination potential, and for filtering atmospheric emissions described in the applicable environmental regulations for routine and Design-Basis Accident (DBA) conditions.

Airflow. The PPB would be divided into four ventilation zones with preset pressure differentials for contamination control. The airflow pattern would ensure the flow of air from the environment into the building and, within the building, from zones of lower to higher contamination potential. Backflow prevention would be provided at interfaces between zones.

In addition to these zones to control the airflow from zones of lower to higher contamination potential, a single-stage high-efficiency particulate air (HEPA) filtration system would be installed to provide in excess of 99.9-percent filtration of outside air into the SIS PPB. This HEPA filtration system would protect employees within the SIS PPB from any radioactive particulates that might be emitted as a result of potential accidents at other ICPP or INEL facilities.

Zone III areas are defined as contaminated spaces, generally within enclosures (glove boxes, process liquid tanks, the process storage vault, etc.), where plutonium would be processed or stored. Zone II areas are spaces where contamination would be likely to occur on occasion, including all spaces adjacent to Zone III enclosures. Zone I includes clean areas that could be contaminated (corridors, control rooms, mechanical equipment rooms, etc.). A negative pressure differential would be maintained between Zone III and II confinements and adjacent zones, and between Zones II and I. Areas classified as clean areas form the fourth zone. Within the PPB, airlocks or enclosed vestibules would be placed between clean or non-contaminated areas and potentially radioactively contaminated (Zone I) areas, and between Zone I and II areas.

Exhaust systems. Because of the importance of the building exhaust system, a high degree of reliability would be provided. The final exhaust filters, downstream exhaust ductwork, and plant exhaust stack would be constructed to withstand design-basis natural phenomena in accordance with DOE Order 6430.1A and applicable DOE-Idaho A-E Standards. Redundant mechanical equipment would be provided. Emergency power would be provided for the Zone III exhaust system where it is required to achieve and maintain a safe condition during those postulated accidents which could result in potentially significant offsite consequences. Multiple HEPA filter housings would be installed in parallel at the final filter stage, such that any one housing could be isolated for service without interrupting flow or filtering capability.

The four ventilation zones have different exhaust-system requirements as follows:

(1) Zone III. Exhaust gas from Zone III enclosures, primarily the process glove boxes and storage vault, would be passed through three testable HEPA filters, in series. For glove boxes, an additional untestable HEPA filter would be located at each enclosure inlet and outlet to minimize contamination in the ductwork. Exhaust streams from the inert gas-atmosphere enclosures and the air-atmosphere glove boxes are separate, with each stream conducted through a single-stage testable HEPA filter, generally located in the Zone II space, and then through a two-stage testable HEPA filter, prior to discharge to the stack. For each of these Zone III exhaust streams, a redundant filter bank having 100-percent capacity would be provided so that one filter housing is on-line and the other is on standby. To maintain glove-box pressure differentials and preclude the possibility of flow reversal to Zone II and I spaces, the filtered Zone III streams would then feed directly into the building exhaust stack. Both glove-box exhaust systems would be supplied with redundant fans and emergency power to ensure high system availability. The final two Zone III HEPA filters would be protected by a Category I fire suppression and detection system with mist eliminators. The fire suppression system would automatically extinguish any burning material and cool the airstream before it reached the HEPA filters. Moisture carryover would be removed from the exhaust stream by mist eliminators. Filter housings and related ductwork for the Zone III exhaust system would be constructed to withstand design-basis natural phenomena in accordance with DOE Order 6430.1A and DOE-Idaho A-E Standards.

(2) Zones II and I. Because of the higher potential for contamination in Zone II as compared to Zone I, a higher Zone II change rate of air would be maintained and a prefilter and a testable HEPA filter (mounted close to the floor) would be provided at the room exhaust-duct inlets. The exhaust air from the PPB Zone II and I areas, and exhaust streams not routed through the Zone III exhaust system, would be passed through a common two-stage HEPA filter system prior to release out the exhaust stack. These final two HEPA filters would be fire-protected in the same manner as in the Zone III system (see above). Because of the potential for plutonium contamination, the ventilation exhaust from the change rooms would be routed through the Zone II/I HEPA filters. Each HEPA filter stage would be provided with a differential-pressure indicator. The exhaust-air HEPA filters would be housed in parallel bag-in/-out enclosures that meet the requirements of ANSI Standards

N509 and N510. Redundancy would be provided in the exhaust-air system to maintain ventilation during maintenance. The total exhaust-airflow rate would be maintained constant using automatic controls. The final filter housings and downstream ductwork to the stack would be constructed to withstand design-basis natural phenomena in accordance with DOE Order 6430.1A and DOE-Idaho A-E Standards.

(3) Clean Areas. Because of the clean nature of these areas, air may be either exhausted directly to the atmosphere or recirculated. The change-room area would exhaust to the PPB Zone I/II main exhaust system.

Process piping systems. The process piping systems will be designed and installed in accordance with ANSI B31.3. Process piping would be of continuously welded construction and would be corrosion resistant in accordance with applicable American Society for Testing and Materials (ASTM) Standards. Process pipes carrying radionuclides would be part of a critical system as defined in DOE Order 6430.1A and would meet the seismic requirements of the DOE-Idaho A-E Standards. The process piping would be designed to safely transport radioactive, acid, alkaline, and other material solutions as applicable.

Piping systems for plutonium-bearing materials would be encased when passing outside glove boxes. Provisions for containment integrity and fissile material accumulation monitoring would be in accordance with DOE Order 5480.5.

Nitrogen system. A nitrogen atmosphere would be provided in certain glove boxes and the process vault as an inert cover gas to preclude oxidation of plutonium metal and also for fire safety. Verification and control of atmospheric quality and pressure would be maintained by sampling, monitoring, and warning systems. Nitrogen gas would be recycled through gas purification units.

Argon system. An argon atmosphere would be provided in the plutonium recovery glove box as an inert cover gas to preclude product materials from reacting with contaminants in the atmosphere and for fire protection in the glove box. Argon would be recycled through gas purification units. A small quantity of argon would also be required by the MPCL for sample receiving from the plutonium recovery glove box.

Air sampling system. The air sampling system would consist of vacuum blowers that operate a full complement of air samplers located in potentially contaminated work areas. Continuous air samples would be used to immediately identify radioactivity in working environments. The air sampling system would be equipped with continuous air monitors (CAMs). Redundant vacuum blowers would ensure continued operation of the system. The exhaust from the air sampling system would be released through a roughing prefilter and HEPA filters.

Process gas systems. Distribution piping would route gases from the cylinder gas storage area or the nitrogen/argon system to the appropriate glove boxes that contain a process requiring the particular gas. Suitable protection would be provided as required by applicable Occupational Safety and Health Administration (OSHA) and Department of Labor standards, National Fire Protection Association (NFPA) and Compressed Gas Association (CGA) standards, and state and local codes.

Cooling water. The PPB would employ a single closed-loop cooling-water system that would furnish water for heat removal from glove-box process systems and from process and utility equipment. Heat would be dissipated to the atmosphere via a cooling tower. The tower would be a closed-circuit evaporative cooler. Where exclusion of water is important to safety, limited-volume secondary cooling loops would be used.

A closed-loop chilled-water system would be provided to the nitrogen gas cooling units. Makeup water would be supplied from the treated water system. Cooling tower blowdown would be discharged to the service waste system.

Water systems. Demineralized water from the ICPP would be used in the cold chemical mixing area, the MPCL, and selected glove boxes (liquid waste treatment, dry-salt recycle, and solid waste handling). Backflow preventers would be installed on lines serving glove boxes.

Potable water would be supplied by connecting to an existing main. The potable water system would supply emergency showers, eyewashes, sinks, water fountains, and showers. Treated water would also be supplied from the existing ICPP system and would provide softened water for HVAC humidifiers, process cooling system makeup, and laboratory sinks.

Sanitary and service waste systems. The SIS Project sanitary waste system would connect to the existing ICPP Sewage Treatment Plant. The sanitary waste system services only non-process-related waste water (i.e., restrooms, drinking fountains).

The SIS Project service waste system would also be connected with the existing ICPP service waste system, which currently discharges to one of two percolation ponds. As part of DOE's goal of improving waste management practices, a new percolation pond, or ponds, will be constructed at the ICPP. The liquid effluents discharged to the pond(s) will be nonhazardous and nonradioactive and will meet all Federal and state regulations. The SIS nonradioactive, nonhazardous liquid effluents would be discharged to the new pond(s). The SIS Project's liquid effluents would be monitored to ensure that the effluent is nonradioactive and nonhazardous prior to discharge. The only liquid effluents that would be discharged on a routine basis would consist of cooling tower blowdown and process steam condensate. All other routine liquid waste streams would be either grouted or managed as solid wastes.

Steam supply system. A high-pressure steam line would be routed into the facility from the main located east of the ICPP Coal-Fired Steam-Generating Facility (CFSGF). The steam pressure would be reduced at a pressure-reducing station to accommodate the process requirements and would undergo further pressure reduction for facility heating. Condensate produced at the reducing station would be piped to a local drain. The condensate from facility heating would be returned directly to the condensate pit located at the ICPP steam plant for recycle to the CFSGF. Process steam condensate would be collected in a holding tank located within the PPB. The cooled condensate would then be transferred to a tank for sampling and analysis. Process steam condensate would then either be released to the service waste system or sent to a waste evaporator, depending on the results of sampling.

Electrical System

The PPB will be designed to be capable of going into and maintaining a safe shutdown in the event of the total loss of electrical power. Emergency uninterruptible electrical power in the form of batteries would provide power for components identified by safety analyses that must maintain continuous function during a transition (i.e., until power supplied by the emergency power generators is on-line).

Electrical distribution. Bus duct and other conductors would enter the PPB and terminate at the power control centers. Normal electrical power would be supplied in a preferred- and alternate-source configuration to the line side of the power control centers. One power control center would be dedicated solely to the glove boxes and separators. The other power control center would mainly support HVAC, utilities, and processes. If a fault occurred in either the preferred or the alternate source, appropriate incoming line and tie breakers would be interlocked to transfer the load to the unaffected power source. Both preferred and alternate sources would be designed to carry the entire electrical load.

Emergency power source and distribution. The emergency power system would be provided to support specific engineered safety features. In normal circumstances, these safety features would be powered by the normal electrical distribution system. Automatic transfer switches would serve to transfer these loads to two redundant Class 1E diesel generators, which would be started automatically upon loss of normal power. The generators' fuel supply would sustain the emergency power system for 48 hours. Those emergency power loads requiring on-line uninterruptible power supply (UPS) would be provided with dedicated DBA-type battery backup.

Standby power source and distribution. The standby power system would serve those loads that would have a production or operability impact. In normal circumstances, these loads would be powered by the normal electrical distribution system. The standby diesel generator would have a transfer circuit that would transfer loads to a separate generator (i.e., separate from the two Class 1E generators for emergency power) upon loss of normal power. The generator's fuel supply would sustain the power system for 24 to 48 hours. Those standby power loads requiring uninterruptible power would be fed from on-line UPS units.

Safety Requirements

The PPB will be designed, constructed, and operated in accordance with DOE Order 6430.1A and DOE Orders in the 5480 series. In addition, the PPB will be designed to include appropriate design engineered features to provide spill and vapor detection and mitigation for the consequences of postulated chemical accidents that might occur in the ICPP area, if necessitated by the results of the on-going safety analysis process. The following sections provide a brief discussion of radiation shielding, criticality safety, radiation monitoring and alarm systems, and fire protection.

Radiation Shielding

The decay of plutonium isotopes produces alpha, beta, neutron, and gamma radiation. Of these, neutron and gamma radiation may result in external exposures due to their penetrating nature. In accordance with DOE Orders, personnel exposures would be maintained at as-low-as-reasonably-achievable (ALARA) levels and below an annual effective dose equivalent (EDE) of 5 rem (i.e., 5000 millirem). The design goal of the SIS Project is 1 rem (i.e., 1000 millirem) for radiation workers.

Neutron emissions from plutonium compounds result from spontaneous fission and (α, n) reactions. For neutron-shielding purposes, some PPB glove boxes would be constructed with hydrogenous shielding. Gamma radiation emanating from plutonium and its associated daughter products (primarily americium-241) would be shielded using stainless steel and lead.

Criticality Safety

The SIS Project is being designed to meet the criticality prevention requirements as identified in DOE Order 5480.5, and applicable DOE-Idaho Orders. Enclosures and piping would use geometrically favorable design, considering interaction with other vessels, concrete walls and floors, and other reflectors such as shielding, personnel, liquids, and movable containers. Design for criticality safety would be based on a plutonium isotopic concentration of 100-percent plutonium-239. A criticality alarm activation system would operate separately from all other systems and would provide information to the Integrated Plant Information and Control System (IPICS).

Radiation Monitoring and Alarm Systems

Radiation monitoring system. Radiological protection requirements would be incorporated to protect plant personnel against radiation exposure arising from activities performed throughout the operating life of the SIS facility.

Radiation detectors would be located throughout the PPB. Visual and audible alarms would display and annunciate if alarm set points were exceeded.

Radiation alarms would be annunciated by a public address (PA) system tone generator. The PA annunciator would alert personnel to the type of alarm by varying tones. Alarm signals would be transmitted to the IPICS for monitoring only.

The total airflow, the pressure differentials across filter banks, and the temperature (for fire protection) of the building exhaust would be monitored. The integrity of the filtration system would be verified by CAMs. Detection of activity levels exceeding the prescribed administrative limits would also activate an alarm to initiate isolation of the affected filter housing from the rest of the system.

A stack monitor would be provided for continuous monitoring and isokinetic sampling of radionuclides in the stack effluent in accordance with ANSI N13.1 and DOE Order 6430.1A. The monitoring system would alarm to the IPICS and would initiate investigative/corrective actions if the prescribed administrative limit were exceeded. Both analog and digital alarm signals from the stack monitors would be transmitted to the ICPP Radiation and Environmental Safety computer system. The stack emissions would also be monitored for specific nonradioactive materials as required by the U.S. Environmental Protection Agency (EPA) and/or the State of Idaho.

Area radiation monitors. Area radiation monitors would be provided where a potential exists for personnel to receive radiation doses in excess of prescribed limits. Detectors would be installed at optimal locations throughout the PPB to provide complete coverage of all required areas.

Continuous air monitors/fixed-filter air samplers. Airborne radioactivity would be monitored by CAMs and fixed-filter air samplers. The CAM system would be designed in accordance with the requirements of ANSI N13.1.

Airborne radioactivity in areas with a high potential for contamination would be monitored by a CAM system. The air collection probes for the CAM system would continuously monitor the air for concentrations of alpha activity and would be located near the breathing zones of the operators. The detector would be connected to a nearby monitor that would supply the local readout and warning requirements. The CAMs in the PPB would be connected to a central vacuum system.

Fixed-filter air samplers would be installed in all potentially contaminated areas. These filters would be removed periodically and taken to the counting room to monitor radioactive particulate concentrations and to record the airborne activity within the area.

Criticality monitors. Criticality monitors would be installed as required by DOE Order 5480.5. These monitors would be located in all areas of the PPB where plutonium is handled. To signal an evacuation, two monitors would have to alarm for the minimum accident of concern (defined by ANSI/ANS-8.3-1986).

Survey instruments. Personnel monitoring would be performed using hand and foot monitors located at the PPB access portal. Personnel monitors (friskers) would be placed at the restricted zone exit checkpoints in the PPB so that operating personnel will survey themselves before leaving.

Fire Protection

All floor levels of the PPB would be protected from fire by automatic wet pipe sprinkler systems. Plutonium processing, handling, and storage areas would be served by zoned preaction supervised sprinkler systems to strictly control accidental water discharge based on criticality analysis. Wet pipe sprinklers would also be present and serve as backup to the Halon primary fire suppression systems for the separator control room and local control rooms. All glove boxes and conveyors would be provided with internal thermal fire detectors (glove-box overheat). These would be supervised and monitored by the fire detection and alarm system. The final PPB exhaust HEPA filters would be protected with a deluge water spray system to remove fire-generated particulates and minimize plugging of the filter. PPB fire-water piping, risers, and supply feeds from the fire main would be Design-Basis Earthquake-qualified (DBE-qualified). Additionally, multiple risers serving the PPB would connect to the fire-water supply loop in separate locations, and the fire-water supply loop would be connected to the site water supply in two places. Firehose cabinets would be located in the PPB corridors.

The PPB would be provided with fire detection and alarm systems. Detectors would monitor all rooms. Alarms would be annunciated locally, in the plant operations center, in the ICPP Emergency Control Center, and at the INEL Central Facilities Area (CFA) fire station and other INEL security stations. The system would be compatible with the system already installed at other ICPP facilities. Fire walls with the appropriate fire ratings would be provided to limit the spread of fire within the facility. A maximum possible fire loss (MPFL) separation barrier (4-hour fire wall) will be placed between the Laser Support Building (LSB) and PPB for building protection. This separation wall would physically separate the LSB and PPB to preclude propagation of accidents between the facilities.

2.1.2.2 Laser Support Facility

The LSF would provide the buildings and services required by the laser process to support the separators in the PPB. The LSF would include the LSB, a detached DPB, and an LCB. Laser-beam tubes would transport the laser light from the LSB to the separator system in the PPB.

Laser Support Building

The LSB would be a two-story steel-framed structure and would house the main laser equipment and support services. The lasers themselves would be installed on two floors in a compact arrangement using common vertical support structures and utilities. Refurbishment and other support activities would be consolidated in functional groupings on the ground floor. Equipment for HVAC would be installed and enclosed on the second level.

The LSB would be constructed in accordance with DOE-Idaho A-E Standards and seismic design criteria for UBC Zone 2B earthquakes. In addition, the LSB will be designed to include appropriate design engineered features to provide spill and vapor detection and mitigation for the consequences of postulated chemical accidents that might occur in the ICPP area, as required by the results of the on-going safety analysis process.

Laser Areas

Copper lasers would be housed in modular boxes and linearly mounted on vertical steel-clad concrete support structures. Inert gas, compressed air, low-conductivity cooling water and drains, and 480-volt and 120-volt power connections would be provided at each box. These utilities would be designed to be easily disconnected, and individual boxes would be readily removed and replaced by a forklift truck.

The dye-laser amplifiers would be enclosed in sliding-door cabinets. If an ethanol leak were to occur, it would be detected by a pressure-failure or ethanol-vapor detection system. The normal recirculated air system in the dye-laser and optics area would switch automatically to a once-through, 100-percent outside-air purge system. The purge system would maintain the atmosphere in the dye-laser cabinets and corridors at 25 percent or less of the lower explosive limit (LEL). When the purge system is activated, the dye-flow system would automatically shut down. In addition, floor drains would be provided within the dye cabinets to drain spilled dye solution to an alcohol waste tank. The auxiliary lasers and other diagnostic equipment will be located adjacent to the copper laser areas on the first floor.

Laser and Optics Refurbishment

Optics for copper and dye lasers, beam transport, diagnostic instrumentation, and the separator modules would require routine service and maintenance. Optical subsystems would be periodically cleaned, assembled, and aligned. Used cleaning solvents would be drained to an organic waste tank.

Control and Computer Rooms

The LSB would include a number of control and computer rooms to support laser system processes in the copper and dye-laser area. In addition to the Laser System Control Room and Laser System Computer Room, there would be a Signal Conditioning Room to interface with the distributed laser control system, a Wavelength Control Equipment Room to support the dye-laser system, and an Evaporation Rate Control Equipment Room to measure and control the plutonium evaporation rate consistent with laser light transported to the PPB. In addition, there would be a Separator Control Room, a PPB Computer Room supplementing the local control and computer systems, and a Plant Operations Center providing overall management information and top-level control capability (see Section 2.1.2.4 for a description of the IPICS).

Dye Pump Building

The DPB would be a one-story concrete masonry building that would contain the mechanical equipment serving the LSB, the dye/ethanol system, and other support services.

Stainless-steel pipes in a sand-filled concrete tunnel would connect the DPB with the LSB and would transport the dye/ethanol solution to the dye lasers. A second tunnel between the two buildings would house mechanical, utility, and service piping.

In addition to dye/ethanol pumps, filters, and heat exchangers, the building would contain low-conductivity water chillers, HVAC equipment, dye/ethanol flow-loop chillers, a demineralizer, and related equipment.

The DPB would include a dye-analysis room, a dye-mix room, an ethanol purification room, a combined mechanical/electrical room, a planning and electrical control room, and a load center room to distribute power to the equipment in the building. Transformers would be located in adjacent concrete masonry block stalls outside the building for fire protection.

The DPB would be constructed in accordance with DOE-Idaho A-E Standards. The dye-pump rooms and the filter/heat-exchange room would be separated from the remainder of the facility by appropriately rated fire walls.

Load Center Building

The LCB would be a one-story concrete masonry building that would house the 138-kilovolt control and relay panel and the supervisory control and data acquisition remote terminal unit, the 480-volt electrical load centers for the LSB, 13.8-kilovolt switchgear for the entire plant, and a battery room. The building would be flanked by outdoor transformers installed in concrete masonry block stalls for fire protection. The LCB would be constructed in accordance with DOE-Idaho A-E Standards.

Services and Utilities

Services and utilities for the LSF would include HVAC; distribution of electric power, water, chilled water, and compressed air; an ethanol-supply system; and a sanitary sewer system. A brief description of the important service and utility systems is provided in the following paragraphs.

Mechanical

Clean-room HVAC subsystems would be installed in portions of the optical-refurbishment area (optical area and optical-component test area) and the dye-laser area.

In the dye-laser area, redundant exhaust fans (each 100-percent capacity) would be provided for the dye-laser cabinets to ensure 100-percent purging in case of an alcohol leak in any of the cabinets.

The LSF cooling-water systems would include the low-conductivity cooling-water, the dye-laser amplifier chilled-water, the dye master-oscillator chilled-water, and the cooling-tower water system. The low-conductivity cooling-water system would remove heat generated by the copper and dye lasers, as well as the laser refurbishment stations. A sidestream deionizer would maintain the desired water conductivity. Makeup water would be supplied from the site demineralized water system.

In the event of a major equipment failure or loss of power, standby cooling water would be available from the raw-water system by a line connected to the raw-water main to remove the latent heat stored in the copper lasers.

A chilled-water system would remove heat generated by the dye-laser amplifiers. A chilled-water system would also remove the heat generated by the dye-laser master oscillators.

A cooling-tower system would be provided to remove heat from chillers and from utility equipment located in the LSB and DPB. The cooling-water system would use cooling towers for heat dissipation to the atmosphere. Continuous blowdown of the cooling-water system would be provided to maintain proper water quality. This blowdown would be routed to the service waste system. Makeup water for blowdown, evaporation, and drift losses would be provided by the existing ICPP treated-water system.

Compressed Air System

The compressed air system would service HVAC, process controls, and air tools. Compressed air would be received from the existing ICPP system and distributed to the control and usage points.

Ethanol-Storage System

Underground storage tanks would be deployed external to the DPB for ethanol storage. One tank would collect and accumulate dye ethanol from potential spills in the various processing rooms from the drain system in the DPB and drains in the LSB. Another tank would function as a holding tank for degraded dye ethanol drained from process lines. The dye ethanol in these two tanks would be recycled using a distillation system. A third tank will store fresh ethanol and will also receive the distillate from the distillation system after it has been quality-checked and found to be of acceptable purity. The underground tanks will be double-walled stainless steel and will have interstitial leak detection equipment to meet requirements for underground tanks containing hazardous substances.

The recycling system would include a distillation column to separate degraded dye from the ethanol solvent, a holding tank to retain the distillate, and a tank to retain the concentrated dye/ethanol solution. These tanks would be in the DPB. Material in the holding tank would be transferred to the fresh storage tank after quality verification.

Freon System

Two Freon systems, one for Freon R-11 and one for R-113, would be required in the LSB. Freon R-11 is used as a dielectric coolant in the Pulse Power Electronics (PPE). Freon R-113 is used as a dielectric coolant in the Switching Power Supply. Both the fresh and waste Freons would be stored in closed pressure vessels to minimize vapors released to the atmosphere.

Fresh, filtered Freon R-11 would be required at the workstations in the PPE area to replenish PPE tanks undergoing refurbishment. It would be cooled by a chilled-water system to reduce the rate of evaporation during refurbishment, thereby minimizing atmospheric releases. Cooling the Freon for the PPE before the power is turned on for testing would prevent it from boiling. In addition, the PPE refurbishment workstations would utilize vapor barriers to further minimize exposure of the Freon to ambient air and reduce any uncontrolled emission to the atmosphere. Potential substitutes for Freon are being evaluated and will be used when available.

Electrical

Electrical distribution within the LSF would originate in the LCB. The load centers and electrical switchboards would supply power to the building HVAC equipment, all support equipment, the copper lasers and dye/ethanol pumps, the lighting panelboards, and single-phase 120/240-volt grounded neutral service transformers for convenience receptacles. Standby electrical power would be provided to the LSF to supply power to the cabinet ethanol purge fans, the computer/control room HVAC units, the standby power distribution panel, and the fire alarm system.

Fire Protection

Automatic sprinkler systems would be installed in all areas of the LSB, the DPB, and the LCB. The systems would be designed in accordance with DOE Orders, NFPA Standards, and Factory Mutual Standards. Computers and computer control rooms would be provided with Halon primary fire suppression systems, as well as sprinkler systems as a reserve firefighting measure. The copper-laser/dye-laser areas in the LSB would have sprinkler systems each fed from two separate risers with independent supplies from the fire-water supply loop. The fire-water supply loop would be connected to the site water supply in two places.

The buildings would also be provided with complete fire detection and alarm systems. All areas of the LSB, DPB, and LCB would be monitored by smoke and fire detectors. Shutdown of the HVAC system and the dye-flow system would be initiated through the process operational control system.

The areas where ethanol would be present would have additional fire protection/safety features, with ethanol confined in a closed system to prevent exposure to the atmosphere under normal operating conditions. The dye/ethanol system would be segregated into several flow loops with interlocked stop and shunt valves (actuated by signals from pressure sensors, seismic sensors, flow indicators, and level sensors) to prevent or limit spills. Ethanol areas would be curbed and drained to an underground waste tank to prevent the flow of liquids into adjacent building areas. Dye-laser cabinets containing ethanol would be provided with preaction sprinkler systems. The DPB ethanol area sprinkler systems would have supplemental foam fire protection systems.

Areas containing ethanol would be classified in accordance with Article 500 of the NEC. Wiring and electrical equipment in these areas would either comply with requirements for use in a Group D atmosphere as set forth in the NEC, or other protective measures such as ventilation would be used. Dye-laser cabinets would be provided with a once-through ventilation system designed to prevent vapor from reaching 25 percent of the LEL in the event of a spill.

Rooms containing ethanol would be separated from the rest of the building by appropriately rated fire walls. The LSB laser area would be separated from the PPB by an MPFL wall. Personnel doors and other openings would be provided with appropriately rated fire doors.

2.1.2.3 Stand-Alone Storage Vault

The Stand-Alone Storage Vault would be a vault separate from the PPB vault. This vault and subsequent storage of materials in this vault at the INEL would (1) eliminate the need to transport by-product material offsite, (2) provide a vault designed with a primary emphasis on interim storage of by-product material, and (3) be able to temporarily store SIS feed and product materials.

The Stand-Alone Storage Vault would be a Category I structure designed to resist all design-basis natural phenomena and postulated credible accidents. The vault would also be constructed so that its floor elevation would be above a potential Probable Maximum Flood (PMF). About 50 percent of the new facility would consist of the vault area, with the remainder a support area.

The Stand-Alone Storage Vault would be located within the fenced area of the ICPP near the PPB to facilitate the transfer of materials between it and the PPB process vault. All plutonium stored in the Stand-Alone Storage Vault would be placed in sealed containers on specially designed storage pallets. The pallets would be placed in racks designed to remain in place during a DBE. The pallet racks would be designed for the prevention of criticality. Containers in the vault would be handled remotely.

An alarm activation system would provide information for sensor monitoring and detection. Verification and control of atmospheric quality and pressure would be maintained by sampling, monitoring, and warning systems.

The Stand-Alone Storage Vault would be designed, constructed, and operated in accordance with the requirements contained in DOE Orders. Noncombustible materials will be utilized to the maximum extent. The entire structure will be protected by an automatic fire suppression system. Areas that contain plutonium would be served by zoned preaction sprinkler systems. The HVAC system would include recirculation, cooling, filtration, and contamination monitoring equipment. The ultimate discharge of atmospheric emissions would be through multiple (in series) HEPA filters and through a continuously monitored discharge stack. Final HEPA filters would be protected by a fire suppression and detection system that would automatically extinguish any burning material. During normal operations, there would be no radioactive releases from the vault. Sealed containers would be checked for surface contamination and decontaminated, if required, prior to placement in the Stand-Alone Storage Vault.

Radiation shielding would be provided for neutron and gamma radiation produced by the decay of radionuclides. Safeguard measures for the vault would be implemented in accordance with the 5632 series of DOE Orders.

2.1.2.4 Integrated Plant Information and Control System

The IPICS is the integration of all the local I&C, supervisory control, and information management elements of the SIS Project. The IPICS forms an overall operational and administrative I&C system required for efficient operation of the plant. The hierarchy of the IPICS provides for the first level of collection and management of all information relating to quantity, assay, and movement of special nuclear material (SNM) and other accountable material as well as the support processes and facilities for the plant. The tools and administrative information available from the IPICS assist operations and management personnel in areas such as plant performance planning, production planning and scheduling, reliability and maintenance management, energy management, and plant facility equipment inventory. The capabilities provided by the IPICS include data gathering, coordination, compilation, summarization, display, and storage of the operating parameters.

The IPICS is separated into hierarchical levels that include information management packages, supervisory control levels, and the local I&C levels. The local I&C systems interface with the supervisory I&C system for appropriate overall plant operation and control. The Stand-Alone Storage Vault would have its own independent system with communication channels to the IPICS.

The integration of operating procedures for both normal and emergency conditions would be accomplished by each of the data systems using the operational data available from each of the subsystem elements. The degree of operator interaction would be based on operational requirements established for the SIS Project. The IPICS is composed of the following subsystem elements:

- Laser I&C Subsystem
- LSF HVAC and Utility I&C Subsystem
- Separator I&C Subsystem
- BOP I&C Subsystem
- Material Control and Accountability I&C Subsystem
- PPB HVAC and Utility I&C Subsystem
- Radiation Monitoring Subsystem
- Criticality Monitoring Subsystem
- MPCL I&C Subsystem.

The description of the subsystems is as follows: (1) the Laser I&C Subsystem, which would provide the capability to measure all parameters and directly control all laser functions; (2) the LSF HVAC and Utility I&C Subsystem, which would provide the monitoring and/or control capabilities for the facilities such as HVAC, power, water, gases, instrument air, and nonradioactive emissions; (3) the Separator I&C Subsystem, which would provide the capability to measure all separator parameters and directly control the separator process; (4) the BOP I&C Subsystem, which would provide all local and supervisory control and monitoring of all BOP glovebox operation and PPB transport operations; (5) the Material Control and Accountability I&C Subsystem, which would provide the information and controls necessary to meet DOE nuclear accountability requirements for in-process accounting and control as well as inventory control of stored material; (6) the PPB HVAC and Utility I&C Subsystem; (7) the Radiation Monitoring Subsystem, which would consist of radiation area monitors, CAMs, and the stack monitoring/sampling system; (8) the Criticality Monitoring Subsystem, which would monitor the status of all the criticality alarms throughout the plant and provide immediate operator information as to the nature of any activity within the plant; and (9) the MPCL I&C Subsystem, which would provide the capability to process the analytical chemistry information for process and control and accountability.

The stack monitoring system, listed within the Radiation Monitoring Subsystem, would function independently from the remainder of the radiation monitoring system, would be qualified to operate in a DBE, and would be supplied with an independent qualified battery system. All radiation monitoring devices would be designed to annunciate and alarm independent from the IPICS computer-based network. IPICS monitoring would independently permit an operator to promptly identify that a radiation detection has occurred, identify its location, and provide information for further action to be taken.

The criticality alarm monitors are incorporated into the design of the systems/facilities required for safe operation and shutdown. The criticality alarm monitors are designed to operate independently from the IPICS computer-based network and are qualified to operate in a DBE with their own battery supplies. The criticality alarms would provide their own annunciators and alarms to indicate that an activity has taken place. The IPICS monitoring function would independently permit an operator to promptly identify that a criticality has occurred in the facility, identify the location of the event, and provide information so that further action can be taken to mitigate consequences, if necessary.

2.1.3 Resistance to Natural Forces

The SIS Project would be designed to preclude undue risk to operating personnel, facilities, the environment, and offsite populations during normal and abnormal operating conditions. Structures would be constructed to comply with DOE Order 6430.1A and DOE-Idaho A-E Standards.

Category I structures would be designed in accordance with DOE-Idaho A-E Standards to withstand a DBE having a resultant vertical bedrock acceleration of 0.16g and a horizontal bedrock acceleration of 0.24g. Section 3.1.4.3 contains a detailed discussion of seismicity and volcanic potential in the INEL area, which indicates the appropriateness of these accelerations. The estimated vertical and horizontal ground accelerations associated with the bedrock accelerations, using an amplification factor of 1.5 that would be reviewed based on more specific geophysical evaluations, are 0.24g and 0.36g, respectively. Category I structures would also be designed to withstand a design-basis wind-loading and a Design-Basis Tornado (DBT). Exteriors of Category I structures would be designed to preclude the penetration of tornado-generated missiles as specified in DOE-Idaho A-E Standards.

The SIS Project is being designed to account for a PMF which includes a breach of the Mackay Dam located on the Big Lost River upstream of the INEL. The finished or ground-floor level of the PPB, Stand-Alone Storage Vault, and LSB would be above the elevation of the PMF. To accomplish this, backfill will be placed to raise the existing elevation by approximately 1.5 meters (5 feet). All nuclear materials would be located above the postulated flood elevation, except that which might be contained in two waste tanks located in the PPB basement. Criticality would be prevented under flooded conditions.

2.1.4 Construction

Construction of SIS facilities would be conducted in accordance with all applicable laws and regulations intended to protect the safety and health of the public, construction workers, and the environment. Mitigation measures necessary to control all construction-related effluents would be adopted to ensure compliance with applicable standards.

2.1.4.1 Site Preparation and Facilities Construction

The following sections discuss anticipated construction activities that include grading and earthwork, construction materials handling and processing, and construction water and sanitary facilities.

Grading and Earthwork

For the PPB and LSF facilities, approximately 185,750 square meters (45.9 acres), would be grubbed and graded including 93,080 square meters (23.0 acres) within the ICPP area and 92,670 square meters (22.9 acres) outside the ICPP area. Construction of the Stand-Alone Storage Vault would require approximately an additional 3035 square meters (0.75 acre) of previously disturbed land within the ICPP area to be grubbed and graded. Grubbed material and excavated soils beneath the principal SIS buildings would be disposed of at the existing INEL sanitary landfill and/or a previously utilized borrow area, or gravel pit.

Following grubbing and removal of unsatisfactory soil, the PPB, LSB, and Stand-Alone Storage Vault areas would be graded using engineered backfill to raise the floor-level elevations of these buildings to a level that would protect them in the event of a postulated PMF. Fill material from outside the ICPP area would be obtained by expanding an existing borrow area, or gravel pit, located approximately 0.6 kilometer (0.4 mile) northeast of the northeast corner of the ICPP. Environmental surveys of this borrow area have been conducted, and it was concluded that the area is not of archeological or historical significance and that disturbance would not affect habitats for threatened, rare, or endangered species. In addition, the following provisions will be met as part of the environmental approval for expansion of the borrow area:

- Stockpiling of the soil will be confined to inside the actual gravel pit expansion areas.

- A site closure restoration and revegetation plan will be prepared prior to expansion of the gravel pit. The entire gravel pit expansion area will be recontoured, covered with existing topsoil, and reseeded. The revegetation plan will be reviewed and approved by the DOE-Idaho Radiological and Environmental Sciences Laboratory.

- Provisions will be made to minimize dust generation from the pit and roads by utilizing road base material and applying suppressants as necessary.

During earthwork and grading activities, best management practices would be used to control fugitive-dust emissions and erosion. Best management practices to be employed would be typical of those of any large-scale project and could include routing of surface-water runoff to temporary holding basins, planting and maintaining natural buffer strips, mulching, and wetting of areas to suppress dust emissions. Prior to initiating site grading and earthwork, an erosion and sediment control plan and a fugitive-dust emissions plan would be formulated to mitigate potential impacts from grading and earthwork.

Construction Materials Handling and Processing

Materials to be used in the construction of the proposed SIS Project that would require handling or processing include concrete and chemicals (e.g., asphalt and petrochemical products such as gasoline, oils, propane, and gasohol).

Spill prevention measures for all chemical and petrochemical products that would be stored during construction would be implemented in accordance with a Spill Prevention, Control, and Countermeasures (SPCC) plan. Where necessary, storage areas for chemicals and petrochemicals, and washdown areas for equipment and vehicles would be surrounded by either small temporary berms or by channels to control and prevent the inadvertent runoff of potential contaminants. If a concrete batch plant is utilized during construction, control measures for runoff and atmospheric emissions would be implemented pursuant to any required permit conditions.

Construction Water and Sanitary Facilities

Raw water for construction and potable water for construction personnel would be supplied by temporary lines from the existing ICPP raw and potable water systems, respectively. Sanitary wastes would initially be treated in prefabricated treatment systems and chemical toilets. Wastes from portable facilities would be disposed of at the ICPP Sewage Treatment Plant.

Temporary construction buildings for construction offices would be connected to the existing ICPP sanitary sewer system.

2.1.4.2 Construction Effluents

Construction of the LSF and PPB would generate about 370 cubic meters (13,000 cubic feet) or about 600 metric tons (660 tons) of solid waste that would be transported to the CFA sanitary landfill for disposal. Construction of the Stand-Alone Storage Vault would generate an additional 60 metric tons (66 tons).

In addition to solid waste, construction of the SIS facilities would produce a variety of atmospheric emissions that would include carbon monoxide and hydrocarbons from equipment and truck exhausts as well as suspended particulates or dust from earthwork and grading.

Liquid effluents generated during construction would include runoff that would be controlled to minimize erosion, sanitary effluents that would be treated in situ, and potential spills that would be controlled through preventive measures and appropriate cleanup measures as identified in an SPCC plan.

2.1.4.3 Construction Resource Requirements

Resources required to construct the SIS Project include personnel, energy, materials, and land. The following sections briefly describe the commitments of these resources.

Personnel

During SIS construction, a peak construction workforce of about 490 personnel (direct and indirect) would be employed for construction of the LSF and PPB. Construction of the Stand-Alone Storage Vault would add an estimated additional 24 personnel, or a total estimated peak construction workforce of 514 personnel.

Energy, Materials, and Affected Land Areas

The estimated energy use for construction of the LSF and PPB is listed in Table 2-1. The estimated quantities of materials required to construct the LSF and PPB are listed in Table 2-2. Construction of the Stand-Alone Storage Vault would increase estimated energy use and quantities of construction materials by about 10 percent. Construction of the SIS facilities would involve approximately 108,860 square meters (26.9 acres) within the fenced area of the ICPP and 92,670 square meters (22.9 acres) outside the ICPP area, excluding borrow areas for fill material, disposal of excavated material, and the construction of an electric substation distribution line. A breakdown of the land-use acreage is listed in Table 2-3.

2.1.5 Operation

Operation of the SIS facilities would result in the generation of gaseous, liquid, and solid wastes. Operation of the SIS facilities would also require the transport of radioactive and hazardous materials and the consumption of energy, materials, and resources. The following sections provide a discussion of SIS waste streams and quantities of emissions, effluents, and solid wastes that would be generated; the transport of materials; and resource utilization during operation.

Table 2-1. LSF and PPB Construction Energy Use[a]

Energy source	Amount	
Propane, L (gal)	97,720	(26,000)
Diesel fuel, L (gal)	49,610	(13,200)
Gasoline, L (gal)	114,180	(30,380)
Electricity, peak demand, MW	1.5	
Total energy, kWh		6×10^6

[a] Based on design data available as of September 1988.

Table 2-2. LSF and PPB Construction Materials[a]

Type	Amount	
Concrete, m^3 (yd^3)	38,200	(50,000)
Steel		
Reinforcing, MT (tons)	3,310	(3,650)
Structural, MT (tons)	1,815	(2,000)
Electrical raceway, m (ft)	174,000	(571,000)
Electrical wire and cable, m (ft)	518,000	(1,699,000)
Piping, m (ft)	54,900	(180,000)
Steel decking, m^2 (ft^2)	27,300	(294,000)
Steel siding, m^2 (ft^2)	9,100	(98,000)
Built-up roofing, m^2 (ft^2)	11,500	(124,000)
Masonry blockwork, m^2 (ft^2)	3,070	(33,000)
Lumber (dimensional and forms), m^3 (bd-ft)	6,465	(2,740,000)
HVAC ductwork, MT (tons)	613	(680)
Water, L (gal)	3.3×10^7	(8.7×10^6)
Asphalt paving, MT (tons)	682	(750)

[a] Based on design data available as of September 1988, and equipment is not included.

Table 2-3. SIS Land Use at the INEL[a]

Land use	Inside ICPP Security Zone m^2 (acres)		Outside ICPP Security Zone m^2 (acres)	
	During construction	After construction	During construction	After construction
Total area[b]	108,860 (26.9)[c]	76,890 (19.0)[d]	92,670 (22.9)	11,740 (2.9)
Graded area	93,080 (23.0)[e]	62,320 (15.4)[e]	92,670 (22.9)	11,740 (2.9)
Building foundations[f]	15,780 (3.9)	14,570 (3.6)	--	--
New roads	8,900 (2.2)	8,900 (2.2)	10,120 (2.5)	10,120 (2.5)
Gravel pads other than roads	22,660 (5.6)	22,660 (5.6)	20,230 (5.0)[g]	1,620 (0.4)
Construction storage	20,230 (5.0)	--	60,690 (15.0)	--
Work yards	1,210 (0.3)	--	--	--

[a] Based on design data available as of September 1988.

[b] Total area does not include land areas for electrical substation distribution line (45,330 square meters or 11.2 acres) and borrow areas for disposal of excavated soil and for borrow of fill material for grading (92,900 square meters or 23 acres).

[c] Total area is area within construction fence.

[d] Total area is area within SIS security fence.

[e] Graded area does not include 3035 square meters (0.75 acre) for Stand-Alone Storage Vault.

[f] Building foundation for Stand-Alone Storage Vault not included.

[g] Area includes construction parking area.

2.1.5.1 Operational Emissions, Effluents, and Solid Wastes

During operation of the SIS facilities, wastes would be generated in gaseous, liquid, and solid forms. A primary emphasis in the design of the SIS Project has been to minimize the generation of all effluents and wastes. Proven waste processing technologies would be used to minimize the generation of these wastes and to process wastes, where required, to levels that are well below State of Idaho, DOE, and other Federal environmental standards. The following sections describe the gaseous, liquid, and solid waste streams, the quantities of wastes that would be generated, and the processes and/or methods that would be used to ensure that all wastes would meet applicable Federal and state standards.

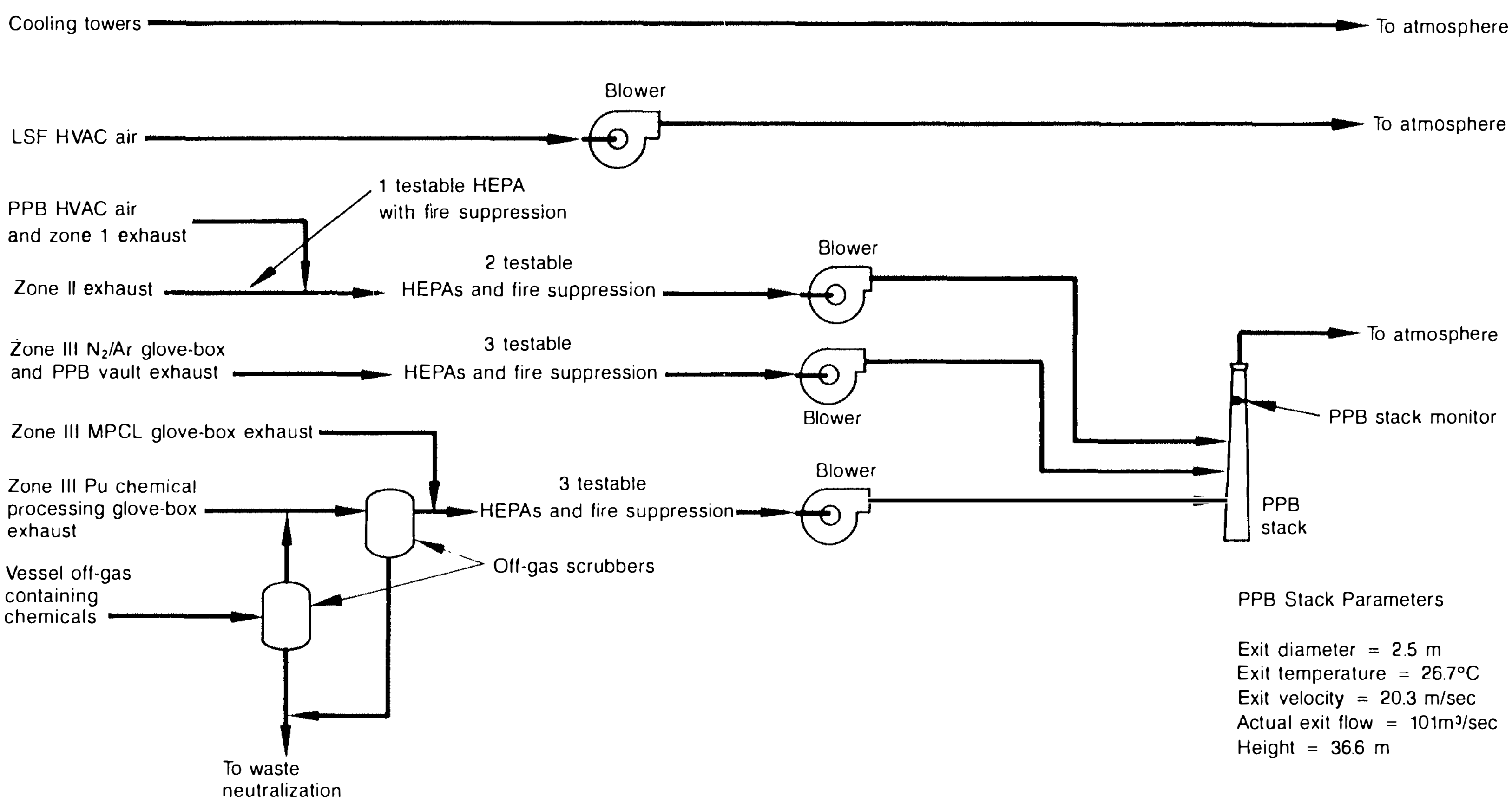
Atmospheric Emissions

Atmospheric emissions during operation of the SIS Project would be exhausted from the LSF and PPB cooling towers, the LSF HVAC air exhaust, and the SIS PPB stack as shown on Figure 2-8. During normal operation, there would be no radioactive atmospheric emissions from the Stand-Alone Storage Vault. All atmospheric emissions from the cooling towers and the LSF HVAC system would be nonradioactive. Atmospheric emissions from the LSF HVAC system would include small quantities of organics (primarily Freon and alcohol) and neon. A small quantity of alcohol vapor would be emitted to the atmosphere from tanks in the DPB.

The exhaust stream from the PPB Zones I and II exhaust systems--including the ventilation exhaust from the PPB change room and the PPB HVAC air would be routed to HEPA filters with a fire suppression and detection system and then to the monitored PPB stack as discussed in Section 2.1.2.1. Zone III inert gas-atmosphere glove-box exhaust and PPB vault exhaust would also be routed through HEPA filters with a fire suppression and detection system and then to the monitored PPB stack as described in Section 2.1.2.1.

All vessel off-gas from aqueous chemical processing would be exhausted through off-gas scrubbers to neutralize acids. The scrubber exhaust would be combined with Zone III chemical processing glove-box exhaust and routed to the stack as described in Section 2.1.2.1. Liquid waste from scrubbers would be sent to a liquid waste neutralizer as discussed in the next section on liquid effluents.

Radioactive atmospheric emissions from the PPB stack are estimated to have a concentration of 1×10^{-17} microcurie per milliliter, resulting in an annual quantity of radioactivity released from the stack of less than 1.4×10^{-2} microcurie. This routine atmospheric emission is based on (1) the maximum annual SIS throughput of material, (2) actual available operating data from other DOE facilities using HEPA filters and involved in plutonium handling or processing (e.g., Rocky Flats), and (3) a conservative estimate of filter efficiencies of 99.97 percent for the first stage of HEPA filtration and 99.95 percent for the two remaining stages of HEPA filtration. Nonradioactive atmospheric emissions from the PPB stack would include the inerting gases of argon and nitrogen; hydrogen from product recovery and dissolution-related operations; helium from separator cryogenic pumps; nitrogen oxides resulting from dissolution of plutonium in nitric acid and from the destruction of excess oxalic acid with nitric acid; carbon



PPB Stack Parameters

Exit diameter = 2.5 m
Exit temperature = 26.7°C
Exit velocity = 20.3 m/sec
Actual exit flow = 101m³/sec
Height = 36.6 m

Figure 2-8. Preliminary Atmospheric Emissions Functional Flow Diagram.

monoxide from oxalate decomposition; and carbon dioxide from oxidation of in-box generated scrap. Chapter 4 discusses these emissions with respect to compliance with appropriate regulatory requirements for atmospheric emissions.

Table 2-4 lists the estimated annual radioactive and nonradioactive atmospheric emissions from the SIS facilities. In addition to these atmospheric emissions, incremental nonradioactive atmospheric emissions would result from the burning of additional coal at the CFSGF in the ICPP area for supplying steam to the SIS facilities.

Liquid Effluents

Liquid waste streams would also be generated as a result of SIS operation. Liquid waste streams would consist of those that are nonradioactive and nonhazardous which, after being monitored and sampled, would be discharged as liquid effluents, and of liquid waste streams, which would be converted to or managed as solid wastes. As shown in Figure 2-9, the preliminary functional flow diagram for liquid waste streams, all liquid waste streams from processes (i.e., scrap dissolution, MSE salt dissolution, and plutonium recovery) have been segregated from nonprocess liquid waste streams.

Liquid waste streams that would be nonradioactive and nonhazardous include (1) HVAC steam condensate from building heating systems, which would be recycled to the ICPP steam condensate collection system for reuse at the CFSGF; (2) precipitation runoff from building roof drains, which would be discharged to the ICPP site drainage system; (3) sanitary waste, which would be sampled and sent via lift station to the ICPP sanitary sewer system and ICPP Sewage Treatment Plant; and (4) LSF cooling tower blowdown and LSF standby cooling water, which would be sampled and then discharged to the ICPP service waste system.

The ICPP service waste system currently discharges to percolation ponds near the ICPP that were constructed to discontinue the use of an injection well as a means of disposal of effluents from the ICPP. Use of the injection well has been discontinued, and it is currently planned that the well will be plugged with cement in 1989. The use of the existing percolation ponds at the ICPP has been considered an interim measure until other available alternatives have been assessed and approved for implementation. Current planning includes (1) use of an acid fraction system to eliminate or reduce trace quantities of radionuclides and metals in the ICPP process evaporator effluents; (2) routing of concentrated radionuclides to the existing high-level radioactive waste system; (3) recycling or evaporation of the cleaned liquid waste stream; and (4) discharge of nonradioactive and nonhazardous ICPP liquid effluents to one or more new percolation ponds. The SIS Project's nonradioactive and nonhazardous liquid effluents would only be discharged to the new percolation pond(s), which would receive only nonradioactive and nonhazardous ICPP liquid effluent.

Several liquid waste streams associated with the PPB would be combined with cement to produce either a TRU or low-level waste (LLW) grout. The PPB liquid waste stream with the largest volume of radioactive liquid would be the MSE dissolver waste stream containing quantities of americium and

Table 2-4. Estimated Annual Quantity of Atmospheric Emissions[a]

Source	Quantity	
Airborne radioactivity[b]	$<1.4 \times 10^{-2}$ μCi (α + β)	
Argon, L (ft^3)	$<2.6 \times 10^9$	(9.2×10^7)
Carbon dioxide, MT (tons)	$<2 \times 10^2$	(2.2×10^2)
Carbon monoxide, MT (tons)	<0.2	(0.2)
Helium, L (ft^3)	<8100	(2.9×10^2)
Hydrogen, L (ft^3)	$<1 \times 10^4$	(3.6×10^2)
Neon, L (ft^3)	$<1.4 \times 10^6$	(4.9×10^4)
Nitrogen, L (ft^3)	$<5.7 \times 10^{10}$	(2×10^9)
Nitrogen oxides (NO and NO_2 mix), MT (tons)	<0.7	(0.8)
Organic vapors[c], MT (tons)	<18	(20)
Water vapor, L (gal) (includes cooling tower and HVAC)	$<3.2 \times 10^8$	(8.5×10^7)
Cooling tower chemicals		
Nonionic polymers, MT (tons)	<0.1	(0.1)
Phosphonates, MT (tons)	<1.1	(1.2)
Phosphates, MT (tons)	<0.6	(0.7)

[a] Based on design data available as of September 1988.

[b] Source term based on (wt. %): Pu-238, 0.1%; Pu-239, 79.5%; Pu-240, 18.5%; Pu-241, 1.6%; Pu-242, 0.3%; Am-241, 1.0%.

[c] Organic vapors, which include acetic acid, acetone, benzyl alcohol, ethanol, Freons, methanol, trichloroethylene, 1,1,1-trichloroethane. Acetone, trichloroethylene, and 1,1,1-trichloroethane emissions are from the volatilization of these materials when they are used as cleaning/degreasing agents and are not process releases.

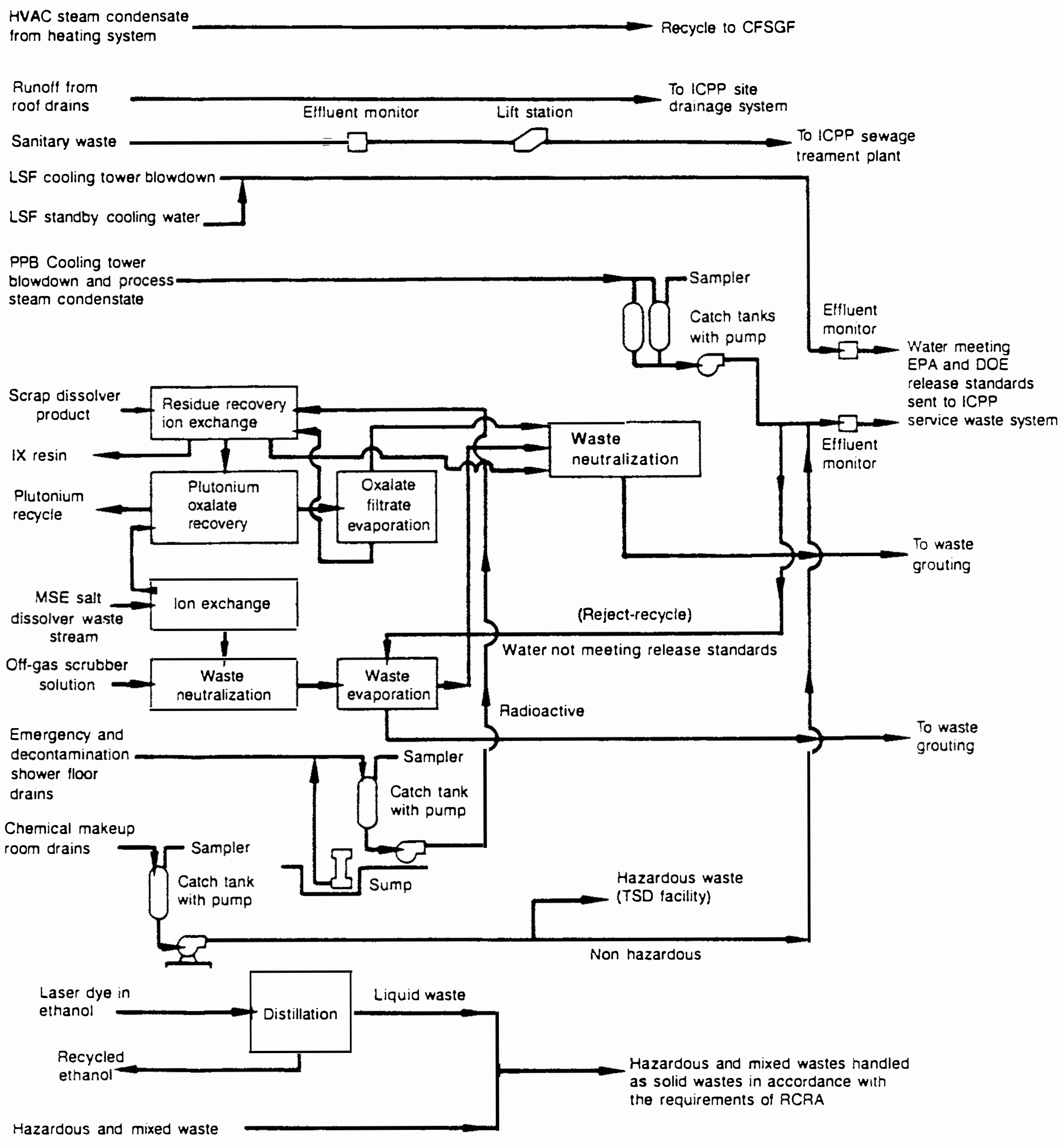


Figure 2-9. Preliminary Liquid Effluent Functional Flow Diagram.

plutonium. The MSE salt dissolver waste stream would be sent to an ion-exchange system. The eluate from the ion-exchange system would be precipitated as plutonium oxalate and recycled for recovery. The depleted feed and wash from the ion exchange of the MSE salt dissolver waste stream would be combined with off-gas scrubber solution and neutralized in a totally enclosed system. The neutralized liquid waste stream would then be evaporated to produce a high-salt concentrate. The salt concentrate, which would contain most of the americium, would be combined with cement to produce a TRU waste grout. Distillate from this evaporation process would be combined with acid waste from residue recovery ion exchange and the distillate from oxalate filtrate evaporation. These combined streams would be neutralized and mixed with cement to produce additional TRU-grouted waste.

Other PPB liquid waste streams would originate from (1) PPB cooling tower blowdown and process steam condensate, (2) emergency and decontamination shower floor drains, and (3) PPB chemical makeup room drains.

The PPB cooling tower blowdown and process steam condensate liquid waste streams would be nonhazardous and nonradioactive and would be monitored prior to discharge to the service waste system. If these liquid waste streams were to be radioactive based on monitoring (e.g., the unlikely failure of a cooling coil and depressurization resulting in radioactive contamination of the steam condensate), these liquid waste streams would be recycled to the evaporator. No hazardous materials would be used in either the PPB cooling tower or process steam condensate systems that could result in these waste streams becoming potentially contaminated with hazardous material.

Liquid waste from emergency and decontamination shower floor drains would be collected in a catch tank. The catch tank would normally be empty. In the event that emergency and decontamination showers are used, the liquid waste that would be collected in the catch tank would be sampled and the potentially radioactive and nonhazardous liquid waste stream would be recycled through the residue recovery ion-exchange system. After ion-exchange recovery, this liquid waste stream would be mixed with cement and grouted.

Liquid waste from chemical makeup room floor drains would also be collected in a catch tank that would normally be empty. After being sampled to determine whether the liquid waste from this source is hazardous, the liquid waste would either be discharged to the service waste system if nonhazardous, or, if hazardous, handled as a hazardous waste commensurate with Resource Conservation and Recovery Act (RCRA) requirements.

Other liquid waste streams associated with the SIS Project include (1) spent laser-dye solutions from the LSF and (2) hazardous and mixed wastes that would be handled as RCRA solid wastes in accordance with EPA requirements. Spent laser dye in ethanol would be concentrated by distillation. The concentrated solution of laser dye would be handled as a hazardous waste and the pure ethanol would be recycled to the LSF for reuse.

Table 2-5 lists the estimated annual quantities of nonradioactive and nonhazardous liquid effluents that would be discharged during SIS operation. Chapter 4 discusses the impacts associated with the quantities of nonradioactive and nonhazardous liquid effluents that would be discharged. Estimated quantities of radioactive, hazardous, and mixed wastes handled as solid wastes are discussed in the next section.

Solid Wastes

Solid wastes generated as a result of SIS operation would consist of nonradioactive and nonhazardous waste, TRU waste, LLW, hazardous waste, and mixed waste. Figure 2-10 shows the preliminary functional flow diagram for solid wastes.

Nonradioactive Nonhazardous Waste

Approximately 900 metric tons (990 tons) of uncompacted nonradioactive and nonhazardous solid waste (i.e., administrative waste and domestic trash) would be generated annually. This solid waste would be disposed of in the CFA sanitary landfill.

TRU Waste

Scrap materials (i.e., spent crucibles, salt molds, separator components, tools, and miscellaneous items) containing recoverable quantities of plutonium would be processed by dissolution as previously discussed under sidestream processing in Section 2.1.1.2. Waste residues from dissolution, together with spent ion-exchange resin slurries, evaporator bottoms, and neutralized waste streams (see discussion under liquid effluents), would be combined with cement to form a grout, which would then be cast into U.S. Department of Transportation (DOT) approved 208-liter (55-gallon) drums. Only radioactive nonhazardous waste would be grouted.

The grouted TRU waste would then be transported to the INEL Stored Waste Examination Pilot Plant (SWEPP), which is located at the INEL Radioactive Waste Management Complex (RWMC). At the SWEPP, the waste would be inspected for compliance with the Waste Acceptance Criteria (WAC) of the Waste Isolation Pilot Plant (WIPP) in New Mexico. Waste containers that are acceptable at the WIPP would then be held in storage areas adjacent to the SWEPP awaiting transport to the planned WIPP. Waste containers not certified acceptable would be held in storage for processing at the INEL's Process Experimental Pilot Plant (PREPP) located at the Test Area North (TAN), or returned to the SIS facilities for rework. The PREPP has the capability to process and repackage unacceptable TRU waste containers to meet WIPP acceptance criteria. DOE is currently preparing an Environmental Assessment (EA) to analyze the potential environmental impacts of processing TRU waste at the PREPP. A RCRA Part B permit application has been submitted for the PREPP and will be updated as required if the PREPP is to process and repackage unacceptable TRU waste generated as a result of SIS operations.

All radioactive waste being placed in containers will be visually inspected to ensure that it meets the WIPP and/or RWMC WAC. In addition, each package will be assayed prior to its placement in a waste container. An inspector will visually inspect each package placed in the waste

Table 2-5. Estimated Annual Quantity of Nonradioactive and Nonhazardous Liquid Effluents[a]

Source	Quantity in liters (gallons)	Discharge
Runoff from building roof drains	--[b]	ICPP site drainage system
LSF standby cooling water	--	ICPP service waste system
Sanitary waste	2.4×10^7 (6.3×10^6)	ICPP Sewage Treatment Plant
PPB chemical makeup room floor drains	--	ICPP service waste system
PPB emergency and decontamination shower floor drains	--	ICPP service waste system
PPB process steam condensate	2.6×10^6 (7.0×10^5)	ICPP service waste system
Cooling tower blowdown	4.3×10^8 (1.1×10^8)	ICPP service waste system

[a] Based on design data available as of September 1988. Nonhazardous wastes are those below the limits of 40 CFR 261 (RCRA); nonradioactive wastes are those below the radioactive limits for safe drinking water.

[b] Quantity is dependent on event.

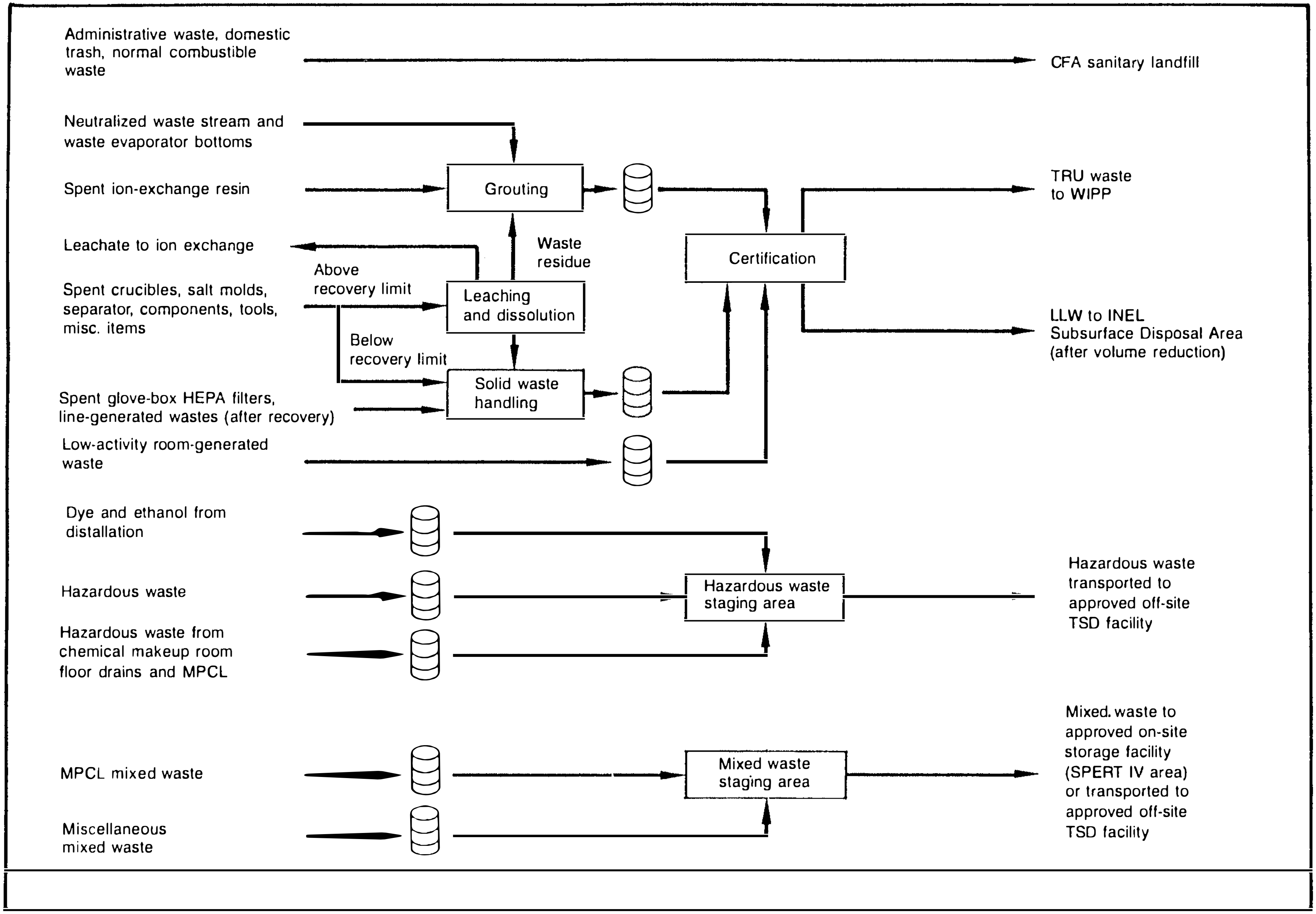


Figure 2-10. Preliminary Solid Waste Functional Flow Diagram.

container. When the waste container is full, it will be sealed, a decision made on its disposition (WIPP, RWMC, SWEPP for certification, waste requiring processing at PREPP, etc.), documentation prepared, and the waste container shipped to the proper location. Classified waste will be processed at the INEL to destroy classified aspects of the waste prior to final dispositioning. Classified wastes that cannot be processed to destroy classification will be managed within the DOE Defense Program system.

A certification plan will be prepared and submitted to the WIPP Waste Acceptance Criteria Certification Committee for approval. This committee is made up of DOE-Albuquerque personnel along with WIPP operations personnel. This plan will provide information on the characterization of the waste streams and the certification methods. The SIS waste certification method and results will be audited by the WIPP Waste Acceptance Criteria Certification Committee on a routine schedule. Prior to startup of the SIS Production Plant, each waste stream will be characterized and documentation prepared to support the SIS certification program.

A sampling program will be part of the SIS waste certification plan for TRU waste. This sampling program will provide a statistically based sample of the WIPP-certified drums. These selected drums will be sent to the SWEPP for a real-time radiography (RTR) examination that will verify WIPP certifiability. Any drums that are not WIPP-certifiable according to the RTR examination will be returned to the SIS facility for further examination, repackaging, and recertification.

A maximum of 400 metric tons (440 tons) of TRU waste meeting WIPP acceptance criteria would be generated each year during SIS operation at maximum throughout capacity. This TRU waste would consist of grouted TRU waste as previously discussed and TRU-contaminated failed process equipment that would also be packaged and transported to the SWEPP and then to the WIPP. The maximum amount of TRU waste that would be generated would amount to about 50 percent of that generated at the INEL and about 10 percent of the amount of TRU waste the INEL stores each year.

DOE plans to transport all stored and newly generated TRU waste to the WIPP in New Mexico, as stated in its Record of Decision prepared on the Final EIS for the WIPP (DOE/EIS-0026). DOE is currently working with the National Academy of Sciences (NAS) to address experimentation and research activities supporting the performance assessment being conducted to demonstrate compliance with EPA standards for TRU waste (40 CFR 191). In addition, the WIPP will comply with all applicable requirements of RCRA. DOE is currently working with the EPA and the State of New Mexico to resolve uncertainties regarding procedures for obtaining a RCRA permit for the WIPP.

Recent discussions on the storage capacity limitations of TRU waste at the WIPP have been focused on the amount of TRU waste that would be initially received by the WIPP for experimental purposes to support performance assessment studies prior to a decision making WIPP fully operational as a disposal facility. These discussions are unrelated to the design capacity for TRU waste emplacement at the WIPP. Reports of the WIPP's leaking involve the intertwining of two separate issues: (1) water that ran down the walls of shafts, before grouting was completed, from water-bearing strata in the rocks overlying the salt beds; and (2) brine migration within the salt beds themselves. With respect to water from overlying strata, the flow has been eliminated by grouting the shaft walls above the salt to seal off the water. When the facility is decommissioned, the shafts will be entirely backfilled and sealed at several locations with engineered materials designed to minimize any leakage. Inflow from this source will then be inconsequential. With respect to brine migration within the salt beds, actual measurements to date indicate that brine migration can be absorbed by backfill materials, preventing the accumulation of liquids. The amount of brine migration is less than originally contained in the salt mined out of the room. DOE will continue to coordinate with the NAS to resolve and conduct those studies required to initiate operations at the WIPP.

In the unlikely event that the WIPP performance assessment indicates that the WIPP is unsuitable for the disposal of TRU waste, DOE would undertake studies and evaluations to determine acceptable alternatives. These alternatives would be covered by a separate National Environmental Policy Act (NEPA) review, as the DOE would be faced with a general issue regarding disposal of TRU wastes from several sources, of which the TRU waste generated by the SIS would be a small part. In summary, assessments of alternatives to the WIPP as part of the SIS Project are not considered appropriate, as (1) DOE has received no evidence nor has it been made aware of any scientific study which negates continuing to plan for the disposal of TRU waste at the WIPP, and (2) the WIPP has been and would continue to be the subject of a separate NEPA review, as part of an independent decision-making process.

Low-Level Radioactive Waste

Less than 30 metric tons (33 tons) of LLW consisting of low-activity room-generated waste would also be generated each year during SIS operation. This LLW would be segregated based on its ability to be compacted and then transported to the SWEPP for examination. Based on the SWEPP examination, noncompactible LLW would be disposed of at the RWMC's Subsurface Disposal Area (SDA) by shallow land burial in pits or soil vaults, and compactible LLW would be compacted at the Waste Experimental Reduction Facility (WERF) prior to disposal at the SDA. The amount is less than 1 percent of the amount of LLW currently being disposed of at the INEL.

Hazardous Waste

Hazardous wastes that would be produced as a result of SIS operation would include spent laser dye in ethanol, 1,1,1-trichloroethane, trichloroethylene, acetone, methanol, ethylene glycol, benzyl alcohol, 2-phenoxyethanol, Freon R-11 and R-113, and limited quantities of liquid wastes from the chemical makeup room floor drains and MPCL activities. Up to 10 kilograms (22 pounds) per year of dye in 1.5×10^4 liters (4000 gallons) of ethanol would be generated as a result of LSF operations and the recovery of ethanol by distillation (see discussion of liquid effluents). Trichloroethylene and 1,1,1-trichloroethane would be used in small quantities for degreasing. Ethylene glycol is used in cooling systems and ethylene glycol/benzyl alcohol is used in the auxiliary dye-laser system. Methanol and acetone would be used in limited quantities (less than 420 liters, or 110 gallons, per year) as drying agents. The acetone/ methanol would account for 40 kilograms (88 pounds) of hazardous solid waste. Up to 1900 liters (500 gallons) per year of nonreusable Freon R-11 and R-113 from the PPE and power supplies would also be generated. The quantity of potentially hazardous waste generated from liquid captured in the PPB catch tank from the chemical makeup room floor drains would be dependent on the occurrence of an event. As an upper limit, approximately 41 kilograms (90 pounds) and 7200 liters (1900 gallons)--primarily solvents--of hazardous waste could be generated as a result of MPCL analytical activities.

In addition to the above wastes, maintenance of outdoor closed cooling loops would generate an estimated 950 liters (250 gallons) of glycol/water. The glycol would be generated as a 20-percent solution in water. Although not a hazardous waste, the glycol generated from maintenance would be managed as a hazardous waste. The estimated hazardous wastes that would be generated are listed in Table 2-6.

All hazardous waste would be handled in accordance with DOE Order 5480.1B and RCRA as implemented by 40 CFR 260-280. Hazardous wastes would be placed in DOT-approved containers and staged for offsite transport within 90 days of container filling. Hazardous wastes would then be transported to a RCRA-approved treatment, storage, or disposal (TSD) facility in accordance with DOT and EPA requirements (49 CFR 100-199 and 40 CFR 263). All RCRA requirements for manifesting, labeling and packaging, and reporting hazardous wastes generated would also be followed (40 CFR 262).

Based on the current design of the SIS facility, hazardous waste would be placed in a 208-liter (55-gallon) drum, and within 72 hours of being filled, the drum would be taken to the INEL Hazardous Waste Staging Area located at the Central Facilities Area (CFA). A Part A permit as required by RCRA has been submitted for the Hazardous Waste Staging Area. A Part B application has also been submitted and will be updated as necessary. Should an offsite RCRA-approved TSD facility not be available, DOE would provide onsite storage facilities meeting RCRA requirements until an offsite TSD facility is available.

Other requirements, such as choosing the proper container and labeling the waste containers for offsite shipment (49 CFR 170-176 and 40 CFR 262), waste manifesting and recordkeeping (40 CFR 262), and "receipt-to-disposal" hazardous material tracking (RCRA) will be met. SIS administrative controls and procedures would be implemented to ensure that all full containers of hazardous waste are taken to the staging area within 72 hours and transferred to an approved TSD facility before the 90-day limit is exceeded.

Mixed Waste

Mixed waste (i.e., waste containing both hazardous and radioactive constituents) would be generated from decontamination and MPCL activities, and limited quantities from PPB processing. Based on preliminary estimates, approximately 10 metric tons (11 tons) per year of mixed waste would be generated, primarily from MPCL analytical activities.

Table 2-6. Estimated Annual Quantities of Hazardous Wastes[a]

Type of Hazardous Waste[b]	Quantity	
Freon, L (gal)	$<1.9 \times 10^3$	(500)
Trichloroethylene (wipes), kg (lb)	2	(5)
Trichloroethylene/detergent solutions, L (gal)	$<1.9 \times 10^3$	(500)
Trichloroethane, L (gal)	$<2.1 \times 10^2$	(55)
Acetone/methanol wipes, kg (lb)	$<4.0 \times 10^1$	(88)
Ethanol, L (gal)	$<1.5 \times 10^4$	(4000)
Laser dye, kg (lb)	$<1.0 \times 10^1$	(22)
Acetic acid/copper solutions, L (gal)	$<5.7 \times 10^3$	(1500)
Glycol/water, L (gal)	$<9.5 \times 10^2$	(250)
2-phenoxy ethanol, L (gal)	$<5.0 \times 10^2$	(132)
Benzyl alcohol/ethylene glycol, L (gal)	$<4.5 \times 10^2$	(120)
Various hazardous wastes from MPCL		
Solid, kg (lb)	$<4.1 \times 10^1$	(90)
Aqueous, L (gal)	$<6.4 \times 10^3$	(1700)
Organic, L (gal)	$<7.6 \times 10^2$	(200)

[a] Based on design data available as of September 1988.

[b] All hazardous waste would be staged and transported to an approved TSD facility.

Like hazardous wastes, mixed wastes would be handled in accordance with the 5400 series of DOE Orders and RCRA as implemented by 40 CFR 260-280. Mixed wastes would be staged and would then be either stored on the INEL in an approved storage facility or transported to an approved offsite TSD facility. A radioactive mixed-waste storage facility is presently operated at the INEL at the Special Power Excursion Reactor Test (SPERT) IV area under RCRA interim permitting status (Part B application has been submitted). This facility, if approved, could provide temporary storage of SIS-generated mixed waste. Current planning at the INEL is also assessing the feasibility of the INEL PREPP for treatment of hazardous and mixed waste (i.e., incineration and stabilization of resulting ash/sludges). A Part B permit application as required by RCRA for the PREPP has been submitted. DOE is currently preparing an EA to analyze the potential environmental impacts of processing mixed waste at the PREPP. As an upper estimate for the transport of mixed waste, all mixed waste is assumed to be mixed with cement to form a grout and cast in drums and handled as a TRU waste (i.e., it is included in the bounding estimate of 400 metric tons of TRU waste to be transported to the WIPP). Alternative methods of disposal/storage to further enhance environmental and safety objectives will continue to be investigated.

Table 2-7 lists the estimated annual quantities of solid wastes that would be generated during SIS operation.

2.1.5.2 Transport of Materials

During SIS operation, materials would be transported to and from the INEL as well as between onsite locations. The materials transported would consist primarily of radioactive materials and radioactive and/or hazardous solid wastes. All shipments would be made by truck.

The radioactive materials transported to or from the INEL would consist of TRU waste from the INEL to the WIPP, plutonium feed (i.e., processed N-Reactor fuel-grade plutonium and small quantities of scrap) from the Hanford Site in Washington and the SRP in South Carolina to the INEL, and plutonium metal product from the INEL to the Rocky Flats Plant in Colorado. If determined not to be usable for other missions, SIS by-product material would be transported from the INEL to the WIPP.

All TRU waste shipments would be packaged in Type A containers within a shipping container or cask that is certified by the U.S. Nuclear Regulatory Commission (NRC) or approved for use by the DOT. Currently it is planned to transport TRU waste to the WIPP in the TRUPACT II, which is presently undergoing regulatory testing for NRC certification. All TRU waste material shipments would be conducted in accordance with DOT regulations (40 CFR 170-179).

The DOE safe secure transports (SSTs) would be used for the offsite transport of plutonium feed and plutonium metal product. The SSTs are essentially mobile vaults with built-in deterrent and disabling devices and special electronically coded locks set in vault-type doors. They are operated by carefully selected, specially trained DOE personnel to provide

Table 2-7. Estimated Annual Quantity of Solid Wastes[a]

Type of Waste	Quantity		Disposal
Administrative wastes and domestic trash, MT (tons)	<900	(990)	Central Facilities Area sanitary landfill
TRU waste, MT (tons)	<400	(440)	Transported to Waste Isolation Pilot Plant
Low-level radioactive waste, MT (tons)	<30	(33)	Subsurface Disposal Area at the INEL RWMC
Mixed waste, MT (tons)[b]	<10	(11)	Staged and either stored onsite in an approved facility or transported to an approved offsite treatment, storage, or disposal facility

[a] Based on design data available as of September 1988.
[b] Quantity included in quantity of TRU waste.

safe and secure transport of SNM. Shipments of these materials would also be conducted in accordance with DOT regulations (49 CFR 170-179). The feed and product shipments would be packaged in Type B shipping containers having a certificate of compliance approved by the NRC or approved for use by the DOT. The Type B shipping containers are designed to prevent the loss or dispersal of radioactive contents, retain shielding efficiency, ensure nuclear criticality safety, and provide adequate heat dissipation under all normal and accident test conditions. Currently, the certified Type B shipping container used for plutonium shipments is the 6M. Extensive testing of the Model 1518 6M shipping containers has been performed (McWhirter et al., 1975; Bonzon, 1977; Fischer et al., 1987). The inner and outer containers of each 6M are individually leak-tested during fabrication and must be inspected prior to each shipment. The NRC has certified the 6M container and the 6M meets DOT specifications. Other Type B shipping containers that are certified by the NRC or approved for use by the DOT may also be used.

If SIS-generated by-product material were to be transported to the WIPP, it is currently planned to transport the by-product material in a certified or approved Type B (e.g., 6M) container within the TRUPACT II shipping container. Shipments of SIS-generated by-product material would also be conducted in accordance with DOT regulations (49 CFR 170-179).

The principal nonradioactive material transported from the INEL would be hazardous waste. As previously discussed in Section 2.1.5.1, all hazardous waste transported from the INEL to an approved offsite TSD facility would be transported in accordance with DOT and EPA requirements (49 CFR 100-199 and 40 CFR 263). In addition, all RCRA requirements for manifesting, labeling and packaging, and reporting hazardous wastes generated would be followed (40 CFR 262).

Onsite transport of SIS material would consist of LLW from the PPB to the RWMC; mixed waste from the PPB to the mixed waste staging area and then to the SPERT IV area; TRU waste; and hazardous waste.

2.1.5.3 Operational Resource Requirements

Resources that would be required during SIS operation include personnel, energy, consumable materials, and land areas. The following sections briefly describe the commitment of resources that would be necessary for SIS operation.

Personnel

During SIS operation, a total of about 750 operating personnel (direct and indirect) would be employed. Hiring of operating personnel would commence with the construction of the SIS. During the period of the peak construction workforce, 274 operating personnel are expected to be hired.

Energy, Consumable Materials, and Affected Land Areas

During operation of the SIS facilities, about 100 million kilowatt-hours of electricity would be required each year for operation. In addition to electricity, about 3785 metric tons (4170 tons) per year of coal would be burned in the ICPP CFSGF to supply steam to the SIS facilities, and 1900 liters (500 gallons) of diesel fuel would be required per year for emergency and standby diesel generator testing. Operation of the SIS facilities would also consume a wide variety of chemicals. Table 2-8 lists the various chemicals that would be consumed and the maximum annual estimated consumption.

An estimated total of 76,890 square meters (19.0 acres) of land area within the ICPP would be dedicated during operation for buildings, roads, and parking areas and 11,740 square meters (2.9 acres) outside the ICPP security fence would be dedicated for roads, electric substation, and liquid nitrogen plant (see Table 2-3).

2.2 CONSTRUCT AND OPERATE THE SIS PROJECT AT THE HANFORD SITE

As an alternative to the construction and operation of the SIS Project at DOE's INEL, the SIS could be constructed and operated at DOE's Hanford Site near Richland, Washington. Although the SIS processes (Sections 2.1.1.1 and 2.1.1.2) would not be modified, locating the SIS Project at the Hanford Site would entail design modifications to account for different site features and different plant support facilities that would be used for waste handling and disposal. The following sections describe the major differences associated with the construction and operation of the SIS Project at the Hanford Site compared to the previous description of locating it at the INEL. Unless otherwise referenced, the source for the information contained in the following sections is Evaluation of the Potential Environmental Consequences Associated with Operation of the AVLIS Process at the Hanford Site, Richland, Washington, prepared by Pacific Northwest Laboratory (PNL) (1987).

2.2.1 Site Description

If the SIS Project were to be constructed and operated at DOE's Hanford Site, the SIS Project site would be adjacent to the existing Plutonium Uranium Extraction (PUREX) Plant in the southeastern quadrant of the 200-East Area. Based on a preliminary technical report prepared in 1986, the PUREX security area would be extended to include about 73,000 square meters (18 acres) for the new facilities. Figure 2-11 shows the location of the SIS facilities in relation to the existing PUREX Plant. SIS-generated by-product material would either be stored in an existing vault at the Hanford Site, or a new Stand-Alone Storage Vault similar to that described for the SIS Project at the INEL (Section 2.1.2.3) would be constructed close to the SIS facilities shown in Figure 2-11.

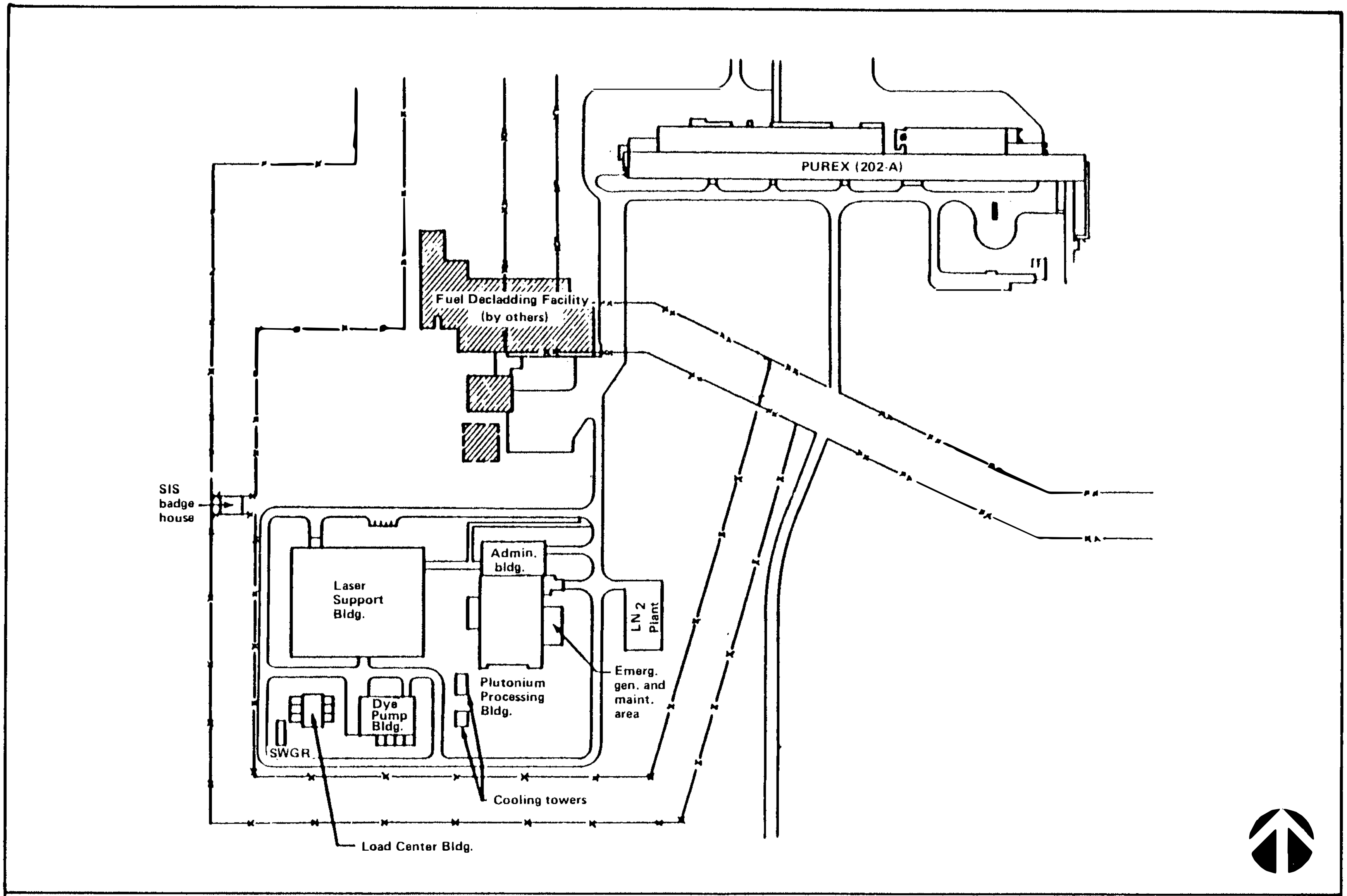
Vehicular access to the site would be from Route 4 South and the existing roads of the PUREX facility. A new road would be constructed that would loop around the SIS facilities inside the perimeter of a protected-area fence. The new road would provide access to the SIS buildings and

Table 2-8. Estimated Chemicals Consumed on an Annual Basis During Operation[a]

LASER SUPPORT FACILITY[b]		
Dye, kg (lb)	<10	(22)
Ethanol (95%), MT (tons)	<12	(13)
Freon (R-11 and R-113), MT (tons)	<18	(20)
Neon, L (ft^3)	$<1.4 \times 10^6$	(4.9×10^4)
Trichloroethane, L (gal)	<208	(55)
Benzyl alcohol, kg (lb)	<44	(97)
Ethanol-2 phenoxy, MT (tons)	<0.6	(0.6)
Ethylene glycol, MT (tons)	<0.9	(1.0)
Methanol/acetone, MT (tons)	<0.3	(0.4)
Trichloroethylene, kg (lb)	<37	(81)
Acetic acid, MT (tons)	<3.0	(3.3)
PLUTONIUM PROCESSING BUILDING		
Argon, L (ft^3)	$<2.6 \times 10^9$	(9.2×10^7)
Calcium, MT (tons)	<1.2	(1.3)
Helium, L (ft^3)	<8,100	(286)
Hydrogen, kg (lb)	<36	(80)
Nitrogen (gas), L (ft^3)	$<2.9 \times 10^{10}$	(1×10^9)
Cement, MT (tons)	<33	(37)
Potassium hydroxide (45%), MT (tons)	<1.5	(1.6)
Resin, anion exchange, kg (lb)	<30	(66)
Magnesium, kg (lb)	<25	(55)
Zinc, kg (lb)	<11	(24)
Halide salts		
Calcium chloride, MT (tons)	<13.5	(14.9)
Calcium fluoride, MT (tons)	<3.3	(3.6)
Potassium chloride, kg (lb)	<25	(55)
Hydrogen chloride, kg (lb)	<65	(143)
Hydrogen peroxide (30%), MT (tons)	<0.2	(0.2)
Hydroxylamine nitrate (24%), MT (tons)	<0.4	(0.5)
Nitric acid (68%), MT (tons)	<18	(20)
Oxalic acid, MT (tons)	<0.6	(0.7)
Silver nitrate, MT (tons)	<0.2	(0.2)
GENERAL		
Demineralized water, L (gal)	$<1.4 \times 10^8$	(3.7×10^7)
Potable water, L (gal)	$<2.8 \times 10^7$	(7.4×10^6)
Raw water, L (gal)	$<1.4 \times 10^7$	(3.7×10^6)
Treated water, L (gal)	$<5.0 \times 10^8$	(1.3×10^8)
COOLING-WATER TREATMENT		
Nonionic polymers, MT (tons)	<1.4	(1.5)
Phosphates, MT (tons)	<7	(7.7)
Phosphonates, MT (tons)	<11.1	(12.2)

[a] Based on design data available as of September 1988.

[b] Small quantities of analytical reagents used in the chemistry laboratory operations are not listed.



Source: PNL (1987).

Figure 2-11. SIS Site Plan at Hanford 200-East Area.

liquid nitrogen plant and would connect with an existing road northeast of the SIS site.

Personnel access to the SIS site would be through a badgehouse located on the outer fence at the northwestern corner of the site. Parking for about 100 vehicles would be located immediately west of the badgehouse and approximately 300 meters (1000 feet) south of Route 4 South, which is directly south of the SIS site.

Double security fencing would enclose the site. A minimum 30-meter-wide (100-foot-wide) isolation zone--fenced on its inner and outer boundaries to create an area for security, intrusion detection, and observation--would surround the site and connect with the existing PUREX double security fencing.

Utilities and services that would be provided include water systems, a steam distribution system, and an underground electric power distribution system. The water system would consist of distribution systems for raw water, potable water, and cooling-tower water. The raw-water distribution system would furnish water for site and building fire protection. The raw water would be supplied from the Columbia River through an underground pipe connected to the existing 200-Area export water system. A common loop inside the SIS complex would supply fire hydrants and fire protection for the buildings. The line would be valved to allow isolating any portion of the line. A reservoir of 380,000 liters (100,000 gallons) of water would be available for fire water in the event the raw-water system fails.

The potable water supply and distribution system would provide water for process and domestic water demand for the SIS facilities. It would also provide emergency cooling water and makeup water to the cooling-tower basins. A common loop inside the SIS complex would supply miscellaneous users in different buildings.

Steam for SIS operation would be provided by a steam distribution system that would consist of aboveground, carbon steel, insulated pipe that would connect with the existing steam pipeline near the PUREX Plant.

Electric power would be supplied from an existing substation, 251-W. The two main 251-W Substation transformers have previously been increased in size and would provide the additional capacity required for SIS operation without further modification. The substation switchgear and distribution system would be designed, as with locating the facilities at the INEL, to provide total redundancy to preclude a single-point failure in the electric power supply.

The SIS facilities would be constructed and designed to preclude undue risk to operating personnel, facilities, the environment, and offsite populations during both normal and abnormal operating conditions. Category I structures (i.e., the PPB and Stand-Alone Storage Vault, if required) would be constructed in accordance with DOE Order 6430.1A and the Hanford Architectural Civil Design Criteria (Hanford Plant Standard, 1985). Other structures would be constructed in accordance with Hanford Civil Design Criteria.

Category I structures, in a manner similar to that described for locating the SIS Project at the INEL, would be able to withstand a DBE. For the Hanford Site, the preliminary estimated design accelerations would be a vertical ground acceleration of 0.17g and a horizontal ground acceleration of 0.25g (DOE, 1986c). Geophysical evaluations would be conducted to verify design-basis accelerations. The PPB would also be designed to withstand a design-basis wind-loading and Design-Basis Tornado (DBT) as specified in DOE Order 6430.1A, and the proposed site of Category I structures would be at an elevation greater than that which would be inundated by a Probable Maximum Flood (PMF).

2.2.2 Waste Handling

Waste streams generated from SIS construction and operation, as previously discussed in Section 2.1.5.1, would include atmospheric emissions, liquid effluents, and solid wastes. No major differences between locating the SIS facilities at the INEL or the Hanford Site are expected with respect to the estimated construction effluents and the measures that would be taken to control them (e.g., fugitive-dust and runoff control). Nonradioactive and nonhazardous waste generated as a result of construction would be disposed of in the Hanford sanitary landfill.

Operational waste streams, while not differing in the estimated quantities that would be generated, would be handled, treated, and disposed of or stored in accordance with waste management practices and operations at the Hanford Site. The following sections briefly describe the major differences of locating the SIS facilities at the Hanford Site compared to the INEL with respect to these waste management practice differences. Atmospheric emissions would not differ from those indicated in Section 2.1.5.1.

2.2.2.1 Liquid Effluents

All PPB liquid waste streams that are radioactive and nonhazardous would be mixed with cement to form a grout as previously described for locating the SIS Project at the INEL. The grout slurry would be placed in drums as described for locating the facilities at the INEL, and then either certified and transported to the WIPP or disposed of onsite as LLW based on the results of assays.

Nonradioactive and nonhazardous liquid effluents, including cooling tower blowdown and PPB process steam condensate, that are below limits set by RCRA (40 CFR 261) and DOE Orders in the 5480 series would be sampled to ensure compliance and then discharged to a process-sewer system. The process-sewer system would discharge to a process-sewer tile field that would consist of a trench system using slotted polyvinyl chloride (PVC) pipe placed in gravel to distribute the waste liquid over a leach field.

Sanitary waste water would be discharged to a septic tank located west of the outer 200-East protected-area fence. The effluent from the septic tank would discharge to a sanitary tile field that would be similar in design to the tile field for process liquid wastes.

All liquid waste streams that are hazardous (i.e., hazardous and mixed wastes) would be managed in accordance with the requirements of RCRA and DOE Orders in the 5480 series, and would not be discharged as liquid effluents.

2.2.2.2 Solid Waste

Grouted TRU wastes would be packaged at the PPB and nondestructively assayed and surveyed for contamination. Current planning at the Hanford Site provides for the construction and operation of a Waste Receiving and Processing (WRAP) facility that would receive the grouted and drummed TRU waste. An extensive discussion of the WRAP facility is contained in the EIS for the disposal of Hanford defense high-level, TRU, and tank wastes (DOE, 1987b). The WRAP facility would perform the same functions as described for the SWEPP and PREPP facilities at the INEL. If the Hanford WRAP facility were not operational by the startup of SIS operations, the grouted and drummed TRU waste would be transported to the existing TRU Storage and Assay Facility (TRUSAF) at Hanford. This facility currently receives, assays, and inspects drums of newly generated, contact-handled TRU waste. Final waste certification activities at the TRUSAF include labeling and data package completion and storage until transport to the WIPP.

Low-level radioactive wastes that would be generated by SIS operation at Hanford would be disposed of at the Hanford low-level radioactive burial facility. Solid nonradioactive nonhazardous wastes generated from operation would be transported and disposed of at the Hanford sanitary landfill.

Hazardous wastes generated during SIS operation would be transported to an authorized TSD facility. Mixed wastes either would be stored at the Hanford Site in conjunction with other mixed wastes in a RCRA-permitted facility or transported off the site to an authorized TSD facility.

2.2.3 Transport of Materials

During SIS operation, materials would be transported to and from the Hanford Site as well as between onsite locations. The materials transported would consist primarily of radioactive materials and radioactive and/or hazardous solid wastes. Unlike the previous description of transport of materials for locating the SIS Project at the INEL, the primary source of feed for the SIS Project is located at the Hanford Site and would, therefore, not be transported offsite. Some feed material (i.e., a small quantity of scrap) would, however, be shipped from the SRP in South Carolina to the Hanford Site.

The radioactive materials transported from the Hanford Site would consist of TRU waste to the WIPP and plutonium metal product from the Hanford Site to the Rocky Flats Plant in Colorado. If determined not to be useful for other missions, SIS by-product material would also be transported to the WIPP. The SIS by-product and TRU waste would be transported to the WIPP by truck in NRC-certified or DOT-approved containers (e.g., Type B containers such as the 6M within the TRUPACT II for by-product material, and Type A containers within the TRUPACT II for TRU waste). All by-product material and TRU waste shipments would be conducted in accordance with DOT regulations (49 CFR 170-179).

The DOE SSTs would be used for the offsite transport of plutonium feed and product as discussed for locating the SIS Project at the INEL. Shipments would be conducted in accordance with DOT regulations (49 CFR 170-179). The feed and product shipments would be packaged in Type B shipping containers (e.g., the 6M) certified by the NRC or approved for use by the DOT.

The principal nonradioactive material transported from the Hanford Site would be hazardous waste. Transport of hazardous waste from the Hanford Site to an approved offsite TSD facility would be conducted in accordance with DOT and EPA requirements (49 CFR 100-199 and 40 CFR 263). In addition, all RCRA requirements for manifesting, labeling and packaging, and reporting hazardous wastes generated would be followed (40 CFR 262).

Onsite transport of SIS material would consist of SIS feed material, LLW, hazardous waste, TRU waste, and mixed waste.

2.2.4 Resource Requirements

Resource requirements for the construction and operation of the SIS facilities at the Hanford Site would be similar to those described for locating the facilities at the INEL (Sections 2.1.4.3 and 2.1.5.3). Table 2-9 lists the estimated land requirements at the Hanford Site for construction and operation of the SIS facilities, based on a 1986 preliminary technical report for locating the SIS Project at the Hanford Site.

2.3 CONSTRUCT AND OPERATE THE SIS PROJECT AT THE SAVANNAH RIVER PLANT

As an alternative to the construction and operation of the SIS Project at either DOE's INEL or Hanford Site, the SIS could be constructed and operated at DOE's SRP near Aiken, South Carolina. The following sections describe the major differences associated with the construction and operation of the SIS at the SRP compared to locating the SIS Project at the INEL. Although site-specific studies have not been conducted for locating the SIS facilities at the SRP, a reference location has been selected based on discussion with DOE Savannah River Operations Office personnel for identifying major site differences and assessing potential environmental consequences.

Table 2-9. SIS Land Use at the Hanford Site[a]

Usage	Protected area	
	Inside	Outside
Total, in extended protected area, m^2 (acres)	73,000 (18)	
Graded and grubbed, m^2 (acres)	57,000 (14)	
Building footprints, m^2 (acres)	24,000 (6)	
New roads, m^2 (acres)	2,000 (0.5)	
Parking lots, m^2 (acres)	1,200 (0.3)	
Construction storage, m^2 (acres)		4,000 (1)
Work yards, m^2 (acres)	800 (0.2)	
Transmission line right-of-way, m^2 (acres)		400,000 (100)[b]
Tile field, m^2 (acres)		12,000 (3)

[a] Estimates based on a 1986 preliminary technical report of the SIS Project as contained in PNL (1987) compared to preliminary design estimates for locating the SIS Project at the INEL.

[b] Only 25 percent of the listed area would be temporarily disturbed during construction.

2.3.1 Site Description

The reference location for the SIS Project, were it to be constructed and operated at DOE's SRP, is to the west of the F-Area (Figure 2-12), which is located in the north-central portion of the SRP. The security area presently surrounding the F-Area would be extended to include the new facilities that would occupy approximately 81,000 square meters (20 acres) during construction. Previously disturbed areas used during the construction of the Fuel Materials Facility would be used to the maximum extent possible for construction-employee parking, construction storage, and construction work yards. SIS-generated by-product material would either be stored in an existing vault at the SRP or a new Stand-Alone Storage Vault similar to that described for the SIS Project at the INEL (Section 2.1.2.3) would be constructed close to the reference location shown on Figure 2-12.

Vehicular access to the site would be provided by an existing road at the western perimeter of the F-Area. Double security fencing would surround the site as in the case of the INEL and Hanford Site. A badgehouse would be located at the southern perimeter of the site.

Utilities and services that would be provided include water systems, steam distribution, and an underground electric distribution system. Water would be provided by connecting to the existing F-Area water distribution system, which withdraws ground water. An emergency water supply reservoir would be constructed in the vicinity of the reference site in the event of raw-water system failure.

Steam for SIS operation would be supplied by connecting into an existing steam line that provides steam to the F-Area. Steam at the F-Area is provided by four coal-fired boilers that use ground water as makeup water for steam generation, and by the D-Area coal-fired powerhouse, which uses makeup water from the Savannah River.

Electric power would be supplied from an existing substation near the F-Area. The substation would be modified to provide the necessary switchgear and transformers, to provide redundancy, and to preclude a single-point failure.

The SIS Project would be designed and constructed to preclude undue risk to operating personnel, facilities, the environment, and offsite populations during both normal and abnormal operating conditions. Category I structures (i.e., the PPB and Stand-Alone Storage Vault, if required) would be constructed in accordance with local SRP design criteria and DOE Order 6430.1A.

For locating the SIS Project at the SRP, Category I structures would be designed to withstand a DBE having an estimated horizontal ground acceleration of 0.20g and a vertical ground acceleration of 0.1g. Category I structures would also be designed to withstand a design-basis wind-loading and a DBT as specified in DOE Order 6430.1A. The proposed sites of Category I structures would be at an elevation greater than that which would be inundated by a postulated PMF.

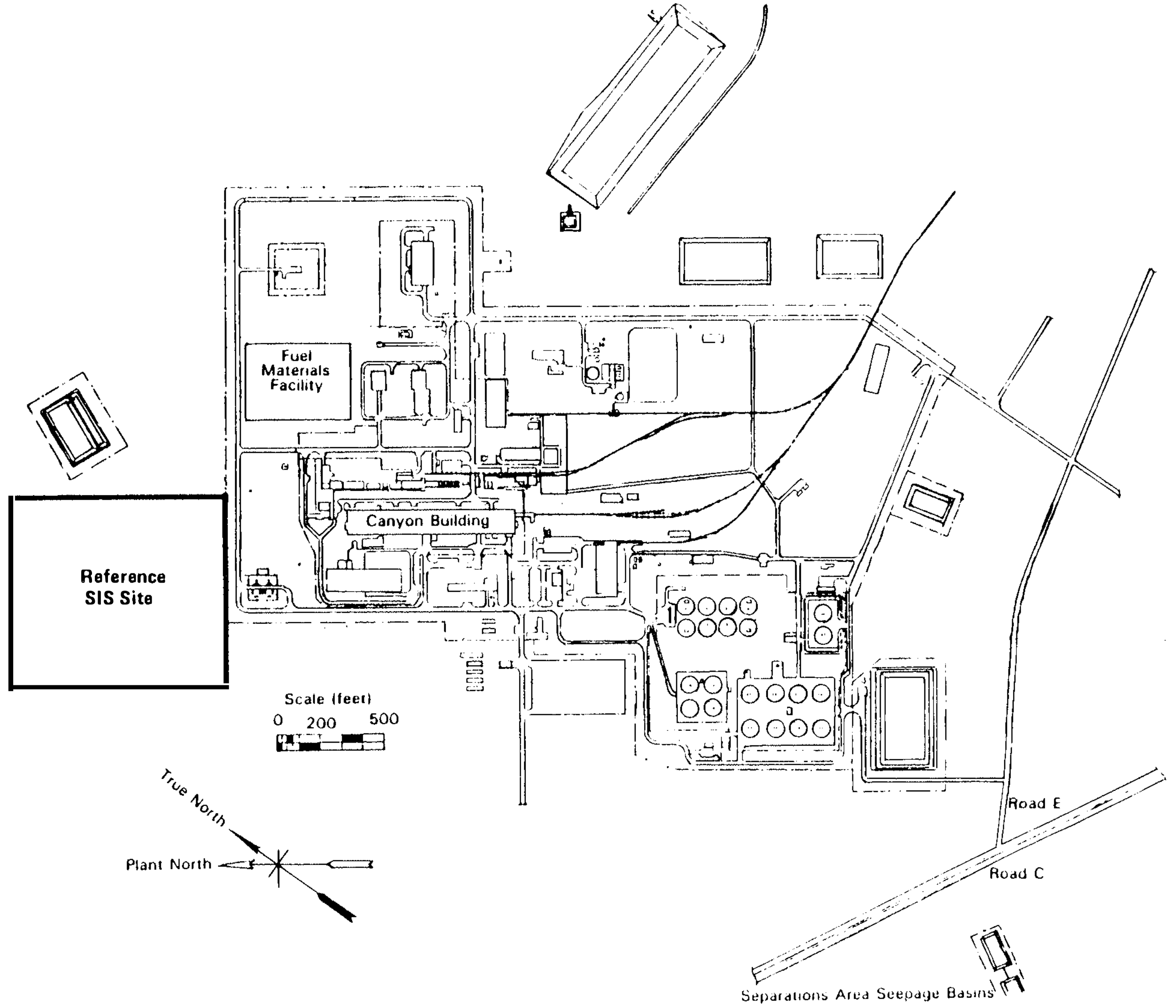


Figure 2-12. SIS Site at the Savannah River Plant.

2.3.2 Waste Handling

Waste streams generated from SIS construction and operation, as previously discussed in Section 2.1.5.1, would include atmospheric emissions, liquid effluents, and solid wastes. No major differences between locating the SIS facilities at the INEL or the SRP are expected with respect to the estimated construction effluents and the measures that would be taken to control these effluents (e.g., fugitive-dust and runoff control), although greater protection measures might be needed to prevent and control runoff and sedimentation at the SRP due to its less arid climate. Nonradioactive and nonhazardous solid waste generated as a result of construction would be disposed of in the SRP sanitary landfill.

Operational effluents, while not differing in the estimated quantities that would be generated, would be handled, treated, and disposed of or stored in accordance with the waste management practices and operations at the SRP. The following sections briefly describe the major differences between locating the SIS facilities at the SRP compared to the INEL with respect to these waste management practice differences. If the SIS Project were located at the SRP, radioactive atmospheric emissions would be exhausted through a combination of HEPA filters and a final sand filter in accordance with local SRP design criteria. Radioactive and nonradioactive atmospheric emissions, however, are not expected to significantly differ (i.e., result in any higher consequences) from those indicated in Section 2.1.5.1.

2.3.2.1 Liquid Effluents

All PPB liquid waste streams that are radioactive would be mixed with cement to form a grout as described for locating the SIS Project at the INEL. The grout slurry would be placed in drums as described for locating the facilities at the INEL, and then either certified and transported to the WIPP or disposed of onsite as LLW, based on the results of assays.

Nonradioactive and nonhazardous liquid effluents, including cooling tower blowdown and PPB process steam condensate, that are below limits set by RCRA and DOE Orders in the 5480 series would be discharged to a process-sewer system. These discharges would be sampled and would flow to a lift station that would discharge the effluents to Four Mile Creek. Sanitary waste water would be discharged to a new package waste-water treatment facility. Treated effluent from the new treatment facility would also flow to a lift station for discharge to Four Mile Creek.

All liquid waste streams that are hazardous (i.e., hazardous and mixed wastes) would be managed in accordance with requirements of RCRA and DOE Orders in the 5480 series, and would not be discharged as liquid effluents.

2.3.2.2 Solid Waste

Grouted TRU wastes would be nondestructively assayed and surveyed for contamination. Currently, planning at the SRP provides for the construction and operation of a new TRU Waste Processing Facility (TWF) that would receive retrieved TRU waste and newly generated TRU waste requiring processing (DOE, 1988). The new facility would perform the same functions as those described for the SWEPP and the PREPP at the INEL. If the SRP facility is not operational by the start of SIS operation, the SIS-generated TRU waste requiring processing would be transported to the existing TRU storage area located next to the existing SRP burial ground until the TWF is operational.

Low-level radioactive wastes that would be generated by SIS operation at the SRP would be disposed of at a new disposal facility located on the SRP. An extensive discussion of the continued disposal of LLW at the SRP is contained in DOE (1987a). Solid nonradioactive nonhazardous wastes generated from operation would be transported and disposed of at the SRP sanitary landfill.

Hazardous wastes and mixed wastes generated during SIS operation would either be stored or disposed of at the SRP in compliance with RCRA requirements. A detailed discussion of the storage and/or disposal of hazardous and mixed wastes at the SRP is documented in DOE (1987a).

2.3.3 Transport of Materials

During SIS operation, materials would be transported to and from the SRP as well as between onsite locations. The materials transported would consist primarily of radioactive materials and radioactive and/or hazardous solid wastes.

The radioactive materials transported to or from the SRP would consist of TRU waste from the SRP to the WIPP, plutonium feed (i.e., processed N-Reactor fuel and a small quantity of scrap) from the Hanford Site in Washington to the SRP, and plutonium metal product from the SRP to the Rocky Flats Plant in Colorado. If determined not to be useful for other missions, SIS by-product material would be transported to the WIPP. The SIS by-product and TRU waste would be transported by truck to the WIPP in shipping containers certified by the NRC or approved for use by the DOT. All TRU waste material shipments would be conducted in accordance with DOT regulations (49 CFR 170-179).

The DOE SSTs would be used for the offsite transport of plutonium feed and plutonium metal product. Shipments would be conducted in accordance with DOT regulations (49 CFR 170-179). The feed and product shipments would be packaged in shipping containers (e.g., the 6M) certified by the NRC or approved for use by the DOT.

Onsite transport of SIS material would consist of a small amount of feed material (i.e., scrap), LLW, hazardous waste, TRU waste, and mixed waste.

2.3.4 Resource Requirements

Resource requirements for the construction and operation of the SIS facilities at the SRP would be similar to those described for locating the facilities at the INEL (Sections 2.1.4.3 and 2.1.5.3). Additional land areas compared to those described for the INEL would include those associated with the construction of a package waste-water treatment plant for sanitary effluents and a lift station for nonradioactive nonhazardous liquid effluents.

2.4 NO ACTION

The No-Action Alternative is to not construct and operate the SIS Project. If the SIS Project is not constructed and operated, the desired level of contingency, technological diversity, and flexibility in the production of weapon-grade plutonium that would be provided by the SIS Project would not be achieved. The operation of DOE's nuclear materials production complex for weapon-grade plutonium would continue to be evaluated on an annual basis. The No-Action Alternative, as well as the previously described alternatives, would not result in changes to the utilization of DOE fuel-grade plutonium in producing weapon-grade plutonium through blending.

Continuation of producing weapon-grade plutonium through blending is dependent on the continued operation of three SRP production reactors that were constructed in the early 1950s. Presently, these reactors are operated at a nominal 50-percent power level pending successful resolution of safety issues. Future operational constraints could further limit production reactor availability. These reactors are also operated on a priority basis for the production of tritium. Continuation of the production of weapon-grade plutonium through blending cannot provide an assured source of weapon-grade plutonium requirements in the mid-1990s.

In the production of weapon-grade plutonium through blending, fuel-grade plutonium is transported from DOE's Hanford Site to the SRP and blended with newly produced plutonium of higher purity than weapon-grade plutonium (i.e., plutonium-240 content of 3 percent). To provide the higher purity plutonium to blend with the fuel-grade plutonium, the SRP reactors are operated with shortened reactor irradiation cycles to limit the amount of plutonium-240 produced in the irradiated targets. Compared to the production of weapon-grade plutonium (i.e., plutonium having a plutonium-240 content of 6 percent), approximately twice the amount of target assemblies must be fabricated, irradiated, and processed at the SRP to produce the higher purity plutonium.

Fuel and targets for plutonium at the SRP are fabricated in the M-Area. Tubular fuel of uranium is manufactured by coextrusion of a composite billet, a process in which the tube is formed and the core is simultaneously clad with aluminum. Targets of depleted uranium are fabricated by electroplating depleted uranium cores with nickel, placing the cores into an aluminum can, capping the can, preheating, and pressing the core through a die to size the can. In the process of fabricating fuel and targets, small amounts of radioactivity associated with the fabrication of fuel are emitted to the atmosphere after HEPA filtration; liquid effluents primarily from electroplating and metal finishing are discharged to a new effluent treatment facility; and solid low-level radioactive wastes are disposed of at an onsite LLW disposal area.

The fabricated fuel and targets are then transported to the SRP reactors. The SRP reactors use heavy water as a neutron moderator and as recirculating primary coolant to remove the heat generated by the nuclear fission process. The recirculating heavy water is in turn cooled in heat exchangers by water pumped from the Savannah River and Par Pond. During irradiation in the reactor, plutonium is produced by the uranium-238 target absorption of neutrons from the uranium-235 fuel to produce uranium-239, which quickly decays to neptunium-239 and subsequently to plutonium-239. Successive neutron captures also result in the production of plutonium-240, 241, 242, and small amounts of plutonium-238. Plutonium-240 content in the irradiated targets is controlled by the length of irradiation of the target.

After target irradiation in the reactor, the targets are removed and stored in the disassembly basin to allow radionuclides to decay to a level to allow shipment to the separations facilities. Periodic purging of the water in the disassembly basins is necessary to reduce radiation exposures to operating personnel. During purging, water from the basin is passed through two deionizer beds in series, and monitored before it is discharged to a seepage basin.

As a consequence of reactor operation, small quantities of radioactive material are released to the environment. The sources of these releases include gaseous effluents generated in reactor building operation and exhausted through a stack; evaporation of water from the reactor disassembly basin; evaporation and ground-water migration of the periodic and deionized disassembly-basin discharges to seepage basins; small process-water leaks into the secondary cooling-water system in the reactor heat exchangers; and the generation of solid LLW. Other nonradioactive effluents and wastes generated include thermal discharges from the reactors and atmospheric releases from steam generation and the operation of emergency diesel generators.

The chemical separations plants located in the F- and H-Areas dissolve the irradiated fuel and targets in nitric acid. A solvent extraction process then yields (1) solutions of plutonium, uranium, or neptunium, and (2) a high-heat liquid waste, containing the nonvolatile fission products. After the product solutions are decontaminated sufficiently from the fission products, further processing is performed in unshielded areas, where plutonium is converted from solution to solid form for shipment. In blending, the fuel-grade plutonium is dissolved and blended with the newly produced plutonium solutions prior to processing the plutonium solutions to a solid form.

Chemical separations of the fuel and targets result in the release of radioactive effluents to the atmosphere (after being filtered through HEPA filters and a sand filter) as well as to ground waters through the discharge of liquids to seepage basins. A new effluent treatment facility for the

F- and H-Areas has been constructed and is beginning operations to eliminate the need for the continued use of the F- and H-Area seepage basins. High-level liquid radioactive wastes, low-level solid wastes, and TRU wastes are also generated. Other facilities associated with the production of plutonium at the SRP include the heavy-water rework area and the Central Shops Area.

A more detailed description of the production of the plutonium of higher-than-weapon-grade purity is contained in the Final EIS for L-Reactor Operation (DOE, 1984b), which based its assessment of environmental consequences on the production of plutonium having a plutonium-240 content of 3 percent. Additional information on SRP production of plutonium and related facilities is contained in several EISs (i.e., DOE, 1982b, 1984b, 1987a, 1987e; ERDA, 1977b). Information on the Hanford Site processing of fuel-grade plutonium that is used in blending is also contained in previously prepared EISs (i.e., ERDA, 1975; DOE, 1983).

The recovery and recycle of existing weapon-grade plutonium from retired weapons as well as accelerated weapon-grade scrap recovery is on-going and will continue irrespective of whether the SIS Project is constructed and operated.

2.5 OTHER ALTERNATIVES CONSIDERED BUT NOT ANALYZED IN DETAIL

Two major categories of alternatives have been considered by DOE in formulating the Proposed Action of constructing and operating the SIS Project using the AVLIS technology. These categories of alternatives, from which no further reasonable alternatives have been identified, include technology alternatives to AVLIS and production alternatives for weapon-grade plutonium. Each of these two categories of alternatives is briefly described and discussed in the following sections.

2.5.1 Technology Alternatives to AVLIS

During the last several years, DOE has investigated potential non-reactor-based processes to adjust the isotopic content of plutonium. Primary efforts were directed at the AVLIS and Molecular Laser Isotope Separation (MLIS) processes as being the most feasible from the standpoint of cost and technical difficulty. Prior to the preparation of this EIS, the DOE studied several alternative technologies for the purpose of plutonium isotopic separation. This review included several technologies as alternatives to the AVLIS separation process, including (1) the MLIS process, (2) the Plasma Separation Process (PSP), (3) the Chemical Exchange process, (4) the Electromagnetic Separation process, (5) the Gaseous Diffusion process, and (6) the Gas Centrifugation process. Conceptually, all of these technologies could be developed for the proposed application. However, because of fundamental technical considerations, cost, or the need to carry out extensive research and development programs, only the MLIS process merited further consideration as an alternative to the AVLIS technology.

During the period between January and March 1986, DOE conducted a Process Readiness Review, for the purpose of designating a preferred laser isotope separation technology for the SIS facility. As part of the technology readiness review, an EA, Special Isotope Separation Process Selection (DOE, 1986d), was prepared to evaluate the potential differences in the environmental impacts between the AVLIS and MLIS technologies. The EA showed that there were no significant environmental differences between the two alternatives, and on April 17, 1986, a Finding of No Significant Impact (FONSI) was issued documenting these results (DOE, 1986e). Subsequent to the NEPA review, and in light of the aforementioned considerations, the Energy System Acquisition Advisory Board designated the AVLIS process as the preferred technology for plutonium Special Isotope Separation (DOE, 1986g). The following briefly describes the various technology alternatives that were reviewed as alternatives to the AVLIS process.

2.5.1.1 Molecular Laser Isotope Separation Process

The MLIS process is similar to the AVLIS process in that both utilize laser energy for isotopic enrichment. However, the MLIS process uses laser energy to selectively dissociate specific isotopes of plutonium as plutonium hexafluoride (PuF_6) molecules in the gas phase. Dissociation of PuF_6 creates plutonium pentafluoride (PuF_5), a solid, for collection and further processing. The MLIS process would be supported by specific chemical processes that fluorinate plutonium compounds, recover plutonium, reduce the fluoride to metal, and provide by-product processing.

Plant design specifications for the MLIS system are dependent on the completion of integrated demonstrations at scale with prototypic hardware to verify plant performance projections. For application to plutonium, major effort would be required to achieve adequate laser performance, beam transport, and systems integration in addition to component reliability. Plutonium hexafluoride gas undergoes slow thermal and radiolytic decomposition producing plutonium tetrafluoride (PuF_4), a solid material that subsequently deposits on process equipment. To minimize this undesirable effect, and to recover plutonium fluorides in general, special handling procedures and BOP processes are required.

An EA prepared in March 1986 (DOE, 1986d) found no significantly different environmental impacts from the construction and operation of either an AVLIS or MLIS plant. The primary MLIS environmental concern would be the handling and storage of large quantities of fluorine and plutonium hexafluoride.

The MLIS process still faces the technical obstacles noted above, which would need to be resolved for application to the SIS production-scale mission. A Process Readiness Review of the AVLIS and MLIS processes was conducted in early 1986 in response to a Congressional request. This review concluded that AVLIS was technically ready to proceed to the definitive plant design phase, while MLIS was not technically ready to permit definitive design at that time.

2.5.1.2 Plasma Separation Process

The PSP is based on the principle of ion cyclotron resonance. In the PSP, an atomic vapor is generated by sputtering from the metal, and the vapor is ionized by heated plasma electrons. The ion-electron stream is confined by a magnetic field and selectively energized (excited) by a resonant electrical field, increasing the spiral orbit radius of the desired ions relative to the unexcited/undesired ions. A physical separation is then accomplished based on the difference in geometric trajectories (or energy) of the ions.

The PSP technology has been demonstrated for the isotopes of medium-mass elements and for uranium, but has not been demonstrated for plutonium isotope separation. Major redesign followed by an extensive development and engineering effort would be required to adapt the PSP system to plutonium isotope separation because of the special operability considerations for plutonium (e.g., criticality, radiation dose, refurbishment).

The environmental concerns for a plant based on the PSP technology would be similar to those for an AVLIS plant.

Because of operability considerations and the lack of demonstrated plutonium separations, PSP is not presently developed to a stage suitable for the SIS mission.

2.5.1.3 Chemical Exchange Process

Chemical separation of isotopes is based on the fact that various energy levels of a molecule (particularly the vibrational states) depend on the mass of the atoms in the molecule. Because of differences in energy levels, both equilibrium constants and reaction rates are affected. The magnitude of the difference in energy levels between the bonds in two molecules containing two isotopes of the same element is a function of the fractional differences in the masses of the two isotopes. Therefore, chemical exchange processes are generally more efficient for light isotopes than for heavier isotopes, where fractional mass differences are smaller.

A plutonium isotope separation plant based on chemical exchange has been considered. To perform the necessary isotopic enrichment at the current state of development, the plant would require an unacceptably large in-process plutonium inventory. Extensive development work with significant risk would be required to reduce this inventory.

The environmental concerns for a plant based on the chemical exchange technology are the relatively large quantities of hazardous solvents and other reagents and the relatively large in-process inventory of plutonium.

Based on the large in-process plutonium inventory and the remaining development effort, chemical exchange is not considered a viable alternative.

2.5.1.4 Electromagnetic Separation Process

In the electromagnetic separation process, an accelerated plutonium ion beam is passed through a magnetic field. The magnetic field causes the ions to move in circular orbits, with the radii being proportional to the isotopic mass. After deflection through an angle determined by the physical parameters of the separator, the ions of different isotopes reach maximum spatial separation and deposit in an array of collectors.

Electromagnetic separation has been useful in separating research quantities of isotopes, but has not been economical for production on an industrial scale. Its fundamental drawback is the limited throughput (beam current) of a single machine. In addition, special chemical processing methods would have to be developed to recover and recycle significant quantities of plutonium-containing materials deposited throughout the machine.

The primary environmental concern for a plant based on the electromagnetic separation technology is the plutonium chemical processing involving large quantities of chlorinated organic reagents.

Because of the inherent limitation on throughput, electromagnetic separation is not a practical approach to meet the SIS mission.

2.5.1.5 Gaseous Diffusion Process

The gaseous diffusion method uses the phenomenon of molecular effusion to effect separation of isotopes. In a vessel containing a mixture of two gases, gas molecules of lower molecular weight travel faster and strike the walls of the vessel more frequently, relative to their concentration, than do gas molecules of higher molecular weight. If the wall of the vessel has minute holes, more of the lighter molecules flow through the wall, relative to their concentration, than do the heavier molecules. This differential flow of individual molecules through minute holes is the basis for gaseous diffusion.

The basic underlying problem with barrier diffusion for plutonium separation is the instability of the required compound plutonium hexafluoride (PuF_6), which would be used as feed. Plutonium hexafluoride is thermodynamically unstable with respect to decomposition to plutonium tetrafluoride (PuF_4). Diffusion barriers are extremely sensitive to plugging, and the decomposition product plutonium tetrafluoride would rapidly plug the barriers. Deposits in lines, valves, and pumps would present additional problems in terms of criticality and accountability.

The environmental concerns for a plant based on the gaseous diffusion technology are the chemical processing, handling, and storage of large quantities of plutonium hexafluoride and fluorine-containing reagents, and the potential leakage of plutonium compounds.

Because of barrier plugging by PuF_4, gaseous diffusion is not being further considered for the SIS mission.

2.5.1.6 Gas Centrifugation Process

The gas centrifugation process takes advantage of the difference in the behavior of isotopic species when subjected to a strong centrifugal force field. Such a field is created in a long, narrow cylinder rotating rapidly about its axis. The centrifugal force causes the heavier species to move preferentially to the periphery of the cylinder, producing a partial separation of isotopes in a radial direction.

As in the MLIS and gaseous diffusion processes, PuF_6 gas would be the feed for application of the centrifuge to plutonium separation. Separative performance would be better for the centrifugation process than for the diffusion process because of the different mass dependence. However, the thermodynamic instability of PuF_6 gas would produce similar problems for the centrifuge as were noted for the gaseous diffusion process. In particular, the gas centrifuge is a very high-precision machine, delicately balanced with very stringent mechanical tolerances. It is doubtful that the expected deposition of solids from PuF_6 decomposition could be tolerated for extended periods in the rotating centrifuge and other portions of the system. In addition, potential leakage of PuF_6 from centrifuge seals would be a major concern requiring secondary radiological confinement for operating the gas centrifuge.

The environmental concerns for a plant based on the gas centrifugation process are similar to those for the gaseous diffusion process.

In view of the PuF_6 chemical-related difficulties previously described and the process development required, the gas centrifugation process is not being further considered for the SIS plutonium mission.

2.5.2 Weapon-Grade Plutonium Production Alternatives

In proposing to construct and operate the SIS Project, DOE has considered alternatives for the production of new weapon-grade plutonium; however, none of the alternatives considered would, either separately or in combination, provide the required contingency, technological diversity, and flexibility provided by the SIS Project. The production alternatives considered were increased blending, use of a new fuel lattice in the reactors at the SRP, restart of the N-Reactor at the Hanford Site, construction and operation of a New Production Reactor (NPR), and conversion of the Washington Nuclear Project Unit 1 (WNP-1), which is located within the Hanford Site, to a DOE production reactor. Alternatives not involving new weapon-grade sources (i.e., weapon recycle and enhanced scrap recovery) have also been considered.

As described in the section on No Action (Section 2.4), the production of weapon-grade plutonium by blending requires the production of new plutonium, of a higher purity than weapon-grade plutonium, to blend with fuel-grade plutonium. Theoretically, increased blending could be implemented either by producing new plutonium that has a lower plutonium-240 content (i.e., a plutonium-240 content of less than 3 percent) or through greater production of new plutonium that has a plutonium-240 content of 3 percent.

Increased blending by producing plutonium with a plutonium-240 content of less than 3 percent, or "super blending," would require excessively high throughput (i.e., more frequent changing of targets) in the production reactors at the SRP to control the buildup of plutonium-240 in the irradiated targets. The more frequent changes in the targets would lead to increased reactor downtime, resulting in a reduction in the quantities of material produced and in the need for additional reactor availability to compensate for the loss of material. Increased blending through greater SRP production of new plutonium with a plutonium-240 content of 3 percent would similarly require greater production reactor availability. Because increased blending, either through "super blending" or greater production, would require additional SRP reactor availability, which is limited both by higher priority need for the production of tritium and by current or potential operational constraints, it is not considered a reasonable alternative to SIS.

Currently, the SRP reactors use a Mark-16-31 lattice for plutonium production. A new fuel lattice has been developed for the SRP reactors to increase the efficiency of plutonium production. A demonstration of the new fuel lattice design was performed in August and September 1983 to verify its design and operability. Similar, though less efficient, uniform lattices have been used in earlier production operations. The implementation of this initiative is not considered to be a reasonable alternative to the SIS Project because, similar to blending, implementation would not significantly alter the current dependency on reactor availability. Also, the production complex requires the flexibility to use these reactors for tritium production while still maintaining plutonium production capacity.

In the past, another source of new weapon-grade plutonium was the N-Reactor at the Hanford Site. During 1987, this reactor was shut down for the application of safety modifications. Later, prior to its restart, this reactor was placed in cold standby because of sufficient near-term plutonium supply and the high cost of continuing to operate the reactor. The N-Reactor has a limited service life that is governed by distortion of the graphite moderator and is potentially subject to problems of aging similar to those of the SRP reactors. The restart of the N-Reactor, while possible, does not meet the requirement of technological diversity, nor does it promise a reliable contingency supply for the period of most-needed performance.

Studies have also been performed with respect to the construction and operation of an NPR and the potential conversion of WNP-1 to a DOE production reactor. Implementation of either initiative was considered unreasonable because neither would provide the flexibility and technological diversity of a reactor-independent source as represented by the SIS Project. Currently, new reactor capacity has been planned to meet long-term tritium needs and would not be operated until after the year 2000.

None of the alternatives discussed above are technologically diverse from reactor-based plutonium production. In addition, flexibility in meeting potential requirements for rapid increases in plutonium production is not provided by these alternatives. Many years would be required to provide significant increases in reactor production capacity once a need is identified. Thus, none of these options is an acceptable alternative to SIS, which can be more readily expanded in terms of throughput.

The nation's stockpile of weapon-grade plutonium physically resides either in the weapons themselves or in inventories associated with manufacture, processing, and storage. When warheads are returned, the material can be reclaimed; however, the numbers and frequencies of return are determined based on national security considerations. During the chemical and physical processing of both new and returned material, scrap is generated. Evaluations of need for new weapon-grade plutonium fully consider the availability of material from returns and scrap. While accelerated processing of these materials can relieve short-term shortages, it adds no weapon-grade material to the stockpile. The recovery and recycling of existing weapon-grade plutonium from retired weapons as well as the acceleration of scrap recovery are, therefore, not reasonable alternatives to the SIS Project because they provide no contingency source material.

2.6 COMPARISON OF THE PROPOSED ACTION AND ALTERNATIVES

In Sections 2.1 through 2.4, the Proposed Action and reasonable alternatives to the Proposed Action, including No Action, were described and discussed. Table 2-10 summarizes the expected annual environmental consequences of each of these based on the information contained in Chapter 4. Section 4.5 discusses cumulative impacts.

Each of the alternatives for constructing and operating the SIS Project would provide the needed contingency, technological diversity, and flexibility in meeting approved requirements for weapon-grade plutonium. No Action, while continuing to provide weapon-grade plutonium, would not meet the same needs as would the SIS Project.

The emissions and effluents resulting from SIS construction and operation would be within all applicable environmental standards. The major differences in the expected environmental consequences between the construction and operation of the SIS Project at the INEL (the preferred location) compared to the other locations considered are primarily related to the different geographic settings/locations (e.g., the different distances involved in the transport of materials, different distances of the location of the SIS relative to the nearest INEL/Hanford Site/SRP boundaries, and the estimated population surrounding each of the alternative sites).

Table 2-10. Consequences of the Proposed Action (PA), Alternatives, and Continuation of Present Practice

Category	Proposed Action (PA) and Preferred Alternative--construct and operate SIS Project at the INEL	Construct and operate SIS Project at the Hanford Site	Construct and operate SIS Project at the SRP	No Action--continuation of present practice
		PROGRAMMATIC IMPACTS		
Need	Would provide DOE with needed contingency, flexibility, and technological diversity in the DOE nuclear materials production complex.	Same as PA.	Same as PA.	Would continue to provide plutonium but would not provide needed contingency, flexibility, and technological diversity.
		CONSTRUCTION IMPACTS		
Land area required	26.9 acres within the ICPP area and about 34.1 acres outside existing ICPP area, of which 11.2 acres would be temporarily disturbed for a substation distribution line, and additional acreage for borrow area.	18 acres within the 200-East Area and 29 acres outside 200-East Area, of which 25 acres would be temporarily disturbed for a transmission line, and additional acreage for borrow area.	20 acres outside existing F-Area and additional acreage for borrow area and other support facilities.	Not applicable--facilities currently in place and operating.
Socioeconomic impacts	No large in-migrating construction workforce or major adverse impacts expected; beneficial impacts would include a stable INEL workforce, indirect job opportunities,	Same as PA. No large in-migrating construction workforce or major adverse impacts expected; beneficial economic impacts similar to those for PA.	Same as PA. No large in-migrating construction workforce or major adverse impacts expected; beneficial economic impacts similar to those for PA.	Not applicable--facilities currently in place and operating.

Table 2-10. Consequences of the Proposed Action (PA), Alternatives, and Continuation of Present Practice (continued)

Category	Proposed Action (PA) and Preferred Alternative--construct and operate SIS Project at the INEL	Construct and operate SIS Project at the Hanford Site	Construct and operate SIS Project at the SRP	No Action--continuation of present practice
		CONSTRUCTION IMPACTS (continued)		
Socioeconomic impacts (continued)	and contributions to tax base.			
Ecological habitat	Habitats and wildlife associated with sagebrush vegetation community would be lost or displaced; successional recovery of all but 2.9 acres outside ICPP area and minor areas for transmission line; no critical habitats, wetland habitats, or habitats for rare or endangered species would be affected.	Same as PA, except a smaller amount of acreage (i.e., about 9 acres) might be affected during construction.	Habitats and wildlife associated with 20 acres of pine and admixtures of hardwoods would be lost; no wetlands impacted.	Not applicable--facilities currently in place and operating.
Effluents and emissions	Typical of those associated with a large construction project; effluents and emissions would be well below applicable environmental standards, and mitigative measures would be	Same as PA.	Same as PA.	Not applicable--facilities currently in place and operating.

Table 2-10. Consequences of the Proposed Action (PA), Alternatives, and Continuation of Present Practice (continued)

Category	Proposed Action (PA) and Preferred Alternative--construct and operate SIS Project at the INEL	Construct and operate SIS Project at the Hanford Site	Construct and operate SIS Project at the SRP	No Action--continuation of present practice
	CONSTRUCTION IMPACTS (continued)			
Effluents and emissions (continued)	implemented for fugitive dust, erosion, and spills.			
Archeologic/historic resources	No sites would be impacted. Periodic inspections of excavations and excavated material will determine whether frequency of paleontological finds requires mitigation.	Same as PA.	Same as PA.	Not applicable--facilities currently in place and operating.
	ROUTINE NONRADIOLOGICAL OPERATIONAL IMPACTS			
Socioeconomic impacts	Potential in-migrating operating personnel would be a small percentage of average population increases; no significant impacts to community facilities; beneficial impacts would include indirect job opportunities and contributions to local tax base.	In-migrating operating personnel would be a small percentage of average population increases; no significant impacts to community facilities; beneficial economic impacts are expected to be similar to those for PA.	In-migrating operating personnel would be a small percentage of average population increases; no significant impacts to community facilities; beneficial economic impacts are expected to be similar to those for PA.	Not applicable--facilities currently in place and operating.

Table 2-10. Consequences of the Proposed Action (PA), Alternatives, and Continuation of Present Practice (continued)

Category	Proposed Action (PA) and Preferred Alternative--construct and operate SIS Project at the INEL	Construct and operate SIS Project at the Hanford Site	Construct and operate SIS Project at the SRP	No Action--continuation of present practice
ROUTINE NONRADIOLOGICAL OPERATIONAL IMPACTS (continued)				
Atmospheric emissions	Additional burning of coal for steam generation and nonradiological process emissions would be well below PSD de minimis levels; Freon emissions would be below PSD de minimis levels for volatile organic compounds; on-going studies examining Freon emission reduction measures; substitute coolants to be used when available.	Same as PA.	Same as PA.	Atmospheric emissions within air quality permit limitations would continue.
Liquid effluents	Only nonhazardous and nonradioactive liquid effluents would be discharged to new percolation pond(s); sanitary effluents would be treated by existing ICPP Sewage Treatment Plant.	Same as PA, except service wastes would be discharged to a tile field and sanitary waste water would be treated through use of a septic tank.	Same as PA, except service wastes and treated sanitary waste water would be discharged to surface water (Four Mile Creek) in accordance with applicable permit requirements.	Liquid effluents associated with current practice would continue; improvements to existing facilities would continue to be undertaken to comply with permit requirements.

Table 2-10. Consequences of the Proposed Action (PA), Alternatives, and Continuation of Present Practice (continued)

Category	Proposed Action (PA) and Preferred Alternative--construct and operate SIS Project at the INEL	Construct and operate SIS Project at the Hanford Site	Construct and operate SIS Project at the SRP	No Action--continuation of present practice
ROUTINE NONRADIOLOGICAL OPERATIONAL IMPACTS (continued)				
Nonhazardous solid waste	Nonradioactive and nonhazardous solid waste would be disposed of in onsite sanitary landfill.	Same as PA.	Same as PA.	Nonradioactive and nonhazardous waste generated as a result of current practice would continue to be disposed of in sanitary landfills.
Hazardous waste	Hazardous wastes would be handled in accordance with applicable RCRA requirements, and would be transported to an approved RCRA TSD facility.	Same as PA.	Hazardous wastes would be stored or disposed of on the site in new facilities meeting RCRA requirements.	Hazardous wastes associated with current practice would continue to be generated; improvements to existing facilities and new TSD facilities would be implemented to comply with RCRA requirements.
ROUTINE RADIOLOGICAL OPERATIONAL IMPACTS				
Atmospheric emissions[a]	Small quantities would be released to atmosphere, resulting in negligible offsite increases; calculated	Same as PA, except calculated annual whole-body doses to maximum individual	Same as PA, except calculated annual whole-body doses to maximum individual	Annual radiological consequences of current practice would continue; doses to

Table 2-10. Consequences of the Proposed Action (PA), Alternatives, and Continuation of Present Practice (continued)

Category	Proposed Action (PA) and Preferred Alternative-- construct and operate SIS Project at the INEL	Construct and operate SIS Project at the Hanford Site	Construct and operate SIS Project at the SRP	No Action-- continuation of present practice
	ROUTINE RADIOLOGICAL OPERATIONAL IMPACTS (continued)			
Atmospheric emissions[a] (continued)	annual increase in whole-body dose to maximum individual and surrounding population would be 1.3×10^{-8} millirem and 2.3×10^{-8} person-rem, respectively; calculated population health effects of 2.5×10^{-12} genetic disorder and 3.5×10^{-11} latent cancer fatality; atmospheric emissions in combination with other emissions would be well below NESHAP standards.	and surrounding population would be 7.3×10^{-9} millirem and 1.4×10^{-7} person-rem, respectively; and slightly higher health effects.	and surrounding population would be 8.9×10^{-9} millirem and 2.0×10^{-7} person-rem, respectively, and slightly higher health effects.	maximum individuals and populations from existing operations are a small fraction of background radiation and are well below NESHAP standards.
Solid waste	Radioactive solid wastes that would be generated include LLW, TRU waste, and mixed waste; TRU waste would be certified and transported to the planned WIPP; LLW would be disposed of in existing land burial facility; mixed waste would either	Same as PA.	LLW would be disposed of onsite and mixed wastes would either be stored or disposed of on the site in RCRA-approved facilities; TRU waste would be certified and transported to the planned WIPP.	LLW, TRU waste, and mixed waste associated with current practice would continue to be generated and managed in the same manner as for the SIS Project; high-level radioactive waste would also

Table 2-10. Consequences of the Proposed Action (PA), Alternatives, and Continuation of Present Practice (continued)

Category	Proposed Action (PA) and Preferred Alternative--construct and operate SIS Project at the INEL	Construct and operate SIS Project at the Hanford Site	Construct and operate SIS Project at the SRP	No Action--continuation of present practice
	ROUTINE RADIOLOGICAL OPERATIONAL IMPACTS (continued)			
Solid waste (continued)	be stored in RCRA-permitted storage facilities separate from hazardous waste or transported to approved TSD facility. Quantities generated would be a small percentage of the quantities currently managed and would result in small exposures.			be generated that would be immobilized at the SRP and the Hanford Site.
Routine transport of materials	All materials would be transported in accordance with appropriate DOE, DOT, and EPA requirements. Annual offsite shipments of SIS feed, product, potentially by-product, and TRU waste and on-site shipments of LLW would result in less than 12 person-rem and 3.5×10^{-3} latent cancer fatality and 1.6×10^{-3} genetic disorder.	Compared to PA, only a few shipments of feed from the SRP would occur, while the transport of TRU waste and potentially by-product would occur over a longer distance. Annual offsite shipments of SIS materials would result in less than 16 person-rem, and slightly higher health effects.	Compared to PA, feed, product, TRU waste, and potentially by-product would be transported longer distances. Annual offsite shipments of SIS material would result in less than 19 person-rem, and slightly higher health effects.	Materials would continue to be transported on and off the site in accordance with appropriate requirements. Radiological exposures for shipments of radioactive materials would continue to be below applicable DOE and DOT criteria and standards.

Table 2-10. Consequences of the Proposed Action (PA), Alternatives, and Continuation of Present Practice (continued)

Category	Proposed Action (PA) and Preferred Alternative--construct and operate SIS Project at the INEL	Construct and operate SIS Project at the Hanford Site	Construct and operate SIS Project at the SRP	No Action--continuation of present practice
		ACCIDENTS		
SIS facility accidents[b]	For all accidents considered, there would be no offsite cases of early fatalities or injuries. For the accidents in which the filtration system would function as designed, the highest dose at the INEL site boundary to an organ would be 2.7 millirem to the thyroid and the highest whole-body dose would be 0.5 millirem, both from the postulated criticality accident. The numbers of potential offsite latent cancer fatalities and genetic disorders for Design-Basis Accidents having the highest consequences range from 1.2×10^{-8} to 7.3×10^{-6} cancer fatality and 1.1×10^{-8} to 6.7×10^{-6} genetic disorder. In addition to the above cases with full	For all accidents considered, there would be no offsite cases of early fatalities or injuries. For the accidents in which the filtration system would function as designed, site-boundary doses would be lower than PA (e.g., 1.8 millirem to the thyroid from the postulated criticality accident) and offsite societal consequences would be higher than PA (e.g., number of offsite latent cancer fatalities for accidents ranges from 3.0×10^{-7} to 2.8×10^{-4}). Although a full spectrum of filter efficiency calculations has not been done for the Hanford Site, the whole-body and	For all accidents considered, there would be no offsite cases of early fatalities or injuries. For the accidents in which the filtration system would function as designed, site-boundary doses would be higher than PA (e.g., 5.1 millirem to the thyroid from the postulated criticality accident) and offsite societal consequences would be higher than PA (e.g., number of offsite latent cancer fatalities for accidents ranges from 4.3×10^{-7} to 5.9×10^{-4}). Although a full spectrum of filter efficiency calculations has not been done for the SRP, the whole-body and	SIS accidents not directly comparable to continuation of current practice.

Table 2-10. Consequences of the Proposed Action (PA), Alternatives, and Continuation of Present Practice (continued)

Category	Proposed Action (PA) and Preferred Alternative--construct and operate SIS Project at the INEL	Construct and operate SIS Project at the Hanford Site	Construct and operate SIS Project at the SRP	No Action--continuation of present practice
		ACCIDENTS (continued)		
SIS facility accidents[b] (continued)	filter efficiencies, a full spectrum of filter efficiencies down to zero was considered. The maximum whole-body dose at the site boundary from the extreme case with zero filter efficiency is 2.8×10^{-1} rem and the maximum dose to the bone surface 3.6×10^{0} rem.	bone-surface doses calculated at the INEL boundary approximate the doses at the Hanford Site boundary because the distances are reasonably close.	bone-surface doses calculated at the INEL boundary approximate the doses at the SRP boundary because the distances are reasonably close.	
Transport of SIS feed, product, and by-product	Annual radiological risk for transport of all SIS radioactive materials would be 1.3×10^{-4} latent cancer fatality and 5.9×10^{-5} genetic disorder; annual nonradiological risk of a fatality would be 1.8×10^{-2}.	Annual radiological risk would be higher than PA, or 1.6×10^{-4} latent cancer fatality and 7.5×10^{-5} genetic disorder; annual nonradiological risk of a fatality would also be higher than PA, or 2.2×10^{-2}.	Annual radiological risk would be higher than PA, or 2.9×10^{-4} latent cancer fatality and 1.3×10^{-4} genetic disorder; annual nonradiological risk of a fatality would also be higher than PA, or 2.1×10^{-2}.	Compared to PA, annual risk of current practice would be higher because of longer distances associated with feed shipments for blending and product shipments.

Table 2-10. Consequences of the Proposed Action (PA), Alternatives, and Continuation of Present Practice (continued)

Category	Proposed Action (PA) and Preferred Alternative--construct and operate SIS Project at the INEL	Construct and operate SIS Project at the Hanford Site	Construct and operate SIS Project at the SRP	No Action--continuation of present practice
		OTHER IMPACTS		
Occupational safety	Construction-worker exposure of about 30 millirem per year would be well within exposure limits for uncontrolled areas; operation exposures would be kept to ALARA levels and below permissible DOE standards; injuries, exposures, and fatalities could potentially occur as a result of accidents; the routine dose to an ICPP worker (i.e., less than 3.0×10^{-8} rem) and doses as a result of postulated accidents, including those filtration systems degraded to 90 percent, would both be below the DOE standard of 5 rem; for the severe accident with 0-percent filtration, the calculated dose is 6.5 rem.	Construction-worker exposure of about 2 millirem would be well within exposure limits and below those expected for PA; operational exposures would be kept to ALARA levels and below permissible DOE standards; routine and accident doses to on-site workers would be similar to those for the INEL, including that as a result of a severe accident.	Construction-worker exposure of about 15 millirem would be well within exposure limits and below those expected for PA; operational exposures would be kept to ALARA levels and below permissible DOE standards; routine and accident doses to on-site workers would be similar to those for the INEL, including that as a result of a severe accident.	Facilities are currently in place and no construction-worker impacts would occur; worker exposures kept to ALARA levels and below permissible DOE standards.

Table 2-10. Consequences of the Proposed Action (PA), Alternatives, and Continuation of Present Practice (continued)

Category	Proposed Action (PA) and Preferred Alternative--construct and operate SIS Project at the INEL	Construct and operate SIS Project at the Hanford Site	Construct and operate SIS Project at the SRP	No Action--continuation of present practice
		OTHER IMPACTS (continued)		
Resource impacts	Ground-water withdrawals would be an insignificant percentage of annual discharge of Snake River Plain aquifer; no significant use of scarce or strategic material would be required for construction and operation.	Surface-water withdrawals would be an insignificant percentage of annual average flow of Columbia River; use of scarce or strategic material would be same as for PA.	Ground-water withdrawals would be an insignificant percentage of current SRP ground-water withdrawals; use of scarce or strategic material would be same as for PA.	Surface- and ground-water withdrawals would continue and would be a small percentage of the capability of ground- and surface-water resources; scarce or strategic material would not be required for continuing current practice.

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[a] Collective (i.e., population) doses presented use a forecast year-2010 population based on a population growth rate for each of the areas as experienced between 1970 and 1980. Collective doses based on local estimates of population for the year 2010 are: INEL, 1.5×10^{-8} person-rem; Hanford Site, 9.7×10^{-8} person-rem; SRP, 1.4×10^{-7} person-rem.

[b] The ranges of potential offsite latent cancer fatalities using year-2010 local population estimates are: INEL, 7.9×10^{-9} to 4.8×10^{-6}; Hanford Site, 1.9×10^{-7} to 1.8×10^{-4}; SRP, 2.8×10^{-7} to 3.9×10^{-4}.

Compared to locating the SIS Project at the INEL, the construction and operation of the SIS Project at the Hanford Site would involve the loss or displacement of similar vegetation communities and ecological habitats, and potentially a smaller amount of land area for SIS facilities. Locating the SIS Project at the SRP would affect a more diverse ecosystem of monotypic pine and admixtures of hardwoods.

Construction of the SIS Project at each of the three alternative locations is not expected to result in major socioeconomic impacts because of the availability of construction workers in each of the three surrounding regions. Socioeconomic impacts resulting from in-migrating operating workers are also expected to be small, as the number of in-migrating workers would constitute a small percentage of the average annual increase in population in the regions surrounding the alternative sites. Economic benefits as a result of the construction and operation of the SIS Project are expected to be similar for each of the alternative sites.

The INEL, with the smallest population surrounding the proposed SIS Project site, has a calculated collective whole-body dose to the surrounding population that is slightly less than the other two sites for normal operating releases. The calculated maximum individual dose for locating the SIS Project at the INEL is slightly higher than for locating the project at either the SRP or the Hanford Site, because of differences in the distance from the SIS Project to the nearest site boundary and meteorological dispersion characteristics. Calculated consequences of postulated SIS facility accidents generally parallel the differences in consequences from normal operating releases (i.e., mean site boundary doses for locating the SIS Project at the INEL and SRP are higher than for locating the SIS Project at the Hanford Site, and the offsite population dose for locating the SIS Project at the INEL is less than those for locating the SIS Project at Hanford and SRP).

Because of the semiarid climate at the INEL, water required for construction and operation would be withdrawn from ground water, and liquid effluents meeting all applicable standards would be discharged to the soil column. The Hanford Site, lying in a similar semiarid climate but close to the Columbia River, would meet SIS water requirements through the withdrawal of water from the Columbia River and would discharge treated liquid effluents that are nonhazardous and nonradioactive to the soil column. The SRP, lying within the less arid climate of the southeastern United States, would withdraw ground water for meeting SIS water requirements, but would discharge liquid effluents to an onsite stream.

Another geographic difference between the INEL and the other potential sites for the SIS Project is the location of each of the sites relative to the origins and destinations of SIS shipments of feed, product, TRU waste, and potential by-product. Because locating the SIS Project at the INEL would involve fewer annual shipment-kilometers of TRU waste and potentially by-product than would locating the SIS Project at either the Hanford Site or the SRP, this alternative has lower calculated routine exposures and risk in the event of a transport accident.

The impacts from the construction and operation of the SIS Project at the INEL, the Hanford Site, or the SRP would not measurably increase the existing or planned cumulative impacts at these locations. The effective dose equivalent and highest organ dose from SIS operation, when added to the existing radiological doses as a result of ongoing operations at any of the alternative sites, would be well below National Emission Standards for Hazardous Air Pollutants (NESHAP) requirements. Annual generation of SIS solid wastes, including LLW, TRU, mixed, and hazardous wastes, would comprise only a small percentage of the same categories of waste currently being received and managed at each of the alternative sites. Nonradioactive atmospheric emissions resulting from SIS operation, which would be below Prevention of Significant Deterioration (PSD) de minimis levels, would also not measurably increase the total amount of nonradioactive emissions from current operations at each of the SIS alternative locations. Nonradioactive and nonhazardous SIS liquid effluent discharges would neither increase nor accentuate potential water-quality impacts, and the cumulative withdrawal of water, whether from surface water or ground water, would be well within the capabilities of the existing water resources at each of the alternative sites.

3 AFFECTED ENVIRONMENT

This chapter describes the environment of each of the alternative sites considered for the Special Isotope Separation (SIS) Project using the Atomic Vapor Laser Isotope Separation (AVLIS) technology. Major emphasis is placed on those environmental characteristics that would either affect or be affected by the proposed SIS Project.

3.1 CHARACTERIZATION OF THE INEL

The following characterization of the U.S. Department of Energy's (DOE) Idaho National Engineering Laboratory (INEL) and the SIS Project site at the INEL is based primarily on a report entitled INEL Environmental Characterization Report (EG&G Idaho, Inc., 1984) and its referenced documents. Appendixes to this report contain several detailed reports on the physical and ecological characteristics of the INEL and the socioeconomic setting of the surrounding region. Additional characterizations may be found in other documents referenced in the subsequent sections.

3.1.1 Site Location and Regional Population

The DOE's INEL was established by the Federal Government in 1949 as the National Reactor Testing Station to provide an isolated location where various kinds of nuclear reactors and support facilities could be built and tested, primarily to demonstrate their safety. As of 1984, 52 reactors have been built at the INEL, of which 14 are still active.

In 1975 the INEL was designated one of the nation's five National Environmental Research Parks for the scientific study of the environment and land management.

Major DOE programs currently being conducted at the INEL site fall into the following five major categories:

- Providing test irradiation services from the one operating high-flux test reactor, the Advanced Test Reactor (ATR), at the Test Reactor Area (TRA)
- Recovering uranium from highly enriched DOE Defense Program spent fuels and calcining liquid radioactive waste solutions into a solid form for storage at the Idaho Chemical Processing Plant (ICPP)
- Operating the Experimental Breeder Reactor, Number 2 (EBR-II)
- Operating the Naval Reactors Facility (NRF)
- Storing and monitoring solid transuranic (TRU) wastes (Radioactive Waste Management Complex).

The INEL has been involved in both defense and non-defense-related activities since its inception. The percentage of effort dedicated to defense-related versus non-defense-related activities has varied and will continue to vary based on national needs and priorities. Examples of defense-related activities conducted at the INEL include the facilities for Naval Reactor Programs that were established in the early 1950s and the ICPP for the recovery of uranium from spent military fuel, which began operation in 1953.

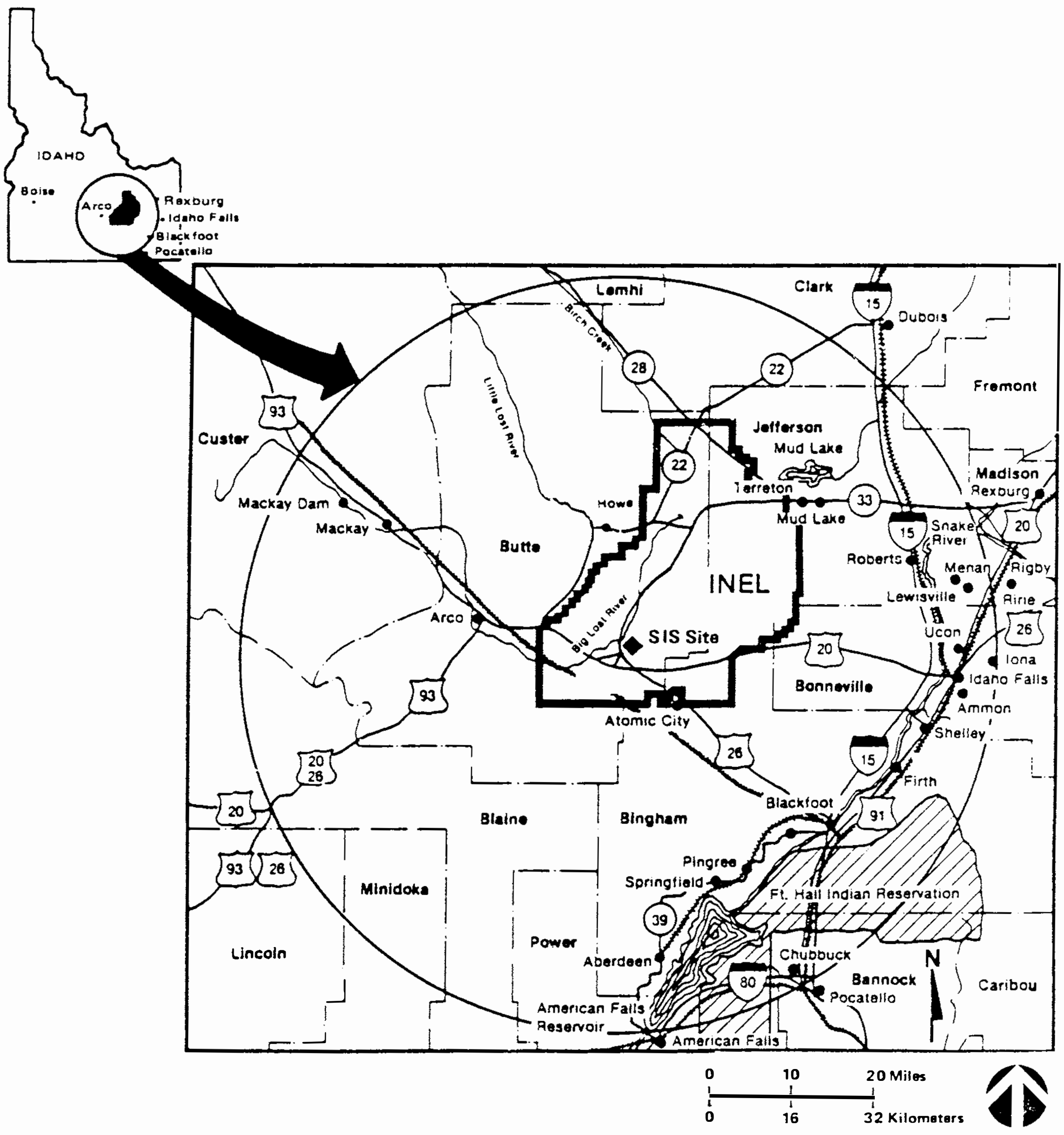
The facilities at the INEL are operated by five separate contractors: EG&G Idaho, Inc.; Rockwell-INEL; Westinghouse Idaho Nuclear Company, Inc. (WINCO); Westinghouse Electric Corporation; and Argonne National Laboratory-West (ANL-W). Programs at the INEL facilities are conducted under the administration of three DOE Operations Offices: Idaho Operations Office, Pittsburgh Naval Reactors Office, and Chicago Operations Office. The SIS Project and all its required support facilities would be administered by the DOE Idaho Operations Office and the project would be operated by WINCO.

The INEL is located in the southeastern portion of Idaho (see Figure 3-1). The site encompasses approximately 2305 square kilometers (890 square miles), extending approximately 63 kilometers (39 miles) from north to south and about 58 kilometers (36 miles) from east to west at its broadest southern part. Regionally, the site is situated on the Upper Snake River Plain and is located roughly equidistant from Salt Lake City, Utah, and Boise, Idaho. Public access to the INEL is restricted to a few public highways that are patrolled by onsite security personnel (EG&G Idaho, Inc., 1984).

The INEL includes portions of three Idaho counties (Bingham, Butte, and Jefferson). The largest population centers nearest the INEL are to the southeast and east along the Snake River and Interstate Highway 15. The largest communities in closest proximity to the boundaries of the INEL include Idaho Falls (39,590 persons in 1980), which is about 35 kilometers (22 miles) east of the nearest site boundary; Blackfoot (10,065 persons in 1980), about 37 kilometers (23 miles) southeast of the nearest site boundary; Pocatello (46,340 persons in 1980), about 71 kilometers (37 miles) south-southeast of the nearest site boundary; and Arco (3342 persons in 1980), about 11 kilometers (7 miles) west of the nearest site boundary. Atomic City (34 persons in 1980), which is within 1 kilometer of the southern boundary of the INEL, is the closest town (EG&G Idaho, Inc., 1984).

No resident populations are located within 16 kilometers (9.9 miles) of the proposed SIS Project site and the nearest INEL boundary is 14 kilometers (8.7 miles) from the proposed SIS Project site. The estimated 1980 population residing within 80 kilometers (50 miles) of the site was about 110,270 persons and included persons living in parts of the Idaho counties of Bonneville, Clark, Fremont, Madison, Bannock, Power, Blaine, Minidoka, Custer, Lincoln, and Lemhi, in addition to those counties in which portions of the INEL are located.

The 1980 population density of approximately 5.5 persons per square kilometer within the 80-kilometer (50-mile) area surrounding the proposed project site was significantly less than the national average of 24.7. The average age of persons residing within the area was also lower than the



Source: EG&G Idaho, Inc. (1984).

Figure 3-1. INEL Vicinity Map (80-Kilometer or 50-Mile Radius).

national average; however, the average age was approximately equal to the average age in the western mountain states.

The proposed SIS Project site is a previously disturbed area within the fenced area of the ICPP. The proposed site and the ICPP are situated in the south-central portion of the INEL.

3.1.2 Regional and Site Activities

Employment at the INEL totaled 10,702 persons in December 1987, of which more than one-half reside in Idaho Falls. The total payroll for INEL employees was $319 million. Between 1950 and 1980, INEL employment was estimated to account for approximately 12.3 percent of the total population increase in southeastern Idaho. Table 3-1 lists the percentage of INEL employees residing in counties surrounding the INEL.

INEL employment grew by an average of 493 employees per year in the 1950s, by 53 employees per year in the 1960s, and by 417 employees per year in the 1970s. Employment in the first half of the 1980s has increased by an average of 28 employees per year (Hofman et al., 1986). Within the INEL region, INEL employment in 1985 represented 11 percent of employment within the counties listed in Table 3-1.

A principal industry of the INEL region is agriculture. Other major industries include services, government, retail trade, and tourism. Idaho State University, with an enrollment of more than 3500 students, is located in Pocatello, Idaho. National forests and parks within 200 kilometers (125 miles) of the INEL provide a variety of opportunities for passive and active recreation including hunting, fishing, and skiing. Major highways in the region include Interstate Highways 15 and 86 and U.S. Highways 20, 26, and 93. Rail freight service is provided from Butte, Montana, to the north and from Pocatello and Salt Lake City, Utah, to the south. The cities of Idaho Falls and Pocatello are both served by passenger and cargo airlines.

The area immediately surrounding the INEL is either desert or agricultural land. Most of the nearby land used for farming is concentrated to the northeast. The INEL site is committed for energy research and development and has been designated a National Environmental Research Park. Approximately 95 percent of the INEL has been withdrawn from the public domain and is controlled by DOE. The remaining 5 percent includes public highways crossing the site, the Naval Reactor Facility (Department of Defense), and the Experimental Breeder Reactor, Number 1 (EBR-1) historic landmark. A series of Public Land Orders, dating back to 1946, has established the present uses of the site. Lands originally under the control of the Bureau of Land Management were withdrawn from the public domain under three principal Public Land Orders: 318, 545, and 637, dated May 13, 1946, January 7, 1949, and April 7, 1950, respectively.

From 1977 to 1982, 2555 acres in the northeast corner of the INEL were sold to area farmers as compensation for land destroyed during the 1976 Teton flood.

Table 3-1. INEL Employment by County of Residence, 1984[a]

County of residence	Percent of INEL employees
Bonneville	71
Bingham	13
Bannock	5
Jefferson	6
Butte	3
Madison	<2

[a] Source: Hofman et al. (1986).

Approximately 330,000 acres of the INEL are open to controlled grazing by cattle or sheep as allocated by DOE and the Department of the Interior (DOI). Permit grazing areas at the INEL are shown in Figure 3-2. Grazing is prohibited within 3 kilometers (2 miles) of any nuclear facility, and no dairy cows are allowed. The grazing area boundary nearest the SIS Project is located approximately 7 kilometers (4.4 miles) to the south.

3.1.3 Socioeconomics and Historic Resources

A previous study in 1984 of the potential impacts of locating a New Production Reactor at the INEL concluded that the primary region that would be impacted by in-migrating people and by increased economic activity would consist of those counties listed in Table 3-1 that are the current residence locations of existing INEL employees (EG&G Idaho, Inc., 1984). This study contains a detailed description of the infrastructure within these counties. Appendix B of this Environmental Impact Statement (EIS) provides the most recent demographic, economic, and tourism information for the INEL region. The following sections summarize these data as well as present a discussion of historic and archeological resources.

3.1.3.1 Demography

Between 1970 and 1980, the average county population growth rates within an 80-kilometer (50-mile) radius of the INEL ranged from 71.2 percent in Blaine County to 7.7 percent in Clark County (Bureau of the Census, 1983). The total 1980 population of the six counties listed in Table 3-1 was 206,052, which represented a 27-percent increase from 1970. This 27-percent increase compared to a 32-percent increase for the State of Idaho and a national increase of 11 percent during the same period. The estimated population of the six counties for 1986 indicates a total population increase of approximately 6 percent since 1980. The State of Idaho and the national population statistics show percentage increases similar to those of the six-county area.

The median age in 1980 for the six counties ranged from 19.9 years in Madison County to 27.8 in Butte County. The median ages for the State of Idaho and the nation were 27.5 and 30.0, respectively. The under-5 age group made up about 12 percent of the 1980 population and had increased 51 percent since 1970. The 5-to-17 age group had grown by 2 percent since 1970 and represented 24 percent of the 1980 population. The largest age group was comprised of those persons between the ages of 18 to 65, who made up 57 percent of the 1980 population and who experienced a 37-percent increase since 1970. Similar growth (i.e., 37 percent) was experienced in the over-65 age group; however, the over-65 age group comprised less than 8 percent of the 1980 population.

The forecast population within an 80-kilometer (50-mile) radius of the SIS Project site at the INEL for the year 2010 could range from 151,922 persons (based on BEA, 1981) to 230,129 persons (based on a continuation of growth rates of counties lying wholly or partially within the 80-kilometer

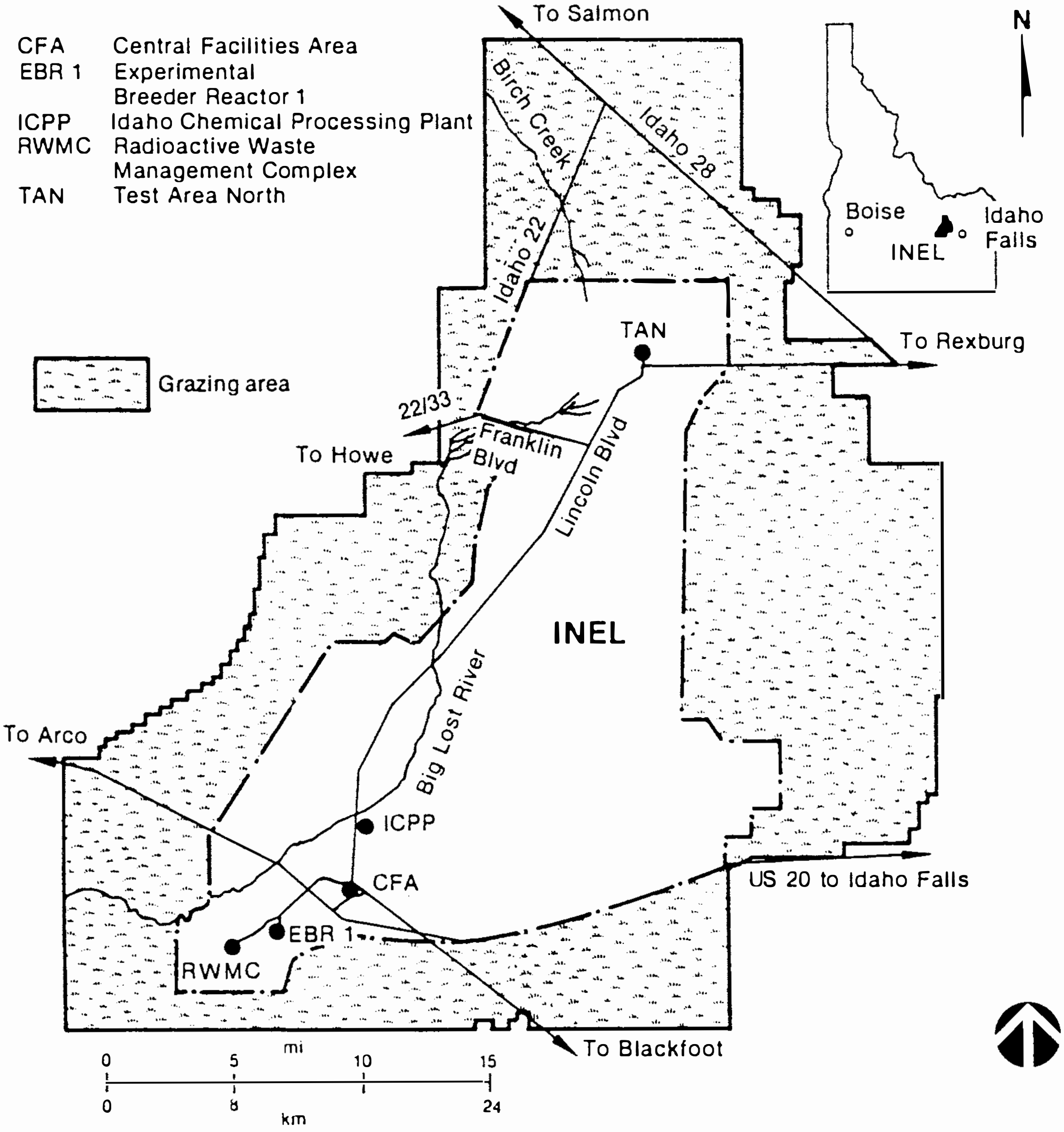


Figure 3-2. Permit Grazing Areas at the INEL.

radius between 1970 and 1980). The population growth rates reflected by the Bureau of Census' estimated 1980 and 1986 population for the six counties that are the principal places of residence for INEL employees indicate that the population growth rate within an 80-kilometer radius of the INEL is slower than that which occurred between 1970 and 1980. In this EIS the estimated radiological doses to the population from SIS Project routine emissions are presented for each of these year-2010 population (i.e., 151,922 and 230,129 persons) projections in Appendix A.

3.1.3.2 Economy

The agricultural industry in the six-county area surrounding the INEL (Bannock, Bingham, Bonneville, Butte, Jefferson, and Madison) contained about 4700 farms in 1982 occupying more than 2.7 million acres. Approximately 38 percent of the farmland is used to produce irrigated and nonirrigated cultivated crops and about 48 percent is used for pasture or grazing. Major farm commodities include grains, feeds (hay and silage), potatoes, vegetables, and livestock. Average 1982 market value of products produced per farm in the six-county area was approximately $107,500. The total value of crops produced in the six-county area during 1982 was $284 million. The market value of crops sale revenues increased by 54 percent between 1978 and 1982.

Other major sources of employment and income in the INEL region include services, government, retail trade, and manufacturing. The three industries with the largest employment in 1980 were services (29 percent), retail trade (15 percent), and manufacturing (11 percent). In the six-county area, these three industries accounted for 55 percent of all employment. The nonagricultural industries with the largest payrolls in 1984 came from the services, government, and manufacturing industries.

During the period of 1980 to 1984, earnings by place of work from agriculture declined by 6 percent in the six-county area. During the same period, it increased by 10 percent in the State of Idaho and 36 percent nationally. Other industries with significant differences when compared to the State and the nation include construction and manufacturing. Construction declined by 10 percent in the six-county area from 1980 to 1984 while increasing by 12 percent in the State and 24 percent nationally. Earnings from manufacturing increased by 50 percent in the six-county area, while State of Idaho and national increases were 28 percent and 25 percent, respectively. Total earnings in the six-county area increased between 1980 and 1984 by 24 percent compared to increases of 25 percent and 35 percent for the State of Idaho and the nation, respectively.

Based on annual unemployment figures for 1987, unemployment in each of the six counties except Bingham County was equal to or below the national unemployment average of 6.2 percent. The highest rate of unemployment occurred in Bingham County, with an annual unemployment rate of 6.7 percent.

3.1.3.3 Infrastructure

Based on 1980 census estimates, the homeowner vacancy rates in the six-county area ranged from 2.7 percent in Butte County to 2.0 percent in Bingham and Bonneville Counties. Rental vacancy rates ranged from 9 percent in Madison County to 16.9 percent in Bingham County. These compare to homeowner vacancy rates of 2.3 percent for Idaho and 1.8 percent for the United States. Rental vacancy rates were 11.4 percent and 7.1 percent for Idaho and the United States, respectively. More than 650 rental and single-family housing units were reported as vacant in November 1983, based on a limited survey of local realtors. A more recent regional survey indicated that there are about 1300 single-family units for sale in addition to many units for rental (GEC Company, 1987).

In the six counties, there are 16 public school districts. Public school enrollment in the 1983-1984 school year was 50,867, or a 2-percent increase above the enrollment of the previous year. In addition, 2 percent of total enrollment was in private schools. During the 1982-1983 school year, most of the elementary schools in the 16 school districts had enrollments that were at capacity, while middle schools and senior high schools tended to have excess capacity. In many cases, the reason for schools having enrollments at their capacity was consolidation and closure of schools as a result of declining enrollments.

The six-county area is the home for five vocational schools, colleges, and universities. During the 1983-1984 school year, enrollments at these institutions totaled 24,000 students. Students in vocational/technical curriculums represented 45 percent of this total. The DOE and its contractors at the INEL maintain contracts with the University of Idaho and Idaho State University (ISU) to conduct post-secondary educational programs in Idaho Falls. Selected Bachelor's and Master's degree programs are offered and are available to all qualified individuals.

Health services in the INEL area are adequate and are continuously being improved. There were seven general medical and surgical hospitals in the six-county area containing 658 licensed beds in 1982. This is 3.2 beds per 1000 population, which is below the national average of 4.1 beds per 1000 population in rural areas. Occupancy of the beds ranged from 20 to 65 percent and averaged 61 percent. Projections of capacity needs in 1982 indicated the 1987 need required 94 percent of the capacity available in 1982. This indicates that the six-county area is below the national average, but capacity is adequate based on local utilization. Nursing homes and intermediate-care facilities had 654 licensed beds in 1982. These were 91 percent occupied. Projections in 1982 showed a shortfall of 47 licensed beds by 1987.

The six-county area had 258 licensed physicians in 1982. The American Academy of Family Practitioners has established a desired ratio of 0.5 direct primary care physician per 1000 population. The national averages for physicians in 1977 were 0.99 physician per 1000 population for counties with a city of over 10,000 population and 0.56 physician per 1000 population in counties with no city over 10,000. The six-county area had an average of 1.2 physicians per 1000 population. Of the four counties that are semi-rural, two (Bannock, with 1.5 physicians per 1000 population, and

Bonneville, with 1.8 physicians per 1000 population) exceeded the national average. Madison (0.7) and Bingham (0.5) were below the national average. Two counties are rural, with Butte (0.6) exceeding the national average, and Jefferson (0.3) falling below the national average. Only Jefferson fell below the desired ratio of the Academy.

The six-county area has an excellent public safety record and is below the national average in all major categories of crime. In 1981, violent crime in Idaho was 49 percent of the national average on a per capita basis. Property crime was 81 percent of the national average. When those crime rates are adjusted for city size, violent crime in Idaho was 63 percent of the national average and property crime was 73 percent of the national average. Crime statistics available for Bannock, Bingham, and Bonneville Counties indicate that violent crime was 53 percent and property crime 62 percent of the average of U.S. cities of 25,000 to 50,000 population.

The number of police officers in Idaho is near the national average. Idaho has 2.4 police officers per 1000 population, with 80 percent of these being members of local forces. Nationally, there are 2.2 police officers per 1000 population, with 84 percent being members of local forces.

Drinking water is supplied through public water supply systems in each of the larger communities in the six-county area. All except Pocatello use ground water. Pocatello obtains 80 percent of its supply from ground water and 20 percent from surface water. Results of a survey of local officials showed that all communities have sufficient capacity to accommodate future growth. Areas outside of communities supply their own water from privately owned wells.

Sewerage services are provided in the communities by the local governments. All systems have excess capacity or have plans to expand to meet future demand. Areas outside of communities provide their own sewerage service.

3.1.3.4 Tourism/Recreation

Statewide, tourism employs an estimated 30,000 persons generating gross annual revenues of $1.3 billion and State taxes of $200 million based on estimates made by the Idaho Department of Commerce.

Although no statistics on tourism and travel are available for counties surrounding the INEL, a national survey of outdoor recreational activities was completed by the U.S. Department of Interior's National Park Service and the U.S. Department of Commerce in 1985, which provides statistics for the nation and the western United States, and a survey of travelers in Idaho recently completed by the University of Idaho's Department of Wildland and Recreation Management's College of Forestry, Wildlife, and Range Sciences provides statistics regarding leisure travel and recreation for the State of Idaho. Results of these two studies are presented in Appendix B.

The study completed by the Idaho Department of Wildland and Recreation Management indicates that 63 percent of the travelers sampled were from outside Idaho and 56 percent of those sampled indicated Idaho as their destination. When asked the purpose of their travel, 52 percent indicated pleasure, and 33 percent indicated the purpose of visiting relatives and friends. These travel purposes compare to national statistics of 32 percent and 37 percent, respectively. The national survey of outdoor recreational activities indicates that the most popular activities nationally are sightseeing, fishing, bicycling, and boating. Activities that were more popular in the western region than nationally were sightseeing, camping, tennis, day hiking, golfing, snowskiing, off-road vehicle riding, and horseback riding.

In addition to these two studies, payroll and employment estimates for 1985 are available as indicators of the importance of the tourism and recreation industry in Idaho. The statistics compiled by the U.S. Travel Data Center indicate that travel-related employment comprised 8.9 percent of the workforce in Idaho, compared to 4.9 percent nationally. The average wage was $6702 for Idaho and $10,926 nationally. In Idaho, average wages ranged from $5264 for food service employees to $15,375 for public transportation employees. Comparable national averages were $6708 and $25,560, respectively. Statistics compiled by the U.S. Census Bureau also indicate that 19 percent of the hotels and motels within the State of Idaho are located in the counties listed in Table 3-1, and in Blaine County, in which Ketchum and Sun Valley are located (note: this figure does not include rentals of privately owned houses, condominiums, and townhouses).

The four most prominent tourist/recreation areas or attractions in the INEL area include Yellowstone National Park, which is approximately 117 kilometers (72.5 miles) northeast of the INEL, and 160 kilometers (99.5 miles) from the proposed SIS Project site; EBR-I, which is situated on the INEL; Craters of the Moon National Monument, which is situated approximately 30 kilometers (19 miles) southwest of the INEL; and the resort areas of Ketchum and Sun Valley, which are approximately 96 kilometers (59.5 miles) west of the INEL, or 116 kilometers (72 miles) from the SIS Project site.

3.1.3.5 Fort Hall Indian Reservation

The Fort Hall Indian Reservation was established by Executive Order on July 30, 1869, for the use of the Shoshone-Bannock Tribes. The 2120-square-kilometer (523,014-acre) reservation is located approximately 56 kilometers (35 miles) south of Idaho Falls and about 8 kilometers (5 miles) north of Pocatello. The reservation lies within the four counties of Bannock, Bingham, Power, and Caribou. In 1980, there were 4088 residents, of whom 2064 were tribal members. The most populated portion of the reservation lies in the valley of the Snake River.

3.1.3.6 Historic and Archeological Sites

Places of historic significance that are listed on the National Register of Historic Places are primarily concentrated in the cities and towns surrounding the INEL. National Register sites located on the INEL include both the EBR-I and Goodales Cutoff. Near the INEL is the Wasden Site (including Owl Cave), listed on the National Register and located approximately 27 kilometers (17 miles) west of Idaho Falls. Big Southern Butte is listed in the National Registry of Natural Landmarks and lies south of the INEL southern boundary. The Craters of the Moon National Monument is approximately 30 kilometers (19 miles) southwest of the INEL.

The INEL protects all cultural resources as required by the Antiquities Act of 1906, the Historic Sites Act of 1936, and the National Historic Preservation Act of 1966. The objective of these procedures is to avoid loss of material that may have archeological or historic value. To date approximately 3 percent (greater than 81 square kilometers or 20,000 acres) of the total land area of the INEL has been surveyed for cultural resources. Based on this sample it is known that the ICPP is located in an area which is very unlikely to contain significant prehistoric cultural resources. All areas within the ICPP facility perimeter have been surveyed. Areas directly affecting the proposed SIS location were surveyed by the ISU Swanson Crabtree Anthropological Research Laboratory in 1986 (Reed, 1986), and it is estimated that 80 percent to 100 percent of the ground surface was examined. During the course of this survey, no significant prehistoric resources were encountered. A survey of an existing borrow area for potential use in SIS Project construction was also conducted by the Laboratory in 1988 (Ross, 1988).

A potentially significant historic resource consisting of an abandoned homestead with a lava block cellar is located approximately 366 meters (400 yards) east of the SIS Plant Personnel Access Guardpost and is posted with signs indicating the location. Project siting will provide sufficient distance from the resource to ensure no primary impact. A small historic can-scatter was also identified and may be associated with this site. It is INEL policy to stop any construction activity whenever previously unidentified cultural resources are encountered. A professional archeologist is then consulted to determine the significance of these resources.

There is a possibility that paleontological resources may be encountered during excavation activities in the vicinity of the ICPP. The locale is characterized by alluvial gravels associated with the Big Lost River floodplain, and previous excavations at TRA and NRF have yielded evidence of this potential. It is probable, however, that such resources will be isolated occurrences and will not represent significant fossil beds.

3.1.4 Physical Environment

This section summarizes the physical characteristics of topography, geology, seismic and volcanic activity, hydrology, and meteorology and climatology of the INEL. More extensive information about the site is contained in publicly available monitoring reports for the INEL; a report entitled INEL Environmental Characterization Report and its appendixes (EG&G Idaho, Inc., 1984); the Final Environmental Impact Statement, Waste Management Operations at the Idaho National Engineering Laboratory (ERDA, 1977a); and an Environmental Evaluation of Alternatives for Long-Term

Management of Defense High-Level Radioactive Wastes at the Idaho Chemical Processing Plant (DOE, 1982a).

3.1.4.1 Topography

The surface of the INEL is relatively flat, with predominant relief manifested either as volcanic buttes jutting up out of the desert floor or as unevenly surfaced basalt flows and/or flow vents and fissures. Elevations on the INEL range from 1585 meters (5200 feet) in the northeast to 1450 meters (4750 feet) in the southwest, with the average being 1525 meters (5000 feet). A broad topographic ridge extends northward through the INEL, effectively separating the drainage of mountain ranges northwest of the INEL from the Snake River.

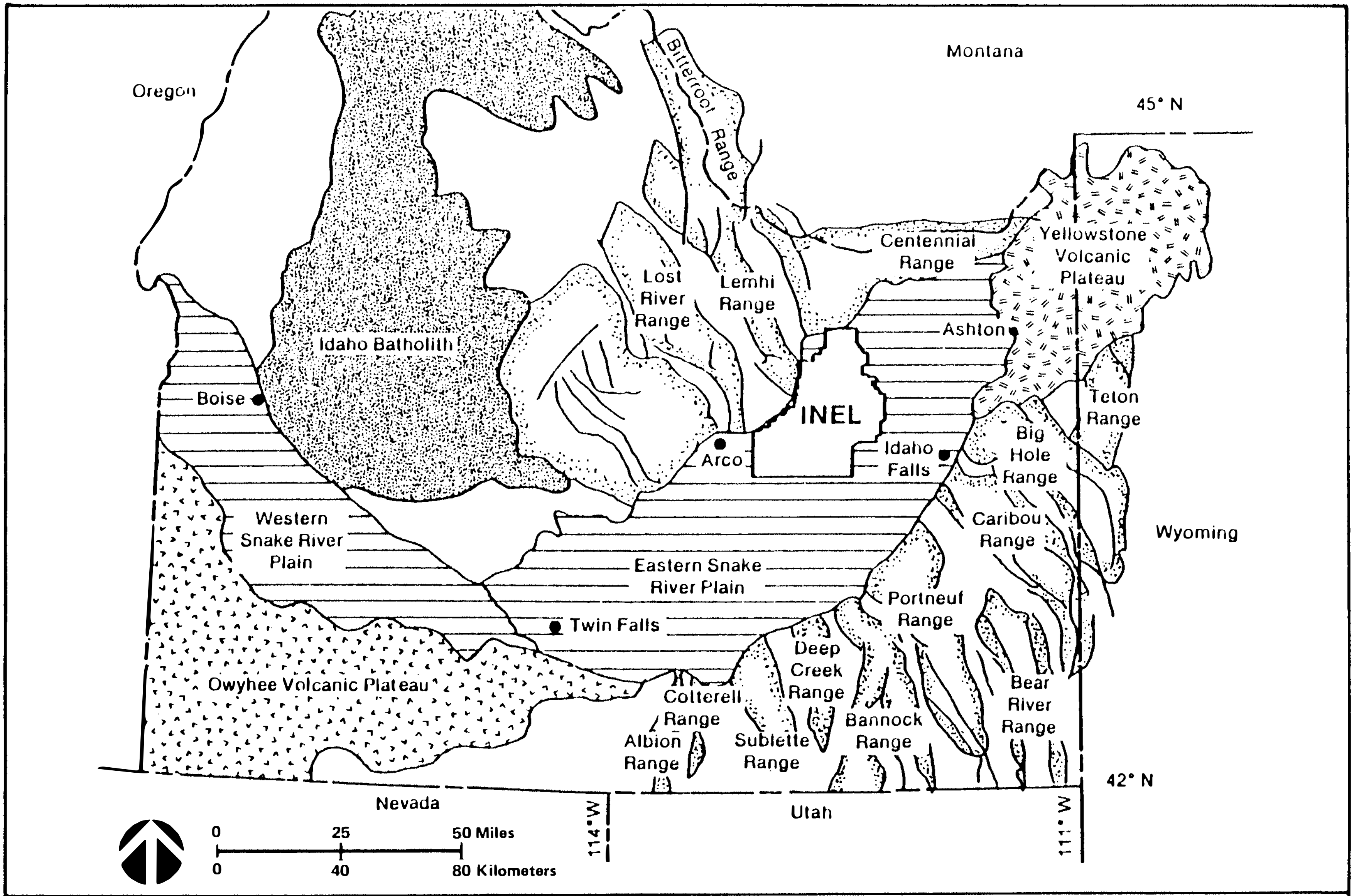
The ground surface of the ICPP area is also relatively flat, with approximately 9 meters (30 feet) of mixed sediments covering the underlying basalt surface. The elevation on the south end of the ICPP area is 1498.9 meters (4917.5 feet), sloping to 1496.7 meters (4910.5 feet) at the northern perimeter.

3.1.4.2 Geologic Setting

The INEL is located on the Snake River Plain, a physiographic depression extending from the Idaho-Oregon border on the west to the Island Park-Yellowstone Volcanic Plateau on the east. The eastern part of the plain (ESRP) is bordered on the northwest and southeast by the Basin and Range Province (Figure 3-3). The Snake River Plain appears to have begun developing in the southwest approximately 15 million years ago as a result of the easterly migration of silicic volcanic centers or calderas produced as the North American plate moved westward over a stationary plume or "hot spot" in the earth's mantle (Armstrong, Leeman, and Malde, 1975; Smith and Christiansen, 1980; Mabey, 1982).

Volcanic rocks of the plain include caldera rhyolites overlain by basaltic lava flows and pyroclastic rocks. These often occur interbedded with alluvial, lacustrine, and eolian sediments. The basalt deposits and interbedded sediments thicken from northeast to southwest along the axis of the ESRP (Armstrong, Leeman, and Malde, 1975). This rock record shows that following the passing of the "hot spot," the cessation of rhyolite volcanism was followed by an extended period of basaltic activity. Following the rhyolitic volcanism and the early basaltic volcanic phase, the topography of the ESRP subsided in response to thermal contraction and cooling of the upper crust (Brott, Blackwell, and Ziago, 1981). There are eight lava fields on the ESRP that are younger than 13,000 years old (Kuntz, Spiker, et al., 1986). Craters of the Moon lava field formed between 2100 and about 15,000 years ago and represents the youngest volcanic activity on the ESRP (Kuntz, Champion, Spiker, et al., 1986).

Adjacent Basin and Range structural features are composed of displaced Precambrian and Paleozoic sedimentary rocks that were folded and



Source: EG&G Idaho, Inc. (1984).

Figure 3-3. Generalized Map of Southern Idaho Showing Geographic and Geologic Features.

faulted during the Early Cretaceous as they were transported eastward on gently dipping thrust faults (Crone et al., 1987). Subsequent Cenozoic tectonism produced the modern basins and ranges by northeast-southwest extension on the normal faults bounding one or both flanks of the ranges (Scott, Pierce, and Hait, 1985). These faults cut or merge at depth with the earlier formed thrust faults (Armstrong and Oriel, 1965).

The significant ranges and their associated range front faults bordering the INEL on the north are the Lost River, Lemhi, and Beaverhead Ranges. Of major concern are the Arco Segment of the Lost River Fault and the Howe Segment of the Lemhi Fault, since they have been active in geologically recent times between 100,000 and 15,000 years ago and are closest to the INEL.

The basalts of the ESRP, upon which the INEL is located, contain several northwest-southeast-trending rift zones that may have formed by extension of the Basin and Range tectonism into the area (Figure 3-4). These rift zones appear to be the main centers of basaltic eruptive activity (Kuntz and Dalrymple, 1979). Normal faults, oriented parallel to the boundary of the plain, are exposed in places but these faults are few and their displacement small. None of the faults show evidence of recent activity. Geophysical investigations of the subsurface suggest that a fault may be present along the edge of the plain near Arco (Rodgers, 1987).

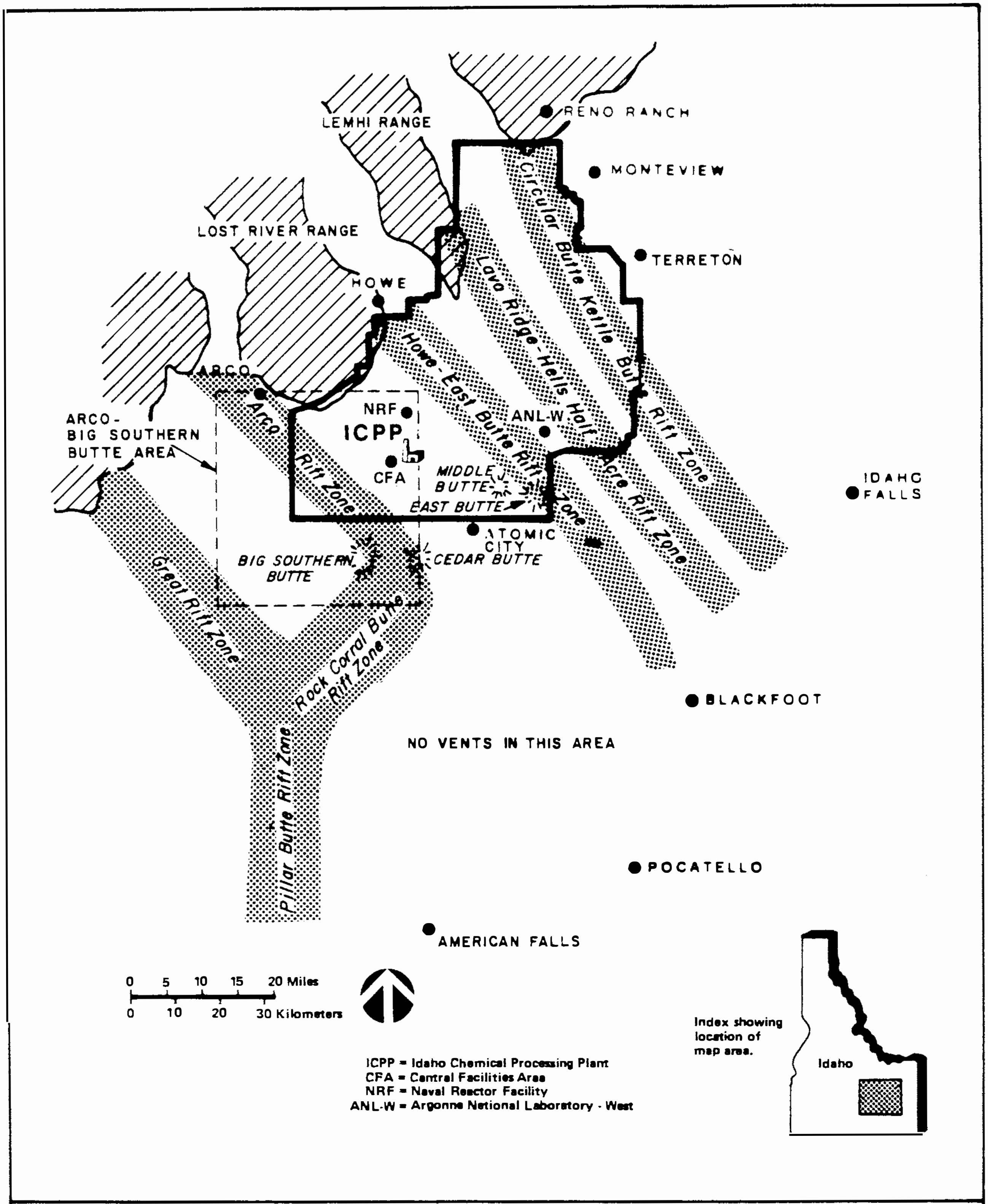
3.1.4.3 Seismic Activity and Volcanism

Seismic Activity

The Intermountain Seismic Belt (ISB) and the Idaho Seismic Zone (ISZ) are the two major areas of seismic activity near the ESRP (Figure 3-5). Although large-magnitude earthquakes do not originate beneath the INEL, large earthquakes do occur in the adjacent seismic belts (EG&G Idaho, Inc., 1984; Leeman, 1988). The largest reported earthquake event in the ISZ occurred along the western flank of Borah Peak (Lost River Range) approximately 64 kilometers (40 miles) northwest of Arco (Table 3-2). This earthquake occurred on October 28, 1983, and had a magnitude of 7.3 on the Richter scale. Although the shock was felt, no structural or safety-related damage occurred at the INEL (Gorman and Guenzler, 1983).

Five earthquakes have been centered within the ESRP since 1971, although none has exceeded a Richter scale magnitude of 1. The only earthquake to have its epicenter within the INEL was a 0.7-magnitude event centered 6 to 8 kilometers (3.7 to 5 miles) east of the NRF. No damage from these earthquakes was reported (King and Doyle, 1982; EG&G Idaho, Inc., 1984).

The likelihood of a sizable earthquake occurring on the INEL or the ESRP in the vicinity of the INEL in the foreseeable future is extremely slight because of the following factors. The ESRP and the Basin and Range Province within about 40 kilometers (25 miles) of it are notably aseismic (Smith, Richens, and Dozer, 1985; Rodgers, 1987) (Figure 3-5). Although recent seismicity does not identify all active or potentially active faults



Source: DOE (1982a).

Figure 3-4. Postulated Rift Zones and Volcanic Structures near the INEL.

Table 3-2. Largest Historic Earthquakes in the Region Surrounding the Eastern Snake River Plain[a]

Date	Latitude (°N)	Longitude (°W)	Modified Mercalli Intensity	Richter magnitude	Location	Distance from SIS site km (mi)
November 10, 1884	42.0	111.3	VIII	6	Bear Lake Valley[b]	221 (137)
October 5, 1909	41.8	112.7	VIII	6	Hansel Valley, Utah[b]	201 (125)
June 27, 1925	46.0	112.2	VIII	6.75	East of Helena, Montana[b]	272 (169)
March 12, 1934	41.7	112.8	IX	6.6 (M_S)[c]	Hansel Valley, Utah[b]	211 (131)
October 18, 1935	46.6	112.0	VIII	6.25	Helena, Montana[b]	341 (212)
October 31, 1935	46.6	112.0	VIII	6	Helena, Montana[b]	341 (212)
July 12, 1944	44.7	115.2	VII	6.1	Seafoam, Idaho[b]	221 (137)
February 13, 1945	44.7	115.4	VI	6.0	Near Clayton, Idaho[b]	234 (145)
November 23, 1947	44.8	112.0	VIII	6.25	Southwestern Montana[b]	152 (94)
August 17, 1959	44.8	111.1	X	7.1	Hebgen Lake, Montana[b]	196 (122)
August 18, 1959	44.8	110.7	VI	7.5	Yellowstone Park, Wyoming[d]	221 (137)
August 18, 1959	44.9	111.6	V	6.25	Southwestern Montana[d]	178 (111)
March 27, 1975	42.1	112.5	VIII	6.1 (M_S) 6.0 (M_L,M_S)[e]	Pocatello Valley, Idaho-Utah border[b]	170 (106)
June 30, 1975	44.8	110.6	VII	6.1 (M_L) 5.9 (M_S)	Yellowstone Park, Wyoming[b]	227 (141)
October 28, 1983	44.05	113.89	VII	7.3	Borah Peak, Idaho	94 (58)

[a] Source: EG&G Idaho, Inc. (1984).

[b] Includes mainshocks (or largest swarm events) of magnitude 6.0 or greater (or Modified Mercalli Intensity VIII for preinstrumental shocks from 1852 through July 1980).

[c] M_S is the magnitude of surface waves.

[d] Part of 1959 Hebgen Lake earthquake sequence.

[e] M_L is the local magnitude.

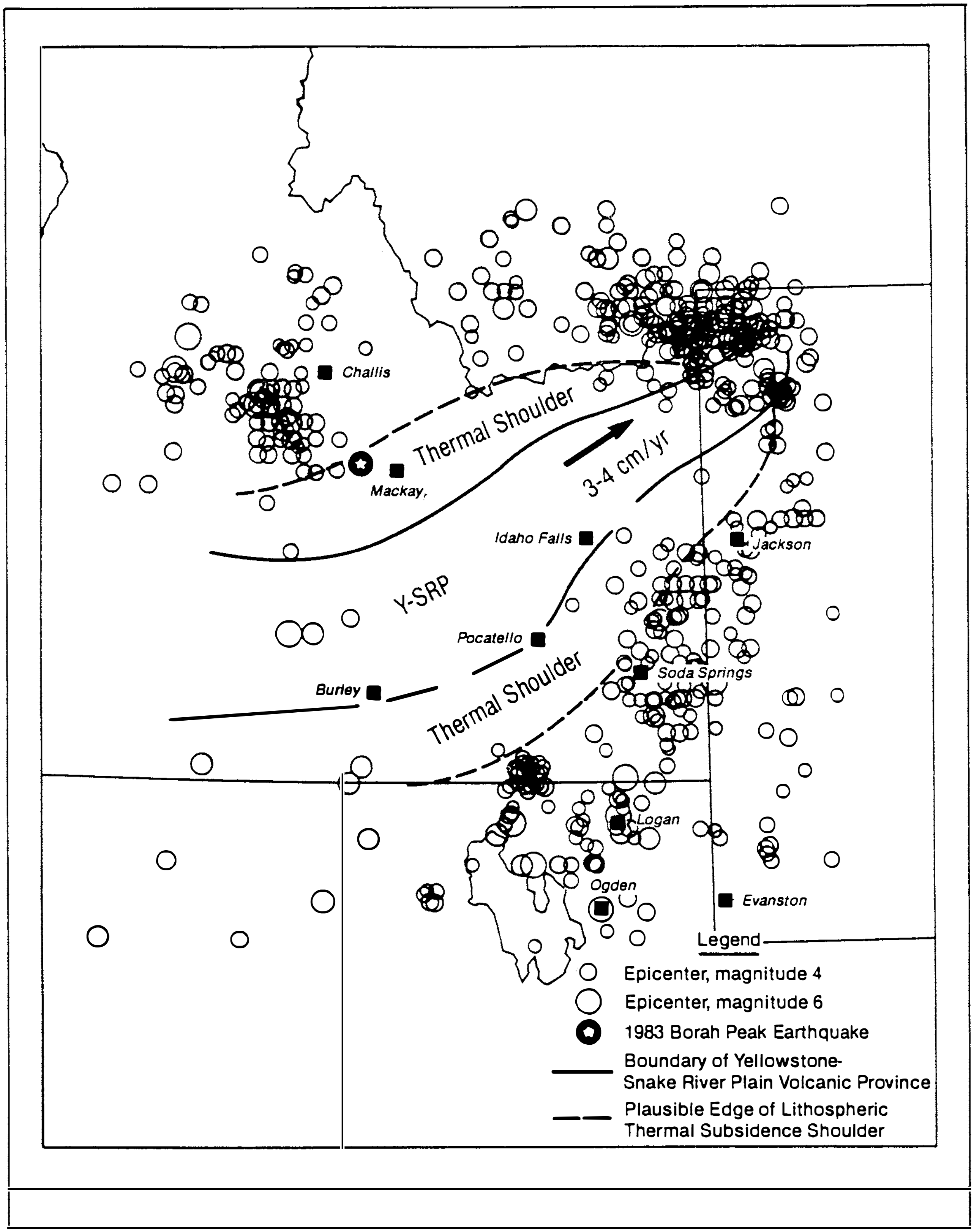


Figure 3-5. Location of Epicenters.

(Scott, Pierce, and Hait, 1985; King, Doyle, and Jackson, 1987), it is an important indicator for recognizing possible future earthquake activity. Basin and Range structures either terminate at the edge of the ESRP or within a few kilometers of it and the Plain shows little evidence of Quaternary faulting except for rift zones associated with basaltic volcanism (Figure 3-6) (Mabey, 1982; Scott, Pierce, and Hait, 1985). Thus it appears that the ESRP responds very differently to the regional northeast-southwest extension than does the adjacent Basin and Range Province (Mabey, 1982). This may be due to the high heat flow of the ESRP, which suggests that the tectonic stress is taken up by aseismic creep rather than large-scale faulting (Brott, Blackwell, and Ziago, 1981; King, Doyle, and Jackson, 1987).

Geophysical surveys of the northeast margin of the ESRP immediately east of Arco have suggested the existence of a possible northeast-trending boundary fault with 1 to 4 kilometers (0.62 to 2.5 miles) of offset, between the ESRP and the Lost River Range (Sparlin, 1982; Pankratz and Akermann, 1982). However, more recent work by Sierra Geophysics (EG&G Idaho, Inc., 1984) indicates that the discontinuity between the Paleozoic rocks and Cenozoic rhyolites is shallow dipping (15-20 degrees) and that a continuous, throughgoing major structure is not present. Surface manifestations of this postulated fault are also equivocal. Scott (1982) mapped some discontinuous low scarplike features in the area but their origin is uncertain (Scott, oral communication, 1988; EG&G Idaho, Inc., 1984). Bedrock along the projections of these lineaments does not show evidence of faulting and, as is the case elsewhere along the margin of the ESRP, faults parallel to the margin are small, with little offset, and do not appear to cut rocks younger than about 3 million years (Rodgers, 1987). If a major northeast-trending fault does exist at depth in this area, it does not appear to have produced any significant movement in the Pleistocene basalts and alluvial cover and is most likely related to caldera subsidence 6.5 million years or more ago.

Based on their proximity to the INEL and the likelihood of generating sizable earthquakes, the faults considered to be of most significance to the proposed SIS are the range front faults located along the western flanks of the Lost River, Lemhi, and Beaverhead Ranges (Figure 3-6). Schwartz and Coppersmith (1984) have developed a model that suggests that individual faults and fault segments tend to generate essentially the same size of "characteristic earthquakes" during successive movements. In support of this model, Crone et al. (1987) and Myers and Hamilton (1964) suggest that the historic Borah Peak and Hebgen earthquakes were nearly identical to prehistoric events on the same faults. Other authors (Arabasc, Pechmann, and Brown, 1988; and Dozer, 1985) present quantitative data to support this model. It is apparent from extensive geologic investigations (Malde, 1971, 1987; Scott, Pierce, and Hait, 1985; Pierce, 1985, and other works) as well as historic evidence that the Lost River, Lemhi, and Beaverhead Faults are capable of producing large (magnitude 7-7.5) earthquakes in the future. These studies also indicate that these earthquakes occur on individual fault segments at intervals of thousands to tens of thousands of years. Wallace (1987) summarizes the history of the Lost River Fault, which is the most thoroughly studied and understood fault in the region. Similar morphology and scarp features on the Lemhi and Beaverhead Faults suggest they may have similar histories.

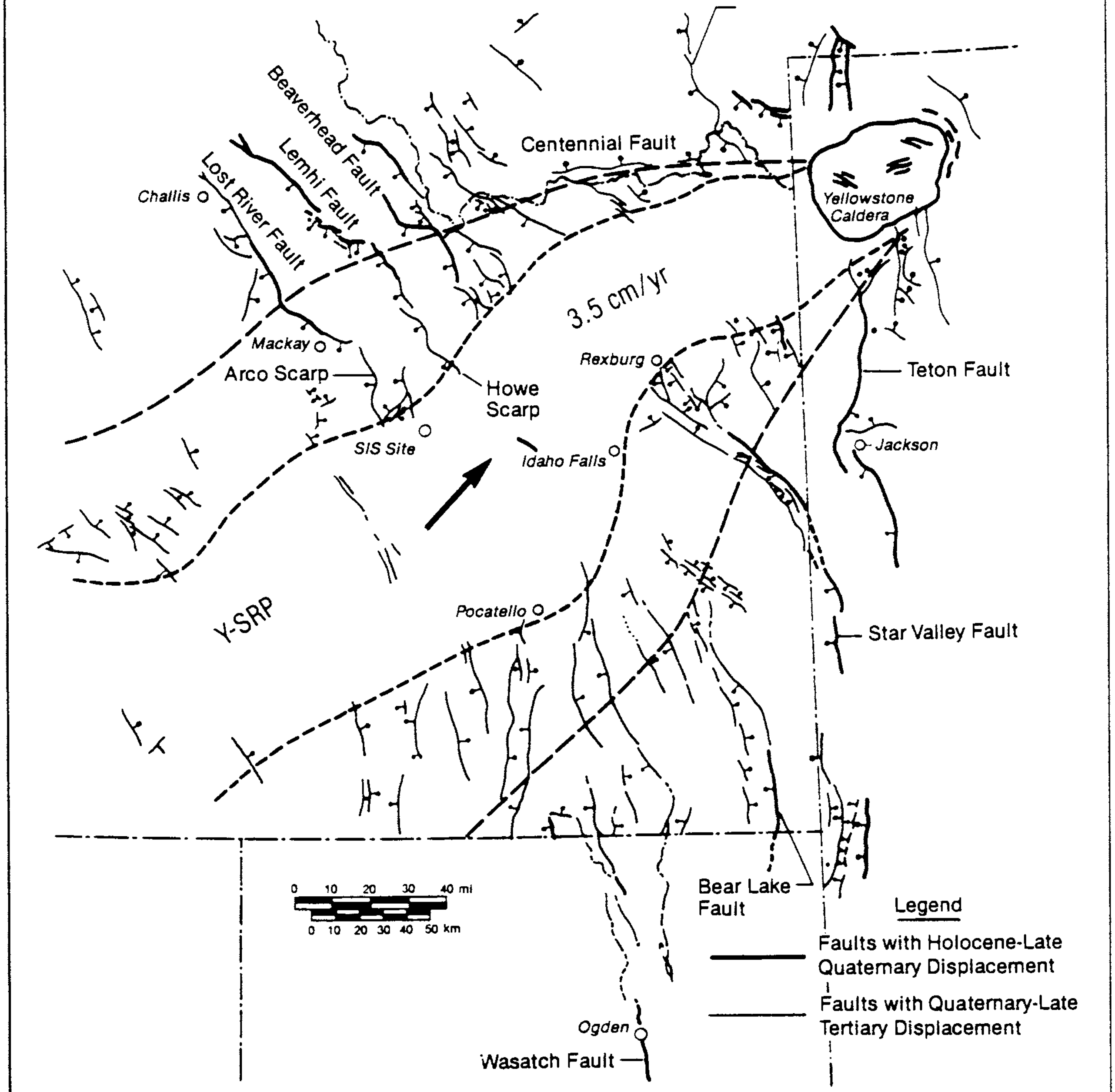


Figure 3-6. Locations of Faults.

Scott, Pierce, and Hait (1985) state that future ruptures could occur along any part of these faults and that it is difficult to predict which segment will move next or when. They do suggest, however, that the most likely candidates could be:

1. The central segments of the Lemhi and Beaverhead Ranges, which have similar characteristics to the Thousand Springs Segment of the Lost River Fault, which produced the 1983 Borah Peak earthquake. These characteristics include: high relief, high long-term slip rates, and latest Quaternary offsets. In addition, there is evidence that all three of those faults may be linked at depth.

2. The segments adjacent to the 1983 break may be next to slip, in order to keep pace with the Thousand Springs Segment. This is especially true of the Mackay Segment, which has latest Quaternary history similar to the Thousand Springs Segment.

Several authors (Scott, Pierce, and Hait, 1985; Pierce, Scott, and Morgan, 1988; Smith, Richens, and Dozer, 1985; Anders and Piety, 1988) have suggested that the zone of maximum fault activity has moved away from the edge of the ESRP after the passing of the Yellowstone "hot spot." With the passing of the "hot spot" in the area of the INEL about 5-6 million years ago, the major zone of earthquake activity has formed a parabolic wake-like pattern, with its apex moving to the northeast (toward Yellowstone) and its sides moving away from the margins of the ESRP into the Basin and Range Province to the north and south. This supports the predictions given above and would explain the historic pattern (Figure 3-6) as well as the apparent lack of seismicity within about 40 kilometers (25 miles) of the Plain.

In spite of the likelihood that near-future earthquakes will most likely occur several tens of kilometers away from the margin of the ESRP, the possibility that the southernmost fault segments (closest to the INEL) might rupture must be addressed. Detailed work on the Arco segment of the Lost River Fault (Malde, 1971, 1987; Pierce, 1985) indicates an average slip rate of 0.1-0.12 meter (0.33-0.39 feet) per 1000 years during the past 160,000 years. The fault has not ruptured in the past 30,000 years, which suggests two possibilities:

1. If the slip rate has been constant, the fault has a potential strain accumulation of 3 meters (9.8 feet). Since characteristic earthquakes along the Lost River Fault produce less offset than this, it could be concluded that the Arco Segment is overdue and should have ruptured 10,000-20,000 years ago (Pierce, 1985).

2. If the slip rate has not been constant, the fault has experienced periods of multiple displacements separated by periods of quiescence. This is consistent with the observations of Wallace (1984) in the Great Basin and appears to better fit the existing data for the Lost River Fault (Pierce, 1985; Wallace, 1987). Wallace's concept of grouping of faulting events in time and space also supports the prediction that the central parts of the range front faults north of the ESRP have the greatest potential for future movement. If the temporal grouping concept is valid, prediction of future activity on these faults is quite uncertain.

It should be noted at this point that the histories of the southernmost segments of the Lemhi Fault (Howe Segment) and Beaverhead Fault are probably similar to the Arco Segment.

Considering the long recurrence intervals as well as irregularities in periodicity along individual segments of the faults concerned, it is not possible to predict if any earthquakes will be generated during the life span of the SIS Project. If an earthquake does occur, it seems most likely that it will be epicentered approximately as far away from the INEL as was the Borah Peak Earthquake, and that it will have approximately the same magnitude. In this event, peak ground accelerations in the vicinity of the SIS Project should be similar to those experienced in 1983 (0.022-0.078g) giving a Modified Mercalli Intensity of VI (Jackson and Boatwright, 1987). In the less likely event that an earthquake would occur on the Arco or Howe Segments during the lifetime of the SIS Project, ground motion would be stronger.

Predicted peak ground accelerations were calculated assuming a 7.25-magnitude earthquake on either the Arco or Howe Segments approximately 30 kilometers (18 miles) from the proposed SIS site. Utilizing attenuation curves calculated for the INEL by Tera Corporation (1984) as part of DOE's Survey of Seismic Hazards (Coats and Murray, 1984), a peak horizontal ground acceleration of 0.22g is predicted. The design basis for SIS is 0.24g horizontal bedrock acceleration. The event would have a longer return period (30,000 years) than the 5000 years recommended for High Hazard Non-Reactor Facilities in DOE Order 6430.1A.

Volcanic Activity

The INEL is located in a province built principally by volcanic eruptions; therefore, there is a potential for resumption of volcanic activity. Volcanic processes that might affect facilities at the INEL are lava flows, earthquakes associated with volcanism, ground deformation, and explosive eruptions (EG&G Idaho, Inc., 1984).

Explosive rhyolitic volcanism associated with the large calderas of the ESRP has not occurred in the vicinity of the INEL for about 4-6 million years (Embree, McBroome, and Doherty, 1982; Morgan, Doherty, and Leeman, 1984). Because the locus of the "hot spot" has now moved on to Yellowstone (less than 200 kilometers or 124 miles to the northeast), it is unreasonable to believe that such eruptions will occur in the INEL area in the future (Kuntz and Dalrymple, 1979; Hackett et al., 1987). The possibility of pyroclastic flows from a Yellowstone eruption reaching the INEL is essentially nonexistent because of the distances involved and intervening topographic barriers (Hackett et al., 1987). The possibility of airfall ash from such an eruption impacting the SIS site is also remote because the recurrence interval of the major eruptions is on the order of 0.5-1 million years and the prevailing winds have generally distributed the ash to the east or southeast of Yellowstone (Izett and Wilcox, 1982).

Four rhyolite lava domes were emplaced along a northeast-trending zone, 16-22 kilometers (9-14 miles) southeast of the SIS site, between 1.4 and 0.3 million years ago (Kuntz and Dalrymple, 1979). These rhyolitic eruptions are anomalies occurring during a time of basaltic activity and are unlikely to occur again. In the unlikely event of such an eruption, it would probably occur along the same linear zone and probably be nonexplosive, posing little hazard to the SIS facility (Kuntz and Dalrymple, 1979; Hackett et al., 1987). In his evaluation of the volcanic hazards of the RWMC, Kuntz (1978a) states that rhyolite dome eruptions would constitute a hazard only if they took place within 10 kilometers (6 miles) of the site.

Kuntz (1978a), Kuntz and Dalrymple (1979), and Kuntz et al. (1980) have evaluated the volcanic hazards to various facilities located within the boundaries of the INEL. From these evaluations and from an examination of the geologic maps of the area (Kuntz, 1978b; Kuntz et al., 1979; Kuntz et al., 1984; Rember and Bennett, 1979), it seems apparent that the principal volcanic hazard to the proposed SIS site would be inundation from basaltic lava flows. Quaternary and Holocene eruptions on the ESRP have not been randomly distributed in space or time. Nearly all are rift controlled (Figure 3-3) and occur during short episodes (less than 100 years) of activity separated by long intervals of quiescence. Most of the vents are lava-cones or shield volcanoes which produce lava flows from relatively nonexplosive eruptions. Some mildly explosive eruptions may deposit cinders within 0.5 kilometer (0.3 mile) of the vents. Lava flows may travel as far as 20-30 kilometers (12-19 miles) from vents (Kuntz and Dalrymple, 1979), with average distances of 5-10 kilometers (3-6 miles) (EG&G Idaho, Inc., 1984). The most recent volcanic activity in the ESRP occurred 64 kilometers (40 miles) west and south of the proposed SIS site along the Great Rift and King's Bowl Rift approximately 2100 years ago (Kuntz, Spiker, et al., 1986). Just outside the eastern boundary of the INEL, the Hell's Half-Acre flow has been dated at 5200 years ago, and just to the south, the North and South Robbers flows and Cerro Grande field have been dated at about 12,000 and about 13,400 years ago (the youngest dated flow to reach the INEL), respectively (Kuntz, Spiker, et al., 1986).

Three factors govern the volcanic hazard of an area; these include topography, location of the vent in relation to the site, and recurrence interval. The proposed SIS site is located in a slight topographic basin partly surrounded by volcanic rift zones (Figure 3-4). This depression exists because flows have not reached this area as often as they have reached the surrounding areas nearer the rifts. The Arco-Big Southern Butte rift zone lies 19 kilometers (12 miles) to the southwest, and could affect the SIS site. Eruptions from most of the Howe-East Butte rift zone pose less of a threat because the vents lie at a lower elevation than the SIS site; but some in the East Butte area (25-30 kilometers or 15-19 miles to the east) and vents in the AEC Butte area (3 kilometers or 2 miles to the northwest) could affect the site. However, AEC Butte has an age of 626 ± 27 thousand years for its youngest activity (Champion, Lanphere, and Kuntz, 1988); therefore it is not expected to have further activity in the future. Other rift zones on the ESRP are not a factor due to distance and elevation relationships to the SIS site. Studies of individual rift zones give considerable insight into recurrence intervals. The Great Rift in the Craters of the Moon area has experienced 8 eruptive episodes in the past 15,000 years. Each episode lasted less than 100 years, and the time lapse between episodes ranged from about 500 to 3000 years with an average recurrence interval of 2000 years (Kuntz, Champion, et al., 1986; Kuntz, Spiker, et al., 1986). The Arco-Big Southern Butte rift zone has produced

67 flows within the past 200,000 years, with an average recurrence interval of 3000 years (Kuntz, 1978a).

Away from the rift zones, individual areas are inundated at less frequent intervals. Studies of cores from wells at the RWMC and Argonne National Laboratory West (ANL-W) sites have determined recurrence intervals for those specific areas located within the same basin as the SIS site (Kuntz et al., 1980; Kuntz and Dalrymple, 1979). Within the RWMC area, flows from 7 different sources have been deposited in the last 500,000 years. These flows were grouped into three major episodes, occurring 450,000, 225,000, and 95,000 years ago (Champion, Lanphere, and Kuntz, 1988), separated by intervals of 150,000-225,000 years during which no flows reached the area. Approximately one out of five eruptions within the basin reached the RWMC site (Kuntz et al., 1980). The ANL-W site has experienced 5 flows during the past 500,000 years. These flows were separated by irregular intervals ranging from 1000-10,000 to 300,000-400,000 years. The likelihood of a given eruption reaching the site is once every 80,000-100,000 years (Kuntz and Dalrymple, 1979). Although the SIS site has not been studied in this detail, it is located approximately 3 times as far away from the Arco-Big Southern Butte Rift Zone as the RWMC and 2-3 times as far from the vents to the south as is ANL-W. This would suggest that, although the SIS site is susceptible to hazards from lava flows, the recurrence interval should be greater than at those other two sites and therefore the SIS should be at less risk.

Champion, Lanphere, and Kuntz (1988) have radiometrically dated lava flows encountered in a 186-meter (609-foot) deep drill hole at a location approximately 4 kilometers (2.5 miles) east of the proposed SIS site. Reliable ages were obtained for six of the eight lava flows encountered in the drill holes. The ages show that the flows were erupted between 641,000 and 233,000 years ago. Using only the 6 dated flows, the recurrence interval during the period of activity is 81,000 years. It is demonstrated that the time period since the last activity (233,000 years) is 3 times the average recurrence interval and 2 times the largest recurrence interval during the period of activity. This suggests that the source(s) of the lava flows is no longer active and would not reasonably be expected to erupt again in the future.

Earthquakes that might be expected in association with volcanic eruptions at the INEL are of two types: (1) earthquakes due to magma movement and (2) sympathetic tectonic earthquakes. Earthquakes due to magma movement are typically shallow (1 kilometer or 0.6 mile), of low magnitude (2 to 5 Richter magnitude) (Kuntz, 1978a; EG&G Idaho, Inc., 1984), and restricted to areas near the magma source. Sympathetic tectonic earthquakes are caused by forceful injection of magma into existing rift zones and as such are generally confined to the rift areas. Because of the low magnitude and localized effects from these types of earthquakes, safety-related problems due to sympathetic tectonic earthquakes and earthquakes due to magma movement are not anticipated (EG&G Idaho, Inc., 1984).

Ground deformation is the inflation or deflation of the land surface due to the movement of magma. The effects of inflation/deflation tend to be localized around active volcanic vents and thus are not expected to impact the INEL (EG&G Idaho, Inc., 1984).

According to Kuntz (1978a), precursory events including ground deformation, seismic activity, and fuming are likely to occur near vents prior to any possible future volcanic activity on the ESRP. At that time geologic and geophysical monitoring should help to predict the likelihood and probable location of an eruption as well as the possible threat to individual facilities at the INEL. If a particular facility like the SIS were in danger, orderly shutdown procedures could be initiated and possibly even lava flow control or diversion methods could be instituted.

3.1.4.4 Hydrology

The surface-water hydrology of the INEL is dominated by the Pioneer Basin, a closed drainage basin that receives water from Big Lost River, Little Lost River, and Birch Creek (Figure 3-7). These rivers are supplied by mountain watersheds located to the north and northwest (Barraclough, Lewis, and Jensen, 1981).

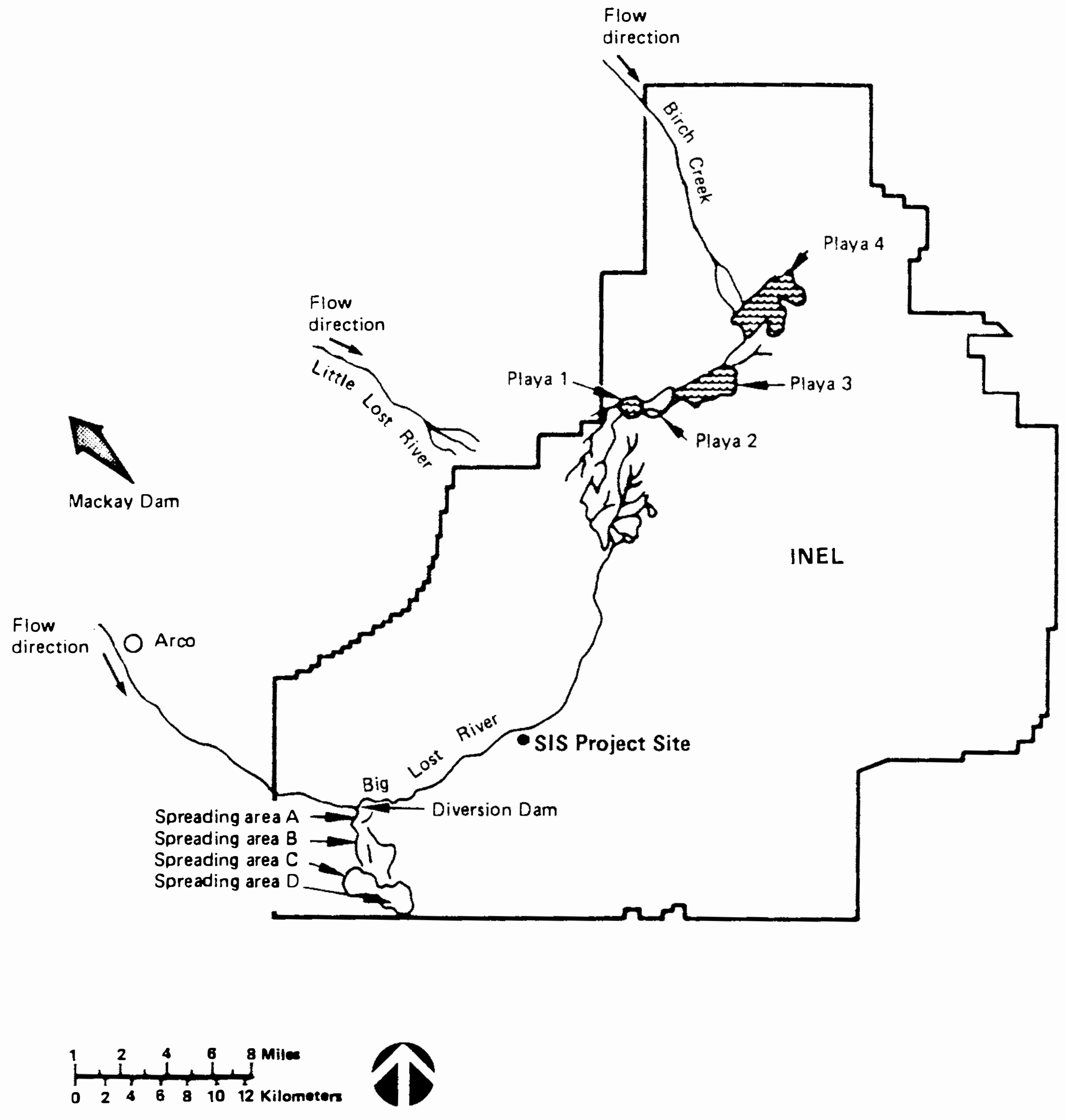
The Big Lost River is the major river on the INEL. This river flows onto the INEL site across the southwest boundary, curves to the northeast, and terminates at the Big Lost River playas (sinks). The average yearly discharge for the Big Lost River is 2.6×10^8 cubic meters per year (2.15×10^5 acre-feet per year) or 8.25 cubic meters per second (291 cubic feet per second) as measured 48 kilometers (30 miles) northwest of Arco, Idaho (Barraclough, Lewis, and Jensen, 1981).

The major storage and diversion structures on the Big Lost River are the Mackay Dam and the INEL flood diversion dam. The Mackay Dam has a storage capacity of 5.0×10^7 cubic meters (4.5×10^4 acre-feet) of water and is located 48 kilometers (30 miles) upstream of Arco, Idaho. The INEL flood diversion system consists of a small dam that functions to divert the river flow away from INEL facilities into four spreading areas. The diversion system has a carrying capacity of approximately 263 cubic meters per second (9300 cubic feet per second) (EG&G Idaho, Inc., 1984). Total capacity of the spreading areas is approximately 7.2×10^7 cubic meters (58,000 acre-feet) at an elevation of 1539 meters (5050 feet) above mean sea level (McKinney, 1985).

Most of the flow from the Little Lost River and from Birch Creek is diverted for irrigation before reaching the INEL. In high-flow years, however, Little Lost River and Birch Creek flow onto the site. There, the remaining water evaporates or infiltrates into the ground through the stream channel or playa bottom (EG&G Idaho, Inc., 1984).

Except for the water lost to evapotranspiration, most of the surface water on the INEL infiltrates into the ground. Water in the Big Lost River ultimately recharges the Snake River Plain aquifer, although some of this water is held, at least temporarily, in perched water zones (EG&G Idaho, Inc., 1984).

The major ground-water body beneath the INEL is the Snake River Plain aquifer. This aquifer is composed of a series of layered basalt flows



Source: EG&G Idaho, Inc. (1984).

Figure 3-7. Surface-Water Features at or near the INEL.

interbedded with sands, gravels, silts, and clays of eolian, fluvial, and lacustrine origin. Ground-water flow in the aquifer varies locally although regional flow is to the southwest (Robertson, Schoen, and Barraclough, 1974). Ground water moving through the aquifer eventually discharges to the Snake River at a rate of approximately 6.2×10^9 cubic meters (5.0×10^6 acre-feet) annually. Ground-water pumpage for irrigation totals about 1.8×10^9 cubic meters (1.5×10^6 acre-feet) per year on the ESRP (EG&G Idaho, Inc., 1984).

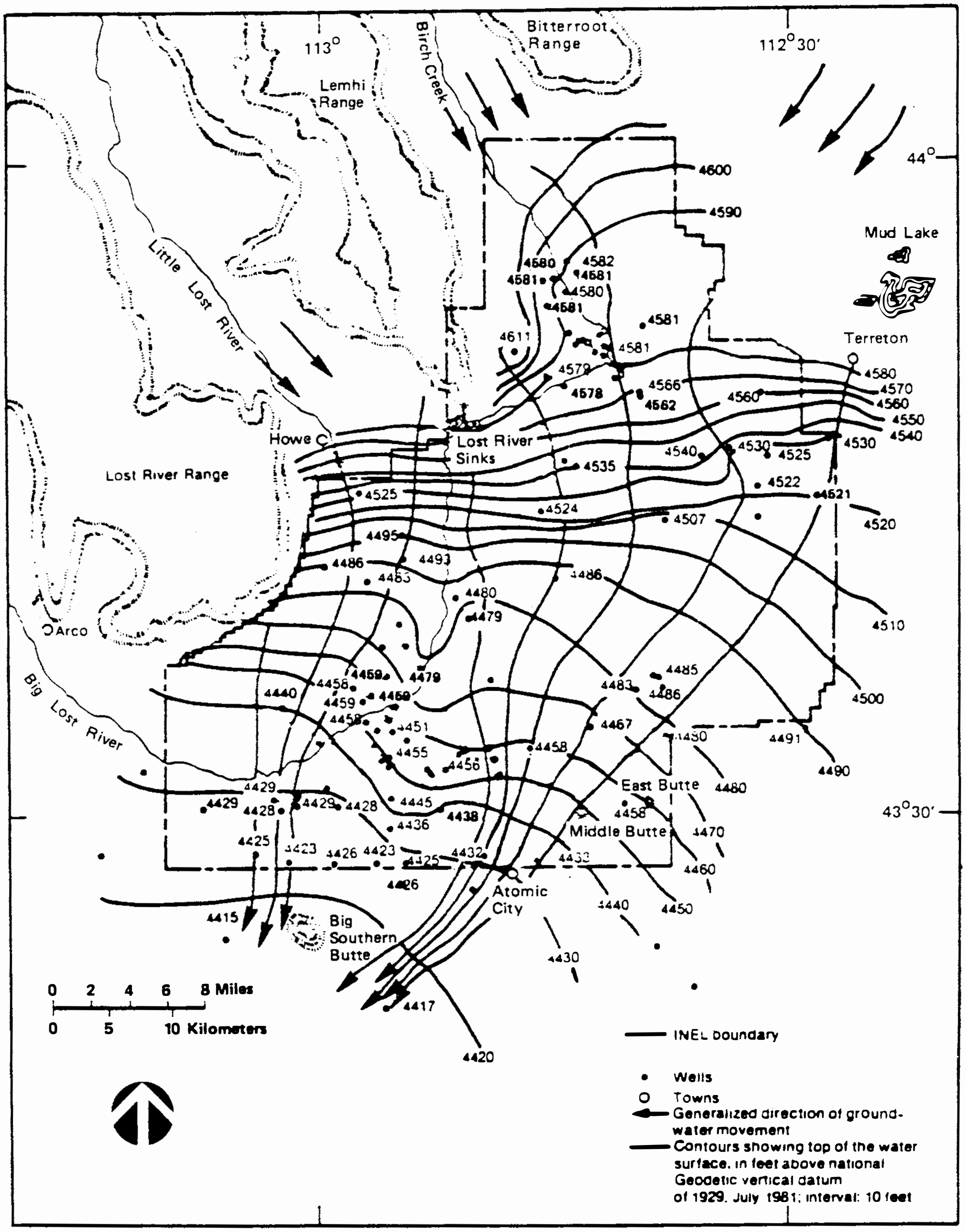
The depth to the Snake River Plain aquifer from the land surface ranges from about 60 meters (200 feet) in the northeast corner of the INEL to 300 meters (1000 feet) in the southeast corner (EG&G Idaho, Inc., 1984). The average slope of the water-table surface is about 0.2 percent from northeast to southwest, with ground-water velocities ranging from 1.5 to 6 meters per day (5 to 20 feet per day). In addition, aquifer transmissivities and storage coefficients range from 3.7×10^5 to 2.2×10^8 liters per day per meter (3×10^4 to 1.8×10^7 gallons per day per foot) and 0.01 to 0.06, respectively (Robertson, Schoen, and Barraclough, 1974). Figure 3-8 shows the potentiometric surface for the Snake River Plain aquifer and the inferred directions of ground-water flow.

The Snake River Plain aquifer recharges by infiltration from streams and rivers that originate in the mountains to the north and may occur in a surprisingly short time. Barraclough, Lewis, and Jensen (1981) have documented water-table-elevation increases of as much as 2 meters (6 feet) a few months after high river flows. Increased flows in the Big Lost River over recent years have raised the regional water-table elevation under much of the INEL.

Perched water tables are areas in which the downward percolation is retarded by one or more layers of less permeable material. A number of these bodies are known to occur underground at the INEL, particularly under the Big Lost River and the percolation ponds at the TRA. The time it takes for the migration of waste water from the TRA percolation ponds to the regional aquifer has been estimated by computer calculations at about 1 year (Robertson, 1977).

The water in the Snake River Plain aquifer is relatively low in total dissolved solids (averaging about 200 milligrams per liter). With modest treatment, it can be made suitable for most uses (EG&G Idaho, Inc., 1984). This aquifer is the only source of water for the INEL. Pumping from water-supply wells causes a drawdown of the water-table surface in the aquifer. This drawdown has a limited impact on the aquifer because the amount of water removed from the aquifer is small in comparison to the total storage and recharge (Barraclough, Lewis, and Jensen, 1981).

Liquid low-level radioactive and dilute chemical wastes have been discharged to the subsurface from the TRA since 1952 and from the ICPP since 1953. Disposal at the TRA is to percolation ponds. Disposal at the ICPP is to percolation ponds that in February 1984 replaced the former practice of using an injection well. The injection well has not been used since February 1984 except in emergency situations. Currently, it is planned to plug the injection well with cement in 1989. The INEL site monitoring reports, the INEL Environmental Characterization Report (EG&G Idaho, Inc.,



Source: Lewis and Jensen (1984).

Figure 3-8. Generalized Surface Contours for the Regional Water Table Aquifer and Inferred Directions of Ground-Water Flow, INEL and Vicinity, July 1981.

1984), and reports by Barraclough, Lewis, and Jensen (1981) and Lewis and Jensen (1984) provide a discussion and characterization of the effects of these discharges on ground water.

Results of recent INEL monitoring of ground water have detected carbon tetrachloride in samples of ground water from one of five monitoring wells at concentrations of between 2 to 6 parts per billion at the Radioactive Waste Management Complex (RWMC). In addition, core samples at the RWMC have detected the presence of plutonium at depths of 33 meters (110 feet) and 70 meters (230 feet). Current monitoring results indicate that the detected level of these contaminants does not pose a health threat and that the plutonium will not reach the Snake River Plain aquifer in detectable quantities. DOE is conducting an expanded monitoring program and study to determine the extent of contamination and the most appropriate means of remedial action, if such action is required.

Currently, three sites at the INEL require corrective action under RCRA due to documented releases of hazardous wastes. The three sites are the TRA Warm Waste Pond, TAN ground water, and the RWMC. The TRA Warm Waste Pond received discharges of potassium dichromate, which was used as an algicide and corrosion inhibitor in the TRA cooling towers prior to 1970. As a result of this discharge to the pond, chromium has been detected in the perched ground water underneath the pond. The extent of potential contamination has not been determined. Ground water at TAN is contaminated with trichloroethylene at concentrations that exceed maximum concentration limits for drinking water. A corrective action workplan is currently being reviewed by EPA to determine the nature and extent of the contamination problem. At the RWMC, there has been a release of chlorinated hydrocarbons, mainly carbon tetrachloride, from TRU wastes shipped to the INEL from the Rocky Flats Plant. The release has had only minor impact on ground water, but a large quantity of chlorinated hydrocarbons is present in the soil gas beneath the RWMC. A corrective action workplan for the RWMC is also currently under review by the U.S. Environmental Protection Agency (EPA).

Through a recent agreement with the EPA, DOE has acknowledged EPA jurisdiction over all hazardous wastes at the INEL. The agreement gives EPA the full jurisdictional responsibility (i.e., enforcement authority) for hazardous wastes regulated under the Resource Conservation and Recovery Act (RCRA) as well as hazardous constituents of mixed wastes.

3.1.4.5 Meteorology and Climatology

The INEL, situated in a flat valley surrounded by mountains, is located in a region that exhibits semiarid steppe characteristics. Moist air masses affecting the region are moderated by the Pacific Ocean. As a result, winters are generally warmer and summers cooler than in locations in a more temperate climate at the same latitude. Average monthly temperatures at the INEL range from -9.0°C (15.8°F) (January) to 20.1°C (68.2°F) (July) (EG&G Idaho, Inc., 1984) and recorded extremes at the CFA are from -44°C (-47°F) to 38°C (101°F) (DOE, 1987d). The average monthly relative humidity fluctuates between 15 percent in August and 89 percent in February and December (DOE, 1982a) and frequently drops to near 5 percent in summer (EG&G Idaho, Inc., 1984).

All air masses entering the region around the INEL must first cross a mountain barrier, which causes precipitation of a large part of the available moisture in the mountains. This contributes to the relatively low annual and monthly precipitation values associated with the INEL. On the average, the INEL receives 23 centimeters (9.07 inches) of precipitation annually and from 1 to 3.3 centimeters (0.40 to 1.28 inches) monthly (EG&G Idaho, Inc., 1984). Annual precipitation totals have ranged from about 11.4 to 36.6 centimeters (4.50 to 14.40 inches) and monthly totals from 0 to 11.2 centimeters (0 to 4.42 inches) (EG&G Idaho, Inc., 1984). Maximum precipitation usually occurs in May and June, with the minimum occurring in July. Precipitation rates occasionally reach 2.5 centimeters (1 inch) or more per day, but 3 centimeters (1.19 inches) of rain were recorded in a 1-hour period in June 1969 (DOE, 1982a). Snowfall at the INEL generally occurs between November and April; however, on occasion, snow has been reported as early as September and as late as June (DOE, 1982a). This can be attributed partly to the INEL's high elevation above sea level (approximately 1500 meters or 5000 feet) (EG&G Idaho, Inc., 1984).

In addition to influencing the amount of precipitation received at the INEL, the terrain also affects the wind patterns. The most significant effect is seen by the channeling of winds by the mountains so that southwesterly winds predominate over the INEL. The second most frequent winds (northeasterlies) may also be attributed to terrain. Nocturnal northeasterly flows frequently develop as the result of cold-air drainage from and channeling by elevated terrain north of the INEL (EG&G Idaho, Inc., 1984). This latter effect is generally associated with low wind speeds; higher wind speeds tend to occur from the west and southwest (DOE, 1982a). The monthly average hourly wind speeds at the INEL span between 2.2 meters per second (5 miles per hour) in December and 4.0 meters per second (9 miles per hour) in April and May. The highest hourly average wind speed was 30 meters per second (67 miles per hour), and the greatest observed peak gust was 39 meters per second (87 miles per hour) (EG&G Idaho, Inc., 1984).

The INEL is in an area where severe weather, mostly consisting of thunderstorms and tornadoes, occurs relatively infrequently. The frequency of thunderstorms is considered low, with an average of two or three thunderstorms a month in the summer. Although small hail frequently accompanies these storms, damage due to hail is generally not a consideration at the INEL (DOE, 1982a). Tornadoes at or near the INEL also have a very low frequency. The annual probability of a tornado striking at the INEL is 7.8×10^{-5} (EG&G Idaho, Inc., 1984).

The transport and dispersion of airborne material are direct functions of air movement. Transport, direction, and speed are governed by the general patterns of airflow (and by the nature of the terrain), whereas the diffusion of airborne material is governed by small-scale, random eddying of the atmosphere (i.e., turbulence). Turbulence is indicated by atmospheric stability classification. As determined by 1983 onsite meteorological monitoring at the Grid 3 meteorological tower, the atmosphere is unstable about 40 percent of the time, neutral about 2 percent of the time, and stable about 58 percent of the time.

Atmospheric contaminant levels that result from operations at the INEL or from nearby communities are small (EG&G Idaho, Inc., 1984). In addition, atmospheric dispersion at the INEL is not constrained by topography, and the site is well ventilated. Measurements made by an onsite monitoring station for total suspended particulates and modeling of offsite concentrations of sulfur dioxide and nitrogen dioxide show that all of these emissions are well below national primary ambient air quality standards (DOE, 1987c).

3.1.5 Ecology

The INEL is located within the ESRP, which is itself composed of a variety of shrub-steppe communities (EG&G Idaho, Inc., 1984). Vegetation at the INEL is representative of a cool desert ecosystem. The Big Lost River flows onto the INEL site across the southwest boundary, curves to the northeast, and terminates at the Big Lost River playas (sinks).

3.1.5.1 Terrestrial Ecology

Based on the presence of dominant vegetation, six major vegetative communities occur on and adjacent to the INEL. These are sagebrush, juniper, crested wheatgrass, Indian ricegrass, and agricultural and wetlands vegetation (EG&G Idaho, Inc., 1984). Sagebrush is the dominant community type. Juniper communities occur in the northwest and southeast portions of the site and are associated with higher elevations. Crested wheatgrass covers about 40 square kilometers (9880 acres) and is found throughout the INEL. A community dominated by Indian ricegrass is found in a relatively narrow band near the eastern site boundary. Irrigated farmland borders about 33 percent of the site. Portions of the INEL site are grazed by cattle and sheep, and wetlands cover about 8 square kilometers (2000 acres) during periods of high waterflow in the Big Lost River. Wetland vegetation is characterized by sedges, cattails, and bulrushes. The proposed SIS Project area is located within the sagebrush community, specifically the big-sagebrush/thickspike-wheatgrass type (ERDA, 1977a).

An inventory of the insect population of the site has not been conducted; however, diverse insect fauna are associated with each of the plant communities and are an integral part of the rangeland ecosystem. A study has been performed on a sagebrush community near the western border of the INEL. In this study, species from 150 families representing 4 orders were found (EG&G Idaho, Inc., 1984).

One species of amphibian and nine species of reptiles have been recorded on the INEL. Based on published ranges, an additional five amphibian and five reptile species may also be found (EG&G Idaho, Inc., 1984). The Great Basin spadefoot toad, the only amphibian observed, is found in the Big Lost River sinks and spreading areas. Of the nine reptile species occurring, the short-horned lizard, sagebrush lizard, gopher snake, and western rattlesnake occur commonly throughout the INEL.

A total of 159 bird species have been observed at various times of the year on the INEL, and an additional 14 species may also occur (EG&G Idaho, Inc., 1984). Of those species known to occur on the site, there were 69 passerines, 29 game birds, 22 raptors, and 39 birds belonging to other groups. The sage sparrow, Brewer's sparrow, and sage thrasher are the most common passerine breeding birds. Twenty-three of the game birds are species of waterfowl whose abundance depends on the flow of Big Lost River. The sage grouse and mourning dove are the most common upland game birds; both breed throughout the site. Ten species of raptors breed on or near the INEL, with the American kestrel and long-eared owl being the most common. The most abundant raptors observed during the nonbreeding season include the American rough-legged hawk, American kestrel, prairie falcon, and golden eagle.

Thirty-seven species of mammals are known to occur on the INEL site. Of these, 18 are rodents, 4 are leporids (i.e., hares and rabbits), 6 are carnivores, and 9 belong to other groups. Of the carnivores, the coyote, long-tailed weasel, and badger are considered common. The mountain lion is rare. Resident populations of mule deer are uncommon, whereas those of pronghorn antelope present during the winter months represent 30 percent of Idaho's total pronghorn population.

3.1.5.2 Aquatic Ecology

Aquatic habitat on the INEL consists of the Big Lost River and its associated playas and spreading areas (EG&G Idaho, Inc., 1984). The most significant aquatic resource of the INEL site is the Big Lost River. The river flows 50 kilometers (31 miles) across the site before it terminates in the Big Lost River playas (EG&G Idaho, Inc., 1984). However, because of runoff flows, irrigation demands, silt and sediment loading, the Mackay Reservoir, and the INEL site flood-control project, it is a highly unstable aquatic environment with intermittent flows. Studies have identified 12 families of insects, as well as representatives of the invertebrate classes Crustacea (crustaceans), Arachnida (spiders and mites), Mollusca (mollusks), Annelida (segmented worms), and Nematoda (roundworms). Aquatic vertebrates include five species of fish, of which the rainbow trout is the most abundant. It is thought that eight additional fish species may be found in the Big Lost River (EG&G Idaho, Inc., 1984). There is no surface drainage that leaves the INEL. Fish habitat adjacent to the SIS Project site in the Big Lost River is poor because of low or no-flow water conditions and channelization of the pre-existing riverbed.

3.1.5.3 Endangered and Threatened Species

No threatened or endangered plants are found on the INEL. However, two species of milkvetch (Astragalus ceramicus varapus and Astragalus purshii var. ophigenes), currently under Federal review for endangered or threatened status, do occur on the site. Neither of these plants has been found near the ICPP (EG&G Idaho, Inc., 1984). The bald eagle and the American peregrine falcon are the only animals observed that are classified by the

Federal government as endangered or threatened. The bald eagle (endangered) usually winters on or near the INEL. The habitat near the proposed SIS Project site lacks the proper combination of water, swamps, and carrion preferred by wintering bald eagles (Steenhof and Brown, 1978; Steenhof et al., 1980; Reynolds et al., 1985; Isaacs and Anthony, 1987). The peregrine falcon (endangered) has been observed infrequently in the northern portion of the site. There are no raptor species on the INEL proposed for listing as endangered or threatened. The Swainson's hawk (Buteo swainsonii) and ferruginous hawk (Buteo regalis) are two additional raptors occurring on the INEL which are candidate species for classification as endangered or threatened. Both Swainson's hawks and ferruginous hawks are uncommon migrants, uncommon summer breeders, and rare winter visitors to the INEL (Reynolds et al., 1985). There are no historic and successful nests of either of these two species within 1.2 kilometers (0.75 mile) of the proposed plant site. This is far greater than the 0.25-kilometer (0.16-mile) buffer zone recommended to prevent nest desertion (White and Thurow, 1985). The proposed SIS Project area is covered with gravel, largely devoid of vegetation, and lacking prey species.

The State of Idaho has developed a State Watch List for taxa considered locally rare or of special interest, although their overall populations may not be in jeopardy. Presently three species found on the site are on this list (Oxytheca, Oxytheca dendroides; cactus, Coryphantha missouriensis; and Gymnosteris, Gymnosteris nudicaulis). Four others (Lesquerella kingii var. cobrensis, Gilia polycadon, Astragalus gilviflorus, and Astragalus kentrophyta) have been recommended for inclusion on the list (EG&G Idaho, Inc., 1984). Also of concern to Idaho (Idaho Department of Fish and Game) and the U.S. Bureau of Land Management are several species of vertebrates. These include the ferruginous hawk, Swainson's hawk, gyrfalcon, osprey, burrowing owl, white-faced ibis, long-billed curlew, and bobcat. Of these, only the burrowing owl, long-billed curlew, and bobcat occur regularly at the INEL.

3.1.6 Background Radiation

3.1.6.1 Environmental Radiation Sources and Exposure

Environmental radiation consists of natural background radiation from cosmic, terrestrial, and internal body sources. Additional sources of background radiation are medical and dental diagnosis, nuclear weapons test fallout, consumer and industrial products, air travel, brick and stone buildings, and radioactive releases associated with INEL operations.

A summary of major radiation sources and their doses to an average individual residing in the vicinity of the INEL is presented in Table 3-3. Natural background radiation (DOE, 1987c) contributes about 54 percent of the annual dose of 266 millirem received by an average member of the population within 80 kilometers (50 miles) of the INEL. Medical exposure accounts for 34.7 percent of the annual dose; brick and stone buildings in the area account for 7.5 percent of the annual dose; and the combined doses from consumer and industrial products and air travel account for 1.9 percent of the annual dose. The radioactivity released to the environment from the

Table 3-3. Major Sources of Radiation Exposure in the Vicinity of the INEL[a]

Sources of exposure	Dose to average individual (mrem/yr)	Percent of exposure
Natural background radiation		
Cosmic radiation	49.0	
External terrestrial radiation	68.0	
Internal radiation	27.0	
Total[b]	144.0	54.1
Fallout radiation		
External	0.9	
Internal	3.7	
Total	4.6	1.7
INEL operations	0.1	<0.1
Medical radiation		
Diagnostic x-rays	78.4	
Medical and dental personnel[c]	0.5	
Radiopharmaceuticals	13.6	
Total	92.5	34.7
Air travel	0.5	0.2
Brick and stone buildings	20.0	7.5
Consumer and industrial products	4.5	1.7
Total	25.0	
Grand total	266.2	

[a] Source: DOE (1987c).

[b] This total does not include a dose associated with radon-222 and its decay products since no estimate has been made specifically for the INEL vicinity.

[c] Prorated over the total population to arrive at an average individual dose.

INEL accounts for less than 0.1 percent (0.1 millirem per year) of the total annual dose.

External natural radiation comes from cosmic rays and the emissions from natural radioactive ores, and the amount depends primarily on location and altitude. Internal natural radiation arises mainly from potassium-40, carbon-14, rubidium-87, and daughters of radium-226. Medical radiation is the largest single source of man-made radiation in the United States (BEIR, 1980). The average dose to an individual from medical and dental x-rays is estimated to be 78.4 millirem per year. Radiopharmaceuticals account for an average dose of 13.6 millirem per year. The prorated occupational exposure of 0.5 millirem per year to medical and dental personnel is added to this medical radiation dose.

Fallout from nuclear weapons tests provides a minor source of radioactivity in the environment. External gamma radiation and ingestion of radioactivity in food and water are the major sources of radiation exposure (i.e., about 4.6 millirem per year) from weapons test fallout.

A variety of consumer and industrial products yield ionizing radiation, causing radiation exposure to the general population. These include television sets, luminous-dial watches, airport x-ray inspection systems, smoke detectors, and tobacco products. Persons who travel by aircraft receive additional exposure to cosmic radiation. Building materials consisting of brick and stone are also sources of radiation, as is the combustion of fossil fuels.

3.1.6.2 Environmental Radiological Monitoring Program and Environmental Radioactivity Levels at the INEL

Environmental monitoring programs at the INEL are conducted to determine: (a) the overall impact of DOE operations on the environment, (b) whether environmental levels of radioactivity comply with applicable standards (40 CFR 61, DOE Order 5400.3), (c) whether containment and control systems at facilities are functioning as planned, and (d) long-term trends of concentrations of radioactivity in the environment and any changes in those trends. Environmental impacts are determined by measuring radionuclides in the environment, where such measurements are possible, or by modeling the transport of radionuclides through environmental pathways in cases where environmental concentrations are too low to measure. Measurements on the INEL or at the INEL boundary are frequently compared to similar measurements at background or control locations, especially in cases where the source of the radioactivity is not INEL operations. All measured concentrations are compared to applicable environmental standards. Where radionuclide concentrations are high enough to be measured regularly, long-term trends are presented. Data are reported yearly in the Environmental Monitoring Program Report for the INEL Site.

The environmental pathways by which radioactivity could affect the population in the vicinity of the INEL are through direct radiation exposure, through atmospheric transport, and through soils, water, foodstuffs, and/or animals. The environmental monitoring program for the

INEL site and vicinity includes the collection and analysis of samples from these potential exposure pathways. The environmental monitoring program is summarized in Table 3-4. Sampling locations are shown in Figures 3-9 through 3-13.

Air and water are routinely monitored for radioactivity at a number of onsite as well as boundary and distant locations. Concentrations of radionuclides in milk, wheat, and lettuce samples are measured at site-boundary and distant locations. Distant locations serve as background controls that are not affected by radioactive releases associated with INEL operations. Onsite soils are sampled annually on a rotating basis, while offsite soils are sampled only in even-numbered years. Environmental radiation exposure rates are measured at site-boundary and distant locations. Based on monitoring data (DOE, 1984a, 1985, 1986a), no significant concentrations of radionuclides from the INEL have been detected. A brief discussion of major pathways is presented below.

Airborne particulate radioactivity is monitored continuously by a network of 12 samplers onsite and 11 samplers offsite at the locations shown in Figure 3-9. Onsite samplers are located to give adequate coverage in the event of INEL facility releases of radioactivity. Seven offsite samplers are located near the site boundary in communities, where possible. The remaining offsite samplers are located at distant communities to provide background measurements for comparison with data from boundary or onsite samplers that might be affected by site operations. The background (distant) locations are usually in a crosswind direction to the site and are sufficiently remote to ensure that radioactivity detected is primarily due to natural background or sources other than site operations. (All the reported results of specific nuclides were very near the minimum detectable concentration.)

The analytical methods for environmental samples are carefully reviewed to verify that such analyses are made with sufficient sensitivity to verify compliance with appropriate standards. High reliability is obtained by a stringent quality assurance program. Gross counting of samples is used for establishing trends or for screening groups of samples.

Because the expected INEL contribution to offsite dose rates is small, it cannot be reliably measured directly. The most sensitive indicators of radiological impacts of INEL operations are the analyses of samples for individual radioisotopes. The minimum detectable concentrations for most radioisotopes permit calculation of dose commitments to the public of 0.1 millirem per year or less.

The Snake River Plain aquifer that lies beneath the INEL site serves as the primary source of drinking water and irrigation water for crops in the Snake River Basin. Onsite and offsite water samples are collected routinely to monitor for movement of waste substances through the aquifer. Tritium, strontium-90, and iodine-129 are found in aquifer samples obtained onsite. The extent of these radionuclides in the aquifer is documented in U.S. Geological Survey (USGS) reports (Hydrologic Conditions at the INEL, Idaho: 1979-1981 Update). Over the last few years, concentrations of these radionuclides in the aquifer have generally been decreasing. Detectable concentrations of several other radionuclides have been found in onsite

Table 3-4. INEL Onsite and Offsite Radiological Environmental Monitoring Program Summary

Medium sampled	Type of analysis	Frequency of analysis	Number of locations	Approximate MDC[a]	Percentage of derived concentration guide
Air					
Low-volume samplers	Gross beta	Weekly	23	8 E-15 μCi/mL	0.3[b]
	I-131	Weekly	23	8 E-15 μCi/mL[c]	0.002
	Specific gamma	Quarterly	23	1 to 10 E-15 μCi/mL	<0.01[d]
	Sr-90	Quarterly	6	1 E-16 μCi/mL	0.002
	Am-241	Quarterly	10	8 E-18 μCi/mL	0.04
	Pu-238,239/240	Quarterly	10	6 E-18 μCi/mL	0.03
Tritium samplers	HTO[e]	3 to 7 weeks	3	1 E-11 μCi/mL	0.005
High-volume samplers	Gross gamma	Daily	2	N/A[f]	N/A
	Specific gamma	Monthly	2	1 to 10 E-16 μCi/mL	<0.001[d]
Water					
Production wells					
Onsite	Gross alpha	Monthly	26	3 E-09 μCi/mL	5
	Gross beta	Monthly	26	5 E-09 μCi/mL	5
	HTO	Monthly	26	4 E-07 μCi/mL	0.02
Offsite	Gross alpha	Semiannually	14	3 E-09 μCi/mL	5
	Gross beta	Semiannually	14	5 E-09 μCi/mL	5
	HTO	Semiannually	14	4 E-07 μCi/mL	0.02

Table 3-4. INEL Onsite and Offsite Radiological Environmental Monitoring Program Summary (continued)

Medium sampled	Type of analysis	Frequency of analysis	Number of locations	Approximate MDC[a]	Percentage of derived concentration guide
Surface water					
Percolation ponds	Specific gamma	Monthly	2	1 to 10 E-08 µCi/mL	<6[d]
	HTO	Monthly	2	4 E-07 µCi/mL	0.02
	Sr-90	Monthly	2	5 E-08 µCi/mL	5
	I-129	Quarterly	1	4 E-10 µCi/mL	0.08
	Pu-238,239/240	Quarterly	1	4 E-11 µCi/mL	0.01
	Am-241	Quarterly	1	5 E-11 µCi/mL	0.05
	U-total	Quarterly	1	0.1 mg/L	N/A
Other sources[g]	Specific gamma	Semiannually	6	1 to 10 E-08 µCi/mL	<6[d]
	HTO	Semiannually	6	4 E-07 µCi/mL	0.02
Snake River	Gross alpha	Semiannually	2	3 E-09 µCi/mL	5
	Gross beta	Semiannually	2	5 E-09 µCi/mL	5
	HTO	Semiannually	2	4 E-07 µCi/mL	0.02
USGS observation wells	Depends on well	Quarterly, semiannually, or annually		N/A --	N/A --
	Specific gamma	Q, S, or A	49	1 to 10 E-08 µCi/mL	<6[d]
	HTO	Q or S	127	4 E-07 µCi/mL	0.01
	Sr-90	Q or S	53	5 E-09 µCi/mL	0.5
	Am-241	S	6	5 E-11 µCi/mL	0.05
	Pu-238,239/240	S or A	10	4 E-11 µCi/mL	0.01
	I-129	~5 years	20-35	3 E-10 µCi/mL	0.06

Table 3-4. INEL Onsite and Offsite Radiological Environmental Monitoring Program Summary (continued)

Medium sampled	Type of analysis	Frequency of analysis	Number of locations	Approximate MDC[a]	Percentage of derived concentration guide
Foodstuffs					
Milk	I-131[h]	Monthly	9	1 E-09 μCi/mL	1.0[i]
	Sr-90	Annually	9	2 E-09 μCi/mL	N/A
	HTO	Annually	9	4 E-07 μCi/mL	N/A
	I-129[j]	Annually	3	3 E-10 μCi/mL	N/A
Wheat	Specific gamma	Annually	10	4 E-09 μCi/g	N/A
	Sr-90	Annually	10	4 E-09 μCi/g	N/A
Lettuce	Specific gamma	Annually	8	2 E-07 μCi/g	N/A
	Sr-90	Annually	8	8 E-08 μCi/g	N/A
Sheep	Specific gamma	Annually	5	1 to 10 E-09 μCi/g	N/A
Beef	Specific gamma	Biennially	2-4	1 to 10 E-09 μCi/g	N/A
	Sr-90	Biennially	2-4	1 to 10 E-10 μCi/g	N/A
	Am-241	Biennially	2-4	1 to 10 E-12 μCi/g	N/A
	Pu-238,239/240	Biennially	2-4	1 to 10 E-12 μCi/g	N/A
Game animals Antelope, sage grouse, deer, and fish	Specific gamma	As available	Varies	1 to 10 E-09 μCi/g	N/A

Table 3-4. INEL Onsite and Offsite Radiological Environmental Monitoring Program Summary (continued)

Medium sampled	Type of analysis	Frequency of analysis	Number of locations	Approximate MDC[a]	Percentage of derived concentration guide
Soil offsite[k]	Specific gamma	Biennially	12	4 E-08 μCi/g	N/A
	Sr-90	Biennially	12	9 E-08 μCi/g	N/A
	Am-241	Biennially	12	3 E-09 μCi/g	N/A
	Pu-238,239/240	Biennially	12	2 E-09 μCi/g	N/A
Direct radiation	Thermoluminescent dosimeter	Semiannually	147	5 mR	N/A

[a] Approximate minimum detectable concentration (MDC); varies somewhat depending on substances present in the sample.

[b] Based on the most restrictive beta emitter, Ra-228.

[c] Makes the improbable assumption that the charcoal-impregnated filters collect all the airborne iodine.

[d] For principal gamma-emitting radionuclides.

[e] Tritium as tritiated water.

[f] Not applicable.

[g] Natural creeks, rivers, lakes near INEL site boundaries.

[h] One dairy is sampled weekly.

[i] The percentage of DCG is based on the guide value for milk established by the Federal Radiation Council (Report No. 2) in 1961.

[j] Analysis performed for three locations only.

[k] Aliquant from a 2000-g sample is analyzed. Onsite soils are sampled intensively around each major facility every 7 years on a rotating schedule. The type of analysis is appropriate to the facility sampled, but all samples are analyzed for specific gamma emitters. Approximate MDCs are the same as for offsite soils.

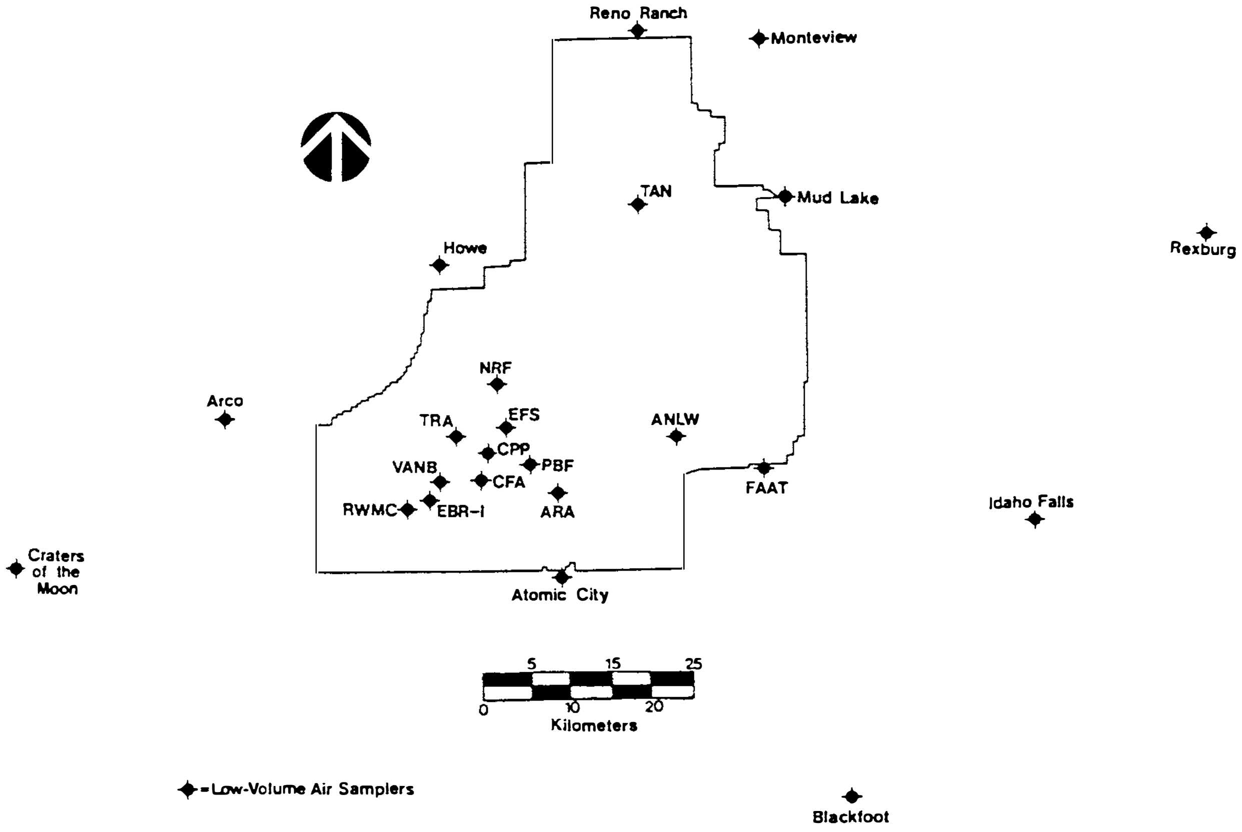


Figure 3-9. INEL Site and Vicinity Air Sampling Network.

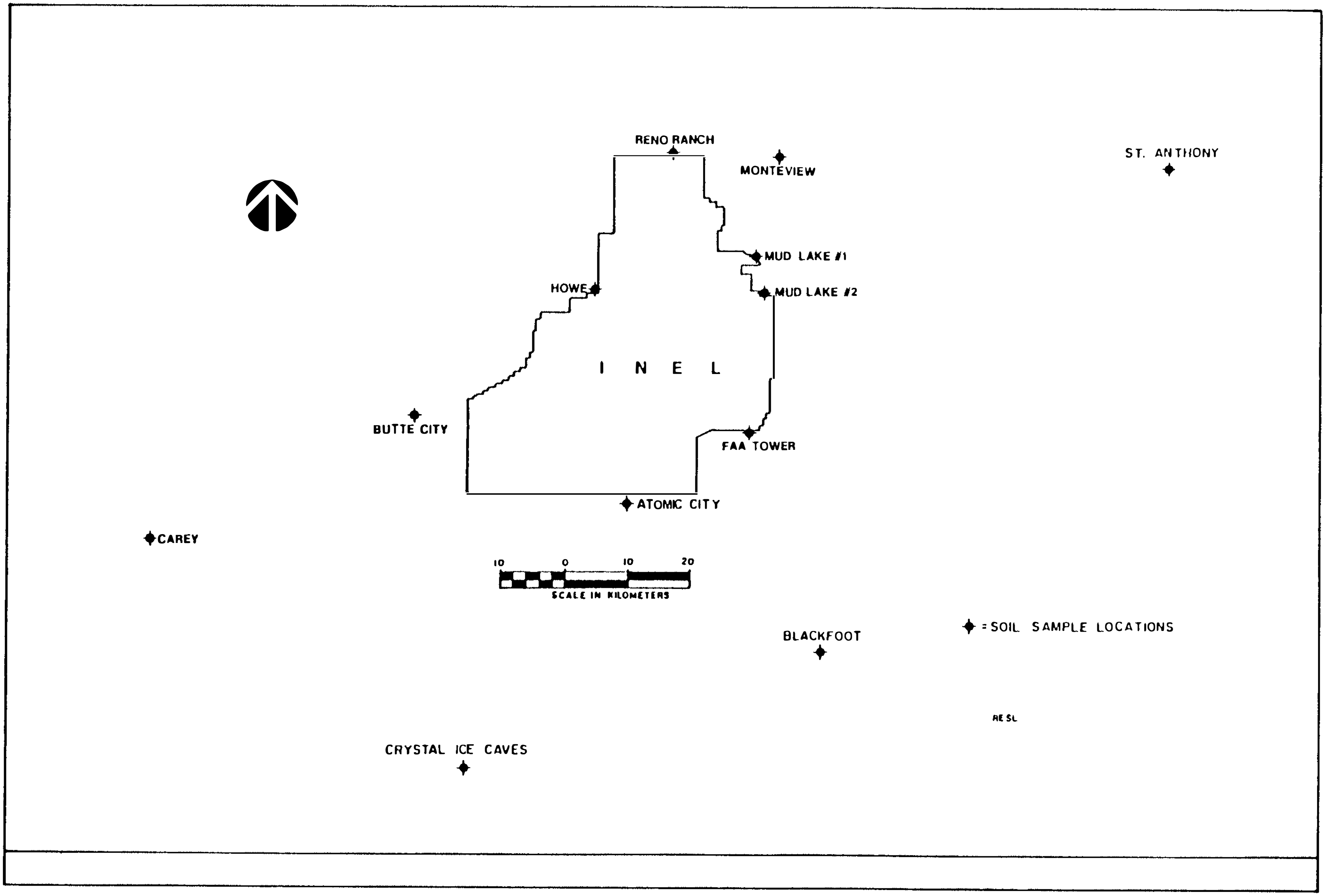


Figure 3-10. Soil Sampling Locations for the INEL Site Vicinity.

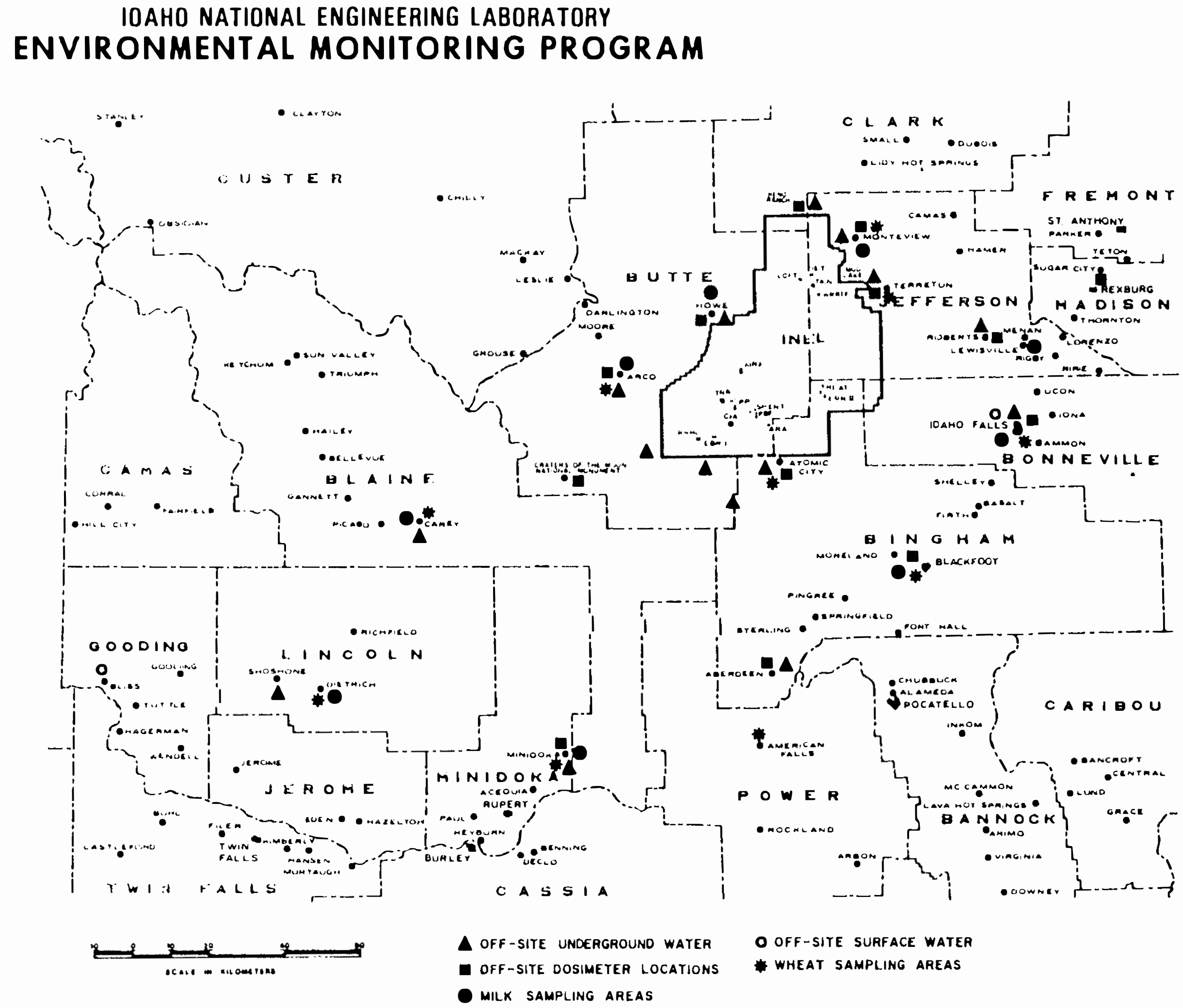


Figure 3-11. Offsite Water, Milk, and Wheat Sampling Locations and Environmental Dosimeter Locations.

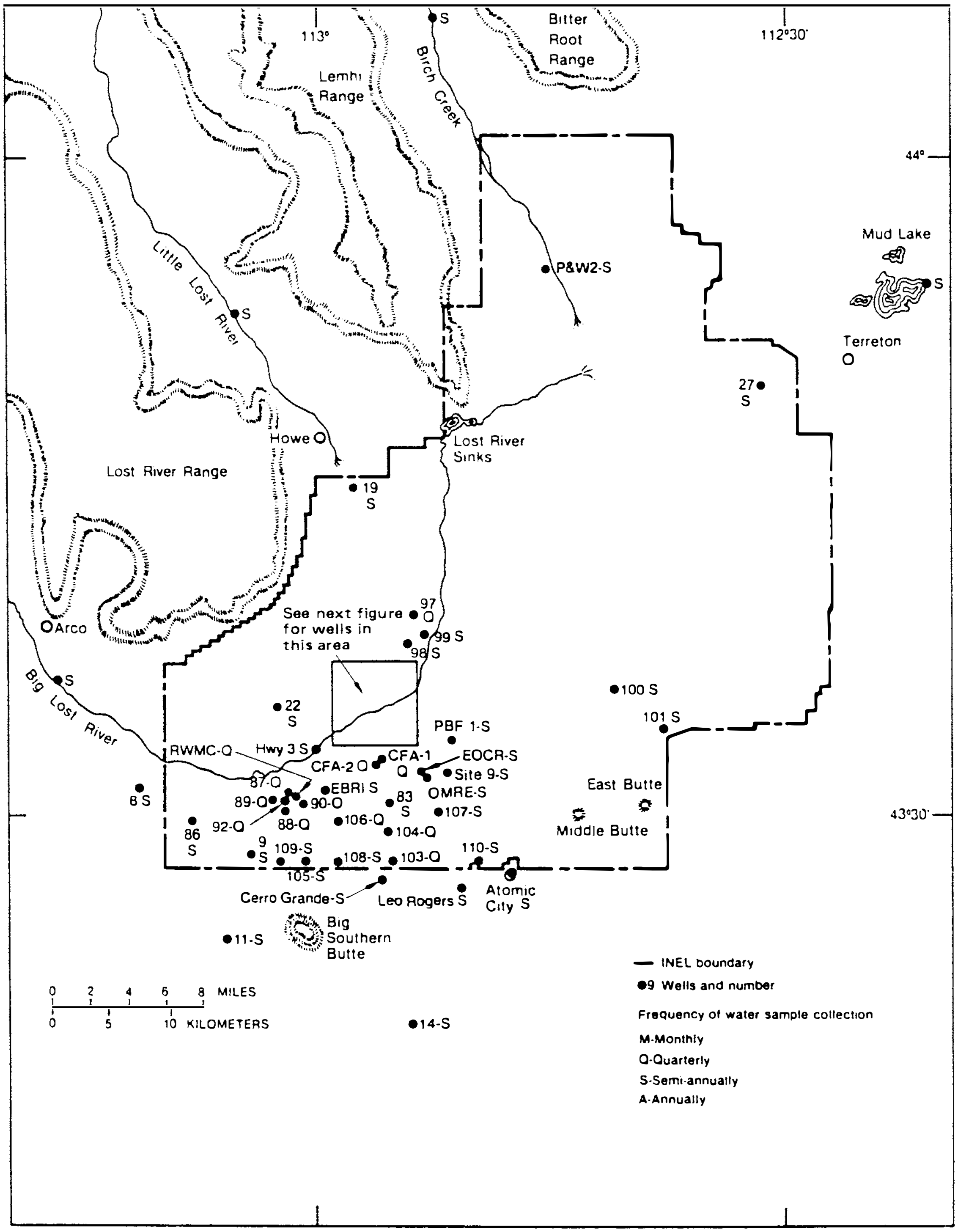


Figure 3-12. Locations of Wells and Frequencies of Water-Sample Collections at the INEL.

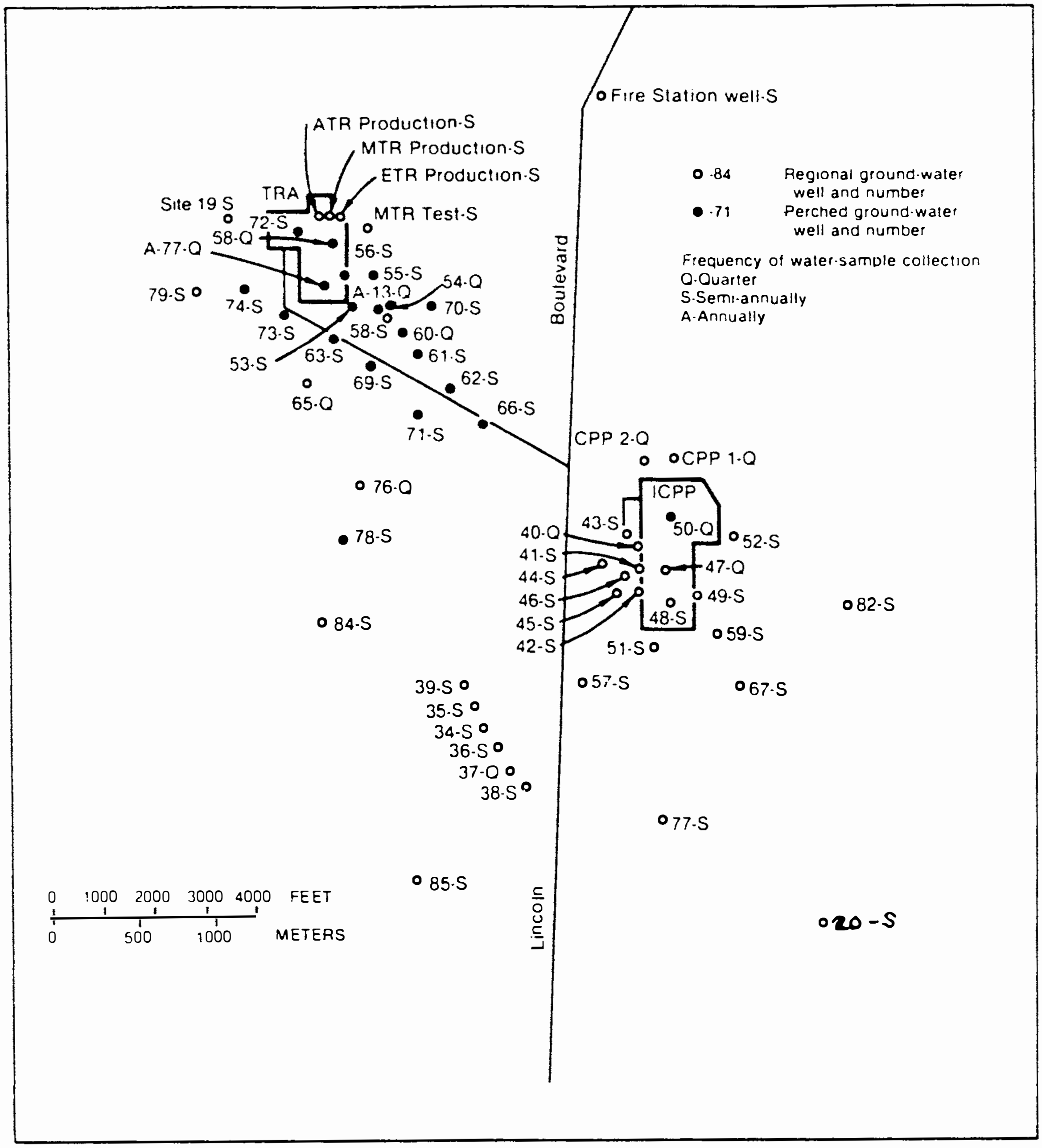


Figure 3-13. Locations of Wells and Frequencies of Water-Sample Collections in the TRA-ICPP Area.

aquifer wells close to the source of the nuclides. Gross alpha, gross beta, and tritium analyses are performed on drinking water samples. Annual averages for gross alpha and beta activity at all drinking water wells were below the EPA drinking water standard.

Milk, wheat, and leafy garden lettuce are sampled routinely and analyzed for radioactivity. All concentrations of iodine-131, strontium-90, and tritium in milk are well below health protection guides. Wheat and lettuce sampling results showed that the concentration of strontium-90 was near or less than the minimum detectable concentrations. Muscle and liver samples were taken in 1985 from sheep that had grazed in the northern and eastern grazing areas of the INEL site. No man-made radionuclides were detected in either the muscle or liver samples of the sheep that had grazed on the site. Only cesium-137, near the minimum detectable concentration, was found in beef muscle and liver samples in 1986. Detectable concentrations of iodine-131 in milk and cesium-137 were measured in 1986 following the Chernobyl accident (DOE, 1987c).

Thermoluminescent dosimeters (TLDs) are used to measure ionizing radiation exposures at 135 onsite locations, 6 boundary locations, and 6 more distant locations. The TLDs measure ionizing radiation exposures from natural radioactivity in the air and soil, cosmic radiation from outer space, fallout from nuclear weapons tests, radioactivity from fossil fuel burning, and radioactive emissions from site operation and other industrial processing. The mean annual TLD exposures for both boundary and more distant locations are generally in the range of 110 to 115 millirem.

Samples of air, precipitation, drinking water, and milk from Idaho Falls and Snake River water from Buhl, Idaho, are analyzed independently by EPA's Eastern Environmental Research Facility. Under a working agreement between the State of Idaho and the DOE, environmental samples collected by the Radiological and Environmental Sciences Laboratory (RESL) or the USGS may be divided between the State and the RESL or the USGS. Water samples have been split with Idaho; the last split was in 1984. In addition, the DOE, in consultation with the State of Idaho, is establishing a contract with Idaho State University to provide independent verification of the environmental monitoring program at the INEL. The DOE will fund the program, and Idaho State University will furnish its findings to DOE and the State of Idaho.

3.2 CHARACTERIZATION OF THE HANFORD SITE

The following sections briefly discuss the Hanford Site and surrounding region. Further environmental information about the Hanford Site is available in Jamison (1982); Rogers and Rickard (1977); Stone et al. (1983); DOE (1982b, 1983, 1986b, 1986c, 1987b); ERDA (1975); NRC (1982); and PNL (1987).

3.2.1 Site Location and Regional Population

The Hanford Site occupies approximately 1480 square kilometers (570 square miles) and extends approximately 48 kilometers (30 miles) from north to south and 38 kilometers (24 miles) from east to west (Figure 3-14). In 1943, the U.S. Army Corps of Engineers selected the Hanford Site as the location for a nuclear reactor, chemical separations facilities, and related activities for the production and purification of defense nuclear materials. Eight graphite-moderated reactors and the more recently constructed N-Reactor, which began operation in 1963, were constructed along the Columbia River.

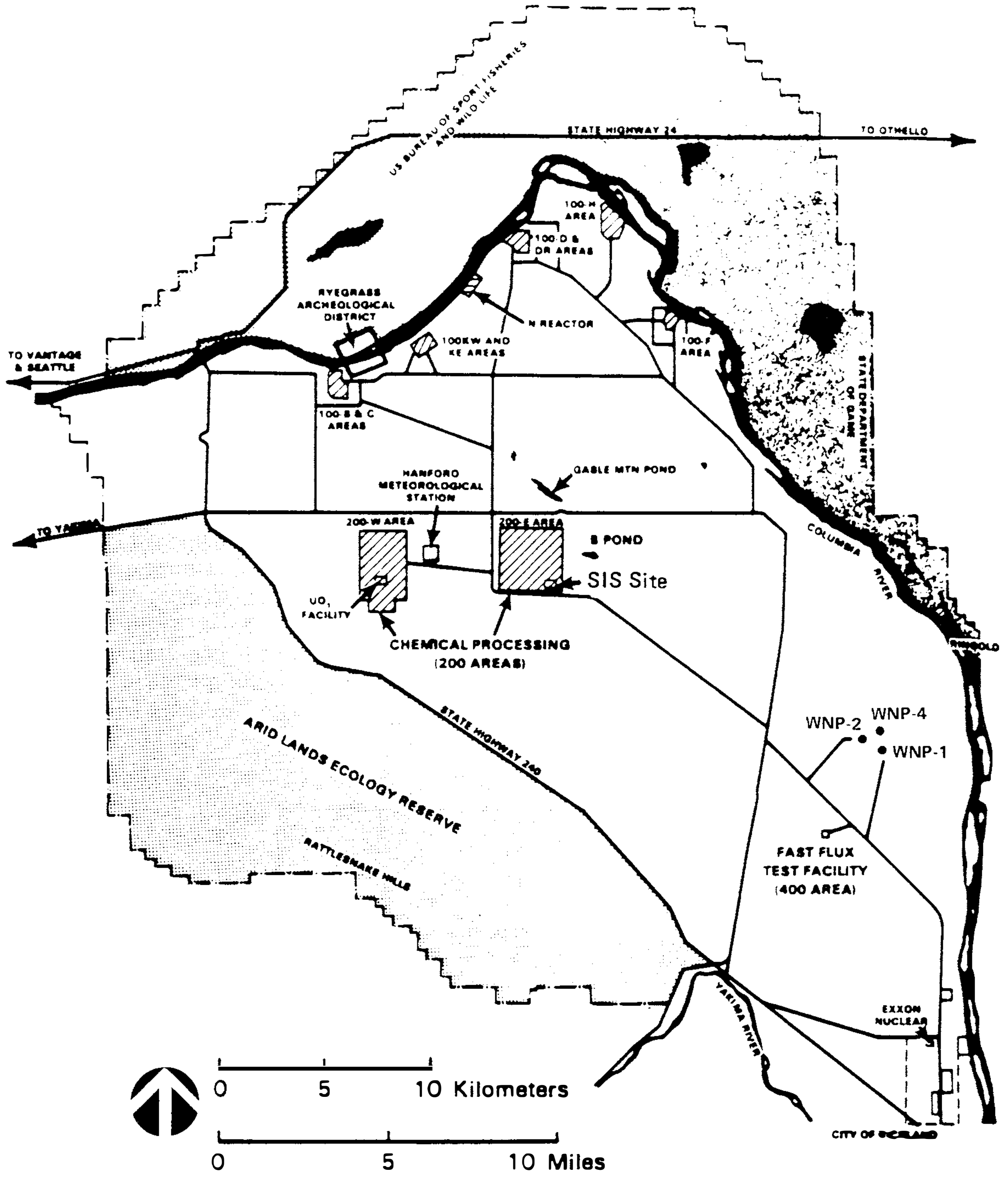
The Hanford Site is located in parts of Benton, Grant, and Franklin counties (Figure 3-15). The Columbia River flows through the northern part of the site and forms part of the eastern boundary. The nearest major population center, Richland, Washington, with a 1980 population of 33,578 (Bureau of the Census, 1981), is about 5 kilometers (3.1 miles) south of the southernmost site boundary. Kennewick (34,387 persons in 1980) and Pasco (17,942 persons in 1980) lie to the southeast of Richland (Bureau of the Census, 1981).

The site of the proposed SIS Project is adjacent to the existing Plutonium Uranium Extraction (PUREX) facility (200-East Area) and is approximately 16 kilometers (10 miles) west of the Columbia River and 32 kilometers (20 miles) northwest of the City of Richland (PNL, 1987). No resident populations are located within 16 kilometers (9.9 miles) of the proposed site. The estimated 1980 population within an 80-kilometer (50-mile) radius of the Hanford 200-Areas (i.e., measured from the Hanford Meteorological Station) was 341,000 and included persons residing in Adams, Kittitas, Klickitat, Walla Walla, and Yakima Counties in addition to those counties in which portions of the Hanford Site are located (DOE, 1986c). The 1980 population density within the 80-kilometer (50-mile) radius was about 17 persons per square kilometer, which is less than the national average of about 25 persons per square kilometer.

3.2.2 Regional and Site Activities

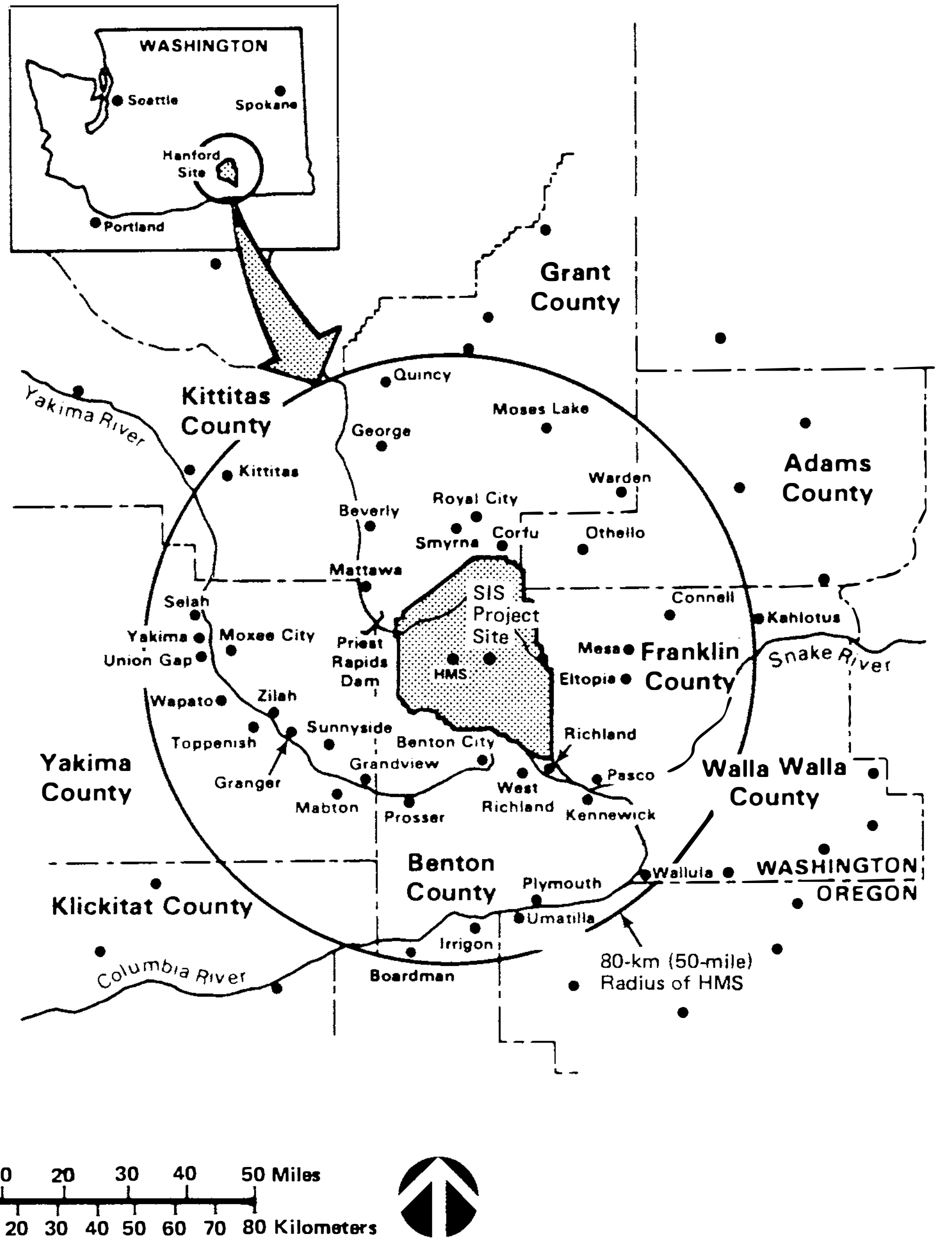
In 1983, about 13,000 persons worked on DOE-related programs at the Hanford Site, and another 2100 persons were employed at the site by the Washington Public Power Supply System (WPPSS). Estimated Hanford Site employment in September 1986 was 14,315 persons (PNL, 1987). Recent suspension of the characterization studies for potentially locating a geologic repository at the Hanford Site and the placement of N-Reactor in cold-standby status is estimated to result in the loss of approximately 4425 jobs at the Hanford Site by FY 1991. Approximately 650 jobs associated with Defense Waste Programs are projected to be created by FY 1991, resulting in a projected net decrease of 3775 employees at the Hanford Site.

More than 90 percent of the Hanford Site employees reside in Benton and Franklin Counties, and approximately 8 percent of the employees reside in Yakima County. Because of the predominance of employees residing in Benton



Source: DOE (1986c).

Figure 3-14. Hanford Site.



HMS = Hanford Meteorological Station

Source: DOE (1986c).

Figure 3-15. Hanford Site Regional Area.

and Franklin Counties, these two counties are considered to be the primary impact area with respect to potential socioeconomic effects.

Major industrial facilities in the Hanford Site region include a meat-packing plant, food-processing facilities, fertilizer plants, a pulp and paper mill, a chemical plant, and small manufacturing firms. Agriculture also provides major support to the regional economy and includes a variety of dryland and irrigated crops. Major roads in the region are State Highways 12, 24, and 240, Interstate Highways I-82 and I-182, and U.S. Highways 12 and 395. Commercial traffic on the Columbia River is available, as the upper limit of navigation is the north Richland dock (DOE, 1986c).

Portions of the Hanford Site were designated a National Environmental Research Park in 1977. Access to the site is limited and restricted. Facilities on the Hanford Site include the N-Reactor, the Fast Flux Test Facility (FFTF), a fuel fabrication plant, the PUREX facilities, waste management facilities, nuclear materials storage, and research laboratories. Site commercial activities include an operating commercial nuclear power station and a privately operated low-level-waste burial area.

3.2.3 Socioeconomics and Historic Resources

A comprehensive description of socioeconomic and community characteristics is contained in the referenced documents listed in Section 3.2. Appendix B of this EIS provides the most recent demographic, economic, and tourism information for the Hanford Site region. The following sections summarize these data as well as present a discussion of historic and archeological resources.

3.2.3.1 Demography

The area utilized for socioeconomic impact assessment consists of two counties: Benton and Franklin. This area is also known as the Richland-Pasco-Kennewick Standard Metropolitan Statistical Area (SMSA).

The 1980 census population estimate of the SMSA was 144,469. This represented a 55-percent increase from 1970, which compares to a 21-percent increase for the State of Washington, and an 11-percent increase for the United States during the same period. Estimates of population for 1986 show a 4-percent increase to 149,500 for the SMSA. The State of Washington experienced an 8-percent increase and the United States a 6-percent increase during the same time period.

The median age in 1980 for the SMSA was 25.7 years in Benton County and 24.5 in Franklin County. The median ages for the State of Washington and the United States were 27.5 and 30.0, respectively. In the SMSA, the under-5 age group made up 12 percent of the 1980 population and had grown 46 percent since 1970. The 5-to-17 age group had grown 1 percent since 1970 and represented 24 percent of the 1980 population. The largest age group in the SMSA was the 18-to-65 age group, which made up 57 percent of the 1980 population and which grew by 34 percent since 1970. Similar growth was experienced in the over-65 age group, but it made up only 8 percent of the 1980 population.

Population in the 80-kilometer (50-mile) Hanford Site area has been forecast in a recent DOE EIS to be about 417,000 persons in 1990 (Sommer, Rau, and Robinson, 1981) and 500,000 persons in the year 2000 (DOE, 1987b). The recent reductions in employment at the Hanford Site would result in lower forecasts of future population. For this EIS, the estimated year-2010 population residing within an 80-kilometer (50-mile) radius of the proposed SIS is presented for a year-2010 population of 500,000 persons (i.e., forecast for year 2000 would be the same as in the year 2010) and an upper bound (i.e., overpredicted) estimate of 709,147 persons based on the growth rate experienced by the counties surrounding the Hanford Site between 1970 and 1980. The upper bound estimate of 709,147 persons is based on the same methodology as the upper bound estimate of population surrounding the INEL to provide for direct comparability of potential upper bound population consequences.

3.2.3.2 Economy

The three industries with the largest employment in Benton and Franklin Counties in 1980 were services (26 percent), construction (13 percent), and manufacturing (12 percent). Services, retail trade, and manufacturing had the greatest percentage of employees in Washington and the United States in 1980. Agriculture (6 percent) was also an important employer in the SMSA. In the state, agriculture represented 4 percent of total employment, while nationally, it was 3 percent of employment.

The three industries paying the highest percentage of personal income in 1980 in the SMSA were services (22 percent), construction (17 percent), and manufacturing (14 percent). This percentage distribution of source of personal income had changed by 1984 to service (22 percent), manufacturing (21 percent), and government (12 percent). These same three industries also paid the highest percentage of personal income in Washington and the United States. Agriculture was also an important contributor to personal income in the SMSA, representing 4 percent of total personal income.

During the period from 1980 to 1984, personal income increased by 18 percent compared to a 22-percent increase statewide and a 35-percent increase nationally. The greatest change was in construction, with a 56-percent decline in the SMSA, reflecting the termination and suspension of construction of WPPSS commercial nuclear power plants. Finance, insurance, and real estate also showed a decline in the SMSA compared to increases for the State and the nation.

Unemployment in 1987 in the State of Washington (7.6 percent) exceeded the national rate of 7.2 percent. Both Benton and Franklin Counties had unemployment rates that exceeded state unemployment rates, with Franklin County having an unemployment rate of 11.5 percent and Benton County having a 9.0-percent unemployment rate.

The SMSA experienced a slight increase (5 percent) in the amount of harvested cropland between 1978 and 1982 and a slight decrease in the percentage of pastureland (1 percent). The average amount of sales per farm in 1982 was $135,321. Crop sales accounted for 84 percent of all agricultural products sold. Approximately one-quarter of the crop sales came from grains. Livestock and poultry were the other primary agricultural products.

3.2.3.3 Infrastructure

In this area, the number of housing units increased by about 94 percent from 1970 to 1982 because of increases in population and employment that accompanied the WPPSS power reactor construction. Since 1981, housing growth has declined sharply, with new-home construction being near a standstill. In 1983, there were an estimated 5000 vacant housing units in the Tri-Cities SMSA (Watson et al., 1984).

Housing vacancy rates have changed significantly since 1965 in the SMSA. Between 1965 and 1973, the average annual vacancy rate was 1.6 percent. This rose to an average 7.8 percent in the period 1973 to 1981. As the population in the area declined as a result of the WPPSS curtailment of planned commercial power units, the vacancy rate for all housing units rose accordingly. In 1983 the vacancy rate for single-family dwellings was 3.6 percent, and for multifamily dwellings, which are predominantly rental units, was 19.1 percent. These compare to homeowner vacancy rates of 2.1 percent for Washington and 1.8 percent for the United States. Rental vacancy rates were 7.3 percent and 7.1 percent for Washington and the United States, respectively.

The area is served by 12 public school districts, 9 private schools, 8 vocational schools, a community college, and the Joint Center for Graduate Study, which offers undergraduate and graduate degrees. The 1984 spring enrollment for the public schools was about 26,300 students. The number of students enrolled in public schools in Benton County has steadily declined since 1980, while modest increases in enrollments have occurred in Franklin County. In the past 4 years, two high schools and four elementary schools have been constructed and additions have been made to existing school buildings in Franklin County. In general, there is some unused public-school capacity in the Tri-Cities area.

There is a general medical and surgical hospital in each of the major municipalities, with a total of 302 licensed beds in 1984. The number of beds per 1000 population was below the national average.

The crime rate in the SMSA in 1980 was 619 crimes per 10,000 population compared to 658 per 10,000 population for the State of Washington. The number of police officers in the local police departments and the Franklin County Sheriff's Department in 1984 was 157. Information on the staffing of the Benton County sheriff's office is not available. The 1.1 police officers per 1000 population was below the national average of 2.2 police officers per 1000 population, although the number of Benton County sheriffs is not included.

Domestic water is supplied through public water supply systems in each of the incorporated communities in the SMSA. Residents in the peripheral areas frequently use individual wells. The systems in Richland and Kennewick obtain water from the Columbia River and from wells. Pasco obtains water from the Columbia River. The water treatment facilities and well fields have a capacity to serve a population of approximately 230,000, although neither the systems in Kennewick nor Richland are designed to operate at full capacity when drawing water from the river and wells.

Sewerage services are provided in the communities by the local governments. The systems in Richland, Kennewick, and Pasco have excess treatment capacity. Areas outside these communities provide their own sewerage service, usually through the use of septic systems.

3.2.3.4 Tourism

No statistics on tourism and travel are available for the SMSA. Statistics are available for the State and for the western region of the United States. A national survey in 1983 on participation in outdoor recreational activities indicates that for the western region of the United States, the most popular activities were camping, day hiking, snowskiing, and horseback riding.

Payroll and employment estimates for 1985 indicate that 5 percent of the State of Washington's employment is in the travel industry, which is equal to national employment in the travel industry. The average wage for employment in the travel industry was $11,472 in Washington, ranging from $6528 for food service employees to $31,362 for public transportation employees. Comparable national averages were $6708 and $25,560, respectively.

3.2.3.5 Historic and Archeological Resources

The National Registry of Natural Landmarks lists four historic sites within an 80-kilometer (50-mile) radius of the Hanford Site. The closest of these is the Ginkgo Petrified Forest, located in Kittitas County approximately 58 kilometers (36 miles) north-northwest of the Hanford Site. There are 10 major archeological sites on or adjoining the Hanford Site and 115 archeological sites on or adjoining the site (DOE, 1987b). Two archeological sites are located just north of the Hanford 200-Areas near Gable Mountain and Gable Butte. No sites are located within the 200-Areas. Properties on the site that may be eligible for inclusion in the <u>National Register of Historic Places</u> are the Hanford townsite and the Hanford irrigation ditch (PNL, 1987; NRC, 1982). A number of other archeological sites, which are not of national significance, have been identified on the Hanford Site (Rice, 1968a,b). Areas along the Columbia River are particularly rich in Indian artifacts.

3.2.4 Geology and Seismicity

The Hanford Site is located in the Pasco Basin (subset of the Columbia Plateau), which is bounded by the Saddle Mountains to the north, the Umtanum and Yakima Ridges to the west, and the Rattlesnake Hills to the southwest (Watson et al., 1984). The elevation of the site ranges from approximately 107 meters (350 feet) to 1090 meters (3581 feet) above mean sea level. The principal stratigraphic units underlying the basin (in ascending order) are the Columbia River Basalt Group, the Ringold Formation, and the Hanford Formation (Jamison, 1982). These units are approximately 3650 meters (12,000 feet), 305 meters (1000 feet), and 61 meters (200 feet) thick, respectively (DOE, 1983).

The Columbia River Basalt Group is composed of basaltic lava flows extruded between 16 and 6 million years ago (Tallman, 1979). The Ringold Formation is composed of fluvial sands, gravels, silts, and clays that were deposited between approximately 8.5 and 3.7 million years ago (Myers et al., 1979). The Hanford Formation unconformably overlies the older stratigraphic units and is composed of sands, gravels, silts, and clays reworked by catastrophic flooding that occurred when glacial dams to the east were breached. The collapse of these dams sent massive volumes of glacial melt water and entrained debris across eastern and central Washington. The youngest part of the Hanford Formation dates from approximately 13,000 years ago (Myers et al., 1979). Locally unconsolidated materials cover the surface of the site. These materials include alluvium, colluvium, and loess.

The Pasco Basin is historically an area of low seismicity (DOE, 1983; NRC, 1982). Although faults have been detected within the basin, none have a proven earthquake-generating potential (NRC, 1982). The largest seismic shock ever recorded in the basin was one that registered V to VI on the Modified Mercalli Intensity (MMI) scale (approximate Richter magnitude of 4.5 to 5.0) that occurred November 1, 1918, near Corfu, about 35 kilometers (22 miles) north of the center of the Hanford Site (Coffman and Von Hake, 1973).

The largest reported earthquake to occur within the larger Columbia Basin was centered near Milton-Freewater, Oregon, about 85 kilometers (53 miles) southeast of the Hanford Site; it had an MMI of VII and a peak acceleration of about 0.10g. Because this seismic event could not be linked to a particular fault or tectonic structure, it was assumed that an event of similar magnitude could occur again anywhere within the basin (DOE, 1986b). Therefore, this event was chosen as the Hanford Regional Historic Earthquake and was used to calculate the operating-basis and safe-shutdown earthquakes (Blume and Associates, 1981).

3.2.5 Hydrology

The major surface-water features near the Hanford Site are the Columbia and Yakima Rivers. The Columbia River flows through the northern part of the site at an average rate of 3400 cubic meters per second (120,000 cubic feet per second); the historic maximum flow of 21,000 cubic meters per second (740,000 cubic feet per second) occurred in 1894 (DOE, 1983). The Probable Maximum Flood (i.e., the flood discharge that may be expected from the most severe combination of meteorologic and hydrologic conditions reasonably possible in the region) calculated for the Columbia River would produce a flowrate of 40,000 cubic meters per second (1,400,000 cubic feet per second), although the flowrate that would occur due to a 50-percent breach in the Grand Coulee Dam is estimated to be 227,000 cubic meters per second (8,000,000 cubic feet per second) (DOE, 1987b). The Yakima River flows along the southern border of the Hanford Site at an average annual rate of approximately 3.2×10^9 cubic meters per year (1.1×10^{11} cubic feet per year). The flowrate of this river is approximately 3 percent of the annual average flow for the Columbia River, which is 1.1×10^{11} cubic meters per year (4×10^{12} cubic feet per year).

The discharge of waste waters from the 200-Areas has formed a number of ponds and streams. These include U-, B-, and Gable Mountain Ponds, and Dry Creek, Cold Creek, and Rattlesnake Springs. U-Pond has been decommissioned, and Gable Mountain Pond is currently being decommissioned. B-Pond is being expanded and a new contingency pond constructed near it.

Dry Creek and Cold Creek are ephemeral streams that drain into the Yakima River. Rattlesnake Springs, on the other hand, is a small stream that flows along the western part of the site for about 3 kilometers (2 miles) before evaporation and infiltration cause it to disappear.

Ground water beneath the Hanford Site lies at a depth of about 46 to 90 meters (150 to 330 feet) below the ground surface. The water occurs in an unconfined aquifer that is over 70 meters (230 feet) thick in some areas but that pinches out along the flanks of Gable Mountain and Gable Butte (DOE, 1983). Natural recharge in the vicinity of the 200-Areas is small, with the ground-water flow direction generally being east toward the Columbia River.

Recharge of the ground water due to waste waters discharged from the 200-Areas has locally raised the water-table elevation approximately 24 meters (79 feet) over the past 35 years (DOE, 1983). Decommissioning of U-Pond and Gable Mountain Pond and the expansion of B-Pond will likely alter the water-table elevation in the 200-Areas.

3.2.6 Meteorology and Climatology

The Hanford Site is located in a semiarid region where the climate is characterized by relatively cool mild winters and long warm summers. Average monthly temperatures at the site span from 0.5°C (32.9°F) in January to 24.7°C (76.5°F) in July (PNL, 1987). The annual average relative humidity is 54 percent and is usually higher in winter (about 75 percent) than in summer (about 35 percent) (PNL, 1987).

The Cascade Mountains west of the Hanford Site greatly influence the local climatology by acting as a natural barrier to Pacific Ocean storm systems. This contributes to the site's relatively low average annual precipitation of approximately 15.9 centimeters (6.25 inches) (PNL, 1987).

Prevailing winds are from the northwest, with average monthly wind speeds ranging from 2.7 meters per second (6.1 miles per hour) in November and December to 4.1 meters per second (9.2 miles per hour) in June (DOE, 1986c).

The Hanford Site is in an area where severe weather occurs relatively infrequently. Thunderstorms occur in the site area an average of 10 times per year and tornadoes, which tend to be less severe in the northwestern portion of the United States, have an estimated annual probability of 4.22×10^{-6} of striking at the site (DOE, 1986c).

3.2.7 Ecology

The Hanford Site is referred to as a shrub-steppe environment because of its general similarity to the steppeland of central Asia (ERDA, 1975). Vegetation within the site can be divided into eight major shrub-steppe communities, with the sagebrush/cheatgrass or sandberg bluegrass community being the predominant type. The two communities are those found within the 200-East Area.

More than 300 species of insects, both terrestrial and aquatic, have been found on the Hanford Site (ERDA, 1975). Insects consume large amounts of plant material and are a major source of food for other animals. Both darkling beetles and grasshoppers are abundant on the 200-Area Plateau (PNL, 1987).

Though 16 species of amphibians and reptiles have been observed at the Hanford Site, only 9 species of reptiles and 4 species of amphibians have been found on the 200-Area Plateau (PNL, 1987). The side-blotched lizard, the green racer, and the gopher snake are the most abundant reptiles. The rattlesnake is present but not abundant.

More than 125 species of birds have been observed on the 200-Area Plateau (PNL, 1987). The sage sparrow, horned lark, and western meadowlark are the most abundant shrub-steppe nesting birds. Ponds in the 200-Area Plateau provide important habitat for songbirds, shorebirds, ducks, and geese (DOE, 1986c).

A total of 39 species of mammals, including 12 species of bats, are found on the Hanford Site (PNL, 1987). The Great Basin pocket mouse is the most abundant mammal. Mammals reported from around waste-water ponds include mule deer, raccoons, and muskrats (ERDA, 1975; DOE, 1986c). The coyote is the most important mammalian predator on the Hanford Site.

The Columbia River is the most significant aquatic resource in the vicinity of the Hanford Site. Forty-five species of fish have been identified from the Hanford Reach, including three economically important species of Pacific salmon and steelhead trout (PNL, 1987). A detailed discussion of the migratory habits of these species is presented in ERDA (1975).

No federally listed endangered or threatened plants are found on the Hanford Site. However, two species that are candidates for future listing do occur on the site. Astragalus columbianus occurs on dryland beaches along the Columbia River near Priest Rapids Dam, whereas Rorippa calycina has been found along the Hanford Reach of the Columbia River. A third candidate species, Arenaria franklinii var. thompsonii, which inhabits sand dunes, has not been found on the site to date (PNL, 1987).

Three animal species listed as endangered or threatened by the U.S. Fish and Wildlife Service occur in the State of Washington (PNL, 1987). The peregrine falcon does not nest on the Hanford Site and would only be expected as a casual migrant. The bald eagle is a regular winter resident, but does not nest on the site. Over the past 20 years, the number of bald eagles wintering along the Hanford Reach of the Columbia River has increased from less than 10 to about 35. The Oregon spotted butterfly has not been observed on the site and its status is not known.

Plant species that are listed by the Washington State Natural Heritage Program as sensitive and that probably occur on the site include Erigeron piperianus, Chaenactis douglasii var. glandula, Cryptantha leucophaea, Cyperus rivularis, and Lindernia anagallidea. The first three are dryland species, whereas the latter two may be found along the shoreline of the Columbia River.

Endangered animals listed by the State of Washington Department of Game that are known to occur or have a potential to occur on the Hanford Site include the American white pelican, sandhill crane, American peregrine falcon, Merriam's shrew, pallid bat, and long-eared bat. Listed threatened animal species include the bald eagle, ferruginous hawk, and pygmy rabbit. An additional 10 animal species are listed as sensitive in Washington.

3.2.8 Background Radiation

The calculated annual natural background radiation dose to an average individual in the vicinity of the Hanford Site is approximately 100 millirem, of which 75 millirem external dose is from cosmic and natural radiation sources and 25 millirem internal dose is from naturally occurring radionuclides (DOE, 1983). This 100-millirem-per-year dose may be compared to the 144-millirem-per-year figure for the INEL as shown in Table 3-3. The other major sources of radiation exposure would be the same as those presented in Table 3-3. The average annual dose to a member of the general population from Hanford Site defense operations is in the range of 0.01 to 0.8 millirem (DOE, 1986c). The radioactivity released to the environment from Hanford Site operations results in only 0.36 percent of the total annual background dose of about 217 millirem (i.e., 100 millirem natural background radiation, 92 millirem from medical radiation, and 25 millirem from consumer and industrial products).

3.3 CHARACTERIZATION OF THE SAVANNAH RIVER PLANT

The following sections briefly describe the Savannah River Plant (SRP) and surrounding region. More detailed descriptions of the SRP environment are available in ERDA (1977b) and DOE (1982b, 1984b, 1987a, and 1987e).

3.3.1 Site Location and Regional Population

The SRP was established in the 1950s for the production of nuclear materials for national defense. Facilities at the SRP include five nuclear production reactors (three of which are currently operating), two chemical separations areas, a fuel and target fabrication facility, and various support facilities. The SRP is located in portions of three South Carolina counties: Aiken, Allendale, and Barnwell.

The SRP is located in southwestern South Carolina. The plant occupies an almost circular area of about 780 square kilometers (300 square miles), and is bounded on its southwestern side by the Savannah River, which is also the Georgia-South Carolina border. The SIS Project would be located to the northwest of F-Area, which is situated in the north-central portion of the plant (Figure 3-16). No resident human populations are located within about a 9-kilometer (5.5-mile) radius of the proposed project site.

The major population centers closest to the SRP site are Augusta, Georgia, about 37 kilometers (23 miles) to the northwest; Aiken, South Carolina, about 27 kilometers (17 miles) to the north; and Barnwell, South Carolina, about 10 kilometers (6 miles) to the east. Of the 31 incorporated communities in the six counties surrounding the SRP (Aiken, Allendale, Bamberg, and Barnwell counties in South Carolina and Richmond and Columbia counties in Georgia), 16 have populations of fewer than 1000 persons, and 11 have populations between 1000 and 5000 persons. Aiken, Columbia, and Richmond counties, which comprise the SMSA, had a combined population of 327,400 in 1980, most of which resided outside the cities or towns (DOE, 1984b).

In 1980, the estimated population within a radius of 80 kilometers (50 miles) around the SRP was approximately 563,300 persons.

3.3.2 Regional and Site Activities

The operating and construction workforce at the SRP has averaged 7500, ranging from a low of 6000 in the 1960s to about 16,700 in June 1988. About 97 percent of this total are employed by the site operating and construction contractor and its subcontractors.

The greatest percentage of employees reside in the six-county area of Aiken, Allendale, Bamberg, and Barnwell Counties in South Carolina, and Columbia and Richmond Counties in Georgia. Together, these six counties house approximately 89 percent of the total SRP workforce. Currently, DOE is constructing the Defense Waste Processing Facility. The Defense Waste

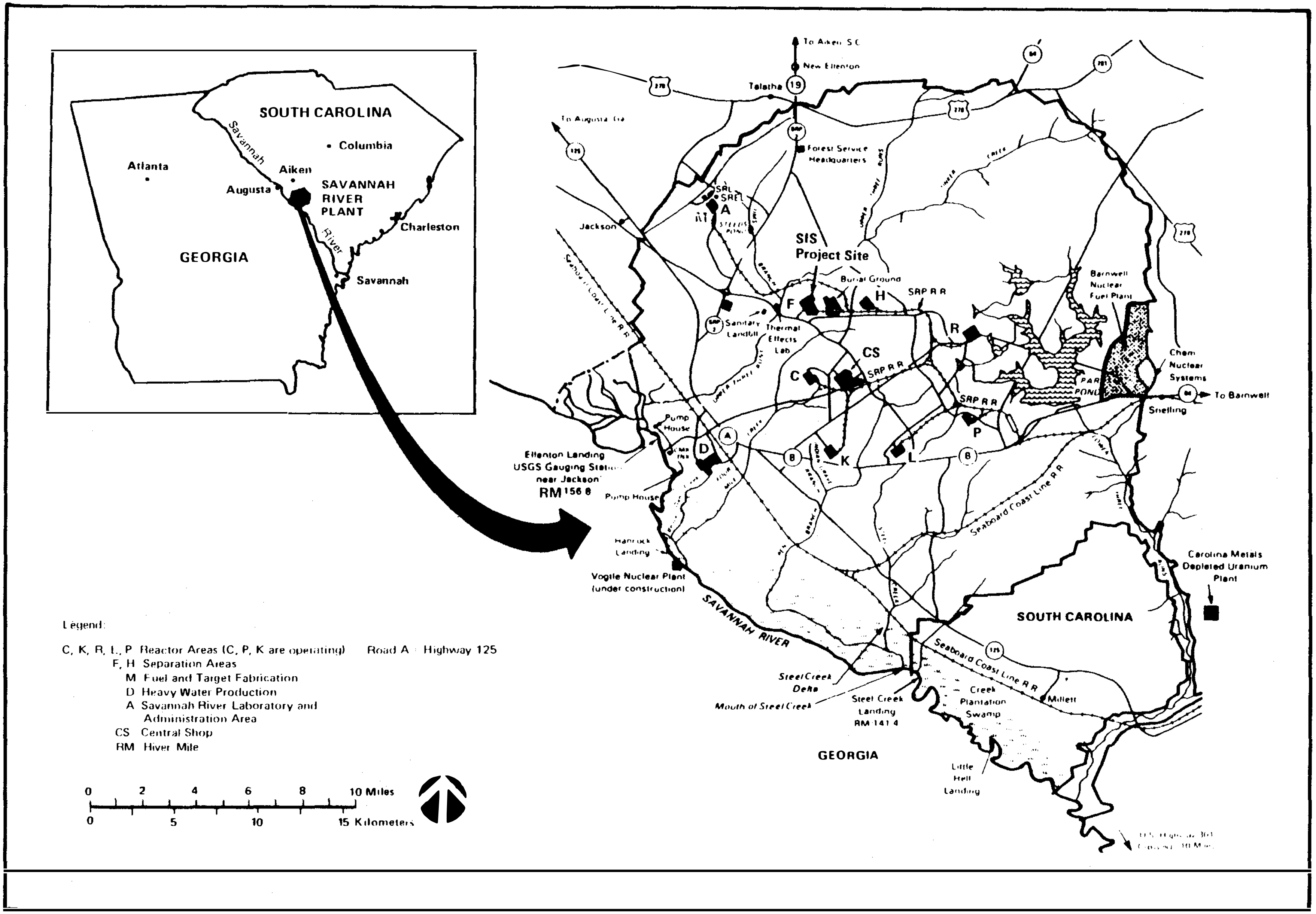


Figure 3-16. Savannah River Plant.

Processing Facility will immobilize high-level radioactive waste into a solid, nonleachable borosilicate glass waste form. Recently, the Naval Reactor Fuel Material Facility, which will produce nuclear fuel for the U.S. Navy, began operation.

Less than 8 percent of the existing land in the six-county area surrounding the SRP is devoted to urban and developed uses that are concentrated primarily in and around the cities of Augusta and Aiken. Nearly 21 percent of the total land use is agriculture; forest, water bodies, and unclassified lands that are predominantly rural constitute about 70 percent of total land use (DOE, 1987e).

The SRP is a controlled area with public access limited to through traffic on South Carolina Highway 125 (SRP Road A), U.S. Highway 278, and SRP Road 1. Less than 5 percent of the total SRP land area is used by facilities engaged in the production of defense nuclear materials. The remaining area is composed of reservoirs, ponds, natural vegetation, and pine plantations that are managed by the U.S. Forest Service under a cooperative agreement with DOE (DOE, 1984b). The SRP was designated a National Environmental Research Park in 1972.

3.3.3 Socioeconomics and Historic Resources

A comprehensive description of socioeconomic and community characteristics was completed in 1984 for the six-county area, in which 89 percent of the SRP workforce resides (DOE, 1987e). Appendix B of this EIS provides the most recent demographic, economic, and tourism information for the SRP region. The following sections summarize these data as well as present a discussion of historic and archeological resources.

3.3.3.1 Demography

The 1980 population of the six-county area was 376,058. This was an 18-percent increase from 1970, which compares to a 19-percent increase for the State of Georgia, a 21-percent increase for the State of South Carolina, and an 11-percent increase for the United States during the same period. Estimates of population for 1986 show a 12-percent increase over the 1980 population to 419,500 for the six-county area. The State of Georgia also experienced a 12-percent increase in population between 1980 and 1986, South Carolina an 8-percent increase, and the United States a 6-percent increase.

The median age in 1980 for the six counties ranged from 26.6 years in Bamberg County to 29.5 in Aiken County. The median ages for the States of Georgia and South Carolina were 28.6 and 28.0, respectively, compared to the national median age of 30.0. In the six-county area, the under-5 age group made up 8 percent of the 1980 population and had grown 5 percent since 1970. The 5-to-17 age group declined 2 percent between 1970 and 1980 and represented 22 percent of the 1980 population. The largest age group constituted those between the ages of 18 and 65, who made up 61 percent of the 1980 population and grew by 26 percent since 1970. The over-65 age group experienced a 48-percent growth and made up 9 percent of the 1980 population.

Forecast population within an 80-kilometer (50-mile) radius of the SRP for the year 2010 is predicted to range from 756,000 persons to 1,086,888 persons (based on 1970 and 1980 county growth rates) lying wholly or partially within the 80-kilometer radius between 1970 and 1980. The Bureau of Census' estimated 1980 and 1986 populations for the six counties that are the principal places of residence for SRP employees indicate that the population growth within an 80-kilometer radius of the SRP is still occurring at a rate similar to that experienced between 1970 and 1980. In this EIS, the estimated radiological doses to the population from SIS Project routine emissions are presented for each of these year-2010 population projections in Appendix A.

3.3.3.2 Economy

The three industries with the largest employment in the six-county area in 1980 were services (24 percent), manufacturing (21 percent), and retail trade (12 percent). These same three industries were the largest employers in Georgia, South Carolina, and the United States. The three industries paying the highest percentage of personal income in 1980 were manufacturing (32 percent), government (27 percent), and services (25 percent). These same three industries also paid the highest percentage of personal income in Georgia, South Carolina, and the United States.

Between 1970 and 1980, the six-county area experienced a 41-percent increase in total employment, from 72,732 to 102,326. Employed residents of Richmond and Aiken Counties accounted for about 77 percent of the study area's employed population in 1980. Unemployment in 1986 in Georgia (6.5 percent) and South Carolina (6.8 percent) were both below the national rate of 7.2 percent. The unemployment rates for the six counties ranged from a low of 3.9 percent in Columbia County to 10.1 percent in Allendale County.

The six-county area had about 561,600 acres of farmland in 1982, a decline of about 6 percent from 1978. The average size of a farm in 1984 ranged from 179 acres in Richmond County to 842 acres in Allendale County. The average amount of sales per farm in the six-county area in 1982 was $41,658. Crop sales in the six-county area in 1982 made up 61 percent of all agricultural products sold. Approximately two-fifths of the crop sales were derived from grain sales. Livestock and poultry were the other predominant agricultural products.

3.3.3.3 Infrastructure

The vacancy rate for owner-occupied housing units for the six-county area in 1980 was 2.3 percent. Individual county rates ranged from 3.6 percent in Columbia County to 0.8 percent in Barnwell County. Vacancy rates for rental units in 1980 ranged from 14.8 percent in Columbia County to

7.1 percent in Bamberg County; the rate in 1980 for the SRP area was 10.5 percent. Since 1970, the largest increases in the number of housing units have occurred in Columbia, Richmond, and Aiken Counties. Columbia County has grown the fastest, more than doubling its number of housing units since 1970. Between 1970 and 1980, Aiken and Richmond Counties both experienced about a 36-percent increase in the number of housing units. In Aiken County, one-fourth of this increase resulted from the high growth rate in the number of mobile homes (DOE, 1984b).

There are nine public school systems in the SRP six-county area. Public school enrollment in the 1982-1983 school year was 69,006. An estimated total of 3642 additional students could have been accommodated in these school systems. Six public or private colleges or universities are also located within the area.

There were eight general medical and surgical hospitals in the six-county area containing 2441 licensed beds in 1982. This is 6.5 beds per 1000 population, which is above the national average of 4.4 beds per 1000 population. Occupancy of the beds ranged from 40 percent to 76 percent and averaged 58 percent. In 1982, the 21 nursing homes and intermediate-care facilities had 1713 licensed beds.

The six-county area had 1004 licensed physicians in 1982. The American Academy of Family Practitioners has established a desired ratio of 0.5 direct primary care physician per 1000 population. The national averages for physicians in 1977 were 0.99 physician per 1000 population for counties with a city of over 10,000 population and 0.56 physician in counties with no city over 10,000. The six-county area had an average of 2.7 physicians per 1000 population. Of the two counties with a city over 10,000 population, Aiken County was below the national average (0.9 physician per 1000), and Richmond County (4.3) exceeded the national average. All of the other four counties, Allendale (0.7), Bamberg (1.0), Barnwell (0.8), and Columbia (2.4) were above the national average for counties without a city of greater than 10,000 population. All counties were above the desired ratio of the Academy.

The six-county area has an excellent public safety record. Five of the six counties are below the national averages for violent and property crimes. In 1982, the violent crime rate in the six-county area ranged from 15.2 per 10,000 population in Columbia County to 109.3 per 10,000 population in Allendale County. Georgia had 49.4 and South Carolina 73.9 per 10,000 population; the national rate was 56.7. The property crime rate ranged from 161.6 per 10,000 population in Barnwell County to 565.0 in Richmond County. Georgia and South Carolina had 488.9 and 476.2 per 10,000 population, respectively. The national average was 510.8 per 10,000 population.

There were 649 local police officers and 55 state police officers in the six-county area in 1980. This is 2.0 police officers per 1000 population. Nationally, there are 2.2 police officers per 1000 population, with 84 percent members of local forces.

Domestic water is supplied through 120 public water supply systems in the six-county area. Thirty of these systems are county or municipal systems that serve about 75 percent of the population. All but four of the county and municipal systems obtain their water from deep wells. The four systems use surface water. All of the systems except one have sufficient capacity to accommodate future growth. Areas outside the communities supply their own water from privately owned wells.

Sewerage services are provided in the communities by the local governments. All systems have excess capacity or have plans to expand to meet future demand. Areas outside the communities' service areas provide their own sewerage service.

3.3.3.4 Tourism/Recreation

Although no statistics on tourism and travel are available for the six-county region, statistics are available for South Carolina and the southern region of the United States. A survey of travelers in South Carolina in 1986-87 indicated the primary purposes of their trips were pleasure (46 percent) and to visit friends and relatives (26 percent). These compare to national statistics of 32 percent and 37 percent, respectively. Based on a national survey in 1983 on participation in outdoor recreational activities in the United States, the most popular activities in the southern region were fishing, hunting, and water skiing.

Based on payroll and employment estimates for 1985, 4 percent of Georgia and 6 percent of South Carolina employment is in the travel industry, compared to 5 percent for the nation. The average wage in the travel industry was $10,264 in Georgia, $8072 in South Carolina, and $10,926 in the nation. In Georgia, average wages ranged from $6665 for food service employees to $30,957 for public transportation employees. Comparable South Carolina and national averages were $6100 and $6708, respectively, for food service employees, and $18,286 and $25,560, respectively, for public transportation employees.

3.3.3.5 Historic and Archeological Sites

As of February 1986, 76 sites in the six-county area were listed in the National Register of Historic Places. Richmond County had the largest number of sites (27), most of which are in the City of Augusta. Thirty-five National Register sites are in Aiken and Allendale Counties. The remaining 14 sites are scattered throughout the remaining three-county area (DOE, 1987a).

Detailed lithologic and paleontologic studies have been in progress at the SRP since 1984 as part of an overall environmental program (Laws, Harris, and Zullo, 1987). Most of this work has been performed by the Savannah River Laboratory of E. I. du Pont de Nemours & Company or other contractors to the DOE, including collaboration with scientists from several universities. To date, much of these data have not been released or published.

Biostratigraphic analyses of selected samples from three SRP wells showed an absence of calcareous nannofossils, foraminifera, and ostracods; palynomorphs (dinoflagellates, pollen, and spores) were present but not abundant (EGC, 1988). Based on palynostratigraphic analysis of 28 samples from a single well (315 to 1065-foot interval), several geologic ages were interpreted, including Eocene, Paleocene, Maestrichtian, Campanian, and Santonian. Although the paleontology of each geologic age varied markedly, some of the more common fossil biota included mixed assemblages of pollen, dinoflagellates, linings from the chambers of microforaminifera, fungi, and algae. Terrestrial forms included *Taxodium* sp., *Cicatricosisporites dorogenesis*, *Quercus* sp., *Liliacidites* sp., *Sphagnumsporites* sp., and *Nyssapollenites* sp. (EGC, 1988).

Other investigators have addressed various aspects of the paleontology of the Savannah River region. These investigators include Laws, Harris, and Zullo, 1987; Harris and Zullo, 1988; Fallaw et al., 1988; Lucas-Clark, 1988; and Lawrence, 1988.

3.3.4 Geology and Seismicity

The SRP is located in the Aiken Plateau physiographic division of the Upper Atlantic Coastal Plain province of South Carolina (Cooke, 1936; Du Pont, 1980). The center of the SRP is about 40 kilometers (25 miles) southwest of the Fall Line (Davis, 1902), which separates the Atlantic Coastal Plain province from the Piedmont province. The Aiken Plateau slopes from an elevation of approximately 200 meters (652 feet) at the Fall Line to an elevation of about 75 meters (245 feet) to the southeast. Relief on the Aiken Plateau is as much as 90 meters (295 feet) locally (Siple, 1967). Because of the SRP's proximity to the Piedmont province, it has somewhat more relief than the near-coastal areas, with onsite elevations ranging from 27 to 128 meters (89 to 419 feet) above mean sea level.

Coastal Plain sediments in South Carolina range in age from Cretaceous to Quaternary; they form a seaward-dipping and thickening wedge of mostly unconsolidated sediments. Near the center of the SRP, these sediments are approximately 280 meters (918 feet) thick (Siple, 1967). The base of the sedimentary wedge rests on a Precambrian and Paleozoic crystalline basement, which is similar to the metamorphic and igneous rocks of the Piedmont, and on the siltstone, claystone, and conglomerates of the down-faulted Dunbarton Triassic Basin (Stephenson, Talwani, and Rawlins, 1985). Immediately overlying the basement are the Middendorf/Black Creek Formations (175 meters or 573 feet thick) which are of Upper Cretaceous age and are composed of water-bearing sands and gravels separated by prominent clay units. Overlying the Middendorf/Black Creek Formations is the Paleocene-age Ellenton Formation, which is about 18 meters (59 feet) thick and consists of sands and clays interbedded with coarse sands and gravel. The Congaree, McBean, Barnwell, and Hawthorn Formations comprise the rest of the Tertiary (Eocene and Miocene) sedimentary section, which is about 85 meters (279 feet) thick and consists predominantly of clays, sands, clayey sands, and sandy marls.

The down-faulted Dunbarton Triassic Basin, which underlies the SRP, contains several interbasinal faults. However, the sediments overlying these faults show no evidence of basin movement since their deposition during the Cretaceous Period (Siple, 1967; Marine, 1976; Du Pont, 1980). Other Triassic-Jurassic basins have been identified in the Coastal Plain province of South Carolina and Georgia; these features are associated with the South Georgia Rift (Du Pont, 1980; Popenoe and Zietz, 1977; Daniels, Zietz, and Popenoe, 1983). The Piedmont, Blue Ridge, and Valley and Ridge provinces, which are associated with Appalachian mountain building, are northwest of the Fall Line. Several fault systems occur in and adjacent to the Piedmont and the Valley and Ridge provinces; the closest is the Belair Fault Zone, about 40 kilometers (25 miles) from the plant, which is not capable of generating major earthquakes (Case, 1977). Surface mapping, subsurface boring, and geophysical investigations at the plant have not identified any faulting of the sedimentary strata that would have an effect on SRP facilities.

Two major earthquakes have occurred within 300 kilometers (186 miles) of the SRP: the Charleston earthquake of 1886, which had an epicentral MMI of X and which occurred about 145 kilometers (90 miles) away; and the Union County, South Carolina, earthquake of 1913, which had an epicentral shaking of MMI VII to VIII and which occurred approximately 160 kilometers (99 miles) away (Langley and Marter, 1973). An estimated peak horizontal acceleration of 0.07g was calculated for the site during the 1886 earthquake (Du Pont, 1982).

On June 8, 1985, a minor earthquake with a local Richter scale magnitude of 2.6, an MMI of III, and a focal depth of 0.96 kilometer occurred at the plant. The epicenter was just west of C- and K-Areas. Seismic alarms at the plant that were set to detect accelerations as small as 0.002g were not triggered.

3.3.5 Hydrology

The Savannah River is the principal surface-water system near the SRP. It adjoins the plant along its southwestern boundary. Within the plant area, a swamp lies in the floodplain along the Savannah River for a distance of about 16 kilometers (9.9 miles); its average width is about 2.4 kilometers (1.5 miles). A small natural levee has built up along the north side of the river from sediments deposited during periods of flooding (DOE, 1987e).

Streamflow in the Savannah River is regulated by five large reservoirs upriver of the SRP: Thurmond Lake, Russell, Hartwell, Keowee, and Jocassee. The average flow of the river has been stabilized by these reservoirs to 295 cubic meters per second (10,415 cubic feet per second) near the SRP (DOE, 1984b). Natural discharge patterns in the Savannah River are cyclic; maximum river flows typically occur in the winter and spring; and the lowest flows occur in the summer and fall.

The SRP is drained almost entirely by six streams: Upper Three Runs Creek, Four Mile Creek, Beaver Dam Creek, Pen Branch, Steel Creek, and Lower Three Runs Creek. These streams originate on the Aiken Plateau and descend 30 to 60 meters (98 to 197 feet) before discharging to the Savannah River.

Routine analyses of samples from onsite stream locations since 1973 indicate that SRP discharges have complied with State of South Carolina water classification standards except for those streams receiving thermal discharges--discharges in which temperature and occasionally dissolved oxygen standards are exceeded (DOE, 1987e).

The Savannah River upstream from the SRP supplies municipal water for Augusta, Georgia, and North Augusta, South Carolina. Downstream, the Beaufort-Jasper Water Authority in South Carolina (River Mile 39.2) withdraws about 19,700 cubic meters per day (695,700 cubic feet per day) to supply domestic water for a population of about 51,000. The Cherokee Hill Water Treatment Plant at Port Wentworth, Georgia (River Mile 29.0), withdraws about 116,000 cubic meters per day (4,100,000 cubic feet per day) to supply a business-industrial complex near Savannah, Georgia, that has an estimated consumer population of about 20,000 (DOE, 1984b). Expansions of both systems are planned for the future (i.e., Beaufort-Jasper Water Authority to supply domestic water to 117,000 people and Cherokee Hill Water Treatment Plant to supply a domestic equivalent of 200,000 people in the year 2000).

Three distinct hydrogeologic systems underlie the SRP: (1) the Coastal Plain sediments, where ground water occurs in porous sands; (2) the crystalline metamorphic rock beneath the Coastal Plain sediments, where ground water occurs in small fractures in schist, gneiss, and quartzite; and (3) the Dunbarton Basin within the crystalline metamorphic complex, where ground water occurs in intergranular spaces in metamudstones and sandstones. The latter two systems are relatively unimportant as ground-water sources near the plant (DOE, 1987a).

The Coastal Plain sediments at the SRP are composed of (in ascending order) the Middendorf/Black Creek Formations, Ellenton, Congaree, McBean, Barnwell, and Hawthorn (Upland unit equivalent) Formations as defined by Siple (1967).

The Middendorf/Black Creek hydrostratigraphic units, which are 170 to 250 meters (557 to 820 feet) thick at the SRP, are the most important aquifers in the vicinity of the SRP. At the plant, these two units are separated by a clay layer, or aquitard, which impedes movement of ground water between the two aquifers. The lower aquifer (Middendorf) consists of about 90 meters (295 feet) of medium-to-coarse sand; the overlying aquifer (Black Creek) consists of about 45 meters (147 feet) of well-sorted medium-to-coarse sand. Beneath the SRP, these two aquifers join only by way of wells that withdraw water from both permeable zones.

The upper Middendorf/Black Creek clay unit and the Ellenton clays form an aquitard over most of the SRP. In some areas, the Ellenton and the upper Middendorf/Black Creek sands appear to be connected hydrologically.

The Congaree is another important local aquifer. Locally, only the Middendorf/Black Creek exceeds the Congaree's water-producing potential. The Congaree's intermediate depth also makes it attractive for water wells. An extensive clay layer at the base of this unit forms a confining bed that separates the permeable sands of the Congaree hydrologically from the sands in the underlying Ellenton and Middendorf/Black Creek units. The green clay, a marker bed at the top of the Congaree, exhibits a very low hydraulic conductivity; therefore, it is a significant aquitard, particularly south and east of Upper Three Runs Creek. The SRP does not withdraw large quantities of ground water from the McBean, Barnwell, and Hawthorn Formations, or from stream valley alluvium deposits (DOE, 1987a).

In F-Area the Middendorf/Black Creek Formations are under confined conditions, with potentiometric levels greater than those in the overlying Congaree aquifer. This is because water in the Congaree Formation is under semiconfined conditions due to drawdown of the head in the unit by natural discharge. The result of this situation is that water passing through the Ellenton aquitard moves from the Middendorf/Black Creek Formations into the Congaree aquifer, thus preventing the downward movement of contaminants into the major regional aquifer (DOE, 1987a).

Like water in the Congaree Formation, water in the McBean Formation is usually under semiconfined conditions. Only along the stream valleys does the water table occur in the McBean Formation. Under most of F-Area, the water table occurs in the Barnwell Formation at a depth of 18 meters (59 feet). The natural discharge from the water table for the SIS site would be to Upper Three Runs Creek. An extensive discussion of ground water and ground-water quality at the SRP and the F-Area is contained in DOE (1987a).

3.3.6 Meteorology and Climatology

The SRP area is located in a temperate region where the climate is characterized by mild winters and long, humid summers. The Blue Ridge Mountains, north and west of the SRP, protect the area from the more severe winters occurring in the Tennessee Valley. Average monthly temperatures at the SRP range from 7°C (44.6°F) in January to 27°C (80.6°F) in July (DOE, 1984b), and the annual average relative humidity is 66 percent (DOE, 1982c). The SRP experiences an average annual precipitation of about 120 centimeters (47 inches), with most rainfall occurring in summer (DOE, 1984b).

Prevailing winds, based on data from nearby Bush Field, Augusta, Georgia, are from the southeast, with an annual average wind speed of 3.0 meters per second (6.7 miles per hour) (DOE, 1984b). Average monthly wind speeds at this station range from 2.5 meters per second (5.6 miles per hour) in August and September to 3.6 meters per second (8.1 miles per hour) in March (DOE, 1984b). An inspection of available wind roses for the SRP indicates that these values are representative of wind conditions at the SRP.

The SRP is in an area where severe weather may be expected. Thunderstorms occur an average of 54 days per year, and tornadoes have an annual occurrence rate of 1.8×10^{-5} per square kilometer (6.96×10^{-4} per square mile) (DOE, 1984b). In addition, hurricanes affect the area with a frequency of 1 storm every 7 years (DOE, 1984b). However, since the SRP is situated 161 kilometers (100 miles) inland, the force of the damaging winds associated with these systems is significantly reduced.

3.3.7 Ecology

The production and support facilities of the SRP occupy less than 5 percent of the site; thus, most of the area remains in a natural state. In fact, 90 percent of the site is forested, and much of this area is actively managed for timber production and wildlife (DOE, 1982b). The SRP is located on the southeastern Coastal Plain, where the oak-hickory-pine and southern mixed forests intermingle. The southern floodplain forest that adjoins the Savannah River is also present (DOE, 1987e). The Savannah River, a number of streams that drain the site, Carolina Bays, farm ponds, and cooling-water reservoirs make up the aquatic resources of the site.

Although much of the SRP site now consists of managed pine forests, the composition of the naturally seeded forests is closely related to the moisture available to the trees (ERDA, 1977b). Within the swamp bordering the Savannah River, bald cypress and tupelo gum are the dominant trees. On the more moist soils often found along small streams or on old floodplains, common trees include tulip poplar, beech, sweetgum, and various oaks. On the more fertile dry uplands, oak-hickory hardwoods are prevalent. Finally, on the dry sandy areas that are typical of the Aiken Plateau upon which the F-Area is located, the scrub oak community is found. Wetlands in the vicinity of the F-Area are largely found along Upper Three Runs Creek and Four Mile Creek and include the following types: open water, cypress/tupelo, emergent marsh, scrub/shrub, and bottomland hardwoods.

The SRP site, with its wide diversity of terrestrial and aquatic habitats, supports a number of reptiles and amphibians. These include 10 species of turtles, 10 species of lizards, 1 species of alligator, 34 species of snakes, 15 species of salamanders, and 28 species of frogs and toads (ERDA, 1977b).

A total of 213 species of birds have been identified on the SRP site (DOE, 1987e). Upland game birds on the site include the quail, dove, and wild turkey. Quail populations have declined since the site has been allowed to revert to forest. The SRP site is used by the state as a breeding ground for wild turkeys; to date, 135 turkeys have been captured and used to restock other areas. Waterfowl use the SRP, especially Par Pond, Savannah River swamps, and the larger Carolina Bays.

The SRP includes the ranges of more than 40 species of mammals (DOE, 1987e). Common or abundant mammals on the site include the gray and red fox, raccoon, wildcat, striped skunk, opossum, cottontail rabbit, gray and fox squirrel, and beaver. Deer, which were uncommon when the area was officially closed to the public in 1952, are now abundant.

Habitats for fish on the plant site are numerous and diversified. These habitats consist of natural and thermally stressed reservoirs, Carolina Bays, abandoned farm ponds, swamp channels, oxbow lakes, and the Savannah River. The two streams that drain the F-Area are Upper Three Runs Creek and Four Mile Creek (DOE, 1982b). The flora and fauna of Upper Three Runs Creek are characteristic of relatively undisturbed, soft, backwater streams of the southeastern United States. Fifty-eight species of fish have been reported from Upper Three Runs Creek, and this creek may be seasonally important as a nursery habitat for a number of important species found primarily in the Savannah River. These species include the American shad, blueback herring, and striped bass. The natural flow of Four Mile Creek is augmented by effluents from SRP facilities. When C-Reactor operated, the stream was thermally stressed and, with the exception of the mosquito-fish, which can tolerate temperatures to about 40°C (104°F), few fish occurred in the thermally altered areas.

Six federally listed endangered vertebrates occur on or in waters adjacent to the SRP. In 1986, one active colony of red-cockaded woodpeckers was located near the northern border of the site, and two lone males were located near the southeastern boundary (DOE, 1987e). Bald eagles have been observed over several areas of the plant, especially Par Pond and along the Savannah River. One active nest has been located in the vicinity of Par Pond Dam (Goodson, 1986). While wood storks do not nest on the SRP, they have been observed feeding within several areas of the Savannah River swamp (DOE, 1987e). The shortnose sturgeon is rare in the area, with only a few larvae being collected from the Savannah River (DOE, 1987e). The brother spike mussel has been collected from the Savannah River below Upper Three Runs Creek (DOE, 1986d). The smooth coneflower (Echinacea laevigata) is found along an unimproved dirt road running between the C- and F-Areas (DOE, 1987e). Listed federally as "threatened due to similarity of appearance," the American alligator is common locally and breeds in Par Pond, near D-Area, in the Savannah River Swamp, along Steel Creek, in Pond B, and in Lower Three Runs Creek. In addition to these species, the State of South Carolina has designated 38 species of flora and fauna as of special concern and 7 as threatened. A complete listing of South Carolina-designated species can be found in DOE (1987e).

3.3.8 Background Radiation

For the SRP, a detailed discussion on background radiation is presented in the EIS for alternative cooling water systems at the SRP (DOE, 1987e).

Natural radiation contributes about 48 percent of the annual dose of 195 millirem received by an average member of the population within 80 kilometers (50 miles) of the SRP (DOE, 1987e). Medical exposure accounts for 47 percent of the annual dose; and the combined doses from offsite weapons test fallout, consumer and industrial products, and air travel account for about 5 percent of the dose. Releases of radioactivity to the environment from the plant account for less than 0.1 percent of the total annual dose (DOE, 1984b).

4 ENVIRONMENTAL CONSEQUENCES

This chapter discusses the potential environmental consequences of the construction and operation of the Special Isotope Separation (SIS) Project. Sections 4.1 through 4.4 discuss the environmental consequences associated with locating the project at the Idaho National Engineering Laboratory (INEL), the Hanford Site, and the Savannah River Plant (SRP) and of taking No Action. The discussion of potential environmental consequences of locating the project at either the Hanford Site or the SRP identifies the major differences in potential environmental consequences from those that would be expected from locating the proposed project at the INEL (the Preferred Alternative).

Sections 4.5 and 4.6 of this chapter discuss potential cumulative effects and emergency preparedness. Section 4.7 discusses decontamination and decommissioning. Section 4.8 discusses the relation of the proposed action to land-use plans, policies, and controls; Section 4.9 discusses irreversible and irretrievable commitment of resources.

4.1 ENVIRONMENTAL CONSEQUENCES OF CONSTRUCTING AND OPERATING THE SIS PROJECT AT THE INEL

This section discusses the expected environmental consequences of constructing and operating the SIS Project at the INEL. The discussion includes the potential nonradiological and radiological effects, the potential impacts of routine transport of nuclear materials, and the potential impacts of abnormal events or accidents. A discussion of the SIS safeguards and security program is also presented, and the unavoidable impacts are identified.

4.1.1 Construction Impacts

Environmental impacts that could occur during construction of the SIS Project at the INEL would result primarily from construction workers who might migrate into the INEL region, from the disturbance and use of land areas associated with the project, from construction effluents and emissions, and from the use of ground water for construction activities. The following sections discuss each of these impact categories.

4.1.1.1 Socioeconomic Impacts

Socioeconomic impacts will result from the increase and decrease in workforces during the construction and operations phases of the SIS Project. Table 4-1 presents the workforce requirements for construction and operations workers during the construction period. Peak employment is estimated to be 788 during the fourth year of construction. The period of peak net

Table 4-1. Employment--Total, In-migration, and Out-migration by Year for Construction and Operation Workforces

Category	Year 1	2	3	4	5	6
CONSTRUCTION WORKFORCE						
Total	151	268	459	514	193	7
Crafts	21	68	239	293	76	0
Management, engineering, support	130	200	220	221	117	7
In-migration	81	54	62	19	0	0
Crafts	5	12	43	13	0	0
Management, engineering, support	76	42	19	6	0	0
Out-migration	0	0	3	7	72	62
OPERATIONS WORKFORCE						
Total	104	140	203	274	434	656
In-migration	16	6	10	12	28	44
TOTAL WORKFORCE						
Total annual employment	255	408	663	788	627	663
Net migration	97	60	70	24	-44	-18

in-migration will be the first year of construction, with 97 workers expected to move into the area. Peak out-migration will be the fifth year of construction, when 72 construction personnel will move out of the area. This number of out-migrating personnel would be partially offset by 28 operations workers moving into the area during the same year. The net migration for the fifth year is expected to be an out-migration of 44 workers.

Of the construction workforce, approximately one-half are expected to be skilled construction craft personnel (e.g., carpenters, electricians, pipefitters, and sheet-metal workers). A recent survey of construction workforce availability for the INEL region (Table 4-2) indicates that more than 3300 construction personnel are available within an 80-kilometer (50-mile) radius of the INEL, and more than 14,000 construction personnel are available within 80 to 320 kilometers (50 to 200 miles) (GEC Company, 1987). Because of the large number of construction personnel available in the INEL region, it is not anticipated that a significant number of construction personnel will migrate into the region. To bound the potential socioeconomic consequences during construction, an estimated 25 percent of the peak number of skilled craft personnel was projected to in-migrate (73 personnel). An additional 143 management, engineering, and support workers for the construction activities are also anticipated to move to the INEL area. These workers are also most likely to move out of the area when their jobs on SIS are completed.

During the construction period, operations personnel will be hired so that at the end of the construction period, 656 of the 750 operating workers would be employed. The percentage of operations workers estimated to in-migrate varies based on skill requirements. Overall, approximately 15.5 percent (116 personnel) are estimated to move into the INEL area. The total of 332 in-migrating personnel would represent about 3 percent of the total 1985 employment at the INEL.

Using an average family size for each of the projected in-migrating personnel of 2.75 persons per household (i.e., the average household size in the United States as reported by the Census Bureau for 1980), the anticipated population increase attributable to the projected in-migrating workers during the construction period would be about 910 persons. During the year of peak in-migration (i.e., the first year) total in-migrating population would be 267 persons, or about 13 percent of 1 year's average population growth in the six primary-impact counties surrounding the INEL.

Table 4-3 presents the distribution of the in-migrating workforce during the construction period. The analysis assumes that the new workers will locate in the communities in the six-county area in a pattern similar to current employees at the INEL (see Table 3-1). The results of the analysis show that the majority of the in-migrating workforce will locate in Bonneville County and that the peak year of population increase in Bonneville County would be 24.9 percent of the annual growth rate for the county from 1980 to 1986, or less than 15 percent of the annual growth rate for the county from 1970 to 1980. This is the highest percentage of annual growth except for Butte County, which lost population from 1980 to 1986. The anticipated population increase from in-migrating population is significantly smaller than the average annual growth rate of the six-county area in

Table 4-2. Workforce Availability[a]

Craft personnel	Number available Within 80-kilometer (50-mile) radius	Within 80- to 320-kilometer (50- to 200-mile) radius	Total in area
Boilermakers	140	610	750
Carpenters	639	1,870	2,509
Cement finishers	70	60	130
Electricians	500	835	1,335
Elevator constructors	0	4	4
Iron workers	210	736	946
Laborers	476	1,075	1,551
Millwrights	45	149	194
Operating engineers	200	4,050	4,250
Painters	100	385	485
Roofers	40	266	306
Sheet-metal workers	180	1,165	1,345
Sprinkler fitters	50	125	175
Teamsters	285	977	1,262
United Association (pipefitters)	456	1,150	1,606
Total	3,391	13,457	16,848

[a]Source: GEC Company (1987).

Table 4-3. In-migration by County, Total, Peak Year, and Percent of Annual Growth

County	In-migration		
	Total	Peak year	Percent of annual 1980-86 growth
Bannock	46	14	3.0
Bingham	118	35	11.6
Bonneville	646	192	24.9
Butte	27	8	(a)
Jefferson	55	16	8.4
Madison	18	5	1.3
Total	910	270	12.9

[a] Butte County lost population between 1980 and the 1986 estimated population.

the past 6 years. The characterization of local infrastructure--presented in Chapter 3 and its referenced documents--shows adequate capacity for continued growth; thus no significant adverse impacts are expected. The six-county area had sufficient vacant housing to accommodate the 332 in-migrating households. Education and vocational training should be strengthened because of the SIS Project through increased tax revenues and apprentice employment opportunities.

The primary impacts to occur would be beneficial; local workers employed during the construction period would total 661 (total construction and operational jobs less in-migration). Some of these would come from projects at the INEL that will terminate during the SIS construction period; thus the SIS Project would stabilize the INEL workforce and could decrease unemployment in the INEL region. Expenditures for construction personnel, equipment, and services would also generate indirect employment opportunities. Using an employment multiplier of 2.36 (Hofman et al., 1986) and an average annual employment during the construction period of about 548 personnel, approximately 746 indirect job opportunities would be created in the INEL region. Contributions to taxes during construction, given a tax burden of $922 per employee (Hofman et al., 1986), would average approximately $505,256 per year during the construction period.

The increase in population during the construction period might also have a beneficial impact on tourism, since new community members would be visited by friends and relatives who might otherwise have chosen to vacation elsewhere. The construction activities are not expected to adversely impact tourism, since construction activities are confined to a site with controlled public access.

4.1.1.2 Land-Utilization Impacts

Utilization of land resources for SIS construction has the potential for impacting land use, historic and archeological resources, and ecological habitat. A discussion of each of these areas of potential impact is provided in the following subsections.

Land Use

Construction of the SIS facilities (i.e., Plutonium Processing Building, Laser Support Facility, and Stand-Alone Storage Vault) at the INEL would require approximately 108,860 square meters (26.9 acres) within the existing Idaho Chemical Processing Plant (ICPP) security area and about 92,670 square meters (22.9 acres) outside the ICPP security area. In addition to these areas, about 45,330 square meters (11.2 acres) outside the ICPP security area would be temporarily affected by construction of an electric substation distribution line and 92,900 square meters (23.0 acres) of an existing borrow area by (1) obtaining fill material for grading and (2) disposing of grubbed and excavated material from site-preparation activities. All lands involved in the construction of the SIS have been withdrawn from public use by the U.S. Department of Energy (DOE). No additional public lands are needed.

The State of Idaho, the East-Central Idaho Planning and Development Association, and Butte County do not have any plans or policies specifically related to land use that would be affected by SIS. The Bureau of Land Management administers grazing areas on lands in the INEL. The grazing area boundary nearest the SIS Project is located approximately 7.0 kilometers (4.4 miles) from the SIS Project. Grazing area boundaries and permits would not be impacted by SIS construction.

All the land area (108,860 square meters) for the SIS Project within the existing ICPP security area has been previously disturbed by ICPP construction and operation activities.

Land areas outside the ICPP security area that would be affected during construction would be predominantly those of the sagebrush vegetation community. During construction, plant and animal habitats associated with this vegetation community would be lost or displaced; however, approximately 92 percent of the area outside the ICPP area would not be affected by SIS operation (i.e., all but 2.9 acres of the 22.9 acres outside the ICPP and less than 1 acre of the 11.2 acres for the electric distribution line). Disturbed areas outside the ICPP not affected by operation would be revegetated and would eventually revert to a sagebrush community through natural plant succession.

Historic and Archeological Resources

Construction of the SIS facilities would not impact sites listed in the National Register of Historic Places. An archeological survey of the ICPP area and borrow area has been completed by the Idaho State University Swanson/Crabtree Anthropologic Research Center (Reed, 1986; Ross, 1988). Results of the survey have identified two sites that would not be directly impacted by the construction of the SIS Project. One site identified is located northeast of the existing ICPP security fence across the Big Lost River. The site is a tin-can scatter not considered eligible for nomination to the National Register of Historic Places. The second site, located east of the ICPP, is a potentially significant abandoned homestead with a lava block cellar. Project siting will provide sufficient distance to ensure that no primary or secondary impact will occur. A professional paleontologist will make periodic inspections of excavations and excavated gravels. Inspection frequency and additional consultation will be based on the frequency of paleontological finds.

Ecological Habitat

Construction and operation of the SIS facilities would not have any significant impacts to wildlife as affected land areas would be small and all effluents and emissions would comply with regulatory standards.

Construction of the SIS facilities would also not impact wetland areas or habitats, or habitats for federally listed endangered and threatened species.

The U.S. Department of the Interior Fish and Wildlife Service has indicated that the bald eagle (Haliaeetus leucocephalis) is the only listed endangered or threatened species that may occur within the proposed SIS Project area on the INEL. The Swainson's hawk (Buteo swainsonii) and ferruginous hawk (Buteo regalis) were the two candidate species identified that occur seasonally on the INEL. Because no bald eagles utilize the area adjacent to the proposed site, it is unlikely that construction or operation activities of the SIS would impact wintering or migrant bald eagle populations on or near the INEL. The proposed SIS Project area is within the hunting range of the nearest nests of the ferruginous and Swainson's hawks. However, the proposed area is covered with gravel, devoid of vegetation, and lacking prey species. Hence, it is unlikely that construction or operation activities would impact the nesting success or hunting activities of either candidate species.

4.1.1.3 Construction Effluent and Resource Impacts

During construction of SIS facilities, short-term impacts would occur from the atmospheric emission of nonradioactive pollutants from construction equipment, construction vehicles, and fugitive dust. In addition, construction of the facilities would require the withdrawal of ground water to meet both potable-water and construction needs.

Based on the estimated energy requirements for construction discussed in Section 2.1.4.3, including construction of the Stand-Alone Storage Vault, Table 4-4 lists the expected total emissions from construction equipment and vehicles using diesel fuel, gasoline, and propane. In addition, Table 4-4 lists the expected fugitive-dust emissions that would occur during 1 year of site-preparation activities and particulate emissions from a concrete batch plant if it were needed for construction. The fugitive-dust emission was calculated assuming that (1) no dust-suppressant measures would be used and (2) grading activities would be continuous over the entire land area throughout the year. The calculation of particulate emissions of the concrete batch plant also assumed that the emissions would be uncontrolled.

To derive an upper bound estimate of the expected concentrations of atmospheric emissions due to construction, atmospheric emissions from construction equipment, vehicles, and the concrete batch plant as listed in Table 4-4 were also averaged over a shorter construction period than currently planned (i.e., a 3-year construction period rather than 4 to 5 years). Table 4-5 lists the calculated increases of pollutants from construction at the INEL boundary.

The calculated increases at the site boundary would all be negligible in comparison with applicable air quality standards, as listed in Table 4-5. Expected particulate emissions from fugitive dust and the concrete batch plant would be lower than those presented in Table 4-5, since fugitive-dust suppressant, erosion-control, and particulate-control measures would be implemented as part of the site-preparation activities.

Table 4-4. Estimated Emissions During Construction[a]

Source	Metric tons (tons)				
	Particulates	NO_x	CO	SO_2	Hydrocarbons
Diesel-powered construction equipment[b]	0.2 (0.2)	2.2 (2.4)	0.8 (0.9)	0.2 (0.2)	0.2 (0.2)
Gasoline-powered construction equipment[b]	0.1 (0.1)	1.7 (1.9)	56.3 (62.1)	0.1 (0.1)	2.1 (2.3)
Propane heating and construction equipment	--[c] --	0.2 (0.2)	-- --	-- --	-- --
Fugitive dust[d]	600.5 (661.0)				
Concrete batch plant[e]	2.9 (3.2)				

[a] Emissions based on emission factors contained in EPA (1985).

[b] Emission factors for diesel-powered and gasoline-powered construction equipment are based on composite averages of construction equipment emission factors.

[c] Less than 0.05 metric ton.

[d] Based on emission factor of 1.2 tons per acre per month multiplied by number of acres that would be graded.

[e] Need for a concrete batch plant has not been determined.

Table 4-5. Calculated Maximum Increases in Annual Average Ambient Air Concentrations (µg/m^3) at the INEL Site Boundary Due to Construction

Source	Inhalable particulates	NO_x	CO	SO_2	Hydrocarbons
Construction[a]	1.6×10^0	3.4×10^{-3}	2.0×10^1	3.0×10^{-4}	6.7×10^{-1}
Standards[b]					
24-hour average	1.5×10^2	none	[c]1.0×10^4	3.6×10^2	none
Annual average	5.0×10^1	1.0×10^2	[d]4.0×10^4	8.0×10^1	[e]1.6×10^2

[a] Based on annual emission rates assuming a 230-day year, 8 hours per day of construction, a long-term dispersion factor of 1.7×10^{-8} second per cubic meter (applied to particulates, NO_x, and SO_2), and a short-term dispersion factor of 6.9×10^{-6} second per cubic meter (applied to CO and hydrocarbons) as contained in DOE (1982a).

[b] National Ambient Air Quality Standards.

[c] Maximum 8-hour concentration not to be exceeded more than once per year.

[d] Maximum 1-hour concentration not to be exceeded more than once per year.

[e] Three-hour average (no 24-hour or annual average).

During construction, an estimated 3.3×10^7 liters (8.7×10^6 gallons) of water would be withdrawn from the Snake River Plain aquifer for potable-water and construction uses. To estimate the upper bounds of impacts of this withdrawal of ground water, it was assumed that all ground water would be withdrawn over a 3-year construction period rather than the currently planned 4- to 5-year construction period. The resulting average annual withdrawal of 1.1×10^7 liters (2.9×10^6 gallons) would not affect the Snake River Plain aquifer (i.e., the annual withdrawal would be about 0.00018 percent of the annual discharge of 6.2×10^9 cubic meters of the aquifer to the Snake River) and would be only about 0.0006 percent of current annual ground-water pumpage of 1.8×10^9 cubic meters for irrigation.

Construction activities would also generate about 660 metric tons (726 tons) of uncompacted nonradioactive nonhazardous waste that would be disposed of in the Central Facilities Area (CFA) sanitary landfill. The amount of nonradioactive and nonhazardous waste that would be generated would not significantly impact the CFA sanitary landfill. No liquid effluents generated during construction would be discharged directly to surface waters. Liquid effluents would include sanitary wastes that would be treated either by a prefabricated treatment system and chemical toilets or by the existing ICPP Sewage Treatment Plant. Other potential liquid effluents would include spills of petrochemical products. Effects of accidental spills would be minimized by measures enacted pursuant to a Spill Prevention, Control, and Countermeasures (SPCC) plan.

Construction equipment would also increase noise levels beyond those currently experienced in the ICPP area. Areas outside the INEL site are not likely to experience any noticeable increase in noise levels because of the distances to the nearest INEL boundaries. Increased noise levels due to construction might result in the temporary dislocation of wildlife.

4.1.2 Normal Operational Impacts

The environmental impacts that would occur during normal operation of SIS facilities at the INEL would result primarily from (1) operating employees who might migrate into the INEL region; (2) nonradioactive and radioactive emissions, effluents, and solid wastes generated during operation; (3) incremental increases in emissions from existing INEL facilities supporting SIS operation; and (4) exposures and releases associated with the transport of materials. The following sections discuss each of these impact categories.

4.1.2.1 Socioeconomic Impacts

Operation of SIS facilities would require an operating workforce of about 750 personnel. Of the total number of operating workers, 656 would be employed at the end of the construction period (see Table 4-1). The remaining 94 would be hired during the first year of operation. Thirteen of these new employees are expected to in-migrate from outside the INEL area.

The total operating workforce would represent about 7 percent of the current employment at the INEL.

Using an average family size for potential in-migrating operating personnel of 2.75 persons per household (i.e., the national average), the expected population increase attributable to in-migrating operating personnel after the construction period would total about 36 persons. The expected population increase due to in-migrating SIS operating employees during the first year would represent less than 2 percent of the average annual population increase in the six counties surrounding the INEL, given that the normal population increase of the six counties surrounding the INEL is about 2200 persons per year (i.e., the average annual population increase between 1980 and 1986).

The population increase that would be associated with in-migrating operating personnel is not expected to have major impacts on local governmental services and community infrastructures. Sufficient housing exists and municipal service systems have sufficient capacities to accommodate future population growth.

Beneficial impacts associated with in-migrating operating personnel would include a stabilized workforce at the INEL, a decrease in the unemployment in the INEL region, and increased expenditures for materials and operating-employee salaries that would generate indirect employment opportunities. Assuming an employment multiplier of 2.36 (Hofman et al., 1986), about 128 additional indirect job opportunities would be created in the INEL region. Contributions to taxes during operation, assuming a tax burden of $922 per operating employee (Hofman et al., 1986), would average approximately $691,500 per year during operation.

The increase in population during the operational period may have a beneficial impact on tourism, since new community members would be visited by friends and relatives who might otherwise have chosen to vacation elsewhere. Operational activities should not have an adverse impact on tourism, since they take place on a site with restricted public access. The INEL has been operating for 40 years with nuclear facilities. The SIS Project would not significantly change the operational characteristics of the INEL; thus no significant adverse impacts to tourism are expected.

The closest grazing areas on the INEL and crop-growing areas off the INEL are at distances from the SIS site that are greater than the minimum required for safe agricultural production in the area of a nuclear facility. In addition, the INEL has been operating nuclear facilities for 40 years and these operations have not endangered Idaho's agriculture or the reputation of its crops.

4.1.2.2 Nonradiological Impacts

The potential nonradiological impacts associated with SIS operation at the INEL would result from (1) atmospheric emissions from SIS facilities; (2) sanitary effluents that would be discharged to the existing ICPP Sewage Treatment Plant, and liquid effluent discharges to the ICPP service waste system; (3) solid waste management; and (4) the consumptive use of ground water.

Atmospheric Emissions

Currently, steam is provided at the ICPP by two coal-fired boilers in the Coal-Fired Steam-Generating Facility (CFSGF), which have a combined capacity of 61,235 kilograms (135,000 pounds) per hour. In addition, there are three oil-fired boilers with a total capacity of 51,030 kilograms (112,500 pounds) per hour. The oil-fired boilers are normally not used and are permitted for only part-time operation.

During operation of the SIS Project, the CFSGF would burn additional quantities of coal to provide steam for SIS facilities. On the basis of CFSGF operational data, the current annual coal usage is estimated at about 11,980 metric tons (13,028 tons) to meet an annual average steam demand of 13,095 kilograms (28,870 pounds) per hour for the ICPP. SIS operation would increase the average steam demand by about 4075 kilograms (8985 pounds) per hour, or by about 31 percent. This additional steam demand would increase total coal usage to about 15,600 metric tons (17,200 tons) per year at the CFSGF, or also by about 31 percent. The peak steam-generation load for existing ICPP facilities is approximately 38,100 kilograms (84,000 pounds) per hour, not including a projected peak demand of 9980 kilograms (22,000 pounds) per hour for the Fuel Processing Restoration (FPR) facility. The estimated peak steam demand for SIS is 21,320 kilograms (47,000 pounds) per hour. This combined total peak demand of about 69,400 kilograms (153,000 pounds) can be met by the CFSGF combined with some production from the oil-fired boilers. This would occur infrequently since the probability of all facilities requiring peak process and heating steam demands at the same time is low.

While the CFSGF is a major stationary source because of its potential to emit nitrogen oxides, the estimated average annual emission increases due to SIS steam demand at the CFSGF would be below the de minimis levels of the U.S. Environmental Protection Agency (EPA) Prevention of Significant Deterioration (PSD) regulations, as indicated in Table 4-6. The incremental use of the CFSGF and oil-fired boilers can be accommodated within existing permit limits.

In addition to the incremental emissions from the burning of coal and infrequent burning of oil for steam production, operation of the SIS facilities would emit argon and nitrogen from glove-box inerting; hydrogen, primarily from dissolution and hydride/dehydride operations; helium from separator cryogenic pumps; neon, which would be used as a buffer gas in the laser system; water vapor from cooling-tower operations; Freon from laser maintenance and repair operations; and small quantities of nitrogen oxides, carbon monoxide, and carbon dioxide from balance-of-plant (BOP) processes. With the exception of nitrogen oxides, carbon monoxide, and Freon, none of these nonradiological emissions are regulated by the Clean Air Act (CAA), as amended. The small quantities of nitrogen oxides and carbon monoxide (Table 2-4), when added to the incremental emissions from the CFSGF, would still be well below the de minimis levels for PSD review.

Table 4-6. Estimated Average Annual Increases in Air Emissions Due to Incremental Steam Generation at the CFSGF

Air pollutants	Annual emissions due to incremental steam generation, metric tons (tons)[a]	PSD de minimis level, metric tons (tons)
SO_2	7.3 (8.0)	36.3 (40)
Particulates	1.4 (1.5)	22.7 (25)
NO_x	20.4 (22.5)	36.3 (40)
CO	2.0 (2.2)	90.7 (100)

[a] Based on incremental burning of 3785 metric tons (4170 tons) of coal and emission factors as contained in EPA (1985).

Although chlorofluorocarbons (Freons) are unreactive with respect to the formation of photochemical oxidants, these compounds have been implicated in aerochemical reactions for stratospheric ozone depletion. This has led to Freons being banned as aerosol propellants under the Toxic Substances Control Act (TSCA). Pursuant to the Montreal Protocol, EPA issued a final rule (40 CFR 82) limiting the production and importation of chlorofluorocarbons (CFCs) and Halons on August 1, 1988. Issuance of the rule fulfilled the U.S. commitment to protect the ozone layer by requiring a 50-percent reduction in production and consumption of these substances, based on 1986 levels, by 1998. The rule would take effect in July 1989 if the protocol is ratified by nations representing two-thirds of the 1986 global consumption of CFCs and Halons.

Volatile organic compound emissions, primarily Freon, would total less than 18 metric tons (20 tons) per year based on current plant design, which is less than 50 percent of the de minimis level of 36.3 metric tons (40 tons) set by the EPA for PSD for volatile organic compounds.

On-going engineering development to further reduce emissions includes measures such as chiller and condensation systems to reduce evaporation of Freon during refurbishment, and vapor recovery systems for recycling the Freon. Designs are also being examined to minimize the required inventory, inventory monitors, local spill detectors, and emission monitors to detect residual Freon losses. In addition, SIS Project personnel are working with commercial Freon manufacturers to identify and/or develop substitute dielectric coolants that will have no adverse impact on the environment. These potential substitutes are being evaluated for use in the SIS Project and will be used when available.

The release of less than 18 metric tons (20 tons) of Freon per year from the SIS facility constitutes approximately 0.006 percent of the estimated one-third of a million tons consumed in the United States in 1985. Using the detailed information presented in Regulatory Impact Analysis: Protection of Stratosphere Ozone (EPA, 1987), calculations of the SIS Project's emissions of Freon indicate that the SIS Project would contribute to:

- Stratospheric ozone depletion by about 1×10^{-6} percent per year
- An annual increase in the risk to an individual member of the U.S. population to fatal skin cancer by 2.7×10^{-12}.

The impacts as indicated above are negligible.

Liquid Effluents

During operation, nonradioactive and nonhazardous liquid effluents, as defined by DOE Order 5480.1B and the Resource Conservation and Recovery Act (RCRA) requirements (40 CFR 261), would be generated.

Sanitary Discharges

Routine discharges of sanitary sewage from SIS facilities to the existing ICPP sanitary sewage system would amount to about 24,000,000 liters

(6,300,000 gallons) per year, or a peak daily generation of 66,250 liters (17,500 gallons). Routine discharges of sewage from SIS facilities would be monitored and treated by the existing ICPP Sewage Treatment Plant.

The ICPP Sewage Treatment Plant consists of a four-cell aerated lagoon system, with two cells capable of being aerated and two which remain quiescent. Sewage from existing ICPP facilities is pumped to the plant via a lift station which contains two pumps, each with a maximum capacity of 645 liters (170 gallons) per minute. Sewage received at the plant can be diverted into either of the first two cells. Following a total of 22 days of aeration (design detention time of both cells operated in series), the sewage flows into the two quiescent cells for at least an 8-day period when they are operated in series. Effluent from the fourth cell is then discharged to one of four infiltration beds for final disposal. The use of the infiltration beds is rotated as conditions warrant to prevent clogging of the bed by settled organic matter.

The design capacity of the existing ICPP Sewage Treatment Plant is 454,250 liters (120,000 gallons) per day. Currently the plant receives a peak daily volume of about 113,560 liters (30,000 gallons). The additional 66,250 liters (17,500 gallons) of peak daily demand that would be generated as a result of SIS operation would not exceed the capacity of the existing waste-water treatment plant. As the treated effluent would be discharged to infiltration beds rather than to a surface-water body, existing surface-water quality in the vicinity of the INEL would not be impacted by the discharges of treated SIS sanitary effluents.

Service Waste Discharges

Routine discharges of SIS effluents to the existing ICPP service waste system would consist of 4.3×10^8 liters (1.1×10^8 gallons) per year of cooling-tower blowdown, and 2.6×10^6 liters (7.0×10^5 gallons) per year of process steam condensate. All discharges from the SIS facilities would be sampled and/or monitored prior to their discharge to the service waste system to ensure that all liquid effluents would be below EPA drinking water standards for radionuclides (40 CFR 141) and below the limits identified in DOE Orders and those of RCRA contained in 40 CFR 261.

SIS liquid effluents that are nonradioactive and nonhazardous would be discharged from the ICPP service waste system to one or more new percolation ponds that would be constructed as part of on-going improvements to ICPP waste management systems (see Section 2.1.5.1). Use of the percolation pond(s) would recycle effluents of drinking water quality to the soil and ground water. The releases of SIS nonradioactive and nonhazardous liquid effluents to the new percolation pond(s), in combination with other ICPP nonradioactive and nonhazardous liquid effluents, would be in compliance with all appropriate ground-water standards and would not impact the ground-water quality of the Snake River Plain aquifer.

One of the current goals of DOE is that effluents of drinking water quality be sent from the SIS facilities to the service waste system so that drinking water is effectively being recycled to the soil.

Nonradioactive Solid Wastes

Nonradioactive solid wastes generated during SIS operation include both hazardous and nonhazardous wastes. All hazardous waste would be handled in accordance with DOE Order 5480.1B and RCRA as implemented by 40 CFR 260-280.

Hazardous Wastes

Hazardous wastes that would be produced as a result of SIS operation would include spent laser dye in ethanol, 1,1,1-trichloroethane, trichloroethylene, acetone, methanol, ethylene glycol, benzyl alcohol, 2-phenoxyethanol, Freon R-11 and R-113, and limited quantities of liquid wastes from the chemical makeup room floor drains and Material and Process Control Laboratory (MPCL) activities. Up to 10 kilograms (22 pounds) per year of dye in 1.5 x 10^4 liters (4000 gallons) of ethanol would be generated as a result of Laser Support Facility (LSF) operations and the recovery of ethanol by distillation (see discussion of liquid effluents). Trichloroethylene and 1,1,1-trichloroethane would be used in small quantities for degreasing. Ethylene glycol is used in cooling systems and ethylene glycol/benzyl alcohol is used in the auxiliary dye-laser system. Methanol and acetone would be used in limited quantities (less than 420 liters, or 110 gallons, per year) as drying agents. The acetone/methanol would account for 40 kilograms (88 pounds) of hazardous solid waste. Up to 1900 liters (500 gallons) per year of nonreusable Freon R-11 and R-113 from the Pulse Power Electronics (PPE) and power supplies would also be generated. The quantity of potentially hazardous waste generated from liquid captured in the Plutonium Processing Building (PPB) catch tank from the chemical makeup room floor drains would be dependent on the occurrence of an event. As an upper limit, approximately 41 kilograms (90 pounds) and 7200 liters (1900 gallons)--primarily solvents--of hazardous waste could be generated as a result of MPCL analytical activities.

In addition to the above wastes, maintenance of outdoor closed cooling loops would generate an estimated 950 liters (250 gallons) of glycol/water. The glycol would be generated as a 20-percent solution in water. Although not a hazardous waste, the glycol generated from maintenance would be managed as a hazardous waste. The estimated hazardous wastes that would be generated are listed in Table 2-6.

Hazardous wastes would be contained at their point of generation at Satellite Staging Areas, where RCRA requirements allow the staging of up to 208 liters (55 gallons) of hazardous waste. Within 72 hours of being filled, the containers of hazardous waste would be taken to the ICPP staging area, and would then be transported to an EPA-approved treatment, storage, or disposal (TSD) facility prior to the 90-day storage limit. All applicable EPA and U.S. Department of Transportation (DOT) regulations (i.e., 40 CFR 262-263 and 49 CFR 100-199) for the handling, sampling, manifesting, packaging, and shipment preparation of hazardous wastes would be followed. During routine operation, hazardous wastes would not pose adverse impacts to operating employees, offsite populations, or the environment. The annual amount of hazardous waste estimated to be generated as a result of SIS operation (about 33,000 liters or 8800 gallons) would, as an upper bound, represent about 23 percent of the hazardous waste generated at the INEL in 1986.

Notification of the use of underground storage tanks for ethanol storage will be made to State of Idaho's Underground Tank Coordinator pursuant to RCRA requirements (40 CFR 280). The underground tanks will be double-walled stainless steel and will have interstitial leak detection equipment to meet requirements for underground tanks containing hazardous substances.

In accordance with the Superfund Amendments and Reauthorization Act (SARA) Title III, DOE will provide the necessary information to the state and local Emergency Response Committees regarding types of materials that could be encountered in an emergency response. Information on the types of materials associated with the SIS Project will be included as part of the on-going reporting process.

Nonradioactive and Nonhazardous Solid Wastes

Approximately 900 metric tons (990 tons) per year of uncompacted solid waste that is nonradioactive and nonhazardous would be generated as a result of SIS operations. This solid waste, consisting of trash, refuse, and other discardable materials, would be disposed of in the CFA sanitary landfill. Nonradioactive and nonhazardous solid waste would be managed in compliance with Subtitle D requirements of RCRA. During normal operation, the disposal of nonradioactive and nonhazardous solid wastes, which represent less than 10 percent of the annual volume disposed of at the CFA, would not cause adverse impacts.

Ground-Water Consumption

The annual average demand of water by SIS operation is expected to be 5.0×10^8 liters (1.3×10^8 gallons) of treated water, 2.8×10^7 liters (7.4×10^6 gallons) of potable water, 1.4×10^8 liters (3.7×10^7 gallons) of demineralized water, and 1.4×10^7 liters (3.7×10^6 gallons) of raw water. The annual withdrawal of this quantity (6.8×10^8 liters or 1.8×10^8 gallons) of ground water would represent less than 0.02 percent of the annual discharge of the Snake River Plain aquifer to the Snake River and would approximate 0.04 percent of the ground water currently being withdrawn for irrigation on the Eastern Snake River Plain annually. The incremental withdrawal of ground water for SIS operations in addition to the amount currently being withdrawn by on-going INEL operations can be obtained within the ground-water pumpage rates in the State of Idaho's water permits for the INEL.

Of the amount withdrawn, approximately 4.5×10^8 liters (1.2×10^8 gallons) per year would be returned to the Snake River Plain aquifer through treated sanitary water discharges or service waste system discharges of drinking water quality (see Table 2-5). The total annual consumptive loss of about 2.3×10^8 liters (6.1×10^7 gallons) of ground water represents less than 0.004 percent of the average discharge of the Snake River Plain aquifer, or less than 0.02 percent of the estimated ground-water pumpage per year for irrigation on the Eastern Snake River Plain.

4.1.2.3 Radiological Impacts

The radiological impacts associated with SIS operation at the INEL would result from normal atmospheric emissions and incremental releases and exposures attributable to the handling, processing, and disposal of radioactively contaminated solid wastes (i.e., transuranic or TRU waste, mixed waste, and low-level radioactive waste or LLW). The following sections discuss each of these areas.

Atmospheric Emissions

During SIS operations, small quantities of radioactive material would be released to the atmosphere from the PPB stack. The source term of this routine atmospheric emission is 1.4×10^{-2} microcurie per year, with the isotopic mix as listed in Table 4-7.

Based on this source term and the parameters related to potential pathways for human exposure identified in Appendix A, radiological doses were calculated for a hypothetical maximally exposed individual (i.e., an individual whose location and habits maximize the radiation dose received) and for the estimated year-2010 population, or expected mid-life of the SIS Project, within an 80-kilometer (50-mile) radius of the SIS Project. The radiological doses were calculated using the AIRDOS-EPA computer code (Moore et al., 1979), which has been approved by EPA for demonstrating compliance with the National Emission Standards for Hazardous Air Pollutants (NESHAP) (40 CFR 61, Subpart H).

The radiological doses calculated for the maximally exposed individual postulated that an individual would continuously reside at a location on the INEL site boundary nearest the SIS Project (i.e., a distance of about 14.0 kilometers or 8.7 miles from the SIS Project) and that the highest annual average concentrations of radionuclides would also occur at this same location. For the year-2010 offsite population within an 80-kilometer (50-mile) radius of the SIS Project, population doses were calculated for a population of 230,129 persons and a population of 151,922 as discussed in Section 3.1.3.1.

The radiological doses calculated by the AIRDOS-EPA computer code and presented in this Environmental Impact Statement (EIS) are committed dose equivalents (i.e., they are the sum of the internal 50-year committed dose equivalent received by an organ or the whole body from ingestion and inhalation during the year of release and the external dose equivalent received during 1 year from exposure to radionuclides in the air and those deposited on the ground). Internal 50-year committed dose equivalents were calculated based on data presented in the International Commission on Radiological Protection (ICRP) Publication 30 (ICRP, 1979). External dose equivalents were calculated based on information presented in Kocher (1981) and assume a continuous annual exposure during the year of release. Appendix A of this EIS compares the dose equivalents calculated using ICRP Publication 30 with those calculated using the RADRISK data base (Dunning, Legett, and Yalcintas, 1980), which uses a methodology consistent with ICRP Publication 30. The RADRISK data base is provided with the AIRDOS-EPA computer code. In addition to the calculation of dose equivalents, an

Table 4-7. Routine Annual Radioactive Atmospheric Release

Isotope	Weight percent	Curies
Plutonium-238	0.1	1.3×10^{-10}
Plutonium-239	79.5	3.8×10^{-10}
Plutonium-240	18.5	3.3×10^{-10}
Plutonium-241	1.6	1.3×10^{-8}
Plutonium-242	0.3	9.2×10^{-14}
Americium-241	1.0	2.7×10^{-10}

effective dose equivalent (EDE) was calculated based on the weighting factors presented in ICRP Publication 26 (ICRP, 1977).

Estimated risks of health effects associated with the routine atmospheric emissions were determined by using health effect risk estimators for high-linear-energy-transfer (LET) radiation as contained in the Biological Effects of Ionizing Radiation (BEIR) III Report. For genetic effects, the health effect risk estimator of 257 genetic effects per million person-rem of high-LET radiation received by the gonads was multiplied by the calculated committed dose equivalent to the gonads presented in Appendix A. For cancer fatalities, each organ committed dose equivalent was multiplied by the appropriate health effect risk estimator and the resultant products summed. The individual health effect risk estimators used for cancer fatalities total 280 cancer fatalities per million person-rem for high-LET radiation.

The BEIR III report suggests that for high-LET radiation, use of the linear model represents the best way to determine probable risk; therefore the linear model was used. However, because its appropriateness for high-LET radiation has not been definitely established, it is possible that the potential number of fatal cancers associated with SIS Project operations is lower than presented in this EIS. This would be the case if either the linear-quadratic or quadratic model would be determined to be more appropriate for high-LET radiation than the linear model. Indeed, if the quadratic model were used, the number of potential fatal cancers could approach zero.

Appendix A provides a more detailed discussion of the methodology used to calculate routine radiological doses and consequences. The following paragraphs discuss the results of the analyses for routine atmospheric emissions.

Maximum Individual

The highest organ (bone surface) and whole-body committed dose equivalents received by the maximally exposed individual were calculated to be 8.2×10^{-7} and 1.3×10^{-8} millirem, respectively. The maximally exposed individual's EDE was calculated at 6.2×10^{-8} millirem. The inhalation pathway contributed over 99 percent of these doses. The calculated EDE of 6.2×10^{-8} (i.e., 0.000000062) millirem is insignificant in comparison with the 25-millirem standard as contained in EPA's NESHAP. A discussion of cumulative doses (i.e., from SIS and other INEL operations) and compliance with NESHAP is contained in Section 4.5.1.4.

Based on the risk estimator of 257 genetic effects per million person-rem to the gonads, the annual risk of genetic disorders to the maximally exposed individual is about 1.5×10^{-15}. Based on the health effect risk estimators for cancer fatalities per million person-rem, the annual risk of a latent cancer fatality to the maximally exposed individual is about 2.1×10^{-14}. The organ of the maximally exposed individual that poses the highest annual risk of a latent cancer fatality is the lung (the risk being 9.8×10^{-15}).

Population

The collective EDE and the collective whole-body dose equivalent received by the offsite population within an 80-kilometer (50-mile) radius of the SIS Project in the year 2010 from normal atmospheric emissions were calculated to be 1.1×10^{-7} and 2.3×10^{-8} person-rem for a year-2010 population of 230,129 persons and 7.0×10^{-8} and 1.5×10^{-8} for a year-2010 population of 151,922 persons, respectively. The collective whole-body dose that would be received by the same populations during the year 2010 from sources other than natural background radiation (see Table 3-3) would be about 28,000 person-rem for a population of 230,129 persons, or about 18,500 person-rem for a population of 151,922 persons.

Based on the health effect risk estimators for genetic effects and cancer fatalities, the population within an 80-kilometer (50-mile) radius of the SIS Project would experience about 2.5×10^{-12} genetic disorder and about 3.5×10^{-11} latent cancer fatality from maximum annual routine atmospheric emissions during the year 2010 using the higher year-2010 population of 230,129 persons.

Other Biota

Radiation doses received by wildlife and crops from radioactive material released during normal SIS operations are expected to be similar to those received by humans. External doses to humans would be slightly higher than those to other biota, while internal doses are expected to be within an order of magnitude. This difference in internal doses is due to the different pathways and metabolism involved (e.g., humans and animals can breathe and ingest radioactive material, while crops can absorb radioactivity through roots and foliage). Since the doses to humans are expected to be extremely small, the same is expected for doses to wildlife and crops. For wildlife and crops located closer than humans to the radioactivity release points, the doses would be somewhat higher but still small.

There is a direct correlation between the biological complexity of an organism and its sensitivity to radiation (BEIR, 1972). Because the doses received by humans, very complex organisms, result in insignificant impacts, doses received by other biota likewise result in insignificant impacts. Further, the ICRP in Publication 26 (ICRP, 1977) states that it believes that if humans are adequately protected from radiation, then other living things are also likely to be sufficiently protected.

Radioactive Solid Wastes

Operation of SIS facilities would require the annual disposal of approximately 30 metric tons (33 tons) of LLW and up to 400 metric tons (440 tons) of TRU waste meeting Waste Isolation Pilot Plant (WIPP) Waste Acceptance Criteria (WAC). In addition to these radioactive solid wastes, up to about 10 metric tons (11 tons) of mixed waste (i.e., radioactive waste having hazardous characteristics as defined by RCRA) would be generated by SIS operations.

Low-Level Radioactive Solid Waste

The LLW requiring disposal would consist of low-activity room-generated solid wastes. These wastes would be packed in drums, nondestructively assayed, and disposed of at the existing Subsurface Disposal Area (SDA) of the Radioactive Waste Management Complex (RWMC). All LLW generated by INEL operations since 1952 has been disposed of in the SDA. Approximately 100,000 cubic meters (3,531,000 cubic feet) of LLW is presently buried in the SDA, estimated from yearly disposal volumes. The volume of LLW generated by SIS would be approximately 30 cubic meters (1060 cubic feet) per year, assuming a waste density of 0.96 gram per cubic centimeter for drummed LLW (Mishima et al., 1986). This quantity represents about 0.8 percent of the total annual volume of LLW being disposed of at the SDA. An assessment of continued operation of the SDA indicates that the maximum individual and population EDEs due to continued SDA operation are 0.2 millirem and 0.7 person-rem per year, respectively, for all internal pathways (i.e., inhalation and ingestion).

To bound the potential consequences of SIS LLW disposal in the SDA, the potential radiological dose to an individual consuming ground water from a well at the edge of an SDA burial pit was calculated based on (1) the ground-water transport model described in <u>The Environmental Evaluation of Alternatives for Long-Term Management of Defense High-Level Radioactive Wastes at the Idaho Chemical Processing Plant</u> (DOE, 1982a), and (2) postulating that all 30 metric tons of LLW would be contaminated at a level slightly below that of TRU waste (i.e., less than 100 nanocuries per gram) with the radionuclides listed in Table 4-7. Both the ground-water transport model described in DOE (1982a) and the postulated level of contamination of SIS LLW are extremely conservative approaches (i.e., result in overestimating consequences) in the assessment of potential consequences of disposal of SIS LLW. The SIS LLW is not expected to be contaminated to the level postulated and the ground-water model provides for (1) approximately one-half of the annual average precipitation infiltrating the ground and coming into contact with the waste, (2) no retardation coefficient or radioactive decay for radionuclide migration in lava rock beneath the SDA, and (3) no ground-water dilution due to downgradient ground-water migration.

Using these conservative approaches, the EDE to an individual that would result from drinking well water was calculated to be only 0.090 millirem per year, using ICRP-26 and ICRP-30 dose commitment and weighting factors as previously cited. In comparison with the on-going LLW disposal at the SDA, SIS LLW would result in only a small fraction of the calculated doses from on-going SDA operations and would be well below EPA's drinking water standard of 4 millirem per year.

As previously identified in Section 3.1.4.4, results of INEL ground-water and core sampling at the RWMC have detected the presence of minute quantities of carbon tetrachloride (i.e., at 1 of 5 wells in quantities of 2 to 6 parts per billion) and other organics in lesser quantities, which are believed to have been contained in waste shipped to the INEL prior to 1969, and extremely low levels of plutonium at depths of 33 meters (110 feet) and 70 meters (230 feet). DOE is currently conducting an expanded monitoring program and study to determine the extent of contamination and the most appropriate means of remedial action, if such action is required. The current monitoring results indicate that the detected levels of contaminants do not pose a health threat and that the detected plutonium will not reach the Snake River Plain aquifer in detectable quantities. DOE officials at the INEL have entered into an agreement with EPA that provides EPA with regulatory authority under RCRA over hazardous waste at the INEL.

Because the additional LLW generated by the SIS Project would be less than 0.8 percent of the annual volume of LLW disposed of at the SDA, the disposal of SIS-generated LLW would not affect future determinations regarding potential actions to protect ground water at the RWMC.

Transuranic Waste

All TRU waste generated by SIS operation is planned to be transported off the INEL to the WIPP located near Carlsbad, New Mexico (see Section 2.1.5.1, Solid Wastes). The TRU waste generated would amount to 400 metric tons (440 tons) per year. Assuming a TRU waste density of 1.8 grams per cubic centimeter for grouted waste (Mishima et al., 1986), the volume of TRU waste that would be generated would amount to 220 cubic meters (7770 cubic feet) per year, or about 0.1 percent of the estimated volume of TRU waste to be emplaced at the WIPP. Before disposal at the WIPP, the TRU waste would be packaged and certified in accordance with WIPP acceptance criteria.

As of 1986, there were an estimated 76,000 cubic meters (2,470,800 cubic feet) of TRU waste in retrievable storage at the RWMC that are to be disposed of at the WIPP, and the estimated annual receipt/handling of TRU waste at the INEL is approximately 2500 cubic meters (88,250 cubic feet) per year. The amount of TRU waste that would be generated by SIS operation would represent a maximum increase of 10 percent in the volume of TRU waste generated, processed, and stored at the INEL per year.

The environmental effects of retrieving, processing, packaging, storing, and transporting INEL TRU waste were discussed extensively in the Final EIS for the WIPP and in the environmental and other evaluations of defense TRU waste at the INEL (DOE, 1980 and 1982c). Under all normal TRU waste handling, processing, and storage conditions, the potential environmental consequences of the additional quantity of TRU waste (i.e., up to 220 cubic meters per year) that would be generated by SIS operation would be negligible. Section 4.1.2.4 of this EIS includes an analysis of the potential consequences of the routine transport of SIS-generated TRU waste to the WIPP.

Mixed Wastes

During SIS operation, up to 10 metric tons (11 tons) of mixed waste would be generated primarily as a result of MPCL activities. The total estimated annual volume of SIS-generated mixed waste would represent about 15 percent of the total mixed wastes generated at the INEL in 1986 (i.e., 35,800 liters).

Mixed wastes, like hazardous wastes, would be contained at their point of generation where no more than 208 liters (55 gallons) would be allowed to accumulate. Within 72 hours of being filled, the container of mixed waste would be taken either to a mixed-waste staging area for shipment off the site within 90 days or to an approved onsite interim storage facility.

Mixed wastes would be stored at the INEL Radioactive Mixed Waste Storage Facility located in the Special Power Excursion Reactor Test (SPERT) IV area. The INEL has submitted a RCRA Part A permit for this facility. A Part B application has also been submitted and will be updated as necessary. Mixed waste would be stored onsite until its disposition is determined, or an offsite TSD facility for such waste is available.

A Part B permit application as required by RCRA has also been submitted and will be updated as required for use of the Process Experimental Pilot Plant (PREPP) in treatment of hazardous and mixed waste. DOE is currently preparing an Environmental Assessment (EA) to analyze the potential environmental impacts of processing mixed waste at the PREPP.

4.1.2.4 Routine Transport of Materials

During SIS operation, the DOE transportation safeguards systems would be used for the offsite transport of SIS feed and product materials. All material shipments would be conducted in accordance with DOT regulations (49 CFR 170-179) for transport. The quantity of material contained in packages is limited so that the standards for external radiation levels, temperature, pressure, and containment are not exceeded.

The environmental consequences associated with routine (nonaccident) transport of plutonium for the SIS Project (i.e., plutonium feed from the Hanford Site and the SRP to the INEL, plutonium metal product from the INEL to the Rocky Flats Plant, transport of plutonium by-product if DOE determined that SIS by-product was not usable for other missions, TRU waste from the INEL to the WIPP, and onsite transport of LLW) have been calculated and are presented in Section A.3 of Appendix A. The radiological impacts were calculated using the RADTRAN computer system (Madsen et al., 1986). Data used in the analysis included the properties of the material being transported, the characteristics of the shipping containers and transport vehicle, the number of shipments and distances traveled, and the population distribution around actual routes to and from the facilities involved. Section A.3 of Appendix A provides a detailed discussion of the modeling of the transport of radioactive materials including transport containers, the safe secure transport (SST), and accident rates.

The radiological impacts result from direct external exposure to people sharing the roads with transport vehicles and those living near the roads. The annual population dose to this group from SIS material shipments was calculated to be less than 12 person-rem. The corresponding risk of radiation-induced health effects for this same population is 3.5×10^{-3} latent cancer fatality and 1.6×10^{-3} genetic disorder. The majority (i.e., about 60 percent) of this transportation risk would result from the transport of by-product material to the WIPP. The remaining 40 percent would result from feed, product, and TRU waste shipments. The 12 person-rem dose to the population would be extremely small (e.g., less than 3 percent of the dose received by a population of 100,000 persons from consumer and industrial products).

4.1.3 Potential Impacts of a Spectrum of Postulated Accidents

Accidents can be postulated that would have the potential for affecting individuals and populations outside the SIS facilities during their operation. These postulated accidents include (1) SIS facility accidents that could result in severe offsite consequences, and (2) severe accidents involving the transport of plutonium feed, product, and by-product.

To determine the potential SIS facility accidents which would dominate consequences, a preliminary hazards evaluation was initially performed to identify those hazards (e.g., industrial, mechanical, and exposures to radiological, hazardous, and toxic substances) that could conceivably result from malfunctions of systems, improper operating conditions, operator error, and natural phenomena. The preliminary hazards evaluation was then used to assess the capability of the facilities (based on their preliminary design) to preclude or mitigate potential hazards by postulating accidents for each major hazard category. Postulated accidents are considered for the purpose of determining maximum consequences that are reasonably foreseeable and, therefore, whether a facility poses acceptable risk to the general public and workers. Critical safety systems are expected to fulfill their safety functions and maintain their integrity for Design-Basis Accidents (DBAs); in addition, severe accidents (i.e., beyond the design basis) have been examined to assess the risks associated with very unlikely events. Section 4.1.3.1 discusses postulated DBAs and their consequences, including the consequences if the high-efficiency particulate air (HEPA) filter systems are not performing to their design. Section 4.1.3.2 provides an additional perspective of the risk associated with the SIS Project by discussing a severe facility accident.

For the SIS Project, six facility accident categories based on the preliminary hazards evaluation were identified as having the potential for severe consequences. These categories were fires, nuclear criticalities, loss of utility (e.g., electricity and cooling water), uncontrolled chemical reactions, natural phenomena (e.g., tornadoes, snow loading, earthquakes, floods), and those of external origin. The postulated accidents within these categories that produced the greatest release of material were then analyzed to determine potential consequences. The postulated accidents with the highest, or most severe, consequences involved the PPB where plutonium is located and include (1) a fire in a single PPB process area, (2) a nuclear criticality, (3) an uncontrolled chemical reaction, and (4) a Design-Basis Earthquake (DBE). For this EIS, the DBE was postulated to be followed by fires to provide an added level of conservatism to the calculated consequences (i.e., fires after the occurrence of a DBE result in higher offsite consequences). In addition, to further bound the potential consequences, a severe (beyond DBA) accident is postulated of undefined origin with a very low probability of occurrence, representing a scenario that further degrades engineered and administrative safety features. Table 4-8 lists the preliminary probability ranges for each facility

Table 4-8. Likelihood of Occurrence of Accident Events Considered[a]

Postulated facility accident	Event probability for HEPA efficiency				
	Full[b]	99%	90%	50%	0%
Glove-box incident		$>10^0$			
Plutonium fire in a single area	10^{-4} - 10^{-6}	10^{-4} - 10^{-6}	$<10^{-6}$		
Criticality	10^{-4} - 10^{-6}	--c	--c		
Uncontrolled chemical reaction	10^{-4} - 10^{-6}	10^{-4} - 10^{-6}	$<10^{-6}$		
Design-basis earthquake followed by fire	10^{-4} - 10^{-6}	10^{-4} - 10^{-6}	$<10^{-6}$		
Severe			$<10^{-6}$	$<10^{-6}$	$<10^{-6}$

[a] Likelihood, or probability of $>10^0$ read as likelihood of occurrence of greater than once per year, 10^{-4} to 10^{-6} as likelihood of occurrence of between once in ten thousand to once in a million per year, and $<10^{-6}$ as likelihood of occurrence of less than once in a million per year.

[b] Full filter efficiency is conservatively assumed to be 99.9 percent for the first stage and 99.8 percent for the second stage of HEPA filtration.

[c] Not significantly affected by HEPA filter efficiency.

accident event considered, including the severe accident, for the various degraded HEPA filter cases considered.

The facility accidents with the highest consequences discussed in this section bound the consequences of many other potential severe facility accidents. For example, the postulated accident for the LSF having the most severe consequences is a rupture of the supply and return ethanol piping in the Dye Pump Building (DPB), leading to an alcohol spill of sufficient magnitude that an explosion occurs followed by a fire. Offsite consequences of the explosion followed by the fire would consist only of smoke, heat, and very small amounts of dye that would not undergo thermal degradation at the fire temperature. Similarly, the postulated accident for the Stand-Alone Storage Vault having the most severe consequences is a nuclear criticality accident that would have potential offsite consequences identical to those for the criticality accident in the PPB. An ion-exchange accident involving a rupture of the ion-exchange column and glove box was also found to have less severe consequences than those for an uncontrolled chemical reaction. To provide a perspective on both the probability of occurrence and consequences of the accidents having the most severe consequences, a high-probability, low-consequence accident (i.e., glove-box incident) has also been included in this Final EIS in Section 4.1.3.1.

The SIS facilities (i.e., DPB, Stand-Alone Storage Vault, and PPB) are physically separate (e.g., by barrier or distance) such that accidents in one facility would not propagate to adjacent facilities. The design safety features associated with the storage of plutonium in the Stand-Alone Storage Vault (e.g., the vault and storage racks) are designed to preclude any release caused by the accelerations up to and including those associated with the DBE. With the exception of insulation on instrument wiring, there are no combustibles in the vault, no chemical reactions conducted, nor any plutonium in an oxidizable form, and the plutonium is triple-contained. Similarly, the SIS facilities are physically separated from other ICPP facilities, such that an accident in any SIS facility would not propagate to an ICPP facility nor would a common designed safety feature or system (i.e., a single designed safety feature or system that serves both SIS and ICPP facilities) be required to achieve a safe shutdown. Furthermore, as discussed in Section 4.1.4, the radiological doses to a worker within the ICPP area as a result of a postulated DBA with the provided designed safety systems at the SIS PPB would not exceed the DOE standard of 5 rem per year for occupationally related internal and external exposures to radiation.

The accidents described in Section 4.1.3.1 and the releases of radionuclides in the event of these accidents are based on the best available data, given the current design of the facilities, and on the basis of experience gained from other plutonium facilities and operations. The accident scenarios are not predictions that any one or more of these accidents would occur.

In addition to the postulated SIS facility accidents that dominate the consequences, analyses of severe (beyond design-basis) accidents involving the transport of SIS materials were performed. Section 4.1.3.3 discusses these transport accidents and their resulting consequences.

The material presented in Sections 4.1.3.1 and 4.1.3.2 will be factored into the emergency planning and preparedness for the SIS facility, thus ensuring that the full spectrum of potential impacts has been considered (see Section 4.6).

4.1.3.1 Postulated Facility Accidents

The following sections describe a high-probability, low-consequence accident and postulated DBAs, discuss the prevention and mitigation of accident consequences, and present the potential consequences, including those resulting from HEPA filter systems not performing to their design specifications.

The potential consequences of the SIS facility accidents were calculated using the CRAC2 computer code, which is a revised version of the code CRAC (Calculation of Reactor Accident Consequences) developed for use in the Reactor Safety Study (NRC, 1975). The exposure pathways modeled by CRAC2 consist of three elements. First, there is inhalation of radioactive material from the passing cloud. Second, there are cloudshine and groundshine, the irradiation of body organs by gamma rays emitted by the passing cloud or by radioactive products deposited on the ground. Third, there are chronic exposure pathways, which include (1) resuspension of deposited radioactive material by the wind; (2) long-term exposure to gamma rays from deposited radionuclides, especially cesium, including the effects of weathering; (3) consumption of milk; (4) consumption of milk products; (5) consumption of contaminated vegetation; and (6) consumption of crops contaminated by root intake.

The inhalation dose conversion factors, the cloudshine and groundshine dose conversion factors, and the treatment of the chronic exposure pathways in CRAC2 are the same as those used in the Reactor Safety Study (NRC, 1975). For the analyses of SIS facility accidents, these dosimetry models were updated using information from work done recently at Sandia Laboratories (Ostmeyer and Runkle, 1985). The recommendations from this publication are based on models in ICRP Publications 26 and 30 (ICRP, 1977 and 1979) and models developed by Kocher (1979). Similarly, the CRAC2 ingestion model, which is based on ingestion of strontium and cesium, was replaced with one based on ingestion of plutonium and iodine, on the basis of work by Bennett (1976), Martin and Bloom (1976), and Drobinski, Magno, and Goldin (1966). Ingestion dose conversion factors were taken from Ostmeyer and Runkle (1985).

The doses presented are committed dose equivalents similar to those previously discussed for routine releases (i.e., they account for the fraction of radionuclides retained in the body for 50 years following the period of intake). The number of calculated latent cancer fatalities and genetic effects due to accidental releases is based on 280 latent cancer fatalities and 257 genetic disorders per million person-rem (i.e., assuming radiation to be high-LET radiation). Section A.2 of Appendix A provides a further discussion of the CRAC2 code and its application to the analysis of SIS facility accidents.

For all the postulated accidents discussed in this section, there are no offsite cases of early fatalities or early injuries. With 99-percent filter efficiency, the highest dose to a maximum individual is 4.5×10^{-4} rem from the postulated criticality event, and the highest dose to a maximum individual with 90-percent filter efficiency is 2.8×10^{-2} rem from the postulated DBE followed by fire. Consequences to onsite workers as a result of accidents are discussed in Section 4.1.4.3.

The CRAC2 computer model contains an economic consequences code that estimates the direct costs of measures needed to mitigate the potential public health effects of an accident, including costs of evacuation, milk and crop disposal, decontamination, and land-use prohibition. For all the accident scenarios considered, including the postulated severe accident with complete loss of HEPA filtration, the releases of radioactivity in the event of the accidents described in the following sections are not of sufficient magnitude to require costs for mitigation. Potential economic costs, including economic losses to agriculture and tourism, are therefore not presented in this EIS.

High-Probability Low-Consequence Accident

To provide a perspective on the probability of occurrence and the potential consequences of the accidents having the most severe consequences described in the following sections, a high-probability incident (i.e., estimated to occur more than once a year) was evaluated. This incident is a glove-box operation-related contamination incident in which an operator might rupture a glove or a bag in a plutonium-oxide handling glove box. The rupture is postulated to contaminate an area up to 9 square meters (100 square feet). Using a conservative release fraction of 1×10^{-2} (Selby et al., 1975) and a filter efficiency of 99.97 percent for the first stage of filtration and 99.95 percent for the second and third stages, the total amount of radioactivity released is calculated to be 4.7×10^{-10} microcurie.

The calculated radiological dose to an offsite individual would be less than 1.2×10^{-14} millirem, or approximately 3×10^{-8} percent less than the normal radiological emissions from the PPB. Radiological doses to the offsite population within an 80-kilometer (50-mile) radius would be equally insignificant.

Postulated Plutonium Processing Building Fire - Single Area

Described in Section 2.1.1 are the various operations and processes to be conducted in the PPB. Different amounts of plutonium are handled in the various operations. However, on average, 7 kilograms (15 pounds) of plutonium would be at risk in any given single process area. Material at risk is that material which might be exposed as a result of the accident, while contained material is that material which would not be exposed as a result of the accident. The following accident is postulated to be a fire in a process area that involves the maximum amount of plutonium at risk. Discussed later in this section is a facility-wide fire involving all plutonium at risk (25 kilograms or 55 pounds) in the facility.

Multiple levels of protection are provided to prevent occurrence of fire in the PPB. In particular, the glove boxes where the plutonium would be at risk will have atmospheres of nitrogen or argon (which also maintains plutonium purity). Isolation between glove boxes is provided by doors in the conveyor systems and by the rooms housing the glove boxes. Releases from the glove boxes and/or rooms will normally be filtered by three or two stages of testable HEPA filtration, respectively. Nonflammable construction materials will be specified. Electrical systems will be designed to minimize ignition sources. Combustible loadings in the PPB will be strictly limited. The last two stages of HEPA filters on both the glove-box and room ventilation systems will be protected by dedicated fire suppression systems. A fire detection and alarm system and an automatic sprinkler system will be provided for the rooms housing the glove boxes.

The normal airflow is from a glove box to the glove-box exhaust filtration system. However, it is postulated that once the fire reached the glove box itself, the box could possibly be pressurized, and products of combustion could migrate into the room from the box. The airborne activity could then follow a path through the room ventilation and filtration systems. As previously noted, it is estimated that the average plutonium available in a processing area at any given time would be approximately 7 kilograms. The fraction released in the postulated fire is 5×10^{-4} based on relative amounts of each form of plutonium (i.e., metal, oxide, and hydride) at risk. For conservatism, all forms readily converted to oxide (e.g., hydride) were added to the oxide total as listed in Table 4-9 and the weighted average rounded to 5×10^{-4}. Thus, the total amount of plutonium that would be available for airborne transport from a processing area is conservatively assumed to be 3.5 grams. Because of the large volume of the process area, the relatively small amount of plutonium available, the fire wall separation, and the fire doors, the fire would not spread to adjacent rooms.

The airborne plutonium released as a result of the fire would be exhausted through a two-stage HEPA final filtration system. Three cases are examined. The full filter efficiency for accident conditions is assumed in Case 1 to be 99.9 percent for the first stage and 99.8 percent for the second stage (Elder et al., 1986), both of which are less than the normal operational efficiency of HEPA filters. To determine the consequences of the HEPA filter systems not performing to their design efficiencies, a parametric study was done in which in Case 2 only one filter performs as designed (99.9 percent efficiency), and in Case 3 the combined filter efficiency is reduced to 90 percent (reduction of a further factor of 100) to provide a conservative filter degradation case. The releases are assumed to have an isotopic distribution as shown in Table 4-7. The release point of the PPB exhaust is from the PPB stack.

The calculated consequences from the postulated fire in a single area to an individual at distances of 0.4, 1.2, 5.2, 10.2, and 14.0 kilometers for full and partial filter efficiencies are listed in Table 4-10. The 0.4-kilometer distance corresponds to the distance from the SIS PPB to the main processing building within the ICPP. The 14 kilometers is the nearest site boundary. The calculated whole-body doses to a maximum individual at the INEL site boundary are 1.6×10^{-7} rem for Case 1, 7.9×10^{-5} rem for Case 2, and 7.9×10^{-3} rem for Case 3. The maximum individual dose to a worker in the ICPP area for all filter efficiency cases would be less than the 5-rem DOE occupational exposure standard.

Table 4-9. Release Fraction for Glove Box in Solid Form[a]

Form	Percent of mass at risk	Fraction available for release[b]	Weighted average release fraction
Oxide	40	1×10^{-3}	4×10^{-4}
Metal	60	1×10^{-5}	6×10^{-6}
Total	100		4×10^{-4}

[a] Sources considered: Elder, 1988; Mishima, 1966; Selby et al., 1975; Stewart, 1961; Walker, 1978.

[b] Fraction represents amount of material hypothetically available for release based on Stewart (1961) for oxide, Mishima (1966) for metal, and the inclusion of a factor of 10^{-1} derived based on the evaluation of the sources identified in footnote "a" above to account for deposition and fallout of only the material contained in the glove box.

Table 4-10. Consequences of a Postulated Plutonium Building Fire at the INEL

Organ	Distance (km)	Dose in rem Case 1[a]	Case 2[b]	Case 3[c]
Bone marrow/whole body	0.4	3.6×10^{-6}	1.8×10^{-3}	1.8×10^{-1}
Bone surface	0.4	4.6×10^{-5}	2.3×10^{-2}	2.3×10^{0}
Lung	0.4	8.0×10^{-6}	4.0×10^{-3}	4.0×10^{-1}
Bone marrow/whole body	1.2	2.8×10^{-6}	1.4×10^{-3}	1.4×10^{-1}
Bone surface	1.2	3.4×10^{-5}	1.7×10^{-2}	1.7×10^{0}
Lung	1.2	6.0×10^{-6}	3.0×10^{-3}	3.0×10^{-1}
Bone marrow/whole body	5.2	9.6×10^{-7}	4.8×10^{-4}	4.8×10^{-2}
Bone surface	5.2	1.2×10^{-5}	6.1×10^{-3}	6.1×10^{-1}
Lung	5.2	2.2×10^{-6}	1.1×10^{-3}	1.1×10^{-1}
Bone marrow/whole body	10.2	3.2×10^{-7}	1.6×10^{-4}	1.6×10^{-2}
Bone surface	10.2	4.0×10^{-6}	2.0×10^{-3}	2.0×10^{-1}
Lung	10.2	7.2×10^{-7}	3.6×10^{-4}	3.6×10^{-2}
Bone marrow/whole body	14.0	1.6×10^{-7}	7.9×10^{-5}	7.9×10^{-3}
Bone surface	14.0	2.0×10^{-6}	1.0×10^{-3}	1.0×10^{-1}
Lung	14.0	3.4×10^{-7}	1.7×10^{-4}	1.7×10^{-2}

[a] Case 1 is full filter efficiency.
[b] Case 2 is 99.9-percent filter efficiency.
[c] Case 3 is 90-percent filter efficiency.

The calculated offsite population doses to 230,129 persons in the year 2010 for Case 1 are 4.2×10^{-5} person-rem; for Case 2, 2.1×10^{-2} person-rem; and for Case 3, 2.1 person-rem. The numbers of latent cancer fatalities and genetic disorders in the population surrounding the INEL, based on 280 latent cancer fatalities and 257 genetic disorders per million person-rem, range from 1.2×10^{-8} latent cancer fatality and 1.1×10^{-8} genetic disorder for Case 1 to 5.9×10^{-4} latent cancer fatality and 5.4×10^{-4} genetic disorder for Case 3. The annual risk of a latent cancer fatality and genetic disorder in the population for Case 3 using a probability of occurrence of less than 10^{-6} (see Table 4-8) is less than 5.9×10^{-10} for a latent cancer fatality and 5.4×10^{-10} for a genetic disorder, and the cumulative risk for 30 years of SIS operation is less than 1.8×10^{-8} for a latent cancer fatality and 1.6×10^{-8} for a genetic disorder. Intermediate distances are provided for comparative purposes.

Postulated Nuclear Criticality

The processing and handling of fissile material in the PPB have a potential for the occurrence of a criticality event. Measures to prevent the occurrence of criticality would be taken in accordance with DOE Orders and, in particular, DOE Order 5480.1B. The preferred criticality-prevention measures are design safety features.

Three general PPB fissile systems were examined from the standpoint of a criticality:

1. Metal systems representing the PPB vault and major processing steps in the separator and pyrochemical process glove boxes

2. Aqueous system representing the recovery and waste dissolution and ion-exchange processes

3. Powder/liquid slurries system representing postulated plutonium oxide and plutonium hydride systems.

To determine the consequences of a criticality accident, the releases from a postulated nuclear excursion occurring in the aqueous process were used. The release from a postulated criticality in an aqueous process was selected, as criticalities in metal systems typically result in lower fission yields, because the energy release tends to break apart the critical assemblage, shutting down the event. In addition, very few, if any, fission products (including noble gases) are released in metal-system criticalities, because they are trapped in the metal matrix.

From the criticality accident, the size of the criticality was derived from an examination of material volumes/masses available in the process. A total of 1×10^{19} fissions is assumed based on U.S. Nuclear Regulatory Commission (NRC) Regulatory Guide 3.35. All the noble gas fission products and 25 percent of the halogens resulting from the criticality event are postulated to be released via the stack. There would also be particulate fission products generated from the criticality. For this case, it is postulated that 1.0 percent of the particles would be released from the material that was involved. Any particles released would pass through two stages of HEPA filtration in which the first stage would trap 99.9 percent of the particulates, and the second stage would trap 99.8 percent of what passes through the first stage (Elder et al., 1986), either of which is less than the normal operational efficiency of HEPA filters.

The predicted release from the PPB stack is listed in Table 4-11 and the calculated consequences using the CRAC2 computer code are listed in Table 4-12. The doses resulting from this event are due almost entirely to the noble gases and halogens. The gases and halogens are not affected by filtration. Total loss of filtration would not cause a significant increase in the resultant doses. Therefore, Case 2 and 3 doses for this accident were not presented. The calculated whole-body dose to a maximum individual at the INEL site boundary is 4.5×10^{-4} rem. The maximum individual dose to a worker in the ICPP area (i.e., at 0.4 kilometer) of 3.8×10^{-2} rem would be less than the 5-rem DOE occupational exposure standard.

The calculated offsite population dose to 230,129 persons in the year 2010 for the postulated criticality event is 2.6×10^{-2} person-rem. The numbers of latent cancer fatalities and genetic disorders in the population surrounding the INEL, based on 280 latent cancer fatalities per million person-rem, would be about 7.3×10^{-6} and 6.7×10^{-6}, respectively. The annual risk of a latent cancer fatality and genetic disorder in the population would be less than 7.3×10^{-10} and 6.7×10^{-10}, respectively, and the cumulative risk for 30 years of SIS operation would be less than 2.2×10^{-8} for a latent cancer fatality and 2.0×10^{-8} for a genetic disorder.

A review of the consequences of criticality indicates that the accident scenario and analysis used for the SIS PPB would also bound a criticality event in the Stand-Alone Storage Vault.

Postulated Uncontrolled Chemical Reaction

Operations in the PPB that have the greatest likelihood for an uncontrolled chemical reaction and subsequent release of radioactivity are the hydriding and dehydriding processes in which hydrogen gas is involved. If sufficiently high concentrations of hydrogen and oxygen were present together with an ignition source, an explosion would occur.

In the hydriding process, collector plates with the product plutonium would be received from the separation process and placed into a hydriding vessel or tub. Hydrogen would be drawn through the vessel where the hydrogen reacts with the plutonium on the collector plate, allowing the plutonium to spall from the collector plate and fall to the bottom of the vessel in particulate form. In the dehydriding process, hydride powder would be heated in a furnace to drive off hydrogen and produce plutonium metal.

The equipment and facilities necessary to support the hydriding and dehydriding processes are designed to prevent an uncontrolled chemical reaction. The reaction would be carried out in a closed system. The gas delivery system would be equipped with a shutoff mechanism that would close when oxygen concentrations become too high in the supply or in the glove box or the exhaust. Instrumentation would activate alarms if gas concentrations above a set limit are detected. Hydrogen gas resulting from the dehydriding

Table 4-11. Stack Releases from a Postulated Criticality Accident at the INEL

Nuclide	Activity (Ci)
Kr-83m	1.1×10^{2}
Kr-85m	7.1×10^{1}
Kr-85	8.1×10^{-4}
Kr-87	4.3×10^{2}
Kr-88	2.3×10^{2}
Kr-89	1.3×10^{4}
Xe-131m	1.0×10^{-1}
Xe-133m	2.2
Xe-133	2.7×10^{1}
Xe-135m	3.3×10^{3}
Xe-135	4.1×10^{2}
Xe-137	4.9×10^{4}
Xe-138	1.1×10^{4}
I-131	2.8
I-132	3.0×10^{2}
I-133	4.0×10^{1}
I-134	1.1×10^{3}
I-135	1.1×10^{2}
Pu-238[a]	1.2×10^{-9}
Pu-239	5.4×10^{-11}
Pu-240	1.2×10^{-10}
Pu-241	3.6×10^{-8}
Pu-242	8.6×10^{-13}
Am-241	4.8×10^{-11}

[a] The particulate source terms are based on NRC Regulatory Guide 3.35 and represent the NRC recommended mix.

Table 4-12. Consequences of a Postulated Criticality Accident at the INEL

Organ	Distance (km)	Dose (rem)
Bone marrow/whole body	0.4	3.8×10^{-2}
Bone surface	0.4	2.5×10^{-2}
Lung	0.4	2.6×10^{-2}
Thyroid	0.4	2.3×10^{-1}
Bone marrow/whole body	1.2	1.5×10^{-2}
Bone surface	1.2	1.0×10^{-2}
Lung	1.2	1.0×10^{-2}
Thyroid	1.2	9.0×10^{-2}
Bone marrow/whole body	5.2	3.6×10^{-3}
Bone surface	5.2	2.4×10^{-3}
Lung	5.2	2.5×10^{-3}
Thyroid	5.2	2.2×10^{-2}
Bone marrow/whole body	10.2	9.9×10^{-4}
Bone surface	10.2	6.6×10^{-4}
Lung	10.2	6.8×10^{-4}
Thyroid	10.2	5.9×10^{-3}
Bone marrow/whole body	14.0	4.5×10^{-4}
Bone surface	14.0	3.0×10^{-4}
Lung	14.0	3.1×10^{-4}
Thyroid	14.0	2.7×10^{-3}

process is purged and routed into a hydrogen recombiner, where it is oxidized before being released into the ventilation system. Strict controls would be applied to gas bottle storage, and strict procedures would be enforced to ensure that no personnel would be allowed to perform bottle hookups until they are trained and certified.

Postulated accident scenarios (all of which could lead to an explosion in the off-gas system) involving the hydriding and dehydriding processes were defined and analyzed. The postulated accident resulting in the highest release of radioactive material involves (1) the entry of sufficient oxygen (from air leakage at a glove port) into the glove box containing the hydriding vessel, (2) air leakage of sufficient magnitude into the hydriding vessel, and (3) detonation of the gas mixture by a hot surface or extremely fast chemical reaction. It is assumed that, as a result of the explosion, the glove box is ruptured and that the contamination spreads into the room.

A fraction of 1×10^{-2} (Selby et al., 1975) of the maximum plutonium estimated to be at potential risk would become airborne in the immediate area as a result of the accident. Because of particle size based on September 1988 design data, only 10 percent of the airborne material would be transported from the reaction site (i.e., a factor of 10^{-1} is applied to account for deposition and fallout of the material released into the room). The room air would be exhausted through a two-stage HEPA filtration system. It is conservatively assumed that the full filter efficiency for accident conditions is 99.9 percent for the first stage and 99.8 percent for the second stage (Elder et al., 1986), either of which is less than the normal operational efficiency of HEPA filters. It is also assumed that the released plutonium has an isotopic distribution as shown in Table 4-7. The calculated consequences from this postulated accident with full and partial filter efficiencies are listed in Table 4-13. The calculated whole-body dose to a maximum individual at the INEL site boundary is 2.3×10^{-7} rem for Case 1, 1.1×10^{-4} rem for Case 2, and 1.1×10^{-2} rem for Case 3. The maximum individual dose to a worker in the ICPP area for all filter efficiency cases would be less than the 5-rem DOE occupational exposure standard (e.g., for Case 3, the maximum individual dose to an ICPP worker at 0.4 kilometer would be 2.6×10^{-1} rem).

The calculated offsite population doses to 230,129 persons in the year 2010 for Case 1 are 6.0×10^{-5} person-rem; for Case 2, 3.0×10^{-2} person-rem; and for Case 3, 3.0 person-rem. The numbers of latent cancer fatalities and genetic disorders in the population surrounding the INEL, based on 280 latent cancer fatalities and 257 genetic disorders per million person-rem, range from 1.7×10^{-8} latent cancer fatality and 1.5×10^{-8} genetic disorder for Case 1 to 8.4×10^{-3} latent cancer fatality and 7.7×10^{-3} genetic disorder for Case 3. The annual risk of a latent cancer fatality and genetic disorder in the population for Case 3 using a probability of occurrence of less than 10^{-6} (see Table 4-8) is less than 8.4×10^{-9} for a latent cancer fatality and 7.7×10^{-9} for a genetic disorder, and the cumulative risk for 30 years of SIS operation is less than 2.5×10^{-8} for a latent cancer fatality and 2.3×10^{-8} for a genetic disorder.

Table 4-13. Consequences of a Postulated SIS Uncontrolled Chemical Reaction at the INEL

Organ	Distance (km)	Dose in rem		
		Case 1[a]	Case 2[b]	Case 3[c]
Bone marrow/whole body	0.4	5.2×10^{-6}	2.6×10^{-3}	2.6×10^{-1}
Bone surface	0.4	6.6×10^{-5}	3.3×10^{-2}	3.3×10^{0}
Lung	0.4	1.1×10^{-5}	5.7×10^{-3}	5.7×10^{-1}
Bone marrow/whole body	1.2	3.9×10^{-6}	1.9×10^{-3}	1.9×10^{-1}
Bone surface	1.2	4.9×10^{-5}	2.5×10^{-2}	2.5×10^{0}
Lung	1.2	8.6×10^{-6}	4.3×10^{-3}	4.3×10^{-1}
Bone marrow/whole body	5.2	1.4×10^{-6}	6.9×10^{-4}	6.9×10^{-2}
Bone surface	5.2	1.7×10^{-5}	8.7×10^{-3}	8.7×10^{-1}
Lung	5.2	3.0×10^{-6}	1.5×10^{-3}	1.5×10^{-1}
Bone marrow/whole body	10.2	4.6×10^{-7}	2.3×10^{-4}	2.3×10^{-2}
Bone surface	10.2	5.8×10^{-6}	2.9×10^{-3}	2.9×10^{-1}
Lung	10.2	1.0×10^{-6}	5.1×10^{-4}	5.1×10^{-2}
Bone marrow/whole body	14.0	2.3×10^{-7}	1.1×10^{-4}	1.1×10^{-2}
Bone surface	14.0	2.9×10^{-6}	1.4×10^{-3}	1.4×10^{-1}
Lung	14.0	5.0×10^{-7}	2.5×10^{-4}	2.5×10^{-2}

[a] Case 1 is full filter efficiency.
[b] Case 2 is 99.9-percent filter efficiency.
[c] Case 3 is 90-percent filter efficiency.

Postulated Design-Basis Earthquake

Unlike the previous postulated accidents, which are internally initiated, potential accidents could occur as a result of natural phenomena, or external initiators. The SIS facilities would be constructed, as appropriate, to protect the process systems and equipment they house from severe natural-phenomenon conditions. In particular, the Category 1 portion of the PPB would withstand such phenomena as design-basis wind loadings, earthquake, tornado, and tornado-driven missiles. The ventilation systems in the PPB would be equipped with tornado dampers to protect the building from depressurization from the Design-Basis Tornado (DBT) and from tornado-missile penetration.

The PPB is being designed with a high level of protection and structural integrity because of its radionuclide inventory. Systems important for mitigating offsite consequences would be seismically qualified for a DBE.

Examples of items that are being designed for protection from the DBE include the following:

- All portions of the PPB that house plutonium
- Final HEPA filtration systems in the PPB
- ZONE III ventilation exhaust systems in the PPB
- Balance-of-plant (BOP) and separator system glove-box structures
- Fire protection systems for the final filtration systems in the PPB
- Process storage vault structure, racks, and stacker/retriever (S/R).

These items would perform their safety functions and maintain integrity during and after a DBE. To mitigate any consequences to the environment, the confinement systems of the plant are required to perform their functions in applicable adverse conditions.

For the postulated DBE accident, it is assumed that all the facilities, systems, and components that were not DBE-qualified would be seriously damaged and inoperable after a DBE. The Category 1 portion of the PPB structure would remain intact, and all final filtration systems would be viable during and after all earthquakes, up to and including the DBE. As a result of the DBE, it is postulated that the PPB glove boxes lose their confinement integrity due to flex breakage of windows or gaskets, glove loss, or other effects. To add conservatism to the calculation of consequences, it is further assumed that multiple fires occur after the DBE. The loss of inert atmosphere in the pyrochemical glove boxes, together with the postulated multiple fires, was then assumed to result in the ignition and subsequent oxidation of all exposed, finely divided plutonium in the glove boxes until all exposed plutonium at risk was consumed. Evaluation has shown that 25 kilograms of plutonium would be at risk. The ventilation system would route the contaminated exhaust air through the final HEPA filtration system and discharge to the environment. The final filtration system will be designed to withstand DBE effects as well as fire. For this postulated accident, no credit is taken for the washing of plutonium oxide particles from the air by either fire sprinklers or exhaust filter fire suppression systems.

In estimating a source term for this accident scenario, it was postulated that the fire would involve all rooms where plutonium is handled or processed in metal or finely divided form. A fraction of 5 x 10^{-4} (see Table 4-9) of the plutonium at risk would become airborne. This results in 12.5 grams of plutonium delivered to the building exhaust system filters. It is conservatively assumed that the building exhaust would be filtered by two stages of HEPA filtration, the first stage having an efficiency of 99.9 percent and the second stage having an efficiency of 99.8 percent (Elder et al., 1986), both of which are less than the normal operational efficiency of HEPA filters. The assumed isotopic mix of the plutonium is as listed in Table 4-7. The consequences of this DBE and resulting fire for the INEL site with full and partial filter efficiencies are tabulated in Table 4-14. The calculated whole-body doses to a maximum individual at the INEL site boundary are 5.6 x 10^{-7} rem for Case 1, 2.8 x 10^{-4} rem for Case 2, and 2.8 x 10^{-2} rem for Case 3. The maximum individual dose to a worker in the ICPP area for all filter efficiency cases would be less than the 5-rem DOE occupational exposure standard (e.g., for Case 3, the maximum individual dose to an ICPP worker at 0.4 kilometer would be 6.5 x 10^{-1} rem).

The calculated offsite population doses to 230,129 persons in the year 2010 for Case 1 are 1.5 x 10^{-4} person-rem; for Case 2, 7.5 x 10^{-2} person-rem; and for Case 3, 7.5 person-rem. The numbers of latent cancer fatalities and genetic disorders in the population surrounding the INEL, based on 280 latent cancer fatalities and 257 genetic disorders per million person-rem, range from 4.2 x 10^{-8} latent cancer fatality and 3.9 x 10^{-8} genetic disorder for Case 1 to 2.1 x 10^{-3} latent cancer fatality and 1.9 x 10^{-3} genetic disorder for Case 3. The annual risk of a latent cancer fatality and genetic disorder in the population for Case 3 using a probability of occurrence of less than 10^{-6} (see Table 4-8) is less than 2.1 x 10^{-9} for a latent cancer fatality and 1.9 x 10^{-9} for a genetic disorder, and the cumulative risk for 30 years of SIS operation is less than 6.3 x 10^{-8} for a latent cancer fatality and 5.7 x 10^{-8} for a genetic disorder.

4.1.3.2 Consequences of a Postulated Severe Facility Accident

In order to provide a perspective of the risk associated with the SIS Project, an accident scenario is considered in this section which goes beyond the DBAs postulated in Section 4.1.3. It represents a scenario which further degrades engineered safety features, and takes no credit for emergency response action. This accident scenario is included in this EIS (a) because it discusses a very low probability type of occurrence and (b) because detailed probabilistic data on equipment failure, etc., from which more mechanistic accident scenarios could be developed were not available at this stage of project design. The discussion presented in this section is not an indication that such a severe accident will ever occur. Rather, this approach attempts to place in perspective the consequences associated with severe accidents of sufficiently low probability of occurrence that they are not included in design bases. A detailed assessment of risk would require a more detailed level of design to support the rigorous risk assessment. As discussed in other parts of this document, the SIS facility, systems, and components necessary to maintain an acceptable level

Table 4-14. Consequences of a Postulated SIS Design-Basis Earthquake and Fire at the INEL

Organ	Distance (km)	Dose in rem		
		Case 1[a]	Case 2[b]	Case 3[c]
Bone marrow/whole body	0.4	1.3×10^{-5}	6.5×10^{-3}	6.5×10^{-1}
Bone surface	0.4	1.7×10^{-4}	8.3×10^{-2}	8.3×10^{0}
Lung	0.4	2.8×10^{-5}	1.4×10^{-2}	1.4×10^{0}
Bone marrow/whole body	1.2	9.8×10^{-6}	4.9×10^{-3}	4.9×10^{-1}
Bone surface	1.2	1.2×10^{-4}	6.1×10^{-2}	6.1×10^{0}
Lung	1.2	2.2×10^{-5}	1.1×10^{-2}	1.1×10^{0}
Bone marrow/whole body	5.2	3.4×10^{-6}	1.7×10^{-3}	1.7×10^{-1}
Bone surface	5.2	4.4×10^{-5}	2.2×10^{-2}	2.2×10^{0}
Lung	5.2	7.6×10^{-6}	3.8×10^{-3}	3.8×10^{-1}
Bone marrow/whole body	10.2	1.2×10^{-6}	5.8×10^{-4}	5.8×10^{-2}
Bone surface	10.2	1.5×10^{-5}	7.3×10^{-3}	7.3×10^{-1}
Lung	10.2	2.6×10^{-6}	1.3×10^{-3}	1.3×10^{-1}
Bone marrow/whole body	14.0	5.6×10^{-7}	2.8×10^{-4}	2.8×10^{-2}
Bone surface	14.0	7.2×10^{-6}	3.6×10^{-3}	3.6×10^{-1}
Lung	14.0	1.2×10^{-6}	6.2×10^{-4}	6.2×10^{-2}

[a] Case 1 is full filter efficiency.

[b] Case 2 is 99.9-percent filter efficiency.

[c] Case 3 is 90-percent filter efficiency.

of safety will be designed to handle and withstand a family of DBAs including effects of natural phenomena.

An initiating event postulated for this accident case is a building-wide fire in the PPB. Another possible severe accident is a criticality; however, the consequences of the criticality accident are not as severe as the event presented here.

The postulated severe fire accident involves all unprotected plutonium. For whatever reason, the glove-box and room filtration systems are degraded below the full filter efficiency considered in Postulated Accident 4 so that airborne plutonium travels more freely to the environment outside the building. For this event to occur, the following conditions must be obtained:

- Facility-wide fire must in some fashion occur.
- The building fire suppression system, which will be DBA qualified, is assumed to be not effective.
- The final filtration systems, including their fire protection systems, both of which will be DBA qualified, are not effective.
- No mitigative action (such as immediately placing plutonium into protected storage upon detection of a fire) is taken.
- No response is made by the ICPP fire brigade or the INEL fire department.

Evaluation of the subject event indicates that in the worst case 25 kilograms (55 pounds) of plutonium might be unprotected against fire involvement. A fraction of 5×10^{-4} of the involved plutonium would become airborne within the building/room complex (see Table 4-9). The plutonium available for release from the building prior to filtration is estimated to be 12.5 grams. The calculated consequences from this postulated severe accident with 90-percent, 50-percent, and 0-percent HEPA filter efficiency are listed on Table 4-15.

The calculated whole-body dose to a maximum individual at the INEL site boundary is 2.8×10^{-2} rem for 90-percent HEPA filter efficiency; 1.4×10^{-1} rem for 50-percent HEPA filter efficiency; and 2.8×10^{-1} rem for 0-percent HEPA filter efficiency. All calculated doses would be a small fraction of the 25-rem criterion used by the NRC for siting commercial nuclear power plants (10 CFR 100). While there are no standards applicable to occupational radiation exposures in the event of a severe accident, it is worth noting that in the case of the most severe postulated accident with complete loss of HEPA filtration (Section 4.1.3.2), the calculated dose to an ICPP worker of 6.5 rem is comparable to the DOE 5-rem standard for normal operations. In addition, when credit is taken for such factors as evacuation and sheltering, the dose to an ICPP worker is expected to be less than the above-normal DOE operations standard.

The calculated offsite population dose to 230,129 persons in the year 2010 for 90-percent HEPA filter efficiency is 7.5 person-rem; for 50-percent

Table 4-15. Consequences of a Postulated Severe Facility Accident

Organ	Distance (km)	Dose in rem filter efficiency		
		90%	50%	0%
Bone marrow/whole body	0.4	6.5×10^{-1}	3.3×10^{0}	6.5×10^{0}
Bone surface	0.4	8.3×10^{0}	4.1×10^{1}	8.3×10^{1}
Lung	0.4	1.4×10^{0}	7.0×10^{0}	1.4×10^{1}
Bone marrow/whole body	1.2	4.9×10^{-1}	2.5×10^{0}	4.9×10^{0}
Bone surface	1.2	6.1×10^{0}	3.1×10^{1}	6.1×10^{1}
Lung	1.2	1.1×10^{0}	5.5×10^{0}	1.1×10^{1}
Bone marrow/whole body	5.2	1.7×10^{-1}	8.5×10^{-1}	1.7×10^{0}
Bone surface	5.2	2.2×10^{0}	1.1×10^{1}	2.2×10^{1}
Lung	5.2	3.8×10^{-1}	1.9×10^{-1}	3.8×10^{0}
Bone marrow/whole body	10.2	5.8×10^{-2}	2.9×10^{-1}	5.8×10^{-1}
Bone surface	10.2	7.3×10^{-1}	3.7×10^{0}	7.3×10^{0}
Lung	10.2	1.3×10^{-1}	6.5×10^{-1}	1.3×10^{0}
Bone marrow/whole body	14.0	2.8×10^{-2}	1.4×10^{-1}	2.8×10^{-1}
Bone surface	14.0	3.6×10^{-1}	1.8×10^{0}	3.6×10^{0}
Lung	14.0	6.2×10^{-2}	3.1×10^{-1}	6.2×10^{-1}

HEPA filter efficiency, 37.5 person-rem; and for 0-percent HEPA filter efficiency, 75 person-rem. The number of latent cancer fatalities and genetic disorders in the population surrounding the INEL, based on 280 latent cancer fatalities and 257 genetic disorders per million person-rem, ranges from 2.1 x 10^{-3} latent cancer fatality and 1.9 x 10^{-3} genetic disorder for 90-percent HEPA filter efficiency to 2.1 x 10^{-2} latent cancer fatality and 1.9 x 10^{-2} genetic disorder for 0-percent HEPA filter efficiency. The annual risk of a latent cancer fatality and genetic disorder in the population for 0-percent HEPA filter efficiency using a probability of occurrence of less than 10^{-6} (see Table 4-8) is less than 2.1 x 10^{-8} for a latent cancer fatality and 1.9 x 10^{-2} for a genetic disorder, and the cumulative risk for 30 years of SIS operation is less than 6.3 x 10^{-7} for a latent cancer fatality and 5.7 x 10^{-7} for a genetic disorder.

To date only one serious building fire involving plutonium has occurred. This was the Rocky Flats fire in 1969. In that fire no plutonium was released from the building except some very small amounts tracked out by personnel entering and leaving during the event and subsequent cleanup. There have been several fires involving uranium from which some understanding can also be gained (Walker, 1978). In these cases, uranium contamination inside the buildings occurred, but other than slight amounts, no outside contamination took place. Because of mass, uranium and plutonium have similar transport characteristics.

The severe facility accident presented is not repeated for the Hanford Site and SRP as the risk of the consequences from this accident at the other sites is judged to be scoped by the INEL evaluation given the relative similarity of accident consequences (i.e., site-boundary doses are generally within an order of magnitude) and the low-probability nature of the accident. Section 4.5.1.4 discusses potential cumulative offsite impacts as a result of simultaneously occurring accidents at more than one facility.

4.1.3.3 Transportation Accidents

The impacts of potential accidents involving the transport of plutonium from the Hanford Site and the SRP to the INEL, the transport of plutonium product metal from the INEL to the Rocky Flats Plant, the potential transport of plutonium oxide by-product and TRU waste to the WIPP, and the onsite transport of LLW were analyzed using the RADTRAN computer system (Madsen et al., 1986). The analysis (Section A.3 in Appendix A) required a definition of the properties of the material to be transported, the accidents that might occur, and representative transportation routes. The computer code was used to calculate the risk per kilometer per shipment of material. Total risks were then calculated for each material based on the transportation distances involved. Radioactive material releases could occur from a TRU waste accident in Categories IV through VIII and in an LLW accident in Categories II through VIII. The probability of accidents in each of the categories depends on the type of road and traffic conditions. The range of probabilities is presented in Table 4-16.

Accident assumptions are included for eight categories of accidents depending on their severity. Category I is the least severe and most

Table 4-16. RADTRAN III Accident Probabilities

Accident Category	Probability/km	
	Lowest	Highest
I	3.73×10^{-9}	8.16×10^{-6}
II	2.44×10^{-9}	5.34×10^{-6}
III	1.78×10^{-10}	5.19×10^{-7}
IV	4.07×10^{-11}	1.19×10^{-7}
V	4.75×10^{-12}	1.56×10^{-8}
VI	9.33×10^{-13}	4.08×10^{-9}
VII	7.21×10^{-14}	1.58×10^{-10}
VIII	6.36×10^{-15}	1.39×10^{-11}

frequent category of accident, whereas Category VIII accidents are very severe but very infrequent. The analysis showed that radioactive material could be released from the SST in only the two most severe accident categories (i.e., VII and VIII).

The transportation analysis uses both route-specific and national average transportation data. The route-specific data include total distance, adjacent population, and fraction of the route on various types of roads (e.g., rural, urban, or suburban). The road-type fractions are then combined with national average truck accident data for each road type. The national average data used in the analysis yield accurate risk estimates for the cross-country routes to which they were applied. Data included in Appendix A, Section A.3, show that the national average combination-truck accident rate on interstate highways is about 3.1×10^{-7} accident per kilometer. The average for only those states through which representative SIS shipments would pass is 3.2×10^{-7} accident per kilometer. State average accident rates along the nine separate representative routes for SIS shipments range from 2.1×10^{-7} to 4.0×10^{-7} accident per kilometer. These rates are for all property-damage accidents involving combination trucks and are much higher than the rates for severe accidents. This limited variability in accident rates supports the use of national average data for SIS shipments. For onsite shipments, the analysis does account for relevant site-specific factors such as low population density.

Weather-related road closures in the region are not expected to affect the risk estimates. Effects due to weather will be kept to a minimum by considering actual and forecast road conditions and by not dispatching trucks either in bad weather or under poor forecast conditions. Restricting truck transport to good weather conditions would reduce the overall truck accident rate by about 10 percent (NRC, 1977b). Since accidents associated with travel in poor weather conditions are included in the DOT accident-rate data that were used in the risk analysis, the risk estimate is slightly conservative with respect to this parameter. The stop time is based on actual operational requirements for SST shipments. A decreased stop time does result in a decrease in incident-free risk, but has no effect on accident risk calculation.

The estimated cleanup costs of the most severe accident involving the transport of plutonium in an urban area with high population density would be relatively high; however, the overall risk of incurring such costs is relatively small given the extremely low probability of such an accident's occurring. The consequences of a severe accident involving the transport of plutonium are presented in the NRC Final Environmental Impact Statement on radioactive material transport (NRC, 1977b) in terms of both the number of potential latent cancer fatalities and the economic consequences (e.g., cleanup and agricultural products). The consequences of the severe plutonium accident presented in NRC (1977b) are probably higher than those associated with SIS shipment of plutonium because of improved containment afforded by the current SST. In evaluating both the consequences and risks of radioactive material transport, including severe accidents, the NRC concluded that "the risks attendant to accidents involving radioactive material shipments are sufficiently small to allow continued shipments by all modes."

For locating the SIS Project at the INEL, the annual radiological accident risk from transporting all materials was calculated to be 1.3×10^{-4} latent cancer fatality and 5.9×10^{-5} genetic disorder to the population along the transport routes. The risk is the product of the number of health effects that would be expected if the accident were to occur multiplied by the probability of occurrence.

Nonradiological accident impacts from the transport of these materials could also occur, and analyses indicate that nonradiological risks dominate radiological risks. These impacts are traffic fatalities due to mechanical injuries from vehicle accidents. The risk (probability of a single traffic death) for a full year of SIS material transport was calculated to be 1.8×10^{-2} fatality. This result is based on statistics for truck accidents and is theoretical; in fact, no one has ever been killed in an accident with an SST.

4.1.4 Occupational Safety

The following sections discuss the potential impacts to SIS and INEL workers during routine construction and operation of the SIS Project as well as potential impacts as a result of accidents. An in-depth study of onsite worker consequences will be performed during the safety analysis process. In this process, which follows the preparation of an EIS (DOE Order 5481.1B), a preliminary safety analysis is prepared to document an early identification of potential health, safety, or environmental problems for the purpose of either eliminating or mitigating these problems as part of the final design process. During the final design process, a final safety analysis is performed to formally document potential hazards and consequences and the methods, measures, or controls to be employed to eliminate or mitigate hazards and consequences to within as low as reasonably achievable (ALARA) levels. The final safety analysis is then reviewed and the review documented to allow independent evaluation of its adequacy. The safety analysis process within DOE is used to ensure that health, safety, and environmental protection will be as intended prior to operation of the facility. As part of the present on-going safety analysis program, a detailed worker exposure reduction evaluation is being completed, and a Preliminary Safety Analysis Report is being reviewed. Elements or topics addressed in the Safety Analysis Report include safety systems and features, industrial safety, radiation protection, events and accidents, and operational safety requirements.

4.1.4.1 Construction Impacts

Construction workers would experience slightly elevated background levels of radiation from gamma radiation in the vicinity of the SIS site and from inhalation of radionuclides emitted to the atmosphere from current INEL operations and earthwork activities. Recent measurements of gamma radiation in the vicinity of the SIS Project site indicate that the gamma radiation level is about 15 microrem per hour above background. Based on this gamma intensity, the external dose to a construction worker who spends 2000 hours

(40 hours per week for 50 weeks per year) in the construction area is estimated to be about 30 millirem per year. The dose to a construction worker from inhalation of radionuclides from current operations and earthwork activities is expected to be negligible (i.e., less than 1 millirem per year). The radiological dose to a construction worker of about 30 millirem per year would be significantly below the DOE occupationally related external and internal exposure standard of 5000 millirem, or 5 rem (committed dose), per year to the whole body.

During some past construction activities at the INEL, radioactively contaminated soil and materials have been encountered. Based on surveys of surface contamination, there is no soil contaminated beyond the ICPP background level at the construction site, and subsurface contamination is not expected.

During construction, accidents could occur that would result in worker injuries and fatalities. The rate of occurrence of injuries and fatalities associated with DOE facilities is generally low in comparison to that of other industries. The maximum number of injuries and fatalities associated with SIS construction can be determined by using accident rates (i.e., 9.59 injuries and 0.04 fatality per 200,000 hours) developed by the National Safety Council (NSC, 1983) for the construction industry. Using this approach, and given an average number of 317 SIS construction workers for the highest 6 years of construction employment who would each spend 2000 hours per year in a construction activity, the resultant projected injuries and fatalities for the highest 6-year SIS construction period would be about 215 injuries and 0.8 fatality. The injuries would be predominantly minor, such as cuts, bruises, and abrasions.

4.1.4.2 Operational Impacts

The SIS facility is being designed with state-of-the-art technology to provide for the protection of workers. Worker exposures to hazardous and/or toxic materials would be limited and in compliance with DOE and all other applicable occupational safety requirements. Worker exposure to radioactivity will be ALARA and below the DOE radiation protection standards for occupationally related external and internal exposures of 50 rem per year to the hands and forearms and 5 rem per year to the whole body. The design goal of the SIS Project is to limit occupational exposures to below 1 rem, or 1000 millirem. To ensure that occupational exposures from both ionizing and nonionizing radiation are at ALARA levels, a number of different methods would be used. Those methods that place a primary emphasis on physical and mechanical methods rather than administrative or procedural controls might include:

- Designing the PPB such that the layout of the rooms within the building would limit the potential for radiation exposure

- Providing shielding to limit the combined neutron-gamma dose rate within work areas

- Using remote technology, robotics, and various mechanical appurtenances to limit the amount of time that workers would spend near radiation fields

- Designing exhaust ventilated enclosures, chemical laboratory hoods, or systems to meet or exceed American National Standards Institute (ANSI) or American Conference of Governmental Industrial Hygienists (ACGIH) standards.

In addition to the methods having a primary emphasis on physical and mechanical methods, administrative and procedural controls would be implemented. These administrative and procedural controls would be based on time-motion studies to be completed as part of the Final Safety Analysis Report to limit the potential exposure of workers to only when their presence is required and to ensure that personnel exposures are kept at ALARA levels. Monitoring programs that include dosimetry badges, bioassay, and radiation area surveys would be implemented to demonstrate compliance with radiation protection standards and to estimate dose equivalents received from external and internal sources of radiation.

In order to determine the potential radiation exposure to operating personnel during normal operations, a series of studies based on the current flowsheet is being performed that seeks to provide a means for cost-effective dose reduction measures to meet DOE guidelines and the principle of ALARA.

As part of the SIS plant integration and design activities, projections are being made of individual plant worker integrated doses and for the total plant integrated dose. These dose estimates are being made for each plant operation and correspond directly to the plant flowsheets and the process flow diagrams coupled with detailed source term descriptions.

The routine radiological exposures to SIS workers are expected to be significantly less than the applicable DOE radiation protection standards for occupational employees. For the 10-year period between 1975 and 1985, only 0.0001 percent of all DOE and DOE contractor personnel exposures to radiation resulted in excesses of the 5-rem standard. In 1985, about 58 percent of DOE and DOE contractor personnel received a whole-body dose equivalent that was less than measurable, 40 percent a measurable dose equivalent of less than 1 rem, and 2 percent a dose equivalent greater than 1 rem.

During operation of the SIS facilities, INEL personnel would be exposed to routine atmospheric emissions of radioactivity. The potential radiological doses to onsite INEL personnel would generally be higher than those to offsite individuals (i.e., as a function of distance to the source of the release); however, the degree to which the radiological dose to an onsite individual would be higher than that to an offsite individual would be greatly influenced by a number of factors. These factors include the amount of time an INEL worker would be exposed to releases (i.e., employees do not reside continuously on the site), sheltering (i.e., the majority of onsite personnel are housed in structures that would tend to mitigate exposure by direct inhalation as opposed to an offsite individual who is assumed not to be sheltered), and administrative procedures (e.g., emergency preparedness procedures) and security measures, which directly affect the number and location of onsite individuals who would have a potential for exposure. Using the same methodology for calculating radiological doses as discussed in Section 4.1.2.3, the whole-body committed dose to an INEL worker at the main processing building in the ICPP area resulting from SIS routine radioactive emissions, a distance of about 0.4 kilometer (0.25 mile), was calculated to be less than 3.0×10^{-8} rem, or significantly below the DOE occupationally related standard of 5 rem. Currently there are an estimated 800 employees working in the ICPP area. Routine exposures to transport crews involved in the transport of radioactive materials would be limited in accordance with the requirement of DOT.

A full range of potential industrial hazards would exist in the SIS facilities. The requirements to prevent or, if necessary, to respond to these hazards are addressed in Occupational Safety and Health Administration (OSHA) regulations and DOE Orders. Selected concerns are listed below:

Noise. Copper-laser power supplies generate noise peaks at specific frequencies. Peripheral locations, such as mechanical equipment rooms and dye pump areas, would be additional noise sources. These places are not routinely occupied and it may be necessary to require hearing protection for people performing activities in these areas.

Radio-Frequency Emissions. Radio-frequency (RF) emissions would occur during normal operation of the CL power supplies. Emission levels are expected to be well under the current exposure criteria as the result of design considerations that incorporate interlocks and cabinet shielding that attenuate RF energy. Temporary covers used during maintenance and test operations include similar controls. The control of nonionizing radiation sources would be in accordance with DOE requirements.

Vacuum Systems. Some systems in the SIS facility would contain equipment having a high vacuum. Protective enclosures and shields would be used to prevent personnel injury from vacuum release. Personnel access would also be restricted in this equipment.

Pressurized Systems. Operations involving pressurized systems have been carefully planned to ensure compliance with all governing regulations, incorporation of appropriate engineering and operational safety measures, and adherence to any Operational Safety Procedures prepared by operating personnel. Design and construction of pressurized piping systems conform to American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME) codes and standards.

Crane/Hoist Operations. Overhead bridge and gantry cranes and hoists are used to move heavy equipment in and around the facilities. All operators of this type of equipment would be specially trained and authorized in order to operate this equipment. All crane/hoist operations concerned with the movement of heavy equipment or machinery would be handled in accordance with the U.S. Department of Energy Idaho

Operations Office (DOE-Idaho) Hoisting and Rigging Manual and all references therein.

Chemicals. Industrial chemicals such as acids, caustics, and cleaners would be used in various areas within the SIS facilities. Design features would be provided for safe handling, use, and storage of these materials. Airborne concentrations would be controlled by exhaust ventilation enclosures or chemical laboratory hoods designed to ANSI and ACGIH standards or specifications.

X-ray Emission. Impact of electron beams upon plutonium in the vaporizer section of the Atomic Vapor Laser Isotope Separation (AVLIS) separator generates soft x-rays. Vacuum chamber walls and special shielding of parts typically would provide sufficient shielding for x-rays.

The use of lasers in the SIS process requires the use of protective measures to prevent any injuries from laser beams. The most common types of injuries associated with laser systems involve the eye, where laser light, which impinges upon any component of the eye (cornea, lens, retina, etc.), can cause permanent injury. The primary means through which this is controlled is designed safety features to eliminate the potential for worker exposure from direct or reflected laser light. Designed safety features, such as enclosure of laser beam paths, erection of shields and baffles, installation of shutters and properly engineered viewing ports, design of systems to permit low power alignments, use of large apertures and optics to reduce reflections, and installation of interlocks on access doors and openings, would be the major types of designed safety features that would be used to prevent exposures during operation of the system. These designed safety features would be enhanced through operational requirements describing the use and maintenance of the equipment. Further, safety eyewear, in the form of multilayered, dielectric coated goggles, would be provided, offering protection against the specific range of wavelengths utilized in the facility.

The buildings will be constructed to conform to the Life Safety Code, Uniform Building Code (UBC), and other applicable codes and standards. All fire protection features will be in accordance with the UBC and the National Fire Protection Association (NFPA) requirements and related Life Safety Code standards.

In support of radiation protection, policies have been developed to ensure that occupational and populations exposures from radiological activities will be ALARA. The radiation protection policies are implemented by an ALARA program that covers all phases of activities involving work with radioactive materials. Related DOE Orders are as follows:

- DOE Order 5480.11, "Radiation Protection for Occupational Workers" (Draft 4-5-88)
- DOE Order 6430.1A, General Design Criteria Manual, Division 13, "Special Facilities"
- DOE Order 6430.1, Chapter XXI "General Design Criteria Manual."

Additional guidance on ALARA is provided in DOE/EV/1830.T5, "A Guide to Reducing Radiation Exposure to As Low As Reasonably Achievable." The ALARA program requires incorporation of ALARA features into all procedures and procedure manuals governing radiation work.

4.1.4.3 Impacts Resulting from Accidents

Table 4-10 and Tables 4-12 through 4-14 list the committed whole-body doses as calculated using the CRAC2 model to an INEL onsite individual as a function of distance from postulated accident releases previously discussed in Section 4.1.3.1. The radiological doses listed are considered conservative estimates of potential onsite doses for the reasons indicated above (i.e., they do not account for residency, sheltering, and administrative controls), and they do not take credit for effectuation of emergency procedures. As listed in the tables, the highest onsite dose at 0.4 kilometer (0.25 mile), or the distance from the PPB to the main processing building within the ICPP, is 3.8 x 10^{-2} rem to the whole body for all cases in which filtration is functioning, and 6.5 x 10^{-1} rem for those cases in which combined filter efficiency is reduced to 90 percent. Both doses are less than the DOE standard of 5 rem for occupationally related exposures. While there are no standards applicable to occupational radiation exposures in the event of a severe accident, it is worth noting that in the case of the most severe postulated accident with complete loss of HEPA filtration (Section 4.1.3.2), the calculated dose to an ICPP worker of 6.5 rem is comparable to the DOE 5-rem standard for normal operations. In addition, when credit is taken for such factors as evacuation and sheltering, the dose to an ICPP worker is expected to be less than the above-normal DOE operations standard. Section 4.5.1.4 discusses potential cumulative impacts to onsite workers as a result of simultaneously occurring accidents at more than one facility.

High exposures, injuries, and potential fatalities to workers in the SIS facilities could occur as a result of extremely unlikely facility accidents. Preliminary assessments of exposures, injuries, and potential fatalities to workers in the SIS facilities are being conducted as part of the design and safety evaluations of the SIS Project (i.e., assessments are on-going and are being used to evaluate potential design alternatives and modifications to enhance occupational safety). The consequences of potential postulated accidents to workers would be dependent on how many workers are in the immediate area of an accident. For example, potential fatalities might occur to workers within a few feet of an extremely unlikely criticality event or to workers in proximity to an explosion. Administrative controls are expected to limit the number of SIS operating personnel in areas of high potential exposure to between four and six personnel. The potential risks (i.e., the potential consequences times the probability of the potential occurrence of the accident) to SIS workers from very unlikely accidents, such as a criticality event or an explosion, are in general very low because the design of the SIS facilities will incorporate those safety features necessary to preclude the occurrence of such accidents.

Any incident that may involve or affect SIS facilities and/or any adjacent facilities will initiate the emergency action plan. Personnel will be expected to respond according to procedures established by the plan. Emergency responses and re-entry personnel will take the appropriate protective measures to minimize exposures and possible injuries. Potential exposures to SIS personnel and personnel from adjacent facilities due to fires or contamination would be minimal.

In the event of an extremely low-probability transport accident as identified in Section 4.1.3.3, which involves significant impact forces, fatalities to the transport crew would occur if crew members were inside the transporter cab at the time of impact.

4.1.4.4 Co-Location Considerations

The SIS Project would be co-located with other facilities in the ICPP area that include those which process and manage radioactive materials as well as a variety of chemicals. The proposed location for the SIS is within 1000 feet of the nearest ICPP facility in the prevailing downwind direction. This configuration of SIS with the ICPP raises the question of whether accidents at one facility could have an impact on the safety of operations at an adjacent facility. The issue is whether an accident at either facility could incapacitate the operators at the other facility, resulting in another accident or requiring evacuation. As discussed in the following paragraphs, the SIS facility would be designed with the intention that an accident in any of the other ICPP facilities would not prevent the safe shutdown of the SIS facilities, cause an impairment on the ability of the operators within the SIS facilities to rapidly place the facilities in a safe-shutdown mode and to safely evacuate the facilities, or result in a significant economic loss to SIS facilities.

The proposed SIS Project, similar to all other facilities at the ICPP, would be a stand-alone operation that would not require the concurrent operation of another process or facility for its safe operation. There would be no process links (piping, electrical, or material transfer) between SIS facilities or those of another ICPP facility that would cause or propagate an accident in one facility to another. Propagation of accidents from one facility to another (including the proposed SIS Project) would also be precluded by ensuring that separation distances between facilities are in conformance with the distances cited at the NFPA fire code, Section 80A, for industrial facilities without special exterior fire protection or fire walls. In addition, the ICPP structures and separation distances including those associated with the SIS Project would ensure that physical or explosive forces would not breach confinement structures or result in significant economic losses to facilities.

Each ICPP facility as well as the proposed SIS Project has the capability of immediate safe shutdown in the event of an unplanned evacuation. Typically, this safe-shutdown capability, because of the requirement for prompt evacuation in the event of a potential criticality accident, entails a push-button trip located in a control room or central process control area. Upon actuating the trip, a combination of pumps would be de-energized, valves closed, and the heating, ventilation, and air conditioning (HVAC) system stabilized automatically. In no event would a shutdown sequence entail a procedure or requirement that would preclude timely evacuation of operating personnel.

Placement of the SIS facilities within the ICPP area is not expected to result in impairment of SIS operators or other ICPP operators to place facilities in a safe-shutdown mode as a result of an accident involving either a radiological or chemical release. As discussed in the preceding section regarding SIS radiological impacts to ICPP workers as a result of postulated SIS accidents, in all cases including that of the most severe postulated accident, the radiological dose to an unsheltered individual in the ICPP area would be below or near the DOE standard for normal occupational exposure. Similarly, based on the safety analysis studies of existing facilities at the ICPP area, the highest radiological dose to an unsheltered individual from a DBA would be 5.7×10^{-1} rem from a postulated criticality accident at the Fluorinel Dissolution and Storage Facility. A preliminary review and analysis of the current and planned chemical inventories at the ICPP area also indicates that potentially catastrophic events associated with the rupture of chemical storage tanks would not result in significant impairment of the SIS operators' ability to place facilities in a safe-shutdown mode. SIS facility design can incorporate features to mitigate the consequences of any ICPP releases (e.g., dual air intakes).

Potential co-location issues will continue to be considered throughout the definitive design and safety analysis process for the SIS Project. Where on-going safety analyses based on co-location considerations identify a potential safety implication, alternatives and mitigation measures will be identified and implemented, as appropriate. For example, for potential chemical releases that might impair the ability of operators to place a facility in a safe-shutdown mode, measures such as vapor scrubbers, chemical sorbers, chemical detection systems, and HVAC filter isolation systems (dampers) would be considered.

The on-going safety analyses may indicate the need for design modifications and/or reconfiguration of the site. This may include the desirability of increasing the distance between the ICPP and SIS facilities and/or a location in a direction other than the prevailing downwind direction. It is anticipated that the analyses in this EIS would remain bounding; however, supplemental National Environmental Policy Act (NEPA) review would be performed as needed.

4.1.5 Safeguards and Security

The safeguards and security program for the SIS facilities would be specifically designed to prevent the loss, theft, or diversion of nuclear materials; to protect classified information; and to protect against damage, theft, loss, or other harm to government property. The safeguards and security function includes physical security and nuclear material control and accountability. For national security reasons, all plutonium processing must be performed in an area that has high levels of security and safeguards. The principal requirements are contained in DOE Orders.

The SIS security protection system would be located within the existing ICPP protected area, which includes physical barriers; entry control (including personnel and material screening); intrusion detection and alarm assessment; perimeter lighting; perimeter alarm systems; and closed-circuit television (CCTV) coverage. Physical barriers for the are protected within the ICPP include perimeter double fencing, vehicle barriers, and a vehicle-monitoring facility.

Access to the SIS site, which would be protected by its own security fencing, would be through a guardpost. Normal access to the PPB would be through the Laser Support Building (LSB), which would have an access-control portal. The access-control portal would be equipped with one or more personnel access booths. Each booth would consist of detectors for special nuclear material (SNM) and metal, access-control devices, equipment for inspection of hand-carried articles, CCTV, communications to the main guardhouse, and visual indicators for access-control requests. Within the PPB, additional safeguards would be provided to control access throughout the building. Access control to areas would consist of a combination of access and detection devices and physical barriers.

Active monitoring systems would be provided to cover the entire building exterior and adjacent grounds; both sides of doors would be equipped with sensors. An exterior protective lighting system would be designed to complement the exterior systems and augment the guardforce surveillance and alarm assessment duties.

Access control would be provided on both sides of doors or booths that allow routine access to rooms containing SNM, classified computers, vital or classified equipment, control rooms, and discrete functional work areas. A positive personnel identification system would control the entry side of doors to areas containing SNM to confirm the identity of personnel.

Intrusion detectors would be provided for all exterior and interior doors that allow access to SNM, control rooms, classified computers, areas containing classified equipment, and other areas. Presence indicators would also be installed in rooms containing SNM and in other areas.

A nuclear-materials control and accountability system would be provided for the SIS processes in accordance with applicable DOE Orders. The plutonium-handling/processing areas would be divided into a series of material-balance areas (MBAs). The transfer of SNM between MBAs, the locations of items containing SNM, and the inventory of SNM within each MBA would be monitored by the material accountability instrumentation and control (I&C) subsystems. Process equipment would be designed to minimize the holdup of SNM and to facilitate the measurement and sampling of contained SNM during physical inventory verification.

The LSB would also be located in the protected area contiguous with the PPB. The areas containing classified equipment and I&C equipment that process and display classified data would be protected by an access-control station with appropriate access, detection, and alarm systems.

DOE safeguards and security programs are integrated with emergency planning, preparedness, and response systems. Emergency planning and preparedness drills in addition to DOE security appraisals routinely test the effectiveness and response of safeguards and security programs. Specific countermeasures for potential terrorist or sabotage actions have been developed by DOE and law enforcement agencies. Details of these countermeasures are not publicly available, as they could provide information that would assist potential terrorists or saboteurs.

4.1.6 Unavoidable Adverse Impacts

The proposed construction of the SIS facilities at the INEL would directly impact a total of 201,530 square meters (49.8 acres) of land area, of which more than 54 percent has been previously disturbed. During construction, plant and animal habitats associated with a sagebrush vegetation community would be lost or displaced from previously undisturbed areas. Approximately 92 percent of the previously undisturbed land area outside the ICPP area [i.e., 11,740 square meters (2.9 acres) out of 138,000 square meters (34.1 acres)] would not be affected by operation, would be revegetated, and would revert to a sagebrush vegetation community through natural plant succession. Construction of the SIS would also generate liquid effluents, atmospheric emissions, and solid wastes typical of those resulting from the construction of a major industrial facility; all effluents and emissions would be below applicable environmental requirements and would not be expected to result in any significant adverse impact.

During the operation of the SIS facilities, occupational radiation exposures and exposures to members of the public would occur. Occupational radiation doses would comply with the criteria contained in DOE Order 5480.1B. These criteria state that an occupational radiation dose design objective of 1 rem per year should be used for new DOE facilities and occupational radiation doses should be kept ALARA. Doses to the public from normal atmospheric releases of radioactive material are expected to be well below the limits contained in EPA's 40 CFR 61 and DOE Order 5480.1B. The dose to a maximum individual from the severe facility accident would only be a small fraction of the criteria used by the NRC for siting a commercial nuclear reactor (10 CFR 100).

Liquid effluents discharged to the soil column through infiltration beds or percolation ponds would all be below applicable environmental standards, including radioactivity standards for drinking water. Solid wastes generated during operation, including TRU, LLW, hazardous, and mixed wastes, would generally represent only a small increment in relation to the amount of such wastes currently being handled and managed at the INEL and would result in small increases in potential exposures to radioactive and hazardous materials. Freon emissions would result in a negligible increase in the risk of skin cancer; substitutes will be used when available.

The INEL has operated numerous defense-related facilities as large or larger than SIS for over 30 years and there is no evidence to suggest that they have adversely affected tourism or agriculture. Because SIS would be a relatively small addition to these on-going activities, it is not expected to significantly impact either agriculture or tourism industries in Idaho. Liquid effluents from the SIS would comply with regulatory standards. There would be no discharges to surface waters; effluents discharged to the percolation pond would not degrade the quality of the Snake River Plain aquifer, and therefore would not impact agriculture. Tourism has increased steadily over the last 4 years and there is no evidence that SIS would adversely affect that trend.

Construction and operation of the SIS facility would not require the use or consumption of scarce resources. Expected ground-water withdrawals during construction and operation would represent a negligible withdrawal in comparison to the Snake River Plain aquifer's estimated discharge to the Snake River. In general, the unavoidable adverse impacts would be few and limited, and none have been identified that would significantly affect public health and safety.

4.2 ENVIRONMENTAL CONSEQUENCES OF CONSTRUCTING AND OPERATING THE SIS PROJECT AT THE HANFORD SITE

The following sections discuss the major differences in potential environmental consequences that would arise if the SIS facilities were to be constructed and operated at DOE's Hanford Site rather than at the INEL.

The environmental consequences of locating the SIS facilities at the Hanford Site are based on the same radiological source terms for normal and accidental releases and the estimated SIS atmospheric emissions, liquid effluents, and solid wastes previously discussed in Section 4.1.

4.2.1 Construction Impacts

If the SIS facilities were to be constructed at DOE's Hanford Site, the potential socioeconomic impacts associated with construction are expected to be equal to or less than those associated with locating the SIS at the INEL because (1) as at the INEL, a large in-migrating construction workforce would not be expected for constructing the project at the Hanford Site due to the availability of construction craft workers who were formerly involved in the construction of commercial nuclear power plants at the Hanford Site; and (2) the existing population base within 80 kilometers (50 miles) of the Hanford Site is larger than that surrounding the INEL and would provide a larger capability to absorb any in-migrating construction workers. The estimates of in-migration requirements of the operational workforce expected to be employed during the construction period are similar to the estimates for the INEL. Construction of the SIS Project would provide job opportunities in the Hanford Site region at a time when jobs at the Hanford Site have been terminated because of the suspension of characterization studies for a geologic repository for commercial nuclear wastes and the placement of N-Reactor in cold-standby status.

During the construction period, operations personnel will be hired so that at the end of the construction period, 656 of the 750 operating workers will be employed. The percentage of operations workers estimated to in-migrate varies based on skill requirements. Overall, approximately 20 percent (116 personnel) are estimated to move into the Hanford area. The total of 332 in-migrating personnel would represent about 2 percent of the 1986 employment at the Hanford Site.

The potential economic benefits to the area are expected to be similar to those for the INEL area. An employment multiplier of 2.2 based on Hanford Site and agricultural employment as the primary economic sector (DOE, 1986b) is not significantly different than the employment multiplier of 2.36 for the INEL area (see Section 4.1.1.1).

Construction of the SIS Project at the Hanford Site would involve a smaller land area than that which would be affected by construction at the INEL based on earlier designs of the SIS Project than are currently being used at the INEL. If the same basis for estimating land requirements were used, the land requirements would most likely increase. The potential for a smaller land area involved as well as the higher elevation of the SIS Project at the Hanford Site relative to a Probable Maximum Flood (PMF) would reduce the amount of grading and the resulting atmospheric emissions from construction.

The land area that would be affected at the Hanford Site has been dedicated through previous operations as a nuclear materials production area. Construction at this SIS site would neither impact any known archeological and historic sites nor disturb any habitats for rare or endangered species. The land area affected by construction is of the sagebrush vegetation community typical of the arid Hanford Site region. Land areas disturbed by construction but not affected during operation would revert to the sagebrush vegetation community through natural succession.

Water required for construction would be withdrawn from the Columbia River. The amount of water withdrawn from the Columbia River would be negligible in comparison with the 1×10^{14} liter (2.6×10^{13} gallon) annual average flow of the river at the Hanford Site. No new water withdrawal intake structure would be required. Sanitary effluents generated during construction would be treated through the use of a septic tank and drain field. Mitigative and control measures for potential spills and fugitive-dust emissions would be undertaken as required, similar to control measures for construction at the INEL. Solid nonradioactive and nonhazardous waste resulting from construction would be disposed of onsite at a sanitary landfill.

4.2.2 Normal Operational Impacts

The normal operational impacts associated with locating the SIS Project at the Hanford Site would be similar to those for locating the project at the INEL. The following sections describe the nonradiological and radiological impacts associated with locating the SIS Project at the Hanford Site.

4.2.2.1 Nonradiological Impacts

Operation of the SIS facilities at the Hanford Site would require the same number of operating personnel as would operation at the INEL. As with the INEL, a portion of the operating personnel would be hired gradually during the construction period. The total operating workforce would represent about 5 percent of the 1986 Hanford Site employment. Although jobs at the Hanford Site have been lost due to suspension of characterization studies for a geologic repository and the placement of N-Reactor in cold-standby status, the number of in-migrating and operating personnel is expected to be similar to that at the INEL (Table 4-1). Given an average family size for in-migrating operating personnel of 2.75 persons per household, the expected population increase attributable to in-migrating operating personnel would be about 36 persons in the first year of operation. This increase would represent less than 5 percent of the 1980 to 1986 average annual population increases experienced in Benton and Franklin Counties.

Given the small percentage of population increase attributable to SIS operation in relation to the normal population increase experienced in the Hanford Site region, no major adverse impacts to local government services and community infrastructures are expected. The beneficial economic impacts to the region are expected to be similar to the economic benefits for the INEL region for the reason indicated for construction economic benefits (i.e., similarity of employment multiplier).

During operation of the SIS facilities, additional coal would be burned to supply steam. The incremental burning of coal for steam production would be below PSD de minimis levels, similar to the levels estimated for locating the SIS Project at the INEL, as the estimated emissions (Table 4-6) are predominantly derived from the tons of coal burned. Total annual average water consumption for the SIS facilities of 6.8×10^8 liters (1.8×10^8 gallons) per year would be withdrawn from the Columbia River. The amount of water that would be withdrawn represents less than 0.0007 percent of the Columbia River's 1×10^{14}-liter (2.6×10^{13}-gallon) annual average flow. No new water withdrawal intake structure would be required and no observed impacts have resulted from previous withdrawals. Total consumptive water losses attributable to cooling tower operations and consumption of potable water by operating personnel represent less than 0.0003 percent of the Columbia River's average annual flow.

Sanitary effluents generated as a result of SIS operation would be discharged to a septic tank located west of the outer 200-East protected-area fence. Effluent from the septic tank would then be discharged to a sanitary tile field. Other liquid effluents (i.e., cooling tower blowdown and process steam condensate) that would be below DOE Order 5480.1B, RCRA, and safe drinking water standards, would be monitored and discharged to a tile field. Liquid effluents meeting these standards and requirements would not result in contamination of ground-water resources.

During SIS operations, nonradioactive and nonhazardous solid waste and hazardous solid waste would be generated in quantities similar to those previously discussed for the INEL. These wastes would be managed in a manner identical to that previously discussed for the INEL (i.e., nonhazardous nonradioactive solid wastes would be disposed of at a sanitary landfill, and hazardous wastes would be contained at their point of generation and transported off site to an approved TSD facility). During normal waste management practices for these wastes, no identifiable impact would occur with respect to public health and safety or the environment.

4.2.2.2 Radiological Impacts

Normal radiological releases to the atmosphere and the quantities of radioactive and mixed wastes generated would not differ from those previously discussed for the INEL; however, the location of the project relative to the surrounding Hanford Site population and the distances to facilities that would be involved in routine shipments of material would result in small differences in potential environmental consequences.

Atmospheric Emissions

The location of the SIS facilities to the nearest Hanford Site boundary is approximately 16 kilometers (9.9 miles), or about 2 kilometers (1 mile) farther than the distance of the SIS site at the INEL to the INEL site boundary. The estimated year-2010 offsite populations within an 80-kilometer (50-mile) radius of the SIS site at Hanford are projected at either 709,147 or 500,000 persons (see Section 3.2.1), compared to 230,129 and 151,922 persons within an 80-kilometer (50-mile) radius of the SIS site at the INEL. As a result of these and meteorological differences, the radiological dose to a hypothetical individual residing at the Hanford Site boundary is less than that to an individual residing at the INEL site boundary, and the calculated collective dose for the Hanford Site is larger than the calculated collective dose for the INEL. The following sections briefly discuss the results of the calculations performed for locating the SIS facilities at the Hanford Site. The methodology used to perform these calculations is the same as discussed in Section 4.1.2.3.

Maximum Individual

The committed whole-body dose, critical-organ (bone-surface) dose, and EDEs received annually by the maximally exposed individual from all pathways were calculated to be 7.3×10^{-9}, 4.5×10^{-7}, and 3.4×10^{-8} millirem, respectively. The inhalation pathway contributed over 99.5 percent of these doses. The calculated EDE of 3.4×10^{-8} millirem is insignificant in comparison with the 25-millirem standard contained in EPA's NESHAP. A discussion of cumulative doses relative to compliance with NESHAP is contained in Section 4.5.2.

Conservatively assuming that all the radioactivity released to the environment will be high-LET radiation, the resulting risks of latent cancer fatality and genetic disorder to the maximally exposed individual from 1 year of operation would be only 1.2×10^{-14} and 8.2×10^{-16}, respectively.

Population

The collective whole-body dose and EDE received from annual releases by the offsite population surrounding the Hanford Site from all exposure pathways were calculated to be 1.4 x 10^{-7} and 6.5 x 10^{-7} person-rem, for a year-2010 population of 709,147 persons and 9.7 x 10^{-8} and 4.6 x 10^{-7} person-rem for a year-2010 population of 500,000 persons, respectively. The inhalation pathway contributed over 99.5 percent of these doses. The calculated collective whole-body dose equivalent of 1.4 x 10^{-7} person-rem is insignificant in comparison with the more than 40,000 person-rem that would be received by the year-2010 population from man-made sources.

Conservatively assuming only high-LET radiation, the number of health effects that would occur in the population (i.e., 709,147 persons) as a result of 1 year of operation during the year 2010 would be only 2.2 x 10^{-10} latent cancer fatality and 1.5 x 10^{-11} genetic disorder.

Radioactive Solid Wastes

Operation of the SIS facilities at Hanford would generate the same quantities of LLW, TRU, and mixed wastes as previously discussed for the INEL. The LLW would be disposed of in the existing Hanford shallow land burial sites located in the 200-Areas. Prior to disposal, the LLW would be packed in drums and nondestructively assayed. Current LLW disposal practice at Hanford involves evacuation of soil trenches to depths of 4.6 to 7.6 meters (15 to 25 feet). Containers of LLW are placed in the trench and covered with at least 1.2 meters (4 feet) of soil. More than 142,000 cubic meters (5 million cubic feet) of radioactive solid waste have been buried within 155 acres of land since 1944.

Recent records indicate that approximately 480 cubic meters per year (17,000 cubic feet per year) of LLW are disposed of at the Hanford shallow land burial sites (Booth et al., 1986). The volume of LLW generated by SIS operation would be about 30 cubic meters (1060 cubic feet) per year, assuming a waste density of 0.96 gram per cubic centimeter (Mishima et al., 1986). This quantity represents about 6.0 percent of the total annual volume of LLW disposed of by shallow land burial at the Hanford Site and would not impact the existing disposal operation. Previous assessments of the disposal of LLW are contained in ERDA (1975) and DOE (1983).

All TRU waste generated during SIS operation is planned to be transported to the WIPP. The TRU waste would be contained in 208-liter (55-gallon) drums, nondestructively assayed, surveyed for contamination, certified, and transported to a planned Waste Receiving and Processing (WRAP) facility, where the waste would be shipped to the WIPP. If the WRAP facility is not operational by the startup of the SIS facilities, the waste-handling function would be performed at the currently operating TRU Storage and Assay Facility (TRUSAF). Certified drums of TRU waste would be stored at the TRUSAF until shipment to the WIPP.

The amount of TRU waste currently held in retrievable storage at Hanford is approximately 12,980 cubic meters (460,000 cubic feet) (DOE, 1987b). Projected waste-generation rates of existing operations are expected to add 12,000 cubic meters (424,000 cubic feet) of TRU waste by the end of 1995 that are planned for emplacement at the WIPP. To compare these volumes with the maximum quantity of TRU waste that would be generated by the SIS facility, a waste density of 1.8 grams per cubic centimeter was applied to the SIS grouted TRU waste. The resulting waste volume of 220 cubic meters (7700 cubic feet) per year is about one-third of the projected annual volume of TRU waste to be generated at Hanford. Previous environmental analyses have shown that processing and packaging TRU waste at the Hanford Site would not cause significant adverse impacts under normal conditions (DOE, 1987b).

Mixed wastes generated during SIS operation would either be transported to an approved mixed waste TSD facility or would be stored at the Hanford Site in an approved interim storage facility. Mixed wastes would be contained at their point of generation in approved containers, and all applicable RCRA requirements would be met. During normal waste management practices for this type of waste, no adverse impacts to public health and safety and the environment would occur.

Routine Transport of Materials

If the SIS facilities were located at the Hanford Site, routine shipments of SIS feed material would primarily occur only on the Hanford Site, with only a small number of feed shipments from the SRP. Most of the feed material would not be transported 979 kilometers (610 miles) as for locating the SIS Project at the INEL. TRU waste and potentially SIS by-product would also be transported to the WIPP. SIS product would be transported from the Hanford Site to Rocky Flats, which is about 705 kilometers (440 miles) farther than the distance from the INEL to Rocky Flats. Low-level waste would be transported onsite for disposal. As previously discussed for locating the SIS facilities at the INEL, offsite shipments of feed and product material would be transported in Type-B certified or approved containers aboard DOE-operated SSTs.

Radiological impacts from routine (nonaccident) transport of SIS material for locating the SIS Project at the Hanford Site were calculated by a method similar to that for the INEL and are presented in Section A.3 of Appendix A. The annual population dose from SIS material shipments was estimated to be less than 16 person-rem. The corresponding risk of a radiation-induced health effect for this population is 4.4×10^{-3} latent cancer fatality and 2×10^{-3} genetic disorder.

4.2.3 Potential Impacts of Accidents

The differences in the potential consequences and risks of accidents if the SIS Project were to be located at the Hanford Site compared to the INEL are related to the meteorological transport of released material, the population exposure, and (for the transport of feed, product, and by-product) the distance of transport. The following sections address the major differences in potential accident consequences and risks associated with locating the SIS Project at the Hanford Site compared to locating the project at the INEL.

4.2.3.1 Facility Accidents

Tables 4-17 through 4-20 list the calculated consequences of postulated facility accidents for locating the SIS Project at the Hanford Site. The accident scenarios presented are the same as those considered at the INEL for those accidents having the highest consequences. The differences in the calculated consequences of locating the SIS Project at the Hanford Site versus the INEL are that site-boundary committed dose equivalents at the Hanford Site are slightly lower than those for the INEL and the collective committed dose equivalents at the Hanford Site are larger than those for the INEL. The lower site-boundary doses are attributable to the longer distance from the proposed SIS Project site to the Hanford Site boundary compared to that at the INEL (i.e., about 2 kilometers) and also to differences in meteorological conditions. The higher population doses at Hanford are due to the larger population estimated to be residing within an 80-kilometer (50-mile) radius of the SIS Project site at the Hanford Site in the year 2010. In general, the results of the calculated consequences for locating the SIS Project at the Hanford Site are similar to those for locating the project at the INEL; there are no early offsite effects from any of the postulated facility accidents and the latent effects are insignificant. The dose to the population (i.e., year-2010 population of 709,147 persons) within an 80-kilometer (50-mile) radius and the estimated number of potential latent cancer fatalities and genetic disorders in the event of each of the accidents considered with full filter efficiency (Case 1) are as follows: for the postulated design-basis fire, 1.1×10^{-3} person-rem, 3.1×10^{-7} latent cancer fatality, and 2.8×10^{-7} genetic disorder; for the postulated criticality event, 1 person-rem, 2.8×10^{-4} latent cancer fatality, and 2.6×10^{-4} genetic disorder; for the postulated uncontrolled chemical reaction, 1.5×10^{-3} person-rem; 4.2×10^{-7} latent cancer fatality, and 3.9×10^{-7} genetic disorder; and for the postulated earthquake followed by fire, 3.8×10^{-3} person-rem, 1.1×10^{-6} latent cancer fatality, and 9.8×10^{-7} genetic disorder. Doses to onsite workers would also be below the standard of 5 rem.

4.2.3.2 Transportation Accidents

For locating the SIS Project at the Hanford Site, SIS material transport would be similar to the INEL alternative except that most of the feed would only be transported onsite for short distances. Plutonium product would be transported to Rocky Flats. The annual radiological risk for potential transport accidents was calculated to be 1.6×10^{-4} latent cancer fatality and 7.5×10^{-5} genetic disorder. The nonradiological risk of fatalities (probability of a single traffic death due to mechanical injuries from vehicle accidents) for a full year of SIS material transport was calculated to be 2.2×10^{-2}. This result is based on statistics for truck accidents and therefore is theoretical; in fact, no one has ever been killed in an accident with an SST.

Table 4-17. Consequences of a Postulated Plutonium Building Fire at the Hanford Site

Organ	Distance (km)	Dose in rem Case 1[a]	 Case 2[b]	 Case 3[c]
Bone marrow/whole body	0.4	4.0×10^{-6}	2.0×10^{-3}	2.0×10^{-1}
Bone surface	0.4	5.0×10^{-5}	2.5×10^{-2}	2.5×10^{0}
Lung	0.4	8.6×10^{-6}	4.3×10^{-3}	4.3×10^{-1}
Bone marrow/whole body	1.2	2.6×10^{-6}	1.3×10^{-3}	1.3×10^{-1}
Bone surface	1.2	3.2×10^{-5}	1.6×10^{-2}	1.6×10^{0}
Lung	1.2	5.6×10^{-6}	2.8×10^{-3}	2.8×10^{-1}
Bone marrow/whole body	5.2	5.8×10^{-7}	2.9×10^{-4}	2.9×10^{-2}
Bone surface	5.2	7.2×10^{-6}	3.6×10^{-3}	3.6×10^{-1}
Lung	5.2	1.3×10^{-6}	6.3×10^{-4}	6.3×10^{-2}
Bone marrow/whole body	10.2	2.4×10^{-7}	1.2×10^{-4}	1.2×10^{-2}
Bone surface	10.2	3.0×10^{-6}	1.5×10^{-3}	1.5×10^{-1}
Lung	10.2	5.0×10^{-7}	2.5×10^{-4}	2.5×10^{-2}
Bone marrow/whole body	16.0	1.1×10^{-7}	5.3×10^{-5}	5.3×10^{-3}
Bone surface	16.0	1.3×10^{-6}	6.7×10^{-4}	6.7×10^{-2}
Lung	16.0	2.4×10^{-7}	1.2×10^{-4}	1.2×10^{-2}

[a] Case 1 is full filter efficiency.

[b] Case 2 is 99.9-percent filter efficiency.

[c] Case 3 is 90-percent filter efficiency.

Table 4-18. Consequences of a Postulated Criticality Accident at the Hanford Site

Organ	Distance (km)	Dose (rem)
Bone marrow/whole body	0.4	3.9×10^{-2}
Bone surface	0.4	3.0×10^{-2}
Lung	0.4	3.0×10^{-2}
Thyroid	0.4	9.8×10^{-2}
Bone marrow/whole body	1.2	1.4×10^{-2}
Bone surface	1.2	9.9×10^{-3}
Lung	1.2	1.1×10^{-2}
Thyroid	1.2	5.2×10^{-2}
Bone marrow/whole body	5.2	2.6×10^{-3}
Bone surface	5.2	1.8×10^{-3}
Lung	5.2	1.9×10^{-3}
Thyroid	5.2	1.1×10^{-2}
Bone marrow/whole body	10.2	8.4×10^{-4}
Bone surface	10.2	5.6×10^{-4}
Lung	10.2	6.0×10^{-4}
Thyroid	10.2	4.2×10^{-3}
Bone marrow/whole body	16.0	3.3×10^{-4}
Bone surface	16.0	2.2×10^{-4}
Lung	16.0	2.3×10^{-4}
Thyroid	16.0	1.8×10^{-3}

Table 4-19. Consequences of a Postulated SIS Uncontrolled Chemical Reaction at the Hanford Site

Organ	Distance (km)	Dose in rem Case 1[a]	Case 2[b]	Case 3[c]
Bone marrow/whole body	0.4	5.6×10^{-6}	2.8×10^{-3}	2.8×10^{-1}
Bone surface	0.4	7.2×10^{-5}	3.6×10^{-2}	3.6×10^{0}
Lung	0.4	1.2×10^{-5}	6.2×10^{-3}	6.2×10^{-1}
Bone marrow/whole body	1.2	3.6×10^{-6}	1.8×10^{-3}	1.8×10^{-1}
Bone surface	1.2	4.6×10^{-5}	2.3×10^{-2}	2.3×10^{0}
Lung	1.2	8.0×10^{-6}	4.0×10^{-3}	4.0×10^{-1}
Bone marrow/whole body	5.2	8.2×10^{-7}	4.1×10^{-4}	4.1×10^{-2}
Bone surface	5.2	1.0×10^{-5}	5.2×10^{-3}	5.2×10^{-1}
Lung	5.2	1.8×10^{-6}	9.0×10^{-4}	9.0×10^{-2}
Bone marrow/whole body	10.2	3.4×10^{-7}	1.7×10^{-4}	1.7×10^{-2}
Bone surface	10.2	4.2×10^{-6}	2.1×10^{-3}	2.1×10^{-1}
Lung	10.2	7.2×10^{-7}	3.6×10^{-4}	3.6×10^{-2}
Bone marrow/whole body	16.0	1.5×10^{-7}	7.6×10^{-5}	7.6×10^{-3}
Bone surface	16.0	1.9×10^{-6}	9.6×10^{-4}	9.6×10^{-2}
Lung	16.0	3.4×10^{-7}	1.7×10^{-4}	1.7×10^{-2}

[a] Case 1 is full filter efficiency.
[b] Case 2 is 99.9-percent filter efficiency.
[c] Case 3 is 90-percent filter efficiency.

Table 4-20. Consequences of a Postulated SIS Design-Basis Earthquake and Fire at the Hanford Site

Organ	Distance (km)	Dose in rem Case 1[a]	 Case 2[b]	 Case 3[c]
Bone marrow/whole body	0.4	1.4×10^{-5}	7.1×10^{-3}	7.1×10^{-1}
Bone surface	0.4	1.8×10^{-4}	8.9×10^{-2}	8.9×10^{0}
Lung	0.4	3.2×10^{-5}	1.6×10^{-2}	1.6×10^{0}
Bone marrow/whole body	1.2	9.0×10^{-6}	4.5×10^{-3}	4.5×10^{-1}
Bone surface	1.2	1.1×10^{-4}	5.7×10^{-2}	5.7×10^{0}
Lung	1.2	2.0×10^{-5}	1.0×10^{-2}	1.0×10^{0}
Bone marrow/whole body	5.2	2.0×10^{-6}	1.0×10^{-3}	1.0×10^{-1}
Bone surface	5.2	2.6×10^{-5}	1.3×10^{-2}	1.3×10^{0}
Lung	5.2	4.6×10^{-6}	2.3×10^{-3}	2.3×10^{-1}
Bone marrow/whole body	10.2	8.2×10^{-7}	4.1×10^{-4}	4.1×10^{-2}
Bone surface	10.2	1.0×10^{-5}	5.2×10^{-3}	5.2×10^{-1}
Lung	10.2	1.8×10^{-6}	9.1×10^{-4}	9.1×10^{-2}
Bone marrow/whole body	16.0	3.8×10^{-7}	1.9×10^{-4}	1.9×10^{-2}
Bone surface	16.0	4.8×10^{-6}	2.4×10^{-3}	2.4×10^{-1}
Lung	16.0	8.4×10^{-7}	4.2×10^{-4}	4.2×10^{-2}

[a] Case 1 is full filter efficiency.
[b] Case 2 is 99.9-percent filter efficiency.
[c] Case 3 is 90-percent filter efficiency.

4.2.4 Occupational Safety

During construction, accidents could occur that would result in worker injuries and fatalities. The rate of occurrence of injuries and fatalities and the projected injuries and fatalities would be the same as discussed for locating the SIS Project at the INEL.

During the construction of the SIS at the Hanford Site, construction personnel would also experience a slightly elevated background level of radioactivity resulting from on-going Hanford Site defense operations. Given a maximum onsite external penetrating dose of about 0.0093 millirem per hour, or 80 millirem per year, measured in the vicinity of the 200-East Area, the annual dose increment to a construction worker who spends 2000 hours per year (40 hours per week for 50 weeks per year) on the site would be about 2 millirem above the background external dose of 75 millirem per year. The potential dose to a construction worker from radionuclides released to the atmosphere from on-going Hanford Site defense operations is expected to be insignificant (i.e., less than 1 millirem). The dose of 2 millirem to a construction worker at the Hanford Site would be well below the DOE standard of 5000 millirem per year for occupationally related external and internal exposure.

During operation of the SIS facilities, Hanford personnel would be exposed to routine atmospheric emissions of radioactivity and exposed to potential emissions from accidents. The radiological doses to onsite personnel would generally be higher than the doses experienced by a hypothetical maximum individual residing at the Hanford Site boundary location nearest to the SIS Project but below the DOE standard for occupationally related external and internal exposure. Approximately 1000 workers are employed in the 200-East Area within a 1.6-kilometer (1-mile) radius of the SIS Project site. Exposures, injuries, and potential fatalities to workers in the SIS facilities could also occur as a result of postulated accidents, as previously discussed in Section 4.1.4 for locating the SIS Project at the INEL.

4.2.5 Unavoidable Adverse Impacts

The proposed construction of the SIS facilities at the Hanford Site would directly impact a total of about 73,000 square meters (18 acres) of land area previously dedicated to the production of defense nuclear materials, and approximately 412,000 square meters (104 acres) outside the protected site area for the construction of a transmission line and tile field. During construction, plant and animal habitats associated with a sagebrush vegetation community would be lost or displaced from areas not previously disturbed. None of the land area outside the protected site area associated with the construction of the transmission line and about half of the land area within the protected site area would be affected by operation, and would revert to a sagebrush vegetation community through natural plant succession. Construction of the SIS Project would also generate liquid effluents, atmospheric emissions, and solid wastes typical of those for construction of any major industrial facility; all effluents and emissions would be below applicable environmental requirements and would not be expected to result in any significant adverse impact.

During operation of the SIS facilities, unavoidable radiation exposures would include occupational exposures and exposures to the public from normal atmospheric emissions of radioactive materials that would be minimal compared to criteria contained in EPA's 40 CFR 61 and DOE Order 5480.1B. Sanitary and service waste liquid discharges that would eventually be discharged to the soil column through tile fields would all be below applicable environmental standards, including radioactivity standards for drinking water. Solid wastes generated during operation, including TRU, LLW, hazardous, and mixed wastes, would result in small increases in potential exposures to radioactive and hazardous materials. Freon emissions would result in a negligible increase in the risk of skin cancer; substitutes will be used when available.

Construction and operation of the SIS facilities would not require the use or consumption of scarce resources. Expected surface-water withdrawals from the Columbia River during construction and operation represent small incremental increases in the amount of water currently being withdrawn by on-going Hanford operations and represent a negligible withdrawal in comparison to the annual average flow of the Columbia River. In general, the unavoidable adverse impacts would be few and limited, and none have been identified that would significantly affect public health and safety.

4.3 ENVIRONMENTAL CONSEQUENCES OF CONSTRUCTING AND OPERATING THE SIS PROJECT AT THE SAVANNAH RIVER PLANT

The following sections discuss the major differences in potential environmental consequences that would occur if the SIS Project were constructed and operated at DOE's SRP rather than at the INEL. The environmental consequences of locating the SIS facilities at the SRP are based on the same radiological source terms for normal and accidental releases and the estimated SIS atmospheric emissions, liquid effluents, and solid wastes discussed in Section 4.1.

4.3.1 Construction Impacts

If the SIS Project were to be constructed at DOE's SRP, the potential socioeconomic impacts associated with construction are expected to be equal to or less than those associated with locating the project at the INEL. No in-migrating construction workers would be expected as a result of constructing the project at the SRP, because after 1987 there would be significant declines in the construction workforce at the SRP associated with the construction of the Defense Waste Processing and Naval Reactor Fuel Materials Facilities and the construction workforce for Georgia Power Company's Vogtle Nuclear Power Plant. Currently, these two construction workforces number more than 14,000 personnel (DOE, 1987e). During the construction period, operations personnel would be hired so that at the end of the construction period, 656 of the 750 operating workers would be employed. The percentage of operations workers estimated to in-migrate varies based on skill requirements. Overall, approximately 20 percent (116 personnel) are estimated to move into the SRP area. The six counties surrounding the SRP had a 1986 population of about 419,500 persons, or about twice that of the INEL. The larger population base associated with the SRP region would also provide a greater capability to absorb any in-migrating personnel during the construction period; however, the larger economic base of the SRP region (DOE, 1984b) would also have a greater tendency to diffuse potential economic benefits compared to locating the project at the INEL.

Construction of the SIS Project would directly affect about 20 acres of land adjacent to the existing F-Area chemical separations area as well as areas previously disturbed by the construction of the Naval Reactor Fuel Materials Facility. The SIS site and its adjacent environs are relatively diverse and contain both monotypic stands of loblolly pine and admixtures of hardwoods. The northern boundary of the SIS site is approximately 0.40 kilometer (0.25 mile) from Upper Three Runs Creek. A large portion of the SIS site has been recently logged as part of the on-going SRP forestry management program. The SIS site does not contain any known archeological or historic sites. Construction would not disturb any critical or sensitive ecological habitats, nor would it impact wetland areas. Compared to the INEL SIS site, however, the SRP SIS site is considered more ecologically diverse.

Because of the SRP SIS site's higher elevation relative to a PMF and consequent reduction in the amount of grading compared to locating the SIS Project at the INEL, fewer emissions of fugitive dust and emissions associated with grading activities would be generated.

Water required for construction would be withdrawn from the F-Area well field and distribution system. The amount of water withdrawn would be negligible in comparison to the approximately 7300 liters (1930 gallons) per minute currently being withdrawn in the F-Area. The amount withdrawn would not affect the water-production capabilities of the Middendorf/Black Creek aquifer. Sanitary effluents generated during construction would be treated through either the use of chemical toilets or a package waste-water treatment facility that would discharge treated sanitary effluent to Four Mile Creek by means of a lift station. Solid waste generated during construction would be disposed of in the SRP sanitary landfill, which is operated in accordance with State of South Carolina guidelines. Mitigation and control measures for potential spills, fugitive dust, and erosion would be undertaken as part of construction activities.

4.3.2 Normal Operational Impacts

The normal operational impacts associated with locating the SIS Project at the SRP would be similar to those for locating the project at the INEL. The following sections briefly describe the nonradiological and radiological impacts associated with locating the proposed SIS Project at the SRP.

4.3.2.1 Nonradiological Impacts

SIS operation at the SRP would require the same number of operating personnel as at the INEL. As at the INEL, 656 of the operating personnel would be hired during the construction period, and a similar number of operating personnel would in-migrate to the SRP region. Given an average family size for in-migrating operating personnel of 2.75 persons per household, the expected population increase attributable to in-migrating operating personnel would be about 36 persons in the first year of operations. This increase would represent less than 1 percent of the 1980 to 1986 average annual growth rate in the six counties surrounding the SRP.

Given the small percentage of population increase attributable to SIS operation in relation to normal population increases in the SRP region, no major adverse impacts to local government services and community infrastructures are expected. The economic benefits to the SRP region are expected to be similar to or less than those for the INEL region as the existing economic base of the SRP region is significantly greater and more diverse (DOE, 1984c) than the INEL region (EG&G Idaho, Inc., 1984).

During SIS operation, additional coal would be burned to supply steam. The incremental burning of coal for steam production would be below PSD de minimis levels, similar to locating the SIS Project at the INEL, as the estimated emissions (Table 4-6) are predominantly derived from the tons of coal burned. Average SIS water utilization of about 1.3 cubic meters (45.8 cubic feet) per minute would represent about a 5-percent increase in the current ground-water withdrawal of 26.8 cubic meters (950.0 cubic feet) per minute (DOE, 1987a). Consumptive water losses of about 0.6 cubic meter (22 cubic feet) per minute would represent about 2 percent of current SRP ground-water withdrawal.

Sanitary effluents generated as a result of SIS operations would be discharged to a package treatment plant. Treated sanitary effluent from the treatment plant would be discharged to Four Mile Creek via a lift station. Liquid effluents would meet applicable South Carolina discharge limitations. Liquid effluents (i.e., cooling tower blowdown and process steam condensate) would be below DOE Order 5480.1B, RCRA, and safe drinking water standards for radioactivity, would be monitored and then discharged to Four Mile Creek via a lift station. These liquid effluents, meeting all standards and requirements, are not expected to result in any contamination of surface waters or to affect aquatic biota.

During SIS operation, nonradioactive and nonhazardous solid waste and hazardous solid waste would be generated in quantities similar to those discussed for the INEL. Nonradioactive and nonhazardous solid waste would be disposed of in the SRP sanitary landfill. Hazardous wastes would be stored/disposed of at the SRP in a combination of RCRA-permitted storage and disposal in landfills or vaults as discussed in DOE (1987a). The amount of hazardous waste generated by SIS operation would be small in comparison to the amount of hazardous waste that is generated and currently in interim storage at the SRP. Based on the analyses contained in DOE (1987a), no significant impacts would result from this strategy for normal hazardous waste management at the SRP.

4.3.2.2 Radiological Impacts

Normal radiological releases to the atmosphere and the quantities of radioactive and mixed wastes that would be generated would not differ from those previously discussed for the INEL; however, the location of the project relative to the surrounding SRP population and the distances to facilities that would be involved in routine shipments of material would result in differences in potential environmental consequences, as discussed in the following sections.

Atmospheric Emissions

The location of the SIS facilities to the nearest SRP site boundary would be approximately 8.9 kilometers (5.5 miles). The estimated year-2010 offsite population within 80 kilometers (50 miles) of the SIS site at the SRP is conservatively projected at about 1,086,888 persons using a 1970-1980 exponential population growth rate or 756,000 persons based on local estimates (DOE, 1982b), compared to the 230,129 persons (based on exponential population growth rate) within an 80-kilometer (50-mile) radius of the SIS site at the INEL. As a result of the closer proximity of the SIS site to the nearest SRP boundary compared to the SIS site's proximity to the nearest INEL boundary and meteorological differences, the calculated radiological dose to a hypothetical individual residing at the SRP site boundary is greater than that to an individual residing at the INEL site boundary. The calculated collective dose for locating the SIS at the SRP is larger than the calculated collective dose for the INEL because of the larger estimated population within an 80-kilometer (50-mile) radius of the SIS Project at the SRP. The following sections discuss the results of the calculations that were performed. The methodology that was used to perform these calculations is the same as that discussed in Section 4.1.2.3.

Maximum Individual

The committed whole-body dose, critical-organ (bone-surface) dose, and EDEs received from all pathways from annual SIS releases by the maximally exposed individual are 8.9×10^{-9}, 5.5×10^{-7}, and 4.2×10^{-8} millirem, respectively. The inhalation pathway contributed over 99 percent of these doses. The calculated EDE of 4.2×10^{-8} millirem is insignificant in comparison with the 25-millirem standard contained in EPA's NESHAP. A discussion of cumulative doses at the SRP and compliance with NESHAP is contained in Section 4.5.2.

Conservatively assuming that all the radioactivity released to the environment would be high-LET radiation, the resulting risk of a latent cancer fatality and genetic disorder to the maximally exposed individual from 1 year of operation would be only 1.4×10^{-14} and 1.0×10^{-15}, respectively.

Population

The collective whole-body dose and EDE received from annual releases by the population surrounding the SRP from all exposure pathways were calculated to be 2.0×10^{-7} and 9.5×10^{-7} person-rem for a year-2010 population of 1,086,888 persons, or 1.4×10^{-7} and 6.6×10^{-7} person-rem for a population of 756,000 persons, respectively. The inhalation pathway contributed over 99.5 percent of these doses. The calculated collective whole-body dose equivalent of 2.0×10^{-7} person-rem to the year-2010 population of 1,086,888 persons is insignificant in comparison with the more than 90,000 person-rem that would be received from sources other than natural background radiation by the population surrounding the SRP.

Conservatively assuming the release to be only high-LET radiation, the number of health effects that would occur in the population as a result of 1 year of operation during the year 2010 to 1,086,888 persons would be only 3.2×10^{-10} latent cancer fatality and 2.3×10^{-11} genetic disorder.

Radioactive Solid Wastes

Low-level waste generated by the SIS facility would be disposed of at the SRP. Prior to disposal, the LLW would be packed into drums and nondestructively assayed. All solid LLW generated by operations of the SRP is presently disposed of at the Radioactive Waste Burial Ground (RWBG), a shallow land burial site covering about 119 acres. To meet future disposal requirements, plans to construct a new LLW disposal/storage facility at the SRP are in progress (Cook, Towler, and Grant, 1987). The facility would be designed to meet the technology standards of applicable DOE Orders. Projected 20-year waste-generation rates from all SRP operations indicate that the new facility would require 356,700 to 542,400 cubic meters (12,600,000 to 19,160,000 cubic feet) of disposal capacity (DOE, 1987a). The 30 cubic meters of LLW generated annually by the SIS Project represents an insignificant quantity when compared to the quantity of LLW disposed of at the SRP and would not impact planned disposal operations.

All TRU waste generated by the SIS facility is planned to be transported to the WIPP. The TRU wastes would be placed in grouted form into 208-liter (55-gallon) drums, nondestructively assayed, surveyed for contamination, and certified for shipment to the WIPP in accordance with WIPP acceptance criteria. Currently, planning at the SRP provides for the construction and operation of a new TRU Waste Processing Facility (TWF) that would receive retrieved TRU waste and newly generated TRU waste requiring processing (DOE, 1988). The new facility would perform the same functions as those described for the Stored Waste Examination Pilot Plant (SWEPP) and the PREPP at the INEL. If the SRP facility is not operational by the start of SIS operation, the SIS-generated TRU waste requiring processing would be transported to the existing TRU storage area located next to the existing SRP burial ground until the TWF is operational. The volume of TRU waste generated by the SIS facility would be 220 cubic meters (7770 cubic feet) per year, assuming a waste density of 1.8 grams per cubic centimeter for grouted material. This quantity would represent only about 10 percent of the total projected annual volume of TRU waste generated at the SRP and would not impact planned waste-handling operations.

Mixed wastes generated by SIS operation would either be stored in shielded storage buildings, disposed of in RCRA-approved landfills or shielded vaults, or managed through a combination of these alternatives as discussed in DOE (1987a). The amount of mixed waste generated would represent a negligible quantity in relation to the quantities requiring storage or disposal from past and on-going SRP operations.

Routine Transport of Materials

If the SIS Project were located at the SRP, routine shipments of feed and product would be transported to and from the site and TRU waste and potentially SIS-generated by-product would be transported to the planned WIPP. LLW would be transported onsite for disposal. As previously discussed for locating the SIS facilities at the INEL, offsite shipments of feed and product material would be transported in Type B certified containers aboard DOE-operated SSTs.

Radiological impacts from routine (nonaccident) transport of SIS material for locating the SIS Project at the SRP were calculated by a method similar to that for the INEL and are presented in detail in Section A.3 of Appendix A. The annual population dose from SIS material shipments was estimated to be less than 19 person-rem. The corresponding risk of a radiation-induced health effect for this population is 5.3×10^{-3} latent cancer fatality and 2.4×10^{-3} genetic disorder.

4.3.3 Potential Impacts of Accidents

The differences in the potential consequences and risks of accidents were the SIS Project to be located at the SRP compared to the INEL are related to the meteorological transport of released material, the population exposure, and (for the transport of feed, product, and by-product) the distance of transport. The following sections address the major differences in potential accident consequences and risks associated with locating the SIS Project at the SRP compared to locating the project at the INEL.

4.3.3.1 Facility Accidents

Tables 4-21 through 4-24 list the calculated consequences of postulated facility accidents having the highest consequences for locating the SIS Project at the SRP. The accident scenarios are the same as those considered at the INEL.

The difference in the calculated consequences of locating the SIS Project at the SRP versus the INEL is that societal consequences (i.e., collective doses) at the SRP would be larger than at the INEL because of the larger estimated year-2010 population within an 80-kilometer (50-mile) radius of the SIS Project site at the SRP. Although the SIS Project site at the SRP is closer to the SRP boundary compared to the SIS site at the INEL, the SRP site-boundary doses are only slightly higher than those of the INEL because of different meteorological dispersion characteristics. In general, the results of the calculated consequences for locating the SIS Project at the SRP are similar to those for locating the project at the INEL; there are no early offsite effects from any of the postulated facility accidents and

Table 4-21. Consequences of a Postulated Plutonium Building Fire at the SRP

Organ	Distance (km)	Dose in rem		
		Case 1[a]	Case 2[b]	Case 3[c]
Bone marrow/whole body	0.4	4.2×10^{-6}	2.1×10^{-3}	2.1×10^{-1}
Bone surface	0.4	5.4×10^{-5}	2.7×10^{-2}	2.7×10^{0}
Lung	0.4	9.4×10^{-6}	4.7×10^{-3}	4.7×10^{-1}
Bone marrow/whole body	1.2	2.4×10^{-6}	1.2×10^{-3}	1.2×10^{-1}
Bone surface	1.2	3.0×10^{-5}	1.5×10^{-2}	1.5×10^{0}
Lung	1.2	5.0×10^{-6}	2.5×10^{-3}	2.5×10^{-1}
Bone marrow/whole body	5.2	5.6×10^{-7}	2.8×10^{-4}	2.8×10^{-2}
Bone surface	5.2	7.2×10^{-6}	3.6×10^{-3}	3.6×10^{-1}
Lung	5.2	1.2×10^{-6}	6.2×10^{-4}	6.2×10^{-2}
Bone marrow/whole body	8.9	2.6×10^{-7}	1.3×10^{-4}	1.3×10^{-2}
Bone surface	8.9	3.4×10^{-6}	1.7×10^{-3}	1.7×10^{-1}
Lung	8.9	6.0×10^{-7}	3.0×10^{-4}	3.0×10^{-2}

[a] Case 1 is full filter efficiency.
[b] Case 2 is 99.9-percent filter efficiency.
[c] Case 3 is 90-percent filter efficiency.

Table 4-22. Consequences of a Postulated Criticality Accident at the SRP

Organ	Distance (km)	Dose (rem)
Bone marrow/whole body	0.4	4.3×10^{-2}
Bone surface	0.4	3.3×10^{-2}
Lung	0.4	3.2×10^{-2}
Thyroid	0.4	8.9×10^{-2}
Bone marrow/whole body	1.2	1.3×10^{-2}
Bone surface	1.2	9.2×10^{-3}
Lung	1.2	9.7×10^{-3}
Thyroid	1.2	4.6×10^{-2}
Bone marrow/whole body	5.2	2.7×10^{-3}
Bone surface	5.2	1.9×10^{-3}
Lung	5.2	2.0×10^{-3}
Thyroid	5.2	1.1×10^{-2}
Bone marrow/whole body	8.9	1.2×10^{-3}
Bone surface	8.9	8.1×10^{-4}
Lung	8.9	8.7×10^{-4}
Thyroid	10.2	5.1×10^{-3}

Table 4-23. Consequences of a Postulated SIS Uncontrolled Chemical Reaction at the SRP

Organ	Distance (km)	Dose in rem		
		Case 1[a]	Case 2[b]	Case 3[c]
Bone marrow/whole body	0.4	6.2×10^{-6}	3.1×10^{-3}	3.1×10^{-1}
Bone surface	0.4	7.8×10^{-5}	3.9×10^{-2}	3.9×10^{0}
Lung	0.4	1.3×10^{-5}	6.6×10^{-3}	6.6×10^{-1}
Bone marrow/whole body	1.2	3.4×10^{-6}	1.7×10^{-3}	1.7×10^{-1}
Bone surface	1.2	4.2×10^{-5}	2.1×10^{-2}	2.1×10^{0}
Lung	1.2	7.2×10^{-6}	3.6×10^{-3}	3.6×10^{-1}
Bone marrow/whole body	5.2	8.2×10^{-7}	4.1×10^{-4}	4.1×10^{-2}
Bone surface	5.2	1.0×10^{-5}	5.1×10^{-3}	5.1×10^{-1}
Lung	5.2	1.8×10^{-6}	8.9×10^{-4}	8.9×10^{-2}
Bone marrow/whole body	8.9	3.8×10^{-7}	1.9×10^{-4}	1.9×10^{-2}
Bone surface	8.9	4.8×10^{-6}	2.4×10^{-3}	2.4×10^{-1}
Lung	8.9	8.4×10^{-7}	4.2×10^{-4}	4.2×10^{-2}

[a] Case 1 is full filter efficiency.
[b] Case 2 is 99.9-percent filter efficiency.
[c] Case 3 is 90-percent filter efficiency.

Table 4-24. Consequences of a Postulated SIS Design-Basis Earthquake and Fire at the SRP

Organ	Distance (km)	Dose in rem Case 1[a]	Case 2[b]	Case 3[c]
Bone marrow/whole body	0.4	1.5×10^{-5}	7.6×10^{-3}	7.6×10^{-1}
Bone surface	0.4	1.9×10^{-4}	9.6×10^{-2}	9.6×10^{0}
Lung	0.4	3.4×10^{-5}	1.7×10^{-2}	1.7×10^{0}
Bone marrow/whole body	1.2	8.2×10^{-6}	4.1×10^{-3}	4.1×10^{-1}
Bone surface	1.2	1.0×10^{-4}	5.2×10^{-2}	5.2×10^{0}
Lung	1.2	1.8×10^{-5}	9.0×10^{-3}	9.0×10^{-1}
Bone marrow/whole body	5.2	2.0×10^{-6}	1.0×10^{-3}	1.0×10^{-1}
Bone surface	5.2	2.6×10^{-5}	1.3×10^{-2}	1.3×10^{0}
Lung	5.2	4.4×10^{-6}	2.2×10^{-3}	2.2×10^{-1}
Bone marrow/whole body	8.9	9.6×10^{-7}	4.8×10^{-4}	4.8×10^{-2}
Bone surface	8.9	1.2×10^{-5}	6.1×10^{-3}	6.1×10^{-1}
Lung	8.9	2.2×10^{-6}	1.1×10^{-3}	1.1×10^{-1}

[a] Case 1 is full filter efficiency.
[b] Case 2 is 99.9-percent filter efficiency.
[c] Case 3 is 90-percent filter efficiency.

the latent effects are insignificant. The dose to the population (i.e., year-2010 population of 1,086,896 persons) within an 80-kilometer (50-mile) radius and the estimated number of potential latent cancer fatalities and genetic disorders in the event of each of the accidents considered with full filter efficiency (Case 1) are as follows: for the postulated design-basis fire, 1.5×10^{-3} person-rem, 4.3×10^{-7} latent cancer fatality, and 3.9×10^{-7} genetic disorder; for the postulated criticality event, 2.1 person-rem, 5.9×10^{-4} latent cancer fatality, and 5.4×10^{-4} genetic disorder; for the postulated uncontrolled chemical reaction, 2.2×10^{-3} person-rem, and 6.2×10^{-7} latent cancer fatality, and 5.7×10^{-7} genetic disorder; and for the postulated earthquake followed by fire, 5.6×10^{-3} person-rem, 1.6×10^{-6} latent cancer fatality, and 1.4×10^{-6} genetic disorder. Doses to onsite workers would also be below the DOE 5-rem standard.

4.3.3.2 Transportation Accidents

For the alternative of locating the SIS Project at the SRP, plutonium feed would primarily be transported from the Hanford Site to the SRP, plutonium metal product would be transported to DOE's Rocky Flats Plant, and TRU waste and potentially SIS-generated by-product would be transported to the WIPP. The annual radiological risk for potential transport accidents was calculated to be 2.9×10^{-4} latent cancer fatality and 1.3×10^{-4} genetic disorder. The nonradiological risk of fatalities (i.e., probability of a single traffic death due to mechanical injuries from vehicle accidents) for a full year of SIS material transport was calculated to be 2.1×10^{-2}. This result is based on statistics for truck accidents and therefore is theoretical; in fact, no one has ever been killed in an accident with an SST.

4.3.4 Occupational Safety

During construction, accidents could occur that would result in worker injuries and fatalities. The rate of occurrence of injuries and fatalities and the projected injuries and fatalities would be the same as discussed for locating the SIS Project at the INEL.

During SIS construction, workers would experience slightly elevated background levels of radiation resulting from on-going SRP operations. The maximum gamma radiation measured near the SIS site is about 128 millirem per year (Du Pont, 1986). Given this measured dose, the annual dose increment to a construction worker who spends 2000 hours per year (40 hours per week for 50 weeks per year) in the construction area would be about 15 millirem above a background external dose of 65 millirem per year. The potential dose to a construction worker from inhalation of radionuclides released to the atmosphere from existing SRP operations is estimated to be about 0.4 millirem per year, which is small compared to the external dose. The dose of 15 millirem per year to a construction worker would be below the DOE standard of 5000 millirem per year for occupationally related external and internal exposures.

During operation of the SIS facilities, SRP personnel would be exposed to routine atmospheric emissions of radioactivity and exposed to potential emissions from accidents. The radiological doses to onsite personnel would generally be higher than the doses experienced by a hypothetical maximum individual residing at the SRP boundary location nearest to the SIS Project but below the DOE standard for occupationally related external and internal exposure. Between 1200 and 1500 workers are employed in the F-Area within a 1-mile radius of the SIS Project site. Exposures, injuries, and potential fatalities to workers in the SIS facilities could also occur as a result of facility accidents, as previously discussed in Section 4.1.4 for locating the SIS Project at the INEL.

4.3.5 Unavoidable Adverse Impacts

The construction of the SIS Project at the SRP would directly impact about 80,930 square meters (20 acres) of land area adjacent to the existing F-Area chemical separations area and areas previously disturbed by construction activities. More than half of the site of the SIS Project has recently been logged as part of on-going forestry management activities. An estimated 10 acres of monotypic stands of loblolly pine and admixtures of hardwoods would be cleared as part of construction activities. During construction, plant and animal habitats associated with pine and hardwood vegetation communities would be lost or displaced from areas not recently affected by forestry management activities. Construction of the SIS would also generate liquid effluents, atmospheric emissions, and solid wastes typical of those for construction of a major industrial facility; all effluents and emissions would be below applicable environmental requirements and would not be expected to result in any major adverse impacts.

During SIS operation, unavoidable radiation exposures would include occupational exposures and exposures to the public from normal atmospheric emissions of radioactive materials that would be minimal compared to criteria contained in EPA's 40 CFR 61 and DOE Order 5480.1B. Sanitary waste and service waste liquid discharges that would eventually be discharged to Four Mile Creek would be below applicable environmental standards. Solid wastes generated during operation, including TRU, LLW, hazardous, and mixed wastes, would result in small increases in potential exposures to radioactive and hazardous materials. Freon emissions would result in a negligible increase in the risk of skin cancer; substi-tutes will be used when available.

Construction and operation of the SIS Project would not require the use or consumption of scarce resources. Expected ground-water withdrawals during construction and operation would represent small incremental increases in the amount of water being withdrawn by on-going SRP operations. In general, the unavoidable adverse impacts would be few and limited, and none have been identified that would significantly affect public health and safety.

4.4 ENVIRONMENTAL CONSEQUENCES OF NO ACTION

The No-Action Alternative is not to construct and operate the SIS Project. If the SIS Project is not constructed and operated, the technical diversity, flexibility, and contingency in the production of weapon-grade plutonium that would be provided by the SIS Project would not be achieved. The operation of DOE's nuclear materials production complex for weapon-grade plutonium would continue to be delineated on an annual basis. The No-Action Alternative would not result in changes to continuing operations at the Hanford Site, the SRP, or any other DOE site.

Blending fuel-grade plutonium with newly produced plutonium of higher than weapon-grade purity will continue to provide an option for the production of weapon-grade plutonium regardless of whether the SIS Project is constructed and operated. The environmental consequences of blending involve a range of activities that are dependent on the approved need for material. The Final EIS for restart of the L-Reactor at the SRP (DOE, 1984b) provides a detailed assessment of the environmental consequences of the production of higher-than-weapon-grade-purity plutonium required for blending. The environmental impacts as described in that EIS include both nonradiological and radiological impacts. Subsequent EISs (DOE, 1987a,e) discuss the environmental consequences of alternative cooling-water systems for other SRP reactors and SRP waste management facilities for LLW and hazardous and mixed wastes.

4.5 CUMULATIVE EFFECTS

Section 4.1 discussed the potential environmental consequences of constructing and operating the SIS Project at the INEL. The environmental consequences of operation were discussed in terms of annual impacts (i.e., radiological doses and health effects, accident risks, and quantities of wastes that would be generated during operation) based on the maximum annual throughput capacity of the proposed project. To bound the potential consequences of up to 30 years of SIS operation, Table 4-25 presents the results of a parametric analysis of accumulated environmental consequences and risks for the INEL as well as for the alternatives of locating the SIS Project at the Hanford Site and the SRP.

The following sections discuss the cumulative impacts (i.e., the impacts of SIS in combination with those of existing and authorized projects) at the INEL and at the alternative locations of the Hanford Site and the SRP.

4.5.1 Cumulative Effects at the INEL

There are currently no projects outside the INEL site boundary (e.g., nuclear facilities, major construction projects similar in scale to that of the SIS, or facilities involving hazardous activities) that would cause potential cumulative impacts beyond those associated with the INEL. The

Table 4-25. Consequences of 30 Years of SIS Project Operations at the Alternative Sites

Category	Proposed Action (PA) and Preferred Alternative--construct and operate SIS Project at the INEL	Construct and operate SIS Project at the Hanford Site	Construct and operate SIS Project at the SRP
	ROUTINE NONRADIOLOGICAL OPERATIONAL IMPACTS		
Socioeconomic impacts	Workforce would contribute to stabilizing workforce and benefits to regional economy.	Same as for PA.	Same as for PA.
Atmospheric emissions	Nonradiological emissions would continue to be below annual standards; substitute coolants expected to be available for Freon emissions. Less than 2160 metric tons of SO_2, particulates, NO_x, CO, and organic vapors emitted.	Same as for PA.	Same as for PA.
Liquid effluents	Only nonradioactive and nonhazardous liquid effluents would be discharged to percolation pond(s). Total SIS liquid discharges would approximate 7.2×10^8 liters of treated sanitary effluent and 7.8×10^7 liters of nonradioactive and nonhazardous process steam condensate and cooling tower blowdown to service waste system.	Same as for PA except discharges would be to tile fields.	Same as for PA except discharges would be to a stream (i.e., Four Mile Creek).

Table 4-25. Consequences of 30 Years of SIS Project Operations at the Alternative Sites (continued)

Category	Proposed Action (PA) and Preferred Alternative--construct and operate SIS Project at the INEL	Construct and operate SIS Project at the Hanford Site	Construct and operate SIS Project at the SRP
	ROUTINE NONRADIOLOGICAL OPERATIONAL IMPACTS (continued)		
Nonhazardous solid waste	Total amount of nonhazardous waste would be less than 27,000 metric tons, which would be disposed of in an onsite sanitary landfill.	Same as for PA.	Same as for PA.
Hazardous waste	Would continue to be handled in accordance with applicable RCRA requirements and would be transported offsite to an approved RCRA TSD facility. Total amount requiring handling, management, and offsite transport less than 990,000 liters.	Same as for PA.	Hazardous waste would be stored or disposed of onsite in compliance with RCRA. Quantity same as for PA.
	ROUTINE RADIOLOGICAL OPERATIONAL IMPACTS		
Atmospheric emissions	Maximum accumulated whole-body dose of 4.0×10^{-7} millirem and accumulated whole-body dose to surrounding population of less than 6.8×10^{-7} person-rem. Total calculated health effects to population of 7.5×10^{-11} genetic disorder and 1.1×10^{-9} latent cancer fatality.	Maximum accumulated individual whole-body dose of 2.2×10^{-7} millirem and accumulated whole-body dose to surrounding population of less than 4.2×10^{-6} person-rem. Total calculated health effects to population of 4.5×10^{-10} genetic disorder and 6.6×10^{-9} latent cancer fatality.	Maximum accumulated individual whole-body dose of 2.7×10^{-7} millirem and accumulated whole-body dose to surrounding population of less than 6.1×10^{-6} person-rem. Total calculated health effects to population of 6.9×10^{-10} genetic disorder and 9.6×10^{-9} latent cancer fatality.

Table 4-25. Consequences of 30 Years of SIS Project Operations at the Alternative Sites (continued)

Category	Proposed Action (PA) and Preferred Alternative-- construct and operate SIS Project at the INEL	Construct and operate SIS Project at the Hanford Site	Construct and operate SIS Project at the SRP
	ROUTINE RADIOLOGICAL OPERATIONAL IMPACTS (continued)		
Solid waste	Total quantities of radioactive waste generated would be: LLW, less than 900 metric tons; TRU waste, less than 12,000 metric tons; mixed waste, less than 300 metric tons. All wastes managed and stored or disposed of as listed in Table S-1.	Same as PA. All wastes managed and stored or disposed of as listed in Table S-1.	Same as PA. All wastes managed and stored or disposed of as listed in Table S-1.
Routine transport of materials	Routine transport of radioactive materials would result in an accumulated exposure of less than 360 person-rem. Total calculated health effects to population of 4.8×10^{-2} genetic disorder and 1.1×10^{-1} cancer fatality.	Routine transport of radioactive materials would result in an accumulated exposure of less than 480 person-rem. Total calculated health effects to population of 6×10^{-1} genetic disorder and 1.2×10^{-1} cancer fatality.	Routine transport of radioactive materials would result in an accumulated exposure of less than 570 person-rem. Total calculated health effects to population of 7.2×10^{-1} genetic disorder and 1.6×10^{-1} cancer fatality.
SIS facility accidents[a]	Risk of offsite genetic disorder and cancer fatality for design-basis accident having highest consequence would be less than 5.7×10^{-7} for a genetic disorder and 6.3×10^{-7} for a latent cancer fatality; because of the extremely low probability of occurrence of the postulated severe accident, the risk to the offsite population would not significantly increase.	Risk of genetic disorder and offsite cancer fatality would be less than 1.5×10^{-6} for a genetic disorder and 1.6×10^{-6} for a latent cancer fatality; postulated severe accident would not significantly increase risk.	Risk of genetic disorder and offsite cancer fatality would be less than 2.2×10^{-6} for a genetic disorder and 2.3×10^{-6} for a latent cancer fatality; postulated severe accident would not significantly increase risk.

Table 4-25. Consequences of 30 Years of SIS Project Operations at the Alternative Sites (continued)

Category	Proposed Action (PA) and Preferred Alternative--construct and operate SIS Project at the INEL	Construct and operate SIS Project at the Hanford Site	Construct and operate SIS Project at the SRP
	ROUTINE RADIOLOGICAL OPERATIONAL IMPACTS (continued)		
Transport accidents[a]	Radiological risk of a single health effect from the transport of feed, product, (potentially) by-product, TRU waste, and onsite transport of LLW, less than 1.8×10^{-3} genetic disorder and 3.9×10^{-3} latent cancer fatality.	Radiological risk of a single health effect from the transport of feed, product, (potentially) by-product, TRU waste, and onsite transport of LLW, less than 2.3×10^{-3} genetic disorder and 4.8×10^{-3} latent cancer fatality.	Radiological risk of a single health effect from the transport of feed, product, (potentially) by-product, TRU waste, and onsite transport of LLW, less than 3.9×10^{-3} genetic disorder 8.7×10^{-3} latent cancer fatality.
Occupational safety	Accumulated whole-body dose to a worker in ICPP would be about 9.0×10^{-7} millirem.	Same as for PA.	Same as for PA.
Resource impacts	Less than 30 times the quantities of materials and energy required for annual operation; no significant use of scarce or strategic material required.	Same as for PA.	Same as for PA.

[a] Risks are the product of the consequences (i.e., potential cancer fatalities), the annual probability of the occurrence of the accident, and the number of years of operation.

following sections provide a discussion of the potential cumulative impacts resulting from proposed SIS construction and operation, on-going INEL operations, and the construction and operation of other authorized projects at the INEL.

4.5.1.1 Socioeconomic Impacts

The INEL currently employs over 10,000 personnel. Authorized projects at the INEL would add an estimated 150 construction workers and about 20 operating employees on approximately the same schedule as construction and operation of the SIS Project. As previously discussed for the construction of the SIS Project, a large availability of construction workers in the INEL region currently exists. The cumulative need for construction workers for the SIS and authorized projects would be well within the current availability of construction personnel. Few construction workers would be anticipated to migrate into the INEL region; hence, no major cumulative socioeconomic impacts would be associated with the SIS and authorized projects.

The estimated additional 20 operating employees for authorized projects would represent only a 3-percent increase beyond the expected 750 operating employees for the SIS Project. As discussed for the SIS Project, no major socioeconomic impacts are associated with increasing the number of operating employees at the INEL.

4.5.1.2 Nonradiological Atmospheric Emissions

The principal cumulative nonradiological releases associated with authorized projects would be nitrous oxides and sulfur dioxides from construction equipment. Cumulative construction emissions for both the SIS and authorized projects would be well within applicable air quality standards. Authorized projects have been permitted for PSD. The cumulative impacts associated with the incremental burning of additional coal for SIS operation would be the same as previously discussed in Section 4.1.2.

4.5.1.3 Ground Water

The ICPP service waste system currently discharges to percolation ponds near the ICPP that were constructed to discontinue the use of an injection well as a means of disposal of effluents from the ICPP. Use of the injection well has been discontinued, and it is currently planned that the well will be plugged with cement in 1989. The use of the existing percolation ponds at the ICPP has been considered an interim measure until other available alternatives have been assessed and approved for implementation. Current planning includes (1) use of an acid fraction system to eliminate or reduce trace quantities of radionuclides and metals in the ICPP process evaporator effluents; (2) routing of concentrated radionuclides to the existing high-level radioactive waste system; (3) recycling or evaporation of the cleaned liquid waste stream; and (4) discharge of nonradioactive and nonhazardous ICPP liquid effluents to one or more new percolation ponds. The SIS Project's nonradioactive and nonhazardous liquid effluents would only be discharged to the new percolation pond(s), which would receive only nonradioactive and nonhazardous ICPP liquid effluent. Combined discharges to the new percolation pond(s) would meet all applicable ground-water quality protection requirements.

Cumulative ground-water withdrawals with the construction and operation of both the SIS and authorized projects would increase total INEL ground-water withdrawals by about 10 percent. The increase in ground-water withdrawals would be well within the capacity of the Snake River Plain aquifer, and would represent less than 0.03 percent (i.e., 0.0003) of the annual discharge of the Snake River Plain aquifer to the Snake River.

4.5.1.4 Radiological Impacts

The cumulative doses for all radioactive atmospheric releases from the entire INEL site in 1986 are reported in the 1986 INEL Environmental Monitoring Report (DOE, 1987c). Given AIRDOS-EPA and RADRISK models, the maximally exposed individual's doses as reported were 0.019 and 0.003 millirem to the critical organ (thyroid) and the whole body, respectively. The EDE was reported to be 0.005 millirem. The cumulative collective EDE received by the 80-kilometer (50-mile) population of 117,030 was reported to be 0.64 person-rem.

Operation of facilities associated with authorized projects would increase doses from present INEL operations. The annual EDE to the maximally exposed individual would be increased by 0.00047 millirem and the collective EDE received by the 80-kilometer (50-mile) population by 0.0013 person-rem. The annual dose to the critical organ (thyroid) of the maximally exposed individual would be increased by 0.015 millirem.

The doses from routine releases from the SIS facility, as presented in Section 4.1.2.3 and in Appendix A using the RADRISK data base, when added to present and projected doses, would result in an insignificant increase in the cumulative dose received from the entire INEL site. The cumulative doses are very small compared with the 1986 annual average background radiation dose of 144 millirem received by an individual in the INEL area and the 16,618 person-rem received by the 1986 population living within 80 kilometers (50 miles) of the SIS facility (117,030 x 0.144). The cumulative dose to the maximally exposed individual would also be well within the NESHAP standards of 25 and 75 millirem to the total body and critical organ, respectively.

Each of the facilities at the ICPP area--as the SIS Project would be--is designed to preclude the propagation of an accident at one facility to another. Each facility is also neither reliant nor dependent on another facility, process, or support service to achieve a safe shutdown in the event that one facility in the ICPP should experience an unplanned event. Thus, the only initiating events that would involve more than one facility are those that would involve external initiators such as an earthquake or tornado. A review of the potential of simultaneously occurring releases initiated by a common DBE was undertaken to determine the potential impacts on ICPP workers. Major facilities at the ICPP area considered included the Fluorinel Dissolution and Storage Facility, the New Waste Calcining Facility, and the to-be-completed Fuel Processing Restoration (FPR) Project. As a result of the simultaneous occurrence of the DBE which has a recurrence interval of 3 x 10^{-4} (see Section 3.1.4.3), potential releases from these facilities as well as from that of the proposed SIS Project could occur. The cumulative releases from these facilities are calculated to result in a maximum individual dose to a person in the ICPP area of about 5 x 10^{-5} rem, based on full filter efficiency and conservatively assuming that a fire also occurs in each facility which is neither initiated by the DBE nor is propagated from one facility to another. Of the calculated 5 x 10^{-5} rem, which is significantly below the DOE normal operations occupational exposure standard of 5 rem, the SIS Project's contribution would be about 1 x 10^{-5} (see Table 4-14). The whole-body dose to the maximum individual at the INEL boundary and the population within 80 kilometers (50 miles) of the INEL as a result of the simultaneously initiated event is calculated to be about 3.0 x 10^{-3} millirem and 7.5 x 10^{-4} person-rem.

To bound the potential cumulative consequences of simultaneously occurring beyond-design-basis accidents at more than one facility in the ICPP area, it is assumed that further releases (i.e., in addition to those of the DBE discussed above) would result from degradation of the HEPA filters to 90-percent filter efficiency (see Table 4-15) at the SIS Project and the loss of the first bank of filters at the proposed FPR Project. Degradations of the HEPA filter efficiency to 90 percent at the SIS PPB and the loss of the first bank of HEPA filters at the FPR have independent probabilities of occurrence that, when combined with those for the DBE, would be less than 10^{-6} per year. These additional releases would result in a calculated increase of less than 1.7 rem to a worker in the ICPP area (i.e., 0.65 rem as a result of degraded SIS filter efficiency plus less than 1 rem for degraded FPR filter efficiency). The cumulative impact of these additional releases to an offsite maximum individual at the INEL boundary and the population within 80 kilometers (50 miles) of the INEL is calculated to be about 7 x 10^{-2} rem and 20 person-rem, respectively. The annual risk of a latent cancer fatality and genetic disorder in the 80-kilometer (50-mile) population using a probability of occurrence of less than 10^{-6} is less than 5.6 x 10^{-9} latent cancer fatality and 5.1 x 10^{-9} genetic disorder, and the cumulative risk for 30 years of SIS operation is less than 1.7 x 10^{-7} latent cancer fatality and 1.5 x 10^{-7} genetic disorder.

4.5.2 Cumulative Effects at the Hanford Site and the Savannah River Plant

The construction and operation of the SIS Project at either the Hanford Site or the SRP are not expected to result in any significant cumulative socioeconomic impacts. Within the time-frame of the potential construction of the SIS Project, the only known potential project that would be constructed at the Hanford Site is a fuel-decladding facility as discussed in Chapter 1. The present status of the restart of construction work on the Washington Public Power Supply System (WPPSS) Washington Nuclear Project Unit 1 (WNP-1) is uncertain, and recent legislation concerning a national high-level waste geologic repository has suspended site characterization work at the Hanford Site until site characterization studies are completed at the Nevada Test Site. The potential cumulative impacts from construction and operation of a fuel-decladding facility and SIS Project are expected to be minor. Community and regional resources were previously expanded during the period of WPPSS construction activities. Construction of one of the WPPSS plants has since been completed, construction of one plant terminated, and construction of WNP-1 suspended indefinitely.

Cumulative socioeconomic impacts associated with constructing and operating the SIS Project at the SRP are also expected to be minor. During the peak construction period for the SIS Project, a number of projects at the SRP and in the SRP region are expected to be either completed or well beyond their peak use of construction manpower. These projects, from which a significant construction labor force availability is expected, include the Defense Waste Processing Facility and the Fuel Materials Facility at the SRP, and the Vogtle Nuclear Power Plant in Georgia, which by itself is expected to make available more than 3000 construction personnel (DOE, 1987e).

Construction and operation of the SIS Project at either the Hanford Site or the SRP are also not expected to result in any significant impacts relative to cumulative nonradiological emissions. Construction of the SIS Project at either site is sufficiently remote and removed from the nearest site boundaries such that concentrations of construction emissions would be well below applicable standards. Emissions from the SIS Project and incremental emissions from steam generation for SIS operation would be well below PSD de minimis levels and are not expected to result in exceeding National Ambient Air Quality Standards (NAAQS), as ambient concentrations of air pollutants at each of the sites are below applicable air quality standards (DOE, 1987b,e).

As previously discussed in Sections 4.2 and 4.3, the withdrawal of surface water for SIS construction and operation at the Hanford Site and the withdrawal of ground water at the SRP would be a small percentage of existing withdrawals and well within the cumulative capabilities of the respective water resources. Discharges of SIS nonradioactive and nonhazardous liquid effluents to tile fields at the Hanford Site are not expected to impact ground-water quality (i.e., either of itself or on a cumulative basis). Similarly, SIS discharges of nonradioactive and nonhazardous liquid effluents to Four Mile Creek at the SRP would not affect water quality. The volume of SIS routine liquid effluents discharged to Four Mile Creek would also not significantly increase the impact to aquatic biota or wetland habitat since C-Reactor has been placed in cold-standby status and no longer discharges about 11.3 cubic meters per second of cooling water to Four Mile Creek.

If the SIS Project were to be located at either the Hanford Site or the SRP, the normal SIS atmospheric emissions of radioactivity would result in only a very small fractional increase in the cumulative radiological doses to offsite populations. The cumulative whole-body dose to the maximum individual at the Hanford Site in 1987 was calculated to be about 0.05 millirem. The cumulative whole-body dose to the maximum individual at the SRP from existing and planned operations was calculated to be about

3.23 millirem (DOE, 1986d). The radiological dose as a result of routine SIS operation (i.e., 7.3 x 10^{-9} millirem to the whole body of the maximum individual at the Hanford Site, and 8.9 x 10^{-9} to the whole body of the maximum individual at the SRP) would not measurably increase the calculated cumulative radiological dose at either site, and the cumulative radiological doses for each site would remain well below NESHAP standards.

4.6 EMERGENCY PREPAREDNESS

Emergency preparedness planning for DOE sites and their environs includes the development and maintenance of programs and plans at four levels of responsibility: (1) site-specific and/or facility-specific contractor response plans; (2) DOE Operations Office emergency management plans; (3) county emergency plans; and (4) state emergency plans.

DOE Operations Office emergency management plans provide the basis for responses by DOE management to incidents on DOE sites and, when necessary, for interfaces with contractor response plans. Site-specific or facility-specific contractor response plans are developed in accordance with the Operations Office's emergency management plans to implement responses to unusual incidents. State emergency plans are used to respond to all types of emergencies within the state, including radiological emergencies. County plans further implement site-specific response actions.

Responsibilities and Agreements

The DOE-Idaho Operations Office (DOE-Idaho) is responsible for the overall direction of emergencies affecting the INEL outside of contractor-operated INEL facilities. Contractor facility management is responsible for emergency actions within their facility until relieved by higher management or DOE-Idaho.

The guidelines for developing DOE facility emergency response plans are contained in DOE Notice 5500.3, "Emergency Preparedness Program and Notification Systems." The local DOE-Idaho field office (DOE-ID) has developed more detailed instructions for DOE-ID contractors in ID Order 5500.2, "Emergency Planning, Preparedness, and Response for Operations." DOE contractors develop emergency response plans for the facilities they operate. These Emergency Response Plans (ERPs) are reviewed and approved by the local DOE field office (DOE-ID).

The development of ERPs is based on the consequences of releasing a quantity of radioactive or other hazardous materials following an accident, such as those discussed in Section 4.1.3 of the Final EIS. Therefore, response plans are valid for all types of emergencies including (1) natural phenomena (e.g., earthquakes), (2) equipment failures, (3) procedural errors, or (4) safeguards and security. The onsite safeguards and security responses would be different if the cause were identified as a deliberate action than if the cause were nondeliberate in nature. In addition, the SIS ERP will take into account any necessary coordination between the SIS facility and adjacent ICPP facilities, based upon the evaluation presented in Section 4.1.3.

A working agreement between the State of Idaho and the U.S. ERDA (now DOE) for environmental monitoring at the INEL provides guidance for notification of agencies in the event of a release of hazardous materials from the INEL in excess of the agreed-upon limits. To ensure prompt and effective care of injured INEL employees who may be contaminated with radioactive materials, DOE-ID and the Eastern Idaho Regional Medical Center (EIRMC) have entered into an agreement that provides for the receipt of injured radioactively contaminated patient(s) as designated in the EIRMC Emergency Plan. Similar plans and arrangements with respect to state, local, and regional medical facilities exist for areas surrounding other DOE sites.

Offsite emergencies are under the jurisdiction of civil authorities. The State of Idaho gives guidance to state and local emergency planning and response agencies in Executive Order 81-8 (EO 81-8). The EO 81-8 assigns the responsibilities involved in emergency management to the proper state and local agencies. Emergencies are managed at the local level with close cooperation and coordination between state, local, and Federal agencies. The E.O.81-8 assigns responsibility to the Bureau of Disaster Services to assist local planning agencies in developing local ERPs; and to the Idaho Department of Health and Welfare for general emergency planning implementation, direction of radiological emergency response operations, and direction of activities in support of fixed nuclear facilities, nuclear waste incidents during transport, and other nuclear incidents. The specifics involved in carrying out evaluations or other emergency actions are detailed in the state and local ERPs.

Several Federal agencies are tasked with providing assistance to the state and local governments, when requested. The Federal Emergency Management Agency (FEMA) provides guidance for developing ERPs and teams, and provides training for emergency management and response teams. Department of Transportation (DOT) regulations provide the procedures that must be followed for transportation incidents involving hazardous materials (which includes radioactive materials). DOT also provides training, when requested, in transportation accident emergency response. The EPA provides guidance in planning and provides training when requested, for first responders to Hazardous Materials (Haz Mat) emergencies. The EPA also has a response team in conjunction with the U.S. Coast Guard, which is the EPA/U.S. Coast Guard National Response Team (NRT). DOE provides assistance in radiological emergencies, assistance in ERP development, and training for emergency response personnel, when requested. For example, the DOE Radiological Assistance Program (RAP), established in 1950, has been used in Idaho for transportation-related incidents.

Coordination

The coordination of emergency response actions occurs at all levels (Federal, state, local). During an INEL site emergency, appropriate facility, contractor, and DOE-ID personnel conduct the emergency response. However, close liaison is maintained with appropriate state and local officials, including dispatch of a DOE-ID representative to the Emergency Operations Center (EOC) of the offsite area, as needed.

During an emergency off the INEL site, the cognizant state agencies monitor, assess, and coordinate response actions to effectively manage all available resources. The same is done at the Federal and local levels. Local EOCs remain in contact with the state EOC to provide information and to request assistance when needed. Assistance can be requested from any of the agencies mentioned in the Responsibilities and Agreements section of this document. The local agency would be in charge of the assistance team provided by the Federal agencies. The responding teams would provide not only manpower, but also resources and technical information and expertise for use in the emergency.

For transportation incidents, the primary responsibility for initial emergency response to any Haz Mat accident resides with local authorities. The On-Scene Commander can request assistance from state or Federal agencies to assist in handling the incident.

The DOE Albuquerque Operations Office is responsible for the transportation system used for transporting strategic quantities of Government-owned special nuclear material (SNM). The SST is devoted to the safe and secure transport of SNM. DOE Albuquerque is responsible for coordination of emergency planning, preparedness, and response for accidents involving the SST. Response actions would include the utilization of DOE regional response teams such as those based at the INEL, as well as other Federal, state, and local law enforcement agencies. Drills and exercises with respect to potential accidents and potential terrorist or sabotage acts directed at the transport of nuclear materials or weapons are conducted routinely.

Onsite Emergency Procedures

The DOE is responsible for informing the affected states of all incidents that have potential offsite consequences. The manner of response and degree of DOE and state involvement depends upon the level of severity of real or potential consequences of the emergency. These levels are defined as follows:

- Unusual Event - An unusual event in progress or having occurred that normally would not constitute an emergency but which indicates a potential reduction of safety of the facility. No potential exists for significant offsite release of radioactive or other toxic material. Activation of offsite emergency response organizations is not expected. Emergency response actions are limited to onsite areas.

- Alert - An event in progress or having occurred that involves an actual or potential substantial reduction of the level of safety of the facility. Limited offsite releases of radioactive materials may occur. For other hazardous materials, off-facility releases are not expected to exceed applicable permissible limits. The purpose of the Alert level is to ensure that onsite and offsite emergency response personnel are promptly advised and available for activation if the situation becomes more serious, to initiate and perform confirmatory monitoring as required, and to ensure appropriate notification of emergency conditions to the responsible organizations within DOE.

- Site Emergency - An event in progress or having occurred that involves actual or likely major failures of facility functions needed for the protection of onsite personnel, the public health and safety, and the environment. Releases offsite of radioactive material not exceeding protective response recommendations (PRRs) are likely or are occurring. For other toxic materials, offsite releases have the potential to exceed applicable permissible limits. The purposes of the Site Emergency level are to ensure that Emergency Control Centers are manned, appropriate monitoring teams are dispatched, personnel required for determining protective measures for onsite personnel are initiated, and to provide current information to DOE and consultation with offsite officials and organizations.

- General Emergency - An event in progress or having occurred that involves actual or imminent substantial reduction of facility safety systems. Releases of radioactive materials are occurring or are expected to occur and exceed PRRs. Offsite releases of other toxic materials are expected to exceed applicable permissible limits. The purpose of the General Emergency level is to initiate predetermined protective measures for onsite personnel, for the public health and safety, and for the environment; to provide continuous assessment of emergency conditions; and exchange information both on the site and off. Declaration of a general emergency will initiate major activation of DOE-wide resources required to effectively mitigate the consequences of emergency conditions and ensure the protection of onsite personnel, the public health and safety, and the environment to the extent possible.

These emergency response levels permit transition from one to another depending on the potential severity of the emergency.

During an emergency on the INEL site, the affected facility ERP and response organizations are activated. The DOE-ID ERP and response organization is also activated to oversee the handling of the emergency by the contractor. Information is exchanged between the facility and the DOE-ID EOC. Conditions are assessed by a competent team of management and safety experts, and protective measures are implemented. The state and local emergency response organizations are notified and apprised of the situation. They are given the nature and severity of the incident and any other requested information within the bounds of national security.

In the event of a release of hazardous materials from the facility, a source term (type and quantity of materials released from the facility) is calculated and reported to DOE-ID, and to state and local officials. This information is used to determine what protective measures, if any, are needed to ensure the safety of site workers and the general public. DOE-ID also dispatches a representative to the local and state EOCs during a site or general emergency to assist in communications, and in evaluation of protective measures needed. DOE-ID may make recommendations to the state and local officials for offsite protective measures, based on DOE-ID's analysis of the situation and the potential for worsening.

Transportation incidents on the INEL site are handled in a manner similar to that discussed above.

Offsite Emergency Procedures

Offsite emergency procedures are the responsibility of civil authorities and are outlined in state and local ERPs. However, at the request of the state or local officials, Federal assistance teams can be brought in. For example, DOE-ID provided assistance to the Shoshone-Bannock Indian Tribe during an incident involving hazardous materials on reservation land. This is beyond the normal scope of DOE assistance, but shows DOE's willingness to be a "good neighbor."

When a transportation incident involving a DOE shipment of hazardous material occurs off the INEL site, the response is as follows:

If the driver is able, he/she notifies the DOE-ID Warning Communications Center (WCC), which is manned 24 hours a day, of the incident and the situation at the accident scene. DOE-ID notifies the appropriate DOE, state, and local officials. If the notification is made by the state police, DOE-ID will notify the appropriate DOE, state, and local authorities. DOE-ID will dispatch a response team to the scene of any incidents involving DOE radioactive materials. The local authorities take charge of the scene, as in any other Haz Mat accident, and isolate the area as appropriate. Requests for Federal assistance can be made from any of the following groups: Federal, state, local authorities, NRC licensee, private organizations, commercial carriers, or private citizens. The assistance team is under the jurisdiction of the local agencies during the emergency. The local officials remain in charge of the accident scene during the emergency. The accident scene is cleaned to EPA standards prior to release for normal use and travel.

Should an accident involving the SST occur, the response is handled in a similar manner. The driver or the escort will notify the regional DOE Coordinating Office for the DOE region in which the accident occurs. The DOE Albuquerque Operations Office will activate a special response team for cleanup and accident scene control. The state and local agencies are notified and will take charge of the accident scene isolation and control. The DOE response teams stabilize the scene and ensure the safety of the SNM. The SNM is transported in Type B shipping containers. After the SNM is removed, the response agencies complete any further cleanup necessary. The accident scene is cleaned up to EPA standards prior to release for normal use and travel.

Training

The primary responsibility for providing training to state and local emergency organizations resides with the state and local governments as stated in EO 81-8. To assist in this effort, training is made available through various Federal agencies. The DOT offers courses in Haz Mat accident response for transportation accidents. The EPA and FEMA offer training in Haz Mat emergency response. The DOE offers training in emergency response to radiological emergencies. All these training sessions are available upon request. Many of these are regularly scheduled and are made available to state and local governments. The use of these training sessions is expected to increase in response to the new Superfund Amendments and Reauthorization Act (SARA) Title III and OSHA requirements for training first responders to Haz Mat emergencies at fixed facilities and to transportation-type accidents.

DOE Albuquerque, New Mexico, has provided training to emergency response agencies in corridor states along the shipping routes for the WIPP shipments. This training has focused on response to a transportation incident involving TRU waste. A similar response would be needed for SIS shipment incidents.

DOE-ID has conducted orientation sessions for local emergency response agencies in the area of radiological emergency response. Guidance for providing training to local and state agencies is found in the DOE-ID Order 5500.2. DOE-ID has always been willing to provide training to local and state agencies when requested.

Emergency response exercises are conducted annually at each INEL facility. One of the facility exercises is used for the annual INEL site-wide exercise. During this exercise, the contractor and DOE-ID EOCs are fully activated, simulating a site-wide response. Actual equipment is used in simulated conditions to test the ability of the response teams to deal with a variety of situations and conditions. The state and local emergency response organizations are informed of the exercise so that they may exercise their emergency response organizations. DOE-ID has interfaced with one of the INEL surrounding county emergency response organizations each year. This is done to help maximize the training for the county while minimizing the impact on the county response agencies' budgets. A different county is involved each year. The exercises and drills, together with on-going training programs for personnel having emergency preparedness responsibilities, ensure the adequacy of personnel, equipment, plans, and procedures to cope with emergency situations.

4.7 DECONTAMINATION AND DECOMMISSIONING

The SIS facilities are being designed to facilitate decontamination and decommissioning (D&D) in accordance with DOE Order 6430.1. This Order includes the following criteria and requirements:

- Design of critical areas shall incorporate measures to simplify decontamination.
- Items such as service piping, conduits, and ductwork shall be kept at a minimum in operating areas and shall be arranged to facilitate decontamination.
- Walls, ceiling, and floors shall be finished with washable or strippable coverings or covered with metal liners, if required. All crevices and joints shall be caulked and finished smooth to prevent contamination of inaccessible areas. Painting of surfaces with

smooth (gloss) finishes is to be considered to improve decontamination ability.

- Modular, separable enclosures shall be provided for radioactive materials to preclude contamination of fixed portions of the structure.
- Glove-box and enclosure design shall account for limitations from dimensions of packing crates or other containers accepted at TRU disposal sites.
- Localized liquid transfer systems shall be used to avoid long runs of contaminated piping. Emphasis shall be placed on localized waste batch solidification. Special provisions shall be made to ensure joint integrity in buried pipelines.
- Exhaust filtration components shall be located to avoid long runs of contaminated ductwork.

In addition to these criteria and requirements, two additional criteria have been developed specifically for the SIS Project. These criteria are as follows: (1) a contaminated equipment area shall be provided to permit glove-box and open-face hoods for hands-on repair of facility equipment; and (2) glove boxes and process enclosures shall be designed with removable shielding, polished interior surfaces, and rounded corners and edges to facilitate decontamination.

A D&D plan for the SIS Project will be developed as part of the overall D&D for the area in which the SIS facilities would be located (ICPP area at the INEL, 200-East Area at the Hanford Site, or F-Area at the SRP). Three basic decommissioning options have been defined according to the NRC Program Status Paper (Calkins, 1980). These options are DECON, SAFSTOR, and ENTOMB. Depending on the results of a subsequent National Environmental Policy Act (NEPA) review of the decommissioning plan, it is expected that SIS decommissioning will follow either the DECON or SAFSTOR option.

DECON is defined as the immediate removal of all radioactive materials to levels considered acceptable to allow the property to be released for unrestricted use (NRC, 1981). This option uses a chemical decontamination of the structure and the internals. Decontamination is followed by dismantlement, transportation, and burial of the internals. In a final step, the outer structure is demolished and the site restored to its precommissioning status.

SAFSTOR involves placing a facility in temporary storage within acceptable risk levels for subsequent decontamination and unrestricted facility use. The SAFSTOR option is divided into six major phases:

1. Chemical decontamination
2. Mechanical decontamination and fixing of residual radioactivity
3. Equipment deactivation
4. Preparation for interim care
5. Interim care (surveillance and maintenance)
6. Final dismantlement.

Chemical decontamination involves rinsing, chemical cleaning, and flushing of internal surfaces of process lines, vessels, and equipment. External surfaces or process equipment, lines, and structures are remotely sprayed with a series of chemical solutions or steam.

Next, all equipment and systems not needed during this interim-care period are deactivated. Typical activities include final draining of process lines, closing or opening valves depending on function, blanking flanges, and disconnecting utilities. Cooling-water systems for diesels are drained and fuel oil is removed from tanks.

During preparation for the interim-care period, security locks are installed on all exterior doors and on doors leading to highly contaminated areas. Intrusion alarms, fire-detection systems, radiation-monitoring equipment, and ventilation systems are inspected to ensure safety during the interim-care period.

During interim care, the facility and the site are kept inaccessible to the public and unavailable for other than nuclear use. Surveillance, maintenance, certain operations such as ventilation, and security activities are conducted to ensure safe confinement of the radioactivity. Scheduled programs of periodic inspections and monitoring are continued.

Final dismantlement begins with a planning phase. Equipment that is necessary for dismantlement but was previously made inoperable is activated and refurbished as necessary. The other phases of final dismantlement are removal of contaminated equipment, mechanical decontamination of structures, demolition of structures, and restoration of the site.

Removal of contaminated equipment involves disconnecting and cutting where necessary for volume reduction; packaging, loading, and transporting the equipment to a waste disposal facility; and final disposal. A remote operational capability is added to accomplish equipment removal where high radiation levels prohibit contact operations.

In the demolition and restoration phase, all above-grade portions of the plant structures are demolished by conventional methods, such as explosive and impact balls. The site is then graded and revegetated.

Decontamination and decommissioning costs are the least known of any that go into the life-cycle cost analysis. The database for D&D activities is limited, and the various options for performing this activity are varied.

The NRC has established guidelines for D&D costs for a nuclear power plant. The guidelines range from 8 to 15 percent of the initial capital cost of a commercial power station and assume the site is returned to its original preconstruction/operation ("green field") condition.

The SIS D&D cost would include decontamination of the facility, removal of equipment and material, packaging of the equipment/materials, transportation of the packaged waste meeting the Waste Acceptance Criteria (WAC) to the WIPP, and entombment of the remaining facility. The D&D cost estimate for the SIS is spread over 3 years, after the SIS operating life.

The decommissioning costs are applied to only those facilities constructed specifically by the SIS Project. The D&D estimate resulted in a cost of $96 million or 18 percent of the initial capital cost.

4.8 RELATIONSHIP OF PROPOSED ACTION TO LAND-USE PLANS, POLICIES, AND CONTROLS

The construction and operation of the SIS Project at the INEL or at the alternative sites of Hanford and the SRP would not conflict with national, state, or local land-use plans or policies. Implementation of the SIS Project at the INEL would utilize areas that are presently committed to the processing of DOE Defense Program spent reactor fuels and waste management activities. Implementation of the SIS Project at the Hanford Site would utilize areas that have already been committed to processing of plutonium and to waste storage activities. Implementation of the SIS Project at the SRP would utilize an area adjacent to one of the existing separation areas that has processed defense nuclear materials since the early 1950s. The utilization of areas at each of the sites that are within or adjacent to existing facilities ensures that potential conflicts with on-going National Environmental Research Park research programs would be minimized.

Where specific land areas associated with the SIS Project at each of the DOE locations have not been individually identified, such as the location of borrow areas or areas for electric transmission lines, special surveys will be undertaken to ensure protection of historic or archeologic resources and preservation of important ecological habitats.

4.9 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

The irreversible and irretrievable commitment of resources for the SIS Project involves land areas committed during operation (although the land areas may be retrievable based on future decontamination and decommissioning) and materials, chemicals, and water that would be consumed during construction and operation. The total land area that would be committed at each alternative site for the operation of the SIS Project is discussed in Sections 2.1.4.1, 2.1.4.3, 2.2.4, and 2.3.4. Quantities of materials, chemicals, water, and energy that would be consumed during construction and operation are discussed in Sections 2.1.4.3 and 2.1.5.3. None of the materials or chemicals identified in these sections and tables are in short supply, and their use would not affect local or national supplies. Other than small amounts of separator materials and possibly some optic coatings, no significant use of scarce or strategic material would be required for construction or operation of the SIS Project.

5 ENVIRONMENTAL REQUIREMENTS

This chapter provides a summary of the major laws, regulations, Executive Orders, U.S. Department of Energy (DOE) Orders, and guidelines applicable to the Special Isotope Separation (SIS) Project that provide for the protection of public health and the environment.

Section 5.1 briefly discusses the Atomic Energy Act (AEA), as amended, and the National Environmental Policy Act (NEPA), as amended. Section 5.2 addresses environmentally related Presidential Executive Orders that clarify issues of national policy and set guidelines under which Federal agencies, including DOE, must act. DOE exercises its responsibilities for protection of public health, safety, and the environment through a series of Departmental Orders that are mandatory for operating contractors of DOE-owned facilities. Section 5.3 discusses DOE Orders related to environmental, health, and safety protection.

In addition to complying with DOE Orders, DOE facilities must comply with various Federal and state requirements, which are discussed in Sections 5.4 and 5.5, respectively. The discussion of state environmental regulations in Section 5.5 is based on the Preferred Alternative of locating the SIS Project at the Idaho National Engineering Laboratory (INEL). Section 5.6 discusses the principal permits, approvals, and consultations required for the proposed project, and Table 5-1 lists the permits and other environmental approvals needed for locating the SIS Project at the INEL.

Finally, DOE has established a general environmental protection policy. DOE has stated its commitment to national environmental protection goals and sound environmental management in all of its programs and at all of its facilities in a policy statement, DOE N.5400.1, issued on January 8, 1986, and extended on January 7, 1987. This policy statement indicates that "it is DOE's policy that efforts to meet environmental obligations be carried out consistently across all operations and among all field organizations and programs."

5.1 NATIONAL ENVIRONMENTAL POLICY AND ATOMIC ENERGY ACTS

5.1.1 National Environmental Policy Act of 1969, as Amended (42 USC 4321 et seq.)

The NEPA establishes a national policy promoting awareness of the environmental consequences of the activity of humans on the environment and promoting consideration of environmental impacts during the planning and decision-making stages of a project. The NEPA requires all agencies of the Federal Government to prepare a detailed statement on the environmental effects of proposed major Federal actions that may significantly affect the quality of the human environment.

This Environmental Impact Statement (EIS) has been prepared in response to these NEPA requirements. It discusses potential environmental impacts of

Table 5-1. Required Regulatory Permits, Consultations, and Approvals for Locating the SIS Project at the INEL

Activity/facility/ regulation	Requirement(s)	Agency	Status
Transport of hazardous waste	Manifesting, labeling, packaging, and transporting	EPA (RCRA, 40 CFR 263); DOT (49 CFR 100-199)	System in place at ICPP and at INEL
Storage of mixed waste	RCRA Part A Permit, RCRA Part B Permit	EPA (RCRA, 40 CFR 260-270)	Interim status for storage approved; application for final permit pending
Increased discharge to Sanitary Treatment Plant	Notification	Idaho Department of Health and Welfare	Pending completion of design
Oil storage	Spill Prevention, Control, and Countermeasures Plan	DOE-Idaho	Already in place at ICPP
Ethanol and ethanol-dye storage in underground storage tanks	Notification of State Underground Tank Coordinator	EPA (RCRA, 40 CFR 280) and State of Idaho	To be filed within 30 days of using tanks for storing regulated substances
Radioactive emissions	Approval of Construction of New Source	EPA (NESHAP)	Application in preparation
	Prevention of Significant Deterioration	State of Idaho	Application in preparation
Atmospheric emissions	Permit To Construct a New Emission Source	State of Idaho	Application in preparation
Bald and Golden Eagle Protection Act	Consultation with U.S. Fish and Wildlife Service (FWS)	FWS	Consultation with FWS completed pending Record of Decision on EIS

Table 5-1. Required Regulatory Permits, Consultations, and Approvals for Locating the SIS Project at the INEL (continued)

Activity/facility/ regulation	Requirement(s)	Agency	Status
Endangered Species Act	Consultation with FWS	FWS	Consultation with FWS completed pending Record of Decision on EIS
Migratory Bird Treaty Act	Consultation with FWS	FWS	Consultation with FWS completed pending Record of Decision on EIS
National Historic Preservation Act	Archeological survey and assessment	Idaho State Historic Preservation Officer	Consultation with Idaho State Historic Preservation Officer completed pending Record of Decision on EIS
SARA Title III	Reporting and coordination with state Emergency Response Commission, local committee, and fire department with jurisdiction	State and local Emergency Response Committees	Information on hazardous materials to be provided as part of ongoing reporting process

the SIS Project and has been prepared in accordance with the Council on Environmental Quality (CEQ) Regulations on Implementing the National Environmental Policy Act (40 CFR 1500-1508) and DOE Guidelines for Compliance with the National Environmental Policy Act (52 FR 47662, December 15, 1987), as amended.

5.1.2 Atomic Energy Act of 1954, as Amended (42 USC 2011 et seq.)

The AEA authorizes DOE to establish standards to protect health or minimize dangers to life or property. In accordance with the Energy Reorganization Act of 1974, DOE defense-related operations are not subject to licensing by the U.S. Nuclear Regulatory Commission (NRC). DOE has established an extensive system of standards and requirements through its Orders to ensure safe operation of its facilities. Compliance with these Orders is mandatory for contractors operating DOE-owned facilities.

5.2 EXECUTIVE ORDERS

Executive Order 12088 [Federal Compliance with Pollution Control Standards (October 13, 1978), as amended by Executive Order 12580 (January 23, 1987)], requires Federal agencies to comply with applicable administrative and procedural pollution control standards established by, but not limited to, the following Federal laws:

1. Toxic Substances Control Act (15 USC 2061 et seq.)
2. Federal Water Pollution Control Act, as amended (33 USC 1251 et seq.)
3. Public Health Service Act, as amended by the Safe Drinking Water Act (42 USC 300F et seq.)
4. Clean Air Act, as amended (42 USC 7401 et seq.)
5. Noise Control Act of 1972 (42 USC 4901 et seq.)
6. Solid Waste Disposal Act, as amended (42 USC 6901 et seq.)

Executive Order 11593 (May 13, 1971) requires Federal agencies, including DOE, to locate, inventory, and nominate properties under their jurisdiction or control to the National Register of Historic Places if those properties qualify. This process requires DOE to provide the Advisory Council on Historic Preservation the opportunity to comment on the possible impacts of the proposed activity on any potential eligible or listed resources.

Executive Orders 11988 (Floodplain Management) and 11990 (Protection of Wetlands) require governmental agencies to avoid to the extent practicable any short- and long-term adverse impacts on floodplains and wetlands wherever there is a practicable alternative. DOE has issued regulations at 10 CFR Part 1022 that establish DOE procedures for compliance with these Executive Orders.

Executive Order 11514 requires Federal agencies to monitor and control on a continuing basis their activities so as to protect and enhance the quality of the environment, and to develop procedures to ensure the fullest practicable provision of timely public information and understanding of Federal plans and programs with environmental impact in order to obtain the views of interested parties. DOE has issued guidelines at 52 FR 47662, December 15, 1987, as amended, and DOE Order 5440.1c for compliance with this Executive Order.

Executive Order 12580 (Superfund Implementation) delegates to the heads of Executive departments and agencies the responsibility for undertaking remedial actions for releases, or threatened releases, that are not on the National Priorities List (NPL) and removal actions other than emergencies, where the release is from any facility under the jurisdiction or control of Executive departments and agencies.

5.3 DEPARTMENT OF ENERGY ORDERS

Through authority of the AEA, DOE is responsible for establishing a comprehensive health, safety, and environmental program for its facilities. The regulatory mechanism through which DOE manages its facilities is the issuance of DOE Orders. These Orders generally set forth policy and the programs and procedures for implementing that policy. The major DOE Orders pertaining to the construction and operation of the SIS Project are listed in Table 5-2. The following sections provide a brief discussion of selected Orders.

DOE Order 5440.1C, National Environmental Policy Act

This Order establishes responsibilities and sets forth procedures necessary for implementing the NEPA of 1969, as amended, in order to operate each of its facilities in full compliance with the letter and spirit of the Act.

DOE Order 5480.1B, Environmental Protection, Safety, and Health Protection Program for DOE Operations

This Order provides the organization, assigns responsibilities, and establishes the components of an environmental protection, safety, and health protection program applicable to all DOE operations. It is currently being revised, and, as part of the revisions, each of its 14 chapters is being issued as separate DOE Orders in the 5480 series. While compliance with draft revisions (i.e., revisions not approved by DOE) is not required, the SIS Project is being designed to comply with the intent of these draft revisions.

Table 5-2. DOE Orders Applicable to the SIS Project

Order	Subject
5000.3	Unusual Occurrence Reporting System
5400.2	Environmental Compliance Issue Coordination
5440.1C	National Environmental Policy Act
5480.1B	Environmental Protection, Safety, and Health Protection Program for DOE Operations
5480.3	Safety Requirements for the Packaging and Transportation of Hazardous Materials, Hazardous Substances, and Hazardous Waste
5480.4	Environmental Protection, Safety, and Health Protection Standards
5480.5	Safety of Nuclear Facilities
5480.7	Fire Protection
5480.9	Construction Safety and Health Program
5480.14	Comprehensive Environmental Response, Compensation, and Liability Act Program
5481.1B	Safety Analysis and Review System
5482.1B	Environmental Protection, Safety, and Health Protection Appraisal Program
5484.1	Environmental Protection, Safety, and Health Protection Information Reporting Requirements
5500.1A	Department of Energy Emergency Management System
5500.3	Reactor and Nonreactor Nuclear Facility Emergency Planning, Preparedness, and Response Program for DOE Operations
5630.11	Safeguards and Security Program
5630.12	Safeguard and Security Inspection and Evaluation Program
5700.6B	Quality Assurance
5820.2	Radioactive Waste Management
6430.1A	General Design Criteria

Chapters XI and XII, which are currently being revised, have the most direct applicability to this EIS. Chapter XI provides, among other things, radiation-protection standards for occupational and nonoccupational exposures and guidance for keeping exposures to radionuclides as low as reasonably achievable (ALARA). It also provides concentration guides for airborne emissions and liquid effluents, and it establishes exposure standards aimed at achieving ALARA dosage rates. Chapter XI additionally sets forth monitoring requirements to ensure that these standards are met. Chapter XII establishes requirements for DOE operations to ensure control of sources of environmental pollution and compliance with environmental protection laws and with Executive Order 12088.

The current draft revision to DOE Order 5480.1B Chapter XI [DOE Order 5480.xx (March 31, 1987)] revises public exposure requirements and adds a new section on environmental protection. The previous radiation dose equivalent of 500 millirem per year has been changed to 100 millirem per year. Additionally, the derived concentration guides (DCGs) for members of the public who are not "occupational workers" have been revised based on input from various national and international organizations [primarily the International Commission on Radiological Protection (ICRP)]. These DCGs establish allowable upper limits of radioisotope concentrations in air and water above natural background levels that would be a result of ingestion or inhalation.

The requirements of the draft revision also implement regulations concerning the protection of soils, aquifers, natural waterways, and aquatic organisms against avoidable contamination by radioactive materials. Definitive radiological monitoring requirements have been established, and additional guidance on recommended procedures and activities has been developed. General requirements also are included concerning capabilities to detect and assess unplanned releases of radioactive material and radiological consequences.

DOE Order 5480.3, Safety Requirements for the Packaging and Transportation of Hazardous Materials, Hazardous Substances, and Hazardous Waste

This Order establishes requirements for packaging hazardous materials similar to the regulations for packaging hazardous materials in 10 CFR 71 and 49 CFR 109-199 for non-DOE facilities. Radioactive materials are segregated into categories based on control of nuclear criticality during shipping. Specifications are based on both amount and type of radioactive material.

DOE Order 5480.4, Environmental Protection, Safety, and Health Protection Standards

Order 5480.4 specifies and provides "requirements for the application of the mandatory environmental protection, safety and health standards applicable to all DOE operations." In essence, this Order sets the standards required by the environmental protection, safety, and health program established by DOE Order 5480.1B.

Order 5480.4 classifies all or parts of the following statutes and regulations as mandatory:

- National Historic Preservation Act of 1966
- Clean Air Act
- Clean Water Act
- Endangered Species Act of 1973
- Federal Insecticide, Fungicide, and Rodenticide Act
- Resource Conservation and Recovery Act
- Comprehensive Environmental Response, Compensation, and Liability Act.

DOE Order 5480.12, General Environmental Protection Program Requirements (Draft)

DOE Order 5480.12 is a draft Order, issued on May 12, 1987, for internal DOE review. When it is issued, this Order will be an "umbrella" directive for the oversight of environmental programs that are the responsibility of the Assistant Secretary for Environment, Safety and Health. It will also restructure several DOE Orders.

DOE Order 5484.1, Environmental Protection, Safety, and Health Protection Information Reporting Requirements

DOE Order 5484.1 establishes the requirements and procedures for reporting information having environmental-protection, safety-protection, and health-protection significance for DOE operations.

DOE Order 5820.2, Radioactive Waste Management

DOE Order 5820.2 establishes policies and guidelines for the management of radioactive waste, waste by-products, and radioactively contaminated surplus facilities. The objective of this Order is to ensure that DOE operations involving the management of radioactive waste, waste by-products, and surplus facilities adequately protect public health and safety in accordance with radiation-protection standards. This Order defines key terms and specifies lines of authority. Chapter III establishes the policies and guidelines for managing low-level waste and specifies criteria for site selection, design, and disposal-site operations. In addition, it details requirements for disposal, and for site closure and postclosure. Chapter IV deals with the management of wastes contaminated with naturally occurring radionuclides. Chapter V discusses the decontamination and decommissioning of surplus facilities.

5.4 FEDERAL STATUTES AND REGULATIONS

The major Federal environmental laws and their implementing regulations that would be applicable to the construction or operation of the SIS Project are discussed in this section.

Clean Air Act, as Amended (42 USC 7401 et seq.)

The Clean Air Act (CAA), as amended, 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 CAA, as amended, requires that each Federal agency, such as DOE, with jurisdiction over any property or facility that might result in the discharge of air pollutants, comply with "all Federal, State, interstate, and local requirements" with regard to the control and abatement of air pollution.

The law sets national primary and secondary ambient air quality standards, requires that specific emission increases be evaluated so as to prevent a significant deterioration in air quality, and provides authority to the U.S. Environmental Protection Agency (EPA) to set national standards for performance of new stationary sources of air pollutants and standards for emissions of hazardous air pollutants. This is accomplished through an air permitting program. The implementing regulations are described in the following paragraphs.

40 CFR 50, National Primary and Secondary Ambient Air Quality Standards

This regulation contains the national primary and secondary ambient air quality standards. National primary ambient air quality standards define levels of air quality judged by the EPA to be necessary to protect public health. Standards are promulgated for sulfur oxides, particulates, carbon monoxide, photochemical oxidants, hydrocarbons, and nitrogen oxides (NO_x).

40 CFR 52, Prevention of Significant Deterioration of Air Quality

This regulation requires in part that any operation with the potential to emit more than 250 tons per year of regulated pollutants, including NO_x, is subject to review for these pollutants. This policy was incorporated into the CAA to limit increases of pollutants in clean air areas to specific increments even though the ambient air standards are being met. The Prevention of Significant Deterioration (PSD) permit ensures that air quality will be protected and that the best available control technology is being applied.

40 CFR 61, National Emission Standards for Hazardous Air Pollutants (NESHAP)

This regulation establishes air emission standards for beryllium, mercury, asbestos, vinyl chloride, and other hazardous materials. 40 CFR 61.92 establishes limits for annual radiation dose equivalents to members of the general public resulting from air emissions from DOE activities at a DOE facility. These annual limits are 25 millirem to the whole body and 75 millirem to the critical organ of any individual. The regulations also require DOE to notify and obtain approval from the

Administrator of the EPA prior to the start of construction on a new source of emissions or modification of an existing source of emissions.

40 CFR 82, Stratospheric Ozone Protection

Pursuant to the Montreal Protocol, EPA issued on August 1, 1988, a final rule limiting the production and importation of chlorofluorocarbons (CFCs) and Halons. Issuance of the rule fulfilled the U.S. commitment to protect the ozone layer by requiring a 50-percent reduction of production and consumption of these substances, based on 1986 levels, by 1998. The rule would take effect in July 1989 if the protocol is ratified by nations representing two-thirds of the 1986 global consumption of CFCs and Halons.

The Clean Water Act, as Amended (33 USC 1251 et seq.)

The Clean Water Act (CWA), which amended the Federal Water Pollution Control Act, was enacted to "restore and maintain the chemical, physical and biological integrity of the Nation's waters." The CWA prohibits the "discharge of toxic pollutants in toxic amounts" to navigable waters of the United States. Section 313 of the CWA, as amended, 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 CWA supplies guidelines and limitations for effluent discharges from point sources, sets standards of performance for new point-source discharges, and provides authority for the EPA to implement the National Pollutant Discharge Elimination System (NPDES) permitting program.

Safe Drinking Water Act, as Amended [42 USC 300(f) et seq.]

The primary objective of the Safe Drinking Water Act (SDWA), as amended, is to protect the quality of public water supplies and all sources of drinking water. The implementing regulations are found in 40 CFR 141, National Interim Primary Drinking Water Regulations. These regulations, administered by the EPA, establish standards applicable to public water systems. They promulgate maximum contaminant levels, including those for radioactivity, in community water systems, which are defined as public water systems that serve at least 15 service connections used by year-round residents or regularly serve at least 25 year-round residents. For radioactive material, the regulations specify that the average annual concentration of man-made radionuclides in drinking water as delivered to the user by such a system shall not produce a dose equivalent to the total body or an internal organ greater than 4 millirem per year beta activity.

Resource Conservation and Recovery Act, as Amended (42 USC 6901 et seq.)

The Resource Conservation and Recovery Act (RCRA), as amended, governs the use, handling, treatment, and disposal of solid and hazardous materials and wastes. The use of underground storage tanks is also regulated. The EPA regulations implementing RCRA are found at 40 CFR 260-280. These regulations define and identify various types of hazardous wastes and specify how the various types must be transported, handled, and disposed of.

The regulations imposed on a generator or a treatment, storage, and/or disposal facility vary according to the type and quantity of material or waste generated, treated, stored, and/or disposed of. The method of treatment, storage, and/or disposal also impacts the extent and complexity of the requirements.

Generally, all generators must provide documentation (a "manifest") of the creation of the waste, and the waste must be tracked from generation through treatment, storage, and/or final disposition. The RCRA regulations also require that Department of Transportation (DOT) regulations for packaging, labeling, and transporting hazardous materials and wastes be followed. These are found at 49 CFR 100-199.

Comprehensive Environmental Response, Compensation, and Liability Act, as Amended (42 USC 9601 et seq.)

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended, provides a regulatory mechanism for the cleanup of previously active waste sites that are now unused or closed and--as amended by the Superfund Amendments and Reauthorization Act (SARA)--provides an emergency response program in the event of a release of a hazardous substance from any site, whether active or inactive. CERCLA requires Federal facilities having such sites to undertake investigations and remediation as necessary. Using the Hazard Ranking System, sites are ranked and may be included on the NPL. The Act also includes requirements for reporting releases of certain materials in specified amounts to identified agencies.

Emergency Planning and Community Right-to-Know Act of 1986 (42 USC 11001 et seq.)

Under this Act, Federal facilities, including those of DOE, are required to provide information, such as inventories of specific chemicals used or stored, 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 in 1987, and inventory and annual emissions reporting is to have begun in 1988, based on 1987 activities and information.

National Historic Preservation Act, as Amended (16 USC 470 et seq.)

The National Historic Preservation Act, as amended, provides that places with significant national historic value be placed on the National Register of Historic Places.

There are no permits or certifications required under the Act. However, if an undertaking may impact a historic property resource, consultation with the Advisory Council on Historic Preservation will generally result in the generation of a Memorandum of Agreement, including stipulations that must be followed to minimize adverse impacts.

Archeological and Historic Preservation Act, as Amended (16 USC 469a et seq.)

This Act is directed at the preservation of historic and archeological data that would otherwise be lost as a result of Federal construction or other federally licensed or assisted activities. It authorizes the Department of the Interior to undertake recovery, protection, and preservation of archeological and historic data. When Federal agencies find that their undertakings may cause irreparable damage to archeological resources, the agency is required to notify the Department of the Interior in writing. The agencies involved may then undertake recovery and preservation, or they may request the Department of the Interior to undertake preservation measures.

Archeological Resource Protection Act, as Amended (16 USC 470aa et seq.)

This Act requires a permit for any excavation or removal of archeological resources from public or Indian lands. Excavations must be undertaken for the purpose of furthering archeological knowledge in the public interest, and resources removed are to remain the property of the United States. Consent must be obtained from the Indian tribe owning lands on which a resource is located prior to issuance of a permit, and the permit must contain terms or conditions requested by the tribe.

Endangered Species Act, as Amended (16 USC 1531 et seq.)

The Endangered Species Act, as amended, is intended to prevent the further decline of endangered and threatened species and to bring about the restoration of these species and their habitats. The Act is jointly administered by the Departments of Commerce and the Interior. Section 7 requires consultation to determine whether endangered and threatened species are known to have critical habitats on or in the vicinity of the proposed action. No such species are expected to be impacted by the project.

Migratory Bird Treaty Act, as Amended (16 USC 703 et seq.)

The Migratory Bird Treaty Act, as amended, is intended to protect birds that have common migration patterns between the United States and Canada, Mexico, Japan, and Russia. It regulates the harvest of migratory birds by specifying the mode of harvest, hunting seasons, bag limits, etc. The Act stipulates that it is unlawful at any time, by any means, or in any manner to "kill...any migratory bird." Although no permit for this project is required under the Act, DOE is required to consult with the U.S. Fish and Wildlife Service (FWS) regarding impacts to migratory birds and to evaluate ways to avoid or minimize these effects in accordance with the FWS Mitigation Policy (DOI, 1981).

Bald and Golden Eagle Protection Act, as Amended (16 USC 668-668d)

The Bald and Golden Eagle Protection Act makes it unlawful to take, pursue, molest, or disturb bald (American) and golden eagles, their nests, or their eggs anywhere in the United States (Section 668, 668c). A permit must be obtained from the Department of the Interior to relocate a nest that interferes with resource development or recovery operations (Section 668a).

There are no permit or approval procedure requirements unless a nest is found; in that case, DOE can attempt to obtain permission from the Secretary of the Interior to move the nest pursuant to Section 668a, claiming interference with resource development.

Noise Control Act of 1972, as Amended (42 USC 4901 et seq.)

Section 4 of the Noise Control Act of 1972, as amended, directs all Federal agencies to carry out "to the fullest extent within their authority" programs within their jurisdictions in a manner that furthers a national policy of promoting an environment free from noise that jeopardizes health or welfare.

5.5 IDAHO LAWS AND REGULATIONS

The Idaho Environmental Protection and Health Act (Idaho Code, Title 39, Chapter 1) establishes general provisions for protection of the environment and public health. The Department of Health and Welfare has been created by this Act to implement these environmental, health, and social services requirements. The Act authorizes the Department to promulgate standards, rules, and regulations relating to water and air quality, noise reduction, and solid waste disposal. The Department is granted authority to issue required permits, collect fees, establish compliance schedules, and review plans for the construction of sewage and public water treatment and disposal facilities.

Authorization is also granted to the Department of Health and Welfare by the Idaho Water Pollution Control Act (Idaho Code, Title 39, Chapter 36) for the protection of the waters of Idaho. General language concerning the prevention of water pollution and the provision of financial assistance to municipalities is contained in this law.

The Department of Health and Welfare is also responsible for enforcement and implementation of the Hazardous Waste Management Act of 1983, as amended (Idaho Code, Title 39, Chapter 44), which provides for the protection of health and the environment from the effects of improper or unsafe management of hazardous wastes and for the establishment of a tracking or manifesting system for these wastes. This program is intended to be consistent with Federal regulations as established under the RCRA, although at this time Idaho does not have primacy over hazardous wastes. The Idaho Act sets forth requirements for the development of plans that address identification of hazardous wastes, unauthorized treatment, storage, release, use, or disposal of these wastes, and permit requirements for hazardous waste facilities. Rules and regulations concerning the transportation, monitoring, reporting, and recordkeeping of hazardous wastes are to be promulgated under authority of this Act.

The following sections discuss the major requirements and regulations pursuant to these acts.

Idaho Air Pollution Control Regulations

Title 1, Chapter 1, of the Rules and Regulations for the Control of Air Pollution in Idaho is intended to provide authority and standards in compliance with the CAA. The Department of Health and Welfare has been granted authority to implement the requirements of the CAA and to adopt rules and regulations for that purpose. These rules and regulations include provisions for establishing compliance schedules and emission limits, reporting and correction of emissions that exceed established limits, and permitting requirements for construction and operation of facilities or activities that may generate emissions in excess of the prescribed standards. The control of open burning and fugitive dust is addressed by these rules, as are specified types of facilities that may exceed emission limits. Also required by the Idaho Air Pollution Control Regulations is the formulation of a plan for the prevention and alleviation of air pollution emergencies. The plan includes definitions of the severity of the emergency, requirements for public notification, and recommended actions to be taken in abating an air pollution emergency.

Idaho Water Quality Standards and Wastewater Treatment Requirements

Provisions are set forth by these regulations (Title 1, Chapter 2) for protection of designated water uses and the establishment of water quality standards that will protect those uses. The Department of Health and Welfare has been authorized to develop and enforce these regulations by Section 39-105 of the Idaho Code. Restrictions are outlined by these regulations for control of point-source and nonpoint-source discharges and other activities that may adversely affect waters of the State of Idaho, including surface and ground waters. These regulations identify water-use classifications, specifically prohibited discharges, water quality criteria, and requirements for treatment of waste water prior to discharge in the waters of Idaho.

Idaho Regulations for Public Drinking Water Systems

Maximum contaminant levels for public drinking water systems are provided by these regulations. The Water Quality Bureau, as a subdivision of the Department of Health and Welfare, sets forth monitoring and reporting requirements for inorganic and organic chemicals and radiochemicals. Other water quality and locational standards are also included in these regulations. The Department reserves the authority to determine whether the contamination is caused by nuclear facilities and to require further monitoring.

Idaho Hazardous Waste Management Regulations

Pursuant to the Hazardous Waste Management Act, the Department of Health and Welfare (Title 1, Chapter 5) has adopted by reference the Federal regulations regarding hazardous waste rulemaking, hazardous waste delisting, and identification of wastes. Included in these regulations are requirements for hazardous waste generators, transporters, and management facilities as well as detailed procedures for permitting these activities. The general requirements for generators, transporters, and management facilities have been incorporated by reference; however, some sections have been revised to reflect Idaho's permitting program. Section 39-4403 (14) of the Act identifies "restricted hazardous waste" that includes liquid hazardous wastes containing specified concentrations of constituents as well as hazardous wastes containing concentrations of halogenated compounds.

Idaho Solid Waste Management Regulations

These regulations, as developed by the Idaho Department of Health and Welfare in Title 1, Chapter 6, of the Solid Waste Management Regulations and Standards Manual, provide standards for the management of solid wastes to minimize the detrimental effects of disposal. These standards include requirements for the review of plans and the approval of procedures and operational and postoperational standards for landfills, incinerators, and processing facilities and for transportation and storage of solid waste.

Idaho Rules and Regulations for Construction and Use of Injection Wells

Requirements for the construction, location, and usage of injection wells within the State of Idaho are set forth in these regulations. The Department of Water Resources has been granted administrative authority over injection wells. Injection of radioactive or hazardous materials through an existing well or above a drinking water source is prohibited. Parameters for quality of fluids discharged and allowable uses of injection wells are included in these regulations as are classifications of well types and permitting requirements for injection wells.

5.6 MAJOR PERMIT, APPROVAL, AND CONSULTATION REQUIREMENTS OF PROPOSED PROJECT

The following sections present a brief discussion of the major permits, approvals, and consultations required for the SIS Project to be constructed and operated at the INEL, the Hanford Site, or the Savannah River Plant (SRP). Table 5-1 lists the permits and other environmental approvals needed for locating the SIS Project at the INEL. Required permits and subsequent reporting and enforcement of permit conditions by agencies other than DOE would provide the principal mechanism for independently ensuring that SIS construction and operation would be in accordance with appropriate environmental standards. Publicly available annual monitoring reports, which are currently prepared at each of the three alternative SIS Project locations, would provide additional current data for an independent assessment of potential offsite consequences of SIS operation.

5.6.1 Historic Preservation

An archeological survey of the INEL's Idaho Chemical Processing Plant (ICPP) area identified two sites of potential historic significance. One site, a small historic can-scatter, to the northeast of the existing ICPP security fence across the Big Lost River, would not be directly impacted by construction of the SIS Project and is not considered eligible for nomination to the National Register of Historic Places. The other site, to the east of the ICPP, an abandoned homestead with a lava block cellar, is sufficiently removed from the SIS construction site to ensure that impacts would not occur. An archeological and historic survey has also been completed of an existing borrow area and has recommended clearance for proposed expansion. Results of surveys, together with a request for determination, have been submitted to the State Historic Preservation Officer. Based on consultations with the State Historic Preservation Officer, no mitigation measures for these sites have been identified. As a result of the ensuing consultation process, DOE would undertake any required mitigation for the protection or preservation of archeological and historic artifacts. No historic or archeologic sites associated with construction and operation of the SIS Project at the Hanford Site or SRP have been identified that would be affected. If the SIS Project were to be located at either of these sites, historic and archeologic surveys would be undertaken and consultations with the State Historic Preservation Office initiated.

The potential exists that paleontological resources may be encountered during excavation activities at each of the alternative sites. Periodic inspection of excavations and excavated gravel by a professional paleontologist would determine whether the frequency of finds would require more intensive consultation or mitigation. Should construction activities appear to threaten any resource, either historic or prehistoric, it is DOE policy to stop construction, determine the significance of the resource, and, based on the potential significance of the resource, consult with the State Historic Preservation Office to determine a suitable mitigation plan.

5.6.2 Wildlife and Wildlife Habitat

In accordance with the Endangered Species Act, the Migratory Bird Treaty Act, and the Bald and Golden Eagle Protection Act, DOE is required to consult with the FWS regarding implementation of the proposed SIS Project. During the consultation process, DOE prepares a biological assessment of the selected site, which is used as the basis for evaluating the effects on federally protected species. DOE is responsible for undertaking any required mitigation that resulted from the consultation process. Consultations with the FWS for locating the SIS Project at the INEL have been completed pending the Record of Decision on this EIS to locate the project at the INEL. Results of these consultations have not identified the need to implement mitigation measures.

5.6.3 Air Quality

In accordance with the NESHAP regulations promulgated pursuant to the CAA, as amended, DOE is to notify and obtain EPA approval for the normal atmospheric radionuclide emissions associated with the SIS Project prior to the start of construction. A PSD permit will be required as radioactive releases pursuant to NESHAP are a regulated emission for which there is not an EPA de minimis level and the SIS emissions would be a modification of an existing major source (i.e., the INEL, Hanford Site, SRP). DOE must also submit a permit application for construction/operation to the cognizant state agency for the selected site.

5.6.4 Surface Water and Ground Water

Locating the SIS Project at either the INEL or the Hanford Site would not result in liquid releases to surface waters; hence, NPDES permits would not be required. For locating the SIS Project at the SRP, an NPDES application for discharges related to construction and operation would be submitted to the State of South Carolina's Department of Health and Environmental Control, Industrial and Agricultural Wastewater Division, for the discharge of liquid effluents to Four Mile Creek.

If the project were to be located at either the INEL or the Hanford Site, discharges of SIS nonradioactive and nonhazardous liquid effluents to the soil column would not require any known permit. To ensure that only nonradioactive and nonhazardous liquid effluents would be discharged, the SIS Project as described in this Final EIS has segregated process liquid waste streams that would be handled and managed as solid wastes (i.e., radioactive, hazardous, and mixed wastes) from nonprocess liquid waste streams (i.e., steam condensate and cooling tower blowdown). All nonprocess liquid waste streams would be monitored to further ensure that these liquid waste streams are nonradioactive and nonhazardous prior to being discharged to the service waste system.

Ground-water withdrawals for constructing and operating the SIS Project at the INEL would be within the present permitted withdrawal as authorized by the Idaho Department of Water Resources. Total ground-water withdrawals that include incremental SIS withdrawals would be reported to the Department of Water Resources as part of the on-going reporting process. If the SIS Project were located at the SRP, ground-water withdrawals would require a permit only for new wells to be used as potable water supplies. Ground-water use for the SIS Project, if it were to be located at the SRP, would be included in quarterly reports submitted to the South Carolina Water Resources Commission.

5.6.5 Hazardous and Mixed Wastes

If the SIS Project were to be located at either the INEL or the Hanford Site, hazardous waste generated by SIS operations would be accumulated for offsite transport. Because these wastes would neither be stored for longer than 90 days nor treated or disposed of, RCRA permits for storage, treatment, or disposal would not be required. Hazardous wastes would be transported off the site in accordance with DOT and EPA requirements (49 CFR 100-199 and 40 CFR 263). RCRA requirements for manifesting, labeling and packaging, and reporting hazardous wastes generated would also be followed (40 CFR 262). Mixed wastes would either be transported off the site or stored on the site. If the mixed wastes were stored on the site in conjunction with other mixed wastes, DOE would submit the required RCRA permit applications to the EPA.

If the SIS Project were located at the SRP, all hazardous and mixed wastes would be stored and disposed of on the site in compliance with RCRA requirements. Based on the selection of the combination waste management strategy for protection of ground water at the SRP as documented in a Final EIS (DOE, 1987a), RCRA permits for new facilities would be submitted to the EPA and the State of South Carolina.

In accordance with RCRA (40 CFR 280), underground storage tanks for regulated materials would be registered with the EPA and the appropriate state agency. Additional information on SIS hazardous and mixed waste is contained in Sections 2.1.5.1, 4.1.2.2, and 4.1.2.3.

5.6.6 Other Requirements

The proposed SIS Project sites at the INEL, the Hanford Site, and the SRP all lie outside a 500-year floodplain. In addition, construction activities would not impact wetlands (i.e., areas inundated by surface or ground water with a frequency sufficient to support a prevalence of vegetative or aquatic life that under normal circumstances requires saturated or seasonally saturated soil conditions for growth and reproduction). Given the absence of activities within the 500-year floodplain and wetlands, a floodplain/wetlands assessment for the SIS Project is not required.

At the INEL, injection wells would not be used to dispose of liquid effluents. The use of the ICPP injection well for disposal of ICPP liquid effluents has been discontinued. Currently, DOE plans to plug the ICPP injection well with cement in 1989 (this process is called abandonment in legal terms) and will meet the requirements set forth in the State of Idaho rules and regulations for construction and use of injection wells published in 1984.

In accordance with SARA Title III, DOE will provide the necessary information to the state and local Emergency Response Committees regarding types of materials that could be encountered in an emergency response. Information on the types of materials associated with the SIS Project will be included as part of the on-going reporting process.

DOE, as a matter of general policy and comity, adheres to state standards and environmental protection requirements, even though (1) specific enforcement authority over Federal facilities has under Federal law not been delegated by the EPA, and (2) a specific state permit may not be required for a Federal facility. DOE is committed to coordinating with EPA and the states concerning the need for and requirements of permits, approvals, or other actions under Federal and state laws, and will continue to do so with respect to the SIS Project.

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ABBREVIATIONS

Btu	British thermal unit
cfm	cubic feet per minute
Ci	curie
cm	centimeter
cm^3	cubic centimeter
ft	feet
ft^2	square feet
g	gram
gal	gallon
gpm	gallon per minute
hr	hour
in	inch
kg	kilogram
km	kilometer
km^2	square kilometer
kVA	kilovolt ampere
L	liter
psig	pounds per square inch (gauge)
m	meter
$\underline{M}$	molar
mg	milligram
Mg	megagram
mi	mile
mi^2	square mile
min	minute
mL	milliliter

mol	mole
mph	miles per hour
MT	metric ton
N x 10^{-p}	number (N) multiplied by 1 over 10 to the (p) power; for example, 1 x 10^{-4} = 1 x 1/10,000 = .0001. Also may be expressed as 1E-04.
N x 10^{p}	number (N) multiplied by 10 to the (p) power; for example, 1 x 10^{4} = 1 x 10,000 = 10,000. Also may be expressed as 1E+04.
ppm	part per million
ppb	part per billion
sec	second
V	volt
yr	year
μ	micro

ACRONYMS

ACGIH	American Conference of Governmental Industrial Hygienists
AEA	Atomic Energy Act
ALARA	as low as reasonably achievable
ALS	auxiliary laser subsystem
AMP	amplifier
ANL-W	Argonne National Laboratory - West
ANSI	American National Standards Institute
ARM	assembly, resupply, and maintenance
ASTM	American Society for Testing and Materials
ASME	American Society of Mechanical Engineers
ATR	Advanced Test Reactor
AVLIS	Atomic Vapor Laser Isotope Separation
BEIR	(Committee on) Biological Effects of Ionizing Radiation
BOP	balance of plant
CAA	Clean Air Act
CAM	continuous air monitor
CCTV	closed-circuit television
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFA	Central Facilities Area
CFC	chlorofluorocarbon

CFSGF	Coal-Fired Steam-Generating Facility
CGA	Compressed Gas Association
CRAC	Calculation of Reactor Accident Consequences
CWA	Clean Water Act

D&D	decontamination and decommissioning
DB	disassembly box
DBA	Design-Basis Accident
DBE	Design-Basis Earthquake
DBF	Design-Basis Fire
DBT	Design-Basis Tornado
DCG	derived concentration guide
DOD	U.S. Department of Defense
DOE	U.S. Department of Energy
DOE Order 5440.1C	National Environmental Policy Act
DOE Order 5480.1B	Environment, Safety, and Health Program for Department of Energy Programs
DOE Order 5480.3	Safety Requirements for the Packaging and Transportation of Hazardous Materials, Hazardous Substances, and Hazardous Waste
DOE Order 5480.4	Environmental Protection, Safety, and Health Protection Standards
DOE Order 5480.5	Safety of Nuclear Facilities
DOE Order 5484.1	Environmental Protection, Safety, and Health Protection Information Reporting Requirements
DOE Order 5632.4	Physical Protection of Security Interests
DOE Order 5820.2	Radioactive Waste Management

DOE Order 6430.1A	General Design Criteria Manual
DOI	U.S. Department of the Interior
DOP	dioctyl phthalate
DOR	direct oxide reduction
DOT	U.S. Department of Transportation
DPB	Dye Pump Building
EA	Environmental Assessment
EBR-1	Experimental Breeder Reactor Number 1
EDE	effective dose equivalent
EIRMC	Eastern Idaho Regional Medical Center
EIS	Environmental Impact Statement
EMCC	emergency motor control center
EOC	Emergency Operations Center
EPA	U.S. Environmental Protection Agency
EPZ	Emergency Planning Zone
ER	electrorefining
ERDA	U.S. Energy Research and Development Administration
ERP	Emergency Response Plan
ESRP	Eastern Snake River Plain
FEMA	Federal Emergency Management Agency
FFTF	Fast Flux Test Facility
FONSI	Finding of No Significant Impact
FPR	Fuel Processing Restoration
FWS	U.S. Fish and Wildlife Service
FY	fiscal year

GI	gastrointestinal
HEPA	high-efficiency particulate air
HF	hydrogen fluoride
HLW	high-level (radioactive) waste
HMS	Hanford Meteorological Station
HPS SDC	Hanford Plant Standard, Standard Design Criteria
HVAC	heating, ventilation, and air conditioning
I&C	instrumentation and control
ICPP	Idaho Chemical Processing Plant
ICRP	International Commission on Radiological Protection
IES	Illuminating Engineering Society
IMS	information management system
INEL	Idaho National Engineering Laboratory
IPICS	Integrated Plant Information and Control System
ISB	Intermountain Seismic Belt
ISZ	Idaho Seismic Zone
LANL	Los Alamos National Laboratory
LCB	Load Center Building
LEL	lower explosive limit
LET	linear-energy transfer
LLI	lower large intestine
LLNL	Lawrence Livermore National Laboratory
LLW	low-level (radioactive) waste
LSB	Laser Support Building

LSF	Laser Support Facility
MBA	material-balance area
MCC	motor control center
MDC	minimum detectable concentration
MLIS	Molecular Laser Isotope Separation
MMI	Modified Mercalli Intensity
MOPA	master oscillator/power amplifier
MPC	maximum permissible concentration
MPCL	Material and Process Control Laboratory
MPFL	maximum possible fire loss
MSE	molten-salt extraction
MSL	mean sea level
NAAQS	National Ambient Air Quality Standards
NAS	National Academy of Sciences
NCRP	National Council on Radiation Protection
NDA	nondestructive assay
NEC	National Electrical Code
NEPA	National Environmental Policy Act
NESHAP	National Emission Standards for Hazardous Air Pollutants
NFPA	National Fire Protection Association
NOI	Notice of Intent
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NPR	New Production Reactor

NRC	U.S. Nuclear Regulatory Commission
NRF	Naval Reactors Facility
NRPB	National Radiological Protection Board
NRT	National Response Team
NSC	National Safety Council
NWSM	Nuclear Weapons Stockpile Memorandum
OSC	oscillator
OSHA	Occupational Safety and Health Administration
PA	public address
PBF	Power Burst Facility
PCB	polychlorinated biphenyl
PFM	Process Facility Modifications
PFP	Plutonium Finishing Plant
PMF	Probable Maximum Flood
PNL	Pacific Northwest Laboratory
PPB	Plutonium Processing Building
PPE	pulse power electronics
PPS	plant protection system
PREPP	Process Experimental Pilot Plant
PRR	protective response recommendation
PSD	Prevention of Significant Deterioration
PSP	Plasma Separation Process
PUREX	Plutonium Uranium Extraction
PVC	polyvinyl chloride

RAP	Radiological Assistance Program
RCRA	Resource Conservation and Recovery Act
RCW	Revised Code of Washington
RESL	Radiological and Environmental Sciences Laboratory
RF	radio frequency
RSIC	Radiation Shielding Information Center
RTR	real-time radiography
RWBG	Radioactive Waste Burial Ground
RWMC	Radioactive Waste Management Complex
SAA	Satellite Accumulation Area
SARA	Superfund Amendments and Reauthorization Act
SCADA	supervisory control and data acquisition
SDA	Subsurface Disposal Area
SDC	Standard Design Criteria
SDWA	Safe Drinking Water Act
SI	small intestine
SIS	Special Isotope Separation
SMSA	Standard Metropolitan Statistical Area
SNL	Sandia National Laboratories
SNM	special nuclear material
SPCC	Spill Prevention, Control, and Countermeasures (plan)
SPERT	Special Power Excursion Reactor Test (facility)
S/R	stacker/retriever
SRP	Savannah River Plant
SSB	separator storage box

SST	safe secure transport
SWEPP	Stored Waste Examination Pilot Plant
TAN	Test Area North
TI	Transport Index
TLD	thermoluminescent dosimeter
TRA	Test Reactor Area
TRU	transuranic
TRUSAF	TRU Storage and Assay Facility
TSCA	Toxic Substances Control Act
TSD	treatment, storage, disposal
TSP	total suspended particulates
TWF	TRU Waste Processing Facility
UBC	Uniform Building Code
ULI	upper large intestine
UPS	uninterruptible power system
WAC	Waste Acceptance Criteria
WCC	Warning Communications Center
WERF	Waste Experimental Reduction Facility
WINCO	Westinghouse Idaho Nuclear Company, Inc.
WIPP	Waste Isolation Pilot Plant
WNP-1	Washington Nuclear Project Unit 1
WPPSS	Washington Public Power Supply System
WRAP	Waste Receiving and Processing (Facility)
WVRF	Waste Volume Reduction Facility

GLOSSARY

Administrative control

Control enforced by management directive, usually in written form, and transmitted to operating personnel in an appropriate directive instrument such as a procedure or a posting.

Air sampler

Unit that draws air through a filter mounted on a collection head. Radioactivity on the filter is subsequently counted in an appropriate counting system.

alpha (α) particle

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

Aquifer

A saturated geologic unit that can transmit significant quantities of water under ordinary hydraulic gradients; the water can be pumped to the surface through a well, or it can emerge naturally as a spring.

Array

A critically safe arrangement of objects or equipment to prevent the possibility of a criticality.

Atomic vapor

A stream of plutonium atoms formed by melting and vaporizing plutonium metal.

Atomic Vapor Laser Isotope Separation

The process developed at the Lawrence Livermore National Laboratory in which lasers are used to photoionize undesirable isotopes in an atomic vapor. The ionized isotopes are extracted from the vapor stream by electrostatic attraction to charged collector plates.

Background radiation

Radiation in the environment from naturally occurring elements, from cosmic radiation, and from fallout.

Bag in/out

A plastic-bag procedure used to introduce and remove material from process glove boxes while maintaining the physical containment barrier around the contents of the glove box.

Balance of plant

A general term for supporting plutonium processes to the separator systems. These processes include purification, conversion, feed-casting, component handling, plutonium recovery, maintenance, scrap recovery, and waste handling. "SIS BOP" refers to the specific processes provided by the SIS Project.

Beam tube

The underground evacuated pipe for transport of laser light between the Laser Support Building and the Plutonium Processing Building.

By-product extractor

A component in the AVLIS vacuum chamber for collecting the ionized isotopes of plutonium.

Calcination

The process of heating materials to remove moisture and other volatile matter to produce calcine.

Category I

Those structures, systems, and components whose continued integrity and/or operability are essential to achieve and maintain a safe condition during accidents that could result in potentially significant offsite exposures.

Cold chemical

A nonradioactive chemical.

Concentration guide

The average concentration of a radionuclide in air or water to which a worker or member of the general population may be continuously exposed without exceeding appropriate radiation dose standards (see maximum permissible concentration).

Conservative

When used with predictions or estimates, leaning on the side of pessimism. A conservative estimate is one in which the uncertain inputs are used in a way that maximizes the impact.

Copper laser

Electrical energy is used to excite and heat vaporized copper in a neon buffer gas to provide short, high-repetition-rate pulses of fixed wavelength, green and yellow radiation. Small-bore copper lasers are used as laser oscillators. Large-bore copper lasers are used as amplifiers to increase the optical power emitted. The large-bore copper lasers are cascaded with the small-bore copper lasers to form a copper laser chain. Chains of copper-laser are suitably pulsed and multiplexed to achieve the required repetition rates.

Copper-laser amplifier package

A package containing a copper-laser amplifier head and supporting equipment such as power supply and control electronics (see copper laser).

Copper-laser oscillator package

A package containing two copper-laser heads and supporting equipment such as power supply and control electronics (see copper laser).

Critical

In nuclear industry terminology, the state of fissile material undergoing nuclear fission at a self-sustaining rate.

Curie (Ci)
A unit of radioactivity equal to 3.7×10^{10} (37 billion) disintegrations per second; also a quantity of any nuclide or mixture of nuclides having 1 curie of radioactivity.

Design-Basis Earthquake
The strength of earthquake a Class I structure must be designed to withstand.

Design-Basis Tornado
The strength of tornado a Class I structure must be designed to withstand.

Direct oxide reduction
Direct conversion of plutonium oxide to metal by reduction with calcium metal in a molten chloride-salt flux.

DOP test
A standard test for determining the efficiency of HEPA filters; consists of introducing a quantity of dioctyl phthalate mist upstream of the filters and determining the fraction of the mist that passes through the filters.

Dose
The energy imparted to matter by ionizing radiation; the unit of absorbed dose is the rad, which is equal to 0.01 joule per kilogram of irradiated material in any medium.

Dose commitment
The dose an organ or tissue would receive during a specified period of time (e.g., 50 to 100 years) as a result of intake (as by ingestion or inhalation) of one or more radionuclides from a 1-year release.

Dose equivalent
The product of the absorbed dose from ionizing radiation and such factors that account for differences in biological effectiveness due to the type of radiation and its distribution in the body; it is measured in rem (Roentgen equivalent man).

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

Dye laser
A tunable-wavelength laser using dyes in an alcohol solvent as a medium.

Emergency procedure
A special procedure for personnel to follow in the event of an abnormal occurrence.

Fallout
The descent to earth and deposition on the ground of particulate matter (which can be radioactive) from the atmosphere.

Fault

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

Feed-casting

A process by which molten plutonium metal is poured into molds to form feed for the AVLIS separators.

Glove box

An enclosure having openings fitted with gas-tight gloves by means of which certain radioactive or other special materials may be safely handled. The enclosure is kept under slight negative pressure, and ventilation is provided from zones of lesser levels of contamination to zones with greater levels of contamination.

Half-life

The time required for the activity of a radionuclide to decay to half its value; used as a measure of the persistence of radioactive materials. Each radionuclide has a characteristic constant half-life.

Hazardous waste

A waste is considered hazardous in accordance with 40 CFR Part 261 if it is specifically listed, listed by source, or has one or more of the following characteristics:

Ignitable - flash point 60°C (140°F)

Corrosive - pH < 2.0 or >12.5

Reactive - reacts violently with water, is capable of detonation, or generates toxic gases

EP toxic - leachate from extraction procedures (EP) contains contaminants at a concentration equal to or greater than the value given in 40 CFR 261

Listed - listed as hazardous waste in 40 CFR 261

Health effect

As used in this EIS, premature death as a result of cancer, significant genetic abnormalities, or mechanical death and injury.

Health risk

The probability that a specified health effect will occur from a defined exposure to a toxic chemical or radiation.

Heel

The quantity of material, usually undissolved, left in a tank or container after steps have been taken to remove or dissolve the material.

High-efficiency particulate air (HEPA) filter

Filter designed to achieve 99.99 percent minimum efficiency in the containment of particulate matter greater than 0.3-micron size.

Ion-exchange

The process in which a solution passes over an ion-exchange medium, which removes the soluble ions by exchanging them with labile ions from the medium; this process is reversible, so the adsorbed ions can be eluted from the medium, and the medium can be regenerated.

Ion-exchange resin

Polymeric spheres (usually polystyrene-divinylbenzene copolymers) containing bound groups that carry an ionic charge, either positive or negative, in conjunction with free ions of opposite charge that can be displaced.

Isotopes

Nuclides with the same atomic number (i.e., the same chemical element), but with different atomic masses; although chemical properties are the same, radioactive and nuclear properties may be quite different among isotopes of an element.

K_{eff} (effective multiplication factor)

The ratio of the average number of neutrons produced by fission in each generation to the total average number of corresponding neutrons absorbed by fuel, moderator, etc., or leaking out.

Laser Support Building

A building housing the process laser systems, support processes, maintenance facilities, and storage areas.

Low-level waste

As defined by DOE Order 5820.2A, radioactive waste having concentrations of less than 100 nanocuries per gram and not classified as high-level waste, TRU waste, spent nuclear fuel, or by-product material.

Material-balance area

An identifiable physical area wherein the quantity of nuclear material being moved into or out is represented by a measured value.

Maximum permissible concentration

The average concentration of a radionuclide in air or water to which a worker or member of the general population may be continuously exposed without exceeding an established standard of radiation.

Millirem

One-thousandth of a rem. See Roentgen equivalent man (rem).

Molten-salt extraction

The oxidation and extraction of americium from molten plutonium metal into a stirred, molten, calcium-potassium-magnesium chloride salt.

Natural radiation; natural radioactivity
Radiation in the environment from naturally occurring elements and from cosmic radiation.

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

Photoionization
Ionization caused by light absorption, as in the AVLIS process.

Plutonium Processing Building
Category I facility where SIS plutonium operations would be housed.

Plutonium Uranium Extraction Facility
The facility and process at Hanford that uses steps of solvent extraction for the separation of plutonium and uranium from irradiated product fuels.

Product collector
A component in the AVLIS vacuum chamber used for condensing the plutonium-239 enriched vapor.

Pyrochemical or pyrometallurgical
Chemical-processing or metal-processing operations conducted at high temperatures.

Radiation
The emitted particles or photons from the nuclei of radioactive atoms. Some elements are naturally radioactive; others are induced to become radioactive by bombardment in a reactor. Naturally occurring radiation is indistinguishable from induced radiation.

Radioactivity
The spontaneous decay or disintegration of unstable atomic nuclei, accompanied by the emission of radiation.

Radionuclide
A nuclide that is radioactive.

Roentgen equivalent man (rem)
The unit of dose for biological absorption; equal to the product of the absorbed dose in rads, a quality factor, and a distribution factor.

Scrubber
An air pollution control device that uses a liquid spray to remove pollutants from a gas stream by absorption or chemical reaction.

Separator line
A general term for two or more separator units in a series, including glove boxes, component-handling vacuum systems, and laser light adjustment and transmission systems.

Source term
The kinds and amounts of radionuclides that make up the source of a potential release of radioactivity.

Ten-year storm
A storm of sufficient magnitude that it is likely to occur only every 10 years.

TRU waste
Without regard to source or form, radioactive waste that, at the end of institutional control periods, is contaminated with alpha-emitting transuranic radionuclides with half-lives greater than 20 years and concentrations greater than 100 nanocuries per gram of waste.

Unit (separator unit)
A complete plutonium separator assembly consisting of cryostats, chamber, and fittings; product and by-product collectors; and collimator, crucible, electron-beam gun, focusing magnets, and port shields.

Zone
The classification of an area on the basis of its potential for contamination.

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[a] This Final Environmental Impact Statement was reviewed and approved in accordance with DOE Order 5440.1C, Implementation of the National Environmental Policy Act.

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Honorable John D. Dingell, Chairman, Subcommittee on Oversight and Investigations, Committee on Energy and Commerce
Honorable Thomas S. Foley
Honorable Newt Gingrich
Honorable Charles F. Hatcher
Honorable Frank Horton, Ranking Minority Member, Committee on Government Operations
Honorable Ed Jenkins
Honorable Ben Jones
Honorable Norman F. Lent, Ranking Minority Member, Committee on Energy and Commerce
Honorable John Lewis
Honorable Mike Lowry
Honorable Jim McDermott
Honorable John Miller
Honorable Sid Morrison
Honorable John T. Myers, Ranking Minority Member, Subcommittee on Energy and Water Development, Committee on Appropriations
Honorable Elizabeth Patterson
Honorable Arthur Ravenel, Jr.
Honorable Richard Ray
Honorable J. Roy Rowland
Honorable Philip R. Sharp, Chairman, Subcommittee on Energy and Power, Committee on Energy and Commerce
Honorable Floyd Spence
Honorable John M. Spratt, Jr.
Honorable Richard Stallings
Honorable Samuel Stratton, Chairman, Subcommittee on Procurement and Military Nuclear Systems, Committee on Armed Services
Honorable Al Swift
Honorable Patrick L. Swindall
Honorable Mike Synar, Chairman, Subcommittee on Environment, Energy, and Natural Resources, Committee on Government Operations
Honorable Robin M. Tallon
Honorable Lindsay Thomas

UNITED STATES HOUSE OF REPRESENTATIVES (continued)

Honorable Jolene Unsoeld
Honorable James L. Whitten, Chairman, Committee on Appropriations

UNITED STATES CONGRESSIONAL STAFF

Georgia Dixon, District Assistant, Office of Senator McClure
Sallee Gasser, Office of Congressman Stallings
Sally Greenslade, Office of Senator Symms
Dixie Richardson, District Assistant, Office of Senator Symms
Roger Rowin, Office of Congressman Stallings
Valorie Watkins, Office of Senator McClure

FEDERAL AGENCIES

Advisory Committee on Historic Preservation, Cynthia Grassby Baker, Chairwoman
Arms Control and Disarmament Agency
Council on Environmental Quality, Dinah Bear, General Council
Council on Environmental Quality, A. Alan Hill, Chairman
Department of Agriculture, Forest Service, F. Dale Robertson, Chief
Department of Commerce, Office of Environmental Affairs
Department of Commerce, Southeast Regional Office, National Marine Fisheries Service
Department of Defense, Honorable F. C. Carlucci, Secretary of Defense
Department of Defense, Environmental Policy, Carl J. Schafer
Department of Health and Human Services, Otis R. Bowen
Department of Interior, United States Geological Survey, Denver Office
Department of Interior, Environmental Project Review, Bruce Blanchard
Department of Interior, Fish and Wildlife Service, Frank H. Dunkle, Director
Department of Interior, Fish and Wildlife Service, Ronald E. Lambertson
Department of Interior, Honorable Donald P. Hodel, Secretary of Interior
Department of Interior, Shirley Martin
Department of Justice, Land and Natural Resources Division, R. J. Marzulla
Department of Labor, Occupational Safety and Health Administration, Director
Department of Labor, Occupational Safety and Health Administration, Honorable J. A. Pendergrass, Assistant Secretary
Department of State, Office of Environmental Affairs, John D. Negroponte, Assistant Secretary
Department of State, Arms Control Matters, Paul Nitze
Department of State, Office of Environmental Protection, Andrew Sens, Director
Department of Transportation, Eugene L. Lehr
Department of Transportation, Honorable James H. Burnley IV, Secretary of Transportation
Environmental Protection Agency, Richard Guimond, Director, Office of Radiation Programs
Environmental Protection Agency, Office of Radiation Programs, Daniel Hendricks
Environmental Protection Agency, Richard E. Sanderson, Director, Office of Federal Activities

FEDERAL AGENCIES (continued)

National Academy of Sciences, Frank Press, President
National Academy of Sciences, Environmental Studies and Toxicology, James Reisa
National Science Foundation, Erich Bloch, Director
Nuclear Regulatory Commission, Office of Nuclear Material Safety and Safeguards, John Davis, Director
Nuclear Regulatory Commission, Office of Government and Public Affairs, Harold Denton, Director
Nuclear Regulatory Commission, Office of Public Affairs, Joseph J. Fouchard, Director
Nuclear Regulatory Commission, Division of Radiation Programs and Earth Sciences, Karl R. Goller, Director
Nuclear Regulatory Commission, Office of Nuclear Reactor Regulation, Melanie A. Miller, Vogtle Licensing Project Manager
Nuclear Regulatory Commission, Office of Nuclear Material Safety and Safeguards, Hugh L. Thompson
Nuclear Regulatory Commission, Michael Tokar
Office of Management and Budget, Environmental Branch, Robert Fairweather, Acting Chief
Office of Management and Budget, James C. Miller III, Director
Office of Management and Budget, Budget Review Division, Carey P. Modlin, Assistant Director
Office of Technology Assessment, John H. Gibbons, Director

Regional Offices of Federal Agencies

Army Corps of Engineers, Charleston District, Lieutenant Colonel Stewart Bornhoft, Commander
Army Corps of Engineers, South Atlantic Division, Brigadier General C. E. Edgar III, Commander
Army Corps of Engineers, Savannah District, Colonel Stanley Genega, Commander
Department of Agriculture, Soil Conservation Service, William Abercrombie, State Conservationist
Department of Agriculture, Southern Region Office, John E. Alcock, Regional Forester
Department of Commerce, Protected Species Management, Charles A. Orazetz
Department of Health and Human Services, Center for Disease Control, James O. Mason, Director
Department of Interior, U.S. Park Service Pacific Northwest Regional Office
Department of Interior, Bureau of Reclamation, Pacific Northwest Region
Department of Interior, Bureau of Indian Affairs, Northern Idaho Agency, Gordon Cannon, Superintendent
Department of Interior, Bureau of Indian Affairs, Tom Remington
Department of Interior, Bureau of Land Management-Boise District, Paul J. Seronko
Environmental Protection Agency, Region IV, Greer Tidwell, Administrator
Environmental Protection Agency, Region IV, Sheppard Moore
Environmental Protection Agency, Region X, R. G. Russell, Administrator
Nuclear Regulatory Commission, Region IV, Robert D. Martin, Regional Administrator
Public Health Service, Ted Ziegler

FEDERAL AGENCIES (continued)

Regional Offices of Federal Agencies (continued)

Public Health Service, Regional Health Administration, Richard Robinson

U.S. Department of Energy

Mr. K. R. Abser, Reactor Operations Branch, Richland Operations Office
Nick C. Aquilina, Manager, Nevada Operations Office
Mr. Pete Armstrong, Transportation Safeguards Division, Albuquerque Operations Office
Mr. Willis Bixby, Director, West Valley Operations
Mr. Robert M. Carosino, Richland Operations Office
Mr. Joel Cote, Assistant Manager for Administration, Schenectady Naval Reactors Office
Mr. Ralph Erickson, Office of Weapons Production (DP-23)
Mr. P. W. Kasper, Manager, Savannah River Operations
Mr. Joe La Grone, Manager, Oak Ridge Operations Office
Mr. Michael J. Lawrence, Manager, Richland Operations Office
Mr. W. P. Rachels, Director, Atlanta Support Office
Mr. Hiliary J. Rauch, Manager, Chicago Operations Office
Mr. Stanley R. Sulak, Director, Program Development and Technical Support, Office of Inspector General
Mr. Virgil Trice, Operations and Projects
Mr. B. G. Twining, Manager, Albuquerque Operations Office
Mr. Lanny L. VanCamp, Assistant Inspector General, Office of Inspector General
Ms. Jo Ann S. Elferink, Manager, San Francisco Operations Office
Mr. William E. Wisenbaker, Chief, Environmental Program Branch, Savannah River Operations Office
Mr. Stephen R. Wright, Environmental Division, Savannah River Operations Office

National Laboratories

Ms. Annette Jones, Pacific Northwest Laboratory
Ms. Silglinde Neuhauser, Sandia National Laboratories
Mr. Jack Robinson, Pacific Northwest Laboratory
Mr. Andrew Hull, Safety Environment Project Division, Brookhaven National Laboratory
Mr. Allen J. Levy, Lawrence Livermore National Laboratory
Mr. Frank A. Guevara, Los Alamos National Laboratory

STATE OF IDAHO

State Elected Officials

Honorable Cecil Andrus, Governor, State of Idaho
Honorable Butch Otter, Lt. Governor, State of Idaho
Honorable Jim Jones, Attorney General of Idaho
Honorable Larrey Anderson, Idaho Senate
Honorable Rod Beck, Idaho Senate

STATE OF IDAHO (continued)

State Elected Officials (continued)

Honorable Ron Beitelspacher, Idaho Senate
Honorable C. E. Bilyeu, Idaho Senate
Honorable Mike Blackbird, Idaho Senate
Honorable Gail Bray, Idaho Senate
Honorable Karl Brooks, Idaho Senate
Honorable Mike Burkett, Idaho Senate
Honorable Marti Calabretta, Idaho Senate
Honorable Herb Carlson, Idaho Senate
Honorable Jim Christiansen, Idaho Senate
Honorable Karen Cooke, Idaho Senate
Honorable Michael D. Crapo, Idaho Senate
Honorable Denton C. Darrington, Idaho Senate
Honorable Brian N. Donesley, Idaho Senate
Honorable Roger Fairchild, Idaho Senate
Honorable Rex L. Furness, Idaho Senate
Honorable Rachel S. Gilbert, Idaho Senate
Honorable Dennis S. Hansen, Idaho Senate
Honorable John Hansen, Idaho Senate
Honorable Norris (Doc) Hyde, Idaho Senate
Honorable Ralph Lacy, Idaho Senate
Honorable Don Mackin, Idaho Senate
Honorable Roger B. Madsen, Idaho Senate
Honorable Marguerite McLaughlin, Idaho Senate
Honorable Bert Marley, Idaho Senate
Honorable Laird Noh, Idaho Senate
Honorable John Peavey, Idaho Senate
Honorable Mary Lou Reed, Idaho Senate
Honorable Mark G. Ricks, Idaho Senate
Honorable Jim Risch, Idaho Senate
Honorable Ann Rydalch, Idaho Senate
Honorable C. A. (Skip) Smyser, Idaho Senate
Honorable Lee Staker, Idaho Senate
Honorable John (Johno) Stocks, Idaho Senate
Honorable Bruce L. Sweeney, Idaho Senate
Honorable Jerry T. Twiggs, Idaho Senate
Honorable George Vance, Idaho Senate
Honorable R. Claire Wetherell, Idaho Senate
Honorable Richard L. Adams, Idaho House of Representatives
Honorable Elizabeth (Liz) Allan-Hodge, Idaho House of Representatives
Honorable Steve Antone, Idaho House of Representatives
Honorable Lee Barnes, Idaho House of Representatives
Honorable Maxine T. Bell, Idaho House of Representatives
Honorable Pam Bengson, Idaho House of Representatives
Honorable Pete Black, Idaho House of Representatives
Honorable Ron Black, Idaho House of Representatives
Honorable Tom Boyd, Idaho House of Representatives
Honorable Carl Braun, Idaho House of Representatives
Honorable Brent Brocksome, Idaho House of Representatives
Honorable L. E. Brown, Idaho House of Representatives
Honorable Cyril O. Burt, Idaho House of Representatives

STATE OF IDAHO (continued)

State Elected Officials (continued)

Honorable Phil Childers, Idaho House of Representatives
Honorable Ron Crane, Idaho House of Representatives
Honorable Dolores J. Crow, Idaho House of Representatives
Honorable Judith Danielson, Idaho House of Representatives
Honorable R. L. (Dick) Davis, Idaho House of Representatives
Honorable Jerry Deckard, Idaho House of Representatives
Honorable Mark Duffin, Idaho House of Representatives
Honorable Freeman B. Duncan, Idaho House of Representatives
Honorable Frances Field, Idaho House of Representatives
Honorable Robert C. Geddes, Idaho House of Representatives
Honorable Celia R. Gould, Idaho House of Representatives
Honorable Kathleen (Kitty) Gurnsey, Idaho House of Representatives
Honorable Dean Haagenson, Idaho House of Representatives
Honorable Ernest A. Hale, Idaho House of Representatives
Honorable Wayne Hall, Idaho House of Representatives
Honorable Jim Hansen, Idaho House of Representatives
Honorable M. Reed Hansen, Idaho House of Representatives
Honorable Mary Hartung, Idaho House of Representatives
Honorable Stan Hawkins, Idaho House of Representatives
Honorable Janet S. Hay, Idaho House of Representatives
Honorable Boyd I. Hill, Idaho House of Representatives
Honorable Louis J. (Lou) Horvath, Idaho House of Representatives
Honorable Ray E. Infanger, Idaho House of Representatives
Honorable Al Johnson, Idaho House of Representatives
Honorable Donna M. Jones, Idaho House of Representatives
Honorable Douglas R. Jones, Idaho House of Representatives
Honorable Myron Jones, Idaho House of Representatives
Honorable Claud Judd, Idaho House of Representatives
Honorable Hilde Kellogg, Idaho House of Representatives
Honorable Leanna Lasuen, Idaho House of Representatives
Honorable Golden C. Linford, Idaho House of Representatives
Honorable Mary Lloyd, Idaho House of Representatives
Honorable Thomas F. Loertscher, Idaho House of Representatives
Honorable Don Loveland, Idaho House of Representatives
Honorable James R. (Doc) Lucas, Idaho House of Representatives
Honorable Con Mahoney, Idaho House of Representatives
Honorable Dorothy McCann, Idaho House of Representatives
Honorable Patricia McDermott, Idaho House of Representatives
Honorable Joyce McRoberts, Idaho House of Representatives
Honorable Gary L. Montgomery, Idaho House of Representatives
Honorable Tom Morrison, Idaho House of Representatives
Honorable Mack W. Neibaur, Idaho House of Representatives
Honorable Bruce Newcomb, Idaho House of Representatives
Honorable Edward Osborne, Idaho House of Representatives
Honorable Raymond Parks, Idaho House of Representatives
Honorable Atwell J. Parry, Idaho House of Representatives
Honorable Ralph B. Peters, Idaho House of Representatives
Honorable Horace B. (Hod) Pomeroy, Idaho House of Representatives
Honorable Harold W. Reid, Idaho House of Representatives

STATE OF IDAHO (continued)

State Elected Officials (continued)

Honorable Dorothy L. Reynolds, Idaho House of Representatives
Honorable Mel Richardson, Idaho House of Representatives
Honorable Gary Robbins, Idaho House of Representatives
Honorable Ken Robison, Idaho House of Representatives
Honorable Robert E. Schaefer, Idaho House of Representatives
Honorable John O. Sessions, Idaho House of Representatives
Honorable Michael K. Simpson, Idaho House of Representatives
Honorable Emerson Smock, Idaho House of Representatives
Honorable Sheila A. Sorensen, Idaho House of Representatives
Honorable Ralph J. Steele, Idaho House of Representatives
Honorable Herm Steger, Idaho House of Representatives
Honorable James F. Stoicheff, Idaho House of Representatives
Honorable Ruby R. Stone, Idaho House of Representatives
Honorable Wayne Sutton, Idaho House of Representatives
Honorable W. O. (Bill) Taylor, Idaho House of Representatives
Honorable J. L. (Jerry) Thorne, Idaho House of Representatives
Honorable John H. Tippets, Idaho House of Representatives
Honorable Lynn S. Tomminaga, Idaho House of Representatives
Honorable Tim Tucker, Idaho House of Representatives
Honorable Marvin G. Vandenberg, Idaho House of Representatives
Honorable Deanna Vickers, Idaho House of Representatives
Honorable Ron Vieselmeyer, Idaho House of Representatives
Honorable Larry R. Vincent, Idaho House of Representatives
Honorable Gino White, Idaho House of Representatives
Honorable Gayle A. Wilde, Idaho House of Representatives
Honorable Jo An E. Wood, Idaho House of Representatives

State Agencies

Mr. Greg Casey, Idaho Association of Commerce and Industry
Mr. Richard Donovan, Idaho Department of Health and Welfare
Mr. Howard Funke, Tribal Attorney, Shoshone-Bannock Tribe
Mr. Wayne Haas, Administrator, Resources Analysis Division, Idaho Department of Water Resources
Mr. Jim Hawkins, Idaho Department of Commerce
Mr. Keith Higginson, Director, Idaho Department of Water Resources
Mr. Kermit Kiebert, Idaho Department of Transportation
Mr. Dennis Martin, District 7 Health Department
State of Idaho Clearinghouse

Local Officials

City of Blackfoot
City of Moscow
Honorable John J. Allen, Jr., Mayor of McCall
Honorable Gary Anderson, Mayor of Leadore
Clarence Billem, County Commissioner
Honorable Dale Bowman, Mayor of Inkom
Honorable Ken Bullock, Mayor of McCammon
Honorable Charlie Burns, Mayor of Challis

STATE OF IDAHO (continued)

Local Officials (continued)

Honorable Clyde Burtenshaw, Chairman, Bonneville County Commissioners
Honorable Tom Campbell, Mayor of Idaho Falls
Honorable Ronald Chaney, Mayor of Sandpoint
Honorable Eugene Christensen, Mayor of Shelley
Honorable John O. Cotant, Jr., Mayor of Chubbuck
Honorable Peter B. Cowles, Mayor of Caldwell
Honorable Alvin Dalley, Mayor of Driggs
Honorable Paschal Drake, Mayor of Hailey
Honorable Carl Dunbar, Mayor of Spirit Lake
Honorable Donald Etter, Mayor of Mountain Home
Honorable R. S. "Dick" Finlayson, Mayor of Pocatello
Honorable Robert S. Fort, Mayor of Filer
Honorable Kenneth Fronk, Mayor of Burley
Honorable Winston K. Goering, Mayor of Nampa
Honorable Roy Grossen, Mayor of Council
Honorable Steve Guerber, Mayor of Eagle
Honorable Karen Hansen, Mayor of Iona
Honorable Kirk L. Hansen, Mayor of Soda Springs
Honorable Gene Heller, Mayor of Gooding
Honorable C. Dean Hill, Mayor of Blackfoot
Honorable Mike Ivie, Mayor of Bellevue
Mr. Jerry Jacobson, Superintendent, School District 91
Honorable Lloyd James, Mayor of Stanley
Honorable Chic Jones, Mayor of Arco
Honorable Dick Kempthorne, Mayor of Boise
Honorable Larry E. Lee, Mayor of Menan
Honorable Ruth Lieder, Mayor of Sun Valley
Honorable Marilyn Lorenzen, Mayor of Emmett
Honorable Newton J. Lowe, Mayor of Lava Hot Springs
Honorable Claude McKercher, Jr., Mayor of Buhl
Honorable Gerald Mitchell, Mayor of Ammon
Ms. Mary Ann Mix, Council Member, City of Hailey
Honorable Frank J. Murphy, Mayor of Lapwai
Honorable Jack Nelson, Mayor of Salmon
Honorable Kirk Olsen, Mayor of Victor
Honorable Merle E. Owsley, Mayor of Hagerman
Honorable Ralph B. Peters, Mayor of Jerome
Honorable John C. Porter, Mayor of Rexburg
Honorable Jesse Posey, Mayor of Kimberly
Honorable Tim Ridinger, Mayor of Shoshone
Honorable Rudolph "Bud" Rogers, Mayor of Firth
Honorable Merrill J. Rose, Mayor of St. Anthony
Honorable Robert Sample, Mayor of Castleford
Honorable Gary L. Scott, Mayor of Moscow
Honorable Keith Scott, Mayor of Rigby
Honorable Gerald Seiffert, Mayor of Ketchum
Honorable Marion Shinn, Mayor of Lewiston
Honorable Kendall Smith, Mayor of Tetonia
Honorable Raymond L. Stone, Mayor of Coeur d'Alene
Honorable George Urie, Mayor of Hansen

STATE OF IDAHO (continued)

Local Officials (continued)

Honorable Marie Vogel, Mayor of Troy
Honorable Doug Vollmer, Mayor of Twin Falls
Honorable W. F. "Bill" Whittom, Mayor of Rupert
Honorable Lawrence J. Young, Mayor of Ketchum
Honorable Rolland Zollinger, Mayor of Bliss

Local Agencies

Mr. Craig Adamson, Butte County Chamber of Commerce
Ms. Betsy Albinson, Nampa Chamber of Commerce
Ms. Ardelle Beck, Greater Blackfoot Area Chamber of Commerce
Mr. Del Brewster, Idaho Falls Chamber of Commerce
Mr. Ronald Carter, Caldwell Chamber of Commerce
Ms. Janice Cisneros, Lava Hot Springs Chamber of Commerce
Mr. Jay M. Clemens, Boise Area Chamber of Commerce
Mr. Jonathon Coe, Greater Sandpoint Chamber of Commerce
Mr. Nick Cozakos, Burley Area Chamber of Commerce
Ms. Glenna Crawforth, Meridian Chamber of Commerce
Mr. Alex D. Creek, Idaho Falls Chamber of Commerce
Mr. Blair W. Dance, Driggs Chamber of Commerce
Ms. Orpha Denney, Buhl Chamber of Commerce
Mr. R. Mark Falconer, Boise Chamber of Commerce
Ms. Rose Funk, American Falls Chamber of Commerce
Mr. John Greene, Mountain Home Chamber of Commerce
Mr. Harry Halkar, South Fremont Chamber of Commerce
Ms. Virginia Hamp, Soda Springs Chamber of Commerce
Ms. Terri Harbison, Hagerman Valley Chamber of Commerce
Ms. Dawn Hatch, Greater Pocatello Chamber of Commerce
Mr. George Humbert, Shelley Chamber of Commerce
Ms. Dawn Hutchinson, Rupert Chamber of Commerce
Ms. Wendy Jaquet, Sun Valley-Ketchum Chamber of Commerce
Mr. Jeffrey E. Jones, Idaho Falls Chamber of Commerce
Mr. Ira Koplow, Greater Idaho Falls Chamber of Commerce
Mr. L. L. Langdon, Greater Twin Falls Area Chamber of Commerce
Ms. Marianne Lawrence, Council Chamber of Commerce
Mr. John M. LoBuono, Moscow Chamber of Commerce
Ms. Jennifa G. Lorenzi, McCall Area Chamber of Commerce
Ms. Merlene Maybury, Jerome Chamber of Commerce
Ms. Roberta McKercher, Hailey Chamber of Commerce
Mr. Ciska Mosher, Salmon Valley Chamber of Commerce
Ms. Joan Pasco, Lewiston Chamber of Commerce
M. Dale M. Reese, Stanley-Sawtooth Chamber of Commerce
Mr. Gary Schultz, Coeur d'Alene Chamber of Commerce
Ms. Paula A. Scott, Post Falls Chamber of Commerce
Ms. Barbara Smith, Shoshone Chamber of Commerce
Ms. Sandra R. Steiner, Gem County Chamber of Commerce
Ms. Lori Wasden, Rexburg Chamber of Commerce
Ms. Mary Ybarguen, Gooding Chamber of Commerce

STATE OF IDAHO (continued)

Newspapers

Post Register, Idaho Falls
Idaho State Journal, Pocatello
North Idaho Press, Wallace
Idaho Statesman, Boise
The South Idaho Press, Burley
Kellogg Evening News, Kellogg
Lewiston Tribune, Lewiston
Idaho Press Review, Nampa
Coeur d'Alene Press, Coeur d'Alene
Idahonian, Moscow
Sandpoint Daily Bee, Sandpoint
Times News, Twin Falls
Morning News, Blackfoot

STATE OF GEORGIA

State Elected Officials

Honorable Joe Frank Harris, Governor, State of Georgia
Honorable Frank Albert, Georgia Senate
Honorable Thomas F. Allgood, Georgia Senate
Honorable Sam P. McGill, Georgia Senate
Honorable George Brown, Georgia House of Representatives
Honorable Donald E. Cheeks, Georgia House of Representatives
Honorable Jack Connell, Georgia House of Representatives
Honorable William S. Jackson, Georgia House of Representatives
Honorable Mike Padgett, Georgia House of Representatives
Honorable Dick Ransom, Georgia House of Representatives
Honorable Charles Thomas, Georgia House of Representatives
Honorable Charles W. Walker, Georgia House of Representatives

State Agencies

Mr. C. H. Badger, Administrator, Georgia State Clearinghouse
Mr. Paul Burks, Director, State Office of Energy Resources
Mr. Joseph W. Griffin, Civil Defense Division, Georgia Department of Defense
Mr. J. Hardeman, Environmental Radiation Programs, Environmental Protection Division, Georgia Department of Natural Resources
Mr. J. Leonard Ledbetter, Director, Environmental Protection Division, Georgia Department of Natural Resources
Mr. J. L. Setser, Chief, Program Coordination Branch, Environmental Radiation Programs, Environmental Protection Division, Georgia Department of Natural Resources
Mr. Clark T. Stevens, State Office of Planning and Budget

Local Officials

Chairman, Burke County Commissioners
Chairman, Richmond County Commissioners
Chairman, Columbia County Commissioners

STATE OF GEORGIA (continued)

Local Officials (continued)

Honorable Charles A. Devaney, Mayor of Augusta
President, Augusta City Council

Local Agencies

County Administrator, Richmond County
County Administrator, Burke County
County Clerk, Columbia County
Director, Augusta-Richmond County Planning and Zoning Commission
Director, Central Savannah River Area Planning and Development Commission
Mr. Bob Stuntz, Chamber of Commerce of Greater Augusta

STATE OF OREGON

Honorable Neil Goldschmidt, Governor, State of Oregon

STATE OF SOUTH CAROLINA

State Elected Officials

Honorable Carroll A. Campbell, Governor, State of South Carolina
Honorable Thomas L. Moore, South Carolina Senate
Honorable Ryan C. Shealey, South Carolina Senate
Honorable Larry E. Gentry, South Carolina House of Representatives
Honorable Thomas E. Huff, South Carolina House of Representatives
Honorable William H. Jones, South Carolina House of Representatives
Honorable Harriett H. Keyserling, South Carolina House of Representatives

State Agencies

Mr. Michael D. Jarrett, Commissioner, South Carolina Department of Health and Environmental Control
Mr. James A. Joy, III, Chief, Bureau of Water Pollution Control, South Carolina Department of Health and Environmental Control
Mr. O. E. Pearson, Chief, Bureau of Air Quality Control, South Carolina Department of Health and Environmental Control
Mr. Lewis R. Shaw, Deputy Commissioner, Environmental Quality Control, South Carolina Department of Health and Environmental Control
Mr. H. G. Shealy, Chief, Bureau of Radiological Health, South Carolina Department of Health and Environmental Control
State of South Carolina Clearinghouse, Office of the Governor
Dr. James A. Timmerman, Jr., Executive Director, South Carolina Wildlife and Marine Resources Department
Mr. Hartsill W. Truesdale, Chief, Bureau of Solid and Hazardous Waste Management, South Carolina Department of Health and Environmental Control
Mr. A. H. Vang, Executive Director, South Carolina Water Resources Commission

STATE OF SOUTH CAROLINA (continued)

Local Officials

Chairman, Allendale County Council
Chairman, Barnwell County Council
Honorable Thomas Greene, Mayor of North Augusta
Honorable Caroll H. Warner, Chairman, Aiken County Council
Honorable H. Odell Weeks, Mayor of Aiken

Local Agencies

Aiken Chamber of Commerce
City Manager, City of Aiken
City Administrator, City of North Augusta
Director, Aiken County Planning Commission

STATE OF WASHINGTON

State Elected Officials

Honorable Booth Gardner, Governor, State of Washington
Honorable John A. Cherberg, Lieutenant Governor
Honorable Max Benitz, Washington State Senate
Honorable Jeannette Hayner, Washington State Senate
Honorable Irving Newhouse, Washington State Senate
Honorable E. G. Patterson, Washington State Senate
Honorable Al Williams, Washington State Senate
Honorable Hal Zimmerman, Washington State Senate

State Agencies

Mr. Richard Watson, Director, Washington State Energy Office
State of Washington Clearinghouse
State of Washington, Department of Social and Health Services
State of Washington, Department of Natural Resources
State of Washington, Department of Ecology

STATE OF WYOMING

Honorable Lynn Dickey, Member, Wyoming State Legislature

LIBRARIES AND PUBLIC READING ROOMS

Department of Energy

Freedom of Information Public Document Room, University of South Carolina at Aiken, Gregg-Graniteville Library, Aiken, SC
Freedom of Information Reading Room, U.S. Department of Energy, Forrestal Building, Washington, DC
Department of Energy, Germantown, MD

LIBRARIES AND PUBLIC READING ROOMS (continued)

Department of Energy (continued)

INEL Technical Library Public Reading Room, Idaho Falls, ID
Public Reading Room, Albuquerque Operations Office, National Atomic Museum, Albuquerque, NM
Public Reading Room, Chicago Operations Office, Argonne, IL
Public Reading Room, Energy Resources Center, San Francisco Operations Office, Oakland, CA
Public Reading Room, Nevada Operations Office, Las Vegas, NV
Public Reading Room, Oak Ridge Operations Office, Federal Building, Oak Ridge, TN
Public Reading Room, Richland Operations Office, Richland, WA

Libraries

Aiken County Library, Aiken, SC
Aiken-Bamberg-Barnwell Regional Library System, Aiken, SC
American Falls District Library, American Falls, ID
Athol Branch Consolidated Library District, Athol, ID
Augusta-Richmond County Public Library, Augusta, GA
Bellevue Public Library, Bellevue, ID
Blackfoot Public Library, Blackfoot, ID
Boise Basin District Library, Idaho City, ID
Boise Public Library and Information Center, Boise, ID
Boise State Library, Boise, ID
Boise State University Library, Boise, ID
Buhl Public Library, Buhl, ID
Burley Public Library, Burley, ID
Caldwell Public Library, Caldwell, ID
Central Washington University Library, Ellensburg, WA
Challis Public Library, Challis, ID
Clark County District Library, Dubois, ID
Coeur d'Alene Public Library, Coeur d'Alene, ID
College of Idaho Library College Campus, Caldwell, ID
Department of Fish and Game Library, Boise, ID
Eagle Public Library, Eagle, ID
Filer Public Library, Filer, ID
Hailey Public Library, Hailey, ID
Hansen Public Library, Hansen, ID
Health Sciences Library, Sun Valley, ID
ISU Library Documents Division, Pocatello, ID
Idaho Falls Public Library, Idaho Falls, ID
Idaho State Library, Boise, ID
Idaho Statesman Library, Boise, ID
Jerome Public Library, Jerome, ID
Ketchum Community Library, Ketchum, ID
Kimberly Public Library, Kimberly, ID
Lewis & Clark State College Library, Lewiston, ID
Lewiston City Library, Lewiston, ID
Little Wood River District Library, Carey, ID
Lost River Community Library District, Arco, ID
Madison County District Library, Rexburg, ID

LIBRARIES AND PUBLIC READING ROOMS (continued)

Libraries (continued)

McCall Public Library, McCall, ID
Mid-Columbia Library Pasco Branch, Pasco, WA
Mountain Home Library, Mountain Home, ID
Nampa Public Library, Nampa, ID
Pocatello Public Library, Pocatello, ID
Portneuf District Library, Chubbuck, ID
Reese Library, Augusta College, Augusta, GA
Richland County Public Library, Columbia, SC
Richland County Public Library, Richland, WA
Ricks College Library, Ricks College, Rexburg, ID
Rigby Public Library, Rigby, ID
Ririe Public Library, Ririe, ID
South Carolina State Library, Columbia, SC
Salmon Public Library, Salmon, ID
Seattle Public Library, Seattle, WA
Shelley Public Library, Shelley, ID
Shoshone Public Library, Shoshone, ID
Shoshone-Bannock Library, Fort Hall, ID
Social Sciences Library University of Idaho, Moscow, ID
Spokane Public Library Comstock Building Library, Spokane, WA
St. Anthony Public Library, St. Anthony, ID
Twin Falls Public Library, Twin Falls, ID
University of Idaho Library, Moscow, ID
University of Washington Libraries, Seattle, WA
Valley of the Tetons Public Library, Victor, ID
Washington State Library, Olympia, WA
Washington State University Library, Pullman, WA

INTERESTED ORGANIZATIONS

Citizens Against Nuclear Weapons and Extermination, Coeur d'Alene, ID
Defenders of Wildlife, Washington, DC
Electricians Union Local No. 449, Pocatello, ID
Environmental Defense Fund, Inc., Washington, DC
Environmental Policy Institute, Nuclear Waste Project, Washington, DC
Groundwater Alliance, Ketchum, ID
Librarian, Hewlett Packard Library, Boise, ID
Hewlett Packard Library, Boise, ID
Idaho Conservation League, Wood River Chapter, Ketchum, ID
Idaho Conservation League, Moscow Chapter, Moscow, ID
International Association of Machinists, Industrial Local No. 1933, Pocatello, ID
Iron Workers Local 732, Pocatello, ID
League of Women Voters of the U.S., Washington, DC
National Audubon Society, Science Division, New York, NY
National Wildlife Federation, Public Lands and Energy Division, Washington, DC
Natural Resources Defense Council, Washington, DC

INTERESTED ORGANIZATIONS (continued)

Palouse-Clearwater Environmental Institute, Moscow, ID
Palouse-Clearwater Hanford Watch, Moscow, ID
Plumber & Steam Fitters Union Local #648, Pocatello, ID
Public Lands and Energy Division, National Wildlife Federation, Washington, DC
Sierra Club, Washington, DC
Sierra Club, San Francisco, CA
Snake River Alliance, Boise, ID
David Albright, Federation of American Scientists, Washington, DC
Michael J. Blain, Snake River Alliance, Boise, ID
Chuck Broscious, Palouse-Clearwater Hanford Watch, Troy, ID
David B. Butler, International Brotherhood of Electrical Workers, Boise, ID
Mary Butters, Palouse-Clearwater Hanford Watch, Moscow, ID
Thomas Cochran, Natural Resources Defense Council, Washington, DC
Tim Connor, Hanford Education Action League, Spokane, WA
Kerry Cooke, Snake River Alliance, Boise, ID
Maggie Coon, Idaho Conservation League, Boise, ID
Gail A. Cordes, American Nuclear Society, Local Chapter, Idaho Falls, ID
Ronald L. Edgley, UA of Journeymen and Apprentices, Pocatello, ID
Mr. & Mrs. Esteban, Nuclear Energy Commission of Spain, Idaho Falls, ID
Garth Gates, Idaho Chapter National Electrical Contractors Association, Boise, ID
Don Hancock, Southwest Research and Information Center, Albuquerque, NM
Jane Hanson, ERT, Fort Collins, CO
M. R. Hardee, Energy Research Foundation, Columbia, SC
Anne Stites Hausrath, Boise Peace Quilt Project, Boise, ID
Jude Hawkes, Global Environmental Project Institute, Ketchum, ID
Milton Hoenig, Nuclear Control Institute
Betty Lu Holland, League of Women Voters, Idaho Falls, ID
Art Honan, Area Research, New York, NY
Ervin L. Huston, Magic Valley Fellowship Reconciliation Church, Twin Falls, ID
Melinda Kassen, Environmental Defense Fund, Boulder, CO
Fuji C. Kreider, Snake River Alliance, Boise, ID
Carol Kriz, League of Conservative Voters, Boise, ID
Paul L. Leventhal, Nuclear Control Institute, Washington, DC
Brent Marchbanks, Snake River Alliance, Boise, ID
Harry Massoth, Magic Valley Peace Committee, Buhl, ID
Gwynne McElhinney, Boise Peace Quilt Project, Boise, ID
Billy McMurtrey, Veterans of Foreign Wars, Idaho Falls, ID
Mike Medberry, Idaho Conservation League, Boise, ID
Gart Milhollin, Natural Resources Defense Council, Washington, DC
Philip Miller, Snake River Alliance, Boise, ID
David Newman, Spokane Spokesan-Review, Coeur d'Alene, ID
Liz Paul, Groundwater Alliance, Ketchum, ID
Birney L. Phillips, Veterans of Foreign Wars, Arco, ID
Glenn A. Phillips, Veterans of Foreign Wars, Arco, ID
Benjamin Rasmussen, Veterans of Foreign Wars, Boise, ID
Dan W. Reicher, Natural Resources Defense Council, Washington, DC
Lisa Shultz, Coalition for Safe Transportation, Johnstown, CO
Liza Shultz, Snake River Alliance and Nuclear Safety, Johnstown, CO
John Souba, Mountain Bell, Idaho Falls, ID

INTERESTED ORGANIZATIONS (continued)

John Stinson-Wilge, Groundwater Alliance, Ketchum, ID
Ed Stockly, Idaho Natural Resources Legal Foundation, Boise, ID
Bill Sulzman, American Friends Services Committee, Denver, CO
The Nature Conservancy, Arlington, VA
Cindy Thiede, Globescope Idaho, Ketchum, ID
Gordon Thompson, Institute of Resources Studies, Cambridge, MA
Claire L. Turner, Ecumenical Association of Churches, Boise, ID
Jon F. Walters, International Brotherhood of Electrical Workers, Idaho Falls, ID
Eugene B. Wright, International Brotherhood of Electrical Workers, Boise, ID
Frank Zollo, Knolls Action Project, Albany, NY

LOCAL COMPANIES

A-Core of Idaho, Inc., Idaho Falls, ID
Acoustic Specialties, Inc., Pocatello, ID
All American Contractors, Blackfoot, ID
Allied Steel Erectors, Pocatello, ID
Amcor, Inc., Idaho Falls, ID
American Fence Co., Pocatello, ID
Andrew Well Drilling, Idaho Falls, ID
Arrington Construction, Idaho Falls, ID
Arrowhead Construction, Idaho Falls, ID
Arrowhead Sand, Inc., Roberts, ID
Asbestos Abatement, Inc., Boise, ID
Atlas Mechanical, Inc., Idaho Falls, ID
BECO, Inc., Idaho Falls, ID
Bannock Paving, Pocatello, ID
Bartausky Steel Builders, Inc., Blackfoot, ID
Bateman Hall, Inc., Idaho Falls, ID
Beneco Enterprises, West Valley City, UT
Biggers Construction Co., Idaho Falls, ID
Builders, Inc., Idaho Falls, ID
Burtch Construction, Dixon, MT
C & H Construction Company, Idaho Falls, ID
Campbell Roofing Co., Caldwell, ID
Deck, Inc., Pocatello, ID
Denning Well Drilling, Ucon, ID
Diversified Metal Products, Idaho Falls, ID
Dynamics, Inc., Idaho Falls, ID
E & E Painting, Idaho Falls, ID
Eagle Rock Mechanical, Inc., Idaho Falls, ID
Electri/Con, Inc., Idaho Falls, ID
Electric Construction and Sales, Inc., Pocatello, ID
Fairway, Inc., Idaho Falls, ID
Fernridge Painting, Shelley, ID
Freitas-Lancaster, Inc., Idaho Falls, ID
G & R Electric, Inc., Idaho Falls, ID
Gardner Builders & Home Improvements, Idaho Falls, ID
Gem State Fire Protection Company, Idaho Falls, ID

LOCAL COMPANIES (continued)

H-K Contractors, Idaho Falls, ID
Haddons Fencing Co., Blackfoot, ID
Hawley Brothers Drilling, Inc., Blackfoot, ID
Horner Construction & Electric, Pocatello, ID
Hughes Roofing Co., Idaho Falls, ID
Hunter-Saucerman Construction Co., Idaho Falls, ID
Idaho Iron, Inc., Pocatello, ID
Idaho Painting & Decorating, Idaho Falls, ID
Industrial Contractors, Inc., Idaho Falls, ID
JACO Steel, Inc., Idaho Falls, ID
Koefoed Painting Co., Idaho Falls, ID
Loveland Construction Co., Idaho Falls, ID
McCabe Brothers Drilling, Inc., Idaho Falls, ID
Modern Roofing & Insulation, Pocatello, ID
Monroc, Idaho Falls, ID
Morrison Mechanical Contractor, Idaho Falls, ID
NBS and B&C Construction, Chubbuck, ID
Ormond Construction, Idaho Falls, ID
Ovard Construction, Inc., Idaho Falls, ID
Pocatello Roofing Co., Pocatello, ID
Reader Painting & Decorating, Blackfoot, ID
Ruskal Construction, Idaho Falls, ID
Snake River Electric, Blackfoot, ID
Sugoi Construction, Rexburg, ID
T. J. Electric, Idaho Falls, ID
Taylor Construction, Blackfoot, ID
Taysom Construction Co., Pocatello, ID
Three-D Fire Protection, Inc., Idaho Falls, ID
Warbonnet Electric, Inc., Fort Hall, ID
Wasatch Electric Co., Salt Lake City, UT
Waters Asbestos & Supply Co., Idaho Falls, ID
Wheeler Electric, Inc., Idaho Falls, ID
Yardley Drilling Co., Spokane, WA

INTERESTED INDIVIDUALS

Patricia Admire
Ed Adolfson
Jerry Ahlberg
Margaret Aho
William A. Akersten, Ph.D.
Daniel L. Alban
Susan Alban
Kristine Albrecht
Donald E. Allen
Duane Allen
Margaret W. Allen
Lane Allgood
Susan K. Alvarez
Randall A. Ambuehl
Karen Amkersmit
Mimi Amrit
Bill Anderson
Candice Anderson
Cathy Anderson
Cinda Anderson
Jack P. Anderson
Jay Anderson
Philip A. Anderson
Randon Anderson
Reid Anderson
Roger G. Anderson
Peter Angstadt
George Anthony
Eric Antonissen
Charles A. Aquilina
Michael H. Armstrong
Larry Asay
Paul Aschenbrenner
Virginia Ash
Ken Ashcom
Dennis Aslett
Larry Aslett
Marvin Aslett
Lindsay Audin
Bruce Augustus
Brandy Auld
Vern Autry
Vickey Babayco
Carol Bachelder
Stuart Backstatter
David L. Bagnard
Alicia Baker
Dick Baker
Kenneth and Heather Baker
Richard P. Baker and Russel L. Baker
Burton Baldwin
Lyn W. Ball
Sue Ball
Joyce E. Ballard
Lucy B. Ballesteros
Ron Balsley
Ed Bamberry
Patricia Barfield
Pamela Barnhill
Jack Barraclough
Sean Barringar
John Barringer
James L. Barta
Roy Bartholomew
Ralph Basinski
Dale Bates
Roberta Bates
Marilyn Bauman
Renee Beal
James Beard
S. J. Beard
Lawrence M. Beasley
Elaine Beebe
Alison Beechert
Terry L. Beemer
Carrie Beezley
Thomas R. Beezley
Leonard F. Beitz
Jock Bell
Zeb Bell
Janice Belson
Frederick F. Belzer
Lt. Col. George A. Bennett
Virginia Bennett
David K. Bennion
Lanie Benson
Charles S. Benson, Jr.
Linda Bergerson
Charles C. Bergman
Rick Bergner
Gene Bergstrom
Bret Berier
Danny Beritich
Howard Berkes
Katrina V. Berman
Janice Berndt
E. J. Bernthal
Randy Berriochoa
Larry N. Beu
Homer Biggers
Donna Bille
James Michael Bird
Scott Bishop
Kathy Bitton

INTERESTED INDIVIDUALS (continued)

Fritz Bjornsen
Lind Bjornsen
Viola Black
Maggie Blair
Florence Blanchard
Tom Blanchard
Nancy Fitz Bloom
Richard Bloom
Andrew Blunt
Robert Bodell
Donna H. Boe
Robert Boester
Paul M. Bohl
Peggy L. Bohl
Sister-Maris Bonnet
Raymond D. Boozel
Wendall R. Bosen
Stephanie Bourgette
Bruce Bowler
Ned W. Bowler
Peter A. Bowler, Ph.D.
J. Atkinson, D. Turman, L. Stanger, L. Bowman
Thomas Boyd
Jean Boyles
Katherine Bradley
Cliff Brady
Beatrice Brailsford
Mary Pat Branch
Tom Branch
Eric Brandt
John H. Brandt
Richard D. Bray
Dee Brazil
Robert P. Breckenridge
Michael S. Breed
Ginny Blakeslee Breen
Mike Breen
Ed Breiter
Tim Brewer
Del Brewster
Carlyle W. Briggs
Anne Bringloe
Marjorie F. Brissenden
James Brock
Jason Brockett
Susan Broderick
Marilyn Brookshier
George W. Brookshier, Jr.
Minette Broschofsky
John Broschosky
Chuck Broscious
Nancy Brossman
Jody Brostron
Arthur Brown
Carolyn Brown
Larry Brown
Linda S. Brown
Michael Brown
Regina Brown
Scott Brown
Elizabeth Browning
Cynthia Brownsmith
Dr. Cynthia Brownsmith
Mark Brownwell
Ingrid Brudenel
William Brudenell
George J. Bruha
Betsy Brunner
Katherine Kemble Brunton
Clifford Bryan
Harry Bryant
Jill Bryson
Gary L. Buchli
Lavonna Buchli
Shirley Buchli
Carl Budell
Verna Buehler
Lamar Bupp
Roger and Una Burgess
Mr. Robert V. Burgraf
Linda Burke
Reece W. Burke
Agnes Burkholder
Diane Burks
Fr. Sergius Burnes
Richard Burnette
Debra Burnham
Robert E. Burns
Steve Burns
Tony Burns
Douglas L. Burrows
Ralph C. Burton
Dick Burwell
Merlin D. Burwell
Robert Butikofer
Dave Butzier
Rita Bybee
John P. Byrom
John C. Caccia
Richard M. Cagen
Jim Cahoon
Larry Caldwell
Dr. Lloyd S. Call

INTERESTED INDIVIDUALS (continued)

Joyce L. Cameron
Bruce Campbell
Mary L. Campbell
Robert Campbell
Julia M. Cannon
Jacquie and Phillip Cano
Ric Cantrell
Dante Cantrill
Judie C. Cantrill
John Capek
Paula Caputo
Bette Carlson
Blair Carlson
Carl S. Carlson
L. Ray Carlson
Leta Carlson
Kathleen Carney
Phil Carney
Lynne Carpenter
Rocky Carpenter
Laura Carson
Bertha M. Cartee
L. T. Cartee
Jerry and Becky Nebelsick Carter
Linda Carter
Max Casbeau
Sally Casler
Phil Casper
Mark D. Casson
Janet R. Celick
Asa Chandler
Kelly Cheney
Rex Cherry
Nathan Chipman
William K. Chisholm
Alan L. Christensen
Ann L. Christensen
Cal Christensen
Fred A. and Dorothy Christensen
Pete Christenson
John E. Christofferson
Ted Chu
Mary Ann Chubb
Marge Chupa
Shelly Cimon
Peggy Ciucci
David E. Clapp
Arthur M. Clark
Beverly Clark
Donald R. Clark
James R. Clark
Patricia Clark
Robert B. Clark
Robert L. Clark
J. E. Clayton
Linda Clayville
Robert Clayville
Edith F. Cleaveland
Dr. Kevin Clifford
Richard S. Clover
Dale W. Clukey
Nancy Coates
Steve and Tamara Cobbley
Terry Cobbley
Daphne Coble
Thomas Cochran
Kent Coe
Arthur L. Cohen
Kimberly Coiner
Walt Coiner
Christine Cole
Tina Cole
Clark Collins
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Pam Conley
Ron C. Conlin
Brian Conner
Terry Connolly
Elizabeth Conrod
A. R. Conroy
William V. Cook
Nora Copeland
Gail A. Cordes
Patricia Corke
Cindy Cornell
Charles W. Cornell, Jr.
Warren Cornwall
Janet Cosho
Robert L. and Gay Cottrell
Carol Craighill
Evelyn Craven
Ian Crawford
Alex D. Creek, Sr.
Dale Cresap
Robert Crew
Nan Crocker
Gregory Crockett
J. B. Croft
Stuart Croghan
Dianne Crowe
Linda Crowley

INTERESTED INDIVIDUALS (continued)

Timothy Culhane
Diane Cunningham
Lynn Curry
April Hall Cutting
Craig Hall Cutting
John Dadaby
Don Daines
David and Mary J. Daley
William J. Dalton
Katherine Daly
Sheldon Dance
Mike Daugherty
Anita David
Ralph M. David
Joan F. Davies
Mrs. James M. Davies
Clarence O. and Grace R. Davis
Dr. Jackson Davis
Jeff Davis
Michele Davis
Bob Day
Nick Day
Brad DeBow
Darrell de Fabry
Cherri DeFigh-Price
Virginia DeFoggi
Valerie K. DeRisio
Susan Dejmal
Trine Dempey
Lisa Dennis
Tara Desmond
Suzanne de Turk
Herb Deuel
John H. Dial
Sherry Dillard
J. J. Dion
Mrs. Crystal Dollhausen
Sally Donart
Dennis Donnelly
Dennis O. Donnelly
David Douglas
Norma Douglas
Barry Dow
Leonard Dowd
Joan K. and Glen Ray Downing
Gene Drabinski
Stephen W. Drayton
Thomas C. Drougas
Lynn R. and Nola E. Drown
Teresa Drown
Mark Druss
James Dubrin
Bill Duffey
Dorian Duffin
Bill Duggan
Larry and Geraldine Duncan
Mary S. Dunham
Paul C. Dunlap
A. Dale Dunn
Tracy L. Dunn
Elaine Durbin
Leslie Durham
Mel Dyer
Kent Dyet
Fred W. Dykes
Susan Eastlake
Kathleen Eastman
Mardo Eaton, R.N.
Eloise Eccles
Debbie Edgers
Ronald Edgley
Charlene K. Edwards
Martin J. Edwards
T. J. Edwards
James A. Eggert
Kathleen A. Eggert
Ginney Elder
Jean Elle
John Elle
Art Elliott
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Lynn Ellis
Matthew Ellis
Megan Ellis
David Emberton
Glenn F. Embree
Dr. A. C. Emery
John Erben
Richard F. Erickson
Steve Erickson
Maria Eschen
Thomas B. Eschen
Mr. & Mrs. Esteban
Scott Evans
Athena Evans-Campbell
Dan Fadness
Doris Fairchild
David W. Falkingham
Suzanne Falkingham
Susan Rutt Fallowfield
Bob Fann
Frank and Sue Farnsworth
Greg Fasano
Joan Fauci

INTERESTED INDIVIDUALS (continued)

James Fease
Charles and Rosalie Ferguson
William A. Ferguson
Lynda Ferrin
Pat Feuerborn
Edson Fichter
Brad Fiero
Phillip Fineman
Dr. Charles M. Fisher
Clair Fitch
Nancy Fitzsimmons
Gary Fleischmann
Pamela Fleischmann
Mary Ann Flesher
Alicia Flinn
Katie Flood
Jeanne Flowers
Jeffrey K. Floyd
Billee Fontana
Jane Foraker-Thompson
Candy Forstmann
Shirley Fortner
Al Fothergill
Ron Fowler
Jim Foyer
Ernest France
Morris, Freeman, Webb, Sharp, Tarren
Frank Freitas
Lexie French
Gail Freund
Robbie A. Freund
Jane Fritz
Will Frymire
Rene Fuentes
L. Fuentes-Williams
T. Fuentes-Williams
Scott W. Fugit
Tom Gabrinetti
Lee Gagner
Norm Galey
Valerie Galindo
Amos Galpin
Carol J. Galpin
Kathyrn Ann Gardner
Stephen A. Gardner
Steven P. Garmon
Troy Garn
Chuck Garvin
Daniel Geery
Craig Gehrke
Pamela Gehrke
Jill Gentillon
Joann S. and Philip A. Gerhart
Christine A. Gertschen
R. J. Gertschen
Allen Getty
Diane P. Gibson
Glenda Gibson
John E. Gibson
Merlin Gifford
Holly Gilchrist
Bridget Gilmore
Walter E. Gilmore
Ellen Glaccum
Mr. & Mrs. Tom Glaccum
JoAnn Glasgow
Tim Gleason
Sandy Glover
Dale Goble
David Goepel
Glen Goldsmith
Mike Gordon
Carolyn Graham
Mary Grant
Ken Grayson
Steve Grayson
Judi Green
Ron C. Green
Sylvia Green
David J. and Jacqueline Griffith
Jack Griffith
John Griffith
George B. Grimes
Harry L. Guelzow
Peggy Guiles
Lorraine Gundersen
David J. Gutierrez
Wayne Haas
Phil Hackbarth
Verlow Haddon
Richard Hahn
Raymond Haight
Beth E. Halaas
Verle Hale
Blake Hall
Dale O. Hall
Dennis Hall
Gary R. Hall
Patricia Hall
R. James Hall
Rick Hall
Susan Hall
Curtis Hamilton
Linda Hammann

INTERESTED INDIVIDUALS (continued)

C. E. Hammond
Waynette Hammond
Wendy Hammond
Vance Hanawalt
David Hand
Carl Haney
Pat Hanggi
Dorothy Hansen
Eric Hansen
Mary Lou and Paul B. Hansen
Virgil D. Hansen
Virginia Hansom
Clayne A. Hanson
Gertie Hanson
Mark Hanson
John W. Harbison
Andrew Harding
Chris Harding
Patti Hardman
Barbara Harker and Dan Harker
Frank Harmon
John Harms
Mr. & Mrs. Grant Haroldsen
John J. Harper, P.E.
Marvin J. Harper, P.E.
James A. Harrington
J. W. Harris
Kenneth E. and Sarah J. Harris
Lex L. Harrison
John Harron
Jeff Harry
H. Ray Hart
Mary Ann Hart
Ralph Hartline
Leanne Hastings
Christine Hatab
Dawn Hatch
R. Terry Hatch
Larry Hauder
Milburn Hawker, Jr.
Judy Hawkes
Michael Hayden
Michael A. Hayes
Roger Hayes
Catherine Haynes
Karen and Tom Haynes
LaMar Hayward
Myna Hayward
Patricia R. Healey
Michael P. Healy
Judy Heath
Roy Heberger
Andy and Deborah Hedden-Nicely
Anne Hedge
David Hedge
Lois Hefferman
Vernon Heidenreich
June E. Heilman
David V. Heimbach
Thomas G. Heinrich, Jr.
Ruth Hemmingway
Dennis K. Hendrick
Sylvia Hendricks
Brad Hendrickson
Anita Henna
David Hensel
Milton M. Heonig
John W. and Geraldine A. Herbert
John Herrington
Ruth Herrington
Woody Hesselbarth
Dr. Barbara Hetrick
Dr. Michael Hetrick
Gail Heylmun
Robert A. Hibbs
Jan Higginbotham
Alex Higgins
Bert Higgins
Beth Hill
C. E. Hill
Delores G. Hill
Don J. Hill
Robin Hirsch
Bebe Hitz
Andrew R. Hixon
Melissa H. Hixon
A. B. Hoag
Cees H. Hoefnagels
Marielle Hoefnagels
Ann Hoene
Phil Hoene
Rodney Hoff
Mike Hoffman
Rita Sellers Hoffman
Jeff Hogan
Mary Jane Hogan
Roger Hogan
William E. Hogan
Andrew H. Holderreed
Betty Lou Holland
Don Hollister
Jane Holt
Mark Holt
William A. Hon

INTERESTED INDIVIDUALS (continued)

Carolyn Hondo
Rochelle J. Honkus
Timothy C. Hopkins
Kim Gardner Hoppie
W. B. and Holly Hopple
John Horan
Alice C. Hori
William T. Hornaday
Charles R. Horrocks
Bridgette Hoskins
George Hoskins
Norma Jean Housley
Irv Houston
R. P. Howard
Robin Howe
Dennis Howell
Roberta Howell
Gil Humberger
Kay Hummel
Doug Hunsaker
Ed Hunter
Joe W. Hunter
Steve & Corinn Hunter
Dennis Hurtt
Joan Huston
Mr. and Mrs. Huston
David Hutchinson
William Hyde
Dorothy J. Ikard
Ike Ikard
Bernita Ingle
Christine D. Isaacs, Ph.D.
Mr. Isham
Julie Isom
Don Ivory
Pamela Ivory
Andrea Jackson
Jay R. Jackson
Maureen Jackson
Merle D. Jackson
Tim Jackson
James F. Jangl
Sherm Janke
Mr. and Mrs. Jaramillo
Kim Jardine
Jeff Jarvis
Ferd G. Jaussi
Gerald Jayne
Paul Jenkins
Wendell Jenks
Chris Jensen
Dwight Jensen
J. Allen Jensen
Jeremial Jensen
Jon C. Jensen
Peter and Janice Jensen
Colvin Jergins
Lowell A. Jobe
Al B. Johnson
Joann Crane Johnson
Karen Johnson
Kolay Johnson
Melissa Johnson
Peter Johnson
Sheri Johnson
Jeff Johnston
Jim Johnstone
Bryce D. and L. S. Jolley
Clark Jones
Glenn Jones
Mary Jones
Mary and Steve Jones
Michael Jones
Ross Jones
Susan Badger Jones and Teresa Jones
Virgil Lee Jones
Jill Joseph
Melissa Josephy
Alvin W. Joslyn
Dana Juant
Paula Jull
Norma K. Justice
Richard E. Kameros
John Kamerrar
Richard T. Kanemasu
Diane Karban
T. X. Karner
Cris and Rebecca Kastores
Theresa M. Kaufmann
Ken Kavanagh
John P. Kearney
Margaret Keener
Dorothy J. Keeney
Rod Keglers
Dave Keller
Christine M. Kelly
Richard L. Kelly
Wallace G. Keltner
Dale V. Kemp
Don Kemper
Mr. & Mrs. Vernon Kendall
Laura Keresty
James E. Kerns
Doran and Chris Key

INTERESTED INDIVIDUALS (continued)

David Keyes
Linn Kincannon
Marden R. King
Kinney Family
Kent Kirby
Gail Kirgis
W. F. Kirk
Cathy Kirkham
Kathy Kirkham
Dorthy Kirkpatrick
John R. Kirkpatrick
Ellie Kiser
L. H. Kissler
Patrica Klahr
Beverly A. Klein
Noah W. Klein
Ronald D. and Nita B. Klingler
Jon Knapp
George Knaup
Philip R. Knight
Orville Knighton
R. B. Knighton
Lois Knowles
Edward Kobe
Michael Kobe
Faye L. Kochuff
Robert Koger
Mona Kohler
Ira Koplow
Roger A. Korus
Debi Kraal
Kevin Kraal
F & J Kreider
Fuji C. Kreider
Mr. and Mrs. Jim Kreider
Gretchen Kreiger
Korrine Kreilkamp
Roger Kreus
John Kriz
Mark Kruskopf
Faye Kuhn
Russell G. Kvanvig
Kevin Lafey
Ruth Lagerberg
Ginna Lagergren
Ken Lagergren
Carol Lamet
Mary Land
Janice L. Landon
Robert J. Lane
Stephen J. and Annette Langenstein
Sidney Langer
Helen Langworthy
Max Lapioli
Charles Larkey
Don B. Larsen
Harvey Eitson Larsen
Sandi Skott Larsen
John Laundre
Denise Laverty
Kent Laverty
Harry Lawroski
Kim H. and L. S. Leavitt
Randolph D. Lee
Jane Leeson
G. Leighton
Dr. Bruce Leim
Kermit Leir
Alan Leisk
Chris Lempke
Charles A. Lenkner
Evelyn K. Leonardson
Thane Lever
David Levinskas
Karen Oswalt and Barge Levy
Suzanne Lewis
Peter M. Lichtenstein, Ph.D.
Jack Liebenthal
William Lindsay
Paul Link
Peter A. Lipovac
Alan Lish
Dr. Bruce Lium
Stacy Pell Livermore
John Locke
Claire S. Lodahl
Andrea Loft
Carol Jean Logue
Brenda Larsen Londer
Darrell G. Long
David Lord
Ernest Lord
Arvin Lords
David Love
William B. Lowe
John M. Lowry
Marsha and Robert Lucchesi
Elise Lufkin
Robert M. Lugar
Marie Luke
Nathan Lundquist
Robert S. Luntey
Alaina Luras
Anthony D. Lutz

INTERESTED INDIVIDUALS (continued)

Donald MacMurran
Margaret Macdonald-Stewart
Cheryl Machacek
Naedene Machacek
Ted Machacek
Monica Mahr
Mary Beth Maj
Shannon Makinen
Bill and Rose Mallory
Al Mangan
Bruce S. Manheim
Glen Marshall
Quay Marshall
C. Brian Martin
Linda S. Martin
William K. Martin
Sylvia Martinez
Jonathan Marvel
Mr. and Mrs. Gabe Maskarinec
Nick Massoth
Mrs. Torhild Masterson
Matthew C. Mathias
Walt Mattell
Paul W. Matthews
Betty Matzek
Marquita M. Maytag
Judy McAllister
J. Karen McCall
Anita McCann
Michael McCann
Kent and Barbara McCarthy
George McCarty
Connie McClaran
Roger O. McClellan
Lyn McCollum
Larry M. McConnell
Bill McDonald
Janet McGary
Dr. K. C. McGee
Kathleen McGinley
Mary McGinnis
Al McGlinksky
Maggie McGovern
John and Jane McGrew
John W. McHugh
Mike McKenzie-Carter
Chris McKim
Elaine McLain
Fred McLain
Robert A. McLaughlin
Ed McLuskie
Bill McMahan
Jeff McMahan
Judd McMahan
Carol McMunigal
Mary McMurtrie
Debby McNamara
Anne E. McNevin
Tony E. McNevin
William C. McQuiston
Elizabeth Medes
Larry E. Meierotto
Jack K. Meikle
Richard R. Meis
J. Casey Meredith
Linda Merigliano
Gerry Merrell
Mickey Merrell
Sheryl L. Merrell
Jennifer Merriam
Constance Y. Merrill
Georgeann Merrill
Kenneth Merrill
Liz Merrill
Scott D. Merrill
Deanah Messenger
Walt Metel
Marie Meyer
Richard S. Meyer
Dana Mikesell
Bert Miller and Beverly Miller
Gary W. Miller
Jack Miller
M. Dell Miller
Roy Miller
David Mills
Thomas G. Minow
Judy Minshall
Wayne Minshell
Richard E. Mitchell
Ron Mitchell
Shirley V. Mix
R. D. Modrow
Ed Moffett
Jennifer Moffett
Damon Moglen
Carolyn Molen
Joan Moller
Frank C. Monasterio
Paul Montgomery
Wayne and Victoria Montgomery
Colleen Moore
Gilbert R. Moore
Harvey Moore

INTERESTED INDIVIDUALS (continued)

Patrick Moore
Mark Moorman
Patti and Jim Moran
Randall Morgan
Bill Morris
Wayne Morris
Bill Morrison
Michelle Morrison
Dean M. Mortimer
Bill Mosley
Peter Mowat
Lauri Mowbray
William Mowry
Burton Muller
Andy Munter
Suzanne Murphey
Kelly Murphy
Bryan K. Murray
Lorie Murray
Keshava S. Murthy
Edie Myers
Denise Myler
Charles E. Naftzger
Raylene A. Naftzger
Mont Nash
Gary R. Neal
Vaughn S. K. Nebeker
Rickie Neff
Steve Neff
DeWitt T. Neill, Ph.D., P.E.
Curtis Neilson
Martha Woodwell Neilson
Iral Nelson
Martin Nelson
Wanda Nelson
David E. and Donna L. Nestor
Robert and Emily Newcomer
Helen Newman
Gerald L. Newton
Rachel Newton
Clay Nichols
Dennis Nicholson
Garry M. Nielsen
Bob Nitschke
Peggy Nolan
Leonard Nolt
Kelly Norman
Randy Norman
Tim Norton
Vera Noyce
John Nycum
Kathy O'Brien
John C. O'Connor
K. J. O'Connor
Janet O'Crowley
Philip Oakes
Dina C. Odak
Eric Oden
Cheryl Olsen
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Morris Osborne
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Denise Palmer
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Gary Park
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Roger Parness
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R. John Taylor
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Kirk Thurman
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Vicki A. Watson
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Joe Wielang
Edith Wiethorn
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Tim C. Williams
Darcy Williamson
Albert E. Wilson
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R. Marlowe Wood
Cynthia Lou Woods
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Kathy Wren
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Richard Wright
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Larry Ybarrando
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Jim Yost
Lois Young
Stuart Yount
Bryan Zaccardi
Jean Zack
Neil R. Zack
Fitz Zillig
Kenneth Zimmerman
Lynn Zweifel

APPENDIX A

METHODS FOR CALCULATING RADIATION DOSES, HEALTH EFFECTS, AND IMPACTS OF TRANSPORTATION

This appendix discusses the methods for calculating both normal and accidental radiation doses and health effects and the methods for calculating the impacts of the transport of feed, product, and by-product materials presented in Chapter 4 of this Environmental Impact Statement (EIS).

A.1 NORMAL OPERATION

The normal operation of the Special Isotope Separation (SIS) Project would result in the release of small amounts of radioactive material to the environment. Essentially all this release would be to the atmosphere and would consist of particulate forms of plutonium and americium isotopes. This section describes the methods and assumptions used to calculate doses and resulting health effects to the maximally exposed individual and to the population within 80 kilometers (50 miles) of the release points assuming operation of the SIS Project at three different sites. These sites are (1) the Idaho Chemical Processing Plant (ICPP) area of the Idaho National Engineering Laboratory (INEL); (2) the 200-Area of the Hanford Site; and (3) the F-Area of the Savannah River Plant (SRP).

Conventionally, doses and health effects have been calculated to the population residing out to a distance of 80 kilometers (50 miles) from nuclear facilities. This has been done for the SIS Project. Atmospheric dispersion of radioactivity carried beyond 80 kilometers (50 miles) results in much smaller doses than those at close-in distances.

Radioactive materials released to the environment generally become involved in a complex series of physical, chemical, and biological processes. The principal pathways by which radioactivity released from the SIS Project could reach people are (1) exposure to nuclides in the air or on the ground; (2) inhalation of radioactivity; and (3) ingestion of radioactivity in food or liquids. Figure A-1 shows these pathways. Only atmospheric pathways are shown, since all liquid discharges from the SIS Project would be nonradioactive.

The calculations of radiological doses to members of the public from these various pathways are based on methods recommended or approved by the U.S. Department of Energy (DOE, 1985). Estimates of doses are based on detailed analyses of the sources and rates of radioactive releases and the pathways by which people can be exposed to dispersed radioactive materials. The DOE methods are adapted to specific site conditions.

Humans can receive doses externally from direct exposure to radioactive materials outside the body or internally from the intake of radioactive material by inhalation or ingestion. Radionuclides that enter the body are

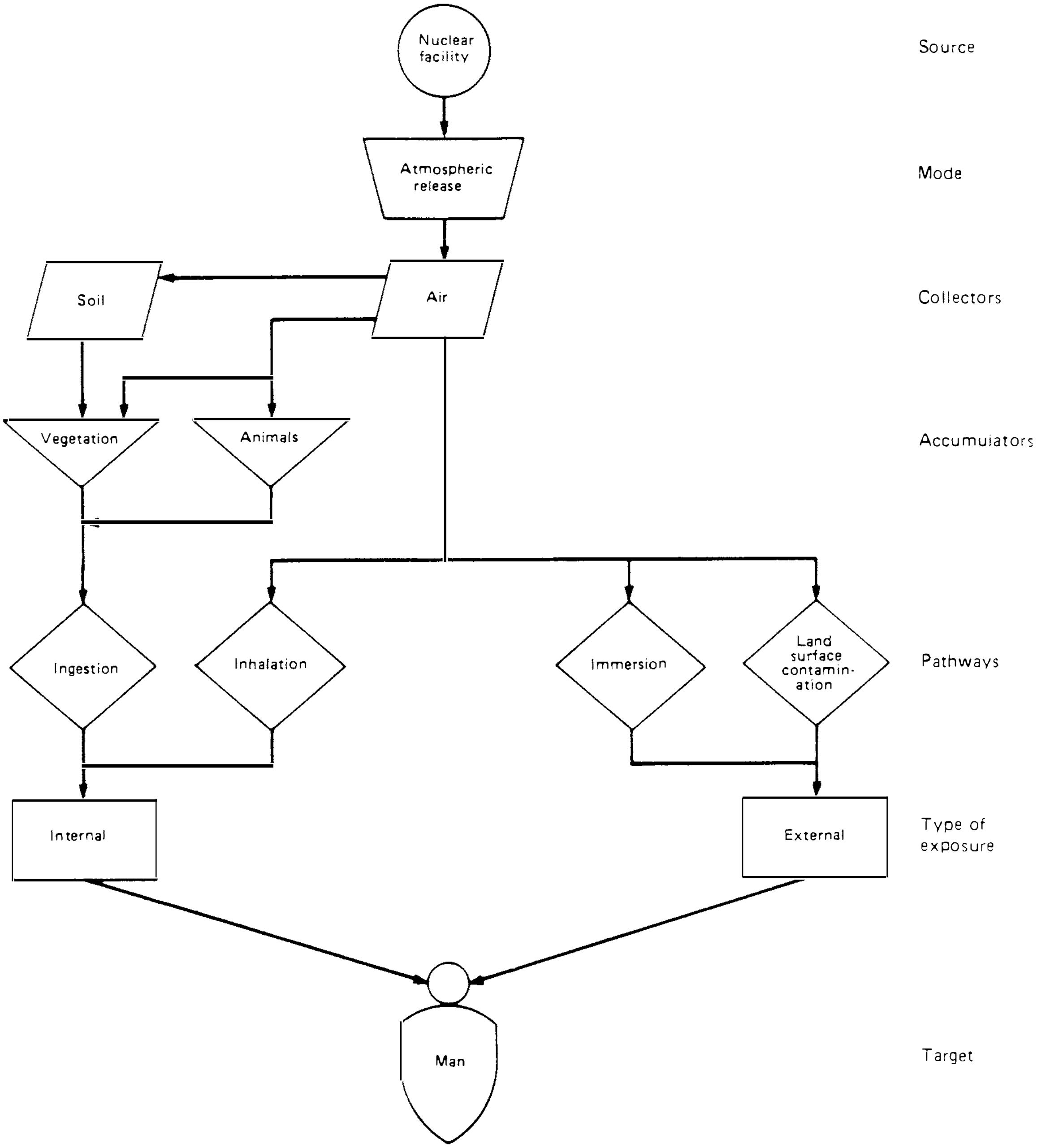

Figure A-1. Exposure Pathways Considered in Radiological Impact Assessments.

distributed to various organs and are removed by normal biological processes and radioactive decay. The rate at which each radionuclide is removed from the body depends on its chemical, physical, and radiological properties. Historically, dose calculations have included an accounting of doses resulting from the fraction of radionuclides that are retained and decay in the body for 50 years following the year of intake. This 50-year "integrating period" was used as the basis of the dose-commitment conversion factors used in these dose calculations. The total dose to an organ is the sum of the internal 50-year committed dose equivalent from 1 year of intake and the external dose equivalent received during an exposure period of 1 year.

Organs for which doses were calculated are the whole body, gonads, breast, red bone marrow, lungs, thyroid, bone surface, upper large intestine (ULI) wall, liver, and stomach wall. The internal dose conversion factors for all organs, except the whole body, were taken from International Commission on Radiological Protection (ICRP) Publication 30 (ICRP, 1979). Uptake fractions for ingestion presented in ICRP Publication 48 (ICRP, 1986) were used (i.e., the uptake fractions were substituted for the default uptake fraction values contained in the radiological dose model). The whole-body dose conversion factor was obtained from the RADRISK data base (Dunning, Leggett, and Yalcintas, 1980). External dose conversion factors were taken from Kocher (1981). Effective dose equivalents (EDEs) for both internal and external exposures were obtained by multiplying the individual organ dose conversion factors by the health-risk weighting factors presented in ICRP Publication 26 (ICRP, 1977) and summing the results.

A.1.1 Computer Code Application to the Calculation of Doses Resulting from Atmospheric Releases to the Environment

The computer code AIRDOS-EPA (Moore et al., 1979) was used to calculate the doses that would result from airborne releases of radioactivity during normal operation of the SIS Project. This code calculates pollutant concentrations at downwind locations using a modified Gaussian plume dispersion model to simulate the horizontal and vertical dispersion of radionuclides. AIRDOS-EPA is one of the codes approved by the U.S. Environmental Protection Agency (EPA) for demonstrating compliance with the National Emission Standards for Hazardous Air Pollutants (NESHAP), 40 CFR 61, Subpart H. To obtain the total dose to an organ, the quantity of each released radionuclide that contributes to radiation exposure is multiplied by the specific organ dose conversion factor, the dispersion factor, and the exposure or uptake rate. The total organ dose is then determined by summing the component doses received from each pathway and each radionuclide.

To evaluate collective (population) doses from airborne releases, AIRDOS-EPA calculates the annual average air concentration and ground deposition per unit release (χ/Q and D/Q) for each of 80 segments (16 wind-direction sectors at 5 distances) within an 80-kilometer (50-mile) radius of the release point. To determine the doses received by the maximally exposed individual, AIRDOS-EPA calculates χ/Qs and D/Qs for 16 locations (16 wind-direction sectors for the use-specific site-boundary distance). Site-specific meteorological data were used to generate frequency distributions of stability classes and direction for input to AIRDOS-EPA (Table A-1).

Table A-1. Wind Frequencies of Stability Classes and Direction for All Three Sites[a,b]

Direction[c]	Stability class A	B	C	D	E	F	G	Wind frequency
				INEL				
N	4.702E-02	1.311E-01	2.412E-01	5.730E-03	2.380E-01	3.370E-01	0.000E-01	5.936E-02
NNW	4.737E-02	1.147E-01	2.786E-01	2.927E-03	2.214E-01	3.350E-01	0.000E-01	3.759E-02
NW	5.678E-02	1.725E-01	2.663E-01	0.000E-01	7.614E-02	4.283E-01	0.000E-01	2.273E-02
WNW	4.204E-02	1.784E-01	2.240E-01	0.000E-01	9.850E-02	4.571E-01	0.000E-01	1.665E-02
W	5.639E-02	1.552E-01	2.307E-01	0.000E-01	5.432E-02	5.034E-01	0.000E-01	1.934E-02
WSW	3.216E-02	2.042E-01	2.374E-01	8.678E-03	1.136E-01	4.040E-01	0.000E-01	3.919E-02
SW	2.581E-02	1.801E-01	3.129E-01	5.091E-03	9.547E-02	3.806E-01	0.000E-01	1.120E-01
SSW	1.145E-02	1.169E-01	2.482E-01	1.556E-02	1.093E-01	4.985E-01	0.000E-01	1.022E-01
S	9.879E-03	9.399E-02	1.990E-01	1.115E-02	1.574E-01	5.286E-01	0.000E-01	7.088E-02
SSE	2.529E-02	8.449E-02	2.063E-01	0.000E-01	1.856E-01	4.983E-01	0.000E-01	3.244E-02
SE	4.971E-03	4.925E-02	2.187E-01	4.971E-03	1.577E-01	5.644E-01	0.000E-01	2.214E-02
ESE	1.411E-02	5.527E-02	2.046E-01	0.000E-01	1.105E-01	6.154E-01	0.000E-01	2.552E-02
E	1.730E-02	7.533E-02	2.057E-01	2.384E-02	1.967E-01	4.811E-01	0.000E-01	4.740E-02
ENE	2.262E-02	9.499E-02	2.188E-01	6.549E-02	2.741E-01	3.241E-01	0.000E-01	1.220E-01
NE	3.103E-02	1.449E-01	2.597E-01	3.508E-02	2.750E-01	2.543E-01	0.000E-01	1.825E-01
NNE	5.500E-02	1.556E-01	1.916E-01	1.943E-02	2.823E-01	2.961E-01	0.000E-01	8.802E-02
TOTAL	2.905E-02	1.293E-01	2.403E-01	2.109E-02	1.945E-01	3.858E-01	0.000E-01	
				Hanford Site				
N	2.371E-02	1.909E-01	1.809E-01	2.850E-01	1.200E-01	1.689E-01	3.055E-02	4.091E-02
NNW	3.268E-02	1.363E-01	1.748E-01	2.710E-01	1.865E-01	1.557E-01	4.316E-02	3.244E-02
NW	3.297E-02	1.676E-01	2.143E-01	1.810E-01	9.066E-02	2.231E-01	9.035E-02	3.276E-02
WNW	4.567E-02	2.044E-01	2.403E-01	1.656E-01	9.931E-02	1.881E-01	5.654E-02	2.759E-02
W	5.056E-02	2.488E-01	2.767E-01	1.629E-01	8.544E-02	1.390E-01	3.652E-02	4.272E-02
WSW	4.565E-02	2.087E-01	2.837E-01	2.272E-01	4.964E-02	1.286E-01	5.652E-02	2.760E-02
SW	3.477E-02	2.781E-01	2.548E-01	2.581E-01	6.002E-02	8.855E-02	2.558E-02	3.049E-02
SSW	8.683E-03	2.571E-01	3.308E-01	1.952E-01	4.790E-02	1.210E-01	3.922E-02	3.570E-02
S	2.435E-02	2.017E-01	2.859E-01	1.942E-01	8.557E-02	1.693E-01	3.903E-02	5.995E-02
SSE	1.416E-02	1.348E-01	2.241E-01	2.973E-01	1.547E-01	1.446E-01	3.042E-02	6.641E-02
SE	1.693E-03	4.111E-02	1.044E-01	6.089E-01	1.527E-01	7.076E-02	2.042E-02	1.832E-01
ESE	3.227E-03	4.002E-02	6.568E-02	5.048E-01	2.505E-01	1.169E-01	1.888E-02	1.239E-01
E	2.131E-03	5.920E-02	7.532E-02	3.532E-01	2.613E-01	2.143E-01	3.465E-02	1.079E-01
ENE	5.389E-03	5.941E-02	9.776E-02	5.265E-01	1.874E-01	1.040E-01	1.955E-02	7.980E-02
NE	1.691E-02	7.480E-02	1.198E-01	5.936E-01	8.373E-02	7.640E-02	3.477E-02	6.270E-02
NNE	1.440E-02	8.377E-02	1.219E-01	5.303E-01	8.224E-02	1.300E-01	3.730E-02	4.584E-02
TOTAL	1.465E-02	1.106E-01	1.543E-01	4.062E-01	1.518E-01	1.304E-01	3.210E-02	
				SRP				
N	1.610E-02	7.555E-02	1.265E-01	4.092E-01	8.189E-02	1.424E-01	1.484E-01	7.891E-02
NNW	7.598E-03	7.198E-02	8.878E-02	3.252E-01	1.106E-01	1.666E-01	2.291E-01	7.504E-02
NW	4.406E-03	6.820E-02	1.276E-01	3.889E-01	9.061E-02	1.247E-01	1.956E-01	5.221E-02
WNW	4.605E-03	9.870E-02	1.469E-01	3.285E-01	6.747E-02	1.510E-01	2.028E-01	4.996E-02
W	9.720E-03	1.016E-01	1.534E-01	3.937E-01	5.550E-02	1.272E-01	1.589E-01	7.100E-02
WSW	5.714E-03	9.634E-02	1.894E-01	4.329E-01	7.188E-02	9.644E-02	1.074E-01	9.977E-02
SW	1.002E-02	1.498E-01	1.697E-01	4.025E-01	5.869E-02	9.922E-02	1.101E-01	6.885E-02
SSW	1.485E-02	1.076E-01	1.373E-01	3.345E-01	5.393E-02	9.953E-02	2.522E-01	3.839E-02
S	1.326E-02	1.560E-01	1.718E-01	3.240E-01	3.978E-02	1.006E-01	1.946E-01	3.470E-02
SSE	3.278E-02	1.308E-01	1.699E-01	2.363E-01	4.276E-02	1.220E-01	2.654E-01	3.509E-02
SE	1.328E-02	1.149E-01	1.684E-01	2.385E-01	1.128E-01	1.307E-01	2.215E-01	5.197E-02
ESE	9.657E-03	1.219E-01	1.349E-01	3.635E-01	8.817E-02	1.276E-01	1.542E-01	7.146E-02
E	2.157E-02	1.047E-01	1.841E-01	3.972E-01	7.976E-02	8.888E-02	1.238E-01	6.909E-02
ENE	7.695E-03	1.265E-01	1.663E-01	3.471E-01	9.234E-02	1.122E-01	1.479E-01	5.979E-02
NE	1.644E-02	1.022E-01	1.383E-01	3.525E-01	1.236E-01	1.325E-01	1.344E-01	7.056E-02
NNE	1.093E-02	8.757E-02	1.549E-01	4.027E-01	1.137E-01	1.205E-01	1.097E-01	7.321E-02
TOTAL	1.172E-02	1.042E-01	1.515E-01	3.656E-01	8.321E-02	1.218E-01	1.620E-01	

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[a] Data derived from onsite meteorological data collected at the INEL (1983), Hanford Site (1982), and SRP (1978).

[b] Units expressed in this and other tables in this Appendix are expressed in scientific notation where, for example, 1.00E-04 is equal to 1×10^{-4}, or 0.0001.

[c] Data reflect winds that blow from the given directions.

These stability windrose statistics were derived by 1-hour averaging of data collected at the site meteorological towers over a 1-year period. To conservatively calculate radiation doses, flat terrain was assumed and no credit was taken for plume rise induced by momentum or thermal effects. Additionally, several trial AIRDOS-EPA runs were performed to determine the effect of meteorological conditions at different elevations on radiation doses. In all cases, lower elevation meteorological data resulted in higher doses. To provide additional conservatism in the calculation of radiation doses, all radiological releases from the Plutonium Processing Building (PPB) stack were assumed to occur at an elevation lower than that of PPB stack height.

Dose conversion factors as previously discussed and as presented in Table A-2 were input to the AIRDOS-EPA code. Population, milk animal and beef animal distribution data, and vegetable-area distribution data (Figures A-2 through A-4 and Tables A-3 through A-5) for the 16 wind-direction sectors were also used as input to AIRDOS-EPA for calculating the collective dose to the population. Population data for the year 2010 were used in this analysis since this is the assumed midlife of the SIS Project. The year-2010 populations within 80 kilometers (50 miles) of each of the alternative locations were calculated (1) on the basis of the 1970-to-1980 population increases as reported by the U.S. Bureau of the Census and extrapolating these decennial increases to the year 2010, and (2) on the basis of local estimates. Figures A-2 through A-4 and Tables A-3 and A-4 present the populations for the 16 wind-direction sectors for each site based on extrapolating 1970-to-1980 population increases to the year 2010. For local estimates of year-2010 populations in the 16 wind-direction sectors, the populations surrounding the INEL would be reduced by about 34 percent, for the Hanford Site the populations would be reduced by about 29 percent, and for the SRP the populations would be reduced by about 30 percent.

Source terms that are input to the AIRDOS-EPA code and used in the calculation of doses to the maximally exposed individual and the population are given in Chapter 4.

To calculate collective doses to the population, AIRDOS-EPA uses compass-sector average values of χ/Q and D/Q. All atmospheric releases are assumed to occur at the location of the SIS Project on the site; the population and agricultural production distributions were centered at these same points for the INEL and the Hanford Site. For the SRP, the population and agricultural production distributions were evaluated using the center of the plant because of the readily available data base. The collective dose received by the exposed offsite population was calculated by summing the individual dose commitments in the population. Parameters used in calculating the collective dose to the 80-kilometer-radius population are included in Tables A-6 through A-8.

To calculate doses received by the maximally exposed individual, AIRDOS-EPA uses plume centerline values of χ/Q and D/Q. This individual is assumed to reside continuously at the location on the site boundary that gives the highest dose. Parameters used in calculating doses to maximally exposed individuals are included in Tables A-6 through A-9.

Table A-2. Dose Conversion Factors

Organ	Inhalation (rem/μCi)	Ingestion (rem/μCi)	Submersion in air (rem-cm^3/μCi-hr)	Surface exposure (rem-cm^2/μCi-hr)
		PLUTONIUM-238		
Whole body	5.97E+01	9.33E-02	4.51E-02	1.06E-04
Gonads	0.00E+00	8.50E-02	4.82E-02	1.13E-04
Breast	0.00E+00	0.00E+00	2.06E-01	4.83E-04
Red marrow	2.40E+02	5.60E-01	5.94E-03	1.39E-05
Lungs	1.20E+03	0.00E+00	1.33E-02	3.11E-05
Thyroid	0.00E+00	0.00E+00	1.96E-02	4.59E-05
Bone surface	3.10E+03	6.70E-01	2.38E-02	5.57E-05
ULI wall	0.00E+00	0.00E+00	6.99E-03	1.64E-05
Liver	6.70E+02	1.50E+00	8.03E-03	1.88E-05
Stomach wall	0.00E+00	0.00E+00	9.08E-03	2.13E-05
EDE	3.06E+02	3.79E-01	5.03E-02	1.18E-04
		PLUTONIUM-239		
Whole body	6.51E+01	1.04E+00	4.17E-02	8.01E-05
Gonads	0.00E+00	9.60E-01	4.95E-02	9.52E-05
Breast	0.00E+00	0.00E+00	1.14E-01	2.19E-04
Red marrow	2.80E+02	5.90E-01	2.22E-02	4.28E-05
Lungs	1.20E+03	0.00E+00	2.76E-02	5.30E-05
Thyroid	0.00E+00	0.00E+00	3.87E-02	7.44E-05
Bone surface	3.50E+03	7.80E+00	4.56E-02	8.78E-05
ULI wall	0.00E+00	0.00E+00	2.46E-02	4.73E-05
Liver	7.80E+02	1.60E+00	2.34E-02	4.50E-05
Stomach wall	0.00E+00	0.00E+00	2.36E-02	4.53E-05
EDE	3.31E+02	4.25E-01	4.68E-02	9.00E-05
		PLUTONIUM-240		
Whole body	6.51E+01	1.04E-01	4.42E-02	1.03E-04
Gonads	0.00E+00	9.60E-02	4.78E-02	1.12E-04
Breast	0.00E+00	0.00E+00	1.99E-01	4.65E-04
Red marrow	2.80E+02	5.90E-01	6.36E-03	1.48E-05
Lungs	1.20E+03	0.00E+00	1.37E-02	3.20E-05
Thyroid	0.00E+00	0.00E+00	2.04E-02	4.77E-05
Bone surface	3.50E+03	7.80E+00	2.44E-02	5.70E-05
ULI wall	0.00E+00	0.00E+00	7.69E-03	1.80E-05
Liver	7.80E+02	1.60E+00	8.70E-03	2.03E-05
Stomach wall	0.00E+00	0.00E+00	9.37E-03	2.19E-05
EDE	3.31E+02	4.25E-01	4.92E-02	1.15E-04

Table A-2. Dose Conversion Factors (continued)

Organ	Inhalation (rem/μCi)	Ingestion (rem/μCi)	Submersion in air (rem-cm^3/μCi-hr)	Surface exposure (rem-cm^2/μCi-hr)
PLUTONIUM-241				
Whole body	1.16E+00	2.09E-03	0.00E+00	0.00E+00
Gonads	1.00E+00	2.10E-03	0.00E+00	0.00E+00
Breast	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Red marrow	6.30E+00	1.30E-02	0.00E+00	0.00E+00
Lungs	1.20E+01	0.00E+00	0.00E+00	0.00E+00
Thyroid	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Bone surface	7.80E+01	1.60E-01	0.00E+00	0.00E+00
ULI wall	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Liver	1.60E+01	3.20E-02	0.00E+00	0.00E+00
Stomach wall	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EDE	5.75E+00	8.73E-03	0.00E+00	0.00E+00
PLUTONIUM-242				
Whole body	6.20E+01	9.91E-02	3.76E-02	8.72E-05
Gonads	0.00E+00	9.30E-02	4.07E-02	9.43E-05
Breast	0.00E+00	0.00E+00	1.66E-01	3.84E-04
Red marrow	2.70E+02	5.90E-01	5.58E-03	1.29E-05
Lungs	1.10E+03	0.00E+00	1.23E-02	2.84E-05
Thyroid	0.00E+00	0.00E+00	1.81E-02	4.20E-05
Bone surface	3.30E+03	7.40E+00	2.20E-02	5.10E-05
ULI wall	0.00E+00	0.00E+00	6.97E-03	1.62E-05
Liver	7.40E+02	1.60E+00	8.09E-03	1.87E-05
Stomach wall	0.00E+00	0.00E+00	8.36E-03	1.94E-05
EDE	3.13E+02	4.04E-01	4.18E-02	9.69E-05
AMERICIUM-241				
Whole body	1.30E+02	1.07E-01	9.61E+00	4.36E-03
Gonads	1.20E+02	5.20E-01	1.31E+01	5.96E-03
Breast	0.00E+00	0.00E+00	1.69E+01	7.67E-03
Red marrow	7.40E+02	3.10E+00	4.28E-02	1.94E-03
Lungs	0.00E+00	0.00E+00	7.92E+00	3.60E-03
Thyroid	0.00E+00	0.00E+00	1.24E+01	5.63E-03
Bone surface	9.30E+03	4.10E+01	1.45E+01	6.60E-03
ULI wall	0.00E+00	0.00E+00	6.52E+00	2.96E-03
Liver	2.00E+03	8.50E+00	7.11E+00	3.23E-03
Stomach wall	0.00E+00	0.00E+00	6.52E+00	2.96E-03
EDE	5.18E+02	2.20E+00	1.08E+01	4.92E-03

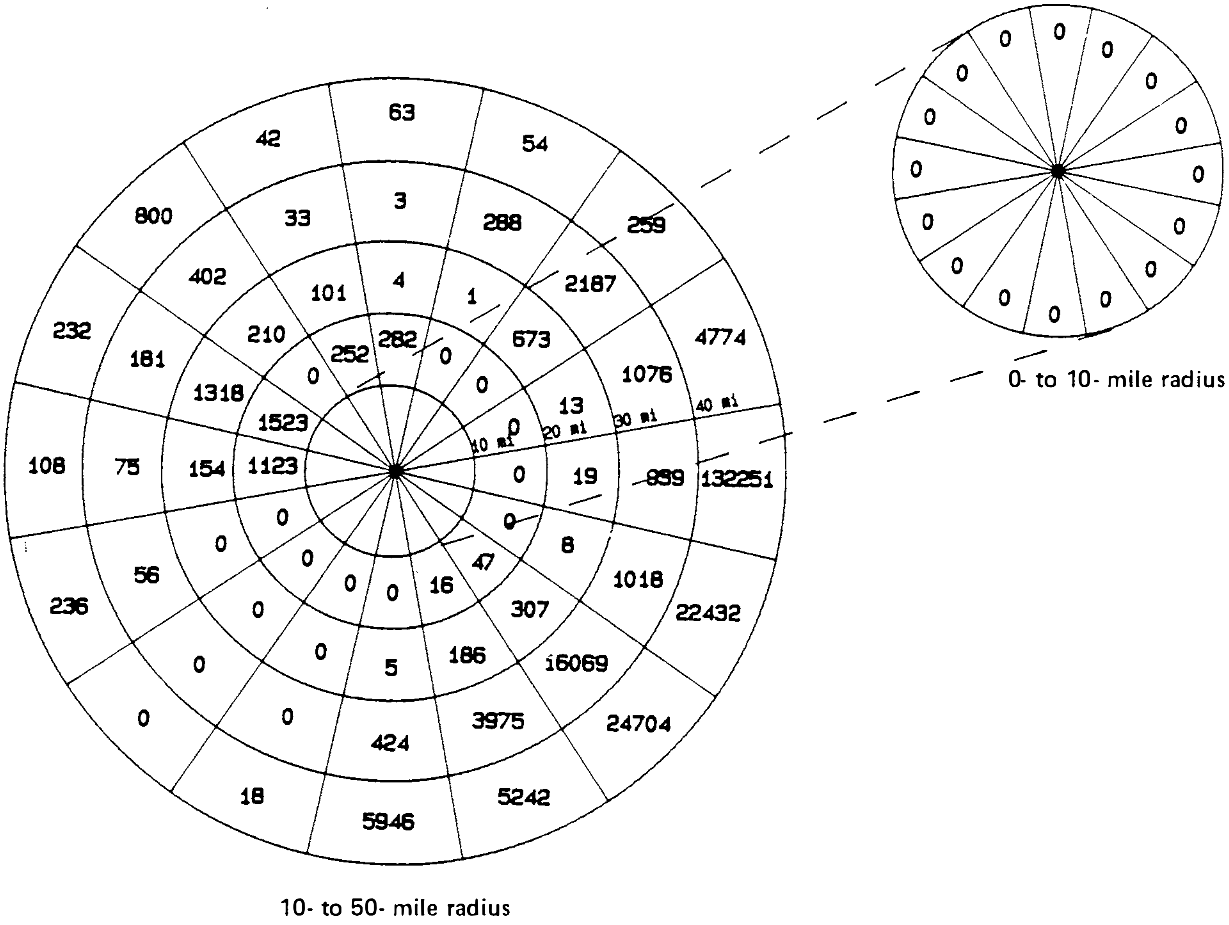

Figure A-2. Forecast Year-2010 Population Within 80 Kilometers (50 Miles) of the INEL Based on 1970 to 1980 Population Increases.

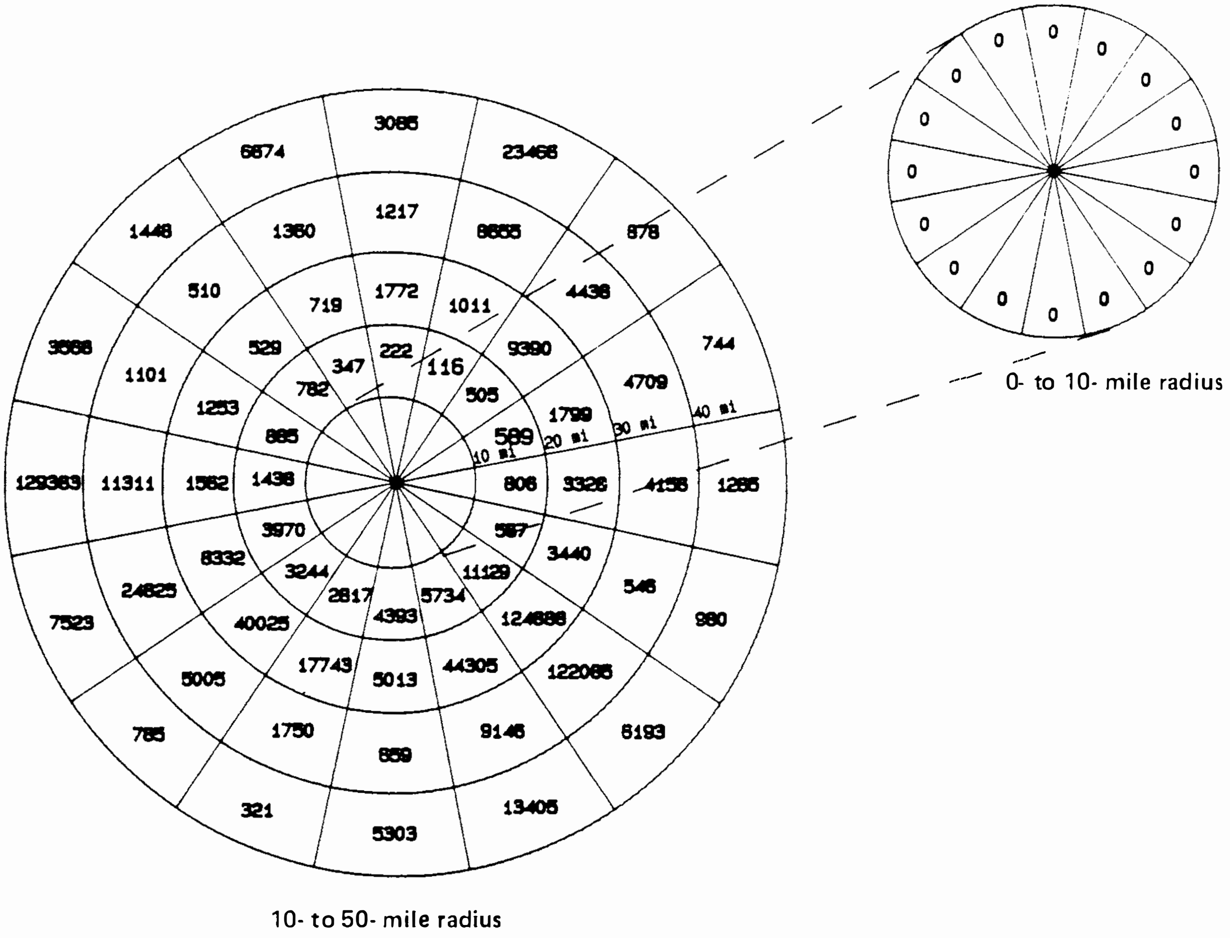

Figure A-3. Forecast Year-2010 Population Within 80 Kilometers (50 Miles) of the Hanford Site Based on 1970 to 1980 Population Increases.

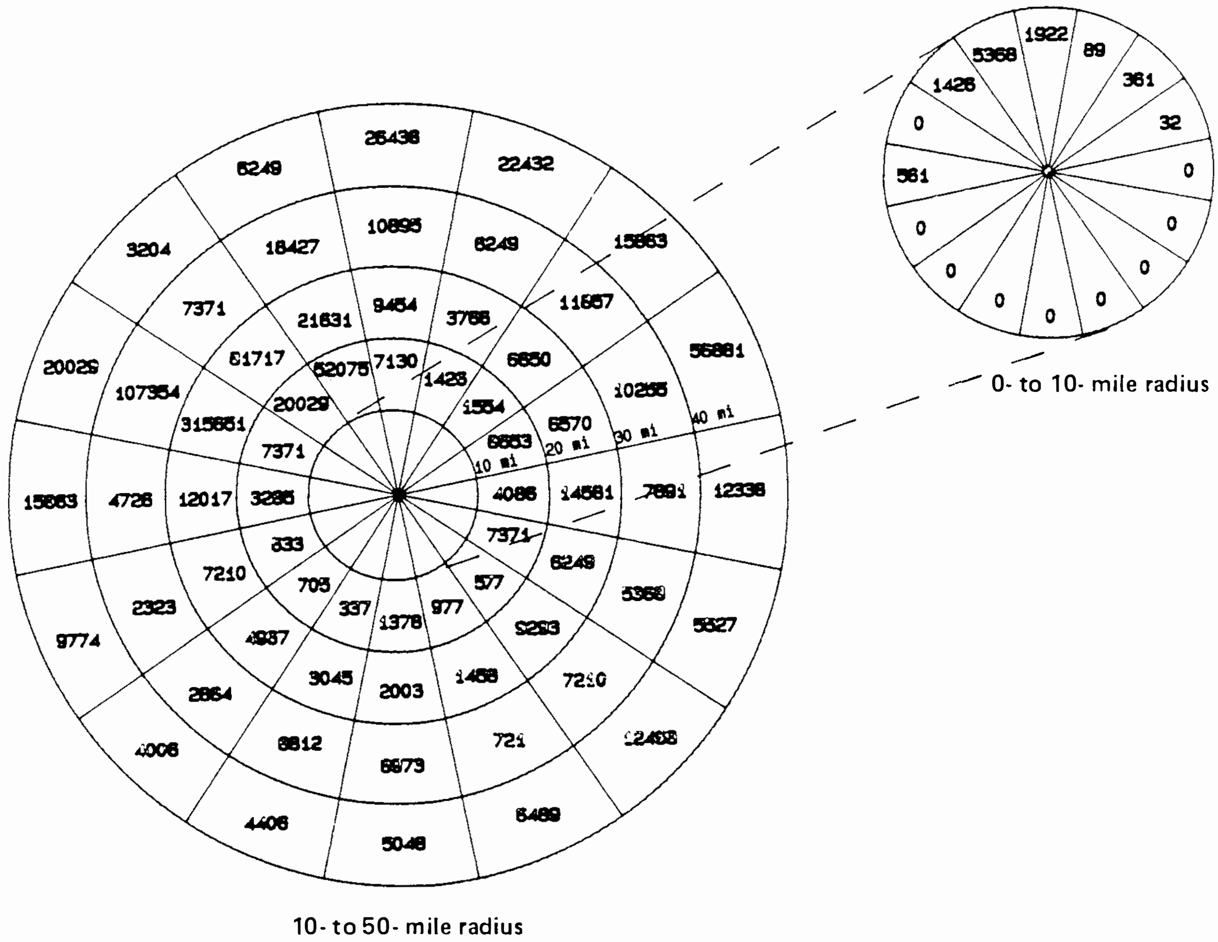

Figure A-4. Forecast Year-2010 Population Within 80 Kilometers (50 Miles) of the Savannah River Plant Based on 1970 to 1980 Population Increases.

Table A-3. Population and Agricultural Data Within 80 Kilometers (50 Miles) of the INEL Release Point

	Distance (km)						
Direction	0-8	8-16	16-32	32-48	48-64	64-80	0-80
				POPULATION (2010)			
N	0	0	282	4	3	63	352
NNW	0	0	252	101	33	42	428
NW	0	0	0	210	402	800	1,412
WNW	0	0	1,523	1,318	181	232	3,254
W	0	0	1,123	154	75	108	1,460
WSW	0	0	0	0	56	236	292
SW	0	0	0	0	0	0	0
SSW	0	0	0	0	0	18	18
S	0	0	0	5	424	5,946	6,375
SSE	0	0	16	186	3,975	5,242	9,419
SE	0	0	47	307	16,069	24,704	41,127
ESE	0	0	0	8	1,018	22,432	23,458
E	0	0	0	19	939	132,251	133,209
ENE	0	0	0	13	1,076	4,774	5,863
NE	0	0	0	673	2,187	259	3,119
NNE	0	0	0	1	288	54	343
Total	0	0	3,243	2,999	26,726	197,161	230,129
				NUMBER OF BEEF CATTLE			
N	0	0	593	1,062	1,361	1,057	4,073
NNW	0	0	659	1,098	1,537	1,681	4,975
NW	0	33	659	1,071	1,349	1,492	4,604
WNW	0	33	659	1,071	1,198	1,492	4,453
W	0	0	659	1,098	1,486	1,732	4,975
WSW	0	0	593	1,098	1,498	1,892	5,081
SW	0	0	593	1,084	2,448	7,543	11,668
SSW	0	16	659	1,056	1,815	3,108	6,654
S	0	33	1,279	3,155	4,278	4,659	13,404
SSE	0	16	2,209	3,682	5,154	1,335	12,396
SE	0	0	1,767	3,682	5,154	5,964	16,567
ESE	0	0	663	2,895	4,713	6,060	14,331
E	0	0	221	2,054	3,980	5,779	12,034
ENE	0	0	0	3,471	8,098	10,412	21,981
NE	0	0	0	2,314	8,098	6,909	17,321
NNE	0	0	0	0	3,201	1,654	4,855
Total	0	131	11,213	29,891	55,368	62,769	159,372

Table A-3. Population and Agricultural Data Within 80 Kilometers (50 Miles) of the INEL Release Point (continued)

	Distance (km)						
Direction	0-8	8-16	16-32	32-48	48-64	64-80	0-80
			NUMBER OF MILK COWS				
N	0	0	24	41	46	36	147
NNW	0	0	26	44	61	58	189
NW	0	1	26	40	36	14	117
WNW	0	1	26	40	16	14	97
W	0	0	26	44	63	78	211
WSW	0	0	24	44	81	121	270
SW	0	0	24	51	366	1,693	2,134
SSW	0	1	26	65	104	313	509
S	0	1	105	309	397	399	1,211
SSE	0	1	222	370	518	99	1,210
SE	0	0	178	370	518	599	1,665
ESE	0	0	67	252	452	581	1,352
E	0	0	22	144	290	440	896
ENE	0	0	0	302	704	905	1,911
NE	0	0	0	201	704	563	1,468
NNE	0	0	0	0	235	50	285
Total	0	5	796	2,317	4,591	5,963	13,672
			TOTAL CROP AREA (HECTARES)				
N	0	0	377	756	1,259	1,050	3,441
NNW	0	0	419	698	977	964	3,059
NW	0	21	419	645	610	312	2,007
WNW	0	21	419	645	316	312	1,713
W	0	0	419	698	854	688	2,659
WSW	0	0	377	698	828	938	2,841
SW	0	0	377	645	2,667	12,147	15,836
SSW	0	11	419	539	3,096	6,240	10,304
S	0	21	1,256	3,453	5,899	8,200	18,829
SSE	0	11	2,512	4,186	5,861	3,059	15,628
SE	0	0	2,009	4,186	5,861	6,804	18,860
ESE	0	0	754	4,373	5,965	7,670	18,761
E	0	0	251	3,628	6,329	8,102	18,311
ENE	0	0	0	2,620	6,113	7,859	16,591
NE	0	0	0	1,747	6,113	5,425	13,284
NNE	0	0	0	0	2,661	1,773	4,434
Total	0	84	10,008	29,517	55,409	71,543	166,561

Table A-4. Population and Agricultural Data Within 80 Kilometers (50 Miles) of the Hanford Site Release Point

	Distance (km)						
Direction	0-8	8-16	16-32	32-48	48-64	64-80	0-80
			POPULATION (2010)				
N	0	0	222	1,772	1,217	3,085	6,296
NNW	0	0	347	719	1,360	6,674	9,100
NW	0	0	782	529	510	1,448	3,269
WNW	0	0	885	1,253	1,101	3,568	6,807
W	0	0	1,438	1,562	11,311	129,383	143,694
WSW	0	0	3,970	8,332	24,825	7,523	44,650
SW	0	0	3,244	40,025	5,005	785	49,059
SSW	0	0	2,817	17,743	1,750	321	22,631
S	0	0	4,393	5,013	659	5,303	15,368
SSE	0	0	5,734	44,305	9,146	13,405	72,590
SE	0	0	11,129	124,888	122,085	6,193	264,295
ESE	0	0	567	3,440	546	980	5,533
E	0	0	806	3,328	4,156	1,265	9,555
ENE	0	0	589	1,799	4,709	744	7,841
NE	0	0	505	9,390	4,438	878	15,211
NNE	0	0	116	1,011	8,655	23,466	33,248
Total	0	0	37,544	265,109	201,473	205,021	709,147
			NUMBER OF BEEF CATTLE				
N	0	0	697	3,872	5,420	6,969	16,958
NNW	0	0	1,394	3,872	5,420	6,842	17,528
NW	0	0	1,394	3,765	4,482	6,332	15,973
WNW	0	0	1,205	3,555	4,926	6,333	16,019
W	0	0	1,438	3,520	4,928	6,336	16,222
WSW	0	0	1,164	3,520	4,928	6,336	15,948
SW	0	0	1,187	3,206	4,928	5,631	14,952
SSW	0	0	1,335	2,473	3,902	3,467	11,177
S	0	0	1,187	2,473	3,462	3,749	10,871
SSE	0	0	1,187	2,473	3,462	3,412	10,534
SE	0	0	1,356	8,544	5,729	5,054	20,683
ESE	0	0	3,622	10,062	13,188	7,701	34,573
E	0	0	5,434	10,062	14,087	13,485	43,068
ENE	0	0	6,037	9,408	9,508	8,693	33,646
NE	0	0	4,045	4,175	5,077	6,401	19,698
NNE	0	0	655	3,696	4,336	6,969	15,656
Total	0	0	33,337	78,676	97,783	103,710	313,506

Table A-4. Population and Agricultural Data Within 80 Kilometers (50 Miles) of the Hanford Site Release Point (continued)

	Distance (km)						
Direction	0-8	8-16	16-32	32-48	48-64	64-80	0-80
			NUMBER OF MILK COWS				
N	0	0	54	299	419	538	1,310
NNW	0	0	108	299	419	447	1,273
NW	0	0	108	223	94	84	509
WNW	0	0	93	333	294	261	981
W	0	0	123	373	523	672	1,691
WSW	0	0	86	373	523	672	1,654
SW	0	0	66	303	523	562	1,454
SSW	0	0	74	137	291	172	674
S	0	0	66	137	192	208	603
SSE	0	0	66	137	192	190	585
SE	0	0	33	192	180	180	585
ESE	0	0	74	205	274	214	767
E	0	0	111	205	287	300	903
ENE	0	0	123	202	262	317	904
NE	0	0	94	172	291	327	884
NNE	0	0	38	234	335	538	1,145
Total	0	0	1,317	3,824	5,099	5,682	15,922
			TOTAL CROP AREA (HECTARES)				
N	0	0	1,040	5,777	8,087	10,398	25,302
NNW	0	0	2,080	5,777	8,087	8,458	24,402
NW	0	0	2,080	4,160	1,244	699	8,183
WNW	0	0	1,805	1,741	1,256	1,249	6,051
W	0	0	1,699	1,406	1,969	2,531	7,605
WSW	0	0	1,870	1,406	1,969	2,531	7,777
SW	0	0	2,723	2,686	1,969	2,661	10,039
SSW	0	0	3,063	5,672	6,150	5,992	20,877
S	0	0	2,723	5,672	7,941	8,599	24,935
SSE	0	0	2,723	5,672	7,941	7,826	24,162
SE	0	0	1,321	7,673	10,281	14,970	34,246
ESE	0	0	2,943	8,174	11,904	20,047	43,067
E	0	0	4,414	8,174	11,443	17,084	41,114
ENE	0	0	4,904	8,405	13,064	18,047	44,420
NE	0	0	4,201	10,257	12,705	18,032	45,195
NNE	0	0	1,605	8,133	6,470	10,398	26,606
Total	0	0	41,193	90,785	112,480	149,523	393,981

Table A-5. Population and Agricultural Data Within 80 Kilometers (50 Miles) of the SRP

	Distance (km)						
Direction	0-8	8-16	16-32	32-48	48-64	64-80	0-80
			POPULATION (2010)				
N	0	1,922	7,130	9,454	10,895	26,438	55,839
NNW	0	5,368	52,075	21,631	18,427	6,249	103,750
NW	0	1,426	20,029	81,717	7,371	3,204	113,747
WNW	0	5,127	7,371	315,651	107,354	20,029	455,532
W	0	561	3,285	12,017	4,726	15,863	36,452
WSW	0	0	633	7,210	2,323	9,774	19,940
SW	0	0	705	4,967	2,884	4,006	12,562
SSW	0	0	337	3,045	8,812	4,406	16,600
S	0	0	1,378	2,003	8,973	5,048	17,402
SSE	0	0	977	1,458	721	6,489	9,645
SE	0	0	577	9,293	7,210	12,498	29,578
ESE	0	0	7,371	6,249	5,368	5,527	24,515
E	0	0	4,086	14,581	7,691	12,338	38,696
ENE	0	32	8,653	6,570	10,255	56,881	82,391
NE	0	361	1,554	6,650	11,857	15,863	36,285
NNE	0	89	1,426	3,766	6,249	22,432	33,962
Total	0	14,886	117,587	506,262	221,116	227,045	1,086,896
			NUMBER OF BEEF CATTLE				
N	0	367	2,308	3,846	6,211	13,877	26,609
NNW	0	401	2,308	3,612	3,145	6,388	15,854
NW	0	390	2,308	3,075	2,568	3,088	11,429
WNW	0	309	771	480	775	1,079	3,414
W	0	260	731	524	1,282	2,251	5,048
WSW	0	47	771	881	1,361	2,930	5,990
SW	0	10	586	885	2,537	3,335	7,353
SSW	0	0	692	1,731	4,978	6,960	14,361
S	0	0	771	2,018	3,225	4,493	10,507
SSE	0	0	1,035	1,916	2,727	4,352	10,030
SE	0	0	1,207	1,683	2,890	4,405	10,185
ESE	0	0	1,330	2,053	2,705	3,128	9,216
E	0	14	1,330	2,088	3,035	4,537	11,004
ENE	0	12	1,330	2,423	3,907	4,670	12,342
NE	0	104	2,075	3,436	7,533	13,260	26,408
NNE	0	292	2,308	3,846	10,088	17,885	34,419
Total	0	2,206	21,861	34,497	58,967	96,638	214,169

Table A-5. Population and Agricultural Data Within 80 Kilometers (50 Miles) of the SRP (continued)

	Distance (km)						
Direction	0-8	8-16	16-32	32-48	48-64	64-80	0-80
			NUMBER OF MILK COWS				
N	0	3	20	33	275	1,085	1,416
NNW	0	3	20	57	288	611	979
NW	0	3	20	83	226	152	484
WNW	0	3	35	67	119	167	391
W	0	2	35	74	197	345	653
WSW	0	0	69	130	204	467	870
SW	0	1	75	131	598	553	1,358
SSW	0	0	70	368	1,246	1,482	3,166
S	0	0	64	112	150	194	520
SSE	0	0	18	47	69	110	244
SE	0	0	24	9	35	78	146
ESE	0	0	35	181	553	284	1,053
E	0	0	35	339	808	1,122	2,304
ENE	0	0	35	374	939	1,063	2,411
NE	0	1	24	259	419	271	974
NNE	0	3	20	33	72	118	246
Total	0	19	599	2,297	6,198	8,102	17,215
			TOTAL CROP AREA (HECTARES)				
N	0	8	52	87	242	348	737
NNW	0	9	52	140	638	714	1,553
NW	0	9	52	178	470	254	963
WNW	0	7	22	19	5	152	205
W	0	6	21	35	132	310	504
WSW	0	1	81	147	208	270	707
SW	0	2	103	149	202	220	676
SSW	0	0	129	149	208	285	771
S	0	0	152	189	280	366	987
SSE	0	0	296	415	560	353	1,624
SE	0	0	305	556	526	323	1,710
ESE	0	0	287	427	385	108	1,207
E	0	3	287	337	304	339	1,270
ENE	0	3	287	323	247	311	1,171
NE	0	5	109	121	178	216	629
NNE	0	7	52	87	132	180	458
Total	0	60	2,287	3,359	4,717	4,749	15,172

Table A-6. Common Parameters Used To Calculate Doses Imparted to the Maximally Exposed Individual and Population from Routine SIS Releases at Alternative Sites

Parameter	Value[a]	Reference
	PHYSICAL STACK DATA	
Stack exhaust velocity (m/sec)	0.0[b]	
Stack diameter (m)	0.0[b]	
Stack height (m)	36.6	
	METEOROLOGICAL DATA	
Height of lid (m)	600	
Surface roughness length (m)	0.01	
Vertical temperature gradient for stabilities E, F, and G (K/m)	0.073 0.109 0.146	Moore et al. (1979)
	RADIONUCLIDE DATA	
Scavenging coefficient (1/sec)	0.0	
Activity median aerodynamic diameter of particulate radionuclide (μm)	1.0	
Dry deposition velocity (m/sec)	0.0018	
Gravitational velocity (m/sec)	0.0	
Interception fraction for pasture	0.32	
Interception fraction for crops	0.014	
Concentration factor for uptake of nuclide from soil for pasture and forage (pCi/kg wet weight per pCi/kg dry soil)	2.0×10^{-3}(Pu), 2.1×10^{-3}(Am)	Ng, Colsher, and Thompson (1982a)

Table A-6. Common Parameters Used To Calculate Doses Imparted to the Maximally Exposed Individual and Population from Routine SIS Releases at Alternative Sites (continued)

Parameter	Value[a]	Reference
Concentration factor for uptake of nuclide from soil by edible portions of crops (pCi/kg wet weight per pCi/kg dry soil)	2.2×10^{-4}(Pu), 4.0×10^{-4}(Am)	Ng, Colsher, and Thompson (1982a)
Fraction of animals' daily intake of nuclide which appears in each liter of milk (days/L)	1.0×10^{-7}(Pu), 4.1×10^{-7}(Am)	Ng (1982) Miller et al. (1980)
Fraction of animals' daily intake of nuclide which appears in each kilogram of flesh (days/kg)	2.0×10^{-6}(Pu), 1.6×10^{-5}(Am)	Ng, Colsher, and Thompson (1982b)
GI uptake fraction (inhalation)	1.0×10^{-5}(Pu), 5.0×10^{-4}(Am)	ICRP (1979)
GI uptake fraction (ingestion)	1.0×10^{-3}(Pu), 1.0×10^{-3}(Am)	ICRP (1986)
Solubility class	Y(Pu), W(Am)	ICRP (1979)
	INGESTION PATHWAY DATA	
Removal rate constant for physical loss by weathering (l/hr)	0.0021	NRC (1977a)
Period of pasture grass exposure during growing season (hr)	720	NRC (1977a)
Period of crop or leafy vegetable exposure during growing season (hr)	1440	NRC (1977a)
Period of long-term buildup of activity in soil (yr)	15	NRC (1977a)

Table A-6. Common Parameters Used To Calculate Doses Imparted to the Maximally Exposed Individual and Population from Routine SIS Releases at Alternative Sites (continued)

Parameter	Value[a]	Reference
Time delay--ingestion of pasture grass by animals (hr)	0	NRC (1977a)
Time delay--ingestion of stored feed by animals (hr)	2160	NRC (1977a)
Time delay--ingestion of leafy vegetables by Man (hr)	24 (Max. Ind.), 336 (Pop.)	NRC (1977a)
Time delay--ingestion of produce by Man (hr)	1440 (Max. Ind.), 336 (Pop.)	NRC (1977a)
Fraction of radioactivity retained on leafy vegetables and produce after washing	1.0	Moore et al. (1979)
Fraction of year animals graze on pasture	0.4	Shor and Fields (1979b)
Fraction of daily feed that is pasture grass when animals graze on pasture	0.43	Shor and Fields (1979b)
Fraction of produce ingested grown in garden of interest	1.0	DOE (1987)
Fraction of leafy vegetable grown in garden of interest	1.0	DOE (1987)
Consumption rate of contaminated feed or forage by an animal (kg/day)	15.6	Shor and Fields (1979a,b)
Transport time from animal feed-milk-Man (days)	2 (Max. Ind.), 4 (Pop.)	NRC (1977a)
Average time from slaughter of meat animal to consumption (days)	20	NRC (1977a)

Table A-6. Common Parameters Used To Calculate Doses Imparted to the Maximally Exposed Individual and Population from Routine SIS Releases at Alternative Sites (continued)

Parameter	Value[a]	Reference
Relative amount of ingested vegetables produced locally, regionally, and outside the assessment area, respectively[c]	0.7, 0, 0.3 (Max. Ind.) 0, 0.5, 0.5 (Pop.)	EPA (1984) DOE (1987)
Relative amount of ingested meat produced locally, regionally, and outside the assessment area, respectively[c]	0.442, 0, 0.558 (Max. Ind.) 0, 0.5, 0.5 (Pop.)	EPA (1984) DOE (1987)
Relative amount of ingested milk produced locally, regionally, and outside the assessment area, respectively[c]	0.399, 0, 0.601 (Max. Ind.) 0, 0.5, 0.5 (Pop.)	EPA (1984) DOE (1987)
	USAGE	
Breathing rate of Man (m^3/yr)	8035	EPA (1978)
Rate of ingestion of produce by Man (kg/yr)	520 (Max. Ind.), 176 (Pop.)	NRC (1977a), Rupp (1979)
Rate of ingestion of milk by Man (L/yr)	310 (Max. Ind.), 112 (Pop.)	NRC (1977a), Rupp (1979)
Rate of ingestion of meat by Man (kg/yr)	110 (Max. Ind.), 94 (Pop.)	NRC (1977a), Rupp (1979)
Rate of ingestion of vegetables by Man (kg/yr)	64 (Max. Ind.), 18 (Pop.)	NRC (1977a), Rupp (1979)

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[a] Pu = Plutonium, Am = Americium, Max. Ind. = Maximum Individual, Pop. = Population.

[b] To conservatively calculate radiation doses, no credit was taken for plume rise induced by momentum or thermal effects. Results of modeling using momentum-induced or buoyant plumes indicate that the calculated doses reported in Table A-10 are about 5 times higher than if a momentum-induced or buoyant plume were assumed.

[c] Locally means in immediate vicinity, regionally means within 80 kilometers (50 miles), and outside means outside the 80-kilometer area.

Table A-7. Unique Parameters Used To Calculate Doses Imparted to the Maximally Exposed Individual and Population Associated with Routine Releases from the SIS Facility at the INEL

Parameter	Value	Reference[a]
METEOROLOGICAL DATA		
Rainfall rate in area (cm/yr)	23.0	DOE (1984b)
Height of wind-speed measurement (m)	10[b]	
INGESTION PATHWAY DATA		
Agricultural productivity by unit area, grass-cow-milk-Man pathway (kg/m^2)	0.7	EG&G (1984)
Agricultural productivity by unit area, produce and leafy vegetable-Man pathway (kg/m^2)	0.910	Site-specific[c]
Muscle mass of meat-producing animal at the time of slaughter (kg)	227	Site-specific
Milk production of cow (L/day)	16.4	Site-specific
Fraction of meat-producing herd slaughtered per day	0.00153	Site-specific
Effective surface density of soil (assumes a 15-cm plow layer, expressed in dry weight) (kg/m^2)	225	Site-specific

[a] Parameter values given without references are based on site-specific data or staff judgments.

[b] Height of wind-speed measurement was selected to provide a conservative (i.e., overestimate of) radiological dose.

[c] Site-specific data were calculated from county agricultural reports.

Table A-8. Unique Parameters Used To Calculate Doses Imparted to the Maximally Exposed Individual and Population Associated with Routine Releases from the SIS Facility at the Hanford Site

Parameter	Value	Reference[a]
METEOROLOGICAL DATA		
Rainfall rate in area (cm/yr)	15.9	PNL (1987)
Height of wind-speed measurement (m)	15.24[b]	
INGESTION PATHWAY DATA		
Agricultural productivity by unit area, grass-cow-milk-Man pathway (kg/m^2)	0.7	Heath et al. (1973)
Agricultural productivity by unit area, produce and leafy vegetable-Man pathway (kg/m^2)	3.75	Site-specific[c]
Muscle mass of meat-producing animal at the time of slaughter (kg)	160	Site-specific
Milk production of cow (L/day)	19.9	Site-specific
Fraction of meat-producing herd slaughtered per day	0.00144	Site-specific
Effective surface density of soil (assumes a 15-cm plow layer, expressed in dry weight) (kg/m^2)	240	Fletcher and Dotson (1971)

[a] Parameter values given without references are based on site-specific data or staff judgments.

[b] Height of wind-speed measurement was selected to provide a conservative (i.e., overestimate of) radiological dose.

[c] Site-specific data were calculated from county agricultural reports.

Table A-9. Unique Parameters Used To Calculate Doses Imparted to the Maximally Exposed Individual and Population Associated with Routine Releases from the SIS Facility at the SRP Site

Parameter	Value	Reference[a]
METEOROLOGICAL DATA		
Rainfall rate in area (cm/yr)	121.3	DOE (1984a)
Height of wind-speed measurement (m)	61[b]	
INGESTION PATHWAY DATA		
Agricultural productivity by unit area, grass-cow-milk-Man pathway (kg/m^2)	0.501	Site-specific[c]
Agricultural productivity by unit area, produce and leafy vegetable-Man pathway (kg/m^2)	0.894	Site-specific
Muscle mass of meat-producing animal at the time of slaughter (kg)	227	Site-specific
Milk production of cow (L/day)	14.1	Site-specific
Fraction of meat-producing herd slaughtered per day	0.00381	Moore et al. (1979)
Effective surface density of soil (assumes a 15-cm plow layer, expressed in dry weight) (kg/m^2)	240	Fletcher and Dotson (1971)

[a] Parameter values given without references are based on site-specific data or staff judgments.

[b] Measurement height. For calculation of radiation doses, wind-speed data for a 10-meter (33-foot) height were calculated using the wind profile law. Use of the 10-meter height was selected to provide a conservative (i.e., overestimate of) radiological dose.

[c] Site-specific data were calculated from county agricultural reports.

The following exposure pathways were considered for the atmospheric dose assessment:

1. Plume--External dose from radioactive materials transported through the atmosphere
2. Ground--External dose from radioactive materials deposited on the ground
3. Inhalation--Internal dose from inhalation of radioactive materials transported through the atmosphere
4. Vegetation--Internal dose from consumption of crops that have been contaminated by radioactive deposits from the atmosphere
5. Milk--Internal dose from consumption of milk from cows that consume vegetation contaminated by radioactive deposits from the atmosphere
6. Meat--Internal dose from consumption of meat products from beef cattle that consume vegetation contaminated by radioactive deposits from the atmosphere.

The doses to the maximally exposed individual and collective doses to the population within 80 kilometers (50 miles) of the release points that would result from normal operation of the SIS facility are presented in Tables A-10 through A-15.

A.1.2 Radiation-Induced Health Effects

Radiation can affect human health by causing cancer, genetic disorders, and other health problems. The Committee on Biological Effects of Ionizing Radiation (BEIR) of the National Academy of Sciences has published a detailed review of available data on radiation-induced health effects (BEIR, 1980). This report (BEIR III) uses a variety of data and accepted methods to quantify the health impacts of low levels of radiation. Its estimates of health risk associated with radiation exposure have been used to quantify the possible changes in radiation-induced health effects that might be caused by operation of the SIS facility; these potential health effects are discussed in Chapter 4.

Although BEIR IV (BEIR, 1988) was issued some 8 years after BEIR III, its focus is on health effects from radon. Cancer risk estimates for transuranics are based on human exposure studies of alpha-emitting radionuclides other than transuranics and on the results of animal exposure studies. Epidemiological data were not available for transuranics and therefore were not included in BEIR IV. Because of the limitations on specific transuranic data, BEIR IV was not used to calculate health effects associated with SIS Project operations. All the health risk estimators given in BEIR IV for fatal lung, bone, and liver cancers, and for genetic effects are less than the risk estimators derived from the information presented in BEIR III. The calculated number of health effects using BEIR IV would therefore be less than those calculated using BEIR III.

Table A-10. Doses Imparted to the Maximally Exposed Individual from Annual Radioactive Releases from the SIS Project Located at the INEL

TOTAL DOSE TO EACH ORGAN THROUGH ALL PATHWAYS

Organ	Dose (rem)
Whole body	1.32E-11
Gonads	5.79E-12
Breast	2.70E-14
Red marrow	6.51E-11
Lungs	1.48E-10
Thyroid	1.79E-14
Bone surface	8.17E-10
ULI wall	9.40E-15
Liver	1.77E-10
Stomach wall	9.42E-15
EDE	6.23E-11

CONTRIBUTION OF EXPOSURE MODES TO WHOLE-BODY DOSES

Exposure mode	Annual dose (rem)	Percent of total dose
Submersion in air	3.60E-19	0.000
Direct surface exposure	1.43E-14	0.108
Inhalation	1.32E-11	99.574
Ingestion	4.21E-14	0.318
Vegetables	4.21E-14	0.318
Meat	3.60E-18	0.000
Milk	7.76E-19	0.000

Table A-10. Doses Imparted to the Maximally Exposed Individual from Annual Radioactive Releases from the SIS Project Located at the INEL (continued)

CONTRIBUTION OF EXPOSURE MODES TO BONE SURFACE DOSES

Exposure mode	Annual dose (rem)	Percent of total dose
Submersion in air	5.41E-19	0.000
Direct surface exposure	2.10E-14	0.003
Inhalation	8.11E-10	99.286
Ingestion	5.81E-12	0.712
Vegetables	5.81E-12	0.712
Meat	4.57E-16	0.000
Milk	1.80E-16	0.000

CONTRIBUTION OF EXPOSURE MODES TO EDE DOSES

Exposure mode	Annual dose (rem)	Percent of total dose
Submersion in air	4.06E-19	0.000
Direct surface exposure	1.61E-14	0.026
Inhalation	6.20E-11	99.469
Ingestion	3.15E-13	0.505
Vegetables	3.14E-13	0.505
Meat	2.48E-17	0.000
Milk	9.69E-18	0.000

Table A-11. Doses Imparted to the 80-Kilometer (50-Mile) Population from Annual Radioactive Releases from the SIS Project Located at the INEL

TOTAL DOSE TO EACH ORGAN THROUGH ALL PATHWAYS

	Year-2010 dose (person-rem)	
Organ	230,129 persons	151,922 persons
Whole body	2.26E-08	1.49E-08
Gonads	9.83E-09	6.49E-09
Breast	4.62E-11	3.05E-11
Red marrow	1.11E-07	7.33E-08
Lungs	2.53E-07	1.67E-07
Thyroid	3.05E-11	2.01E-11
Bone surface	1.39E-06	9.18E-07
ULI wall	1.61E-11	1.06E-11
Liver	3.01E-07	1.99E-07
Stomach wall	1.61E-11	1.06E-11
EDE	1.06E-07	7.00E-08

CONTRIBUTION OF EXPOSURE MODES TO WHOLE-BODY DOSES

	Year-2010 dose (person-rem)		
Exposure mode	230,129 persons	151,922 persons	Percent of total dose
Submersion in air	6.15E-16	4.06E-16	0.000
Direct surface exposure	2.45E-11	1.62E-11	0.108
Inhalation	2.25E-08	1.49E-08	99.730
Ingestion	3.64E-11	2.40E-11	0.161
Vegetables	3.64E-11	2.40E-11	0.161
Meat	1.33E-14	8.78E-15	0.000
Milk	1.35E-15	8.91E-16	0.000

Table A-11. Doses Imparted to the 80-Kilometer (50-Mile) Population from Annual Radioactive Releases from the SIS Project Located at the INEL (continued)

CONTRIBUTION OF EXPOSURE MODES TO BONE SURFACE DOSES

Exposure mode	Year-2010 dose (person-rem) 230,129 persons	Year-2010 dose (person-rem) 151,922 persons	Percent of total dose
Submersion in air	9.23E-16	6.09E-16	0.000
Direct surface exposure	3.58E-11	2.36E-11	0.003
Inhalation	1.38E-06	9.11E-07	99.636
Ingestion	5.02E-09	3.31E-09	0.361
Vegetables	5.02E-09	3.31E-09	0.361
Meat	1.69E-12	1.12E-12	0.000
Milk	3.12E-13	2.06E-13	0.000

CONTRIBUTION OF EXPOSURE MODES TO EDE DOSES

Exposure mode	Year-2010 dose (person-rem) 230,129 persons	Year-2010 dose (person-rem) 151,922 persons	Percent of total dose
Submersion in air	6.93E-16	4.57E-16	0.000
Direct surface exposure	2.75E-11	1.82E-11	0.026
Inhalation	1.06E-07	7.00E-08	99.718
Ingestion	2.72E-10	1.80E-10	0.256
Vegetables	2.72E-10	1.80E-10	0.256
Meat	9.15E-14	6.04E-14	0.000
Milk	1.68E-14	1.11E-14	0.000

Table A-12. Doses Imparted to the Maximally Exposed Individual from Annual Radioactive Releases from the SIS Project Located at the Hanford Site

TOTAL DOSE TO EACH ORGAN THROUGH ALL PATHWAYS

Organ	Dose (rem)
Whole body	7.31E-12
Gonads	3.18E-12
Breast	1.50E-14
Red marrow	3.59E-11
Lungs	8.20E-11
Thyroid	9.90E-15
Bone surface	4.50E-10
ULI wall	5.20E-15
Liver	9.74E-11
Stomach wall	5.21E-15
EDE	3.44E-11

CONTRIBUTION OF EXPOSURE MODES TO WHOLE-BODY DOSES

Exposure mode	Annual dose (rem)	Percent of total dose
Submersion in air	1.99E-19	0.000
Direct surface exposure	7.93E-15	0.108
Inhalation	7.30E-12	99.810
Ingestion	6.00E-15	0.082
Vegetables	5.99E-15	0.082
Meat	1.99E-18	0.000
Milk	4.30E-19	0.000

Table A-12. Doses Imparted to the Maximally Exposed Individual from Annual Radioactive Releases from the SIS Project Located at the Hanford Site (continued)

CONTRIBUTION OF EXPOSURE MODES TO BONE SURFACE DOSES

Exposure mode	Annual dose (rem)	Percent of total dose
Submersion in air	2.99E-19	0.000
Direct surface exposure	1.16E-14	0.003
Inhalation	4.49E-10	99.810
Ingestion	8.41E-13	0.187
Vegetables	8.41E-13	0.187
Meat	2.53E-16	0.000
Milk	9.96E-17	0.000

CONTRIBUTION OF EXPOSURE MODES TO EDE DOSES

Exposure mode	Annual dose (rem)	Percent of total dose
Submersion in air	2.25E-19	0.000
Direct surface exposure	8.93E-15	0.026
Inhalation	3.43E-11	99.842
Ingestion	4.55E-14	0.133
Vegetables	4.55E-14	0.132
Meat	1.37E-17	0.000
Milk	5.36E-18	0.000

Table A-13. Doses Imparted to the 80-Kilometer (50-Mile) Population from Annual Radioactive Releases from the SIS Project Located at the Hanford Site

TOTAL DOSE TO EACH ORGAN THROUGH ALL PATHWAYS

Organ	Year-2010 dose (person-rem) 709,147 persons	 500,000 persons
Whole body	1.38E-07	9.73E-08
Gonads	5.99E-08	4.22E-08
Breast	2.83E-10	2.00E-10
Red marrow	6.77E-07	4.77E-07
Lungs	1.55E-06	1.09E-06
Thyroid	1.87E-10	1.32E-10
Bone surface	8.49E-06	5.99E-06
ULI wall	9.84E-11	6.94E-11
Liver	1.84E-06	1.30E-06
Stomach wall	9.86E-11	6.95E-11
EDE	6.49E-07	4.58E-07

CONTRIBUTION OF EXPOSURE MODES TO WHOLE-BODY DOSES

Exposure mode	Year-2010 dose (person-rem) 709,147 persons	 500,000 persons	Percent of total dose
Submersion in air	3.77E-15	2.66E-15	0.000
Direct surface exposure	1.50E-10	1.06E-10	0.109
Inhalation	1.38E-07	9.73E-08	99.875
Ingestion	2.23E-11	1.57E-11	0.016
Vegetables	2.23E-11	1.57E-11	0.016
Meat	2.47E-14	1.74E-14	0.000
Milk	2.36E-15	1.66E-15	0.000

Table A-13. Doses Imparted to the 80-Kilometer (50-Mile) Population from Annual Radioactive Releases from the SIS Project Located at the Hanford Site (continued)

CONTRIBUTION OF EXPOSURE MODES TO BONE SURFACE DOSES

Exposure mode	Year-2010 dose (person-rem)		Percent of total dose
	709,147 persons	500,000 persons	
Submersion in air	5.66E-15	3.99E-15	0.000
Direct surface exposure	2.20E-10	1.55E-10	0.003
Inhalation	8.49E-06	5.99E-06	99.961
Ingestion	3.12E-09	2.20E-09	0.037
Vegetables	3.12E-09	2.20E-09	0.037
Meat	3.13E-12	2.21E-12	0.000
Milk	5.47E-13	3.86E-13	0.000

CONTRIBUTION OF EXPOSURE MODES TO EDE DOSES

Exposure mode	Year-2010 dose (person-rem)		Percent of total dose
	709,147 persons	500,000 persons	
Submersion in air	4.25E-15	3.00E-15	0.000
Direct surface exposure	1.69E-10	1.19E-10	0.026
Inhalation	6.49E-07	4.58E-07	99.948
Ingestion	1.69E-10	1.19E-10	0.026
Vegetables	1.69E-10	1.19E-10	0.026
Meat	1.70E-13	1.20E-13	0.000
Milk	2.94E-14	2.07E-14	0.000

Table A-14. Doses Imparted to the Maximally Exposed Individual from Annual Radioactive Releases from the SIS Project Located at the SRP

TOTAL DOSE TO EACH ORGAN THROUGH ALL PATHWAYS

Organ	Dose (rem)
Whole body	8.93E-12
Gonads	3.91E-12
Breast	1.83E-14
Red marrow	4.40E-11
Lungs	1.00E-10
Thyroid	1.21E-14
Bone surface	5.51E-10
ULI wall	6.35E-15
Liver	1.19E-10
Stomach wall	6.35E-15
EDE	4.21E-11

CONTRIBUTION OF EXPOSURE MODES TO WHOLE-BODY DOSES

Exposure mode	Annual dose (rem)	Percent of total dose
Submersion in air	2.43E-19	0.000
Direct surface exposure	9.66E-15	0.108
Inhalation	8.89E-12	99.569
Ingestion	2.89E-14	0.323
Vegetables	2.89E-14	0.323
Meat	3.39E-18	0.000
Milk	7.30E-19	0.000

Table A-14. Doses Imparted to the Maximally Exposed Individual from Annual Radioactive Releases from the SIS Project Located at the SRP (continued)

CONTRIBUTION OF EXPOSURE MODES TO BONE SURFACE DOSES

Exposure mode	Annual dose (rem)	Percent of total dose
Submersion in air	3.65E-19	0.000
Direct surface exposure	1.42E-14	0.003
Inhalation	5.47E-10	99.275
Ingestion	3.98E-12	0.723
Vegetables	3.98E-12	0.723
Meat	4.30E-16	0.000
Milk	1.69E-16	0.000

CONTRIBUTION OF EXPOSURE MODES TO EDE DOSES

Exposure mode	Annual dose (rem)	Percent of total dose
Submersion in air	2.74E-19	0.000
Direct surface exposure	1.09E-14	0.026
Inhalation	4.18E-11	99.461
Ingestion	2.16E-13	0.513
Vegetables	2.16E-13	0.513
Meat	2.33E-17	0.000
Milk	9.12E-18	0.000

Table A-15. Doses Imparted to the 80-Kilometer (50-Mile) Population from Annual Radioactive Releases from the SIS Project Located at the SRP

TOTAL DOSE TO EACH ORGAN THROUGH ALL PATHWAYS

Organ	Year-2010 dose (person-rem) 1,086,888 persons	 756,000 persons
Whole body	2.03E-07	1.41E-07
Gonads	8.79E-08	6.11E-08
Breast	4.15E-10	2.89E-10
Red marrow	9.93E-07	6.91E-07
Lungs	2.27E-06	1.58E-06
Thyroid	2.74E-10	1.91E-10
Bone surface	1.25E-05	8.69E-06
ULI wall	1.44E-10	1.00E-10
Liver	2.70E-06	1.88E-06
Stomach wall	1.44E-10	1.00E-10
EDE	9.52E-07	6.62E-07

CONTRIBUTION OF EXPOSURE MODES TO WHOLE-BODY DOSES

Exposure mode	Year-2010 dose (person-rem) 1,086,888 persons	 756,000 persons	Percent of total dose
Submersion in air	5.52E-15	3.84E-15	0.000
Direct surface exposure	2.20E-10	1.53E-10	0.108
Inhalation	2.02E-07	1.41E-07	99.830
Ingestion	1.26E-10	8.76E-11	0.062
Vegetables	1.26E-10	8.76E-11	0.062
Meat	6.03E-14	4.19E-14	0.000
Milk	4.50E-15	3.13E-15	0.000

Table A-15. Doses Imparted to the 80-Kilometer (50-Mile) Population from Annual Radioactive Releases from the SIS Project Located at the SRP (continued)

CONTRIBUTION OF EXPOSURE MODES TO BONE SURFACE DOSES

	Year-2010 dose (person-rem)		
Exposure mode	1,086,888 persons	756,000 persons	Percent of total dose
Submersion in air	8.29E-15	5.77E-15	0.000
Direct surface exposure	3.22E-10	2.24E-10	0.003
Inhalation	1.24E-05	8.62E-06	99.858
Ingestion	1.73E-08	1.20E-08	0.139
Vegetables	1.73E-08	1.20E-08	0.139
Meat	7.65E-12	5.32E-12	0.000
Milk	1.04E-12	7.23E-13	0.000

CONTRIBUTION OF EXPOSURE MODES TO EDE DOSES

	Year-2010 dose (person-rem)		
Exposure mode	1,086,888 persons	756,000 persons	Percent of total dose
Submersion in air	6.22E-15	4.33E-15	0.000
Direct surface exposure	2.47E-10	1.72E-10	0.026
Inhalation	9.50E-07	6.61E-07	99.876
Ingestion	9.37E-10	6.52E-10	0.099
Vegetables	9.37E-10	6.52E-10	0.098
Meat	4.14E-13	2.88E-13	0.000
Milk	5.62E-14	3.91E-14	0.000

The ICRP also provides risk estimates for radiation exposure in Publication 26. BEIR III risk estimates were used in this EIS because (1) BEIR III is a more comprehensive evaluation of radiation-induced health effects and (2) BEIR III results in higher estimates of total health effects.

The BEIR III report identifies the following three categories of radiation-induced human health effects: (1) cancer, (2) genetic disorders, and (3) somatic effects other than cancer. The BEIR Committee believes that carcinomas are the most important effect of low-dose radiation. In this context, the term "low dose" refers to doses as high as a few rads per person per year. Natural background radiation ranges from 0.1 to 0.2 rad per person per year. Genetic effects of low-level radiation have been well documented and are addressed in detail in the BEIR III report. Somatic effects other than cancer include cataract induction and fertility impairment. The BEIR III report concludes that low-dose exposure of human populations does not increase the risk of somatic effects other than cancer and developmental changes in unborn children. The report also indicates that developmental changes in unborn children are probably not caused by radiation at or below natural background levels. For these reasons, only cancer and genetic disorders are considered in the analysis for this EIS.

Cancer data from the Japanese survivors of atomic bomb blasts in World War II are used in most of the analyses in the BEIR III report. A major question addressed by the BEIR III report is how to extrapolate the cancer risks observed at the relatively high dose rates down to the lower dose rates caused by most nuclear facilities. The BEIR III report adopted a parametric family of functions to accomplish this extrapolation. The linear model represents an upper limit or maximum risk; the linear-quadratic model, an intermediate or probable risk; and the quadratic model, a low-limit or minimum risk. These functions have been suggested by the report for low-linear-energy-transfer (LET) radiation. This type of radiation includes gamma-, x-, and electron (beta particle) radiation. High-LET radiation includes alpha particles encountered in the decay of transuranic (TRU) radionuclides. This type of radiation is associated with the majority of the SIS Project radioactive releases. The BEIR III report suggests that for high-LET radiation, use of the linear model represents the best way to determine probable risk; therefore, the linear model was used. However, because its appropriateness for high-LET radiation has not been definitely established, it is possible that the potential number of fatal cancers associated with SIS Project operations is lower than presented in this EIS. This would be the case if either the linear-quadratic or quadratic model would be determined to be more appropriate for high-LET radiation than the linear model. Indeed, if the quadratic model were used, the number of potential fatal cancers could approach zero.

One characteristic of radiation-induced cancer is that it takes a long time to develop, a period referred to as the "latent period." Leukemia has a characteristically short latent period (less than 25 years), whereas other cancers can have latent periods as long as the life span of an individual. Because only about 40 years of cancer data have been collected on the survivors of atomic bomb blasts, the data do not account for all the cancers that might develop because of the bombs' radiation. The following two projection models have been developed to account for these future cancer deaths: (1) the absolute-risk projection model, which assumes that the cancer rate (risk per year) observed since the atomic bomb blasts will continue throughout the life spans of those exposed; and (2) the relative-risk model, which assumes that the excess radiation-induced risk is proportional to the natural incidence of cancer with age. The relative-risk model results in cancer risk estimates greater than those predicted by the absolute model. However, the BEIR III report states that the absolute model is generally more applicable to most forms of cancer. The cancer risk estimates used in this EIS represent an average of those calculated using the absolute-risk and relative-risk models for both low-LET and high-LET radiation.

Both low-LET and high-LET radiation are associated with radionuclides released to the environment during operation of the SIS Project and during operation of other facilities at the INEL, the Hanford Site, and the SRP. An evaluation of the decay modes of the specific radionuclides released from these facilities has been made to determine the type of radiation most applicable for specific health-effect calculations performed for this EIS.

Health effects estimators for low-LET and high-LET radiation were derived for use in estimating health effects based on an evaluation of the data presented in the BEIR III report. The resulting health effects estimators used in this EIS are summarized in Table A-16. They total 120 cancer fatalities per million person-rem for low-LET radiation and 280 cancer fatalities per million person-rem for high-LET radiation. The health effects estimate for genetic effects used in this EIS is 257 genetic effects per million person-rem of radiation, received by the gonads, for either type of radiation.

The health effects estimators given in Table A-16 are the best estimates of risk based on present data. The estimators could vary widely, depending on the models used. For cancer fatalities, they could range from near 0 to as high as 400 per million person-rem. For genetic effects, the risk estimator could range from 60 to 1100 per million person-rem.

The use of the absolute-risk model or the relative-risk model, or any combination of both, leads to an insignificant number of health effects and risk values. Ranges of risks are not believed to be of merit for inclusion in the EIS because of this insignificance.

A.1.3 Comparison of ICRP 30 and RADRISK Dose Conversion Factors

A comparison has been made of the total doses calculated using the internal dose conversion factors contained in ICRP 30 and in the RADRISK data base. For this comparison, AIRDOS-EPA was run for both the individual and population cases associated with the INEL site. External dose conversion factors and all other input data were identical. The resulting doses are presented in Table A-17.

The organs for which plutonium and americium internal dose conversion factor values are contained in both ICRP 30 and in the RADRISK data base are red bone marrow, bone surface, and liver. The total doses calculated for

Table A-16. Health Effects Estimators Used in the Evaluation of Radiation Health Effects

Organ/cancer	Cancer fatalities per million person-rem Low-LET radiation[a,b]	High-LET radiation[c]
Leukemia[d]	19.5	44
Bone cancer[e]	0.5	1
Lung	28	66
Liver	6.5	16
Intestinal tract	5.3	13
Thyroid	6.9	17
Breast	9.8	24
Stomach	11	27
Other[f]	33	72
Total	120	280

[a] LET = linear-energy transfer.

[b] An average of the absolute and relative model values has been used. In addition, the linear-quadratic model has been assumed.

[c] An average of the absolute-risk and relative-risk model values has been used. In addition, the linear model has been assumed.

[d] This health effects estimator is multiplied by the dose to the red bone marrow, since the marrow is associated with leukemia induction.

[e] This health effects estimator is multiplied by the dose to the bone surface, since the bone surface is associated with the induction of bone cancer.

[f] This health effects estimator is multiplied by the EDE.

Table A-17. Individual and Population Doses Calculated by AIRDOS-EPA Using Dose Conversion Factors Presented in ICRP 30 and the RADRISK Data Base

Organ	Maximum individual (rem)		80-kilometer population (person-rem)[a]	
	ICRP 30	RADRISK	ICRP 30	RADRISK
Red bone marrow	6.5×10^{-11}	6.9×10^{-11}	1.1×10^{-7}	1.1×10^{-7}
Bone surface	8.2×10^{-10}	8.2×10^{-10}	1.4×10^{-6}	1.4×10^{-6}
Liver	1.8×10^{-10}	1.8×10^{-10}	3.0×10^{-7}	3.0×10^{-7}
Gonads[b]	5.8×10^{-12}	1.1×10^{-11}	9.8×10^{-9}	1.8×10^{-8}
Breast[c]	2.7×10^{-14}	1.1×10^{-12}	4.6×10^{-11}	1.8×10^{-9}
Lungs[d]	1.5×10^{-10}	1.4×10^{-10}	2.5×10^{-7}	2.4×10^{-7}
Thyroid[c]	1.8×10^{-14}	1.1×10^{-12}	3.1×10^{-11}	1.9×10^{-9}
ULI wall[b]	9.4×10^{-15}	1.1×10^{-12}	1.6×10^{-11}	1.7×10^{-9}
Stomach wall	9.4×10^{-15}	1.1×10^{-12}	1.6×10^{-11}	1.7×10^{-9}
EDE	6.2×10^{-11}	7.4×10^{-11}	1.1×10^{-7}	1.3×10^{-7}

[a] Comparison is based on year-2010 population of 230,129 persons.

[b] ICRP 30 contains ingestion dose factors for this organ for the radionuclides in question and inhalation dose factors for plutonium-241.

[c] ICRP 30 does not contain internal dose factors for this organ for the radionuclides in question.

[d] ICRP 30 contains only inhalation dose factors for this organ for all plutonium radionuclides in question.

these organs, using RADRISK dose factors, were equal to or only slightly higher than those calculated using ICRP 30 dose factors. For the remaining organs except the lungs, RADRISK dose factors result in considerably higher doses. This is primarily because of the 10 percent rule inherent to ICRP 30 (1979), which, for a particular radionuclide, causes the omission of those organ internal dose factors whose weighted values are less than 10 percent of the highest weighted dose factor.

A.2 CALCULATIONS OF CONSEQUENCES FROM ACCIDENTAL RELEASES

The consequence analysis for the accidental release of radioactivity was conducted using the CRAC2 code (Ritchie, Johnson, and Blond, 1983). This is a revised version of the code CRAC (Calculation of Reactor Accident Consequences) developed for use in the Reactor Safety Study (NRC, 1975). This section of the appendix summarizes the general modeling in CRAC2, the modifications made to the health-effect and risk models for this study, and also the input data used.

A.2.1 Elements of the CRAC2 Model

The elements of the CRAC2 consequence model are (1) the transport and diffusion of radioactivity in the atmosphere; (2) the deposition processes; (3) processes that lead to the accumulation of radiation doses; (4) protective measures, such as evacuation and sheltering; and (5) the effects of radiation doses on the human body. Figure A-5 contains a schematic outline of the arrangement of the computational elements or submodels of the CRAC2 code.

The consequence calculation begins with a description of the characteristics of the radionuclide release, including the quantity of each radionuclide released to the environment, the amount of energy associated with the release, the duration of the release, the time of the release after accident initiation, and the warning time for evacuation. The significance of each of these parameters, and the values used in this EIS, are discussed below.

For each accident considered in this analysis, the source terms (i.e., the radionuclides released and their quantity) were as discussed in Section 4.1.3 of this EIS.

The time of release is the time between the initiation of the accident and the start of the release of radionuclides to the atmosphere. This parameter is used for isotope decay calculations. In this analysis, the time to release is conservatively taken to be zero.

The duration of release is a parameter that is used in CRAC2 for three purposes: first, to allow for further radioactive decay; second, to allow for the broadening of the time-averaged plume due to the action of large-scale turbulent eddies in the atmosphere; and third, to define the length of

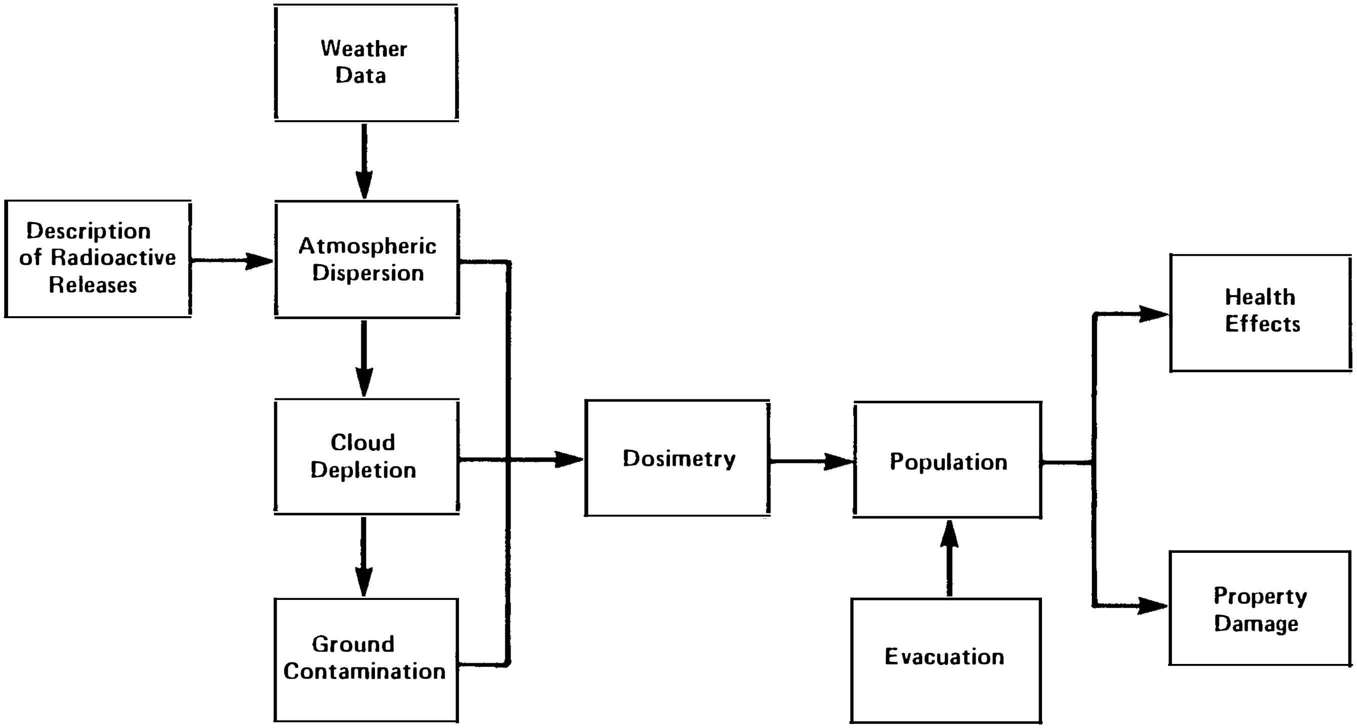

Figure A-5. Schematic Outline of Consequence Model, CRAC2.

the plume in the evacuation model. For this analysis, all the radioactivity is assumed to be released over a period of 2 hours.

The warning time is the time period between the declaration of a general emergency and the release of radioactive material to the atmosphere. Since no evacuation was assumed, this time is taken to be zero.

The elevation of all releases was assumed to be from a 36.6-meter-high stack. The rate of release of heat that accompanies the escaping radionuclides is used in the calculations of plume rise. A buoyant plume can be an important mitigating factor, particularly for larger source terms. However, in this analysis, it was assumed that all radionuclide releases are cold.

A.2.2 Transport and Diffusion of Radioactivity in the Atmosphere

The atmospheric transport and dispersion model used in CRAC2 is based on a standard Gaussian plume formulation. This was simplified by replacing the Gaussian crosswind profile with a rectangular (or "top hat") function of width 3 σy. The amplitude of the top hat is 0.836 of the Gaussian peak; however, the area under the top-hat curve is identical to the area under the Gaussian crosswind profile.

The meteorological data required by CRAC2 consist of a full year of consecutive hourly values of wind speed, wind direction, atmospheric stability class, and precipitation. In order to reduce computing time, weather sequence sampling is performed by selecting a limited number of starting times for accident sequences from the 8760 that are possible in a full year. A technique called importance sampling is used to reduce the uncertainty attributable to sampling. Before sampling sequences, the entire year of data is sorted into 29 weather categories, or bins. Categories include sequences in which either rainfall or wind-speed slowdowns occur within specified distance intervals from the plant. Atmospheric-stability and wind-speed categories are also considered. The probability of each weather category is estimated from the number of sequences in the category. Sequences are then sampled from each of the 29 categories (and weighted with appropriate probabilities) for use in risk calculations, thus ensuring that low-probability adverse weather conditions (e.g., rainfall, wind-speed slowdowns) are adequately included.

For this analysis, the meteorological data for the SRP site were processed from measurements taken at the K-Area meteorological tower during the year 1978, together with hourly precipitation data from Augusta, Georgia. For the INEL site, 1983 data from the tower north of the ICPP were used. For the Hanford Site, hourly data from the Hanford Meteorological Station for the year 1982 were used.

A.2.3 Deposition Processes

As the plume of radioactive material travels outward from the facility, various mechanisms remove the airborne material. In addition to radioactive decay, the radioactive material is removed by such depositional processes as impaction on obstacles (dry deposition) and precipitation scavenging (wet deposition).

These depositional mechanisms cannot be specified precisely. Removal rates depend significantly on such factors as the type and rate of precipitation, particle density and size distribution, the surface characteristics of the ground, and weather conditions. For simplicity, the dry-deposition velocity (i.e., ratio of the deposition flux to the air concentration at a particular distance from the surface) is assumed to be constant for particulate matter. When it rains or snows, wet deposition occurs simultaneously with dry deposition. Wet deposition is modeled by a simple exponential removal rate, which should be dependent on the rate of rainfall. Precipitation is assumed to have fallen uniformly in time and throughout the spatial interval in which the plume is located. The removal rate is a function of the thermal stability. Noble gases are assumed to be insoluble and nonreactive, and therefore are not removed by either dry or wet deposition.

The concentration of radionuclides on the ground is calculated from the airborne concentration and from the depositional rate. The material deposited on the ground is subtracted from the airborne material.

A.2.4 Processes that Lead to the Accumulation of Radiation Doses

Using the procedures described above, for each selected accident start time, spatial distributions of instantaneous and time-integrated airborne concentrations and deposited levels of radioactive material were calculated for selected accidents. These quantities were then used to calculate the potential radiation doses received by individuals and to calculate the population doses accumulated.

The exposure pathways modeled by CRAC2 consisted of three elements. First, there is inhalation of radioactive material from the passing cloud. Second, there are cloudshine and groundshine, the irradiation of body organs by gamma rays emitted by the passing cloud or by radioactive products deposited on the ground. Third, there are chronic exposure pathways, which include (1) resuspension of deposited radioactive material by the wind; (2) long-term exposure to gamma rays from deposited radionuclides, especially cesium, including the effects of weathering; (3) consumption of milk; (4) consumption of milk products; (5) consumption of contaminated vegetation; and (6) consumption of crops contaminated by root intake.

The inhalation dose conversion factors, the cloudshine and groundshine dose conversion factors, and the treatment of the chronic exposure pathways presently in CRAC2 are the same as those used in the Reactor Safety Study (NRC, 1975). For the analyses conducted, these dosimetry models were updated using information from work done recently at Sandia National

Laboratories (Ostmeyer and Runkle, 1985). The recommendations from this publication are based on models in ICRP Publications 26 and 30 (ICRP, 1977 and 1979) and models developed by Kocher (1979 and 1981).

Like the rest of the chronic exposure models, the ingestion pathway model in CRAC2 is identical to that used in the Reactor Safety Study and is based on ingestion of strontium, cesium, and iodine since these radionuclides dominate the ingestion dose from postulated nuclear power plant accidents. Since source terms in this EIS do not contain strontium or cesium, the CRAC2 ingestion model was replaced with one that is based on the ingestion of plutonium and iodine. For this, work by Bennett (1976); Martin and Bloom (1976); and Drobinski, Magno, and Goldin (1966) was used. Ingestion dose conversion factors were taken from Ostmeyer and Runkle (1985).

Once the radiation doses delivered to individuals have been calculated, they must be combined with the population distribution. In this study, the population distribution around each site was assigned to a grid consisting of 16 sectors, the first of which is centered on due North, the second on 22½ degrees east of North, and so on. There are also 24 radial intervals starting at the plant site and extending to 80 kilometers (50 miles). Population data for each site were obtained using U.S. census data and projected to the year 2010.

A.2.5 Evacuation Modeling and Other Protective Measures

In this assessment, no evacuation or special sheltering measures were assumed.

A.2.6 Health Effects

Three categories of potential health effects were calculated: early and continuing somatic effects, late somatic effects (cancers), and genetic effects. Early and continuing somatic effects manifest themselves within days up to a year after exposure. By contrast, latent cancers would probably be observed from at least 2 to 40 or more years after exposure, and genetic effects in succeeding generations. For this EIS, the health effects model of CRAC2 has been updated to reflect information from the BEIR III report (1980) and the ongoing follow-up of the survivors of the bombings of Hiroshima and Nagasaki (Evans and Moeller, 1985).

As discussed in Section A.2.4, doses to the individual organs were calculated using dose conversion factors based on ICRP Publications 26 and 30. These dose conversion factors for selected radionuclides are tabulated in NUREG/CR-4185 (Ostmeyer and Runkle, 1985) and also in a report by the National Radiological Protection Board (NRPB, 1982). The conversion factors from these references include the effects of both low-LET and high-LET radiation. The risk of cancer to each individual organ was then calculated using risk factors based on the BEIR III report. The total number of latent cancer fatalities was calculated by summing the risk of cancer to the following organs: bone marrow, lung, breast, skeletal bone, gastrointestinal tract, thyroid, and "other" (tissues other than lungs, bone marrow, walls of the gastrointestinal tract, and thyroid).

A.3 RADIOLOGICAL IMPACTS OF TRANSPORTATION

The impacts of transporting feed, product, by-product, TRU waste, and low-level waste (LLW) for the SIS facility were analyzed using the RADTRAN computer code developed by Sandia National Laboratories. This section of Appendix A describes this computational method and the analysis performed.

The purpose of the analysis is to provide a technical assessment of radiological and nonradiological risk associated with transportation of radioactive materials to and from the SIS facility. It does not assess directly those phenomena that have been collectively referred to as the "social amplification of risk," which may be affected by public perceptions (Kasperson et al., 1988). No generally accepted method has yet been developed for the formal analysis of these factors. However, awareness of these concerns is responsible, at least in part, for the recognition of "secondary factors" in the U.S. Department of Transportation (DOT) routing guidelines and for the strong tendency toward conservatism (i.e., toward overestimation of risk) in the risk analysis.

A.3.1 RADTRAN Model

The RADTRAN risk analysis model was developed by Sandia National Laboratories to calculate radiological risks associated with the transport of radioactive materials by a variety of modes, including truck, rail, air, ship, and barge (Madsen et al., 1986). The RADTRAN computer code consists of two major modules for each transport mode: the incident-free transport module, in which doses resulting from normal transport are modeled; and the accident module, in which consequences and probabilities of accidents are evaluated and used to generate a risk estimate. RADTRAN is the central code of the RADTRAN Computational System. With this system, nonradiological transport risks can be estimated, and it is well suited to complex problems involving multiple package types, transport mode options, and potential destinations. The RADTRAN computer code is being updated and improved continuously. One recent improvement is the ability to describe route segments in more detail. A preliminary version of what will be released as RADTRAN IV was used in this analysis.

The single greatest "limitation" facing users of RADTRAN or any code of this type is a scarcity of statistical data for certain input parameters. This difficulty can be overcome by using conservative estimates of these parameters (i.e., values that tend to maximize the risk). The resulting risks tend to be overestimates (Neuhauser and Reardon, 1986), but are appropriate for use as bounding estimates in environmental documents. In this context, use of confidence limits as a measure of uncertainty would be inappropriate. See the references for a discussion of the limitations of parameter uncertainty analysis.

An extensive analysis of the sensitivity of RADTRAN risk calculations to variations in parameters was performed in 1986 (Neuhauser and Reardon, 1986) for a sample truck transport case. The parameters that had the greatest effect on the incident-free risk calculation for truck transport were found to be, in decreasing order of importance: exposure distance while stopped; Transport Index (TI) value; packages per shipment; shipments per year; K_0 (a factor that accounts for the shape of the package); distance traveled; number of persons exposed while stopped; stop time; shipments per year; distance from source to crew; and number of crew members. All of these are either deterministic (i.e., have known, fixed values for the problem being analyzed) or can be appropriately bounded by a conservative assumption. The accident risk calculation was sensitive to values for release fraction and for probability of occurrence of accident-severity categories; it was relatively insensitive to changes in accident rate or fractions of travel in urban and suburban population-density zones. Consequently, where data are not available, conservative assumptions regarding package release fractions and accident-severity-category probabilities are used.

Incident-Free Radiological Risk

Included in the incident-free module for highway and rail transport are models describing:

- Dose to persons within 800 meters of the transport link
- Dose to persons sharing the transport link
- Dose to persons at stops (e.g., refueling stops, rail classification yards).

The magnitude of this risk depends mainly on the TI and the surrounding population densities. The TI is a regulatory dose-rate index and is defined as the dose rate in millirads per hour at 1 meter from the package surface. Three population density zones (rural, suburban, and urban) are used. These correspond to mean population densities of 6, 719, and 3861 persons per square kilometer, respectively.

Radiological Accident Risk

Accident risk may be generically defined as the consequences of an accident multiplied by the probability of that accident. In practice, any number of different accident sequences exist, each of which has an associated probability. These various types of accident sequences may be grouped according to their severities; in RADTRAN, each of these groupings is considered an Accident Severity Category. Severity is a function of the magnitudes of the impact, puncture, and thermal forces to which a package may be subjected during an accident. Because all accidents may be described in terms of these basic physical forces, severity is scenario-independent. That is, any sequence of events that results in an accident in which a package is subjected to forces within a certain range is assigned to the

Accident Severity Category associated with that range of values. Each value in the severity category matrix represents a conditional probability. That is, each value is the probability, given that an accident occurs, that it will be of that particular severity. To determine the expected frequency of each severity category, each value must be multiplied by the baseline accident rate. Each population density zone has a distinct baseline accident rate and distribution of accident severities because of differences in average velocity, traffic density, and other factors in rural, suburban, and urban areas.

Radiological consequences were calculated by assigning release fractions to each category for each chemically and physically distinct type of radioisotopes. The release fraction is defined as that fraction of the radioisotope group in the package that could be released in a given severity of accident. Release fractions vary by package type. Most solid materials are relatively nondispersible and would be difficult to release in particulate form. Therefore, RADTRAN allows the user to assign values for aerosolized and respirable aerosol fractions of the released radioactive material for each Accident Severity Category. Distinct aerosol and respirable aerosol fractions are assigned by material dispersibility category; these categories describe the physical form of the material (e.g., gas, liquid, solid in powder form, monolithic or nondispersible solid).

RADTRAN contains a meteorological model that allows the user to define the behavior of a plume of particulates, if one is produced by the type of accident considered. Material released in aerosol form is assumed to travel away from the immediate vicinity of an accident in a particulate plume.

To calculate health effects, five exposure pathways are considered:

- Inhalation of respirable aerosols in the passing plume
- Cloudshine, defined as exposure to penetrating radiation (e.g., gamma radiation) from the passing plume
- Groundshine, defined as exposure to penetrating radiation from radioactive material that is deposited on the ground from the plume
- Resuspension, defined as inhalation dose from respirable aerosols that are deposited on the ground by the passing plume and subsequently resuspended
- Ingestion, defined as exposure from ingestion of agricultural products from areas contaminated by particulates from the plume (rural zones only).

Cloudshine and inhalation of respirable aerosols occur only while persons are exposed to the plume. Since persons outdoors would be most directly affected, RADTRAN allows the user to account for pedestrian densities in urban areas. Groundshine, resuspension, and ingestion doses would be incurred at later times, and their magnitudes would depend in part on how rapidly a contaminated area is evacuated and whether the area is cleaned up or restricted from use. RADTRAN allows the user to estimate evacuation times, and it includes contamination thresholds for determining whether interdiction or cleanup will occur. The cleanup level is in accordance with EPA regulations.

Total Radiological Risk of Transport

To calculate total transport risk, the risk per kilometer per shipment is multiplied by the number of kilometers a shipment travels in the appropriate population density zone and by the number of shipments of that type; these products are then summed. These operations are performed by a postprocessor in the RADTRAN System.

Nonradiological Risk of Transport

The RADTRAN postprocessor performs similar calculations for nonradiological unit-risk factors (e.g., risk of fatality from mechanical injury) to determine total nonradiological risks. Note that for these risks the two-way travel distance is used because, while radiological risk may be incurred only for a shipment containing radioactive material, nonradiological risks are equally likely when the transport vehicle is traveling empty.

Representative Routes

For truck transport, to estimate the fraction of travel in each population density zone, representative interstate highway routes are generated for each origin-destination combination, and population densities along these routes are determined from 1980 census data. These data and one-way mileage estimates are generated by a highway routing code.

A.3.2 SIS Analysis

Input Assumptions

RADTRAN requires substantial amounts of input data to adequately model the packaging, the packaging contents, the vehicle and transport link, and potential radiological consequences. In addition, a conditional probability must be assigned to each Accident Severity Category for each population density zone, and accident rates for each vehicle type and transport mode must be determined. Many of these values do not change for a specific application. For example, interstate highway lane dimensions do not change regardless of what vehicle type or payload is being analyzed. Since predetermined default values may be used for these parameters, the user needs to consider only the values of those parameters that may change as a result of project-specific conditions. In this section, project-specific conditions and related input values are discussed and documented.

The SIS Project would receive shipments of fuel-grade plutonium primarily from the Hanford Site and small amounts from the SRP. All fuel-grade plutonium shipments, for analysis purposes, were considered to be in oxide form. The output of the SIS Project would consist of weapon-grade plutonium (product), which would be shipped to the Rocky Flats Plant in Colorado, and plutonium oxide (by-product), which would (for the purposes of this analysis) be shipped to the Waste Isolation Pilot Plant (WIPP) near

Carlsbad, New Mexico. Transuranic wastes and LLW would also be generated during SIS operations. The TRU wastes would be shipped to the WIPP, and the LLW would be disposed of onsite.

A set of conservative baseline conditions was defined for analysis to provide a point of comparison for relative risk assessment. Briefly, each material would be shipped by truck; shipments of feed and product would consist of Type B packages (55-gallon size) in safe secure transports (SSTs). By-product would be shipped in Type B packages in TRUPACT II containers. The TRU waste would be grouted and shipped in Type A packages (55-gallon drums) in TRUPACT II containers, and the LLW would be packaged in various size packages and hauled to the onsite disposal facility. In a preliminary analysis, two shipment sizes--full and half-full loads--were analyzed. This was considered because it was possible that a reduced payload might decrease the consequences of a severe accident and thus reduce the overall risk. The results of that analysis indicate that, although there was some reduction in high-severity accident consequences, this was more than offset by the increase in risk resulting from the fact that twice as many shipments must be made to transport the same amount of material. Therefore, only full loads are considered in this analysis.

The contents of a Type B package of feed, product, or by-product and of representative shipments of these materials are classified information (Neuhauser, 1987). The TI values of a full load of each material were estimated and are shown in Table A-18.

Low-level waste generated during SIS operations will be disposed of onsite. This waste will consist primarily of alpha-contaminated material. Because the exact makeup of this waste is not easily predicted, it was modeled as containing 100 nanocuries per gram, which is the maximum allowable concentration for LLW. The radionuclide makeup is assumed to be similar to that for the SIS feed material. The total annual output of LLW from SIS operations is expected to be about 5.5 tons with a volume of 52 cubic meters, which is equivalent to about 250 55-gallon drums. The radionuclide inventory of a typical drum is 2.2E-03 curie. Although the transport distance could vary at the three alternative sites, the maximum distance of 30 kilometers was used for all sites. A minimum of 25 drums (or containers) per truck was assumed, which gives an estimate of 10 shipments per year. The average velocity onsite was assumed to be 50 kilometers per hour (about 30 miles per hour).

Data for radioactive half-lives and photon energies were obtained from ICRP Publication 38 (1983). Dose factors for inhalation and ingestion of the radionuclides were taken from Dunning (1976).

Stop times associated with transport by SST differ from those for commercial truck transport. Stop time was set at 0.0021 hour per kilometer in accordance with safe operating procedures for the SST. The value for commercial truck transport is 0.011 hour per kilometer which was used for all other shipments (Mulryan, 1987). The operating procedures for the SST are classified.

Representative interstate highway routes from each potential origin to each potential destination were generated by the INTERSTAT routing network

Table A-18. Transport Index Values for SIS Material

Material	TI value (mrem/hr at 1 meter)
Feed	9.3
Product	1.6
By-product	9.8
TRU waste	0.15[a]
LLW	10.0[b]

[a] This TI value applies to 99% of the TRU waste shipments. A TI value of 3 mrem/hr was used for the remaining 1% of the waste which is americium enhanced.

[b] Maximum allowed by regulations.

code, which also gives fractions of travel in rural, suburban, and urban population density zones (Cashwell, 1987) and total one-way distance. These are listed in Table A-19.

The INTERSTAT routing network includes the Interstate Highway system, state-designated alternate routes, and access routes into various DOE facilities. Because of their high and uniform levels of engineering and safety, the Interstate Highways have been identified by the DOT as the preferred routes for transport of highway-route-controlled quantities of radioactive materials (formerly called large-quantity shipments); where available, urban beltways and bypasses must be used. States and tribes may designate alternate routes when the designation is accompanied by a safety analysis demonstrating equal or greater levels of safety.

The accident rates used in the analysis are from DOT data for the entire commercial shipping industry (i.e., accidents on interstate highways involving at least one commercial tractor-trailer regardless of payload), and are based on millions of total vehicle-kilometers of travel. Available unclassified accident/incident data for radioactive materials shipments indicate, for example, that for the 11-year period from 1971 to 1982, a single shipment containing plutonium-239 (and uranium isotopes) was involved in a highway accident (Wolff, 1984). In the plutonium case, a Type B truck cask was involved in a rollover accident. Twenty-five other shipments in Type B packagings were also involved in truck or rail accidents in this time period, but none carried plutonium. There was no release of radioactive material in any of these accidents. An accident rate derived from this information should not be used; the statistical significance would be questionable because the total truck-kilometers involved are relatively small and because few accidents (none with releases) occurred. Therefore, the accident rates in this analysis are conservatively set equal to the national average accident rates for commercial tractor-trailers, which are the default values in the RADTRAN code for truck transport. The national average rates are derived from DOT data and are appropriate for relatively long-distance routes that traverse several states. Sandia National Laboratories has conducted a number of tests to demonstrate the validity of this conclusion. Table A-20 presents various accident rates based on state averaged data for combination trucks (tractor-trailers) on interstate highways. The average for the entire United States is 3.1×10^{-7} accident per kilometer, and for the states through which SIS shipments would pass is 3.2×10^{-7}. Along the nine separate SIS shipment routes, the accident rate ranges from 2.1×10^{-7} to 4.0×10^{-7} accident per kilometer. This limited variability in accident rates supports the use of national average data for the SIS shipments.

These rates are for all reported combination truck accidents on interstate highways. The possibility of the very severe accidents which would be required to result in a release of SIS radioactive material is much lower. The overall frequency of under-reporting of accidents is about 40 percent for property-damage-only accidents; the reporting of serious and fatal accidents is virtually 100 percent (Smith and Wilmot, 1982). Thus, the base accident rate is not adjusted for under-reporting, since doing so would serve only to raise the relative frequency of occurrence of low-severity accidents and lower the relative frequency of occurrence of high-severity accidents, which would remove a certain level of conservatism in

Table A-19. Transportation Distances for SIS Alternatives

Alternative number	Alternative site	Origin	Destination	Material[a]	Kilometer per shipment	Percent of travel		
						Rural	Suburban	Urban
1	Idaho Falls	Hanford	Idaho Falls	Feed	979	80	17	3
		Savannah River	Idaho Falls	Feed	3797	75	24	1
		Idaho Falls	Rocky Flats	Product	1113	87	12	1
		Idaho Falls	WIPP	By-product/ TRU Waste	2252	87	12	1
2	Hanford	Hanford[c]	Hanford	Feed	8	100	0	0
		Savannah River	Hanford	Feed	4539	75	23	2
		Hanford	Rocky Flats	Product	1817	83	15	2
		Hanford	WIPP	By-product/ TRU Waste	2956	84	14	2
3	Savannah River	Hanford	Savannah River	Feed	4539	75	23	2
		Savannah River	Savannah River	Feed	8	100	0	0
		Savannah River	Rocky Flats	Product	2672	73	26	1
		Savannah River	WIPP	By-product/ TRU Waste	2389	77	21	2

[a] Onsite transportation of LLW assumed to be 30 kilometers (19 miles) for all sites.

Table A-20. Comparison of State Average Accident Rates[a]

Routes/states	Accident rate ($\times 10^{-7}$)[b]
Along route between:	
INEL and Hanford	2.8
INEL and Savannah River	4.0
INEL and Rocky Flats	4.0
INEL and WIPP	3.7
Hanford and Savannah River	3.7
Hanford and Rocky Flats	3.5
Hanford and WIPP	3.4
Savannah River and Rocky Flats	3.2
Savannah River and WIPP	2.1
All states along all SIS routes	3.2
All states	3.1

[a] Based on Department of Transportation statistics (DOT, 1984).

[b] Accidents involving combination trucks (tractor-trailers) in 1984.

the accident-risk calculation. The eight-category Accident Severity Category matrix for commercial truck transport from NUREG-0170 (NRC, 1977b) is used.

Additional conservatism is attributed to the fact that SSTs do not operate in poor weather conditions. Restricting truck transport to good weather conditions reduces the overall truck accident rate by about 10 percent (NUREG-0170, Section 6.3.3). Since accidents associated with travel in poor weather conditions are included in the DOT accident-rate data that were used in the risk analysis, the risk estimate is slightly conservative with respect to this parameter. In the unlikely event of an unforeseen road closure, radiological impacts would be associated mainly with an increase in stop time and perhaps an increase/decrease in distance traveled (e.g., if a vehicle were able to use an alternate route). Since only one or a few shipments would be affected on an annual basis, the overall annual incident-free risk estimate would not change significantly.

The SST would be used to transport SIS-related shipments of feed and product material in Type B packagings in close-packed arrays. The SST acts as a significant secondary barrier; it provides additional shielding that reduces the external dose rate of the shipments, and it provides additional levels of accident resistance. For shipments of by-product material and TRU waste to the WIPP, the TRUPACT II would be used. The TRUPACT II is presently undergoing regulatory testing for U.S. Nuclear Regulatory Commission (NRC) certification, and the final package design may vary somewhat from the present design. However, in view of the present uncertainty regarding the final design of the TRUPACT II, the Type B/TRUPACT II shipment configuration for by-product material was modeled conservatively. No credit was taken for any protection afforded by the TRUPACT, and the release fractions for the entire shipment configuration were set equal to those for the Type B alone (NRC, 1977b). For the TRU shipments, since the final TRUPACT II design must meet the NRC regulatory standards, release fractions for a typical Type B package were used (NRC, 1977b), and no credit was taken for any protection that might be afforded by the inner Type A packages (drums). The LLW packages were modeled as typical Type A packages.

The 6M (a Type B package now in use by DOE) is one of the few NRC-certified packagings for which a large amount of data exists on response to the higher severity category accidents, and the release fraction values used here and in earlier studies are based on these data (McWhirter et al., 1975; Bonzon, 1977; Fischer et al., 1987). The accident resistance provided by the SST is significant. The high integrity of the trailer acts as an impact-force-reducing barrier and provides thermal protection. The release fractions assigned to the Type B packaging in Accident Severity Categories VI, VII, and VIII for the packaging itself must be modified to reflect the protection afforded a shipment by the SST. Lesser accident categories (I through V) result in no release of material to the environment (NRC, 1977b).

In the Type B/SST shipment configuration, an externally applied mechanical force (e.g., a rapid change in velocity or a direct impact force) would result in a crush force's being applied to the Type B packagings, because the SST wall and the arrangement of the Type B (close-packed array) would act to distribute even-concentrated external impact loadings. Thus, in order to model the response of this shipment configuration to the higher

Accident Severity Categories, an estimate of the response of Type B packages under static crush loading was developed. The failure threshold was conservatively set at 70,000 pounds, although structural analysis indicates that it is actually higher. The 70,000-pound value was selected because it is the recommended static loading for a proposed regulatory crush test. If forces within the Category VI range [defined in NUREG-0170 (NRC, 1977b) for highway transport as approximately 100,000 to 300,000 pounds] are applied to an SST, the force translated to Type B packagings in a close-packed array inside will be below the Type B failure threshold (70,000 pounds).

The SST also provides enhanced thermal protection, being capable of withstanding temperatures in excess of the regulatory test-fire temperature (1475°F) for periods exceeding the test duration of 30 minutes without significant elevation of internal temperature (SNL, 1976). The SST provides additional thermal protection such that the Type B packagings, which are themselves highly fire-resistant, would not directly experience thermal loads characteristic of a Category VI fire. Note that both fire and impact forces of the magnitudes defined above are required for an accident to be classified as Accident Severity Category VI; this is also true of the definitions of Categories VII and VIII. The SST so effectively prevents either of these conditions from affecting the payload that a Category VI accident would not result in any release of contents. Therefore, the release fraction for this severity category is equal to zero for shipments of the Type B/SST configuration.

The forces a shipment may experience in Category VII accidents (300,000-500,000 pounds), if applied uniformly to the SST, would not result in crush forces in the interior of the trailer that exceeded the Type B failure threshold (70,000 pounds). However, concentrated application of such forces could cause local deformation of the SST. Crush forces on packagings in the immediate vicinity of the impact point could exceed the Type B threshold. Forces of this magnitude are seldom encountered in actual accidents. A grade-crossing accident involving a train moving at high velocity could conceivably provide the requisite force at a 90-degree impact angle, and the force would be concentrated in a relatively small area rather than being uniformly distributed. Therefore, for the purposes of this study, all accidents of this severity are modeled conservatively as being of the local-deformation type. For a close-packed array, four Type Bs in the immediate vicinity of the local deformation would be affected (two tiers of Type Bs). The four Type Bs damaged by crush forces generated as a result of impact could be subjected to a Category VII fire (1475°F for up to 2 hours) and could release some fraction of their contents. The release fraction for each shipment was then conservatively set equal to the product of the fraction of affected Type Bs and the release fraction for a Type B in a Category VII accident (as defined in NUREG-0170 using Model II).

Accident Severity Category VIII, as defined in NUREG-0170 (NRC, 1977b) for highway transport, includes accidents involving both forces greater than 500,000 pounds and fires over 2 hours in duration at 1475°F (or equivalent thermal load). No highway accident this severe has ever been recorded, so for the purposes of this study the local-deformation scenario used in Category VII was extended. Six Type Bs would be damaged as a result and subjected to fire. The shipment release fraction is again conservatively set equal to the product of the fraction of affected Type Bs and the release fraction for a Type B package in a Category VIII accident (as defined in NUREG-0170).

Aerosol and respirable aerosol fraction values for dispersibility category 5 (loose, small powder) are used for feed and by-product, and values for dispersibility category 3 (sintered, loose chunks) are used for product (NRC, 1977b). They determine the amounts of material that may be dispersed and eventually inhaled in each severity category in which a release may occur. The fraction of airborne material that is less than 10 microns in size (mean aerodynamic diameter) and that could therefore enter the human respiratory system (ICRP, 1979) was set at 5 percent for product and by-product and 50 percent for feed. Ninety percent (mass percentage) of all airborne particles between 10 and 20 microns (mean aerodynamic diameter) and 100 percent of all particles over 20 microns (mean aerodynamic diameter) are deposited in the nasopharyngeal region. That is, they never reach the lung. Insoluble particulates, such as plutonium and plutonium oxide, are typically cleared from the nasopharyngeal region within a few hours. Respirable aerosols may be generated by impact forces and, more importantly, by fire. Bulk plutonium metal is difficult to aerosolize by either mechanism. The plutonium oxide, although it will not burn, is more dispersible when in powder form, and this was accounted for in the analysis by the dispersivity category assignment. The respirable aerosols potentially generated in severe accidents are, therefore, estimated in a conservative, material-specific manner. The deposition velocity of all released particulates was set at the default value of 0.01 meter per second, which is representative of aerosols. The fraction of all radionuclides that would be deposited on agricultural land and then transferred to food products was set equal to 2.8×10^{-6} (Ostmeyer, 1986).

For this analysis, RADTRAN results are given in terms of population dose (i.e., person-rem per kilometer). To obtain risk in terms of health effects, these values are multiplied by the health effect estimators discussed in Appendix A.1. The effective whole-body doses calculated by RADTRAN were reduced by a factor of 2 to yield gonadal dose for genetic risks as suggested by the ICRP (ICRP, 1977).

Results

Radiological unit-risk factors from the RADTRAN System are expressed in units of health effects (cancer deaths and genetic effects) per kilometer traveled for each type of shipment. Risk factors are calculated separately for the public under incident-free and accident conditions. Separate factors are provided for each of the three population zones (rural, suburban, and urban).

Nonradiological risks are deaths arising from traffic accidents (mechanical injuries) and deaths from respiratory ailments resulting from vehicular air pollution. Nonradiological unit-risk factors based on national statistics were obtained from Rao, Wilmot, and Luna (1981).

The gamma and neutron components of the TI were analyzed separately. In a preliminary analysis, the entire TI was modeled as gamma, which tends to overestimate total integrated dose because neutrons are rapidly attenuated in air whereas gamma radiation is not. However, over 50 percent of the TIs for the SIS-related shipments of feed, product, and by-product are attributable to neutrons, and separate analysis gives a more realistic estimate of incident-free radiological risk for these shipments.

The postprocessor code of the RADTRAN system combines the unit risks with total distances traveled in each population density zone and the number of shipments per year of each material type to give total annual risk estimates. The total annual radiological risks for transporting feed, product, by-product, and TRU waste are given in Tables A-21, A-22, A-23, and A-24, respectively. The number of genetic effects is 46 percent (about half) of the number of cancer deaths shown in these tables. The risk to the public from transportation of low-level and hazardous wastes that are to be treated and disposed of onsite is negligible. The annual radiological risks of LLW transport onsite are 0.028 person-rem (7.8×10^{-6} latent cancer fatality and 3.6×10^{-6} genetic effect) for incident-free transport and 2.9×10^{-5} person-rem (8.3×10^{-9} latent cancer fatality and 3.8×10^{-9} genetic effect) for accidents. The annual nonradiological risk of an accident-related fatality is less than 1 in 10 million and may be considered negligible. Total annual nonradiological risks are given in Table A-25.

Table A-26 is a summary of total annual radiological risks for all materials that includes both the annual risks for incident-free conditions and the annual risks for accident conditions.

The radiological risks of transportation result mainly from the transport of by-product to the WIPP. Although the impacts of transporting this material have been included here, by-product would be shipped to the WIPP only if no other uses are identified. Most of the radiological risk is attributed to incident-free transport. That is, potential accidents contribute little to the total radiological risks. Nonradiological risks are about 10 times higher than radiological risks and would result from mechanical injuries from traffic accidents. The predicted number of traffic accident fatalities of 2.21×10^{-2} is trivial in comparison with the thousands of traffic deaths on American highways each year.

The total transportation risks for the three alternative sites are very similar (maximum difference of 35 percent). Locating the SIS Project at the INEL would result in the lowest risk since it is the shortest distance from the WIPP. Hanford was identified as the lowest-risk alternative in the Draft EIS. This was due to the short distance required for feed transport. With the addition of by-product and TRU waste transport risk to the Final EIS, feed transport risk has become a small fraction of total transportation risk.

Table A-21. Annual Cancer Risks of Transport of Feed from Hanford to Alternative SIS Locations[a]

		Health effects		
Source	Risk group	Hanford	INEL	SRP
Hanford	Incident-free - Public	1.90E-06	2.70E-04	1.27E-03
	Accident - All persons	3.02E-09	2.53E-05	1.20E-04
	Total	1.90E-06	2.95E-04	1.39E-03
SRP	Incident-free - Public	1.60E-04	1.33E-04	1.50E-07
	Accident - All persons	1.50E-05	1.21E-05	3.78E-10
	Total	1.75E-04	1.45E-04	1.50E-07
Total		1.77E-04	4.40E-04	1.39E-03

[a] Genetic risk is about half (46%) the cancer risk shown here.

Table A-22. Annual Cancer Risks of Transport of Product from SIS Alternative Locations to Rocky Flats Plant[a]

	Health effects		
Risk group	Hanford	INEL	SRP
Incident-free - Public	2.45E-04	1.44E-04	3.78E-04
Accident - All persons	6.09E-08	2.58E-08	1.17E-08
Total	2.45E-04	1.44E-04	3.78E-04

[a] Genetic risk is about half (46%) the cancer risk shown here.

Table A-23. Annual Cancer Risks of Transport of By-product from SIS Alternative Locations to the WIPP[a]

	Health effects		
Risk group	Hanford	INEL	SRP
Incident-free - Public	2.91E-03	2.10E-03	2.67E-03
Accident - All persons	1.46E-04	8.88E-05	1.62E-04
Total	3.06E-03	2.19E-03	2.84E-03

[a] Genetic risk is about half (46%) the cancer risk shown here.

Table A-24. Annual Cancer Risks of Transport of TRU Waste from SIS Alternative Locations to the WIPP[a]

	Health effects		
Risk group	Hanford	INEL	SRP
Incident-free - Public	1.11E03	8.36E-04	9.21E-04
Accident - All persons	3.40E-06	2.34E-06	3.26E-06
Total	1.11E-03	8.38E-04	9.24E-04

[a] Genetic risk is about half (46%) the cancer risk shown here.

Table A-25. Annual Nonradiological Risks of Transport of SIS-Related Shipments

Potential SIS site	Material	Fatalities[a]
Hanford	Feed	5.26E-04
	Product	8.88E-04
	By-product	2.54E-03
	TRU waste	1.81E-02
	Total	2.21E-02
INEL	Feed	1.37E-03
	Product	5.52E-04
	By-product	1.95E-03
	TRU waste	1.40E-02
	Total	1.79E-02
SRP	Feed	4.14E-03
	Product	1.18E-03
	By-product	1.93E-03
	TRU waste	1.37E-02
	Total	2.10E-02

[a] These are mainly the result of mechanical injuries during accidents. Fatalities due to air pollution range from 2 to 5 percent of the total.

Table A-26. Total Annual Radiological Risks

	Health Effects	
Potential SIS Site	Cancer deaths	Genetic effects
Hanford	4.59E-03	2.11E-03
INEL	3.61E-03	1.66E-03
SRP	5.53E-03	2.54E-03

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APPENDIX B

SOCIOECONOMIC CHARACTERISTICS

B.1 INTRODUCTION AND SUMMARY

This Appendix presents the demographic and economic characteristics of the counties around the Idaho National Engineering Laboratory (INEL), Hanford Site, and Savannah River Plant (SRP). Demographic and economic descriptions are based on available data from the U.S. Bureau of the Census. Separate subsections present agricultural and tourism characteristics.

Demographic characteristics presented are recent trends in total population and age, and components of population change. Economic characteristics presented are trends in personal income, employment by industry, and unemployment. Agricultural characteristics include the amount of acreage, land use, and market value of the products produced. Tourism characteristics include hotel and motel characteristics, and travel by purpose of trip. The references at the end of the Appendix present a list of previous socioeconomic characterization studies completed for each site.

B.1.1 Summary

This section summarizes the characteristics of the areas around each of the sites. The study areas, which are based on the predominant residence location of existing employees (see Chapter 3), include six counties in Idaho for the INEL, two counties in Washington for the Hanford Site, and four counties in South Carolina and two in Georgia for the SRP. The Hanford Site study area is significantly smaller geographically than the study areas for the SRP and the INEL (i.e., about one-third the size).

B.1.1.1 Population Characteristics

The population characteristics of the three study areas, the state(s) in which the study areas are located, and the United States are presented in Table B-1.

The population in the Hanford Site study area grew 54.8 percent, the fastest of the three areas, between 1970 and 1980. This compares to 18 percent growth of the SRP area population, and 11.4 percent growth for the United States. The population increase in the Hanford Site study area was also more than twice that of the State of Washington. For the period 1980 to 1986, the Hanford Site study area increased by 3.5 percent. The SRP grew by 11.6 percent and the United States by 6.4 percent during the period of 1980 to 1986. Population increases during both periods in the INEL area were between those of the Hanford Site and the SRP.

The distribution of population by age in 1980 at each of the study areas is similar, with the population in the SRP area being slightly older.

The changes in the percentage of population by age between 1970 and 1980 are different for each area. The INEL and Hanford Site areas experienced large percentage increases in the 5-and-under, 18-to-65, and over-65 age groups. The percentage of the population in the 5-to-17 age group did not change significantly. The SRP area experienced a small increase in the percentage of population under 5, a decrease in the percentage in the 5-to-17 age group (a decrease in the actual number of people in this group), and significant increases in the 18-to-65, and 65-and-over age groups. The changes in age characteristics of the United States were similar to those of the SRP. The United States, however, had a decrease in actual numbers of people in both of the younger age groups. The comparison shows that in terms of percentage of population all three areas experienced greater growth in the 1970s than the United States. Since 1980 this growth has slowed to close to the average for the United States for the INEL, double the national rate at the SRP, and one-half the national rate at the Hanford Site.

B.1.1.2 Economic Characteristics

Table B-2 presents a summary of the economic characteristics of the three study areas, the state(s) included in each area, and the U.S. average. The three sectors of services, retail trade, and manufacturing represented 54.6 and 57.5 percent, respectively, of all employment in 1980 in the INEL and SRP areas. They represented 67.2 percent of the U.S. economy. In the Hanford Site study area, construction replaced retail trade in the list of the top three which totaled 51.5 percent of the economy. In the Hanford Site study area, between 1980 and 1984, personal income from construction decreased by 56.0 percent, reflecting the decline in construction at the Hanford Site that occurred during this period.

Agriculture, forestry, and fisheries make up 6.6 percent and 10.0 percent of total employment for the INEL area and Idaho, respectively. This compares to 5.5 percent for the Hanford Site area, 1.5 percent for the SRP area, and 3.0 percent for the United States.

Total personal income and per capita income in the INEL and Hanford Site study areas and the States of Idaho and Washington grew at a slower pace between 1980 and 1984 than the U.S. average. The SRP area and the States of Georgia and South Carolina grew at a faster pace than the U.S. average. In 1980, per capita income in the Hanford Site area was 35.5 percent higher than the INEL area and 40.5 percent higher than the SRP area. These differences had decreased to 26.7 percent and 11.6 percent in 1984.

B.1.1.3 Agricultural Characteristics

Table B-3 presents a summary of the agricultural characteristics of the three study areas, the state(s) included in each area, and the U.S. average. The average farm size in the INEL and Hanford Site study areas was approximately 600 acres, compared to approximately 300 acres in the SRP area and the U.S. average of 440 acres.

About one-half (49.3 percent) of the farmland in the INEL study area is used to grow crops, compared to 63.0 percent in the SRP study area and a U.S. average of 45.1 percent. Statistics are not available for the Hanford Site area due to the Census Bureau policy of not reporting information which will disclose confidential information. Over 76.7 percent of the farmland in the INEL area is irrigated. The Hanford Site study area is 55.0 percent and the SRP area 23.9 percent irrigated. For the United States, 25.0 percent of the farmland is irrigated.

The average market value of agricultural products per farm in 1982 in the INEL area was $107,437. This compares to $135,321 for the Hanford Site area, $41,658 in the SRP area, and a U.S. average of $58,858. Between 1978 and 1982, the percent increase in the average market value of agricultural products per farm for the INEL and SRP areas exceeded the U.S. average. The percent increase in the Hanford Site area was slightly over one-half the U.S. average increase.

B.1.1.4 Tourism and Travel Characteristics

Table B-4 presents a summary of the tourism and travel characteristics of the three study areas, the state(s) included in each area, and the U.S. average. The only statistics available that allow for comparisons of areas smaller than a state are hotel and motel receipts and employment. The receipts and employment characteristics are not completely reported for two of the three study areas. This is due to the policy of the Bureau of the Census to not publish information where confidential information could be disclosed. The Bureau of the Census does not report hotel and motel information for counties that are not in urban areas. Of the three study areas, complete reporting is available only for the Hanford Site. Of the 50 establishments in the INEL area, 15 are included in the receipts and employment reports. At the SRP, 49 establishments are identified, with 45 included in receipt reports and 40 in employment reports. The INEL area had 19.1 percent of total establishments in Idaho, while the Hanford Site area had 3.8 percent of Washington establishments, and the SRP had 3.1 percent of Georgia/South Carolina establishments.

People travel for a wide variety of reasons. Survey statistics are available on the reasons for travel for Idaho and South Carolina. Leisure and vacation activities are the biggest reasons cited in both surveys for travel. It was given by 51.8 percent of the Idaho respondents and 46.0 percent of the South Carolina respondents. Visiting friends and relatives accounted for 32.7 percent of the responses in Idaho and 26.3 percent in South Carolina. Business, conventions, and other purposes were the reasons for the remaining travel trips.

B.2 IDAHO NATIONAL ENGINEERING LABORATORY

Previous studies of potential socioeconomic impacts of a large project at the INEL have defined the primary area impacted by people moving to the area and increased economic activity. The area consists of six counties, Bannock, Bingham, Bonneville, Butte, Jefferson, and Madison (EG&G Idaho, Inc., 1984). This characterization uses the same six-county primary impact area.

B.2.1 Population Characteristics

Population characteristics include total population and trends in population growth, population by age and trends by age group, and estimates of the components of population change. Population counts result from complete counts and from estimates based on sample questionnaires. Sampling errors could result from the use of sample questionnaires. Nonsampling errors made during the processing of questionnaires could also occur. As a result, slight differences may be found in similar numbers presented in these tables. The errors and the techniques used by the Bureau of the Census to correct them are explained in detail in each source document.

Table B-5 presents recent population trends. Population increases from 1970 to 1980 were 27.2 percent for the six-county area and 32.4 percent for the State of Idaho. Both exceeded the 11.4-percent increase for the United States. Madison County had the highest percent change (44.8), while Butte County had the lowest (14.3).

Population increase slowed from 1980 to 1986. The six-county area increased approximately 6.1 percent, the State 6.3 percent, and the United States 6.4 percent. Madison County continued to experience the largest percentage increase in the six-county area. Butte County's population has declined since 1980. It was the only county to have a decline in population.

The population in each age group in the six-county area changed between 1970 and 1980 (Tables B-6 and B-7). The under-5, 18-to-64, and 65-and-over age groups increased significantly. The 5-to-17 age group experienced a small increase. The State had similar changes, while the nation experienced declines in the under-5 and 5-to-17 age groups.

The median age in each county is lower than that for the State and the United States. The median age increased between 1970 and 1980 for all three areas. The State increased from 26.4 to 27.5. Nationally the median age rose from 28.1 to 30.0. For the six counties, Butte had the highest median age in 1970 (25.7 years) and in 1980 (27.8 years). Madison County had the lowest in 1970 (19.8 years) and 1980 (19.9 years).

Changes in the population are made up of births, deaths, and people moving in and out of an area. Table B-8 presents the estimates of the components of population change from 1980 to 1985. The population change in the six-county area (12.6 percent) doubled the change in the State (6.5 percent) and the nation (5.4 percent). In all counties, births exceeded deaths. Bannock and Jefferson Counties experienced more people moving out than moving in.

B.2.2 Economic Characteristics

Economic characteristics presented include employment and earnings by place of work, personal income by place of residence, and unemployment. Employment, earnings and personal income are reported by major industry category for the six-county area, the State, and the nation. Unemployment is reported by county, State, and nation. See the discussion of sampling and nonsampling errors, which result in minor errors between tables, in Section B.2.1. Earnings by place of work include wages and salaries, other labor income, and proprietors' income. Personal income by place of residence includes total earnings by place of work, less personal contributions for social insurance plus adjustment for residence where different from place of work, plus dividends, interest, rent, and transfer payments.

Table B-9 presents employment by place of work by industry for the six-county area, the State, and the United States in 1980. The three industries with the largest employment in the six-county area are services, retail trade, and manufacturing. These three industries also are the largest in the State and the nation. In the six-county area, they represent 54.6 percent of all jobs. Butte and Jefferson Counties have higher employment in agriculture than in manufacturing and retail trade. Bingham County has higher employment in agriculture than in retail trade. Madison County has higher employment in agriculture than in manufacturing.

Agriculture, including forestry and fisheries (6.6 percent of employment), is important in the six-county area. It is, however, not as important in the six-county area as in the State, where it is 10.0 percent of total employment. Nationally, agriculture is 3.0 percent of employment. The percentage of employment in manufacturing in the six-county area is 19.4 percent below the State and 50.0 percent below the United States.

Table B-10 presents the trends in earnings by place of work by industry. The industrial sector with the largest number of employees does not always provide the largest payrolls. This is true in the six-county area, where 53.0 percent of the earnings in 1984 came from the services, government, and manufacturing sectors. These same three sectors were the largest contributors to State (53.9 percent) and national (60.5 percent) earnings. The percentage of earnings from agriculture in the six-county area was approximately 40.2 percent below the percentage for the State, but 126.1 percent higher than the United States.

From 1980 to 1984, earnings from agriculture declined 6.4 percent in the six-county area. During the same period, earnings increased by 9.9 percent for the State, and by 35.6 percent nationally. Other industries with significant changes in earnings when compared to the State and the nation include construction and manufacturing. Construction earnings declined by 10.2 percent in the six-county area from 1980 to 1984. They increased by 11.5 percent in the State and 23.6 percent in the nation during the same period. Manufacturing earnings increased by 50.1 percent in the six-county area. The State and national increases were 28.0 percent and 24.6 percent, respectively.

Total personal income by place of residence (Table B-10) in the six-county area increased between 1980 and 1984 by 30.8 percent. This compares to increases of 32.3 percent for the State and 39.9 percent for the nation. Within the six counties, total personal income increases between 1980 and 1984 ranged from 27.5 percent in Bingham County to 34.7 percent in Madison County.

Per capita income for the counties and the State increased at a lower rate than the nation. The State per capita income increased by 25.3 percent between 1980 and 1984. National per capita income increased by 34.5 percent during the same period. The increase for the counties ranged from 20.8 percent in Jefferson County to 31.2 percent in Butte.

Unemployment in 1987 in Idaho (5.7 percent) was below the national rate (6.2 percent) (Table B-11). Three counties had unemployment rates below the State rate. Bingham County (6.7 percent) had the highest rate, and Madison County (4.3 percent) the lowest.

B.2.3 Agricultural Characteristics

The amount of land in farms, land use, and the market value of the products produced describe agricultural activity. Table B-12 presents the trends in farms, land in farms, and land use. The six-county area had 2.7 million acres of farmland in 1982, approximately the same amount as in 1978. The State had 13.9 million acres of farmland in 1982, a 5.3-percent decline from 1978. The nation experienced a decrease of 2.8 percent between 1978 and 1982, to 986.8 million acres. The amount of farmland in 1982 for the six counties ranged from 0.2 million acres in Butte County to 1.07 million acres in Bingham County.

The average size of a farm in 1984 ranged from 447 acres in Madison County to 744 acres in Butte County. The average for the six counties was 586 acres. The average for the State was 563 acres, and for the United States 440 acres. The average size of a farm declined between 1978 and 1982 by 1.0 percent for the six counties, 7.1 percent for the State, and 2.0 percent for the nation.

Farmland use divides into three categories, harvested cropland, pastureland, and other. Some farmland is also irrigated. Harvested cropland in the six-county area was 38.1 percent of all farmland in 1982. This compares to 35.1 percent for the State and 33.1 percent for the United States. Pastureland in the six-county area was 48.2 percent of all farmland in 1982. This compares to 53.4 percent for the State and 53.4 percent for the United States. Other uses make up the remaining acreage. The six-county area had 76.7 percent of all farmland irrigated in 1982, an increase of 17.3 percent over 1978. The State had 65.8 percent farmland irrigated in 1982, a decline of 1.1 percent since 1978. The United States had 24.9 percent of all farmland irrigated, a decline of 2.0 percent from 1978.

The six counties have experienced a slight increase in the amount of harvested cropland between 1978 and 1982. The increases ranged from 0.1 percent in Bingham County to 10.6 percent in Butte County. The change in harvested cropland for the State for the same period was a 1.4-percent increase. The United States had a 2.9-percent increase.

Changes between 1978 and 1982 in the percentage of pastureland in the six counties varied significantly. The average for the six counties was a 5.6-percent decrease. The range was a 9.7-percent increase in Jefferson County, while Madison County experienced an 18.6-percent decrease. The State experienced an 8.4-percent decline during the same period. Pastureland in the United States declined by 4.8 percent.

Irish potatoes, Idaho's leading crop, used 5.4 percent of all cropland in the six-county area in 1982. This is a decline of 8.6 percent from 1978. Irish potatoes use 2.3 percent of all cropland in the State.

The market value of agricultural products is presented on Table B-13. The average market value of products produced per farm in the six-county area in 1982 was $107,437. The range is a high of $120,180 in Bingham County to a low of $40,578 in Bannock County. This compares to an average for the State of $90,297, and $58,858 for the United States.

The market value of crops produced in the six-county area in 1982 made up 66.9 percent of all agricultural products; 28.6 percent of the crop market value came from grains. The dollar value of crops in 1982 ranged from a high of $107,806,000 in Bingham County to a low of $11,565,000 in Butte County. Bingham County also produced the greatest dollar value of grains, $44,088,000, while Butte County had the lowest, $5,341,000. The State produced $2,231,605,000 of agricultural products in 1982. Approximately 52.0 percent or $1,160,742,000 was in crops, of which $554,691,000 was grains. The United States produced $131,900,223,000 in agricultural products, of which 47.2 percent was in crops. Of the crops, 58 percent was grains.

The market value of the crops produced in the six-county area between 1978 and 1982 increased by 54.0 percent. This change ranged from an increase of 78.4 percent in Bonneville County to an increase of 46.6 percent in Butte County. The market value of crops produced in the State increased by 45.7 percent during the same period. The United States experienced a 29.2-percent increase from 1978 to 1982.

Livestock and poultry make up the remainder of the market value of agricultural products. The six-county area produced $140,423,000 in livestock and poultry in 1982. Of these products, 68.3 percent were for cattle. The value of livestock and poultry produced in 1982 ranged from $66,095,000 in Bingham County to $7,450,000 in Butte County. Bingham County also produced the greatest value of cattle, $49,646,000 or 75.1 percent of county livestock production. Madison County had the lowest production, $4,437,000. The State produced $1,070,863,000 of livestock and poultry products in 1982, of which 67.4 percent were cattle. The United States produced $69,644,136,000 of livestock and poultry products; 45.4 percent were cattle.

Livestock production between 1978 and 1982 in the six-county area increased by 8.1 percent. This change ranged from an increase of 34.7 percent in Butte County to a decrease of 8.2 percent in Bonneville County. Livestock and poultry production in the State increased by 28.0 percent during the same period. The United States experienced an 18.3-percent increase from 1978 to 1982.

B.2.4 Tourism and Travel Characteristics

Tourism activities described in this study focus on hotel and motel characteristics and on the results of a traveler survey. Limited hotel and motel characteristics are available for counties. Traveler surveys are available for Idaho and South Carolina.

The Bureau of the Census uses the Standard Industrial Classification (SIC) for the definitions of the categories it uses. The hotel and motel group includes establishments that provide lodging, or lodging and meals, and camping facilities.

The study area for this analysis is expanded to include Blaine County. The Ketchum and Sun Valley resort areas are in Blaine County and make up one of the larger tourist attractions.

The study area had 50 hotels and motels, or 19.0 percent of the total number in the State (Table B-14). Receipts and employment reported by the Census in 1982 were not complete enough to allow evaluation.

Travelers in the State were surveyed from June 1986 to June 1987. The significant results of this survey are shown in Table B-15 and Table B-16. The results show that more leisure travelers are from out of state (63 percent). The majority of leisure travelers will stay overnight. Summer is the most popular tourist season. The travelers with Idaho as a destination seek recreation in the rural sections of the State.

The survey also showed that travelers have different purposes for their trips. The majority travel for leisure or vacation. The second-largest group (32.7 percent) comes to visit relatives and friends.

B.3 HANFORD SITE

Previous studies of potential socioeconomic impacts of a large project at the Hanford Site have defined the primary area impacted by people moving to the area and increased economic activity. The area consists of two counties, Benton and Franklin. The Bureau of the Census has classified this area as the Richland-Kennewick-Pasco Standard Metropolitan Statistical Area (SMSA). This characterization uses the SMSA as the primary impact area.

B.3.1 Population Characteristics

Population characteristics include total population and trends in population growth, population by age and trends by age group, and estimates of the components of population change. Population counts result from complete counts and from estimates based on sample questionnaires. See the discussion of sampling and nonsampling errors, which result in minor errors between tables in Section B.2.1.

Table B-17 presents recent population trends. Population increases from 1970 to 1980 were 54.8 percent for the SMSA and 21.1 percent for the State. Both exceeded the 11-percent increase for the United States. Population increase slowed from 1980 to 1986. The SMSA increased approximately 3.5 percent, the State 8.0 percent, and the United States 6.4 percent.

The population in each age group in the SMSA changed between 1970 and 1980 (Tables B-18 and B-19). The 18-to-64 age group had the largest percentage (73.1 percent) increase. The 5-to-17 age group had the smallest percentage (15.5 percent) increase. The State had the largest percentage increase of 34.0 percent in the over-65 age group and experienced a 5.2-percent decline in the 5-to-17 age group. The nation experienced a decline of 9.6 percent in the 5-to-17 age group. The age group with the highest percentage increase (27.3 percent) in the nation was the over-65 age group.

The median age in each county was below the State and the United States. The median age increased between 1970 and 1980 for all three areas. The median age for the State increased from 27.5 to 29.8 years. Nationally the median age rose from 28.1 to 30.0. For the SMSA, Benton County had the highest median age in 1970 (27.0 years) and in 1980 (28.0 years). Franklin County's median age went from 25.6 years in 1970 to 26.7 in 1980.

Births, deaths, and people moving in and out of an area are the components of population change. Table B-20 presents the estimates of the components of population change from 1980 to 1986. The population in the SMSA declined by 3.4 percent compared to increases in the State (10.7 percent) and the nation (5.4 percent).

B.3.2 Economic Characteristics

Economic characteristics presented include employment and earnings by place of work, personal income by place of residence, and unemployment. Employment and earnings are reported by major industry category for each county, the State, and the nation. Personal income and employment are reported by county, State, and nation. See the discussion of sampling and nonsampling errors, which result in minor errors between tables, in Section B.2.1. Earnings and personal income are defined in Section B.2.2.

Table B-21 presents employment by place of work by industry in 1980 for each county, the SMSA, the State, and the United States. The three industries with the largest employment in the SMSA are services, construction, and manufacturing (51.5 percent of all employment). Services, retail trade, and manufacturing are the largest employment areas in the State and the nation. In the SMSA they represent 50.6 percent of all jobs. In Franklin County, employment in retail trade is higher than in construction.

Agriculture, including forestry and fisheries (5.5 percent of employment), is important in the SMSA. It is, however, more important in the SMSA than in the State, where it is 3.8 percent of total employment. Nationaily, agriculture is 3.0 percent of employment. The percentage of employment in manufacturing in the SMSA area (12.4 percent) is below the State (19.5 percent) and the United States (22.4 percent). The percentage of employment in construction in the SMSA is 92.6 percent higher than the percentage for the State. The SMSA is 122.0 percent higher than the percentage of construction employment for the nation.

Table B-22 presents the trends in earnings and personal income. The industrial sector with the largest number of employees does not always provide the largest payrolls. This is true in the SMSA, where 54.7 percent of the earnings in 1984 came from the services, government, and manufacturing sectors. These same three sectors were the largest contributors to the State (60.8 percent) and national (60.5 percent) earnings. The percentage of earnings from agriculture in 1984 in the SMSA was 35.1 percent above the percentage for the State, and 117.4 percent higher than the United States.

From 1980 to 1984, earnings in the SMSA increased by 8.9 percent, compared to a 21.6-percent statewide increase and a 35.4-percent national increase. The percentage of change in each industrial category is significantly different for the SMSA when compared with the State and national changes. The greatest difference was in construction with a 56.0-percent decline in the SMSA. Earnings from construction in the State declined 11.6 percent, and rose 23.6 percent nationally. Finance, insurance, and real estate also showed a decline in the SMSA (-12.1 percent) compared to an increase for the State (22.1 percent) and nation (50.3 percent). Manufacturing had the largest increase (69.6 percent) compared to increases of 16.1 percent for the State and 24.6 percent for the nation. Earnings from agriculture increased by 4.2 percent in the SMSA, 21.6 percent for the State, and 35.6 percent for the nation. Total personal income in the SMSA increased between 1980 and 1984 by 18.9 percent. This compares to increases of 30.5 percent for the State and 39.9 percent for the nation.

Per capita income for the counties in the SMSA and the State had smaller percentage increases when compared to the national increase. The State per capita income increased by 24.5 percent between 1980 and 1984. National per capita income increased by 34.5 percent during the same period. The increase for the counties was 16.9 percent in Benton County and 15.1 percent in Franklin County.

Unemployment in 1987 in Washington (7.6 percent) exceeded the national rate (7.2 percent) (Table B-23). Both counties had unemployment rates above the State rate. Franklin County (11.5 percent) had the highest rate, and Benton County (9.0 percent) the lowest.

B.3.3 Agricultural Characteristics

The amount of land in farms, land use, and the market value of the products produced describe agricultural activity. Table B-24 presents the trends in farms, land in farms, and land use. The SMSA had 1.3 million acres of farmland in 1982, approximately the same as 1978. The State had 16.5 million acres of farmland in 1982, a 1.5-percent decline from 1978. The nation experienced a decrease of 2.8 percent between 1978 and 1982, to 986.8 million acres. The average size of a farm in 1982 for the SMSA was 608 acres. The average for the State was 456 acres, and for the United States 440 acres. The average size of a farm in the SMSA declined 13.7 percent between 1978 and 1982. Similarly, the State (-15.6 percent) and the nation (-2.0 percent) experienced declines.

Farmland use divides into three categories, harvested cropland, pastureland, and other. Some farmland is also irrigated. Harvested cropland in the SMSA was 43.6 percent of all farmland in 1982. This compares to 32.1 percent for the State and 33.1 percent for the United States. Pastureland in the SMSA was 30.8 percent of all farmland in 1982. This compares to 47.6 percent for the State and 53.4 percent for the United States. Other uses make up the remaining acreage. The SMSA had 55.0 percent of all farmland irrigated in 1982, an increase of 9.1 percent over 1978. The State had 36.4 percent irrigated in 1982, a decline of 9.1 percent since 1978. The United States had 25.0 percent of all farmland irrigated, a decline of 2.0 percent from 1978.

The SMSA has experienced a slight increase (4.7 percent) in the amount of harvested cropland between 1978 and 1982. The change in harvested cropland for the State for the same period was a 5.3-percent increase. The United States had a 2.9-percent increase.

Between 1978 and 1982, the percentage of pastureland in the SMSA decreased by 1.3 percent. The State experienced a 2.8-percent decline during the same period. Pastureland in the United States declined by 4.8 percent.

Table B-25 presents the market value of agricultural products. The average market value of products produced per farm in the SMSA in 1982 was $135,321. This compares to an average for the State of $78,469 and $58,858 for the United States. The market value of crops produced in the SMSA in 1982 made up 84 percent of all agricultural products. Thirty-one percent of the crop production came from grains. The value of crops produced in the SMSA in 1982 was $291,211,000. The State produced $2,831,159,000 of agricultural products in 1982; 60.6 percent or $1,714,741,000 was in crops, of which $685,640,000 was grains. The United States had $131,900,223,000 in agricultural products, of which 47.2 percent was in crops. Of the crop production, 58.4 percent was grains.

The SMSA experienced a 34.0-percent increase in crop production between 1978 and 1982. Crop production in the State increased by 32.5 percent during the same period. The United States experienced a 29.2-percent increase from 1978 to 1982.

Livestock and poultry make up the remainder of agricultural products. The SMSA produced $46,691,000 in livestock and poultry in 1982; 75.9 percent of these products were for cattle. The State produced $1,116,418,000 of livestock products in 1982, of which 53.2 percent was cattle. The United States produced $69,644,136,000 of livestock and poultry with 45.4 percent in cattle.

Livestock and poultry production from the SMSA increased by 16.1 percent between 1978 and 1982. Production of livestock and poultry in the State increased by 42.9 percent during the same period. The United States experienced an 18.3-percent increase from 1978 to 1982.

B.3.4 Tourism and Travel Characteristics

Tourism activities described in this study focus on hotel and motel characteristics. Limited hotel and motel characteristics are available for counties.

The Bureau of the Census uses the SIC for the definitions of the categories it uses. The hotel and motel group includes establishments that provide lodging, or lodging and meals, and camping facilities.

The study area had 31 hotels and motels or 3.8 percent of the total number in the State (Table B-26). Receipts reported by the Census in 1982 were 3.6 percent of the total for the State. The receipts for the State represented approximately 1.3 percent of the national total. Hotel and motel employment was 665 in 1982. This represents 4.0 percent of all hotel and motel employment in the State. The State represents 1.5 percent of national hotel and motel employment.

B.4 SAVANNAH RIVER PLANT

Previous studies of potential socioeconomic impacts of a large project at the SRP have defined the primary areas impacted by people moving to the area and of increased economic activity. The area consists of six counties, Aiken, Allendale, Bamberg, and Barnwell in South Carolina, and Columbia and Richmond in Georgia. This characterization uses the same six-county primary impact area.

B.4.1 Population Characteristics

Population characteristics include total population and trends in population growth, population by age and trends by age group, and estimates of the components of population change. See the discussion of sampling and nonsampling errors, which result in minor errors between tables, in Section B.2.1.

Table B-27 presents recent population trends. Population increases from 1970 to 1980 were 18.0 percent for the six-county area, 19.1 percent for Georgia, and 20.5 percent for South Carolina. All exceeded the 11.4-percent increase for the United States. Columbia County had the highest percent change (79.7 percent), while Allendale County had the lowest (9.4 percent). Population increase slowed from 1980 to 1986. The six-county area increased 11.6 percent, Georgia 11.7 percent, South Carolina 8.1 percent, and the United States 6.4 percent. Columbia County continued to experience the largest percentage increase (40.6 percent) in the six-county area. Allendale County's population declined 0.9 percent since 1980, the only county to have a decline.

The population in each age group in the six-county area changed between 1970 and 1980 (Tables B-28 and B-29). For the six-county area, the number of people in the under-5, 18-to-64, and 65-and-over age groups increased. The number of people in the under-5 age group increased for the six-county area (4.8 percent) and for South Carolina (1.2 percent); Georgia (-1.6 percent) and the United States (-4.7 percent) experienced declines. The 5-to-17 age group in the six-county area declined by 2 percent between 1970 and 1980. South Carolina (-2.2 percent) and the United States (-9.7 percent) also declined, while Georgia increased (0.7 percent). Population increase in the 18-to-64 age group in the six counties (26.2 percent), Georgia (28.0 percent), and South Carolina (31.0 percent) exceeded the national increase of 20.9 percent. For the 65-and-over age group, percentage increases for the six-county area (47.5 percent), Georgia (40.6 percent), and South Carolina (50.5 percent) exceeded the nation (27.3 percent).

The median age in each county except Aiken is lower than for their respective states and the United States. The median age increased between 1970 and 1980 for all counties, the two states, and the nation. The median age in Georgia increased from 25.9 to 28.6 years, and South Carolina increased from 24.8 to 28.0 years. Nationally the median age rose from 28.1 to 30.0 years. For the six counties, Aiken County had the highest median age in 1970 (26.0 years) and in 1980 (29.5 years). Bamberg County had the lowest in 1970 (22.9 years) and 1980 (26.6 years).

Changes in the population are made up of births, deaths, and people moving in and out of an area. Table B-30 presents the estimates of the components of population change. The changes cover the period of April 1, 1980, to July 1, 1986, for South Carolina, and from April 1, 1980, to July 1, 1985, for Georgia and the United States. The population change in the six-county area (9.8 percent) exceeded the change in Georgia (9.4 percent), South Carolina (7.2 percent) and the nation (5.4 percent). In all counties, births exceeded deaths. Allendale and Bamberg Counties experienced more people moving out than moving in.

B.4.2 Economic Characteristics

Economic characteristics presented include employment and earnings by place of work, personal income by place of residence, and unemployment. Employment and earnings are reported by major industry category for each county, the State, and the nation. Personal income and unemployment are reported by county, State, and nation. See the discussion of sampling and nonsampling errors, which result in minor errors between tables, in Section B.2.1. Earnings and personal income are defined in Section B.2.2.

Table B-31 presents employment by place of work by industry for the six-county area and the two states. The three industries with the largest employment in the six-county area are services, manufacturing, and retail trade. These three industries also are the largest in both states and in the nation. In the six-county area they represent 57.5 percent of all jobs. Allendale County has higher employment in agriculture than in retail trade.

Table B-32 presents the trends in earnings and personal income. The industrial sector with the largest number of employees does not always provide the largest payrolls. This is true in the six-county area, where 72.6 percent of the earnings in 1984 came from the services, government, and manufacturing sectors. These same three sectors were the largest contributors to Georgia (56.2 percent), South Carolina (50.1 percent), and national (60.5 percent) earnings. The percentage of earnings from agriculture in the six-county area was 68.0 percent below the percentage for Georgia, 33.3 percent below the percentage for South Carolina, and 65.2 percent below the percentage for the United States.

From 1980 to 1984, earnings in the six counties increased by 44.1 percent. This compares with a 52.2-percent increase in Georgia, a 38.0-percent increase in South Carolina, and a 35.4-percent increase nationally. In the six-county area, significant increases occurred in construction (67.0 percent), wholesale trade (60.7 percent), and services (75.7 percent), when compared with South Carolina, Georgia, and the nation. Increases in earnings from transportation and public utilities in Georgia and South Carolina nearly doubled the increases in the six-county area and the nation. Retail trade experienced a faster growth rate in the six-county area, Georgia, and South Carolina than in the nation.

Total personal income in the six-county area increased between 1980 and 1984 by 54.5 percent. This compares to increases of 44.4 percent for South Carolina, 52.9 percent for Georgia, and 39.9 percent for the nation.

Per capita income for the counties increased at a higher rate when compared to the states and national increases. The Georgia per capita income increased by 43.6 percent between 1980 and 1984, and South Carolina increased 36.7 percent during the same period. The six-county area increased by 46.5 percent during this period. National per capita income increased 34.5 percent during the same period. The increase for the counties ranged from 42.1 percent in Bamberg County to 47.4 percent in Richmond County.

Unemployment in 1986 in Georgia (6.5 percent) and South Carolina (6.8 percent) was under the national rate (7.2 percent) (Table B-33). The unemployment rates for the six counties ranged from a low of 3.9 percent in Columbia County to 10.1 percent in Allendale County.

B.4.3 Agricultural Characteristics

The amount of land in farms, land use, and the market value of the products produced describe agricultural activity. Table B-34 presents the trends in farms, land in farms, and land use. The six-county area had 561,587 acres of farmland in 1982, a decline of 5.9 percent from 1978. Georgia had 12.3 million acres of farmland in 1982, an 8.4-percent decline from 1978. South Carolina had 5.6 million acres, a 7.5-percent decline. The nation experienced a decrease of 2.8 percent between 1978 and 1982, to 986.8 million acres. The amount of farmland in 1982 for the six counties ranged from 24,941 acres in Richmond County to 146,842 acres in Aiken County.

The average size of a farm in 1982 ranged from 179 acres in Richmond County to 842 acres in Allendale County. The average for the six counties was 314 acres. The average acreage per farm is 248 in Georgia, 224 in South Carolina and 440 in the United States. The average size of a farm increased between 1978 and 1982 by 3.9 percent for the six counties, while declining by 5.0 percent and 0.9 percent for Georgia and South Carolina, respectively, and 2.0 percent for the nation.

Farmland use divides into three categories, harvested cropland, pastureland, and other. Some farmland is also irrigated. Harvested cropland in the six-county area was 51.5 percent of all farmland in 1982. This compares to 38.7 percent and 44 percent for Georgia and South Carolina, respectively, and 33.1 percent for the United States. Pastureland in the six-county area was 14.1 percent of all farmland in 1982. This compares to 26.3 percent for Georgia, 20.4 percent for South Carolina, and 53.4 percent for the United States. Other uses make up the remaining acreage. The six-county area had 23.9 percent of farmland irrigated in 1982, an increase of 132.2 percent over 1978. Georgia had 23.1 percent irrigated in 1982, an increase of 2.2 percent since 1978. South Carolina had 8.9 percent irrigated in 1982, a 58.1-percent increase from 1978. The United States had 25.0 percent of all farmland irrigated, a decline of 2.0 percent from 1978.

The six counties have experienced a slight decrease (0.4 percent) in the amount of harvested cropland between 1978 and 1982. The changes ranged from a decrease of 8.3 percent in Aiken County to an increase of 9.5 percent in Allendale County. The changes in harvested cropland for the states for the same period were a 1.6-percent increase in Georgia and a 2.0-percent decrease in South Carolina. The United States had a 2.9-percent increase.

Changes between 1978 and 1982 in the percentage of pastureland in the six counties varied significantly. The average for the six counties was a 17.3-percent decrease. The high was an 86.5-percent increase in Allendale County, while Barnwell County experienced a 44.9-percent decrease. Georgia and South Carolina experienced 12.5-percent and 16.5-percent declines, respectively, during the same period. Pastureland in the United States declined by 4.9 percent.

The market value of agricultural products is presented on Table B-35. The average market value of products produced per farm in the six-county area in 1982 was $41,658. The range is a high of $91,095 in Allendale County to a low of $16,538 in Columbia County. This compares to an average of $55,766 for Georgia, $38,853 for South Carolina, and $58,858 for the United States. The market value of crops produced in the six-county area in 1982 made up 61.0 percent of all agricultural products; 41.6 percent of the crops came from grains. The dollar value of crops in 1982 ranged from a high of $13 million in Allendale County to a low of $966,000 in Columbia County. Allendale County also produced the greatest dollar value of grains, $9.5 million, while Columbia County had the lowest, $285,000. Georgia and South Carolina produced $2.8 billion and $969 million, respectively, of agricultural products in 1982. Crops represented 42.7 percent and 62.1 percent of the totals. Grains made up 27.2 and 17.3 percent of total agricultural products in South Carolina and Georgia, respectively. The United States had $13 billion in agricultural products, of which 47.2 percent was in crops, and 58.5 percent was in grains.

The market value of crops produced between 1978 and 1982 in the six-county area increased by 23.6 percent. The change ranged from an increase of 64.2 percent in Richmond County to an increase of 13.7 percent in Aiken County. The value of crop production increased by 29.3 percent in Georgia and 10.6 percent in South Carolina during the same period. The United States experienced a 29.2 percent increase from 1978 to 1982.

Livestock and poultry make up the remainder of agricultural products. The six-county area produced $29 million in livestock and poultry in 1982. One-quarter of these products was for poultry. The value of livestock sold in 1982 ranged from $9 million in Bamberg County to $2 million in Allendale County. Georgia and South Carolina produced $1.6 billion and $368 million, respectively, of livestock and poultry products in 1982. The United States produced $69.6 billion of livestock and poultry products.

Livestock and poultry production between 1978 and 1982 in the six-county area increased by 15.7 percent. The change ranged from an increase of 94.5 percent in Columbia County to a decrease of 20.0 percent in Richmond County. Production of livestock and poultry in Georgia and South Carolina increased by 11.2 percent and 17.9 percent, respectively, during the same period. The United States experienced an 18.3-percent increase from 1978 to 1982.

B.4.4 Tourism and Travel Characteristics

Tourism activities described in this study focus on hotel and motel characteristics, activities participated in while visiting South Carolina, and the purpose of trips. Limited information on hotel and motel characteristics is available for counties. Purpose of trip estimates and activity participation are available for South Carolina.

The Bureau of the Census uses the SIC code for the definitions of the categories it uses. The hotel and motel group includes establishments that provide lodging, or lodging and meals, and camping facilities.

The study area had 49 hotels and motels (Table B-36) or 3.1 percent of the total number in Georgia and South Carolina. Receipts reported in 1982, representing 92 percent of the establishments in the six-county area, were

1.7 percent of the total for Georgia and South Carolina. The receipts for Georgia and South Carolina represented 3.7 percent of the national total. Data available for employment from hotel and motel operations in the study counties are not complete enough to allow evaluation.

A survey of out-of-state travelers to South Carolina during the period of June 1, 1986, through May 31, 1987, identified activities participated in while in South Carolina. The results of this survey are shown in Table B-37. The most popular activities are shopping and participating in beach activities. The least popular activities are participating in tennis and other sports, and attending cultural events and festivals.

Table B-38 presents the results of South Carolina's survey of out-of-state visitors. Forty-six percent come to South Carolina for pleasure, compared to 31.8 percent for the United States. The second-largest group (26.3 percent) came to visit relatives and friends. For the United States, 37.0 percent of all travelers indicated this category was the key reason for travel.

Table B-1. Summary of Population Characteristics

Characteristic	INEL study area	State of Idaho	Hanford Site study area	State of Washington	SRP study area	Georgia and South Carolina	United States
			POPULATION				
1970-80 % change	27.2	32.4	54.8	21.1	18.0	19.6	11.4
1980-86 % change	6.1	6.3	3.5	8.0	11.6	10.4	6.4
1986 population	218,600	1,003,000	149,500	4,463,000	419,500	9,480,000	240,941,000
			AGE IN 1980				
% under 5	12.1	9.9	11.8	9.9	7.9	7.6	7.2
% 5 to 17	23.9	22.6	23.6	22.6	22.4	22.5	20.9
% 18 to 65	56.5	57.6	56.6	57.6	61.0	60.5	60.6
% over 65	7.5	9.9	8.0	9.9	8.7	9.4	11.3
			% CHANGE IN AGE GROUPS				
Under 5 - 1970-80	50.7	46.5	45.6	46.5	4.8	-0.6	-4.7
5 to 17 - 1970-80	2.4	6.9	0.7	6.9	-2.4	-0.4	-9.7
18 to 65 - 1970-80	37.4	42.5	33.8	42.5	26.2	29.1	20.9
Over 65 - 1970-80	37.1	38.2	32.7	38.2	47.5	44.0	27.3

Table B-2. Summary of Economic Characteristics

Characteristic	INEL study area	State of Idaho	Hanford Site study area	State of Washington	SRP study area	Georgia and South Carolina	United States
			EMPLOYMENT BY SECTOR				
Total in 1980	94,369	383,652	76,852	1,794,354	189,761	3,655,805	
% in agriculture, forestry, fisheries	6.6	10.0	5.5	3.8	1.5	2.8	3.0
% in mining	0.5	1.4	0.1	0.2	0.5	0.3	1.1
% in construction	5.9	7.0	13.1	6.8	5.2	6.7	5.9
% in manufacturing	11.2	13.9	12.4	19.5	21.3	27.1	22.4
% in nondurable goods	7.2	6.8	9.3	5.3	15.0	17.1	8.6
% in durable goods	4.0	7.2	3.2	14.2	6.3	10.0	13.8
% in transportation and public utilities	7.9	7.5	9.1	7.8	4.6	7.2	7.3
% in wholesale trade	4.4	4.5	2.5	5.1	2.3	4.4	4.3
% in retail trade	14.7	17.6	12.2	16.9	11.9	15.0	16.1
% in finance, insurance, real estate	4.5	5.4	3.7	6.2	3.3	5.1	6.0
% in service	28.7	26.7	26.0	28.8	24.3	26.0	28.7
% in government	4.5	5.9	2.9	4.9	3.9	5.2	5.3
			PERSONAL INCOME				
Personal income - 1980 ($1,000)	1,583,075	7,672,783	1,515,494	42,509,924	2,790,307	67,187,048	2,156,715,000
Per capita income in 1980	7,663	8,100	10,380	10,248	7,390	7,804	9,494
Per capita income in 1984	9,536	10,146	12,082	12,755	10,829	11,029	12,772
% change in personal income 1980 to 1984	30.8	32.3	18.9	30.5	54.5	50.0	39.9
% change in per capita income 1980 to 1984	24.3	25.3	16.4	24.5	46.5	41.3	34.5

Table B-3. Summary of Agricultural Characteristics

Characteristic	INEL study area	State of Idaho	Hanford Site study area	State of Washington	SRP study area	Georgia and South Carolina	United States
			LAND IN FARMS BY USE IN 1982				
Total land in farms (acres)	2,740,826	13,921,639	1,309,356	16,469,678	561,587	17,881,684	986,796,579
% in cropland	49.3	46.6	66.2[a]	49.7	63.0	54.3	45.1
% in woodland	4.3	5.8	0.4[a]	16.2	29.9	34.4	8.8
% in other land	44.2	47.6	33.1	34.1	7.1	11.4	46.0
% in pastureland, all types	48.2	53.5	30.8	47.6	13.9	24.5	53.4
% irrigated	76.7	65.9	55.0	36.4	23.9	18.6	25.0
Number of farms	4,680	24,714	2,152	36,080	1,786	74,559	2,240,976
Average size of farm	586	563	608	456	314	240	440
			% CHANGE IN LAND IN FARMS BY USE, 1978 TO 1982				
Total land in farms	0.1	-5.3	1.1	-1.5	-5.9	-8.1	-2.8
Cropland	-3.7	-0.9	5.4[a]	-0.6	-5.3	-4.8	-1.9
Woodland	27.4[b]	-5.1	106.5[a]	1.0	-9.6	-14.7	-5.1
Other land	-2.1	-9.3	-3.5	-4.0	5.5	-1.4	-3.1
Pastureland, all types	-5.6	-8.4	-1.3	-2.8	-17.3	-13.6	-4.8
Irrigated	17.3	-1.1	9.4	-9.1	132.2	8.0	-2.0
Number of farms	1.1	1.9	17.1	16.4	-9.5	-4.5	-0.7
Average size of farm	-1.0	-7.1	-13.7	-15.6	3.9	-3.7	-2.0
			MARKET VALUE OF AGRICULTURAL PRODUCTS IN 1982				
Total sales ($1,000)	424,414	2,231,605	291,211	2,831,159	74,402	3,736,233	131,900,223
% crop sales	66.9	52.0	84.0	60.6	61.0	47.7	47.2
% livestock and poultry	33.1	48.0	16.0	39.4	39.0	52.3	52.8
Average per farm ($)	107,437	90,297	135,321	78,469	41,658	50,111	58,858

Table B-3. Summary of Agricultural Characteristics (continued)

Characteristic	INEL study area	State of Idaho	Hanford Site study area	State of Washington	SRP study area	Georgia and South Carolina	United States
% CHANGE IN MARKET VALUE OF AGRICULTURAL PRODUCTS, 1978 TO 1982							
Total sales	35.0	36.6	30.8	36.4	20.4	16.9	23.2
% crop sales	54.0	45.7	34.0	32.5	23.6	22.4	29.2
% livestock and poultry	8.1	28.0	16.1	42.9	15.7	12.4	18.3
Average per farm	34.9	34.1	11.6	17.2	33.0	22.5	24.1

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[a] Area includes five of six counties; data withheld to avoid disclosure of confidential information.

[b] Area includes one of two counties; data withheld to avoid disclosure of confidential information.

Table B-4. Summary of Tourism and Travel Characteristics

Characteristic	INEL study area[a]	State of Idaho	Hanford Site study area	State of Washington	SRP study area	Georgia and South Carolina	United States
			HOTEL AND MOTEL CHARACTERISTICS IN 1982				
# of establishments	50	262	31	818	49	1,578	41,231
# of establishments reporting receipts and employment	15	262	31	818	45[b]	1,578	41,231
Receipts ($1,000)	6,837	113,023	15,599	432,627	20,903	1,243,177	33,214,751
Employment	279	5,114	665	16,425	756	43,130	1,102,097
			CHARACTERISTICS OF TRAVEL			South Carolina	
Visit friends/relatives	NA[c]	32.7	NA[c]	NA[c]	NA[c]	26.3	37.0
Leisure/vacation	NA[c]	51.8	NA[c]	NA[c]	NA[c]	46.0	31.8
Business/conventions	NA[c]	7.1	NA[c]	NA[c]	NA[c]	15.7	23.9
Other purpose(s)	NA[c]	8.3	NA[c]	NA[c]	NA[c]	12.0	7.3

[a] Area includes 6 impact counties plus Blaine County.

[b] Only 40 reported employment.

[c] NA = Information not available.

Table B-5. Recent Population Trends[a]

County	1970	1980	1970-80, % change	1986 estimate	1980-86, % change
Bannock	52,200	65,421	25.3	68,100	4.1
Bingham	29,167	36,489	25.1	38,300	5.0
Bonneville	52,457	65,980	25.8	70,600	7.0
Butte	2,925	3,342	14.3	3,100	-7.2
Jefferson	11,740	15,340	30.7	16,500	7.6
Madison	13,452	19,480	44.8	22,000	12.9
Six-county totals	161,941	206,052	27.2	218,600	6.1
Idaho total	713,015	943,935	32.4	1,003,000	6.3
United States total	203,302,031	226,545,805	11.4	240,941,000	6.4

[a] Source: Bureau of the Census (1981b,d; 1986; 1987).

Table B-6. Population by Age, 1970[a]

Location	Age				Total	Median age
	Under 5	5 to 17	18 to 64	65 and over		
Bannock	5,153	14,208	28,845	3,994	52,200	23.6
Bingham	3,125	9,634	14,225	2,183	29,167	23.0
Bonneville	5,638	16,146	26,326	3,140	51,250	23.4
Butte	275	973	1,458	219	2,925	25.7
Jefferson	1,175	3,858	5,655	931	11,619	23.4
Madison	1,139	3,222	8,234	857	13,452	19.8
Six-county totals	16,505	48,041	84,743	11,324	160,613	NA[b]
Idaho total	63,840	199,388	381,563	67,776	712,567	26.4
United States total	17,154,337	52,489,744	113,502,343	20,065,502	203,211,926	28.1

[a] Sources: Bureau of the Census (1971b; 1983b,d).

[b] NA = Information not available.

Table B-7. Population by Age, 1980[a]

Location	Age				Total	Median age
	Under 5	5 to 17	18 to 64	65 and over		
Bannock	7,230	14,202	38,768	5,221	65,421	25.7
Bingham	4,823	9,818	18,875	2,973	36,489	24.5
Bonneville	7,764	16,441	37,133	4,642	65,980	25.5
Butte	392	816	1,765	369	3,342	27.8
Jefferson	2,153	4,011	7,837	1,303	15,304	24.0
Madison	2,504	3,928	12,033	1,015	19,480	19.9
Six-county totals	24,866	49,216	116,411	15,523	206,016	NA[b]
Idaho total	93,531	213,134	543,590	93,680	943,935	27.5
United States total	16,348,254	47,406,706	137,241,418	25,549,427	226,545,805	30.0

[a] Source: Bureau of the Census (1983b,d).

[b] NA = Information not available.

Table B-8. Estimates of the Components of Population Change, 1980-85[a]

County	Births	Deaths	Net migration	Population change	Percent change
Bannock	9,685	1,840	(458)[b]	7,387	11.3
Bingham	4,501	1,076	512	3,937	10.8
Bonneville	9,200	1,683	823	8,340	12.6
Butte	303	96	681	888	26.6
Jefferson	1,951	444	(309)[b]	1,198	7.8
Madison	4,565	372	49	4,242	21.8
Six-county totals	30,205	5,511	1,298	25,992	12.6
Idaho total	100,000	37,000	(2,000)[b]	61,000	6.5
United States total	19,219,000	10,555,000	3,530,000	12,194,000	5.4

[a] Sources: Bureau of the Census (1988); GEC Company (1987).

[b] Numbers in parentheses are negative.

Table B-9. Employment by Place of Work by Industry[a]

Category	Six-county area		Idaho		United States	
	1980	Percent	1980	Percent	1980	Percent
Agriculture, forestry, fisheries	6,261	6.6	38,516	10.0	2,913,589	3.0
Mining	443	0.5	5,443	1.4	1,028,178	1.1
Construction	5,545	5.9	26,718	7.0	5,739,598	5.9
Manufacturing	10,537	11.2	53,455	13.9	21,914,754	22.4
Nondurable goods	6,798	7.2	26,016	6.8	8,435,543	8.6
Durable goods	3,739	4.0	27,439	7.2	13,479,211	13.8
Transportation and public utilities	7,500	7.9	28,789	7.5	7,087,455	7.3
Wholesale trade	4,187	4.4	17,239	4.5	4,217,232	4.3
Retail trade	13,830	14.7	67,556	17.6	15,716,694	16.1
Finance, insurance, real estate	4,271	4.5	20,755	5.4	5,898,059	6.0
Services	27,037	28.7	102,445	26.7	27,976,330	28.7
Government	4,221	4.5	22,736	5.9	5,147,466	5.3
Total by industry	94,369		383,652		97,639,355	

[a] Source: Bureau of the Census (1983g,i).

Table B-10. Trends in Earnings and Personal Income (thousands of dollars)[a]

	Six-county area					Idaho				
	1980		1984		1980 to 1984	1980		1984		1980 to 1984
Category	Income	Percent	Income	Percent	% change	Income	Percent	Income	Percent	% change
EARNINGS BY INDUSTRY BY PLACE OF WORK										
Agriculture, forestry, fisheries	93,378	6.8	87,413	5.2	-6.4	557,168	9.9	613,272	8.7	10.1
Mining	401[b]	0.0	(179)[c]	0.0	--	107,433	1.9	128,904	1.8	20.0
Construction	100,776	7.4	90,510[d]	5.4	-9.7[d]	424,167	7.5	472,797	6.7	11.5
Manufacturing	141,478	10.3	212,368	12.6	50.1	998,142	17.7	1,278,090	18.1	28.0
Nondurable goods	70,334[d]	5.1	104,782[d]	6.2	49.0[d]	409,213	7.3	603,021	8.6	47.4
Durable goods	71,079[d]	5.2	67,127[d]	4.0	-5.6[d]	588,929	10.5	675,069	9.6	14.6
Transportation and public utilities	112,403	8.2	129,344	7.6	15.1	439,960	7.8	544,307	7.7	23.7
Wholesale trade	82,441[d]	6.0	104,747	6.2	26.4[d]	356,572	6.3	421,702	6.0	18.3
Retail trade	115,170	8.4	148,504	8.8	28.9	587,420	10.4	742,683	10.5	26.4
Finance, insurance, real estate	52,627	3.8	62,229[d]	3.7	20.9[d]	263,694	4.7	327,952	4.7	24.4
Services	340,175	24.8	433,666	25.6	27.5	923,083	16.4	1,258,233	17.9	36.3
Government	189,103	13.8	250,837	14.8	32.6	974,453	17.3	1,260,416	17.9	29.3
Total earnings	1,369,365		1,691,348		23.5	5,632,092		7,048,356		25.1
INCOME BY PLACE OF RESIDENCE										
Total personal income	1,583,075		2,070,274		30.8	7,672,783		10,153,172		32.3
Per capita income	7,670		9,537		24.3	8,100		10,146		25.3

Table B-10. Trends in Earnings and Personal Income (thousands of dollars)[a] (continued)

	United States				
	1980		1984		1980 to 1984
Category	Income	Percent	Income	Percent	% change
EARNINGS BY INDUSTRY BY PLACE OF WORK					
Agriculture, forestry, fisheries	35,824,000	2.2	48,575,000	2.3	35.6
Mining	28,593,000	1.8	34,753,000	1.6	21.5
Construction	94,633,000	5.9	116,946,000	5.4	23.6
Manufacturing	412,134,000	25.9	513,341,000	23.8	24.6
Nondurable goods	145,826,000	9.2	187,494,000	8.7	28.6
Durable goods	266,308,000	16.7	325,847,000	15.1	22.4
Transportation and public utilities	123,758,000	7.8	162,708,000	7.5	31.5
Wholesale trade	108,888,000	6.8	144,799,000	6.7	33.0
Retail trade	153,067,000	9.6	206,554,000	9.6	34.9
Finance, insurance, real estate	92,627,000	5.8	139,177,000	6.4	50.3
Services	281,471,000	17.7	437,769,000	20.3	55.5
Government	262,655,000	16.5	353,479,000	16.4	34.6
Total earnings	1,593,650,000		2,158,101,000		35.4
INCOME BY PLACE OF RESIDENCE					
Total personal income	2,156,715,000		3,016,317,000		39.9
Per capita income	9,494		12,772		34.5

[a] Source: Bureau of Economic Analysis (1986b,d).

[b] Total is two of six counties. Data withheld to avoid disclosure of confidential information.

[c] Total is for Madison County only. Data withheld to avoid disclosure of confidential information.

[d] Total and percent are for five of six counties. Data withheld to avoid disclosure of confidential information.

Table B-11. Unemployment Rates, 1987[a]

County	Percent unemployment
Bannock	6.2
Bingham	6.7
Bonneville	4.6
Butte	4.7
Jefferson	6.0
Madison	4.3
Six-county total	5.5
Idaho	5.7
United States	6.2

[a] Sources: Federal Reserve Board, 1988; Idaho Department of Employment, 1988.

Table B-12. Trends in Farms, Land in Farms, and Land Use[a]

	Six-county area					Idaho				
	1978		1982		1978 to 1982	1978		1982		1978 to 1982
Category	Amount	Percent	Amount	Percent	% change	Amount	Percent	Amount	Percent	% change
LAND IN FARMS BY USE (ACRES)										
Cropland	1,401,433	51.2	1,350,216	49.3	-3.7	6,540,493	44.5	6,484,076	46.6	-0.9
Harvested	1,033,162	37.7	1,045,255	38.1	1.2	4,820,928	32.8	4,887,805	35.1	1.4
Irish potatoes	162,897	5.9	148,932	5.4	-8.6	363,309	2.5	320,019	2.3	-11.9
Pasture or grazing	91,908[b]	3.4	80,879[c]	3.0	-0.9[c]	748,883	5.1	763,021	5.5	1.9
Other	198,590[b]	7.3	144,462[c]	5.3	-25.1[c]	970,682	6.6	833,250	6.0	-14.2
Woodland	33,772[b]	1.2	117,917	4.3	27.4[b]	850,999	5.8	807,403	5.8	-5.1
Woodland pastured	25,019[b]	0.9	33,124[c]	1.2	33.3[c]	640,581	4.4	613,877	4.4	-4.2
Woodland not pastured	8,749[b]	0.3	9,479[c]	0.3	10.2[c]	210,418	1.4	193,526	1.4	-8.0
Other land	1,237,644[b]	45.2	1,214,006	44.2	-3.8[b]	7,307,608	49.7	6,630,160	47.6	-9.3
Pasture	1,167,799	42.7	1,089,740	39.8	-6.7	6,748,908	45.9	6,074,020	43.6	-10.0
House lots, etc.	69,845[b]	2.6	124,266	4.5	-0.2[b]	558,700	3.8	556,140	4.0	-0.5
Pastureland, all types	1,399,505	51.1	1,320,437	48.2	-5.6	8,138,372	55.4	7,450,918	53.5	-8.4
Set aside in Federal programs	61,424	2.2	26,136	1.0	-57.4	288,048	2.0	143,434	1.0	-50.2
FARMS AND LAND IN FARMS (ACRES)										
Farms (number)	4,629		4,680		1.1	24,249		24,714		1.9
Land in farms	2,737,883		2,740,826		0.1	14,699,100		13,921,639		-5.3
Average size of farm	591		586		-1.0	606		563		-7.1
Land in irrigated farms	1,792,139		2,102,887		17.3	9,271,632		9,168,380		-1.1

Table B-12. Trends in Farms, Land in Farms, and Land Use[a] (continued)

	United States				
	1978		1982		1978 to 1982
Category	Amount	Percent	Amount	Percent	% change
LAND IN FARMS BY USE (ACRES)					
Cropland	453,874,133	44.7	445,362,028	45.1	-1.9
Harvested	317,145,955	31.3	326,306,462	33.1	2.9
Irish potatoes					
Pasture or grazing	73,204,828	7.2	65,027,715	6.6	-11.2
Other	63,523,350	6.3	54,027,851	5.5	-14.9
Woodland	91,815,487	9.0	87,088,255	8.8	-5.1
Woodland pastured	47,022,313	4.6	43,420,212	4.4	-7.7
Woodland not pastured	44,793,174	4.4	43,668,043	4.4	-2.5
Other land	469,087,614	46.2	454,346,296	46.0	-3.1
Pasture	433,316,686	42.7	418,264,264	42.4	-3.5
House lots, etc.	35,770,928	3.5	36,082,032	3.7	0.9
Pastureland, all types	553,543,827	54.5	526,712,191	53.4	-4.8
Set aside in Federal programs	16,116,763	1.6	8,413,553	0.9	-47.8
FARMS AND LAND IN FARMS (ACRES)					
Farms (number)	2,257,775		2,240,976		-0.7
Land in farms	1,014,777,234		986,796,579		-2.8
Average size of farm	449		440		-2.0
Land in irrigated farms	251,648,772		246,603,071		-2.0

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[a] Source: Bureau of the Census (1984b,d).

[b] Total and percentage is for five of six counties. Data withheld to avoid disclosure of confidential information.

[c] Total and percentage is for four of six counties. Data withheld to avoid disclosure of confidential information.

Table B-13. Trends in Market Value of Agricultural Products Sold (in thousands of dollars)[a]

	Six-county area					Idaho				
	1978		1982		1978 to 1982	1978		1982		1978 to 1982
Category	Amount	Percent	Amount	Percent	% change	Amount	Percent	Amount	Percent	% change
Crop sales	184,423	58.7	283,991	66.9	54.0	796,800	48.8	1,160,742	52.0	45.7
Grains	76,577	24.4	121,449	28.6	58.6	361,317	22.1	554,691	24.9	53.5
Hay, silage, and field seeds	15,148	4.8	21,682	5.1	43.1	87,770	5.4	118,536	5.3	35.1
Vegetables, sweet corn, and melons	10[b]	0.0	36[b]	0.0	260.0[b]	24,335	1.5	28,168	1.3	15.8
Other crops	92,688	29.5	140,824	33.2	51.9	323,378	19.8	459,347	20.6	42.0
Livestock and poultry	129,888	41.3	140,423	33.1	8.1	836,360	51.2	1,070,863	48.0	28.0
Poultry & products	27[c]	0.0	39[c]	0.0	44.4[c]	10,792	0.7	14,240	0.6	31.9
Dairy products	19,790	6.3	33,053	7.8	67.0	143,701	8.8	255,988	11.5	78.1
Cattle & calves	99,315	31.6	95,955	22.6	-3.4	612,577	37.5	721,743	32.3	17.8
Hogs & pigs	2,478	0.8	2,564	0.6	3.5	11,343	0.7	12,373	0.6	9.1
Other livestock	8,278	2.6	8,812	2.1	6.5	57,947	3.5	66,519	3.0	14.8
Total sales	314,311		424,414		35.0	1,633,160		2,231,605		36.6
Average per farm ($)	79,654		107,437		34.9	67,350		90,297		34.1

Table B-13. Trends in Market Value of Agricultural Products Sold (in thousands of dollars)[a] (continued)

	United States				
	1978		1982		1978 to 1982
Category	Amount	Percent	Amount	Percent	% change
Crop sales	48,203,200	45.0	62,256,087	47.2	29.2
Grains	26,747,307	25.0	36,409,105	27.6	36.1
Hay, silage, and field seeds	2,275,068	2.1	2,312,006	1.8	1.6
Vegetables, sweet corn, and melons	3,238,826	3.0	4,145,446	3.1	28.0
Other crops	15,941,999	14.9	19,389,530	14.7	21.6
Livestock and poultry	58,870,258	55.0	69,644,136	52.8	18.3
Poultry & products	8,463,486	7.9	9,796,927	7.4	15.8
Dairy products	11,228,899	10.5	16,320,417	12.4	45.3
Cattle & calves	29,610,751	27.7	31,635,157	24.0	6.8
Hogs & pigs	8,071,766	7.5	9,867,741	7.5	22.3
Other livestock	1,495,356	1.4	2,023,894	1.5	35.3
Total sales	107,073,458		131,900,223		23.2
Average per farm ($)	47,424		58,858		24.1

[a] Source: Bureau of the Census (1984b,d).

[b] Totals and percent change for one of six counties. Data withheld to avoid disclosure of confidential information.

[c] Totals and percent change for four of six counties. Data withheld to avoid disclosure of confidential information.

Table B-14. Hotel and Motel Characteristics, 1982[a]

Location	Number of establishments	Receipts ($1,000)	Employment
Bannock	14	(b)	(b)
Bingham	5	(b)	NA[c]
Blaine	13	(b)	NA[c]
Bonneville	15	6,837	279
Butte	1	(b)	NA[c]
Jefferson	--	--	NA[c]
Madison	2	(b)	NA[c]
County totals[d]	50	6,837	279
Idaho	262	113,023	5,114
United States	41,231	33,214,751	1,102,097

[a] Source: Bureau of the Census (1984g,i).

[b] Not shown to avoid disclosure of confidential information.

[c] NA = information not provided by Census publications.

[d] County totals do not include information that has been withheld to avoid disclosure or that has not been provided.

Table B-15. Travel by Purpose of Trip, Idaho and United States[a]

Purpose of trip	Idaho (percent)	United States (percent)
Visit relatives/friends	32.7	37.0
Other pleasure	51.8	31.8
Business/convention	7.1	23.9
Other purpose	8.3	7.3

[a] University of Idaho (1988); U.S. Travel Data Center (1987).

Table B-16. Activities of Leisure Travelers in Idaho[a]

Characteristic	Estimated percentage
Leisure travelers from outside the State	63
Leisure travelers who stay overnight	78
Leisure travelers who stay overnight and are from out of State	70
Travelers who have Idaho as a destination	56
Travelers by season	
Summer	36
Fall	20
Winter	20
Spring	24
Travelers with one key destination	
Non-Idaho destination	52
Rural Idaho	36
Idaho's 10 largest cities	12

[a] Source: University of Idaho (1988).

Table B-17. Recent Population Trends[a]

Location	1970	1980	1970-1980 % change	1986 estimate	1980-1986 % change
Benton	67,540	109,444	62.0	112,700	3.0
Franklin	25,816	35,025	35.7	36,800	5.1
Two-county totals	93,356	144,469	54.8	149,500	3.5
Washington total	3,413,244	4,132,156	21.1	4,463,000	8.0
United States total	203,302,031	226,545,805	11.4	240,941,000	6.4

[a] Source: Bureau of the Census (1981d,e; 1986; 1987).

Table B-18. Population by Age, 1970[a]

Location	Age				Total	Median age
	Under 5	5 to 17	18 to 64	65 and over		
Benton	5,714	20,428	37,001	4,397	67,540	27.0
Franklin	2,253	7,647	14,219	1,697	25,816	25.6
Two-county totals	7,967	28,075	51,220	6,094	93,356	NA[b]
Washington total	280,442	879,332	1,927,334	322,061	3,409,169	27.5
United States total	17,154,337	52,489,744	113,502,343	20,065,502	203,211,926	28.1

[a] Source: Bureau of the Census (1971d; 1983d,e).

[b] NA = Information not available.

Table B-19. Population by Age, 1980[a]

Location	Age				Total	Median age
	Under 5	5 to 17	18 to 64	65 and over		
Benton	9,683	24,593	67,949	7,219	109,444	28.0
Franklin	3,831	7,823	20,710	2,661	35,025	26.7
Two-county totals	13,514	32,416	88,659	9,880	144,469	NA[b]
Washington total	306,123	833,237	2,561,234	431,562	4,132,156	29.8
United States total	16,348,254	47,406,706	137,241,418	25,549,427	226,545,805	30.0

[a] Source: Bureau of the Census (1983d,e).

[b] NA = Information not available.

Table B-20. Estimates of the Components of Population Change, 1980-86 for Counties and State, 1980-85 for United States[a]

Location	Births	Deaths	Net migration	Population change	Percent change
Benton	14,305	4,118	(15,531)[b]	(5,344)[b]	-4.9
Franklin	5,887	1,590	(3,822)[b]	475	1.4
Two-county totals	20,192	5,708	(19,353)[b]	(4,869)[b]	-3.5
Washington total	484,451	231,403	188,400	441,448	10.7
United States total	19,219,000	10,555,000	3,530,000	12,194,000	5.4

[a] Sources: Bureau of the Census (1988); Office of Financial Management (1987).
[b] Parentheses indicate a negative number.

Table B-21. Employment by Place of Work by Industry[a]

Category	Benton		Franklin		Two-county area		Washington		United States	
	1980	Percent	1980	Percent	1980	Percent	1980	Percent	1980	Percent
Agriculture, forestry, fisheries	2,162	4.2	2,058	13.5	4,220	5.5	69,017	3.8	2,913,589	3.0
Mining	77	0.1	16	0.1	93	0.1	3,706	0.2	1,028,178	1.1
Construction	8,461	16.3	1,614	10.6	10,075	13.1	122,396	6.8	5,739,598	5.9
Manufacturing	7,276	14.0	2,271	14.9	9,547	12.4	349,977	19.5	21,914,754	22.4
Nondurable goods	5,146	9.9	1,980	13.0	7,126	9.3	95,166	5.3	8,435,543	8.6
Durable goods	2,130	4.1	291	1.9	2,421	3.2	254,811	14.2	13,479,211	13.8
Transportation and public utilities	5,123	9.8	1,836	12.0	6,959	9.1	139,132	7.8	7,087,455	7.3
Wholesale trade	1,303	2.5	651	4.3	1,954	2.5	91,171	5.1	4,217,232	4.3
Retail trade	7,169	13.8	2,180	14.3	9,349	12.2	303,562	16.9	15,716,694	16.1
Finance, insurance, real estate	2,220	4.3	648	4.2	2,868	3.7	111,485	6.2	5,898,059	6.0
Services	16,588	31.9	3,410	22.3	19,998	26.0	515,905	28.8	27,976,330	28.7
Government	1,651	3.2	591	3.9	2,242	2.9	88,003	4.9	5,147,466	5.3
Total by industry	52,030		15,275		76,852		1,794,354		97,639,355	

[a] Source: Bureau of the Census (1983i, j).

Table B-22. Trends in Earnings and Personal Income (in thousands of dollars)[a]

	Two-county area					Washington				
	1980		1984		1980 to 1984	1980		1984		1980 to 1984
Category	Income	Percent	Income	Percent	% change	Income	Percent	Income	Percent	% change
EARNINGS BY INDUSTRY BY PLACE OF WORK										
Agriculture, forestry, fisheries	83,327	6.6	86,826	5.0	4.2	1,150,747	3.7	1,399,642	3.7	21.6
Mining	(b)	--	(b)	--	--	75,899	0.2	76,878	0.2	1.3
Construction	249,276	19.8	109,679	6.4	-56.0	2,403,251	7.7	2,125,435	5.6	-11.6
Manufacturing	209,840	16.7	355,992	20.6	69.6	7,400,221	23.6	8,592,134	22.6	16.1
Nondurable goods	188,099	15.0	332,724	19.3	76.9	1,798,483	5.7	2,304,999	6.1	28.2
Durable goods	21,741	1.7	23,268	1.3	7.0	5,601,738	17.9	6,287,135	16.5	12.2
Transportation and public utilities	57,222	4.6	62,129	3.6	8.6	2,270,128	7.2	2,83[illegible],474	7.4	24.7
Wholesale trade	34,138	2.7	39,828	2.3	16.7	2,133,912	6.8	2,536,305	6.7	18.9
Retail trade	96,395	7.7	101,725	5.9	5.5	3,160,756	10.1	3,903,712	10.3	23.5
Finance, insurance, real estate	27,001	2.1	23,731	1.4	-12.1	1,691,251	5.4	2,065,716	5.4	22.1
Services	326,246	26.0	374,606	21.7	14.8	5,109,033	16.3	6,635,607	17.4	29.9
Government	173,494	13.8	214,208	12.4	23.5	5,930,955	18.9	7,915,123	20.8	33.5
Total earnings	1,256,939		1,368,724		8.9	31,326,153		38,081,026		21.6
INCOME BY PLACE OF RESIDENCE										
Total personal income	1,515,494		1,801,425		18.9	42,509,924		55,471,825		30.5
Per capita income	10,380		12,082		16.4	10,248		12,755		24.5

[a] Source: Bureau of Economic Analysis (1986a,d).

[b] Not shown to avoid disclosure of confidential information.

Table B-23. Unemployment Rates, 1987[a]

Location	Percent unemployment
Benton	9.0
Franklin	11.5
Two-county total	NA[b]
Washington	7.6
United States	7.2

[a] Sources: Bureau of the Census (1988); Washington Employment Security Department (1988).

[b] NA = Information not available.

Table B-24. Trends in Farms, Land in Farms, and Land Use[a]

	Two-county area[b]					Washington				
	1978		1982		1978 to 1982	1978		1982		1978 to 1982
Category	Amount	Percent	Amount	Percent	% change	Amount	Percent	Amount	Percent	% change
LAND IN FARMS BY USE (ACRES)										
Cropland	725,731	56.0	571,057	43.6	-21.3	8,236,401	49.3	8,190,984	49.7	-0.6
Harvested	545,216	42.1	571,057	43.6	4.7	5,014,228	30.0	5,278,772	32.1	5.3
Pasture or grazing	24,474	1.9	(c)	--	--	553,482	3.3	612,088	3.7	10.6
Other	156,041	12.0	(c)	--	--	2,668,691	16.0	2,300,124	14.0	-13.8
Woodland	2,355	0.2	4,863	0.4	106.5	2,633,179	15.7	2,660,062	16.2	1.0
Woodland pastured	651	0.1	(c)	--	--	2,197,348	13.1	2,199,021	13.4	0.1
Woodland not pastured	1,704	0.1	(c)	--	--	435,831	2.6	461,041	2.8	5.8
Other land	449,424	34.7	433,874	33.1	-3.5	5,852,256	35.0	5,618,632	34.1	-4.0
Pasture	383,815	29.6	377,814	28.9	-1.6	5,315,782	31.8	5,028,706	30.5	-5.4
House lots, etc.	65,609	5.1	56,060	4.3	-14.6	536,474	3.2	589,926	3.6	10.0
Pastureland, all types	408,940	31.6	403,576	30.8	-1.3	8,066,612	48.2	7,839,815	47.6	-2.8
Set aside in Federal programs	15,819	1.2	9,624	0.7	-39.2	298,553	1.8	215,283	1.3	-27.9
FARMS AND LAND IN FARMS (ACRES)										
Farms (number)	1,837		2,152		17.1	30,987		36,080		16.4
Land in farms	1,295,525		1,309,356		1.1	16,721,836		16,469,678		-1.5
Average size of farm	705		608		-13.7	540		456		-15.6
Land in irrigated farms	658,191		719,915		9.4	6,605,946		6,002,592		-9.1

[a] Source: Bureau of the Census (1984d,e).

[b] Totals are for reported information. Information withheld to avoid disclosure of confidential information at county level is not included.

[c] Not shown to avoid disclosure of confidential information.

Table B-25. Trends in Market Value of Agricultural Products Sold (in thousands of dollars)[a]

	Two-county area					Washington				
	1978		1982		1978 to 1982	1978		1982		1978 to 1982
Category	Amount	Percent	Amount	Percent	% change	Amount	Percent	Amount	Percent	% change
Crop sales	182,427	81.9	244,520	84.0	34.0	1,293,857	62.3	1,714,741	60.6	32.5
Grains	40,976	18.4	75,841	26.0	85.1	453,984	21.9	685,640	24.2	51.0
Hay, silage, and field seeds	18,505	8.3	22,674	7.8	22.5	87,968	4.2	103,709	3.7	17.9
Vegetables, sweet corn, and melons	9,793	4.4	15,542	5.3	58.7	80,929	3.9	107,460	3.8	32.8
Other crops	113,153	50.8	130,463	44.8	15.3	670,976	32.3	817,932	28.9	21.9
Livestock and poultry	40,227	18.1	46,691	16.0	16.1	781,298	37.7	1,116,418	39.4	42.9
Poultry & products	5[b]	0.0	13[b]	0.0	160.0	72,621	3.5	89,240	3.2	22.9
Dairy products	4,819	2.2	6,839	2.3	41.9	257,831	12.4	393,522	13.9	52.6
Cattle & calves	33,086	14.9	35,451	12.2	7.1	416,920	20.1	593,402	21.0	42.3
Hogs & pigs	332	0.1	390	0.1	17.5	9,741	0.5	12,050	0.4	23.7
Other livestock	795[b]	0.4	573[b]	0.2	-27.9	24,185	1.2	28,204	1.0	16.6
Total sales	222,654		291,211		30.8	2,075,155		2,831,159		36.4
Average per farm ($)	121,205		135,321		11.6	66,969		78,469		17.2

[a] Source: Bureau of the Census (1984d,e).

[b] Total for Benton County only; data withheld to avoid disclosure of confidential information.

Table B-26. Hotel and Motel Characteristics, 1982[a]

Location	Number of establishments	Receipts ($1,000)	Employment
Benton	20	8,520	373
Franklin	11	7,079	292
Two-county totals	31	15,599	665
Washington	818	432,627	16,425
United States	41,231	33,214,751	1,102,097

[a] Source: Bureau of the Census (1984i,j).

Table B-27. Recent Population Trends[a]

Location	1970	1980	1970-80 % change	1986 estimate	1980-86 % change
South Carolina counties					
Aiken	91,023	105,625	16.0	118,500	12.2
Allendale	9,783	10,700	9.4	10,600	-0.9
Bamberg	15,950	18,118	13.6	18,200	0.5
Barnwell	17,176	19,868	15.7	21,000	5.7
Georgia counties					
Columbia	22,327	40,118	79.7	56,400	40.6
Richmond	162,437	181,629	11.8	194,800	7.3
Six-county totals	318,696	376,058	18.0	419,500	11.6
Georgia	4,587,930	5,462,989	19.1	6,104,000	11.7
South Carolina	2,590,713	3,121,820	20.5	3,376,000	8.1
United States	203,302,031	226,545,805	11.4	240,941,000	6.4

[a] Source: Bureau of the Census (1981a,c,d; 1986; 1987).

Table B-28. Population by Age, 1970[a]

Location	Age				Total	Median age
	Under 5	5 to 17	18 to 64	65 and over		
South Carolina counties						
Aiken	8,503	26,287	49,915	6,318	91,023	26.0
Allendale	954	2,752	5,049	937	9,692	25.1
Bamberg	1,516	4,665	8,299	1,470	15,950	22.9
Barnwell	1,567	5,180	8,827	1,602	17,176	24.9
Georgia counties						
Columbia	2,347	6,715	12,211	1,054	22,327	23.0
Richmond	13,497	40,828	97,331	10,781	162,437	23.7
Six-county totals	28,384	86,427	181,632	22,162	318,605	NA[b]
Georgia	421,709	1,222,579	2,577,829	367,458	4,589,575	25.9
South Carolina	235,764	719,399	1,444,393	190,960	2,590,516	24.8
United States	17,154,337	52,489,744	113,502,343	20,065,502	203,211,926	28.1

[a] Source: Bureau of the Census (1971a,c; 1983a,c,d).

[b] NA = Information not available.

Table B-29. Population by Age, 1980[a]

	Age					
Location	Under 5	5 to 17	18 to 64	65 and over	Total	Median age
South Carolina counties						
Aiken	8,105	24,256	63,241	10,023	105,625	29.5
Allendale	924	2,696	5,799	1,281	10,700	28.2
Bamberg	1,409	4,361	10,343	2,005	18,118	26.6
Barnwell	1,770	4,942	11,045	2,111	19,868	27.8
Georgia counties						
Columbia	3,547	9,987	24,562	2,022	40,118	27.3
Richmond	13,979	38,101	114,306	15,243	181,629	26.7
Six-county totals	29,734	84,343	229,296	32,685	376,058	NA[b]
Georgia	414,935	1,231,195	3,300,244	516,731	5,463,105	28.6
South Carolina	238,516	703,450	1,892,526	287,328	3,121,820	28.0
United States	16,348,254	47,406,706	137,241,418	25,549,427	226,545,805	30.0

[a] Source: Bureau of the Census (1983a,c,d).
[b] NA = Information not available.

Table B-30. Estimates of the Components of Population Change[a]

Location	Births	Deaths	Net migration	Population change	Percent change
ESTIMATES FOR APRIL 1, 1980 - JULY 1, 1986					
South Carolina counties					
Aiken	11,000	5,800	7,700	12,900	12.2
Allendale	1,300	700	(600)	0	0.0
Bamberg	1,800	1,000	(700)	100	0.6
Barnwell	2,000	1,200	200	1,000	5.0
ESTIMATES FOR APRIL 1, 1980 - JULY 1, 1985					
Georgia counties					
Columbia	4,400	1,200	9,500	12,700	31.7
Richmond	17,500	7,900	600	10,200	5.6
Six-county totals	38,000	17,800	16,700	36,900	9.8
Georgia	483,000	242,000	273,000	514,000	9.4
South Carolina	270,000	136,000	91,000	225,000	7.2
United States	19,219,000	10,555,000	3,530,000	12,194,000	5.4

[a] Sources: Bureau of the Census (1988); Personal Communication (1988); South Carolina Division of Research and Statistical Services (1988).

Table B-31. Employment by Place of Work by Industry[a]

Category	Six-county area		South Carolina		Georgia	
	1980	Percent	1980	Percent	1980	Percent
Agriculture, forestry, fisheries	2,767	1.5	34,564	2.6	68,125	2.9
Mining	893	0.5	2,435	0.2	8,588	0.4
Construction	9,905	5.2	95,206	7.2	150,041	6.4
Manufacturing	40,387	21.3	430,065	32.6	562,023	24.1
Nondurable goods	28,448	15.0	284,826	21.6	341,941	14.6
Durable goods	11,939	6.3	145,239	11.0	220,082	9.4
Transportation and public utilities	8,654	4.6	76,015	5.8	188,676	8.1
Wholesale trade	4,394	2.3	46,451	3.5	113,927	4.9
Retail trade	22,526	11.9	191,168	14.5	358,122	15.3
Finance, insurance, real estate	6.239	3.3	57,429	4.4	130,329	5.6
Services	46,146	24.3	330,837	25.1	620,630	26.6
Government	7,463	3.9	55,800	4.2	135,374	5.8
Total by industry	189,761		1,319,970		2,335,835	

[a] Source: Bureau of the Census (1983f,h,i).

Table B-32. Trends in Earnings and Personal Income (in thousands of dollars)[a]

	Six-county total					South Carolina				
	1980		1984		1980 to 1984	1980		1984		1980 to 1984
Category	Income	Percent	Income	Percent	% change	Income	Percent	Income	Percent	% change
EARNINGS BY INDUSTRY BY PLACE OF WORK										
Agriculture, forestry, fisheries	4,744	0.2	25,519[b]	0.8	437.9	219,734	0.9	403,808	1.2	83.8
Mining	71[b]	0.0	9,915[b]	0.3	0.3	30,577	0.1	38,084	0.1	24.6
Construction	118,795	5.5	198,362[c]	6.4	67.0	1,169,658	5.0	1,655,312	5.1	41.5
Manufacturing	730,098	33.7	1,003,473	32.1	37.4	5,960,008	25.3	7,781,798	24.0	30.6
Nondurable goods	538,092[c]	24.8	736,095	23.6	36.8	4,033,613	17.1	5,101,421	15.7	26.5
Durable goods	181,372[c]	8.4	267,381	8.6	47.4	1,926,395	8.2	2,680,377	8.3	39.1
Transportation and public utilities	109,753	5.1	139,421[c]	4.5	27.0	1,132,564	4.8	1,667,810	5.1	47.3
Wholesale trade	65,485[d]	3.0	105,247	3.4	60.7	889,313	3.8	1,181,247	3.6	32.8
Retail trade	187,284	8.6	284,281	9.1	51.8	1,601,049	6.8	2,344,030	7.2	46.4
Finance, insurance, real estate	69,704	3.2	98,772	3.2	41.7	739,022	3.1	1,073,457	3.3	45.3
Services	234,447	10.8	411,940	13.2	75.7	2,132,688	9.1	3,387,432	10.4	58.8
Government	646,102	29.8	846,606	27.1	31.0	3,692,494	15.7	5,161,573	15.9	39.8
Total earnings	2,166,488		3,123,536		43.7	23,527,115		32,476,349		38.0
INCOME BY PLACE OF RESIDENCE										
Total personal income	2,790,307		4,311,162		54.5	23,106,059		33,366,955		44.4
Per capita income	7,390		10,829		46.5	7,389		10,111		36.8

Table B-32. Trends in Earnings and Personal Income (in thousands of dollars)[a] (continued)

	Georgia					United States				
	1980		1984		1980 to 1984	1980		1984		1980 to 1984
Category	Income	Percent	Income	Percent	% change	Income	Percent	Income	Percent	% change
					EARNINGS BY INDUSTRY BY PLACE OF WORK					
Agriculture, forestry, fisheries	432,658	1.3	1,313,561	2.5	203.6	35,824,000	2.2	48,575,000	2.3	35.6
Mining	142,758	0.4	200,769	0.4	40.6	28,593,000	1.8	34,753,000	1.6	21.5
Construction	1,889,869	5.5	3,046,281	5.9	61.2	94,633,000	5.9	116,946,000	5.4	23.6
Manufacturing	8,137,645	23.8	11,493,490	22.1	41.2	412,134,000	25.9	513,341,000	23.8	24.6
Nondurable goods	4,806,174	14.1	6,491,882	12.5	35.1	145,826,000	9.2	187,494,000	8.7	28.6
Durable goods	3,331,471	9.8	5,001,608	9.6	50.1	266,308,000	16.7	325,847,000	15.1	22.4
Transportation and public utilities	3,424,442	10.0	5,072,349	9.8	48.1	123,758,000	7.8	162,708,000	7.5	31.5
Wholesale trade	3,189,307	9.3	4,915,378	9.5	54.1	108,888,000	6.8	144,799,000	6.7	33.0
Retail trade	3,448,249	10.1	5,143,520	9.9	49.2	153,067,000	9.6	206,554,000	9.6	34.9
Finance, insurance, real estate	1,914,288	5.6	3,101,111	6.0	62.0	92,627,000	5.8	139,177,000	6.4	50.3
Services	5,057,167	14.8	8,561,042	16.5	69.3	281,471,000	17.7	437,769,000	20.3	55.5
Government	6,523,289	19.1	9,145,705	17.6	40.2	262,655,000	16.5	353,479,000	16.4	34.6
Total earnings	34,159,672		51,993,206		52.2	1,593,650,000		2,158,101,000		35.4
					INCOME BY PLACE OF RESIDENCE					
Total personal income	44,080,989		67,402,835		52.9	2,156,715,000		3,016,317,000		39.9
Per capita income	8,041		11,548		43.6	9,494		12,772		34.5

[a] Bureau of Economic Analysis (1986c,d).

[b] Total is for one of six counties. Other county data withheld to avoid disclosure of confidential information.

[c] Total is for five of six counties. Other county data withheld to avoid disclosure of confidential information.

[d] Total is for three of six counties. Other county data withheld to avoid disclosure of confidential information.

Table B-33. Unemployment Rates, 1986[a]

County	Percent unemployment
South Carolina counties	
Aiken	5.1
Allendale	10.1
Bamberg	9.4
Barnwell	7.8
Georgia counties	
Columbia	3.9
Richmond	6.7
South Carolina	6.8
Georgia	6.5
United States	7.2

[a] Sources: Bureau of the Census (1988); Personal Communication (1988); South Carolina Division of Research and Statistical Services (1988).

Table B-34. Trends in Farms, Land in Farms, and Land Use[a]

	Six-county total					South Carolina				
	1978		1982		1978 to 1982	1978		1982		1978 to 1982
Category	Amount	Percent	Amount	Percent	% change	Amount	Percent	Amount	Percent	% change
LAND IN FARMS BY USE (ACRES)										
Cropland	373,506	62.6	353,865	63.0	-5.3	3,375,565	55.8	3,179,278	56.9	-5.8
Harvested	290,411	48.6	289,263	51.5	-0.4	2,524,147	41.8	2,474,025	44.3	-2.0
Pasture or grazing	39,973	6.7	34,328	6.1	-14.1	586,511	9.7	483,916	8.7	-17.5
Other	41,122	6.9	30,274	5.4	-26.4	264,907	4.4	221,337	4.0	-16.4
Woodland	185,802	31.1	167,954	29.9	-9.6	2,132,777	35.3	1,888,743	33.8	-11.4
Woodland pastured	38,212	6.4	25,570	4.6	-33.1	523,628	8.7	391,166	7.0	-25.3
Woodland not pastured	147,590	24.7	142,384	25.4	-3.5	1,609,149	26.6	1,497,577	26.8	-6.9
Other land	37,702	6.3	39,768	7.1	5.5	537,377	8.9	521,778	9.3	-2.9
Pasture	16,447	2.8	18,826	3.4	14.5	258,315	4.3	267,096	4.8	3.4
House lots, etc.	21,255	3.6	20,942	3.7	-1.5	279,062	4.6	254,682	4.6	-8.7
Pastureland, all types	94,632	15.9	78,278	13.9	-17.3	1,368,454	22.6	1,142,178	20.4	-16.5
Set aside in Federal programs	8,507	1.4	3,244	0.6	-61.9	59,147	1.0	23,598	0.4	-60.1
FARMS AND LAND IN FARMS (ACRES)										
Farms (number)	1,973		1,786		-9.5	26,706		24,929		-6.7
Land in farms	597,010		561,587		-5.9	6,045,719		5,589,799		-7.5
Average size of farm	303		314		3.9	226		224		-0.9
Land in irrigated farms	57,808		134,231		132.2	316,002		499,686		58.1

Table B-34. Trends in Farms, Land in Farms, and Land Use[a] (continued)

Category	Georgia					United States				
	1978		1982		1978 to 1982	1978		1982		1978 to 1982
	Amount	Percent	Amount	Percent	% change	Amount	Percent	Amount	Percent	% change
LAND IN FARMS BY USE (ACRES)										
Cropland	6,828,187	50.9	6,531,234	53.1	-4.3	453,874,133	44.7	445,362,028	45.1	-1.9
Harvested	4,687,895	34.9	4,761,260	38.7	1.6	317,145,955	31.3	326,306,462	33.1	2.9
Pasture or grazing	1,481,305	11.0	1,290,028	10.5	-12.9	73,204,828	7.2	65,027,715	6.6	-11.2
Other	658,987	4.9	479,946	3.9	-27.2	63,523,350	6.3	54,027,851	5.5	-14.9
Woodland	5,067,480	37.8	4,253,839	34.6	-16.1	91,815,487	9.0	87,088,255	8.8	-5.1
Woodland pastured	1,345,256	10.0	1,036,749	8.4	-22.9	47,022,313	4.6	43,420,212	4.4	-7.7
Woodland not pastured	3,722,224	27.7	3,217,090	26.2	-13.6	44,793,174	4.4	43,668,043	4.4	-2.5
Other land	1,521,166	11.3	1,508,812	12.3	-0.8	469,087,614	46.2	454,346,296	46.0	-3.1
Pasture	866,885	6.5	903,989	7.4	4.3	433,316,686	42.7	418,264,264	42.4	-3.5
House lots, etc.	654,281	4.9	602,843	4.9	-7.9	35,770,928	3.5	36,082,032	3.7	0.9
Pastureland, all types	3,693,446	27.5	3,230,746	26.3	-12.5	553,543,827	54.5	526,712,191	53.4	-4.8
Set aside in Federal programs	167,956	1.3	45,010	0.4	-73.2	16,116,763	1.6	8,413,553	0.9	-47.8
FARMS AND LAND IN FARMS (ACRES)										
Farms (number)	51,405		49,630		-3.5	2,257,775		2,240,976		-0.7
Land in farms	13,416,833		12,291,885		-8.4	1,014,777,234		986,796,579		-2.8
Average size of farm	261		248		-5.0	449		440		-2.0
Land in irrigated farms	2,772,167		2,834,176		2.2	251,648,772		246,603,071		-2.0

[a] Source: Bureau of the Census (1984a,c,d).

Table B-35. Trends in Market Value of Agricultural Products Sold (in thousands of dollars)[a]

	Six-county total					South Carolina				
	1978		1982		1978 to 1982	1978		1982		1978 to 1982
Category	Amount	Percent	Amount	Percent	% change	Amount	Percent	Amount	Percent	% change
Crop sales	36,694	59.4	45,353	61.0	23.6	543,171	63.5	601,018	62.1	10.6
Grains	27,093	43.8	30,947	41.6	14.2	228,223	26.7	263,041	27.2	15.3
Hay, silage, and field seeds	1,012	1.6	748	1.0	-26.1	9,901	1.2	7,563	0.8	-23.6
Vegetables, sweet corn, and melons	1,602	2.6	1,734	2.3	8.2	28,767	3.4	37,386	3.9	30.0
Other crops	6,987	11.3	11,924[b]	16.0	70.7	276,280	32.3	293,028	30.3	6.1
Livestock and poultry	25,101	40.6	29,049	39.0	15.7	311,804	36.5	367,536	37.9	17.9
Poultry & products	6,151[c]	10.0	7,445[d]	10.0	21.0	132,847	15.5	159,580	16.5	20.1
Dairy products	3,561[e]	5.8	4,999[c]	6.7	40.4	53,199	6.2	75,815	7.8	42.5
Cattle & calves	5,377	8.7	6,653	8.9	23.7	63,556	7.4	61,493	6.3	-3.2
Hogs & pigs	4,903[e]	7.9	6,162[b]	8.3	25.7	59,295	6.9	66,575	6.9	12.3
Other livestock	5,109	8.3	3,790	5.1	-25.8	2,907	0.3	4,073	0.4	40.1
Total sales	61,795		74,402		20.4	854,975		968,554		13.3
Average per farm ($)	31,320		41,658		33.0	32,014		38,853		21.4

Table B-35. Trends in Market Value of Agricultural Products Sold (in thousands of dollars)[a] (continued)

	Georgia					United States				
	1978		1982		1978 to 1982	1978		1982		1978 to 1982
Category	Amount	Percent	Amount	Percent	% change	Amount	Percent	Amount	Percent	% change
Crop sales	913,046	39.0	1,180,988	42.7	29.3	48,203,200	45.0	62,256,087	47.2	29.2
Grains	282,979	12.1	477,976	17.3	68.9	26,747,307	25.0	36,409,105	27.6	36.1
Hay, silage, and field seeds	17,254	0.7	16,324	0.6	-5.4	2,275,068	2.1	2,312,006	1.8	1.6
Vegetables, sweet corn, and melons	28,133	1.2	37,731	1.4	34.1	3,238,826	3.0	4,145,446	3.1	28.0
Other crops	584,680	25.0	648,957	23.4	11.0	15,941,999	14.9	19,389,530	14.7	21.6
Livestock and poultry	1,427,458	61.0	1,586,691	57.3	11.2	58,870,258	55.0	69,644,136	52.8	18.3
Poultry & products	828,092	35.4	936,860	33.9	13.1	8,463,486	7.9	9,796,927	7.4	15.8
Dairy products	137,499	5.9	188,068	6.8	36.8	11,228,899	10.5	16,320,417	12.4	45.3
Cattle & calves	238,838	10.2	217,019	7.8	-9.1	29,610,751	27.7	31,635,157	24.0	6.8
Hogs & pigs	213,974	9.1	225,806	8.2	5.5	8,071,766	7.5	9,867,741	7.5	22.3
Other livestock	9,055	0.4	18,938	0.7	109.1	1,495,356	1.4	2,023,894	1.5	35.3
Total sales	2,340,504		2,767,679		18.3	107,073,458		131,900,223		23.2
Average per farm ($)	45,531		55,766		22.5	47,424		58,858		24.1

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[a] Source: Bureau of the Census (1984 a,c,d).

[b] Total is for five of six counties. Nonreported county data withheld to avoid disclosure of confidential information.

[c] Total is for two of six counties. Nonreported county data withheld to avoid disclosure of confidential information.

[d] Total is for three of six counties. Nonreported county data withheld to avoid disclosure of confidential information.

[e] Total is for four of six counties. Nonreported county data withheld to avoid disclosure of confidential information.

Table B-36. Hotel and Motel Characteristics, 1982[a]

Location	Number of Establishments	Receipts ($1,000)	Employment
South Carolina counties			
Aiken	12	1,612	44
Allendale	2	(b)	NA[c]
Bamberg	5	273	NA[c]
Barnwell	2	(b)	NA[c]
Georgia			
Augusta SMSA (Georgia part)	28	19,018	712
Six-county total[d]	49	20,903	756
South Carolina	768	479,797	15,772
Georgia	810	763,380	27,358
United States	41,231	33,214,751	1,102,097

[a] Source: Bureau of the Census (1984f,h,i).

[b] Not shown to avoid disclosure of confidential information.

[c] Information not provided by Census publications.

[d] County totals do not include information that has been withheld to avoid disclosure or that has not been provided in the source documents.

Table B-37. Activities Participated in While in South Carolina[a]

Activity[b]	Percent participation
Shopping	51.2
Beach activities	38.4
Historic sites/sightseeing	31.2
Attractions, museums, zoos	15.9
Golf	13.1
Nightlife	12.5
Fishing	9.8
Hiking, outdoor activities	9.4
Cultural events/festivals	7.9
Tennis and other sports	5.3

[a] Source: South Carolina Department of Parks, Recreation, and Tourism (1988).

[b] Respondents could pick more than one activity.

Table B-38. Travel by Purpose of Trip, South Carolina and United States[a]

Purpose of trip	South Carolina (percent)	United States (percent)
Visit relatives/friends	26.3	37.0
Other pleasure	46.0	31.8
Business/convention	15.7	23.9
Other purpose	12.0	7.3

[a] Sources: South Carolina Department of Parks, Recreation and Tourism (1988); U.S. Travel Data Center (1987).

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