DOE/EIS-0

FINAL
ENVIRONMENTAL IMPACT STATEMENT

Continued Operation of K-, L-, and P-Reactors
Savannah River Site
Aiken, South Carolina

Volume I

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FOREWORD

This environmental impact statement (EIS) analyzes the environmental impacts of the proposed action, which is to continue operation of K-, L-, and P-Reactors at the Savannah River Site (SRS) to ensure the capability to produce nuclear materials, and to produce nuclear materials as necessary for United States defense and nondefense programs. The EIS also analyzes alternatives to the proposed action. The U.S. Department of Energy (DOE) prepared this statement to further the purposes of the National Environmental Policy Act (NEPA), as amended. It was prepared in accordance with the requirements of NEPA, the Council on Environmental Quality (CEQ) NEPA regulations (40 CFR 1500-1508), and DOE NEPA Guidelines (52 FR 47662). TC

Following the April 1986 nuclear accident at Chernobyl in the Soviet Union, then Secretary of Energy John S. Herrington requested the National Academy of Sciences (NAS) and the National Academy of Engineering (NAE) to provide an independent assessment of the implications of the accident for the safe operation of DOE's 11 larger reactors. The academies formed the Committee to Assess Safety and Technical Issues at DOE Reactors and began their study in August 1986.

The NAS-NAE Report, issued in October 1987, described a number of technical issues, including acute aging, potential severe accidents, power operating limits, confinement systems, and treatment of liquid radioactive effluents at the reactors. The Committee presented a number of recommendations. In response to the NAS-NAE report, DOE issued an "Action Plan for Resolution of Technical Recommendations" in May 1988.

In November 1986, DOE reduced the operating power of the SRS production reactors in response to uncertainties related to the capabilities of the reactors' emergency core cooling systems. K- and L-Reactors began their scheduled maintenance outages in April 1988 and June 1988, respectively. A maintenance outage to address seismic concerns began at P-Reactor in April 1988. Following resolution of the seismic concerns, DOE started P-Reactor but did not resume production. The Operating Contractor and DOE jointly decided that substantial improvements in operation and management were necessary. These improvements are being made and verified. C-03-01 L-48-02 L-78-70

DOE is continually evaluating the safety of its reactors and implementing safety improvements and programs at SRS. To further this effort, such activities as an updating of the Reactors Safety Analysis Report, development of a Probabilistic Risk Assessment (PRA), seismic and fire protection upgrades, verification of primary system integrity, improvements to the emergency cooling system, and a severe accident program are under way.

DOE is proposing to continue operation of K-, L-, and P-Reactors at SRS. The continued operation of these reactors is proposed to ensure the capability to meet current and projected needs for nuclear materials. DOE proposes to operate the SRS reactors to meet the need for tritium production, as defined in the annually updated Nuclear Weapons Stockpile Memorandum, for weapons TC

TE research and development, and for commercial applications. DOE proposes to continue to use the reactors to produce plutonium-238 for space programs and
TC other applications. In addition, the reactors could be operated to produce other nuclear materials such as plutonium for national defense and for
TC nondefense purposes if such material were required.

These reactors were constructed and began operation before the enactment of NEPA in 1969; therefore, NEPA documentation analyzing the environmental impacts of their operation was not required. K- and P-Reactors have been in continuous operation since their construction and startup in 1954. No NEPA documentation has been prepared on the operation of K- and P-Reactors. However, DOE provided a detailed evaluation of the thermal effects of the
TC operation of a once-through cooling-tower system and a recirculating cooling-tower system for K-Reactor in the Final EIS for Alternative Cooling Water Systems (DOE/EIS-0121). L-Reactor was maintained in standby from 1968 to 1985. Before the restart of L-Reactor in 1985, DOE prepared an EIS on its operation. Accordingly, DOE is preparing this EIS to further the purposes of NEPA and to provide the public with updated information on the environmental impacts of the continued operation of K-, L-, and P-Reactors at SRS. This EIS will be completed prior to any decision on the startup of K-, L-, or P-Reactor following the current extended outage and will enable decisionmakers to have
TC the additional benefit of an EIS that includes insights gained from the public comment process.

DOE published a Notice of Intent (NOI) to prepare this EIS in the Federal Register on March 21, 1989 (54 FR 11562). This notice solicited comments and suggestions for DOE to consider in determining the scope of the EIS and announced a public scoping period that ended May 8, 1989.

In response to the NOI, 315 individuals, organizations, and government agencies submitted comments. DOE held public scoping meetings in Savannah, Georgia; Columbia, South Carolina; and Aiken, South Carolina, on April 17, 20, and 28, 1989, respectively.

Transcripts of public testimony, copies of scoping letters, scoping comments and DOE responses, and reference materials cited in the EIS are available for review in the DOE Public Reading Rooms, located at the University of South Carolina's Aiken Campus, Aiken, South Carolina (803) 648-8851; and the Freedom of Information Reading Room, Room 1E-190, Forrestal Building, 1000
TE Independence Avenue, S.W., Washington, D.C. (202) 586-6020.

On May 11, 1990, the U.S. Environmental Protection Agency published a Notice of Availability (NOA) in the Federal Register (55 FR 19784), which officially started the public comment period on the Draft EIS; DOE published a correspondng NOA for the Draft EIS on May 11, 1990 (55 FR 19773). The public comment period ended on June 25, 1990.

TC

DOE has revised the Draft EIS, as appropriate, in response to the comments received in letters and during three public hearings (May 31, June 5, and June 8, 1990) from individuals, organizations, and Federal and state agencies. These revisions are indicated in the Final EIS by vertical change bars in the margin. Most of these change bars are marked either TC (technical change) or

TE (editorial change). The remaining change bars are cross-referenced to specific public comments, which are presented in Appendix C, along with the DOE responses to the comments and cross-references to appropriate sections of the EIS.

DOE has prepared this EIS in accordance with the CEQ NEPA regulations (40 CFR 1500-1508) and the DOE NEPA guidelines (52 FR 47662; December 15, 1987). The EIS identifies the methodologies that were used and the scientific and other sources of information that were consulted. In addition, it incorporates, physically or by reference, available results of ongoing studies. TC

Extensive reference material, including Environmental Information Documents (EIDs), used to prepare this EIS is available for review in the U.S. Department of Energy Public Reading Room, University of South Carolina, Aiken Campus, University Library, 2nd Floor, University Parkway, Aiken, South Carolina, and the Department's Freedom of Information Reading Room, Room 1E-190, Forrestal Building, 1000 Independence Avenue, S.W., Washington, D.C.

Chapter 1 of this EIS describes the purpose and need for the proposed action.

Chapter 2 describes the proposed action, current operating practices, and planned modifications, in detail; describes alternatives to the proposed action that are assessed in this EIS; and describes alternatives that have been considered but not analyzed. TE

Chapter 3 describes the affected SRS environment, primarily as it is related to the alternatives discussed.

Chapter 4 assesses the environmental consequences of continued reactor operation, accidents, transportation, termination of K-, L-, and P-Reactor operation, decontamination and decommissioning, and cumulative impacts; and describes the consequences of terminating operation of one, two, or all three reactors. TC

Chapter 5 summarizes Federal and State of South Carolina environmental and other regulatory requirements that apply to the continued operation of the reactors, and the status of compliance with these requirements.

Appendix A, which is classified, contains quantitative projections for nuclear materials production requirements based on the 1990 Nuclear Weapons Stockpile Memorandum, descriptions of the production complex, and analyses of the capabilities of alternative production sources to meet the requirements. Appendix A also includes an analysis of a potential reduced-need scenario. TC

Appendix B describes continuing studies and monitoring programs on the SRS and its environs.

Appendix C contains public and agency comments on the Draft EIS and the DOE responses to these comments. TE

Since 1984, DOE has published several environmental impact statements and
TC | reports that contribute to an understanding of the environmental consequences of continued K-, L-, and P-Reactor operation:

- Final Environmental Impact Statement, L-Reactor Operation, Savannah
TE | River Plant, Aiken, South Carolina, DOE/EIS-0108

- Final Environmental Impact Statement, Waste Management Activities for Groundwater Protection, Savannah River Plant, Aiken, South Carolina,
TE | DOE/EIS-0120

- Final Environmental Impact Statement, Alternative Cooling Water Systems, Savannah River Plant, Aiken, South Carolina, DOE/EIS-0121 (DOE, 1987b)

TE | - Savannah River Site Environmental Report for 1988, WSRC-RP-89-59-1

TC | - Radioactive Releases at Savannah River Site, 1954-1988, WSRC-RP-89-737

SUMMARY

1. NEED AND PURPOSE FOR THE PROPOSED ACTION

The U.S. Department of Energy (DOE) operates a nuclear reactor/chemical processing production complex at the Savannah River Site (SRS) in South Carolina to produce nuclear materials for defense and nondefense purposes. Three SRS reactors (K, L, and P) are operational; at present, their safety and management systems are undergoing improvements.

The purpose of the proposed action is to ensure the capability to meet nuclear material production requirements. The continued operation of K-, L-, and P-Reactors at SRS would serve this purpose at least until replacement production capacity has been demonstrated, and is the preferred alternative. TC

Pursuant to the Atomic Energy Act (AEA) of 1954, as amended, DOE is responsible for developing and maintaining a capability to produce nuclear materials required for the defense of the United States. DOE also is authorized to provide certain nondefense nuclear materials, including plutonium-238, for power generators used in civilian space missions and in terrestrial applications.

The primary use of nuclear materials in defense programs is in building and maintaining the nation's stockpile of nuclear weapons. Two materials required for the production of nuclear weapons, tritium and weapons-grade plutonium-239, are produced through the irradiation of target material in nuclear reactors. Because tritium decays at a rate of 5.5 percent per year, it is replenished periodically in nuclear weapons to maintain the stockpile. Appendix A, which is classified, contains quantitative projections for nuclear materials production requirements based on the 1990 Nuclear Weapons Stockpile Memorandum (NWSM), descriptions of the production complex, and analyses of the capabilities of alternative production sources to meet the requirements. Appendix A also includes an analysis of a potential reduced-need scenario, and examines delaying the resumption of production at one or more reactors, including delaying the resumption of production at K-Reactor until the completion of a cooling tower. TC

Based on the analysis in Appendix A, there will be a continuing need for the production of tritium and plutonium-238.

DOE must also maintain the capability to produce weapons-grade plutonium and other reactor-produced isotopes. To meet these needs, DOE proposes to continue to operate K-, L-, and P-Reactors at SRS. TC

2. PROPOSED ACTION AND ALTERNATIVES

2.1 PROPOSED ACTION - ALTERNATIVE 1

Continue to operate K-, L-, and P-Reactors at SRS.

Under this alternative, DOE would continue to operate K-, L-, and P-Reactors to ensure the capability to meet nuclear material production needs. Continued TC

TC S-12-10 L-05-01 reactor operation includes power operation and cold shutdown. Power operation includes startup and power ascension; cold shutdown includes refueling. This environmental impact statement (EIS) analyzes the environmental consequences TC of this alternative, assuming all three reactors operate at a hypothetical full power of 3,000 megaWatts. The EIS also includes qualitative discussions of the effects from a range of startup and partial-power operations; the EIS describes the environmental effects of these operations for each reactor if such effects differ more than minimally from those of full-power operation. TC The impacts of cold shutdown are essentially the same as those described for the cold standby condition analyzed in Alternatives 2 and 3, except that the loss of jobs associated with Alternative 3 would not exist in the case of cold shutdown.

The proposed action includes ongoing improvements and enhancements in reactor safety systems, training, management, and administrative functions, and general technical areas.

TC The EIS addresses safety concerns including health effects associated with normal operation and potential severe accidents.

2.2 ALTERNATIVE 2

Terminate operation of one or two reactors at SRS in the immediate future and maintain in cold standby.

Under this alternative, current upgrade and modification activities would be TC terminated in the immediate future and the affected reactor(s) would be defueled and placed in cold standby. A matrix approach is used to portray the environmental effects of terminating the operation of one or two reactors; the matrix refers to other sections of the EIS for details. Six combinations are TC analyzed in this alternative. Appendix A analyzes the ability of this alternative to meet material production requirements.

2.3 ALTERNATIVE 3

Terminate operation of K-, L-, and P-Reactors in the immediate future and maintain in cold standby.

Under this alternative, the capability to meet nuclear material production TC requirements would not be maintained. Environmental effects of terminating operation and maintaining all three reactors in cold standby (i.e., defueled and closed down) are described if the effects differ among the reactors.

2.4 ALTERNATIVE 4

Other production options to K-, L-, and P-Reactor operation:

- DOE reactor options - Operate other DOE reactors
- Technology options - Use of technologies other than reactors
- Other supply options - Commercial power reactors; acquire material from foreign countries

The proposed construction of the new production reactor capacity is not considered as an alternative to the proposed action in this EIS, because this EIS considers alternatives to allow DOE to meet requirements at least until replacement production capacity has been demonstrated. The time required for the procurement, design, and construction of this new capacity is too long to satisfy nuclear materials requirements in the near term. The schedule cannot be accelerated sufficiently to satisfy near-term material requirements. TC

Other DOE reactors would require conversion; the time requirements and excessive costs of such conversions eliminate the alternative of operating other DOE reactors as a reasonable alternative. Other production options either lack near-term proven production capability or they require overcoming significant institutional issues; therefore, they are not considered to be reasonable alternatives. TC

3. AFFECTED ENVIRONMENT

3.1 REGIONAL SETTING

The SRS, in southwestern South Carolina near the Savannah River, encompasses approximately 800 square kilometers (198,737 acres) within the Atlantic Coastal Plain physiographic province.

Since 1951, the SRS has been a defense facility owned by DOE and its predecessor agencies. It is a controlled area with public access limited to through traffic only. TE

SRS facilities include five reactors (C-, K-, L-, P-, and R-Reactors), two chemical separations areas (F- and H-Areas), a target and fuel fabrication facility (M-Area), a defense waste processing facility (S-Area), a saltstone facility (Z-Area), and various support facilities. K-, L-, and P-Reactors, the operational reactors, are the subject of this EIS, and are located in the south-central portion of the SRS.

The SRS includes portions of Aiken, Allendale, and Barnwell Counties, South Carolina. Four population centers - Augusta, Georgia, and Aiken, Barnwell, and North Augusta, South Carolina - are within 40 kilometers (25 miles) of the Site. Three small towns, Jackson, New Ellenton, and Snelling, are immediately adjacent to the SRS boundary to the northwest, north, and east, respectively. TC

3.2 ENVIRONMENTAL RESOURCES AND CHARACTERISTICS

This EIS addresses the following environmental resources, characteristics, and SRS activities that might be affected by the preferred alternative: TE

- Socioeconomic and community characteristics
- Geology, hydrology, and seismology
- Water resources
- Biotic resources

- Radiation and hazardous chemical environment
- Wetlands
- Waste management
- Emergency preparedness

The EIS also addresses archaeological and historic resources, and meteorology and climatology.

4. ENVIRONMENTAL CONSEQUENCES

4.1 K-, L-, AND P-REACTOR OPERATION

Table S-1 summarizes the environmental consequences of the proposed action
TC (Alternative 1) and the termination alternatives (Alternatives 2 and 3).

4.2 TERMINATE OPERATION OF ONE OR TWO REACTORS AT SRS IN THE IMMEDIATE FUTURE AND MAINTAIN IN COLD STANDBY

The environmental consequences of terminating operation of one or two of the SRS reactors would result in an approximately proportionate reduction in the environmental consequences for the termination of all three reactors, as listed in Table S-1.

4.3 TERMINATE K-, L-, AND P-REACTOR OPERATION IN THE IMMEDIATE FUTURE AND MAINTAIN IN COLD STANDBY

Table S-1 summarizes the environmental consequences of termination of operation of K-, L-, and P-Reactors.

4.4 DECONTAMINATION AND DECOMMISSIONING

Regardless of the alternative selected, K-, L-, and P-Reactors would
TC eventually be decontaminated and decommissioned; before any such decontamination and decommissioning could begin, the DOE proposal would be subject to environmental review. Previous SRS-related documents provide information on decontamination and decommissioning options and plans.

Table S-1. Comparison of Impacts of Alternatives (Page 1 of 10)

Impact[a]	**Alternative 1.** Proposed/No Action[b]		**Alternative 2.** *Terminate K-, or L-, or P-Reactor or Combination of Any Two*[c] K or	L or	P	**Alternative 3.** Termination[d] (K, L, and P)	TC
Land Use	No change in land use; additional land would not be required.		No change in land use; additional land would not be required.	No change in land use; additional land would not be required.	No change in land use; additional land would not be required.	No change in land use; additional land would not be required.	TC
Socioeconomics	Workforce and operating jobs continue as at present. No impacts beyond current levels. Current economic trends would continue.	<u>Job losses</u>:				Approximately 9,600 operating and workforce jobs would be lost at three reactors and some support facilities. Permanent and part-time standby workforce of about 100 for all three reactors would be retained.	
		Operate	No loss	No loss	No loss		
		Terminate	Approximately 5,300 jobs at reactors and some support facilities would be lost with terminations of two reactors; approximately 2,200 jobs would be lost with termination of only one reactor. Permanent and part-time standby workforce of about 35 for each terminated reactor would be retained.				
Archaeological/ historic sites	No impacts would occur.		No impacts would occur.	No impacts would occur.	No impacts would occur.	No impacts would occur.	
Cooling water withdrawal	Cooling water withdrawals from Savannah River total a maximum of 24 cubic meters (about 850 cubic feet) per second for K-, L-, and P-Reactors and 4 cubic meters (about 140 cubic feet) per second for D-Area powerhouse. Maximum withdrawal with K-Reactor tower would be 18.5 cubic meters (about 650 cubic feet) per second.	<u>Flow rates</u>:				Approximately 1.5 to 3 cubic meters (53 to 106 cubic feet) of water per second would be withdrawn to maintain access by fish to Steel Creek for spawning.	TC
		Operate (K-Reactor without cooling tower)	11.3 cubic meters (about 400 cubic feet) per second pumped from Savannah River	11.3 cubic meters (about 400 cubic feet) per second pumped from Savannah River	1.0 to 1.4 cubic meters (35 to 49 cubic feet) per second from Savannah River; 10 cubic meters (about 350 cubic feet) per second from Par Pond		
		Operate (K-Reactor with cooling tower)	1.8 cubic meters (64 cubic feet) per second pumped from Savannah River				
		Terminate	No plans for flow maintenance in Pen Branch	Flow maintenance: 1.5 to 3.0 cubic meters (53 to 106 cubic feet) per second pumped from Savannah River	No plans for flow maintenance		

Table S-1. Comparison of Impacts of Alternatives (Page 2 of 10)

Impact[a]	Alternative 1. Proposed/No Action[b]	Alternative 2. Terminate K-, or L-, or P-Reactor or Combination of Any Two[c]	K or	L or	P	Alternative 3. Termination[d] (K, L, and P)	TC
Impingement/ entrainment	Impingement and entrainment impacts continue at a mean loss of 18.8 x 10^6 fish larvae, 10.1 x 10^6 eggs, and about 7,716 fish per year at Savannah River intakes, including D-Area. Additional 198 x 10^6 fish larvae and 0.2 x 10^6 fish eggs were lost in a 17-month study period (Jan. 1984-June 1985) at the Par Pond intake. Section 316(a) and (b) studies were performed and submitted to SCDHEC.	Operate (K-Reactor without cooling tower)	8.3 x 10^6 fish larvae, 4.4 x 10^6 fish eggs, 2,772 fish impinged per year	8.3 x 10^6 larvae, 4.4 x 10^6 eggs, 2,772 fish impinged per year	19.8 x 10^7 larvae, 0.2 x 10^6 eggs in Par Pond in 17-month study period; 1 x 10^6 larvae, 0.5 x 10^6 eggs, about 341 fish impinged in Savannah River per year.	Impingement/entrainment impacts from reactor operation would be less than 10-15% of those experienced during full-power operation.	TC
		Operate (K-Reactor with cooling tower)	Reduction of 84% in impingement/ entrainment losses due to K-Reactor withdrawal				
		Terminate	No fish larvae, fish eggs, or fish losses	<15-30% of above (70-85% reduction)	No fish larvae, fish eggs, or fish losses		
Cooling water discharge	Thermal discharges to Par Pond, L-Lake, and Pen Branch continue. Restrictions imposed on operation of L-Reactor so that L-Lake temperature does not exceed 32.2°C (90°F) over 50% of lake.	Operate (K-Reactor without cooling tower)	Stream temperature 73°C (163°F) maximum	Thermal discharge to L-Lake would continue	Thermal discharge to Par Pond would continue	No thermal discharges to onsite water bodies. Flows would be maintained at 1.5-3.0 cubic meters (53 to 106 cubic feet) per second in L-Lake to keep fish protective flows in Steel Creek.	TC
		Operate (K-Reactor with cooling tower)	Maximum design blowdown temperature below discharge 27°C (81°F) in summer				
		Terminate	No flow maintenance; no thermal discharge	Maintain protective flow; no thermal discharge	No flow maintenance; no thermal discharge		

Table S-1. Comparison of Impacts of Alternatives (Page 3 of 10)

Impact[a]	Alternative 1. Proposed/No Action[b]	Alternative 2. Terminate K-, or L-, or P-Reactor or Combination of Any Two[c]	K or	L or	P	Alternative 3. Termination[d] (K, L, and P)	TC
Groundwater quality (tritium at surface outcrops)	Disassembly-basin purge water containing tritium will continue to be discharged to L- and P-Reactor seepage basins and K-Area containment basin. Since reactor operation began (resumed at L-Reactor), a total of about 3,300 curies of tritium has been released from L-Area and 33,000 curies from P-Area basins since startup in the 1950's; as much as 10,000 curies per year have been released from the K-Area basin.	Operate	2,780 curies per year to Indian Grave Branch	1,240 curies per year to Steel Creek, L-Lake	133 curies per year to Steel Creek	No discharges from reactors to L- and P-Area seepage basins or K-Reactor containment basin; basins would be maintained for future use. Seepages to groundwater would continue for 6 years from K-Reactor basin, for 5 years from L-Reactor basin, and as long as 30 years from P-Reactor basin. Radioactive decay would cause a decrease in tritium concentrations in the seepages to groundwater of 5.5 percent per year.	TC
		Terminate	See Alternative 3.	See Alternative 3.	See Alternative 3.		
Groundwater use	Estimated 39,000 cubic meters (1.0×10^7 gallons) per day are withdrawn from several aquifers for K-, L-, and P-Reactors and support facilities. No major withdrawal impacts.	Operate	2 wells; 1,080 cubic meters (0.28×10^6 gallons) per day	2 wells; 1,354 cubic meters (0.36×10^6 gallons) per day	2 wells; 1,944 cubic meters (0.51×10^6 gallons) per day	Groundwater withdrawal for reactors and support facilities would be reduced to about 4,300 cubic meters (1.1×10^6 gallons) per day or less.	TC
		Terminate	Estimated: <10% of above	Estimated: <10% of above	Estimated: <10% of above		
Air quality	Operational emissions from SRS coal-fired powerplants continue. They consist primarily of NO, SO_2, particulate matter, and CO; no detectable impact on local or regional air quality occurs. A total electric power demand of 175 megaWatts for three reactors would be required.	Operate	SO_2 1,390 metric tons (1,532 tons) per year, NO_x 420 metric tons (463 tons) per year, TSP 216 metric tons (238 tons) per year, CO 56 metric tons (62 tons) per year	No powerplant; electricity and steam come from K-Area; emissions same as K-Area	SO_2 1,040 metric tons (1,147 tons) per year, NO_x 320 metric tons (353 tons) per year, TSP 160 metric tons (176 tons) per year, CO 42 metric tons (46 tons) per year	SRS powerplants would operate at reduced level with corresponding decrease in particulate emissions; each reactor would require 2.5 megaWatts of electric power.	TC
		Terminate	See Alternative 3.	See Alternative 3.	See Alternative 3.		

Table S-1. Comparison of Impacts of Alternatives (Page 4 of 10)

Impact[a]	**Alternative 1.** Proposed/No Action[b]	**Alternative 2.** Terminate K-, or L-, or P-Reactor or Combination of Any Two[c]	K or	L or	P	**Alternative 3.** Termination[d] (K, L, and P)	TC
Wetlands/ habitats	Operation of K-Reactor without cooling tower: Recurrent loss of 670 acres of previously impacted wetlands in Pen Branch and delta; additional loss of 10-12 acres of previously unimpacted forested wetlands per year.	Operate (K-Reactor without cooling tower)	Recurrent loss of 670 acres of previously impacted wetlands; additional loss of 10-12 acres of previously unimpacted forested wetlands per year.	Loss rates of wetlands are negligible; some minor adjustment of Steel Creek corridor and delta from increased flows would occur.	Little or no wetlands impacts from continued operation	No additional impacts. 1,350 acres of wetlands (670 acres on Pen Branch and 680 acres on Steel Creek) would continue to revegetate.	
	Operation of K-Reactor with cooling tower: Loss of 170 acres of previously impacted wetlands by resumption of production.	Operate (K-Reactor with cooling tower)	Recovery and revegetation of 500 of the 670 acres of previously impacted wetlands. Additional losses of 10-12 acres per year of previously unimpacted wetlands would stop.				TC
	Operation of L-Reactor: Loss of negligible amount of forested wetlands; some minor adjustment of Steel Creek corridor and delta from increased flows would occur.	Terminate	See Alternative 3.	See Alternative 3.	No wetlands impact.		
	Operation of P-Reactor: Little or no wetlands impacts from continued operation.						
Aquatic impacts							
Erosion	Impacts from reactor discharges would be total of those from individual reactors.	Operate (K-Reactor without cooling tower)	Stream erosion, sedimentation	Stream erosion, sedimentation	No impacts from erosion	Erosion impacts would diminish	TC
		Operate (K-Reactor with cooling tower)	Erosion and sedimentation impacts would diminish.				

Table S-1. Comparison of Impacts of Alternatives (Page 5 of 10)

Impact[a]	Alternative 1. Proposed/No Action[b]	Alternative 2. Terminate K-, or L-, or P-Reactor or Combination of Any Two[c]	K or	L or	P	Alternative 3. Termination[d] (K, L, and P)	TC
Chemical	Minor chemical impacts in L-Lake and Par Pond as nutrient levels increase.	Operate	No impact	Minor chemical impacts in L-Lake.	Minor chemical impacts in Par Pond.	Chemical concentration would diminish.	
Thermal	Restrictions imposed on operation of L-Reactor so that L-Lake temperature does not exceed 32.2°C (90°F) over 50% of lake. Fish kills in Indian Grave Branch, Pen Branch, L-Lake, and Pond C at startup.	Operate (K-Reactor without cooling tower)	Fish kills occur only at startup. Fish absent in main corridors or creeks below reactor discharge during power operation	Fish kills in upper L-Lake on startup. Restricted reactor operation when L-Lake exceeds 32.2°C (90°F). See Alternative 1.	Fish kills in Pond C on startup	No thermal discharges to onsite water bodies; SRS would pump Savannah River water to L-Lake to maintain Steel Creek discharge at 1.5-3.0 cubic meters (53 to 106 cubic feet) per second to protect fish and spawning.	TC
		Operate (K-Reactor with cooling tower)	Cooling tower will mitigate above impacts; stream temperature will not exceed 32.2°C (90°F).				
Eutrophication /anoxia	Anoxic zone formation common in hypolimnion of Southeast lakes in summer is increased in L-Lake and Par Pond because of thermal loading.	Operate	No impact	Eutrophication, anoxia in hypolimnion of L-Lake	Eutrophication, anoxia in hypolimnion of Par Pond	Anoxic zone would substantially diminish.	TC
		Terminate	No impact	See Alternative 3.	See Alternative 3.		
Threatened and endangered species	Potential impacts have been mitigated by provision of offsite foraging habitat for wood stork. No impact on other species.	Operate	Potential impacts have been mitigated by offsite measures.	Potential impacts have been mitigated by offsite measures.	Potential impacts have been mitigated by offsite measures.	Former habitats on SRS would be restored. Offsite mitigation measures would continue.	TC
		Terminate	See Alternative 3.	See Alternative 3.	See Alternative 3.		
Water quality (nonthermal)	Liquid effluents discharged to onsite streams would be in compliance with NPDES permit requirements.	Operate	Liquid effluents discharged to onsite streams would be in compliance with NPDES permit requirements.			Liquid effluents from reactors would essentially be eliminated.	TC
		Terminate	Liquid effluents from reactors would essentially be eliminated.				

Table S-1. Comparison of Impacts of Alternatives (Page 6 of 10)

Impact[a]	Alternative 1. Proposed/No Action[b]	Alternative 2. Terminate K-, or L-, or P-Reactor or Combination of Any Two[c]	K or	L or	P	Alternative 3. Termination[d] (K, L, and P)	TC
Solid waste (nonradioactive nonhazardous)	All onsite unsalvageable domestic waste (3,600 metric tons (about 3,967 tons) per year) is packaged and disposed of in SRS landfill. Domestic waste and sanitary waste sludge are disposed in SRS landfills and sludge pit.	Operate	About 1,200 metric tons (1,322 tons) per year	About 1,200 metric tons (1,322 tons) per year	About 1,200 metric tons (1,322 tons) per year	Substantial reduction in generation of solid and domestic wastes.	TC
		Terminate	See Alternative 3.	See Alternative 3.	See Alternative 3.		
Hazardous waste	Operation of K-, L-, and P-Reactors and support facilities generates about 225 cubic meters (295 cubic yards) per year of hazardous wastes, which would be disposed of in approved facilities.	Operate	About 75 cubic meters (98 cubic yards) per year	About 75 cubic meters (98 cubic yards) per year	About 75 cubic meters (98 cubic yards) per year	Substantial reduction in generation of hazardous wastes.	TC
		Terminate	See Alternative 3.	See Alternative 3.	See Alternative 3.		
Solid low-level radioactive waste	Operation of K-, L-, and P-Reactors generates about 2,005 cubic meters (2,623 cubic yards) per year of solid low-level radioactive wastes, which would be disposed of on SRS; this does not include other SRS facilities plus offsite receipts.	Operate	About 640 cubic meters (837 cubic yards) per year	About 675 cubic meters (883 cubic yards) per year	About 690 cubic meters (903 cubic yards) per year	Substantial reduction in generation of low-level wastes.	TC
		Terminate	See Alternative 3.	See Alternative 3.	See Alternative 3.		
Mixed waste	Operation of K-, L-, and P-Reactors and support facilities would generate about 4,750 cubic meters (6,213 cubic yards) per year of mixed wastes, which would be disposed of on SRS.	Operate	About 1,580 cubic meters (2,067 cubic yards) per year	About 1,580 cubic meters (2,067 cubic yards) per year	About 1,580 cubic meters (2,067 cubic yards) per year	Substantial reduction in generation of mixed wastes.	TC
		Terminate	See Alternative 3.	See Alternative 3.	See Alternative 3.		

Table S-1. Comparison of Impacts of Alternatives (Page 7 of 10)

Impact[a]	Alternative 1. Proposed/No Action[b]	Alternative 2. Terminate K-, or L-, or P-Reactor or Combination of Any Two[c]	K or	L or	P	Alternative 3. Termination[d] (K, L, and P)	TC
Transuranic (TRU) waste	Operation of K-, L-, and P-Reactors would generate about 1,130 cubic meters (1,478 cubic yards) per year of TRU wastes, which eventually would be disposed of off SRS.	Operate	About 377 cubic meters (493 cubic yards) per year	About 377 cubic meters (493 cubic yards) per year	About 377 cubic meters (493 cubic yards) per year	Substantial reduction in TRU waste from reactors. Continued work-off of stored retrievable TRU waste for shipment to Waste Isolation Pilot Project.	TC
		Terminate	See Alternative 3.	See Alternative 3.	See Alternative 3.		
High-level liquid radioactive wastes	Operation of K-, L-, and P-Reactors would generate about 1,600 cubic meters (2,093 cubic yards) per year of high-level liquid radioactive waste.	Operate	About 533 cubic meters (697 cubic yards) per year	About 533 cubic meters (697 cubic yards) per year	About 533 cubic meters (697 cubic yards) per year	Substantial reduction of high-level waste from reactors. Work-off of about 8,400 cubic meters (10,987 cubic yards) per year of high-level wastes stored in tanks would continue, as would reprocessing of research reactor spent fuels [about 200 cubic meters (262 cubic yards) per year].	TC
		Terminate	Substantial reduction of waste generation.		See Alternative 3.		
Cesium-137	Cesium-137 releases from onsite streambeds (about 72% from reactors) produce maximum individual EDE of about 0.28 millirem per year.	Operate				Substantial immediate reduction in offsite doses from resuspension of Cs-137 due to reduced flow and temperature.	TC
		Maximum individual EDE[e] (millirem per year)	0.01	0.11	0.081		
		Collective EDE to population within 80 kilometers (50 miles) and downriver water users (person-rem per year)	0.039	0.45	0.32		
		Terminate	See Alternative 3.	See Alternative 3.	See Alternative 3.		

Table S-1. Comparison of Impacts of Alternatives (Page 8 of 10)

Impact[a]	Alternative 1. Proposed/No Action[b]	Alternative 2. Terminate K-, or L-, or P-Reactor or Combination of Any Two[c]	K or	L or	P	Alternative 3. Termination[d] (K, L, and P)	TC
Normal operation[f]		Operate				Radioactive releases from K-, L-, and P-Reactors and support facilities would diminish by at least 1 order of magnitude. No significant change in individual or collective radiation doses from all sources.	TC
		Dose - area fence (millirem per year)	99	79	76		
Radiation dose maximum individual	0.58 millirem per year, (Natural background=296 millirem per year	Maximum offsite (including Cs-137) (millirem per year) (DOE limit = 100 millirem per year)	0.20	0.26	0.24		
Population within 80 kilometers (50 miles)	22.0 person-rem per year	Collective (including Cs-137) (person-rem per year)	7.2	7.5	7.4		
Downriver water users only	9.48 person-rem per year	(person-rem per year)	6.6	1.4	1.5		
	(Above doses include cesium remobilization associated with reactor operation)	Terminate	See Alternative 3.	See Alternative 3.	See Alternative 3.		
Health effects (annual)		Operate				Radioactive releases from K-, L-, and P-Reactors and support facilities would diminish, as noted above. There would be no excess health effects (cancer risks) due to radioactive releases from the reactors and support facilities.	TC
Maximum individual risk	Fatal cancer risk is 2.3×10^{-7} per year	Maximum individual risk	0.81×10^{-7}	1.0×10^{-7}	0.95×10^{-7}		
Population risk within 80 kilometers (50 miles)	8.8×10^{-3} excess cancer fatality	Population risk within 80 kilometers (50 miles)	2.9×10^{-3}	3.0×10^{-3}	2.9×10^{-3}		
Downriver water users	3.8×10^{-3} excess cancer fatality	Downriver water users	2.6×10^{-3}	5.5×10^{-4}	6.1×10^{-4}		
		Terminate	See Alternative 3.	See Alternative 3.	See Alternative 3.		

Table S-1. Comparison of Impacts of Alternatives (Page 9 of 10)

Impact[a]	Alternative 1. Proposed/No Action[b]		Alternative 2. Terminate K-, or L-, or P-Reactor or Combination of Any Two[c] K or	L or	P	Alternative 3. Termination[d] (K, L, and P)	TC
Accidents		Operate					
Design-basis							
Probable 2-hour individual effective dose equivalent at the SRS boundary	0.51 rem	Onsite[g]	20.9	22.0	21.6	There would be no releases as a result of reactor accidents.	
		Offsite[g]	0.47	0.51	0.44		
Probable 2-hour individual thyroid dose at the SRS boundary	0.39 rem	Onsite[g]	2.5	2.5	2.7		
		Offsite[g]	0.39	0.39	0.33		
		Terminate	See Alternative 3.	See Alternative 3.	See Alternative 3.		
Severe							TC
Prompt fatality risk (per reactor-year) for individual within 1.6 kilometers (1 mile) of SRS boundary	8×10^{-11}	Onsite[h]	1.6×10^{-7}	1.6×10^{-7}	1.6×10^{-7}		
		Offsite	5.9×10^{-11}	5.9×10^{-11}	8×10^{-11}		
Latent fatality risk (per reactor-year) for individual within 16 kilometers (10 miles) of SRS boundary	7.2×10^{-8}	Onsite[h]	2.9×10^{-7}	2.9×10^{-7}	2.9×10^{-7}		
		Offsite[i]	7.2×10^{-8}	7.2×10^{-8}	7.2×10^{-8}		
	Both severe accident risks are well within Draft DOE Safety Goals.	Terminate	See Alternative 3.	See Alternative 3.	See Alternative 3.		
Commitment of resources	Resource commitments include water and energy use, coal and oil for power, labor, chemicals, and raw materials. Electric power demands for three reactors would be 175 megaWatts.	Operate	Resource commitments for each reactor would be about one-third of those required for the total of K-, L-, and P-Reactors.			No long-term commitment of resources at reactors; reduced commitment at support facilities.	
		Terminate	See Alternative 3.	See Alternative 3.	See Alternative 3.	SRS cleanup and institutional control would continue.	

Table S-1. Comparison of Impacts of Alternatives (Page 10 of 10)

Impact[a]	Alternative 1. Proposed/No Action[b]	Alternative 2. Terminate K-, or L-, or P-Reactor or Combination of Any Two[c] K or L or P	Alternative 3. Termination[d] (K, L, and P)	
			A commitment for electricity to pump river water to maintain Steel Creek flows would be required in addition to 2.5 megaWatts for each reactor.	TC

a. Where specified, the impacts consider the impacts of reactor operation and routine operations of the facilities supporting reactor operation (support facilities). Section 4.1.6 presents a detailed assessment of impacts, including those from support facilities.
b. The Proposed Action/No-Action alternative is defined as the continued operation of K-, L-, and P-Reactors. Operation includes normal outages for fuel and target replacement and for maintenance. In general, impacts listed in this column represent the total of the individual impacts from each reactor.
c. Alternative 2 includes termination of K-, or L-, or P-Reactor, or K + L, K + P, or L + P-Reactors in the immediate future and maintaining in cold standby. The remaining reactors would continue to operate. Impacts are shown for operating or terminating operation of each reactor. In general, impacts from operating or terminating any two reactors would be additive. For combinations involving the termination of K-Reactor operation, DOE also would terminate the construction of the cooling tower. TC
d. The Termination alternative is defined as terminating the operation of K-, L-, and P-Reactors in the immediate future and maintaining them in cold standby.
e. EDE = effective dose equivalent.
f. Normal operation includes the use of seepage basins.
g. Due to 2-hour exposure, with typical meteorological conditions, for an accident resulting from a reloading error (3% core melt).
h. Any variance in onsite population dose and fatality risks due to differing meteorological or topographical conditions among the three reactors is expected to be within the bounds of uncertainty of the severe accident analysis.
i. Any variance in offsite fatality risks due to different meteorological or topographical conditions or slight differences in center of radii for the different reactor locations is expected to be within the bounds of uncertainty of the severe accident analysis.

4.5 MITIGATION MEASURES

The EIS discusses a number of mitigation measures in addition to those that are included in the preferred alternative. These alternative mitigation measures include the following:

- Containment dome
- Internal containment structure
- Detritiation system
- Confinement improvements
- Elevated piping concept
- Entrainment mitigation
- Thermal mitigation

TC

5. FEDERAL AND STATE ENVIRONMENTAL REQUIREMENTS

The EIS discusses major Federal and State of South Carolina environmental requirements that apply to the operation of K-, L-, and P-Reactors.

In addition, two Executive Orders, Floodplain Management (EO 11988) and Protection of Wetlands (EO 11990), apply to the operation of these reactors.

Appendix A. ANALYSIS OF NUCLEAR MATERIALS PRODUCTION OPTIONS

Appendix A, which is classified, provides a quantitative discussion of the need to produce nuclear materials and of the capabilities of the Savannah River Site reactors to produce material at various power levels. It also addresses the capabilities of other production options.

TC

Appendix B. STUDIES AND MONITORING

Appendix B discusses continuing environmental studies and monitoring at SRS.

Appendix C. PUBLIC AND AGENCY COMMENTS ON DRAFT ENVIRONMENTAL IMPACT STATEMENT AND DEPARTMENT OF ENERGY RESPONSES

Appendix C contains public and agency comments on the Draft EIS and the Department of Energy responses to these comments.

TC

LIST OF ACRONYMS AND ABBREVIATIONS

AACS	Airborne Activity Confinement System	
ABS	Automatic Backup Shutdown (system)	TC
AC	alternating current	TC
ACNFS	Advisory Committee on Nuclear Facility Safety	TC
AEA	Atomic Energy Act	
AEC	U.S. Atomic Energy Commission	
ALARA	as low as reasonably achievable	TC
ANSI	American National Standards Institute	
ASME	American Society of Mechanical Engineers	
BBC	balanced biological community	TC
CCDF	complementary cumulative distribution function	
CEQ	Council on Environmental Quality	TC
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act	TC
CFR	Code of Federal Regulations	TC
CHRS	Confinement Heat Removal System	
Ci	Curie	
CIF	Consolidated Incineration Facility	TC
COE	U.S. Army Corps of Engineers	
cpm	counts per minute	
CPZ	Contingency Planning Zone	
CRAF	Comet Rendezvous Asteroid Flyby (NASA mission)	TC
CWA	Clean Water Act	TC
DBA	design-basis accident	
DBE	design-basis earthquake	
DC	direct current	TC

TC	DEGB	double-ended guillotine break
TE	DNFSB	Defense Nuclear Facilities Safety Board
	DOE	U.S. Department of Energy
	DOE-HQ	U.S. Department of Energy - Headquarters
	DOE-SR	U.S. Department of Energy - Savannah River Operations Office
TC	DOT	U.S. Department of Transportation
	DPSOL	Du Pont Savannah Operating List
	DPSOP	Du Pont Savannah Operating Procedure
	DWPF	Defense Waste Processing Facility
	D_2O	heavy water or deuterium oxide
TC	ECS	Emergency Cooling System
TC	EID	Environmental Information Document
	EIS	environmental impact statement
	EOF	Emergency Operations Facility
	EPA	U.S. Environmental Protection Agency
	EPZ	Emergency Planning Zone
TC	ETF	effluent treatment facility
	FEIS	final environmental impact statement
TC	FR	Federal Register
TC	FWPCA	Federal Water Pollution Control Act
	FWS	U.S. Fish and Wildlife Service
TC	FY	Fiscal Year
	GDNR	Georgia Department of Natural Resources
TC	G-M	Geiger-Mueller
TC	GTM	Gang Temperature Monitor
TC	HEPA	high-efficiency particulate air (filter)

HLW	high-level waste	TC
INPO	Institute of Nuclear Power Operations	
ISEP	Integrated Safety Evaluation Program	
kg	kilogram	TC
km	kilometer	TC
kW	kiloWatt	
L	liter	TC
LET	linear energy transfer	TC
LLNL	Lawrence Livermore National Laboratory	
LOCA	loss-of-coolant accident	
LOPA	loss-of-pumping accident	
MACCS	MELCOR Accident Consequence Code System	TC
MCL	maximum contaminant level	TC
mg	milligram (one-thousandth of a gram)	
ml	milliliter (one-thousandth of a liter)	
MMI	Modified Mercalli Intensity	TC
mrem	millirem (one-thousandth of a rem)	
MRS	Moderator Recovery System	
mW	megaWatt	
NAAQS	National Ambient Air Quality Standards	
NAE	National Academy of Engineering	TC
NAS	National Academy of Sciences	
NASA	National Aeronautics and Space Administration	TC
NEPA	National Environmental Policy Act of 1969	TC
NERP	National Environmental Research Park	
NESHAP	National Emission Standards for Hazardous Air Pollutants	TC
NMFS	National Marine Fisheries Service	

	NO_x	nitrogen oxides
	NOI	Notice of Intent
	NPDES	National Pollutant Discharge Elimination System
	NPL	National Priority List
TC	NPR	New Production Reactor
	NRC	U.S. Nuclear Regulatory Commission
TC	NWS	National Weather Service
	NWSM	Nuclear Weapons Stockpile Memorandum
	OCC-A	Offsite Communications Center of Aiken, South Carolina
	PCB	polychlorinated biphenyl
	PDS	plant damage state
TC	ppm	parts per million (10^{-6})
	PRA	probabilistic risk assessment
TC	QA	quality assurance
	rad	radiation absorbed dose
	RC	release category
	RCRA	Resource Conservation and Recovery Act
	rem	roentgen equivalent man
TC	REMACS	remote emergency monitoring and control system
	RI	reactor incident
TC	RIMP	Restart Issue Management System
	RRSS	Reactor Room Spray System
	RSIP	Reactor Safety Improvement Program
	SAAP	Severe Accident Assessment Program
	SAR	Safety Analysis Report
	SCDHEC	South Carolina Department of Health and Environmental Control

SCWMRD	South Carolina Wildlife and Marine Resources Department	
SCWRC	South Carolina Water Resources Commission	
SID	Safety Information Document	|TC
SO_2	Sulfur dioxide	
SO_x	Sulfur oxides	|TC
SR	(DOE) Savannah River Operations Office	
SREL	Savannah River Ecology Laboratory	
SRFS	Savannah River Forest Station	
SRL	Savannah River Laboratory	
SRP	Savannah River Plant (before April 1, 1989)	|TC
SRS	Savannah River Site (since April 1, 1989)	|TC
SRSPO	Savannah River Special Projects Office	
SSS	supplementary safety system	
TLD	thermoluminescent dosimeter	
TRU	transuranic	
TSA	Technical Safety Appraisal	
TSC	Technical Support Center	
TSCA	Toxic Substances Control Act	
TSP	total suspended particulates	|TC
TSS	total suspended solids	|TC
UCNI	Unclassified Controlled Nuclear Information	|TC
USC	United States Code	|TC
USFS	U.S. Forest Service	
USGS	U.S. Geological Survey	|TC
WIND	Weather Information and Display System	
WISR	Westinghouse Independent Safety Review	
WRS	Water Removal and Storage (system)	|TC

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APPENDIX B Studies and Monitoring

APPENDIX C Responses to Public Comments on Draft Environmental Impact Statement, Continued Operation of K-, L-, and P-Reactors

NOTE: Due to its large size, Appendix C has been divided into two parts. The first part is in Volume I of this Final EIS; it consists of an introduction and summary of responses, four tables listing individuals and organizations that submitted comments, and the letters received by DOE that contained comments. The second part, which consists of comments on the Draft EIS received during public meetings in Savannah, Georgia, and in Columbia and Aiken, South Carolina, comprises Volume II of this Final EIS.

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CHAPTER 1

PURPOSE AND NEED FOR THE PROPOSED ACTION

The purpose of the proposed action is to ensure the capability to meet nuclear material production requirements. The operation of K-, L-, and P-Reactors at the U.S. Department of Energy (DOE) Savannah River Site (SRS) would serve this purpose at least until new production capability has been demonstrated. TC

Tritium is needed to build and maintain the nation's nuclear weapons stockpile, to support weapons and nonweapons research and development, and for other minor uses such as medical and luminescence applications. Plutonium-238 is used for space and military missions and medical applications; additional quantities will be needed in the near future to support planned space and military missions. DOE is responsible for maintaining the capability to produce certain nuclear materials, such as weapons-grade plutonium (plutonium-239), which might be needed in the future for a variety of defense and nondefense uses. TC

1.1 PURPOSE

DOE operates a nuclear reactor production complex at SRS in South Carolina to produce tritium, plutonium, and other nuclear materials for the U.S. Nuclear Weapons Program. Three SRS reactors (K, L, and P) are operational; at present, their safety and management systems are undergoing improvements.

The 1990 Nuclear Weapons Stockpile Memorandum (NWSM) indicates that there will be a continuing need for the production of tritium to replenish material lost from the current weapons stockpile through decay and to support ongoing warhead-modernization programs. In addition, the production of tritium for defense purposes enables DOE to provide material for commercial applications. Plutonium-238 is needed for space missions and other purposes. In the future, there might be a need for additional weapons-grade plutonium and other reactor-produced isotopes. TC

Appendix A (which is classified) contains a quantitative discussion of the need to produce nuclear materials, including the capability of alternative production sources to meet the need. In addition, Appendix A examines delaying the resumption of production at one or more reactors, including delaying the resumption of production at K-Reactor until the completion of a cooling tower. TC

The continued operation of K-, L-, and P-Reactors is proposed to ensure the capability to meet the currently defined requirements for tritium and plutonium-238, at least until replacement production capability has been demonstrated. DOE has proposed to site, construct, and operate new production reactor (NPR) capacity to ensure a long-term, reliable supply of defense nuclear materials. NPR planning and preliminary design activities have begun; however, DOE will make no final decisions regarding that proposal until the completion of an environmental impact statement (EIS). Current plans estimate that NPR production capacity could be available in the year 2000. TC

1.2 NEED

Pursuant to the Atomic Energy Act (AEA) of 1954, as amended, DOE is responsible for developing and maintaining a capability to produce nuclear materials required for the defense of the United States. DOE also is authorized to provide certain nondefense nuclear materials, including plutonium-238, for the power generators used in civilian space missions and in terrestrial applications.

The primary use of nuclear materials in defense programs is in building and maintaining the nation's stockpile of nuclear weapons. Two materials required for the production of nuclear weapons, tritium and weapons-grade plutonium, are produced through the irradiation of target material in nuclear reactors. Because tritium decays at a rate of 5.5 percent per year, it must be replenished periodically in nuclear weapons to maintain the stockpile. Other requirements for nuclear materials arise because of changes in the character of the weapons stockpile; for research, development, and testing; and for the inventories needed to operate production and recycling facilities. Materials from recycling from existing weapons and recovery from retired weapons are included in determining if the production of nuclear materials is needed to meet requirements. (Appendix A, which is classified, contains quantitative projections for nuclear materials production requirements based on the 1990 NWSM, descriptions of the processing complex, and analyses of the capabilities of alternative production sources to meet the requirements.)

L-15-06
S-12-03
A-06-08
A-76-04
L-37-03

TC

The AEA defines the DOE role in national security activities. The legislation assigns to DOE the responsibility for developing and maintaining the capability to produce nuclear materials required for the defense of the United States. The primary use of nuclear materials produced by DOE is for building and maintaining the Nation's stockpile of nuclear weapons. The Nuclear Weapons Stockpile Plan, as included in the NWSM, is the Presidentially approved document that directs the production of, and retirement of, nuclear weapons. The President also directs the establishment and maintenance of nuclear material reserves.

TC

The NWSM is forwarded annually from the Secretaries of the Departments of Energy and Defense via the National Security Council to the President for approval. The NWSM reflects the size and composition of the stockpile needed to defend the United States and provides an assessment of the DOE ability to support the proposed stockpile. Many factors are considered in the development of the NWSM, including the status of the currently approved stockpile, arms control negotiations and treaties, Congressional constraints, and the status of the nuclear material production and fabrication facilities. Revisions of the NWSM are issued when any of the factors indicate the need to change the requirements established in the annual document. The current NWSM, which was approved by President Bush on July 12, 1990, authorizes weapon production and retirements through Fiscal Year (FY) 1995. It also provides a projection of material requirements for the FY 1996-2000 period. DOE based the revised analyses in Appendix A on this new NWSM. Appendix A also presents an analysis of a potential revision of the newest NWSM.

L-02-01
S-03-03
C-01-01
A-06-01

DOE proposes to continue to base its production and outage schedules for K-, L-, and P-Reactors on providing the capability to meet the need for nuclear materials established by the July 1990 NWSM, which took into account the changing world geopolitical situation, and other mission needs. When the President approves a new NWSM, or a revision based on changes in that situation or other factors, DOE will reexamine its production schedules, and change them as appropriate to meet changing nuclear material requirements. The generation of each new NWSM incorporates the effects of strategic arms reduction treaties, current world geopolitical situations including potential future scenarios, budget constraints, and other such factors. Therefore, the production schedules for K-, L-, and P-Reactors will continue to take into account the changing world geopolitical situation. L-02-01 L-37-10 L-39-01 S-03-03 S-33-02 C-01-01 C-18-02 A-06-01 A-06-07

DOE has recognized the potential that material requirements could decrease in the future due to the changing world geopolitical situation (e.g., potential Strategic Arms Reduction Talks Treaties; potential reduction of U.S. tactical presence in the North Atlantic Treaty Organization) and budget constraints, and has included an analysis of a potential reduced-need scenario in Appendix A. (Conversely, there is also a potential that the world geopolitical situation could necessitate an increase in material requirements.) TC L-02-01 L-37-03 S-03-03 C-01-01 A-06-01

Ensuring the capability to meet the material requirements established in the NWSM enables DOE to satisfy requests for relatively small quantities of nuclear materials for other applications, including the following:

- Tritium for use in nonweapons research and development
- Tritium for commercial and medical applications TC
- Other isotopes (e.g., californium-252, americium-242, krypton-85, cobalt-60)

During FY 1989 and 1990, DOE and the Department of Defense (DOD) implemented several initiatives that allowed DOE to meet the demand for tritium while the SRS production reactors were shut down. These initiatives included the use of tritium process inventories and coordination between DOE and DOD to meet current needs with smaller inventories. TC

Plutonium-238 is needed for various applications by the National Aeronautics and Space Administration (NASA) space program, DOD, and DOE. At present, DOE has approximately 59 kilograms of plutonium-238 in inventory. Through 1999, 134.8 kilograms of plutonium-238 are needed to support NASA, DOD, and DOE applications. The currently identified requirements are 22.0 kilograms for a U.S. Navy mission; 62.0 kilograms for NASA applications, which include the Comet Rendezvous Asteroid Flyby (CRAF) and Cassini missions; and 50.8 kilograms for DOE to maintain two process lines for NASA and Navy products, conduct safety testing, perform qualification testing for advanced radioisotope thermal generators, and allow for annual decay and process losses. Newly produced material is necessary to raise the isotopic content of the existing inventory to specification levels. This is achieved by blending existing low-assay material with newly produced material of higher assay, about 85 to 90 percent plutonium-238. Without new production, about 40 TC L-37-04 L-47-01 L-47-02 L-48-21 L-48-31

percent of the existing inventory cannot be used because of its low isotopic assay. New material is also required to replenish the strategic inventory as well as to meet program requirements. The SRS reactors are considered to be the only facilities capable of meeting these near-term needs. The Nuclear Weapons Council has confirmed a demand for plutonium-238 that will exceed the DOE supply in the early 1990s (Herzfeld, 1990). In particular, Congressional approval of FY 1990 starts for the NASA CRAF and Cassini projects, and confirmation of a classified Navy mission with plutonium-238 requirements in 1991, 1992, and 1993, will require early resumption of plutonium-238 production by DOE.

TC
L-47-04
L-47-05
L-48-38

Tritium requirements plus requirements for plutonium-238 constitute the anticipated demand for reactor capacity to produce nuclear materials through at least the mid-1990s. Although not currently anticipated, a need for the production of weapons-grade plutonium and other nuclear materials in SRS reactors could develop in the future.

TC

The continued operation of the SRS reactors would enable DOE to provide the capability to meet production requirements for tritium and plutonium-238, and would ensure the capability to produce nuclear materials as necessary, at least until replacement production capability has been demonstrated.

REFERENCE

Herzfeld, C. M., 1990. "Plutonium-238 Requirements Assessment: 1990 Update," U.S. Department of Defense and U.S. Department of Energy, Nuclear Weapons Council, Washington, D.C.

CHAPTER 2

PROPOSED ACTION AND ALTERNATIVES

The proposed action in this environmental impact statement (EIS) is to continue to operate K-, L-, and P-Reactors at the Savannah River Site (SRS; see Figure 2-1) to produce nuclear materials as needed, at least until proposed replacement reactors are available and fully demonstrated. The EIS considers the following alternatives: TC

1. Continue to operate K-, L-, and P-Reactors at SRS (the proposed action) (Section 2.1) - This is the preferred alternative of the U.S. Department of Energy (DOE) and represents no change from the current situation (i.e., no action). L-02-01

2. Terminate operation of one or two reactors at SRS in the immediate future and maintain in cold standby (Section 2.2).

3. Terminate operation of K-, L-, and P-Reactors in the immediate future and maintain the reactors in cold standby (Section 2.3).

4. Other production options to K-, L-, and P-Reactor operation (Section 2.4).

   - DOE reactor options
   - Technology options
   - Other supply options

DOE proposes to continue to operate K-, L-, and P-Reactors at SRS to ensure the capability to meet currently defined requirements for tritium and plutonium-238, at least until replacement production capability has been demonstrated. Ensuring the capability to meet the material requirements established in the Nuclear Weapons Stockpile Memorandum (NWSM) enables DOE to satisfy requests for relatively small quantities of nuclear materials for other applications.

Terminating operation of one, two, or all three reactors in the immediate future would result in DOE not having as much capacity to meet nuclear materials requirements. Termination in the immediate future would require the cessation of the programs and activities currently underway to modify and upgrade the reactors, and placement of these reactors in a cold-standby status, as described in Section 2.2, without having completed such upgrades and demonstrated the capability of each reactor to resume production. Any plan for the potential recall of the reactors from cold-standby status for resumption of production would be hampered by the uncertainty in the schedule for the completion of upgrades and a demonstration of production capability. TC

DOE has evaluated several alternatives to the production of the required quantities of tritium in SRS reactors. These include production in other DOE-owned reactors, such as the N-Reactor at the Hanford Reservation or small

research and test reactors; in civilian power reactors; by advanced technologies such as linear accelerators or more speculative technologies such as fusion reactors; or by procurement from foreign nations.

Other DOE reactors would require conversion to produce tritium, a process requiring 4 to 6 years, and therefore would not be capable of meeting tritium requirements during the conversion period. Further, the excessive costs of such conversions and of converting and maintaining needed support facilities and staff, and the significant technological and schedule risks of conversion, eliminate the conversion of these reactors as a reasonable alternative. Rebuilding an existing reactor facility, such as C-Reactor on the SRS, would take nearly as long as the construction of a new reactor, and, therefore, is not a reasonable alternative. TC

The production of tritium for defense purposes in civilian nuclear power reactors is technically feasible, but is contrary to the national policy separating civilian and military uses of nuclear energy. Similarly, the regular procurement of tritium from foreign nations is contrary to U.S. policy, as well as the policies of some potential foreign suppliers. Therefore, these alternatives are not considered reasonable.

The use of linear accelerators for tritium production is technically possible, but would require considerable time to develop production feasibility. Fusion reactors as a source of tritium supply are highly speculative, because the basic demonstration of a sustained fusion reaction has yet to occur. TC

DOE has also evaluated potential production options for plutonium-238; these include the Fast Flux Test Facility/Fuels and Materials Examination Facility (FFTF/FMEF) at the Hanford Reservation, Richland, Washington, and other DOE test reactors. Construction and modification of FFTF/FMEF required to support plutonium-238 production would not meet schedule requirements for National Aeronautics and Space Administration projects and a classified Navy mission; therefore, continuing the production of plutonium-238 in SRS reactors is the only reasonable alternative. TC

The construction of new production reactor capacity is not considered as an alternative to the proposed action in this EIS, because this EIS considers alternatives to allow DOE to meet requirements at least until replacement production capacity has been demonstrated. The time required for the procurement, design, and construction of this new capacity is too long to satisfy nuclear materials requirements in the near term. Although proceeding with construction of new production reactor capacity is proposed by DOE, the schedule cannot be accelerated sufficiently to satisfy near-term material requirements. TE TC

Thus, there are no reasonable alternatives to the continued operation of K-, L-, and P-Reactors to ensure the capability to meet nuclear materials requirements, at least until new production capability has been demonstrated. TC

2.1 PROPOSED ACTION AND NO ACTION - CONTINUE TO OPERATE K-, L-, AND P-REACTORS AT THE SAVANNAH RIVER SITE

Under this alternative, DOE would continue to operate K-, L-, and P-Reactors at SRS as necessary to meet nuclear material production requirements (based primarily on the annual NWSM). DOE would schedule production runs and outages for these reactors to meet the needs based on the then-current NWSM, and other
L-37-07 requirements for nuclear materials, while accommodating continued implementation of safety and environmental enhancements. Under this alternative, DOE would continue to operate all three reactors over a wide range of production capacity to meet nuclear materials production needs.

This range of production capacity extends from the operation of K-, L-, and P-Reactors at full authorized power to yield the maximum production possible, to one or more reactors operating at less than full authorized power to yield
L-37-02 intermediate production rates, to maintaining one or more reactors in cold
L-44-07 shutdown to meet minimal production rates or ensuring the availability of
C-03-04 increased production capability. This alternative also includes the possibility of placing one or more reactors in cold standby after completion of ongoing upgrades and tests and an analysis of their capability if the nuclear materials requirements can be met. In any event, DOE would consider placing these reactors in cold standby after new production capability is demonstrated.

DOE considers K-, L-, and P-Reactors to be in operation during the current outage, just as NRC considers commercial nuclear powerplants that are in
L-05-01 extended outages for major modifications to be in operation; these commercial
L-37-02 plants remain under their operating licenses. The range of operation for the
L-44-07 SRS reactors encompasses a variety of operating modes; these include cold
C-03-04 shutdown conditions (e.g., for refueling, maintenance, or implementation of
A-07-02 safety or environmental enhancements); startup and power ascension (including
S-12-10 the component/system testing performed under conditions ranging from zero power to maximum authorized power); to operation at full authorized power as necessary to meet production requirements.

The proposed action for this EIS also represents the no-action alternative because it represents no change from the present DOE course of action (46 FR 18026). The proposed action includes ongoing improvements and enhancements in
L-48-04 reactor safety systems, training, management and administrative functions, and
S-08-01 general technical areas. The following sections present SRS process
C-03-03 descriptions, reactor descriptions, responses to oversight, process and
A-08-01 effluent monitoring, safeguards and security, and the K-Reactor cooling tower. The K-Reactor cooling-tower impacts already have been evaluated (DOE/EIS-0121).

Chapter 4 of this EIS analyzes and bounds the environmental consequences of this alternative, assuming each reactor operates at a hypothetical full power of 3,000 megaWatts (the normal range is 1,200 to 2,800 megaWatts thermal). For comparison purposes, Chapter 4 also includes qualitative discussions of the environmental effects of partial-power operation; these effects are
TE described for each reactor if such impacts differ more than minimally from those of full-power operation, and are included in the effects of full-power

operation if the differences are minimal. The impacts of cold shutdown and cold standby are essentially the same as those described for the cold standby condition analyzed under Alternatives 2 and 3, except the loss of jobs would be less in the case of cold shutdown. L-44-07

2.1.1 SRS PROCESS DESCRIPTION

The SRS production reactors are part of an integrated complex for the production of nuclear materials; this complex includes facilities across the country. At SRS, the complex includes a fuel and target fabrication plant, three operating reactors, two chemical separations plants, a heavy-water rework facility, and waste management facilities. The SRS fabricates fuel and target materials into elements and assemblies for loading into the reactors; irradiates them in the reactors; separates transuranic elements, tritium, and residual uranium from waste byproducts; recovers and purifies heavy water; and processes, stores, and disposes of wastes. The Defense Waste Processing Facility (DWPF), which is being constructed on the SRS, will immobilize high-level radioactive wastes currently stored in underground tanks. The SRS fabrication plant manufactures fuel and target elements to be irradiated in the production reactors. Its major products are extruded enriched-uranium, TC aluminum-clad fuel; and lithium-aluminum control rods and targets.

Each reactor building houses one production reactor and its supporting operational and safety systems. The reactor buildings incorporate heavy concrete shielding to protect personnel from radiation and a confinement system to minimize atmospheric radioactive releases. The reactors use heavy water (deuterium oxide, D_2O) as a neutron moderator and as a recirculating primary coolant to remove the heat generated by the nuclear fission process. The recirculating heavy-water coolant is, in turn, cooled in heat exchangers by water pumped from the Savannah River for K- and L-Reactors, and from Par Pond for P-Reactor. Figure 2-2 shows the reactor process system.

The core of each SRS reactor is composed of individual assemblies, containing fissile and/or target materials, which are combined in various loading patterns to form a charge. Depending on the size and design of the charge, reactor power can vary from 1,200 to 2,800 megaWatts thermal. To help set the appropriate reactor power level, thermal-hydraulic limits are calculated and imposed on each specific charge to ensure safe reactor operation. The type of charge is governed by such factors as irradiation characteristics, quality, schedule, target availability, and economics (see Table 2-1).

Reactor charges for currently projected product requirements consist primarily of two types. One is a uniform lattice of Mark 22 combined fuel and target assemblies used for tritium production. It consists of uranium-235 fuel tubes, which provide neutrons for a lithium-6 target (absorber) assembly. The other charge is a mixed lattice of Mark 16 series fuel assemblies and Mark 53 series targets for plutonium-238 production. The fuel assemblies produce neutrons for the target assemblies, which contain neptunium. A mixed lattice would also be used for plutonium-239, if required; Mark 31 series targets would contain depleted uranium.

During the period when the SRS reactors have operated, a large variety of targets have been irradiated with neutrons. These have included neptunium-237

Table 2-1. Normal SRS Reactor Operating Parameters

Parameter	Value
Lattice - Mark 22 (for tritium production)	
Fuel	Enriched uranium
Target	Lithium
Lattice - Mark 16-53 (for plutonium-238 production)	
Fuel	Enriched uranium
Target	Neptunium
Lattice - Mark 16-31 (for plutonium-239 production)	
Fuel	Enriched uranium
Target	Depleted uranium
Power	Range from 1,200 to 2,800 megaWatts thermal
Primary coolant	
Assembly effluent temperature	107°C
Coolant flow	9.78 cubic meters/second
Gage pressure	34 kiloPascals (5 pounds per square inch)
Secondary coolant	
Outlet temperature	Up to 80°C
Coolant flow	11.3 cubic meters/second

for the production of plutonium-238 heat sources; cobalt metal for the production of radioactive cobalt-60 of high specific activity for use in research activities; and the extended irradiation of plutonium-239 for production of the versatile neutron source californium-252.

Fuel and target assemblies are both clad with aluminum, which provides a good heat transfer surface as well as a low neutron absorption cross-section. These assemblies are discharged from the reactors after a specified exposure period and stored in a water-filled disassembly basin to permit the decay of short-lived, unwanted radioactive products. After this temporary underwater storage, the assemblies are transferred to the separations areas in special shipping casks.

At the chemical separations plants, the irradiated fuel and target materials are dissolved in nitric acid. A solvent extraction process yields (1) solutions of plutonium, uranium, and neptunium, and (2) a high-heat liquid waste, containing the nonvolatile fission products. After the product solutions are separated from the fission products, further processing is performed in unshielded areas, where plutonium, uranium, and other products

are converted from solution to solid form for shipment, recycling, or further processing (e.g., plutonium-238 heat source fabrication).

In the tritium facilities, gases are extracted from irradiated reactor
TE elements and processed through several purification steps to produce tritium of high purity. Reactor elements are placed in a crucible in an electric furnace and heated to more than 600°C to extract gases. Purification steps, which employ vacuum technology, include various types of diffusion pumps,
TE palladium-membrane diffusers, thermal diffusion columns, and filters. Hydrogen isotopes are separated from other gases in the feed stream in initial production steps. Further processing isolates each isotope.

Heavy water for use as the reactor coolant/moderator was originally separated from river water at the heavy-water production facility by a hydrogen sulfide extraction process, and purified by distillation. At present, this facility, which is needed only to purify the existing inventory of heavy water, does not use hydrogen sulfide.

The liquid radioactive wastes produced from the chemical processing of irradiated fuel and targets are partially concentrated and stored in large underground tanks. When operational, the DWPF will immobilize the wastes from these tanks in borosilicate glass disposal forms (DOE, 1982). These solidified waste forms will be stored on the SRS until their final disposal in a Federal repository. Low-level radioactive solid wastes produced on the SRS are disposed of in a centrally located onsite burial ground.

These facilities originally were designed to support five reactors. The continued operation of K-, L-, and P-Reactors is not expected to cause major operational changes in the fuel and target fabrication facility and the chemical separations facilities. Operation of the DWPF will eliminate the need for new waste tanks to accommodate the liquid waste generated from the processing of nuclear material as a result of continued reactor operations. Current inventories of high-level wastes are to be processed by 2008.

2.1.2 REACTOR DESCRIPTION

This section contains many examples of upgrades and modifications that will be completed either before or after the resumption of production. While not exhaustive, these examples show the wide range and depth of the efforts
L-44-10 undertaken to address issues concerning reactor safety. DOE uses the Restart
A-34-09 Issue Management Program (RIMP; see Section 2.1.3.2.1) to establish priorities for these upgrades for either before or after the resumption of production.

The following sections describe the sites and site layouts, the reactors, their subsystems, and safety features. Internal and external reviews of existing practices have resulted in a number of ongoing modifications in both systems and operating practices for these reactors. The applicable sections describe the status of these modifications as they apply to the reactor systems. Section 2.1.2.7 describes modifications in management practices, operating procedures, staffing, training, and other administrative areas.

2.1.2.1 Site

Each of the three operating production reactors is within a controlled area roughly rectangular in shape, measuring approximately 520 meters (1,700 feet) by 730 meters (2,400 feet). These areas are clustered around the geographical center of the SRS, as shown on Figure 2-1. The reactors are about 4 kilometers (2.5 miles) apart and at least 7 kilometers (4 miles) from the SRS boundary.

K-Reactor is about 5 kilometers (3 miles) southwest of the geographical center of the Site, about 9 kilometers (6 miles) east of the closest boundary. K-Area, an upland area between Pen Branch and Indian Grave Branch, has a level-to-gently-rolling topography; it is about 82 meters (270 feet) above mean sea level.

L-Reactor is about 3 kilometers (1.9 miles) south of the geographical center of the Site, about 9 kilometers (6 miles) northwest of the closest boundary. L-Area, an upland area between Steel Creek and Pen Branch, has a level-to-gently-rolling topography; it is about 76 meters (249 feet) above mean sea level.

P-Reactor is about 4 kilometers (2.5 miles) east-southeast of the geographical center of the Site and about 7 kilometers (4 miles) west of the closest boundary. P-Area, an upland area between Meyers Branch and Steel Creek, has a level-to-gently-rolling topography; it is about 96 meters (315 feet) above mean sea level.

2.1.2.2 Reactor Areas

Figures 2-3, 2-4, and 2-5 show the locations of the following major structures in the K-, L-, and P-Reactor areas, respectively:

- Reactor Buildings (105-Buildings) - Each reactor building is a reinforced concrete structure that houses the four major process areas: the reactor area, the assembly area, the disassembly area, and the purification area. The reactor area contains the reactor and associated support systems. The assembly area contains the fuel and target receiving areas, assembly and testing areas, and fuel storage areas. The disassembly area contains a pool for the storage and disassembly of irradiated fuel and target elements. The purification area contains the heavy-water moderator/coolant purification facilities.

- Cooling Water Basins (186-Basins) - Cooling water from the Savannah River supplies the 186-Basins at K- and L-Reactors. The basin at P-Area receives cooling water primarily from Par Pond, supplemented by water from the river to replace evaporative and other losses. Each basin has a capacity of approximately 95 million liters (25 million gallons).

- Contaminated Water Storage Tank and Basin (904-Basins) - Adjacent to each reactor area is a 1.9-million-liter (500,000-gallon) tank within a 190-million-liter (50-million-gallon) earthen basin. The tank collects

contaminated moderator and emergency coolant in the event of an accident. If the tank overflows, the discharge is collected in the basin. |TC

- Support Facilities - Other facilities at each reactor area include transformer yards, water treatment plants, sanitary treatment facilities, radiological health protection areas, and security areas.

- Miscellaneous Buildings - Other facilities include office and shop buildings.

2.1.2.3 Reactor Systems

2.1.2.3.1 Reactor Building and Airborne Activity Confinement System

Each reactor building is a large, reinforced concrete structure that contains four major process areas, as described in Section 2.1.2.2. The reactor area is in the center of the building; its process areas house the reactor and its control systems, as well as the reactor coolant system pumps, valves, and heat exchangers, and the fuel handling systems. Figure 2-6 shows a cross-section of this area.

The reactor building is a confinement structure; it controls and directs any accidental releases of materials through the Airborne Activity Confinement System (AACS). During reactor operation, the process area exhaust air is filtered before being released from the reactor building. The AACS maintains the process areas at a pressure lower than that of the external atmosphere to |TE ensure that all air from the process areas exhausts through the system filters (Du Pont, 1982). Filters are online at all times, precluding the need to open and close ventilation dampers in the event of an accident. As shown in Figure 2-7, the filtered air exhausts through a stack that is 61 meters high. |TE

Three large centrifugal fans exhaust the air from the process areas. Each fan has two motors, a primary motor and a backup motor. The primary motor has three sources of electrical power: (1) normal building power; (2) auxiliary building power (routed independent of normal power); and (3) emergency building power from diesel generators. The source of power for the backup motor is an engine-generator (EG) set. Normally, two fans are operating, one on auxiliary building power and the other on normal building power. The two EG sets provide backup power for the two operating fans. If power to the primary motor fails, the EG set for that fan starts automatically and supplies power to the backup motor to keep the fan operating. Only one of the three fans is required to maintain negative pressure in the process area. With two fans operating, the rated air flow is 60 cubic meters per second at a negative |TE pressure of approximately 15 centimeters of water.

Exhaust filters remove moisture, particulate, and halogen activity. The filters are enclosed in five separate compartments; three to five of the filter banks are normally online. Because the compartments are in parallel,

each can be isolated for maintenance and testing. Each compartment contains three filter banks in the following order of air flow treatment:

1. Moisture separators - Remove about 99 percent of entrained water (spherical particles measuring 1 to 5 microns) to protect against significant moisture pluggage of the water-repellent particulate filters

2. Particulate filters - Retain more than 99 percent of all particulates with diameters of 0.3 micron or larger

3. Activated carbon beds - Retain halogen activity that might be released in the event of an accident

In the event of a core-melt accident, a confinement heat removal system (CHRS) prevents a failure of the AACS due to heat degradation of the filters. The CHRS provides water flooding in the -40-foot (-12-meter) level floor to cool any molten material that might penetrate the reactor vessel or process water pipes. A reactor room spray system also provides a means to cool reactor room air.

The AACS and other systems reduce the temperature and pressure of radioactive effluents that could result from an accident. They also control the flow of these effluents through prescribed filter bank pathways that are equipped to reduce the release of radionuclides other than tritium and noble gases, as
L-44-10 described above. The following modifications to the confinement system will be completed before the resumption of production:

- The AACS exhaust fans are being altered to better withstand conditions that might exist in a post-accident environment. The following changes are being made:

  - Existing motor thermal overload relays will be replaced by solid-state breaker trips.

  - Fan motor insulation type will be upgraded to increase thermal resistance.

  - Fan bearings, lubrication, and belts will be replaced.

- The confinement filter compartment supports will receive seismic modifications to prevent them from separating from the reactor building during a seismic event. The modification consists of adding seismically resistant chocks to the filter compartment removal system.

Originally, the SRS reactor buildings were designed to protect equipment from an external blast of 48 kiloPascals (7 pounds per square inch). This design provided substantial protection against such natural phenomena as tornadoes, floods, hurricanes, and earthquakes.

TC The criteria used in the original reactor design did not account for the effects of earthquakes, because the SRS reactors were constructed before the

development of nuclear industry criteria for seismic strength in reactor systems, components, and structures. In 1969, Blume and Associates analyzed the reactor building structures for their response to seismic criteria developed by Dr. George Housner of the California Institute of Technology, and recommended a set of seismic criteria for SRS facilities; these criteria were updated in 1982 (URS/Blume, 1982). Reactor area buildings and associated systems were then classified according to their required seismic resistance. These studies resulted in changes that strengthened the actuator towers and exhaust stacks. At present, the SRS reactors are being qualified to seismic criteria that are accepted by the U.S. Nuclear Regulatory Commission (NRC) for commercial nuclear plants licensed before 1974. The following work being performed for the seismic qualification of each reactor will be completed before the resumption of production: L-76-12 L-44-10

- The support structure for the reactor stack is undergoing seismic modifications.

- The control room ceiling in the reactor building is being seismically qualified to prevent ceiling tiles from falling during an earthquake and impairing the operation of the reactor.

- Seismically qualified emergency lighting is being installed in the reactor building. The emergency lighting would be used not only after a seismic event, but also after the loss of normal lighting due to a fire or a loss of offsite power.

The long-term seismic program will include mitigation systems in addition to accident prevention systems. These modifications are planned after the resumption of production. L-76-13

Reactor fire protection systems mitigate the consequences of fires with respect to the loss of life, equipment damage, property loss, and programmatic loss. The following projects and evaluations to enhance overall fire protection will be completed at each reactor before the resumption of production: L-44-10

- Completion of a safe shutdown analysis that will demonstrate reactor safe shutdown capability from any single credible fire

- A new firewater system standpipe in the reactor building

- Improved procedures that control the introduction of combustible materials into the reactor building

- Improved procedures for operator action during a suspected or confirmed fire

- A comprehensive program to assess fire risk and identify any additional necessary detection and suppression systems

- A fire detection system in areas of the reactor building that are not normally accessible during reactor operation

- Fire patrols to detect fires in accessible areas until additional fire detection and suppression systems are installed

2.1.2.3.2 Primary Coolant System and Reactor Vessel

The reactor vessel is a cylinder, approximately 4.5 meters in height by 5
TC| meters in diameter, fabricated from 1.25-centimeter-thick Type 304 stainless steel. The vessel contains the lattice of fuel and target assemblies, control rods, and instrumentation immersed in the heavy-water moderator-coolant. An upper plenum receives primary coolant through six nozzles and distributes it through the fuel and target assemblies in the vessel. The coolant leaves the vessel through six nozzles at its bottom (Figure 2-8). A gas plenum and top radiation shield are between the inlet water plenum and the reactor vessel. Under the reactor vessel, a bottom radiation shield containing 600 monitor pins provides flow and temperature monitoring for each fuel and target position. The vessel is surrounded by a 50-centimeter-thick water-filled thermal shield and a 1.5-meter-thick concrete biological shield (Du Pont, 1982).

The stainless-steel reactor vessels have experienced no unacceptable deleterious effects as a result of neutron irradiation (Ward et al., 1980). No significant deleterious metallurgical effects should occur because neutron fluence has been accumulating very slowly since the change to lithium-blanketed charges in 1968.

A detailed stress analysis of the vessels, including seismic loads, has been performed. The estimates for material properties for the stress analysis were conservative. Subsequently, irradiated material properties, including strength and toughness, were determined experimentally in a plant-specific pre- and post-irradiation testing program. The program found that the actual properties of the SRS reactors vessels exceed the estimated properties for all material conditions.

The heavy-water primary coolant is maintained at low pressure and low
TC| temperature. Heat generated in the reactor core is removed by heavy water, which serves as both the primary coolant and as a neutron moderator. The heavy water is circulated through each reactor by six primary coolant loops. Each loop consists of a main coolant pump, two heat exchangers and associated piping, instrumentation, and valves. The flow through each coolant loop is approximately 1,600 liters per second.

TE| Each of the six coolant loops contains a centrifugal coolant pump, which draws coolant through a nozzle at the bottom of the vessel and circulates it through a pair of heat exchangers to an upper plenum nozzle. Each main coolant pump produces a total pressure head rated at 128 meters of water; pumps are driven by 2,500-kiloWatt, alternating-current (AC) motors. One direct-current (DC) motor backs up each AC pump motor.

If AC power (supplied from either of two substations) is interrupted, the reactor automatically shuts down; the DC motors alone provide adequate pumping power to remove decay (residual) heat from the reactor. During reactor operation, the DC motors run in parallel with the AC motors. A 2.7-metric-ton

flywheel on each pump stores sufficient energy to provide a smooth transition
TE from AC to DC flow rate if all AC motors are lost. Each DC motor receives power from its own dedicated diesel generator and provides approximately 25 percent of the total rated flow per loop.

The six main reactor coolant pumps and their motors are divided into two groups. Each group has separate pump and motor rooms; the motor drives the pump via a shaft extending through the concrete wall that separates the two rooms.

Limits on pD (the heavy-water equivalent of pH), conductivity, and impurity levels of the heavy water are maintained to control the corrosion of aluminum and stainless steel and to reduce the decomposition of the heavy water. Sustained reactor operations on the Site have demonstrated that the corrosion rate of aluminum components and associated problems of high radioactivity and turbidity in the process systems can be reduced substantially by controlling pD. To minimize aluminum corrosion, nitric acid is added to the heavy water through a pump suction line, maintaining a heavy-water pD of about 5.2. Because some of the acid is neutralized as the reactor coolant water flows through the purification deionizers (causing the pD to increase), periodic injections of nitric acid are necessary.

The potential for intergranular stress corrosion cracking has been subjected to close scrutiny. Extensive inspections and analyses, which began in 1968, have shown that, with respect to rapid crack propagation, a large margin of safety exists for cracks that have been observed in external piping. All accessible piping larger than 30 centimeters in diameter has been inspected ultrasonically. Analyses have also shown an even greater margin of safety for the reactor vessels. A visual inspection was made of all accessible vessel wall welds in three production reactors; in addition, a program is now under way to inspect each reactor vessel ultrasonically.

In the last several years, ultrasonic testing (UT) of austenitic stainless steel has been developed sufficiently to provide reliable detection of small, partially-through-wall cracks. Specially designed robotic equipment has been developed for the SRS UT tank inspection effort. The equipment consists of a remotely operated robotic manipulator capable of moving a UT transducer along the inside surface of the tank wall, and other tools containing cameras, lights, and calibration plates. Each piece of equipment is designed for insertion into the reactor tank through 10-centimeter diameter access ports normally used for insertion/removal of fuel and target assemblies. The
L-44-64 initial inspections called for in the SRS reactor inservice inspection (ISI)
L-66-17 plan have been completed for P- and K-Reactors. The P-Reactor inspection
L-66-18 covered 40 percent of the accessible fabrication welds, while the K-Reactor
L-69-09 inspection covered 60 percent of the accessible welds. The results of both
L-76-14 inspections were similar (WSRC, 1989f, 1990) in that no evidence of service-induced degradation (i.e., indications of cracking) was found. Various other artifacts of the original tank fabrication processes, such as weld repairs, geometric reflectors, etc., were identified. None of these has any adverse impact on the structural integrity of these two reactor tanks, and all were within the approved flaw acceptance criteria that had been developed before the inspections by nationally recognized experts in the commercial

nuclear industry. UT of the L-Reactor tank began in the fall of 1990, and will be completed before the resumption of production. These tank inspections using UT technology are state-of-the-art programs that, when used in conjunction with routine surveillance, analytical, and leak detection programs, provide continuing assurance of tank integrity. L-44-10 L-44-64 L-66-17 L-66-18 L-69-09 L-76-14

The ultrasonic surveillance program adopted for the SRS reactor tanks specifies 100-percent vessel inspection every 5 years (WSRC, 1989f); this is half the interval required by American Society of Mechanical Engineers (ASME) Section XI, Boiler and Pressure Vessel Code, which calls for 100-percent inspection over 10 years (ASME, 1986). Although the Section XI requirements are based on the existence of a preoperational baseline inspection, those requirements did not exist when the SRS reactor vessels were fabricated and installed. In addition, sensitive leak detection capability is being used to detect degradation of the reactor coolant system boundary, including the reactor vessel. L-44-64

As a result of these programs, no life-limiting mechanisms have been identified for the three reactors. Although continued aging might reduce their availability, K-, L-, and P-Reactors will be able to meet production requirements for tritium and plutonium-238, and will ensure the capability to produce nuclear materials as necessary, at least until replacement production capability has been demonstrated. TC

The following projects and programs are planned to maintain reactor coolant system operation and integrity, and will be completed before the resumption of production: L-44-10

- Existing expansion joints in the reactor coolant piping will be replaced; there are 12 of these joints in each reactor. Some of the units have incurred minor mechanical damage, and all are about 30 years old. Consequently, they are being replaced by expansion joints of a new design that will improve their resistance to corrosion and facilitate their inspectability and maintainability. TC

- A new system (the moderator recovery system) will be installed in each reactor to mitigate the consequences of an intermediate-size break (less than 63 liters per second) loss-of-coolant accident (LOCA) in the reactor coolant system. This new system has two submersible pumps, each rated at 63 liters per second, which are capable of recirculating moderator back to the reactor primary system. This increased makeup capacity provides reactor operators with the option of not having to initiate light-water Emergency Cooling System (ECS) injection for small leaks in the primary system.

- New tritium monitors more sensitive than those currently in place are being installed in each reactor building to enable earlier detection of small leaks in the reactor cooling water system. This will provide early warning of potential leaks in the system, allowing an orderly reactor shutdown for inspection.

- Installation of seismically qualified relays in primary coolant system valve controllers.

New lubricating oil systems for the reactor coolant pumps and their associated AC and DC motors are planned, but not scheduled for completion before the resumption of production; they will be provided as part of the continuing safety improvement process. The systems will consist of all welded (as opposed to flanged and bolted) stainless steel piping with redundant pumping and filtering systems. The new welded configuration minimizes the risk of lubricating oil fires due to pipe joint leakage. System design also improves the reliability of lubrication for the process water pumps and motors.

2.1.2.3.3 Secondary Cooling System

Each of the six primary coolant loops for each reactor contains two parallel, single-pass heat exchangers, which transfer heat generated in the reactor core from the primary coolant (heavy water) to the secondary coolant (light
TC | water). The secondary coolant is pumped from either the Savannah River (K- and L-Reactors) or Par Pond (P-Reactor) into the reactor area basins, where it is supplied to the reactor building at a constant flow rate to provide heat exchanger cooling. Discharged secondary coolant from K-Reactor flows into Indian Grave Branch, which is a tributary of Pen Branch. Discharged secondary coolant from L-Reactor flows into L-Lake, which discharges into Steel Creek. Discharged secondary coolant from P-Reactor returns to Par Pond, the overflow from which discharges into Lower Three Runs Creek. All three streams return their flow to the Savannah River.

Two pumping stations on the Savannah River pump river water to the reactor area reservoirs (186-Basins) through reinforced concrete lines. P-Area also
TE | receives water from Par Pond, where the heat from the secondary coolant is dissipated before the water is pumped to the P-Area 186-Basin. The river water supply replaces water lost by evaporation and other mechanisms. Individual lines supply each reactor area, and alternate tielines provide an emergency backup supply if the primary source is unavailable.

A pumphouse adjacent to each reactor area reservoir (186-Basin) delivers water to the reactor building. If the pumphouse is inoperable, several options are available to deliver water to the reactor building: (1) gravity flow from the reservoir through the pumphouse; (2) gravity flow from the reservoir to the emergency pumps in the reactor building via a bypass line; (3) forced flow from the river pumphouses using a pipeline that bypasses the reservoir and delivers cooling water directly to the reactor building; (4) recirculation of reservoir water with the emergency pumps; and (5) recirculation of disassembly-basin water with the emergency pumps.

The following projects are enhancements to the secondary cooling system at
L-44-10 | each reactor; they will be completed before the resumption of production:

- Modifications for the two 760-liter-per-second pumps that recirculate discharged reactor cooling water back to the 186-Basin. These modifications include new pump motor starters, new underground power cables, flow meters in the pump discharge lines, and a loss of flow alarm in the reactor control room.

- A cooling water conservation study to maximize the length of time the 186-Basin can supply secondary cooling water without any river water makeup.

Full-flow tests of the secondary cooling system are a normal part of routine testing at intervals during cold shutdown and before startup. These tests result in the discharge of the full flow of cooling water, at ambient temperature, to the receiving water body. TC

2.1.2.3.4 Reactor Lattice and Control System

Each reactor contains positions for 600 fuel and target assemblies; other principal positions in the reactor lattice are used for control rod housings, spargers, gas ports, and pressure-relief tubes. Depending on the products required, different arrangements and types of fuel and target assemblies are loaded to provide the desired products from a particular reactor. Between the lattice positions are 162 secondary positions that can be occupied by safety rods, instrument rods, and other components.

Neutron-absorbing rods in 61 positions control neutron flux in each reactor; each position contains seven individually motor-driven control rods. These control rods can be moved either in gangs (groups) for simultaneous positioning or individually in sequence. Two half-length rods in each position control the axial flux distribution; the remaining full-length rods control overall power and radial flux distribution. The control rods enter the core from the top of the reactor vessel. For conditions that are slightly out of specification, control rods are inserted sequentially into the core (rod reversal) to reduce power until the monitored variable returns to within its limits.

The bottom shield contains flow and temperature sensors for each principal fuel and target position, which are monitored in the control room. Flows and pressures at other locations in the primary and secondary cooling systems are also displayed in the control room.

Process monitoring and reactor control are accomplished from the central control room, either manually or automatically by an online computer. Computer and instrumentation systems provide reactor operators with the information necessary to monitor and control reactor operation. Some of these systems are part of the reactor shutdown systems. The following ongoing projects will be completed for each reactor before it resumes production; they will result in an enhanced capability to monitor and control reactor operation: L-44-10

- Improvements in axial power monitoring and calculation are being implemented for better definition of core power limits, control rod configuration limits, and reactor hydraulic limits. These programmatic improvements consist of the following: (1) axial power monitoring uncertainty analysis; (2) Technical Specifications on control rod position to control radial and axial power distribution; and (3) an assessment of present and proposed axial power monitoring systems. TC

- The existing T-Amplifiers in the control rod positioning instrumentation will be replaced by new, solid-state components to improve control of the precise positioning of reactor control rods.

- The reactor data acquisition and control system (REDAC) has been replaced by a new remote emergency monitoring and control system (REMACS). The REMACS will provide remote monitoring and control of a reactor from any other reactor or a remote control station.

- A system that can monitor and archive control rod position versus reactor power density/distribution is being established. Such information is important to the independent assessment of operational anomalies and upset conditions.

These projects are part of the continuing safety improvement process; they are
L-44-10 not scheduled for completion before the resumption of production:

- To provide better monitoring of local core conditions, 27 new monitoring thimbles will be installed in each reactor. Each thimble will contain sensors for axial power monitoring and bulk moderator temperature monitoring.

- Improved incident monitoring circuitry will provide a higher confidence level in the information displayed by alarms. This modification will help to eliminate the vulnerability to single failures that can initiate multiple spurious and misleading alarms in the reactor control room.

- The installation of state-of-the-art, processor-based calculators for all three reactors, which can operate independently of the plant control computer, will provide a redundant and diverse means of computing reactor power.

2.1.2.3.5 Core Reloading and Discharge

New fuel is received, assembled, tested, inspected, and stored in the reactor assembly area. Subsequently, fuel is transferred to the reactor charging machine for core reloading when each reactor is shut down for this purpose. Engineered safety features and administrative controls prevent criticality while the fuel is being handled and stored. These features include racks and hangers that maintain adequate spacing between fuel assemblies for criticality control. In addition, the storage racks are constructed of a material that absorbs neutrons. The storage techniques and the quantity and type of material in process at any time are limited by administrative safeguards and controls.

The equipment for core reloading includes an inlet conveyor, a charge machine, a discharge machine, and a deposit-and-exit conveyor. The charge and discharge machines are similar, and each can perform most functions of the other. However, only the discharge machine can provide heavy- or light-water cooling to an irradiated assembly. The machines travel on tracks on two parallel ledges that are part of the reactor-room wall; power for their operation is provided through cables along the ledges.

The discharge machine removes fuel and target assemblies from each reactor vessel. Four sources of water are available on the discharge machine to cool an assembly during the discharge operation: primary heavy water, primary light water, secondary heavy water, and secondary light water. The primary and secondary sources supply cooling water to the assembly through different paths. Each source has independent hoses, pipes, and actuation valves. Cooling starts automatically when an irradiated assembly is completely withdrawn from the reactor; it can also be maintained if an assembly sticks during withdrawal.

Each type of assembly (i.e., fuel or target) has a specified upper limit for heat-generation rate at the time of discharge; discharge of an assembly does not start until the heat-generation rate of the assembly has decayed to this upper limit. In addition, each type of assembly has a specified maximum allowable stress (static pull force) that can be applied during withdrawal. This stress is limited to a value safely below the ultimate strength of the component.

Reloading and discharge operations are conducted from a control room adjacent to each reactor control room. The charge and discharge machines utilize a remote control system with automatic, semiautomatic, and manual features that allow precise operation. Graphic displays on the control console track the location and operation of the machines.

The following projects are part of the continuing safety improvement process, but are not scheduled for completion before the resumption of production. They will result in upgraded fuel handling systems at the three reactors:

- The disassembly monorails will be upgraded to meet current American National Standards Institute (ANSI) standards (ANSI/ANS-57.1-1980, "Design Requirements for Light-Water Reactor Fuel Handling Systems") on safety factors for fuel-handling devices. The assembly monorails will be upgraded to improve the factor of safety to a value accepted by ANSI.

- Existing relays and the computer that controls charge and discharge machine operations will be replaced by a new, state-of-the-art minicomputer. The new computer will reduce the likelihood of a fuel or target misloading error because it will automatically track and identify such components while they are being handled. This upgrade will also increase the reliability of charge and discharge machine operations in general.

2.1.2.3.6 Fuel Disassembly and Storage

The deposit-and-exit conveyor, which is in a water-filled canal connecting the reactor room and the disassembly basin, receives an assembly from the discharge machine and carries it under the reactor room wall to a water-filled disassembly basin for temporary storage. Irradiated fuel and target assemblies are stored initially in the Vertical Tube Storage (VTS) basin until their decay heat levels are low enough to permit processing. After their removal from the VTS basin, the assemblies are disassembled and prepared for shipment in the machine basin. Disassembly is accomplished underwater, using

submerged power tools. Disassembled components are stored until their decay heat reaches levels acceptable for transport to the Separations Area.

From this final storage point, the disassembled components are moved to a transfer bay where they are placed in shielded shipping casks. These casks are transported to the Separations Area by tractor-trailer or railroad.

While in the disassembly basin, the assemblies and components are cooled by natural convection. The basin water also shields personnel from the radiation in these assemblies and components. Redundant sources of makeup water maintain basin water at the proper level. Procedural controls and instrumentation prevent the shipment of insufficiently cooled assemblies.

2.1.2.3.7 Blanket-Gas System

The helium blanket-gas system pressurizes the gas plenum over the moderator; this system serves four functions: (1) dilute the mixture of deuterium (D_2) and oxygen (O_2) evolved from the heavy-water moderator by radiolytic decomposition to a nonflammable concentration; (2) transport deuterium and oxygen gases to the catalytic recombiners; (3) carry gaseous impurities to a gas chromatograph that monitors for fission products, aiding in early detection of fuel failures; and (4) maintain a gage pressure of 34 kiloPascals to increase the saturation temperature of the heavy-water moderator. Helium is used as the blanket gas because it does not react with moderator decomposition products, fission gases, or neutrons to produce radioactive gases.

TC During operation at power, gases evolve from the reactor and enter the gas plenum. From the plenum, the gases are routed to catalytic recombiners and spray separators where the deuterium and oxygen are recombined; most of the entrained heavy water is removed from the helium and returned to the reactor. The helium is returned to the gas plenum.

2.1.2.3.8 Liquid Radioactive Waste System

As the primary heavy-water coolant/moderator circulates, it accumulates suspended and dissolved impurities. These contaminants are removed continuously to minimize the following:

- Corrosion of aluminum cladding on the fuel and targets
- Impurities that absorb neutrons that would otherwise be utilized in the production of nuclear materials
- Radiolytic decomposition of the moderator into deuterium and oxygen
- Neutron activation of suspended corrosion products and impurities
- Light-water buildup in the moderator

The primary coolant/moderator is treated continuously by withdrawing a side stream from the reactor circulating system and sending it through a

purification area where it is filtered, deionized, and filtered again. Most of this side stream returns to the reactor system; the remainder goes to a distillation area for the removal of light water.

The purification system circulates about 1.9 liters per second through a prefilter, a deionizer, and an afterfilter. The deionizer contains deuterized cation and anion exchange resin. The filters retain particles larger than 10 micrometers in diameter. The prefilter removes suspended solids and the afterfilter retains any resin fines that might leave the deionizer.

The filters and deionizers are in a shielded cell area. Radioactive impurities removed from the primary coolant/moderator are concentrated in disposable filter and deionizer units. Vessels containing spent deionizer are loaded remotely into heavily shielded casks for transport to a facility for the eventual recovery of heavy water. After processing, these vessels are sent to the low-level radioactive waste Burial Ground for disposal.

An evaporator system concentrates particulate matter from the reboiler purge of the heavy-water distillation column. At present, no facilities are available to remove tritium from the reactor moderator, which is generated from neutron irradiation of deuterium. When the heavy-water distillation columns are emptied for maintenance or repair, the water is either collected in a tank to be reused or placed in drums to be reworked at the heavy-water production plant.

Target and spent-fuel assemblies are rinsed with light water in the discharge machine as soon as irradiated assemblies have been withdrawn fully from the reactor vessel. Rinsing has two purposes: (1) it allows heavy water to be reclaimed from the discharged assemblies; and (2) it minimizes the carryover of tritiated heavy water to the disassembly basin. The rinse water is collected by the discharge machine water pan and sent to a 2,270-liter rinse collection tank. Subsequently, the rinse water is placed in drums and reworked to remove the light water from the heavy-water moderator.

The disassembly basin has water-circulating systems to control radioactivity, chemistry, clarity, and temperature. Sections of the basin can be isolated to aid in controlling the temperature of the water or the spread of contamination. Contamination in the basin can result from a number of sources. Discharged assemblies carry a thin liquid film from the reactor vessel that contains activated corrosion products, particulate activities, tritium, and other radioisotopes that can escape from irradiated assemblies. In the basin, assembly corrosion and component processing add to the contamination of the water.

Periodic purging of the disassembly-basin water is necessary to reduce the radiation exposure to operating personnel from the accumulation of radioactive contaminants, particularly tritium, which is not removed by the basin water purification system. During the purging operation, water from the basin passes through two deionizer beds in series; the water is monitored before it is discharged to a low-level radioactive seepage basin. This process minimizes the release of any radioactivity other than tritium to the seepage basin. The spent resin from the deionizer beds is regenerated in the Chemical

Separations Area, and the spent regenerant is concentrated and stored in high-level radioactive waste tanks in the Separations Area.

Two sand filters maintain the clarity of the disassembly-basin water by removing suspended particles. Particulate matter in the basin water tends to agglomerate and adsorb radioisotopes. When the basin water passes through the sand filters, the particulate burden is reduced. The filtration rate can vary from 32 to 95 liters per second, depending on the initial fluid clarity and the demand for treatment. When the differential pressure across the filter beds indicates the need, a filter can be isolated and backflushed. Backflushed radioactive material is transferred to the Chemical Separations
TC | Area for concentration and storage in high-level radioactive waste tanks.

2.1.2.4 Reactor Shutdown Systems

The shutdown systems at the SRS reactors provide multiple lines of defense to protect the reactors in the event of abnormal conditions during operation. These systems respond rapidly when monitored variables exceed conservative operational limits. Fifteen monitored variables, or plant conditions, will produce a complete reactor shutdown (scram) when any variable exceeds preset limits.

2.1.2.4.1 Scram System

Automatic and manual circuits provide separate scram signals to achieve rapid reactor shutdown. Each automatic circuit responds to one of 15 monitored variables that represent plant operating conditions. The setpoints for these circuits can be adjusted to meet the changing requirements of new reactor charge designs and operating conditions. Operating personnel check scram setpoints at intervals specified in operating procedures to verify that they are at specified values.

A scram signal releases all safety rods, simultaneously drives all full-length control rods into the reactor, and shuts down the reactor within approximately 1 second after generation of the signal. The safety rod system is independent of the control rod system. During normal operation, magnetic clutches hold the safety rods above the core. When a scram occurs, the magnetic clutch deenergizes, allowing the safety rods to drop into the core by gravity. When they have traveled about halfway into the core, their rate of travel slows to prevent mechanical damage.

Safety rods are withdrawn before control rods during reactor startup, and are inserted first during a reactor scram. If the safety rod scram fails to shut down the reactor, the Supplementary Safety System (SSS), described in the following section, injects a liquid neutron poison to shut down the reactor safely.

2.1.2.4.2 Supplementary Safety System

The SSS is the primary shutdown system for the design-basis seismic event and
TC | the anticipated transient without scram (ATWS) event, in which the safety rod scram is postulated to have failed. The SSS is a backup shutdown system to

the safety rod scram system for all other accident events. When actuated, the SSS injects a solution of gadolinium nitrate, an efficient neutron absorber or poison, into the reactor moderator through special sparjet assemblies in the reactor tank and also into the six main pump suction pipes. The SSS consists of two identical subsystems with tanks that contain the poison solution. These tanks are pressurized with nitrogen gas, which provides the driving force for injection. Either of the two subsystems is capable of shutting down a reactor independently and of keeping it subcritical. TC

The portion of the SSS subsystem that injects poison into the sparjet assemblies contains three parallel lines with individual actuation valves, only one of which is required for system success. Two of the three lines have explosive discharge valves, and the third line has a pneumatic valve. Each subsystem also injects poison solution into three alternate pump suction pipes. A pneumatic valve actuates the pump suction injection. This design maintains diversity and redundancy in the system. TC

The SSS can be actuated automatically by the seismic trigger circuit (set at 0.05g peak ground acceleration), the Automatic Backup Shutdown (ABS) system, or the Gang Temperature Monitor (GTM). It can also be actuated manually from any of three separate locations in the central control room. Additional storage tanks and injection ports are being included for each subsystem to ensure an adequate shutdown margin. TC

2.1.2.4.3 Automatic Backup Shutdown - Safety Computer

The Automatic Backup Shutdown - Safety Computer (ABS-S/C) system actuates the SSS if the primary scram system fails to shut down the reactor promptly. It uses special logic, which has been programmed into the two safety computers. Each computer scans half (approximately 300) of the assembly coolant effluent temperatures every 0.36 second. This rapid scan of many distributed sensors is the source for automatic backup shutdown action. ABS-S/C action is based on the change of the reactor assembly average ΩT (i.e., coolant exit temperature minus coolant inlet temperature) before, during, and after the time at which a scram signal is generated.

Normal reactor operation with both safety computers online produces redundant backup shutdown protection. One safety computer is required to maintain backup shutdown protection at all times during reactor operation. An automatic shutdown occurs if both computers are offline. The ABS-S/C provides 100-percent backup protection for the primary scram system for terminating transient conditions.

2.1.2.4.4 Automatic Backup Shutdown Gang Temperature Monitor

The ABS/GTM system actuates the SSS in response to transient conditions. It detects assembly effluent temperatures that exceed predetermined limits in large regions of the reactor core. The ABS/GTM provides protection for a gang rod withdrawal incident and for total loss of AC pumping power without scram. TE

2.1.2.5 Engineered Safety Features

2.1.2.5.1 Emergency Cooling System

TC The ECS provides makeup water during a process-water LOCA; the DC motors enable coolant flow. If the process-water pumps are lost due to either a primary or secondary LOCA, the ECS provides cooling. A LOCA would occur as the result of a significant break in the primary heavy-water coolant system. TE The most credible mechanism for a loss-of-pumping-accident (LOPA) is a postulated rupture of the secondary cooling water system that coincidentally floods all drive motors for the primary coolant circulation pumps. After the unlikely occurrence of a LOCA or LOPA, the ECS injects cooling water directly into the reactor coolant inlet piping.

The ECS consists of water sources and isolation/injection valves, along with the associated piping and instrumentation. All ECS components are in the reactor building, with the exception of a booster pump that receives power from its own dedicated diesel engine in a separate area. The maximum total flow in the ECS is approximately 1,200 liters per second through four parallel lines, each of which is piped into the reactor inlet plenum line in one of four (of the six) primary coolant loops.

Four pumping sources are available for emergency cooling at each reactor:

- A diesel-driven booster pump that supplies water from the 95-million-liter cooling water reservoir
- Two headers, each independently pressurized by five pumps that draw water from the cooling water reservoir
- Two emergency pumps that can supply water from the cooling water reservoir
- A pipeline from the river pumphouse directly to the ECS, pressurized by river water pumps

The ECS can be actuated manually or automatically. For example, a LOCA would cause the heavy-water coolant level to decrease in the reactor vessel; this would cause automatic incident action. When the ECS is actuated, the diesel-driven booster pump starts and the appropriate valves automatically open or close to provide cooling water to the reactor core. Borated water from a storage header will be injected into the reactor first to prevent a reactivity transient when the light water displaces the heavy water in the reactor core. If the booster pump fails to start, the other sources of emergency cooling supply the water.

The maximum pressure developed by the ECS pumping sources is limited by design, so injection cannot take place when AC motors are driving the process water pumps during normal reactor operation.

Modifications to the ECS pump controls at each reactor consist of the following enhancements, which will be completed before the resumption of production: L-44-10

- Addition of an automatic start of the two electrically driven ECS pumps, following "incident actuation"; the diesel-driven pump already receives an automatic start.

- Control signals to ensure that essential ECS valves are in their proper postincident positions. L-44-65

- Addition of control and power circuit monitoring through the essential equipment monitor for electrically driven ECS pumps and associated isolation or addition valves.

Additional modifications to the diesel-driven ECS booster pump will consist of instrumentation and control room alarms to monitor debris buildup in the cooling water strainer, and a strainer bypass line that would enable the diesel engine to receive adequate cooling water flow in the event of strainer blockage. These modifications to the diesel-driven ECS booster pump are part of the continuing safety improvement process; they are not scheduled for completion before the resumption of production.

2.1.2.5.2 Water Removal and Storage

The Water Removal and Storage (WRS) system removes water from the basement of each reactor building. LOCA and LOPA events challenge the safety functions of this system. During such events, the WRS operates in conjunction with the ECS to establish and maintain once-through cooling for the reactor.

The WRS system consists of reactor building drains and sumps, high- and low-capacity sump pumps, drain collecting tanks (outside the reactor building), a large earthen retention basin, and associated valves, piping, and instrumentation. These components can remove large volumes of water from the reactor building while controlling the postaccident release of radioactivity to the environment. TE

The WRS system pumps water from the sumps into a 225,000-liter underground tank. When this tank is full, the overflow goes to a 1.9-million-liter tank that is inside the 190-million-liter earthen basin. If this tank becomes full, additional water overflows to the earthen basin. Both holding tanks are designed to retain most of the primary heavy-water coolant, and they are vented back to the AACS in the reactor building to control any gaseous or volatile activity that the water might release. TE

With the installation of the fourth ECS addition line at each reactor, ECS exit flow through a double-ended guillotine break (DEGB) will increase. (A DEGB is considered to be extremely unlikely.) As a result, the existing flood control capacity of the reactor building sump pumps could be marginal if all four addition lines successfully inject after a DEGB. A modification planned for completion after the resumption of production will increase the flood control capacity of the reactors. The modification is being designed such

that flood control capacity will not be degraded after a DEGB and the additional failure of a sump pump or an emergency diesel generator.

L-44-10 Portions of the WRS system will be seismically strengthened; this will be completed before the resumption of production. Modifications include a new seismically qualified diesel generator that will provide power to a seismically qualified sump pump(s). Discharge piping also will be seismically qualified, and trash screens will be installed to prevent pump blockage from seismically induced debris.

2.1.2.5.3 Remote Control Station

The remote control station primarily provides remote control and monitoring of reactor cooling and activity confinement functions if a reactor control room cannot be occupied. Operators perform routine data acquisition tasks using the station's data display. The operators also check for abnormal condition indications and initiate reactor incident action if necessary. They examine the recorded data and follow procedures to analyze and control the incident (e.g., increase fuel cooling, minimize heavy-water leakage, minimize pump and motor room flooding, adjust ventilation dampers).

Underground cables link the remote control station to the reactor areas and transmit data and control signals. Each reactor area is linked by two data telemetering wire pairs and two control function wire pairs. In both cases, the first wire pair is for primary use and the second pair is a backup. All wire pairs are in separate cables; the primary and backup cables follow different routes from the reactor areas to the remote control station.

As noted in Section 2.1.2.3.4, the reactor data acquisition and control system has been supplemented by the REMACS. In addition to the REMACS upgrade, modifications are planned to provide seismically qualified equipment to monitor essential reactor parameters outside each reactor control room. The spectrum of parameters includes information that is required to show that the reactor is shut down (subcritical) and that the decay heat removal function is operational. The modifications, which are scheduled for completion after the resumption of production, consist of alternate safe shutdown panels that will provide critical information to reactor operators following a flood, fire, or seismic event.

2.1.2.6 Support Systems

2.1.2.6.1 Electric Power

South Carolina Electric and Gas Company supplies SRS with 115- and
TC 230-kiloVolt electric power. The D-Area Powerhouse supplies power to the SRS transmission system. This system consists of a network of transmission lines, switching stations, and substations that are under the jurisdiction of an onsite electrical system dispatcher. Each reactor area receives electric power from two independent 115-kiloVolt transmission lines, which are part of this network.

Normal Supply

Two independent transformers at P- and K-Reactors reduce the power from the transmission system from 115 to 13.8 kiloVolts; three independent transformers perform the same function at L-Reactor. Feeders from the 13.8-kiloVolt substation buses at all three reactors route underground to supply power directly to the process water pumps and stepdown transformers, which reduce the 13.8-kiloVolt supply to the required levels for other equipment.

Transformers in the reactor building supply 480-Volt power to the normal operating and safety equipment. Power flows to equipment through a set of normal and emergency buses. Nonessential equipment is connected to the normal buses, while equipment important to safety (i.e., incident/accident mitigation) is fed through the emergency buses.

Emergency Supply

If the normal electrical supply fails, two 1,200-kiloWatt emergency diesel-driven generators at each reactor resupply the emergency buses. The system isolates the emergency buses from the normal supply and transfers them to the diesel generator source. Control power for this operation comes from either of two sets of independent batteries, which are maintained continuously in a ready state. Batteries are also used as backup emergency sources for reactor shutdown systems, including scram circuits, safety and control rod drives, and the SSS. TC

DC motors powered by dedicated diesel generators continuously back up the process water pumps. There are eight DC diesel generators for the six DC motors; two serve as spares. If the electrical source were lost to the AC motors, the DC motors, which would already be running due to their dedicated sources, would assume the required pump load.

The ventilation system fans are backed up by two dedicated diesel generators that automatically provide emergency power to two of the three fans. Other diesels provide backup power for lighting and miscellaneous equipment.

Planned Upgrades

DOE has scheduled several project upgrades at each reactor to improve the reliability of the reactor electrical distribution system (REDS) and the various diesel generators. The following project will be completed before the resumption of production: L-44-10

- To reduce loading on the two emergency diesel generators and to improve their reliability, additional diesel generators are being installed to assume some of the load. These new, seismically qualified diesel generators will supply AC power to such safety equipment as the reactor building sump pumps and the moderator recovery system (MRS) pumps and valves.

- Flow tests will be conducted to verify the adequacy of gravity flow cooling to the heat exchangers for the DC diesel generators. Any

identified flow deficiencies will be corrected before the resumption of production.

The following items are part of the continuing safety improvement process; they are not scheduled for completion before the resumption of production:

- Various diesel generators are to be upgraded through the planned installation of additional fuel and lubricating oil supplies, which would increase diesel run time under postaccident conditions. The two emergency AC diesel generators and the eight DC diesel generators will have additional fuel oil capacity. The two exhaust fan diesel generators and the diesel for the booster pump will have increased fuel and lubricating oil capacities.

- The reliability of the REDS will be improved by the replacement of emergency bus feeder cables. This planned project also includes the rebuilding of 480-Volt circuit breakers to increase their reliability and current-carrying capacity.

- Reactor instrumentation loads will be removed from the emergency buses and transferred to existing, rebuilt motor-generator sets that will have new backup batteries. This planned modification will further reduce loading on the two emergency diesel generators.

- An emergency power load sequencer will be installed to connect safety equipment automatically to the emergency buses. This enhancement will help prevent diesel generator overloading; it will also minimize start times for safety equipment motors.

- Miscellaneous upgrades: Automatic transfer switches in AC and DC power circuits will be replaced with new switches; the firing circuits for redundant supplementary safety system valves will be separated and isolated to achieve independence in the circuits; the two emergency diesel generators will receive reliability improvements through the replacement or upgrade of such support systems as the diesel governor, lubricating oil, fuel oil systems, and the generator control system.

2.1.2.6.2 Steam

The reactor facilities use steam for process service and ventilation air heating. P- and K-Reactors receive steam supplies from powerhouses, including package boilers, in their respective areas. An interarea pipeline supplies steam from the K-Area powerhouse to L-Reactor. TC

2.1.2.6.3 Potable Water

Several deep wells in each area supply potable water to each reactor facility. The wells draw from the Middendorf/Black Creek aquifer, which underlies the Site. The water is chlorinated and pH-controlled before use. In addition to drinking water, well water is used for service water, filtered water, domestic water, and fire protection water.

2.1.2.6.4 Sanitary Sewage

A secondary treatment plant processes the sanitary sewage at each reactor area, using an extended aeration-activated sludge process. Chlorinated discharges from the treatment plant flow to the process sewer, which discharges to the Savannah River through outfalls at P- and K-Reactors (separate from effluent cooling water outfalls) and to L-Lake from L-Reactor. Sludge from each treatment plant is removed periodically to a South Carolina Department of Health and Environmental Control (SCDHEC)-approved "borrow pit" at F- or H-Area. TE

2.1.2.6.5 Solid Radioactive Waste System

The following items are the principal sources of solid radioactive waste from the reactor areas:

- Irradiated scrap metal (activation products)
- Spent ion-exchange resin
- Sludge from moderator purification and the disassembly basin
- Miscellaneous low-level wastes

The highest radioactive inventory is in irradiated scrap metals; it consists of induced activities produced by neutron capture in removable metal components (excess aluminum from fuel and target assemblies). All metal components are stored underwater to permit decay of the short-lived activation products. The scrap metal is then monitored to ensure that it contains no fissionable material. After monitoring, the scrap metal is cut or sheared underwater in the disassembly basin to reduce volume and sent to the Burial Ground for disposal. Most metal components are placed in areas of the Burial Ground that correspond to their activity levels, which are determined before shipment.

Bulky wastes that might be contaminated with transuranic radionuclides to greater than 10 nanocuries per gram or intensely contaminated with gamma emitters are stored directly in shallow land burial (SLB) trenches. Waste contaminated with less than 10 nanocuries of transuranics per gram is designated low-level alpha waste and buried with other low-level wastes. DOE Order 5820.2A defines transuranic waste as having greater than 100 nanocuries per gram of alpha-emitting radionuclides and having half-lives greater than 20 years. The fraction of retrievably stored waste contaminated in the 10- to 100-nanocurie-per-gram range will ultimately be disposed of in Greater Confinement Disposal (GCD).

Waste contaminated with beta-gamma emitters is separated into two categories for burial: low-level beta-gamma and intermediate-level beta-gamma. Low-level beta-gamma waste is defined as waste that radiates less than 300 millirem per hour at 7.6 centimeters from an unshielded container. Intermediate-level beta-gamma waste is defined as waste that radiates more than 300 millirem per hour at 7.6 centimeters from an unshielded package. Containerized low-level beta-gamma waste is buried in an engineered low-level trench with low-level alpha waste; the noncontainerized fraction (soil and bulky items that do not fit in standard containers) is placed in an SLB trench. The intermediate-level waste is buried in segregated SLB trenches.

In GCD, an improved disposal method, the waste is encapsulated in concrete/grout, and is monitored for water leaching of any radionuclides. GCD provides cylindrical holes (20 have been constructed) that are 2.1 meters in diameter and 9.2 meters deep, and a trench (currently under construction) with cells that are 15.3 meters wide, 7.6 meters long, and approximately 9.2 meters deep. Waste packages are placed in the cylinders or trenches, and concrete/grout is poured around the containers for stabilization (Jaegge et al., 1987).

Sludge and similar wastes are monitored, packaged, and sent to the intermediate-level beta-gamma trench for burial. Sources of this waste include purification filters and evaporator units.

Solid wastes that are classified as low-level wastes do not contribute significantly to the radioactive inventory in the Burial Ground (i.e., shipments are generally less than 1 millicurie per package). Such wastes include solids from the disassembly-basin filters and deionizers, absorbent pads used for decontamination, shoe covers, protective clothing, stepoff pads, and other trash generated in radiologically controlled areas of the reactor areas. These wastes are packaged and shipped to the low-level beta-gamma burial trenches. DOE has described the strategies for management of radioactive wastes in the Final Environmental Impact Statement, Waste Management Activities for Groundwater Protection, Savannah River Plant (DOE, 1987a).

2.1.2.7 Accident Prevention

Several onsite practices and programs and external review programs are in place to identify and correct potential accident conditions, improve safety, and prevent accidents. Unplanned events are evaluated to form an experience base on which to judge potential modifications and improvements. The results of the accident prevention practices and programs are the upgrades and modifications, such as those described in this section, that enhance accident prevention and safety, and ensure adequacy of plant practices.

A large part of the SRS effort is directed to ensure accident prevention and mitigation. This effort is organized in many programs and projects, which change with time, reflecting advances in science and engineering, completion of projects, and changes in upper-level management structures. In addition to system modification programs and projects, several programs designed to enhance human performance are under way. Training programs place an increased emphasis on professionalism, teamwork, technical knowledge, and reactor fundamentals, while projects for procedure modifications enhance the technical basis for safe operation, management accountability, and formality of operations.

The following paragraphs summarize the SRS programs and practices related to accident prevention:

Predictable Operation

L-66-02 The nuclear industry recognizes that predictable normal operation is a key aspect of accident prevention. Predictable operation reduces the number of

demands on shutdown systems, emergency cooling systems, and critical monitoring systems. The 100-plus reactor-years of operation at SRS provide a firm basis for predictable operation. Systems and equipment are maintained and replaced, as appropriate, to support predictable operation of the reactors. Reactor operators, maintenance personnel, and inspection personnel are trained to conduct normal operating activities according to written procedures. This provides confidence that the reactors will operate predictably and prevent accidents. L-66-02

Conservative Design TE

The SRS reactor plants are designed, constructed, and operated in a manner that provides a significant margin of safety in the event of off-normal events. The fundamental low-temperature, low-pressure design, coupled with a metallic fuel of high thermal conductivity, provide much of the margin. Those fundamental attributes are supplemented with redundant and diverse systems for shutting down and cooling the reactor for the spectrum of credible events.

Accident Analysis/Operating Envelope

The SRS reactors are the subjects of continuing safety analyses that determine the ability of systems to mitigate the effects of design-basis accidents. These analyses are used as the bases for establishing an envelope (technical specifications) within which the reactors can be operated safely (i.e., with confidence that the systems are capable of properly mitigating design-basis accidents, thereby preventing significant radionuclide releases).

The accident analyses are continuously updated and upgraded to reflect changes in reactor charge design, new data, and new understanding of relevant physical phenomena. A current example of an updated analysis is the Power Limits Program, which is designed to integrate state-of-the-art analytical methods with the latest experimental thermal-hydraulic data. The results of the program will be used to establish technical specifications limiting the maximum reactor power level for which systems can safely mitigate loss-of-cooling and loss-of-pumping accidents. The Power Limits Program was initiated as a result of recommendations of the National Academy of Sciences in 1987 (see Section 2.1.3.1).

The sensitivity of controlling power limit design-basis accident scenarios to the burnup parameter have been examined, and the increase in safety margin to an already very safe plant that results from reduced power levels (nominally 50 percent of historic powers) has proved to be marginal. Due to the equilibrium characteristics of the core, considerable reduction in burnup is required for any potential safety benefit, which in the extreme stands to be counterbalanced with the increased risk associated with the additional movement and handling of fuel. L-44-06

Procedures and Training

Reactor operations and maintenance personnel are trained to conduct normal operations according to procedures designed to ensure reliable operation. In addition, reactor operators are trained to respond to off-normal events, including major reactor accidents, using formal procedures. The procedures

esigned to maximize the ability of the operators to terminate incidents without accidental releases, and to minimize any accidental releases that occur. Procedures are studied periodically to ensure that they properly reflect SRS hardware, the state-of-the-art understanding of accident progression, and accepted human factors principles for maximizing performance. Significant programs are under way to upgrade selected procedures in each of these areas. A fifth operating shift has been added for continuous operator training and requalification.

Surveillance Programs

A number of surveillance programs ensure that SRS hardware retains its capabilities as designed or analyzed, and that administrative and operating activities are conducted according to procedure. These programs range from formal reviews by line management to audits by independent safety and quality assurance groups within the Operating Contractor organization, reviews and audits by DOE and DOE contractors, and reviews by groups that are independent of DOE (e.g., National Academy of Sciences, General Accounting Office, Advisory Committee on Nuclear Facility Safety). Events occurring at SRS reactors are evaluated to determine the cause; actions to prevent recurrence are defined and implemented. Events taking place at other nuclear-industry locations are also evaluated for their applicability to SRS; descriptions of these events are distributed to SRS functional groups for appropriate responses. These surveillance programs provide a broad spectrum of findings and recommendations directed to improve hardware, procedures, training, accident analysis, management systems, and staffing.

Corrective Action Programs

Recommendations and findings from surveillance activities, events that occur during operation, and concerns expressed by individual employees are handled in one or more corrective action programs conducted by the Operating Contractor. Corrective action programs provide systems for evaluating, reporting (to DOE), assigning responsibility for resolution, resolving, and closing significant items, especially those directly related to the prevention and mitigation of accidents. Evaluations are performed by line management or review groups, at levels appropriate to the source and nature of the item. The evaluator(s) determine the action to be taken to resolve the item, and the degree of urgency. The greatest urgency is attached to items with the greatest potential to prevent and mitigate accidental releases. Processes taken to close the item provide assurance that proper resolution has occurred before the item is removed from the tracking systems.

Reactor Safety Improvement Program

Many findings are resolved as part of base activities that support continued SRS operation, or through relatively minor short-term actions. However, some items require a significant effort outside normal support activities. The
L-44-29 Reactor Safety Improvement Program (RSIP) assigns priorities to and integrates these efforts. Funding for RSIP is separate from other funding to ensure that safety improvement items are addressed, even in the face of demands to support normal operation.

Findings from practices and programs that identify potential accidents are followed by responses necessary to complete the accident prevention process. Responses to findings can take two forms: (1) the findings can provide assurance that current practices and systems are adequate and that no further response is necessary; or (2) the findings can identify needs for upgrades or modifications required to eliminate the potential accident or inadequacy.

Upgrades and modifications might be required in one or more of three general areas: (1) physical, (2) administrative, or (3) personnel. Physical upgrades include modifications or additions to existing plant systems or equipment. Administrative upgrades involve changes or additions to procedures or operating practices. Personnel upgrades include improvements in training and changes in work practices, as described in the following section.

2.1.2.8 Reactor Operating Organization and Practices

This section describes the organization and practices used by DOE and its Operating Contractor, the Westinghouse Savannah River Company (WSRC), to operate and oversee the operation of SRS production reactors.

2.1.2.8.1 Operating Work Force

The Operating Contractor's Reactor Restart Division is managed by that division's Vice President and General Manager. The Deputy General Manager, Reactor Operations, WSRC, is the contractor official responsible for the nuclear safety of the reactors as part of the responsibility for the operation of K-, L-, and P-Reactors. TE

The reactors and associated equipment are operated in accordance with approved Technical Specifications, the Safety Analysis Report, Technical and Mechanical Standards, and operating procedures. All reactor operations are performed under the direct supervision of a Certified Reactor Supervisor or a Certified Central Control Room Operator, who is responsible for reactor safety. A Certified Reactor Supervisor must be in the Central Control Room whenever the reactor contains fuel, fissionable target assemblies, or moderator. Reactor control is accomplished by Certified Reactor Operators according to detailed written procedures. Before certification, a trainee can operate the reactor controls only when a Certified Central Control Room Operator is present. TC

Generally, each shift consists of four members of Supervision: a Shift Manager, a Central Control Room Supervisor, a Work Control Supervisor, and a Reactor Building Supervisor. At least one member of the shift supervisory team must hold a science or engineering degree if the reactor contains heat-generating assemblies or when nuclear startup of an unirradiated charge begins. Figure 2-9 shows the normal shift personnel complement for each reactor. The reactors are staffed and operated around the clock in a five-shift rotation; on a given day, three shifts would rotate duty hours, one shift would be in training, and one would be on leave status.

Human Performance and Management Systems

The following paragraphs discuss the procedural modifications being implemented before the resumption of production and as part of the continuing

improvement process in the areas of human performance and management systems. These modifications will provide enhancement of the technical bases for safe operation, formality of operations, and accountability of management. Figure 2-10 shows the human performance and management systems program for reactor operation. A number of the specific operating criteria described by the Safety Review (WISR) deal with human performance and management systems. Detailed scopes of work have been developed for the activities shown in Figure 2-10, which are summarized below.

Reactor Operating Envelope

The technical bases for safe reactor operation are being enhanced in the areas of thermal hydraulics and physics. These enhancements are scheduled for completion before the resumption of production. In general, two areas have received the most attention from outside experts during the past few years:

- LOCA power limits
- Reactivity transients during reactor startup

The development of a state-of-the-art methodology to calculate LOCA power limits based on conservative criteria will be completed, documented, independently reviewed, and approved. Analyses will also be completed on startup accidents. Limits on operational practices will then be modified to incorporate the results of this analysis.

As an accelerated part of the Technical Specification upgrade program, the Operating Contractor will develop new Technical Specifications for reactivity-related parameters and leak detection limits. A second group of specifications, in recognition of possible pipe cracks, will establish a process water leakage limit beyond which the reactor cannot be operated.

Quality Assurance

Quality Assurance (QA) is an activity that is being improved, based on an internal review of the development and implementation status of the program within the Operating Contractor divisions. The objective is to implement appropriate elements of the Operating Contractor Quality Assurance Plan for operations-related activities concurrent with the Reactor Division integration of the Operating Contractor Quality Assurance Program into its activities. A comprehensive review of the Operating Contractor QA Plan identified 41 QA work items for implementation before the resumption of production. These actions complement the actions being taken for the longer term (i.e., after the resumption of production) implementation of quality assurance as part of the Reactor Safety Improvement Program. TC

Operating Aspects

Major upgrades are under way to improve substantially the general operational practices of personnel working in the reactor facilities.

The following projects are under way and will be completed before the resumption of reactor operation: L-44-10

- New piping and instrumentation diagrams for critical safety analysis; this project provides additional information to operators to assist the performance of daily operations and to respond more effectively in the unlikely event of off-normal conditions not covered by procedures.

- The logkeeping practices are being upgraded to commercial industry standards, and uniform shift turnover practices are being implemented.

- Fire protection measures are being improved through the introduction of periodic inspections for combustible materials, institution of fire watches, and requirements for walkdowns by a certified fire protection engineer.

- Capabilities of the operations staff are being upgraded by instituting a fifth operating shift of training and requiring a degreed supervisor on each shift.

A degreed supervisor with Shift Technical Engineer (STE) training will be on each shift, capable of reporting to the Control Room on demand within 10 minutes at any time the reactor contains heat-generating assemblies or when reactivity manipulation is in progress. TC

Commercially licensed or Certified Reactor Operators from the power reactor industry and the U.S. Navy have been hired as shift advisors; these individuals serve as temporary "coaches" to the shift crews on administrative practices; they do not provide technical advice on operating the reactor. No reactor operations constraints are tied to having a shift advisor in the reactor area. A shift advisor will be assigned to each crew for at least 12 weeks after resumption of production.

Work Controls

This element collects all improvements that address control of work in the reactor facility. For example, a Shift Manager is responsible for the release of all maintenance work and for authorizing the return of equipment to service. Written job plans are required for all maintenance and construction work on designated systems. Approximately 300 procedures are being revised for performing maintenance on safety-related equipment, including QA holdpoints, requirements on the control of calibration equipment, and return-to-service requirements. The safety-related procedures will be completed before the resumption of production. L-44-10

Corrective and Preventive Maintenance

The following paragraphs discuss scheduled preventive maintenance and corrective maintenance activities on safety and safety-related equipment that are identified as necessary before the resumption of production; they will be completed during the current outage. TC

Selected key valves in the Emergency Cooling, Cooling Water, and Contaminated Water Removal Systems will be inspected physically to ensure structural
TC integrity.

In addition to performing the scheduled preventive maintenance activities, a program to test safety-related, motor-operated valves (MOVs) has been initiated. As part of this valve diagnostics program, selected MOVs in the Emergency Cooling, Cooling Water, Process Water, and Confinement Heat Removal Systems will be tested on a periodic basis.

A reactor layup program intended to ensure that plant chemistry and plant material conditions are not allowed to degrade during outage periods is being implemented. The program has the following major characteristics:

- Modification of procedural limits to strengthen moderator chemistry requirements during shutdown conditions

- Procedural requirements for moderator sampling frequencies during reactor shutdowns

Plant Lineups and Startup and Periodic Tests

The above elements verify the operational status of critical plant systems. Each system lineup is verified after modification, removal from service, or
TC repair. Lineups (i.e., the proper connection and arrangement of pipes, valves, switches, and other components in a system) require verification of the status of essential components in each system to ensure that the system is ready for use.

Startup and periodic tests are performed to verify proper operation of equipment. Startup tests are required during the startup of a specific system to verify the function of the system. Safety systems require testing after modification or repair; they are also tested on a periodic basis. These periodic tests verify the calibration or setpoint of equipment and ensure that it responds as designed.

A comprehensive startup test program is planned to ensure operability and to assess compliance with functional requirements for more than two dozen individual systems and combinations of systems. Several of these tests will involve cooling water flow rates above the low partial gravity flow that has been typical for several months. Approximately eight phases in the program involve cold-flow testing; the durations of these phases will vary from less than 1 day to more than a month. Tests of this type are typical to ensure correct flow rates, valve closure times, ability to alter flow paths, and full
TC functionality after modifications or repairs. Because these tests would occur before operation of the reactor, none of the discharges would be thermal discharges (i.e., the water discharged will have approximately the same ambient temperature as river water).

In extended periods of cold shutdown, most systems would be operated at least periodically and tested in accordance with procedural frequency requirements. The full complement of operators and plant staff would be required to maintain the plant in a "ready-to-operate" status. Periodic testing to demonstrate

system operability, check setpoints, and verify plant configuration or alignment would continue. These tests would include cooling water pump flow testing and other testing that would result in ambient temperature discharges to the outfalls. Periodic maintenance and routine surveillances would continue. Water chemistry requirements for the process water and disassembly-basin water would be maintained by running purification systems with chemical additions. TC

Management and Oversight Involvement

This element includes a variety of management and oversight activities designed to identify and resolve design and operational deficiencies that could impact the safety of SRS reactor operation. This category of work includes scheduled plant inspections by senior reactor operations management and increased use of Institute of Nuclear Power Operations (INPO) assistance visits. Safety issues raised in previous reviews and assessments are being processed through a formal issue review to identify immediate actions or longer term improvement activities. A formal issue-tracking system is being instituted as part of this review process to ensure the appropriate documentation of the disposition of issues before the resumption of operation. Finally, the responsibilities and staffing of the Reactor Safety Evaluation Section and the involvement of the Safety Advisory Committee, the SRS groups responsible for independent oversight of reactor operations, are being expanded significantly. TE

2.1.2.8.2 DOE Reactor Operations Management

In June 1989, DOE formed the Savannah River Restart Office at DOE Headquarters to provide coordination, independent technical review, and staff support to the Assistant Secretary for Defense Programs in directing the safe and timely restart of the SRS reactors. Also in June 1989, DOE formed the Savannah River Special Projects Office (SRSPO) to provide line management and oversight of the resumption of reactor operation (DOE, 1989); the SRSPO reports to the Assistant Secretary for Defense Programs. The SRSPO consists of four divisions (Technical Support Division, Safety Oversight Division, Reactor Operations Division, and Reactor Engineering Division).

The Technical Support Division is responsible for overall support activities; its areas of responsibility include planning, issue resolution, budget, reporting, commitment tracking, Reactor Safety Improvement Program, and staff support. TC

The Safety Oversight Division has responsibility for the reactor overview program; its areas of responsibility include appraisals, assessment of reactor upgrades implementation, radiation protection, quality assurance, policy, and environment.

The Reactor Operations Division is responsible for overseeing the day-to-day operation of the SRS production reactors; this includes maintaining full-time staff at each reactor to perform oversight of contractor activities (training, procedures, maintenance, project management, security, and emergency planning). The Reactor Engineering Division has responsibility for directing the design and analysis of reactor operating and safety systems. TC

DOE is upgrading its onsite technical vigilance and routine surveillance of operations. Enhanced management controls before the resumption of production will ensure the maintenance and promotion of an aggressive policy of technical vigilance. In addition, DOE is implementing an organization that has a technically qualified line and safety staff, with resident engineers (Area Engineers) at all reactors. The following paragraphs describe upgrades and
TE | enhancements that will be accomplished before the resumption of production.

DOE Organization and Functions

TC | DOE has developed charters (DOE-SR Directives) for the Divisions that are part of the SRSPO. These charters establish lines of responsibility and describe the duties and functions for the four divisions. The charters also describe the responsibilities and authorities for Area Engineers. DOE is developing procedures to assist these personnel in the performance of their duties, which include monitoring the activities performed by SRS contractors.

DOE Staffing

TE | DOE is assigning experienced personnel to fill the Area Engineer positions to provide onsite safety oversight. The long-term goal (after the resumption of production) is for each reactor area to have four Area Engineers.

DOE is issuing procedures emphasizing oversight performance for all SRS personnel (i.e., DOE and contractor) as part of its ongoing responsibility to ensure safe and reliable operation of SRS nuclear facilities. To ensure that
TE | all personnel understand the importance of its oversight duties, DOE is directing supervisors to emphasize this philosophy to their subordinates.

Training for DOE Area Engineers, Technical Staff, and Management

DOE is reviewing the individual position responsibilities for SRSPO personnel (e.g., Area Engineers, technical staff) to identify requirements for the Training Development Program (TDP). This program is designed to provide the necessary methodology to ensure that personnel receive sufficient initial training to establish the qualifications required for reactor startup and continuing training to further demonstrate proficiency in specific positions. The initial portion of the TDP provides general overview material on significant plant systems and operations at SRS. It also provides guidance on commercial nuclear industry standards for plant operations and safety practices. The continuing TDP will build on the initial material by providing more detail on specific aspects of plant operations and DOE oversight responsibilities.

TC | A key feature of the program is the maintenance of documentation of the current qualification status of each individual, thus providing an auditable trail for any independent review. Final determination of qualification status is made by the individual's Division Director. Qualification determinations are based on reviews of completed training activities, evaluative measures, and the individual's on-the-job performance.

TE | DOE has developed a management training program for all SRSPO supervisory personnel; objectives of this program are to enhance the DOE ownership role to

ensure management awareness of ongoing activities; clearly focus management's perspective on safety oversight; familiarize management with the new administrative controls; improve each manager's technical overview capabilities through a better understanding of reactor layout, system function, and operation; and provide lessons learned from the commercial nuclear industry experience. TE

Procedures for DOE Onsite Surveillances and Audits

DOE is implementing a reporting process for the prompt disposition of surveillance findings. DOE has developed the surveillance procedure, which covers the reporting requirements and tracking of surveillance-related issues. Surveillances are documented in reports and tracked in a computerized system.

DOE is implementing a policy for unannounced inspections by management that cover all reactor operating shifts on a rotating basis, starting with resumption of production. The purpose of the inspections is to observe and monitor activities to ensure proper implementation of DOE policies and directives. TE

DOE is generating a procedure for reactor operation coverage, including duties and assignments, for special reactor evolutions (e.g., resumption of production). This procedure calls for 24-hour, all-shift coverage by DOE Area Engineers and the additional onsite presence of DOE management.

DOE Disposition of Safety Issues

DOE has developed a program for the management of safety issues. The Restart Issue Management Program (RIMP) process has identified many upgrades and modifications. (See Section 2.1.3.2.1.) The RIMP identifies issues that must be addressed before the resumption of production. Items that can be addressed after the resumption of production are put into the Operating Contractor RSIP. RSIP will identify, set priorities for, and manage a comprehensive set of activities to be performed in Fiscal Years 1991, 1992, and 1993 designed to upgrade or confirm the safety of reactor operation. C-04-22 L-44-10 L-44-29 L-78-52

Prompt Notification of Appropriate Parties of Important Events

Before resuming production, DOE will complete the development of procedures that govern the duties and responsibilities of designated duty officers for each reactor facility. In addition, a formal reporting procedure covers the notification of DOE management for off-normal occurrences. A separate directive will be formulated to ensure that the appropriate level of DOE management is responsible for authorizing reactor startup following an event that causes reactor shutdown. TC

A formal agreement between DOE and the Operating Contractor (Standing Instruction 317) already documents off-normal notification requirements. These requirements direct the Operating Contractor to notify the duty officer promptly after the identification of off-normal occurrences.

DOE Approval of New or Revised Technical Specifications

DOE has implemented a program that requires its approval of revised technical
TE | specifications and other documents related to the limits of safe operation.
As part of this program, DOE is reviewing and will approve technical
TC | specifications for control rod position and reactivity control.

2.1.2.8.3 Operating Practices

Upgrading the training program and procedures is a major part of the SRS reactor operation program. The following paragraphs discuss new procedures and training that will be implemented before the resumption of production.

Training

The training program is designed to ensure that operators have the skills and knowledge necessary to operate the SRS reactors safely when production resumes. The enhanced performance-based initial and continuing training programs will improve the skills and knowledge of the operating crews to a level comparable to that of personnel working for licensed nuclear utilities. A five-shift rotation for reactor operations personnel has been instituted to provide time for these training programs.

L-44-33 | The Central Control Room Supervisor and Operator training cycles for the reactors are focused on upgrading professionalism, technical knowledge, teamwork, and fundamentals, along with specific training on plant and
TE | procedure changes. Additional training has been developed to address changes resulting from items identified by the K-Reactor Restart Strategy Criteria (DOE, 1988a), and to address the recommendations and modifications identified
TE | by the WISR.

Training for maintenance personnel addresses work practices, procedure compliance, professionalism, and technical knowledge appropriate for items associated with the K-Reactor Restart Strategy Criteria (DOE, 1988a). Maintenance personnel will receive additional training based on items identified through the WISR. Other support and technical personnel will receive the following training:

- Training on changes in work practices and formality of operation for first- and second-line supervision
- Training for component handling operators
- Shift technical engineer training for degreed reactor supervisors

Procedures

The Operating Contractor has identified a large number of procedures that might require improvements due to the K-Reactor Restart Strategy Criteria and

the WISR items. For resumption of production, safety-related procedures will be established in the following major areas:

- Administrative Procedures
- General Plant Procedures for Startup, Shutdown, Power Operations, Process Monitoring, and Fuel/Target Handling
- System Operating Procedures
- Abnormal, Off-Normal, or Alarm Condition Procedures
- Maintenance Procedures
- Radiation Control Procedures
- Chemical and Radiochemical Control Procedures
- Emergency Operating Procedures
- Emergency Plan Implementing Procedures
- Modification Procedures
- Reactivity Manual
- Calibration, Surveillance Test and Inspection Procedures, including Control of Measuring and Test Equipment

Training Assessment

To determine the skills and knowledge of the operating crews, the Operating Contractor will conduct extensive evaluations and assessments before resuming production. Written examinations, formal simulator evaluations, and an oral and field evaluation will occur. The Operating Contractor will perform a management assessment to determine if the crews are properly qualified to operate the reactors. Figure 2-11 shows the training program evaluation process.

2.1.3 RESPONSES TO EXTERNAL OVERSIGHT

Since the beginning of SRS operations, changes have been made to the production reactors and to operating practices as part of an ongoing safety and environmental improvement program. Improvements have also been made in response to internal and external oversight programs. The following sections describe improvements proposed in response to concerns raised by the National Academy of Sciences and the National Academy of Engineering (NAS/NAE, 1987) and the Advisory Committee on Nuclear Facility Safety (ACNFS, 1988a,b). Section 2.1.2 describes modifications that are part of the ongoing safety improvement program or are in response to internal oversight activities. The Defense Nuclear Facilities Safety Board (DNFSB), which was created by law in September 1988 with members appointed by the President, provides independent L-69-05 TC

the WISR items. For resumption of production, safety-related procedures will be established in the following major areas:

- Administrative Procedures
- General Plant Procedures for Startup, Shutdown, Power Operations, Process Monitoring, and Fuel/Target Handling
- System Operating Procedures
- Abnormal, Off-Normal, or Alarm Condition Procedures
- Maintenance Procedures
- Radiation Control Procedures
- Chemical and Radiochemical Control Procedures
- Emergency Operating Procedures
- Emergency Plan Implementing Procedures
- Modification Procedures
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external oversight of the DOE weapons complex, including SRS. Section 2.1.3.3 describes the functions of the DNFSB and summarizes its areas of focus to date. TC

2.1.3.1 National Academy of Sciences/National Academy of Engineering Concerns

Shortly after the accident at the Chernobyl Nuclear Station in April 1986, then-Secretary of Energy Herrington requested the NAS and the NAE to provide DOE with an independent assessment of safety and technical issues at the DOE reactors. The National Research Council established a review committee, and the requested effort began in August 1986. NAS published the results of its initial assessment of the four DOE production reactors (K-, L-, and P-Reactors at SRS and N-Reactor at Hanford) in October 1987 (NAS/NAE, 1987). That report contained a number of observations, conclusions, and recommendations on safety for these reactors and on the DOE process for managing and implementing reactor safety. Shortly after receiving the report, Secretary Herrington announced a number of actions to respond to its recommendations, including the development of an action plan to resolve each of the report's technical recommendations. DOE published that plan in May 1988 (DOE, 1988b).

The NAS/NAE report grouped its concerns into three major categories: Safety Framework, Technical Issues, and Management Structure. The following sections describe modifications that DOE has proposed in response to recommendations in each category.

2.1.3.1.1 Safety Framework

The NAS/NAE report contains four safety framework concerns that are applicable to SRS production reactors:

- Safety Objective
- Department Orders
- Verification of Compliance
- Technological Vigilance

The following paragraphs briefly discuss NAS/NAE recommendations and the DOE responses.

Safety Objective

The NAS/NAE recommended that DOE clarify its safety objective for reactor operation so the Department could achieve and maintain the desired level of safety.

Independent of resumption of production, DOE is developing a department statement for the identification and application of safety objectives that will draw on available information from the NRC, the International Atomic Energy Agency, and other applicable sources. Section 4.1.3.1.5 compares draft safety goals from the proposed policy statement with severe accident risks for the production risks. Based on the safety policy statement, DOE will conduct a 2-year trial use of the proposed safety objective. At the conclusion of these actions, DOE will issue revised and final safety objectives in DOE Orders.

Department Orders

The NAS/NAE concluded that DOE needs to revise its Orders to specify clear requirements and deadlines for implementation.

DOE is implementing a revised centralized system for the review and issuance of its Orders that deal directly with reactor safety. Before resuming production, DOE will complete development of criteria to ensure that Orders are consistent with the recognized attributes of clarity, prescriptiveness, uniformity, technical soundness, and timeliness. The process includes external standards review, technical peer review, and Advisory Committee review.

Verification of Compliance

The NAS/NAE recommended that verification of compliance with DOE Orders be based on comprehensive, vigorous, and frequent inspections of contractor performance.

DOE is broadening the scope of Technical Safety Appraisal (TSA) coverage to consider other aspects of facility operation that are necessary for an assessment of safety performance. DOE is developing procedures to categorize appraisal findings and recommendations so it can provide guidance to the Operating Contractor and the Operations Office for establishing priorities for corrective actions. To ensure the qualifications of the appraisers themselves, DOE is establishing a formal training program as a prerequisite
TC for participation on TSAs. DOE will complete these activities before resuming production.

Technological Vigilance

The NAS/NAE recommended that DOE achieve an indepth understanding of technical issues related to the safety of its reactors, using methodology that is, at a minimum, comparable to that found in the commercial nuclear industry.

DOE has initiated an integrated program of nuclear industry cooperation to be
TE facilitated through a recently signed cooperative agreement with the Institute of Nuclear Power Operations (INPO), outside expert reviews, internal contractor assistance, and information exchange. The purpose of the program is to ensure that both DOE personnel and operating contractors make full use of both (1) the methods and techniques available for monitoring commercial power reactors, and (2) the results of safety research performed at national laboratories.

DOE has established a program for the management of safety issues. The
TE program establishes DOE responsibilities for the Operating Contractor RSIP. The RSIP identifies, sets priorities for, and manages a comprehensive set of
TE activities designed to upgrade or confirm the safety of reactor operation at SRS.

DOE has initiated a program on the application of probabilistic risk assessment (PRA) techniques in the performance of safety analyses for its production reactors.

2.1.3.1.2 Technical Issues

The NAS/NAE report contains 11 technical issues that are applicable to the SRS production reactors:

- Acute Aging Phenomena
- Maintenance and Plant Modernization
- Power Operating Limits
- Probabilistic Risk Assessment
- Severe Accident Evaluation (two concerns)
- Confinement Systems
- Hydrogen Generation and Mitigation
- Cermet Fuel
- Human Performance
- Liquid Effluents
- Emergency Planning

The following paragraphs briefly discuss concerns raised by the NAS/NAE issues and the DOE responses.

Acute Aging Phenomena

The NAS/NAE concern is that aging phenomena can limit useful reactor life to less time than that required to authorize, fund, design, and build new facilities to produce special nuclear materials. DOE has a number of activities in progress to address aging, as described in Section 2.1.2.3.2. Results of these activities have not identified any life-limiting mechanisms for the three SRS reactors. Although continued aging might reduce their availability, continued operation of K-, L-, and P-Reactors will ensure the capability to produce nuclear materials as necessary, at least until replacement production capability has been demonstrated. TC

Maintenance and Plant Modernization

DOE agrees with the NAS/NAE that increased attention to preventive maintenance planning, procedures, and training is required. An enhanced maintenance Training Program is being implemented; it will be completed before the L-44-10 resumption of production. The program includes initial continuing, and specialty training that is based on job performance, and that recognizes the problems inherent in the operation of aging facilities. Safety-related maintenance requirements are being implemented as a prerequisite to the resumption of production. Section 2.1.2 discusses upgrades in the area of TC maintenance in more detail.

Power Operating Limits

DOE agrees with the NAS/NAE that, before resuming operation at power at the TC SRS, there must be a thorough understanding of the behavior of the reactors in a loss-of-cooling accident, based on rigorous external review. To achieve this level of understanding, DOE has enlisted the expertise of the Los Alamos National Laboratory and the Idaho National Engineering Laboratory to assist in technical reviews.

Power limits will be established based on the results of thermal-hydraulic analysis using new experimental data. A fourth Emergency Cooling System
TC injection path will be completed before the resumption of production in each of the three reactors during the current outage to enhance reactor safety for current design-basis LOCA conditions.

Probabilistic Risk Assessment

TE A PRA is a systematic, structured approach to identifying and evaluating the ways in which failures in components, systems, and human performance can propagate; estimating the likelihood of alternative failure sequences that lead to significant consequences; and calculating the consequences associated with a defined accident sequence and probability. The results are useful not only for providing an estimate of the range of potential consequences and their associated likelihood, but also for indicating those components, systems, and human performance areas that offer the greatest opportunity for improvements in reliability and safety. PRAs have been applied in space system reliability evaluations and nuclear reactor safety assessments, among other applications.

Both DOE and the Operating Contractor are committed to the use of PRA methodology. The PRA for the SRS production reactors will evaluate both
TC internal and external initiating events. At present, a full-scope PRA is being performed for K-Reactor; the analyses are broad enough to include L- and P-Reactors. The PRA is part of the continuing safety improvement process. The Level-1 PRA was completed in June 1990; the completion of Levels 2 and 3
TC is not scheduled before the resumption of production. (Section 4.1.3.1.5 describes PRA levels and methodology.)

During the performance of the full-scope PRA, components and systems personnel in the Operating Contractor Reactor Engineering Department review the documents published by the PRA groups for accuracy and application to reactor design and operation. These applications include both hardware improvements and procedural changes.

Independent review of the SRS PRA takes place on a number of levels by several groups. Westinghouse established the Senior Review Panel in 1985. This panel, which consists of nationally recognized experts in PRA, provides independent review on a continuing basis. The DOE Independent Review Panel,
C-04-12 which consists of PRA practitioners, provides a detailed review, also on a
L-44-16 continuing basis. The DOE High Level Peer Review consisted of nationally recognized PRA experts, who performed a one-time review of the Level-1 PRA and determined if it was adequate to support the startup effort. The Advisory Committee on Nuclear Facility Safety (ACNFS) and the DNFSB provide oversight reviews for the Secretary of Energy and Congress, respectively.

The point estimates of core damage frequencies (CDFs) from the Final Level-1
L-44-20 PRA are 2.1×10^{-4} per reactor-year for internal events and 2.2×10^{-4} per
L-75-03 reactor-year for external events, for a total CDF of 4.3×10^{-4} per
C-04-16 reactor-year. On the other hand, the Reactor Operation Safety Information Document (SID; WSRC, 1990) shows a CDF point estimate from internal events of 1.2×10^{-4} per reactor-year, a CDF point estimate of 6.8×10^{-5} per

reactor-year from external events, and a total of about 2.0 x 10^{-4} per reactor-year (Sharp, 1990).

The CDF point estimates released in the SID are different from the CDFs in the Final Level-1 PRA. The Level-1 PRA is based on the K-Reactor configuration of June 1987, for which the only upgrades were the fourth ECS line and the seismic design based on the P-Reactor configuration of June 1988. The SID numbers are lower because the SID is based on the planned reactor configuration when production resumes (WSRC, 1990). L-44-20 L-75-03 C-04-16

Severe Accident Evaluation

DOE acknowledges NAS/NAE concerns about severe accidents and has initiated a program to implement the recommendations. DOE has placed substantial emphasis on developing a Severe Accident Assessment Program (SAAP) at SRS that complements ongoing PRA activity and that will provide an improved technical basis for future design and operational changes. SRS personnel are developing two levels of severe accident computational models, which will provide state-of-the-art computational tools for all significant severe accident phenomena, including those areas judged to be significant by the NAS/NAE committee (radionuclide release, fuel damage progression, etc.).

An experimental program is under way, but is not planned for completion before the resumption of production; its purpose is to develop more information about elements of severe accident behavior that are specific to the SRS reactors. Small-scale steam explosion experiments were performed at Sandia National Laboratories (SNL) in Albuquerque, New Mexico, using SRS uranium-aluminum alloy. Initial SRS-specific metal-water experiments have been performed at Rice University. SNL is in the process of conducting SRS-specific core-concrete reaction experiments.

Human factors play an important role in the progression of severe accidents. One of the explicitly defined outputs of the SAAP is the development of accident management procedures to aid the operators in making decisions on possible courses of action. The SAAP is part of the continuing safety improvement process; it is not scheduled for completion before the resumption of production. In addition, Abnormal Condition Control (ACC) procedures will be revised to reflect operator actions necessary to respond to severe accident scenarios.

Confinement Systems

Efforts are under way to reevaluate and better determine the conditions that the confinement system might experience during postulated severe accidents, including the ability of these systems to respond as expected. The severe accident conditions being evaluated include filter aerosol loadings, pressure pulses, and source-term data.

As part of the SAAP work on the SRS, researchers have developed quantitative release data for specific fission products from irradiated fuel samples melted under simulated accident conditions. As further information is developed in the SAAP, the impact of severe accidents on the confinement system will be evaluated, and improvements will be made, if appropriate.

Hydrogen Generation and Mitigation

Previous analyses of the SRS reactors have indicated that hydrogen generation rates would not be high enough to produce explosive mixtures in the event of core melting. To confirm this conclusion, an improved mechanistic model being developed under the SAAP will utilize experimentally determined hydrogen evolution information specific to the SRS reactors. Using results from the PRA, researchers will analyze confinement system modifications to balance the tradeoff between radionuclide retention and hydrogen buildup to reduce risk. This model is not scheduled for completion before the resumption of production.

Cermet Fuel

The present form of fuel used in the SRS reactors is an alloy of uranium and aluminum. Since the early 1970s, studies and analyses have been performed at SRS to introduce another form, known as "cermet" (ceramic-metallic) fuel.

The buildup of uranium-236 at SRS encourages an increase in the uranium content in fuel. Associated with this advantage of increased uranium content, the volume of high-level radioactive waste is reduced due to a decrease in the amount of aluminum used. In addition, the ceramic uranium oxide is able to sustain higher temperatures than metallic uranium-aluminum fuel and is, consequently, better at fission product retention.

Recent programmatic considerations make the future of the Cermet Fuel Testing program at SRS uncertain due to budget constraints and growing interest in microsphere fuel technology, in which the fissionable material, in the form of TC minute coated spheres, is dispersed in a moderating matrix. If the program continues, SRS personnel will perform studies and sample irradiation to qualify further the uranium oxide fuel and to address the NAS/NAE concern on exothermic uranium oxide-aluminum reactor tests.

Human Performance

DOE and its contractors are implementing programs at SRS to address NAS/NAE concerns related to operating and emergency procedure training, as described in Section 2.1.2.8. Among these are the addition of a fifth operating shift to permit more time for reactor operator training and the provision of a degreed supervisor on each shift to increase the availability of engineering expertise. The Abnormal Condition Control Procedures are being converted to flowcharts (similar to those used by some utilities) to train reactor personnel in the use of these procedures on the reactor simulator. SRS personnel are also working to develop symptom-based procedures for application TC to the Site. The fifth operating shift and the flowcharts will be in place before the resumption of production. The symptom-based procedures are part of the continuing safety improvement process; they are not scheduled for completion before the resumption of production. In addition, DOE is pursuing the expanded use of the simulator and modification of emergency procedures based on simulator experience. There is an improvement in the methods used for on-the-job training, utilizing a structured training support system suggested by INPO.

DOE concurs with NAS/NAE recommendations on modifications to the SRS incident reporting procedures. DOE is implementing modifications to these procedures that respond to these recommendations by requiring a more thorough analysis of the cause(s) of reactor events, a broader review of the implications of events, and providing direction for corrective actions that will improve human performance (see Section 2.1.2.7.3). DOE is also initiating root cause trend analyses on unusual occurrence report findings. TC L-44-51

DOE agrees with the NAS/NAE recommendation on software review. As part of its continuing safety improvement process, DOE is developing and implementing formally documented and rigorous quality assurance programs, using appropriate national standards; they are not scheduled for completion before the resumption of production. DOE has also initiated the development of derivative documents for implementation at SRS. An assessment of computer software fault tolerance is performed for new systems before they are installed.

Liquid Effluents

SRS is designing and installing liners in the emergency retention basins in the reactor areas. The liners will be high-density polyethylene with underliners of bentonite clay or polyethylene. The phased project plans call for a polyethylene cover. This upgrade will be completed before the resumption of production. TC

Emergency Planning

Current DOE offsite emergency planning considers state, county, and other Federal agencies, and provides personnel and services to assist state and local programs. DOE plans to continue conducting emergency exercises involving state and local participation on a biennial basis. In a major radiological accident, SRS-specific emergency plans and procedures ensure the activation and staffing of state and local Emergency Operating Centers (EOCs) in the vicinity of the Site. SRS liaison with state and local EOCs ensures that changes to local conditions can be factored readily into activities associated with the protection of public health and safety. DOE continues to analyze the events that occurred at Chernobyl in April 1986, and incorporate the information obtained from that and other events into emergency planning. TC

Nuclear Regulatory Commission Comparability/Equivalence in Regulations with DOE

During the public scoping period for this EIS (March 21 to May 8, 1989), DOE received 21 comments related to the public concern about the comparability or equivalence of NRC regulations and guidelines with DOE Orders or guidelines. While DOE is not required by law to adhere to NRC standards or regulations, it has implemented or adapted many NRC programs, keeping in view the fundamental physical differences between commercial power reactors and the DOE nuclear material production reactors.

The DOE approach and guidance for implementing NRC standards and related industry standards are contained in DOE Orders. The Orders that apply to the SRS production reactors are (1) Order 5480.4, "Environmental Protection, Safety and Health Protection Standards," and (2) Order 5480.6, "Safety of L-44-30

L-44-30 DOE-Owned Reactors." Other Orders provide more detailed guidance regarding use of NRC standards in specific technical areas.

Among others, DOE has implemented, or adapted with modifications, the following NRC programs:

- Probabilistic risk assessments
- ANSI/ASME - NQA-1 Quality Assurance requirements
- Seismic criteria
- Radiation protection guidelines
- Transuranic waste management - offsite transport
- Reactor safety objectives
- Offsite radiological dose calculation models: LADTAP, GASPAR, XOQDOQ, MAXIGASP

TC DOE and its Operating Contractor began an Integrated Safety Evaluation Program (ISEP) based on the NRC Systematic Evaluation Program (SEP). The SEP process provided technical assessments of the proper extent and approach for backfitting modern regulations and standards to older NRC-licensed nuclear plants. The SEP assessments were conducted over a period of years, during which the plants continued operating. The "corrective actions" called for by the SEPs are still being implemented in the licensed plants. Similarly, the ISEP assessment began during SRS reactor operation in 1987. The ISEP process was interrupted by the Issue Management program, which is being conducted during the current outage. Many of the corrective actions that eventually would be taken as a result of ISEP are being taken on an accelerated basis in the Issue Management program. ISEP topics will be addressed in the RSIP after the resumption of production. On completion of the effort associated with the ISEP topics, the SRS reactors will be at a demonstrable level of safety on a par with that of licensed nuclear plants -- through a similar process and in the same relative timeframe as commercial, NRC-licensed plants.

DOE anticipates that designs of proposed new reactors would incorporate additional NRC licensing standards related to plant siting, reactor containment, management structure, and other related areas as a result of Congressional action that included these standards in authorizing legislation.

2.1.3.1.3 Management Structure

The NAS/NAE report contains three management structure concerns that are applicable to the SRS production reactors:

- DOE Relationship with its Operating Contractor
- Management Structure
- External Oversight

DOE plans to complete these activities before resuming production. The following paragraphs briefly discuss how DOE is addressing each of these concerns.

<u>DOE Relationship with its Operating Contractor</u>

DOE has established a Savannah River Special Projects Office (see Section 2.1.2.8.2) to direct the Operating Contractor's efforts on all matters related

directly to the managerial, technical, operational (including training), and scheduling aspects of K-, L-, and P-Reactor operation (DOE, 1989a). Significant aspects of the Operating Contractor's test and operational activities are being covered by DOE Area Engineers and supporting SRSPO staff. A new DOE team, composed of persons with commercial, U.S. Navy, and DOE reactor experience, will perform day-by-day monitoring of Operating Contractor performance at the three reactors. | TC

Management Structure

The Secretary of Energy is constructing a new system for reactor safety similar to those that have been proven to be effective in both the U.S. Navy and the commercial industry since Three Mile Island (Watkins, 1989). As part of the new system, the Secretary created the SRSPO to assign clear accountability and responsibility for reactor safety to DOE line management. The SRSPO reports directly to the Assistant Secretary for Defense Programs and interacts with the Manager of the Savannah River Operations Office, the President of the Westinghouse Savannah River Company, and their staffs.

The incident reporting system, which in the past was limited in scope and sporadic, is being firmly established between DOE Headquarters and the Field Offices. To ensure that there are sufficient line personnel with expertise in reactor safety at Headquarters, DOE is adding a significant number of personnel with reactor experience (i.e., 20 to 30 individuals). This will ensure that technical safety reviews are performed by the line organization, rather than by contractors. The additional personnel and enhancements to the incident reporting system will be in place before the resumption of production. | L-44-10

External Oversight

Three recent actions are relevant to this finding. First, DOE has established the Advisory Committee on Nuclear Facility Safety (ACNFS), which is chaired at present by former NRC Chairman John Ahearne. The committee, which consists of 13 experts in disciplines related to nuclear safety, has provided guidance and independent assessment of nuclear safety aspects of DOE facilities.

Second, the DNFSB, which is patterned after the Civil Aeronautics Board, was established by Congress in September 1988 (P.L. 100-456). The DNFSB consists of five members appointed by the President and confirmed by the Senate. The DNFSB is authorized to hire as many as 100 people as full-time staff. | TE

Third, a "Tiger Team" Assessment was conducted at the SRS from January 29 to March 23, 1990. The purpose of the assessment was to provide the Secretary of Energy with a report on the status of Environment, Safety and Health Programs at SRS. While the environmental subteam did not deal directly with the reactors, it identified no environmental conditions at SRS that represent an undue risk to public health and the environment from the active operations reviewed. The management of the environmental program is still faced with compliance deficiencies and environmental contamination issues (e.g., M-Area groundwater contamination, radiological contamination in the Savannah River Swamp and Creek Plantation Swamp, radioactive and mixed waste tanks, the inactive waste disposal sites, and facility decommissioning and decontamination) that will be a part of the long-term environmental management efforts (DOE, 1990). | L-05-02 L-69-05

2.1.3.2 ACNFS Concerns

In response to NAS/NAE concerns, then-Secretary of Energy Herrington formed the independent ACNFS to advise him on safety matters at defense production facilities. The ACNFS has met periodically at the SRS since June 1988. Committee members have met with representatives of DOE and the Operating Contractor and received briefings on priority issues and on plans to address safety questions concerning SRS facilities. On April 30, 1990, the Chairman TC of the ACNFS advised Secretary Watkins that oversight of reactor restart activities at SRS was being transferred to the DNFSB. Remaining issues and unresolved questions, along with all backup material, were transferred to the DNFSB in May 1990.

2.1.3.2.1 Technical Issues

TE Three ACNFS letters (ACNFS, 1988a,b, 1990) to the Secretary of Energy contain concerns associated with technical issues:

- Maintenance and Upgrades
- Site Boundary Definition
- Safety Philosophy
- Operating Power Level
- Reactivity Control System
- Seismic
- Ultrasonic Testing
- Configuration Verification
- Probabilistic Risk Assessment

The following paragraphs briefly discuss each of these concerns and the modifications proposed in response.

Maintenance and Upgrades

The ACNFS concluded (ACNFS, 1988a) that inadequate attention is given to reactor system maintenance and upgrades. This issue is discussed in Section 2.1.3.1.2.

Site Boundary Definition

The ACNFS believes that the application of NRC site-boundary criteria, which were developed for commercial plants, is "inappropriate for the SRS site" (ACNFS, 1988a). A commercial plant has only the immediate plant staff within its boundaries, whereas the SRS, with an area significantly larger than a TC commercial site, has more than 18,000 workers within its boundaries.

DOE is evaluating the applicability of these criteria to the SRS. Section 4.1.3 discusses the impact (i.e., dose and consequences) of potential accidents from reactor operation on the SRS workforce.

Safety Philosophy

The ACNFS expressed the concern that the K-Reactor Restart Strategy (DOE, 1988a) attempts to bring the reactors to an acceptable safety level without

defining that level. The ACNFS recommends that a reasonable objective for the safety level on the SRS is "comparable to commercial standards." The ACNFS also recommends that decisions on nuclear safety be made by knowledgeable persons who have experience with both commercial and DOE reactors (ACNFS, 1988b).

After the development of the Restart Strategy, the SRS implemented the Restart Issue Management Program. The purpose of the RIMP is to evaluate and resolve potential nuclear safety issues before the resumption of production. The issues include those from the K-Reactor Restart Strategy (DOE, 1988a), as well as issues identified by peer review groups (e.g., ACNFS). Sources of emerging issues include audits and assessments, special projects, operational occurrences and normal work initiators, and line management concerns and observations. TE

The RIMP Issue Management Committee reviews each issue with regard to the following criteria:

- The issue might prevent reactor shutdown, maintenance of required shutdown margin, long-term cooling, or essential monitoring.
- The issue might require operator action in less than 10 minutes to prevent or mitigate the consequences of events described in the SRS safety analyses.
- The issue might cause operation outside the Technical Specifications.
- The issue might result in a reduction in the margin of safety, as described in the SRS safety analyses.
- The issue might result in insufficient ability to operate within the regulatory environmental release limits resulting from reactor operations.

This review will be completed before the resumption of production. L-44-10

Issues that meet any one of the above criteria are recommended for resolution before the resumption of production, unless the Issue Management Committee concludes that there is not a significant increase in risk to public health and safety. The Committee can make additional allowances to avoid disproportionate impacts by considering the age of the facility, the practicality of retroactive application, and the time at risk. Based on these considerations, the Committee can conclude that resolution is not essential for resumption of production, but that it must be completed on a priority basis after the resumption of production. However, if the Committee cannot reach a consensus that an issue can be resolved after the resumption of production, it will recommend resolution before the resumption of production. TC

Operating Power Level

The ACNFS expressed its concern that the present analytic methods of determining reactor power limits are supported by experiments of questionable

value; this would result in power limits that are only a fraction of the nominal power rating (ACNFS, 1988b). Section 2.1.3.1.2 discusses this issue.

The Operating Contractor has established a program to demonstrate a power level that minimizes the potential for fuel damage following a design-basis LOCA. To date, experiments have involved flow tests in single fuel assemblies and a recent full-scale flow test at L-Reactor. DOE agrees with an earlier NAS/NAE recommendation (Section 2.1.3.1.2) that there must be a thorough
TC understanding of accident behavior before achieving reactor operation at power. As a result, DOE will scrutinize the Operating Contractor's power ascension program and related experiments before authorizing the initial power level and any subsequent increase. In addition, DOE is establishing a Power Limits Peer Review Panel of recognized experts in thermal hydraulics to perform an independent review of the Operating Contractor recommendations; the panel plans to complete its review before the resumption of production.

Reactivity Control System

The ACNFS expressed its concern about the reliability of the reactivity control system at the K-, L-, and P-Reactors (ACNFS, 1988b).

The existing rod positioning instruments (T-Amplifiers) are being replaced by
L-44-10 new solid-state components. DOE will complete this item before resuming production. After the resumption of production, new monitoring thimbles will be installed in each reactor to provide better monitoring of core axial power
TC and bulk moderator temperature.

Seismic

The ACNFS indicated its concern that the seismic resistance issue in the K-Reactor Restart Strategy is narrowly focused and does not indicate what must be accomplished before startup. "The ACNFS recommend[ed] that the ECS and the confinement system be seismically upgraded prior to restart" (ACNFS, 1988b).

L-44-10 The Operating Contractor has developed a schedule for completing certain activities before the resumption of production (WSRC, 1989a). Upgrades include improving the seismic resistance of the confinement filters and upgrading the seismic resistance of the stack buildings. In addition, the Operating Contractor has ongoing programs to evaluate piping qualifications, which are not planned for completion before the resumption of production. Section 2.1.2 discusses these and other seismic upgrades in more detail.

Ultrasonic Testing

The ACNFS expressed its concern over the omission from the K-Reactor restart
TC strategy of thorough ultrasonic testing and visual inspection of the piping and reactor vessels for cracks (ACNFS, 1988b). The Operating Contractor performs UT and visual inspections, which is an ongoing program. The Operating Contractor has also reviewed potential degradation mechanisms for the reactor. (See Section 2.1.2.3.2.)

Configuration Verification

The ACNFS is concerned that system drawings do not reflect the actual configuration of plant systems, and that the sample number proposed by DOE is too small (ACNFS, 1988b).

DOE agrees with the ACNFS and has initiated a program in which all 25 safety-related systems will undergo a configuration verification inspection; associated drawings will be updated and controlled. The increase in sample number was based largely on the number of discrepancies revealed during the initial inspections.

Before the resumption of production, 13 major safety-related systems will undergo a detailed inspection to determine their actual configurations; L-44-54
as-built drawings associated with those systems will be updated and controlled. Operational flow drawings will be developed and controlled for the remaining 12 systems. While not as detailed as the 13 as-built drawings, these 12 operational drawings will be verified by field inspections; they will contain sufficient information for equipment lockouts, system lineups, and training.

After the resumption of production, plans call for all plant systems to undergo detailed inspections, with updated and controlled as-built drawings.

Probabilistic Risk Assessment

The ACNFS Subcommittee on PRA and Severe Accidents concluded that the overall quality of the ongoing PRA effort at SRS appears to be high and that the SRS has the skills needed to perform such assessments. As a consequence of the review of the Draft Level-1 PRA, the ACNFS made three recommendations:

- The PRA consider the probability of ECS failure given the additional uncertainty that assembly flow instability might lead to core damage.
- The PRA include more detailed analysis of the Manual Incident Action (MIA) system.
- That SRS evaluate seismic risk using hazard curves developed by both the Electric Power Research Institute (EPRI) and the Lawrence Livermore National Laboratory (LLNL).

The Draft Level-1 PRA assumes that flow instability does not occur. The Power TE
Limits Program is studying flow instability and will define maximum operating power levels with a high degree of certainty that flow instability will not occur (see Section 2.1.2.7).

At present, MIA system unavailability is estimated with operator failure to actuate the system being an important contributor to system failure for certain hypothetical accidents. In all likelihood, detailed modeling will not materially change the failure probability of the system. However, a more detailed system analysis is planned, primarily to determine if system upgrades would be beneficial.

The seismic PRA analysis uses hazard curves that are generated using the EPRI methodology. This methodology has been accepted as a basis for seismic risk assessment for many commercial nuclear powerplants. However, an alternative methodology developed by LLNL produces hazard curves that, for many geographical areas, show higher frequencies of damaging earthquakes than the results obtained with the EPRI methodology. At present, there is no consensus on a preferred methodology, although NRC has had this issue under consideration for the past 5 years. The authors of NUREG 1150, "Severe Accident Risks: An Assessment for Five U.S. Nuclear Power Plants," used both seismic hazard curves to calculate the seismic risk for the Surry and Peach Bottom nuclear generating plants. For these plants, the calculated mean annual seismic risk, using the LLNL methodology, increased by a factor of 5 and 25, respectively, when compared to that calculated using the EPRI
L-75-10 methodology. Median values increased by a factor of 2 and 6, respectively, and there was considerable overlap of the distributions of risk. The major contributors to risk were not changed by the use of either methodology. The same findings could be true for SRS reactors, although no confirming calculations exist. Further studies on differences between the EPRI and LLNL methodologies appropriate for application to SRS are underway. The PRA will include seismic risk results generated from both sets of curves. DOE will take appropriate action on this issue based on the generic NRC resolution.

2.1.3.2.2 Administrative Issues

TC Two of the ACNFS letters to the Secretary of Energy (ACNFS, 1988a,b) contain four concerns regarding administrative issues:

- Change of Contractor
- Management
- Control Room and Operating Philosophy
- Quality Assurance

The following paragraphs briefly discuss these concerns and the modifications proposed in response.

Change of Contractor

The ACNFS was concerned about the change of Operating Contractor and the number of safety-related problems the new contractor would have to address (ACNFS, 1988a).

The Operating Contractor conducted an independent safety review of the reactors and recommended additional safety-related activities to be accomplished (WSRC, 1989b). Section 2.1.2 describes these activities.

Management

The ACNFS concluded that management directions should be transmitted along a single, clearly identified line (ACNFS, 1988b).

As discussed in Section 2.1.2.8.2, SRSPO is responsible for SRS reactor operation. Section 2.1.3.1.3 describes other modifications to the DOE management structure that resulted from NAS/NAE concerns.

Control Room and Operating Philosophy

The ACNFS was concerned that the number of people proposed to be in the control room during reactor startups (at least 12) is excessive. The committee recommended that the list of people be reviewed carefully and that access be limited to essential personnel. The ACNFS also expressed concern about the delegation of responsibility to the Shift Technical Engineer for ensuring that the reactor operates within the safe operating envelope (ACNFS, 1988b). TE

The Operating Contractor shift crew has been restructured, as described in Section 2.1.2.8.1 and shown in Figure 2-9. Present plans call for nine individuals (five Central Control Room Operators, one Central Control Room Supervisor, one STE-trained supervisor, one Shift Advisor, and one Shift Manager) to be in the control room during the next startup. TC

Quality Assurance

The ACNFS recommended that DOE require the Operating Contractor to review and evaluate the QA plan, to perform a baseline assessment of the state of quality on the Site and its extent of verification, and to determine the needs for continuing improvements (ACNFS, 1988b).

The Operating Contractor has conducted an internal review of the development and implementation status of the QA program. Section 2.1.2.8.1 describes the results of that review and the proposed actions.

2.1.3.3 Defense Nuclear Facilities Safety Board

The DNFSB, established by Congress in September 1988, has held several meetings to review SRS issues. The early focus has been on operator training and seismic issues. The first formal recommendation to the Secretary of Energy deals with operator training. L-05-02 L-44-32

The functions of the DNFSB are to review and evaluate standards for design, construction, operation, and decommissioning of DOE defense nuclear facilities; to investigate events or practices that might affect public health and safety; to analyze design and operational data; and to recommend to the Secretary of Energy measures to ensure adequate protection of public health and safety. DNFSB powers include enforcement, holding hearings, prescribing regulations, imposing reporting requirements on the Secretary of Energy, conducting special studies, and evaluating scientific and industrial information. The DNFSB reports its recommendations to Congress; the Secretary of Energy is required to report DOE decisions and reasoning in response to each recommendation to Congress as well. All recommendations are published for public review and comment. L-44-51 TC

On February 28, 1990, the DNFSB published its Recommendation 90-1 in the Federal Register (55 FR 7022). This recommendation deals with the training of reactor plant operators and supervisors at SRS. The Board made six specific recommendations to SRS. At DNFSB request, DOE made these recommendations available in its public reading rooms, and requested public comments on the L-44-51

TC response of the Secretary of Energy to Recommendation 90-1. On April 13, 1990, DOE published a series of responses to the recommendation in the Federal Register (55 FR 13941).

TC On March 14, 1990, the DNFSB published a second recommendation (90-2) in the Federal Register (55 FR 9487) related to the adequacy of specific standards applicable to the design, construction, operation, and decommissioning of defense nuclear facilities, particularly K-, L-, and P- Reactors at SRS. The Board also requested public review and comment on its recommendation. On April 18, DOE requested a 45-day extension to respond to the recommendation because of its magnitude and complexity; on April 23, DNFSB approved the DOE request. On June 12, DOE published the Secretary of Energy's response to the DNFSB recommendation in the Federal Register (55 FR 23783).

2.1.4 PROCESS AND EFFLUENT MONITORING

All gaseous radioactive releases through the K-, L-, and P-Area stacks are monitored continuously. Two ion chambers in parallel flowpaths monitor stack effluent tritium. A continuous sampling technique with daily quantitative analysis is also used. All other air and water samples are monitored routinely, and quantitative release records are kept. DOE investigates every above-normal activity level to locate the source and correct the condition. The secondary cooling water is monitored continuously after discharge from the reactor heat exchangers to detect any radioactivity leakage from the primary coolant.

An upgrade in the isotopic release monitoring system will allow a better assessment of postaccident core damage and offsite dose rates. A proposed project would involve the installation of a computer-controlled detection system; it would be completed after the resumption of production. Upgrades in the existing monitoring system will allow continuous online monitoring of noble-gas releases.

TC All monitoring instruments must be inspected and calibrated at defined intervals. Appendix B describes environmental studies and monitoring.

2.1.5 SAFEGUARDS AND SECURITY

Safeguards considerations for K-, L-, and P-Reactors include physical security and materials control and accountability. Access to the SRS is controlled on primary roads at barricades that are permanently manned by guards employed by an independent security contractor. Other roads are closed to travel by gates or other barriers. SRS is fenced (except along the Savannah River), and the boundary is posted against trespass under State of South Carolina and Federal statutes. The operating areas are fenced separately; each fence is patrolled continuously by security personnel. Primary responses to safeguards and security incidents are from area patrol personnel who are engaged in roving patrols or access control activities.

Stringent controls are used throughout the manufacturing, storage, and shipment cycles to protect against unauthorized diversions of nuclear materials. Accurate measurement and analytical procedures and equipment are part of the SRS materials control and accountability system.

The security contractor uses extensive training programs and exercises to instruct its personnel in the use of methods to avert or counteract potential terrorist attacks or other illegal activities.

2.1.6 K-REACTOR COOLING-TOWER PROJECT

On October 11, 1989, DOE awarded a contract to begin the construction of a recirculating, natural-draft, cooling-tower system for K-Reactor, with a completion date no later than December 31, 1992. Operation of the K-Reactor once-through cooling water system after that date would not be permitted (Consent Order 84-4-W, as amended; see Section 5.2.5). On November 14, 1990, DOE directed that the cooling-tower contract schedule be accelerated such that the construction project could be completed on the earliest possible date (Kaspar and McCoy, 1990); this could shorten the construction period by an estimated 6 months, making the completion date about June 1992. With the cooling tower in operation, the design maximum discharge water temperature will be 27°C; overflow blowdown and flow rate to Indian Grave Branch and Pen Branch will be about 1.3 cubic meters per second. About 1.8 cubic meters per second will be withdrawn from the Savannah River as makeup water. L-05-03 L-78-11 L-84-04 TC

2.2 TERMINATE OPERATION OF ONE OR TWO REACTORS AT SRS IN THE IMMEDIATE FUTURE AND MAINTAIN IN COLD STANDBY

This section describes the actions that DOE would take to terminate operation of one or two of the SRS reactors in the immediate future (i.e., before resuming production), and to maintain them in cold standby. Cold standby involves the defueling of the reactors; storage of the moderator in tanks in the reactor buildings; layup (i.e., shutdown arrangement in a protected condition) of reactor equipment and systems to prevent deterioration; and maintenance in a defueled, protected status by a skeleton staff, which would permit future refueling and restart. TC

As discussed in Section 1.2 and analyzed in Appendix A (which is classified), the capability of K-, L-, and P-Reactors is needed to meet the base and reserve requirements established by the NWSM most recently approved by the President (in July 1990). If subsequent revisions to the NWSM reduce the base and reserve requirements, as exemplified by the potential reduced-need scenario analyzed in Appendix A, DOE would consider terminating the operation of one or more SRS reactors, after ensuring the capability to meet material requirements with operating reactor capacity. L-37-07

If DOE decided to terminate the operation of one or more SRS reactors in the immediate future (i.e., before resuming production), currently committed and planned upgrade activities would be discontinued. The continued operation of K-Reactor would include continuing the construction of the recirculating cooling-tower system; construction of the cooling tower would stop if K-Reactor operation were terminated. L-37-07 TC

The three reactors have similar designs. Except as noted below, their releases to and impacts on the environment are similar, if not the same. Atmospheric, liquid, and solid discharges would diminish, as would the need for process and potable water supplies and steam and electric power supplies.

The permanent workforce for each reactor to maintain the facility status and
TC security would be about 20 persons.

Termination of the operation of one or two reactors would lead to corresponding reductions in the requirements for fabrication of fuel and target assemblies and in the quantities of irradiated assemblies requiring reprocessing. Reductions in these operations would result in decreased effluents to air and water and the production of smaller quantities of solid radioactive and hazardous wastes from those facilities. The termination of operation of one or two reactors and their associated support facilities would also result in the loss of 2,200 or 5,300 jobs, respectively.

TC Cooling water withdrawal effects and the impacts of discharges of cooling waters on the ecosystems to which they are returned differ among the reactors. Table 2-2 lists sections of this EIS that discuss these and other reactor-specific environmental impacts of the six combinations for terminating operation of one or two reactors.

The termination combinations evaluated under this alternative include the following:

- Terminate L- and P-Reactors; operate K-Reactor
- Terminate K- and P-Reactors; operate L-Reactor
- Terminate K- and L-Reactors; operate P-Reactor
- Terminate L-Reactor; operate K- and P-Reactors
- Terminate P-Reactor; operate K- and L-Reactors
- Terminate K-Reactor; operate L- and P-Reactors

Table 2-2 lists these reactor combinations and the appropriate sections in
TC Sections 4.1 and 4.3 that present the selected environmental consequences of operation.

2.3 TERMINATE OPERATION OF K-, L-, AND P-REACTORS IN THE IMMEDIATE FUTURE AND MAINTAIN IN COLD STANDBY

This section describes the actions that DOE would take to terminate operation of K-, L-, and P-Reactors in the immediate future (i.e., before resuming production) and to maintain them in cold standby. As in the one- or two-reactor termination alternative described above, the three SRS reactors would be defueled, and equipment and systems would be maintained to permit future refueling and restart.

Currently planned upgrade activities, including the construction of the K-Reactor cooling-tower system, would be discontinued. Withdrawals from the Savannah River of as much as 3 cubic meters per second would maintain access
TC by fish to Steel Creek for spawning. Atmospheric and liquid discharges would diminish by at least an order of magnitude, as would the need for process and potable water supplies. Steam generation of about 2,270 kilograms per hour required to maintain the reactor building environment would be provided by small package boilers. Electric power needs for lighting, fans, sump pumps, monitoring equipment, etc., would be about 2.5 megaWatts per reactor. The permanent workforce for each reactor to maintain the facility status and security would be about 20 persons (Jenkins, 1989).

In addition, because the reactors would not require fabrication of fuel and target assemblies, fabrication and reprocessing facilities would be largely inactive. No irradiated fuel and target materials would be produced for reprocessing; those facilities would continue to be used for the reprocessing of weapons components to reclaim and process plutonium and tritium, and to reprocess fuel stored in H-Area and received at the Receiving Basin for
L-78-72 Offsite Fuel (RBOF). Therefore, facilities other than the reactors would continue to produce waste. These reduced operations would not require the level of operating and other support personnel currently employed at SRS; termination of K-, L-, and P-Reactor operation would result in the loss of about 9,600 jobs (about half the SRS workforce in May 1989).

Terminating the operation of K-, L-, and P-Reactors immediately, and placing them in cold standby, rather than continuing their operation, would result in
TC DOE not being able to ensure the capability to produce nuclear materials, as discussed in Section 1.2 of this EIS and in Appendix A (which is classified).

2.4 OTHER PRODUCTION OPTIONS

This section discusses alternatives to the operation of K-, L-, and P-Reactors to ensure the capability to supply needed nuclear materials, including new
TC production reactors; operation of the N-Reactor at the Hanford Reservation, Richland, Washington; operation of the Fast Flux Test Facility/Fuel Materials Examination Facility at Hanford; C-Reactor renovation at SRS; other nonfission-reactor production technologies; and acquisition of nuclear materials by such means as production in commercial nuclear reactors and procurement from foreign sources. These alternatives have been considered, but not analyzed in detail, because, as discussed here and in Appendix A, none are considered reasonable alternatives to meet near-term requirements for nuclear materials, at least until new production capability has been demonstrated.

By necessity, this discussion on production options is qualitative and limited because, in general, quantitative information on most nuclear material requirements, inventories, production capacity, and projected shortages is
TC classified. Appendix A of this EIS (which is classified) presents a discussion of requirements based on the 1990 NWSM and capabilities.

Assessments indicate that other options for the production of tritium would lack proven near-term capability (e.g., tritium production by linear accelerators is conceptually possible but requires considerable technical development; large-scale production of tritium in N-Reactor would require the qualification of new fuel and target elements) or would require overcoming significant institutional issues (e.g., treaty amendments to allow the purchase of goal quantities of nuclear materials from other sources; national policy against the production of material for defense programs in commercial reactors). For plutonium-238 production, FFTF/FMEF availability would not meet the requirements for this material on the schedule necessary for U.S. space projects and for Navy missions, which need new fuel to meet minimum
TC power requirements. DOE will assess options for some nuclear material

In addition, because the reactors would not require fabrication of fuel and target assemblies, fabrication and reprocessing facilities would be largely inactive. No irradiated fuel and target materials would be produced for reprocessing; those facilities would continue to be used for the reprocessing of weapons components to reclaim and process plutonium and tritium, and to reprocess fuel stored in H-Area and received at the Receiving Basin for
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TC power requirements. DOE will assess options for some nuclear material

production capacity well into the twenty-first century in the New Production Reactor Capacity EIS (NOI, 53 FR 36094, September 16, 1988), which is in preparation. TC

2.4.1 NEW PRODUCTION REACTORS

DOE is proposing to construct new production reactor capacity. The heavy-water, light-water, and modular high-temperature gas-cooled reactor technologies proposed for new production reactor capacity, however, would not be operational before about the year 2000. DOE cannot advance the projected schedules for construction and operation of the alternatives sufficiently for them to be considered reasonable sources for near-term production of nuclear materials. The proposed action for this EIS is to continue to operate K-, L-, and P-Reactors at least until replacement production capacity has been demonstrated. As such, the operation of new production reactors is not an alternative to the proposed action because the eventual availability of such reactors is assumed. TC

The light-water reactor alternative for new production reactor capacity includes the potential conversion of the partially completed WNP-1 pressurized light-water reactor, located on the DOE Hanford Reservation, for the production of tritium. The 7- to 10-year schedule for the completion of construction and conversion, including fuel and target development and demonstration, would not meet the near-term supply requirements. However, DOE will consider the conversion of this reactor as an alternative in the EIS being prepared on new production reactor capacity. TC

2.4.2 OPERATION OF N-REACTOR

DOE has considered the operation of N-Reactor at the Hanford Reservation as an alternative for the production of tritium and other nuclear materials. N-Reactor is a light-water-cooled, graphite-moderated reactor of about 4,000 megaWatts thermal power, which began operation for production of plutonium and byproduct steam for electricity in 1963. It entered a stand-down in January 1987 to address safety concerns in the wake of the NAS/NAE review following the accident at Chernobyl, and is being maintained in a standby condition. TC

To operate N-Reactor in a tritium production mode would require, at a minimum, the successful completion of the following activities, some of which could be done in parallel but some of which could only be done in series:

- New Core Design Containing Highly Enriched Uranium - Operation of N-Reactor in a tritium production mode would require a new core design containing highly enriched uranium (HEU). Safety analyses for such a core would have to be prepared, reviewed, and approved by DOE, and reviewed and approved by the DNFSB. Such a process would require at least 2 years to complete. TE

- Fuel Billet Availability - The availability of fuel billets to support the restart of N-Reactor is uncertain, because the type of fuel required has not been manufactured. Fuel billets might be supplied by the DOE Y-12 Plant at Oak Ridge or from commercial vendors, but delivery schedules would need to be demonstrated.

- Staffing and Training - Approximately 2.5 years would be needed to recruit and train the personnel needed to operate, maintain, and test the reactor equipment and systems. This assumes that enough people, with appropriate backgrounds, could be recruited within 6 months to staff five shifts, and would allow 2 years for training.

- NAS Severe Accident Concerns - Concerns expressed by the NAS regarding severe accidents for low enriched fuel cores would also have to be addressed as applicable for any new proposed core design utilizing highly enriched fuel. A fuel performance demonstration effort probably would be required to address these issues properly. This effort would take between 2 and 3 years to complete.

- NAS Technical Issues - Technical issues raised by the NAS would have to be resolved. DOE has generated responses to many of those issues, but these responses have not been reviewed outside DOE. At a minimum, the DNFSB would need to review and concur with the DOE responses.

- Preoperational Test Program - A Preoperational Test Program would be needed to verify the proper operation of N-Reactor systems and components, both individually and in integrated system operation, before the reactor could be declared ready. Because N-Reactor is in cold standby, extensive testing would be needed to obtain the necessary assurance that the hardware was ready to operate. This effort would require approximately 2 years, but could not start until after trained operators were available, thus extending startup activities to 4-1/2 years.

- Environmental Compliance - For N-Reactor to operate in compliance with environmental requirements, environmental upgrades would have to be implemented. In particular, a liquid effluent treatment facility (LETF) would have to be built at a significant cost (presently estimated at $35 million). TE

- N-Reactor Aging Effects - Engineering studies are needed to identify any potential life-limiting mechanisms before restart. Aging effects have already been identified that would limit the useful lifetime of N-Reactor to about 9 years in a tritium production mode. In addition, a significantly augmented engineering staff would need to be recruited and trained to monitor plant performance to identify any aging effects.

- Processing - If tritium were produced in N-Reactor, the zirconium cladding would have to be cut from the targets, and the irradiated targets would have to be shipped over public roads and/or rails to the tritium extraction and purification facility at SRS, because there is no such facility at Richland. The cutting and shipping of irradiated targets would add to the lead-time for the availability of tritium from N-Reactor and would entail additional environmental risk.

TC In summary, it would take an estimated minimum of 4 to 5 years before N-Reactor would be capable of producing tritium. There is technical uncertainty associated with a number of the steps required prior to any potential restart.

The successful restart of N-Reactor in a tritium production mode is considered to entail significant technical risk. In light of the remaining technological risks, schedule uncertainties, and costs associated with its restart, the restart and operation of N-Reactor, to produce tritium or other nuclear materials, either alone or in combination with other DOE reactors, is not a reasonable alternative to the continued operation of K-, L-, and P-Reactors. TC

2.4.3 RENOVATION OF C-REACTOR

The design of C-Reactor at SRS is similar in most respects to those of K-, L-, and P-Reactors. However, C-Reactor was placed in cold standby in 1987 when cracking was observed in the reactor vessel. The cracks occurred in a "knuckle" region that is unique to C-Reactor. Attempts to repair the cracks failed; however, new technology has been developed that potentially could permit repair of the C-Reactor tank. The production capacity of C-Reactor would be similar to that of K-, L-, or P-Reactor. The estimated cost of repairing, refurbishing, and modernizing C-Reactor is at least $1 billion, and the estimated lead time for resumption of production from C-Reactor is 6 to 8 years. TE TE TC

2.4.4 OTHER DOE REACTORS

Several DOE test reactors could be used to provide small quantities of tritium or to provide other required nuclear materials. These include the Engineering Test Reactor (ETR) and Advanced Test Reactor (ATR) at the Idaho National Engineering Laboratory, and the FFTF at the Hanford Reservation. These reactors together, if converted to a tritium mode, could not provide more than a small quantity of tritium. This quantity is so small that their conversion to a tritium production mode is not considered to be a reasonable alternative to the operation of the SRS reactors. TC

DOE has examined the FFTF as an alternative to the SRS reactors as a source of plutonium-238. The FFTF is a modern facility meeting all current safety, security, and environmental requirements. The advantages of the FFTF would be the consolidation of plutonium-238 production and radioisotope thermoelectric generator (RTG) assembly and testing activities at one location; and an assured long-term source of supply for this material beyond the mid-1990s that would not interfere with the production of tritium. TC

The disadvantages of using the FFTF include a substantially higher cost product; this would be due largely to the need to construct new facilities within the FMEF to support plutonium-238 production and encapsulation, which essentially would duplicate facilities already in place at the SRS. Although the SRS facilities are being upgraded, the costs have been largely independent of the decision on a location for plutonium-238 production. The costs of facility upgrades attributable solely to plutonium-238 production and encapsulation at SRS are small (several tens of millions of dollars) in relation to the costs for comparable facilities at the FMEF (more than $120 million). In the absence of other long-term users of the FFTF, the entire operating cost of this reactor (about $115 million per year) would be associated with plutonium-238 production; in comparison, the production of plutonium-238 in the SRS reactors would not result in additional operating costs above those for defense materials production. TE

As indicated in Section 1.1.1, requirements for plutonium-238 for a classified Navy mission and for the National Aeronautics and Space Administration's Comet
TE | Rendezvous and Asteroid Flyby and Cassini projects in the early to mid-1990s can be met only by production from K-, L-, and P-Reactors. Facility construction and modification required at the FFTF and FMEF to support plutonium-238 production and encapsulation would not permit production at that site earlier than mid-Fiscal Year 1994.

An additional consideration is the difference in the level of plutonium-236 impurity provided by the production processes at SRS and FFTF. This nuclide, decay products of which emit energetic gamma rays that can affect sensitive instruments on spacecraft and increase personnel radiation exposure, during manufacturing and ground handling operations is present at an average of about 1.3 parts per million in plutonium-238 produced at SRS due to the neutron spectrum in the heavy-water-moderated reactors; irradiation tests at FFTF have demonstrated that an impurity level of about 5.5 parts per million of plutonium-236 would be present at reactor discharge in the plutonium-238 from that reactor. These impurity levels are too high and would require additional decay time of 1 to 2 years or blending with older material to reduce the plutonium-236 content to the 2-parts-per-million specification range. In some mission requirements, the plutonium-236 level must be below 1 part per million.

In view of the considerations of cost, schedule, and product purity, the production of plutonium-238 at FFTF/FMEF is not considered a reasonable alternative.

2.4.5 OTHER TECHNOLOGIES

Theoretically, technologies other than fission reactors could be used to produce tritium. Such technologies include linear particle accelerators, thermonuclear (i.e., fusion) reactors, and catalytic-cryogenic separation of tritium from contaminated light- or heavy-water streams.

The linear accelerator process would be energy-intensive, requiring an estimated input of about 900 megaWatts of electrical power (compared to 175 megaWatts for the three SRS reactors); this technology is not fully developed, and would require more than 10 years to complete the necessary research, development, design, and construction efforts before tritium production could
TC | be planned (ERAB, 1990). Due to the considerable technological uncertainties and the high research and development costs required to ensure successful demonstration and operation of an accelerator for the production of tritium, the use of accelerators would not provide DOE with the capability to meet its near-term tritium requirements; therefore, this is not considered a reasonable alternative to the proposed action.

Thermonuclear reactors do not currently exist, and their feasibility remains to be demonstrated. Similarly, although the process of separating tritium from aqueous solutions has been demonstrated on a small scale, the adequacy of
TC | the available feedstock for a larger scale production operation is in question. DOE considers these alternatives to be speculative and unreasonable as tritium production alternatives to the proposed action.

2.4.6 CONVERSION OF MATERIAL FROM COMMERCIAL NUCLEAR REACTORS

Nuclear materials could be produced directly in existing light-water reactors, or separated isotopically from high-assay plutonium in existing spent fuel from light-water reactors. Although the law that prohibits the conversion of special material in spent fuel from NRC-licensed reactors to nuclear explosive uses (P.L. 97-415) does not specifically prohibit the production of tritium in commercial nuclear reactors (because tritium is considered a byproduct and not special nuclear material), the production of tritium for defense purposes in commercial nuclear reactors would be contrary to the long-standing national policy to separate the commercial nuclear reactor program from the nuclear weapons production program. The use of commercial nuclear reactors for defense purposes could cause other countries to question U.S. nonproliferation policy. Due to the institutional barriers discussed above, DOE does not consider production of defense nuclear materials in commercial nuclear reactors to be a reasonable alternative to the proposed action.

2.4.7 ACQUISITION OF NUCLEAR MATERIALS BY OTHER MEANS

DOE has considered the purchase of tritium from other sources, including foreign nations. Conceptually, the purchase of tritium from foreign governments could provide a fraction of the tritium requirement. However, it is contrary to national security policy to be dependent on foreign governments for the supply of defense nuclear materials. Based on the uncertainty associated with obtaining tritium from foreign sources, considering national security policy, the purchase of defense nuclear materials from foreign governments is not considered to be a reasonable alternative to the proposed action. TC

2.5 SUMMARY OF ENVIRONMENTAL IMPACTS OF ALTERNATIVES

This section and Table 2-3 summarize the following alternatives and their impacts:

1. Continue to operate K-, L-, and P-Reactors at SRS to produce nuclear materials (preferred alternative). Under this alternative, DOE would continue to operate K-, L-, and P-Reactors, over a wide range of production capability, as necessary to meet nuclear material production needs. DOE would schedule production runs and outages for these reactors to meet needs based on the then-current NWSM and other mission needs. DOE would also continue to implement safety and environmental enhancements. This is also the No-Action Alternative. TC

2. Terminate operation of one or two reactors at SRS in the immediate future and maintain in cold standby. This alternative involves the examination of six combinations.

3. Terminate operation of K-, L-, and P-Reactors in the immediate future and maintain in cold standby. This alternative examines the effects of terminating operation and maintaining all three reactors in cold standby. The effects are described for each reactor where different, and shown as a total effect where the differences are minimal.

The alternative of other production options to K-, L-, and P-Reactor operation was considered but not analyzed in detail because, as explained in Section 2.4, no other production options are considered to be reasonable alternatives.

The proposed action (continuing to operate K-, L-, and P- Reactors) would cause the following effects:

- Impingement and entrainment impacts on fish, fish eggs, and larvae
- Thermal discharges to Par Pond and L-Lake
- TC Thermal impacts to Pen Branch (until the completion of the cooling tower)
- Reactor disassembly-basin purge water discharges to L- and P-Reactor seepage basins and the K-Reactor containment basin
- Wetlands losses in Steel Creek and Pen Branch corridors and delta areas of the swamp

Aquatic impacts would be due primarily to thermal and high stream flow conditions. Chemical impacts on aquatic systems would be minor; L-Lake shows evidence of eutrophication as a result of nutrient enrichment from Savannah River water. Anoxic conditions develop seasonally in the L-Lake hypolimnion, a condition typical of lakes and reservoirs in the southeast United States. Fish kills due to high temperatures would occur in upper L-Lake and in Pond C of Par Pond on resumption of L-Reactor and P-Reactor operation, respectively; TC fish kills caused by high temperatures on startup would occur in Pen Branch due to the resumption of operation of K-Reactor without the cooling tower. Offsite radiation doses from normal operation would be well within applicable DOE and U.S. Environmental Protection Agency (EPA) radiation standards. TC Accident risks are listed in Table 2-3.

DOE has estimated the differences in impacts of operation of K-, L-, and P-Reactors at reduced power levels, and has identified three major changes in impacts:

- Reduced atmospheric releases and lower radiation doses to the maximum exposed individual and the population within 80 kilometers of SRS.
- Reduced temperature in reactor cooling water discharges (flow rates TC remain the same), resulting in fewer aquatic impacts.
- A lower concentration of radionuclides in discharges to reactor seepage basins, yielding reduced impacts on SRS groundwater (WSRC, 1989c,d,e).

Changes in impacts to other environmental elements resulting from operation at reduced power levels would not occur, be insignificant, or diminish, but not linearly so, with power level (WSRC, 1989c,d,e). Full-power reactor operation bounds the impacts of reduced power operation.

The environmental consequences of terminating operation of one or two reactors at SRS are given for the individual reactors if differences in these consequences are more than minimal. Table 2-3 summarizes these impacts by reactor. Table 2-2 identifies subsections in Sections 4.1 and 4.3 that describe these impacts for each reactor. TC

The Termination alternative, which places K-, L-, and P-Reactors in cold standby, would result in the loss of about 9,600 jobs at SRS in the reactor areas and nonoperating support facilities; about 100 permanent and part-time workers would be required to maintain the three reactors on standby.

Impingement/entrainment impacts would be reduced by approximately 80 to 90 percent. Withdrawal of Savannah River water at a maximum rate of about 3.0 cubic meters per second would be required to maintain access by fish to Steel Creek for spawning. Radiation doses from reactors would diminish by at least 1 order of magnitude, as would the generation of hazardous, mixed, or radioactive waste. Severe accident risk would be eliminated. There would be no additional impacts to wetlands; previously impacted wetlands would continue to revegetate. TC

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CHAPTER 3

AFFECTED ENVIRONMENT

This chapter describes existing socioeconomic and environmental characteristics of the Savannah River Site (SRS) and the nearby region. Its purpose is to support the assessment of the environmental consequences discussed in Chapter 4.

The SRS is in southwestern South Carolina near the Savannah River, which borders Georgia. It encompasses approximately 800 square kilometers (198,737 acres) within the Atlantic Coastal Plain physiographic province. Figure 3-1 shows the location of the Site in the South Carolina-Georgia region.

Since 1951, the SRS has been a defense facility for the U.S. Department of Energy (DOE) and its predecessor agencies. It is a controlled area with public transit limited to through traffic only on S.C. Highway 125, U.S. Highway 278, SRS Road 1, and the CSX Railroad corridors.

The Atomic Energy Commission (AEC), a DOE predecessor agency, selected the present location for SRS in November 1950 following a study of more than 100 prospective locations. Criteria used in this selection included the low population density, the accessibility of an adequate cooling water supply, and the low frequency of floods and destructive storms (DOE, 1980). Initial construction of SRS facilities began in February 1951. The first reactor (R-Reactor) began operation in December 1953. TE

Figure 3-2 shows individual SRS facilities, which include five reactors (C-, K-, L-, P-, and R-Reactors), two chemical separations areas (F- and H-Areas), a target and fuel fabrication facility (M-Area), a defense waste processing facility (S-Area), a saltstone facility (Z-Area), and various support facilities. K-, L-, and P-Reactors, the subjects of this environmental impact statement (EIS), are in the south-central portion of the SRS.

The SRS includes portions of Aiken, Allendale, and Barnwell Counties, South Carolina (Figure 3-1). Four population centers - Augusta, Georgia, and Aiken, Barnwell, and North Augusta, South Carolina - are within 40 kilometers of the Site (NUS, 1990). Three small towns, Jackson, New Ellenton, and Snelling, are immediately adjacent to the SRS boundary to the northwest, north, and east, respectively. TC

3.1 HISTORIC AND ARCHAEOLOGICAL RESOURCES

Field studies conducted over the past two decades by the South Carolina Institute of Archaeology and Anthropology, University of South Carolina, under contract with DOE, have provided considerable knowledge of the distribution and content of archaeological and historic resources on the SRS (Sassaman et al., 1989). There are no known archaeological resources within the K-, L-, and P-Reactor areas (Section 2.1.2.2). Construction activities associated with the reactor areas would have destroyed any historic and archaeological evidence during the 1950s. TE TE

3.2 SOCIOECONOMIC AND COMMUNITY CHARACTERISTICS

This section summarizes the socioeconomic characteristics of demographics, employment and income, and land use in the region; it is based on a comprehensive characterization of the socioeconomic and community
TC | characteristics around the SRS (NUS, 1990). The operation of K-, L-, and P-Reactors has had a major influence on these characteristics, and this section establishes a baseline for predicting the socioeoconomic impacts of terminating K-, L-, and/or P-Reactor operation (i.e., alternatives discussed in this EIS).

3.2.1 PAST IMPACTS OF THE SAVANNAH RIVER SITE

The socioeconomic impacts of the Savannah River Site on the people and communities in its vicinity began in 1951 with the relocation of the resident population from the Site and construction of the first facilities. In 1952, the construction workforce peaked at 38,500 people. Populations of nearby towns increased, and the number of trailer courts and new homes increased rapidly (Chapin et al., 1954).

Since completion of the initial construction at the SRS, its primary socioeconomic impact has been the creation of a large number of permanent jobs. The permanent operating and construction workforce has ranged from 6,000 in the 1960s to 18,635 people in May 1989. About 92 percent of the workforce is employed by Westinghouse Savannah River Company and its subcontractors; the remaining 8 percent is employed by Wackenhut Services, Inc. (982), the Department of Energy (383), the University of Georgia (141), and the U.S. Forest Service (25).

The greatest impact of the SRS has been on Aiken County, especially on the Cities of Aiken and North Augusta, and the small towns immediately adjoining the Site. Table 3-1 lists the distribution of current SRS workers by place of residence, the latest population estimates for each county and selected city, and the percentage of the SRS workforce living in each jurisdiction.

TE | 3.2.2 SITE IMPACT AREA

TC | At present, approximately 93 percent of SRS employees reside in a 13-county area surrounding the Site; nine of these counties are in South Carolina and four are in Georgia. Approximately 83 percent of the employees reside in the six-county area of Aiken, Allendale, Bamberg, and Barnwell Counties in South Carolina, and Columbia and Richmond Counties in Georgia (Figure 3-3). Because changes in employment related to reactor operation would affect current employees or attract new workers who are likely to reside in a distribution similar to that listed in Table 3-1, DOE studied this six-county area to assess potential socioeconomic and community effects. DOE also selected cities in the six counties to evaluate impacts. Table 3-1 lists these cities, which are shown in Figure 3-3.

3.2.3 DEMOGRAPHY

The Site region includes an area within an 80-kilometer radius of the center of the Site and the transient population within a 16-kilometer radius of the

Table 3-1. 1988 Estimated Population in Six-County Area and Distribution of SRS Workforce by Place of Residence (May 1989[a]) | TE

Jurisdiction	1988 Population (est.)	SRS Workforce	Percentage of SRS Workforce[b]
South Carolina			
Aiken County	122,200	9,192	49
Aiken (city)	(19,550)[c]	(4,060)	(22)
Jackson	(2,120)	(533)	(3)
New Ellenton	(3,370)	(486)	(3)
North Augusta	(17,300)	(2,415)	(13)
Allendale County	10,600	303	2
Bamberg County	17,600	328	2
Barnwell County	21,000	1,549	8
Barnwell (city)	(6,100)	(799)	(4)
Other South Carolina	NA[d]	1,463	8
Georgia			
Columbia County	62,500	1,119	6
Richmond County	191,400	3,081	17
Augusta	(44,760)	(2,647)	(14)
Other Georgia	NA	421	2
Other states	NA	337	2
Not responding to survey	NA	842	4
Total	425,300	18,635	100

a. Source: Adapted from NUS, 1990. | TC
b. Based on the total number of employees (18,635).
c. Numbers in parentheses are included in the total county population.
d. NA = not applicable. | TE

center of the Site. The following sections describe the demographic characteristics of the Site region.

3.2.3.1 Six-County Area Population | TC

In 1988, the six-county population was 425,300, up from 376,058 in 1980. Table 3-1 lists the 1988 populations for the six counties and selected cities. The largest cities in this area are Augusta, Georgia, and Aiken and North Augusta, South Carolina. Aiken, Columbia, and Richmond Counties comprise the Augusta Standard Metropolitan Statistical Area (SMSA) as defined by the U.S. Bureau of the Census. In 1988, the estimated total SMSA population was 376,100. In 1980, about three-fourths of the six-county population lived in areas classified as urban by the U.S. Bureau of the Census.

From 1970 to 1980, the population in the six-county area grew by approximately 18 percent. During the same period, South Carolina's growth was 21 percent and Georgia's was 19 percent. The growth from 1980 to 1988 was 13 percent for the six-county area, and 11 percent and 16 percent for South Carolina and Georgia, respectively. TC TC

The most significant population increase occurred in Columbia County, Georgia, which had an average growth rate of about 8 percent per year between 1970 and 1980. The rural counties of the six-county area - Allendale, Bamberg, and Barnwell Counties in South Carolina - experienced population declines between 1960 and 1970, but this trend was reversed between 1970 and 1980 when population increases for these counties ranged from 10 to 16 percent. From 1980 to 1988, changes ranged from a decrease of 2 percent in Bamberg County to an increase of 55 percent in Columbia County. TC

In 1980, the population in the six-county area was slightly younger (median age of 27.6) than the national average (median age of 30.0). In 1984, birth rates in the six-county area were somewhat higher (16.8 births per 1000 persons) than the national averages (15.5 births per 1000 persons). TC

3.2.3.2 Regional Population

In 1980, the estimated population in the Site region (i.e., within 80 kilometers of the center of SRS) was 589,803 people. The estimated population for the year 2000 is 796,356 people. This estimate assumes that the 1970-to-1980 growth rates of each county in the Site region applies the U.S. Bureau of the Census state-level growth-rate projections to the 1980 estimated population (NUS, 1990). TC TC

3.2.3.3 Transient Population

The transient population includes people who are at a specified location, other than their normal residences, for short periods of time and could potentially be affected by accidental releases from reactor operations. This includes people at industrial plants, schools, churches, hospitals, prisons, military and airport installations, and recreational centers. The transient population within 16 kilometers of the center of the Site includes the SRS workforce; the current (December 20, 1989) workforce of 1,270 at the Vogtle Electric Generating Plant in Burke County, Georgia; and about 300 personnel working for Chem-Nuclear Systems, Inc., in Barnwell County, South Carolina. The Barnwell Nuclear Fuel Plant, which is owned by Allied General Nuclear Services, and Carolina Metals, Inc., are also in the Site region and maintain small work forces.

Recreational hunting and camping account for about 10,000 visitor-days per year within a 24-kilometer radius of the center of the SRS. Travelers crossing the Site on U.S. Route 278, S.C. Highway 125, and SRS Road 1, and on the CSX Railroad add about 20,800 person-days per year to the 16-kilometer transient population.

3.2.4 LAND USE

The Site region contains approximately 20,341 square kilometers. Table 3-2 lists the distribution of land use within the Site region.

Table 3-2. Land Use Within the Site Region

Land Use	Percent
Savannah River Site	4.0
Pine Forest and Forested Wetland	50.5
Nonforested Wetland and Water	3.3
Agriculture, Grasslands, and Bare Soil	40.7
Urban Areas	1.5

Source: NUS, 1990.

3.2.5 ECONOMY

In 1988, the largest segment of nonfarm employment in the six-county area was governmental services, which represents 25 percent of the workforce. Manufacturing constitutes the largest nonfarm employment category in each county except Richmond and Columbia Counties, where government is the largest employment category.

Employment levels in the six-county area have increased in recent decades as both the total labor force and participation rates have increased.

Incomes per capita in Aiken, Columbia, and Richmond Counties were the highest in the six-county area. In 1986, the per capita income for the six-county area ($13,145) was 17 percent below the national average ($15,763); the other counties were 28 percent to 46 percent below the national average.

The SRS has contributed substantially to the rise in the standard of living in the Site region. The Fiscal Year (FY) 1989 SRS operating budget was $3.2 billion, and the FY 1990 budget is nearly $3.7 billion.

The socioeconomic region of influence consists of four counties in South Carolina and two in Georgia. A comparison of the standard of living, housing rents and values, and inflation rate in the region of influence to those of South Carolina, Georgia, and the United States indicates that the region of influence is similar to or slightly below these areas.

The SRS operating budget pays for labor, materials, and equipment. DOE estimates that 15 percent of total costs are for materials, 75 percent for labor, and the remainder for equipment. For a large manufacturing complex, the labor and materials expenditures generally go into the local economy; equipment is purchased from outside the local area. Labor expenditures need

to be adjusted for taxes, social security withholding, and savings; this usually amounts to about 30 percent of total payroll. Thus, a general estimate of the percentage of the SRS budget going into the local-area economy is approximately 70 percent.

The delivery of public services is driven by the number of people served, and the level of service acceptable by those served. If a community maintains a balanced budget and has a stable population and economy, revenues should equal expenditures. If the P-, K-, and L-Reactors resume production, no changes at SRS should impact the fiscal structures of the counties, cities, and school districts. Thus, the existing relationship between demand for services and revenues for SRS employees and their families would not change. If there are changes in the workforce, corresponding changes can be assumed to occur in the local communities. L-48-14

3.3 GEOLOGY, HYDROLOGY, AND SEISMOLOGY

This section describes the geologic, hydrogeologic, and seismologic features of the SRS that influence both the safety and environmental impacts of reactor operation.

3.3.1 GEOLOGY

This section describes the geologic setting of the SRS and the formations that comprise that setting. Volume I of the Reactor Operation Environmental Information Document (EID; WSRC, 1989a) provides detailed geologic information on the SRS reactor areas.

The SRS is on the Aiken Plateau of the Upper Atlantic Coastal Plain about 40 kilometers southeast of the Fall Line that separates the Atlantic Coastal Plain and the Piedmont provinces (see Figure 3-4). The Aiken Plateau is underlain by southeast dipping layers of sands, clays, and limestone that lie on top of a harder, older "basement."

The northern part of the SRS has a basement consisting of crystalline rock greater than 230 million years old. The southern part has a basement consisting of 140- to 230-million-year-old sandstones, siltstones, claystones, and conglomerates. The two types of basement are separated by a fault. Neither type has much effect on the groundwater of the SRS.

The upper layers are between 35 and 100 million years old and are between 200 and 400 meters thick in the vicinity of the SRS; Figure 3-5 shows the depths and thicknesses of the layers. The many formations that make up the layers can be grouped into several different permeable zones (aquifers) separated by mostly impermeable clay layers (aquitards). Volume I of the Reactor Operation EID (WSRC, 1989a) provides detailed information on the thickness and permeability characteristics of these features.

The bottom-most layer is the Cape Fear Formation, which consists of silty to clayey sands and interbedded clays. The aquifers on top of the Cape Fear Formation consist of the Middendorf, Black Creek, and Pee Dee Formations. The

clay layer in the middle of the Black Creek Formation divides this aquifer into what are known as the Lower Cretaceous and Upper Cretaceous Aquifers. This aquifer is capped by the Rhems, Williamsburg, and lower Fishburne Formations which contain considerable clay throughout and make up a water-confining zone.

The upper part of the Fishburne Formation and the Congaree Formation make up a second aquifer beneath the SRS consisting of clean sands. A thin continuous clay layer called the "green clay" at the bottom of the overlying Santee Limestone Formation is the cap for this aquifer. The "green clay" overlies the Congaree and is continuous over most of SRS; it varies in thickness, but is no thicker than 3 meters. The rest of the Santee Limestone Formation is composed of quartz sand, limestone, and calcareous clay. The Clinchfield Formation made of silty sand, the Dry Branch Formation made of carbonates and sand with thin clay layers, and the Tobacco Road Sand Formation made of sand with thin clay layers comprise a thick zone that is locally water-bearing. Figure 3-5 does not show the Clinchfield Formation, which has not been mapped on a sitewide basis; however, this formation has been identified at several locations on SRS, including the reactor areas. On top of the Tobacco Road Sand Formation in some areas of the SRS is the Upland Unit, which consists of silty sands and lenses of conglomerates and clays.

3.3.2 SEISMOLOGY

This section describes the geologic structures in the SRS region, and the Site's susceptibility to earthquakes. Seismic events are an important factor in the assessment of the consequences and risks associated with postulated reactor accidents in Chapter 4.

3.3.2.1 Geologic Structures

The Blue Ridge, the Valley and Ridge, and the Piedmont provinces, all of which are associated with the Appalachian Mountain building episodes (see Figure 3-4), contain several fault systems that are located northwest of the Fall Line. The closest offsite fault system of significance is the Augusta Fault Zone, approximately 40 kilometers from the SRS. In this fault zone, the Belair Fault has experienced the most recent movement, but it is not considered capable of generating major earthquakes (Case, 1977). There is no conclusive evidence of recent displacement along any fault within 300 kilometers of the SRS, with the possible exception of the buried faults in the epicentral area of the 1886 Charleston earthquake (which occurred approximately 145 kilometers from the Site) (Lyttle et al., 1979; Behrendt et al., 1981; Talwani, 1982; Du Pont, 1982a; Hamilton, Behrendt, and Ackermann, 1983). An onsite exception includes possible strike-slip or reverse motion on the fault associated with the Dunbarton Basin (Stephenson, Talwani, and Rawlins, 1985).

Several Triassic-Jurassic basins, 140 to 230 million years old, have been identified in the Coastal Plain province of South Carolina and Georgia. The Dunbarton Triassic Basin, which is under the SRS, was formed by the normal fault movement along a northeast-trending zone of weakness. After infilling, deposition, and erosion of Triassic sediments, possible reverse movement

occurred along this fault during the Late Cretaceous. A recent study cites three other faults in the area, two transverse and one now called the Pen Branch Fault, which closely parallels and might coincide with the Dunbarton Fault. Geophysical data indicate minimal vertical movement along the transverse fault but possible reverse fault motion along the Pen Branch Fault (Chapman and DiStefano, 1989). TC

Investigations to date indicate that the Pen Branch Fault is at least 32 kilometers long (Snipes, Fallaw, and Price, 1988) and runs almost parallel to and might, in part, coincide with the previously known border fault of the Dunbarton Basin. The maximum vertical displacement of the fault is on the order of 30 meters near the base of the Coastal Plain sediments. The sense of movement of the fault however is not yet fully understood. At depth, the Pen Branch Fault offsets geologic stratum of Cretaceous and Tertiary age suggesting intermittent movement from 90 to 35 million years before the present. The date of the last movement on the Pen Branch Fault has not been determined. The Pen Branch Fault investigation program now under way is designed to address fault capability according to U.S. Nuclear Regulatory Commission (NRC) reactor siting criteria (10 CFR 100, Appendix A). Under these criteria, a fault is considered capable if it has moved within the last 35,000 years, has recurring movement within the last 500,000 years, has any earthquake activity related to it, or is associated with another capable fault. The current investigation program is designed to characterize the Pen Branch Fault in terms of dimensions, regional geologic relationships, and magnitude and history of movement. The program consists of well drilling, shallow seismic reflection surveys, and trenching. TC

Surface mapping, subsurface boring, and geophysical investigations on the Site have detected several other surficial faults. These faults are generally less than 300 meters long with displacements of less than 1 meter (Du Pont, 1980). The relationship of these features to the Pen Branch Fault and their capability is being investigated under the Pen Branch Fault investigation program. TC

3.3.2.2 Seismicity

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

Within the SRS boundary, two earthquakes have occurred during recent years. On June 8, 1985, an earthquake with a local magnitude of 2.6 and a focal depth of 0.96 kilometer occurred on the Site. The epicenter was just to the west of the C- and K-Areas. The acceleration produced by the earthquake did not activate instrumentation in the reactor areas (detection limits of 0.002g).

On August 5, 1988, an earthquake with a local magnitude of 2.0 and a focal depth of 2.68 kilometers occurred on the Site. Its epicenter was just to the northeast of K-Area. Although the 1988 earthquake was not felt onsite, it was recorded by sensors within 100 kilometers of the Site.

Figure 3-6 shows the locations of these two earthquakes in relation to the Dunbarton Basin border fault and associated features. A report on the August 1988 earthquake (Stephenson, 1988) reviewed the latest earthquake history. This report predicts recurrence rates of 1 year for a magnitude 2.0 earthquake for the southeast coastal plain. However, the report notes that historic data to calculate recurrence rates accurately are sparse.

3.4 WATER RESOURCES

The use and quality of water resources are affected by reactor operation. This section describes the surface- and subsurface-water resources of the SRS.

3.4.1 SURFACE-WATER RESOURCES

This section describes the features and quality of the surface-water bodies on or adjacent to the SRS.

3.4.1.1 Surface-Water Systems

The Savannah River is the principal surface-water system near the Site. The river adjoins the Site along its southwestern boundary. The total drainage area of the river, 27,388 square kilometers, encompasses all or parts of 41 counties in Georgia, South Carolina, and North Carolina. More than 77 percent of the drainage area is upriver of the Site (Lower, 1985). On the Site, a swamp lies in the floodplain along the river for a distance of about 16 kilometers. The average width of the swamp is about 2.4 kilometers.

The SRS contains six principal streams: Upper Three Runs Creek, Beaver Dam Creek, Fourmile Branch, Pen Branch (including its tributary, Indian Grave
TE Branch), Steel Creek (including its tributary, Meyers Branch), and Lower Three Runs Creek (Figure 3-7). Pen Branch flows into Steel Creek before reaching the Savannah River. These streams rise on the Aiken Plateau and descend 30 to 61 meters before discharging into the river. DOE utilizes three of these
TC streams - Pen Branch, Steel Creek, and Lower Three Runs Creek - as receiving streams for cooling water discharges from K-, L-, and P-Reactors, respectively.

3.4.1.2 Surface-Water Hydrology

3.4.1.2.1 Savannah River

Five large reservoirs upriver of the Site - J. Strom Thurmond (formerly Clarks Hill), Richard B. Russell, Hartwell, Keowee, and Jocassee (Figure 3-8) - regulate the streamflow in the Savannah River (COE, 1989; Duke Power Company, 1977). The operation of these reservoirs and the New Savannah River Lock and Dam at Augusta has stabilized river flows near Augusta; the average annual flow for the 81-year period of record is 283.9 cubic meters per second (Figure 3-8; Bennett et al., 1989).

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 (DOE, 1984). Since the mid-1950s, three severe droughts (1954-1956; 1980-1981; 1985-1988) have occurred in the southeastern United States (SAIC, 1989). The most recent drought is considered the worst on record; inflows to the river during this period are the lowest recorded during this century (COE, 1989).

Average river flows recorded at Augusta during 1981 and 1982 were markedly lower than the historical mean; the mean value for 1981 (197 cubic meters per second) was, at that time, the lowest since the very dry year of 1955 (193 cubic meters per second; SAIC, 1989). During Water Years (October 1 through September 30) 1985 through 1988, mean annual river discharges at Augusta have averaged 183 cubic meters per second (range: 107-759 cubic meters per second) (Bennett et al., 1986; Bennett et al., 1987, 1988, 1989; SAIC, 1989).

During the recent drought, the U.S. Army Corps of Engineers (COE) maintained minimum water releases from the Thurmond Dam based on water use requirements of downstream users, primarily the Savannah River Site (SAIC, 1989). Low-flow tests during 1980 and 1981 established minimum river flow requirements of 138 TC and 117 cubic meters per second at the Site to enable pumping of cooling water for three- and two-reactor operation, respectively. Maintaining these flows requires a discharge from Thurmond Dam of 102 cubic meters per second. Maintaining water quality and managing fish and wildlife resources downstream requires flows at Augusta of at least 127 cubic meters per second (COE, 1989). Mean monthly river flows at Augusta were close to this value during October and November 1986 and were lower during the spring, summer, and fall of 1988 (SAIC, 1989).

Beginning in 1986, the COE began developing a strategy and plans to address the worsening water-shortage conditions in the Savannah River Basin; this effort has resulted in the Savannah River Basin Drought Contingency Plan (COE, 1989). One of the primary objectives of the plan is to operate Thurmond Dam at water-release levels of no less than 102 cubic meters per second to meet downstream water requirements. This plan would maintain river flows required for the maintenance of downstream water quality and for the management of fish and wildlife resources as long as possible without jeopardizing water supplies.

The peak historic flood for the 81-year period of record was 9,910 cubic meters per second in 1929 near Augusta (Bennett et al., 1989). Since the construction of the upstream reservoirs, the maximum average monthly flow has been 1,242 cubic meters per second for the month of April (1964-1981; DOE, 1984).

3.4.1.2.2 Pen Branch

The only significant tributary to Pen Branch is Indian Grave Branch, which flows into Pen Branch about 8 kilometers upstream from the swamp (Du Pont, 1987a; see Figure 3-7). Pen Branch enters the swamp about 5 kilometers from the river, and flows parallel to the river before discharging into Steel Creek about 0.8 kilometer from its mouth.

Pen Branch and Indian Grave Branch drain about 56 square kilometers of watershed upstream from the swamp. Indian Grave Branch receives the effluent cooling water from K-Reactor. Upstream of K-Area discharges, Indian Grave Branch flow averages about 0.03 cubic meter per second. Pen Branch is also a small stream at its confluence with Indian Grave Branch, with an average natural flow of 0.1 to 0.3 cubic meter per second (Du Pont, 1987a). TC

K-Reactor presently withdraws approximately 11.3 cubic meters of water per second from the Savannah River. This flow passes through a supply reservoir (186-Basin) and the reactor heat exchangers, and discharges down Indian Grave Branch and Pen Branch back to the river. K-Reactor discharges approximately 11.3 cubic meters of reactor cooling water per second; this flow includes 10.5 to 10.9 cubic meters per second from the reactor heat exchangers and 0.3 to 0.6 cubic meter per second of service water and other flows.

In addition to reactor cooling water effluents from K-Area, discharges to Pen Branch and Indian Grave Branch include nonprocess cooling water, ash basin effluent waters, powerhouse wastewater, waste treatment plant overflow, reactor process wastewater, and sanitary wastewater, all of which are associated with K-Area operation. TC

Since November 1976, the U.S. Geological Survey (USGS) has maintained a flow recorder on Pen Branch at SRS Road A-13.2 (see Figure 3-7). From 1976 to 1982, the flow at this station ranged from a minimum of 0.6 cubic meter per second during a K-Reactor outage to a maximum of about 27 cubic meters per second during K-Reactor operation and a simultaneous heavy precipitation event. TE

During Water Years 1985 to 1988, the stream flow measured in Pen Branch at SRS Road A-13.2 averaged 8.2 cubic meters per second, with individual measurements ranging from 0.6 to 14.8 cubic meters per second. Flow rates measured in Pen Branch upstream of the influence of reactor cooling water discharge (at SRS Road B) during this period averaged 0.2 cubic meter per second, with individual values ranging from 0.02 to 6.4 cubic meters per second (Bennett et al., 1986; Bennett et al., 1987, 1988, 1989).

3.4.1.2.3 Steel Creek and L-Lake

Steel Creek flows southwest, enters the Savannah River Swamp, and then flows approximately 3 kilometers before discharging into the river (Du Pont, 1987a; see Figure 3-7). In the swamp, it joins the flow from Pen Branch and part of the flow from Fourmile Branch.

The drainage area of Steel Creek and its main tributary, Meyers Branch, covers about 90 square kilometers. Historically, Steel Creek received cooling water discharges from P- and L-Reactors. P-Reactor discharges have been rerouted to Par Pond. Steel Creek currently receives cooling water discharges from L-Reactor via L-Lake. TC

DOE constructed L-Lake on Steel Creek in 1985 to receive and cool the thermal effluent from L-Reactor (Du Pont, 1988b). The construction of the dam impounded approximately 7.2 kilometers of the upper portions of Steel Creek (Figure 3-7). Dam construction and reservoir filling were complete in October 1985, and L-Reactor resumed operation at the end of that month.

The width of L-Lake averages about 600 meters, reaching a maximum of about 1,200 meters. The normal pool elevation of the lake is 58 meters. At this elevation, the dam impounds about 31 million cubic meters of water, covering about 1,034 acres.

The L-Reactor secondary cooling system withdraws water from the Savannah River at a rate of approximately 11.3 cubic meters per second. The heated river water discharges into L-Lake through National Pollutant Discharge Elimination System (NPDES) outfall L-007. After passing through L-Lake, cooling water exits through L-Lake Dam and returns to the river through Steel Creek. During normal operating conditions, cooling water flow from the reactor averages approximately 11.3 meters per second. With full reactor coolant flow, discharge from the lake to Steel Creek is maintained at about 11.3 cubic meters per second, except during periods of extreme rainfall. During reactor outages between March and June, which is the spring spawning season, the flow through the dam is controlled to provide a minimum of 3 cubic meters per second, maintaining access by fish to Steel Creek for spawning. During reactor outages in the remainder of the year, flow through the dam is maintained at a minimum of 1.5 cubic meters per second to allow fish to move freely from the base of the dam to the river. The natural flow in Steel Creek provides part of this 1.5-cubic-meter-per-second flow.

Other discharges to Steel Creek come from P- and L-Areas and the Railroad Yard TC| (618-G), which is 2 kilometers east of P-Reactor. These facilities discharge effluents to Steel Creek or to Meyers Branch; the discharges include ash basin effluent water, nonprocess cooling water, powerhouse wastewater, reactor process effluents, sanitary treatment plant effluents, water treatment plant wastewater, and vehicle washwater. Occasionally water is diverted from Par Pond to Steel Creek through NPDES outfall P-013. Since the formation of L-Lake, effluent from outfall P-013 has averaged 0.13 cubic meter per second. Flow in Steel Creek just upstream from L-Lake has averaged 0.17 cubic meter per second since May 1985.

From March 1974 to September 1985, the USGS maintained a continuous-flow recorder on Steel Creek at Old Hattiesville Bridge, which is about 0.8 kilometer above the confluence of the creek with the swamp. From 1974 to 1982, the minimum recorded flow at this station was 0.24 cubic meter per second; the maximum flow was 13 cubic meters per second.

Since March 1985, USGS has measured the stream flow at the point where SRS TC| Road A crosses Steel Creek (see Figure 3-7). In the period since the construction of L-Lake (Water Years 1986-1988), the stream flow in Steel Creek at Road A averaged 7.4 cubic meters per second, with individual measurements ranging from 0.2 to 14.2 cubic meters per second (Bennett et al., 1987, 1988, 1989).

3.4.1.2.4 Lower Three Runs Creek and Par Pond

Lower Three Runs Creek has the second largest watershed of the onsite streams (about 466 square kilometers; Du Pont, 1987a; see Figure 3-7). In 1958, the AEC impounded its headwaters with an earthen dam to form Par Pond (Figure 3-7); the purpose of the pond was to provide cooling for recirculated cooling water for P- and R-Reactors. The pond has three major arms: the north or upper arm, the middle arm, and the south or lower arm, which follow the stream

bed and drainage areas of the upper reaches of Lower Three Runs Creek and its tributaries, Poplar Branch, and Joyce Branch, respectively. The surface area of Par Pond is about 2,640 acres. The pond has an average depth of about 6 meters; the maximum depth near the dam is about 17 meters. From the dam, Lower Three Runs Creek flows for about 32 kilometers to the Savannah River. Several small tributaries rising off the Site flow into the creek in its lower reaches. Volume III of the Reactor Operation EID (WSRC, 1989[c]) describes the surface hydrology of the Lower Three Runs Creek-Par Pond system in detail. TE

Secondary cooling of P-Reactor is provided by a flow of water supplied primarily from Par Pond (Du Pont, 1985a). Water flow from Par Pond to P-Area ranges from 5.9 cubic meters per second to 11.6 cubic meters per second, and averages 9.8 cubic meters per second when P-Reactor is operating. When P-Reactor is not operating, flow from Par Pond has ranged from 0.0 to 11.0 cubic meters per second, and averages 4.8 cubic meters per second. During periods of reactor operation (typically about 72 percent of the year), losses from evaporation, seepage, and overflow from the Par Pond system are compensated by pumping makeup water, at a rate of 1.0 to 1.4 cubic meters per second, from the Savannah River. When the reactor is not operating, approximately 0.6 to 0.8 cubic meter per second of river water is pumped (Wilde and Tilly, 1985). The effluent cooling water flows from the reactor heat exchangers back to the middle arm of Par Pond through 6.8 kilometers of manmade canals and six smaller impoundments, including Pond C. Pond C was constructed at the same time as Par Pond. Between Pond C and Par Pond is the "Hot Dam." At this dam, the reactor cooling water effluent is funneled, under gravity head, from the bottom of Pond C (at 11 meters), entraining and mixing with the cooler water and forming a thermal plume after spreading out at the surface. TE

Since March 1974, USGS has maintained a gauging station on Lower Three Runs Creek (Figure 3-7). From 1974 to 1982, the average flow at this station was 2.6 cubic meters per second. The maximum flow recorded at this station was 20.8 cubic meters per second; the minimum flow was 0.4 cubic meter per second.

During Water Years 1985 to 1988, the stream flow on Lower Three Runs Creek averaged 1.7 cubic meters per second; individual flow measurements for this period ranged from 0.4 to 8.6 cubic meters per second (Bennett et al., 1986; Bennett et al., 1987, 1988, 1989).

3.4.1.3 Surface-Water Quality

In the vicinity of the Site, the Savannah River has the classification of a Class B stream under the South Carolina Water Classification Regulations (SCDHEC, 1989). These regulations broadly define Class B waters as suitable for secondary-contact recreation and as a source of drinking water after conventional treatment according to approved regulatory regimes.

The South Carolina Department of Health and Environmental Control (SCDHEC) classifies SRS streams that are tributaries to the Savannah River as Class B streams. Routine analyses of samples taken since 1973 from onsite stream locations indicate that SRS discharges have complied with Class B water classification standards, with the exception of streams receiving thermal

discharges, which exceed temperature and occasionally are below dissolved oxygen standards.

In July 1983, DOE initiated a 2-year Comprehensive Cooling Water Study (CCWS) to ascertain the effects of thermal discharges on the Savannah River and onsite stream water quality (Du Pont, 1987a). The following sections summarize the water quality of the Savannah River and major onsite streams.

3.4.1.3.1 Savannah River

SRS discharges wastewater into the Savannah River via onsite tributaries under the sitewide NPDES permit. These discharges are primarily thermal effluents, but also include domestic and industrial wastes (Lower, 1985).

The variability of the chemistry of the Savannah River has decreased over the past 20 years, primarily because of improved waste treatment and the stabilized flow provided by upstream dams. The pH of the river has remained slightly acidic. River water is relatively soft and well oxygenated. Water temperatures range from an average winter low of 8°C to more than 24°C during summer months. Table 3-3 compares the mean concentrations of water-quality parameters measured at locations upstream and downstream of the Site from 1983 to 1985. In the vicinity of the Site, South Carolina Class B stream water classification standards are met in the river (Lower, 1985).

River temperatures increase by about 1.0°C over the 18 River Miles between Ellenton Landing near the SRS pumphouses and Millet, South Carolina, below Steel Creek. River temperatures are affected by withdrawal of relatively cold water from the lower levels of Lake Thurmond (hypolimnetic withdrawal). From June 1955 through September 1982, the river temperature at Ellenton Landing upstream of SRS thermal discharges equaled or exceeded 28°C three times and equaled or exceeded 28.3°C once (DOE, 1984).

3.4.1.3.2 Onsite Streams

Data collected from 1983 to 1985 as part of the CCWS indicate that the major factors affecting the water chemistry of onsite streams include a natural chemical gradient (a change in the chemical concentration of water as it flows over and dissolves chemicals from soil, sediments, mineral deposits, or dissolves gases from the atmosphere), thermal and current velocity conditions, addition of Savannah River water for reactor secondary cooling, natural transport and transformation processes, and point-source discharges related to SRS operations (Du Pont, 1987a). Other sources of onsite water-quality data
TE include CCWS annual and final reports (Du Pont, 1985b, 1987a) and the Clean Water Act (CWA) Section 316(a) demonstrations for L-Lake and Par Pond (Du Pont, 1985a, 1988b).

3.4.1.4 Surface-Water Use

Upstream from the Site, the Savannah River supplies municipal water for Augusta, Georgia, and North Augusta, South Carolina (DOE, 1987a). Downstream, the Beaufort-Jasper Water Authority in South Carolina (River Mile 39.2) withdraws about 19,700 cubic meters per day (0.23 cubic meter per second) to supply domestic water for a population of about 51,000. The Cherokee Hill

Table 3-3. Mean Concentrations (except pH) of Water-Quality Parameters Measured in the Savannah River at Locations Upstream and Downstream of the Savannah River Site, 1983-1985[a] | TE

Parameters (units)	Station Location[b]	
	Upstream at RM 158.5[c]	Downstream at Highway 301 Bridge, RM 118.7[c]
Temperature (°C)	17.0	18.0
pH (range; units)	6.2 - 7.7	6.1 - 7.8
Dissolved oxygen (mg/L)	9.6	9.3
Alkalinity (mg/L)	19.0	18.7
Conductivity (µmhos/cm)	77.7	77.0
Turbidity (NTU)[d]	5.0	4.6
Suspended solids (mg/L)	8.9	9.7
Volatile solids (mg/L)	3.0	3.0
Total dissolved solids (mg/L)	59.7	60.7
Total solids (mg/L)	68.7	70.7
Chemical oxygen demand (mg/L)	10.1	10.2
Chlorides (mg/L)	6.2	6.4
Nitrates + nitrites (mg N/L)	0.42	0.37
Sulfates (mg/L)	5.5	5.7
Total phosphates (mg P/L)	0.09	0.11
Aluminum (mg/L)	0.22	0.19
Ammonia (mg N/L)	0.12	0.066
Calcium (mg/L)	5.0	5.1
Copper (mg/L)	0.01	0.01
Cadmium (mg/L)	0.01	0.01
Magnesium (mg/L)	1.24	1.21
Manganese (mg/L)	0.15	0.10
Mercury (mg/L)	0.00017	0.00018
Nickel (mg/L)	0.06	0.06
Sodium (mg/L)	7.8	7.66
Iron (mg/L)	0.48	0.61
Lead (mg/L)	0.01	0.01
Chromium (mg/L)	<0.01	<0.01
Zinc (mg/L)	<0.03	0.024

a. Source: Du Pont, 1987a.
b. For station locations, see Figure 3-8.
c. RM = River Miles measured from the mouth of the Savannah River.
d. NTU = Nephelometric turbidity units.

Water Treatment Plant at Port Wentworth, Georgia (River Mile 29.0), withdraws about 116,000 cubic meters per day (1.35 cubic meters per second) to supply a population of about 20,000 in a business-industrial complex near Savannah,

TE Georgia (DOE, 1987b). Both systems plan plant expansions in the future (i.e., Beaufort-Jasper will supply domestic water to 117,000 people, and Cherokee Hill will supply a domestic equivalent of 200,000 people by the year 2000).

When K-, L-, and P-Reactors and the D-Area Powerhouse are at power, the maximum SRS withdrawal rate from the river is about 28.5 cubic meters per second, primarily for use as cooling water in the production reactors and coal-fired steam plants. Almost all of this water returns to the river via SRS streams; consumptive water use is about 0.85 cubic meter per second at K-Reactor, 1.25 cubic meters per second each at L- and P-Reactors, and about 0.3 cubic meter per second at the D-Area Powerhouse (DOE, 1987b).

Along with the heated SRS cooling water, the river receives sewage treatment plant effluents from Augusta, Georgia, and North Augusta, Aiken, and Horse Creek Valley, South Carolina; and other waste discharges via its tributaries.

In 1987 and 1989, Unit One and Unit Two, respectively, of the Vogtle Electric Generating Plant began operation. Each unit withdraws an average of 1.3 cubic meters per second from the river, primarily for cooling-tower makeup, and returns an average of 0.35 cubic meter per second (NRC, 1985). The Urquhart Steam Generating Station at Beech Island withdraws approximately 7.4 cubic meters per second of once-through cooling water (DOE, 1987b).

Recreational use of impoundments on the Savannah River, including swimming, fishing, and boating water contact recreation, is more extensive upstream than
L-78-74 it is near the Site and downstream. Downstream of SRS, Savannah River water is not used for irrigation.

3.4.2 SUBSURFACE-WATER RESOURCES

This section describes the groundwater units, movement, quality, and use on and near the SRS.

3.4.2.1 Hydrostratigraphic Units

Three distinct hydrogeologic systems underlie the Site: (1) the coastal plain sediments, where groundwater exists in porous sands and clays; (2) the crystalline metamorphic rock beneath the coastal plain sediments, where groundwater exists in small fractures in schist, gneiss, and quartzite; and (3) the Dunbarton Triassic Basin within the crystalline metamorphic complex, where groundwater exists in intergranular spaces in metamudstones and sandstones. The latter two hydrogeologic systems do not serve as groundwater sources at the SRS.

TE The hydrogeologic units used in this document are defined in Volume I of the EID prepared in support of this EIS (WSRC, 1989a). Within the SRS boundaries, the coastal plain sedimentary units involved in the hydrogeologic system are the Tobacco Road, Dry Branch, Clinchfield, Santee Limestone, Congaree, Fishburne, Williamsburg, Rhems, Peedee, Black Creek, Middendorf, and Cape Fear Formations. Table 3-4 lists relationships between the hydrogeologic and stratigraphic units used in this document. The following paragraphs describe the hydrostratigraphic zones.

Table 3-4. Hydrostratigraphic and Stratigraphic Units

Hydrogeologic Unit	Stratigraphic Unit(s)
Water Table	Upland Tobacco Road Dry Branch Formation Clinchfield Formation
"Green Clay" Aquitard	Santee Limestone Formation
Aquifer 2 (Tertiary Age)	Congaree Formation Four Mile Member of Fishburne Formation Snapp Member of Williamsburg Formation
"Ellenton" Aquitard	Ellenton Member of Rhems Formation and 6 meters of Steel Creek Member of Peedee Formation TE
Aquifer 1 (Cretaceous Age)	Steel Creek Member of Peedee Formation Black Creek Formation Middendorf Formation
Base Aquitard	Cape Fear Formation

Aquifer 1, formerly called the Tuscaloosa, consists of the Cretaceous sediments of the Middendorf, Black Creek, and Peedee Formations. This zone forms a prolific groundwater aquifer that is approximately 140 meters thick. Wells in this aquifer can yield as much as 4 cubic meters of water per minute.

The "Ellenton" Aquitard, a zone that restricts the flow of groundwater, caps Aquifer 1, and is composed of the uppermost section of the Peedee Formation and the lower sections of the Rhems Formation. This aquitard is approximately 15 meters thick and is believed to form the principal confining zone beneath the Site based on an elevation of head differences (the elevation of the free-standing groundwater above sea-level datum) and other hydraulic properties. This confining layer restricts the downward movement of water into the sands of Aquifer 1.

Aquifer 2, which overlies the "Ellenton" Aquitard, consists of the Williamsburg, Fishburne, and Congaree Formations. Wells in this aquifer can yield up to 0.4 cubic meter of water per minute.

Overlying Aquifer 2 is the "Green Clay" Aquitard. This aquitard primarily consists of the clay-rich, fine-grained sands of the Santee Limestone Formation. This layer is continuous over most of the Site and thickens toward

the southeast. The "Green Clay" Aquitard, where present, can locally be a barrier to vertical groundwater flow between aquifers. For example, this aquitard supports a large head difference of approximately 17 meters between TE |Aquifer 2 and the water table in the central part of the Site (DOE, 1987a).

The water table lies within the Clinchfield, Dry Branch, and Tobacco Road Formations and the "Upland Unit," 10 to 30 meters beneath the surface at the SRS. This aquifer consists primarily of fine-to-coarse sands and sandy clays and ranges from 0 to 27 meters in thickness. The high clay content of this unit restricts the production capacity of wells; therefore, the aquifer accommodates only domestic wells of low production (Scott et al., 1987; Root, 1983; Du Pont, 1983a).

In the central portion of the Site, the head in Aquifer 1 is higher than that of Aquifer 2. This relationship prevents the downward movement of water from Aquifer 2 to Aquifer 1.

3.4.2.2 Groundwater Movement

The water table on the Site is recharged primarily by precipitation, which moves through the formations in a predominately vertical direction at a rate of approximately 0.9 to 2.1 meters per year (Haskell and Hawkins, 1964). The lower formations are also partially recharged by flow from offsite areas. Natural flow directions in the aquifer are toward discharge points at the Savannah River tributaries, specifically Upper Three Runs Creek, Fourmile Branch, Pen Branch, and Indian Grave Branch (a tributary of Pen Branch).

Aquifer 2 is recharged in offsite outcrop areas updip and by seepage from the overlying formations on the Site. Natural flow directions in this aquifer are from the recharge areas toward discharge points at the wetlands along Upper Three Runs Creek and the Savannah River.

Aquifer 1 is recharged in offsite outcrop areas near the Fall Line in Aiken County and through the overlying sediments north and west of Upper Three Runs Creek. Natural flow direction in this aquifer is toward its discharge point in the wetlands along the Savannah River. Under the Site, the direction of groundwater movement in these formations is southwest toward the Savannah River valley.

The groundwater near the Savannah River and onsite streams is diverted toward low hydraulic head areas caused by natural discharge to the surface water. Each stream dissects the hydrogeologic units differently: the smaller streams become natural discharge points for groundwater in the water table; the Savannah River tributaries are discharge points for Aquifer 2; and the Savannah River is the discharge point for groundwater in the deeper Aquifer 1. Thus, discrete groundwater subunits are created, each with its own recharge and discharge areas.

3.4.2.3 Groundwater Quality

A substantial amount of groundwater data has been generated from SRS monitoring wells over the past several years. Data from groundwater sampling since 1982 were reported in Technical Summary of Groundwater Quality

Protection Program at Savannah River Plant (Christensen and Gordon, 1983); the SRP Environmental Reports for 1985, 1986, and 1987 (Zeigler, Lawrimore, and Heath, 1986; Zeigler et al., 1987; Mikol et al., 1988); and in the 26 EIDs prepared for the Final Environmental Impact Statement, Waste Management Activities for Groundwater Protection Savannah River Plant, Aiken, South Carolina (DOE, 1987a).

3.4.2.4 Groundwater Use

Aquifer 1, which becomes shallower towards the Fall Line, forms the base for most municipal and industrial water supplies in Aiken County. Toward the coast, in Allendale and Barnwell Counties, Aquifer 1 exists at increasingly greater depths. Consequently, the shallower Aquifer 2 supplies some municipal, industrial, and agricultural users. Aquifer 2 and the water table are the primary sources for domestic water supplies in the vicinity of the Site.

DOE (1987a) has identified 56 major municipal, industrial, and agricultural groundwater users within 32 kilometers of the center of the Site. The total pumpage for these users is about 135,000 cubic meters per day. TC

The Talatha community in South Carolina is the closest user of a public water supply to the Site (about 11 kilometers north of the center of the Site near New Ellenton). Talatha uses about 480 cubic meters per day. The town of Jackson, South Carolina, about 16 kilometers northwest from the center of the Site, pumps about 1,070 cubic meters per day. The town of New Ellenton, South Carolina, about 13 kilometers north of the center of the Site, pumps about 1,360 cubic meters per day. Of the total municipal pumpage (52,605 cubic meters per day), Aquifer 1 supplies 34,270 cubic meters; the remainder (about 18,335 meters per day) comes from Aquifer 2. Total industrial/agricultural pumpage from Aquifer 1 is about 71,940 cubic meters per day; this includes 38,550 cubic meters per day drawn by the Site.

3.5 METEOROLOGY AND CLIMATOLOGY

Meteorology is an important factor in the assessment of the consequences of postulated reactor accidents. This section describes the meteorology of the SRS based on data collected on the Site, and at Bush Field in Augusta, Georgia (Du Pont, 1980, 1982b; NOAA, 1988). A recent report (WSRC, 1989c) was a primary source of the information in this section. TE

3.5.1 REGIONAL CLIMATOLOGY

The SRS area has a temperate climate with mild winters and long summers. The region is subject to continental influences, but is protected from the more severe winters in the Tennessee Valley by the Appalachian Mountains to the north and northwest. Gently rolling hills with no unusual topographical features that would significantly influence the general climate characterize the Site and the surrounding area.

3.5.2 LOCAL METEOROLOGY

3.5.2.1 SRS Meteorological Monitoring System

The data summarized in this section were collected from instrumentation on a network of seven towers located adjacent to each SRS production area. These instruments were 62 meters above the ground (WSRC, 1989c).

3.5.2.2 Average Wind Speed and Direction

The average wind speed, from onsite data, from 1982 to 1986 was 3.25 meters per second. Hourly wind speeds less than 2 meters per second occurred about 9 percent of the hours. For about half of the hours, wind speeds were less than
TE 4 meters per second. From 1975-1979 onsite data, the average speed was greatest during the winter (3.35 meters per second) and least during the summer (2.48 meters per second). The average wind speed for Augusta, from data collected from 1951 through 1986, was 2.9 meters per second. The highest monthly average wind speed occurred in March (3.6 meters per second); the lowest monthly average speed occurred in August and September (2.5 meters per second). National Weather Service (NWS) instruments at Augusta collected wind data at 6.1 meters above the ground during this period.

Figure 3-9 shows an annual wind rose for H-Area, which is near the center of the SRS. These data indicate that observed wind directions tend to favor the southwest and northeast quadrants (28 and 30 percent of the time, respectively) in relation to the northwest (20 percent) and southeast (22 percent) quadrants. For all data, winds from the northeast sector occurred most frequently (nearly 10 percent of the time). That is, emissions would have been transported toward the southwest more frequently than toward any other direction. Winds from direction sectors in the southwest quadrant also occurred with a relatively high frequency (7 to 8 percent of the time).

3.5.2.3 Precipitation

The annual average precipitation for the SRS (1952 to 1987) was about 122 centimeters; for Augusta (1951 to 1986), it was about 109 centimeters. Precipitation is fairly well distributed throughout the year. Average precipitation totals for the fall months (September, October, and November), however, are less than the average totals for the other seasons, accounting for about 18 percent of the average annual total. For Augusta, precipitation totals greater than 0.025 centimeter occurred, on average, about 107 days per year. The average number of days per month with measurable precipitation ranged from about 6 in October to about 12 in July.

Monthly precipitation extremes in Augusta ranged from a maximum of about 30 centimeters, recorded in March 1980, to a trace, observed in October 1959. The greatest observed rainfall for a 24-hour period was about 15 centimeters in August 1964. Hourly observations from Augusta indicated that the rainfall rate is usually less than 1.3 centimeters per hour, although rates greater than 1.3 centimeters per hour can be expected during spring and summer
L-76-41 thunderstorms. The calculated 24-hour/100-year rainfall at SRS is 20.8 centimeters (WSRC, 1989c).

3.5.2.4 Fog

Heavy fog, reducing visibility to less than 0.4 kilometer, occurred at Augusta on an average of about 28 days per year (1951-1986). Occurrences averaged about 3 days per month during fall and winter and slightly more than 1 day per month during spring and summer. Most of the heavy fog observed at Augusta is due to the proximity of the Savannah River. The frequency of naturally occurring fog at each reactor would probably be less because they are at elevations higher above the river than the Augusta NWS station (Section 2.1.2.1).

3.5.3 SEVERE WEATHER

3.5.3.1 Extreme Winds

Strong sustained surface winds occur during hurricanes, thunderstorms, and winter storms. During the history of the Site, only Hurricane Gracie, in September 1959, had onsite winds stronger than 34 meters per second. On occasion, SRS instruments have recorded winds as high as 39 meters per second during winter storms (Du Pont, 1982b). Thunderstorms can generate winds as high as 18 meters per second and even stronger gusts. The highest 1-minute wind speed recorded at Augusta between 1950 and 1986 was 37 meters per second
TC | (WSRC, 1989c).

3.5.3.2 Thunderstorms

On average, 56 thunderstorm days occur per year on the Site. Summer thunderstorms occur primarily during the late afternoon and evening; they can be accompanied by strong winds, heavy precipitation, or, less frequently, hail
L-76-42 | (NOAA, 1988). On the average, based on observations in a 1-degree square of latitude and longitude, hail occurred once every 2 years (WSRC, 1989c).

3.5.3.3 Tornadoes

Statistics (Ramsdell and Andrews, 1986) show reports of 37 tornadoes from 1954 to 1983 for a 1-degree square of latitude and longitude that includes the Site; this is an average of about one tornado per year. Based on data for this 30-year period, the estimated average frequency of a tornado striking any given location in South Carolina was 7.11×10^{-5} per year; this results in a point-strike recurrence interval of about once every 14,000 years. Older tornado statistics for a 3-degree-square area centered on the Site for 1950 to 1978 resulted in occurrence frequency estimates similar to those in the more recent data. These data indicate that about half the total number of observed tornadoes, and most of the tornadoes resulting in severe or devastating damage, occurred in March, April, and May. However, tornadoes have been observed in the SRS area in every month of the year.

Since SRS operations began, six confirmed tornadoes have occurred on or close to the Site: late June 1952; May 28, 1976; July 2, 1976; April 23, 1983; August 26, 1985; and October 1, 1989. With the exception of the most recent tornado, only light to moderate damage resulted on each of these occasions. The October 1, 1989, tornado caused considerable damage to timber resources on

about 1,097 acres and lighter damage on about 1,497 acres, all in a swath 23 kilometers long on the east side of the Site. None of the damage was to an SRS production facility. Several tornadoes have been sighted in undeveloped areas of the Site; however, investigations indicated no damage, suggesting these tornadoes did not touch the ground. Investigations of tornadoes occurring near the Site in 1975 and 1976 indicated wind speeds between about 45 and 78 meters per second (WSRC, 1989c).

3.5.3.4 Hurricanes

Thirty-six hurricanes caused damage in South Carolina from 1700 to 1987 (WSRC, 1989c). On September 22, 1989, Hurricane Hugo struck the coast of South Carolina near Charleston; sustained winds recorded at SRS were 17 meters per second (Augusta Chronicle, 1989). The average frequency of occurrence of a hurricane in the State is once every 8 years; however, the observed interval between hurricane occurrences has ranged from 2 months to 27 years. Because the Site is approximately 161 kilometers inland, winds associated with tropical weather systems usually have diminished below hurricane force (sustained speeds of 121 kilometers per hour or greater). Instruments at SRS measured the winds associated with Hurricane Gracie, which passed to the north of the Site on September 29, 1959, as high as 34 meters per second. No other hurricane-force wind has been measured on the Site. Extreme rainfall and tornadoes, which frequently accompany tropical weather systems, usually have the most significant impact on facility operations. TE

3.5.3.5 Ice and Snow

Winter storms that produce more than 2.5 centimeters of ice or snow are rare. Snowfalls of 2.5 centimeters or greater occur once every 5 years on the average. Any accumulation of snow rarely lasts longer than 3 days (WSRC, 1989c). TE

The NWS station at Augusta, Georgia, observes maximum total snowfalls for 24-hour and monthly periods (see NOAA, 1988). From 1951 to 1987, the maximum snowfall in the SRS area was 36 centimeters, recorded in February 1973 (WSRC, 1989c). L-76-41

For a 9-year period of record, storms resulting in an accumulation of ice on exposed surfaces occurred in the SRS vicinity an average of about once every 2 years (Tattelman, 1973). Based on a 50-year period of record (1920 to 1969), a 1.3-centimeter accumulation of ice would probably occur once every 25 years (WSRC, 1989c).

3.5.4 ATMOSPHERIC DISPERSION

This section describes the transport and dispersion of airborne material, which are direct functions of air movement. Pollutant dispersion depends on atmospheric stability and winds. Annual wind roses are available for each SRS tower for seven atmospheric stability classes (WSRC, 1989c). TE

3.5.4.1 Atmospheric Stability

The general patterns of airflow (and the nature of the terrain) governs transport direction and speed, whereas small-scale, random eddying of the atmosphere (i.e., turbulence) governs the diffusion of airborne material. Turbulence is indicated by atmospheric stability classification. Based on measurements by onsite instruments, the atmosphere in the SRS region is unstable approximately 45 percent of the time; it is neutral 30 percent of the time; and it is stable about 25 percent of the time (WSRC, 1989c).

TE #### 3.5.4.2 Mixing Depths and Low-Level Inversions

The mixing depth, which is a vertical restriction to atmospheric dilution, can be described as the thickness of the atmospheric layer, measured from the surface upward, in which vigorous vertical mixing is taking place caused by the daytime heating of the surface. The approximate annual morning and afternoon mixing depths for the SRS region (interpolated from Holzworth, 1972) are 375 meters and 1450 meters, respectively. The approximate seasonal morning and afternoon mixing depths are 350 and 1025 meters (winter), 375 and 1700 meters (spring), 400 and 1800 meters (summer), and 300 and 1400 meters (fall).

The estimated frequency of occurrence of low-level inversions or isothermal layers based at or below a 150-meter elevation in the SRS region is approximately 42 percent of the total hours on an annual basis (Hosler, 1961). Seasonally, the greatest frequency of inversions, based on percent of total hours, occurs during the fall; it is approximately 47 percent. Spring
TE has the lowest frequency of inversions, which occur only 37 percent of the time. Most of these inversions are nocturnal.

3.5.4.3 Restrictive Dilution Conditions

Restrictive dilution conditions are generally periods of high air pollution potential; they usually are related to stagnating anticyclones ("highs") with low average wind speeds, no precipitation, and a shallow mixing depth (Stackpole, 1967). The greatest air pollution potential in the SRS region is during the fall and winter. Seven anticyclone (high-pressure) stagnation cases of 7 days or more occurred in the SRS region from 1936 to 1965 (Korshover, 1967).

3.5.4.4 Air Quality

Air quality is monitored at several SRS locations for total suspended particulates, sulfur dioxide, nitrogen dioxide, and ozone (Davis, Martin, and Todd, 1989). The States of South Carolina and Georgia perform additional monitoring of ambient air near the Site. Table 3-5 compares monitoring results from the SRS monitoring program for 1988 with applicable standards;
TC the comparison indicates that air quality on SRS is within these standards.

Table 3-5. South Carolina and Georgia Air Quality Standards Compared to SRS Ambient Air Quality[a,b]

Air Quality Standard	South Carolina[c]	Georgia	SRS Maximum[d]	Percent Standard[e]
Sulfur dioxide ($\mu g/m^3$)				
3 hour	1300[f]	1300	196	15
24 hour	365[f]	365	73	20
Annual	80	80	39	49
Total suspended particulates ($\mu g/m^3$)				
24 hour	150	150	135	90
Annual geometric mean	50	75	29.6	59
Ozone (ppm)				
1 hour	0.12[g]	0.12	0.096	80
Nitrogen dioxide ($\mu g/m^3$)				
Annual	100	100	8	8

a. Source: Davis, Martin, and Todd, 1989.
b. Standards established under EPA-approved State Implementation Plans.
c. Lead, carbon monoxide, and gaseous fluorides are not monitored because the potential release is insignificant compared to the standard.
d. Highest measured ambient concentration at SRS.
e. Compared to the most restrictive standard.
f. Not to be exceeded more than once a year.
g. Not to be exceeded more than 1 day a year.

3.6 BIOTIC RESOURCES

The U.S. Government acquired the SRS in 1951. At that time, the Site was approximately two-thirds forested and one-third cropland and pasture (Dukes, 1984). At present, more than 90 percent of the Site is forested. With the exception of the production and support areas, natural succession has reclaimed many previously disturbed areas that had been open fields. In addition, an extensive forest management program conducted by the U.S. Forest Service Savannah River Forest Station has converted many crop and pasture areas to pine plantations. Table 3-6 lists SRS land cover, other than the land used for nuclear reactors and support facilities. TE

In 1972, the SRS was designated the first National Environmental Research Park by the Atomic Energy Commission. As a result, the natural resources of the Site and the effects of production activities on SRS ecosystems have been the subjects of extensive studies. Research has addressed the impact of thermal discharges on wetlands, the diverse ecological communities found in Carolina Bays, and many other topics.

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Table 3-6. Land Cover on SRS[a]

Land Cover Types	Acres	Percent of Total
Roads	4,114	2.1
Production areas	3,185	1.6
Utility corridors	2,743	1.4
Upland pine/hardwood	145,681	73.3
Subtotal	155,723	78.4
Wetlands		
Bottomland hardwoods	27,696	13.9
Cypress-tupelo	5,879	3.0
Scrub-shrub	2,167	1.1
Emergent marsh	1,722	0.9
Water[b]	5,550	2.8
Subtotal	43,014	21.7
Total	198,737	100.0

a. Source: Du Pont, 1987a.
b. Includes the Savannah River.

3.6.1 TERRESTRIAL ECOLOGY

3.6.1.1 Vegetation

This section describes both uplands and wetlands vegetation on the Savannah River Site. Volume II of the Reactor Operation EID (WSRC, 1989b) describes the land cover in the vicinity of the reactor areas and stream corridors. TE

3.6.1.1.1 Uplands

The Site is near the transition area between the oak-hickory-pine forest and the southern mixed forest. Consequently, species typical of both associations occur (Dukes, 1984). In addition, farming, fire, soil features, and topography have strongly influenced existing SRS vegetation patterns.

A variety of vascular plant communities occur in the upland areas of the Site (Dukes, 1984). Typically, scrub oak communities occur on the drier, sandier areas. Longleaf pine, turkey oak, bluejack oak, blackjack oak, and dwarf post oak dominate these communities, which typically have understories of three-awn grass and huckleberry. Oak-hickory hardwood communities occur on more fertile, dry uplands; characteristic species are white oak, post oak, southern red oak, mockernut hickory, pignut hickory, and loblolly pine, with an understory of sparkleberry, holly, greenbriar, and poison ivy.

3.6.1.1.2 Wetlands

The Site contains extensive, widely distributed wetlands, most associated with floodplains, creeks, and impoundments. In addition, 190 Carolina bays occur on the Site (Shields et al., 1982). Table 3-6 lists the areas of major wetlands types on the Site; Table 3-7 lists the dominant plant species found in these communities (classified according to Cowardin et al., 1979).

The southwestern SRS boundary adjoins the Savannah River for approximately 16 kilometers. The river floodplain supports an extensive swamp, covering about 7,460 acres of the Site; a natural levee separates the swamp from the river. Timber was cut in the swamp in the late 1800s. At present, the swamp forest consists of second-growth cypress, gum, and many other hardwood species (Sharitz, Irwin, and Christy, 1974).

Six major streams drain the Site and eventually flow into the Savannah River. Upper Three Runs and Lower Three Runs Creeks flow directly to the river. Beaver Dam Creek and part of the flow from Fourmile Branch drain into the northern section of the swamp and discharge into the river at the mouth of Beaver Dam Creek. The remainder of Fourmile Branch discharges through a natural levee between the swamp and the river, or moves through the swamp, mixes with the flows from Steel Creek and Pen Branch, and discharges into the river at the mouth of Steel Creek. DOE utilizes Pen Branch, Steel Creek, and Lower Three Runs Creek for the operation of K-, L-, and P-Reactors, respectively.

Thermal discharges from the reactors and the D-Area powerhouse have affected each major SRS stream, with the exception of Upper Three Runs Creek, for varying periods of time. Beaver Dam Creek supports a narrow band of bottomland hardwoods and scrub-shrub wetland vegetation; the stream received heated effluent water from the D-Area coal-fired powerhouse. The maximum temperature has been reduced by the use of an SCDHEC-approved thermal mitigation plan of increased pumping during periods when effluent temperatures might exceed compliance (i.e., 32.2°C). TC

The mitigation plan, which is detailed in the Alternative Cooling Water Systems EIS (DOE, 1987b), entails the intermittent use of existing excess capacity pumping of Savannah River water (to increase flows to as much as 4.5 cubic meters per second) from the 5G pumphouse to a raw-water receiving basin. Excess water not utilized in the powerhouse and the 400-Area water treatment plant overflows a weir to mix with the powerhouse effluent stream before discharging into the D-Area outfall canal. The overflow rate is adjusted to maintain a maximum instream temperature of 32.2°C. L-83-08

K-Reactor effluent discharges to Pen Branch via Indian Grave Branch, a small tributary. The thermal discharges have changed Pen Branch from a single-channel, meandering creek to a wide, multichannel, braided stream flowing within a partially vegetated floodplain (Mackey et al., 1987). The original wetland flora of the stream and the swamp where the stream enters the swamp has been eliminated; before the current outage, the flora was depauperate, TC dominated by herbaceous species growing on sandbars and islands created by stumps or fallen logs (Du Pont, 1987a). At present (September 1990), TC

K-Reactor has been in an outage for more than 2 years and herbaceous vegetation has regrown in the stream floodplain. TC

L-Lake, a 1,000-acre impoundment, cools heated L-Reactor effluents before discharge to Steel Creek. Section 3.4.1.2 describes the surface hydrology of the Steel Creek system and the effects of L-Reactor operation on stream flow. After the cessation of L-Reactor operation in 1968, much of the previously affected Steel Creek floodplain corridor underwent natural succession, or revegetation, and is now scrub-shrub or young bottomland hardwood wetland (Du Pont, 1987a). As part of the monitoring program required for compliance with Section 316(a) of the Clean Water Act, DOE is conducting a vegetation monitoring program to document wetland conditions and the establishment of a balanced biological community in the Steel Creek corridor and delta (Du Pont, 1988b). In addition, DOE has planted wetland vegetation along the shoreline of L-Lake to accelerate the establishment of wetland habitats (Du Pont, 1988b).

P-Reactor discharges to Par Pond, a recirculating cooling lake of about 2,640 acres (Du Pont, 1987a). Section 3.4.1.2 describes the surface hydrology of the Par Pond-Lower Three Runs Creek system. Wetland areas downstream from Par Pond that had been affected by thermal discharges from R-Reactor before the construction of Par Pond have partially recovered; bottomland hardwood communities dominate these areas. R-Reactor discharges and beaver activity affected a few areas of scrub-shrub and emergent wetlands in the Lower Three Runs Creek main channel and tributaries (Du Pont, 1987a). On the basis of several studies of wetland communities in Par Pond, SRS researchers have concluded that (1) a well-developed macrophyte community occurs in Par Pond, (2) relatively stable water levels maintained by reactor operation enhance macrophyte development, and (3) the dominant macrophytes in Par Pond are typical of the region (Du Pont, 1988b).

Carolina bays are unique wetland features of the southeastern United States. They are islands of wetland habitat dispersed throughout the uplands of the Site. The 190 bays on the Site exhibit extremely variable hydrology and a range of plant communities from herbaceous marsh to forested wetland (Shields et al., 1982). SRS scientists have studied Carolina bay ecology extensively, particularly in relation to the construction of the Defense Waste Processing Facility (DWPF; SREL, 1980).

3.6.1.2 Wildlife

The diversity and abundance of wildlife that inhabit the SRS reflect the interspersion and heterogeneity of the plant communities. Because of the mild climate and the variety of aquatic and terrestrial habitats, the Site contains a varied and abundant herpetofauna (DOE, 1987a; Gibbons and Patterson, 1978); species of amphibians and reptiles found on the Site include, depending on taxonomic uncertainties, 31 or 32 snakes, 25 or 26 frogs and toads, 16 or 17 salamanders, 11 turtles, 9 lizards, and the American alligator (WSRC, 1989b). TC

Forty-eight of the 57 species of mammals found in South Carolina can occur on the SRS; 40 are known to occur on the SRS (WSRC, 1989b). Several introduced mammal species, including the feral dog, feral cat, feral pig, and Norway rat,

are found on the Site. Of these species, only the feral pig occurs in large numbers; pigs are hunted to control the population (WSRC, 1989b). The only other species that is hunted on the Site is the white-tailed deer; controlled public hunts are held each year (WSRC, 1989c; Davis, Martin, and Todd, 1989). Furbearing species, including gray fox, bobcat, mink, otter, and beaver are TC also found on the Site. (WSRC, 1989b; Smith, Sharitz, and Gladden, 1981).

Biologists have identified at least 213 species of resident and migratory birds on the Site. Upland gamebirds such as bobwhite quail and mourning dove have declined since the 1960s due to the conversion of agricultural fields to forest through planting and natural succession. In 1972, the South Carolina Wildlife and Marine Resources Department initiated a turkey breeding program on the Site; by 1989, about 270 turkeys had been captured and used to restock other areas of the State (WSRC, 1989b).

Waterfowl on the Site are mainly winter migrants. Wood ducks are the only waterfowl species to breed consistently in the SRS region. An estimated 10,000 to 15,000 ducks and coots spend the winter on the Site; most congregate on Par Pond and on other large ponds and Carolina bays. Another 1,000 to 2,000 ducks spend the winter in the lower swamps and on the Savannah River (Dukes, 1984). The completion of L-Lake in 1985 has provided additional habitat for wintering waterfowl and other water birds. In a period from TC January 1986 through December 1987, 17 waterfowl and associated Avian species were observed at L-Lake including the Canada goose, mallard, wood duck, common loon, great egret, cattle egret, and great blue heron (WSRC, 1989b).

3.6.1.3 Threatened and Endangered Species

Table 3-8 lists species that have been documented on the Site and have been listed as threatened or endangered by the U.S. Fish and Wildlife Service (FWS) or the State of South Carolina. DOE has requested information related to the proposed action from the FWS, in accordance with Section 7 of the Endangered Species Act. The Site currently has no areas designated as critical habitat for any species.

3.6.1.4 Commercially and Recreationally Valuable Biota

The Site supports many commercially and recreationally valuable game populations. DOE restricts recreational use to controlled hunts for white-tailed deer. DOE manages a contract to control feral hog populations. Many species are highly mobile and travel offsite, where hunting is allowed. Edible species that might travel offsite include the white-tailed deer, feral hog, wood duck, mallard, mourning dove, bobwhite quail, bullfrog, and various species of turtles. Controlled hunts for white-tailed deer are held each year on the Site (Davis, Martin, and Todd, 1989). During 1988, trapping contractors removed 326 feral hogs from locations where the animals were causing damage to forest resources and research sites (Davis, Martin, and Todd, 1989).

An active timber management program, including reforestation, timber stand improvement, harvest, and research is carried out on the Site. During 1988 TE the Federal Government received nearly $2 million for 22.9 million board feet of cut timber (Davis, Martin, and Todd, 1989).

3.6.2 AQUATIC ECOLOGY

SRS researchers have conducted comprehensive studies to characterize and monitor the aquatic ecosystems on and near the Site. The following sections present brief summaries, based on these studies, on the major features of the systems affected by the operation of K-, L-, and P-Reactors: the Savannah River near the Site, Pen Branch, L-Lake and Steel Creek, and Par Pond and Lower Three Runs Creek (for more detailed descriptions of these systems, see Du Pont, 1985b, 1987a, 1988b, and WSRC, 1989b).

3.6.2.1 Aquatic Flora and Fauna

3.6.2.1.1 Savannah River

The Savannah River has experienced two significant alterations since the early 1950s: (1) dredging in the main channel as far upstream as Augusta, Georgia, and (2) completion of five upstream reservoirs. These changes have affected the aquatic community by reducing shallow habitat and reducing transport of sediment and particulate organic material (e.g., leaf litter; Patrick, Cairns, and Roback, 1967; DOE, 1987b). The microflora of the river is dominated by TE periphytic diatoms; although periphytic blue-green algae are sometimes common upstream from the Site, their abundance is related to organic loading from municipal sources. The occurrence and distribution of phytoplankton depend on upstream reservoir overflow. Macrophytes, most of which are rooted, are limited to shallow areas of reduced current, such as oxbows, behind sandbars, in swamp areas, and along the shallow margins of tributaries. Eight species of aquatic macrophytes have been identified from the river adjacent to the TC Site; the most common are water milfoil, hornwort, alligatorweed, waterweed, and duck potato (DOE, 1984, 1987b).

Past thermal impacts on the Savannah River and the Savannah River Swamp forest TE from the operation of K-, L-, and P-reactors have been thoroughly documented in the Final EIS for L-Reactor Operation (DOE, 1984) and the Final EIS on TE Alternative Cooling Water Systems at the Savannah River Plant (DOE, 1987b).

Shallow areas and quiet backwaters and marshes of the river near the Site support a diverse aquatic invertebrate fauna (Patrick, Cairns, and Roback, TE 1967). However, the stabilization of the river discharge and the elimination of habitat caused by the reduction in the flooding of backwater areas has contributed to a decline in the total number of invertebrate species.

Results of macroinvertebrate studies in the river have indicated substantial organic loading upstream of the Site (DOE, 1984; Du Pont, 1987a). True-flies (particularly chironomids) dominate the drift communities, which is typical of southeastern riverine systems. Mollusks, such as snails and clams, are also an important component of the river invertebrate community. The Asiatic clam, *Corbicula fluminea*, occurs in the river and larger tributary streams in the vicinity of the Site.

The Savannah River and its associated swamp and tributaries exhibit a diverse fish fauna typical of other southeastern coastal plain rivers and streams (Dahlberg and Scott, 1971; Bennett and McFarlane, 1983). The most intensive

study to date of the fish community of the Savannah River in the vicinity of the Site occurred between 1983 and 1985; the Comprehensive Cooling-Water Study
TE |(Du Pont, 1987a) presents the results of this study. Dominant fish species in the river near the Site include redbreast sunfish, spotted sunfish, spotted sucker, largemouth bass, channel catfish, white catfish, and flat bullhead.

Anadromous species of importance in the Savannah River include American shad, hickory shad, Atlantic sturgeon, shortnose sturgeon, and striped bass (WSRC, 1989b). Both shortnose sturgeon and striped bass are protected from commercial harvest, and the shortnose sturgeon is listed as an endangered species. The catadromous American eel is harvested commercially in some sections of the river.

Recent studies on ichthyoplankton of the middle and lower reaches of the Savannah River (including ichthyoplankton entrainment) began in 1982 and ended in 1985 (WSRC, 1989b). These studies indicate that gizzard and/or threadfin shad, American shad, blueback herring, sunfishes, crappie, minnows, and suckers are among the most abundant icthyoplankton taxa in the river. Generally, the clupeids (including anadromous American shad and blueback herring, and resident gizzard and threadfin shad) dominated collections in the river from 1983 to 1985. Some species, such as the largemouth bass and other centrarchids, were comparatively abundant as adults in the river, but scarce in the ichthyoplankton collections because their eggs and larvae reside in sheltered areas where they are unlikely to become entrained in currents and carried into open water. Such species are less susceptible to SRS entrainment impacts than those that produce drifting eggs and larvae.

3.6.2.1.2 Pen Branch

This section summarizes the results of studies conducted in Pen Branch (for
TE |greater detail, see Du Pont, 1987a, 1989; and WSRC, 1989b).

Wood provides the primary stream structure in the main channels of Pen Branch (Du Pont, 1987a). Stumps and logs that accumulated when the streamside forest
TC |was killed by thermal effluents in the 1950s are more abundant than in the nonthermal streams on the Site. Debris is also abundant, but trailing roots and macrophytes are scarce.

Elevated water temperatures exclude many plants and animals when K-Reactor is
TC |operating at power. Breakdown of leaf litter in the stream is rapid at first due to abrasion from inorganic sediment particles, but is not as complete as in the nonthermal streams, due to the absence of invertebrate shredders.

TC |During reactor operation at power, periphyton diversity is low in areas of Pen Branch experiencing the highest temperatures (greater than 45°C) from reactor cooling water effluent. When water in this stream cools to ambient temperature (due to reactor shutdown), periphyton diversity increases. Blue-green algae, which are not abundant in the nonthermal areas, dominate the biomass in thermal areas.

TC |During reactor operation at power with once-through cooling, temperatures in Indian Grave Branch and most of Pen Branch downstream from its confluence with Indian Grave Branch are too high to support most species of macroinvertebrates.

Suitable habitat during reactor operation is minimal, and is limited primarily to deep muds, which might be cool enough to support oligochaetes and nematodes, and to the peripheral edges of the stream channels in the delta. When K-Reactor is shut down temporarily, the streams are rapidly colonized by macroinvertebrates (particularly chironomids) and algae, including forms other than blue-greens. The taxa richness, density, and biomass of some macroinvertebrate groups that are absent during reactor operation increase during reactor shutdowns. The ability to disperse widely and the reproductive potential of recolonizing taxa are important factors in determining the rate of recovery of fauna after thermal discharges cease. TC TE

Studies conducted after the shutdown of K-Reactor in April 1988 (Enwright, 1989a,b,c) have shown that Pen Branch has been recolonized by many macroinvertebrate taxa; a limited sampling program that began 8 months after thermal discharges to the creek had ended collected 86 taxa from portions of the creek that had been subjected to thermal perturbation. Although the macroinvertebrate community of Pen Branch has shown substantial recovery, taxonomic richness and biomass are still depressed downstream from the reactor outfall; this indicates that recovery is not complete. Indian Grave Branch, which is closer to the reactor outfall and which, therefore, experienced a more severe thermal regime than Pen Branch, appears to be recovering more slowly than Pen Branch (WSRC, 1989b).

During periods when heated effluents are being released to Pen Branch channel, fish utilization is minimal (Aho et al., 1986; Paller and Saul, 1986; Du Pont, 1987a, 1989). The resident fish assemblage is depauperate, with mosquitofish predominating, mostly in side channels and pools connected to the main channel. Following a temporary cessation in reactor production and a return to seasonally ambient water temperatures, fish rapidly recolonize the main channel from locations in the Savannah River swamp.

The type of fish assemblage present where Pen Branch flows through the Savannah River swamp system is determined largely by the location along two major environmental gradients: (1) environmental harshness (especially as related to water temperature), and (2) the extent of canopy closure. Physical conditions along these gradients have a direct and predictable effect on the structure of fish assemblages in the swamp. Areas experiencing high levels of thermal loading have depauperate assemblages dominated by the mosquitofish when water temperatures are elevated; however, they are reinvaded rapidly by large and more mobile fish when ambient temperature conditions return. As temperature extremes along the thermal plumes are lessened, there is an associated increase in the number of species and abundance in the assemblage. TE

Studies conducted in the Pen Branch system since K-Reactor was shut down in April 1988 (Mealing and Paller, 1988; Mealing and Heuer, 1989a,b,c,d) have demonstrated the degree to which fish recolonize formerly thermal areas. In the absence of elevated temperatures, habitat becomes the primary determinant of community structure, with small stream species such as yellowfin shiner and bluehead chub predominating in the upper reaches, and a typical southeastern swamp community including longnose gar, brook silverside, largemouth bass, coastal shiner, and chain pickerel inhabiting the deep swamp reaches. Studies to date suggest that fish abundance remains relatively low in areas that have suffered habitat degradation. TE TC

3.6.2.1.3 L-Lake and Steel Creek

Studies have been under way to characterize and monitor the biotic and abiotic features of developing communities in L-Lake and Steel Creek since construction of the L-Reactor cooling reservoir. The following paragraphs summarize results of the first 2 years of monitoring (for greater detail, see Du Pont, 1988b, and WSRC, 1989b).

The structural attributes of the L-Lake habitat reflect activities during construction of the lake and the early developmental stage of the reservoir (Du Pont, 1988b). During construction, most living and nonliving vegetation was removed from the reservoir basin, resulting in a structurally simple habitat. Numerous artificial structures (e.g., brush, log, cinderblock, and tire reefs) were constructed in the lake prior to filling, and portions of the shore zone were planted with aquatic and semiaquatic vegetation after the lake was filled. Overall, the habitat-formers component of the L-Lake ecosystem is progressing toward supporting the development of a balanced community. Although few physical and biotic structural features existed when L-Lake was filled, aquatic and semiaquatic plants are becoming established in the littoral zones of L-Lake. The stability of water levels in L-Lake should facilitate the development of macrophyte communities.

The structure and function of primary producer populations in L-Lake reflect the eutrophic nature of the new reservoir. The combined effects of nutrient loading from Savannah River water used as secondary cooling for L-Reactor and nutrient release from the inundated lake bed result in nutrient levels that foster the development of algal communities dominated by species characteristic of eutrophic waters. Nutrient loading in L-Lake also results in algal abundance and productivity levels higher than those found in most reservoirs of the southeastern United States. Although nutrient release from lake sediments is expected to subside, the high levels of nutrients in Savannah River water are expected to result in continued high algal abundance and primary productivity.

Zooplankton abundance is high in L-Lake, with the zooplankton community being dominated by protozoa (primarily ciliates) and rotifers. The taxonomic diversity of the zooplankton community in L-Lake is comparable to that in other lakes of the southeast. The abundance of macrozooplankton is also comparable to that in most reservoirs considered, while the abundance of microzooplankton is substantially higher than reported for other reservoirs in the region.

Aquatic macroinvertebrate communities in L-Lake have exhibited substantial increases in abundance and biomass since the lake was filled in 1985 (Du Pont, 1988b). Overall, 130 taxa of macroinvertebrates were collected during 1986 and 1987, and the community is dominated by multiple groups of chironomids, as occurs in most reservoirs.

The initial composition of the fish community in L-Lake was strongly influenced by the species composition of fish previously occurring in the inundated portions of Steel Creek and the initial stocking of the new reservoir with bluegill and largemouth bass. Substantial changes occurred in the fish community from 1986 to 1987 as a result of the change from a stream

to lake habitat and changes in the trophic relationships of the fish populations within the lake (Du Pont, 1988b; WSRC, 1989b). Several species that are either best adapted to stream habitats or require well-developed littoral zone habitats with a substantial organic detritus base have declined in abundance or been lost from the lake. Gizzard and threadfin shad, lake species capable of planktonic feeding, have been added to the fish community. By the end of 1988, L-Lake was dominated by bluegill, threadfin shad, redbreast sunfish, and largemouth bass. Overall fish abundance in the lake is higher than that reported for most regional reservoirs.

Fish kills have occurred in L-Lake when fish that entered the reactor cooling water discharge area during outages were caught by the rapid rise in temperature that follows reactor restarts. These kills, however, have not affected the development of a balanced population in the lake. Section 4.1.1.4.2 describes proposals to mitigate these fish kills. TC

Areas of the Steel Creek drainage affected by reactor operations prior to 1968 continue to undergo post-thermal succession (Du Pont, 1988b). These areas, which are dominated by a mixture of scrub-shrub and herbaceous vegetation, include the Steel Creek corridor and delta areas. Areas that were not affected by previous operations are dominated by closed canopy, mixed bottomland hardwood (Meyers Branch), or cypress-tupelo swamp forest (closed-canopy river swamp) vegetation.

The release of water from L-Lake Dam has resulted in channel erosion in stream corridor and lower channel areas where stream courses are well defined. Before the restart of L-Reactor, there was little aquatic macrophyte growth in upstream corridor areas, and most of that vegetation was scoured following the resumption of reactor operations. Herbaceous biomass in delta/swamp and lower channel areas varied substantially from 1986 to 1987 but was usually higher than that measured before the restart of L-Reactor. Periphyton communities in Steel Creek were dominated by diatoms, green algae, and blue-green algae during 1986 and 1987. Periphyton dry-weight biomass and chlorophyll a concentrations on periphytometers were higher at stream corridor stations than in other habitat types.

Steel Creek supports an extremely diverse macroinvertebrate community, due to the diversity of habitats present in the stream. Like most Coastal Plain streams in the southeast, the macroinvertebrate community is numerically dominated by chironomids, with substantial representation of caddisflies, mayflies, gastropods, amphipods, and oligochaetes.

The results of macroinvertebrate sampling in 1986 and 1987 indicate that the macroinvertebrate community in Steel Creek has been altered somewhat since the restart of L-Reactor, particularly in the area immediately downstream from L-Lake Dam. These changes include increases in the density and biomass of macroinvertebrate (mostly filter-feeders), decreases in species richness, and shifts in the structure of the macroinvertebrate community. These changes appear to be due to increased discharge in the stream channel and to inputs of organic seston (food supply) from L-Lake rather than to a change in the thermal regime of Steel Creek.

The fish community of Steel Creek is dominated by warm-water species typical of streams of the southeastern United States. In 1986 and 1987, SRS scientists collected 35 species in the Steel Creek corridor area, 51 species in the delta/swamp, and 47 species from the lower Steel Creek channel. Species richness is higher than that found in most other drainage systems in the region. Most aspects of fish community structure in the delta/swamp area are comparable to preoperational conditions (Du Pont, 1988b).

The discharge of water from L-Lake has resulted in physical and biological changes in Steel Creek that have caused localized changes in the fish community of the creek. Community structure in the portions of Steel Creek closest to L-Lake Dam has been affected by the volume of discharge from L-Lake and the export of fish (centrarchids, primarily bluegill) produced in the lake. No major changes attributed to the operation of L-Reactor have been observed in the fish assemblages of either the delta/swamp or lower stream channel areas.

3.6.2.1.4 Par Pond and Lower Three Runs Creek

This section summarizes the results of comprehensive aquatic ecology studies conducted in Par Pond and Lower Three Runs Creek. (For greater detail, see
TC Du Pont, 1985a and 1987a.)

A study conducted in 1984 and 1985 (Chimney, Cody, and Starkel, 1985) indicated that the phytoplankton community of Par Pond has maintained species composition, density levels, and species diversity similar to those reported for 1978 (Wilde, 1983). In addition, primary productivity values were similar to values previously reported for Par Pond in studies conducted between 1965 and 1973 (Tilly, 1973, 1974a,b).

Data on the phytoplankton taxa observed, the relative abundance of numerically important taxa, and the seasonal and year-round community composition of phytoplankton in Par Pond during 1984 and 1985 were similar to values reported for other lakes and reservoirs of the southeastern United States (Chimney, Cody, and Starkel, 1985); mean phytoplankton diversity and productivity in Par Pond were intermediate in relation to other regional lakes and reservoirs.

Several studies of the macrophytes of Par Pond were conducted during the 1970s (Wilde and Tilly, 1985). Conclusions derived from these studies were as follows: (1) a well-developed macrophyte community occurs in Par Pond, (2) relatively stable water levels maintained by reactor operation enhance macrophyte development, and (3) the dominant macrophyte species in Par Pond
TC are typical of the geographic region (Du Pont, 1985a). More recent studies have revealed substantial expansion of macrophyte coverage in Par Pond between 1975 and 1983, demonstrating a high suitability of habitat for the growth of wetland plants (Grace, 1985).

Studies conducted in 1984 and 1985 determined that zooplankton community structure in Par Pond is quite similar to that found in other southeastern lakes and reservoirs, with protozoans and rotifers dominating (Chimney, Cody, and Starkel, 1985).

Researchers conducted a comprehensive study of the macroinvertebrate community of Par Pond from January 1984 to June 1985 (Kondratieff, Chimney, and Painter, 1985). Several less comprehensive studies were conducted before 1984 (Wilde and Tilly, 1985). The complement of macroinvertebrate species occurring in Par Pond is also common in other southeastern U.S. reservoirs. Par Pond values for number of taxa per sample, diversity, density, and biomass were intermediate in relation to the values reported for other lakes and reservoirs. Comparison with studies conducted before 1984 (Wilde and Tilly, 1985) suggests that the only major long-term change in the Par Pond macroinvertebrate fauna has been the introduction of the Asiatic clam. This species probably entered Par Pond by the pumping of Savannah River water via the 186-P basins when P-Reactor was not operating (Wilde and Tilly, 1985). TE TC

An examination of historical data suggests that the fish community in Par Pond has remained stable in its major features from 1969 to the present (Paller and Saul, 1987; Wilde and Tilly, 1985). Although relative abundance has fluctuated over the years, all major species have persisted; numerically dominant species in Par Pond are largemouth bass, bluegill, black crappie, lake chubsucker, and brook silverside. The stability of the Par Pond fish community is also suggested by the collection of larvae and juveniles of most of the major Par Pond species.

Environmental studies, such as Section 316(a) studies on the effects of reactor thermal discharges, have demonstrated that a balanced biological community has been maintained in Par Pond. Fish have been killed in Pond C, a precooler pond upstream of Par Pond, due to thermal discharges when P-Reactor starts up after extended outages. Section 4.1.1.4.3 describes proposals to mitigate these fish kills. TC

Stream structure in Lower Three Runs Creek is dominated by logs and sticks, but macrophytes and trailing vegetation are abundant in some of the larger areas, where stream structure is most diverse (Du Pont, 1987a). The energy base is primarily allochthonous; leaf litter input is high. Leaves that fall into the stream are colonized by microbes and rapidly broken down by macroinvertebrate shredders. In many areas, the canopy provided by the streamside trees is complete and dense; as a result, periphyton and macrophyte biomass are low, especially in the summer when light is most limiting. The periphyton that do occur are dominated by green algae and diatoms. The macroinvertebrate communities are diverse (56 to 70 taxa) and include pollution-sensitive taxa.

The fish assemblage occurring in Lower Three Runs Creek is similar to that found in nonthermal portions of the Savannah River near the Site, except catfish are not as well represented. Dominant species in Lower Three Runs Creek include shiners, spotted suckers, redbreast sunfish, American eel, flathead bullhead, bowfin, bluegill, and spotted sunfish.

3.6.2.2 Endangered and Threatened Species

Fisheries surveys conducted in the Savannah River beginning in 1982 have collected larvae of both the Atlantic sturgeon and the endangered shortnose sturgeon (see Table 3-8; DOE, 1987c). Sturgeon (Atlantic and shortnose TC

combined) larval abundance was highest in 1982. It appears that both species spawn upstream or near the Site and that shortnose sturgeon spawn earlier and TC |at cooler water temperatures than Atlantic sturgeon. Planktonic stages of Atlantic and shortnose sturgeon are demersal in nature; consequently, most larvae are collected in samples near the river bottom.

DOE submitted a biological assessment of the potential effects of SRS operations on the shortnose sturgeon in the Savannah River (Muska and Matthews, 1983) to the National Marine Fisheries Service (NMFS). The NMFS has concurred with the DOE determination that the population of the shortnose sturgeon in the Savannah River would not be jeopardized by SRS operations (Oravetz, 1983).

3.6.2.3 Commercially and Recreationally Valuable Biota

The Savannah River supports both commercial and sport fisheries (DOE, 1987b). Most fishing is confined to the marine and brackish waters of the coastal regions of South Carolina and Georgia. The only commercial fish of significance near the Site are the American shad, the channel catfish, and the Atlantic sturgeon. These species are exploited to a limited degree by local fishermen.

Sport fishermen are the principal consumers of river fishes, primarily sunfish and crappie. Striped bass are classified as game fish in South Carolina and Georgia (Ulrich et al., 1978).

The Georgia Department of Natural Resources evaluated the fishery resources in the Savannah River downstream of the New Savannah Bluff Lock and Dam from 1980 to 1982 (Schmitt and Hornsby, 1985; DOE, 1987c). The estimated average annual sport fishing harvest from the freshwater portions of the river (approximately River Miles 21 to 187) ranged from 171,561 fish per year in 1982 to 550,282 fish per year in 1980 (a 3-year average of 305,778 fish per year). Dominant species in the sport harvest were redbreast sunfish, bluegill, composite category of "bream," composite category of "catfish," crappie, and warmouth. Notably, anadromous species (striped bass and American shad) did not contribute substantially to the angler's harvest. However, the American shad harvest might be underestimated because of the development of a fishery for this species near the New Savannah Bluff Lock and Dam, while the assessment for this species emphasized downstream areas of the river (Schmitt and Hornsby, 1985).

3.7 RADIATION AND HAZARDOUS CHEMICAL ENVIRONMENT

3.7.1 RADIATION ENVIRONMENT

The release of radioactivity to the environment from any nuclear facility is a significant and sensitive issue for onsite workers and the public. Because there are many other sources of radiation in the human environment, it is important to evaluate radioactive releases from nuclear facilities in the context of all the ionizing radiation to which people are routinely exposed.

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The Savannah River supports both commercial and sport fisheries (DOE, 1987b). Most fishing is confined to the marine and brackish waters of the coastal regions of South Carolina and Georgia. The only commercial fish of significance near the Site are the American shad, the channel catfish, and the Atlantic sturgeon. These species are exploited to a limited degree by local fishermen.

Sport fishermen are the principal consumers of river fishes, primarily sunfish and crappie. Striped bass are classified as game fish in South Carolina and Georgia (Ulrich et al., 1978).

The Georgia Department of Natural Resources evaluated the fishery resources in the Savannah River downstream of the New Savannah Bluff Lock and Dam from 1980 to 1982 (Schmitt and Hornsby, 1985; DOE, 1987c). The estimated average annual sport fishing harvest from the freshwater portions of the river (approximately River Miles 21 to 187) ranged from 171,561 fish per year in 1982 to 550,282 fish per year in 1980 (a 3-year average of 305,778 fish per year). Dominant species in the sport harvest were redbreast sunfish, bluegill, composite category of "bream," composite category of "catfish," crappie, and warmouth. Notably, anadromous species (striped bass and American shad) did not contribute substantially to the angler's harvest. However, the American shad harvest might be underestimated because of the development of a fishery for this species near the New Savannah Bluff Lock and Dam, while the assessment for this species emphasized downstream areas of the river (Schmitt and Hornsby, 1985).

3.7 RADIATION AND HAZARDOUS CHEMICAL ENVIRONMENT

3.7.1 RADIATION ENVIRONMENT

The release of radioactivity to the environment from any nuclear facility is a significant and sensitive issue for onsite workers and the public. Because there are many other sources of radiation in the human environment, it is important to evaluate radioactive releases from nuclear facilities in the context of all the ionizing radiation to which people are routinely exposed.

3.7.1.1 Sources of Environmental Radiation

Environmental radiation consists of natural background radiation from cosmic, terrestrial, and internal body sources; radiation from medical diagnostic and therapeutic practices; radiation from weapons test fallout; radiation from consumer and industrial products; and radiation from nuclear facilities.

Natural background radiation contributes about 82 percent of the annual dose of 361 millirem received by an average member of the population within 80 kilometers of the Site. All radiation doses mentioned in this EIS are "effective dose equivalents" (i.e., organ doses weighted for biological effect to yield equivalent whole-body doses), unless specifically identified otherwise (e.g., "thyroid dose," "bone dose"). Based on national averages, medical exposure accounts for an additional 15 percent of the annual dose, and the combined doses from weapons test fallout, consumer and industrial products, and air travel account for about 3 percent of the dose. L-78-30

Releases of radioactivity to the environment from the Site account for less than 0.1 percent of the total annual average environmental radiation dose within 80 kilometers. Typically, the average radiation dose to individuals within 80 kilometers of a nuclear facility is quite low. Releases from 61 nuclear powerplant sites operating in 1985 contributed an average radiation dose commitment within 80 kilometers of a plant of about 0.0026 millirem per capita (Baker, 1988).

External radiation from natural sources comes from cosmic rays and the emissions from natural radioactive materials in the ground. The radiation dose from external radiation varies greatly with location and altitude.

Internal radiation from natural terrestrial sources consists primarily of potassium-40, carbon-14, rubidium-87, and daughters of radium-226. Because the distribution of fertilizers and food is widespread and the population is mobile, there is an averaging effect for the long-lived radionuclides that produce the internal dose. The estimated average internal radiation exposure in the United States from natural radioactivity (primarily indoor radon daughter products) is 240 millirem per year (NCRP94, 1987).

Medical radiation is the largest source of population exposure to manmade radiation in the United States. The average dose to an individual from medical and dental X-rays, prorated over the total population, is 39 millirem per year (NCRP93, 1987). (Prorating the dose over the population, as used in this section, is a means of arriving at an average dose that, when multiplied by the population size, produces an estimate of population exposure. It does not mean that every member of the population receives a radiation exposure from these sources.) In addition, radiopharmaceuticals administered to patients for diagnostic and therapeutic purposes account for an average annual dose of 14 millirem when prorated over the population. Thus, the average medical radiation dose in the U.S. population is about 53 millirem per year.

Fallout of radioactive material from nuclear weapons tests is a small source of radioactivity in the environment. Atmospheric tests conducted by the

United States (193 tests, 1945 to 1962) and the Soviet Union (142 tests, 1949 to 1962) introduced the largest amounts of radioactive materials into the stratosphere that were later distributed worldwide. A small amount of radioactivity from these tests continues to be deposited. The more recent Chinese (22 tests, 1964 to 1980) and French (45 tests, 1960 to 1974) tests were sufficient to maintain a relatively constant rate of fallout TC |depositionfor some time (Eisenbud, 1987). The current and past fallout contributes to the environmental radiation exposure through the following:

- External radiation from radioactive material on the earth's surface
- Internal radiation from inhalation of airborne fallout
- Internal radiation from ingestion of food and water contaminated by fallout

Cesium-137 deposited from past nuclear weapons tests is the major source of long-lived external gamma radiation from fallout. Short-lived radionuclides also contribute to the external dose for short periods of time following tests. The estimated dose rate from external gamma radiation is about 0.9 millirem per year (Dukes, 1984).

Most of the internal dose from inhalation of fallout is received in the years immediately after exposure. However, doses from strontium-90 and plutonium-239 are received over a lifetime because of the long residence time of these radionuclides in the body. The estimated annual dose from inhaled fallout radioactivity was 0.04 millirem in 1969 (Dukes, 1984) and is even lower at present.

Ingestion of radioactivity in food and water is the largest source of radiation exposure from fallout. This exposure pathway resulted in an estimated 3.7 millirem per year in 1980, consisting of 0.6 millirem from carbon-14, 0.4 millirem from cesium-137, and 2.7 millirem from strontium-90 (Dukes, 1984).

In 1980, the estimated average annual dose from fallout from nuclear weapons tests was 4.6 millirem (0.9 millirem from external gamma radiation and 3.7 millirem from ingested radioactivity). Because there have been no atmospheric nuclear weapons tests since 1980, the average annual dose from fallout at present is less than 1 millirem. This decline is due principally to radioactive decay.

A variety of consumer and industrial products yield ionizing radiation or radioactive materials and, therefore, result in radiation exposure to the general population. Some of these sources are television sets, luminous dial watches, airport X-ray inspection systems, smoke detectors, tobacco products, fossil fuels, and building materials. The estimated average annual dose for the U.S. population from these sources is 10 millirem per year (NCRP95, 1987). About one-third of this dose is from external exposure to naturally occurring radionuclides in building materials.

People who travel by aircraft receive additional exposure from cosmic radiation because, at high altitudes, the atmosphere provides less shielding

from this source of radiation. The average annual airline passenger dose, when prorated over the entire U.S. population, amounts to 1.0 millirem (NCRP94, 1987).

3.7.1.2 Radiation Levels in the Vicinity of the Savannah River Site

Table 3-9 summarizes the major sources of exposure for the population within 80 kilometers of the Site and for the river-water-consuming population in Beaufort and Jasper Counties, South Carolina, and in Port Wentworth, Georgia. Many of the factors, such as natural background dose and medical dose, are independent of the Site.

In 1975, an airborne radiological survey at the mouth of the Savannah River established terrestrial dose equivalent rates (Hayes, 1977). These rates varied from about 0.001 millirem per hour over water to 0.009 millirem per hour at one location on Wassaw Island, about 32 kilometers south of Savannah, Georgia. In general, the higher rates occurred over beaches where heavy minerals containing natural thorium and uranium occur. Excluding the water areas, the terrestrial rate averages about 0.003 millirem per hour, which is comparable with other Coastal Plain rates of 0.002 to 0.003 millirem per hour, and which is about half that measured for the Site. The average dose equivalent rate for the Savannah River marine area is about the same as the rates measured in Galveston, Texas, and Cape Canaveral, Florida, and somewhat less than the rate in the Los Angeles, California, area. Researchers defined one radiation anomaly in this survey at Hutchinson Island, where dredge soils have been deposited. The cesium-137 concentration of the post-1957 dredge soil sediment ranges from about 0.3 to 2.7 picocuries per gram. About half the cesium-137 in the post-1957 sediment can be attributed to fallout from weapons testing (Marter, 1974). The following paragraphs discuss factors that are Site-dependent.

The Site and the surrounding area lie between latitudes 33°N and 34°N; the altitude varies between sea level and roughly 300 meters above sea level. The total estimated unshielded dose equivalent from cosmic radiation in the vicinity of the Site (80-kilometer radius) is 35 millirem per year, of which 29 millirem per year are from the ionizing component and 6 millirem per year are from neutrons (Dukes, 1984), which ionize indirectly. | TC

Within 80 kilometers of the Site, measured external gamma dose rates range from 6 millirem to 385 millirem per year (Dukes, 1984). A value of 35 millirem per year represents the average unshielded external terrestrial background in the vicinity of the Site (NCRP94, 1987). Shielding of any kind can reduce terrestrial and cosmic radiation doses to about 28 millirem per year each, a 20-percent reduction (NCRP94, 1987). | L-78-33

Atmospheric testing caused 25,600,000 curies of cesium-137 to be deposited on the earth's surface (United Nations, 1977). About 104 millicuries of cesium-137 per square kilometer were deposited in the latitude band where South Carolina is located (30°N to 40°N). The total resultant deposition was 2,850 curies on the 27,400 square kilometers of the Savannah River watershed and 80 curies of cesium-137 on the Site. The deposited cesium-137 became attached to soil particles and has undergone only slow transport from the watershed. Results from routine health protection monitoring programs

80-kilometer-radius population and 0.06 millirem per year to downstream consumers of Savannah River water (Ziegler et al., 1987; Mikol et al., 1988; Davis, Martin, and Todd, 1989). TE

All doses not otherwise specified are effective dose equivalents. In 1980 the population within 80 kilometers was 589,803 (see Section 3.2.3.2); thus, the collective effective dose equivalent to that population from recent SRS operations was about 30 person-rem per year. Similarly, the average individual dose of about 0.06 mrem per year for the current Port Wentworth and Beaufort-Jasper river-water-consuming population of about 71,000 (see Section 3.4.1.4) would yield a collective effective dose equivalent to that population of about 4 person-rem per year. L-78-34

Nuclear facilities within 80 kilometers of the Site include a low-level waste burial site operated by Chem-Nuclear Systems, Inc., near the eastern SRS boundary, and Georgia Power Company's Vogtle Electric Generating Plant, located directly across the Savannah River from the Site. In addition, Carolina Metals, Inc., which is northwest of Boiling Springs in Barnwell County, processes depleted uranium. The Chem-Nuclear facility, which began operation in 1971, releases essentially no radioactivity to the environment (Chem-Nuclear Systems, Inc., 1980), and the population dose from normal operations is negligible. The 80-kilometer-radius population receives an immeasurably small radiation dose from transportation of low-level radioactive waste to the burial site. Plant Vogtle began commercial operation in 1987, and its releases to date have been far below DOE guidance levels and NRC regulatory requirements (Davis, Martin, and Todd, 1989).

Gamma radiation levels, including natural background terrestrial and cosmic radiation, measured on and around the Site during 1988 yielded an average dose rate of about 73 millirem per year, approximately equal to the background dose rate. L-78-35

From 1986 to 1988, the calculated maximum individual annual dose at the SRS boundary from atmospheric releases averaged 0.57 millirem (Ziegler et al., 1987; Mikol et al., 1988; Davis, Martin, and Todd, 1989). Atmospheric releases of tritium accounted for more than 60 percent of the offsite population dose; tritium is the only radionuclide of SRS origin that is monitored and detected routinely in offsite air. Table 3-10 lists average atmospheric tritium concentrations. TC

Liquid releases of tritium generally account for more than 99 percent of the total radioactivity introduced into the Savannah River from SRS activities. These releases will increase due to the operation of the reactors and their support facilities. The F- and H-Area Effluent Treatment Facility, which replaced the F- and H-Area seepage basins, would discharge tritiated water to Upper Three Runs Creek. The averaged tritium concentration in the river below the Site at U.S. Highway 301 was 3.4 picocuries per milliliter from 1986 to 1988 (Ziegler et al., 1987; Mikol et al., 1988; Davis, Martin, and Todd, 1989). The calculated maximum individual annual dose resulting from liquid releases over this period averaged 0.82 millirem. Table 3-11 lists the mean values for tritium in the river upstream and downstream of SRS for 1985 to 1988. L-49-07 S-06-05

Table 3-10. Average Atmospheric Tritium Concentrations in the Vicinity of the Savannah River Site

Location	1988 Tritium (pCi/m^3)	1987 Tritium (pCi/m3)	1986 Tritium (pCi/m^3)
Onsite	840	1000	755
Site perimeter	54	81	79
40-kilometer radius	17	25	22
160-kilometer radius	12	10	10

Table 3-11. Tritium in Savannah River (pCi/ml)[a]

L-49-07
S-06-05

Year	Upstream	± 2σ	Downstream	± 2σ
1985	0.46	0.68	3.7	1.9
1986	0.36	0.42	4.1	6.8
1987	0.37	0.32	3.2	2.3
1988	0.27	0.40	3.3	2.4

a. Data from Annual Environmental Reports

The groundwater monitoring program at the Site is designed to detect and monitor both radioactive and nonradioactive contaminants in and around process operations, burial grounds, seepage basins, and drinking-water supplies. The 1988 Savannah River Site Environmental Report (Davis, Martin, and Todd, 1989) describes the sampling program, monitoring locations, and contaminant levels for an extensive array of monitoring wells. In 1988, groundwater below areas affected by process operations showed elevated readings for tritium and other specific isotopes (see Section 3.4.2.3 for discussion on reactor areas). The level of contamination varies with the area being monitored, and depends on the process or facility located in that area. Tables 5-2 through 5-16 of the 1988 Environmental Report summarize the maximum constituent levels found in each of the areas monitored.

Average concentrations of radioactivity routinely detected in milk, food, drinking water, wildlife, rain water, soil, sediment, and vegetation in 1988
TE were within ranges observed during previous years. With the exception of tritium, the concentrations observed were similar to those reported in other parts of the country and can be attributed to fallout from atmospheric nuclear
TC weapons tests. Table 3-12 lists average and maximum tritium concentrations found during 1988 in food, milk, and drinking water (Davis, Martin, and Todd, 1989).

Table 3-12. Tritium Concentrations in 1988 SRS Sampling Program (pCi/ml)

Medium	Average	Maximum
Drinking Water		
Surrounding towns	0.12	0.6
SRS	0.39	4.1
Beaufort-Jasper/Savannah	2.5	4.0
Milk	0.5	4.0
Food (free water content)	1.2	7.0

L-78-37

Releases from SRS since the beginning of operations have also been assessed to estimate the doses that might have accrued to maximally exposed hypothetical individuals and to population groups that resided in the affected areas since 1954. These dose estimates made several assumptions: (1) that the individuals and population groups have remained at their current locations since 1954 and will remain there for another 50 years; (2) that the current site-specific data (meteorological and hydrological parameters, population sizes, etc.) are representative of this entire period; and (3) that the Beaufort-Jasper water treatment plant has operated continously since 1954 (it began operating in 1965).

All known measured and calculated atmospheric and liquid release values have been included with the exception of krypton-85 releases before 1970, which are classified; inclusion of the krypton-85 releases would not materially change the cumulative dose results. Table 3-13 lists the principal contributors to the maximally exposed individual from atmospheric releases and to the downstream water consumer (Bauer, 1990). This table lists the cumulated 36-year release and the maximum individual effective dose equivalent by nuclide. It indicates that about half of the 36-year total of about 20 mrem would have been due to tritium, and a third of the total to strontium-89 and -90 (which includes unidentified beta-gamma emitters for this dose assessment). About 60 percent of the 36-year atmospheric release dose of about 100 mrem resulted from tritium, argon-41, and iodine-131, which do not accumulate in the body over long time periods. TC

Table 3-14 summarizes the maximum individual effective dose and organ dose equivalents from airborne and liquid releases by all pathways, as well as collective effective dose commitments to the neighboring and downstream populations. As indicated in this table, the hypothetical individual receiving the maximum exposure from SRS atmospheric and liquid discharges over 36 years would have received a cumulated total effective dose equivalent of about 580 mrem, or about the same dose as would be received in 2 years from natural radiation in the SRS vicinity. L-02-02 L-64-04 S-03-01 C-02-04 C-13-01 A-30-03 A-85-03

Table 3-13. Cumulative Releases and Doses by Principal Nuclide (1954-1989)

Atmospheric Releases			Liquid Releases		
Nuclide	Ci	Max. ind. (mrem)	Nuclide	Ci	Drinking Water (mrem)
HTO	2.38×10^{7}	25	HTO	1.91×10^{6}	9.8
C-14	2.98×10^{3}	1.7	Sr-89-90	5.94×10^{2}	6.3
Ar-41	6.36×10^{6}	11	I-131	3.02×10^{2}	1.2
Sr-89-90	4.70×10^{1}	4.2	Cs-137	6.08×10^{2}	2.5
Ru-106	1.39×10^{2}	9.3	Ce-144	3.50×10^{2}	0.6
I-129	5.67	5.8	Pu-239	5.21×10^{1}	0.2
I-131	2.52×10^{3}	26	All Others	6.60×10^{3}	0.8
Pu-238	6.98×10^{-1}	2.8			
Pu-239	3.10	14	Total	1.92×10^{6}	20
All Others	1.15×10^{7}	1.2			
Total	4.16×10^{7}	100			

From Bauer, 1990.

L-02-02
L-64-04
S-03-01
C-02-04
C-13-01
A-30-03
A-85-03

TC 3.7.1.3 Radiation Levels Around Reactor Areas and SRS

Radiation-level surveys are conducted continually on and around the Site with thermoluminescent dosimeters (TLDs). Radiation levels measured from 1985 to 1987 at the K-, L-, and P-Area fences averaged 99, 79, and 76 milliRoentgens per year, respectively (Du Pont, 1986, 1987b, 1988c). These can be compared with natural background gamma levels measured by TLDs, which ranged from 62 to 99 milliRoentgens per year at the SRS boundary to a radius of 160 kilometers. TC In addition, a radiation survey is conducted annually along major SRS roads.

3.7.2 HAZARDOUS CHEMICAL ENVIRONMENT

The operation of the SRS reactors and other facilities uses hazardous chemicals or produces them as potentially hazardous byproducts. Also, hazardous or potentially hazardous chemicals have been disposed of on the Site. The following sections describe the existing hazardous chemical environment on the Site for the atmosphere, groundwater, surface water, and soils.

3.7.2.1 Atmosphere

TE Permits issued by SCDHEC, National Emission Standard for Hazardous Air Pollutants (NESHAP; subpart U), and the National Ambient Air Quality Standard (NAAQS) regulate nonradioactive atmospheric emissions from SRS stacks. Emissions from SRS coal-fired powerplants include sulfur dioxide, nitrous oxides, and total suspended particulates; all were within applicable emission

Table 3-14. Cumulated 36-Year Doses From SRS Releases (1954-1989)[a,b]

Exposure	Maximum Individual EDE (mrem)	Maximum Individual DE (mrem)	Collective EDE (person-rem)
Atmospheric releases	100	1110 (thyroid)	6800
Liquid releases			
Below SRS (all paths)	480	827 (bone surface)	
Drinking water (Beaufort-Jasper)	20	75 (bone surface)	
80-km population			
Shoreline exposure			2.47
Swimming			0.002
Boating			0.028
Beaufort-Jasper water			503
Port Wentworth water			197
Saltwater shellfish			1.7

a. From Bauer, 1990.
b. The 36-year effective dose equivalent from natural radiation sources is about 10,600 mrem; collective population dose within 80 kilometers over 36 years is 5,900,000 person-rem from natural sources

L-02-02
S-03-01
C-02-04
C-13-01
A-30-03
A-85-03

standards in 1986, 1987, and 1988 (Zeigler et al., 1987; Mikol et al., 1988; Davis, Martin, and Todd, 1989).

Six onsite process stacks produce major emissions of nonradioactive materials. In 1987 and 1988, all stacks met the regulated limits except the 291-F stack, which occasionally exceeded the 40-percent limit for opacity of nitrous oxides. A number of projects are under way to ensure full regulatory compliance (Mikol et al., 1988; Davis, Martin, and Todd, 1989).

In December 1987, SCDHEC conducted a compliance inspection of all permitted air emission sources; all emissions were within applicable standards (Mikol et al., 1988).

3.7.2.2 Groundwater

During nearly 40 years of operation, at least 168 sites have been or are being used for the disposal or storage of solid and liquid wastes at the SRS. Most of these sites contain nonradioactive wastes. Thirty-seven sites either might have received or potentially contain hazardous wastes; 19 are low-level

radioactive sites; and 21 are potential mixed-waste sites (DOE, 1987a). Of the 202 SRS sites recently identified in the DOE Environmental Restoration and Waste Management Five-Year Plan, 15 are Resource Conservation and Recovery Act (RCRA) sites, 70 are in the RCRA Facility Investigation Program, 30 are potential Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) sites, and 87 are being closed under SCDHEC requirements (DOE, 1989a). Section 3.8 discusses current SRS actions to address groundwater contamination.

TC

Nonradioactive wastes disposed of on the Site include the following categories (Christensen and Gordon, 1983):

Nonhazardous	- Coal pile runoff, ash sluices, wood, lumber, concrete blocks and slabs, bricks, glass, fenceposts, tires, rubber, trash, fuel, motor oil and grease, waste oil, and paint
Hazardous	- Acids, caustics, liquid chemicals, biocidal compounds (such as herbicides and pesticides) used in either plant operation or maintenance, heavy and reactive metals, metal shavings, mercury, chlorinated hydrocarbons, chlorinated biphenyls (PCBs), solvents, and other organics
	NOTE: PCBs are regulated under the Toxic Substances Control Act (TSCA), not RCRA. Some solvents and other organic liquids are shipped from the SRS to approved RCRA disposal facilities.

TE

In 1988, groundwater was monitored in nearly 900 monitoring wells at waste disposal sites, operating facilities, and spill sites for hazardous constituents; 68 wells were associated with K-, L-, and P-Areas (Davis, Martin, and Todd, 1989). Types of potential groundwater contaminants include chlorinated organics, heavy metals, and nitrates. Levels of contamination range from below detectable limits to greater than U.S. Environmental Protection Agency (EPA) drinking-water standards. About half the radioactive, nonradioactive, and mixed-waste sites for which groundwater monitoring data exist have some contaminants that exceed drinking-water standards.

TE

Groundwater contaminants have been identified at several of the K-, L-, and P-Area waste management facilities. The Site has used these facilities to dispose of a variety of industrial chemicals. Suspected or confirmed contaminants include the following (Huber, Johnson, and Marine, 1987; Ward, Johnson, and Marine, 1987; Scott, Kolb, Price, and Bledsoe, 1987; Pekkala,

Jewell, Holmes, and Marine, 1987; Pekkala, Jewell, Price, and Bledsoe, 1987; Mikol et al., 1988; Davis, Martin, and Todd, 1989):

K-Area burning/rubble pit	- Lead, nickel, manganese, sodium, total organic halogen, sulfate, trichloroethylene
K-Area retention basin	- Lead
K-Area acid/caustic basin	- Acids, chloride, sulfate, sodium, total organic halogen
K-Area disassembly basin	- Lead, trichloroethylene
L-Area acid/caustic basin	- Acids, sulfate, sodium, tetrachloroethylene, trichloroethylene
L-Area burning/rubble pit	- Lead
L-Area disassembly basin	- Lead, trichloroethylene
Chemicals, metals, and pesticides (CMP) pits	- Acids, zinc, nitrate, sulfate, sodium benzene, methylene chloride, tetrachloroethylene, toluene, bisphthalate, lead, mercury, zinc, copper, trichloroethylene, carbon tetrachloride TE
L-Area oil and chemical basin	- Cadmium, chromium, mercury, nickel, lead, tetrachloroethylene, trichloroethylene
P-Area burning/rubble pit	- Acids, barium, lead, magnesium, sodium, total organic carbon, total organic halogen, tetrachloroethylene, trichloroethylene
P-Area disassembly basin	- Lead
P-Area acid/caustic basin	- Acids, sodium, zinc, sulfate, chloride, total dissolved solids
P-Area coal pile runoff containment basin (189-P)	- Cadmium, lead, sulfate

Additional data on waste site groundwater monitoring and groundwater transport modeling and information on chemical contaminants are available in the 26 EIDs prepared as support for the Final Environmental Impact Statement, Waste Management Activities for Groundwater Protection, Savannah River Plant, Aiken, South Carolina (DOE, 1987a).

3.7.2.3 Surface Water

Water-quality monitoring for nonradioactive parameters for onsite streams began as early as 1959. Routine water-quality monitoring of the streams began in 1971. Surface water is monitored at the 71 active SCDHEC-permitted outfalls, at locations on the six SRS streams, and at three locations in the Savannah River (Davis, Martin, and Todd, 1989). SRS had a 99.8-percent NPDES compliance rate in 1988.

Sediments from the Par Pond pumphouse and most locations in the onsite streams contained detectable levels of beta-benzene hexachloride. Other chemicals reported in measurable quantities in sediments from SRS streams were 4,4-DDD, 4,4-DDE, 4,4-DDT, and heptachlor (Zeigler et al., 1987); DDD and DDE are metabolic residues or degradation products of the pesticide DDT; they were also produced as byproducts of the manufacture of DDT (which is no longer produced in the United States) (Parmeggiani, 1983). There is no significant difference between upriver and downriver concentrations. These data indicate that the occasional positive pesticides, herbicides, and PCB concentrations detected in SRS water and sediments originate off the Site (Zeigler, Lawrimore, and Heath, 1986).

3.7.2.4 Soils

At the K-, L-, and P-Areas, information on soil contaminated with hazardous material is limited primarily to that soil underlying nonradioactive or mixed-waste sites. Potential soil contaminants are associated with the wastes disposed of at nonradioactive or mixed-waste sites; these include nonvolatile organics, anions, pesticides, heavy metals, and volatile organics (Stone and Christensen, 1983). Suspected soil contaminants or contaminants identified from borings or sediment sampling and analyses at waste sites include metals
TE and other inorganics at the L- and P-Area acid/caustic basins (Huber, Johnson, and Marine, 1987).

3.8 WASTE MANAGEMENT

This section describes wastes and contaminated materials generated from the operation of K-, L-, and P-Reactors and support facilities that require
TC treatment and disposal or storage. Other documents (e.g., DOE, 1987a) provide more detail on the types and potential quantities of waste generated.

DOE initiated a comprehensive waste management program on the Site following the analysis and selection of a preferred waste management strategy (DOE, 1987a). Through a proposed Federal Facilities Agreement with EPA Region IV and SCDHEC, DOE is categorizing a number of waste site actions under the
TC requirements of RCRA and CERCLA. The final version of this agreement is expected to be completed in the second quarter of Fiscal Year 1991.

In 1987, DOE selected a combination strategy to remove wastes at selected existing hazardous, mixed, and low-level radioactive waste sites and to implement closure and groundwater remedial actions; established a combination of retrievable-storage above- and belowground disposal facilities; and continued the use of seepage and containment basins for the periodic discharge

of reactor disassembly-basin purge water. DOE could dedicate some land areas (about 270 acres) for waste management purposes under this strategy, if it could not return such areas to public use after an institutional control period (DOE, 1987a). | TC

3.8.1 TYPES OF WASTE

The Site generates five basic types of waste: | TC

- Hazardous waste
- Low-level radioactive waste
- Mixed waste (combined hazardous and radioactive wastes)
- High-level radioactive (including transuranic) waste
- Nonhazardous and nonradioactive waste

These liquid, solid, and semisolid wastes originate in reactor and support facility operation, maintenance, and renovation, and include waste held in storage pending treatment or disposal, and wastes from closure or remediation activities at existing waste sites. Closure/remedial-action waste includes contaminated soil or soil/waste mixtures that might be exhumed during the remediation or closure of existing waste sites. | TC

The Site generates or will generate the following hazardous, mixed, low- and high-level radioactive, and nonhazardous and nonradioactive wastes: | TC

- Hazardous and mixed-waste combustible oils, solvents, and solids

- Mixed and low-level radioactive solvents, scintillation solutions, contaminated equipment, building rubble, and job control waste

- Mixed-waste sludges from M-Area and F- and H-Area effluent treatment facilities (ETFs) | TC

- Hazardous, mixed, and low-level radioactive ash and scrubber blowdown from incinerators

- Hazardous, mixed, and low-level radioactive wastes, including contaminated soil that might be exhumed from existing waste sites | TC

- Low-level radioactive liquid wastes from DWPF and the tank farms | TC

- High-level radioactive liquid wastes, including wastes from the operation of K-, L-, and P-Reactors and the chemical separations facilities; these consist primarily of fission products currently stored in tank farms

- Transuranic wastes from the processing of irradiated uranium and plutonium

- Nonhazardous, nonradioactive domestic, solid, and sanitary wastes; sanitary and process liquid effluents (regulated under NPDES); coal ash from steam plant and powerplant operations; and laboratory wastes

- Gaseous (nitrogen oxides and sulfur dioxide) and particulate emissions from coal-fired steam plants and powerplants and auxiliary diesel generators

3.8.2 RATES OF WASTE GENERATION

TE The Site generates large volumes of wastes; Table 3-15 lists typical annual generation-rate estimates for SRS reactors and support facilities. In addition, the Site has a large amount of waste in storage, as indicated in
TE Table 3-16.

3.8.3 WASTE MANAGEMENT FACILITIES

The Site has the following operational waste management facilities:

- Eight regulated hazardous waste management units; four hazardous waste management units exempt from RCRA (totally enclosed waste treatment facilities); and seven regulated solid (nonhazardous) waste management units

- Fifty-three active process and sanitary wastewater treatment plants,
TE including the M-Area Liquid ETF; F- and H-Area ETF, TNX-Area ETF; an air stripper in M-Area to remove volatile organic compounds from contaminated groundwater; staging and satellite waste management areas; and a beta-gamma (radioactive waste) incinerator, currently out of service

The following waste management facilities are in the design or construction phase at the Site:

- Waste Solidification and Disposal Facility (Y-Area)
- Consolidated Incineration Facility (CIF)
- Defense Waste Processing Facility
- New Hazardous/Mixed Waste Disposal Facility
- New Low-Level Radioactive Waste Storage/Disposal Facility
- TRU Waste Facility

The following are demonstration projects for other waste management activities:

- Box/drum compactor
- Greater confinement disposal

3.8.4 WASTE TREATMENT METHODS

DOE has used or is planning to use the following methods for predisposal treatment and/or management of wastes:

TC
- Secure burial
- Interim storage
- Neutralization
- Filtration/oil separation (F- and H-Area ETF)
- Ion exchange/demineralization (F- and H-Area ETF)

- Biological oxidation (sanitary sewage treatment plant) | TC
- Reverse osmosis (F- and H-Area ETF)
- Carbon adsorption (F- and H-Area ETF)
- Stabilization/solidification (Y- and Z-Areas)
- Incineration (CIF)
- Landfilling (sanitary landfills) | TC
- Spray irrigation/land farming
- Evaporation
- Compacting/shredding
- Vitrification (DWPF)
- Offsite management (currently limited to PCBs and some types of organic solvents; eventually TRU and vitrified high-level wastes will be shipped off the site) | TC

Table 3-17 summarizes how many of the existing or planned waste treatment technologies are applied to the five basic types of wastes. | L-78-27

3.8.5 WASTE MANAGEMENT CAPACITY

The capacity for waste management at the Site is limited primarily by the availability of suitable space and by restrictions imposed by state and Federal waste management regulations. In addition, some tanks currently used to store high-level liquid radioactive wastes pending solidification in the Defense Waste Processing Facility are approaching the end of their useful lives; others have been retired from high-level waste storage. | TC

The low-level radioactive waste burial ground is approaching full capacity; it is expected to be full by 1990 or 1991. Similarly, interim hazardous waste storage facilities are approaching physical size limits. The following actions will alleviate these situations in the near future: | TC

- Startup of the DWPF to reduce the volume of high-level radioactive wastes and to convert them to a form suitable for their ultimate disposal; scheduled for operation in 1992 | TC

- Construction and operation of a new low-level solid radioactive waste storage/disposal facility; scheduled for 1991 | TC

- Construction and operation of a new hazardous/mixed solid waste disposal facility; scheduled for 1991 | TC

- Processing of TRU wastes in the TRU Waste Facility (scheduled for completion in 1995) for offsite disposal at the Waste Isolation Pilot Project | TC

- Construction and operation of the CIF to detoxify hazardous, mixed, and low-level combustible wastes; scheduled for 1992 | TC

3.9 EMERGENCY PREPAREDNESS

The comprehensive emergency preparedness planning effort for the Site and the potentially affected areas off the Site includes the development and maintenance of programs and plans at four levels of responsibility: the DOE

Savannah River Operations Office (DOE-SR); the Operating Contractor; the States of South Carolina and Georgia; and Aiken, Allendale, and Barnwell Counties in
TE South Carolina and Burke County in Georgia. Table 3-18 lists specific procedures and emergency plans. The detailed plans contain facility descriptions and equipment lists for emergency response situations. These plans also address operating, design-basis, and potential severe accidents that involve substantial core meltdown.

Emergency planning zones are defined for both on- and offsite areas. These zones represent areas in which planning has occurred to ensure prompt and effective actions for the protection of onsite personnel, public health and safety, and the environment. The onsite emergency planning zone (EPZ) includes the entire site. The offsite EPZ consists of two zones: a plume exposure pathway emergency planning zone and an ingestion exposure pathway emergency planning zone (WSRC, 1990). Plans for response in the plume exposure emergency planning zone are designed to minimize external exposures
TC from the plume and deposited material and skin absorption/inhalation exposures. Plans for response in the ingestion exposure emergency planning zone are designed to minimize exposures from ingesting contaminated food or water.

The affected state is responsible for determining and recommending protective actions for the public within the plume exposure emergency planning zone. (SRS provides recommendations based on accident assessment to aid the state in the decisionmaking process.) The primary protective actions taken for the plume exposure emergency planning zone are sheltering and evacuation. Sheltering is accomplished by personnel going inside a building and reducing exposure to outside air. Evacuation is accomplished by personnel leaving the area by prescribed routes and reporting to a reception center/shelter.

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The offsite plume exposure emergency planning zone for SRS includes all offsite land within approximately 16 kilometers of any incident reactor. Counties that fall within this area include portions of Aiken, Barnwell, and Allendale in South Carolina and a part of Burke County in Georgia. (Richmond County, Georgia, falls outside these zones and does not require planning for the prompt removal of people.) This area has been divided into sections called zones. These zones generally follow easily recognizable geographical and/or political boundaries to help members of the general public determine the zone in which they are located. Zone division also enables a graded response so those members of the general public most at risk (based on the incident type and wind direction) receive instructions addressed specifically to their zone(s). This enhances protective actions such as evacuation because only those people in the identified zone(s) should be on the evacuation routes rather than the population of the entire 16-kilometer radius.

The ingestion exposure emergency planning zone consists of areas that might need to be monitored for contamination of food and water supplies. This
TC covers all areas within an approximate 80-kilometer radius from the center of SRS, and includes the Savannah River Basin to the Atlantic Ocean.

The affected state is responsible for determining and recommending protective measures for the ingestion exposure emergency planning zone. Protective measures could include replacing drinking water supplies, placing animals on

Table 3-18. Emergency Plans and Procedures | TE

Level	Title
DOE	Interim Operations Plan for DOE Field Response to Major Radiological Emergencies, Nevada Operations Office DOE-SR Federal Radiological Monitoring and Assessment Plan, SR 503
Contractor	Emergency Response Plan for Real Time Meteorological and TRAC Support During Unplanned Atmospheric Releases, DPSTOM-75 Savannah River Plant Radiation and Contamination Control, DPSOP 40 100-Areas Emergency and Disaster Plans, DPSOP 67 Fire Control Plan 100 Areas, DPSOP 67-1 200-H Area Emergency and Disaster Plans, DPSOP 115-H Emergency and Disaster Plans, 300/700 Areas, DPSOP 119 400-Area Emergency and Disaster Plans, DPSOP 135 | TC SRP Emergency Operating Center Procedures for EOC Communications Personnel, DPSOP 287 Savannah River Site Emergency Plan 6Q | TC
State	State of Georgia Radiological Emergency Plan Annex C to the Georgia Radiological Emergency Plan (Savannah River Plant) South Carolina Operational Radiological Emergency Response Plan (implemented by the SC Emergency Preparedness Division) South Carolina Technical Radiological Emergency Response Plan (implemented by the SCDHEC, Bureau of Radiological Health)
County	Annex Q, Fixed Nuclear Facility (FNF) Radiological Emergency Response Plan (RERP) to the Aiken County Emergency Operations Plan (EOP) Annex Q, Fixed Nuclear Facility (FNF) Radiological Emergency Response Plan (RERP) to the Allendale County Emergency Operations Plan (EOP) Annex Q, Fixed Nuclear Facility (FNF) Radiological Emergency Response Plan (RERP) to the Barnwell County Emergency Operations Plan (EOP) Annex C, Burke County Emergency Management Agency Emergency Operations Plan for Nuclear Incidents/Accidents Involving the Department of Energy Savannah River Plant | TC

stored feed and groundwater, cleaning produce, milling and polishing grains, diverting products to long-term processing, and isolating contaminated food to prevent consumption. | TC

Within both offsite emergency planning zones, SRS provides information and education about SRS operations, and notifies the public of incidents. In | TC

addition, the States have procedures for population sheltering and possible evacuation within the offsite EPZ. SRS promptly informs the States of all incidents having potential offsite consequences greater than those stipulated in 10 CFR 20 (NRC, 1964).

In August 1974, the Atomic Energy Commission established Memoranda of Understanding (MOU) with the States of South Carolina and Georgia concerning general responsibilities for notification and emergency response to incidents or potential incidents on the Site. DOE renegotiated its memoranda with South Carolina in November 1983 and October 1987, and with Georgia in February 1988 (DOE, 1983, 1987d, 1988b). Table 3-19 lists the agencies and organizations notified.

Table 3-19. Agencies Notified of SRS Radiological Emergencies

Always	When Necessary
DOE-HQ	South Carolina Governor's Office
South Carolina Department of Health and Environmental Control	Georgia Governor's Office
South Carolina Emergency Preparedness Division	U.S. Army Corps of Engineers
Georgia Department of Natural Resources	Federal Aviation Administration
Georgia Emergency Management Agency	Fort Gordon
Vogtle Electrical Generating Plant	Federal Emergency Management Agency
Aiken County, SC	Fort Jackson
Barnwell County, SC	Chem-Nuclear Services, Inc.
Allendale County, SC	CSX Railroad
Burke County, GA	Richmond County, GA

DOE also has an MOU with the Dwight David Eisenhower Army Medical Center at Fort Gordon, Georgia, which has agreed to assist in SRS emergencies and to accept radiation-exposed or contaminated emergency patients (DOE, 1985). In 1986, DOE established MOUs with Georgia Power Company (DOE, 1986a) and the State of South Carolina (DOE, 1986b) concerning incidents at Plant Vogtle, the Site, and cooperative responses.

The Savannah River Site Emergency Plan (WSRC, 1990) provides the basis for responses by DOE and contract management to incidents on the Site, and, when necessary, for interfaces with offsite organizations. These plans provide information and guidance on SRS incidents in the form of organization, responsibilities, and operations. DOE is revising these plans to make them consistent with the requirements of commercial nuclear reactors. DOE is using

a segmented approach in which 3-month milestones mark the update of individual plans. Under the current schedule, the update for DOE emergency plans will be complete by December 1993.

The Operating Contractor, Westinghouse Savannah River Company (WSRC), prepares and implements Site- and facility-specific contractor response plans in accordance with the DOE-SR emergency management orders. These response plans include specific responses to particular onsite incidents for specific facilities, processes, or events. WSRC has either used all plans in actual emergencies or exercised them in simulated operating conditions. DOE and WSRC have integrated these SRS plans with State and local offsite plans to enable coordination of a total response to SRS incidents.

Emergency plans used by the governments of South Carolina and Georgia provide responses to all types of emergencies in the States. Table 3-18 lists the applicable radiological response plans. The State plans establish emergency organizations and assign responsibilities and resources. At present, these plans, along with those of the counties, are undergoing updates. TE

County plans further the implementation of site-specific response actions defined in the state plans. The county plans assign responsibilities for responding to emergency situations. Four of the five counties listed in Table 3-19 have either full- or part-time emergency preparedness directors. Richmond County, Georgia, which is outside the plume exposure EPZ, but which has a large population, also has plans for the notification of and public education about SRS incidents. A-34-10

Like the counties, DOE and the States have designated persons responsible for emergency preparedness. For the portions of the plume exposure EPZ and the ingestion exposure IPZ lying outside the SRS boundary but within the State and county jurisdictions, DOE, the States, and the county agencies have cooperated fully in the development of response plans. TC

In addition to the emergency plans at the various levels, there are onsite and offsite facilities for emergency purposes. The SRS Technical Support Center (TSC; formerly the Emergency Operations Center) is a dedicated facility staffed on a 24-hour basis by operating and security contractor personnel. The TSC is the primary point of contact for reporting SRS emergencies to offsite locations or for receiving emergency communications from offsite. The TSC is the central control point for coordinating onsite emergency response activities. In an emergency situation, senior WSRC personnel control the TSC. At least four emergency training exercises per year test and evaluate the performance of TSC personnel and equipment. The TSC is a self-contained facility with emergency generators and air-filtration systems. The TSC maintains communications through commercial and dedicated telephone lines, including the Emergency Notification Network, which links the TSC with South Carolina, Georgia, county, and Plant Vogtle Emergency Operating Centers.

The SRS Emergency Operations Facility (EOF) is activated in emergency situations to provide the following:

- Overall direction and control of the SRS emergency response effort TC

- Technical interactions with offsite Federal, state, and local officials and agencies

TC - Approval of emergency classification and protective action recommendations to state and local officials

- Generation of news releases

- Strategic and recovery planning

TC Senior DOE personnel provide oversight of contractor response activities in the EOF and TSC. Commercial and ringdown telephones maintain direct communications links with the TSC.

DOE has established an Offsite Communications Center (OCC-A), in Aiken, South Carolina, to ensure a communications link with the Site if highways are impassable, telephone lines are inoperable, or the TSC is not accessible. The OCC-A provides an offsite location for TSC staff or key personnel during a national or local emergency. Communications equipment in the OCC-A is checked TC at least monthly to ensure its operability during emergency communications.

Other offsite planning at the DOE level includes agreements between the States for communications and coordination of all SRS incidents that will affect the TC plume and ingestion exposure areas. DOE also established procedures for responding to offsite radiological transportation accidents (SR 503, "Federal Radiological Monitoring and Assessment Plan"). An emergency response plan being developed by the Nevada Operations Office (Interim Operations Plan for DOE Field Response to Major Radiological Emergencies) will supersede these plans for offsite radiological emergencies. When complete, this document will address DOE response and coordination with other Federal facilities and agencies to offsite radiological emergencies and assessments. At the state level, radiological response plans are based on a full NRC-type Emergency Planning Zone response. The county plans for offsite incidents identify organizations, responsibilities, resources, and coordination to be undertaken by the county. The plans specifically address notification, communication and coordination, public information, public warning, law enforcement, and protective responses, depending on whether portions of the county are in the TC plume exposure EPZ, the ingestion exposure EPZ, or both.

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CHAPTER 4

ENVIRONMENTAL CONSEQUENCES

The purpose of this chapter is to assess the environmental consequences of continuing to operate K-, L-, and P-Reactors at the Savannah River Site (SRS), and of terminating the operation of one or more of these reactors. TC

As discussed in Section 2.4 of this environmental impact statement (EIS), there are no other production options that are reasonable alternatives to the continued operation of K-, L-, and P-Reactors. Accordingly, this chapter does not discuss the environmental impacts of other production options.

Section 4.1 analyzes the environmental impacts of continued operation of K-, L-, and P-Reactors under normal conditions and under postulated accident conditions; it also analyzes impacts from transportation activities associated with reactor operation. Section 4.1.1 describes the impacts associated with the operation of K-Reactor using the existing once-through cooling water system. It also presents a predictive assessment of impacts following the installation of a recirculating cooling-tower system for thermal mitigation at K-Reactor. The proposed cooling system, required under Consent Order 84-4-W between the South Carolina Department of Health and Environmental Control (SCDHEC) and the U.S. Department of Energy (DOE), will consist of a single, recirculating, gravity-flow, natural-draft, cooling tower. The system will operate in a manner similar to that described in the Alternative Cooling Water Systems EIS (DOE, 1987b), and will result in a reduction of environmental impacts compared to those associated with the existing once-through cooling system (Du Pont, 1989). The analysis in this EIS is based on all three reactors operating at a hypothetical full power of 3,000 megaWatts to bound the effects. It also discusses the impacts of operating the reactors at less than full power. The impacts of cold shutdown and cold standby are essentially the same as those described for the cold standby condition analyzed under Alternatives 2 and 3, except the loss of jobs would be less in the case of cold shutdown. Section 4.1.6 presents the cumulative effects of the operation of K-, L-, and P-Reactors in combination with other SRS and nearby facilities. TC

Section 4.2 analyzes the effects of terminating operation of one or two reactors in the immediate future and maintaining the reactors in cold standby; TC
Section 4.3 analyzes the effects of terminating the operation of K-, L-, and P-Reactors in the immediate future and maintaining them in cold standby. TC
Section 4.4 discusses decontamination and decommissioning, and Section 4.5 discusses possible mitigation measures that are not considered to be part of the proposed action or alternatives.

4.1 K-, L-, AND P-REACTOR OPERATION

This section characterizes the expected nonradiological and radiological impacts of continuing the operation of K-, L-, and P-Reactors.

4.1.1 NONRADIOLOGICAL IMPACTS OF REACTOR OPERATION

Nonradiological effects include those that result from withdrawal and discharge of cooling water, discharge of liquid and atmospheric chemical effluents, and disposal of solid nonradiological wastes.

4.1.1.1 Land Use and Socioeconomics

The continued operation of K-, L-, and P-Reactors would not result in a change of land use at SRS. The construction and operation of the K-Reactor cooling tower would produce some impacts at SRS; DOE has assessed these impacts (DOE, 1987b).

Socioeconomic impacts should show a continuation of past trends, as described in Section 3.2. For the most part, the socioeconomic effects of continued operation would be beneficial. SRS has contributed substantially to the rise in the standard of living in the region. The SRS budget for Fiscal Year (FY) 1989 was about $3.2 billion; the FY 1990 budget is nearly $3.7 billion.

4.1.1.2 Surface-Water Usage

Secondary cooling water for L- and K-Reactors would continue to be withdrawn from the Savannah River. P-Reactor would continue to withdraw secondary
TE cooling water from Par Pond and supplementary cooling water from the river to replace evaporative and other losses. A recirculating cooling tower for
TC K-Reactor is under construction.

As noted in Section 3.4.1.2, withdrawals from the Savannah River would continue at a rate of about 11.3 cubic meters per second each for K- and L-Reactors using once-through cooling; withdrawals from the river for makeup water for P-Reactor will remain at about 1.0 to 1.4 cubic meters per second. Beginning in 1993, the operation of the K-Reactor cooling tower would reduce surface-water usage by K-Reactor to the quantities required for makeup of
TE evaporative losses and blowdown and other flows (about 1.8 cubic meters per second). Surface-water withdrawal for K-, L-, and P-Reactors would total about 24 cubic meters per second (not including D-Area) prior to cooling-tower operation. With the K-Reactor cooling tower in operation, total SRS withdrawal for the reactors from the river would decrease to about 14.5 cubic meters per second, of which less than 3 cubic meters per second would be removed from the river system by evaporation.

TC The withdrawal rates of 24 and 14.5 cubic meters per second represent about 13 and 8 percent, respectively, of the mean annual Savannah River flow at Augusta, Georgia, during the 1985-1988 drought period. A minimum Savannah River flow of 138 cubic meters per second is required to enable the pumping of cooling water to three reactors. The withdrawal rates of 24 and 14.5 cubic
L-46-02 meters per second represent about 17 and 11 percent, respectively, of this
L-46-04 flow. The minimum river flow requirement to enable two-reactor operation is 117 cubic meters per second. With two reactors operating, withdrawals from the river would be reduced by at least 1.4 cubic meters per second to 22.3 cubic meters per second before and to 13.1 cubic meters per second after the K-Reactor cooling tower begins operating. Flow rates of 22.3 and 13.1 cubic

meters per second represent 19 and 11 percent, respectively, of the 117 cubic meters per second required to enable the operation of two reactors. L-46-02 L-46-04 Withdrawal of this water would affect the aquatic ecology of the Savannah River by (1) entraining aquatic organisms (predominantly fish eggs and larvae) and macroinvertebrates smaller than the screen mesh in the intake system, and (2) impinging aquatic organisms (primarily fish) on the intake screens. No significant effect on downstream water users should occur from this water withdrawal, because less than 3 cubic meters per second would be lost to the river system by evaporation. TE

If a prolonged drought were to recur, DOE would cooperate with the U.S. Army Corps of Engineers and other Federal and state agencies in the allocation of available water resources among competing uses.

TC

Operation at reduced power levels would not affect the rate of cooling water withdrawals, because secondary coolant flow is constant and does not vary with the power level (Jenkins, 1989); the discharge temperature increment is directly proportional to the reactor power level. For a given amount of material to be produced, the operation of the reactors at reduced power levels would require a longer period of operation at power, thereby extending the impacts. The following sections present impacts on a per-year basis, unless noted otherwise. Evaporative losses would diminish due to lower heat rejection demands. The following sections discuss the effects on surface water of the continuing operation of each reactor.

4.1.1.2.1 K-Reactor Operation

The SRS withdraws Savannah River water at the 1G and 3G pumphouse intakes (see Figure 3-7) to supply once-through cooling for K- and L-Reactors (approximately 11.3 cubic meters per second for each reactor; Du Pont, 1987a, 1988a), and makeup water for Par Pond (1.0 to 1.4 cubic meters per second when P-Reactor is operating at full power) to compensate for water losses from TC evaporation, overflow, and seepage (Du Pont, 1985a). Based on studies conducted from 1983 to 1985 (DOE, 1987a,b), this withdrawal results in the average annual loss of approximately 17.6 x 10^6 fish larvae (range: 10.2 x 10^6 to 26.1 x 10^6 larvae) during the February-to-July spawning season at the SRS. Estimated losses of fish eggs average 9.3 x 10^6 (range: 5.3 x 10^6 to 14.0 x 10^6 eggs) each spawning season. Because about 47 percent of the water drawn into the two intakes is used for cooling K-Reactor, this percentage of the total loss of larvae (8.3 x 10^6) and eggs (4.4 x 10^6) can be attributed to the operation of this facility. The taxonomic groups whose larvae are most impacted by entrainment through the 1G and 3G intakes are the Clupeidae (shad, herring, etc.) the Centrarchidae (crappie, sunfish, etc.), and the Cyprinidae (carp, etc.). The eggs of the American shad and striped bass are entrained most often, accounting for an average 73 percent of all eggs entrained.

From 1983 to 1985, overall entrainment losses for K-Reactor operation averaged approximately 5.1 percent (range: 4.1 to 7.0 percent) of the ichthyoplankton TC passing the SRS intakes. Egg losses were concentrated among two anadromous species, American shad and striped bass, but only populations spawning in the reach between the New Savannah Bluff Lock and Dam and the SRS are affected. American shad and striped bass spawn throughout the Savannah River, but the primary region for striped bass spawning is in tidally influenced portions of

TE | the river near Savannah. Entrainment of ichthyoplankton of nonanadromous species primarily affects the eggs and larvae of individuals that spawn in the vicinity of the intake canals, either in the river or in the 1G and 3G canals. Consequently, the effect of entrainment of fish eggs and larvae should be minimal and restricted to local fish populations (Du Pont, 1987a).

During investigations conducted annually from 1983 to 1985 (DOE, 1987a,b), projected annual impingement for the 1G and 3G intakes combined averaged approximately 5,885 fish (range: 2,986 to 9,534 fish per year), about 47 percent (2,772 fish per year) of which can be attributed to the operation of K-Reactor. The principal species affected were bluespotted sunfish and threadfin shad; gizzard shad, redbreast sunfish, and warmouth were also impinged frequently.

TC | After the K-Reactor cooling tower becomes operational, river withdrawals to supply cooling water for this reactor would be reduced from 11.3 to 1.8 cubic meters per second. Entrainment and impingement losses due only to K-Reactor generation would be reduced proportionately (by about 84 percent). Based on the 1983-1985 studies conducted on the SRS (DOE, 1987a,b), average entrainment losses of 13.2 x 10^5 fish larvae and 7.0 x 10^5 fish eggs (or an average of 0.8 percent of the ichthyoplankton passing the SRS intakes) and average impingement losses of about 450 fish are predicted to occur annually as a result of the operation of K-Reactor with a recirculating cooling tower.

4.1.1.2.2 L-Reactor Operation

As with many new reservoirs, eutrophication occurred in L-Lake initially following impoundment through the release of nutrients from basin sediments. However, the input of nutrients in Savannah River water pumped to cool
TC | L-Reactor is sufficient to maintain eutrophic conditions in the lake (Du Pont, 1988a). Typical eutrophication effects, such as high primary productivity and algal biomass and dominance by bluegreen algae, have been observed during monitoring studies conducted in L-Lake. However, no clearly adverse impacts of eutrophic conditions on the overall functioning of the L-Lake ecosystem have been observed. Section 4.1.1.4.2 contains details on the development of the L-Lake ecosystem.

Based on studies conducted from 1983 to 1985 (DOE, 1987a,b), estimated average entrainment losses of 8.3 x 10^6 fish larvae and 4.4 x 10^6 fish eggs (or an average of 5.1 percent of the ichthyoplankton passing the SRS intakes) and average impingement losses of 2,772 fish would occur annually as a result of the operation of L-Reactor.

4.1.1.2.3 P-Reactor Operation

The addition of Savannah River makeup water to Par Pond results in nutrient enrichment, because water contributed through rainfall and natural drainage in the watershed to the pond is considerably lower in nutrients than water pumped
TE | from the river (Du Pont, 1985a). A comparison of recent data (1983-1985; Du Pont, 1985a) with historic data (1972-1976; Tilly, 1981) revealed no substantial changes in the physiochemical characteristics of Par Pond. Par Pond can be classified as an oligotrophic to mesotrophic lake (reservoir) on

the basis of water chemistry and biological community characteristics. Comparative data indicate that Par Pond is lower in nutrients than most other lakes and reservoirs of the southeastern United States (Du Pont, 1985a).

A maximum of 5.8 percent of the water withdrawn from the 1G and 3G pumphouses is used as makeup for Par Pond when P-Reactor is operating at full power (Du Pont, 1985a). Based on studies conducted from 1983 to 1985 (DOE, 1987a,b), an estimated average of 10.2×10^5 fish larvae and 5.4×10^5 fish eggs (or an average of 0.6 percent of the ichthyoplankton passing the SRS intakes) would be lost annually from the Savannah River population through entrainment in the makeup water. An average of 341 fish would be lost annually from the river as a result of this withdrawal. |TC |TE

Reactor operation, with its accompanying pumping of Savannah River makeup water and recycled Par Pond water, reduces the retention time of water in Par Pond by a factor of approximately 10 compared to the retention time estimated on the basis of natural drainage alone. This decreased retention time results in enhanced mixing and distribution of plankton and nutrients in the limnetic zone. Present pumping practices associated with reactor operation also cause less severe water-level fluctuations (generally less than 0.3 meter) in Par Pond than would occur naturally (estimated to be more than 0.6 meter), enhancing the stability of habitats for macrophytes, macroinvertebrates, periphyton, and fish in the littoral zone.

Ichthyoplankton in Par Pond are subject to entrainment in the P-Reactor cooling system because the reactor operates in a recirculation cooling mode. All ichthyoplankton entrained in the P-Reactor cooling system when the reactor is operating are assumed to be killed due to the high lethal temperatures in the heat exchangers. Based on samples taken during daylight hours, an estimated 19.8×10^7 larvae and 0.2×10^6 eggs were entrained in the Par Pond water intakes during the 17 months from January 1984 to June 1985 (Paller and Saul, 1985). Entrainment rates were 15 times higher from January to mid-June 1984 than from January to mid-June 1985. This was the result of higher larval densities near the intakes during 1984 and higher pumping rates during April 1984. Diurnal samples indicated that entrainment rates were as much as 10 times higher during the night than during the day; thus, total entrainment in Par Pond might have been as much as 5 times greater than the earlier estimate, which was based only on daytime samples. Researchers observed a lack of correlation between entrainment rates and lakewide ichthyoplankton densities (Paller and Saul, 1985). Ichthyoplankton densities in Par Pond were much higher in 1984 than in 1985, despite the fact that pumping rates were higher during 1984, suggesting that factors other than entrainment control ichthyoplankton abundance in Par Pond. |TC |TC

Based on the 1984-1985 studies, entrainment has no adverse effect on the fish community of Par Pond because (1) the Par Pond fish community compares favorably with fish communities in other reservoirs in the southeastern United States in terms of species richness, species diversity, and standing crop; (2) the percentage of gamefish is higher in Par Pond than in most other southern reservoirs, and the percentage of nongamefish is lower; (3) the fish in Par Pond represented all the major trophic levels typically found in southeastern reservoirs; (4) historic data suggests that the fish community in Par Pond is relatively stable in its major features, such as standing crop and |TC

species composition; and (5) collection of early life stages (juveniles, larvae, and eggs) indicates that most or all Par Pond fish populations are reproducing and represent self-maintaining populations (Du Pont, 1985a).

Impingement of fish on intake screens is minimal in Par Pond. The stationary screens at the Par Pond water intakes are inspected once a year and the trash racks are inspected approximately every 5 years. Dead fish have never been observed on either the trash racks or the screens during these inspections. Mean current velocities are approximately 23 centimeters per second at the trash rack and 11 centimeters per second at the stationary screens. These velocities are considerably less than the maximum swimming speeds of healthy adult specimens of the common Par Pond species.

4.1.1.3 Groundwater Usage

Six wells in the K-, L-, and P-Areas withdraw groundwater from the Cretaceous sediments of the Black Creek/Middendorf Formation. Specifically, production figures for the first quarter of 1989 indicate that two wells in K-Area withdraw 1,080 cubic meters per day, two wells in L-Area withdraw 1,354 cubic meters per day, and two wells in P-Area withdraw an average of 1,944 cubic meters of groundwater per day (WSRC, 1989a). In 1987, the SRS withdrew approximately 38,880 cubic meters of groundwater daily (0.45 cubic meter per second) (DOE, 1987c).

Overall, activities associated with reactor operation in K-, L-, and P-Areas have little or no lasting effects on SRS or regional groundwater levels. The Cretaceous sediments of the Black Creek/Middendorf Formation can sustain well
TC | yields as high as 7 cubic meters per minute, or approximately 10,000 cubic meters per day, for reactor operation with no adverse effects on pumping capabilities (Siple, 1967). At present, groundwater use in K-, L-, and P-Areas is substantially below this estimate (WSRC, 1989a). In addition, the Cretaceous sediments can supply about 37.8 cubic meters per minute (0.63 cubic meter per second), or approximately 54,432 cubic meters per day, for SRS operations (Siple, 1967). The Cretaceous sediments aquifer could be even more productive with better designed well fields. Further, pumping from the Black Creek/Middendorf will have no effect on the hydraulic heads in the Congaree and overlying formations because the Black Creek/Middendorf has a poor hydraulic connection with them (DOE, 1984a). Finally, simulations conducted on groundwater production at the reactors indicate that reactor operation have produced no changes in groundwater levels (WSRC, 1989a).

4.1.1.4 Thermal Discharge

4.1.1.4.1 K-Reactor Operation

Flow and Temperature: Once-Through Cooling and Recirculating Cooling Tower

The average flow in the Pen Branch system when K-Reactor operates in the once-through cooling mode is about 11.3 cubic meters per second higher than natural stream flows (0.03 cubic meter per second for Indian Grave Branch and 0.1 to 0.3 cubic meter per second for Pen Branch) (DOE, 1987b). These flow
TC | rates would be maintained under full-flow testing and when K-Reactor resumes production without a cooling tower. After completion of the K-Reactor

cooling-tower system, flow to Pen Branch from K-Reactor would be reduced to 1.3 cubic meters per second higher than natural stream flows. | TC

When K-Reactor operates in the once-through cooling mode, maximum water temperatures of the discharge reach about 73°C during extreme summer conditions, with water temperatures at the Pen Branch delta reaching about 52°C. Maximum ambient stream temperatures during summer are about 33°C. When K-Reactor operates in the once-through cooling mode under average winter conditions, temperatures along Indian Grave Branch and Pen Branch below the confluence with Indian Grave Branch range from 66°C at the discharge point to 43°C in the delta area. These discharge temperatures do not comply with South Carolina Class B water classification standards (i.e., 32.2°C maximum temperature and a maximum 2.8°C rise above ambient temperature; SCDHEC, 1989). Consent Order 84-4-W, as amended, allows the continued discharge of thermal effluents pending completion and operation of the recirculating cooling tower by December 1992. With respect to the maximum 2.8°C rise in ambient temperature, DOE will continue to operate under Consent Order 84-4-W, even after the cooling tower begins operation, until a Section 316(a) study has been completed, and SCDHEC has accepted it. DOE has started the construction of the recirculating cooling tower. TC

When K-Reactor operates with the recirculating cooling tower under summer conditions, predicted mean water temperatures at the Pen Branch delta would be 27°C, or 3.5°C above the mean ambient water temperature (Du Pont, 1989). During January (when water temperatures reach the yearly low), water temperatures at the delta would average 8°C, 0.3°C above the average ambient January temperature (Du Pont, 1989).

Impacts of Once-Through Cooling Mode of Operation

Stream flow and water temperatures in Pen Branch resulting from operation of K-Reactor in the once-through cooling mode would affect the aquatic and terrestrial communities in and along Indian Grave Branch and lower Pen Branch as they have in the past (DOE, 1987b). In the area closest to the thermal discharge, species of algae with high thermal tolerance would be the only biota to occur in limited areas. Farther downstream, aquatic vegetation would be limited to thermally tolerant algae, but riparian vegetation would occur in certain areas. In the lower Pen Branch corridor, the high flows and temperatures resulting from once-through discharge would allow the occurrence of isolated riparian communities on sandbars and stumps. In the delta area, riparian vegetation would consist of thermally tolerant herbaceous flora. In the swamp, loss of tree canopy in the forested wetlands would continue at the rate of about 10 to 12 acres per year, the historic average, as a result of temperature effects and flow-induced sediment transport and delta formation (Du Pont, 1987a; WSRC, 1989b).

The operation of K-Reactor at higher power levels in the once-through cooling mode would eliminate most of the aquatic macroinvertebrate species that have become established in the stream during the cessation of thermal discharges. Most species would continue to be absent from Indian Grave Branch and the Pen Branch corridor during reactor operations. A few benthic species would occur deep in the stream mud and in the cooler refuges along the margins of the creek. Macroinvertebrates would be virtually absent from the stream corridor.

With the continued operation of the reactor in the once-through cooling mode, resident populations of fish (sunfish, shiners, bullheads, etc.) would be present in the upper reaches of Pen Branch above the confluence with Indian Grave Branch; some spawning could continue. Fish kills would occur only at reactor startup; this is because the secondary cooling flow that begins before TC reactor startup washes many fish downstream. Any remaining fish trapped in the pools or eddies are killed due to thermal effects. No fish would be present in the main corridors of the creeks below K-Reactor during discharge of heated effluent; in addition, species diversity and abundance would be smaller in the swamp/delta area during once-through cooling operation. Fish would be found in cooler refuge areas along the shoreline of the main thermal channels. Because the heated discharge water cools to within permit limits by the time the flow reaches the mouth of Steel Creek (Du Pont, 1987a), no impact should occur to fish populations in the Savannah River. Ichthyoplankton would continue to be absent or at greatly reduced densities in Pen Branch. In the delta, the dominant ichthyoplankton would be mosquitofish, which are found principally in the cooler refuge areas.

With the operation of K-Reactor in the once-through cooling mode, waterfowl use of Pen Branch would continue to be associated primarily with the delta and slough areas where the creek empties into the swamp. These areas, as well as much of the Savannah River Swamp near the SRS, would continue to provide foraging habitat for migratory species during fall and winter.

Reduction in K-Reactor power levels when the once-through cooling mode is used would result in improved development of diverse zooplankton and algal TE populations in the Indian Grave Branch and Pen Branch stream and delta. In addition, progressively greater improvement in the diversity of stream macroinvertebrate communities would occur as effluent temperatures decreased from 40°C to 32°C, and substantial increases in the abundance and diversity of fish would occur if the water temperatures are reduced to or below 30°C to 35°C.

The operation of K-Reactor at production-power levels in the once-through TE cooling mode would result in water temperatures that exceed the critical thermal maximum for the American alligator; a few individuals could occupy cooler refuges along the margins of the creeks and delta. The endangered wood stork probably would not use Pen Branch during reactor operations with once-TC through cooling because the habitat is extremely limited for foraging. No impacts are expected on the endangered shortnose sturgeon or red-cockaded woodpecker.

Cold-flow testing of K-Reactor (see Section 2.1.2.3.3) will have a number of physical and biological effects in the Indian Grave Branch/Pen Branch system, the severity of which will depend on the duration of testing and magnitude of flows. The magnitude of these flows, however, would be less than those that occur naturally from an intense rainfall over the Indian Grave Branch/Pen TC Branch watershed. Substantial increases in Pen Branch flows will produce upstream scouring of the streambed and downstream deposition of sediments. These increased flows will also result in downstream displacement or loss of resident phytoplankton, zooplankton, and macroinvertebrates (especially aquatic insects). Increased flows will drive fish downstream to regions of reduced flow and could strand a small number of fish in upland areas when "flood" waters recede.

However, there could also be short-term benefits downstream from increased nutrient loads and the creation of temporary habitat for foraging wading birds (such as the wood stork) and migrating waterfowl. Downstream transport of stream invertebrates during periods of high discharge will present fish in downstream sections and the Pen Branch delta area with a valuable (if short-lived) food source. There will be, to some degree, a balancing of ecological "accounts," with upstream animals suffering and downstream animals benefitting. The potential impacts of cold-flow testing will be insignificant in comparison to impacts of full-power operation. TC

Impacts of Recirculating Cooling-Tower Operating Mode

Reductions in stream flow and water temperature resulting from the operation of K-Reactor with the recirculating cooling-tower system would greatly reduce impacts to biota in the Pen Branch system and the Savannah River Swamp. Operation of K-Reactor with the cooling-tower system should permit the establishment of balanced biological communities, including plants, macroinvertebrates, and fish, in the Pen Branch and Fourmile Branch ecosystems, as described in the Alternative Cooling Water Systems EIS (DOE, 1987b), the Predictive Section 316(a) Demonstration for Steel Creek (Du Pont, 1984b), and the Predictive Section 316(a) Demonstration for Pen Branch (Du Pont, 1989). TE

When K-Reactor is operated with the recirculating cooling-tower system, initial rapid recolonization of the macroinvertebrate community should occur, but several years would be required, at a minimum, for the community to approach stability. This community should continue to undergo long-term succession, as regrowth of vegetation in the delta area occurs, providing greater habitat diversity. Potential impacts on the American alligator and the wood stork would decrease because of the reduced water temperatures and reduced stream flow, which would provide new available habitat for these species.

4.1.1.4.2 L-Reactor Operation

The cooling water discharge for L-Reactor was incorporated into the SRS National Pollutant Discharge Elimination System (NPDES) permit with an effective date of March 19, 1985. To meet water temperature criteria for this discharge, DOE constructed L-Lake. NPDES permit requirements for the thermal discharge are as follows:

- At least 50 percent of the lake must be maintained at 32.2°C or below, based on a consecutive 5-day integrated average temperature measured at a depth of 0.6 meter. TE
- The integrated daily average temperature over at least 50 percent of the lake must not exceed 35°C. TE
- The temperature of water exiting L-Lake into Steel Creek should not exceed 32.2°C.

In addition, the NPDES specifications for the L-Reactor discharge mandated biological studies to confirm the initial DOE predictions on the development and maintenance of a balanced biological community in at least 50 percent of

L-Lake (Du Pont, 1984a) and in Steel Creek (Du Pont, 1984b). These specifications required biological studies for Steel Creek because DOE predicted that exit temperatures from the lake would exceed 2.8°C above seasonal ambient temperatures.

DOE submitted a plan to SCDHEC to conduct a biological monitoring program in L-Lake and Steel Creek; the plan was implemented in January 1986. Results of the first 2 years of the biological monitoring program were reported in June 1988 (Du Pont, 1988a) and are presently being reviewed by SCDHEC. The following paragraphs summarize pertinent results.

The monitoring studies conducted in L-Lake indicate that the primary influences on biological components of the ecosystem are the early age of the reservoir and the input of nutrient-rich Savannah River water through the L-Reactor cooling system. Most biotic communities in L-Lake are undergoing substantial fluctuations in population size and species composition that do not appear to be related to the release of thermal effluents from L-Reactor. The only occurrence during the first 2 years of monitoring in L-Lake that is clearly related to the input of thermal effluents and that has adverse consequences for biota are fish kills that occur during reactor startup operations. These fish kills are restricted to areas near the L-Reactor outfall; they have not extended downstream of the mid-lake compliance zone.

The first 2 years of monitoring have shown that the fish community in the lower half of L-Lake is developing satisfactorily toward a balanced biological community (Paller et al., 1987; Paller et al., 1988; Du Pont, 1988a). Community composition is generally similar to that occurring in other cooling reservoirs; all major fish species have demonstrated successful reproduction and recruitment to juvenile and adult stages. All expected trophic groups and typical reservoir food chains are present. The major fish kills have been associated with reactor startups after extended outages and have primarily affected juveniles believed to be the spawn of fish that immigrated to the discharge area from other lake regions during periods of return to ambient water temperatures. Extensive studies to date have provided no evidence that fish community structure or productivity in the lower 50 percent of the lake has been adversely affected by these kills.

Overall, the ecosystem in the lower 50 percent of L-Lake is progressing satisfactorily toward the development of a balanced biological community. The composition of the biota does not appear to be strongly influenced by the thermal effluent, overall species richness and organism abundance are developing satisfactorily, the vast majority of species are self-maintaining, and the trophic structure of the lake ecosystem is functioning properly.

TE | The Steel Creek ecosystem downstream from the L-Lake dam does not appear to have been adversely affected by the small changes in the creek thermal regime that resulted from the construction of the lake and the release of thermal effluents into the reservoir. Although biotic components of the stream ecosystem have changed since the resumption of L-Reactor operation, the changes are largely those to be expected as a result of the construction of a reservoir on the stream and the increases in stream discharge. Observed changes are restricted primarily to the Steel Creek corridor between the L-Lake dam and the post-thermal delta and swamp. Many biotic components of

the Steel Creek ecosystem continued to change during the first 2 years of the study, and further changes are expected. These changes are neither thermally related nor deleterious to the development and persistence of a balanced biological community in Steel Creek downstream from the dam.

On June 6, 1990, SCDHEC issued an executed settlement agreement with DOE on fish kills in upper L-Lake. This agreement requires DOE to submit a report to SCDHEC describing options for avoiding future fish kills, identifying the selected options to be pursued, and providing a schedule for implementation. On July 5, 1990, as required by the settlement agreement, DOE submitted to SCDHEC a Remedial Action Plan describing options for avoiding future fish kills. After SCDHEC review and approval, DOE will undertake the selected options in accordance with the approved schedule. The options include a reduction of the rate of temperature increase during reactor restarts; limited shoreline contouring to eliminate fish entrapment; and isolation of the L-Reactor discharge canal by the use of a weir. L-45-02

The power level of L-Reactor is reduced during warmer seasons to maintain L-Lake water temperatures within thermal limits. Cooling water discharge volume remains constant regardless of power level. Consequently, although discharge temperatures are lower and temperatures in the upper half of L-Lake are reduced, water temperatures in the lower half of L-Lake change little with changes in reactor power level. Reduced power operation of L-Reactor might alter algal and zooplankton communities in the lower lake by improving conditions in the upper lake. Macroinvertebrate communities in the lower half of L-Lake would not be affected by power level reduction. The operation of L-Reactor at reduced power levels probably would reduce the magnitude of fish kills in the upper end of L-Lake. Reduced power levels probably would not affect fish resources in the lower half of the lake. Operation of L-Reactor at reduced power would not alter the environmental consequences described for reactor operation for algal and zooplankton, macroinvertebrate, and fishery communities in Steel Creek (WSRC, 1989b). TC L-45-02 L-80-01

DOE believes that the operation of L-Reactor could cause increases in populations of pathogenic Naegleria fowleri based on previous observations and studies in L-Lake (Tyndall et al., 1989). DOE will continue its present monitoring programs and consider study results to determine the need for any future actions. L-78-18

Cold-flow testing at L-Reactor will have similar, but less, impact on the Steel Creek corridor and delta due to the natural damping effect of the L-Lake reservoir and outlet structure. Similar to the effects of K-Reactor, the short-term potential impacts of L-Reactor testing will be insignificant in comparison to the impacts of full-power operation. TC

4.1.1.4.3 P-Reactor Operation

Comprehensive Section 316(a) Demonstration studies conducted for P-Reactor during 1984 and 1985 (Du Pont, 1985a) demonstrated the maintenance of a balanced biological community, and that thermal effects on aquatic biota are highly localized near the effluent entry point in Par Pond (Hot Dam) and are generally of a stimulatory nature (e.g., higher primary and secondary production). A comparison of 1984-1985 data with data collected earlier TC TE

(primarily in the 1970s) indicated that few changes in the function and structure of the principal biological communities in Par Pond have occurred over the years. Thus, these communities are assumed to have remained
TC | relatively stable over a period of several years.

The biotic communities of Par Pond compare favorably in terms of species composition, relative abundance, and diversity to all other lakes and reservoirs for which comparable data could be obtained. Thus, Par Pond clearly contains a balanced indigenous biological community that (1) is not dominated by pollution-tolerant organisms, (2) has diversity and productivity characteristic of lakes in the region, (3) contains representatives of all trophic groups typical of lakes in the region, and (4) contains biotic communities that are self-sustaining (successfully reproducing). Red sore disease observed in bass in Par Pond has been attributed at least in part to thermal conditions (Esch and Hazen, 1978). It was not observed in 1984 or 1985 (Paller and Saul, 1985).

Fish kills have been documented in Pond C, which is the last in a series of six precooler ponds located between P-Reactor and Par Pond. Fish kills in Par
L-80-01 | Pond are very unusual. The only reported fish kill involved several thousand spawning blueback herring; this kill was attributed to thermal shock from swimming from 16°C water to 25°C water near the Pond C discharge (Clugston, 1973). Fish kills in Pond C principally occur following a startup of P-Reactor after outages longer than approximately 2 weeks. These protracted outages occur approximately once per year for reactor maintenance. The fish killed are primarily young-of-the-year and yearling bluegill and mosquitofish. Most of the fish killed are believed to be part of resident populations that reside principally in isolated cool water refugia within Pond
TC | C (Aho et al., 1986). Fish kills in Pond C have no detrimental effects on fish communities in Par Pond, Lower Three Runs Creek, or the Savannah River (WSRC, 1989b).

The Section 316(a) Demonstration studies conducted during 1984 and 1985 indicated the maintenance of a balanced biological community (BBC) in Par Pond and demonstrated that the thermal effects on aquatic biota are highly
L-45-02 localized near the effluent entry point. SCDHEC concurred with this
L-80-01 conclusion and with the determination that the operation of P-Reactor poses no threat to the continued existence of this BBC, but stipulated that thermally caused fish kills that occasionally occur in Pond C be eliminated (Joy, 1987). On June 6, 1990, SCDHEC issued an executed settlement agreement with DOE on fish kills in Pond C. This agreement requires DOE to submit a report to SCDHEC describing options for avoiding future fish kills, identifying the selected options to be pursued, and providing a schedule for implementation. On July 5, 1990, as required by the settlement agreement, DOE submitted to SCDHEC a Remedial Action Plan describing options for avoiding future fish kills. After SCDHEC review and approval, DOE will undertake the selected options in accordance with the approved schedule. These options include a reduction of the rate of temperature increase during reactor restarts, and limited shoreline contouring to eliminate fish entrapment.

Operation of P-Reactor at less than full power would not have a significant adverse impact on the phytoplankton, periphyton, or zooplankton communities of
TC | Par Pond; primary and secondary productivity would decline slightly. However,

reduced power operation probably would reduce algal productivity, and thus reduce secondary production of macroinvertebrates in the Hot Arm of Par Pond. The environmental consequences for fishery resources in Par Pond are not expected to be altered by P-Reactor power reduction; reduction of water temperatures below approximately 35°C would result in substantial reduction or elimination of fish kills in Pond C (WSRC, 1989b). TC TC

Cold-flow testing at P-Reactor should have even less impact on Lower Three Runs Creek than those in Pen Branch or Steel Creek, due to the use of the recirculating cooling water from Par Pond and natural flow effects in Lower Three Runs Creek below the Par Pond dam. TC

4.1.1.5 Wastewater Discharge Permit Compliance

Nonradiological effluent limits for outfalls in the K-, L-, and P-Reactor areas have been established by the NPDES permit (No. SC0000175). Table 4-1 lists the results of the required NPDES permit monitoring program chemical limits as they apply to K-, L-, and P-Reactor area outfalls for 1985 through 1988. K-, L-, and P-Reactors produced nuclear materials from 1985 through 1987, but have been inactive from 1988 to the present.

As indicated in Table 4-1, compliance with chemical permit limitations for operating years 1985 through 1988 was above 99 percent. Based on the past history of extensive monitoring to ensure compliance with NPDES permit requirements, impacts of the continued operation of K-, L-, and P-Reactors should have insignificant effects on the chemical water quality of Pen Branch and Indian Grave Branch, L-Lake and Steel Creek, and Par Pond and Lower Three Runs Creek, respectively. TC

4.1.1.6 Floodplain/Wetlands

This section describes the potential impacts of the continued operation of K-, L-, and P-Reactors on the SRS floodplains and wetlands. DOE regulations (10 CFR 1022) that implement Executive Orders 11988 (Floodplain Management) and 11990 (Protection of Wetlands) require an assessment of the impacts of DOE actions that could affect floodplain/wetland values.

The continued operation of K- and L-Reactors would result in the continued alteration of wetlands in the Pen Branch and Steel Creek corridors, respectively. The final report of the Comprehensive Cooling Water Study (Du Pont, 1987a) and the Reactor Operation Environmental Information Document (WSRC, 1989b) describe the SRS wetlands resources, historical impact patterns, and impacts of reactor operation more fully. TE

4.1.1.6.1 Floodplain

Executive Order 11988 requires the use of the base floodplain when evaluating Federal actions. The base floodplain is the area that, during any given year, has 1 chance in 100 of being inundated (i.e., the 100-year flood). The SRS base floodplain (compiled from U.S. Geological Survey quadrangle maps) covers approximately 37,000 acres (Figure 4-1). It is associated primarily with the Savannah River and the six principal streams that drain the SRS. Nearly half (46.6 percent) of the SRS base floodplain is adjacent to the river; the

TC

Table 4-1. Comparison of K-, L-, and P-Reactor Area Outfalls with NPDES Chemical Permit Limits

Area/Year	Percent Compliance (%)	Noncompliance
K-Area[a]		
1985	100	2 exceedances of TSS[b] limits
1986	99.5	1 exceedance of TSS and 2 of oil and grease limits
1987	99.4	
1988	100	
L-Area[c]		
1985	99	2 cases of failure to report required information
1986	100	
1987	100	
1988	100	
P-Area[d]		
1985	99.2	2 exceedances of TSS limit
1986	100	
1987	99.8	1 exceedance of pH limit
1988	100	

a. K-Area Outfalls = K-001, K-006, K-008, K-010, K-011, K-012.
b. TSS = Total suspended solids.
c. L-Area Outfalls = L-007, L-007A, L-008, L-010.
d. P-Area Outfalls = P-005, P-007, P-013, P-014, P-019.

remainder occupies the corridors of Upper Three Runs Creek (19.0 percent), Lower Three Runs Creek (17.3 percent), Par Pond (8.3 percent), Steel Creek (4.6 percent), Fourmile Branch (2.4 percent), and Pen Branch (1.7 percent).

Access to the SRS is strictly controlled. No dwellings, hospitals, schools, nursing homes, or other structures are within the base floodplain. The continued operation of the SRS reactors would not require any construction activities within the floodplain; consequently, there would be no change to flooding potential or flood levels.

4.1.1.6.2 Wetlands

All SRS streams and their associated wetland communities, except Upper Three Runs Creek, have been influenced by SRS cooling water discharges. These discharges, 10 to 20 times the natural stream flows, have caused the streams to overflow their original banks and to scour and erode the stream channels

along much of their lengths. The original bottomland forests have been reduced or modified along much of Fourmile Branch, Pen Branch, and Steel Creek.

Species of typical wetlands plants that are prominent constituents of thermal, post-thermal, and nonthermal wetland communities on the SRS have been listed (Mackey et al., 1987). The swamp is affected by reactor operation through heated effluent discharges carried by the streams that discharge into it. The increased flows and sediment loads have created deltas in the swamp and eliminated much of the original swamp forest vegetation.

Extensive remote sensing studies of the SRS wetlands were performed between 1981 and 1985 during the Comprehensive Cooling Water Study (Du Pont, 1987a).
TC When the reactors are not running, rapid colonization or revegetation of exposed mud flats and sandbar islands occurs on the delta areas of the Savannah River Swamp system (Jensen et al., 1986; Sharitz, Gibbons, and Gause, 1974; Sharitz, Irwin, and Christy, 1974). Revegetation patterns include development of a variety of annual herbaceous plants, including both persistent and nonpersistent wetland communities, as well as the development of scrub-shrub wetland communities within a few years following reactor shutdown (Sharitz, Gibbons, and Gause, 1974; Sharitz, Irwin, and Christy, 1974; Tinney, Ezra, and Mackey, 1986; Smith, Sharitz, and Gladden, 1981, 1982). Heterogeneous mixtures of wetland communities occur in the delta areas of the swamp within a few years following reactor shutdowns. After reactor shutdowns of several months, woody vegetation begins to become reestablished. This pattern was observed in Steel Creek during the shutdown of L-Reactor between 1968 and 1985 (DOE, 1984a) and in Lower Three Runs Creek following the closure of the Par Pond dam in 1958 (Du Pont, 1987a). When production resumes, using once-through cooling systems, the wetlands vegetation that has
TC recolonized previously affected areas would be lost as a result of increased flows and temperatures, assuming the same volume of cooling water flow in the affected stream.

TE Reactor operation at less than full-power levels should have environmental consequences little different from the consequences of full-power operation for the macrophyte communities in Par Pond, L-Lake, and the Steel Creek corridor and delta. Reduced power operation (at lower discharge temperatures) would produce less thermal environmental impacts to herbaceous wetland
TC communities in the Pen Branch corridor and delta than would full-power operation; delta growth rates (loss of cypress/swamp forest) should be less with reduced power operation (WSRC, 1989b).

4.1.1.6.2.1 Indian Grave Branch and Pen Branch

In Indian Grave Branch and Pen Branch, wetland vegetation that has revegetated areas previously impacted by the operation of the existing once-through
TC cooling system would be altered if K-Reactor resumes full-flow testing and production without a cooling tower. This vegetation consists primarily of nonpersistent emergent species found in the Pen Branch corridor and the delta created by Pen Branch cooling water flows in the Savannah River Swamp. In
TC addition, the continued operation of the once-through cooling system would adversely affect 10 to 12 acres of forested wetland in the swamp per year of operation as a result of high temperatures and flows. This estimate is based

on historic patterns of reactor operation and Savannah River hydrology (WSRC, 1989b).

The construction and operation of a cooling tower to reduce the flows and temperatures of K-Reactor effluents would greatly reduce impacts on floodplain and wetlands. Stream flows and temperatures would follow ambient conditions more closely; this reduction in flow rates would be significant, and would tend to minimize changes in stream morphology. A reduction in reactor power would result in impacts that would be slightly less than those at full power due to reduced blowdown temperatures and flows. DOE described the following projected effects of cooling-tower operation in the Final Environmental Impact Statement, Alternative Cooling Water Systems, Savannah River Plant (DOE, 1987b): TC

- Enhancement of wetland habitat because of reduced flows and thermal effects.
- Reestablishment of wetlands vegetation through the process of natural succession on about 500 acres of the thermally impacted 670 acres of wetlands in the Pen Branch delta. About 170 acres, consisting of the stream channel and the associated banks, would not be reestablished. L-78-05
- Reduced rate of delta growth and associated wetlands alteration.
- Stream flows and temperatures more closely approximating ambient conditions, facilitating plant and animal diversity improvement related to current conditions.
- Improved spawning conditions for indigenous and migratory fish.
- No potential for cold shock during a winter reactor shutdown due to discharge temperatures similar to ambient temperatures.
- Stabilization of aquatic and wetland habitats due to minimized changes in stream morphology resulting from small changes in flow volume.
- Long-term return of the impacted floodplain and wetlands area to a closed-canopy bottomland hardwood forest (except for cypress/tupelo). TC

4.1.1.6.2.2 Steel Creek

The wetlands of the Steel Creek drainage have been studied extensively since 1981 (Smith, Sharitz, and Gladden, 1981, 1982; Du Pont, 1987a). These studies document that the Steel Creek ecosystem was in a state of secondary successional revegetation between the shutdown of L-Reactor in 1968 and its restart in 1985. Earlier releases of thermal effluents resulted in the elimination of most stream biota and substantial erosion of the floodplain area in the Steel Creek corridor between L-Reactor and the Savannah River Swamp. Sedimentation of material eroded upstream resulted in the creation of a large open delta where Steel Creek enters the swamp, resulting in extensive tree kill in swamp forest communities. Tree kill also occurred in deeper water areas of the swamp beyond the sedimentary delta (WSRC, 1989b). Biological succession in the stream corridor and delta/swamp areas began with the cessation of thermal effluent release in 1968 (Du Pont, 1982).

The Steel Creek corridor and delta/swamp areas were surveyed in the springs of
TC 1985, 1986, 1987, and 1988 using airborne multispectral scanning (Du Pont, 1988a; WSRC, 1989b; Best, 1989). Bottomland hardwood and scrub-shrub vegetation classes dominate the Steel Creek corridor between L-Lake and the
TC swamp. The only trend evident across the four sampling periods was a shift from bottomland hardwood to emergent wetland vegetation types (WSRC, 1989b). This change indicates that portions of the hardwood forest canopy are opening along the Steel Creek corridor, and herbaceous vegetation is invading the areas where light penetrates through the canopy. Although changes have occurred in coverage by both scrub-shrub and open-water classes, consistent
TC trends are not evident (WSRC, 1989b). Tables 4-2 and 4-3 list vegetation changes in the Steel Creek corridor and in the delta and swamp, respectively.

Table 4-2. Changes in Area of Wetland Vegetation Classes in Steel Creek Corridor from L-Lake Dam to Delta (acres)

L-78-17
L-84-12

Vegetation	1985	1986	1987	1988
Bottomland hardwood	400	395	373	388
Scrub-shrub	262	235	259	252
Emergent wetland	7	27	35	20
Parrots feather	0	0	0	7
Open water	2	17	5	5
Total	671	674	672	672

Sources: Du Pont, 1988a; Best, 1989.

Table 4-3. Changes in Area of Wetland Vegetation Classes in Steel Creek Delta/Swamp (acres)

L-78-17
L-84-12

Vegetation	1985	1986	1987	1988
Bottomland hardwood	190	178	198	198
Deciduous swamp forest	267	247	259	230
Scrub-shrub	168	170	143	158
Nonpersistent emergent marsh	22	47	47	37
Persistent emergent marsh	35	1	0	10
Parrots feather	0	32	20	49
Open water	27	32	37	25
Total	709	707	704	707

Sources: Du Pont, 1988a; Best, 1989.

In 1984, DOE assessed the potential effects of the operation of L-Reactor on wetlands using L-Lake as a cooling reservoir (DOE, 1984a). Recent observations from the L-Lake/Steel Creek monitoring program indicate that, following L-Reactor restart in 1985, the increased flow caused a shift from bottomland hardwood to emergent wetland vegetation types in the Steel Creek corridor and the Savannah River Swamp/Steel Creek delta area (WSRC, 1989b). This trend should continue as a result of the proposed action.

4.1.1.6.2.3 Par Pond and Lower Three Runs Creek

Because Par Pond serves as a recirculating cooling lake for P-Reactor effluent and discharge temperatures into Lower Three Runs Creek are near ambient, no adverse impacts to the wetlands of the Lower Three Runs Creek corridor should occur as a result of the proposed action. The thermal effluent impacts and entrainment and impingement losses related to P-Reactor operation on the wetland and aquatic resources of Par Pond and Lower Three Runs Creek have been addressed in Clean Water Act Section 316(a) and 316(b) demonstrations, respectively, that were submitted to SCDHEC (Du Pont, 1985a). These demonstrations indicate that a balanced biological community has been maintained in Par Pond and Lower Three Runs Creek despite thermal discharges and intake entrainment and impingement losses.

4.1.1.6.3 Savannah River

DOE has addressed the thermal impacts on the Savannah River of K- and L-Reactors operating in the once-through cooling mode (DOE, 1987b). Direct discharge of cooling water causes slight temperature elevations only near the mouth of Steel Creek at its confluence with the Savannah River. Downriver from the confluence, no adverse impacts to terrestrial fauna or riparian habitats should occur. TC

4.1.1.7 Atmospheric Releases TC

The primary sources of nonradiological air pollutants emitted into the atmosphere as a direct result of the operation of K-, L-, and P-Reactors are the K- and P-Area powerhouses, which produce steam for most of the space heating requirements and some of the electric power needs of K-, L-, and P-Areas, and six continuously operating diesel generators in each reactor facility that supply power to direct current (DC) motors that maintain the supply of primary cooling water to the reactors in the event of a primary power outage. Other sources of nonradiological air pollutants in the reactor areas include emergency diesel generators, coal transfer and handling operations associated with the boilers, and vehicular traffic.

Table 4-4 lists estimated annual air emissions for each powerhouse for each criteria pollutant (WSRC, 1989c). The emergency diesel generators are in the 108-Building of each reactor facility. Each generator is rated at 1,200 kiloWatts. Table 4-4 also lists estimated annual air emissions for each reactor area from the operation of the diesel generators. The values listed in this table are based on standard emission factors and estimated annual fuel consumption. TC TE

TE | Table 4-4. Estimated Atmospheric Emissions of Criteria Pollutants (Metric Tons Per Year), K- and P-Area Powerhouse and 108-Building Diesel Generators

Source	Consumption	SO_2	TSP	NO_x	CO
K-Powerhouse	55,575[a]	1,390	216	420	56
P-Powerhouse	53,543[a]	1,040	160	320	42
108-Building diesels	946,000[b]	4	4	59	13

a. Metric tons of coal.
b. Liters of No. 2 diesel fuel.

The continued operation of K-, L-, and P-Reactors would not exceed any ambient air quality standards (see Table 3-5). SRS emissions of nonradiological air pollutants and the corresponding ambient air quality impact would be relatively unaffected by the power level of the reactors, because the heating, electric power, and diesel operation requirements are not affected significantly by the power level (WSRC, 1989c).

4.1.1.8 Nonradioactive Solid Wastes

Solid, hazardous, nonradioactive wastes generated annually by the operation of K-, L-, and P-Reactors and their support facilities consist of 225 cubic meters of miscellaneous organic paint solvents, waste oils, and solids contaminated with heavy metals. These wastes are stored in Resource Conservation and Recovery Act (RCRA)-approved interim-status storage (ISS) buildings before shipment offsite to approved treatment or disposal facilities. The ISS facilities have concrete floors and diked spill containment systems. Eventually, these wastes will be detoxified onsite in
TC | the Consolidated Incineration Facility (CIF; after its construction) or disposed of in the Hazardous Waste/Mixed Waste Disposal Facility (after 1993).

Solid nonhazardous, nonradioactive wastes generated by the continued operation of K-, L-, and P-Reactors consist of trash and sanitary waste sludge. The total SRS (reactors and support facilities) trash generation rate is approximately 3,600 metric tons per year. It is disposed of in the SRS sanitary landfill, which has been operated since 1973.

At the landfill, standard trash materials are placed in trenches; the trenches are covered with soil daily. The landfill also receives pesticide bags, punctured and empty aerosol cans, food waste, and asbestos in double bags. The landfill is operated under South Carolina Domestic Waste Permit No. 87A.

Periodically, treated sludge is pumped from the Sanitary Waste Treatment Plant Holding Tank to a mobile tank and transported to the F-Area Sludge Land Application Site. When this site becomes exhausted, sludge disposal will begin at the H-Area Sludge Land Application Site (DOE, 1984a; Davis, Martin, and Todd, 1989). Approximately 48 cubic meters (50 percent water) of the

sludge per reactor area would be disposed of in the sludge pit annually. Operation of the sludge pit should produce no impact (DOE, 1984a).

Other solid domestic and nonhazardous, nonradioactive wastes generated at the SRS, at a rate of about 4,000 cubic meters per year, include coal ash from steam and powerplant operation, noncontaminated equipment and building rubble, and laboratory wastes. They are disposed of in a number of ash basins, rubble pits and piles, or other waste management units on the SRS. Many of the disposal areas are inactive. TE

4.1.1.9 Noise from Reactor Operation

During the normal operation of K-, L-, and P-Reactors, external noise levels would be associated primarily with the movement of motor vehicles; they are well within acceptable levels in the area. At the nearest offsite residence, about 10 kilometers from any reactor, noise from normal operations is not detectable. Inside buildings, operators exposed to noise from machinery and other operating equipment would be required to wear protective equipment in accordance with SRS standards (Du Pont, 1986a), which are identical to those of the U.S. Occupational Safety and Health Administration (DOL, 1989).

4.1.2 RADIOLOGICAL IMPACTS OF REACTOR OPERATION

The operation of K-, L-, and P-Reactors would produce radiological impacts similar to those observed throughout their production history. This section characterizes the radiological impacts due to the normal operation of K-, L-, and P-Reactors. These impacts would be essentially the same, no matter what nuclear material was being produced during reactor operation.

A modified version of the U.S. Nuclear Regulatory Commission (NRC) GASPAR code (Eckerman et al., 1980) was used to calculate doses from atmospheric releases, and the LADTAP II code (Simpson and McGill, 1980) was used to calculate doses from liquid releases and cesium remobilization. Dose-conversion factors presented in ICRP Publication 30 (ICRP, 1979) were input to the codes. When possible, area-specific parameters were used in the assessments (e.g., meteorology, milk-, meat-, and vegetable-production distributions, annual fish consumption rates, and population distributions). Appendix A of the Reactor Operation Environmental Information Document (WSRC, 1989c) describes dose calculation models and basic assumptions used to derive these impacts, and presents more detailed dose results.

Figure 4-2 shows potential pathways for human radiation exposures resulting from radionuclides released from a nuclear facility. External doses result from exposure to airborne effluents, from swimming and other recreational activities, and from exposure to radionuclides deposited on the ground. Internal doses result from inhalation and from ingestion of food and water that contain radionuclides of SRS origins. There are no known users of Savannah River water for irrigation downstream from the SRS; therefore, this potential pathway is not considered. Contaminants that might reach the groundwater beneath the SRS would not reach offsite groundwater sources (DOE, 1987c). S-31-34 L-78-24

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One component of radioactive releases from the operation of K-, L-, and P-Reactors is the periodic purging of the disassembly basins (see Section 2.1.2.3.8). At present, the purge water from these basins discharges to seepage basins in each reactor area; this minimizes any release of radioactivity to the environment (DOE, 1984a, 1987c).

In the Draft EIS, DOE indicated that it had advised SCDHEC that SRS is considering the submission of an application for NPDES permits for the direct discharge of disassembly-basin purge water to approved NPDES outfalls. This would result in an increase in the collective exposure of downstream water users; this exposure still would be very small, as indicated later in this section. During the public comment period on the Draft EIS, DOE received a number of comments expressing concern about this proposal. In its comments, the U.S. Environmental Protection Agency (EPA) indicated that DOE should eliminate the use of the seepage basins. SCDHEC, in turn, indicated that the basins could continue to be used if certain conditions are met. Finally, downriver water users objected to any increase in exposure, no matter how small. S-11-04 S-06-03 C-02-06 A-12-02 L-45-04 L-49-01 L-78-02 L-44-61 L-45-03

In collaboration with EPA, SCDHEC, and affected water users, DOE is reexamining its proposal and other options, and is examining candidate options for reducing the discharges or possibly eliminating the need to discharge altogether. Pending the resolution of the discharge mode with EPA and SCDHEC, this EIS assumes the continued discharge of the disassembly-basin purge water to seepage basins. However, Sections 4.1.2.3, 4.1.2.5, and 4.1.2.6 compare the doses and health effects associated with seepage basin usage to two other options - direct discharge and evaporation.

Section 4.5.3 presents a variety of alternatives to the purging of disassembly-basin purge water that DOE is considering.

4.1.2.1 Atmospheric Releases of Radioactivity

Radioactive materials would be released to the atmosphere during K-, L-, and P-Reactor operation from three release points: (1) from reactor stacks, which would discharge most of the gaseous effluents generated in the reactor building; (2) at ground level from evaporation of water in the disassembly basins; and (3) at ground level from evaporation of water from seepage basins. The releases from the stacks would consist of radioactive gases that would enter the reactor ventilation system from the evaporation of primary cooling water, from the pressurized blanket-gas system, and from the air space between the reactor and the thermal shield. Table 4-5 lists the combined atmospheric releases from normal K-, L-, and P-Reactor operation from the above-listed sources. The values are based on annual releases from reactor operation from 1984 to 1986, which is the last period when three SRS reactors operated at full power (WSRC, 1989c). TE

The only radionuclide releases to the atmosphere that depend directly on reactor power levels are carbon-14 and argon-41, which would be released from the reactor stacks. Releases of tritium, resulting from moderator evaporation during charge and discharge operations, and the rate of accumulation of tritium in the disassembly basins and seepage basins also would depend on

TC | Table 4-5. Expected Combined Atmospheric Releases from K-, L-, and P-Reactor Operation (curies per year)[a]

Radionuclide	Total
Tritium[b]	1.97×10^{5}
Carbon-14	4.17×10^{1}
Argon-41	5.70×10^{4}
Krypton-85m	1.49×10^{3}
Krypton-87	1.03×10^{3}
Krypton-88	1.55×10^{3}
Iodine-131	8.60×10^{-3}
Xenon-133	6.30×10^{3}
Xenon-135	2.29×10^{3}
Unidentified beta-gamma[c]	3.13×10^{-4}
Unidentified alpha[d]	6.61×10^{-6}

a. Derived from WSRC, 1989c.
b. Includes evaporative losses at ground level from the disassembly basins and the seepage basins.
c. Assumed to be strontium-90.
d. Assumed to be plutonium-239.

power level. Lower power levels would decrease the frequency of charge and discharge operations and the rate of tritium accumulation in these basins (WSRC, 1989c).

4.1.2.2 Wastewater Discharges of Radioactivity

K-, L-, and P-Reactors are similar in design and, therefore, would discharge similar liquid effluents to the environment. During normal operations, they would discharge radioactive materials in liquid effluents as a result of small
TC | primary coolant leaks into the secondary cooling water in the reactor heat exchangers and by release from sumps (after analyses) to the process sewer, and from there to an NPDES-regulated outfall.

In addition, deionized liquids would be discharged about twice a year from the disassembly basins to the reactor seepage basins (containment basin in K-Area). The disassembly-basin water would be filtered, deionized, and monitored before being discharged to the seepage basins. Tritium, which would not be removed by any of these treatments, would be the major radionuclide discharged to the basins; only trace amounts of other radionuclides would be
TE | in the water discharged to the basins. Table 4-6 lists the combined expected annual liquid radioactive releases from K-, L-, and P-Reactors to seepage basins.

TE | Table 4-7 lists the combined expected annual liquid radioactive releases from K-, L-, and P-Reactors to surface streams. These values include measured migration of tritium from seepage basins and direct discharges to streams from reactor heat exchanger cooling water, process sewers, and overflows from Par

Table 4-6. Expected Combined Liquid Releases to Seepage Basins from K-, L-, and P-Reactor Operation (curies per year)[a] | TC

Radionuclide	Total
Tritium	1.21×10^{4}
Phosphorus-32	1.24×10^{-3}
Sulfur-35	2.83×10^{-2}
Chromium-51	2.19×10^{-1}
Cobalt-58, -60	5.12×10^{-3}
Strontium-89	1.63×10^{-3}
Strontium-90	1.02×10^{-3}
Zirconium, Niobium-95	5.38×10^{-2}
Ruthenium-103, -106	2.89×10^{-3}
Antimony-124, -125	6.81×10^{-3}
Iodine-131	2.64×10^{-2}
Cesium-134	9.36×10^{-3}
Cesium-137	9.55×10^{-2}
Cerium-141, -144	4.12×10^{-2}
Promethium-147	8.79×10^{-3}
Unidentified beta	3.99×10^{-1}
Unidentified alpha	4.58×10^{-3}

TC

a. Derived from WSRC, 1989c.

Table 4-7. Expected Annual Liquid Releases to Surface Streams from K-, L-, and P-Reactor Operation (curies per year)[a] | TE

Radionuclide	Total
Tritium	1.16×10^{4}
Cobalt-58, -60	1.00×10^{-3}
Cesium-137	3.33×10^{-7}
Strontium-90[b]	1.30×10^{-2}
Plutonium-239[c]	3.19×10^{-4}

TC

a. Derived from WSRC, 1989c, includes direct discharges from reactors and migration to streams.
b. Includes unidentified beta and gamma. | TC
c. Includes unidentified alpha.

Pond, L-Lake, and certain basins. The values are based on annual average releases from 1984 to 1986 (WSRC, 1989c).

Liquid releases are reactor-specific because of the varying contribution of tritium from seepage basins. Releases other than tritium would be treated the same for the three reactor areas (Marter, 1989).

Groundwater in K-Area flows to the east, discharging at Pen Branch, and to the west, discharging at Indian Grave Branch. Indian Grave Branch merges with Pen Branch and flows toward the mouth of Steel Creek, which discharges at the Savannah River.

Groundwater in L-Area flows to the southeast toward L-Lake and to the west toward Pen Branch. P-Reactor lies on top of a water table "mound"; therefore, groundwater moves in all directions from P-Area. Probable discharge points are Steel Creek, Par Pond, and Meyers Branch.

The water from seepage basins would enter shallow aquifers where tritium undergoes radioactive decay as it migrates to outcrops at onsite surface streams. Transport and flow modeling results have shown that migration from
TE the K-Area basin to Indian Grave Branch takes as long as 6 years; from L-Reactor basin to L-Lake, as long as 5 years; and from P-Reactor basins to Steel Creek, as long as 30 years. The migration pathway from P-Area to Steel Creek has a large vertical hydraulic gradient that causes the water table to move vertically before it moves horizontally (WSRC, 1989a). Migration from P-Area can also move to Par Pond and Meyers Branch over presumably longer periods of time.

Reactor operation at less than full power would result in less frequent discharges of the same volume of purge water; therefore, reduced amounts of radionuclides would be discharged to the seepage basins. In addition, the
TC carryover of radioactivity in moderator to the disassembly basins decreases with power levels, because lower power levels would decrease the frequency of charge and discharge operations (WSRC, 1989a). As a result, the concentration of radionuclides reaching the groundwater would be reduced. The movement of radionuclides in groundwater to surface streams does not depend directly on reactor power levels.

4.1.2.3 Dose Commitments from Reactor Operations

4.1.2.3.1 Maximum Individual Dose from Atmospheric Releases

The hypothetical member of the public who would receive the highest dose from atmospheric releases from K-, L-, and P-Reactors was assumed to be located continuously at the SRS boundary in the southwest sector. The selection of the location of maximum potential dose in this sector was based on considerations of distance to the SRS boundary, releases to the atmosphere, and meteorological dispersion characteristics.

The calculated maximum committed effective dose equivalent to this hypothetical individual was 0.34 millirem as the result of combined annual K-, L-, and P-Reactor atmospheric releases, which is within the limit of 10 millirem
L-78-40 per year for the Site from the air pathway (EPA, 1989a). An average annual dose of 296 millirem from natural radiation is received by an individual living near the SRS. A reduction in reactor power levels would reduce this dose, but not in a directly proportional manner. The only radionuclide releases to the atmosphere directly dependent on power level, carbon-14 and argon-41, contribute 7 and 30 percent, respectively, of the atmospheric dose. Thus, 37 percent of the atmospheric dose would depend directly on power level (WSRC, 1989c).

On an individual reactor basis, the calculated maximum annual committed effective dose equivalent is 0.17 millirem from K-Reactor, 0.14 millirem from L-Reactor, and 0.15 millirem from P-Reactor. The location of maximum potential dose is different for each reactor. Therefore, the maximum dose to a hypothetical individual from the combined K-, L-, and P-Reactor atmospheric releases reported above is less than the sum of those from the individual reactors when treated as a single point source.

4.1.2.3.2 Population Dose from Atmospheric Releases

The collective committed effective dose equivalent to the population of 852,000 (projected for the year 2000) living within 80 kilometers of the SRS was calculated to be 21.4 person-rem from combined annual atmospheric releases from K-, L-, and P-Reactors. This same population would receive an average annual dose of 252,000 person-rem from natural radiation.

4.1.2.3.3 Maximum Individual Dose from Liquid Releases

The hypothetical member of the public who would receive the highest dose from liquid effluents from K-, L-, and P-Reactor operation was assumed to live near the Savannah River, downstream from the SRS. This individual was assumed conservatively to use river water regularly for drinking, to consume fish from the river, and to receive external exposures from shoreline activities, swimming, and boating. In addition, this individual was assumed to eat more fish than an average person.

The calculated maximum committed effective dose equivalent to this hypothetical individual as a result of combined annual K-, L-, and P-Reactor liquid releases was 0.032 millirem, which is within the DOE limit of 100 millirem per year (DOE, 1990a), as well as the 4-millirem-per-year drinking-water standard (EPA, 1987). This dose is primarily from K-Reactor (71 percent of the total). The doses from L- and P-Reactors are 13 and 16 percent of the total, respectively. TE

4.1.2.3.4 Population Dose from Liquid Releases

Savannah River water is not used for drinking within 80 kilometers downstream of the SRS; therefore, the dose to the population in this area would come from liquid releases of SRS origin, from eating fish and shellfish, from shoreline activities, and from swimming and boating. TC

The collective committed effective dose equivalent to the population of 852,000 (projected for the year 2000) living within 80 kilometers of the Site was calculated to be 7.4×10^{-3} person-rem from combined annual liquid releases from K-, L-, and P-Reactors. This same population would receive an average annual collective dose of 252,000 person-rem from natural radiation.

The Beaufort-Jasper and Port Wentworth population groups use the Savannah River as a source of potable water. Although these groups are beyond the 80-kilometer radius of the SRS (about 160 kilometers downstream), their drinking-water doses have been calculated. A projected population of about 317,000 people will be consuming water from the Beaufort-Jasper and Port Wentworth water treatment plants by the year 2000. The collective committed

effective dose equivalent delivered to these populations from drinking water was calculated to be 9.3 person-rem from combined annual K-, L-, and P-Reactor liquid releases. These populations would receive an average annual collective dose of 94,000 person-rem from natural radiation. This population dose is primarily from K-Reactor (71 percent of the total). The population doses from L- and P-Reactors are 13 and 16 percent, respectively, of the total.

L-45-03
L-45-04
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C-02-06
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4.1.2.3.5 Comparison of Doses from Alternative Purge-Water Disposal Options

Table 4-8 compares the maximum individual and population doses from the discharge of disassembly-basin purge water to seepage basins to those resulting from direct discharge to streams and evaporation to the atmosphere.

Both the individual and collective doses were calculated to be highest for the direct-discharge alternative. However, the maximum individual dose for any of the methods of tritium release (i.e., through the current use of seepage basins, through the proposed use of direct discharge, or through evaporation to the atmosphere) is a small fraction of applicable standards.

4.1.2.4 Cesium-137 and Cobalt-60 Redistribution Dose Commitment

SRS has released cesium-137 to onsite streams and bottomlands, including Fourmile Branch, Pen Branch, Steel Creek, and Lower Three Runs Creek (see Figure 3-7). Most of this cesium-137 [about 460 curies (Du Pont, 1981)] originated from releases in the 1960s from fuel storage facilities at the five production reactors operating at that time. Additional releases between 1955 and 1980, totaling as much as 100 curies, included discharges to Fourmile Branch from the 200-F and 200-H Separations Areas, weapons test fallout, and other sources (Du Pont, 1981; DOE, 1984a). Of the 560 curies released to onsite streams, approximately 290 curies (Du Pont, 1981) have been measured in transport at stream monitoring stations at Road A (SC Highway 125).

Approximately 66 curies of cobalt-60, formed by neutron activation of stainless steel in the reactors, were released to onsite streams in the years following startup of the first reactor in December 1953 (DOE, 1984a). An estimated 27 curies (15 from L-Reactor and 12 from P-Reactor) of this total were discharged to Steel Creek. Cobalt-60 has a half-life of 5.26 years; therefore, most of this radiocobalt has been eliminated through radioactive decay. For example, only an estimated 2.1 curies of cobalt-60 remained in the Steel Creek-Savannah River system in 1984 (DOE, 1984a).

Environmental concerns for the remobilization of the cesium-137 and cobalt-60 in Steel Creek associated with the restart of L-Reactor operation prompted special studies, starting in 1983, to measure cesium-137 and cobalt-60 in the Savannah River (DOE, 1984a, 1987b). Sampling stations for these measurements are located at Shell Bluff (upriver) and the Highway 301 Bridge (downriver). River flow is also measured upriver and downriver of the SRS (Du Pont, 1984c, 1985b; Zeigler, Lawrimore, and Heath, 1986; Zeigler et al., 1987; Mikol et al., 1988; Davis, Martin, and Todd, 1989). Cesium-137 has been detected in these special studies of river water, but cobalt-60 has not been detected.

The annual SRS contribution of cesium-137 to the Savannah River can be estimated by multiplying total annual flow by the mean annual concentration of

cesium-137 and subtracting the upriver value from the downriver value. For example, for 1983 the downriver flow of 1.19 x 10^{10} cubic meters with an average concentration of 0.067 picocurie per liter resulted in 0.797 curie being carried from the SRS vicinity. The upriver flow of 9.9 x 10^{9} cubic meters with an average concentration of 0.016 picocurie per liter, delivered 0.159 curie to the SRS vicinity. The difference, 0.638 curie, represents the SRS contribution of cesium-137 in 1983.

From 1955 to 1985, approximately 600 curies of cesium-137 were released from K-, L-, and P-Reactors. About 13 curies of cesium-137 remain in Indian Grave/Pen Branch; about 164 curies of cesium-137 remain in Steel Creek; and
TE about 116 curies of cesium-137 remain in Lower Three Runs Creek, for a total of about 293 curies (decay corrected). Table 4-9 lists these discharges. The contribution of cesium-137 in Lower Three Runs was due to releases from R-Reactor, which was shut down in 1964.

TC Table 4-10 lists the average flow rates of the three stream systems that would receive K-, L-, and P-Reactor cooling system and other discharges during operation and the flows expected after termination of operation. Sections 4.2 and 4.3 discuss alternatives that would involve terminating the operation of one, two, or three reactors at SRS. Section 4.3.3 discusses cooling water withdrawal and discharge associated with the termination of three SRS reactors. This analysis qualitatively indicates that the greatest potential
TE for redistribution of cesium-137 would exist in Steel Creek when L-Reactor was operating (high flow), and the lowest potential for resuspension would occur in Indian Grave/Pen Branch when K-Reactor was not operating (low flow) or when K-Reactor was operating with a cooling tower. Sections 4.2 and 4.3.12 discuss the impacts caused by termination.

The continued operation of K-, L-, and P-Reactors would result in little change in the remobilization of cesium-137 from SRS streams. This is based on extensive measurements of cesium-137 concentrations in the Savannah River below SRS during reactor operation and the effect of L-Reactor operation from 1985 to 1988. Cesium-137 concentrations would remain at or near their present levels, 0.05 to 0.2 picocuries per liter in the Savannah River below SRS.

The current annual average cesium-137 concentrations in the river below SRS do
L-78-42 not exceed 0.1 percent of the U.S. Environmental Protection Agency (EPA) cesium-137 annual average drinking-water standard of 200 picocuries per liter. The annual average cesium-137 concentration should remain at or below 0.5 percent of the EPA standard during K-, L-, and P-Reactor operation (WSRC, 1989c).

TC Table 4-11 lists SRS cesium-137 transport results for 1983 and similar calculations performed for 1984 through 1988. Over this 6-year period, the estimated average annual release of cesium-137 from SRS streams to the Savannah River was approximately 0.51 curie. Based on the values listed in
TE Table 4-11, the restart of L-Reactor in October 1985 did not have a significant impact on cesium-137 transport in the river resulting from SRS operations. By analogy, the continuing operation of K-, L-, and P-Reactors should not increase cesium-137 transport significantly in the river. The anticipated SRS contribution of cesium-137 transport should remain in the range of 0.25 to 0.77 curie per year (mean ± 2 standard deviations).

TE

Table 4-11. Cesium-137 Transport in the Savannah River Resulting from SRS Operation

Year	River Flow (L/yr)[a]	Mean Cs-137 (pCi/L)	Mean Transport (Ci/yr)
		Above SRS	
1983	9.91×10^{12}	0.016	0.16
1984	8.94×10^{12}	0.012	0.11
1985	6.69×10^{12}	0.015	0.10
1986	5.33×10^{12}	0.021	0.11
1987	5.70×10^{12}	0.010	0.06
1988	4.68×10^{12}	0.014	0.06

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Year	River Flow (L/yr)[a]	Mean Cs-137 (pCi/L)	Mean Transport (Ci/yr)	Transport from SRS[c] (Ci/yr)
		Below SRS		
1983	1.19×10^{13}	0.067	0.80	0.64
1984	1.07×10^{13}	0.064	0.68	0.58
1985	8.02×10^{12}	0.077	0.62	0.52
1986	6.06×10^{12}	0.11	0.69	0.58
1987	7.22×10^{12}	0.074	0.53	0.48
1988	5.15×10^{12} (c)	0.065	0.34	0.27
			6-year average	0.51
			Standard deviation = ±	0.13

L-78-43

a. Liters per year x 3.17×10^{-11} = cubic meters per second.
b. Transport from SRS is the difference between the mean transport above SRS and the mean transport below SRS.
c. Measured below Vogtle Electric Generating Plant.

The maximum committed effective dose equivalent to a member of the public was calculated to be 0.28 millirem as a result of annual cesium transport to the Savannah River from total SRS operations. The corresponding dose to this same individual resulting from only those streams directly affected by K-, L-, and P-Reactor operation is 0.20 millirem. Both of these doses are within the DOE limit of 100 millirem per year (DOE, 1990a).

TE

TE

The collective committed effective dose equivalent to the population of 852,000 (projected for the year 2000) living within 80 kilometers of the SRS was calculated to be 0.79 person-rem from annual cesium transport to the

Savannah River from total SRS operations. This population would receive an annual collective dose of 252,000 person-rem from natural radiation. The calculated dose to the projected population of 317,000 people who will consume water from the Beaufort-Jasper and Port Wentworth water treatment plants in the year 2000 was 0.32 person-rem from annual cesium transport to the river; that population would receive an annual collective dose of 94,000 person-rem from natural radiation. The corresponding doses to the population groups living within 80 kilometers of the SRS and at Beaufort-Jasper/Port Wentworth from only those streams directly affected by K-, L-, and P-Reactor operations are 0.58 and 0.23 person-rem, respectively.

Because of the nonuniform distribution of the cesium-137 deposits in onsite streams, the operation of each reactor would contribute a different fraction to the overall SRS release of remobilized cesium. K-Reactor discharge remobilization via Pen Branch would contribute about 4 percent; L-Reactor, via Steel Creek, would contribute about 40 percent; and P-Reactor would contribute about 29 percent of the total, via Lower Three Runs Creek. The remaining 27 percent would be remobilized from Fourmile Branch via the 200-Area discharges. The operation of the K-Reactor cooling tower would reduce the 4-percent contribution to a significantly smaller amount.

4.1.2.5 Summary of Offsite Dose Commitments from K-, L-, and P-Reactor Operation

For each of the alternative purge-water disposal options, Table 4-12 summarizes the maximum individual committed effective dose equivalents and collective committed effective dose equivalents from combined annual K-, L-, and P-Reactor operation. The totals for individual doses are conservative maximums; to receive these doses, the "composite" individual would have to occupy several locations simultaneously. TE

The composite maximum individual dose of 0.58 millirem for the seepage-basin alternative is in addition to the average annual dose of 296 millirem from natural radiation received by an individual living near SRS; it is within the DOE limit of 100 millirem per year from all pathways and the EPA limits of 10 millirem per year for the Site from the air pathway only and 4 millirem per year from the drinking-water pathway only (DOE, 1990a; EPA, 1987, 1989a). The collective dose to the 80-kilometer-radius population (852,000 people) and downriver water-consuming population groups (317,000 people) is 31.5 person-rem. The annual collective dose received by these population groups from natural radiation is 346,000 person-rem. Additional calculations were made to estimate the collective dose to the population living within 16.1 kilometers of the SRS boundary resulting from annual operation of one reactor. The collective dose to this population of approximately 65,100 (projected for the year 2000) was calculated to be 1.32 person-rem per year from atmospheric releases. This collective dose is equivalent to an average individual dose of 0.02 millirem per year. TC L-78-40

4.1.2.6 Health Effects from K-, L-, and P-Reactor Operation

The health effects reported in this section assume continued periodic discharge of the disassembly-basin purge water to seepage basins. Table 4-13 compares the health effects from discharge to seepage basins to those TC

Table 4-13. Annual Health Effects from Alternative Purge-Water Disposal Options

Health Effect	Seepage Basin	Direct Discharge	Evaporation
Maximum individual fatal cancer risk	2.3×10^{-7}	2.7×10^{-7}	2.3×10^{-7}
80-kilometer population excess cancer fatality	8.8×10^{-3}	8.8×10^{-3}	9.1×10^{-3}
Downriver water-consuming population excess cancer fatality	3.8×10^{-3}	8.1×10^{-3}	3.8×10^{-3}

TC resulting from direct discharge to streams, and to those resulting from evaporation to the atmosphere.

The calculation of radiation-induced health effects that could occur as a result of atmospheric and liquid radioactive releases from K-, L-, and P-Reactor operation was based on EPA health-risk estimators (EPA, 1989b). The risk estimator used was 400 cancer deaths per 1,000,000 person-rem exposure (4×10^{-4} per person-rem). Multiplying the maximum individual dose (from Table 4-12) by this risk estimator results in an annual fatal cancer risk of $2.3 \times$ TE 10^{-7} to that individual. Similarly, multiplying the regional population doses (from Table 4-12) by this risk estimator projects 8.8×10^{-3} excess cancer fatality in the population within 80 kilometers of the SRS and 3.8×10^{-3} excess cancer fatality in the downriver water-consuming populations of Port Wentworth and Beaufort-Jasper as a result of annual reactor operations.

Vital statistics on mortality rates from all cancer types for 1986 (Statistical Abstract of the United States, 1989) indicate that the rates for TC South Carolina (171 deaths per 100,000 population) and Georgia (169 deaths per 100,000) were below the rate for the United States as a whole (195 per 100,000). Thus, the calculated health effects would not be discernable, were they to occur.

Two recent epidemiological studies have confirmed that the risks from nuclear facilities, if they exist, are not detectable. The first, by the National Cancer Institute/National Institutes of Health (Jablon et al., 1990), examined mortality rates from leukemia and other forms of cancer in populations around L-02-02 62 nuclear sites in the United States, including SRS and other DOE and commercial facilities, and found no evidence to link these sites to excess deaths from cancer (see Appendix B, Section B.1.5). The second study (Hatch et al., 1990), which dealt with cancer in the population around the Three Mile Island plant after the 1979 accident, found no evidence that the accident had influenced cancer risks in the area.

The fifth in a series of National Research Council committee reports on the biological effects of ionizing radiation (BEIR V), which was released in mid-December 1989, updates the findings of the 1980 BEIR III committee report on the risks of ionizing radiation exposure. An evaluation of this report and its implications for DOE operations and standards is under way; similar evaluations are being performed by national and international radiation protection organizations. The mean value in BEIR V for increased cancer mortality due to an acute whole body dose of 10 rem to 100,000 individuals (i.e., 1,000,000 person-rem) is about 785 (760 for males; 810 for females), or about 7.9×10^{-4} per person-rem. BEIR V also indicates that "for low LET radiation, accumulation of the same dose over weeks or months, however, is expected to reduce the lifetime risk appreciably, possibly by a factor of 2 or more". Thus the risk factor used in this EIS of 4×10^{-4} per person-rem for normal releases of radioactive materials is consistent with the findings of the BEIR V Committee. TC

4.1.2.7 Occupational Dose

At K-, L-, and P-Reactors, DOE minimizes the occupational dose in keeping with the as-low-as-reasonably-achievable (ALARA) principle. All personnel who work in or enter areas that have the potential for radiation exposure receive personal monitoring devices. In addition, the SRS maintains a comprehensive bioassay program for all employees who work in areas with a potential for biological uptake of radioactivity. Table 4-14 lists historic dose commitments to workers in the C-, K-, and P-Reactor areas during operation at full power and with the moderator containing typical amounts of tritium. When L-Reactor operated at full power during part of 1985 and 1986, the heavy-water moderator contained little tritium. During 1987, all reactors operated at partial power; in 1988 they were shut down after operating at 50 percent of full power. TE

Table 4-14 lists average and maximum doses resulting from 11 reactor-years of operation with tritium in equilibrium in the moderator. The annual average occupational dose commitment per reactor-year was 56 person-rem. The use of the health-risk estimator presented in Section 4.1.2.6 would result in an excess cancer risk of 0.02 fatality per reactor-year in that workforce. The workforce for a reactor area varies with the amount of construction work and work crew assignments consistent with program schedules. The average workforce in each reactor area is about 400 people; thus, the average annual individual dose to workers in the K-, L-, and P-Areas would be about 140 millirem during continued reactor operation, which is within the DOE limit of 5,000 millirem per year (DOE, 1988a); because there is no current guidance for average exposure, the DOE limit is for comparison purposes only. TE TC TC

The maximum individual dose during the period listed in Table 4-14 was 2,800 millirem. The personal exposure guideline set by DOE is 5,000 millirem per year; the guideline set for the SRS by the past and present Operating Contractors is 3,000 millirem per year. Between 1952 and 1989, the DOE and SRS guidelines were exceeded 2 and 48 times, respectively. L-72-01 L-78-46

The first dose that exceeded 5,000 millirem occurred in 1956, when an employee assimilated tritium while working in the Separations Area. His estimated total whole-body dose equivalent due to tritium was 10,300 millirem and his TC

TE

Table 4-14. Occupational Dose in Reactor Areas with Moderator Tritium in Equilibrium[a,b]

L-72-01

Year	Reactor (collective person-rem per year) C	K	P	Maximum Individual Dose (millirem)
1983	59	61	54	2,800
1984	59	61	48	2,000
1985	60	51	42	1,900
1986	Shutdown	59	57	2,000
Average	59	58	50	2,200
Overall average per reactor-year - 56 person-rem				

a. L-Reactor operated in November-December 1985 and 1986 but moderator contained little tritium.
b. References: Du Pont, 1985c, 1986b, 1987b.

TC

external dose equivalent for that year was 200 millirem. His estimated whole-body radiation dose equivalent for the year was 10,500 millirem. The second dose that exceeded the DOE annual guideline occurred in 1971, when an employee's thermoluminescent dosimeter (TLD) badge registered 23,600 millirem in 1 month. An investigation determined that the employee received only 100 millirem during that month and that the TLD badge had been exposed to an unknown source. The employee's annual dose for 1971 was recorded as 24,800 millirem, although his actual exposure was only 1,335 millirem.

TC

The SRS Health Protection Department maintains radiation dose records for all occupational workers on the Savannah River Site.

4.1.2.8 Solid Low-Level Radioactive Waste

Annually, K-, L-, and P-Reactors would generate about 640, 675, and 690 cubic meters, respectively, of solid low-level radioactive waste. This waste would be packaged and transported to the SRS low-level waste burial ground. The burial ground is divided into sections to accommodate different levels of radioactivity. The waste is buried in trenches about 6 meters deep and 6 meters wide. The exact location of each burial trench is defined, and accurate records are kept of the contents of each trench.

At present, low-level radioactive waste from the reactor areas is separated into two types, trash in metal burial boxes and metal scrap from fuel and target disassembly operations. Existing burial space for trash will be filled by the first quarter of 1992; for metal scrap, space will be filled in the fourth quarter of 1991. When existing burial space is full, DOE plans to put a new burial ground into operation just north of the existing burial ground.

The new burial ground will have the capacity to accommodate waste generated during 20 years of operation of SRS facilities.

Many monitoring wells are used to measure radioactivity concentrations in groundwater flowing beneath the burial ground. These include wells inside the border of the burial ground and others along its perimeter. The tritium, total radium, gross alpha, and nonvolatile beta measurements that are made are reported to the public in the Annual Environmental Reports published by DOE. Based on the activity levels in the groundwater, appropriate remedial actions are taken to minimize the transport of radioactive constituents from the burial ground. These actions assume that doses to workers and to members of the public are maintained well within appropriate regulatory guides. The Final EIS on Waste Management Activities for Groundwater Protection (DOE, 1987c) contains results of groundwater monitoring; the Annual Environmental Reports for the SRS also present these results. L-78-48

4.1.2.9 Liquid Low-Level Radioactive Wastes

As a result of the operation of the chemical separations areas, SRS generates about 460,000 cubic meters per year (design flow rate) of liquid low-level radioactive wastes, including contaminated cooling water and storm water runoff. These wastes are treated in the F- and H-Area effluent treatment facility (ETF) and released through an NPDES outfall to Upper Three Runs Creek. Solid waste residuals resulting from ETF treatment are disposed of as saltstone in Z-Area.

4.1.2.10 Mixed Wastes

SRS reactors and support facilities generate an estimated 4,750 cubic meters of liquid and solid mixed wastes (low-level radioactive plus hazardous components) annually. These consist of contaminated solvents and oils, contaminated equipment, rubble and job control wastes, and mixed-waste sludges from ETFs (M-Area and F- and H-Areas). Mixed wastes are stored in interim-status storage facilities for eventual disposal or treatment on SRS.

4.1.2.11 Transuranic Wastes

The SRS chemical separations facilities generate an estimated 1,130 cubic meters of transuranic (TRU) wastes annually. This amount is in addition to approximately 10,000 cubic meters held in retrievable or nonretrievable storage. Much of the newly generated and retrievably stored TRU waste will be processed and certified for eventual disposal at the DOE Waste Isolation Pilot Project. The nonretrievably stored TRU waste is secured in the low-level radioactive waste burial ground.

4.1.2.12 High-Level Liquid Radioactive Wastes

The amount of high-level liquid radioactive waste estimated to be generated at SRS as a result of K-, L-, and P-Reactor operation is about 1,600 cubic meters per year. These wastes would be transferred from the chemical separations areas directly to the high-level waste storage tanks. The three pretreated components of these wastes (salt, sludge, and supernatant) eventually will treated by the saltstone process (decontaminated salt) or the Defense Waste

Processing Facility (DWPF) vitrification process (high-level components) for ultimate disposal in Z-Area or an offsite geologic repository. Canisters containing the vitrified high-level waste will be stored in a belowground concrete vault until the geologic repository is operational.

Saltstone and vitrification processing will also take place independently of reactor operation to work off the 30-year inventory of stored high-level liquid wastes at the rate of 5,000 to 10,000 cubic meters per year.

4.1.3 ACCIDENTS

4.1.3.1 Reactor Accidents

The SRS production reactors are designed and operated to ensure the safety of the public, the operating staff, the Site, and the environment by preventing, arresting, or mitigating the effects of accidents. To ensure that these designs and operating practices are consistent with current safety requirements and experience, DOE performs continuing evaluations of potential malfunctions and system failures that can lead to accidents.

The following sections discuss accident experience and prevention on the SRS; describe the features that mitigate accident consequences; discuss the effects of system modifications that influence accident occurrence, accident consequences, or accident consequence mitigation; describe the types of accidents analyzed for the SRS production reactors; and assess the consequences and risks associated with postulated reactor accidents. The consequences and risks associated with such accidents do not differ significantly with the nuclear material being produced (see Sections 4.1.3.1.4 and 4.1.3.1.5).

L-44-06
C-04-06

Risks from operating K-, L-, and P-Reactors at reduced power levels would be smaller than, and bounded by, risks from full-power operation. In addition, in Section 4.1.3.1.5, the subsections entitled Reduced-Power Operation and Multiple-Reactor Operation discuss reduced-power effects and the effects of multiple reactors.

4.1.3.1.1 Accident Experience and Prevention at the Savannah River Site

Accident Experience

In the context of safety engineering, an "accident" is generally an unplanned event that can result in damage to property or individuals. The accident analysis in this EIS examines the consequences and risks of such potential unplanned events. Although no reactor accidents have occurred on the SRS that
TE had significant offsite impacts, incidents have occurred that deviated markedly from the accepted normal operation of the reactors.

A task force established in 1985 by the previous Operating Contractor examined the Reactor Incident (RI) Reports documenting such incidents and identified 30 RIs judged to be the most significant in the history of the SRS (Du Pont,
TE 1985d). Table 4-15 summarizes the 30 incidents. Seven of these incidents resulted in releases of radioactivity; six were associated with reactor operation (No. 5, 7, 11, 15, 19), and the other one (No. 12) involved testing

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Table 4-15. SRS Reactor Incidents of Greatest Significance TE

No.	Date	Synopsis
1	1/12/60	Power overshoot - Numerous procedure violations resulted in 500-MW/minute power rise (procedural limit is 40 MW/minute) and first power leveling at 1,250 MW (procedure requires 40 MW) when attempting to recover from reactor scram. Power overshoot was minimum of 450 MW; boiling in assemblies would have occurred in another 40 seconds.
2	1/3/58	Reactor critical on safety rods - Procedure violations permitted reactor criticality on safety rods; reactor was not shut down until Reactor Technology personnel so ordered.
3	4/24/64	Unwanted power increase - Operator inattention during scheduled reactor shutdown resulted in inadvertent power increase from 500 MW to 925 MW within 2.5 minutes during repositioning of partial control rods to bottom of reactor.
4	2/11/72	Technical limit exceeded - Inadequately controlled operations to insert full control rod for radial flux control resulted in twice exceeding technical limit for channel effluent temperature (by 1.5°C and 2.2°C). Inspections indicated no fuel damage.
5	5/10/65	Reactor tank top leak - Sleeve raised during power operation resulted in significant leak and reactor scram; operator disregard for low moderator level alarms after shutdown caused delay in observing and correcting leak. About 7,950 liters of moderator spilled.
6	5/24/64	Loss of reactor scram capability - Safety rods failed to drop during manual scram at end of operating cycle due to short circuit in holding-voltage bus. Safety rod scram capability had been unavailable for as long as 40 days of operation.
7	11/09/70	Source rod failure - Melting of source rod during discharge resulted in 6,250 Ci on filters, 85,000 Ci in process area (of which 3×10^{-3} Ci was released), and 600 person-rem accumulated by 900 people during cleanup.
8	2/12/64	Reduction of forced cooling during shutdown - During reactor shutdown, with irradiated assemblies in reactor, primary coolant flow was reduced to that provided by one or fewer pumps powered from DC motors (condition of one loop was unknown) for 10 to 13 minutes.

TE | Table 4-15. SRS Reactor Incidents of Greatest Significance (continued)

No.	Date	Synopsis
9	3/24/72	Lack of nominal burnout safety factor ($BOSF_N$) monitoring - Undetected computer programming error precluded $BOSF_N$ monitoring for 66 assemblies during 4-year period. No known localized assembly damage occurred during that period.
10	12/5/79	Loss of offsite power - Two most significant events resulting from loss of offsite power were: • Loss of power to discharge machine in K-Area while it held irradiated target, and loss of three of four discharge-machine cooling systems and reactor room spray system. Power was restored and discharge completed in about 2 minutes. • Failure of both diesel generators in C-Area to start after loss of transformers, and failure of diesel generator output breakers to close after diesels were started manually.
11	5/5/57	Loss of reactor moderator - Inadequate procedures resulted in poor handling of heat exchanger leak and subsequent loss of 5,900 kg of moderator and degradation of another 3,600 kg.
12	11/16/57	Assembly melting in disassembly area - SRL heating tests on irradiated assembly resulted in significant melting; activity releases were not quantified but required 7 days for cleanup.
13	1/26/70	Burnout failure of four assemblies - Incorrectly calculated $BOSF_N$ limits resulted in burnout in four assemblies that produced moderator activity levels as high as 5×10^6 cpm/ml (normal level is approximately 5×10^5 cpm/ml).
14	8/16/85	Incorrect fuel component charged to reactor - Two inner fuel tubes were interchanged and misidentified and, after being charged to reactor, caused rod reversal during power ascension.
15	12/22/70-12/27/70	Outer tube melting of fuel assembly - Localized flow instability resulted in damage to outer tube of fuel assembly, causing four scrams and small activity release.
16	2/25/69	Dropped target assembly and housing - Charge-machine malfunction caused housing containing fresh target to be raised out of reactor. Operator released housing about 1 meter above its seated position, damaging clam shell but not monitor pin.

Table 4-15. SRS Reactor Incidents of Greatest Significance (continued) | TE

No.	Date	Synopsis
17	11/9/64	Lack of assembly flow and temperature monitoring - Assembly was incorrectly treated as vacant position, and temperature and flow monitoring was not provided for about 3 weeks. No damage occurred.
18	5/26/68	Cracked target sleeve housings - Vibration of mispositioned slug stabilizers damaged sleeve housings for numerous targets (severely in some cases). Total failure of housing during flow monitor bypass would cause assembly melting.
19	4/18/66	Incorrect incident action alarms - Activity alarms occurring during fuel failure were disregarded; one alarm setpoint was subsequently shown to be too low.
20	2/3/83	Spurious incident action alarms - Spurious alarms caused by construction personnel were not believed. Procedures do not state that alarms are to be verified.
21	8/28/69	Discharge-machine cable-handling system failure - Discharge-machine movement was stopped during charge and discharge operations when two chains in cable-handling system broke.
22	2/15/82	Discharge-machine cable-handling system damage - During charge and discharge operations, cable-handling system track was found to be severely damaged, which could have prevented discharge-machine movement.
23	2/19/75	Target assembly stuck out of reactor - During discharge, irradiated assembly became stuck in housing with one-third of target out of reactor; target was discharged 3 hours later; discharge machine cooling was maintained throughout incident.
24	10/29/80	Near-drop of irradiated assembly - During discharge of target, discharge-machine grasping device began to open, but target was safely deposited. During investigation of incident, fresh target was dropped when grasping device opened.
25	9/2/75	Chlorine gas leak - Chlorine leak developed outside during charge and discharge operations and chlorine gas entered building. All personnel, except two supervisors wearing self-contained air-breathing devices, were evacuated. If all personnel had been evacuated, Incident Action would have been required, which would have diluted moderator and sent contaminated heavy water to 190-million-liter basin.

TE | Table 4-15. SRS Reactor Incidents of Greatest Significance (continued)

No.	Date	Synopsis
26	1/9/68	Discharge-machine broken mast chain - During charge and discharge operations, mast chain broke while driving mast down to engage irradiated assembly, making mast inoperable.
27	8/5/76	Adjacent target positions vacated - During charge and discharge operations, fresh target was removed when charge-machine grasping device failed to release it. Discharge-machine operators discharged next scheduled target, which was adjacent to vacant position.
28	6/24/69	Raised irradiated fuel assembly - Irradiated fuel assembly was inadvertently raised from reactor during discharge of auxiliary assembly orifices. Operator dropped assembly about 2 meters back into housing without any damage.
29	12/19/73	Raised irradiated fuel assembly - During charge and discharge operations, irradiated fuel assembly caught on grasping device and was raised about 2 meters. Assembly was recharged without difficulty.
30	2/9/61	Fuel assembly fitting failure - During discharge of irradiated fuel assembly, top fitting separated and assembly remained in reactor. Assembly was discharged with special grasping device after steps were taken to mitigate possible dropping of assembly.

Adapted from Du Pont, 1985d.

in the disassembly area. None of the six events associated with reactor operation resulted in releases of radioactivity from the SRS in excess of DOE (or predecessor agency) requirements for normal operation (DOE Order 5480.1A, Chapter XI, superseded by DOE Order 5400.5 in February 1990).

TE | In addition to the 30 incidents described above, the Integrated Safety Evaluation Program (ISEP) Operating Experience History (OEH) Report (NUS, 1988) documents the results of a search of RIs generated since 1971. The purpose of the study documented in the OEH was to screen and categorize the
TC | events identified as potential ISEP safety topics. Issues requiring long-term resolutions were transferred to the Reactor Safety Improvement Program (RSIP; see Sections 2.1.2.7 and 2.1.3.1.1)], using NRC significance criteria for reportable events at commercial nuclear powerplants. The OEH includes summaries of forced reactor shutdowns due to design-basis events, reactor-area releases greater than SRS administrative monthly area ALARA release guides (well below DOE limits), and significant problem areas based on reactor operating experience.

SRS management establishes annual operating release guides each year for each area as a tool to ensure that such releases are ALARA, and to alert management TE to abnormal releases. These release guides reflect operating experience and production plans, and are intended to be reduced continuously as technology and facilities are improved. Actual releases from each area are reported for each month, and the incremental and cumulative releases are compared to the preapportioned fractions of the annual release guides applicable to that month. The release guides for an area represent a very small fraction of applicable DOE limits. For example, the 1989 atmospheric release guide for tritium from K-Area (60,000 curies per year) represents a dose to a maximally exposed member of the public of about 0.065 millirem per year, compared to the EPA limit (under 40 CFR 61) of 10 millirem per year for the Site. L-78-40

From 1971 through 1987, design-basis events initiated 53 reactor shutdowns. Forty-six of the shutdowns were due to flow-reduction events; 31 of these were caused by flow reduction in a single assembly. The other flow-reduction events consisted of losses of power to the secondary cooling water pumps, losses of power to the primary coolant pumps, losses of power to both the primary and secondary pumps, losses of control rod cooling, rotovalve closures, and loss of blanket-gas pressure. The remaining shutdowns caused by design-basis events were due to reactivity addition events (single control rod withdrawals and partial control rod insertions) (NUS, 1988).

Between 1975 and 1987, SRS environmental records describe seven releases in the reactor areas in excess of SRS Release Guides but well within DOE dose limits. Table 4-16 summarizes these releases. TE

Two recent incidents provided insight into the influence of human performance on reactor safety. In August 1988, startup of P-Reactor was attempted after it had been shut down for several months for seismic modifications. During the removal of the control rods, the power did not increase as expected. Helium-3 that had built up in the core from tritium decay was absorbing the neutrons that would normally maintain the fission chain reaction. Rather than stopping to determine why reactor power was not increasing, the operators and control room engineer continued to remove control rods. The necessity of withdrawing at least five more control rods than calculated was not uncommon due to the difficulty of monitoring the actual rod position and the tendency of the rods to stick. However, in this case operators pulled out 60 more rods than expected. Eventually the reactor was shut down when power could not be maintained. This event posed no threat to the public, but was not consistent with sound reactor operating practices (DOE, 1988b).

The second incident occurred on January 22, 1989. A large pressure transient (water hammer) caused damage in the secondary system of K-Reactor. The reactor was not fueled at the time and there was no risk to the health and safety of the public. Following a functional test of the secondary cooling water recycle system, a bypass line check valve was left pinned open, contrary to the test procedure. Three days later a test began that required operation of the cooling water pumps, but did not require verification of the bypass line check valve position. When the first pump was started, it was noted that the secondary cooling water system pressure was lower than expected. As required by the test procedure, the cooling water effluent valve was throttled to increase system pressure; the effluent valve was fully closed, yet pressure

TE | Table 4-16. Reactor Area Releases in Excess of SRS ALARA Release Guides (1975-1987)

Date	Area	Description
4/20/75	100-K	Liquid release to Pen Branch, approximately 130 kg of moderator leaked from evaporator steam coil (6,457 Ci tritium; 52 mCi ruthenium-103 and -106; 163 mCi cesium-134; 342 mCi cesium-137; 23 mCi cerium-141 and -144).
10/25/77	100-K	2.2 million liters of contaminated water released to Pen Branch when K-Area disassembly basin overfilled (1,250 Ci tritium; 545 mCi sulfur-35; 250 mCi strontium-89 and -90; 186 mCi cesium-137; 159 mCi chromium-51; 143 mCi cerium-141 and -144; 0.05 mCi alpha).
11/7/83	105-C	Atmospheric release of 150 Ci of tritium from target element leak in disassembly area. Offsite dose calculated to be 0.004 mrem (Du Pont, 1984d).
12/29/83	105-P	85-Ci release of tritium to Steel Creek from small moderator leak at distillation pad.
2/16/84	105-C	900 Ci of tritium released to atmosphere when cap used to temporarily seal opening on reactor tank top dislodged during pressure test of blanket-gas system and primary coolant spilled. Offsite dose calculated to be 0.008 mrem (Du Pont, 1985e).
6/30/84	105-K	40-mCi release of bromine-82 to atmosphere when Halon fire suppression system inadvertently actuated and resulted in formation of bromine-82 (and four other minor isotopes) in annular cavity. Offsite dose calculated to be 0.00004 mrem (Du Pont, 1985e).
2/87	100-K	7,490 Ci of tritium released to atmosphere when tank overflow caused spill.

Source: NUS, 1988.

remained low. The supervisor then decided that starting another cooling water pump would increase the pressure. Almost immediately after starting the second pump, the water hammer occurred. The water hammer was caused as reverse flow through the check valve caused the mechanical failure of the
TC | valve gate, and the valve closed. The sudden closure stopped the flow of water and resulted in a large pressure pulse (DOE, 1989a).

These incidents illustrate the types of events that are potential accident precursors at the SRS reactors; such incidents are reviewed to determine their

root causes so appropriate corrective actions can be taken to prevent their recurrence.

Safety Milestones

Accident prevention practices and programs, such as those described in Section 2.1, have been in use since operation of the SRS production reactors began in 1953. As the process identified a need for change, DOE undertook projects to upgrade and supplement existing systems and practices. The history of the reactor safety evolution on the SRS (Du Pont, 1988b) describes the many upgrades made between 1953 and 1988, which included the following:

- The supplementary safety system (SSS) was installed in 1955 to provide manual reactor shutdown via the injection of a liquid neutron absorber if the safety rods fail to drop on demand. Upgrades to shorten the SSS response time and to automate SSS actuation were implemented in 1974 and 1979, respectively.

- In 1960 and 1961, a major project provided moisture separators, particulate filters, and halogen adsorbers (carbon filters) in the process area ventilation exhaust stream to remove airborne contamination, particularly iodine-131. In addition, the reactor room and process areas were sealed to minimize leakage around the confinement filters pathway. Carbon coimpregnated with triethylene diamine (TEDA) and potassium iodide was placed in service beginning in 1976. The chemical form of iodine released depends greatly on the individual accident sequence and fuel burnup, and cannot be characterized as a given percentage. The carbon beds effectively retain both elemental iodine and organic iodides. L-78-51

- The automatic incident action system added in 1973 automates the capability for light-water [emergency cooling system (ECS)] addition in the event of a large primary coolant leak or loss of primary coolant circulation.

- Studies on confinement carbon filter overheating culminated in 1979 with the addition of the confinement heat removal system (CHRS; see Section 2.1.2.3.1). To maintain air temperatures low enough to prevent filter failure, the CHRS in L-Area was upgraded for automatic actuation in 1988; following reliability studies of the L-Area system, automatic actuation will be provided in K- and P-Areas.

- The diagnosis of multiple alarms (DMA) system, which was placed on line in 1984, aids the operators in managing abnormal reactor conditions by automatically analyzing patterns of alarms and sensor inputs, and is especially useful during multiple alarm events.

- In 1988, a moderator recovery system (MRS) was installed to respond to primary coolant leaks smaller than those assumed for the design-basis accident (i.e., leaks in the range of 0.3 to 63 liters per second). Use of the MRS could make ECS actuation unnecessary and reduce the amount of contaminated water leaving the reactor building.

Figure 4-3 shows these and other safety milestones. DOE continues to
TE | implement upgrades to incorporate information from recent SRS experiences and comments from external review groups, and to ensure that standards applied to SRS reactors more closely approach those applied to commercial reactors.

Section 2.1.2 describes the safety-significant upgrades currently planned, and those being evaluated for implementation. The severe accident risk assessment described in Section 4.1.3.1.5 considers the reactors as they would be configured when production resumes, including new upgrades in system design.

4.1.3.1.2 Mitigation of Accident Consequences

DOE imposes limits for the safe operation of the SRS reactors under normal and postulated transient conditions. The governing limits for reactor operation are called thermal-hydraulic limits. Five types of thermal-hydraulic limits comprise the lines of defense against consequences associated with reactor transients:

- Technical limits, which are specified to protect the fuel and target assembly cladding and the reactor structure for continuous operation at the limit. Technical limits are applied to the assembly heat flux, assembly effluent temperatures, and reactor effluent temperature to ensure that design lifetimes are achieved.

- Transient protection limits, which have a purpose similar to that for technical limits, but which are oriented toward the dynamic situation of faster-acting transients. Transient protection limit calculations assume safety rod scram occurs; they are applied to assembly heat flux, assembly effluent temperatures, and reactor effluent temperature to maintain reactor operation within constraints on fission product release and reactor damage.

- Confinement protection limits, which maintain the integrity of the airborne activity confinement system (AACS) during specific postulated transients not terminated by safety rod scram. Prevention of a major breach in the reactor tank and/or primary coolant system boundary is the criterion used to protect the confinement system. To achieve this, steam pressure forces are limited to values less than those required to lift the plenum, which precludes high rates of steam release to confinement, by requiring timely SSS actuation to prevent attainment of a damaging pressure level.

- Emergency cooling limits, which are imposed on assembly effluent temperatures to ensure that the ECS is capable of maintaining a coolable core geometry in the event of a loss-of-primary-coolant or a loss-of-primary-coolant-circulation accident.

- Operating limits, which establish the highest authorized operating power level for continuous reactor operation. Operating limits are derived by finding the most conservative operating parameters, as defined by the previous limits, and adding a margin to account for normal process fluctuations and instrument errors.

The employment of thermal-hydraulic limits in SRS reactor operation ensures a coolable inplace core geometry following any of the transients, and that significant radiological releases would not occur. In addition to the lines of defense provided by the thermal-hydraulic limits, the reactor design features and SRS features described in the following paragraphs, along with the emergency planning described in Section 3.9, act to reduce the consequences of accidents.

Reactor Design Features

Reactor Shutdown Systems

Several redundant and diverse systems operate to shut the reactor down rapidly, if necessary. Section 2.1.2.4 describes the reactor shutdown systems- the control-rod system, the safety-rod scram system, the supplementary safety system, and the automatic backup shutdown systems.

Emergency Cooling System

The ECS protects against the consequences of two postulated accidents: (1) loss of primary coolant and (2) loss of primary coolant circulation. Section 2.1.2.5.1 describes the ECS.

Airborne Activity Confinement System

Each reactor has an AACS, as described in Section 2.1.2.3.1. As shown in Figures 2-6 and 4-4, each reactor is completely surrounded by a massive concrete structure that, in combination with the confinement system, forms a barrier against the possible release of radioactive material other than the noble gases. The confinement system has the capacity to accommodate unexpected gas or energy releases. Hydrogen formed during an accident would be swept from the building by the high ventilation flow before explosive concentrations could be reached.

The AACS is assumed to operate for all design-basis reactor accidents. The three exhaust fans provide a high degree of assurance that at least one would remain in operation to maintain the process-area exhaust through the filter system. The probability that all three fans would fail is 10^{-4} per year. The occurrence of such a fan failure at the same time as one of the described accidents would be extremely unlikely.

Under certain rare severe accidents (which are assessed in Section 4.1.3.1.5), the AACS is assumed to be severely degraded or failed due to conditions beyond the design basis (WSRC, 1990).

Water Removal and Storage System

The water removal and storage system (WRS) described in Section 2.1.2.5.2 removes the contaminated water released during accident conditions from the lower level of the reactor building. The main sources of contaminated water are primary coolant leaks, reactor room spray water, and reactor pressure relief and overflow lines.

If a loss-of-pumping accident occurred, primary coolant, forced from the reactor tank by the addition of emergency cooling water, would flow from the two vacuum breakers and other vent pipes into the reactor room. A 60-centimeter gravity drain in the process area floor would direct this contaminated water to the contaminated water storage tank. Smaller drains, with 15-centimeter slotted standpipes, located throughout the process area floor, would drain to the -40-foot (-12-meter) elevation. The sump pumps are connected to the emergency power supply. Therefore, the loss of offsite power would not affect the operation of sump pumps.

Confinement Heat Removal System

The CHRS, which is described in Section 2.1.2.3.1, would prevent a failure of the confinement system and significant desorption of iodine from the carbon filters due to excessive air temperature in the event of a postulated core meltdown.

Reactor Room Spray System

TE | The reactor room spray system (RRSS) would mitigate the consequences of a dropped irradiated assembly by spraying cooling water on an assembly accidentally dropped or dislodged during discharge operations. Section 2.1.2.3.1 describes this system.

Remote Monitoring and Control System

The Remote Monitoring and Control System (REMACS), which is described in Section 2.1.2.5.3, would provide remote monitoring and control of critical reactor core cooling and activity confinement systems for the three operating reactors in the event of a reactor incident or any incident that requires evacuation of the reactor Central Control Room. The Technical Support Center (TSC), which is described in Section 3.9, can monitor the data and equipment status through the Remote Control Station, but cannot establish control for any reactor area.

Moderator Recovery System

The MRS would recover the moderator from intermediate-sized primary system
TE | leaks (0.3 to 63 liters per second) and return it to the reactor tank via the blanket-gas space in the reactor. The recovery of moderator from intermediate-sized leaks minimizes the impact of the leaks by averting ECS action and the resulting moderator degradation and contamination of the 190-million-liter earthen basin. The central control room operator operates the MRS manually in response to a decrease in the reactor tank moderator level.

SRS Features for Accident Mitigation

The feature of the Savannah River Site that would mitigate the consequences of an accident most effectively is its size; the minimum distance from any reactor to the nearest SRS boundary is 7 kilometers (from P-Reactor) in comparison to the 1-kilometer (or less) distance typical of NRC-licensed power reactors. Although South Carolina Highway 125 passes within 3 kilometers of K-Reactor, DOE controls access to onsite portions of the highway and has

procedures in place for stopping traffic and clearing all people from the highway within a short time of any incident.

Emergency Planning

The comprehensive emergency preparedness planning effort for the SRS and its environs, which is described in Section 3.9, includes the development and maintenance of programs and plans such as emergency planning zones (EPZs), the emergency classification and notification system, and the emergency response facilities. Offsite EPZs have been established to facilitate planning, preparedness, response, and dissemination of emergency information to the public (WSRC, 1989d).

The SRS emergency classification system uses four event classifications, in increasing order of severity: (1) Notification of Unusual Event, (2) Alert, (3) Site Area Emergency, and (4) General Emergency. Onshift supervision in the affected area(s) or the Emergency Duty Officer in the Technical Support Center makes the decision to declare an emergency. The communications staff in the TSC notifies state and local authorities and the DOE-Headquarters Emergency Operations Center, and activates the SRS emergency response organization, as appropriate. TC

SRS facilities and equipment for responding to emergencies include the following:

- Technical Support Center
- Emergency Operation Station
- Joint Information Center
- Offsite agency emergency facilities
- Communications equipment
- Onsite medical facilities
- Emergency monitoring equipment

TC

4.1.3.1.3 Effects of Modifications

This section describes the effects of modifications to systems and procedures (described in Section 2.1.2) on accident occurrence and accident mitigation.

Effects of System Modifications

The following paragraphs describe the effects on reactor safety of system modifications that are planned for completion before the resumption of production.

The upgrade of reactor seismic capability involves major hardware modifications, some of which will be completed as part of the continuing safety improvement effort on the reactors. The primary goals of this seismic upgrade are to ensure further that the reactor will shut down safely and that adequate core cooling will be maintained following a design-basis earthquake (DBE) of 0.2g peak ground acceleration. To enhance the goal of safe shutdown, seismic triggers will be installed on each subsystem of the supplementary safety system, as described in Section 2.1.2.4.2. The SSS modification provides a backup to the existing seismometer-actuated safety rod scram system. TE

The Operating Contractor will install seismically qualified upgrades to systems that would support the reactor core cooling function after a DBE. These upgrades (described in Sections 2.1.2.3.2, 2.1.2.3.3, and 2.1.2.5.2) include a qualified MRS, additional sump pump capacity, and a new seismically qualified diesel generator to supply power for these loads. The purpose of these modifications is to provide further confidence in the ability of the MRS to return primary coolant to the reactor vessel if pipe flange or seal leakage occurs following a DBE.

In addition, seismic qualification of the reactor stack support structure, the control room ceiling, and emergency lighting (described in Section 2.1.2.3.1) is under way.

Other planned seismic upgrades include the installation of qualified relays in the primary coolant system valve controllers. The new relays would prevent inadvertent valve closure and subsequent isolation of primary cooling due to seismically induced relay chatter during a DBE.

Another modification, the addition of an automatic start of the two electrically driven ECS pumps, as described in Section 2.1.2.5.1, would eliminate the need for operator action following a demand for ECS with a subsequent failure of the diesel-driven pump. This modification would improve both the accident mitigation response time and the reliability of the ECS.

Several of the systems and pieces of equipment planned to be upgraded seismically for DBE mitigation are important to reactor safety for other than seismic reasons. Such systems and equipment include the MRS, the sump pumps in the water removal and storage system, and the seismically qualified diesel generator.

Although seismically qualified, the MRS is designed primarily to mitigate the consequences of an intermediate-sized leak (as great as 63-liter-per-second
TE | break flow) loss-of-cooling accident (LOCA) in the primary coolant system. Without the MRS, the ECS would have to provide makeup water to the reactor vessel in a once-through mode. The use of the ECS would result in the transfer of tritiated heavy water (moderator) outside the reactor building to the 1.9-million-liter storage tank in the discharge basin. However, the MRS significantly reduces the likelihood of moderator tritium escaping to the environment because it recirculates moderator (released through the break) back to the reactor vessel. The MRS not only provides an additional line of defense for a small-break LOCA, it also reduces risk by retaining moderator inside, rather than outside, the reactor building.

The leak-before-break (LBB) program is influencing the analysis of accident occurrence. The current design-basis accident is assumed to result from a double-ended guillotine break (DEGB) of the largest primary coolant pipe. However, the DEGB is a very low probability LOCA event and might not realistically represent the manner in which piping would fail at the SRS reactors.

The LBB program uses methodology adopted by the NRC to support the position that degraded piping would leak before it breaks and, therefore, would be detected before a LOCA occurs. A comprehensive inspection program (e.g., ultrasonic testing of pipe welds to ensure their integrity) that ensures that

key components will not undergo sudden catastrophic failure supports the LBB methodology. To guarantee prompt detection of any potential pipe cracks (e.g., leaks), plans for the installation of a new, more sensitive, tritium monitoring system are being developed. The tritium in the heavy water allows the detection of leaks with great sensitivity. As a point of reference, the system can detect a leak of about 0.02 liter per minute at the SRS reactors, while in commercial reactors the corresponding primary coolant leak detection limit is about 20 liters per minute.

The following system modifications are part of the continuing safety improvement process and are not scheduled to be complete before the resumption of production.

The Operating Contractor will install new seismically qualified, redundant instrumentation in a remote safe shutdown panel. This panel will enable operators to verify reactor shutdown and to monitor essential core parameters from outside the control room (Section 2.1.2.5.3).

In conjunction with parallel analyses of the DEGB, the Savannah River Laboratory (SRL) is using the LBB program to redefine the design-basis LOCA on a more realistic basis. Ultimately, this work should result in a smaller, more realistic break located in a primary coolant system expansion joint. As part of the LBB program, the Operating Contractor is replacing existing expansion joints to facilitate periodic inspections of their interior surfaces and to ensure the integrity of the primary coolant system.

Although a more realistic break should replace the DEGB, the current design-basis accident analysis assumes that a DEGB occurs in one of the primary coolant pipes that also serves for ECS injection. To compound the accident (i.e., the "worst case"), the analysis also assumes that one of the remaining ECS injection paths fails to provide cooling water. A recent modification added a fourth ECS injection line to ensure that at least two paths would be available to cool the reactor core after an accident. The modification increases ECS reliability and makes the system fully redundant for the assumed worst-case accident of a DEGB followed by failure of an ECS line.

Effects of Human Factors Modifications

Human factors modifications currently under way or planned for completion before the resumption of production include upgrading operating procedures and operator training, which increases reactor safety by reducing the probability of operator error, and by providing the operators with the knowledge and skills required to handle off-normal operational occurrences.

The training program described in Section 2.1.2.7.3 will enhance the safety of reactor operations because of the increased emphasis on professionalism, technical knowledge, teamwork, and fundamentals, along with specific training on plant and procedural changes. In addition, DOE personnel are receiving training required to ensure that their oversight functions are performed in accordance with those at commercial nuclear powerplants (see Section 2.1.2.7.2).

The procedural modifications described in Section 2.1.2.7.3 will provide enhancement of the technical basis for safe operation, formality of

operations, and accountability of management, for both DOE and its Operating Contractor.

4.1.3.1.4 Design-Basis Accidents

Reactor accidents are considered in two distinct categories: design-basis accidents and severe accidents. This section describes the postulated scenarios and doses for design-basis accidents. The Safety Information Document supporting this EIS (WSRC, 1990) describes reactor accident analyses in more detail.

Design-basis accidents consist of the spectrum of postulated occurrences and accidents that the reactor protection systems must accommodate by continuing to perform their intended function. The occurrences range from relatively minor events such as equipment malfunctions to postulated accident situations with a potential for serious consequences.

Severe accidents are those that could produce significant reactor core damage and releases generally greater than the maximums calculated for design-basis accidents. Because severe accidents require multiple independent failures of engineered safety features, they are much less probable than design-basis accidents. Section 4.1.3.1.5 assesses severe accidents.

Accident Characterization

The accidents that define the design bases for transients at the SRS reactors fall into the following categories:

- Reactivity addition accidents that increase the reactor power or the power generated by local regions of the core
- Flow reduction accidents or losses of coolant that reduce the capacity to cool the reactor or individual fuel assemblies
- Accident releases that are used to calculate potential offsite radiological doses

The rationale employed in determining the design requirements necessary to prevent or mitigate the consequences of each type of transient or accident is that any consequence that is not acceptably low should have an offsetting low probability of occurrence that will, over all, produce an acceptably low risk.

Analysis shows that transient conditions resulting from all accidents enveloped by the design-basis accidents are terminated or mitigated by:

- The inherent stability of the systems that bring the transient under control and limit the consequences
- The operation of reactor shutdown systems that maintain the integrity of the fuel and primary reactor coolant system
- The operation of engineered safety features or other safety-related systems that maintain the integrity of the reactor core and confinement

and, thereby, limit the potential for offsite doses to the public when one of the protective barriers is not effective

Table 4-17 lists the events that can lead to the design-basis accidents evaluated for the SRS reactors. The following paragraphs describe each type of accident. TC

Reactivity Addition Accidents

The following events would increase the reactor power or the power of local regions in the core:

- Decrease/Increase in Heat Removal by Secondary Cooling Water System - Transients caused by the increase/decrease of secondary cooling water temperature and flow are bounded by normal environmental temperature variations and by variations in the equipment operation. The consequences of such variations are very slow-acting transients in which the temperature changes by several degrees over a period of several hours. Therefore, the results of such events are bounded by other transients, as described below.

- Single Control Rod Withdrawal/Partial Control Rod Insertion - During normal reactor operation the control rods are moved in and out of the core to accommodate the burnup of fuel and production in target material as well as other changing reactor parameters. Analyses of the transients caused by the inadvertent motion of both full and partial control rods indicate that the worst condition resulting from either a single rod withdrawal or a partial rod insertion transient would be a maximum primary coolant temperature increase of less than 5°C for the hottest core assembly (WSRC, 1990). A scram of the safety rods would terminate the transient. The resultant transient temperature is within the acceptable value range, as defined by normal power operation at the temperature equal to or less than the transient protection limit. TE

- Gang Control Rod Withdrawal - During normal operation, groups of control rods (gangs) move together in and out of the core. For accident analysis purposes, a gang of control rods is assumed to move inadvertently. Two separate cases were analyzed: one at full power to simulate normal operation and one at low power to simulate a startup.

  The consequences of a full-power gang rod withdrawal are essentially the same as those for a single rod withdrawal accident. A low-power gang rod withdrawal accident is analyzed to establish confinement protection limits and to determine whether some minimum downtime is required before a reactor may be restarted after a shutdown.

  The analyses for these two cases indicated that the most limiting conditions occurred for the gang rod withdrawal at high reactor power. At low power, resulting core temperatures are less than those produced by the gang rod withdrawal accident at full power because the control rods can be pulled at low power only after full primary coolant flow has been established. This is also true for shutdown actuated by the automatic backup shutdown (ABS).

TE | Table 4-17. Events Leading to the Design-Basis Accidents Evaluated for SRS Reactors

REACTIVITY ADDITION ACCIDENTS

- Decrease/Increase in Heat Removal by Secondary Cooling Water System
- Single Control Rod Withdrawal/Partial Control Rod Insertion
- Gang Control Rod Withdrawal
- Loss of Control Rod Cooling (Control Rod Melting)
- Loss of Target
- Loss of Fuel
- Reloading Error During Shutdown

FLOW REDUCTION ACCIDENTS

- Loss of Primary Cooling Water Pump AC Power
- Loss of Secondary Cooling Water Pump Power
- Combined Loss of Primary and Secondary Cooling Water Pump Power
- Rotovalve Closure
- Pump Shaft Break
- Flow Reduction in a Single Assembly
- Loss of Control Rod Cooling
- Loss of Blanket-Gas Pressure
- Decrease in Primary Cooling Water Inventory
- Decrease in Secondary Cooling Water Inventory
- Loss of Primary Coolant Circulation
- Loss of Cooling During or After Discharge

ACCIDENT RELEASES USED FOR CALCULATING OFFSITE RADIOLOGICAL DOSES

- Release or Spill of Moderator from Primary Coolant Loop
- Fuel Assembly Drop During Discharge Operations
- Loss-of-Coolant Accident
- Radioactive Material Release
- Reloading Error During Shutdown

In the design of each core charge, the transient temperatures and resultant consequences for any accident must be within the acceptable values defined by (1) steady-state operation at temperatures equal to or less than the transient protection limits for shutdown by the safety rod system, or (2) steady-state operation at temperatures equal to or less than the confinement protection limit for the case in which the safety rods are assumed conservatively not to insert, and shutdown is achieved by the ABS. Because the net effect on the rate of power rise for the gang rod withdrawal is very close to that for the single rod withdrawal, and because it initiates the same scram signal, a safety rod scram would also terminate the transient with a resultant maximum primary coolant temperature increase of less than 5°C in the hottest assembly.

- Loss of Control Rod Cooling (Control Rod Melting) - A reactivity insertion transient caused by a loss of control rod cooling that results in control rod melting is unlikely even with a total loss of cooling flow to the control rod housings. The control rods in current charges would not melt because heat fluxes in them are too low. Control rod melting would require a heat flux of more than 1,140,000 Watts per square meter. The design of the core charge limits the maximum heat flux to between 570,000 and 740,000 Watts per square meter. The paragraphs that describe flow reduction accidents (below) further discuss this accident.

- Loss of Target - This postulated accident begins with an abrupt reduction in primary coolant flow to a fairly high-powered target assembly. The accident scenario assumes that the flow reduction is severe enough and the target is of high enough power to melt the affected assembly, whether the reactor is shut down immediately or not.

  The scenario conservatively assumes that removal of the target material from the core occurs as it melts. This produces a positive reactivity addition transient that would increase reactor power and distort the power distribution. The main factors that affect the loss of target accident are the neutron absorption strength of the target assembly, its heat capacity, and its power. The last two factors determine how quickly an assembly will melt. If the location of the affected assembly is toward the outside of the reactor, the radial flux distortion amplifies the reactivity change.

  For an assembly with a low ratio of power to heat capacity, loss of flow would trip the scram instruments and the reactor would shut down before melting begins, even if the safety rods failed and the ABS signal was required for the shutdown. Thus, if the affected target melted, the reactor would remain subcritical because the design of the targets is such that any reactivity addition caused by a loss of target would not be great enough to override either the safety rods or the ABS signal.

  For an assembly with a high ratio of power to heat capacity, melting could begin before the ABS responded if the safety rod scram fails. For this case, the reactivity transient would cause the reactor power and the hottest assembly power to increase until the ABS could initiate shutdown.

  The analyses have identified no credible initiating mechanisms for the loss-of-target accident. Nevertheless, this accident scenario is used in the establishment of the confinement protection limits.

- Loss of Fuel - This accident is like a loss-of-target accident, except it is not assumed that the material is removed from the reactor as it melts. Molten debris from aluminum-clad, uranium-aluminum alloy fuel is postulated to be swept along with the moderator. As long as fuel particles are in the core region, there could be a temporary increase in reactivity. The reactor protection system (the safety rod scram system and the Supplemental Safety System actuated by the ABS) would

terminate the event. A postulated single-assembly melting event in the core would not result in the release of radioactivity beyond that assumed in the dose calculations in this chapter.

- Reloading Error During Shutdown - Manual reloading operations call for discharging a target assembly in one step, and charging a fresh target to that position in the next step. A postulated error is to discharge additional targets from adjacent positions without charging fresh targets. A second postulated error is to charge a fresh fuel assembly in place of a fresh target assembly. To achieve criticality from either postulated error, charge design constraints, which limit the lattice reactivity to accommodate such errors, would have to fail, and the plant operators would have to fail to observe instrument readings and alarms.

  Postulated reactivity and power anomalies from reloading errors would occur under shutdown conditions while the primary coolant system is open to the confinement atmosphere. The paragraphs that describe accidents used for calculating offsite radiological doses (below) further discuss this accident.

Flow Reduction Accidents

Flow reduction accidents reduce the capability to cool the reactor or individual assemblies.

- Loss of Primary Cooling Water Pump AC Power - On loss of alternating current (AC) power to the primary cooling water pumps, the backup DC motors would drive the pumps at reduced speed to deliver about 29 percent of the normal full flow to the reactor. As the primary cooling water flow decreased, the core coolant temperatures would begin to increase. An inherent property of the nuclear core design is a negative moderator temperature coefficient, which causes the reactor power to decrease with an increase in temperature. This power decrease and the core heat capacity would attenuate the rate of temperature rise.

  The first instruments to respond to this reduction in flow would be the two plenum pressure monitors, followed almost immediately by the assembly coolant flow monitors and the primary cooling water pump power supply monitors. Each of these instruments would independently initiate safety rod scram signals.

  With a safety rod scram, the maximum primary coolant temperature rise would be only about 5°C. In the unlikely event that the safety rods did not scram, the ABS would actuate, resulting in a temperature rise of less than 8°C. No bulk boiling would occur because the maximum primary coolant temperature reached in this transient is less than its saturation temperature (i.e., boiling point) by at least 4°C.

- Loss of Secondary Cooling Water Pump Power - If electrical power was lost to all the pumps supplying secondary cooling water to the reactor heat exchangers, flow would decrease rapidly and then level off at

approximately 25 percent of full flow. Gravity feed from the 95-million-liter reservoir would maintain this flow.

As a result of the decrease in secondary cooling water flow, the primary coolant temperature would increase. Due to the negative moderator temperature coefficient, reactor power would be reduced gradually until scram occurred. The first scram-initiating instruments to respond would be all the individual heat exchanger flow monitors, followed by the secondary cooling water header flow monitors, and then the assembly coolant temperature monitors. The primary maximum coolant temperature increase is less than 1°C, even for ABS. No bulk boiling would occur because the maximum primary coolant temperature is about 19°C less than its saturation temperature.

- Combined Loss of Primary and Secondary Cooling Water Pump Power - This accident scenario assumes that primary coolant heat removal decreases from a combined loss of AC power to both the primary and secondary cooling water pumps. As the flows decrease, core coolant temperatures would increase. This would cause the reactor power to decrease because of the negative moderator temperature coefficient. This decrease in power and the core heat capacity would slow the rate of temperature rise.

  The first scram-initiating instruments to respond would be the plenum pressure monitors, followed by the assembly coolant flow monitors and the primary coolant pump power supply monitors. Results from this evaluation show that the maximum primary coolant temperature increase would be less than 6°C for safety rod scram and less than 8°C for the ABS. No bulk boiling would occur because the maximum primary coolant temperature reached is less than the saturation temperature by at least 4°C.

- Rotovalve Closure - Inadvertent closure of a rotovalve would cause a decrease in the primary coolant flow to the reactor core. This analysis, assuming a flow decrease caused by the simultaneous closure of all rotovalves, provides a bounding case in relation to milder transients involving fewer valve closures or slower closing rates. The negative moderator temperature coefficient would cause a decrease in reactor power, as described above.

  The plenum pressure monitors would initiate the first scram signal. The assembly coolant flow rate instrumentation would also generate scram signals. The decrease in power and the core heat capacity would slow the temperature rise. The maximum primary coolant temperature would increase by less than 5°C for the safety rod scram and by less than 11°C for the ABS. Although some bulk boiling of primary coolant would occur for the ABS case, it would not exceed the confinement protection limit.

- Pump Shaft Break - The postulated pump shaft break accident is caused by a break in a primary coolant pump drive shaft somewhere between the pump impeller and the flywheel. With the flywheel no longer connected to the impeller, fluid momentum drops to zero much more quickly than

with a loss of pump motor power. The first instruments to respond to this transient would be the plenum pressure monitors, followed by the assembly coolant flow instrumentation. Reactor power would decrease due to the negative moderator temperature coefficient, which slows the temperature rise, but does not reverse it until after scram occurs.

The maximum primary coolant temperature increase with safety rod scram is less than 10°C. For the ABS, the temperature increase is less than 20°C, which would result in exceeding the saturation temperature by about 8°C for 2 seconds. However, the resultant pressure from the steam is not sufficient to lift the shield/plenum structure and cause the roll anchors to fail.

- Flow Reduction in a Single Assembly - Various methods can be postulated for causing local flow decreases to the core assemblies. The bounding cases are the local flow reductions for fuel/target assemblies. Neither loss-of-target nor loss-of-fuel accidents have ever occurred in the SRS reactors. Automatic scram circuits exist for the assembly coolant flow to terminate flow reductions before damage would exceed that allowed for the transient protection limits. The loss-of-target accident is considered limiting in the establishment of confinement protection limits.

- Loss of Control Rod Cooling - The heavy-water moderator leaving the heat exchangers in the external loops supplies control rod cooling. Three loops on each side of the reactor supply two headers. Each header normally supplies coolant to half the control rod housings (septifoils). Thus, a loss of control rod cooling would require a reduction of flow in one or both of these headers or in an individual septifoil. A reduction of flow in a single header is unlikely because the headers are cross-tied. However, even with a total loss of flow to a septifoil, the control rods in current charges would not melt because heat fluxes in them are too low. Loss of flow to the control rods does not cause a safety problem because the reactor can operate at its full power level with a postulated zero coolant flow to the control rods and not melt them.

- Loss of Blanket-Gas Pressure - As blanket-gas pressure decreases, the saturation temperature decreases for the primary coolant system. The lower saturation temperature can cause cavitation in the primary coolant pumps and a resultant reduction in total reactor coolant flow and an increase in coolant temperatures. Subsequent negative moderator temperature coefficient effects would decrease reactor power.

  The maximum primary coolant temperature increase with safety rod scram is less than 1°C. For the ABS, the temperature increase is less than 19°C. The ABS resultant temperature exceeds the saturation temperature by about 10°C for 4 seconds. However, the resultant pressure from the steam is not sufficient to lift the shield/plenum structure and cause the roll anchors to fail.

- Decrease in Primary Cooling Water Inventory - Events that would result in a decrease in the inventory of the primary coolant system are leaks

and failures of small lines, primary coolant heat exchanger tube leaks, and LOCAs. The reactor can continue to operate with some coolant leakage, provided the reactor overflow tank can make up the leakage and the radiological consequences are acceptable. The MRS would collect any released coolant and return it to the primary coolant system for small line leaks and failures ranging from 0.3 to 63 liters per second. This would preclude the actuation of the ECS. Larger losses of coolant from postulated small pipe breaks would result in a reactor trip, ECS actuation, and a possible overflow of the coolant to the 190-million-liter earthen basin. The largest such "small" break would be in a line supplying the septifoil cooling system. The radiological consequences of the postulated break of small lines are bounded by the large LOCA event.

The release of radioactivity to the environment that would result from a postulated leak from the primary coolant system to the secondary cooling water system through the heat exchangers is small because the postulated leakage rate is small (averaging less than 0.09 liter per second). The secondary cooling water discharge is monitored by gamma-radiation monitors to detect heat exchanger leakage. If the radiological consequences of the leak exceed defined limits, the reactor will be scrammed and the secondary cooling water effluent line will be isolated. Thus, the radiological consequences of this event are bounded by the large LOCA event described below.

The design-basis LOCA is the DEGB of a line in the primary recirculation loop of the primary coolant system at full power. To ensure that the reactor core can be maintained in a coolable geometry, analyses of each charge design are required to demonstrate the ability of the ECS to preclude bulk boiling in the core if a LOCA should occur. The paragraphs that describe accidents used for calculating offsite radiological doses (below) discuss this accident further.

- Decrease in Secondary Cooling Water Inventory - A loss of secondary cooling water inventory (conservatively assumed to be an abrupt and total loss) would result in increased primary coolant temperature and decreased reactor power from negative moderator temperature coefficient effects. Even with the conservative assumptions of an abrupt and total loss by double-ended pipe break in both secondary cooling water headers, the maximum increase in primary coolant temperature is less than 1°C prior to safety rod scram and less than 10°C for ABS scram. The maximum coolant temperature remains less than the saturation temperature by 10°C, and no bulk boiling occurs.

- Loss of Primary Coolant Circulation - This accident is also referred to as a loss-of-pumping accident (LOPA). A rupture of piping in the secondary cooling water system could result in flooding of the primary coolant pump motor rooms at the -40-foot (-12-meter) level of the reactor building. This would cause a total loss of primary coolant pumping capability, which would require manual activation of the ECS to meet the emergency cooling limit and maintain a coolable core geometry. The introduction of the ECS displaces the heavy-water primary coolant/moderator to the WRS, which operates in conjunction TE TE

with the AACS to control the release of tritium and other liquid and airborne contaminants that might be present in the displaced reactor coolant.

- Loss of Cooling During or After Discharge - To prevent the overheating of the fuel and target assemblies during discharge operation, a continuous flow of water cools the assemblies. The assembly is adequately cooled if water exits the assembly at less than 100°C. If this cooling were lost, damage to the assembly would result. The radiological consequences of this event are less than those assumed for the accident of dropping an assembly onto the process area floor, as described below.

Accident Releases Used for Calculating Offsite Radiological Doses

This EIS analyzes accident releases in two ways to present two perspectives on reactor accident consequences. The analysis described in this section uses the design-basis accidents to obtain source terms and consequences on a deterministic basis; that is, conservatively realistic assumptions are made about the functioning of preventive and mitigative systems to estimate releases that are used with expected (or "typical") environmental transport parameters to provide an estimate of the most probable accident consequences. This approach is consistent with that used in environmental reports and impact statements prepared for commercial nuclear powerplants.

The analysis presented in Section 4.1.3.1.5 deals with a range of more severe accidents involving multiple human and equipment failures leading to greater releases of radioactivity, but also explicitly incorporates the probability of these releases and consequences in presenting the results. The results of this type of analysis are presented in terms of "risk," which is defined as the product of the consequence (e.g., radiation dose) and its calculated frequency (e.g., likelihood per year), and which is expressed in units of consequence per year (e.g., radiation dose per year).

The following paragraphs describe, in decreasing order of severity of consequences, the four design-basis accidents taken as representative of the spectrum of accidents described above; the source terms from these accidents are used for subsequent consequences analyses.

- Reloading Error During Shutdown - Postulated reactivity and power distribution anomalies from the reloading-error type of accident would occur during shutdown conditions while the primary coolant system is open to the confinement. A small region of the reactor could be made supercritical (causing a power excursion) by incorrect reloading operations. A reactor made critical by a reloading error would require procedural injection of the SSS gadolinium nitrate solution. If the reactivity is large enough, the power excursion would continue until termination of the nuclear chain reaction by fuel melting in a highly localized region of the reactor core. The highly localized damage would involve less than 3 percent of the core. The radiological consequences of a reloading accident are described later in this section.

- Loss-of-Coolant Accident - The design-basis LOCA is the DEGB of an inlet plenum line in the primary recirculation loop of the primary coolant system at full power. Such a break causes the plenum pressure and coolant flow through the core to decrease rapidly. When the moderator level in the reactor tank drops to 3.9 meters, the automatic incident action (AIA) system prepares the ECS for injection by opening isolation valves and starting the booster pump. ECS injection begins at a moderator level of 3.3 meters. This scenario assumes that all ECS flow to one primary coolant loop is lost from the break, and that ECS flow to a second loop is ineffective due to an arbitrary single failure of an active component in the injection path. ECS flow to a fourth loop can be initiated manually, or it will be initiated automatically by AIA at a moderator level of 1.5 meters. In addition, the AIA system will automatically align the AACS dampers and fans to maintain a negative pressure in the process area so all exhaust air will be filtered. The reactor room spray system is actuated manually, in accordance with procedures, to aid in the removal of fission products that might be released to the confinement. The consequences of this accident are described later in this section. TE

- Fuel Assembly Drop During Discharge Operations - Dropping an assembly during discharge is considered to be the most limiting accident for the release of radioactivity from a subsystem or component. The irradiated assembly is assumed to fall into a position such that it is not adequately cooled by the reactor room spray system. One irradiated assembly is assumed to release noble gases, iodine, and, in some cases, tritium. If melting occurs, the spray system would keep much of the iodine and particulates from becoming airborne. No credit is taken for this, however, and 50 percent of the iodine and 100 percent of the noble gases and tritium available for release are assumed to escape the assembly and become airborne within the confinement. This accident could release no more than 0.0246 percent of the core inventory of fission products at the time of shutdown because discharge operations do not begin until fission products have experienced at least 14 hours decay from their equilibrium values. The consequences of a dropped assembly are described later in this section.

- Release or Spill of Moderator from Primary Coolant Loop - A large primary coolant leak or activation of the ECS could spill the entire coolant/moderator inventory and release its contained tritium. The three events that can result in a primary coolant/moderator leak or spill are (1) a loss of secondary cooling water inventory without the resultant loss of primary coolant pumping power, (2) a loss of secondary cooling water inventory with the resultant loss of primary coolant pumping power, and (3) a decrease in the primary coolant inventory due to a small pipe break, a primary coolant heat exchanger tube leak, or a large primary LOCA.

  The first two events (loss of secondary cooling water inventory without and with loss of primary coolant pumping power) result in the operator manually actuating the ECS in accordance with emergency procedures. The light water from the ECS would then be forced through the reactor and out the vacuum breakers and U-tube into the reactor building. Most

of the heavy-water moderator is driven out of the reactor ahead of the ECS flow; the remainder is rinsed out over a longer period of time. Most of the radioactivity in the moderator (principally tritium) will be contained in the closed contaminated water storage tanks, which hold the first 2 million liters of the spilled moderator. Some radioactivity will be released up the stack by evaporation of heavy water in the reactor building and in the storage tanks, which are vented back to the reactor building. There will also be some evaporation of any moderator that flows to the earthen basin after the storage tanks are filled. The consequences of this accident are described later in this section.

Decreases in the primary coolant inventory are bounded radiologically by the primary system LOCA, which is evaluated as a separate accident for the calculation of offsite doses.

Consequence Assessment

This section describes the techniques used to calculate on- and offsite doses that result from postulated design-basis reactor accidents (WSRC, 1990). The calculations use dose models and assumptions consistent with NRC guidelines for accident analysis (NRC, 1979), specifically the computer code NRC145-2 (Pendergast, 1982). These methods are used for analysis of the design-basis accidents, including fuel melting and moderator spill accidents, as listed below:

- Reloading Error During Shutdown - The design-basis misloading of a fuel assembly during reactor refueling could cause an inadvertent criticality and release 3 percent of the reactor core fission products.

- Loss-of-Coolant Accident - The design-basis LOCA at full power is assumed conservatively to cause 1 percent of the core fission products to be released.

- Fuel Assembly Drop During Discharge Operations - A single irradiated fuel assembly, 0.23 percent of the core, could release fission products as a result of a mishap during discharging. Because assembly discharge operations do not begin before 14 hours after shutdown, this accident could release no more than 0.0246 percent of the core inventory of fission products. L-78-53

- Release or Spill of Moderator from Primary Coolant Loop - A large primary coolant leak or activation of the ECS could spill the entire coolant/moderator inventory and release its contained tritium.

The three sources of radioactivity considered are tritium in the heavy-water moderator, fission products in the fuel, and tritium in the targets of tritium-producing charges. (Charges for other reactor products are discussed at the end of this section, with other operating options that can affect risk.) The two types of accidents considered are moderator spills and assembly melting accidents. For the moderator release or spill accident, the conservative assumption for the maximum amount of radioactivity available for

release from the spilled coolant/moderator was 5 megacuries of tritium (the actual value is substantially less, about 2 to 4 megacuries), compared to the 70 megacuries available in the target assemblies in the reactor core. About 3.3 percent, 0.165 megacurie, would evaporate in the first 2 hours. For the fuel or target assembly melting accidents, the damage to the core is specified as the fraction of the fission product inventory that is available for release (e.g., the computation for a reloading error accident assumes 3 percent of the core inventory of radioactivity was available for release). Depending on the type of assembly that is melting and the accident circumstances, the radioactivity released would include noble gases (xenon and krypton), iodine, tritium, and radioactive particulates (fission products, cobalt-60, plutonium-239, etc.). Table 4-18 lists the inventories of these isotopes in the core at 3,000 megaWatts thermal. Operation at lower levels would produce lower inventories and accident consequences. | TC | TC

All releases are assumed to go up the 61-meter stack of each reactor. The computation assumes that any tritium or noble gas activity released to the confinement system is discharged from the stack because the confinement system has no mechanism for removing these isotopes. The source term for iodine is the amount that would penetrate and desorb from the filters in the first 2 hours after the accident. The average iodine retention efficiency assumed for the carbon filter is for carbon that had aged 19 months; this is intended to be typical of normal operation. Carbon beds are replaced on a staggered schedule, so some beds have relatively fresh carbon, some have carbon of intermediate age, and some have carbon approaching its service limit of 30 months.

The release from the stack is assumed to propagate as a continuous Gaussian plume, and the exposure of an individual is treated as a time-integrated calculation. The irradiation period begins with the release of the radioactive material. The calculation assumes that both the noble gas and iodine source terms decay during transport. The calculation does not include decay during the exposure period. The calculation of offsite dose assumes invariant atmospheric dispersion conditions for a 2-hour duration; this implies that the subject was exposed for a 2-hour period at the plume centerline. The calculations of onsite doses are based on 2-hour exposures. | TE

The meteorological data used in the dose calculations were collected from 1982 through 1986 in accordance with NRC Safety Guide 23 (NRC, 1972). The data were obtained at towers near K- and P-Reactors. Calculations for L-Reactor use data from the closest tower (K-Area). The meteorological data from each tower were averaged for 2-hour periods and sorted into 16 direction sectors, 6 wind speeds, and 7 stability classes. (Stability classes are based on the standard deviation of the mean wind direction.) Corrections for topography and jet rise of the released plume were applied. As described above, median meteorological dispersion parameters (yielding doses exceeded 50 percent of the time) are used in this assessment, in contrast to the more conservative parameters (yielding doses exceeded only 0.5 percent of the time) used to evaluate these accidents in the Safety Analysis Report, consistent with the practices in evaluations at commercial nuclear powerplants. | TE | TE

The downwind concentrations of iodine, tritium, and noble gases are calculated using the computer code NRC145-2 (Pendergast, 1982). This code, which was | TE

developed at SRS, uses a Gaussian plume model based on NRC Regulatory Guide 1.145 (NRC, 1979).

For an assembly melting accident (i.e., reloading error, LOCA, or dropped assembly), the effective dose equivalent consists of an inhalation component from iodine and tritium, and a direct radiation exposure component from the gamma emission of the noble gases. The inhalation component is computed by multiplying the relative concentration by the source strength, breathing rate, and dose conversion factor. The direct gamma exposure component is obtained by integrating the gamma dose from the entire (finite) cloud. The inhalation of particulate plutonium-239 released from the stack after an assembly melting accident produces a bone dose, which is included in the effective whole-body dose equivalent listed for that accident. The thyroid dose is due mainly to the inhalation of iodine. The effective dose equivalent for a moderator spill accident is from tritium released from the stack.

The onsite dose calculations for these accident releases determine doses received by reactor area personnel and doses received by other SRS personnel due to a release of radioactivity from the stack of the reactor building. The doses for SRS personnel are calculated for concentric rings centered on each
TC | of the three reactors at distances of 0.8, 1.6, 2.4, 3.2, and 6.4 kilometers (0.5, 1.0, 1.5, 2.0, and 4.0 miles) and at the SRS boundary. Calculations are made at each distance for the 16 22.5-degree sectors around the SRS
TE | perimeter. Tables 4-19 through 4-22 list, for each of the four accident releases, the maximum of the 16 direction dose values for each concentric ring
TC | and the SRS boundary.

The calculations based the maximum offsite doses on:

1. Specifying the source of radioactivity, the release rate, and isotope type.

2. Computing the transport of the released isotopes by the wind.

3. Computing the amount of radiation absorbed by an individual, both internally and externally, at the SRS boundary. This calculation requires the specification of a standard man, breathing rates, and several parameters related to the absorption of energy from a particular isotope. Because simplified models only approximate actual conditions, they are biased to overestimate the doses.

TE | Table 4-23 lists the dose to a hypothetical person at the most-exposed SRS boundary location from each accident.

These calculations indicate the median dose to an individual. Individual body characteristics, time of exposure, and atmospheric transport variability are important factors that are generalized in the computation of the dose received by an individual. In an actual accident, the SRS WINDS computer would predict the plume behavior and indicate appropriate actions to minimize exposure to people off the SRS (Garrett et al., 1981). Evacuation procedures would reduce the actual dose to an individual.

Table 4-23. Median SRS Boundary Dose[a] | TE

Accident	Effective dose equivalent (2-hr) (rem)	Thyroid dose (2-hr) (rem)
Reloading error	0.51	0.39
Loss-of-coolant	0.17	0.13
Fuel assembly drop	0.0042	0.0032
Moderator release/spill	0.0023	N/A

TC

a. Adapted from WSRC, 1990, as described in Tables 4-20 and 4-21. | TE

Multiple-Reactor Operation

The design-basis accident consequences described in this section are presented by individual reactor. From these results, Table 4-24 lists the median individual doses from a 2-hour exposure after the reloading error accident, which is the worst of the design-basis accidents occurring at K-, L-, or P-Reactor. As this table indicates, the consequences will vary according to the reactor(s) that are operating. Based on the health risk estimator discussed in Section 4.1.2.6, the incremental probability of a fatal cancer to an individual at the SRS boundary resulting from this dose would be about 0.0002 for L-Reactor, which has the largest SRS boundary dose. | TE | L-44-56

Production of Other Nuclear Materials

The analysis of design-basis accidents evaluates accident consequences for a source term based on the core inventory for a tritium-producing charge. To provide an estimate of the relative magnitude of the potential offsite effects of several nonfission product isotopes, full-charge inventories of several possible products were calculated; Table 4-25 lists the offsite doses from these inventories. The health consequences described above would not be changed by these doses. | TE

The inventories listed in Table 4-25 are based on the production capability of a single reactor producing a single product (except for the plutonium-238 inventory, which is based on the availability of intermediates as feed material). If two or more products are produced simultaneously in a single reactor (mixed lattice), the maximum inventory of any one would be lower. | TE

Few, if any, nonfission product isotopes that might be present in large quantities in mixed-lattice charges will be able to generate enough heat to melt the target. Hence, major releases of product materials in mixed-lattice charges would occur only in a major reactor accident (WSRC, 1990).

VEGP is based on a health risk estimator of 400 fatal cancers per million person-rem, or 4 x 10^{-4} fatal cancers per person-rem (EPA, 1989b). Using this value and the cumulative maximum individual and collective effective dose equivalents listed in Table 4-47, the additional likelihood of a fatal cancer in the maximally exposed individual in the immediate vicinity of the SRS is 5.0 x 10^{-7} per year, and the increased number of fatal cancers in the exposed populations within 80 kilometers of the SRS and at Beaufort-Jasper and Port Wentworth would be 0.039 per year. TE

4.1.7 COMMON RISKS

To provide a perspective on common risks, but not a basis for comparison of risks, Table 4-48 gives ranges of the estimated risks of death in a single year for some human activities that include various occupations, lifestyles, accidents, and environmental exposures, incidents, or situations. The risks to the different categories listed in Table 4-48 cannot be compared either explicitly or implicitly, because the methods used to calculate them are fundamentally different. TE TC

As a perspective on carcinogenic risks, the average risk in the United States of a person dying from cancer is about 1.9 x 10^{-3} (or almost 2 chances in 1,000) per year. However, rates in individual states range from a low of about 0.76 x 10^{-3} (in Alaska, with a young average population) to a high of 2.5 x 10^{-3} (in Florida, which has an older average population). The average risk of dying from lung cancer is about 5 x 10^{-4} per year; about one in four cancer deaths is due to this cause. The lifetime (age-adjusted) average risk of death by cancer is about 1.6 x 10^{-1} (or 16 chances in 100). TC

EPA has adopted a lifetime risk value of 1 x 10^{-6} as a reference point for the management and regulation of carcinogens in the environment. Thus, an incremental risk from an environmental carcinogen at the EPA guideline limit would raise the lifetime risk to an average U.S. resident of death by cancer from 0.16 to 0.160001. Similarly, at an incremental annual risk of 1 x 10^{-6} from a particular exposure, the total annual risk to an average U.S. resident of death by cancer would rise from 0.0019 to 0.001901.

4.2 TERMINATE OPERATION OF ONE OR TWO REACTORS AT SRS IN THE IMMEDIATE FUTURE AND MAINTAIN IN COLD STANDBY

This section describes the consequences that would result if operation of one or two of the SRS reactors were terminated, and maintenance in cold standby were to occur. Cold standby involves the defueling of the reactors; storage of the moderator in tanks in the reactor building; layup of reactor equipment and systems to prevent deterioration; and maintenance in a defueled, protected status by a skeleton staff that would permit future refueling and restart. TE TC

The three reactors have similar designs; in most instances, their releases to and impacts on the environment are similar, if not the same. If DOE decided to terminate the operation of one or more reactors at SRS in the immediate future (i.e., before resuming production), currently planned upgrade activities would be discontinued. The continued operation of K-Reactor would include construction of the recirculating cooling-tower system regardless of TC

whether DOE resumed production before the operation of the cooling tower; TC construction of the cooling tower would stop if K-Reactor operation were terminated in the immediate future. Atmospheric, liquid, and solid discharges TC would diminish, as would the need for process and potable water supplies and steam and electric power supplies. The permanent workforce required to maintain facility status and security would comprise about 20 persons at each reactor. Table 4-49 lists EIS sections that discuss reductions in staff for TE reactors and support facilities that are estimated to result from the termination of operation of one or two reactors.

Termination of the operation of one or two reactors would lead to corresponding reductions in the requirements for fabrication of fuel and target assemblies and in the quantities of irradiated assemblies requiring reprocessing. Reductions in these operations would result in decreased effluents to air and water and the production of smaller quantities of solid radioactive and hazardous wastes from these facilities. The termination of operation of one or two reactors and their associated support facilities would also result in the loss of 2,200 or 5,300 jobs, respectively.

Cooling water withdrawal effects and the impacts of these discharges on the ecosystems to which they are returned differ among the reactors. Table 4-49 TE lists the sections of this EIS that discuss these and other reactor-specific environmental impacts of the six combinations of terminating the operation of one or two reactors.

The termination combinations evaluated under this alternative include the following: TE

- Terminate L- and P-Reactors; operate K-Reactor
- Terminate K- and P-Reactors; operate L-Reactor
- Terminate K- and L-Reactors; operate P-Reactor
- Terminate K-Reactor; operate L- and P-Reactors
- Terminate L-Reactor; operate K- and P-Reactors
- Terminate P-Reactor; operate K- and L-Reactors

Table 4-49 lists these reactor combinations and the appropriate sections in Appendix A, Section 1.2, or Sections 4.1 and 4.2 that present the need to TC ensure production capability and the selected environmental consequences of operation.

4.3 TERMINATE K-, L-, AND P-REACTOR OPERATION IN THE IMMEDIATE FUTURE AT SRS AND MAINTAIN IN COLD STANDBY

An alternative to the continued operation of K-, L-, and P-Reactors would be to terminate their operation in the immediate future and maintain them in cold standby, as described in Section 4.3. The following sections describe the TC environmental consequences of termination of K-, L-, and P-Reactor operation.

Currently planned upgrade activities would be discontinued. Withdrawals from the Savannah River of 1.5 to 3.0 cubic meters per second for minimum fish TC protection flows in Steel Creek and Lower Three Runs Creek would be maintained. Atmospheric and liquid discharges would diminish by at least one

order of magnitude, as would the need for process and potable water. Power for steam generation (about 2,270 kilograms per hour required to maintain the reactor building environment) would come from the commercial grid; electric power needs for lighting, fans, sump pumps, monitoring equipment, etc., would total about 2.5 megaWatts per reactor. The permanent workforce required to maintain the facility status and security for each reactor would comprise about 20 persons (a total of 60). Another 10 to 15 persons per reactor would be employed on an occasional basis. TC

In addition, because the reactors would not require the fabrication of fuel and target assemblies, fabrication facilities would become inactive. No irradiated fuel and target materials would be produced for reprocessing, and those facilities would be used only for the reprocessing of weapons components to reclaim and process plutonium and tritium, and to reprocess fuel stored in H-Area and received at the Receiving Basin for Offsite Fuel (RBOF). These reduced operations would not require the level of operating and other support personnel currently employed at SRS; termination of K-, L-, and P-Reactor operation would result in the loss of an estimated 9,600 jobs at SRS.

4.3.1 SOCIOECONOMICS AND LAND USE

This alternative, termination of operation and maintenance in cold standby, would result in a sharp reduction of staff (9,600 jobs) at the reactors themselves and at such supporting facilities as fuel and target fabrication plants and spent fuel and target processing plants. Termination would sharply reduce direct expenditures by DOE for local purchases and wages and salaries. There would be a consequent secondary loss to the local economy of a large number of jobs, as well as taxes to local and state governments, due to the reduction in staffing and wages at SRS.

4.3.2 HISTORIC AND ARCHAEOLOGICAL RESOURCES

Termination of reactor operation would not restore any resources disturbed by prior construction.

4.3.3 COOLING WATER WITHDRAWAL AND DISCHARGE

Termination of reactor operation would greatly reduce withdrawals from the Savannah River. Approximately 1.5 to 3.0 cubic meters per second would be withdrawn to maintain water levels in L-Lake and flow in Steel Creek to protect fish in the stream. The reduced flow would result in less than 10 to 15 percent of the impingement and entrainment effects estimated to occur during reactor operation. No thermal discharges would occur. Table 4-10 lists discharges to onsite streams expected after termination of operation. TC TE

4.3.4 WATER QUALITY

The termination alternative would sharply reduce the discharge of liquid effluents to onsite streams. The chemical characteristics of these streams would change from those existing during reactor operation. TC

4.3.5 GROUNDWATER USE AND QUALITY

Termination of reactor operation would reduce groundwater withdrawal to less than 4,300 cubic meters per day. Discharges from reactor disassembly basins would cease, but tritiated water moving from the seepage basins would continue to outcrop at L-Lake for about 5 years, at Indian Grave Branch for about 6 years, and at Steel Creek for 30 years after reactor operation ceases. The basins would be maintained for possible future use.

4.3.6 AIR QUALITY

Termination of reactor operation would require substantially less steam (an estimated 2,270 kilograms per hour per reactor) and electrical energy (2.5 megaWatts per reactor). Onsite powerplants would operate at reduced power levels, with consequent reductions in emissions.

4.3.7 FLOODPLAIN/WETLANDS

Termination of reactor operation would not affect the SRS floodplain. In
TC | addition, termination would permit the eventual recovery of wetlands and end the growth of the delta in the swamp.

4.3.8 AQUATIC BIOTA IMPACTS

Termination of reactor operation would eliminate the thermal, stream erosion, and depositional effects in receiving streams. A reduction in eutrophication and hypolimnion anoxia in L-Lake would occur. Fish kills would be
TC | eliminated. Flows in Steel Creek to support fish spawning activity would be maintained by makeup water withdrawals from the Savannah River to L-Lake.

4.3.9 THREATENED AND ENDANGERED SPECIES

Termination of reactor operation would not adversely affect any threatened or endangered species; mitigation measures currently in effect for protection of
TC | these species would be maintained.

4.3.10 SOLID WASTES

Placing the reactors in cold standby would sharply reduce the volume of domestic trash from these areas. In addition, reductions in support facility activities would result in smaller volumes of domestic solid wastes.

4.3.11 HAZARDOUS WASTES

Termination of reactor operation at SRS would sharply reduce the rate of generation of hazardous, radioactive, and mixed wastes, but would not affect continuing waste management strategies for treatment and cleanup of SRS waste sites.

4.3.12 NORMAL RADIOLOGICAL RELEASES AND EFFECTS

Termination of reactor operation would substantially reduce the SRS radiological exposure contribution, but would not measurably change the total

radiation exposure to the local or regional population from other sources, including natural background.

4.3.13 REACTOR ACCIDENT RELEASES AND EFFECTS

Termination of reactor operation, defueling, and maintenance of the reactors in cold standby would eliminate the possibility of releases of radioactivity from design-basis and more severe reactor accidents and their risks.

4.3.14 SUMMARY OF ENVIRONMENTAL CONSEQUENCES OF TERMINATION ALTERNATIVE

Table 2-3 summarizes the impacts of the termination alternative and compares them to the impacts of the proposed action/no-action alternative.

4.4 DECONTAMINATION AND DECOMMISSIONING

Regardless of the alternative selected, K-, L-, and P-Reactors eventually would undergo decontamination and decommissioning. Plans for these activities would be subject to environmental and public review before they could occur. Previous SRS-related documents (DOE, 1984a, 1987c) provide information on options and decommissioning plans. TC TE

4.5 MITIGATION MEASURES

This section describes various potential mitigation measures for the SRS reactors that are not already included in the description of the proposed action or the alternatives [40 CFR 1502.14(f)]. It also describes biological resource mitigation efforts related to thermal effects (fish kills and wetlands) and entrainment. L-78-12 L-84-01 TC

4.5.1 CONTAINMENT DOME

The containment-dome concept would involve surrounding each SRS reactor building complex with a containment structure similar to those used in commercial nuclear powerplants. A containment structure effectively becomes a large pressure vessel or tank that contains the steam, water, and radioactive material that could be released in the event of a reactor coolant system pipe break (i.e., a LOCA). The containment structure at a commercial nuclear powerplant is typically a large, reinforced-concrete, domed cylinder with a steel liner that is as leaktight as practical. Such containment structures are designed to withstand the pressure (in excess of 0.35 megaPascal) that would result if the reactor coolant system (RCS) piping suddenly burst and released steam and water (typically held at 15 megaPascals pressure and 293°C in the RCS) to the reactor building.

Unlike commercial reactors, the SRS reactors operate at relatively low pressures and temperatures of 0.034 megaPascals and 105°C, respectively. Consequently, these reactors operate with essentially no stored energy that would be released to the surrounding confinement structure in the event of a LOCA. Because of the very low stored energy and the venting of the confinement structure through filters and a stack, the risk of

overpressurizing confinement following an accident is much less than overpressurizing containment in a commercial plant. The National Academy of
TE | Sciences-National Academy of Engineering Report (NAS/NAE, 1987) notes that there is no compelling evidence to show that adoption of the containment concept would substantially improve the safety of the SRS reactors. In fact,
TE | the NAS/NAE Report also notes that some countries in Western Europe have expressed interest in modifying the containments of some commercial plants so they can function more like confinements following a severe accident.

The SRS reactors were built in the early 1950s, before containment/confinement systems became accepted practice for commercial nuclear reactors. In the 1960s, a variety of containment/confinement systems was considered for SRS; at that time, the filtered and vented confinement system was selected as the optimum balance between cost and risk. While possible in principle, the construction of containment domes over the SRS reactor buildings would represent a formidable engineering challenge.

Each containment dome would have to be a concrete structure, semiellipsoid in shape, with an approximate diameter of 183 meters at the base and a height of more than 60 meters. The concrete would have to be lined with welded steel plate to achieve a leak-tightness standard similar to that for commercial plants (i.e., less than 0.1 percent leakage of the enclosed volume per day). The belowgrade areas of the reactor buildings would also have to be sealed with steel plate to achieve the same leak-tightness standard. Extensive modifications to the existing ventilation system would be required to supply fresh air to the new dome during normal plant operation. These modifications would also include the ability to isolate and recirculate air inside the dome after an accident.

Based on 1989 dollars, the estimated cost of constructing such a containment dome is more than $900 million. Calculations show that the dome would reduce exposure to the public following a design-basis accident with an existing confinement by 450 person-rem. This translates into a cost/benefit ratio of $2 million per person-rem averted and contrasts sharply with the NRC cost/benefit ratio per person-rem averted. The NRC provides the value of $1,000 per person-rem (1983) as a basis for estimating the need for additional equipment to reduce exposure from radioactivity in effluents from nuclear
TC | powerplants (10 CFR 50, Appendix I; NRC Regulatory Guide 1.110).

4.5.2 INTERNAL CONTAINMENT STRUCTURE

In this concept, the containment structure would be located inside the reactor buildings in the form of a steel liner. The internal containment would seal the actuator tower, the reactor process room, the heat exchanger bays, and the main pump rooms. The entire containment zone would be lined with welded steel plate, which would have seal-welded penetrations in most cases and nonshrink grout for others, such as electrical conduits and cable trays. Special enclosures would be provided for corridors, doors, pump shaft penetrations, and other entrance/exit points.

A new heat-removal system would have to be provided to prevent containment overpressurization due to the heat released from a core-melt accident. The system would include a deluge spray that would be used to cool the open volume

inside the containment zone. After the initial supply of water was sprayed into the containment, it would be recycled by pumping it through heat exchangers and into the spray nozzles.

A new recirculating ventilation system would also be required for the containment zone. The system would always be on line except for purging operations during reactor shutdown. The existing ventilation system could serve the areas outside the containment zone. During reactor operation, a small amount of outside makeup air would have to admitted to keep the actuator tower and crane service areas habitable.

The estimated cost of the containment concept is $250 million; it should reduce the dose from a design-basis accident by approximately 455 person-rem. This represents a cost/benefit ratio of $550,000 per person-rem averted, which is 550 times the NRC value for reactor equipment improvements (i.e., $1,000 per person-rem averted).

4.5.3 DETRITIATION SYSTEM

The heavy-water coolant/moderator accumulates tritium in concentrations that can represent a significant source of exposure to the reactor's operating and maintenance staff. The small quantities of moderator transferred with the fuel to the disassembly basin also carry tritiated water, which has been discharged after processing to seepage basins. As noted in Section 2.1.2, DOE is considering direct discharge of this water to onsite surface streams via NPDES outfalls in each reactor area to eliminate this source of groundwater contamination, and will meet with EPA and SCDHEC to determine the preferred approach.

A detritiation system should lower the tritium content of the heavy-water moderator in the SRS reactors by a factor of approximately 10 (e.g., from about 17 to 1.7 curies per liter). Detritiation of the moderator would be accomplished in a central facility or moderator detritiation plant (MDP) that is remote from the three reactors. The process most likely to be considered is based on vapor-phase catalytic exchange between heavy-water feed and detritiated deuterium, coupled with cryogenic distillation of the gaseous deuterium to remove the tritium. DOE has periodically examined the feasibility of detritiating the reactor coolant/moderator (DOE, 1984a, 1987c), and has concluded that the dose reduction benefits were not adequate given the cost of such a facility. L-44-61 L-45-03 L-49-05 L-78-02 S-06-06 S-11-04 S-31-32

The lowered tritium activity in the moderator could result in reduced offsite releases, reduced occupational exposures to onsite personnel, and reduced impact of low probability loss-of-pumping and heavy-water spill accidents at the reactors. However, new hazards would be introduced as the result of transporting moderator to and from the reactors. Assuming transportation by 7,500-liter truck, there would be an approximate total of four feed and product shipments per week between the reactors and the MDP. Initially, each feed shipment to the MDP could contain as much as 129,000 curies of tritiated moderator; over time, this figure would reduce to 12,900 curies per shipment. The product shipments that are returned to the reactors would contain about 22 percent of the feed shipment. Moderator handling equipment would be required at both the reactors and the MDP. Careful makeup of joints and flanges on

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this equipment would be necessary to prevent spills that could result in both offsite releases and exposures to personnel operating the equipment.

The collective dose averted by the MDP over a 10-year period was determined, assuming that each reactor's heavy-water tritium concentration was a maximum of 17.2 curies per liter, that the MDP would be capable of reducing these concentrations by a factor of 10 in a 9-year period, and that the releases to the environment would be proportional to the coolant/moderator concentration. The results indicate a collective dose savings over this period of about 430 person-rem. With an estimated capital cost of $125 million, and an annual operating cost of more than $6 million per year (DOE, 1984a), the cost per person-rem averted over the 10-year period would be about $400,000. This substantially exceeds the value of $1,000 per person-rem used by the NRC to assess the cost-benefit of additional effluent reduction at commercial nuclear powerplants.

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Previous studies (Baumgarten, 1983) concluded that the best permanent solution is reduction of moderator tritium level by detritiation, although they identified other less adequate, solutions, including the replacement of reactor deuterium with virgin unirradiated deuterium, increased holding time for disassembly-basin purges, and improved flushing of discharged assemblies.

Considerable effort has been expended to minimize the tritium carryover from the reactor to the disassembly basin. A thorough literature search of past efforts will be used to minimize such carryover further (Fanning, 1990).

These abatement measures include the following:

- Isolate the Discharge and Exit Canal - A small basin (such as the Discharge and Exit Canal) could be isolated from the rest of the disassembly-basin to receive discharged assemblies. This area would receive most of the transferred tritium. Water from this basin would be treated or disposed of as waste. As an alternative, a separate dip tank could be installed in the process room. The tank would provide extra washing of the assemblies. The tank water would have to be treated or disposed.

- Store Purge Water - Given sufficient capacity, disassembly purge water could be stored to allow tritium decay. After the tritium level had decayed to an acceptable level, the water could be released to the environment.

- Increase Disassembly Worker Shielding - If workers were shielded from the basin water itself, purging to reduce worker exposure would be unnecessary.

- Increase Discharge Machine Flushing Ability - Increased flow rates and coverage would increase moderator recovery and reduce tritium carryover.

Several waste management options for the handling of tritiated disassembly-basin water have been documented (DOE, 1987c). These options include direct discharge to onsite streams, evaporation, and continued use of seepage basins. Each of these evaluations has selected the continued use of seepage

basins as the environmentally preferred option. Table 4-8 summarizes the radiological impacts of these three disposal options. As the table indicates, direct discharge of disassembly-basin purge water produces collective doses about 30 percent higher than either evaporation or the continued use of seepage basins. The evaporation option produces the highest maximum individual dose at the SRS boundary. L-45-03 S-06-06 S-11-04 S-31-32

The continued consideration of tritium abatement procedures will enable DOE to determine if it can implement cost-effective solutions.

4.5.4 CONFINEMENT IMPROVEMENTS

Improved reactor confinement is a concept that would aid in the reduction of airborne radionuclides that could be released during a core-melt accident. The current Airborne Activity Confinement System would prevent the release of most major radiation sources, but it would not retain noble gases or tritium. The improved reactor confinement concept includes such design features as a taller stack, an improved water spray system, and a low-temperature adsorption system. Collectively, these features would provide a more effective means of reducing the noble gas and tritium dose contribution from a core-melt accident. In the event that one of these features experiences a failure, the improved reactor confinement system would revert to a system that is at least as effective as the original AACS. TE

As part of the improved confinement concept, each reactor would receive a new stack 142 meters high, which would be seismically qualified to a peak ground acceleration level of 0.2g. The stack would receive the combined airflow from the reactor process room and other areas of the reactor building (belowgrade purification). All air would have to pass through the existing confinement filters before reaching the stack. In the event of a reactor accident, the air from the reactor room would also have to pass through the low-temperature adsorption system. The taller stack provides a better means to disperse gaseous radioisotopes passively, allowing more decay time before they reach the ground than the existing stack.

The reactor room spray system, which includes both water supply and collection systems, is another design feature that is part of the improved confinement concept. In the event of a core-melt accident, the system would be actuated automatically to reduce reactor room temperature and pressure. The system would also reduce bromine and iodine loading on the confinement filters by at least 75 percent through the use of a buffered water solution that is sprayed during the initial 20 minutes of system operation. After nearly exhausting the buffered spray water, the system would switch automatically to plain water, which would be sprayed until the system was manually shut down. Contaminated spray water would be diverted to a collection tank that would be shielded for radiation and cooled to remove decay heat.

In the event of a core-melt accident, air drawn from the reactor room recirculating system would be diverted through a low-temperature adsorption system (LTAS) to capture tritium and noble gases. At the same time, all sources of air into the reactor room or recirculating loop, except unavoidable leakage, would be isolated. The LTAS would operate in several stages. In the first stage, hydrogen and tritium in the air stream would be oxidized in a TE

converter vessel to form ordinary and tritiated water. Next, moisture would be removed, leaving dry air that would contain only the noble gases xenon and krypton. The air stream would be cooled to about -60°C just before entering the noble gas adsorption columns, which would release a concentration of noble gas that is 25 percent of the incoming concentration but that had decayed for more than 6 hours. The LTAS would be designed to process a maximum estimated
L-44-12 | flow rate of 0.93 cubic meter per second (Petry et al., 1986).

Rough estimates for the improved reactor confinement concept place the cost at more than $150 million. Based on an estimated exposure reduction of 460 person-rem, the concept has a cost/benefit ratio of at least $325,000 per person-rem averted. This ratio is substantially more than the NRC ceiling value of $1,000 per person-rem averted. A more detailed analysis should show the cost/benefit ratio to be even higher, because the rough cost estimate does not include the costs of constructing the reactor room spray system or the research and development costs associated with LTAS.

4.5.5 ELEVATED PIPING CONCEPT

The elevated piping concept embodies plant design features that would preclude flow instability and ECS phase problems, following a DEGB in the reactor coolant system piping at 100-percent power. These features involve new modifications that would allow adequate water levels to be maintained in both the plenum and reactor tank (vessel), so fuel assembly channel boiling would be prevented during all phases of the DEGB, including long-term cooling. The following paragraphs describe important design features of this elevated piping concept.

Sections of primary water (PW) piping that connect to the plenum inlet nozzles would be elevated approximately 1.5 meters higher to ensure that water does not reverse-flow from the plenum via a PW supply-line break. To guard against siphoning from the break, antisiphon valves would be installed in the piping at the apex of each elevated PW line. A concrete coffer dam (guard vessel) approximately 1.5 meters high would be constructed around the plenum to contain any leakage from breaks in the plenum itself or the plenum inlet nozzles. The elevated piping would pass over this guard vessel before connecting with the plenum inlet nozzles. Both the elevated piping and the guard vessel would allow an adequate plenum water level to be maintained after an accident.

To prevent the loss of flow from an ECS line due to a break in a PW loop, all ECS lines would be rerouted and connected to plenum inlet lines inside the concrete guard vessel. The gas volume that presently separates light water in the ECS lines from heavy water in the PW piping would be eliminated to avoid the introduction of noncondensable gases in the plenum. In addition, an automatic tank injection system (ATIS) would be installed to minimize the possibility of introducing air into the plenum. The ATIS would inject heavy water directly into the bottom of the reactor tank, preventing a drop in tank level and subsequent air ingress via pump aspiration or O-ring leakage.

As a final mitigative measure, secondary (guard) piping would be placed around the existing PW piping in all six coolant loops, from the concrete penetration near the tank outlet to the highest point that the piping reaches before it

converter vessel to form ordinary and tritiated water. Next, moisture would be removed, leaving dry air that would contain only the noble gases xenon and krypton. The air stream would be cooled to about -60°C just before entering the noble gas adsorption columns, which would release a concentration of noble gas that is 25 percent of the incoming concentration but that had decayed for more than 6 hours. The LTAS would be designed to process a maximum estimated
L-44-12 | flow rate of 0.93 cubic meter per second (Petry et al., 1986).

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Sections of primary water (PW) piping that connect to the plenum inlet nozzles would be elevated approximately 1.5 meters higher to ensure that water does not reverse-flow from the plenum via a PW supply-line break. To guard against siphoning from the break, antisiphon valves would be installed in the piping at the apex of each elevated PW line. A concrete coffer dam (guard vessel) approximately 1.5 meters high would be constructed around the plenum to contain any leakage from breaks in the plenum itself or the plenum inlet nozzles. The elevated piping would pass over this guard vessel before connecting with the plenum inlet nozzles. Both the elevated piping and the guard vessel would allow an adequate plenum water level to be maintained after an accident.

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As a final mitigative measure, secondary (guard) piping would be placed around the existing PW piping in all six coolant loops, from the concrete penetration near the tank outlet to the highest point that the piping reaches before it

enters the heat exchangers. The PW pumps would not be enclosed by this guard piping, which would limit the break flow to much less than the DEGB. During the accident recovery phase, the guard pipe would also create a standpipe effect to maintain acceptable tank levels while the reactor is being defueled (EG&G, 1989). L-44-12

The elevated piping concept is being considered only as a possible mitigative measure for a DEGB that occurs (estimated frequency of less than or equal to 1 x 10^{-5} per year) when the reactor is operating at full power. The preliminary cost estimate for modifications associated with the elevated piping concept is more than $75 million. Other concepts being considered, such as a fast shutdown system, could add as much as 50 percent to the preliminary cost estimate. Although no final cost estimate is available for the elevated piping concept, such a number would be expected to be much higher than the NRC ceiling value of $1,000 per person-rem averted.

4.5.6 ENTRAINMENT MITIGATION

DOE has confirmed the absence of significant impacts of past entrainment losses on fish and other aquatic populations in the Savannah River in a Section 316(b) Demonstration and other extensive river studies. Further, DOE is planning to conduct additional studies in the river to address the current effects of SRS operations. Ichthyoplankton sampling will be conducted from March to June 1991 to assess the abundance and distribution of fish eggs and larvae near river intakes 1G and 3C. The sampling, which will occur at least weekly during the main spawning season, will assess diurnal and seasonal changes in abundance and distribution. L-78-08 L-83-06 L-84-01 L-84-07

In addition, DOE will conduct studies near the intake canals during periods of cooling water withdrawal to determine the portions of the river that potentially are subject to the effects of entrainment. The results of the data analysis will be used to assess striped bass and American shad abundance in relation to previous river sampling studies; to estimate ichthyoplankton entrainment rates, particularly for striped bass and American shad; and to determine if mitigation is required.

4.5.7 THERMAL MITIGATION

TE

4.5.7.1 K-Reactor

Since K-Reactor came on line in 1954, it has been operated in a once-through cooling mode, with direct discharge of cooling water effluent to Indian Grave Branch.

DOE prepared an EIS (DOE, 1987b) to address the potential environmental consequences of constructing and operating cooling water systems for thermal discharges from K-Reactor (and C-Reactor and the D-Area coal-fired powerhouse). That EIS considered three cooling water alternatives: the construction and operation of a once-through cooling tower, the construction and operation of a recirculating cooling tower, and the continuation of direct discharge - or no action.

In its Record of Decision (DOE, 1988e), DOE decided to construct and operate (subject to the authorization and appropriation of funds by Congress) recirculating cooling towers for both K- and C-Reactors and to implement increased-flow-with-mixing for the D-Area powerhouse at SRS. The recirculating system would discharge only blowdown water to the receiving stream. The implementation of cooling water systems for major sources of thermal effluents at SRS will enable compliance with the thermal provisions of Federal and state water-quality standards and with Consent Order 84-4-W (as amended) between DOE and SCDHEC (see Section 5.2.5). DOE originally supported once-through cooling towers as its preferred alternative. However, comments received from EPA (DeHihns, 1987) stated that the once-through cooling-tower alternative does not ensure the "protection and propagation of a balanced indigenous population of shellfish, fish and wildlife"; the State of South Carolina (Shaw, 1987) reinforced the EPA opinion that the recirculating cooling alternative would be the only permittable (and, therefore, environmentally preferable) alternative.

TC Deferring the full-flow testing and the resumption of production at K-Reactor until the cooling tower is available would mitigate the immediate consequences of the flow and thermal discharges.

Following mitigation with the recirculating cooling-tower system, the 32.2°C maximum Class B water-quality criterion (SCDHEC, 1989) will be met consistently in Pen Branch; however, the other Class B temperature criterion, which requires no more than a 2.8°C rise above ambient, will be exceeded occasionally in Indian Grave Branch and to a lesser extent in Pen Branch. These exceedances of the Class B limits should be infrequent and generally result in less than a 3°C increase above ambient stream temperatures. TC However, a biological monitoring [i.e., Section 316(a)] study will be performed after the cooling tower is operating to demonstrate if a balanced biological community would be maintained as previously estimated.

DOE is evaluating options for mitigating impacts to wetlands on Pen Branch resulting from resumption of production without a cooling tower. These options are being evaluated within a framework that recognizes that, although the resumption of production will result in the loss of 10 to 12 acres per year of previously unimpacted forested wetlands, it will not convert wetlands to uplands or open water and that such wetland functions as retention of flood waters, fish and wildlife habitat, nutrient export and retention, and biological productivity may be largely restored on 500 acres after the cooling tower becomes operational.

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Of the 670 acres of wetland communities in the Pen Branch delta that could be altered as a result of resumption of production without a cooling tower, approximately 500 acres would revegetate naturally within a short period after the cooling tower becomes operational. This would leave approximately 170 acres consisting of a stream channel and adjacent banks within the influence of the flow from the recirculating cooling tower. Some of this 170 acres would require replacement. This 670 acres has revegetated by natural succession since the cessation of K-Reactor production in April 1988. In the Pen Branch swamp, an additional loss of tree canopy in the forested wetlands (cypress-tupelo forest) would continue at the rate of 10 to 12 acres annually as a result of high temperatures and flows during the period of production without a cooling tower.

DOE is evaluating two basic mitigation approaches for implementation. The first approach is to evaluate and examine the feasibility of restoring wetlands on Pen Branch after the cooling tower becomes operational. Actions to be evaluated focus on the reforestation of the delta with 2-year-old cypress-tupelo seedlings. This option would utilize knowledge acquired since 1988 of natural revegetation of the Pen Branch delta and should accelerate natural succession of the wetland communities to the original cypress-tupelo forest.

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L-84-01
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S-11-04

The second approach is to evaluate and determine the feasibility of providing enhancements at wetlands sites other than Pen Branch, and/or of establishing new wetlands in place of or in addition to reforestation on Pen Branch. The highest priority would be given to examining opportunities for enhancements to similar riverine wetland sites on SRS streams (e.g., Steel Creek or Fourmile Branch). Opportunities for enhancements of nonriverine areas on and off SRS would also be considered; this includes evaluation of the potential for restoration of nonriverine wetlands, including Carolina bays, impacted by activities that occurred before DOE acquisition of the Site. Potential methods that DOE would consider for restoration of these wetland areas would consist primarily of reforestation of wetlands or alteration of the current hydrologic regimes to mimic historic conditions more closely.

The DOE evaluation of these mitigation options includes a commitment to implement a monitoring program to determine the precise nature and magnitude of wetland losses resulting from the resumption of K-Reactor production before cooling-tower operation, and subsequent recovery and revegetation after the start of tower operation. An initial phase of this monitoring would occur during the first year of K-Reactor production to provide input to select appropriate mitigation actions. DOE must discuss these actions with appropriate Federal and state agencies to obtain their input before they become final. This implementation process will be fully explained and documented in a mitigation action plan (MAP), which will detail the course of action to be taken and a timetable for action completion.

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L-84-01
L-84-08
S-11-04

Any mitigation involving enhancements to riverine wetlands, streams, or areas other than Pen Branch would begin as soon as possible after the mitigation action plan becomes final. Any mitigation involving Pen Branch would begin after the cooling tower becomes operational. DOE policy is to preserve and protect wetlands resources at SRS in accordance with the national goal of no net loss of wetlands. DOE will implement mitigation to achieve this goal.

4.5.7.2 L-Reactor

TE

L-Reactor operated originally from 1954 until 1968, when it was placed in standby status due to a decreasing demand for defense nuclear materials. In March 1981, activities were initiated to renovate and upgrade L-Reactor to the same condition as that of the operating SRS reactors. Renovation and upgrading activities were essentially complete in October 1983.

TE

Thirty-three alternative cooling-water systems and seven other alternatives were considered for implementation in the restart of L-Reactor. The 33 systems included seven once-through cooling lakes, four recirculating cooling lakes, nine once-through cooling towers, nine recirculating cooling towers,

and four direct discharge alternatives. The seven other mitigation alternatives included thermal cogeneration, low-head hydropower, modified reactor operation, fisheries management programs, restocking, protection of similar wetlands, and support of fisheries research.

The EIS led to a Record of Decision (Hodel, 1984) that stated that DOE had decided to proceed with the restart of L-Reactor using the preferred cooling water mitigation alternative discussed in the EIS. Before restart, DOE would construct a 1,000-acre cooling lake by impounding a portion of Steel Creek, which, when coupled with modifications to the reactor's power level, would ensure that the thermal effluent from the reactor would comply with the NPDES permit to be issued by SCDHEC. (Permit requirements are described in Section 4.1.1.4.2.)

After L-Reactor became operational, DOE would conduct studies to confirm the effectiveness of the cooling lake and decide on the need for precooling devices to allow greater operational flexibility (DOE, 1984a,b). As discussed in Section 4.1.1.4.2, DOE is presently conducting biological studies in L-Lake and Steel Creek to confirm the adequacy of the lake as a cooling reservoir. Initial results of the studies suggest that balanced biological communities are developing satisfactorily in L-Lake and Steel Creek. Fish have been killed in the upper end of L-Lake due to thermal discharge when L-Reactor started up after extended outages.

On June 6, 1990, SCDHEC issued an executed settlement agreement with DOE on fish kills in upper L-Lake. This agreement requires DOE to submit a report to SCDHEC describing options for avoiding future fish kills, identifying the selected options to be pursued, and providing a schedule for implementation. On July 5, 1990, as required by the settlement agreement, DOE submitted to SCDHEC a Remedial Action Plan describing options for avoiding future fish kills.

DOE has explored the following options:

L-78-06
L-84-05
L-84-08

- Reducing the rate of temperature increase during restarts to give fish more time to leave the discharge areas
- Recontouring the shoreline to eliminate areas where fish have become trapped by thermal plumes
- Using curtains to alter thermal plume mixing and produce relatively cool refugia in the discharge areas
- Reducing discharge temperatures by greatly reducing reactor operations
- Constructing cooling towers
- Placing a weir in the mouth of the discharge canal to keep fish from entering
- Removing aquatic vegetation to reduce fish abundance in the discharge area

- Isolating the upper end of L-Lake to prevent it from being recolonized by fish

The options that DOE selected for implementation include reducing the rate of temperature increase during reactor restarts, constructing a weir in the mouth of the discharge canal, and limited recontouring of the shoreline near the discharge points in L-Lake. DOE would conduct research and monitoring to determine the effectiveness of these options and the direction of further actions in L-Lake, if necessary.

TC

Procedures for reducing the rate of power ascension during reactor startups would be developed and implemented before the resumption of production of L-Reactor. The weir in the discharge canal would be constructed before the resumption of production of L-Reactor. Shoreline recontouring, which requires more extensive design, construction, and permitting activities, would be conducted during the first extended outage that follows the granting of a Corps of Engineers 404 permit. After SCDHEC review and approval, DOE will undertake the implementation of the selected options in accordance with the approved schedule.

4.5.7.3 P-Reactor

TE

P-Reactor cooling water was withdrawn from the Savannah River and discharged to Steel Creek from 1954 to 1961. Par Pond was formed in 1957 and 1958 by placing an earthen dam across Lower Three Runs Creek. Par Pond was used as a principal source of cooling water for R-Reactor from 1958 to 1964 and as a partial source of cooling water for P-Reactor from 1961 to 1964, supplementing Savannah River water. Since 1964, when R-Reactor was placed on standby, P-Reactor has used Par Pond as a source of recirculating cooling water.

The renewal NPDES permit, issued to SRS to be effective January 1, 1984 (State of South Carolina, 1983), specified that P-Reactor cooling water must meet South Carolina Class B stream criteria, with maximum temperatures of 32.2°C and rises above ambient of no more than 2.8°C at the cooling water outfall near the discharge from the P-Reactor heat exchangers. Although water temperatures at the outfall range from ambient to approximately 75°C, continued temporary operation of P-Reactor with temperature requirements as described in the 1976 NPDES permit was allowed under Consent Order 84-4-W, which accompanied the NPDES permit renewal. However, it also ordered that biological studies be conducted, according to Section 316(a) and (b) of the Federal Water Pollution Control Act, as amended (33 USC 1326), and a report submitted to SCDHEC on or before December 31, 1985.

DOE conducted the Section 316(a) and 316(b) studies (see Section 5.2.5) and submitted the results to SCDHEC. On May 14, 1987, SCDHEC concurred with the DOE conclusions that balanced indigenous populations of fish, shellfish, and wildlife presently exist in Par Pond and that the present operations of P-Reactor pose no threat to the continued existence of a balanced indigenous biological community (Joy, 1987).

Biological studies in the P-Reactor cooling system, including Section 316(a) studies on the effects of reactor thermal discharges, have demonstrated that balanced biological communities have been maintained in Par Pond. Fish have TC

been killed in Pond C, a precooler pond upstream of Par Pond, due to thermal discharges when P-Reactor starts up after extended outages.

On June 6, 1990, SCDHEC issued an executed settlement agreement with DOE on fish kills in Pond C. This agreement requires DOE to submit a report to SCDHEC describing options for avoiding future fish kills, identifying the selected options to be pursued, and providing a schedule for implementation. On July 5, 1990, as required by the settlement agreement, DOE submitted to SCDHEC a Remedial Action Plan describing options for avoiding future fish kills.

DOE has explored the following options:

- Reducing the rate of temperature increase during restarts to give fish more time to leave the discharge areas
- Recontouring the shoreline to eliminate areas where fish have become trapped by thermal plumes
- Using curtains to alter thermal plume mixing and produce relatively cool refugia in the discharge areas
- L-78-07 L-84-01 Reducing discharge temperatures by greatly reducing reactor operations
- Constructing cooling towers
- Isolating the refuge areas in Pond C so fish cannot emigrate from them to potentially lethal areas
- Raising the Pond C outlet crib so fish cannot emigrate from Par Pond to Pond C

The options that DOE selected for implementation include reducing the rate of temperature increase during reactor restarts and limited recontouring of the shoreline near the discharge points in Pond C. DOE would conduct research and monitoring to determine the effectiveness of these options and the direction of further actions in Pond C, if necessary.

Procedures for reducing the rate of power ascension during reactor startups would be developed and implemented before the resumption of production of P-Reactor. Shoreline recontouring, which requires more extensive design, construction, and permitting activities, would be conducted during the first extended outage that follows the granting of a Corps of Engineers 404 permit. After SCDHEC review and approval, DOE will undertake the implementation of the selected options in accordance with the approved schedule.

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CHAPTER 5

FEDERAL AND STATE ENVIRONMENTAL REQUIREMENTS

5.1 APPLICABLE STATUTES, REGULATIONS, AND DOE ORDERS

This chapter summarizes the major Federal and State of South Carolina requirements that are applicable to the operation of K-, L-, and P-Reactors. Table 5-1 lists the permits and other environmental approvals needed for reactor operation. In addition, the U.S. Department of Energy (DOE) has established its own Orders to ensure the environmental, health, and safety protection of its facilities.

National Environmental Policy Act of 1969, as amended (42 USC 4321 et seq.)

The National Environmental Policy Act (NEPA) of 1969, as amended, requires "all agencies of the Federal Government" to prepare a detailed statement on the environmental effects of proposed "major Federal actions significantly affecting the quality of the human environment." This environmental impact statement has been prepared to further the purposes of NEPA and to provide information to the public in accordance with the Council on Environmental Quality Regulations on Implementing 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).

Atomic Energy Act of 1954, as amended (42 USC 2011 et seq.)

Pursuant to the Atomic Energy Act (AEA) of 1954, as amended, and the Energy Reorganization Act of 1974, most DOE defense-related operations are not subject to regulation by the Nuclear Regulatory Commission. DOE has issued extensive standards and requirements to ensure safe operation of its facilities that are exempt from NRC licensing.

National Historic Preservation Act of 1966 (16 USC 470 et seq.)

No permits, certifications, or approvals related to historic preservation are required; however, DOE must provide the Advisory Council on Historic Preservation an opportunity for comment and consultation as required by the Historic Preservation Act of 1966. Section 106 of this Act requires any agency with jurisdiction over a Federal agency undertaking to provide the Council an opportunity to comment on the effect the activity might have on properties included in, or eligible for nomination to, the National Register of Historic Places (16 USC 470f).

Executive Orders 11988 (Floodplain Management) and 11990 (Protection of Wetlands) (May 24, 1977) (10 CFR 1022)

These Executive Orders 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 (10 CFR 1022) that establish procedures for compliance with these Executive Orders.

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Table 5-1. Required Regulatory Permits and Notifications for Reactor Operation

Facility/Activities	Requirements	Responsible Agency	Status
Water			
Process and Sanitary sewer outfalls	NPDES permit - CWA	SCDHEC, IAWD	Permitted; permit renewal application currently under review
Domestic water supply system	Permit to construct groundwater wells, treatment, and distribution systems	SCDHEC, Water Supply Division	Permitted
Cooling-water discharge	CWA Section 316(a) (thermal impact study)	SCDHEC, IAWD	Study complete
	NPDES permit	SCDHEC, IAWD	Discharge permitted
K-Reactor cooling-tower construction	Dredge and fill permit, CWA (Section 404)	COE	Application under review, permit is considered by operating contractor to come under nationwide permit
	Certification, CWA (Section 401)	SCDHEC, IAWD	
Wastewater treatment collection and transmission systems	Operating permit	SCDHEC, Bureau of Water Pollution Control	Permitted
Water Supply	Operating permit	SCDHEC, Bureau of Water Supply and Special Programs	Permitted
Water withdrawal water use	Quarterly report	South Carolina Water Resources Commission	Ongoing
Air			
K-, L-, and P-Reactor emergency diesel generators and diesel water pumps	Operating permit	SCDHEC, BAQC	Permitted; permit renewal application currently under review
F-, H-, and M-Area process facilities	Operating permit, amendments	SCDHEC, BAQC	Permitted
D-, K-, and P-Area powerhouses	Operating permit	SCDHEC, BAQC	Permitted
Airborne Pollutants and Radionuclides	NESHAP standards for hazardous air pollutants, including radionuclides	EPA	Ongoing
Hazardous Wastes	RCRA; "cradle-to-grave" management of hazardous wastes	DOE/SCDHEC/EPA	Interim and final status: 5 RCRA hazardous waste units, 96 ISS units, 13 units proposed; FFA being negotiated

Table 5-1. Required Regulatory Permits and Notifications for Reactor Operation (continued) | TC

Facility/Activities	Requirements	Responsible Agency	Status
Solid Wastes	SCDHEC Regulations, permits, and modifications	SCDHEC	7 permitted solid (nonhazardous waste management facilities)
Hazardous Substances	CERCLA, reporting, remedial action	DOE/SCDHEC/EPA	Plan in place; FFA being negotiated
Endangered Species	Consultation/biological assessment	FWS and NMFS	Complete
Fish and Wildlife Coordination Act	Consultation/consideration of fish and wildlife resources	FWS	Complete
Anadromous Fish Conservation Act	Consultation with FWS and development of mitigation plans	FWS	Complete
Historic Preservation	Archaeological survey and assessment	SCHPO	Complete
Floodplain/Wetlands	Assessment and determination	DOE	Complete
Underground Storage Tanks	Notification for existing tanks, permitting for new/modified tanks	SCDHEC	Notified

Abbreviations:

BAQC	Bureau of Air Quality Control
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
COE	U.S. Army Corps of Engineers
CWA	Clean Water Act
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
FFA	Federal Facilities Agreement
FWS	U.S. Fish and Wildlife Service
IAWD	Industrial and Agricultural Wastewater Division
NESHAP	National Emission Standard for Hazardous Air Pollutant
NMFS	National Marine Fisheries Service
NPDES	National Pollutant Discharge Elimination System
RCRA	Resource Conservation and Recovery Act
SCDHEC	South Carolina Department of Health and Environmental Control
SCHPO	South Carolina Historic Preservation Office

Clean Air Act, as amended (42 USC 7420)

The U.S. Environmental Protection Agency (EPA) has delegated authority for regulation of air emissions (with the exception of radionuclide emissions) to the South Carolina Department of Health and Environmental Control (SCDHEC), Bureau of Air Quality Control. SCDHEC requires air emission construction permits for construction, alteration, or addition to a source of air emissions. An air emission operating permit is required for any new and continuing source of air contaminants. A Prevention of Significant Deterioration (PSD) review is required for any proposed new construction, or
TE | any modification, of a major source that will result in a significant increase in the emission rate.

State authority for implementing and enforcing these regulations is provided in the South Carolina Pollution Control Act (1987 South Carolina Code of Laws, annotated, Sections 48-10 et seq.) and SCDHEC Air Pollution Control Regulations and Standards, 61-62.

EPA has promulgated regulations for radionuclide emission limits at DOE facilities (NESHAP, 40 CFR 61; 54 FR 51654).

Federal Water Pollution Control Act, as amended (33 USC 1251 et seq.)

- Section 316(a) (33 USC 1326) - Section 316(a) of the Federal Water Pollution Control Act, as amended, authorizes the EPA Administrator (or the State, if appropriate) to set alternative effluent limitations on the thermal component of discharges if the owner/operator demonstrates (to the satisfaction of the Administrator or, if appropriate, the State) that the proposed thermal effluent limitations are "more stringent than necessary to ensure the protection and propagation of a balanced, indigenous population of fish, shellfish, and wildlife in or on a body of water into which the discharge is to be made." The State
TE | of South Carolina has an approved National Pollutant Discharge Elimination System (NPDES) program; therefore the satisfactory Section 316(a) demonstration is to be made to SCDHEC, which is the decisionmaker. The owner/operator must demonstrate, for a cooling water alternative to be implemented, that the critical functions of a particular trophic level are maintained in the water body as they existed before the introduction of heat and that the impact caused by the heated effluent will not result in appreciable harm to the balanced indigenous community. This demonstration is to include scientific evidence that a balanced biological community will be maintained; no adverse impacts to threatened and endangered species will occur; no unique or rare habitats will be destroyed; passage zone for representative important species will be provided; and receiving- water temperatures outside any (State-established) mixing zone will not exceed the upper temperature limits for survival, growth, and reproduction of any representative important species occurring in the receiving water (Code of Laws of South Carolina, Title 48, Section 48-1-100; NPDES Regulations 61-9, Sections 1-21).

- Section 316(b) (33 USC 1326) - Section 316(b) of the Federal Water Pollution Control Act (FWPCA), as amended, states that: "Any standard

established pursuant to Section 301 or Section 306 of FWPCA and applicable to a point source shall require that the location, design, construction, and capacity of cooling water intake structures reflect the best technology available for minimizing adverse environmental impact." In South Carolina, this demonstration is to be made to SCDHEC, which has received NPDES authority from EPA. The overall goal is to obtain sufficient information on intake entrainment and impingement impacts on shellfish, etc., in the water body to aid in determining whether the applicant's intake technology is the best available to minimize adverse impact on the aquatic communities. For existing intakes, the goal is accomplished by providing reliable quantitative estimates of the entrainment and impingement damage/losses and by projecting the long- range effects of such damage/losses on the community and water body. The extent of adverse impact is estimated by assessing the relative biological value of the source water body zone of influence for selected "critical aquatic organisms" and determining the potential for damages/losses by the intake structure. TE

- Section 401 (33 USC 1341) - Section 401 of the Federal Water Pollution Control Act, as amended, requires certification from SCDHEC that discharges into navigable waters will comply with applicable effluent limitations and water-quality standards. This certification is a prerequisite for a 402 or 404 permit.

- Section 402 (33 USC 1342) - Section 402 of the Federal Water Pollution Control Act, as amended, is the basis for controlling "point source" discharges of pollutants into navigable waters of the United States through the NPDES. This system is administered by EPA, which has delegated NPDES permitting authority in South Carolina to SCDHEC. The State of South Carolina Class B water classification standards (Regulation 61-68) provide limitations on thermal effluents.

- Section 404 (33 USC 1344) - The U.S. Army Corps of Engineers (COE) has the authority to implement these requirements for the discharge of dredged or fill material into the navigable waters of the United States (404 permits). EPA reviews applications for permits under Section 404 of the Federal Water Pollution Control Act, as amended, and has "veto" authority. The discharge of dredged and fill material into waters of the United States, above the headwaters (defined as the point of average annual flow of less than 0.142 cubic meter per second), providing applicable reporting/permitting requirements are met, is covered under a nationwide permit issued by COE.

The South Carolina Budget and Control Board has a parallel permitting system with COE (permits for construction in navigable waters, Regulation 19-450), which is administered by the South Carolina Water Resources Commission (SCWRC). The permit application submitted to COE also serves as the permit application to SCWRC.

Resource Conservation and Recovery Act of 1976, as amended (42 USC 6901 et seq.)

The Resource Conservation and Recovery Act (RCRA) hazardous waste program, which is administered by EPA, is designed to regulate hazardous waste by imposing management requirements on generators and transporters of hazardous waste and on owners and operators of hazardous waste treatment, storage, and disposal (TSD) facilities (40 CFR 260-270).

EPA has authorized SCDHEC to implement most elements of the RCRA program in South Carolina.

In addition to hazardous waste management, RCRA applies to nonhazardous solid
TE | waste and underground storage tanks. The Savannah River Site (SRS) has SCDHEC-regulated solid (nonhazardous) waste management units and SCDHEC-regulated underground storage tanks.

Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended (42 USC 9601 et seq.)

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) requires the investigation and remediation of hazardous substance releases. In July 1989, EPA (54 FR 29820) proposed SRS for inclusion on the National Priority List (NPL) under CERCLA (40 CFR 300), and adopted the final rule in November 1989 (54 FR 48184). Accordingly, DOE is negotiating an Interagency Agreement (Federal Facilities Agreement) with the State and EPA Region IV. This agreement should be completed in the second quarter of Fiscal
TC | Year 1991. As a result of this agreement, many of the SRS waste sites (potentially 30) will be cleaned up under CERCLA.

Noise Control Act of 1972, as amended (42 USC 4901 et seq.)

Section 4(a) of this Act directs Federal agencies to the fullest extent consistent with their authority under Federal laws administered by them to carry out programs within their control in a manner that furthers the national policy of promoting an environment free from noise that jeopardizes health or welfare [42 USC 4903(a)].

Endangered Species Act of 1973, as amended (16 USC 1531 et seq.)

The Endangered Species Act of 1973, 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 [National Marine Fisheries Service (NMFS)] and the Interior [Fish and Wildlife Service (FWS)]. Section 7 of the Act requires Federal agencies to consult with the appropriate agency to ensure that any action authorized, funded, or carried out by a Federal agency is not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of critical habitat of such species unless the agency is granted an exemption pursuant to Section 7(h) (16 USC 1536).

Fish and Wildlife Coordination Act, as amended (16 USC 661 et seq.)

The Fish and Wildlife Coordination Act requires that Federal agencies give full consideration to the conservation of fish and wildlife resources before proposing or authorizing development of water resource development projects. Specifically, the Act requires that consultation be carried out with FWS and appropriate state wildlife agencies with a view to the conservation of wildlife resources by preventing loss of and damage to such resources and by providing for the development and improvement thereof in connection with the project. The reporting agency is required to give full consideration to the recommendations of the Secretary of the Interior and the state agency. The project plan shall include such justifiable means and measures for wildlife purposes as the reporting agency finds should be adopted to obtain maximum overall project benefits. No permit is required by this Act.

Migratory Bird Treaty Act, as amended (16 USC 703-712)

The Migratory Bird Treaty Act was enacted primarily to protect birds that have common migration patterns between the United States and Canada, Mexico, Japan, and the Soviet Union. 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 to "kill...any migratory bird" outside an established season or within a restricted area.

Safe Drinking Water Act of 1974, as amended (42 USC 300f et seq.)

The primary objective of the Safe Drinking Water Act is to protect the quality of public water supplies and all sources of drinking water. SCDHEC has primary enforcement responsibility through the State Safe Drinking Water Act of 1976 (codified as Title 44, Chapter 55, of the 1976 Code of Laws of South Carolina, as amended). SCDHEC administration and enforcement consist of construction permits, preliminary site inspections, final construction inspections, monthly sampling of drinking water, and regular operations and maintenance inspections of public water supplies and facilities.

Department of Energy Environmental, Health, and Safety Orders

DOE is responsible for ensuring the health and safety of its facilities and has established comprehensive health, safety, and environmental programs. These programs are based on administrative directives or DOE Orders, which specify the procedures, responsibilities, and authorities for performing the various DOE functions. In March 1990, the Secretary of Energy formed a Task Force to review DOE nuclear safety Orders to issue replacement regulations. This review is continuing; however, until specific regulations are adopted through rulemaking, the following Orders are pertinent to SRS reactor operations: TC

- Order 5400.1, "General Environmental Protection Program"
- Order 5400.5, "Radiation Protection of the Public and the Environment" TC
- Order 5440.1C, "National Environmental Policy Act"

- Order 5480.1B, "Environmental Protection, Safety, and Health Program for DOE Operations"
- Order 5480.4, "Environmental Protection, Safety, and Health Standards"
- Order 5480.6, "Safety of Department of Energy-Owned Nuclear Reactors"
- Order 5481.1B, "Safety Analysis and Review System"
- Order 5482.1B, "Environmental, Safety, and Health Appraisal Program"
- Order 5483.1, "Occupational Safety and Health Program for a Government Owned Contractor Operated Facility"
- Order 5484.1, "Environmental Protection, Safety, and Health Protection Information Reporting Requirements"
- Order 5500.3, "Reactor and Non-Reactor Facility Emergency Planning, Preparedness and Response for DOE Operations"

Other applicable Orders include the following:

- Order 5400.3, "Hazardous and Radioactive Mixed Waste Program"
- Order 5400.4, "Comprehensive Environmental Response, Compensation, and Liability Act Requirements"

5.2 STATUS OF REGULATORY COMPLIANCE

5.2.1 HISTORIC PRESERVATION

Archaeological and historical investigations of the K-Area cooling tower and associated facility locations were completed in March 1989; these are the only locations involving ongoing construction associated with continued reactor operation. The survey revealed no archaeological or historic sites that are eligible for nomination to the National Register of Historic Places.

DOE submitted an archaeological survey and testing report, which was prepared by the University of South Carolina Institute of Archaeology and Anthropology, to the South Carolina State Historic Preservation Officer (SCSHPO). An SCSHPO representative visited the survey area in the spring of 1989. DOE requested a concurrence in a determination of "no adverse effect" from the SCSHPO for the project because no sites eligible for nomination to the National Register of Historic Places were within the K-Reactor cooling-tower construction area.
TC | The Deputy SCSHPO concurred in June 1989 with the DOE determination.

5.2.2 SOLID AND HAZARDOUS WASTE MANAGEMENT

Reactor operations generate a variety of residuals defined as solid and hazardous wastes under Federal and South Carolina law. Disposal will take place on the Site. There are seven permitted nonhazardous solid waste

management units (SWMUs) on the Site. DOE submits permit modifications to SCDHEC from time to time for expansion of existing units. In addition, DOE has developed a RCRA Program Management Plan (Sires, 1984) for nonradioactive solid and hazardous waste on the Site, based on EPA and SCDHEC regulations.

SRS has many hazardous waste management units/facilities that are subject to either interim or final status regulations under RCRA Sections 3004 and 3005. SRS submitted an original Part A hazardous waste management permit application to SCDHEC and EPA in 1979. Since that time, SRS has modified its Part A to include new units and/or modifications to existing units. SRS submitted the first volume of its Part B permit application in 1985, and received a RCRA permit on September 30, 1987, which permitted five RCRA hazardous waste management units. At present, SRS has 96 interim status units and 13 units proposed for construction that require permitting.

Several regulatory violations were cited during the Compliance Evaluation Inspection that EPA and SCDHEC conducted on March 13-17, 1989. These violations included deficiencies in inspections, the waste analysis plan, personnel training, and missing warning signs. A Notice of Violation (NOV) was issued on June 1, 1989, concerning these violations. SCDHEC conducted a followup inspection on October 17, 1989, and found that all the violations had been addressed satisfactorily.

SRS received an NOV in December 1989 for recurring violations of South Carolina Hazardous Waste Management Regulations (SCHWMR) R.61-79.262.34(b) and R.61-79.270 for storage of hazardous waste for more than 90 days at 90-day accumulation areas without having applied for or received a permit for storage. A final settlement agreement (90-64-SW, September 6, 1990) has been developed to address these violations. TC

SRS received Notices of Deficiency (NODs) from SCDHEC about inadequacies in the RCRA Part B permit application volumes for the Consolidated Incinerator Facility, the Mixed Waste Management Facility, and the Defense Waste Processing Facility Organic Waste Storage Tank. SRS has answered these NODs. In addition, SRS received an NOD from SCDHEC about inadequacies in the RCRA Part B Closure Plan for F- and H-Areas. Revisions were submitted in May 1989; SCDHEC approved these revisions on June 23, 1989. TE

SRS entered into two settlement agreements during 1989 as the result of violations of SCHWMR R.61-79. Settlement Agreement 89-06-SW, effective February 22, 1989, resulted from the NOV issued in July 1988 on the accumulation of hazardous waste in drums of saltcrete at the Naval Fuel Materials Facility. SCDHEC renewed the Z-Area DWPF Saltstone Facility Permit and incorporated changes to allow final disposition of the drums in that facility. Settlement Agreement 89-40-SW, effective December 21, 1989, concerned a violation of SCHWMR R.61-79.262.34(b), resulting from the speculative accumulation of photographic fixer solution. The violation has been corrected and the settlement agreement satisfied. TE

In 1977, SRS submitted to SCDHEC the first application for a solid (nonhazardous) waste permit (for the sanitary landfill). Subsequently, DOE obtained several solid waste permits and permit modifications (necessary for

expanding existing units) from SCDHEC. At present, SRS has seven permitted solid (nonhazardous) waste management facilities. In accordance with the SRS permits, DOE is investigating SRS solid waste management units for remedial action needs.

Both SCDHEC and EPA have issued RCRA permits to SRS for certain hazardous waste management facilities. SRS also has facilities operating under "interim status" requirements; this means that the facilities were in existence before the effective regulatory date and that SRS has filed the necessary notifications and permit applications. These facilities will remain subject to interim status regulations (40 CFR 265) until SCDHEC finalizes its permitting actions. Some SRS hazardous waste management facilities are exempt
TE from RCRA permitting requirements because they are permitted under the Clean Water Act (CWA); some facilities are operating subject to enforcement agreements with SCDHEC and EPA. SRS is also resolving minor violations with SCDHEC and EPA. SCDHEC and EPA perform annual RCRA inspections at SRS, and SCDHEC performs routine inspections at SRS at least weekly.

The seepage basins at L- and P-Reactors and the containment basin at K-Reactor
TC have been added to the SRS CERCLA Site Evaluation List. A schedule for closure of these basins is being prepared by the Operating Contractor.

5.2.3 THREATENED AND ENDANGERED SPECIES

Formal consultations have occurred between DOE and FWS to comply with the Endangered Species Act of 1973. Based on these consultations, FWS issued a biological opinion that the preferred alternative cooling system for K-Reactor should have no effect on the American alligator, red-cockaded woodpecker, wood stork (Parker, 1986), or bald eagle (Henry, 1986). NMFS had previously concurred in the DOE determination that the population of shortnose sturgeon in the Savannah River would not be adversely affected by SRS operations (Oravetz, 1983). Similar conclusions were reached for L-Reactor operations (DOE, 1984), and for the endangered species evaluated in P-Reactor area habitats as part of the P-Reactor Section 316(a) and (b) compliance demonstrations (Du Pont, 1985). In 1989, DOE again consulted with FWS, requesting information on species that could be affected by the proposed action (Wright, 1989).

5.2.4 WILDLIFE AND FISHERIES

The Department of Energy has consulted with the U.S. Fish and Wildlife Service about impacts to fish and wildlife. Furthermore, DOE and FWS will undertake a cooperative effort to mitigate impacts to fish and wildlife resources in accordance with the FWS Mitigation Policy.

5.2.5 WATER QUALITY

On December 15, 1983, SCDHEC issued SRS NPDES permit SC0000175. Previously, EPA Region IV administered this permit and generally required thermal
TC compliance at the point of discharge to the Savannah River. In the permit renewal negotiations, SCDHEC stated that SRS operations caused State water quality standards to be violated in onsite streams and water bodies. To

require compliance with the State water-quality standards, SCDHEC reissued the NPDES permit with the compliant thermal limitations (32.2°C maximum temperature and a maximum 2.8°C rise-above ambient temperature) at the point of discharge (e.g., end of pipe) into an onsite water body.

On January 3, 1984, SCDHEC and DOE entered into Consent Order 84-4-W allowing the continued discharge of thermal effluents pending completion of thermal mitigation studies and thermal mitigation projects required for SRS to come into compliance with water quality standards. The Consent Order superseded the NPDES permit's thermal limitations and imposed alternative thermal limits at the discharge point from Par Pond Dam and the onsite streams' points of discharge into the Savannah River. For evaluation of cooling water systems for C- and K-Reactors and the D-Area coal-fired powerplant, DOE submitted the Thermal Mitigation Study to SCDHEC on October 3, 1984. For P-Reactor discharge to Par Pond, SRS undertook a CWA Section 316(a) Demonstration in Par Pond to determine if a variance to thermal standards was acceptable. Results of this study (Du Pont, 1985) were submitted to SCDHEC on December 26, 1985. SCDHEC conditionally approved the Section 316(a) Demonstration on May 14, 1987. SCDHEC approval is conditioned upon SRS elimination of fish kills in Par Pond. SCDHEC is currently reviewing a fish kill remedial action plan submitted by DOE. For the evaluation of other SRS discharges, DOE submitted the Comprehensive Cooling Water Study to SCDHEC on March 2, 1988. TC

Consent Order 84-4-W has been amended twice to provide a schedule for the construction of thermal mitigation alternatives (i.e., a recirculating cooling tower for K-Reactor). Amendment 2 mandates completion of the K-Reactor cooling tower by December 31, 1992.

The cooling water discharge for L-Reactor was incorporated into the SRS NPDES permit with an effective date of March 19, 1985. To meet water temperature criteria for this discharge, DOE created a 1,000-acre cooling lake on Steel Creek. NPDES permit requirements for L-Lake mandate the maintenance of State water-quality temperature criteria over at least 50 percent of the lake full-pool surface area; Section 316(a) Demonstration studies were required to confirm initial predictions by DOE [Preliminary Predictive 316(a) for L-Lake, May 17, 1984; Preliminary Predictive 316(a) for Steel Creek, August 16, 1984] of the development and maintenance of a balanced biological community in at least 50 percent of the lake and in Steel Creek.

DOE submitted a plan to SCDHEC to conduct a biological monitoring program in L-Lake and Steel Creek; the plan was implemented in January 1986. The plan includes the monitoring of any fish kills that occur in L-Lake. Results of the first 2 years of the biological monitoring program were reported in June 1988 (Du Pont, 1988) and are presently undergoing review by SCDHEC.

DOE evaluated and presented cooling water alternatives for K-Reactor in the Environmental Impact Statement, Alternative Cooling Water Systems, Savannah River Plant (DOE, 1987). Subsequently, a predictive Section 316(a) Demonstration was prepared on the selected alternative, a recirculating cooling tower (Du Pont, 1989). Construction of this tower is currently under way on an accelerated schedule; this could shorten the construction period by an estimated 6 months, or make the completion date about June 1992. K-Reactor TC

will operate with once-through cooling under Consent Order 84-4-W until the completion of cooling-tower construction on or before December 31, 1992. Because the Class B water quality criterion requiring no more than a 2.8°C rise above ambient temperature, will occasionally be exceeded following mitigation, DOE will continue to operate under Consent Order 84-4-W with a cooling tower until a Section 316(a) Demonstration has been performed, and SCDHEC has accepted it. DOE anticipates that the Section 316(a) process will take approximately 20 months. TC

On June 6, 1990, SCDHEC issued an executed settlement agreement with DOE on fish kills in Pond C and L-Lake. This agreement requires DOE to submit a report to SCDHEC describing options for avoiding future fish kills, identifying the selected options to be pursued, and providing a schedule for implementation. On July 5, 1990, as required by the settlement agreement, DOE submitted to SCDHEC a Remedial Action Plan describing options for avoiding future fish kills. After SCDHEC review and approval, DOE will undertake the selected options in accordance with the approved schedule. TC L-45-02 L-80-06

On June 11, 1990, the Natural Resources Defense Council and the Energy Research Foundation filed a lawsuit against DOE in the U.S. District Court for the District of South Carolina. The plaintiffs, in their complaint, allege that DOE is in violation of its NPDES permit thermal limitations for K-Reactor. The complaint specifically attacks the validity of Consent Order 84-4-W. L-69-12

5.2.6 FLOODPLAINS/WETLANDS

In the Notice of Intent to Prepare an Environmental Impact Statement on Reactor Operation, DOE also announced its intention to comply with the requirements of 10 CFR 1022. The floodplain/wetland assessment required by 10 CFR 1022.12 is included in the ecology sections of Chapters 3 and 4 of this environmental impact statement.

DOE policy, as stated by Secretary Watkins, is that Department actions will support the President's national goal of no net loss of wetlands (Watkins, 1989). In addition, 10 CFR 1022.15 requires that DOE design or modify its actions to minimize potential harm to or within wetlands or floodplains. As stated in Section 4.1.1.6, continued operation of K-, L-, and P-Reactors will result in the loss of some wetland communities. Previous experience demonstrates that wetland vegetation will become established in the stream when reactor operation ceases, although the community might differ from that which existed before reactor operations. In addition, the operation of a recirculating cooling tower for K-Reactor will reduce impacts to wetlands in Pen Branch and the Savannah River Swamp. However, studies are underway to characterize the current state of wetland development in affected areas, and to evaluate the feasibility of wetland forest restoration in these areas. DOE policy is to preserve and protect wetlands resources at SRS in accordance with the national goal of no net loss of wetlands. DOE will implement mitigation to achieve this goal. TC TC

5.2.7 AIR QUALITY

The SCDHEC Bureau of Air Quality Control issues operating permits and performs PSD reviews. Because existing facilities will be used to supply steam and electric power to K-, L-, and P-Reactors on a continuous basis, no new SCDHEC operating permits will be required for these facilities. TE

The State has designated the Site and its environs as attainment areas for all criteria pollutants under the Clean Air Act. Existing facilities are not required to comply with PSD or new source performance standards (NSPS) requirements because they were in operation before these regulations existed. TE SCDHEC air pollution regulations require both construction and operating permits for emergency diesel generators and diesel water pumps that have capacities rated greater than 150 kiloWatts. K-, L-, and P-Areas each have TE six emergency diesel generators with an operating limit of 1,000 hours per year, as specified in the SCDHEC permit. Permits for booster water pumps of about 400 horsepower are in progress.

A NESHAP construction approval for the K-Reactor cooling tower will not be required because radionuclides emissions will be less than 0.1 millirem per year, as specified in Subpart H of 40 CFR 61.96(b). No other NESHAP approvals L-78-09 are required because all other sources at K-, L-, and P-Reactors were in L-78-69 existence before the regulations went into effect. However, airborne emissions from the operation of the reactors, together with those from other SRS facilities, will be subject to the dose limits and monitoring requirements of NESHAP.

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Watkins, J. D., 1989. Memorandum to Assistant and Deputy Assistant Secretaries, June 12, 1989.

Wright, S. R. (Director, Environmental Division), 1989. "Request for Endangered Species Information," letter to R. L. Banks (U.S. Fish and Wildlife Service), U.S. Department of Energy, Savannah River Operations Office, Aiken, South Carolina.

4.1.3.3.3 Nearby Industrial or Military Facility Accidents

Within a 40-kilometer radius of the SRS are approximately 120 industrial facilities with 25 or more employees. Four of these facilities are within a 16-kilometer radius of the SRS: the Allied General Nuclear Services (AGNS) Fuel Plant; Carolina Metals, Inc.; Chem-Nuclear Systems, Inc. (CNSI); and VEGP. The AGNS Nuclear Fuel Plant at the Barnwell Industrial Park is shut down and will not be utilized in the foreseeable future. Other than those on the SRS, the only major storage facilities within a 40-kilometer radius are the facilities at CNSI, VEGP, and a cluster of natural gas storage tanks near Beech Island. However, the facilities within a 16-kilometer radius of the SRS boundary (the closest of which is less than 1 kilometer from the boundary) are still at least 10 kilometers from the nearest reactor, and thus present a negligible risk to reactor operation.

4.1.3.3.4 Waterway Accidents

No Savannah River traffic would have an effect on the safety of SRS reactors.

4.1.4 TRANSPORTATION

4.1.4.1 Onsite and Offsite Shipments

Hazardous material flows to and from each onsite facility can be grouped into three categories: essential materials, products, and wastes. Essential materials are raw materials, process chemicals, and other supplies that are the feed stocks used in SRS facilities to produce products. Products of a facility can be feed stocks for one or more other facilities. Each facility also generates wastes as inevitable byproducts of its function. Some wastes are chemical only, some are mixed radioactive-chemical wastes, and others are radioactive only. The following paragraphs describe the effects of these hazardous material shipments.

Uranium fuel and target assemblies are produced in the 3/700-Area from raw materials received from offsite sources. The assemblies are transported to the 100-Area reactors, where they are charged into the reactor core. The irradiated fuels and targets that are discharged from the reactors are transported to the 200-Area for chemical processing.

Nitric acid, sodium hydroxide, liquid chlorine, petroleum distillates, and more than 100 other nonradioactive hazardous materials are transported to the facilities to be utilized in processing and reactor support activities. [Where possible, liquid chlorine, which is used in water purification, is being replaced by a much less volatile sodium hypochlorite solution. This change has been addressed only to a limited extent by the analyses of transportation risks (WSRC, 1989d)]. Gasoline and other light petroleum distillates are the most frequently transported nonradioactive hazardous materials shipped by truck. Coal and cask-car movements comprise most of the rail traffic.

Low-level radioactive wastes or mixed wastes are transported to the Burial Ground in the 200-Area. Low-level liquid radioactive wastes are shipped from the reactor areas to the 200-Area for evaporation before being transferred

into waste tanks. Nonradioactive hazardous waste is transported on trucks to onsite storage.

4.1.4.1.1 Onsite Shipments

Rail shipments to and from the SRS reactor areas include 64-metric-ton fuel element casks, 50-metric-ton failed fuel element casks, and occasional containers of nonradioactive materials. Truck shipments include unirradiated fuel and other reactor lattice components in steel shipping boxes, moderator in stainless-steel 208-liter drums, liquid and gas samples, and dry and liquid light-water wastes (WSRC, 1989d). Table 4-39 summarizes shipments of radioactive materials to and from the reactor areas. TE

4.1.4.1.2 Offsite Shipments

Shipments of materials from off the SRS to support reactor operation include petroleum distillate products from major distribution terminals in Augusta, Georgia, and Aiken County, South Carolina; chemicals from commercial distribution points; and nuclear materials from other DOE sites (WSRC, 1989c).

4.1.4.2 Radiological Impacts

4.1.4.2.1 Routine Radiation Exposures

Onsite Transportation

Radioactive materials moved on the SRS around the K-, L-, and P-Reactors are packaged to contain the material during transport and shielded to minimize radiation exposures to crew, riggers, and others near the materials during transportation activities. The DOE contract permits the Operating Contractor to use procedural controls, escorts, and traffic controls to transport materials to and from K-, L-, and P-Reactors.

The 64-metric-ton railroad casks used to ship irradiated reactor fuel are separated from the locomotive by one or two spacer cars. The estimated incremental exposure to the rail crew is less than 10 millirem per year, based on records and analysis (WSRC, 1989c).

The casks used to ship irradiated materials from the reactor areas by truck are mounted on assigned trailers and do not require rigging. The drivers, who exclusively transport scrap and metal and deionizer casks, are expected to receive annual radiation exposures of no more than 300 millirem. This assumption is based on radiation exposures from C-, K-, and P-Reactors, averaged over a 6-year period. Radiation exposure records show that cumulative exposures to Traffic and Transportation employees average about 2 to 3 person-rem per year per reactor area for all rigging and transportation activities (WSRC, 1989c).

Offsite Transportation

The radiation levels from offsite shipments on exclusive-use vehicles to or from the SRS are well below U.S. Department of Transportation (DOT) radiation limits for transportation of nuclear materials. Typical measured radiation

levels from these shipments are (1) depleted uranium shapes - less than 1 percent of DOT radiation limits, (2) uranyl nitrate solutions in MC312 cargo tanker - less than 2 percent of DOT radiation limits, and (3) safe secure transporter (SST) - about 10 percent of DOT radiation limits.

The collective radiological exposure from the transportation of these nuclear materials from and to the SRS is about 0.01 person-rem per year to the population along the shipping route (NRC, 1977), which is a negligible impact.

4.1.4.2.2 Accident Release Risks

The likelihood and consequences of onsite transportation accidents resulting in releases of radioactive materials have been analyzed (WSRC, 1989d). The estimated total risks of radionuclide release (i.e., annual frequency times release magnitude) during onsite transportation to and from the reactor areas are 5.1×10^{-5} curies of alpha per year, 5.2×10^{-3} curies of beta-gamma per year, and 6.8×10^{-2} curies of tritium per year, as listed in Table 4-40 (WSRC, 1989c).

TE

Table 4-41 lists the overall risks presented by transportation accidents in terms of the probability of receiving a specified dose in a year. The values listed in Table 4-41 for atmospheric releases are associated with inhalation of radioactive material and direct radiation from exposure to the plume. If a transportation accident occurred near an onsite stream or wetland, the potential offsite transport of radioactivity via the Savannah River would be of concern. Because onsite streams are not used as drinking water sources for SRS personnel or accessible to the public, onsite population risks are not applicable. In addition, spills from transportation accidents would be small and should not impact groundwater.

The radiological impacts to the onsite and offsite populations from these transportation accidents, expressed in units of annual radiation doses, are insignificant. For example, these doses would be calculated to result in 5×10^{-7} additional cancers or less per year in the on- or offsite populations.

4.1.4.3 Nonradiological Impacts

Transportation activities can influence air quality because of emissions of pollutants from vehicles, can result in fatalities and injuries due to collisions, and can expose populations to nonradioactive hazardous materials leaked during transport or released after a transportation accident. The following sections describe these nonradiological impacts of transportation activities.

4.1.4.3.1 Vehicular Emissions

Pollutants are released to the atmosphere from routine transportation operations supporting all SRS activities. Table 4-42 lists nonradiological emissions of pollutants from SRS vehicle fleets, including those of the Operating Contractor, the Security Contractor, DOE, and vendors. Vehicle emissions directly related to operation of the K-, L-, and P-Reactors are approximately one-tenth of the totals listed in Table 4-42.

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TE

Table 4-40. Risk of Radionuclide Release from Shipments to and from Reactor Areas (curies per year)[a] | TE

Shipment	Alpha	Beta-gamma	Tritium
Truck			
Irradiated target casks	---	---	2×10^{-7}
100-Area scrap metal casks	ES[b]	ES	ES
Analytical samples (every shift)	---	---	6.8×10^{-3}
Unshielded tank trailers	5.1×10^{-5}	5.0×10^{-3}	---
Deionizer casks	---	2×10^{-4}	---
D_2O drums	---	---	6×10^{-2}
Unirradiated fuel/ target assemblies	ES	ES	---
Rail			
Irradiated fuel element casks	5×10^{-9}	2×10^{-6}	8×10^{-4}
Total	5.1×10^{-5}	5.2×10^{-3}	6.8×10^{-2}

a. Source: WSRC, 1989d. | TC
b. ES = Extremely small.

4.1.4.3.2 Accident Fatalities and Injuries

The South Carolina Department of Highways and Public Transportation collects data on fatal traffic accidents. Based on these data, the average fatal accident rate in South Carolina for the years 1984 through 1988 was 2.2 accidents per 100 million vehicle-kilometers traveled (3.54 per 100 million vehicle-miles) (DOE, 1989b). | TE

The potential for onsite transportation accidents with resultant fatality or injury is much less than that for public highways. Onsite shipments are not made during shift change and occur when traffic densities on the SRS roads are low. Therefore, the risk of injury or fatality from onsite injury is estimated to be much less than 1 per year (DOE, 1984a).

Table 4-42. Estimated Annual Emissions of Air Pollutants from Routine Transportation Activities at SRS[a] | TE

Source	Cars and Light Trucks	Heavy-Duty Trucks[b]
Fuel	Gasoline	Diesel
Liters consumed	3,280,000	2,082,000
Kilometers traveled	20,117,000	4,828,000
Emissions (metric tons)		
Carbon monoxide	296	18
Nitrogen oxides	38	32
Hydrocarbons	33	7
Particulates[c]	300	72

a. Source: WSRC, 1989c.
b. Includes emissions from offsite vehicles.
c. Particulate matter resulting from vehicle exhaust, tire abrasion, and roadway dust.

4.1.4.3.3 Accident Release Risks

Transportation activities involving nonradioactive hazardous materials might expose populations to hazardous materials leaked in transit or during loading/unloading operations, or dispersed after a vehicular accident.

Of nonradioactive hazardous materials transported onsite by truck or rail, bulk acids (nitric, sulfuric, and phosphoric) and liquid chlorine present the greatest nonradiological risks to onsite and offsite populations. Table 4-43 | TE summarizes the total population risks, in terms of persons exposed above the toxic health effects thresholds per year (WSRC, 1989c).

4.1.5 UNAVOIDABLE/IRREVERSIBLE IMPACTS

This section describes impacts of the proposed action alternative that cannot be avoided. It also describes irreversible and irretrievable commitments of resources and the short-term uses and long-term productivity impacts of these uses.

4.1.5.1 Unavoidable Impacts

The SRS would experience some unavoidable impacts from the continued operation of K-, L-, and P-Reactors.

Under present conditions, K-Reactor, in the once-through cooling mode, and L-Reactor each withdraw about 11.3 cubic meters per second of cooling water from the Savannah River. P-Reactor requires about 1.4 cubic meters per second

TE Table 4-43. Population Risks from Releases of Nonradioactive Hazardous Materials During Transport[a]

Released Material	Risk[b] Onsite Population (persons exposed per year)	Risk[b] Offsite Population (persons exposed per year)
Liquid chlorine	1.3×10^{-1}	4.3×10^{-3}
Bulk acids (nitric, sulfuric, and phosphoric)	4.0×10^{-1}	0
Sodium hypochlorite	6.9×10^{-2}	4.5×10^{-3}
TOTAL	5.9×10^{-1}	8.8×10^{-3}

a. Adapted from WSRC, 1989d.
b. Risk is expressed in units of number of persons exposed above the toxic health effects thresholds per year.

from the river and 10 cubic meters per second from Par Pond. The total withdrawal from the river, 24 cubic meters per second, causes entrainment and impingement of aquatic biota (Section 4.1.1.2).

TC After the K-Reactor cooling tower becomes operational, river withdrawals to supply cooling water for this reactor will be reduced from 11.3 to 1.8 cubic meters per second; entrainment and impingement losses will be reduced proportionately. Discharges of heated water from K-Reactor in the once-through cooling mode would increase the flow to Pen Branch (via Indian Grave Branch) an annual average of 8 cubic meters per second. This flow rate would be maintained for K-Reactor after the resumption of production but before the operation of the K-Reactor cooling tower. After the completion of the K-Reactor cooling-tower system, flow to Pen Branch from K-Reactor would be TC reduced to 1.3 cubic meters per second (DOE, 1987b).

Heated water discharges from L-Reactor (a maximum of 11 cubic meters per second) raise the temperature in the lower half of L-Lake slightly (2°-3°C) above that in other southeastern reservoirs. Temperatures in the upper half of the lake can be much higher. Heated discharge water from P-Reactor (a maximum of 11 cubic meters per second) results in surface temperatures 4° to 6°C higher near the Hot Dam of Par Pond than in much of the rest of the pond TC (Du Pont, 1985a).

Direct discharges of thermal effluent to Pen Branch when K-Reactor is in the once-through cooling mode impact a total wetlands area of approximately 670 TC acres; estimated additional losses of 10 to 12 acres per year of previously unimpacted forested wetlands would occur (DOE, 1987b). The wildlife and fish populations supported by this habitat are impacted (Section 4.1.1.4.1). When

the recirculating cooling tower becomes operational, wetlands vegetation should become reestablished on about 500 acres of the thermally impacted Pen Branch delta. Stream flows and temperature will more closely approximate ambient conditions. Additional losses of 10 to 12 acres per year of previously unimpacted forested wetlands would stop. TC

Once-through cooling water effluents at the point of release to Pen Branch from K-Reactor commonly exceed 70°C and raise the water temperature throughout the length of the Pen Branch stream channel above 45°C in the summer months (Du Pont, 1987a). Fish and other aquatic biota that have repopulated much of Pen Branch since reactor shutdown will be eliminated from the area when water temperatures rise. Some fish will be killed on startup. High temperatures and flows will also cause continued habitat degradation in the Pen Branch channel. Under average winter conditions, temperatures along Pen Branch range from 66°C at the discharge point to 43°C in the delta (DOE, 1987b). When K-Reactor operates with the new recirculating cooling tower under summer conditions, predicted mean water temperatures at the Pen Branch delta would be 27°C, or 3°C above the mean ambient water temperature (Du Pont, 1989). During January (when water temperatures reach the yearly low), water temperatures at the delta would average 8°C, 0.3°C above the average ambient January temperatures (Du Pont, 1989). However, reactor shutdowns during winter result in gradual heat loss, which minimizes any cold shock effects. TC TC

Unavoidable radiation exposures, which include increased occupational exposures and exposures to the general public from normal reactor operation, and possible resuspension of radionuclides from Indian Grave Branch, Pen Branch, and Steel Creek, are well below DOE limits (Section 4.1.2).

The operation of K-, L-, and P-Reactors at reduced power would not reduce water withdrawal, the associated entrainment and impingement of aquatic biota, or the possible resuspension of radionuclides. However, the temperature of reactor cooling water discharges would be reduced, allowing biota to invade some areas that are too hot to support life when the reactors operate at full power. TC

In addition to direct discharges of heated effluents, increased discharges from incidental sources would occur during reactor operation. For example, NPDES-permitted discharges to Pen Branch and Indian Grave Branch would include nonprocess cooling water, ash basin effluent waters, powerhouse wastewater, reactor process wastewater, and sanitary wastewater. In addition to condenser cooling water from the D-Area coal-fired powerhouse, Beaver Dam Creek would receive neutralization wastewater, sanitary wastewater, ash basin effluent waters, and various laboratory wastewaters. Similar incidental effluents would discharge to Steel Creek, Lower Three Runs Creek, and Par Pond. Upper Three Runs Creek would receive direct discharges from the F- and H-Area ETF and indirect discharges from the M-Area liquid effluent treatment facility (LETF) via Tims Branch. However, analytical results of stream monitoring programs indicate that the impacts of such operations are minimal (Zeigler et al., 1987; Mikol et al., 1988). TE TC

4.1.5.2 Irreversible or Irretrievable Commitments of Resources

The operation of K-, L-, and P-Reactors would consume energy, raw materials, and other resources. Resources that would be committed irreversibly or

irretrievably during operation include materials that could not be recovered or recycled, and materials that would be consumed or reduced to irrecoverable forms.

The continued operation of K-, L-, and P-Reactors would involve land that was committed previously to this use. Land as well as construction materials would be required for K-Area cooling-tower construction. The final disposal of low-level radioactive and mixed wastes from reactor operation would involve additional land use when the new low-level radioactive waste disposal facility and the hazardous-mixed waste disposal facility become available (Section 3.8).

Irretrievable electric energy consumption would result from reactor operation. Electric power would be provided by onsite generation and purchases of offsite power. Three-reactor operation would require 175 megaWatts of power. Onsite generators of electricity and steam for space heating and process use would burn approximately 528,000 metric tons of coal per year. When operating, the production reactors would have continuously operating diesel generators to provide power to backup reactor coolant pumps. Other areas that would depend on electrical power for emergency functions also would have local emergency diesel generators. The diesel fuel consumption for one reactor area would be 1.5×10^6 liters per year (DOE, 1984a).

4.1.5.3 Short-Term Uses and Long-Term Productivity

The short-term effects of reactor operation would include the unavailability of terrestrial areas for their natural productivity and wildlife habitat, and impacts to wetlands and aquatic biota from water intakes, heated effluents, and process water discharges. However, continued reactor operation involves only terrestrial and aquatic areas that were committed previously, with the exception of the additional 10 to 12 acres per year of previously unimpacted forested wetlands that would be lost due to the operation of K-Reactor in a once-through cooling mode. TC

The SRS reactor buildings, support facilities, and paved areas have disturbed approximately 10,600 acres of site and access-road/rights-of-way areas or removed them from their natural state. This is approximately 5 percent of the total 198,737-acre SRS area. Areas in which natural soils have been removed, transported, compacted, or covered with concrete, asphalt, waste rock, or gravel would revert to their natural vegetative states after decommissioning and decontamination, assuming such barriers to regrowth would be removed.

Continued reactor operation would create few additional terrestrial habitat or soil-related impacts, with the exception of construction and operation of the K-Area cooling tower and the disposal of hazardous, mixed, and low-level radioactive waste (DOE, 1987c). However, reactor operation would impact wetlands, wetlands habitat, and aquatic biota due to cooling water withdrawal and thermal effluent discharge (Section 4.1.1.4). Many of the impacts on aquatic resources would result from operation of K-Reactor in the once-through cooling mode. TC The subsequent operation of K-Reactor with the recirculating cooling-tower system would permit the establishment of balanced biological communities, including plants, macroinvertebrates, and fish, in the Pen Branch ecosystem.

There was a potential loss of part of the local habitat for the endangered wood stork in the Savannah River Swamp, but the establishment of foraging areas in Kathwood Lake has mitigated this potential loss. In the long term, wetlands that have been disturbed could become reestablished through the process of ecological succession, as could affected stream reaches of Indian Grave Branch and Pen Branch, and areas of Beaver Dam Creek affected by thermal discharges from the D-Area coal-fired powerhouse. TE TC

Solid nonradioactive waste generated from continued reactor operation would require additional land at a sanitary landfill site that was unavailable for other uses. Radioactive solid waste requires additional space (100 acres) at an already designated burial ground site, the low-level radioactive waste disposal facility.

High-level liquid radioactive waste requires temporary onsite in-tank storage (Section 3.8), waste processing, interim storage of solidified wastes in canisters, and disposal in an offsite geologic repository, with the commitment of associated land, transportation, processing facilities, and other disposal resources (ERDA, 1977; DOE, 1982a).

4.1.6 CUMULATIVE IMPACTS

In accordance with CEQ regulations (40 CFR 1508.7), this section presents the cumulative impacts of the proposed action, including the impacts of the related support facilities, and other existing and planned activities, both onsite and offsite. Planned onsite activities discussed in this EIS do not include the proposed New Production Reactor (NPR). DOE is preparing an EIS that will describe the environmental impacts of the NPR and its potential cumulative impacts on the SRS region (see Section 2.4.1). TC

The Annual Environmental Reports for the SRS (Zeigler et al., 1987; Mikol et al., 1988; Davis, Martin, and Todd, 1989) and the Final EIS on L-Reactor operation (DOE, 1984a) describe the environmental impacts of support facility operation for C-Reactor (which is currently on standby) and for K-, L-, and P-Reactors. These SRS facilities include M-Area fuel fabrication, F- and H-Area separations, D-Area powerhouse and heavy-water rework, Savannah River Laboratory, and various waste management and disposal facilities. The impacts of these facilities will continue unchanged under the proposed action from those already documented. TC

4.1.6.1 Existing SRS Support Facilities

4.1.6.1.1 M-Area Fabrication Facility

The SRS M-Area fabrication facility manufactures fuel and target elements to be irradiated in the production reactors. At present, its major products are extruded enriched uranium, aluminum-clad fuel, and lithium-aluminum control rods and targets.

4.1.6.1.2 F- and H-Area Separation Facilities

After fuel and target elements are irradiated, they are dissolved in nitric acid at the chemical separations plants. A solvent extraction process yields (1) a solution of plutonium, uranium, and neptunium, and (2) a high-heat

liquid waste, containing the nonvolatile fission products. After the product solutions are separated from the fission products, further processing is performed in unshielded areas, where plutonium, uranium, and other products are converted from solution to solid form for shipment, recycling, or further processing (e.g., plutonium-238 heat source fabrication).

4.1.6.1.3 Tritium Facilities

In the tritium facilities, gases are extracted from irradiated reactor elements and processed through several purification steps to produce tritium of high purity. Reactor elements are placed in a crucible in an electric furnace and heated to more than 600°C to extract gases. Purification steps, which employ vacuum technology, include various types of diffusion pumps, palladium-membrane diffusers, thermal diffusion columns, and filters. Hydrogen isotopes are separated from other gases in the feed stream in initial production steps. Further processing isolates each isotope.

4.1.6.1.4 Heavy-Water Rework Facility

Heavy water for use as the reactor coolant/moderator was separated originally from river water at the heavy-water production facility by a hydrogen sulfide extraction process, and purified by distillation. At present, this facility is needed only to purify the existing inventory of heavy water; the facility does not use hydrogen sulfide.

4.1.6.1.5 Savannah River Laboratory

SRL is the major research and development laboratory at SRS. It engages in a number of fuel and target development, waste management, process modification, site changes, upgrades, and improvement programs.

Research and development on separations processes involve both laboratory and pilot-scale work. Process operations range from the handling of irradiated fuels and targets to the packaging of the final product. All effluent streams (gaseous, liquid, and solid) are monitored.

SRL facilities include a coal-fired powerplant with three boilers, which supplies power to SRL and the M-Area. It releases particulates, hydrocarbons, CO, CO_2, NO_x, and SO_2. Particulate emissions are controlled by two dust collectors in series. No emission controls are required for hydrocarbons, CO, CO_2, NO_x, and SO_2. Other permitted air emission sources include emergency
TE | power diesel generators, which require no emission controls.

Radioactive wastes include aqueous low- and high-level wastes. Low-level waste is sent to evaporators in F-Area. High-level wastes are transferred to a tank for transportation and storage in F-Area.

Nonradioactive wastes from SRL operations are small amounts of chemicals flushed into the low-level drains or the chemical waste system. The chemical waste system is designed to handle waste chemicals that are not contaminated beyond trace levels. These wastes enter a common vitreous pipeline that will discharge into an NPDES outfall. Vapors are released to the hood exhaust system; nonhazardous-nonradioactive solid wastes are placed in the sanitary landfill.

All contaminated and potentially contaminated solid wastes from SRL operations are transported to the low-level disposal facility.

Section 3.8 describes existing and planned waste management facilities.

4.1.6.2 New and Planned SRS Facilities

In addition to ongoing SRS operations, a number of new support facilities have been completed or are under construction; their actual contributions to SRS impacts have not yet been confirmed by measurements, but will be when they become operational. The following sections describe these new facilities; these descriptions do not include new or planned facilities with little or no impacts (e.g., technology demonstrations). Operation of the ETF will be documented in the next annual Environmental Report (for 1989). Separate NEPA documentation has been or is being prepared for each facility, as noted in the following subsections. L-78-63 TC

4.1.6.2.1 Tritium-Loading Facility

This facility, also called the Replacement Tritium Facility (RTF), is designed to replace and upgrade some of the processing and loading functions in the present tritium-loading facility. Construction is under way, and the facility is scheduled to be completed in late 1990.

The routine operation of the facility will reduce atmospheric releases substantially, which will be beneficial. Tritium-contaminated solid waste generation and storage/disposal rates are expected to decrease. Mercury will be eliminated in the new process, thereby eliminating storage and disposal needs for mercury-contaminated wastes from this process. (See DOE, 1986; also, see the Finding of No Significant Impact, 51 FR 12727.) TC

4.1.6.2.2 F- and H-Area Effluent Treatment Facility

The F- and H-Area ETF, located in H-Area, is operated to store and treat routine wastewater and potential spills from the chemical separations facilities in F- and H-Areas. The operation of this new facility eliminated the discharge of these effluents to the F- and H-Area seepage basins. The facility, which began operation in November 1988, provides improved treatment of routine process effluents and contaminated cooling or storm water. Processed liquid effluents that exceed discharge limits are recycled. Dewatered solids from the coarse filtration step are disposed of in the burial ground or (eventually) in the Y-Area Facility. Evaporator concentrates are transferred to the H-Area waste tank farm. Tritium is not removed in the treatment processes.

The discharge of an estimated 30,000 curies of tritium per year from the ETF into Upper Three Runs Creek is partially offset by decreases in atmospheric releases from seepage-basin evaporation and tritiated groundwater outcrops due to the closure of the F- and H-Area seepage basins. Storage basins are provided to contain large flows of contaminated cooling water or storm water prior to processing through the ETF. (See DOE, 1987c.) TC

4.1.6.2.3 Defense Waste Processing Facility

The DWPF is being constructed to begin processing accumulated high-level
TC | radioactive liquid wastes in 1994. At present, these wastes are stored as insoluble sludges, precipitated salt, and supernatant liquid in tanks in the F- and H-Area tank farms. The DWPF process includes the removal of wastes from tank storage; immobilization of the high-level sludge and cesium, strontium, and plutonium recovered from supernatant liquid in borosilicate glass; encapsulation of the waste and glass mixture in steel canisters; storage of the canisters in a subsurface facility until shipment to an offsite geologic repository; and processing of the decontaminated salt into saltstone
TC | monoliths (see Section 4.1.6.2.6). (See DOE, 1982a, 1988c, 1988d; also, see 47 FR 23801.)

4.1.6.2.4 Consolidated Incineration Facility

TC | A Consolidated Incineration Facility (CIF) is being designed and is proposed to be constructed by 1992 to incinerate a variety of hazardous, mixed, and low-level radioactive wastes (e.g., contaminated soil, sludges, and liquid and solid wastes). This incinerator would consist of a primary rotary kiln, a secondary combustion chamber, and an off-gas treatment system that includes evaporative coolers and particulate and chloride removal systems. An
TC | environmental assessment is being prepared for this facility. The process allows simultaneous destruction of solids and aqueous and organic liquid wastes. (See DOE, 1987c.)

4.1.6.2.5 Y-Area Waste Solidification and Disposal Facility

TC | The Y-Area Waste Solidification and Disposal Facility (Y-Area), which consists of 22 acres in the northwest corner of Z-Area, will provide stabilization and disposal of liquid salt solution wastes generated from M-Area and eventually from the CIF. The reference process for Y-Area is the Z-Area saltstone solidification process (see Section 4.1.6.2.6). Waste will be pumped from a storage tank into a mixer unit where it will be combined with flush water, the Z-Area (boiler slag/fly-ash/cement) premix, and a set-retarding additive. The grout mix will be pumped to a disposal vault where it will form into a monolith. Each disposal vault will be capped with concrete to prevent rainwater intrusion. The process and disposal vaults will be RCRA-permitted for disposal of hazardous wastes. Further covering or "closure," as it pertains to final disposal of low-level radioactive wastes, will be provided after a number of years, during which the integrity of the vault will be assured. This cover will meet or exceed the performance standards of the
TC | South Carolina Hazardous Waste Management Regulations. (See DOE, 1987c.)

4.1.6.2.6 Z-Area Saltstone Disposal Facility

The Z-Area disposal facility is designed for the disposal of low-level radioactive wastes, especially decontaminated salt solution resulting from processing high-level radioactive liquid wastes in the high-level waste tanks
TC | and the DWPF. This facility began operation in June 1990. The decontaminated salt solution and recycled wash water from the in-tank precipitation will be processed with a feed stream from the F- and H-Area ETF of 28-percent salt (by weight). Fresh water will be used to flush equipment and piping, and then
TC | recycled into saltstone production (DOE, 1982a, 1987c, 1988c,d).

The salt solution will be mixed with flyash, slag, and a lime source to produce saltstone (with an overall radioactivity of approximately 62 nanocuries per gram) at an expected average rate of 1,300 cubic meters per week (DOE, 1988d). The saltstone will be placed in reinforced concrete disposal vaults (8 meters high by 180 meters long by 50 meters wide and 3 meters belowgrade). As a result of leachate testing, SCDHEC has ruled that saltstone is nonhazardous. About 10,000 210-liter drums of Fuel Materials Facility saltstone, produced before and during shutdown activities of that facility, will also be placed in the vaults. The Z-Area facilities and vaults cover about 160 acres (DOE, 1982a, 1987c, 1988c, 1990b). TE TC TC

4.1.6.2.7 New Low-Level Radioactive Waste Storage/Disposal Facility

Low-level waste generated on the SRS and received from offsite DOE facilities is estimated at a volume of about 31,000 cubic meters per year. The space available in the present Burial Ground for shallow land burial, engineered low-level trenches, and greater confinement disposal (GCD) facilities has become limited (DOE, 1987c).

A 100-acre area (G-Area) due north and adjacent to the present Burial Ground has been selected as the site for future disposal and storage of solid low-level radioactive waste generated on the SRS. The disposal units will be belowgrade concrete vaults designed to have sufficient strength to withstand the stresses of final closure. The storage portion of the facility will consist of two types of units - vaults and buildings. Tritiated wastes will be stored in abovegrade strong concrete vaults. Long-lived wastes (half-life greater than 30 years) will be stored in an abovegrade metal building located on a concrete pad. The facility will begin operation in 1991. (See DOE, 1990b.) TC

4.1.6.2.8 New Hazardous/Mixed Waste Disposal Facility

A new hazardous/mixed-waste disposal facility of about 200 acres is planned for construction adjacent to the new low-level facility. It is scheduled to begin operation in early 1993. Facility design calls for RCRA-type vaults or landfills and buildings for retrievable storage of hazardous or mixed wastes; some wastes would be embedded in a cement or lime-flyash matrix (DOE, 1987c).

4.1.6.3 Offsite Facilities

This section describes nearby offsite facilities that, in conjunction with continuing operation of the three SRS reactors and support facilities, would result in cumulative impacts on the region.

4.1.6.3.1 Vogtle Electric Generating Plant

VEGP is a two-unit nuclear powerplant located across the Savannah River from the SRS. Unit 1 was licensed for full-power operation in May 1987. Unit 2 began operation in May 1989 and is approaching full-power operation.

4.1.6.3.2 Chem-Nuclear Services, Inc.

Chem-Nuclear Services, Inc., operates a low-level radioactive waste burial ground adjacent to the east-central boundary of the SRS.

4.1.6.3.3 Urquhart Steam Station

South Carolina Electric and Gas Company operates the Urquhart Station, a three-unit, 250-megaWatt, coal- and natural-gas-fired steam electric plant in Beech Island, South Carolina, on the Savannah River about 32 kilometers north of the SRS.

4.1.6.4 Cumulative Environmental Impacts

4.1.6.4.1 Land Use and Socioeconomic Impacts

In addition to the land currently occupied by the existing onsite support facilities, construction at SRS of the new facilities described above will require additional land, ranging from 100 to 300 acres for each facility. The operation of these new facilities will produce inconsequential socioeconomic impacts, because their workforce requirements are a minute fraction of the total SRS workforce.

The estimated cumulative sum of individual land use requirements for new support facilities is about 700 acres; no offsite land would be needed. The boundaries of SRS would not change; there is no cumulative impact on land availability of SRS activities and those offsite.

Cumulative workforce requirements are expected to be greater than the May 1988
TC figure of 18,635 (NUS, 1990). This workforce, together with those at the offsite facilities, will be readily accommodated within the SRS region.

4.1.6.4.2 Archaeological Resources

Locations for new support facilities have been surveyed for archaeological impacts; concurrence from the State Historic Preservation Officer (SHPO) has been obtained. No cumulative impacts on these resources would occur.

4.1.6.4.3 Cooling and Surface-Water Withdrawal

Surface water will not be used in the operation of the F- and H-Area ETF,
DWPF, CIF, Y-Area, Z-Area, the Low-Level Radioactive Waste Facility, and the
TE Hazardous/Mixed Waste Facility. SRS withdraws 24 cubic meters per second from the Savannah River for cooling at K-, L-, and P-Reactors and an additional
TC 4 cubic meters per second for the D-Area Powerhouse. New and planned SRS facilities will not change water usage significantly.

Based on studies conducted in the Savannah River from 1983 to 1985, this rate of water withdrawal for SRS facilities, including K-Reactor without a cooling
L-84-13 tower, results in estimated average annual entrainment of 18.8 x 10^6 fish larvae and 10.1 x 10^6 fish eggs, and estimated annual impingement of 7,716 fish. After the K-Reactor cooling tower becomes operational, estimated annual

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entrainment from SRS facilities is expected to be reduced to an average of 11.8 x 10^6 fish larvae and 6.4 x 10^6 fish eggs; estimated annual impingement with operation of SRS facilities including the K-Reactor cooling tower is expected to be reduced to an average of 5,394 fish. L-84-13

VEGP withdraws a maximum of 3.9 cubic meters per second from the river for use as cooling-system makeup water, and returns 3.5 cubic meters per second as blowdown and service water discharge flows. The maximum cooling-system blowdown is 1.9 cubic meters per second. The Urquhart Steam Station withdraws and returns about 7.4 cubic meters per second as once-through cooling water for its turbine condensers. The Chem-Nuclear Services facility does not use surface water. No quantitative entrainment and impingement data are available for these facilities; however, for comparison, studies conducted at SRS from 1983 to 1985 lead to the assumption that cooling water withdrawals for VEGP and the Urquhart Steam Station result in an estimated average annual entrainment of 8.3 x 10^6 fish larvae and 4.4 x 10^6 fish eggs and an estimated average annual impingement of 2,771 fish, which are proportional to the withdrawal rates for these facilities. L-84-13

With a mean annual Savannah River flow of 285 cubic meters per second, the cumulative surface-water usage by the SRS and the other facilities (39 cubic meters per second) represents about 14 percent of the river flow, compared to about 9.8 percent usage by the SRS alone. Because most of the withdrawn water is returned to the river, cumulative impacts of surface-water usage are minimal.

4.1.6.4.4 Thermal Discharges

Thermal discharges occur at VEGP and the Urquhart powerplant. VEGP discharges about 3.5 cubic meters per second of cooling-tower blowdown and service water. The maximum cooling system blowdown is 1.9 cubic meters per second at temperatures of 33°C in the summer and 29°C in the winter. Urquhart discharges about 7.4 cubic meters per second of once-through cooling water at a maximum temperature of 32°C to 33°C in the summer. The Chem-Nuclear facility does not discharge heated cooling water.

The DWPF would discharge slightly heated process cooling-tower blowdown, which would be processed along with other liquid effluents in an industrial wastewater treatment facility before discharge from an NPDES outfall at ambient temperatures. There would be no thermal impacts to onsite streams.

The CIF would use some existing groundwater for process cooling (see Section 4.1.6.4.6). Blowdown from the cooling system would be treated in onsite facilities and either discharged through approved NPDES outfalls or disposed of on the Site.

There are no large-volume heated discharges from other support facilities to onsite streams.

Because none of the thermal discharges from SRS, VEGP, or the Urquhart powerplant interact in the Savannah River, there are no cumulative thermal impacts. (See Section 4.1.6.4.9.)

4.1.6.4.5 Groundwater Quality

Other environmental documentation prepared for SRS has described the effects of existing facilities on shallow groundwater quality. The design, construction, and operation of the new support facilities (DWPF, CIF, ETF, Z- and Y-Areas) would prevent any potential contamination of shallow aquifers. An extensive system of groundwater quality monitoring wells would be installed around each facility to detect any chemical or radiological contamination of shallow or deep aquifers. Migration from shallow to deep aquifers is unlikely at SRS.

TE | At VEGP, because the permeability of a compacted clay layer is essentially zero and the water-table aquifer is hydraulically separated from the underlying confined aquifers, contaminants potentially released could not migrate downward from the water-table aquifer directly into the deeper aquifers. Hypothetically, contaminants could reach the confined aquifers by migrating through the water-table aquifer to a stream that discharged to the Savannah River. The river is in hydraulic contact with the deep aquifers and might offer a potential pathway to these deep aquifers. However, the deep aquifers discharge into the river because their hydraulic heads are substantially higher than that of the river. Therefore, any contaminants still remaining after migrating to the river could not enter the deeper aquifers and migrate downgradient to offsite groundwater users.

A similar condition prevails at SRS in the artesian zones near the Savannah River and presumably exists at the Urquhart powerplant as well. As a result of these natural conditions, no cumulative impacts to groundwater quality are expected to occur in the SRS region. Continuing remediation measures undertaken at M-Area have alleviated groundwater quality impacts resulting from previous chlorocarbon contamination; these measures would reduce further any likelihood of offsite migration of such compounds.

4.1.6.4.6 Groundwater Use

TE | DWPF, F- and H-Area ETF, CIF, Z- and Y-Areas, and the new waste management facilities will use existing groundwater supply systems at a total estimated rate as high as 15,000 cubic meters per day. DOE does not consider these flow rates to create major withdrawal impacts on nearby onsite or offsite groundwater users.

TE | Groundwater withdrawals by the major offsite facilities - VEGP (0.5 cubic meter per second), Urquhart Steam Station, and Chem-Nuclear - come from areas that are not affected by the SRS or that are not sufficient to contribute to SRS withdrawal rates or to cause a deterioration in quality. The use of groundwater by offsite facilities has no direct impact on SRS uses.

4.1.6.4.7 Air Quality

The new support facilities will not add a substantial increment to nonradiological emissions, with the exception of the DWPF and CIF. DWPF will emit 34 metric tons of benzene per year, 68 kilograms of mercury per year, 34 metric tons of nitrogen oxides per year, and 3.2 metric tons of particulates per year. CIF will emit 0.8 metric ton of hydrochloric acid per year, 0.7

metric ton of sulfur dioxide per year, and 27 metric tons of NO_x per year. These emissions will comply with permit conditions and standards established by EPA and SCDHEC.

Because of the distance between SRS coal-fired powerplants and the Urquhart station and the regional wind direction frequencies, there is little opportunity for an interaction of plant emissions, and no significant cumulative impact on air quality. Section 4.1.6.4.14 presents cumulative impacts of airborne radiological releases.

4.1.6.4.8 Wetlands/Habitats

The impacts to SRS wetlands described above result from the operation of SRS reactors and support facilities. Direct impacts to SRS wetlands from VEGP and Urquhart or Chem-Nuclear are extremely unlikely due to the lack of thermal or flow interactions as a result of the distances from previously and temporarily affected areas on the Site. Thus, there would be no cumulative impacts in the Savannah River swamp areas from offsite facility operations.

4.1.6.4.9 Aquatic Impacts

There are no cumulative thermal impacts in the Savannah River resulting from the VEGP and Urquhart powerplants because the thermal discharges from K-, L-, and P-Reactors in the Savannah River do not interact with each other, or with the discharges from VEGP or Urquhart. There is no thermal blockage of the river, and a zone of passage for anadromous fish and other aquatic organisms would continue. The estimated maximum cumulative entrainment and impingement are 65 percent greater than for three-reactor operation alone. TC L-84-13

4.1.6.4.10 Threatened and Endangered Species

DOE has described potential impacts to threatened and endangered species on the SRS in other environmental documentation (DOE, 1984b). Mitigation measures that resulted in the creation of offsite foraging habitat (Kathwood Lake) for the wood stork have been implemented and are continuing.

VEGP, Urquhart, and Chem-Nuclear, because of their locations and distances from SRS habitat and Kathwood Lake, would have no combined effect on threatened and endangered species. The effects of VEGP operation on threatened and endangered species are discussed in appropriate documents (NRC, 1985). Regional cumulative impacts are extremely unlikely.

4.1.6.4.11 Water Quality

Thermal effluents from K-, L-, and P-Reactor operation do not interact in the Savannah River with effluents from offsite powerplants; all are NPDES-permitted. Releases of tritium from support facilities and reactors at SRS comprise the major component of the tritium inventory in the river. The contribution of VEGP is small by comparison. In all cases, the cumulative chemical water quality in streams or effluents discharged to the river is chemically similar to the water quality in the river. TE TE

4.1.6.4.12 Solid, High- and Low-Level Radioactive, Hazardous, and Mixed Wastes

DOE has described the generation and disposal of radioactive solid and hazardous wastes, including TRU and mixed wastes in environmental documentation prepared for various projects (e.g., DOE, 1982b, 1984a, 1987b,c).

There are no interactions among SRS solid and radioactive wastes and similar wastes generated by offsite powerplants or the Chem-Nuclear low-level waste disposal facility. Cumulative impacts are represented by the summation of such wastes generated by existing and new SRS support facilities.

4.1.6.4.13 Cesium-137

Resuspended cesium-137 releases (about 0.5 curie per year) from onsite stream beds (72 percent from K-, L-, and P-Reactors) yield an individual maximum dose of 0.28 millirem per year; of this dose, 27 percent, or 0.08 millirem per year, is attributable to the operation of the F- and H-Areas (see Section 4.1.2.4). No measurable interaction of SRS releases (resuspension) of cesium-137 with releases from VEGP (2.1×10^{-4} curie per year) is expected to occur.

4.1.6.4.14 Radiation Dose

The previous sections discuss present and planned nuclear facilities within an 80-kilometer radius of K-, L-, and P-Reactors. DOE reviewed the operations of these facilities to determine the potential cumulative radiological impacts of all facilities operating together in the year 2000. The GASPAR and LADTAP-II computer codes were used to calculate doses, as discussed in Section 4.1.2. Appendix A of the Reactor Operation Environmental Information Document (WSRC, 1989c) describes the dose calculation models and basic assumptions and
TC | parameters used to derive dose impacts.

The cumulative offsite radiation dose is the sum of the doses resulting from radioactivity releases from K-, L-, and P-Reactors and their support facilities, the DWPF, the F- and H-Area ETF, the CIF, the RTF, SRL, and VEGP.
TE | Tables 4-44 and 4-45 list the annual releases of radioactivity from existing and new SRS facilities, and from the VEGP. Table 4-46 lists the committed effective dose equivalents resulting from these releases, both to the maximally exposed individual and to the affected population groups. Table
TE | 4-47 lists cumulative doses.

The cumulative committed effective dose equivalent to the maximally exposed
TC | individual is 1.25 millirem (Table 4-47). This dose is within the DOE limits
L-78-40 | of 100 millirem per year from all pathways and 10 millirem per year for the
TC | Site from the air pathway, and 4 millirem per year from the drinking-water pathway (DOE, 1988a; EPA, 1987, 1989a). The cumulative collective committed effective dose equivalent to the population living within 80 kilometers of the SRS and the Beaufort-Jasper and Port Wentworth drinking-water populations is
TC | 96.8 person-rem (Table 4-47); the average annual collective dose to this population from natural radiation is 346,000 person-rem.

The number of radiation-induced fatal cancers that might eventually occur as a result of 1 year of operation of all existing and planned SRS facilities and

VEGP is based on a health risk estimator of 400 fatal cancers per million person-rem, or 4 x 10^{-4} fatal cancers per person-rem (EPA, 1989b). Using this value and the cumulative maximum individual and collective effective dose equivalents listed in Table 4-47, the additional likelihood of a fatal cancer in the maximally exposed individual in the immediate vicinity of the SRS is 5.0 x 10^{-7} per year, and the increased number of fatal cancers in the exposed populations within 80 kilometers of the SRS and at Beaufort-Jasper and Port Wentworth would be 0.039 per year. TE

4.1.7 COMMON RISKS

To provide a perspective on common risks, but not a basis for comparison of risks, Table 4-48 gives ranges of the estimated risks of death in a single year for some human activities that include various occupations, lifestyles, accidents, and environmental exposures, incidents, or situations. The risks to the different categories listed in Table 4-48 cannot be compared either explicitly or implicitly, because the methods used to calculate them are fundamentally different. TE TC

As a perspective on carcinogenic risks, the average risk in the United States of a person dying from cancer is about 1.9 x 10^{-3} (or almost 2 chances in 1,000) per year. However, rates in individual states range from a low of about 0.76 x 10^{-3} (in Alaska, with a young average population) to a high of 2.5 x 10^{-3} (in Florida, which has an older average population). The average risk of dying from lung cancer is about 5 x 10^{-4} per year; about one in four cancer deaths is due to this cause. The lifetime (age-adjusted) average risk of death by cancer is about 1.6 x 10^{-1} (or 16 chances in 100). TC

EPA has adopted a lifetime risk value of 1 x 10^{-6} as a reference point for the management and regulation of carcinogens in the environment. Thus, an incremental risk from an environmental carcinogen at the EPA guideline limit would raise the lifetime risk to an average U.S. resident of death by cancer from 0.16 to 0.160001. Similarly, at an incremental annual risk of 1 x 10^{-6} from a particular exposure, the total annual risk to an average U.S. resident of death by cancer would rise from 0.0019 to 0.001901.

4.2 TERMINATE OPERATION OF ONE OR TWO REACTORS AT SRS IN THE IMMEDIATE FUTURE AND MAINTAIN IN COLD STANDBY

This section describes the consequences that would result if operation of one or two of the SRS reactors were terminated, and maintenance in cold standby were to occur. Cold standby involves the defueling of the reactors; storage of the moderator in tanks in the reactor building; layup of reactor equipment and systems to prevent deterioration; and maintenance in a defueled, protected status by a skeleton staff that would permit future refueling and restart. TE TC

The three reactors have similar designs; in most instances, their releases to and impacts on the environment are similar, if not the same. If DOE decided to terminate the operation of one or more reactors at SRS in the immediate future (i.e., before resuming production), currently planned upgrade activities would be discontinued. The continued operation of K-Reactor would include construction of the recirculating cooling-tower system regardless of TC

4.1.3.1.5 Severe Accidents

Section 4.1.3.1.4 discusses the postulated events considered in the dose assessment of the production reactor design-basis accidents. These events include transients that serve as the design-basis accidents for each reactor charge. This section discusses accident scenarios and risks associated with severe accidents.

Severe accidents are less likely to occur than design-basis accidents, but the consequences could be more serious, because they involve the failure to function of more than one engineered safety feature. Both the frequency and the consequences of these severe accidents are evaluated to ensure that they do not represent an unacceptable risk from reactor operation. The risk due to severe accidents is estimated as the product of the expected frequency of a release of radioactivity during a severe accident and the consequences (e.g., number of fatalities or dose) resulting from that radioactive release, summed over all severe accident scenarios. Severe accidents generally involve substantial physical deterioration of the fuel, to the point of melting inside or outside the tank. In addition, they might involve deterioration of the capability of the AACS to perform its function of limiting the release of radioactive materials to the environment.

To estimate the frequency of occurrence of severe accidents, the estimates of the frequencies of the various initiating events are combined with the probability of failure of the accident prevention systems. Potential accident sequences are projected using event trees that estimate the likelihood of success or failure for each part of the event sequence. By combining the results from each initiating event and the possible sequences, an overall frequency of severe accidents can be projected.

The probabilistic risk assessment (PRA) of the SRS production reactors (see Section 2.1.3) will provide a quantitative evaluation of the likelihood and consequences of severe accidents. This will be a detailed state-of-the-art PRA based on the methodology used for commercial nuclear powerplants, which considers both equipment and human failures. The PRA has three phases or levels: the Level-1 PRA evaluates the frequency of core-melt accidents, based on internal (accidents initiated by causes within the plant systems) and external (accidents initiated by causes external to the plant systems) events; the Level-2 PRA analyzes fuel damage progression, confinement system response, and resulting radionuclide release to determine the probability-weighted source term; and the Level-3 PRA evaluates the consequences of the radionuclide release, considering the probabilities of meteorological dispersion conditions and the effectiveness of evacuation and other protective measures. The Level-1 PRA was completed in June 1990. | TC

No uncertainty analysis was performed for the core-damage frequencies generated for the EIS. The uncertainty range is believed to be about the same size as that for the Level-1 PRA core-damage frequencies. The uncertainty in the core-damage frequency comes primarily from a combination of uncertainties in the data base and uncertainties in the models used. | C-04-13 L-44-17 L-44-20 L-44-57

The Final Level-1 PRA shows a point estimate of core damage frequency (CDF) from internal initiators to be 2.1×10^{-4} per reactor-year, with 5 percent and

95 percent confidence values of 1.7×10^{-5} and 9.8×10^{-4}, respectively. The point estimate of CDF from external initiators is 2.2×10^{-4} per reactor-year, with 5 percent and 95 percent confidence values of 1.04×10^{-4} and 6.5×10^{-4}, respectively. The point estimate of overall CDF is 4.3×10^{-4} per reactor-year (Sharp, 1990).

C-04-13
L-44-17
L-44-20
L-44-57

Some of the information in this section is derived from a special study that provides preliminary Level-1, -2, and -3 results based on the configurations of the plant when production is resumed, as documented in the Safety Information Document (WSRC, 1990). The Final Level-1 PRA CDFs are based on the K-Reactor configuration of June 1987, with the only upgrade being the fourth ECS line, while the seismic design is based on the P-Reactor configuration of June 1988.

Accident Characterization

The currently available severe accident assessment (WSRC, 1990) includes five internal event initiator classes: (1) primary coolant system LOCA, (2) secondary cooling water system LOCA, (3) loss of heat sink, (4) loss of river water supply, and (5) reactivity or power transients. The analysis also evaluates external initiators, such as earthquakes, fires, and floods; Sections 4.1.3.2 and 4.1.3.3 discuss these external initiators.

A number of accident initiators are categorized into each of these five classes, based on the types of responses required from the reactor systems and operators. "Negligible risk" initiators were not considered in the analysis. Although such initiators might be more probable than others that are considered, the quantity of radioactive materials released would be far less than that from the less probable but more severe accidents that are analyzed. For example, criticality due to a reloading error can occur only if a large number of errors are made and remain undetected. This accident is slightly more likely to occur with a plutonium production charge than with a tritium production charge but, due to the low inventory of radionuclides, is still a negligible contributor to risk.

In addition to the initiating events, the analysis considers the availability of reactor mitigative features. The mitigating systems are modeled in detail. The combination of the initiating event frequencies with the failure probabilities for the mitigating systems results in the severe accident frequencies, which, when totaled, yield the overall core damage, or core melt, frequency.

The accident classes bound not only the types of incidents that have occurred in the past, but also potential accidents identified by the Advisory Committee on Nuclear Facility Safety (ACNFS, 1988). Such events include the control rods mechanically locking together in a withdrawn position, which is considered in the analysis of the reactor shutdown function following a transient or other initiator; and failure of engineered safety features (such as the ECS and the confinement system filters) under seismic loading, which is also considered in the analysis of mitigative features. The following paragraphs describe the accidents that might result from each of the five internal event initiator classes.

A primary system LOCA requires the use of either the moderator recovery system or the emergency cooling system. For small leaks, the MRS or the ECS must be actuated manually. Manual actuation of the ECS is considered a high-stress decision for the operator, because unnecessary actuation will result in degradation of the heavy-water moderator by light water. Manual actuation of the MRS, however, is a low-stress decision because unnecessary actuation has no undesirable consequences. For leaks larger than those that can be handled by the MRS but smaller than those that automatically actuate the ECS (between 63 and 88 liters per second), the operator must eventually actuate the ECS manually. Manual actuation for such intermediate-sized leaks would not be needed for at least 30 minutes, and thus is a relatively low-stress decision for the operator. Large leaks resulting in automatic actuation of the ECS, and smaller leaks concurrent with partial failure of the WRS, require the operator to decrease ECS flow to prevent flooding of the primary coolant pump motors; if the motors flood, the ECS must provide long-term cooling of the core. Decreasing the ECS flow must be performed manually; it is also possible to decrease the flow excessively, which can result in core damage.

A large pipe break in the secondary system beyond the capacity of the WRS will flood the primary coolant pump motors, requiring the operator to actuate the ECS to force cooling flow through the core. Core damage occurs when the operators fail to isolate the leak to prevent primary coolant pump motor flooding and fail to actuate the ECS, or when the ECS fails. Because core damage results from the loss of heavy-water circulation, these sequences are called loss-of-pumping accidents.

Loss-of-heat-sink accidents (LOHSAs) involve the loss of heat removal capability on either the primary or secondary side due to the closure of many valves, or to circumstances other than a pipe break. Again, the ECS must be actuated manually to provide the capability for core cooling. TE

A loss-of-river-water accident results when the river water supply pumps stop running. After recognizing the loss of river water supply, the operator can take corrective actions, such as reducing secondary cooling water flow to a minimum and recirculating water from the outlet sump to the inlet basin, to allow the reactors to cope with the event.

The final class of internal initiators, reactivity or power transients, requires no operator response other than reactor shutdown and maintenance of core cooling to prevent a core-damage accident. The safety rod scram and supplementary safety system are provided to shut down the reactor before core damage can occur.

Loss of offsite power is not a significant contributor to risk for SRS reactors. Unlike commercial nuclear powerplants, SRS reactors have cooling systems that are not vulnerable to a loss of offsite power. The continuous operation of the process water pumps is ensured by the operation of the DC motors, each of which is powered by a dedicated DC diesel generator. TE Redundancy is ensured because two operating process water loops can remove core decay heat adequately. Gravity flow of secondary cooling water to the process water heat exchangers and other components provides additional protection from a loss of offsite power. Other important components receive power from dedicated diesel generators or batteries.

Probability Assessment

TE | When possible, actual records collected during 110 reactor-years of operation at the SRS are used to determine initiating event frequencies. If SRS-specific data for low-frequency events, such as pipe rupture, are unavailable, data generic to the commercial nuclear power industry are used. To estimate the core-damage frequencies for severe accidents, the initiator frequencies are combined with the failure probabilities of the systems provided to prevent core damage after an initiating event, and with the probabilities associated with operator failure to perform required actions. In addition, SRS-specific data are used where possible to determine these system and human failure probabilities. The total core damage frequency is found by summing the frequencies for all accidents.

TE | Table 4-26 summarizes the initiating event frequencies and the resulting core-damage frequencies for the severe accident probability assessment, which are discussed in the following paragraphs.

The initiating event frequency for primary system LOCAs is 5.6×10^{-3} per reactor-year. The bellows of the expansion joints in the piping of the SRS reactors, which serve to minimize the stress in the piping, are the part of the system considered most susceptible to failure. However, a rupture in the bellows will result in a leak rate far less than that for a DEGB of the largest pipe. Primary system LOCAs dominate the frequency of severe accidents due to internal initiators, and account for 35 percent of the total core-damage frequency. Small pipe or bellows breaks are the largest contributors to the core damage frequency due to primary LOCAs. This dominance exists because the ECS is not actuated automatically for such breaks, and a conservative estimate is used for operator failure to actuate the ECS or MRS. The core-damage frequency due to primary system LOCAs is 6.8×10^{-5} per reactor-year.

Like the primary system, the secondary system contains expansion joint bellows
TE | that are believed to be the part most susceptible to failure. The total initiating event frequency for secondary system LOCAs is 3.3×10^{-3} per reactor-year. LOPAs contribute approximately 11 percent of the total estimated core-damage frequency. The most dominant LOPA sequences are those involving breaks of very large cooling water headers. The leak rate from such a break overwhelms the WRS. The core damage frequency due to LOPAs is 2.2×10^{-5} per reactor-year.

The initiating event frequency for a loss of heat sink accident is 1.2×10^{-4}
TE | per reactor-year. The LOHSA core-damage frequency of 9.9×10^{-6} per reactor-year comprises 5 percent of the total core-damage frequency.

The loss-of-heat-sink initiating event class yields 4 percent of the severe core-melt frequency. this class has three subclasses of initiators: The total loss of primary system circulation accounts for 5 percent of the frequency; the total loss of secondary cooling due to effluent header failure
L-75-09 accounts for less than 1 percent; and the total loss of secondary cooling due to inlet header failure accounts for less than 1 percent. The response to loss-of-heat-sink initiators involves shutdown and direct core cooling by the Emergency Core Cooling System (ECCS). The dominant sequence in a LOHSA is a

Table 4-26. Severe Accident Probability Assessment[a] | TE

Accident Class[b]	Initiating Event Frequency (per reactor-year)	Core Damage Frequency (CDF) (per reactor-year)	Percent of Total CDF
Internal Events			
LOCA	5.6×10^{-3}	6.8×10^{-5}	35
LOPA	3.3×10^{-3}	2.2×10^{-5}	11
LOHSA	1.2×10^{-4}	9.9×10^{-6}	5
LORWA	1.2×10^{-3}	1.3×10^{-5}	7
Transient	2.5×10^{0}	1.6×10^{-5}	8
Total	--	1.3×10^{-4}	65	TC
External Events			
Seismic	c	6.8×10^{-5}	35
Fire	1.2×10^{-1}	1.4×10^{-7}	<0.1	TC
Total	--	6.8×10^{-5}	35
Total - All Severe Accidents		2.0×10^{-4}	100

a. Source: WSRC, 1990.
b. LOCA = Loss-of-coolant accident; LOPA = loss-of-pumping accident; LOHSA = loss-of-heat-sink accident; LORWA = loss-of-river-water accident.
c. Many degrees of seismic excitation are considered, each with an associated frequency of occurrence, which are represented by the seismic hazard curve described in the SID (WSRC, 1990).

failure to inject emergency coolant for direct cooling (accounting for about 80 percent of the total severe core-melt frequency). This sequence is dominated by the failure of the operator under high stress to activate the ECCS. Hardware failures account for only 20 percent of the total severe core-melt frequency contribution. L-75-09

All SRS reactor operators are receiving extensive training in the reactor simulator for handling all classes of accident initiators, including the LOHSA. Part of this training includes the activation of the ECCS in accordance with approved operating procedures.

Loss-of-river-water accidents would be caused by a failure of the river water supply pumps due to loss of the electric power supply or to upstream dam failure resulting in a flood inundating the pumps. The frequency for this class of initiator is the sum of the frequencies for these two events, which is 1.2×10^{-3} per reactor-year. Loss-of-river-water accidents have a core-damage frequency of 1.3×10^{-5} and, therefore, contribute 7 percent of the total core-damage frequency. TC

The most frequently occurring types of initiating events are reactivity and power transients, but successful termination of such events requires only reactor shutdown and continuation of core cooling. Based on historic data for the specific types of transient initiators, the total initiating event frequency for transients is 2.5 events per reactor-year. However, a significant fraction of the historic events that contributed to this frequency did not last long enough to require the actuation of the reactor shutdown systems. The core damage frequency of 1.6×10^{-5} per reactor-year for transients accounts for 8 percent of the total core-damage frequency.

As part of the analysis for this EIS, a thorough search was performed for plant-specific transients. Tha analysis considered all classes of transients (i.e., reactivity-addition, flow-reduction, and coolant-heatup). No subclass of transient initiator dominated. The response to these transients involves only shutdown. An automatic shutdown (Safety Rod System or SSS ink injection) is required to prevent core damage. After shutdown, primary coolant (heavy water) and secondary coolant (light water) are maintained indefinitely to cool the reactor core. Primary coolant flow to the core is maintained by the six online DC diesel generators that drive the six primary cooling pumps. Cooling water flow is maintained via gravity from the 95-million-liter cooling water reservoir to the primary coolant heat exchangers.

L-75-08

The analysis shows that the reactors are not vulnerable to dependent failures of DC power supplies. The PRA results show that the unreliability/unavailability of electric power (grid and 480-volt buses) is not an important factors in LOCAs, but is important in loss-of-river-water accidents because loss of offsite power is an initiating event. The DC power supplies are modeled in the generic subtrees (i.e., component fault trees), which trace the supply of electric power back to key buses. The availability and reliability of electric power at buses is represented as a series of basic events in the generic subtrees. These probabilities are analyzed in a Markov model that considers the frequencies of losing normal power, the probabilities of failure of emergency power, and the mean times to repair parts of the electric power supply.

Severe accidents initiated by seismic events contribute 35 percent of the total core-damage frequency (6.8×10^{-5} per reactor-year). Section 4.1.3.2 presents details of the seismic severe accident analysis. Fire-initiated severe accidents, also discussed in Section 4.1.3.2, are very small (less than 0.1 percent) contributors to the total core-damage frequency.

The total core-damage frequency resulting from all severe accidents is 2.0×10^{-4} per reactor-year. The conservative assumption is made that "core damage" implies a 100-percent core melt.

The next phase of the severe accident risk assessment requires evaluation of accident progression, and response of the confinement systems to a core melt and subsequent release of material from the reactor tank, to determine the accident source terms. Performing the analysis of the confinement system response requires a knowledge of the conditions under which core melt occurred. Different accident sequences resulting from the same initiating event can lead to different core-melt conditions. Thus, all core-damage

sequences are sorted into groups or "bins" according to their resultant core-melt conditions. These bins are called "plant damage states" (PDS). Figure 4-5 is the "bridge" event tree, illustrating the logic of the binning process.

Table 4-27 defines the eight plant damage states (four for internal events and four for seismic events) that cover the possible core-melt conditions resulting from the accident sequences that are analyzed. These plant damage states make note of the conditions that will be important in later analyses. Table 4-27 indicates, for example, that in Plant Damage State 4 (PDS-4), the reactor tank would be dry at core melt; that the RRSS and the CHRS would be operating with makeup water available; that the lower level of the reactor building would not be flooded in the long term and, thus, would not provide additional scrubbing of fission products; and that the AACS would be operating at the onset of fuel damage. The core-damage frequencies for all accident sequences in a plant damage state were summed, as indicated in Table 4-28, to determine the total core-damage frequency for each plant damage state. DOE did not perform an uncertainty analysis for the core-damage frequencies generated for the EIS. It is believed that the uncertainty range would be about the same size as that for the Level-1 PRA core-damage frequencies (see Section 2.1.3.2.1). The uncertainty in the core-damage frequency comes primarily from a combination of uncertainties in the data base and uncertainties in the models used. TE TE TE TC

Source-Term Determination

All severe accident core-damage sequences are assumed conservatively to lead to complete core melting. The source-term determination for radionuclide release due to severe accidents includes the rate of release to the confinement, the aerosol size distribution, and the deposition of radionuclides on the reactor vessel and other areas in the confinement. Each of the eight plant damage states described above yields a release from the reactor tank to the confinement with certain characteristics.

After the conditions at core melt are characterized by plant damage states, the performance of the confinement system is evaluated. With the exception of specific information on the effect of the accident on mitigating systems, severe accidents progress very similarly after primary system failure. The important physical mechanisms after primary system failure are the release of radionuclides from material external to the reactor tank and the ability of the confinement systems to retain them.

These physical mechanisms are assessed using a confinement event tree (CET). The CET consists of a series of events that represent the important phenomena that might occur during the progression of the accident and that can significantly alter the radionuclide source term. Each path through the event tree represents a set of unique release features for that accident sequence progression, and has an associated probability. One CET, such as that shown in Figure 4-6, was evaluated for each of the eight plant damage states. Table 4-29 defines the top events for the event tree. TE

Each CET sequence is assigned to a release category (RC) outcome. An RC has a unique source term, and thus a consequence, associated with it. The frequency of the various RCs is calculated as the sum of the frequencies of the

Table 4-27. Definition of Plant Damage States TE

Condition	Plant Damage State 1	2	3	4	5	6	7	8
Water in reactor vessel at onset of fuel damage	Yes	No	Yes	No	No	No	Yes	Yes
Minimum of 1 meter of water on lower-level floor	Yes	No	No	No	No	No	Yes	Yes
Makeup available to RRSS and CHRS	NA[a]	No	NA	Yes	No	No	NA	NA
AACS operable at onset of fuel damage	Yes	Yes	Yes	Yes	No[b]	No[c]	No[b]	No[c]

TE

a. NA = not applicable
b. Large openings exist in AACS exhaust ducts from above- and belowgrade areas.
c. AACS filters, fans, and stack isolated from confinement building, resulting in ground-level releases. TE

Table 4-28. Total Core Damage Frequency by Plant Damage State

Plant Damage State	Core Damage Frequency (per reactor-year)
1	2.9×10^{-5}
2	1.3×10^{-5}
3	6.7×10^{-5}
4	1.9×10^{-5}
5	2.9×10^{-6}
6	3.2×10^{-5}
7	2.8×10^{-6}
8	3.1×10^{-5}
Total	2.0×10^{-4}

sequences assigned to it. The frequency of a sequence is a product of the sequence conditional probability, from the CET analysis, and the frequency of the associated PDS.

The unique features of accident progression are represented in this assessment
TE | by the 26 release categories listed in Table 4-30. The release categories for a given number designation (e.g., 2, 2a, 2b) are very similar, differing only in one aspect, such as release timing.

For each RC, a source term is estimated to form the basis for the consequence calculations. Mechanistic calculations for the primary release categories (RC-1, 2, 3, 4, etc.) were performed with the CONTAIN computer code, which incorporates models for various phenomena that might occur during severe reactor accidents (Murata et al., 1989). The version used in this analysis, CONTAIN/SR, was modified to incorporate models of the SRS confinement fans and filters. The calculations performed for the primary release categories are associated with 11 postulated accident sequences.

Three mechanisms for the release of fission products from the reactor fuel to the confinement system were considered: release from fuel in the reactor vessel, release from the molten core debris when it interacts with the concrete confinement floor, and release from molten fuel that is involved in a molten-fuel-coolant interaction (MFCI, or steam explosion). The releases from the fuel debris within the reactor vessel will be scrubbed if they pass
TE | through water before reaching the confinement. The in-vessel fission product releases can also deposit on surfaces within the primary system. Releases from the molten-core-concrete interaction (MCCI) can be scrubbed by water present on the confinement floor. These scrubbing and deposition mechanisms, which reduce the confinement source term, are also considered.

TE | Based on the core inventory listed in Table 4-18, Table 4-31 summarizes the calculated percent of fission products released from the reactor tank to the confinement for each of the 11 postulated accident sequences chosen to represent the 11 primary release categories.

CONTAIN/SR is also used to analyze the response of the confinement system and establish the source term to the environment, based on the release fractions
TE | listed in Table 4-31. Table 4-32 lists the resulting release fractions to the environment and the release location.

Consequence Assessment

Consequences of hypothetical severe accidents are presented as health effects incurred by the populations on the SRS and in the surrounding area. The MELCOR Accident Consequence Code System (MACCS) is a probabilistic consequence analysis code developed by Sandia National Laboratories and modified by SRL to include the calculation of effects due to inhalation and ingestion of tritium (Chanin, Ritchie, and Sprung, 1987; Ritchie, Chanin, and Sprung, 1987). MACCS
TE | uses the fission product inventory (see Table 4-18) and the release fractions for each release category (see Table 4-32), and calculates the following:

1. The radiological releases from the confinement into the atmosphere (in curies of each isotope).

2. The downwind concentrations for 16 sectors around the reactor, using a Gaussian plume model, which also approximates all possible dispersion and deposition effects. These calculations are based on a probabilistic model for meteorology, which reflects the variability of weather conditions over the cycle of 1 year at SRS.

3. The impact of emergency protective action strategies (i.e., evacuation) for both onsite (colocated workers) and offsite (general public) populations

4. The health effects in terms of prompt fatalities, latent fatalities, and collective population exposure (person-rem)

MACCS uses models to relate the calculated doses and dose rates to individual target organs to the risk of various health effects. These models are based on a 1985 update by a scientific panel (NUREG/CR-4214) of the National Academy
TE | of Sciences-National Research Council (NAS-NRC) committee study of the biological effects of ionizing radiation (BEIR III). The latent cancer risk factors for exposure at low doses and low dose rates generated by the 1985 panel was about 50 percent higher (about 1.9×10^{-4} per person-rem) than the 1980 study (about 1.2×10^{-4} per person-rem).

The NAS-NRC committee released the fifth in this series of studies (BEIR V) in mid-December 1989. An evaluation of this report and its implications for DOE operations and standards is under way; similar evaluations are being performed by national and international radiation protection organizations. Assuming the adoption of these findings, the risks calculated on the basis of the recent report would be higher by three to four times than those calculated using BEIR III risk factors.

As discussed in Section 4.1.2.6, this EIS uses the EPA health risk estimator (4×10^{-4} per person-rem); latent cancer risks calculated by MACCS (WSRC, 1990) have, therefore, been adjusted by a factor of 2.1 (4/1.9) to be consistent with the health risks estimated elsewhere in this EIS. If the
TC | median BEIR V risk factors were to be applied to the acute exposures from severe accidents, latent cancer risks from these accidents on and near the SRS would be about twice those presented in this analysis. This factor of 2 is not significant considering the overall uncertainty in this type of assessment.

The input to MACCS also includes meteorological data gathered for K-Area from 1982 through 1986, the population characteristics on the SRS and within an 800-kilometer radius of the SRS (1980 census), offsite land usage factors for chronic health effects due to food pathway uptake, and parameters for onsite and offsite protective actions, such as evacuation.

Offsite consequences are determined for three phases of each assumed reactor accident: an emergency phase that begins with the radiological release and lasts for 7 consecutive days, an intermediate phase that begins at 7 days and lasts for 30 days from the time of the accident initiation, and a long-term phase that lasts for 30 years after the end of the intermediate phase. The onsite consequence analysis considers only the emergency phase of the accident.

Tables 4-33 and 4-34 summarize the evacuation and/or sheltering assumptions and parameters associated with each release category for offsite and onsite populations, respectively. Emergency plans have been established for postulated design-basis accidents. Evacuation plans have been developed for the Emergency Planning Zone, which is approximately the area encompassed by 16-kilometer circles around each reactor. The 32-kilometer evacuation radius was chosen to include the EPZ radius of 16 kilometers, and an additional 16 kilometers that represents a reasonable distance that would be evacuated under state emergency plans. The speeds chosen (2 to 4 kilometers per hour) are conservative because they represent reasonable speeds for walking or for slow-moving traffic. C-04-17 L-44-21

Severe Accident Risks

The MACCS calculated results can be displayed both as Complementary Cumulative Distribution Functions (CCDFs) and as mean risk values:

Expected frequency of release category	X	Mean consequences from radiological release

This is summed over all possible release categories to obtain total mean severe accident risk.

The CCDFs in Figures 4-7 through 4-9 show the relationships between the frequencies and consequences of reactor accidents. These graphs, which show the predicted frequency with which the corresponding magnitude of a consequence is equaled or exceeded, display the decrease in accident frequency that occurs as the magnitude of the consequence increases. TC

The different releases and atmospheric dispersion conditions, source-term magnitudes, and dose effects result in wide ranges of calculated magnitudes of consequences. Similarly, the frequency of equaling or exceeding a given consequence magnitude varies over a wide range because of varying probabilities of accidents and dispersion conditions. Therefore, the CCDFs are presented as logarithmic plots, in which numbers varying over a large range can be shown on a graph scaled in powers of 10.

Figure 4-7 shows the CCDF for prompt fatalities, in both on- and offsite populations, due to severe accidents. It indicates that the likelihood of producing one or more prompt fatalities in the offsite population is less than 2 in 10 million per reactor-year, and of producing 10 or more prompt fatalities, about 1 in 100 million per reactor-year. It also indicates that the likelihood of one or more prompt fatalities on the SRS is less than 1 in 100,000 per reactor-year. Figure 4-8 shows the CCDF for latent cancers calculated for on- and offsite populations, and Figure 4-9 shows the CCDF for the collective population dose from which the latent cancer data are derived.

Figure 4-10 also shows risk, in terms of the frequency of exceeding a red bone marrow dose level at the SRS boundary. The boundary ranges from approximately 9 kilometers (to the west) to approximately 23 kilometers (to the north-northeast) from K-Reactor. Therefore, the figure presents red bone marrow doses in two curves, one representing 9 to 11 kilometers and the other

representing 22 to 24 kilometers from K-Reactor. The dose curve at 16 kilometers should be bounded by these two curves.

TE Table 4-35 summarizes the mean health effects values for on- and offsite populations. The calculated mean offsite population dose within 16 kilometers of the SRS from severe accidents is 210 person-rem per reactor-year; this can be compared to the natural background dose to this same population group of TE about 19,300 person-rem per year. Less than one-millionth of one prompt fatality per reactor-year is calculated to occur on average in this same population as a result of severe accidents.

TE Table 4-35. Mean Health Effects Risks due to Severe Accidents

Health Effect Measure	Offsite	Onsite
Mean population dose (person-rem/reactor-year)	210 (within 16 km of SRS) 900 (within 800 km of SRS)	2.5 (entire SRS)
Mean individual dose (mrem/reactor-year)	5.9 (within 16 km of SRS) 0.018 (within 800 km of SRS)	0.31 (entire SRS)
Prompt fatalities (number/reactor-year)	1.4×10^{-7} (within 1.6 km of SRS) 5.7×10^{-7} (within 16 km of SRS)	8.4×10^{-5} (within 1.6 km of K-Reactor) 4.0×10^{-4} (entire SRS)
Latent (cancer) fatalities (number/reactor-year)	4.9×10^{-3} (within 16 km of SRS) 0.19 (within 800 km of SRS)	2.3×10^{-3} (within 16 km of K-Reactor) 2.3×10^{-3} (entire SRS population)

TE Table 4-36 compares the individual risks to persons offsite and onsite to Draft DOE Safety Goals (DOE, 1989b). As the table indicates, in each instance compared, the individual risks due to severe accidents meet these goals with a substantial margin.

L-78-58 Offsite individual risks of prompt (early) and latent fatalities are computed separately with two different grids. For early fatalities, the populated grid extends 1.6 kilometer from the SRS boundary in each of 16 compass directions. For the latent (cancer) fatalities, the populated grid extends 16 kilometers from the SRS boundary in each of 16 compass directions. Offsite populations greater than 1.6 and 16 kilometers in each direction are not included for individual early and latent risk calculations, respectively, for comparison against the Draft DOE Goals. The last column of Table 4-36 lists the

Table 4-36. Comparison of Risks due to Severe Accidents to DOE Safety Goals

Risk Measure	K-Reactor Risk	Draft DOE Safety Goal	Population at Risk
Offsite			
Individual risk of prompt fatality within 1.6 km of SRS boundary	5.9×10^{-11}	4×10^{-7}	2,450
Individual risk of latent (cancer) fatality within 16 km of SRS boundary	7.2×10^{-8}	2×10^{-6}	35,191
Onsite			
Individual risk of prompt fatality within 1.6 km of K-Reactor	1.6×10^{-7}	1×10^{-6}	541
Individual risk of latent (cancer) fatality within 16 km of K-Reactor	2.9×10^{-7}	2×10^{-6}	8,000

L-78-58

Source: DOE, 1989b.

population totals for these two grids. The individual latent (cancer) fatality risk considers direct exposure from the cloudshine, groundshine, and inhalation pathways to the population within 16 kilometers of the SRS boundary.

The same onsite grid is used for both measures of worker individual risks. However, the early individual risk considers only the day-averaged worker population within 1.6 kilometer of K-Reactor. "Day-averaged" is defined as the peak onsite workforce weighted by 11 hours added to the off-normal workforce weighted by 13 hours. The latent (cancer) risk considers the day-averaged worker population within 16 kilometers of K-Reactor. Both onsite risk calculations for comparison to the Draft DOE Safety Goals include K-Area workers; these workers are included in the evacuation model discussed in this section. The last column of Table 4-36 lists the worker population used for the two measures of individual risk.

The quantitative safety goals listed in Table 4-36 were adopted from similar goals applied to commercial nuclear powerplants. Their objective is to ensure that no significant increase in risk occurs to the public or onsite workers from the operation of DOE facilities. The values listed in Table 4-36 are based on a specified percentage of several fatality statistics, which are listed in Table 4-37. TE

TE | Table 4-37. Fatality Statistics

Risk Due to Facility Operation	Fatality Statistic (per year)	Percentage	Draft Goal (per year)
Risk of prompt fatality to individual in vicinity of SRS	Average fatal accident rate for U.S. citizen is 4×10^{-4}	0.1	4×10^{-7}
Risk of latent fatality to individual in area near SRS	Average cancer fatality rate for U.S. citizen is 2×10^{-3}	0.1	2×10^{-6}
Risk of prompt fatality to onsite worker	Occupational death rate for U.S. worker is 1×10^{-4}	1.0	1×10^{-6}
Risk of latent fatality to onsite worker	Average cancer fatality rate for U.S. citizen is 2×10^{-3}	0.1	2×10^{-6}

TE | Source: DOE, 1989b.

TE | DOE management has not formally approved the goals listed in Table 4-37. These goals are seen as a means to foster a more consistent and predictable assurance of safety for the diverse DOE nuclear facilities. It is expected that these goals will be applied to check the adequacy of DOE safety-related Orders and to help allocate resources. The goals will not be used as strict requirements for individual facilities, but will enable DOE to evaluate its safety program as a whole. Nevertheless, these goals have been compared to the SRS reactors; the reactors meet the goals, primarily for the following reasons:

- The effectiveness of the safety systems limit the frequency of a core-damage accident to about 2×10^{-4} per reactor-year. This is a low frequency that is comparable to those in commercial nuclear powerplants.

- In the event of an accident in which fuel melts, the mitigative features of the confinement system generally would be effective. In addition, many of these hypothetical accidents involve the presence of significant quantities of water either in the reactor tank or on the floor below the tank. This water would capture radionuclides before they could escape to the environment.

- In the very rare accident in which a severe release of radioactivity occurs, the large SRS boundary distance would help ensure deposition and good dispersion of the material before it reaches offsite individuals.

- The large SRS area also helps to ensure effective evacuation of both onsite workers and the public.

Reduced Power Operation

The radiological inventory present in the reactor core is directly proportional to the reactor power level and the length of the reactor operating cycle. Furthermore, substantial changes in the core damage frequency as a function of reactor power level should not occur. Therefore, the risk of operating at reduced reactor power would be bounded by the risk associated with operation at the 100-percent power level.

Multiple-Reactor Operation

The severe accident risk associated with the simultaneous operation of two or three reactors at SRS is affected by the following factors:

- The possibility of common cause failures among reactors in response to an initiating event that affects two or more reactors
- The nonlinearities in health effects exposure thresholds that affect prompt fatalities

Health effects also show some sensitivity to differences in SRS reactor siting. The location of P-Reactor has been evaluated for its influence on offsite risk to the individual due to postulated severe accident releases. For the same radiological releases, accidents at P- and K-Reactors would result in indistinguishable health effects at distances greater than 160 kilometers. Within 16 kilometers, the differences in latent fatalities are negligible. Within 1.6 kilometers of the SRS boundary, the mean prompt fatality risk is 1.4 times greater, although still 5,000 times lower than the draft DOE safety goals. Due to the location of L-Reactor, assessments for severe accident releases at K- and P-Reactors will bound the severe accident risks for L-Reactor.

Notwithstanding these factors, reactor operating practices are expected to limit the total risk due to operation of K-, L-, and P-Reactors to no more than 2.4 times the risk from the operation of a single reactor operating at 3,000 megaWatts. Table 4-38 lists the risks due to multiple-reactor operation. | TE

Production of Other Nuclear Materials

The severe accident analysis is based on a tritium-producing reactor charge. Requirements include the production of plutonium-238, and future requirements might include plutonium-239 and small quantities of a variety of special radioisotopes.

The production of plutonium-238 (or plutonium-239) requires the use of fuel and target assemblies that are different from those used for tritium production. Thus, additional accident-initiating events must be considered; these include misloading accidents, such as target assemblies loaded in fuel positions and dropped irradiated targets. However, these accidents would result in no more than localized fuel melting, so a significant quantity of radionuclides would not be released. There are also only small differences in the end-of-cycle core inventories for plutonium-238 (or plutonium-239) and tritium production charges. A plutonium charge has a very small tritium

TE | Table 4-38. Annual Risks Due to Multiple Reactor Operation

Risk Measure	K-Reactor	L-Reactor	P-Reactor	SRS Total[a]
Mean population dose (person-rem)				
Offsite (to 800 km)	900	900	900	2,700
Onsite	2.5	2.5	2.5	8
Individual prompt fatality				
Offsite (to 1.6 km)	5.9×10^{-11}	5.9×10^{-11}	8.0×10^{-11}	2×10^{-10}
Onsite	1.6×10^{-7}	1.6×10^{-7}	1.6×10^{-7}	5×10^{-7}
Individual latent fatality				
Offsite (to 16 km)	7.2×10^{-8}	7.2×10^{-8}	7.2×10^{-8}	2×10^{-7}
Onsite	2.9×10^{-7}	2.9×10^{-7}	2.9×10^{-7}	9×10^{-7}

a. Three reactors.

inventory, and a tritium charge contains essentially no plutonium. Neither plutonium nor neptunium is a volatile element under severe accident conditions in an SRS reactor, and neither would contribute greatly to the health effects resulting from the severe accident. Thus, the probability of a severe accident occurring during plutonium production and the resulting consequences are not appreciably different from those for tritium production (WSRC, 1990).

4.1.3.2 Natural Phenomena Affecting Risk

This section discusses natural phenomena incorporated in the risk and consequence analysis presented in Section 4.1.3.1.5 (WSRC, 1990). Sections 4.1.3.2.1 and 4.1.3.2.2 describe the natural phenomena analyses for seismic events and fires; Section 4.1.3.2.3 describes other natural phenomena in less detail.

4.1.3.2.1 Seismic Events

Based on seismic activity information in the past 300 years, earthquakes greater than a Modified Mercalli Intensity (MMI) of VII are not projected to occur on the SRS. Section 3.3.2 describes the seismology of the area in the vicinity of the SRS. The design-basis earthquake for the SRS is a MMI VII event, which corresponds to a horizontal peak ground acceleration of 0.2g. Based on current technology, as applied in various probabilistic evaluations of the seismic hazard in the SRS region, the 0.2g peak ground acceleration can be associated with a 2×10^{-4} annual probability of exceedance (5,000-year return period). This approach is consistent with the methodology accepted at commercial nuclear reactors. The 0.2g peak ground acceleration is consistent with the design-basis earthquake for the nearby Vogtle Electric Generating Plant (VEGP).

Seismic events could lead to severe accidents by causing one or more of the initiating events discussed in Section 4.1.3.1.5. In addition, seismic events could cause failure of the confinement systems. A detailed analysis of the SRS seismic risk has been performed based on the seismic model developed by the Electric Power Research Institute for the eastern United States (WSRC, 1990). This seismic model (called a seismic hazard curve) represents the varying degrees of seismic excitation and the associated frequencies of occurrence. The seismic analysis also used component fragility curves that represent the failure probabilities of safety system components as a function of seismic acceleration.

As discussed in Section 2.1.3.2.1, an alternative methodology developed by Lawrence Livermore National Laboratory for the development of hazard curves is being evaluated, and seismic risk results generated from both sets of curves will be included in the completed PRA. TC

The frequency of core damage resulting from a seismic event is 6.8×10^{-5} per reactor-year. Breaks of cooling water pipes and loss of river water are dominant contributors to seismic risk (WSRC, 1990). The core damage sequences due to seismic events were also sorted into Plant Damage States, as described in Section 4.1.3.1.5. Seismic sequences were grouped into Plant Damage States 5 through 8, according to the failure mode of the AACS that is assumed. The remainder of the severe accident analysis, as described in Section 4.1.3.1.5, considered internal events and seismic events together, according to their Plant Damage State groupings.

4.1.3.2.2 Fires

The presence of flammable materials in the reactor buildings is minimized to reduce the probability of a large internal fire due to transient combustibles. The designs of the shutdown and emergency cooling systems include safety redundancies and "fail-safe" devices for use in the event of a fire. In addition, operators can shut down and maintain the reactors in a safe condition from the Remote Control Station.

Large areas have been cleared around the reactor buildings to prevent the spread of fires arising outside the facilities. Smoke from a forest fire could require the temporary evacuation of a reactor, but the SRS has normal and emergency facilities to shut down the reactor from the Remote Control Station (WSRC, 1989d).

After a reactor accident, the carbon filters of the confinement system could ignite and burn, resulting in a release of absorbed fission products. To reduce this possibility, the reactor room spray system operates to remove a portion of the released halogens and to cool the air in the reactor. The confinement heat removal system is designed to keep belowgrade areas cool, prevent fires, and prevent the desorption of halogens. The burning of the carbon filters is considered in the confinement event tree analysis described in Section 4.1.3.1.5.

The fire analysis (WSRC, 1990) includes identification of reactor building zones that have a significant probability of occurrence of a fire and that contain equipment or electrical cables important to safe shutdown;

determination of fire temperature response, component fire fragilities, and fire barrier failure probabilities; and fire recovery analysis.

Analysis of the SRS fire history and the fire experience of commercial nuclear powerplants results in an estimated fire frequency of 1.2×10^{-1} per reactor-year. A reactor building fire is unlikely to occur simultaneously with another internal initiating event other than a transient; thus, the only response required for a fire is reactor shutdown and maintenance of adequate core cooling. The frequency of core damage resulting from a fire is 1.4×10^{-7} per reactor-year. This low frequency results from the widely separate, redundant supplies of primary and secondary cooling water, and the minimal postshutdown cooling requirements of the reactor.

4.1.3.2.3 Other Natural Phenomena

Several other natural phenomena have been evaluated; further detailed analysis has not been performed because the risks are insignificant. The following paragraphs describe these phenomena.

Extreme Winds, Hurricanes, and Tornadoes

The only credible failure due to high winds is loss of the normal electric power supply to the reactor building, which is explicitly considered as an initiating event and found to be an insignificant contributor to core-damage frequency (WSRC, 1990). Most reactor facilities are designed to withstand the maximum winds expected at the SRS.

The strongest sustained winds at the SRS would occur in tornadoes, with wind speeds estimated as high as 116 meters per second. The estimated average frequency of a tornado striking any given location in South Carolina is 7.11×10^{-5} per year (Ramsdell and Andrews, 1986). Design criteria specify that the buildings for the reactor facilities must be able to withstand a maximum pressure drop of 10,500 Pascals, which corresponds to a 125-meter-per-second windspeed with a probability of a building strike of 10^{-7} per year. The areas that could not withstand this pressure drop include the exhaust stacks, the confinement filter compartments, the booster-pump diesel motors, and the exhaust fan casings. A failure of these components alone would not result in a reactor accident (WSRC, 1989d).

Floods

The only credible failure due to external flooding is loss of the river water supply following flooding of the pumphouses, which are the only important structures less than 30 meters above river level. This event is explicitly considered as an internal initiator (WSRC, 1990). Flood sources external to the reactor facilities that might propagate to the reactors include Par Pond, L-Lake, and the Savannah River. Failure of the Par Pond or L-Lake dam would not jeopardize reactor safety, and water from the reactor secondary cooling water basins would be sufficient to supply the necessary cooling. The maximum
TC | historic flood stage for the Savannah River is 36 meters at SRS, and the calculated flood stage for the "domino" failure of dams upriver from the SRS is 43.6 meters. The reactors, which are on high ground (see Section 2.1.2.1),

are not subject to local flooding; Savannah River floods of the magnitudes described would result in the loss of the river water pumps as described above.

K-, L-, and P-Reactors are 46, 40, and 60 meters, respectively, above the maximum flood [36 meters above mean sea level (MSL)]. SRS support facilities are from 10 to 71 meters above the maximum flood. The D-Area pumphouse intakes are about 30 meters above MSL, and would be flooded during a maximum flood. L-76-50 TC

Ice Cover

The climate in the area is not conducive to ice storms that would produce any credible initiating event other than loss of normal electric power (WSRC, 1990). The SRS generally experiences one or two ice storms per year. With the exception of the power distribution system, the reactors are immune to damage from ice cover. The power distribution system is designed to withstand a 0.6-centimeter-thick ice cover concurrent with 35.8-meter-per-second winds (WSRC, 1989d).

4.1.3.3 Non-Nuclear Hazards

The severe accident analysis (WSRC, 1990) considers several non-nuclear hazards for the risk they might present to reactor operation.

4.1.3.3.1 Aircraft Impact

There is essentially no probability of a commercial or military aircraft crash in an SRS reactor area, because there are no airports within 16 kilometers of the three reactor sites, and because there are no low-altitude military training routes, pilot training areas, or approach/departure paths to airports or military facilities over the SRS (WSRC, 1989d). Since the air space restriction over the SRS was lifted in 1976, the frequency of general aviation (noncommercial, nonmilitary) flights over the SRS has increased to approximately 4,000 per year. The crash frequency for general aviation is 3×10^{-15} per flight per square meter (WSRC, 1989d). Based on 4,000 flights over the SRS per year, a Site area of 8×10^{8} square meters, and reactor areas totaling 1×10^{6} square meters, the frequency of an aircraft crash in a reactor area is 1.5×10^{-8} per year. This would not add measurably to the reactor severe accident risk.

4.1.3.3.2 Chemical or Toxic Gas Release from Onsite Facilities

The major hazards from chemical or toxic gas releases are explosions of flammables and dispersion, particularly to the Control Rooms. Risks due to chemical or toxic gas releases were not considered further because no toxic gases are used or transported in or near the reactor areas (WSRC, 1990). DOE has replaced chemical and toxic gases with other materials or has discontinued the processes in which they were used.

The SRS topography has no location at which plumes would tend to accumulate and allow concentrations to increase to a dangerous limit (WSRC, 1989d).

4.1.3.3.3 Nearby Industrial or Military Facility Accidents

Within a 40-kilometer radius of the SRS are approximately 120 industrial facilities with 25 or more employees. Four of these facilities are within a 16-kilometer radius of the SRS: the Allied General Nuclear Services (AGNS) Fuel Plant; Carolina Metals, Inc.; Chem-Nuclear Systems, Inc. (CNSI); and VEGP. The AGNS Nuclear Fuel Plant at the Barnwell Industrial Park is shut down and will not be utilized in the foreseeable future. Other than those on the SRS, the only major storage facilities within a 40-kilometer radius are the facilities at CNSI, VEGP, and a cluster of natural gas storage tanks near Beech Island. However, the facilities within a 16-kilometer radius of the SRS boundary (the closest of which is less than 1 kilometer from the boundary) are still at least 10 kilometers from the nearest reactor, and thus present a negligible risk to reactor operation.

4.1.3.3.4 Waterway Accidents

No Savannah River traffic would have an effect on the safety of SRS reactors.

4.1.4 TRANSPORTATION

4.1.4.1 Onsite and Offsite Shipments

Hazardous material flows to and from each onsite facility can be grouped into three categories: essential materials, products, and wastes. Essential materials are raw materials, process chemicals, and other supplies that are the feed stocks used in SRS facilities to produce products. Products of a facility can be feed stocks for one or more other facilities. Each facility also generates wastes as inevitable byproducts of its function. Some wastes are chemical only, some are mixed radioactive-chemical wastes, and others are radioactive only. The following paragraphs describe the effects of these hazardous material shipments.

Uranium fuel and target assemblies are produced in the 3/700-Area from raw materials received from offsite sources. The assemblies are transported to the 100-Area reactors, where they are charged into the reactor core. The irradiated fuels and targets that are discharged from the reactors are transported to the 200-Area for chemical processing.

Nitric acid, sodium hydroxide, liquid chlorine, petroleum distillates, and more than 100 other nonradioactive hazardous materials are transported to the facilities to be utilized in processing and reactor support activities. [Where possible, liquid chlorine, which is used in water purification, is being replaced by a much less volatile sodium hypochlorite solution. This change has been addressed only to a limited extent by the analyses of transportation risks (WSRC, 1989d)]. Gasoline and other light petroleum distillates are the most frequently transported nonradioactive hazardous materials shipped by truck. Coal and cask-car movements comprise most of the rail traffic.

Low-level radioactive wastes or mixed wastes are transported to the Burial Ground in the 200-Area. Low-level liquid radioactive wastes are shipped from the reactor areas to the 200-Area for evaporation before being transferred

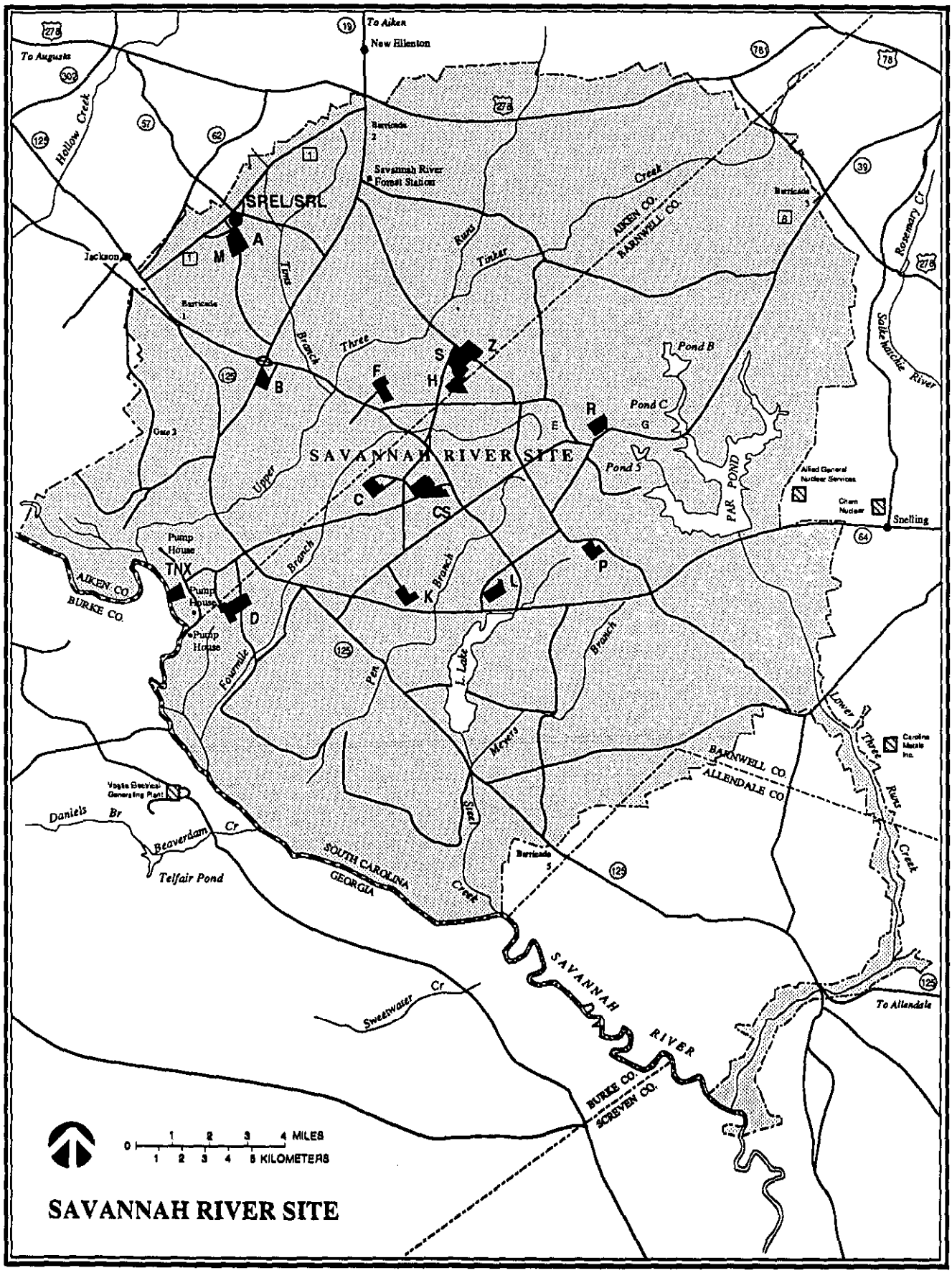


Figure 2-1. SRS Map.

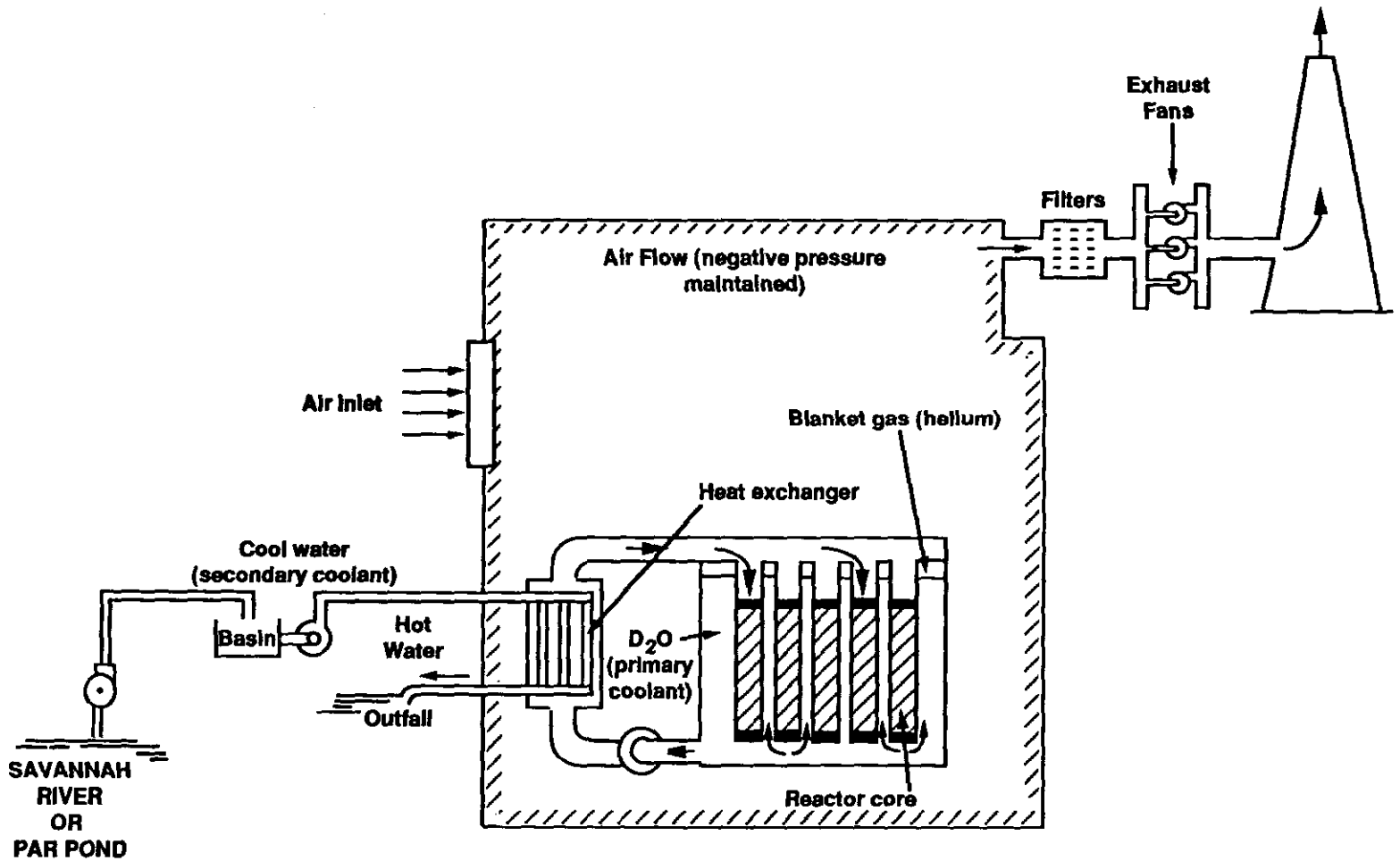


Figure 2-2. Production Reactor Process System.

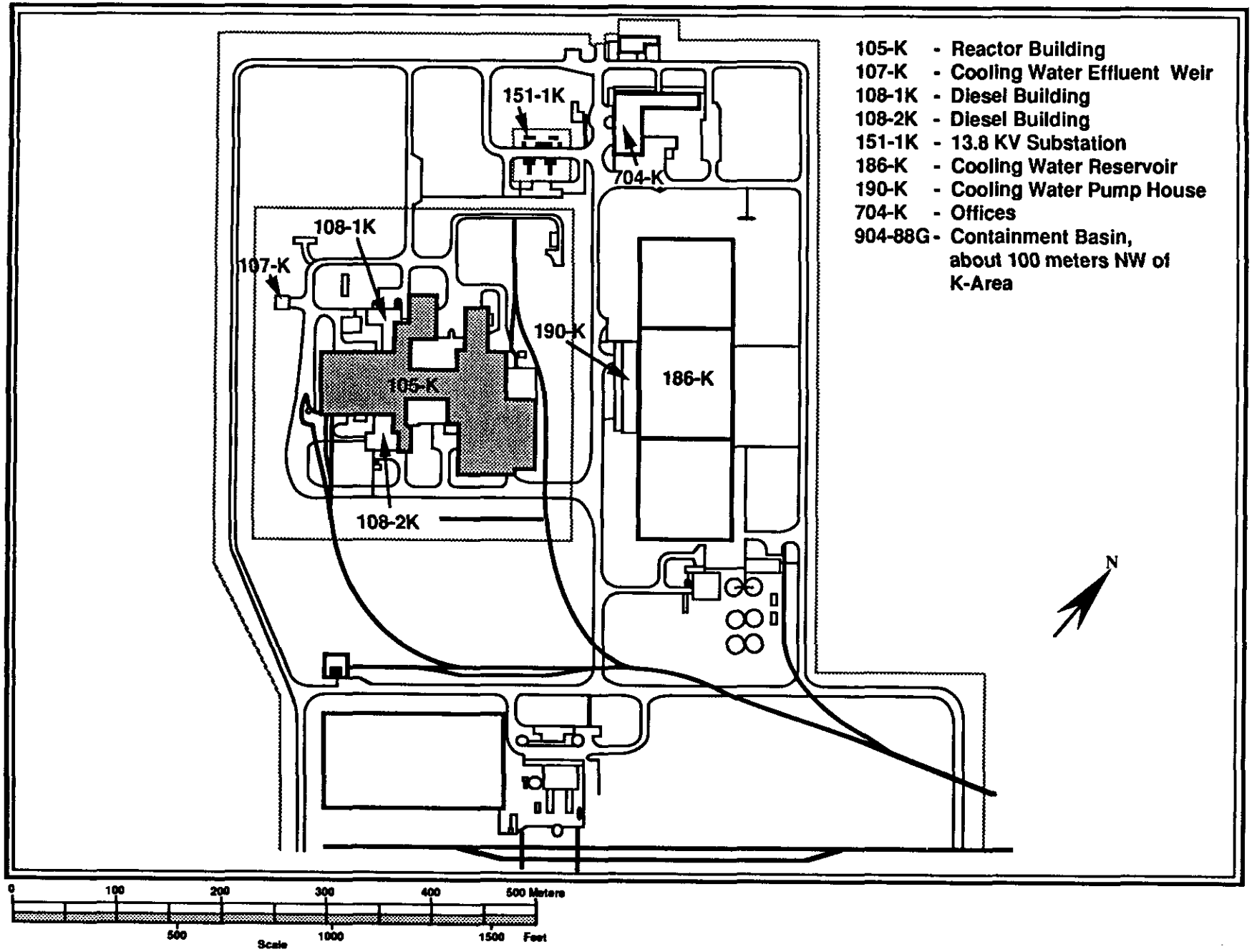


Figure 2-3. K-Area.

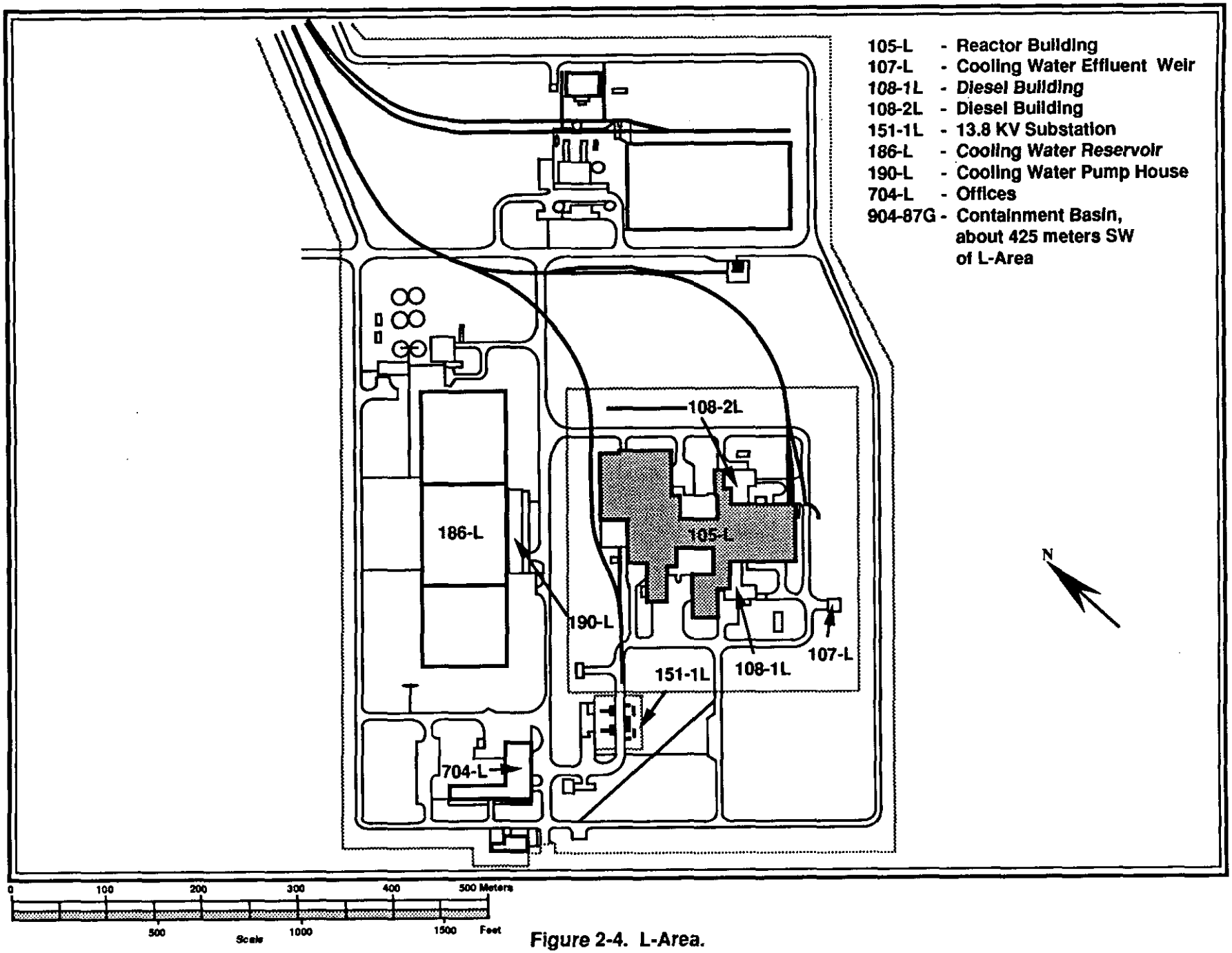


Figure 2-4. L-Area.

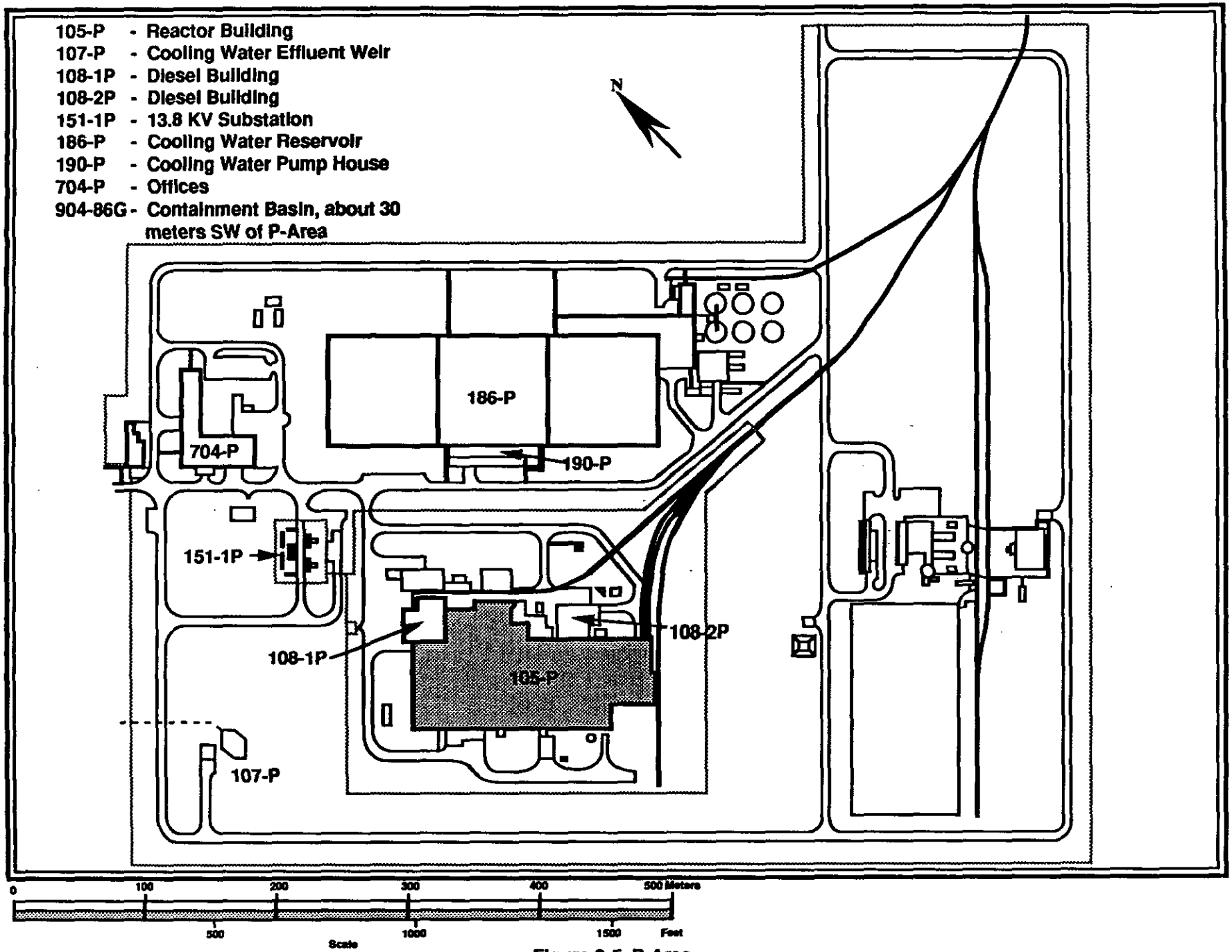
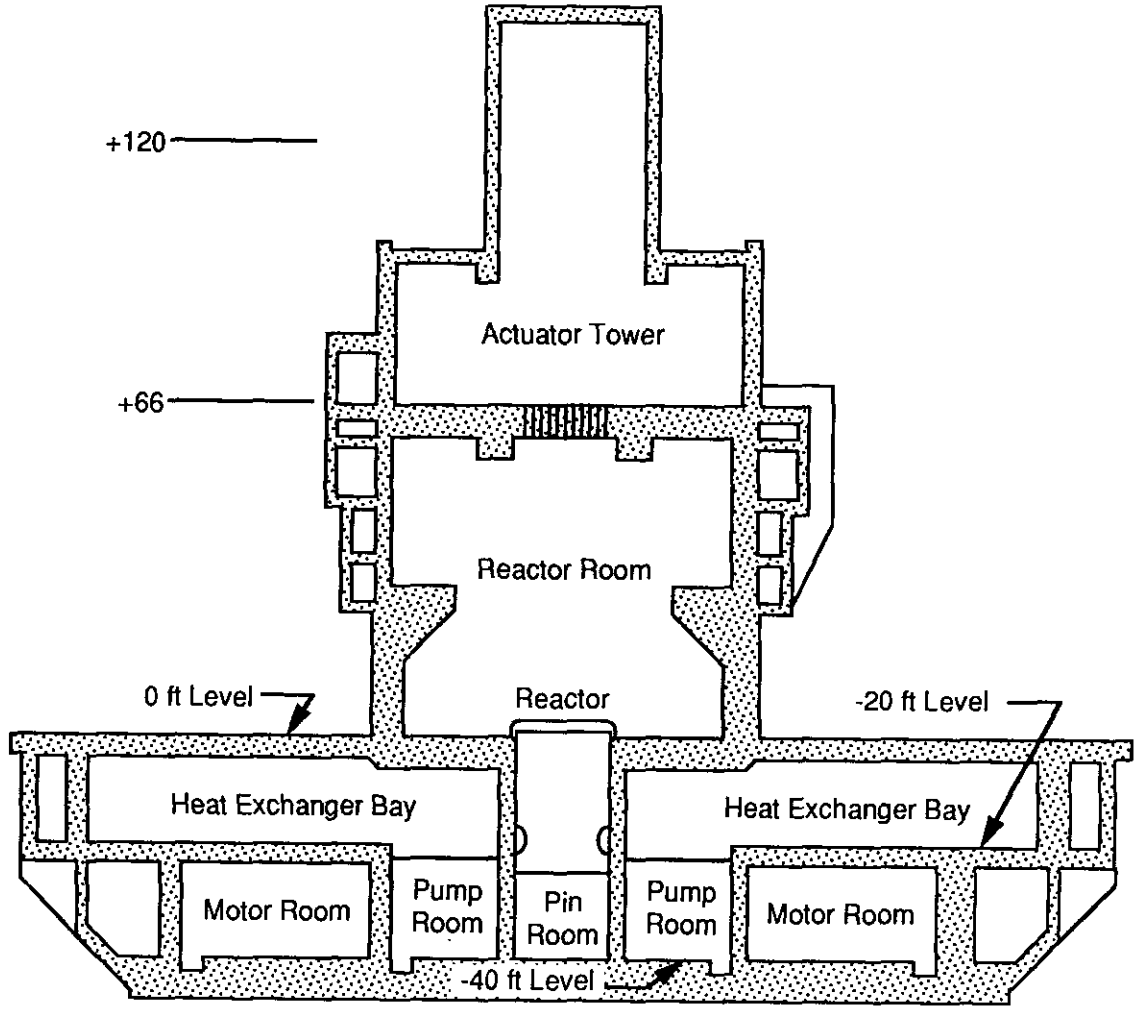


Figure 2-5. P-Area.



1 foot = 0.3048 meter

Figure 2-6. Cross Section of Reactor Process Areas (K-, L-, P-Reactors).

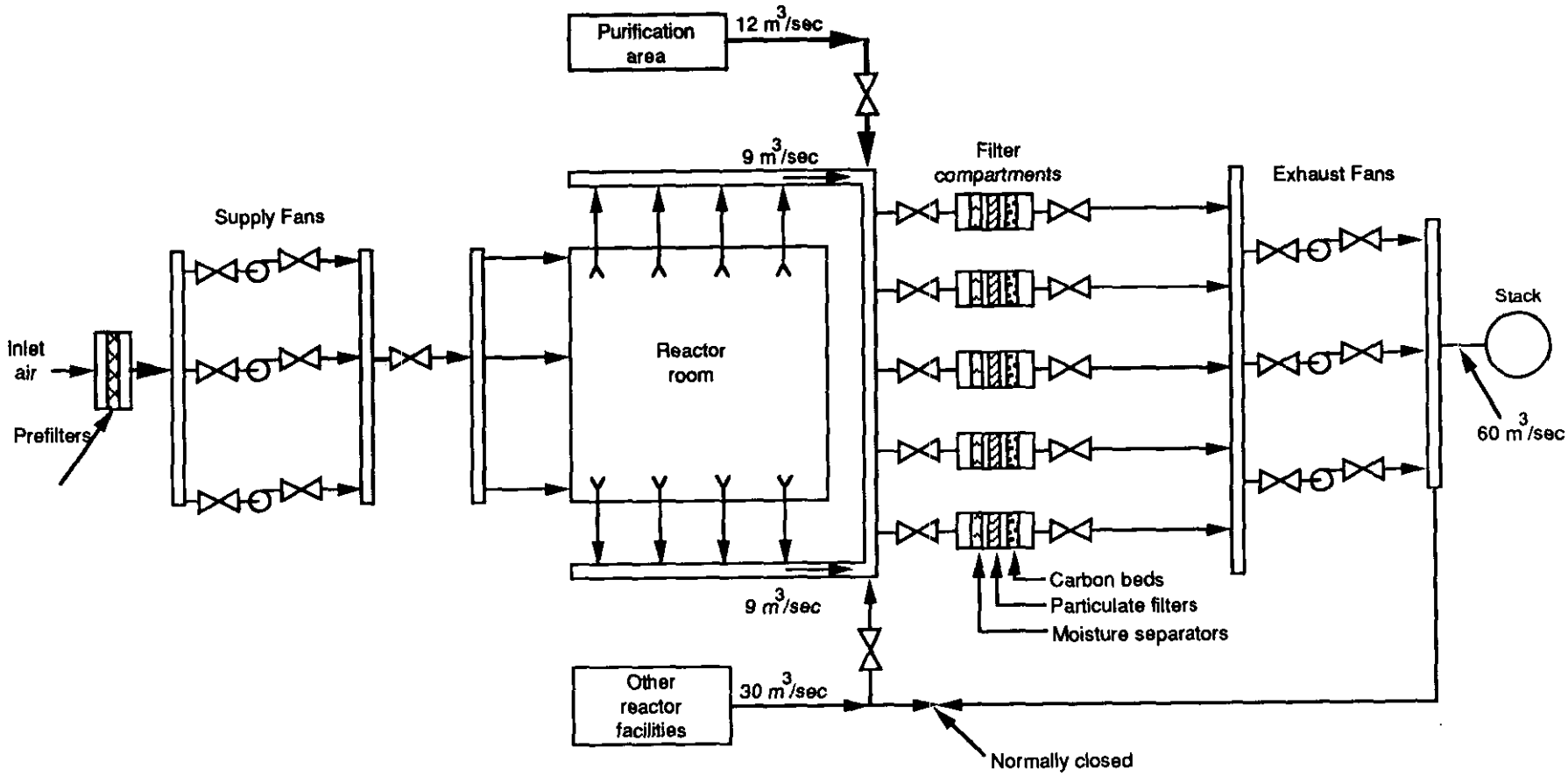


Figure 2-7. Typical Reactor Confinement System.

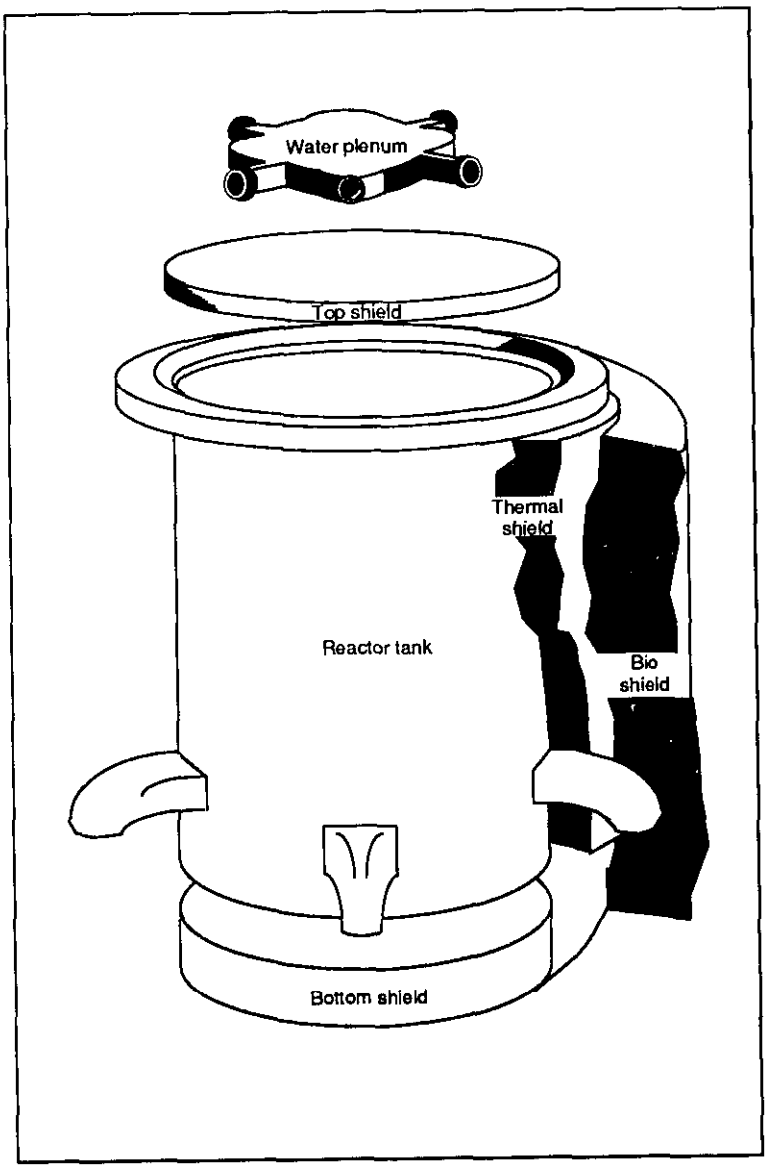
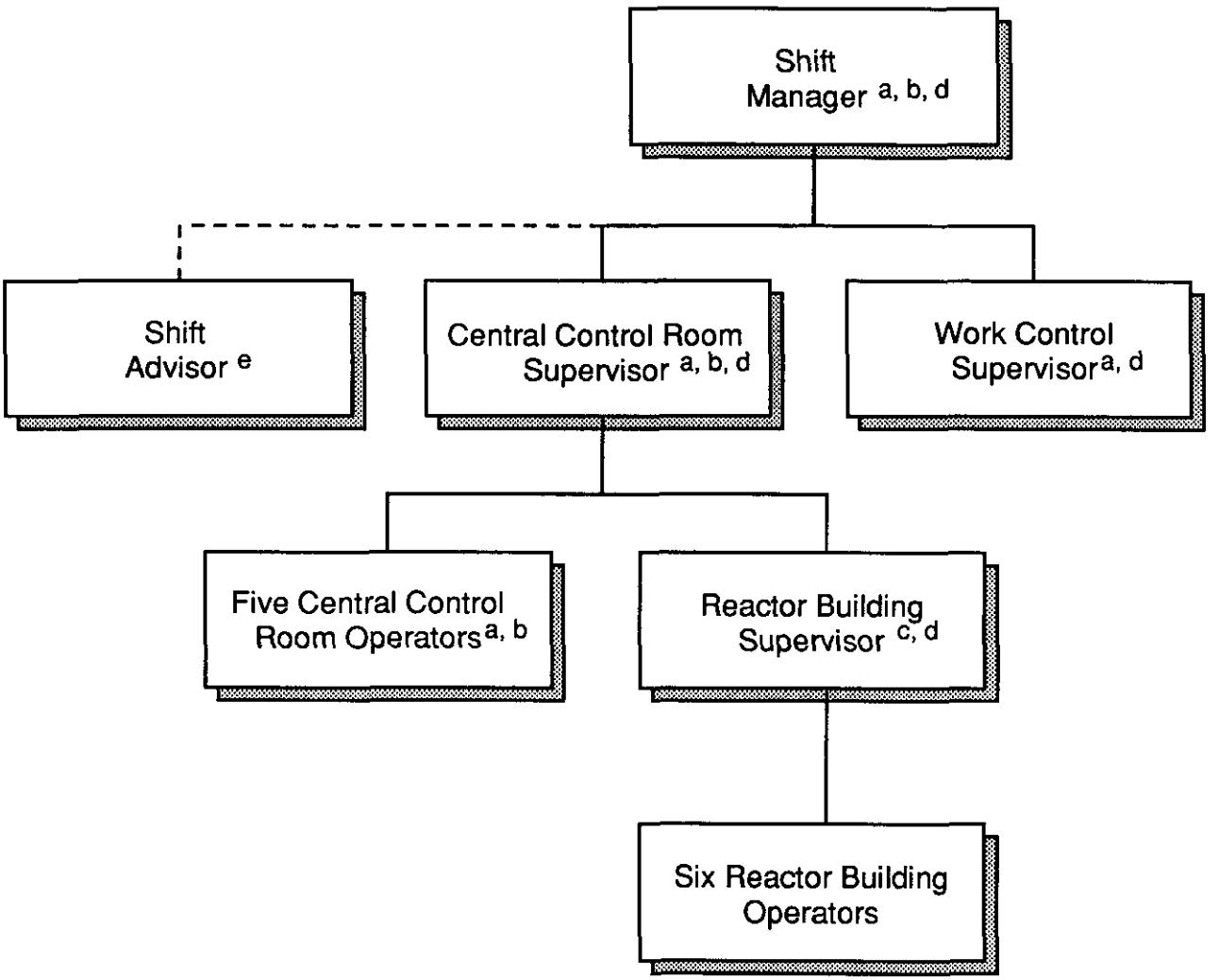


Figure 2-8. Reactor Vessel Structure.



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a. Certified Reactor Supervisor
b. In Control Room during next reactor startup
c. May be Certified Position
d. One Certified Supervisor will be STE-trained
e. Assigned to each crew for at least 12 weeks after resumption of production

Figure 2-9. Operating Contractor Reactor Shift Organization.

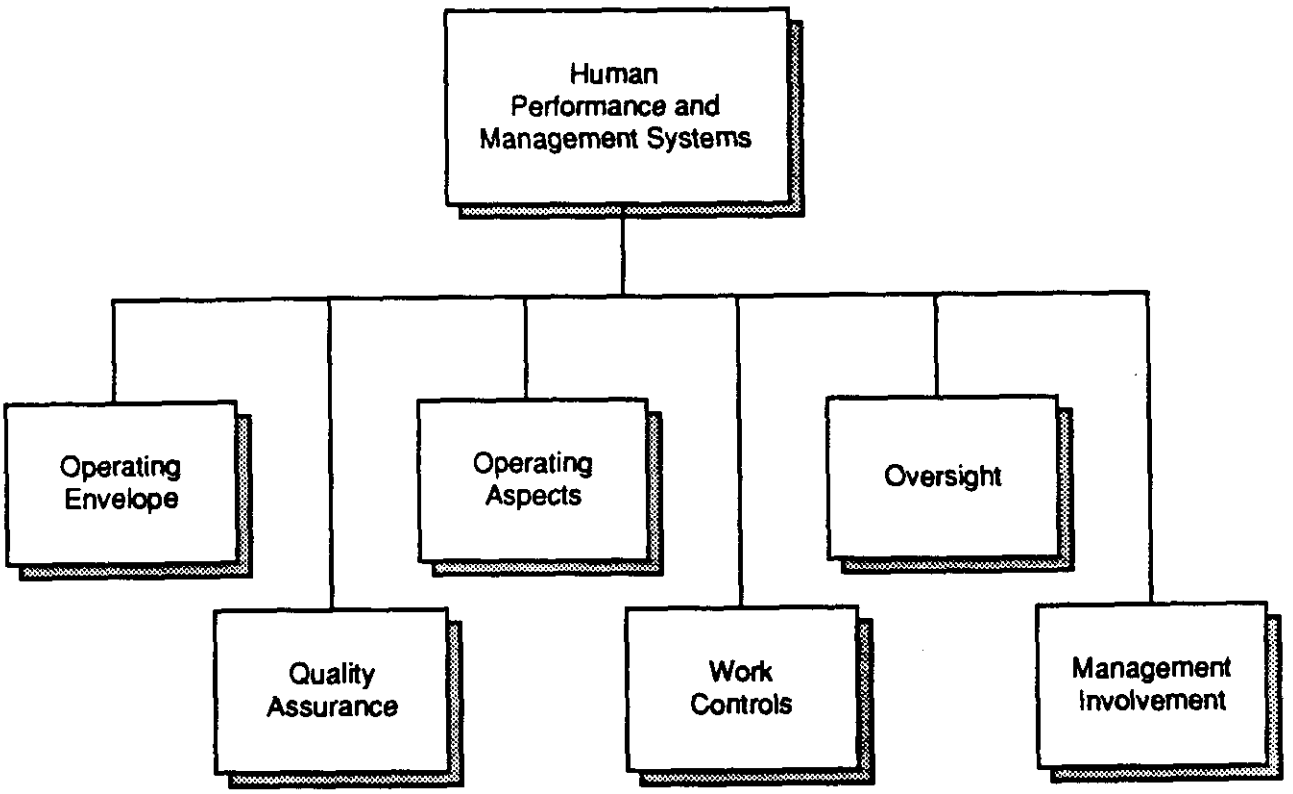


Figure 2-10. Human Performance and Management Systems Programs.

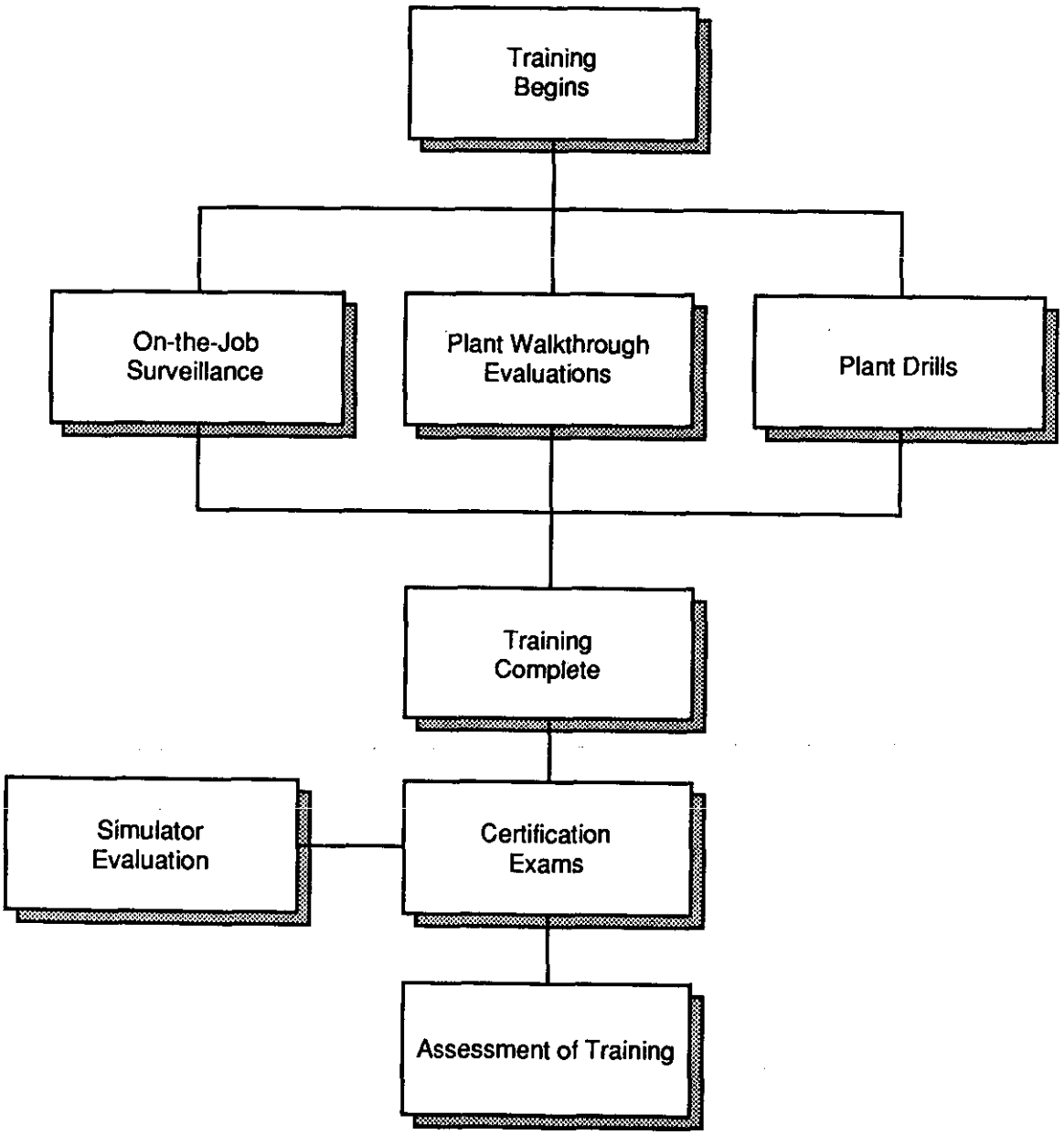


Figure 2-11. Training Evaluation Process.

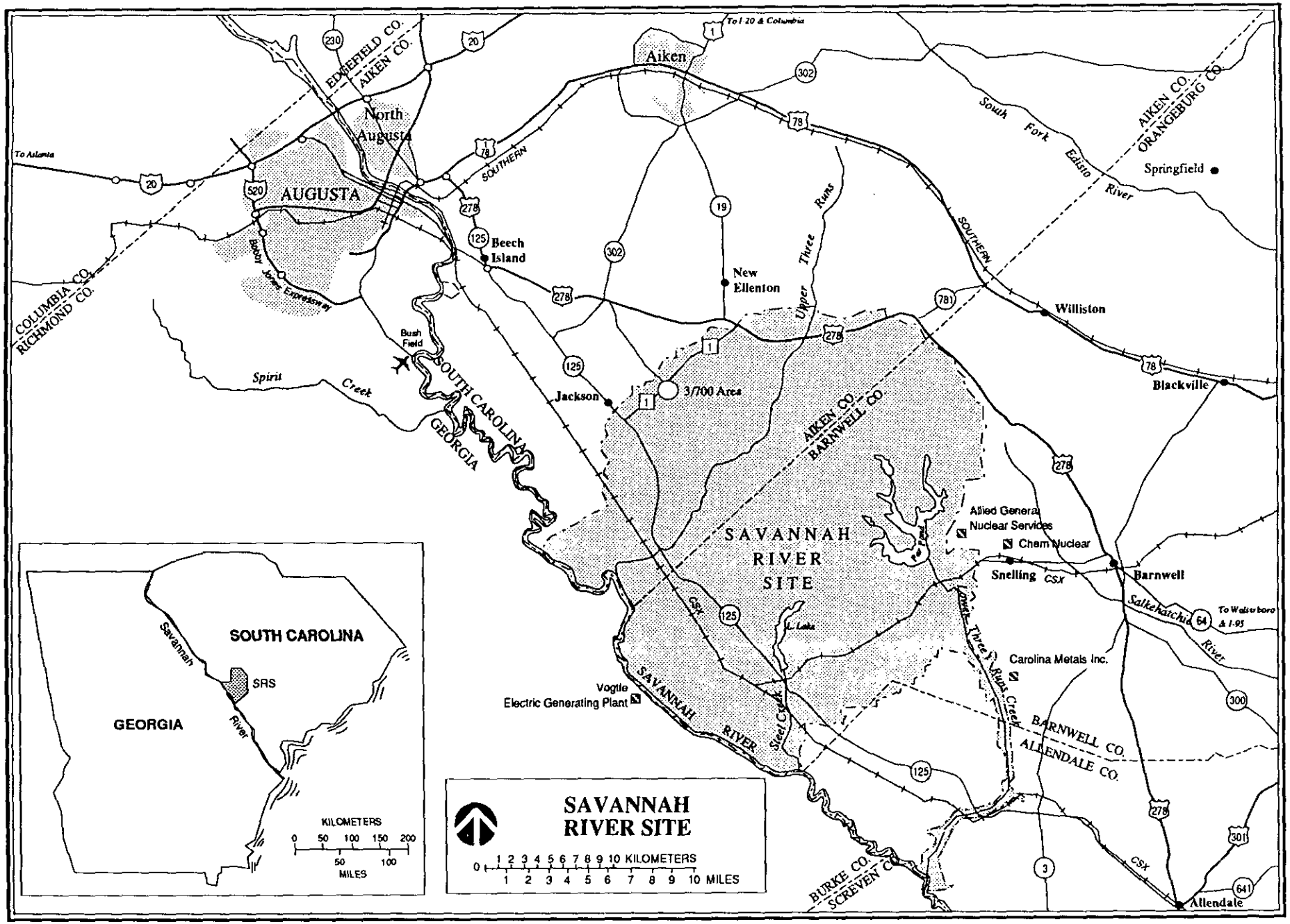


Figure 3-1. Savannah River Site.

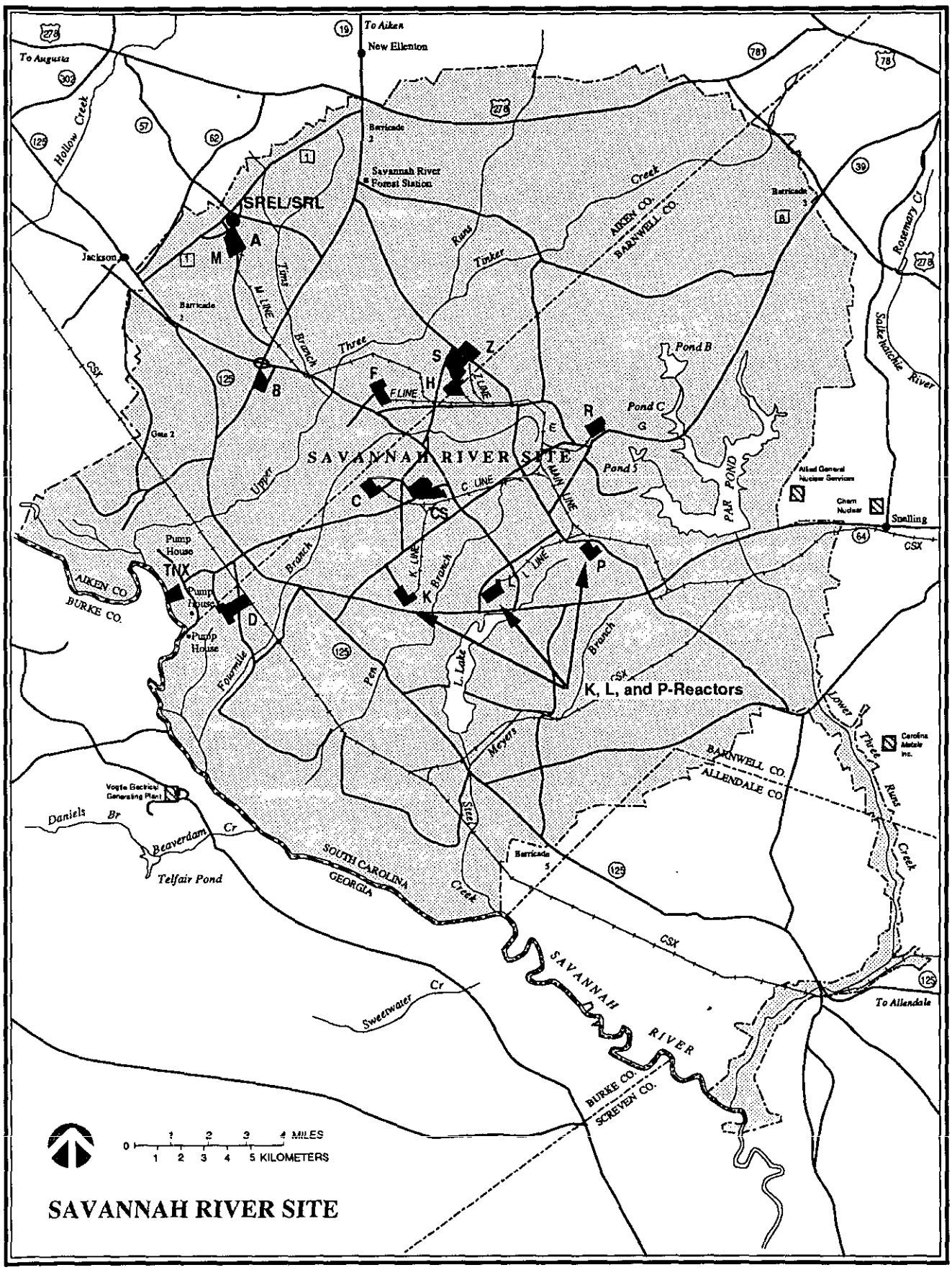
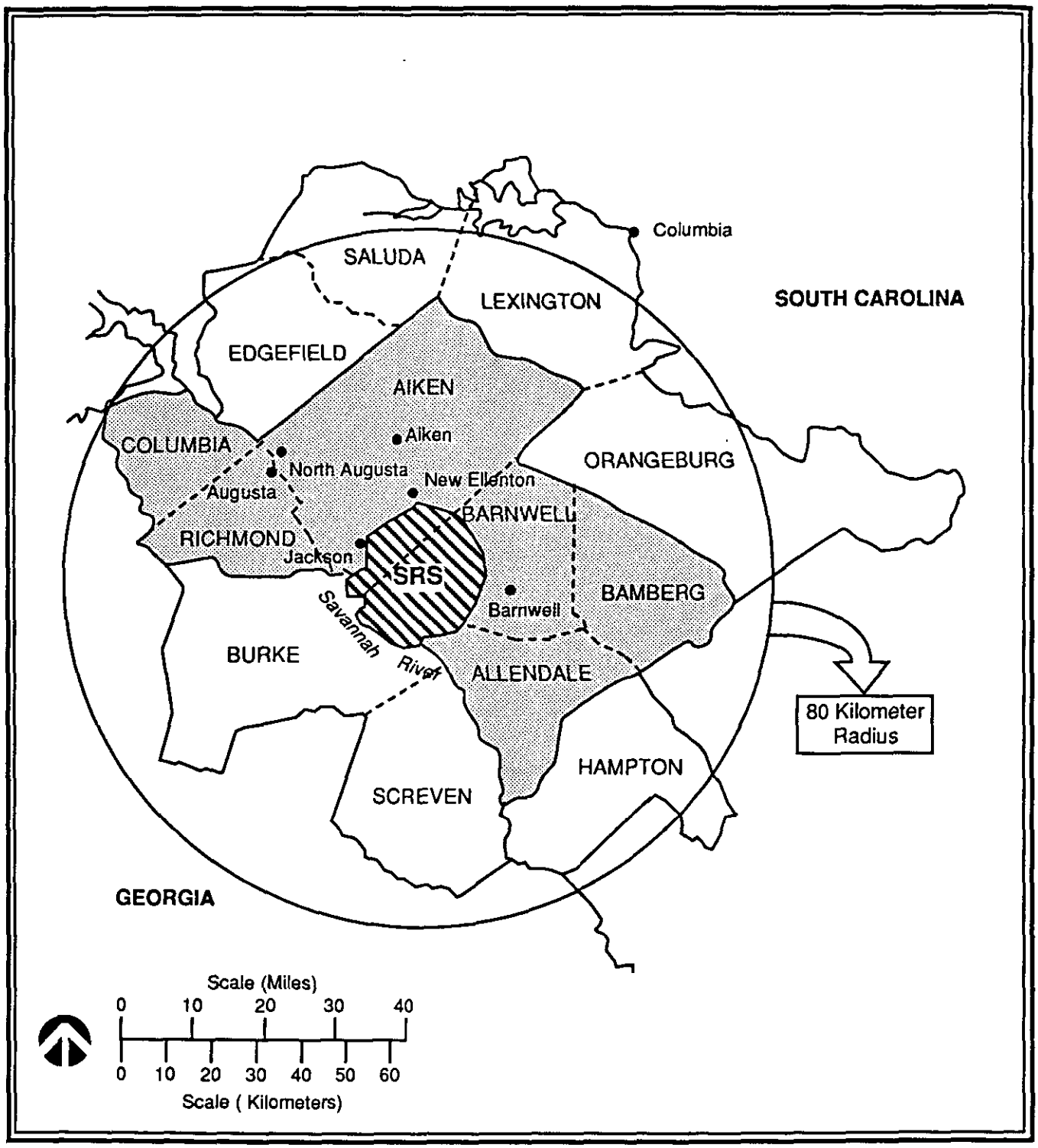


Figure 3-2. Savannah River Site Map.

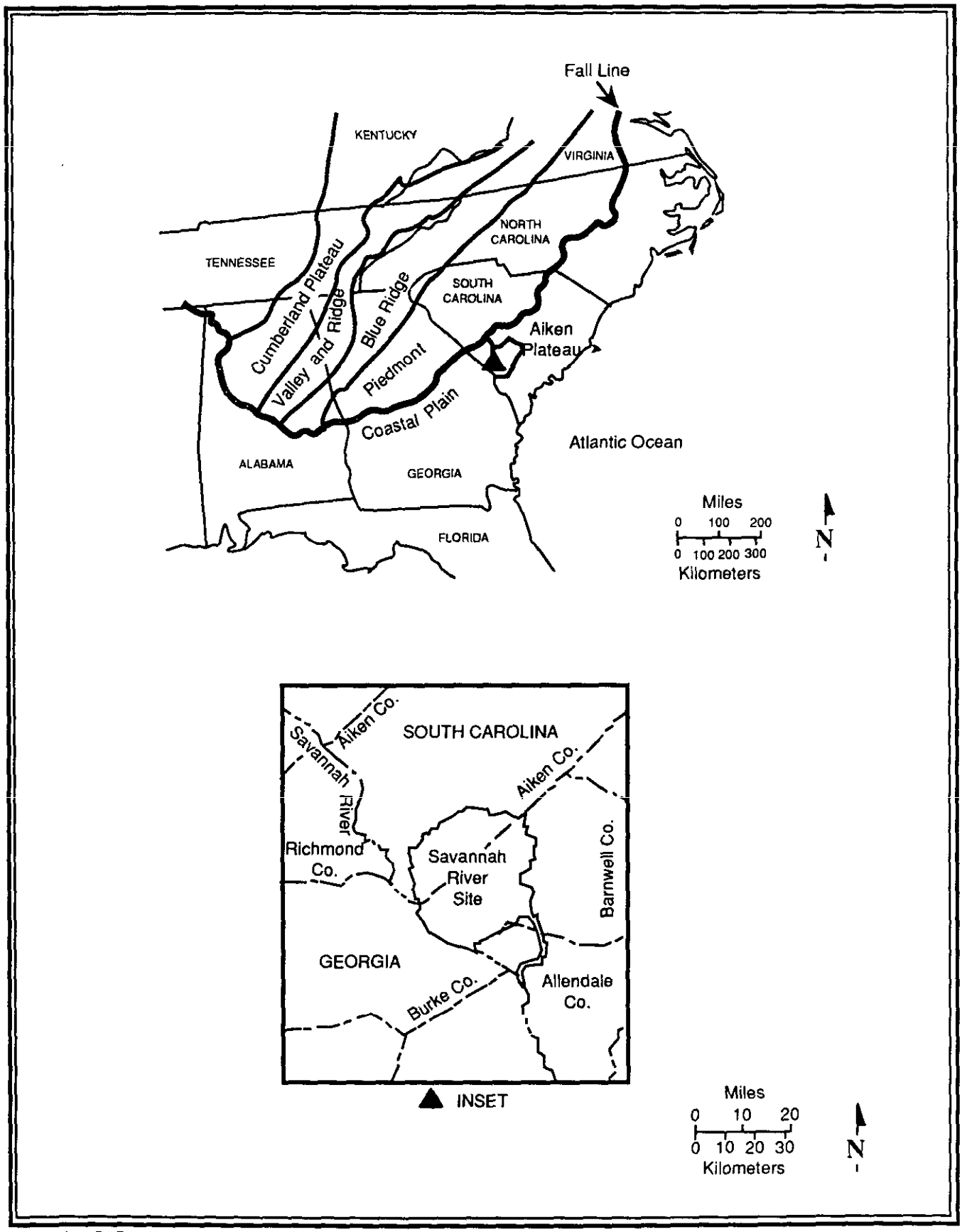


Six-county area

TC

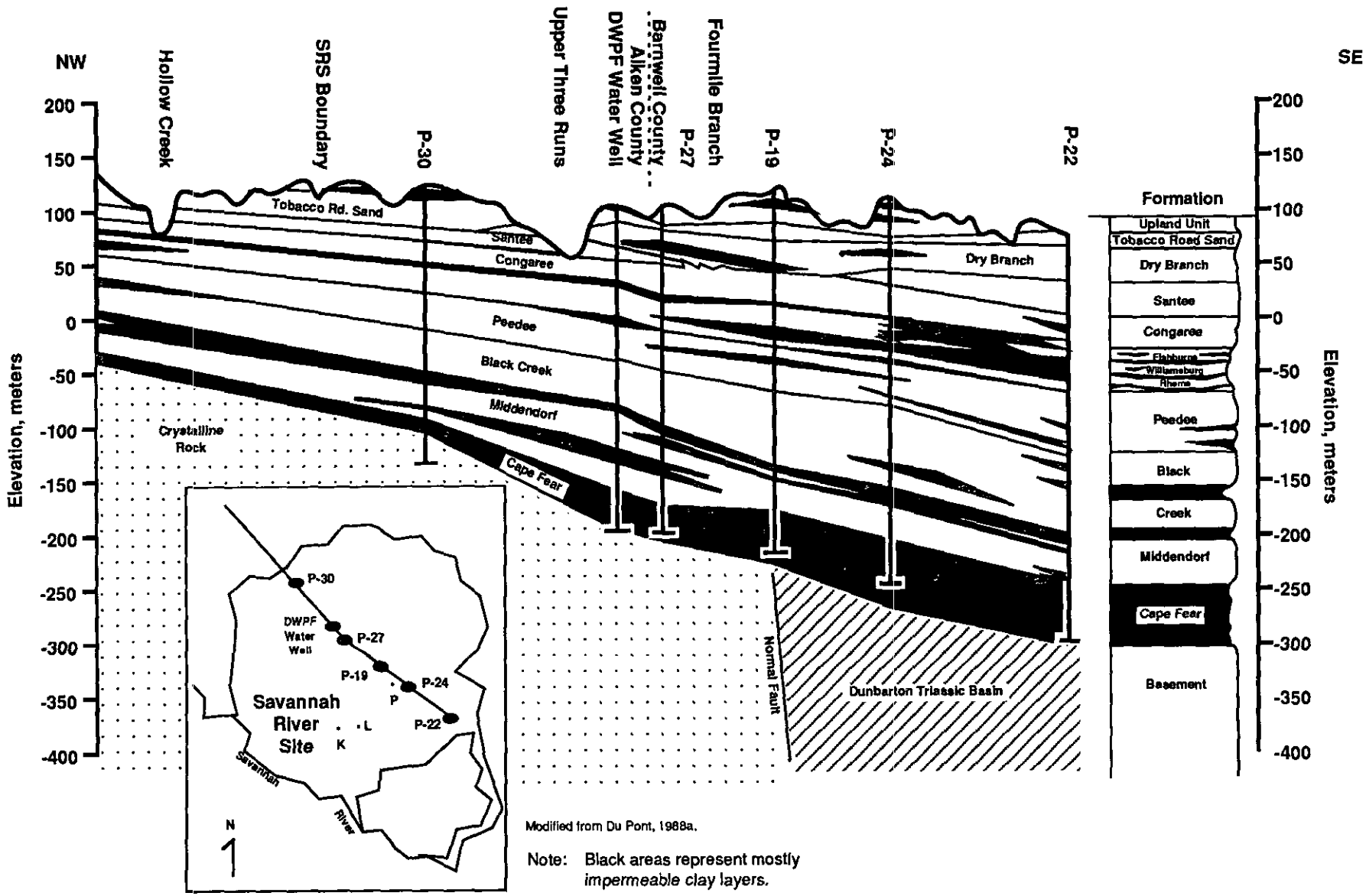
TC

Figure 3-3. The Site Region.



Modified from DOE, 1987a.

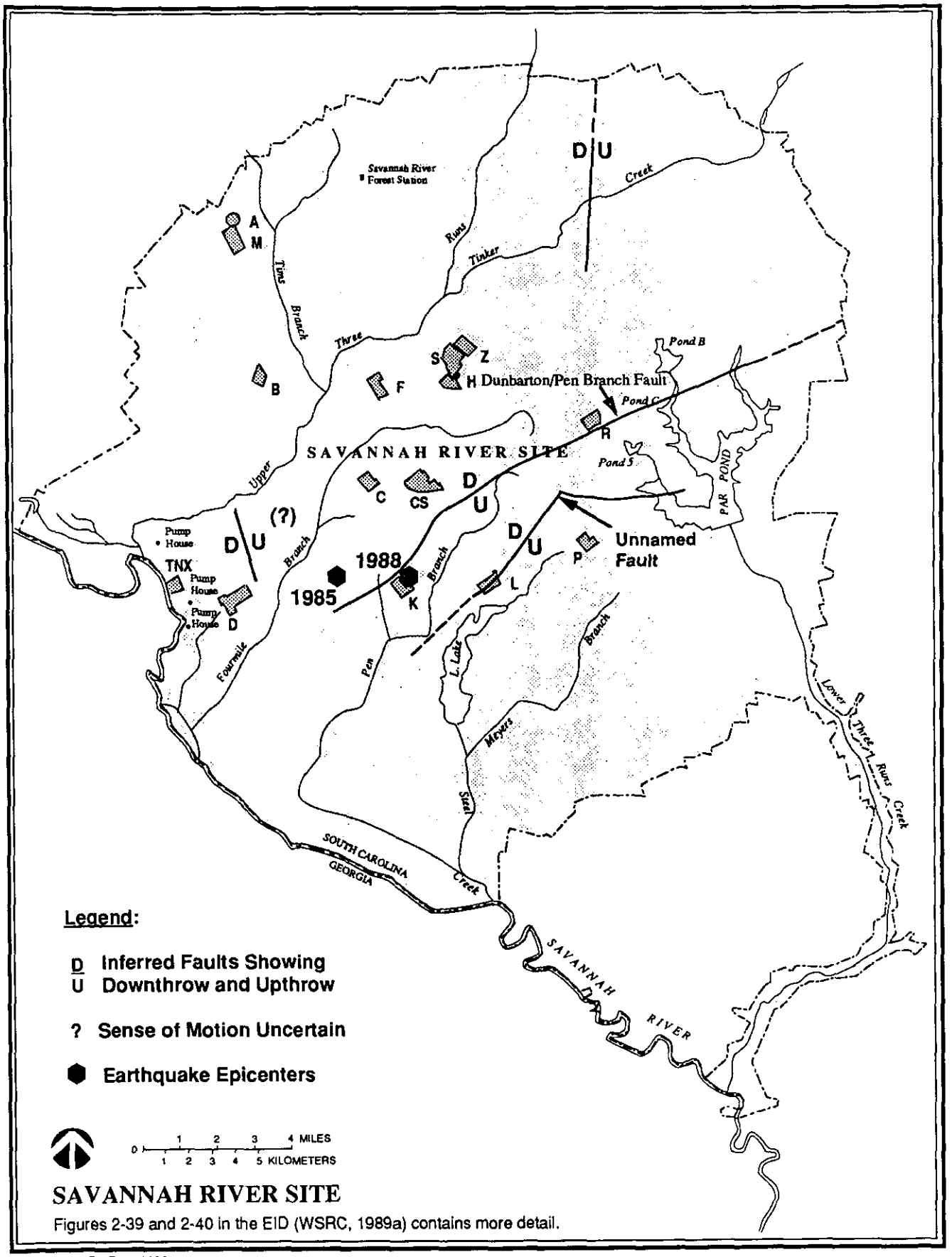
Figure 3-4. General Location of the Savannah River Site and Relationship to Physiographic Provinces of Eastern North America.



Modified from Du Pont, 1988a.

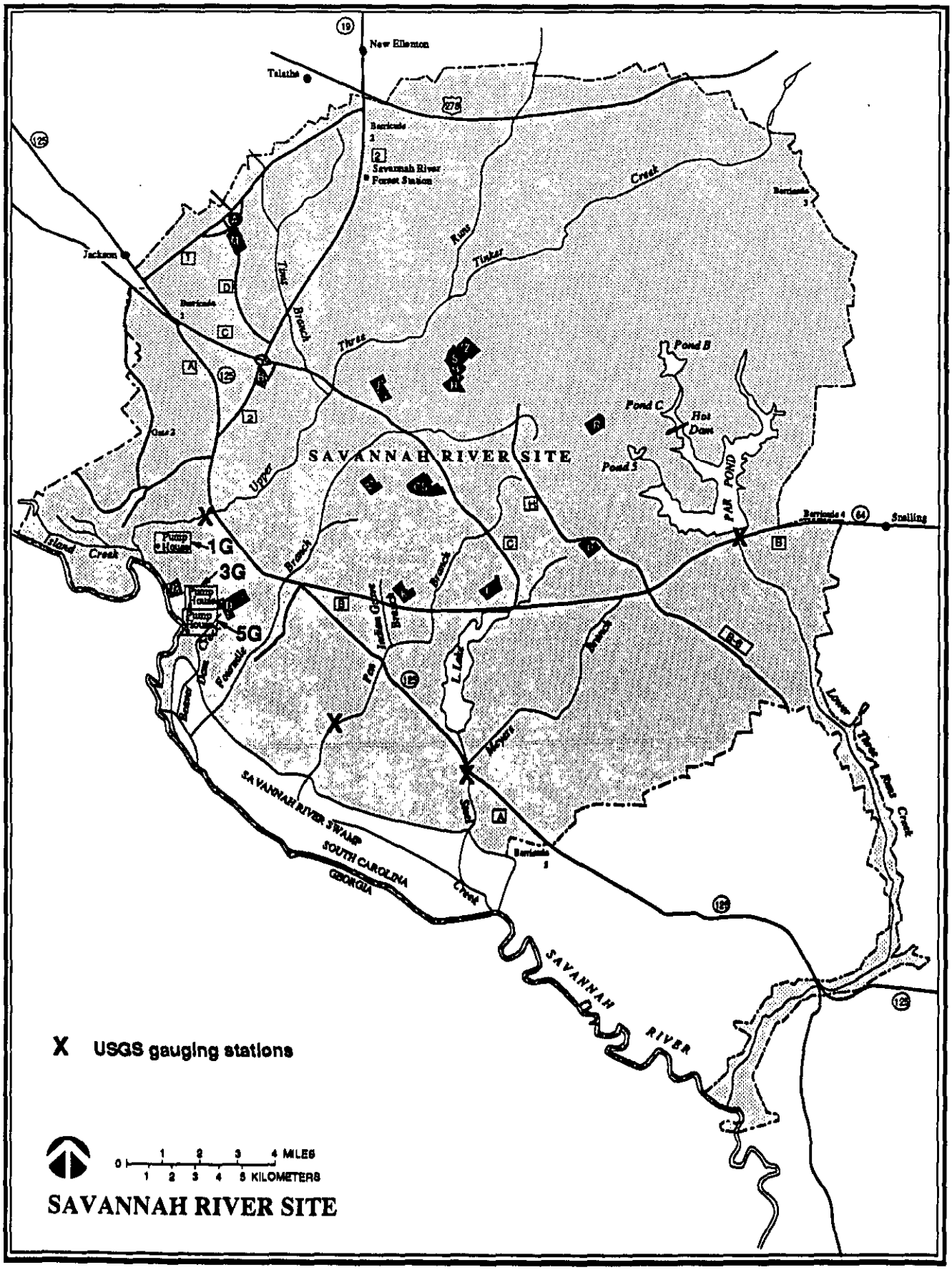
Note: Black areas represent mostly *impermeable clay* layers.

Figure 3-5. Generalized Subsurface Cross Section Across the Savannah River Site.



Modified from Du Pont, 1988a.

Figure 3-6. Location of Known Earthquakes Since 1985 Beneath SRS in Relation to Inferred Faults.



L-78-73

TC

TC

Figure 3-7. Surface Water Features at the Savannah River Site.

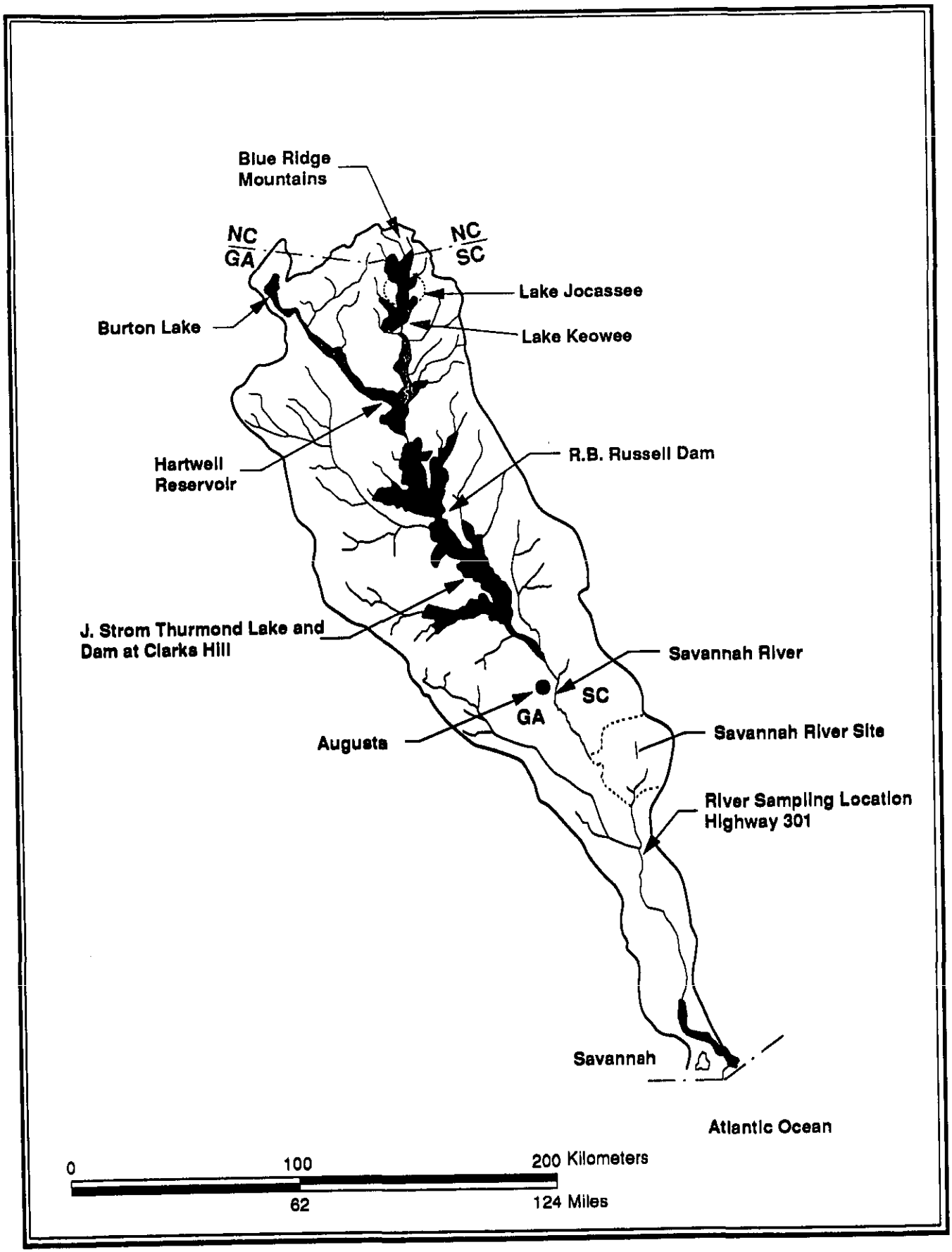
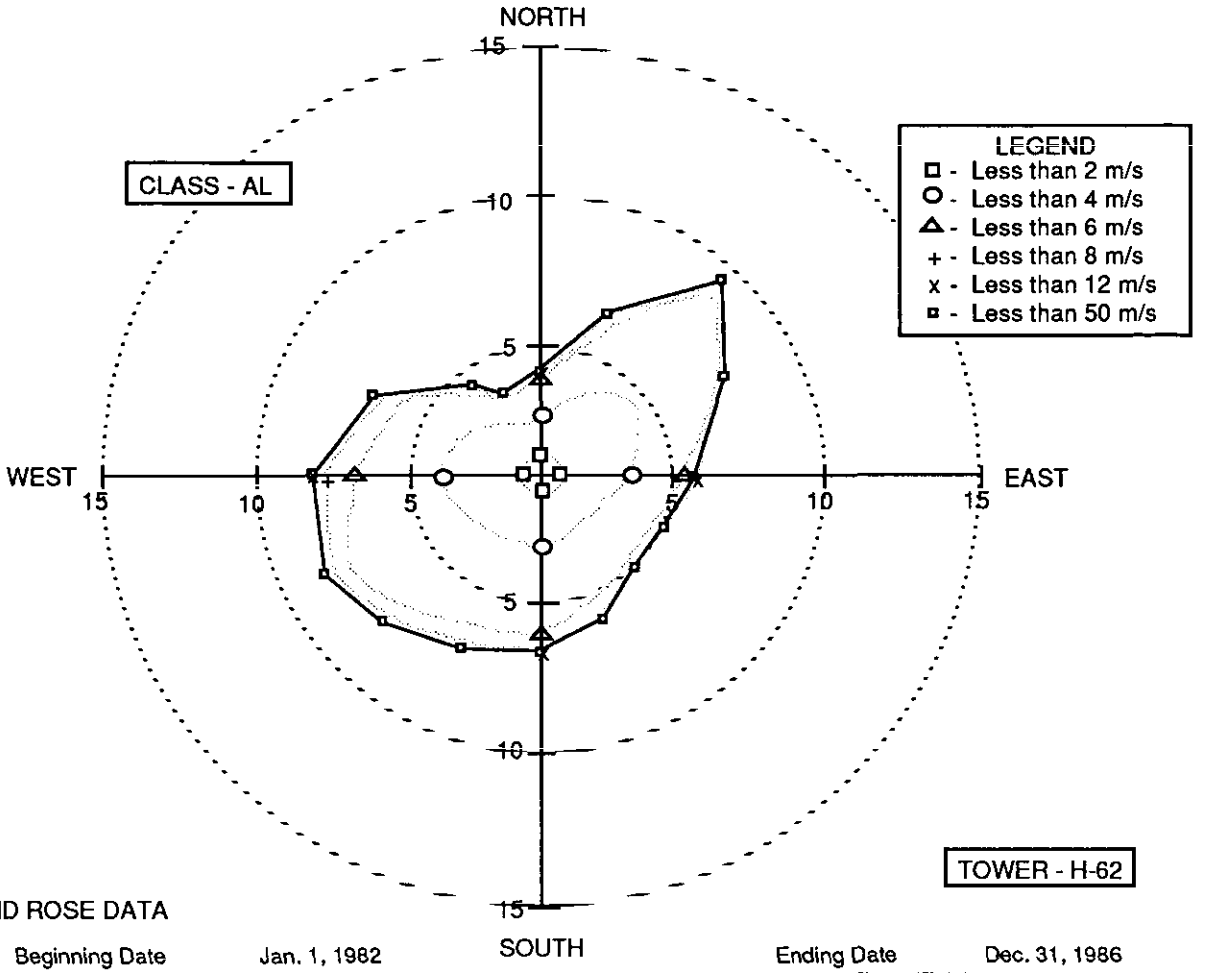


Figure 3-8. Savannah River Drainage Basin and Reservoirs.

Plot and Table Indicate Direction From Which the Wind Blows



WIND ROSE DATA

Beginning Date Jan. 1, 1982
Beginning Time (Zulu) 0000
Observations (All Classes) 36262

Ending Date Dec. 31, 1986
Ending Time (Zulu) 2400
Observations (This Class) 35252

Direction	Number of Observations[1] at Indicated Wind Speed[2] 0-2	2-4	4-6	6-8	8-12	>12	Average Wind Speed	Total Observ.[1]	Percent Time at Indicated Wind Speed[2] 0-2	2-4	4-6	6-8	8-12	>12	Total % Time
N	204	571	460	80	13	0	2.96	1328	0.58	1.62	1.30	0.23	0.04	0.00	3.77
NNE	190	896	911	131	13	0	3.31	2141	0.54	2.54	2.58	0.37	0.04	0.00	6.07
NE	234	1341	1559	229	18	0	3.38	3381	0.66	3.80	4.42	0.65	0.05	0.00	9.59
ENE	229	1266	1078	122	1	0	3.19	2696	0.65	3.59	3.06	0.35	0.00	0.00	7.65
E	191	980	737	85	2	0	3.13	1995	0.54	2.78	2.09	0.24	0.01	0.00	5.66
ESE	138	832	631	102	7	0	3.24	1710	0.39	2.36	1.79	0.29	0.02	0.00	4.85
SE	153	743	722	106	25	0	3.27	1749	0.43	2.11	2.05	0.30	0.07	0.00	4.96
SSE	171	861	927	140	25	0	3.21	2124	0.49	2.44	2.53	0.40	0.07	0.00	6.03
S	170	923	1050	226	18	0	3.46	2387	0.48	2.62	2.96	0.54	0.05	0.00	6.77
SSW	214	928	1051	218	33	1	3.25	2445	0.51	2.63	2.96	0.52	0.09	0.00	6.94
SW	226	1075	1105	220	31	0	3.30	2657	0.54	3.05	3.13	0.52	0.09	0.00	7.54
WSW	228	1197	1150	243	71	2	3.38	2901	0.55	3.40	3.29	0.59	0.20	0.01	8.23
W	234	1082	1074	342	124	2	3.35	2858	0.55	3.07	3.05	0.97	0.35	0.01	8.11
WNW	241	863	922	277	113	2	3.33	2438	0.56	2.50	2.52	0.79	0.32	0.01	6.92
NW	197	584	483	125	24	0	3.97	1413	0.56	1.55	1.37	0.35	0.07	0.00	4.01
NNW	175	463	299	75	17	0	2.80	1029	0.50	1.31	0.85	0.21	0.05	0.00	2.92
No Direction	0	0	0	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Avg. Speed[2]	1.25	3.01	4.80	6.54	9.01	13.93	3.25								
Total Observations[1]	3195	14625	14169	2721	535	7		36262							

[1] An observation is a record covering a 1-hour period of time.
[2] Wind speed in meters/sec (m/s).

Figure 3-9. Annual Wind Rose of Hourly Averaged Winds from H-Area Tower, 1982-86. (Directions Are Sectors from Which Wind Blows.)

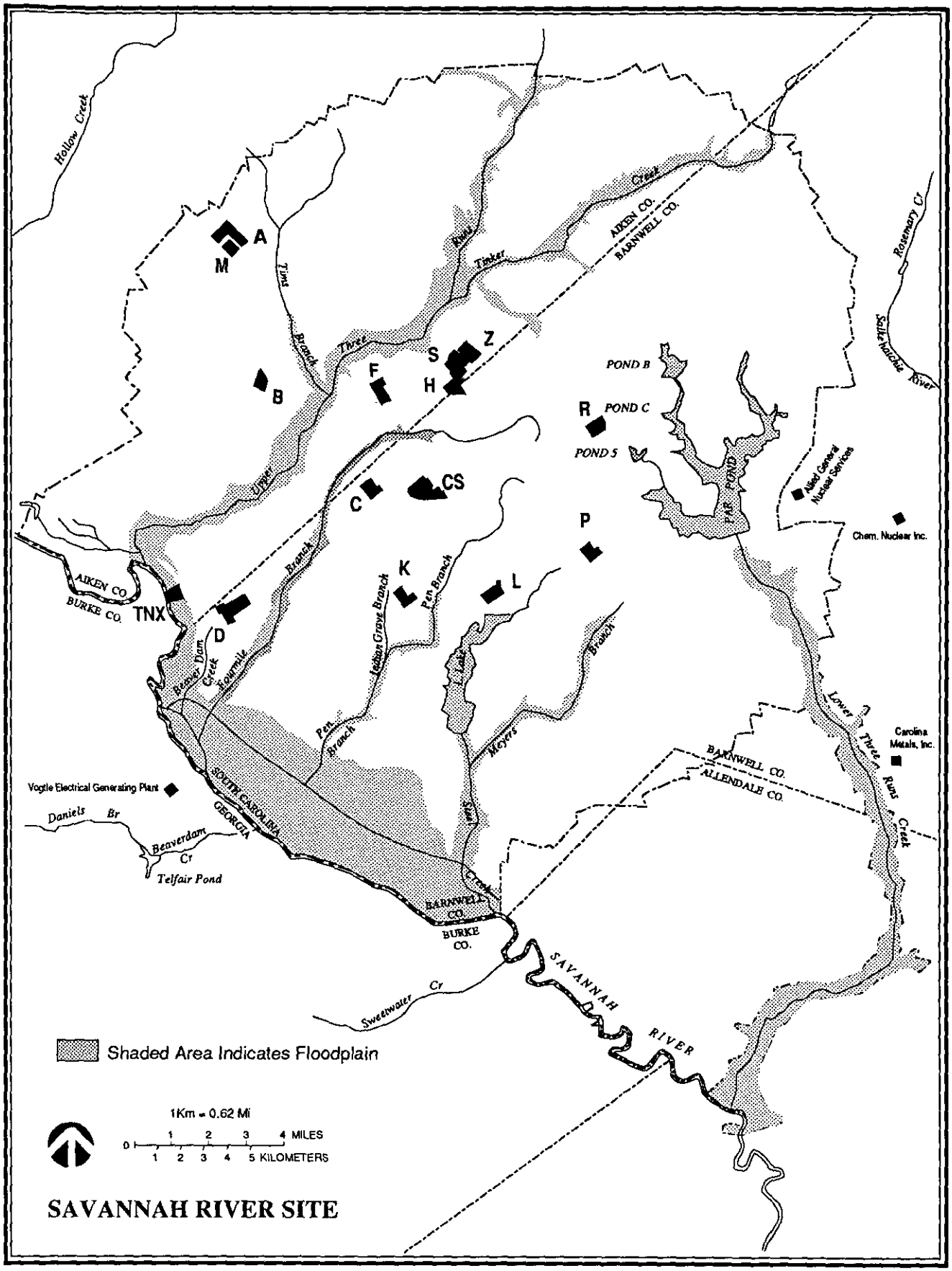


Figure 4-1. Base Floodplain (100-Year) of Savannah River Site.

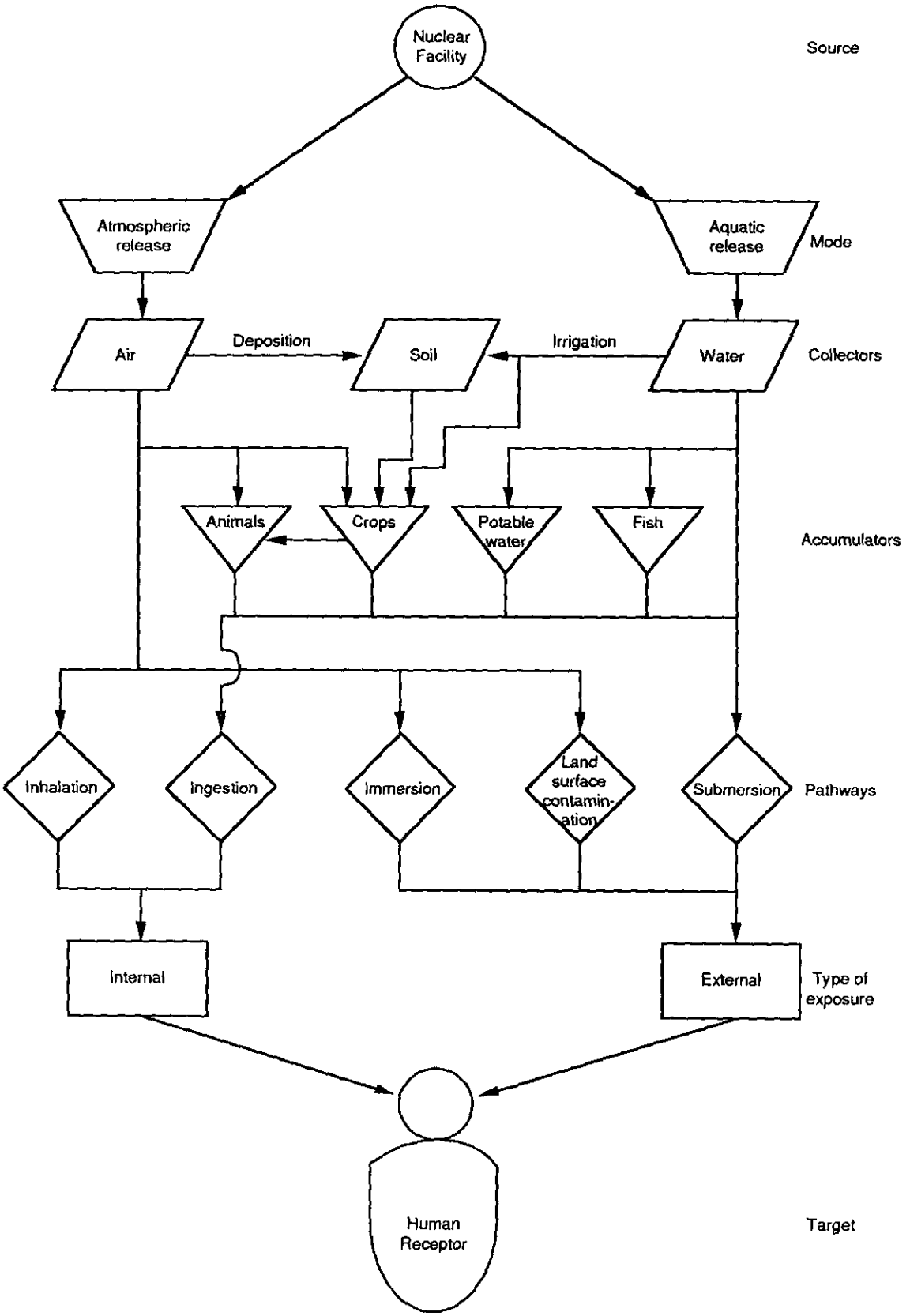
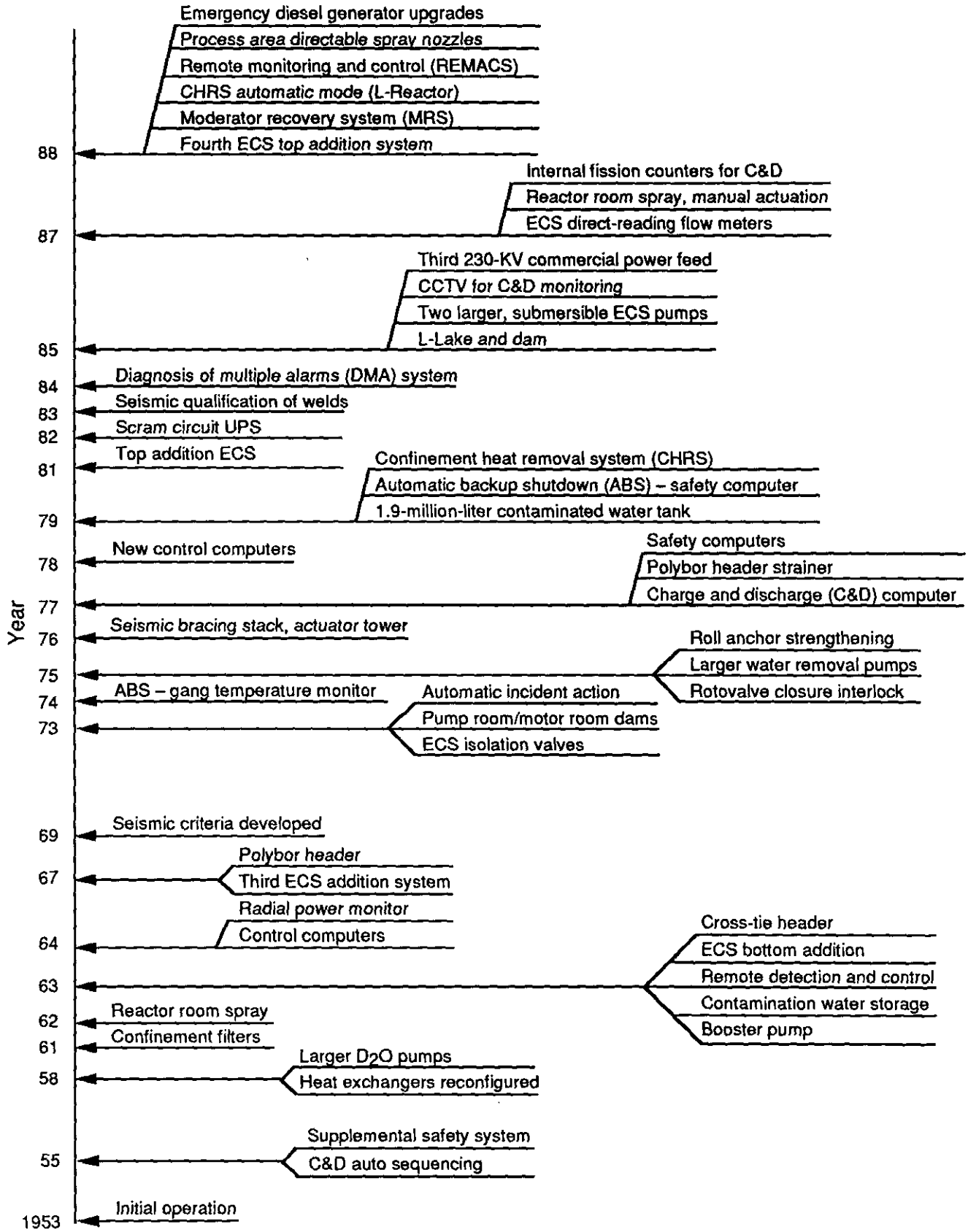
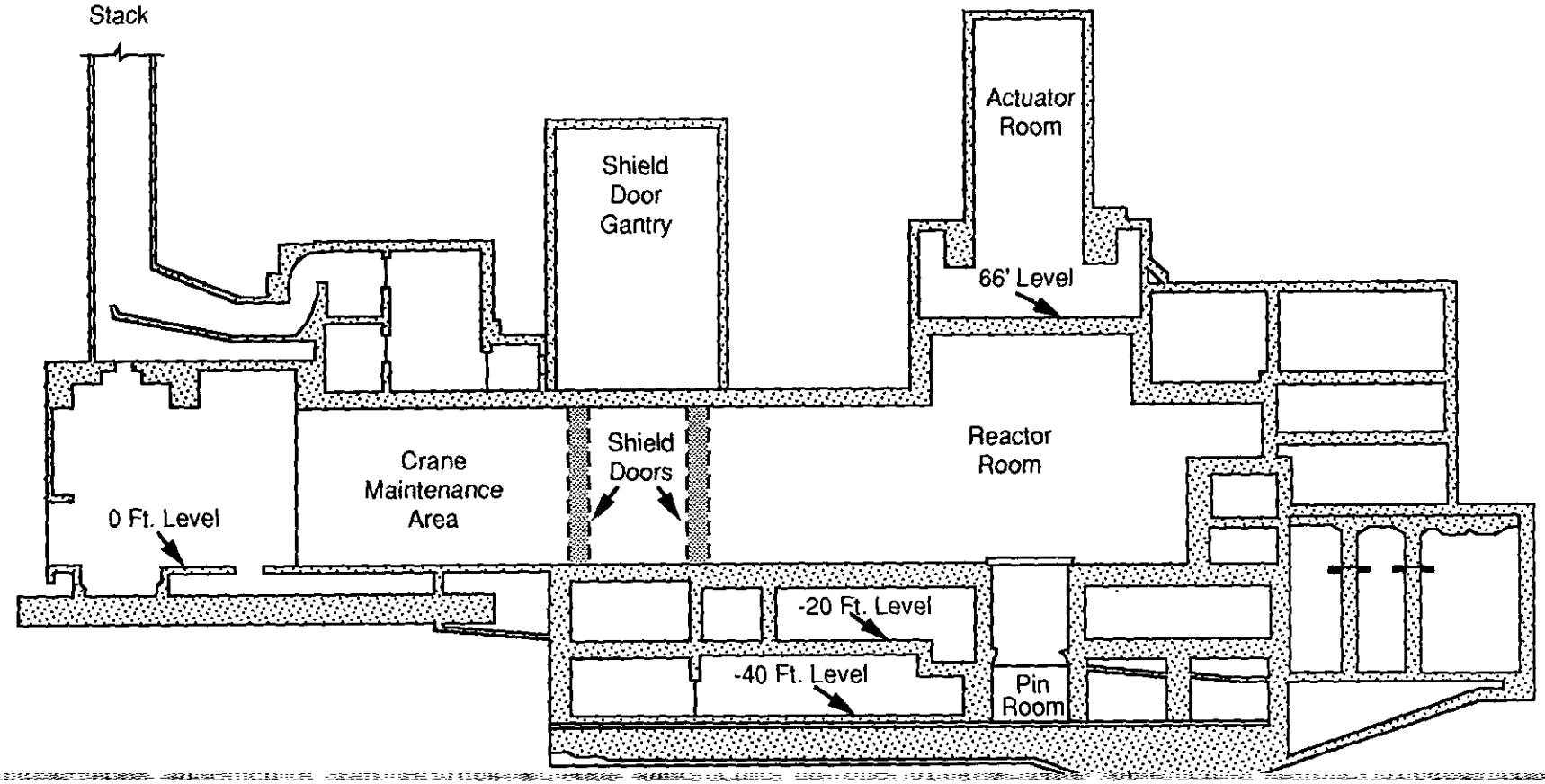


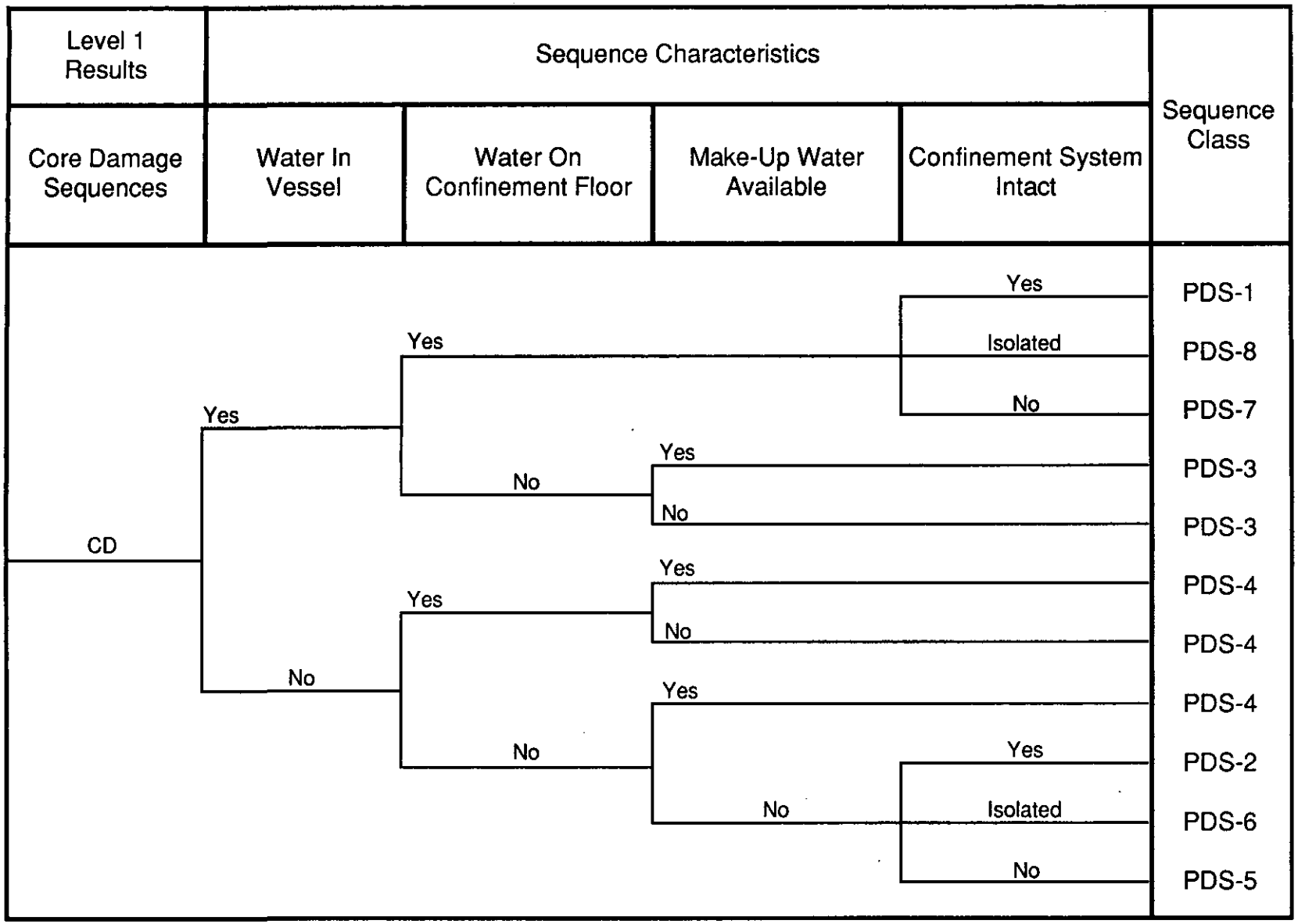
Figure 4-2. Exposure Pathways Considered in Radiological Impact Assessments.



Adapted from Du Pont, 1988b

Figure 4-3. Reactor Safety Milestones.


Stack
Shield
Door
Gantry
Actuator
Room
66' Level
Crane
Maintenance
Area
Shield
Doors
Reactor
Room
0 Ft. Level
-20 Ft. Level
-40 Ft. Level
Pin
Room



Source: WSRC, 1990

Figure 4-5. "Bridge" Event Tree for Plant Damage State Binning.

TC

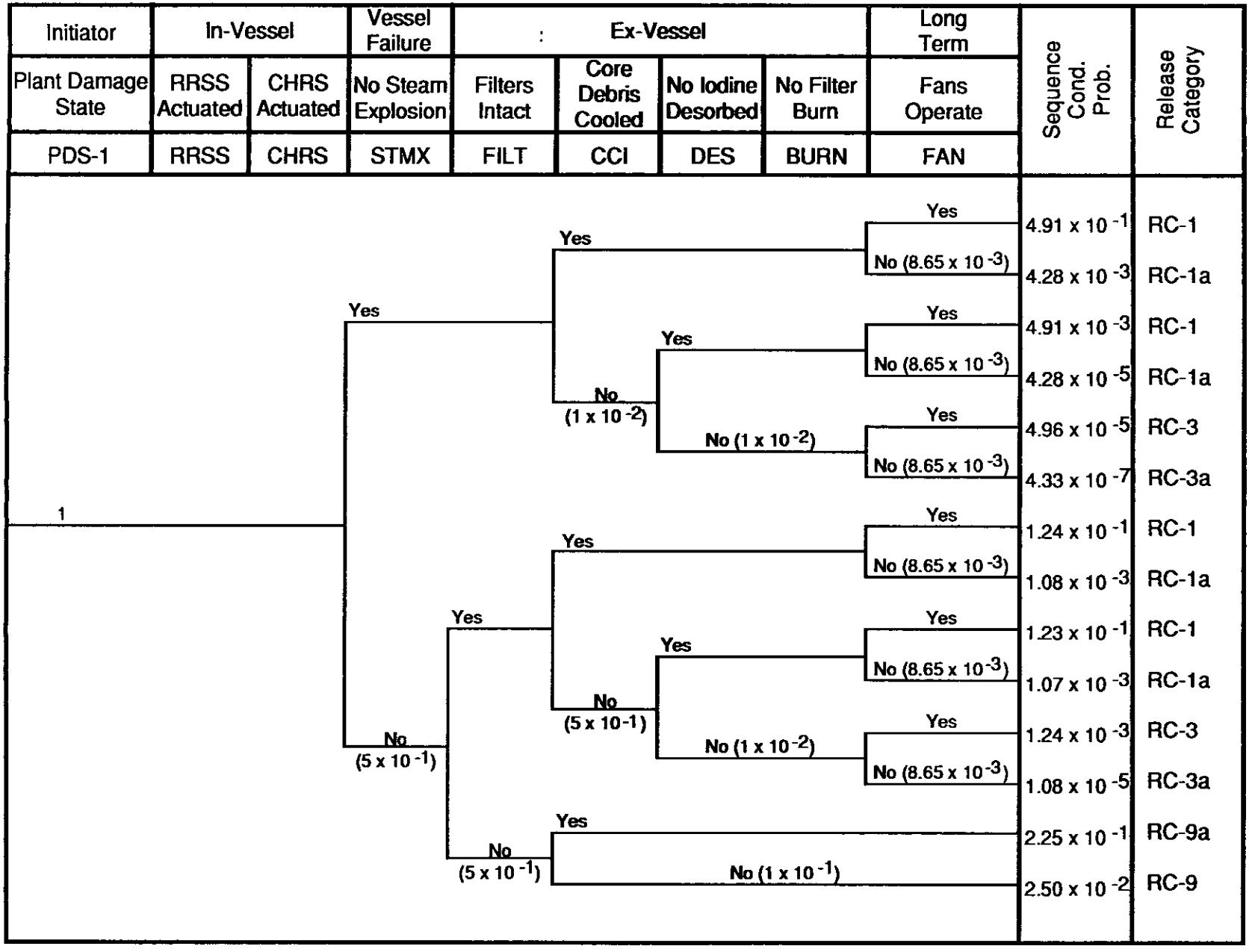
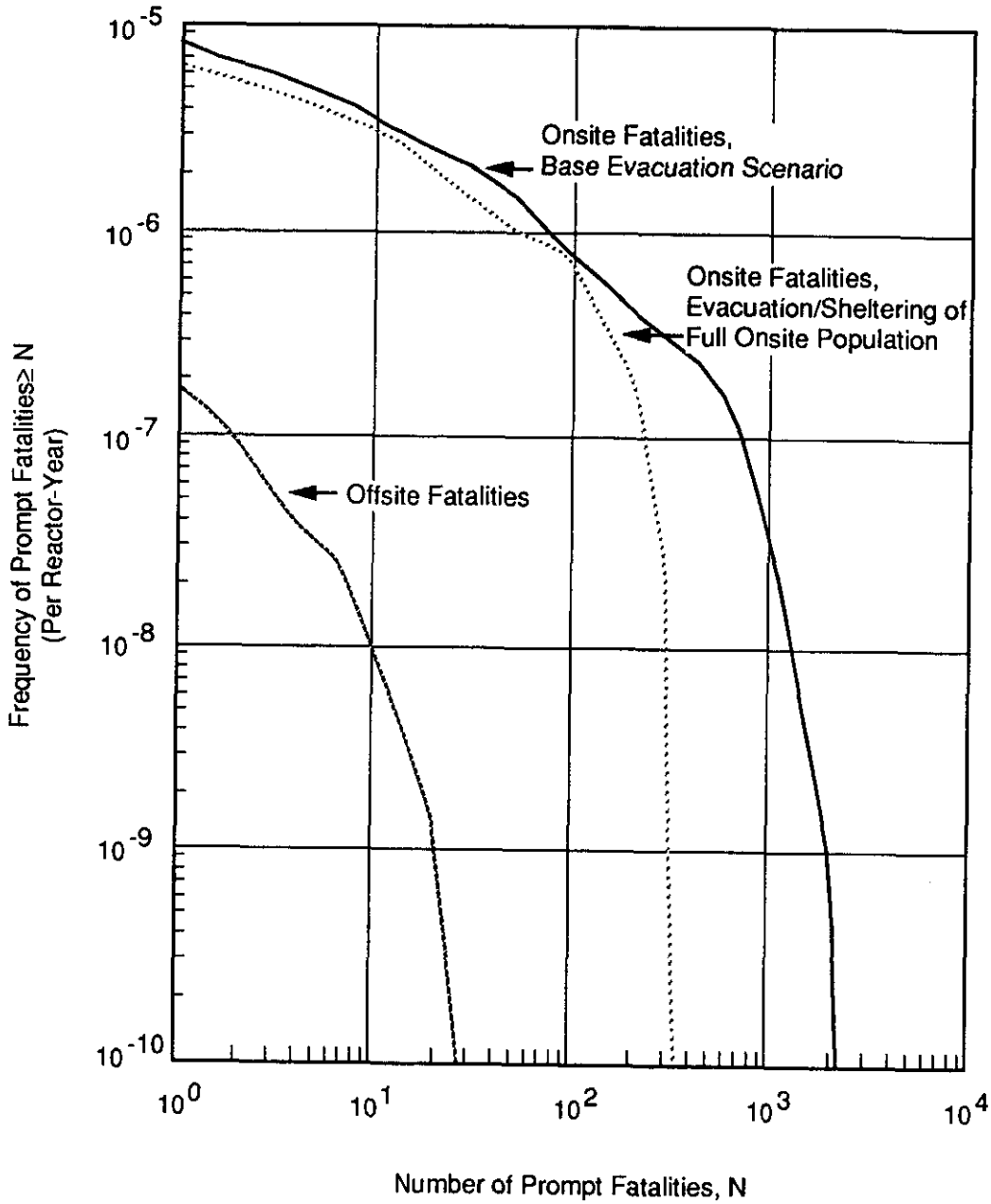


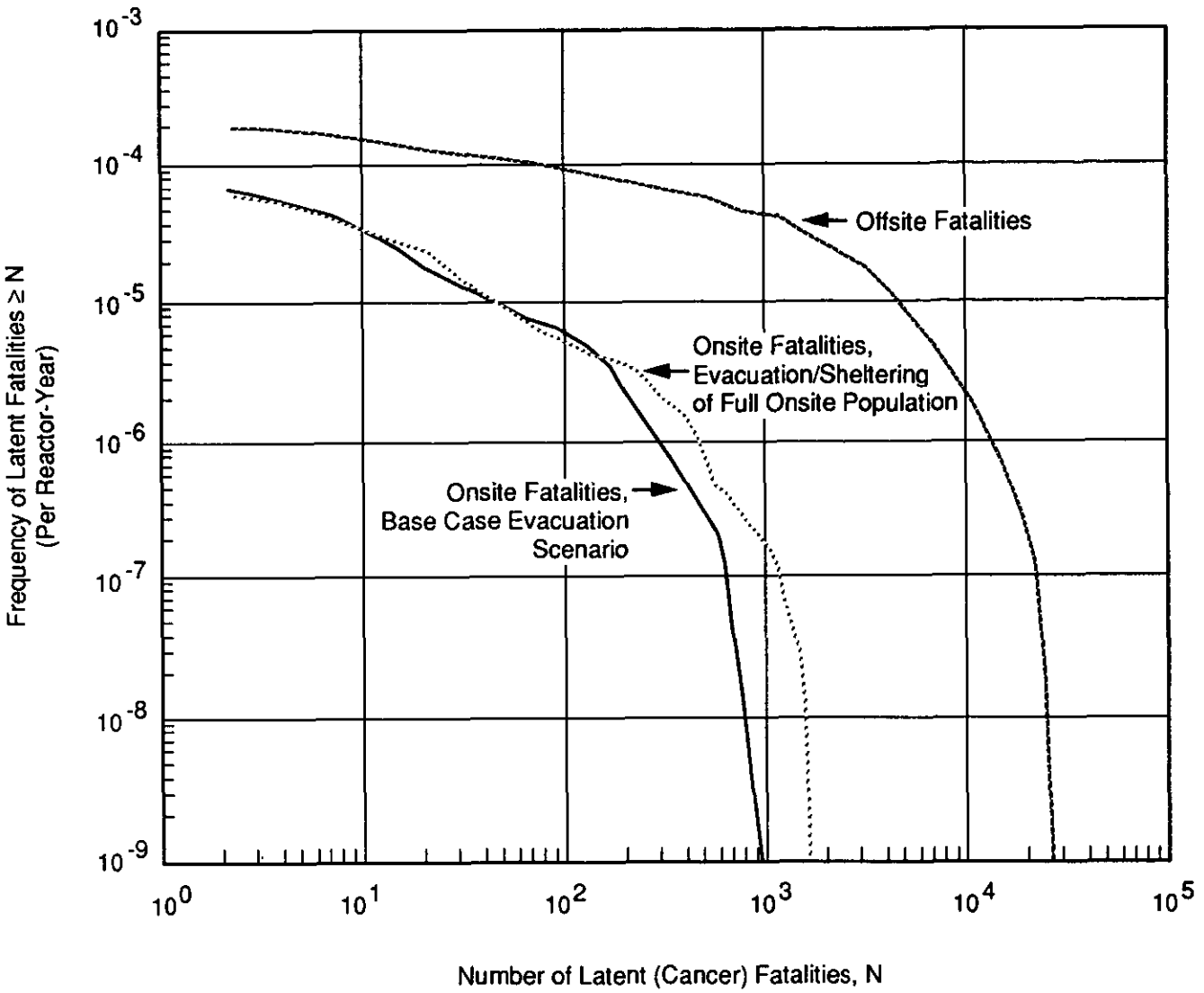
Figure 4-6. Confinement Event Tree (for PDS-1).



TC

Source: WSRC, 1990.

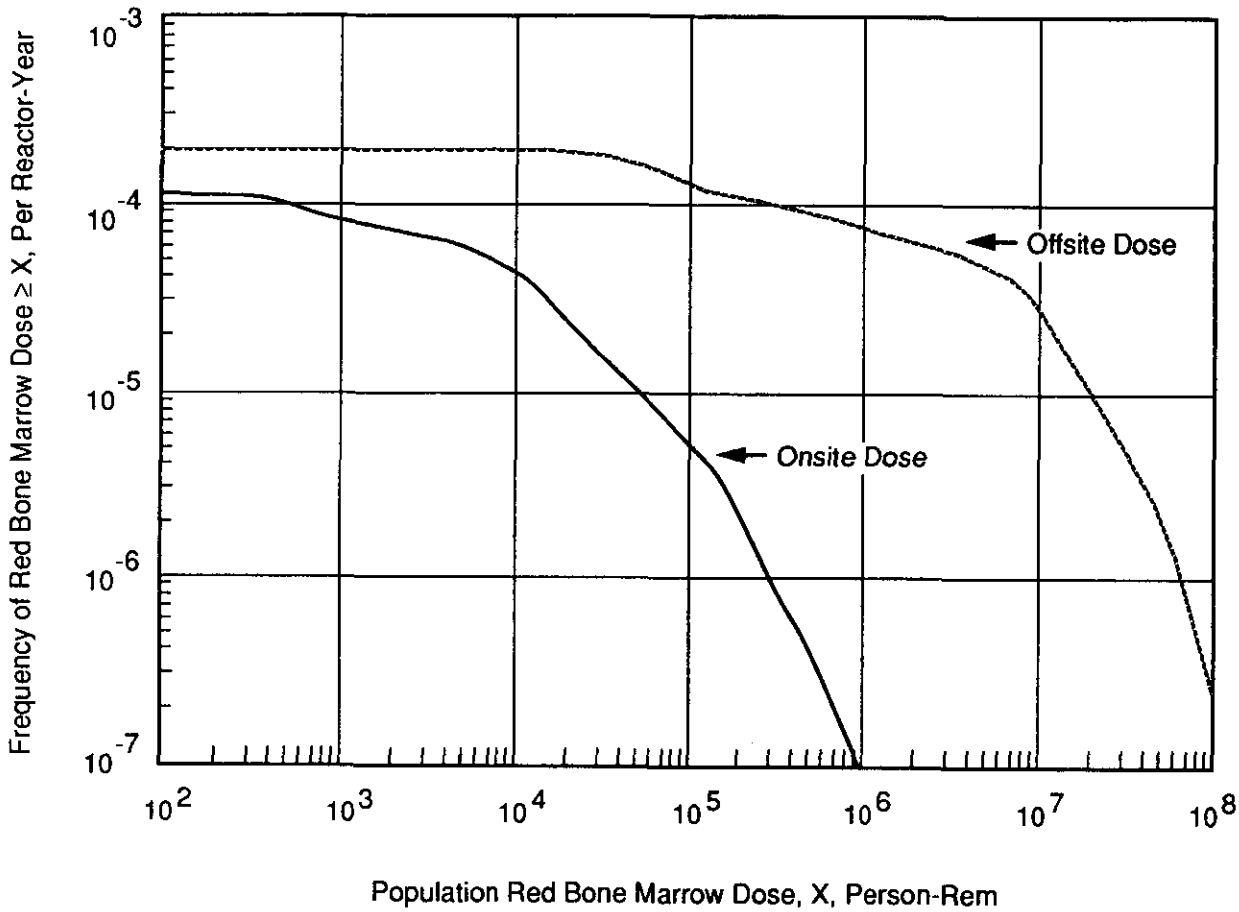
Figure 4-7. Frequency of Prompt Fatalities Due to Severe Accidents.



Source: WSRC, 1990.

TC

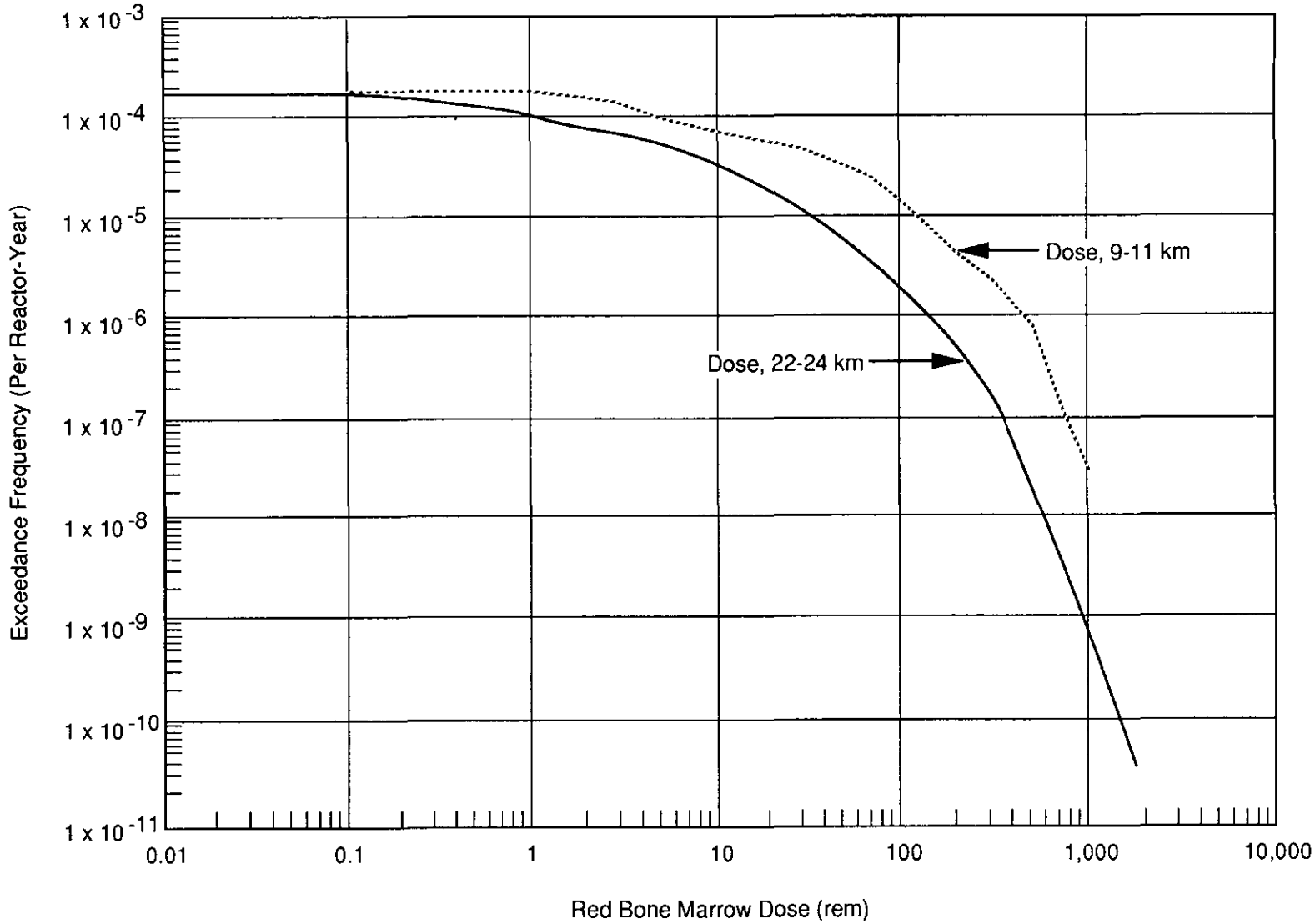
Figure 4-8. Frequency of Latent (Cancer) Fatalities Due to Severe Accidents.



TC

Source: WSRC, 1990.

Figure 4-9. Frequency of Red Bone Marrow Dose Due to Severe Accidents.



Source: O'Kula and East, 1990.

TC

Figure 4-10. Exceedance Frequency Versus Red Bone Marrow Dose (rem).

Table 2-2. Reference Sections for Environmental Consequences of Termination of One or Two Reactors

Reactor Combination	Socioeconomics	Surface water/ groundwater	Cooling water discharge	Floodplain/ wetlands	Accidents
Operate K-Reactor; terminate L- and P-Reactors	4.1.1.1, 4.3.1	4.1.1.2.1, 4.1.1.3, 4.1.2.2, 4.3.3, 4.3.4, 4.3.5	4.1.1.4.1, 4.3.3	4.1.1.6.1, 4.1.1.6.2.1, 4.3.7	4.1.3.1.4, 4.1.3.1.5, 4.3.13
Operate L-Reactor; terminate K- and P-Reactors	4.1.1.1, 4.3.1	4.1.1.2.2, 4.1.1.3, 4.1.2.2, 4.3.3, 4.3.4, 4.3.5	4.1.1.4.2, 4.3.3	4.1.1.6.1, 4.1.1.6.2.2, 4.3.7	4.1.3.1.4, 4.1.3.1.5, 4.3.13
Operate P-Reactor; terminate K- and L-Reactors	4.1.1.1, 4.3.1	4.1.1.2.3, 4.1.1.3, 4.1.2.2, 4.3.3, 4.3.4, 4.3.5	4.1.1.4.3, 4.3.3	4.1.1.6.1, 4.1.1.6.2.3, 4.3.7	4.1.3.1.4, 4.1.3.1.5, 4.3.13
Operate L- and P-Reactors; terminate K-Reactor	4.1.1.1, 4.3.1	4.1.1.2.2, 4.1.1.2.3, 4.1.1.3, 4.1.2.2, 4.3.3, 4.3.4, 4.3.5	4.1.1.4.2, 4.1.1.4.3, 4.3.3	4.1.1.6.1, 4.1.1.6.2.2, 4.1.1.6.2.3, 4.3.7	4.1.3.1.4, 4.1.3.1.5, 4.3.13
Operate K- and P-Reactors; terminate L-Reactor	4.1.1.1, 4.3.1	4.1.1.2.1, 4.1.1.2.3, 4.1.1.3, 4.1.2.2, 4.3.3, 4.3.4, 4.3.5	4.1.1.4.1, 4.1.1.4.3, 4.3.3	4.1.1.6.2.1, 4.1.1.6.2.3, 4.3.7	4.1.3.1.4, 4.1.3.1.5, 4.3.13
Operate K- and L-Reactors; terminate P-Reactor	4.1.1.1, 4.3.1	4.1.1.2.1, 4.1.1.2.2, 4.1.1.3, 4.1.2.2, 4.3.3, 4.3.4, 4.3.5	4.1.1.4.1, 4.1.1.4.2, 4.3.3	4.1.1.6.2.1, 4.1.1.6.2.2, 4.3.7	4.1.3.1.4, 4.1.3.1.5, 4.3.13

TC

Table 2-3. Comparison of Impacts of Alternatives (Page 1 of 10)

Impact[a]	**Alternative 1.** Proposed/No Action[b]		**Alternative 2.** Terminate K-, or L-, or P-Reactor or Combination of Any Two[c] K or	L or	P	**Alternative 3.** Termination[d] (K, L, and P)	TC
Land Use	No change in land use; additional land would not be required.		No change in land use; additional land would not be required.	No change in land use; additional land would not be required.	No change in land use; additional land would not be required.	No change in land use; additional land would not be required.	TC
Socioeconomics	Workforce and operating jobs continue as at present. No impacts beyond current levels. Current economic trends would continue.	Job losses:				Approximately 9,600 operating and workforce jobs would be lost at three reactors and some support facilities. Permanent and part-time standby workforce of about 100 for all three reactors would be retained.	
		Operate	No loss	No loss	No loss		
		Terminate	Approximately 5,300 jobs at reactors and some support facilities would be lost with terminations of two reactors; approximately 2,200 jobs would be lost with termination of only one reactor. Permanent and part-time standby workforce of about 35 for each terminated reactor would be retained.				
Archaeological/ historic sites	No impacts would occur.		No impacts would occur.	No impacts would occur.	No impacts would occur.	No impacts would occur.	
Cooling water withdrawal	Cooling water withdrawals from Savannah River total a maximum of 24 cubic meters (about 850 cubic feet) per second for K-, L-, and P-Reactors and 4 cubic meters (about 140 cubic feet) per second for D-Area powerhouse. Maximum withdrawal with K-Reactor tower would be 18.5 cubic meters (about 650 cubic feet) per second.	Flow rates:				Approximately 1.5 to 3 cubic meters (53 to 106 cubic feet) of water per second would be withdrawn to maintain access by fish to Steel Creek for spawning.	TC
		Operate (K-Reactor without cooling tower)	11.3 cubic meters (about 400 cubic feet) per second pumped from Savannah River	11.3 cubic meters (about 400 cubic feet) per second pumped from Savannah River	1.0 to 1.4 cubic meters (35 to 49 cubic feet) per second from Savannah River; 10 cubic meters (about 350 cubic feet) per second from Par Pond		
		Operate (K-Reactor with cooling tower)	1.8 cubic meters (64 cubic feet) per second pumped from Savannah River				
		Terminate	No plans for flow maintenance in Pen Branch	Flow maintenance: 1.5 to 3.0 cubic meters (53 to 106 cubic feet) per second pumped from Savannah River	No plans for flow maintenance		

Table 2-3. Comparison of Impacts of Alternatives (Page 2 of 10)

Impact[a]	Alternative 1. Proposed/No Action[b]	Alternative 2. Terminate K-, or L-, or P-Reactor or Combination of Any Two[c]	K or	L or	P	Alternative 3. Termination[d] (K, L, and P)
Impingement/ entrainment	Impingement and entrainment impacts continue at a mean loss of 18.8 x 10^6 fish larvae, 10.1 x 10^6 eggs, and about 7,716 fish per year at Savannah River intakes, including D-Area. Additional 198 x 10^6 fish larvae and 0.2 x 10^6 fish eggs were lost in a 17-month study period (Jan. 1984-June 1985) at the Par Pond intake. Section 316(a) and (b) studies were performed and submitted to SCDHEC.	Operate (K-Reactor without cooling tower)	8.3 x 10^6 fish larvae, 4.4 x 10^6 fish eggs, 2,772 fish impinged per year	8.3 x 10^6 larvae, 4.4 x 10^6 eggs, 2,772 fish impinged per year	19.8 x 10^7 larvae, 0.2 x 10^6 eggs in Par Pond in 17-month study period; 1 x 10^6 larvae, 0.5 x 10^6 eggs, about 341 fish impinged in Savannah River per year.	Impingement/entrainment impacts from reactor operation would be less than 10-15% of those experienced during full-power operation.
		Operate (K-Reactor with cooling tower)	Reduction of 84% in impingement/ entrainment losses due to K-Reactor withdrawal			
		Terminate	No fish larvae, fish eggs, or fish losses	<15-30% of above (70-85% reduction)	No fish larvae, fish eggs, or fish losses	
Cooling water discharge	Thermal discharges to Par Pond, L-Lake, and Pen Branch continue. Restrictions imposed on operation of L-Reactor so that L-Lake temperature does not exceed 32.2°C (90°F) over 50% of lake.	Operate (K-Reactor without cooling tower)	Stream temperature 73°C (163°F) maximum	Thermal discharge to L-Lake would continue	Thermal discharge to Par Pond would continue	No thermal discharges to onsite water bodies. Flows would be maintained at 1.5-3.0 cubic meters (53 to 106 cubic feet) per second in L-Lake to keep fish protective flows in Steel Creek.
		Operate (K-Reactor with cooling tower)	Maximum design blowdown temperature below discharge 27°C (81°F) in summer			
		Terminate	No flow maintenance; no thermal discharge	Maintain protective flow; no thermal discharge	No flow maintenance; no thermal discharge	

Table 2-3. Comparison of Impacts of Alternatives (Page 3 of 10)

Impact[a]	Alternative 1. Proposed/No Action[b]	Alternative 2. Terminate K-, or L-, or P-Reactor or Combination of Any Two[c]	K or	L or	P	Alternative 3. Termination[d] (K, L, and P)	TC
Groundwater quality (tritium at surface outcrops)	Disassembly-basin purge water containing tritium will continue to be discharged to L- and P-Reactor seepage basins and K-Area containment basin. Since reactor operation began (resumed at L-Reactor), a total of about 3,300 curies of tritium has been released from L-Area and 33,000 curies from P-Area basins since startup in the 1950's; as much as 10,000 curies per year have been released from the K-Area basin.	Operate	2,780 curies per year to Indian Grave Branch	1,240 curies per year to Steel Creek, L-Lake	133 curies per year to Steel Creek	No discharges from reactors to L- and P-Area seepage basins or K-Reactor containment basin; basins would be maintained for future use. Seepages to groundwater would continue for 6 years from K-Reactor basin, for 5 years from L-Reactor basin, and as long as 30 years from P-Reactor basin. Radioactive decay would cause a decrease in tritium concentrations in the seepages to groundwater of 5.5 percent per year.	TC
		Terminate	See Alternative 3.	See Alternative 3.	See Alternative 3.		
Groundwater use	Estimated 39,000 cubic meters (1.0×10^7 gallons) per day are withdrawn from several aquifers for K-, L-, and P-Reactors and support facilities. No major withdrawal impacts.	Operate	2 wells; 1,080 cubic meters (0.28×10^6 gallons) per day	2 wells; 1,354 cubic meters (0.36×10^6 gallons) per day	2 wells; 1,944 cubic meters (0.51×10^6 gallons) per day	Groundwater withdrawal for reactors and support facilities would be reduced to about 4,300 cubic meters (1.1×10^6 gallons) per day or less.	TC
		Terminate	Estimated: <10% of above	Estimated: <10% of above	Estimated: <10% of above		
Air quality	Operational emissions from SRS coal-fired powerplants continue. They consist primarily of NO, SO_2, particulate matter, and CO; no detectable impact on local or regional air quality occurs. A total electric power demand of 175 megaWatts for three reactors would be required.	Operate	SO_2 1,390 metric tons (1,532 tons) per year, NO_x 420 metric tons (463 tons) per year, TSP 216 metric tons (238 tons) per year, CO 56 metric tons (62 tons) per year	No powerplant; electricity and steam come from K-Area; emissions same as K-Area	SO_2 1,040 metric tons (1,147 tons) per year, NO_x 320 metric tons (353 tons) per year, TSP 160 metric tons (176 tons) per year, CO 42 metric tons (46 tons) per year	SRS powerplants would operate at reduced level with corresponding decrease in particulate emissions; each reactor would require 2.5 megaWatts of electric power.	TC
		Terminate	See Alternative 3.	See Alternative 3.	See Alternative 3.		

Table 2-3. Comparison of Impacts of Alternatives (Page 4 of 10)

Impact[a]	**Alternative 1.** Proposed/No Action[b]	**Alternative 2.** Terminate K-, or L-, or P-Reactor or Combination of Any Two[c]				**Alternative 3.** Termination[d] (K, L, and P)	TC
		K	or	L	or P		
Wetlands/ habitats	Operation of K-Reactor *without cooling tower:* Recurrent loss of 670 acres of previously impacted wetlands in Pen Branch and delta; additional loss of 10-12 acres of previously unimpacted forested wetlands per year.	Operate (K-Reactor *without cooling tower*)	Recurrent loss of 670 acres of previously impacted wetlands; additional loss of 10-12 acres of previously *unimpacted* forested wetlands per year.	Loss rates of wetlands are negligible; some minor adjustment of Steel Creek corridor and delta from increased flows would occur.	Little or no wetlands impacts from continued operation	No additional impacts. 1,350 acres of wetlands (670 acres on Pen Branch and 680 acres on Steel Creek) would continue to revegetate.	
	Operation of K-Reactor with cooling tower: Loss of 170 acres of previously impacted wetlands by resumption of production.	Operate (K-Reactor with cooling tower)	Recovery and revegetation of 500 *of the 670 acres of* previously impacted wetlands. Additional losses of 10-12 acres per year of previously unimpacted wetlands would stop.				TC
	Operation of L-Reactor: Loss of negligible amount of forested wetlands; some minor adjustment of Steel Creek corridor and delta from increased flows would occur.	Terminate	See Alternative 3.	See Alternative 3.	No wetlands impact.		
	Operation of P-Reactor: Little or no wetlands impacts from continued operation.						
Aquatic impacts							
Erosion	Impacts from reactor discharges would be total of those from individual reactors.	Operate (K-Reactor without cooling tower)	Stream erosion, sedimentation	Stream erosion, sedimentation	No impacts from erosion	Erosion impacts would diminish	TC
		Operate (K-Reactor with cooling tower)	Erosion and sedimentation impacts would diminish.				

Table 2-3. Comparison of Impacts of Alternatives (Page 5 of 10)

Impact[a]	Alternative 1. Proposed/No Action[b]	Alternative 2. Terminate K-, or L-, or P-Reactor or Combination of Any Two[c]	K or	L or	P	Alternative 3. Termination[d] (K, L, and P)	TC
Chemical	Minor chemical impacts in L-Lake and Par Pond as nutrient levels increase.	Operate	No impact	Minor chemical impacts in L-Lake.	Minor chemical impacts in Par Pond.	Chemical concentration would diminish.	
Thermal	Restrictions imposed on operation of L-Reactor so that L-Lake temperature does not exceed 32.2°C (90°F) over 50% of lake. Fish kills in Indian Grave Branch, Pen Branch, L-Lake, and Pond C at startup.	Operate (K-Reactor without cooling tower)	Fish kills occur only at startup. Fish absent in main corridors or creeks below reactor discharge during power operation	Fish kills in upper L-Lake on startup. Restricted reactor operation when L-Lake exceeds 32.2°C (90°F). See Alternative 1.	Fish kills in Pond C on startup	No thermal discharges to onsite water bodies; SRS would pump Savannah River water to L-Lake to maintain Steel Creek discharge at 1.5-3.0 cubic meters (53 to 106 cubic feet) per second to protect fish and spawning.	TC
		Operate (K-Reactor with cooling tower)	Cooling tower will mitigate above impacts; stream temperature will not exceed 32.2°C (90°F).				
Eutrophication /anoxia	Anoxic zone formation common in hypolimnion of Southeast lakes in summer is increased in L-Lake and Par Pond because of thermal loading.	Operate	No impact	Eutrophication, anoxia in hypolimnion of L-Lake	Eutrophication, anoxia in hypolimnion of Par Pond	Anoxic zone would substantially diminish.	TC
		Terminate	No impact	See Alternative 3.	See Alternative 3.		
Threatened and endangered species	Potential impacts have been mitigated by provision of offsite foraging habitat for wood stork. No impact on other species.	Operate	Potential impacts have been mitigated by offsite measures.	Potential impacts have been mitigated by offsite measures.	Potential impacts have been mitigated by offsite measures.	Former habitats on SRS would be restored. Offsite mitigation measures would continue.	TC
		Terminate	See Alternative 3.	See Alternative 3.	See Alternative 3.		
Water quality (nonthermal)	Liquid effluents discharged to onsite streams would be in compliance with NPDES permit requirements.	Operate	Liquid effluents discharged to onsite streams would be in compliance with NPDES permit requirements.			Liquid effluents from reactors would essentially be eliminated.	TC
		Terminate	Liquid effluents from reactors would essentially be eliminated.				

Table 2-3. Comparison of Impacts of Alternatives (Page 6 of 10)

Impact[a]	Alternative 1. Proposed/No Action[b]		Alternative 2. Terminate K-, or L-, or P-Reactor or Combination of Any Two[c] K or	L or	P	Alternative 3. Termination[d] (K, L, and P)	TC
Solid waste (nonradioactive nonhazardous)	All onsite unsalvageable domestic waste [3,600 metric tons (about 3,967 tons) per year] is packaged and disposed of in SRS landfill. Domestic waste and sanitary waste sludge are disposed in SRS landfills and sludge pit.	Operate	About 1,200 metric tons (1,322 tons) per year	About 1,200 metric tons (1,322 tons) per year	About 1,200 metric tons (1,322 tons) per year	Substantial reduction in generation of solid and domestic wastes.	TC
		Terminate	See Alternative 3.	See Alternative 3.	See Alternative 3.		
Hazardous waste	Operation of K-, L-, and P-Reactors and support facilities generates about 225 cubic meters (295 cubic yards) per year of hazardous wastes, which would be disposed of in approved facilities.	Operate	About 75 cubic meters (98 cubic yards) per year	About 75 cubic meters (98 cubic yards) per year	About 75 cubic meters (98 cubic yards) per year	Substantial reduction in generation of hazardous wastes.	TC
		Terminate	See Alternative 3.	See Alternative 3.	See Alternative 3.		
Solid low-level radioactive waste	Operation of K-, L-, and P-Reactors generates about 2,005 cubic meters (2,623 cubic yards) per year of solid low-level radioactive wastes, which would be disposed of on SRS; this does not include other SRS facilities plus offsite receipts.	Operate	About 640 cubic meters (837 cubic yards) per year	About 675 cubic meters (883 cubic yards) per year	About 690 cubic meters (903 cubic yards) per year	Substantial reduction in generation of low-level wastes.	TC
		Terminate	See Alternative 3.	See Alternative 3.	See Alternative 3.		
Mixed waste	Operation of K-, L-, and P-Reactors and support facilities would generate about 4,750 cubic meters (6,213 cubic yards) per year of mixed wastes, which would be disposed of on SRS.	Operate	About 1,580 cubic meters (2,067 cubic yards) per year	About 1,580 cubic meters (2,067 cubic yards) per year	About 1,580 cubic meters (2,067 cubic yards) per year	Substantial reduction in generation of mixed wastes.	TC
		Terminate	See Alternative 3.	See Alternative 3.	See Alternative 3.		

Table 2-3. Comparison of Impacts of Alternatives (Page 7 of 10)

Impact[a]	Alternative 1. Proposed/No Action[b]	Alternative 2. Terminate K-, or L-, or P-Reactor or Combination of Any Two[c]	K or	L or	P	Alternative 3. Termination[d] (K, L, and P)	TC
Transuranic (TRU) waste	Operation of K-, L-, and P-Reactors would generate about 1,130 cubic meters (1,478 cubic yards) per year of TRU wastes, which eventually would be disposed of off SRS.	Operate	About 377 cubic meters (493 cubic yards) per year	About 377 cubic meters (493 cubic yards) per year	About 377 cubic meters (493 cubic yards) per year	Substantial reduction in TRU waste from reactors. Continued work-off of stored retrievable TRU waste for shipment to Waste Isolation Pilot Project.	TC
		Terminate	See Alternative 3.	See Alternative 3.	See Alternative 3.		
High-level liquid radioactive wastes	Operation of K-, L-, and P-Reactors would generate about 1,600 cubic meters (2,093 cubic yards) per year of high-level liquid radioactive waste.	Operate	About 533 cubic meters (697 cubic yards) per year	About 533 cubic meters (697 cubic yards) per year	About 533 cubic meters (697 cubic yards) per year	Substantial reduction of high-level waste from reactors. Work-off of about 8,400 cubic meters (10,987 cubic yards) per year of high-level wastes stored in tanks would continue, as would reprocessing of research reactor spent fuels [about 200 cubic meters (262 cubic yards) per year].	TC
		Terminate	Substantial reduction of waste generation.		See Alternative 3.		
Cesium-137	Cesium-137 releases from onsite streambeds (about 72% from reactors) produce maximum individual EDE of about 0.28 millirem per year.	Operate				Substantial immediate reduction in offsite doses from resuspension of Cs-137 due to reduced flow and temperature.	TC
		Maximum individual EDE[e] (millirem per year)	0.01	0.11	0.081		
		Collective EDE to population within 80 kilometers (50 miles) and downriver water users (person-rem per year)	0.039	0.45	0.32		
		Terminate	See Alternative 3.	See Alternative 3.	See Alternative 3.		

Table 2-3. Comparison of Impacts of Alternatives (Page 8 of 10)

Impact[a]	Alternative 1. Proposed/No Action[b]	Alternative 2. Terminate K-, or L-, or P-Reactor or Combination of Any Two[c]	K or	L or	P	Alternative 3. Termination[d] (K, L, and P)	TC
Normal operation[f]		Operate				Radioactive releases from K-, L-, and P-Reactors and support facilities would diminish by at least 1 order of magnitude. No significant change in individual or collective radiation doses from all sources.	TC
		Dose - area fence (millirem per year)	99	79	76		
Radiation dose maximum individual	0.58 millirem per year, (Natural background=296 millirem per year	Maximum offsite (including Cs-137) (millirem per year) (DOE limit = 100 millirem per year)	0.20	0.26	0.24		
Population within 80 kilometers (50 miles)	22.0 person-rem per year	Collective (including Cs-137) (person-rem per year)	7.2	7.5	7.4		
Downriver water users only	9.48 person-rem per year	(person-rem per year)	6.6	1.4	1.5		
	(Above doses include cesium remobilization associated with reactor operation)	Terminate	See Alternative 3.	See Alternative 3.	See Alternative 3.		
Health effects (annual)		Operate				Radioactive releases from K-, L-, and P-Reactors and support facilities would diminish, as noted above. There would be no excess health effects (cancer risks) due to radioactive releases from the reactors and support facilities.	TC
Maximum individual risk	Fatal cancer risk is 2.3×10^{-7} per year	Maximum individual risk	0.81×10^{-7}	1.0×10^{-7}	0.95×10^{-7}		
Population risk within 80 kilometers (50 miles)	8.8×10^{-3} excess cancer fatality	Population risk within 80 kilometers (50 miles)	2.9×10^{-3}	3.0×10^{-3}	2.9×10^{-3}		
Downriver water users	3.8×10^{-3} excess cancer fatality	Downriver water users	2.6×10^{-3}	5.5×10^{-4}	6.1×10^{-4}		
		Terminate	See Alternative 3.	See Alternative 3.	See Alternative 3.		

Table 2-3. Comparison of Impacts of Alternatives (Page 9 of 10)

Impact[a]	Alternative 1. Proposed/No Action[b]	Alternative 2. Terminate K-, or L-, or P-Reactor or Combination of Any Two[c]	K or	L or	P	Alternative 3. Termination[d] (K, L, and P)	TC
Accidents		Operate					
Design-basis							
Probable 2-hour individual effective dose equivalent at the SRS boundary	0.51 rem	Onsite[g]	20.9	22.0	21.6	There would be no releases as a result of reactor accidents.	
		Offsite[g]	0.47	0.51	0.44		
Probable 2-hour individual thyroid dose at the SRS boundary	0.39 rem	Onsite[g]	2.5	2.5	2.7		
		Offsite[g]	0.39	0.39	0.33		
		Terminate	See Alternative 3.	See Alternative 3.	See Alternative 3.		
Severe							TC
Prompt fatality risk (per reactor-year) for individual within 1.6 kilometers (1 mile) of SRS boundary	8×10^{-11}	Onsite[h]	1.6×10^{-7}	1.6×10^{-7}	1.6×10^{-7}		
		Offsite	5.9×10^{-11}	5.9×10^{-11}	8×10^{-11}		
Latent fatality risk (per reactor-year) for individual within 16 kilometers (10 miles) of SRS boundary	7.2×10^{-8}	Onsite[h]	2.9×10^{-7}	2.9×10^{-7}	2.9×10^{-7}		
		Offsite[i]	7.2×10^{-8}	7.2×10^{-8}	7.2×10^{-8}		
	Both severe accident risks are well within Draft DOE Safety Goals.	Terminate	See Alternative 3.	See Alternative 3.	See Alternative 3.		
Commitment of resources	Resource commitments include water and energy use, coal and oil for power, labor, chemicals, and raw materials. Electric power demands for three reactors would be 175 megaWatts.	Operate	Resource commitments for each reactor would be about one-third of those required for the total of K-, L-, and P-Reactors.			No long-term commitment of resources at reactors; reduced commitment at support facilities.	
		Terminate	See Alternative 3.	See Alternative 3.	See Alternative 3.	SRS cleanup and institutional control would continue.	

Table 2-3. Comparison of Impacts of Alternatives (Page 10 of 10)

Impact[a]	Alternative 1. Proposed/No Action[b]	Alternative 2. Terminate K-, or L-, or P-Reactor or Combination of Any Two[c] K or L or P	Alternative 3. Termination[d] (K, L, and P)	
			A commitment for electricity to pump river water to maintain Steel Creek flows would be required in addition to 2.5 megaWatts for each reactor.	TC

a. Where specified, the impacts consider the impacts of reactor operation and routine operations of the facilities supporting reactor operation (support facilities). Section 4.1.6 presents a detailed assessment of impacts, including those from support facilities.
b. The Proposed Action/No-Action alternative is defined as the continued operation of K-, L-, and P-Reactors. Operation includes normal outages for fuel and target replacement and for maintenance. In general, impacts listed in this column represent the total of the individual impacts from each reactor.
c. Alternative 2 includes termination of K-, or L-, or P-Reactor, or K + L, K + P, or L + P-Reactors in the immediate future and maintaining in cold standby. The remaining reactors would continue to operate. Impacts are shown for operating or terminating operation of each reactor. In general, impacts from operating or terminating any two reactors would be additive. For combinations involving the termination of K-Reactor operation, DOE also would terminate the construction of the cooling tower. TC
d. The Termination alternative is defined as terminating the operation of K-, L-, and P-Reactors in the immediate future and maintaining them in cold standby.
e. EDE = effective dose equivalent.
f. Normal operation includes the use of seepage basins.
g. Due to 2-hour exposure, with typical meteorological conditions, for an accident resulting from a reloading error (3% core melt).
h. Any variance in onsite population dose and fatality risks due to differing meteorological or topographical conditions among the three reactors is expected to be within the bounds of uncertainty of the severe accident analysis.
i. Any variance in offsite fatality risks due to different meteorological or topographical conditions or slight differences in center of radii for the different reactor locations is expected to be within the bounds of uncertainty of the severe accident analysis.

Table 3-7. Classification and Dominant Plant Species of SRS Wetlands[a]

Wetlands Classification (Cowardin et al., 1979)	Dominant Plant Species of Selected SRS Wetlands		
	Nonthermal[b]	Thermal[c]	Post-Thermal[d]
Open water			
Aquatic bed			
Algal		Blue-green algae	
Submerged vascular			*Ceratophyllum demersum* *Myriophyllum brasiliense*
Emergent wetland persistent			*Typa latifolia* *Scripus cyperinus* *Aneilema keisak* *Leersia* spp. *Boehmeria cylindrica* *Panicum agrostoides*
Nonpersistent		*Ludwigia* spp. *Ammannia coccinea* *Cyperus* spp. *Echinodorus* spp. *Aeschynomene indica*	*Hydrolea quadrivalvis* *Aneilema keisak* *Polygonum hydropiperodies* *Ludwigia palustris* *Sagittaria latifolia*
Scrub-shrub wetland			
Broad-leaved deciduous		*Cephalanthus occidentalis* *Salix* spp. *Planera aquatica*	*Cephalanthus occidentalis* *Salix* spp. *Planera aquatica*
Forested wetland			
Deciduous Bottomland Hardwoods	*Quercus* spp. *Liquidambar styraciflua* *Acer rubrum* *Carya aquatica*	*Quercus* spp. *Liquidambar styraciflua* *Ulmus* sp. *Carpinus caroliniana*	*Salix* spp. *Fraxinus* spp. *Quercus* spp. *Liquidambar styraciflua* *Acer rubrum* *Carya aquatica*
Deciduous Swamp forest	*Taxodium distichum* *Nyssa aquatica*	*Taxodium distichum* *Nyssa aquatica*	*Taxodium distichum* *Nyssa aquatica*
Mixed forest/scrub-shrub			*Taxodium distichum* *Nyssa aquatica* *Cephalanthus occidentalis*
Mixed forest/scrub-shrub/ Nonpersistent emergent wetland			*Taxodium distichum* *Nyssa aquatica* *Cephalanthus occidentalis* *Polygonum lapathifolium*

a. Source: Du Pont, 1987a.
b. Nonthermal: Wetlands that have never been affected by thermal discharges (e.g., Upper Three Runs Creek).
c. Thermal: Wetlands currently affected by thermal effluents (e.g., Pen Branch).
d. Post-Thermal: Wetlands formerly, but no longer, affected by thermal effluents; many plants are early successional, adventive species (e.g., Fourmile Branch).

Table 3-8. Species on the Federal or South Carolina Lists of Threatened or Endangered Species that Occur on the Savannah River Site[a]

Species	Status: Federal[b] Threatened	Status: Federal[b] Endangered	Status: State[c] Threatened	Status: State[c] Endangered	Observations on or near SRS	
Birds						
Picoides borealis (Red-cockaded woodpecker)		X		X	A few scattered colonies in pine stands on SRS.	TC
Haliaeetus l. leucocephalus (Bald eagle)		X		X	Thirty-six birds have been observed on the SRS, most of which have occurred on Par Pond and L-Lake. A single active nest containing two juveniles was located below Par Pond dam in the Lower Three Runs Creek drainage area in 1986, 1987, 1988, and 1989. Young were fledged from this nest each year except 1989, when the nest was destroyed by strong winds.	
Aquila chrysaetos (Golden Eagle)				X	Two sightings on SRS, both in winter (Mayer et al., 1986).	TC
Falco peregrimus (Peregrine falcon)		X		X	Listed as a rare winter visitor near Par Pond (WSRC, 1989b).	
Mycteria americana (Wood Stork)		X		X	Individuals have been observed foraging in the SRS Savannah River Swamp.	
Pandion Haliaetus (American osprey)			X		A few individuals have been observed as migrants over SRS.	
Deudroica Kirtlandii (Kirtland's Warbler)		X		X	Listed as a rare transient visitor (no location given) (WSRC, 1989b).	TC
Reptiles						
Alligator mississippiensis (American alligator)	X[d]		X		Common on Par Pond, Beaver Dam Creek, and in the SRS Savannah River Swamp.	

Table 3-8. Species on the Federal or South Carolina Lists of Threatened or Endangered Species that occur on the Savannah River Site[a] (continued)

Species	Status				Observations on or near SRS
	Federal[b]		State[c]		
	Threatened	Endangered	Threatened	Endangered	
Fish					
Acipenser brevirostrum (Shortnose sturgeon)		X		X	Rare; a few larvae (5) were collected in 1982-1985 surveys in the Savannah River near the SRS pumphouses; two larvae were collected in the intake canals.
Invertebrates					
Elliptio fraterna (Brother spike mussel)		X		X	Rare; only one collected from Savannah River below Lower Three Runs Creek.

a. Dukes, 1984; DOE, 1987c.
b. 50 CFR 17.11 and 17.12.
c. South Carolina Code of Laws, Sections 50-11-3810 et seq., 50-11-3990, and 50-15-30 et seq.; Regulations 123 to 150, Non-Game and Endangered Species.
d. Threatened due to similarity of appearance.

Table 3-9. Major Sources of Radiation Exposure in the Vicinity of the Savannah River Site[a]

Source of Exposure	Dose to Average Individual (mrem/yr)	Percentage of Exposure
Natural background radiation[b]		
Cosmic radiation	28	
External terrestrial	28	
Internal terrestrial	40	
Radon in homes	200	
TOTAL NATURAL	296	81.9
Medical radiation		
Diagnostic X-rays	39	
Radiopharmaceutical	14	
TOTAL MEDICAL	53	14.7
Weapons test fallout	<1	<0.3
Consumer and industrial products	10	2.8
Air travel	1	0.3
Nuclear facilities (other than SRS)	<0.1	<0.03
Savannah River Site - environmental radioactivity (1988)	<0.1	<0.03
TC GRAND TOTAL	361	

a. Modified from Davis, Martin, and Todd, 1989.
b. National average for the United States.

TE indicate that, since 1963, about 1 percent of the 2,850 curies of cesium-137 deposited on the total Savannah River watershed has been transported down the river (Du Pont, 1983b).

Onsite monitoring shows that an average of 50 millicuries per square kilometer (1976-1982 average) of cesium-137 are in the upper 5 centimeters of the soil column. This value is one-half of the amount originally deposited. This difference demonstrates that some of the radiocesium has moved down in the soil column and some has undergone hydrologic transport to the Savannah River.

Releases of radioactive material to the environment from SRS operation from 1986 to 1988 resulted in an average dose of 0.05 millirem per year to the

Table 3-15. Typical Annual Waste Generation Rates and Activity Levels for SRS Reactors and Support Facilities[a]

Waste Type	Amount	Activity (curies)
Hazardous	225 cubic meters	N/A[f]
Mixed	4,750 cubic meters	N/A
High-level liquid radioactive	5,000-10,000 cubic meters[b]	$2.6 \times 10^7 - 5.2 \times 10^7$
Low-level solid radioactive	31,000 cubic meters[c]	1.5×10^5
Low-level liquid radioactive (F- and H-Area; as tritium)	460,000 cubic meters[d]	3×10^4 (as tritium) L-78-38 L-78-47
Low-level liquid radioactive (DWPF)	11,360 cubic meters[e]	10.8[g]
TRU	1,130 cubic meters	1.3×10^5
Nonhazardous	3,600 metric tons	N/A
Sanitary/domestic	4,000 cubic meters	N/A

a. Source: DOE, 1988a, 1989b.
b. Includes workoff of high-level waste inventory held in storage tanks.
c. Includes low-level solid wastes shipped from offsite.
d. Design flow rate for F- and H-Area ETF; actual volume could be smaller.
e. Low-level liquid waste volume from DWPF to replacement high-level waste evaporator in 1993.
f. N/A = Not applicable.
g. Reported as cesium-137. The activity of this combined stream varies considerably. If it is less than 1,500 disintegrations per minute per milliliter in H-Area or 2,500 disintegrations per minute per milliliter in F-Area, it is sent to the F- and H-Area ETF. Otherwise, it is recycled to the evaporator.

Table 3-16. SRS Waste in Storage[a]

Waste	Amount (cubic meters)	Storage Location	Activity (curies)
High-level liquid radioactive	128,000	2 tank farms	6.6×10^8
Low-level solid radioactive	570,000[b]	LLRSWSDF	2.8×10^6 [d]
Hazardous	2,300	Interim storage facilities	N/A[e]
Mixed	1,900	Interim storage facilities	N/A
TRU nonretrievable	4,534	LLRSWSDF	5.2×10^4
TRU retrievable	6,489[f]	LLRSWSDF	8.0×10^5

L-78-38
L-78-47

a. Source: DOE, 1988a, 1989b.
b. Includes some permanently stored TRU waste.
c. LLRSWSDF = Low-level radioactive solid waste storage/disposal facility.
d. Inventory on December 31, 1988.
e. N/A - Not applicable.
f. Includes certified, certifiable, and waste to be reclassified as LLW.

Table 3-17. Waste Treatment Methods

Waste Type	Current Treatment	Planned
• Hazardous	• Interim storage and • Offsite shipment to approved facility	• Incineration (CIF - 1992) or • New hazardous/mixed waste disposal facility, secure burial in HW/MW DF (1991)
• Mixed waste	• Interim storage	• Incineration (CIF - 1992) or
(Sludge from M-Area ETF)	• Interim storage	• Secure burial in HW/MW DF (1991) or • Saltstone - stabilization/ solidification Y-Area (1991)
• Low-level solid radioactive	• Secure burial facility will be exhausted in 1991	• Incineration (CIF - 1992) or • Secure burial in new Low-Level Radwaste Storage/Disposal Facility (1991)
• Low-level liquid radioactive waste from F- & H-Area	• F- and H-Area ETF: filtration, oil removal, carbon filtration, ion exchange, reverse osmosis, mercury removal. Discharge to NPDES outfall	• ETF began operation in November 1988, NPDES discharge to continue
(mixed waste solids, dewatered filter solids)	• Interim storage	• Y-Area saltstone - stabilization (1991)
• Low-level liquid radioactive waste from DWPF	• Z-Area saltstone, stabilization/solidification	• Z-Area began operation in June 1990

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Table 3-17. Waste Treatment Methods (continued)

Waste Type	Current Treatment	Planned
• High-level radioactive liquid waste	• Interim storage in HLW tanks	• DWPF (vitrification) 1992, interim storage of canisters, then Federal Repository
	• Dewatering by evaporation	
(Low-level fraction)	• Saltstone processing (stabilization) of treated salt from tanks to Z-Area, June 1990	• Low-level waste continues in Saltstone process, to Z-Area
• Transuranic waste (TRU - newly generated)	• Interim storage in LLW burial ground	• Storage in WIPP (Secure burial)
(Retrievably stored)	• Certification	• Low-level waste disposal (Secure burial) or
(Retrievably stored)	• Certification	• Transuranic Waste Facility (1995)
(Nonretriveably stored)	• Secure burial	• Secure burial continues
• Nonhazardous nonradioactive waste	• Landfills	• Treatment/disposal processes to continue
(Sanitary sewage, domestic wastes, coal ash, and process liquids)	• Biological oxidation	
	• Shedding, compacting	
	• Neutralization	
	• Spray irrigation - experimental	
	• Incineration	
	• Ash basin disposal	

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Table 4-8. Radiological Impacts from Alternative Purge-Water Disposal Options

Pathway	Seepage Basin	Direct Discharge	Evaporation[a]
Liquid Releases			
Maximum individual EDE[b] (mrem/yr)	0.0318	0.138	0.0318
Public collective EDC[c] (person-rem/yr)			
80-kilometer population			
Shoreline exposure	9.9×10^{-6}	5.5×10^{-4}	9.9×10^{-6}
Swimming	6.4×10^{-9}	4.1×10^{-7}	6.4×10^{-9}
Boating	8.8×10^{-8}	5.6×10^{-6}	8.8×10^{-8}
Sport fish consumption	6.8×10^{-3}	1.9×10^{-1}	6.8×10^{-3}
Commercial fish consumption	5.2×10^{-4}	1.4×10^{-2}	5.2×10^{-4}
Saltwater invertebrates	2.2×10^{-5}	1.7×10^{-5}	2.2×10^{-5}
Total (80-kilometer population)	7.4×10^{-3}	0.21	7.4×10^{-3}
Population beyond 80 kilometers			
Beaufort-Jasper	3.42	7.35	3.42
Port Wentworth	5.84	12.6	5.84
Total (beyond 80 kilometers)	9.26	19.95	9.26
Total Collective EDC	9.27	20.1	9.27
Atmospheric Releases			
Maximum individual EDE (mrem/yr)	0.342	0.338	0.351
80-kilometer collective EDC (person-rem/yr)	21.4	21.1	22.0
Total Liquid and Atmospheric Releases			
Total maximum individual EDE (mrem/yr)	0.374	0.476	0.383
Total Collective EDC (person-rem/yr)	30.7	41.2	31.4

L-45-04
L-49-01
L-78-02
L-78-41
S-06-03
C-02-06
A-12-02

a. The evaporation option assumes continued 6,860 curie-per-year groundwater migration to surface streams; evaporation of 12,100 curies per year in purge water; and 4,870 curies per year discharged to surface streams.
b. EDE = effective dose equivalent
c. EDC = environmental dose commitment

Table 4-9. Cesium-137 Discharges from K-, L-, P-, and R-Reactors (curies) | TE

Creek System	Release	Corrected for Decay Through 1985
Indian Grave/Pen Branch		
K-Reactor	24.4	13.2
Steel Creek		
L-Reactor	29.4	16.3
P-Reactor	254.7	147.3
Total	284.1	163.6
Lower Three Runs Creek		
R-Reactor	220.1	116.4
Total	528.6	293.2

Table 4-10. Cooling System Discharges from K-, L-, and P-Reactors | TE

Discharge	Flow	Cubic Meters/Second (approximate)
Operation		
K-Reactor IG/PB		
Without cooling tower	High flow rate	10-11
With cooling tower	Low flow rate	1
L-Reactor L-Lake/SC	High flow rate	10-11
P-Reactor Par Pond/LTR	Low flow rate	10-11
Termination		
IG/PB	Natural flow	0.1 to 0.3
LL/SC	Fish maintenance flow	1.5 to 3.0
PP/LTR	Fish maintenance flow (not planned)	Natural flow of 0.6 to 0.8	TC

IG/PB = Indian Grave/Pen Branch; LL/SC = L-Lake/Steel Creek; PP/LTR = Par Pond/Lower Three Runs Creek

Table 4-9. Cesium-137 Discharges from K-, L-, P-, and R-Reactors (curies) | TE

Creek System	Release	Corrected for Decay Through 1985
Indian Grave/Pen Branch		
K-Reactor	24.4	13.2
Steel Creek		
L-Reactor	29.4	16.3
P-Reactor	254.7	147.3
Total	284.1	163.6
Lower Three Runs Creek		
R-Reactor	220.1	116.4
Total	528.6	293.2

Table 4-10. Cooling System Discharges from K-, L-, and P-Reactors | TE

Discharge	Flow	Cubic Meters/Second (approximate)
Operation		
K-Reactor IG/PB		
Without cooling tower	High flow rate	10-11
With cooling tower	Low flow rate	1
L-Reactor L-Lake/SC	High flow rate	10-11
P-Reactor Par Pond/LTR	Low flow rate	10-11
Termination		
IG/PB	Natural flow	0.1 to 0.3
LL/SC	Fish maintenance flow	1.5 to 3.0
PP/LTR	Fish maintenance flow (not planned)	Natural flow of 0.6 to 0.8	TC

IG/PB = Indian Grave/Pen Branch; LL/SC = L-Lake/Steel Creek; PP/LTR = Par Pond/Lower Three Runs Creek

Table 4-12. Committed Effective Dose Equivalents from Annual Operation of K-, L-, and P-Reactors Based on Alternative Purge-Water Options[a]

MAXIMUM INDIVIDUAL DOSE (millirem)

Seepage Basins	K-Reactor	L-Reactor	P-Reactor	SRS Reactors
Atmospheric	0.17	0.14	0.15	0.34[b]
Liquid	0.022	0.0043	0.005	0.032
Cs-137 remobilization[c]	0.0098	0.11	0.081	0.20
Total				0.58

Direct Discharge	K-Reactor	L-Reactor	P-Reactor	SRS Reactors
Atmospheric	0.17	0.14	0.15	0.34[b]
Liquid	0.048	0.025	0.064	0.14
Cs-137 remobilization[c]	0.0098	0.11	0.081	0.20
Total				0.68

Evaporation	K-Reactor	L-Reactor	P-Reactor	SRS Reactors
Atmospheric	0.18	0.14	0.16	0.35
Liquid	0.022	0.0043	0.005	0.032
Cs-137 remobilization[c]	0.0098	0.11	0.081	0.20
Total				0.58

COLLECTIVE DOSE TO REGIONAL POPULATION (person-rem)

Seepage Basins	Within 80 km	Beaufort-Jasper and Port Wentworth
Atmospheric releases		
All reactors	21.4	--
Liquid releases		
K-Reactor	0.0050	6.56
L-Reactor	0.0011	1.24
P-Reactor	0.0013	1.44
Total (liquid)	0.0074	9.25
Cs-137 remobilization[c]		
K-Reactor	0.028	0.011
L-Reactor	0.32	0.13
P-Reactor	0.23	0.092
Total	0.57	0.23
Total	21.98	9.48

Table 4-12. Committed Effective Dose Equivalents from Annual Operation of K-, L-, and P-Reactors Based on Alternative Purge-Water Options[a] (continued)

Direct Discharge	Within 80 km	Beaufort-Jasper and Port Wentworth
Atmospheric releases		
All reactors	21.1	--
Liquid releases		
K-Reactor	0.043	10.3
L-Reactor	0.046	2.82
P-Reactor	0.12	6.8
Total (liquid)	0.21	19.92
Cs-137 remobilization[c]		
K-Reactor	0.028	0.011
L-Reactor	0.32	0.13
P-Reactor	0.23	0.092
Total (cesium-137)	0.57	0.23
TOTAL	21.88	20.15

Evaporation	Within 80 km	Beaufort-Jasper and Port Wentworth
Atmospheric releases		
All reactors	22.1	--
Liquid releases		
K-Reactor	0.005	6.56
L-Reactor	0.0011	1.24
P-Reactor	0.0013	1.44
Total (liquid)	0.0074	9.25
Cs-137 remobilization[c]		
K-Reactor	0.028	0.011
L-Reactor	0.32	0.13
P-Reactor	0.23	0.092
Total (cesium-137)	0.57	0.23
TOTAL	22.68	9.48

TC

a. WSRC, 1989c.

b. The location of maximum potential dose is different for each reactor. Therefore, the dose from combined K-, L-, and P-Reactor atmospheric releases listed in the table is less than the sum of doses from the individual reactors.

c. Section 4.1.2.4 discusses the doses from cesium-137 remobilization from streams that are directly affected by the operation of K-, L-, and P-Reactors versus the doses from remobilization of cesium-137 from all SRS streams.

TE

Table 4-18. Typical Production Reactor Core Inventory for a Tritium-Producing Charge at 3,000 MW Thermal[a]

Group/ radionuclide	Release Group[b]	Radioactive inventory (curies)	Half-life	Parent
Tritium	10	7.0×10^7	12.3 years	--
		NOBLE GASES		
Krypton-85	1	2.2×10^5	10.7 years	--
Krypton-85m	1	3.2×10^7	4.48 hours	--
Krypton-87	1	6.5×10^7	1.27 hours	--
Krypton-88	1	8.9×10^7	2.86 hours	--
Xenon-133	1	1.8×10^8	5.25 days	Iodine-133
Xenon-135	1	1.6×10^7	9.10 hours	Iodine-135
		IODINES		
Iodine-131	2	7.6×10^7	8.04 days	Tellurium-131m
Iodine-132	2	1.1×10^8	2.28 hours	Tellurium-132
Iodine-133	2	1.8×10^8	20.9 hours	--
Iodine-134	2	2.0×10^8	52.5 minutes	--
Iodine-135	2	1.6×10^8	6.61 hours	--
		ALKALI METALS		
Rubidium-86	3	7.0×10^4	18.8 days	--
Cesium-134	3	1.9×10^6	2.06 years	--
Cesium-136	3	7.6×10^5	13.0 days	--
Cesium-137	3	1.8×10^6	30.1 years	--
		TELLURIUM-ANTIMONY		
Tellurium-127	4	2.7×10^6	9.35 hours	Antimony-127
Tellurium-127m	4	3.0×10^5	109.0 days	--
Tellurium-129	4	1.6×10^7	1.16 hours	Antimony-129
Tellurium-129m	4	4.3×10^6	33.5 days	--
Tellurium-131m	4	9.5×10^6	1.25 days	--
Tellurium-132	4	1.1×10^8	3.26 days	--
Antimony-127	4	3.0×10^6	3.91 days	--
Antimony-129	4	1.7×10^7	4.41 hours	--
		ALKALINE EARTHS		
Strontium-89	5	1.1×10^8	50.6 days	--
Strontium-90	5	1.8×10^6	28.8 years	--
Strontium-91	5	1.5×10^8	9.48 hours	--
Strontium-92	5	1.5×10^8	2.7 hours	--
Barium-139	9	1.7×10^8	83.2 minutes	--
Barium-140	9	1.6×10^8	12.8 days	--

Table 4-19. Median Doses, 2-Hour Exposure, Reloading Error During Shutdown (3 Percent of Core Damaged)[a] | TE

Distance from reactor [km (miles)]	Effective Dose Equivalent (rem)			Thyroid dose (rem)			
	K-Reactor	L-Reactor	P-Reactor	K-Reactor	L-Reactor	P-Reactor	TE
0.8 (0.5)	21	22	22	2.5	2.5	2.7	
1.6 (1.0)	13	13	14	2.2	2.5	2.4	
2.4 (1.5)	9.4	9.8	9.6	2.2	2.4	2.2	TC
3.2 (2.0)	7.1	7.2	7.2	1.8	2.0	1.9	
6.4 (4.0)	3.0	3.0	3.0	0.87	0.91	0.87	
SRS boundary	0.47	0.51	0.44	0.39	0.39	0.33	

a. Adapted from WSRC, 1990.

Table 4-20. Median Doses, 2-Hour Exposure, Loss-of-Coolant Accident (1 Percent of Core Damaged)[a] | TE

Distance from reactor [km (miles)]	Effective Dose Equivalent (rem)			Thyroid dose (rem)			
	K-Reactor	L-Reactor	P-Reactor	K-Reactor	L-Reactor	P-Reactor	TE
0.8 (0.5)	7.0	7.3	7.2	0.82	0.84	0.91	
1.6 (1.0)	4.4	4.4	4.5	0.73	0.84	0.78	TC
2.4 (1.5)	3.1	3.2	3.2	0.74	0.81	0.75	
3.2 (2.0)	2.4	2.4	2.4	0.61	0.65	0.62	
6.4 (4.0)	0.98	0.99	0.99	0.29	0.30	0.29	
SRS boundary	0.16	0.17	0.15	0.13	0.13	0.11	TC

a. Adapted from WSRC, 1990. The doses resulting from a 1-percent release of the core inventory are proportional to the doses from a 3-percent release; thus the values in Table 4-20 are one-third of the doses in Table 4-19. | TC

Table 4-19. Median Doses, 2-Hour Exposure, Reloading Error During Shutdown (3 Percent of Core Damaged)[a] | TE

Distance from reactor [km (miles)]	Effective Dose Equivalent (rem)			Thyroid dose (rem)			
	K-Reactor	L-Reactor	P-Reactor	K-Reactor	L-Reactor	P-Reactor	TE
0.8 (0.5)	21	22	22	2.5	2.5	2.7	
1.6 (1.0)	13	13	14	2.2	2.5	2.4	
2.4 (1.5)	9.4	9.8	9.6	2.2	2.4	2.2	TC
3.2 (2.0)	7.1	7.2	7.2	1.8	2.0	1.9	
6.4 (4.0)	3.0	3.0	3.0	0.87	0.91	0.87	
SRS boundary	0.47	0.51	0.44	0.39	0.39	0.33	

a. Adapted from WSRC, 1990.

Table 4-20. Median Doses, 2-Hour Exposure, Loss-of-Coolant Accident (1 Percent of Core Damaged)[a] | TE

Distance from reactor [km (miles)]	Effective Dose Equivalent (rem)			Thyroid dose (rem)			
	K-Reactor	L-Reactor	P-Reactor	K-Reactor	L-Reactor	P-Reactor	TE
0.8 (0.5)	7.0	7.3	7.2	0.82	0.84	0.91	
1.6 (1.0)	4.4	4.4	4.5	0.73	0.84	0.78	TC
2.4 (1.5)	3.1	3.2	3.2	0.74	0.81	0.75	
3.2 (2.0)	2.4	2.4	2.4	0.61	0.65	0.62	
6.4 (4.0)	0.98	0.99	0.99	0.29	0.30	0.29	
SRS boundary	0.16	0.17	0.15	0.13	0.13	0.11	TC

a. Adapted from WSRC, 1990. The doses resulting from a 1-percent release of the core inventory are proportional to the doses from a 3-percent release; thus the values in Table 4-20 are one-third of the doses in Table 4-19. | TC

TE | Table 4-21. Median Doses, 2-Hour Exposure, Fuel Assembly Drop During Discharge Operations (0.0246 Percent of Core Damaged)[a]

Distance from reactor [km (miles)]	Effective Dose Equivalent (rem)			Thyroid dose (rem)		
	K-Reactor	L-Reactor	P-Reactor	K-Reactor	L-Reactor	P-Reactor
0.8 (0.5)	0.17	0.18	0.18	0.02	0.021	0.022
1.6 (1.0)	0.11	0.11	0.11	0.018	0.021	0.019
2.4 (1.5)	0.077	0.08	0.78	0.018	0.02	0.018
3.2 (2.0)	0.058	0.059	0.058	0.015	0.016	0.015
6.4 (4.0)	0.024	0.024	0.024	0.007	0.008	0.007
SRS boundary	0.0039	0.0042	0.0036	0.003	0.003	0.003

TC

a. Adapted from WSRC, 1990. The doses resulting from a 0.0246-percent release of the core inventory are proportional to the doses from a 3-percent release; thus, the values in Table 4-21 are a fraction of 0.0082 (0.024/3) of the doses in Table 4-20.

TE

TE | Table 4-22. Median Doses, 2-Hour Exposure, Release or Spill of Moderator from Primary Coolant Loop[a]

Distance from reactor [km (miles)]	Effective dose equivalent (rem)		
	K-Reactor	L-Reactor	P-Reactor
0.8 (0.5)	0.013	0.013	0.015
1.6 (1.0)	0.012	0.014	0.013
2.4 (1.5)	0.013	0.014	0.013
3.2 (2.0)	0.010	0.011	0.011
6.4 (4.0)	0.005	0.005	0.005
SRS boundary	0.002	0.002	0.002

TC

a. Source: WSRC, 1990.

TE | Table 4-21. Median Doses, 2-Hour Exposure, Fuel Assembly Drop During Discharge Operations (0.0246 Percent of Core Damaged)[a]

Distance from reactor [km (miles)]	Effective Dose Equivalent (rem)			Thyroid dose (rem)		
	K-Reactor	L-Reactor	P-Reactor	K-Reactor	L-Reactor	P-Reactor
0.8 (0.5)	0.17	0.18	0.18	0.02	0.021	0.022
1.6 (1.0)	0.11	0.11	0.11	0.018	0.021	0.019
2.4 (1.5)	0.077	0.08	0.78	0.018	0.02	0.018
3.2 (2.0)	0.058	0.059	0.058	0.015	0.016	0.015
6.4 (4.0)	0.024	0.024	0.024	0.007	0.008	0.007
SRS boundary	0.0039	0.0042	0.0036	0.003	0.003	0.003

TC

a. Adapted from WSRC, 1990. The doses resulting from a 0.0246-percent release of the core inventory are proportional to the doses from a 3-percent release; thus, the values in Table 4-21 are a fraction of 0.0082 (0.024/3) of the doses in Table 4-20.

TE

TE | Table 4-22. Median Doses, 2-Hour Exposure, Release or Spill of Moderator from Primary Coolant Loop[a]

Distance from reactor [km (miles)]	Effective dose equivalent (rem)		
	K-Reactor	L-Reactor	P-Reactor
0.8 (0.5)	0.013	0.013	0.015
1.6 (1.0)	0.012	0.014	0.013
2.4 (1.5)	0.013	0.014	0.013
3.2 (2.0)	0.010	0.011	0.011
6.4 (4.0)	0.005	0.005	0.005
SRS boundary	0.002	0.002	0.002

TC

a. Source: WSRC, 1990.

TE | Table 4-24. Median Individual Doses from Maximum Design-Basis Accident Occurring at K-, L-, or P-Reactor

TE	Measure	Dose (rem) K-Reactor	L-Reactor	P-Reactor
	Effective Dose Equivalent			
TC	Onsite (0.8 km)	21	22	22
	Offsite (Site boundary)	0.47	0.51	0.44
	Thyroid			
	Onsite (0.8 km)	2.5	2.5	2.7
TC	Offsite (Site boundary)	0.39	0.39	0.33

TE | Table 4-25. Probable Offsite Doses from Full-Charge Inventories of Possible Nonfission Products[a]

	Isotope	Maximum Inventory (Ci)	Effective Dose Equivalent (rem)
TC	Plutonium-238	1.5×10^5	0.015
	Plutonium-239	2.2×10^4	0.005
	Uranium-233	5.0×10^2	<0.001
	Curium-244	2.5×10^5	0.015

a. Release fraction of 5×10^{-5} from 3 percent of core melted.

TE | Table 4-24. Median Individual Doses from Maximum Design-Basis Accident Occurring at K-, L-, or P-Reactor

TE	Measure	Dose (rem) K-Reactor	L-Reactor	P-Reactor
	Effective Dose Equivalent			
TC	Onsite (0.8 km)	21	22	22
	Offsite (Site boundary)	0.47	0.51	0.44
	Thyroid			
	Onsite (0.8 km)	2.5	2.5	2.7
TC	Offsite (Site boundary)	0.39	0.39	0.33

TE | Table 4-25. Probable Offsite Doses from Full-Charge Inventories of Possible Nonfission Products[a]

	Isotope	Maximum Inventory (Ci)	Effective Dose Equivalent (rem)
TC	Plutonium-238	1.5×10^5	0.015
	Plutonium-239	2.2×10^4	0.005
	Uranium-233	5.0×10^2	<0.001
	Curium-244	2.5×10^5	0.015

a. Release fraction of 5×10^{-5} from 3 percent of core melted.

Table 4-29. Confinement Event Tree Top Event Definitions | TE

Time Period	Event	Description
In-vessel	RRSS Actuated	Operators turn on RRSS. Spray water will absorb iodine released to reactor room, thus reducing burden on filters.
	CHRS Actuated	Operators turn on CHRS. Water dumped from disassembly basin forms 20-cm-deep pool on lower-level floor for cooling core debris.
Vessel Failure	No Steam Explosion	Energetic event does not accompany primary system failure. This event also subsumes recriticality events (i.e., effects of recriticality assumed to be essentially those of steam explosion).
Ex-vessel	Filters Intact	HEPA and charcoal filters are not functionally damaged. Operation of exhaust fans is implied.
	Core Debris Cooled	Fuel and target debris generated during core melt is cooled to solidification within primary system or on confinement floor.
	No Iodine Desorbed	Charcoal filters retain all iodine they absorb; implies that charcoal bed temperatures are maintained below 500°C and HEPA filter aerosol capture is sufficiently low.
	No Filter Burn	Charcoal filters do not ignite. Failure assumes that all fission products captured are released.
Long Term	Fans Operate	Building exhaust fans continue to operate for 30 days following core melt. Failure assumes charcoal bed ignition occurs.

Table 4-30. Release Category Characteristics[a] TE

Release Category	Confinement Status	Water Present for Scrubbing In-Vessel Releases	Intermediate Filter Status	Water Present for Scrubbing Ex-Vessel Releases	Filter Heat-Up
1	AACS on	Deep Water	Intact	Deep Water	None
1a	AACS on	Deep Water	Intact	Deep Water	Delayed Desorption
2	AACS on	Dry	Intact	Dry	Desorption
2a	AACS on	Dry	Intact	Dry	Delayed Burn
2b	AACS on	Dry	Intact	Dry	Burn
3	AACS on	Some Water	Intact	Dry	Small Desorption
3a	AACS on	Some Water	Intact	Dry	Delayed Desorption
4	AACS on	Spray Only	Intact	Some Water	Moderate Desorption
4a	AACS on	Spray Only	Intact	Some Water	Delayed Desorption
4b	AACS on	Spray Only	Intact	Some Water	Burn
4c	AACS on	Spray Only	Intact	None	None
4d	AACS on	Spray Only	Intact	None	Delayed Desorption
5	Failed	Dry	NA[b]	Dry	NA
5a	Failed	Dry	NA	Dry	NA
6	Isolated	Dry	NA	Dry	NA
6a	Isolated	Dry	NA	Dry	NA
7	Failed	Deep Water	NA	Deep Water	NA
7a	Failed	Deep Water	NA	Deep Water	NA
8	Isolated	Deep Water	NA	Deep Water	NA
8a	Isolated	Deep Water	NA	Deep Water	NA
9	AACS on	Deep Water	Failed	Deep Water	Complete Desorption
9a	AACS on	Deep Water	Failed	Deep Water	Complete Desorption
10	AACS on	Dry	Failed	Dry	Complete Desorption
10a	AACS on	Dry	Failed	Dry	Complete Desorption
11	AACS on	Spray Only	Failed	Some Water	Complete Desorption
11a	AACS on	Spray Only	Failed	Some Water	Complete Desorption

TE

a. Source: WSRC, 1990.
b. NA = Not Applicable. TE

TE | Table 4-31. Fission Products Released to Confinement During Severe Accidents[a]

TC	Primary Release Category – Postulated Accident Sequence Release Group	Release to Confinement (Percent of Core Inventory)								
		Noble Gas[b] 1	Iodine as I_2 2	Iodine as C_sI 2	Cs[c] 3	Te[c] 4	Sr[c] 5	Ru/La/Ce[d] 6,7,8	Ba[c] 9	Eu,Sm[c] 9
	1. LOPA due to secondary LOCA	100	1	5	5	5	75	–	14	21
	2. LOHSA due to basin drain	100	50	50	75	60	75	–	19	30
	3. LOCA with degraded ECS	100	25	13	25	13	63	–	28	25
	4. LOCA	100	50	50	75	60	75	–	19	30
	5. Seismic LOHSA due to external cooling line break (confinement fails)	100	50	50	75	60	75	–	19	30
	6. Seismic LOHSA due to external cooling line break (confinement filters/fans isolated)	100	50	50	75	60	75	–	19	30
	7. Seismic LOPA due to internal cooling line break (confinement fails)	100	1	5	5	5	75	–	14	21
	8. Seismic LOPA due to internal cooling line break (confinement filters/fans isolated)	100	1	5	5	5	75	–	14	21
	9. LOPA due to secondary LOCA (steam explosion)	100	1	6	6	6	77	1	15	22
	10. LOHSA due to basin drain (steam explosion)	100	50	51	76	61	77	1	20	31
	11. LOCA (steam explosion)	100	50	51	76	61	77	1	20	31

a. Source: WSRC, 1990.

b. Tritium is assumed to transport with the characteristics of a noble gas (xenon, krypton); this is conservative because much of the tritium will be retained throughout the reactor and confinement as tritiated water. TE

c. Cs = cesium; Te = tellurium; Sr = strontium; Ba = barium; Eu = europium; Sm = samarium. TC

d. Release of low-volatility groups headed by ruthenium (Ru), lanthanum (La), and cerium (Ce) was assumed, based on fission-product chemistry for metal fuel, to be zero for scenarios that do not contain MFCI. For MFCI scenarios, releases of 1 percent of Ru/La/Ce were assumed. TC

Table 4-32. Fission Products Released to the Environment During Severe Accidents[a] | TE

Release Category	Release Location	Release to Environment (Fraction of Core Inventory)							
		Noble Gas[b] 1	Iodine 2	Cesium 3	Tellurium 4	Strontium 5	Ru/La/Ce[c] 6,7,8	Ba (Eu,Sm)[d] 9	Tritium 10
1	Stack	1.0	1.3×10^{-5}	1.3×10^{-5}	1.3×10^{-5}	1.0×10^{-4}	—	7.0×10^{-5}	1.0
1a	Stack	1.0	3.4×10^{-2}	1.3×10^{-5}	1.3×10^{-5}	1.0×10^{-4}	—	7.0×10^{-5}	1.0
2	Stack	1.0	8.0×10^{-2}	3.7×10^{-4}	2.9×10^{-4}	3.7×10^{-4}	—	2.4×10^{-4}	1.0
2a	Stack	1.0	9.9×10^{-1}	3.7×10^{-4}	2.9×10^{-4}	1.1×10^{-3}	—	2.4×10^{-4}	1.0
2b	Stack	1.0	9.9×10^{-1}	7.1×10^{-1}	2.9×10^{-1}	3.7×10^{-4}	—	2.4×10^{-4}	1.0
3	Stack	1.0	2.3×10^{-4}	9.3×10^{-5}	4.8×10^{-5}	2.0×10^{-4}	—	1.3×10^{-4}	1.0
3a	Stack, roof	1.0	2.8×10^{-1}	9.3×10^{-5}	4.8×10^{-5}	2.0×10^{-4}	—	1.3×10^{-4}	1.0
4	Stack	1.0	3.3×10^{-2}	2.3×10^{-4}	1.8×10^{-4}	3.1×10^{-4}	1.2×10^{-4}	7.8×10^{-5}	1.0
4a	Stack	1.0	6.6×10^{-1}	2.3×10^{-4}	1.8×10^{-4}	3.1×10^{-4}	1.2×10^{-4}	7.8×10^{-5}	1.0
4b	Stack	1.0	6.6×10^{-1}	4.3×10^{-1}	1.7×10^{-1}	3.1×10^{-4}	1.2×10^{-4}	7.8×10^{-5}	1.0
4c	Stack	1.0	3.3×10^{-2}	2.3×10^{-4}	1.8×10^{-4}	7.0×10^{-5}	2.8×10^{-5}	2.2×10^{-5}	1.0
4d	Stack	1.0	6.6×10^{-1}	2.3×10^{-4}	1.8×10^{-4}	7.0×10^{-5}	2.8×10^{-5}	1.7×10^{-5}	1.0
5	Roof	1.0	9.4×10^{-1}	6.6×10^{-1}	5.4×10^{-1}	6.8×10^{-1}	—	4.1×10^{-1}	1.0
5a	Roof	1.0	9.4×10^{-1}	6.6×10^{-1}	5.4×10^{-1}	6.9×10^{-1}	1.0×10^{-2}	4.2×10^{-1}	1.0
6	Ground	1.0	5.0×10^{-1}	5.5×10^{-3}	8.6×10^{-3}	6.7×10^{-2}	—	7.0×10^{-2}	1.0
6a	Ground	1.0	5.0×10^{-1}	5.5×10^{-3}	8.6×10^{-3}	6.7×10^{-2}	—	7.0×10^{-2}	1.0
7	Roof	1.0	4.8×10^{-3}	5.8×10^{-3}	5.6×10^{-3}	2.4×10^{-1}	—	1.5×10^{-1}	1.0
7a	Roof	1.0	4.8×10^{-3}	5.8×10^{-3}	5.6×10^{-3}	2.3×10^{-3}	—	2.1×10^{-3}	1.0
8	Ground, roof	1.0	7.8×10^{-3}	7.8×10^{-3}	7.7×10^{-3}	2.4×10^{-1}	—	1.5×10^{-1}	1.0
8a	Ground, roof	1.0	7.8×10^{-3}	7.8×10^{-3}	7.7×10^{-3}	3.8×10^{-3}	—	3.1×10^{-3}	1.0
9	Stack, ground, roof	1.0	3.5×10^{-2}	1.7×10^{-2}	8.5×10^{-3}	1.3×10^{-1}	8.8×10^{-3}	8.2×10^{-2}	1.0
9a	Stack, ground, roof	1.0	3.5×10^{-2}	1.7×10^{-2}	8.5×10^{-3}	1.3×10^{-3}	8.8×10^{-3}	2.2×10^{-3}	1.0
10	Stack, ground, roof	1.0	7.4×10^{-1}	4.5×10^{-1}	2.0×10^{-1}	4.8×10^{-1}	8.8×10^{-3}	3.1×10^{-1}	1.0
10a	Stack, ground, roof	1.0	7.4×10^{-1}	4.5×10^{-1}	2.0×10^{-1}	1.7×10^{-2}	8.8×10^{-3}	1.9×10^{-2}	1.0
11	Stack, ground, roof	1.0	6.4×10^{-1}	3.6×10^{-1}	1.9×10^{-1}	3.9×10^{-1}	8.8×10^{-3}	2.5×10^{-1}	1.0
11a	Stack, ground, roof	1.0	6.4×10^{-1}	3.6×10^{-1}	1.9×10^{-1}	1.2×10^{-2}	8.8×10^{-3}	1.6×10^{-2}	1.0

a. Source: WSRC, 1990.

b. Noble gas = xenon, krypton.

c. *Ru = ruthenium*; La = lanthanum; Ce = cerium.

d. Barium (Ba), europium (Eu), and samarium (Sm) species are assumed, based on fission-product chemistry for metal fuel, to be released in proportion to their vapor pressures at 1,463°C. These species are tracked individually in confinement analyses and "lumped together" for consequence analysis. | TC

TC | Table 4-33. Offsite Consequence Mitigation Model Parameters by Release Category

TC |

Release Category	Radius of Applicability (km from K-Reactor)	Start Time (hours after Release)	Radial Evac. Velocity (km/hr)
1	0 - 32	2	4.0
1a	0 - 32	2	4.0
2	0 - 32	2	4.0
2a	0 - 32	2	4.0
2b	0 - 32	2	4.0
3	0 - 32	2	4.0
3a	0 - 32	2	4.0
4	0 - 32	2	4.0
4a - 4d	0 - 32	2	4.0
5	0 - 32	4	2.0
5a	0 - 32	4	2.0
6	0 - 32	2	4.0
6a	0 - 32	2	4.0
7	0 - 32	4	2.0
7a	0 - 32	4	2.0
8	0 - 32	2	4.0
8a	0 - 32	2	4.0
9	0 - 32	2	4.0
9a	0 - 32	2	4.0
10	0 - 32	2	4.0
10a	0 - 32	2	4.0
11	0 - 32	2	4.0
11a	0 - 32	2	4.0

TC | Source: WSRC, 1990.

Table 4-34. Onsite Consequence Mitigation Model Parameters by Release Category | TC

Release Category	Radius of Applicability (km from K-Reactor)	Start Time (hours after Release)	Radial Evac. Velocity (km/hr)
1, 1a	0 - 8	0.5	13.6
	8 - 32	Not sheltered	
2, 2a,b	0 - 8	0.5	13.6
	8 - 32	Not sheltered	
3, 3a	0 - 8	0.5	13.6
	8 - 32	Not sheltered	
4, 4d	0 - 8	0.5	13.6
	8 - 32	Not sheltered	
5, 5a	0 - 8	1.0	6.8
	8 - 32	Not sheltered	
6, 6a	0 - 8	0.5	13.6
	8 - 32	Not sheltered	
7, 7a	0 - 8	1.0	6.8
	8 - 32	Not sheltered	
8, 8a	0 - 8	0.5	13.6
	8 - 32	Not sheltered	
9, 9a	0 - 8	0.5	13.6
	8 - 32	Not sheltered	
10, 10a	0 - 8	0.5	13.6
	8 - 32	Not sheltered	
11, 11a	0 - 8	0.5	13.6
	8 - 32	Not sheltered	

Source: WSRC, 1990. | TC

Table 4-41. Estimated Annual Transportation Accident Doses[a]

Event	Event frequency (per year)	Dose[b]			
		Maximum individual 60 meters (mrem/year)	Maximum individual site perimeter (mrem/year)	Onsite population (person-rem/year)	Offsite population (person-rem/year)
Atmospheric releases					
TRU drum failure and fire	1.5×10^{-5}	6.4×10^{-1}	2.3×10^{-4}	1.2×10^{-3}	1.3×10^{-3}
HLW trailer accident	1.5×10^{-9}	8.5×10^{-5}	3.8×10^{-8}	1.7×10^{-7}	1.5×10^{-7}
Rupture of D_2O drum	3.1×10^{-5}	1.8×10^{-2}	2.5×10^{-5}	5.6×10^{-6}	5.9×10^{-5}
Liquid releases					
HLW trailer accident	1.5×10^{-11}	N/A	3.8×10^{-10}	N/A	8.2×10^{-8}

a. Source: WSRC, 1989d.
b. The dose is the product of the dose per event and the frequency of the event.

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Table 4-44. Cumulative Atmospheric Releases (curies per year)[a]

Nuclide	K-, L-, and P-Reactors	Existing Support Facilities					New SRS Facilities not in Operation 1984-1986					VEGP[l]	Cumulative Total
		Separations[b]	Fabrication[c]	Heavy Water[d]	SRL[e]	Subtotal[f]	DWPF[g]	F&H ETF[h]	CIF[i]	RTF[j]	Subtotal[k]		
H-3 (oxide)	1.97×10^{5}	1.88×10^{5}		1.55×10^{3}	1.65×10^{1}	1.89×10^{5}							N/A
H-3 (elem.)		1.60×10^{5}				1.60×10^{5}							N/A
H-3 Total	1.97×10^{5}	3.48×10^{5}		1.55×10^{3}	1.65×10^{1}	3.49×10^{5}	1.99×10^{1}	5.99×10^{2}	8.08×10^{1}	5.00×10^{3}	5.70×10^{3}	1.86×10^{2}	5.52×10^{5}
Be-7												8.77×10^{-6}	8.77×10^{-6}
C-14	4.17×10^{1}	2.80×10^{1}				2.80×10^{1}	2.12×10^{-2}				2.12×10^{-2}		6.97×10^{1}
Ar-41	5.70×10^{4}											1.32×10^{1}	5.70×10^{4}
Cr-51								2.35×10^{-7}	6.48×10^{-5}		6.50×10^{-5}		6.50×10^{-5}
Kr-85m	1.49×10^{3}												1.49×10^{3}
Kr-85		6.80×10^{5}				6.80×10^{5}						8.49×10^{-5}	6.80×10^{5}
Kr-87	1.03×10^{3}											2.75	1.03×10^{3}
Kr-88	1.55×10^{3}												1.55×10^{3}
Xe-131m		2.65				2.65						5.20×10^{-1}	3.17
Xe-133m												7.70×10^{-2}	7.70×10^{-2}
Xe-133	6.30×10^{3}	3.20×10^{-3}				3.20×10^{-3}						1.71×10^{2}	6.47×10^{3}
Xe-135	2.29×10^{3}											1.72×10^{1}	2.31×10^{3}
I-129		7.60×10^{-2}				7.60×10^{-2}	8.19×10^{-5}	5.41×10^{-8}			8.20×10^{-5}		7.61×10^{-2}
I-131	8.60×10^{-3}	3.14×10^{-2}			1.80×10^{-3}	3.32×10^{-2}		5.41×10^{-8}			5.41×10^{-8}	2.28×10^{-5}	4.18×10^{-2}
I-133												1.88×10^{-4}	1.88×10^{-4}
Co-58								4.69×10^{-8}			4.69×10^{-8}	5.16×10^{-6}	5.21×10^{-6}
Co-60		4.00×10^{-6}				4.00×10^{-6}	6.12×10^{-8}	4.69×10^{-8}	1.76×10^{-5}		1.77×10^{-5}		2.17×10^{-5}
Zn								3.76×10^{-8}			3.76×10^{-8}		3.76×10^{-8}
Se-75		1.52×10^{-5}				1.52×10^{-5}							1.52×10^{-5}
Se-79							8.84×10^{-9}				8.84×10^{-9}		8.84×10^{-9}
Sr-89, 90	3.13×10^{-4}	1.39×10^{-3}			1.30×10^{-5}	1.40×10^{-3}	2.29×10^{-5}	5.13×10^{-6}	9.25×10^{-5}		1.21×10^{-4}		1.84×10^{-3}
Y-90							2.36×10^{-5}	7.95×10^{-7}	9.05×10^{-7}		2.53×10^{-5}		2.53×10^{-5}
Y-91								3.49×10^{-6}	3.00×10^{-5}		3.35×10^{-5}		3.35×10^{-5}
Zr-95		1.68×10^{-2}				1.68×10^{-2}		8.07×10^{-6}	2.02×10^{-5}		2.83×10^{-5}		1.68×10^{-2}
Nb-95		2.89×10^{-2}				2.89×10^{-2}		1.13×10^{-5}	4.86×10^{-5}		5.99×10^{-5}		2.90×10^{-2}
Tc-99							3.79×10^{-7}				3.79×10^{-7}		3.79×10^{-7}
Ru-103		7.25×10^{-3}				7.25×10^{-3}		1.40×10^{-5}			1.40×10^{-5}		7.26×10^{-3}
Ru-106		5.12×10^{-2}				5.12×10^{-2}	3.18×10^{-5}	8.44×10^{-5}	3.52×10^{-5}		1.51×10^{-4}		5.14×10^{-2}
Sn-126							6.89×10^{-9}				6.89×10^{-9}		6.89×10^{-9}
Sb-125							6.67×10^{-7}	9.38×10^{-9}			6.76×10^{-7}		6.76×10^{-7}
Te-125m							1.00×10^{-5}	7.52×10^{-10}			1.00×10^{-5}		1.00×10^{-5}
Te-127m							4.46×10^{-9}				4.46×10^{-9}		4.46×10^{-9}

Table 4-44. Cumulative Atmospheric Releases (curies per year)[a] (continued)

Nuclide	K-, L-, and P-Reactors	Existing Support Facilities					New SRS Facilities not in Operation 1984-1986					VEGP[l]	Cumulative Total
		Separations[b]	Fabrication[c]	Heavy Water[d]	SRL[e]	Subtotal[f]	DWPF[g]	F&H ETF[h]	CIF[i]	RTF[j]	Subtotal[k]		
Te-127							4.37×10^{-9}				4.37×10^{-9}		4.37×10^{-9}
Cs-134		3.62×10^{-4}				3.62×10^{-4}	2.92×10^{-5}	1.97×10^{-6}			3.12×10^{-5}		3.93×10^{-4}
Cs-135							9.37×10^{-9}				9.37×10^{-9}		9.37×10^{-9}
Cs-137		4.07×10^{-3}				4.07×10^{-3}	4.07×10^{-3}	5.71×10^{-6}	1.70×10^{-4}		4.25×10^{-3}		8.32×10^{-3}
Ce-141		1.83×10^{-3}				1.83×10^{-3}		9.81×10^{-7}			9.81×10^{-7}		1.83×10^{-3}
Ce-144		3.11×10^{-2}				3.11×10^{-2}	3.04×10^{-6}	3.94×10^{-5}	1.32×10^{-4}		1.74×10^{-4}		3.13×10^{-2}
Pr-144							3.05×10^{-6}	3.87×10^{-5}	1.32×10^{-4}		1.74×10^{-4}		1.74×10^{-4}
Pm-147							7.62×10^{-6}	1.37×10^{-6}	6.16×10^{-5}		7.06×10^{-5}		7.06×10^{-5}
Sm-151							1.59×10^{-7}				1.59×10^{-7}		1.59×10^{-7}
Eu-152							1.39×10^{-9}				1.39×10^{-9}		1.39×10^{-9}
Eu-154							2.30×10^{-7}				2.30×10^{-7}		2.30×10^{-7}
Eu-155							1.61×10^{-7}				1.61×10^{-7}		1.61×10^{-7}
Os-185		3.60×10^{-4}				3.60×10^{-4}							3.60×10^{-4}
Th-234								3.22×10^{-10}			3.22×10^{-10}		3.22×10^{-10}
U-235, 238		2.00×10^{-3}	1.04×10^{-4}			2.10×10^{-3}		4.25×10^{-8}			4.25×10^{-8}		2.10×10^{-3}
Pu-238		1.28×10^{-3}				1.28×10^{-3}	7.89×10^{-7}	1.46×10^{-7}			9.35×10^{-7}		1.28×10^{-3}
Pu-239	6.61×10^{-6}	4.01×10^{-4}	1.41×10^{-5}		1.50×10^{-6}	4.17×10^{-4}	7.10×10^{-9}	8.84×10^{-8}			9.55×10^{-8}		4.23×10^{-4}
Pu-240							4.82×10^{-9}				4.82×10^{-9}		4.82×10^{-9}
Pu-241							7.71×10^{-7}				7.71×10^{-7}		7.71×10^{-7}
Am-241, 243		2.90×10^{-4}				2.90×10^{-4}	8.62×10^{-9}				8.62×10^{-9}		2.90×10^{-4}
Cm-242, 244		1.37×10^{-4}				1.37×10^{-4}	2.66×10^{-8}				2.66×10^{-8}		1.37×10^{-4}
Alpha[m]												7.04×10^{-7}	7.04×10^{-7}

a. Reactor data for 1984-86; data for other facilities are average of 1985 and 1986 (WSRC, 1989c).
b. 200-F and 200-H Area Chemical Separations Facilities
c. 300-M Area Fuel and Target Fabrication Facility
d. 400-D Area Heavy Water Rework Facility
e. Savannah River Laboratory facilities
f. Total atmospheric releases from existing support facilities
g. Defense Waste Processing Facility
h. 200-F and 200-H Areas Effluent Treatment Facility
i. Consolidated Incineration Facility
j. Replacement Tritium Facility
k. Total atmospheric release from new SRS facilities
l. Vogtle Electric Generating Plant
m. Assumed to be Pu-239

Table 4-45. Liquid Releases to the Savannah River (*curies per year*)[a]

Nuclide	K-, L-, and P-Reactors	Support Facilities					New Facilities Subtotal F & H ETF[g]	VEGP[h]	Cumulative Total
		Separations[b]	Fabrication[c]	Heavy Water[d]	SRL[e]	Subtotal[f]			
H-3	1.16×10^{4}	1.38×10^{4}		3.12×10^{3}		1.70×10^{4}	3.25×10^{4}	8.78×10^{2}	7.41×10^{4} TC
Be-7								5.90×10^{-3}	5.90×10^{-3}
Na-24								5.35×10^{-3}	5.35×10^{-3}
Cr-51								4.36×10^{-1}	4.36×10^{-1}
Mn-54								6.66×10^{-2}	6.66×10^{-2}
Fe-55								2.85×10^{-1}	2.85×10^{-1}
Fe-59								5.08×10^{-2}	5.08×10^{-2}
Co-57								3.25×10^{-3}	3.25×10^{-3}
Co-58, 60	1.00×10^{-3}							1.65	1.66
Ni-65								2.31×10^{-5}	2.31×10^{-5}
Zn-65								1.95×10^{-3}	1.95×10^{-3}
Rb-86								3.05×10^{-5}	3.05×10^{-5}
Sr-90	1.30×10^{-2}	2.73×10^{-1}		6.73×10^{-3}	1.39×10^{-4}	2.80×10^{-1}	5.00×10^{-2}		3.43×10^{-1}
Beta[i]							1.20×10^{-1}		1.20×10^{-1}
Y-92								2.05×10^{-5}	2.05×10^{-5}
Zr-95							2.00×10^{-2}	3.00×10^{-2}	5.00×10^{-2}
Zr-97								2.25×10^{-5}	2.25×10^{-5}
Nb-95							1.50×10^{-2}	4.55×10^{-2}	6.05×10^{-2}
Nb-97								1.53×10^{-5}	1.53×10^{-5}
Mo-99								1.37×10^{-3}	1.37×10^{-3}
Tc-99m								1.81×10^{-3}	1.81×10^{-3}
Ru-103								4.61×10^{-5}	4.61×10^{-5}
Ru-105								4.97×10^{-5}	4.97×10^{-5}
Ru-106							6.00×10^{-1}		6.00×10^{-1}
Sb-122								1.61×10^{-3}	1.61×10^{-3}
Sb-124								3.23×10^{-2}	3.23×10^{-2}
Sb-125								2.14×10^{-2}	2.14×10^{-2}
I-129		2.20×10^{-2}				2.20×10^{-2}			2.20×10^{-2}
I-131								3.78×10^{-3}	3.78×10^{-3}
I-132								2.52×10^{-4}	2.52×10^{-4}
I-133								6.51×10^{-3}	6.51×10^{-3}
I-135								1.86×10^{-3}	1.86×10^{-3}
Te-129m								3.92×10^{-3}	3.92×10^{-3}
Te-132								6.13×10^{-5}	6.13×10^{-5}

Table 4-45. Liquid Releases to the Savannah River (curies per year)[a] (continued)

Nuclide	K-, L-, and P-Reactors	Support Facilities					New Facilities Subtotal	VEGP[h]	Cumulative Total
		Separations[b]	Fabrication[c]	Heavy Water[d]	SRL[e]	Subtotal[f]	F & H ETF[g]		
Cs-134								5.12×10^{-6}	5.12×10^{-6}
Cs-137[j]	3.33×10^{-7}	1.49×10^{-1}		4.83×10^{-4}		1.49×10^{-1}	2.50×10^{-2}	2.07×10^{-4}	1.75×10^{-1} TC
Ba-139								4.78×10^{-5}	4.78×10^{-5}
Ba-140								9.17×10^{-5}	9.17×10^{-5}
La-140								1.11×10^{-3}	1.11×10^{-3}
Pr-144								2.21×10^{-3}	2.21×10^{-3}
Pm-147							5.00×10^{-2}		5.00×10^{-2}
Hf-181								2.45×10^{-2}	2.45×10^{-2}
W-187								3.97×10^{-3}	3.97×10^{-3}
U-235, 238			1.83×10^{-2}			1.83×10^{-2}			1.83×10^{-2}
Pu-239	3.19×10^{-4}	1.47×10^{-2}		1.26×10^{-2}	2.22×10^{-4}	2.75×10^{-2}			2.78×10^{-2}
Alpha[k]							5.00×10^{-3}		5.00×10^{-3}

a. Average for 1984-1986 (WSRC, 1989c).
b. 200-F and 200-H Area Chemical Separations Facilities.
c. 300-M Area Fuel and Target Fabrication Facility.
d. 400-D Area Heavy Water Rework Facility.
e. Savannah River Laboratory Facilities.
f. Total liquid releases from existing support facilities.
g. 200-F and 200-H Areas Effluent Treatment Facility. Defense Waste Processing Facility, Consolidated Incineration Facility, and Replacement Tritium Facility have no liquid radioactive releases to the Savannah River.
h. Vogtle Electric Generating Plant.
i. Assumed to be Sr-90.
j. An additional 0.51 curie per year of Cs-137 is remobilized and transported from onsite streams to the Savannah River.
k. Assumed to be Pu-239.

Table 4-46. Committed Effective Dose Equivalents from Annual Routine Releases

Release	Dose Equivalent				
	K-, L-, and P-Reactors	Existing Support Facilities	New Support Facilities	Cs-137 Remobilization	VEGP
LIQUID					
Maximum Individual, mrem	3.18×10^{-2}	1.41×10^{-1}	1.11×10^{-1}	2.81×10^{-1}	1.57×10^{-2}
Collective, person-rem					
Port Wentworth	5.84	9.90	1.68×10^{1}	2.03×10^{-1}	5.10×10^{-1}
Beaufort-Jasper	3.42	5.79	9.80	1.19×10^{-1}	2.99×10^{-1}
Fish-sport	6.85×10^{-3}	2.39×10^{-1}	6.97×10^{-2}	7.34×10^{-1}	2.96×10^{-2}
Fish-commercial	5.24×10^{-4}	1.83×10^{-2}	5.30×10^{-3}	5.62×10^{-2}	2.15×10^{-3}
Salt-water invertebrates	2.22×10^{-5}	5.68×10^{-4}	4.17×10^{-4}	1.40×10^{-5}	4.40×10^{-4}
Shoreline	9.91×10^{-6}	7.98×10^{-4}	2.39×10^{-4}	2.42×10^{-3}	1.10×10^{-3}
Swimming	6.44×10^{-9}	2.16×10^{-7}	4.23×10^{-7}	7.13×10^{-7}	5.11×10^{-6}
Boating	8.82×10^{-8}	2.96×10^{-6}	5.80×10^{-6}	9.77×10^{-6}	7.00×10^{-5}
Total	9.27	1.59×10^{1}	2.67×10^{1}	1.11	8.42×10^{-1}
ATMOSPHERIC					
Maximum Individual, mrem	3.42×10^{-1}	3.12×10^{-1}	6.42×10^{-3}	0	5.85×10^{-3}
Collective, person-rem					
Plume	4.11	3.63×10^{-1}	-	0	3.69×10^{-3}
Ground	2.66×10^{-5}	1.75×10^{-1}	2.49×10^{-2}	0	5.04×10^{-7}
Inhalation	9.93	1.01×10^{1}	2.88×10^{-1}	0	9.54×10^{-3}
Vegetables	4.77	7.47	1.29×10^{-1}	0	3.99×10^{-3}
Cow milk	1.37	1.62	3.54×10^{-2}	0	1.09×10^{-3}
Meat	1.23	1.36	2.67×10^{-2}	0	8.37×10^{-4}
Total	2.14×10^{1}	2.11×10^{1}	5.04×10^{-1}	0	1.92×10^{-2}

Table 4-47. Cumulative Maximum Doses from Annual Routine Releases[a]

Release	Dose equivalent
LIQUID	
Maximum Individual, mrem	
Reactors at SRS	3.18×10^{-2}
Support Facilities at SRS	1.41×10^{-1}
Cs-137 Redistribution from SRS Streams	2.81×10^{-1}
New Facilities at SRS	1.11×10^{-1}
VEGP	1.57×10^{-2}
Total	5.81×10^{-1}
Collective, person-rem	
Reactors at SRS	9.27
Support Facilities at SRS	1.59×10^{1}
Cs-137 Redistribution from SRS Streams	1.11
New Facilities at SRS	2.67×10^{1}
VEGP	8.42×10^{-1}
Total	5.38×10^{1}
ATMOSPHERIC	
Maximum Individual, mrem	
Reactors at SRS	3.42×10^{-1}
Support Facilities at SRS	3.12×10^{-1}
New Facilities at SRS	6.42×10^{-3}
VEGP	5.85×10^{-3}
Total	6.66×10^{-1}
Collective, person-rem	
Reactors at SRS	2.14×10^{1}
Support Facilities at SRS	2.11×10^{1}
New Facilities at SRS	5.04×10^{-1}
VEGP	1.92×10^{-2}
Total	4.30×10^{1}
ALL ROUTINE CUMULATIVE RELEASES	
Maximum Individual, mrem	1.25
Collective, person-rem	9.68×10^{1}

a. Committed effective dose equivalents.

Table 4-48. Common Risks[a,b] | TE

Estimated Annual Risk of Death	Occupation	Lifestyle	Accidents	Environmental
1 in 100(10^{-2})	Stuntman	-	-	Contaminated water (microbiological)
1 in 1,000(10^{-3})	Race Car Driver	Smoking (1 pack/day)	Skydiving	-
1 in 5,000(2×10^{-4})	Fireman, Miner, Farmer	Heavy drinking	Driving motor vehicle	-
1 in 8,000(1.25×10^{-4})	Policeman	-	-	Contaminated water (chemicals)
1 in 10,000(10^{-4})	Truck Driver	-	All home accidents Frequent air travel	-
1 in 25,000(4×10^{-5})	-	Two beers/day	Pedestrian/vehicle	-
1 in 50,000(2×10^{-5})	Banker, Engineer	Contraceptive pills	Skiing, home fires	-
1 in 100,000(10^{-5})	Insurance Agent	Diagnostic X-rays	Fishing	"Clean" drinking water Natural radiation Passive smoking Living below dam
1 in 500,000(2×10^{-6})	-	-	Poisoning	-
1 in 1,000,000(10^{-6})	-	Small pox vaccination	One air flight/year	Living within 8 km of nuclear reactor for 50 years
1 in 5,000,000(2×10^{-7})	-	One charcoaled steak/week	-	Hurricane, tornado, lightning
1 in 10,000,000(10^{-7})	-	-	-	Animal bite or insect sting

a. Adapted from: EPRI Journal, July/August 1985.
Hazardous Waste Management Engineering, Van Nostrand Reinhold, 1987.
Environmental Risk Analysis for Chemicals, Van Nostrand Reinhold, 1982.
Environmental Science and Technology, Vol. 23, No. 12, 1989. | TE

b. This table is provided for perspective only; it should not be used for comparison. | TC

Table 4-49. Reference Sections for Environmental Consequences of Termination of One or Two Reactors

Reactor Combination	Socioeconomics	Surface water/ groundwater	Cooling water discharge	Floodplain/ wetlands	Accidents
Operate K-Reactor; terminate L- and P-Reactors	4.1.1.1, 4.3.1	4.1.1.2.1, 4.1.1.3, 4.1.2.2, 4.3.3, 4.3.4, 4.3.5	4.1.1.4.1, 4.3.3	4.1.1.6.1, 4.1.1.6.2.1, 4.3.7	4.1.3.1.4, 4.1.3.1.5, 4.3.13
Operate L-Reactor; terminate K- and P-Reactors	4.1.1.1, 4.3.1	4.1.1.2.2, 4.1.1.3, 4.1.2.2, 4.3.3, 4.3.4, 4.3.5	4.1.1.4.2, 4.3.3	4.1.1.6.1, 4.1.1.6.2.2, 4.3.7	4.1.3.1.4, 4.1.3.1.5, 4.3.13
Operate P-Reactor; terminate K- and L-Reactors	4.1.1.1, 4.3.1	4.1.1.2.3, 4.1.1.3, 4.1.2.2, 4.3.3, 4.3.4, 4.3.5	4.1.1.4.3, 4.3.3	4.1.1.6.1, 4.1.1.6.2.3, 4.3.7	4.1.3.1.4, 4.1.3.1.5, 4.3.13
Operate L- and P-Reactors; terminate K-Reactor	4.1.1.1, 4.3.1	4.1.1.2.2, 4.1.1.2.3, 4.1.1.3, 4.1.2.2, 4.3.3, 4.3.4, 4.3.5	4.1.1.4.2, 4.1.1.4.3, 4.3.3	4.1.1.6.1, 4.1.1.6.2.2, 4.1.1.6.2.3, 4.3.7	4.1.3.1.4, 4.1.3.1.5, 4.3.13
Operate K- and P-Reactors; terminate L-Reactor	4.1.1.1, 4.3.1	4.1.1.2.1, 4.1.1.2.3, 4.1.1.3, 4.1.2.2, 4.3.3, 4.3.4, 4.3.5	4.1.1.4.1, 4.1.1.4.3, 4.3.3	4.1.1.6.2.1, 4.1.1.6.2.3, 4.3.7	4.1.3.1.4, 4.1.3.1.5, 4.3.13
Operate K- and L-Reactors; terminate P-Reactor	4.1.1.1, 4.3.1	4.1.1.2.1, 4.1.1.2.2, 4.1.1.3, 4.1.2.2, 4.3.3, 4.3.4, 4.3.5	4.1.1.4.1, 4.1.1.4.2, 4.3.3	4.1.1.6.2.1, 4.1.1.6.2.2, 4.3.7	4.1.3.1.4, 4.1.3.1.5, 4.3.13

TC

GLOSSARY

abiotic

Nonliving components of the environment.

absorbed dose

Energy transferred to matter when ionizing radiation passes through it; measured in rad or millirad (thousandth of a rad).

absorption

The process by which the number and energy of particles or photons entering a body of matter are reduced by interaction with the matter.

accident

An unplanned event that could have significant effects within and/or beyond the SRS boundary.

accident sequence

An initiating event followed by system failures or operator errors, which can result in significant core damage, confinement system failure, and/or radionuclide releases.

activation products

Nuclei, usually radioactive, formed by the bombardment of material with neutrons, protons, or other nuclear particles.

acute exposure

The exposure incurred during and shortly after a radiological release. Generally, the period of acute exposure ends when long-term interdiction is established, as necessary. For convenience, the period of acute exposure is normally assumed to end 1 week after the inception of a radiological accident.

adsorption

The adhesion of a substance to the surface of a solid or solid particles.

air quality

A measure of the levels of constituents in the air.

air-quality standards

The legally prescribed level of constituents in the outside air that cannot be exceeded during a specified time in a specified area.

air sampling

The collection and analysis of air samples for detection or measurement of
TC | airborne substances.

alkalinity

Acid-neutralizing capacity of water.

allochthonous

Not indigenous; not originally produced in an area.

alpha (α) particle

A positively charged particle, consisting of two protons and two neutrons, that 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).

alteration
TC

A change in biological form, structure, or characteristics.

ambient air

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

anadromous

Fishes that migrate annually from salt to fresh water to spawn.

anion

Any chemical species with a negative charge [e.g., the chloride ion (Cl^-) is an anion].

anoxic

Devoid of oxygen; applied to surface waters, lakes, or streams from which the dissolved oxygen has been depleted by natural, thermal, or biological processes.

anticipated transient without scram (ATWS)
TC

An accident in which a transient that is designed to control a reactor scram fails to perform its function.

anticyclone

An area of high atmospheric pressure, usually 2,400 to 4,000 kilometers (1,500 to 2,500 miles) in diameter; said to be stagnant or stagnating if not advancing at a rate of 32 to 48 kilometers (20 to 30 miles) per hour.

aquatic biota

The sum total of living organisms within any designated aquatic area.

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 or outcrop.

aquitard

A less permeable geologic unit in a stratigraphic sequence. The unit is not permeable enough to transmit significant quantities of water.

archaeological sites (resources)

Areas or objects modified or made by man, and the data associated with these features and artifacts.

artifact

An object produced or shaped by human workmanship of archaeological or historical interest.

Atomic Energy Commission (AEC)

A five-member commission established by the Atomic Energy Act of 1954 to supervise the use of nuclear energy. The AEC was dissolved in 1975 and its functions were transferred to the Nuclear Regulatory Commission (NRC) and to the Energy Research and Development Administration (ERDA), which became the Department of Energy (DOE).

austenitic stainless steel

A type-304 stainless steel (American Iron and Steel Institute) containing 18 percent chromium and 8 percent nickel, used in nuclear applications. When properly heat-treated (annealed), or stabilized with other metals such as columbium (niobium), type-304 stainless becomes very resistant to corrosion or cracking at elevated temperatures. Solutions of salts of chlorine (chlorides; e.g., sodium chloride) have a corrosive effect on type-304 stainless steels and can cause cracking or chloride-stress corrosion.

background exposure

See exposure to radiation.

background radiation

Ionizing radiation present in the environment from cosmic rays and from natural sources in the earth; background radiation varies considerably with location. (See natural radiation.)

balanced biological community

A dynamic biological condition in which a group of plants and animals living in a specific region under relatively similar conditions tends to maintain a state of ecologic equilibrium among its various members. A balanced biological community exhibits species diversity in which the population density of each species is affected by the population densities of all its associated species, as well as by the constantly changing conditions of the physical habitat.

TC

base requirement

A quantity of nuclear material that must be produced such that the supply (existing inventory plus new production) will be equal to the demand.

basement

Crustal layer beneath a sedimentary layer and above the Mohorovicic discontinuity.

bedroom community

An area, adjacent to a city, where a large number of individuals who work in the city reside.

benthic

Bottom-dwelling plants and animals.

beta particle (ß)

An elementary particle emitted from a nucleus during radioactive decay; it is negatively charged, identical to an electron, and easily stopped, as by a thin sheet of metal.

bin

A group used in sorting by uniform category or characteristics.

biofouling

Aquatic organisms such as bacteria, fungi, algae, and clams, that colonize in water-flow structures (e.g., cooling water systems of powerplants/ reactors), often causing restricted water flow.

biological dose

The radiation dose absorbed in biological material measured in rem or millirem (thousandth of a rem).

biological shield

A mass of absorbing material placed around a radioactive source to reduce the radiation to a level safe for humans.

biomass

Total weight of organisms per unit area.

biota (biotic)

The plant and animal life of a region.

British thermal unit (Btu)

A unit of heat; the quantity of heat required to raise the temperature of 1 pound of water by 1 degree Fahrenheit. One Btu equals 1055 joules (or 252 calories).

burial ground

A place for burying unwanted (i.e., radioactive) materials in which the earth acts as a receptacle to prevent the dispersion of wastes in the environment and the escape of radiation.

calcareous

Containing calcium carbonate (calcite or limestone).

cancer

The name given to a group of diseases that are characterized by uncontrolled cellular growth.

canopy

The high, overarching coverage of leaves, twigs, and branches of forest trees or other woody plants.

carbon adsorption

A unit physicochemical process in which organic and certain inorganic compounds in a liquid stream are adsorbed on a bed of activated carbon; used in water or waste purification and chemical processing.

carbon dioxide (CO_2)

A colorless, odorless, nonpoisonous gas that is a normal component of the ambient air; it is an expiration product of normal plant and animal life.

carbon monoxide (CO)

A colorless, odorless gas that is toxic if breathed in high concentration over a certain period of time; it is a normal component of most automotive exhaust systems.

Carolina bay

Ovate, intermittently flooded, marshy depression of a type occurring abundantly on the Coastal Plain from New Jersey to Florida.

cask (radioactive materials)

A massive, heavily-shielded container for holding radioactive material.

cation

Any chemical species with a positive charge [e.g., the sodium ion (Na^+) is a cation].

cavitation

The formation and collapse of vapor cavities in a flowing liquid; collapse of the cavities can produce objectionable noise and vibration and a decrease in the performance and efficiency of the liquid-handling equipment.

cermet fuel

A ceramic-metal (or cermet) composite fuel (U_3O_8 particles dispersed in an aluminum matrix) developed at SRS as an alternative to the current uranium-aluminum alloy fuel clad in aluminum.

chemical oxygen demand

A measure of the quantity of chemically oxidizable components present in water.

chronic exposure

Long-term, low-level exposure incurred over a long time period due to residual contamination, after long-term protective actions and interdiction strategies are in place.

cladding

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

clastic

Consisting of fragments of preexisting rocks. TC

claystone

A clay having the composition of shale, but lacking its fine lamination.

cold shock

A rapid decrease in effluent water temperature that can result in fish mortality.

cold shutdown

A mode of reactor operation in which the reactor is shut down; in this mode, plant systems can undergo maintenance, or the reactor can be fueled or defueled. TC

cold standby

Maintenance of a protected reactor condition in which the fuel is removed, moderator is stored in tanks, and equipment and system layup is performed to prevent deterioration, such that future refueling and restart is possible.

collective committed effective dose equivalent

The committed effective dose equivalent to a population group, expressed in person-rem. See committed effective dose equivalent.

committed dose equivalent

The dose to a tissue or organ of the body from a radionuclide, which is delivered over the effective lifetime of that nuclide in that tissue or organ.

committed effective dose equivalent

The sum of the committed dose equivalents to various tissues of the body, expressed in rem. It does not include contributions from external dose.

community (biological term)

All plant and animal populations occupying a specific area under relatively similar conditions.

complementary cumulative distribution function (CCDF)

The consequence-probability distribution curves used to represent the conditional probabilities for the various health effects due to severe accidents.

concentration

The quantity of a substance in a unit quantity of a sample (e.g., milligrams per liter, or micrograms per kilogram).

conductivity

The ability to transmit a fluid or energy flow.

conglomerate

Rounded rock fragments or pebbles, cemented together by another mineral substance.

coolant

A substance, usually water, circulated through a processing plant to remove heat.

core damage frequency

The rate at which accidents are expected to result in damage to the reactor core (fuel and target materials); core damage can range from slight to full melting of the core materials.

TC coulomb

The quantity of electrical current equivalent to 1 ampere acting for 1 second.

Cretaceous

The geologic period making up the end of the Mesozoic Era, a range from about 144 to 66 million years ago.

criticality

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

crystalline

Of or pertaining to the nature of a crystal, having regular molecular structure.

crystalline rock

Rock consisting of minerals in an obviously crystalline state.

cumulative effects

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

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.

daughter

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

decay heat (radioactivity)

The heat produced by the energy of decay of radionuclides.

decay, radioactive

The spontaneous transformation of one nuclide into a different nuclide or into a different energy state of the same nuclide; the process results in the emission of nuclear radiation (alpha, beta, or gamma radiation) and often heat. TC

decommissioning

Removing facilities such as processing plants, waste tanks, and burial grounds from service and reducing or stabilizing radioactive contamination; includes the following concepts:

- The decontamination, dismantling, and return of an area to its original condition without restrictions on use or occupancy
- Partial decontamination, isolation of remaining residues, and continued surveillance and restrictions on use or occupancy

decontamination (radioactive)

The removal of radioactive contaminants from surfaces of equipment by cleaning or washing with chemicals, by wet abrasive blasting, or by chemical processing.

Defense Waste Processing Facility (DWPF)

TC | The facility designed to process high-level defense waste into a suitable form for permanent storage or disposal; under construction at the SRS.

demersal

Living on or near the bottom of a lake or sea.

demography

The statistical study of human populations, including population size, density, distribution, and such vital statistics as age, sex, and ethnicity.

depauperate

Poor or impoverished, falling short of what occurs naturally (i.e., reduced numbers and species of biological organisms).

deposition

In geology, the laying down of potential rock-forming materials; sedimentation. In atmospheric transport, the settling out on ground and building surfaces of atmospheric aerosols and particles ("dry deposition") or their removal from the air to the ground by precipitation ("wet deposition" or "rainout").

design-basis accident

A postulated accident scenario used for establishing the need for certain design features; normally, the accident that causes the most severe consequences when engineered safety features function as intended.

design-basis events

Postulated disturbances in process variables that can potentially lead to design-basis accidents.

detector

A material or device (i.e., an instrument) that is sensitive to radiation, energy, or emissions and can produce a response signal suitable for measurement or analysis.

detritus

Dead organic tissues and organisms in an ecosystem.

deuterium oxide (D_2O)

See heavy water.

dip

The acute angle that a structural surface (e.g., a bedding or fault plane) makes with the horizontal, measured perpendicular to the strike of the surface. Updip is further up the surface and perpendicular to the strike.

dose

The energy imparted to matter by ionizing radiation; the unit of absorbed dose is the rad, which is equal to 100 ergs per gram 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 defined release, frequently over a year's time.

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; measured in rem.

dose rate

The radiation dose delivered per unit time (e.g., rad per year, millirad per year).

dosimeter

A small device (instrument) that measures accumulated radiation dose (e.g., film badge, TLD, ionization chamber); carried or worn by radiation workers. TC

double-ended guillotine break

A loss-of-coolant accident that involves the complete break of a large pipe such that coolant flow is released from both ends of the break.

downthrow

The wall of a fault that has moved relatively downward.

drawdown

The height difference between the water level in a formation and the water level in a well caused by the withdrawal of groundwater.

drift

Mist or spray carried into the atmosphere with the effluent air vapor from cooling towers.

drinking-water standards

TC The prescribed level of constituents or characteristics (maximum contaminant levels, MCLs) in drinking water that cannot be exceeded legally.

early fatalities

Fatalities associated with the acute radiation exposure syndrome that occur within 1 year of exposure.

ecology

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

ecosystem

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

effective dose equivalent

The dose to the whole body that would have the same biological effect as a given dose equivalent to a particular organ or tissue.

effective porosity

The percent of the total volume of a given mass of soil or rock that consists of interconnecting interstices or voids.

effluent

A gaseous or liquid fluid discharged into the environment.

emission standards

Legally enforceable limits on the quantities and/or kinds of air contaminants that might be emitted into the atmosphere.

endangered species

Species of plants and animals that are threatened with either extinction or serious depletion in an area, and formally listed by the U.S. Fish and Wildlife Service.

engineered safety features

Systems or design characteristics that are provided to prevent or mitigate the potential consequences of postulated accidents.

entrainment

The capture and inclusion of organisms in the cooling water systems of powerplants/reactors. The organisms involved depend on the intake screen mesh size; they include phyto- and zooplankton, fish eggs and larvae (ichthyoplankton), shellfish larvae, and other forms of aquatic life.

environmental impact statement (EIS)

A document prepared pursuant to Section 102(2)(c) of the National Environmental Policy Act (NEPA) of 1969 for a major Federal action significantly affecting the quality of the human environment.

epicenter

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

epicentral

Of, or pertaining to, the epicenter of an earthquake.

epidemiology

The study of diseases as they affect populations.

epilimnion

In thermally stratified lakes, the layer of water above the thermocline.

epizootic condition

A state in which a disease is prevalent among many animals of one kind at the same time; in humans, this condition is called an epidemic. | TC

erosion

The process in which uncovered soil is carried away by the action of wind or water.

eutrophication (eutrophic)

Enrichment of a body of water by mineral and organic nutrients, thereby favoring prolific overabundance of plant and algae growth.

exposure to radiation

The incidence of radiation from either external or internal sources on living or inanimate material by accident or intent:

- Background - exposure to natural background ionizing radiation
- Occupational - exposure to ionizing radiation that takes place during a person's working hours
- TC Population (or collective) - sum of the exposures to a number of persons who inhabit an area

external events

Events that occur outside the reactor systems that can result in an accident, includes natural phenomena such as earthquakes and floods and non-nuclear hazards such as toxic gas releases.

fall line

Imaginary line marking the point at which most rivers drop steeply from the uplands to the lowlands. For example, above the fall line, the TC gradient for the Savannah River is 4 feet per mile (0.2 meters per kilometer); below the fall line, the gradient is 1 foot per mile (0.8 meters per kilometer).

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.

fault (normal)

A fault where the hanging wall has been depressed in relation to the footwall.

fault (reverse)

A fault where the hanging wall has been raised in relation to the footwall.

fault-plane

A fault surface that is more or less planar.

faunal

Animal fossils of a certain rock unit; also relating to the animal life of a region.

filter feeders

Organisms that utilize various filtering mechanisms to obtain nourishment from particulate organic material suspended in water.

filtration

A physical process for separating insoluble material suspended in a liquid or gas.

fission

The splitting of a heavy atomic nucleus into two approximately equal parts, which are nuclei of lighter elements, accompanied by the release of energy and generally one or more neutrons; can occur spontaneously or can be induced by neutron bombardment.

fission products

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

fluence

The number of particles crossing through a unit area; a time-integrated flux over a specified time interval.

fluvial

Relating to, or living in or near, a river.

flux

Rate of flow through a unit area; in reactor operation, the apparent flow of neutrons in a defined energy range (see neutron flux).

foliated

Having leaves or foliage; also, composed or separated into layers, as a <u>foliated</u> rock. TC

food chain

The pathways by which any material entering the environment passes from the first absorbing organism through plants and animals to humans.

footwall

The mass of rock beneath a fault plane.

formation

In geology, the primary unit of formal stratigraphic mapping or description. Most formations possess certain distinctive features.

gamma rays (λ)

High-energy, short-wavelength, electromagnetic radiation accompanying fission and emitted from the nucleus of an atom; gamma rays are very penetrating and require dense (e.g., lead) or a thick layer of materials for shielding.

Gaussian plume

The distribution of material (a plume) in the atmosphere resulting from the release of pollutants from a stack or other source exhibiting the characteristic "bell-shaped" (Gaussian) curve. The distribution of concentrations about the centerline of the plume, which is assumed to decrease as a function of its distance from the source and centerline, depends on the mean wind speed and atmospheric stability.

general public

Individuals who are normally at and beyond the SRS boundary; includes individuals who are on SRS open-access ways (roads, rivers, creeks, railways, etc.).

genetic effects

Radiation effects that can be transferred from parent to offspring; radiation-induced changes in the genetic material of sex cells.

geologic repository (mined geologic repository)

A facility for the disposal of nuclear waste; the waste is isolated by placement in a continuous, stable geologic formation at depths greater than 300 meters.

geology

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

gneiss

Rock formed from bands of granular minerals alternating with bands of minerals that are flakey or have elongate prismatic habits.

gradient

Slope, particularly of a water or land surface. | TC

groundwater

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

habitat

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

habitat formers

Certain kinds of precursor inhabitants whose existence "conditions" the habitat to make it more suitable for the life of the individuals.

half-life (biological)

The time in which half of a particular radioactive substance is removed from the body or one of its organs. | TC

half-life (radiological)

The time in which half the atoms of a radioactive substance disintegrate to another nuclear form; varies for specific radioisotopes from millionths of a second to billions of years.

halogenated

Containing chemically bound halogens, such as fluorine, chlorine, bromine, iodine. Chloroform ($CHCl_3$) is a chlorinated methane. | TC

hanging wall

The mass of rock above a fault plane.

hardwoods

Deciduous trees that yield wood having a hard consistency, such as oaks, hickorys, maples, and tupelo.

harp

A special containment device for transporting irradiated fuel assemblies that have cladding defects.

heat exchanger

A device that transfers heat from one fluid (liquid or gas) to another.

heavy metals

Metallic or semimetallic elements of high molecular weight, such as mercury, chromium, cadmium, lead, and arsenic, that are toxic to plants and animals at known concentrations; many exhibit cumulative effects.

heavy water (D_2O)

Water in which the molecules contain deuterium (D_2), an isotopic form of hydrogen that is heavier than ordinary hydrogen, and oxygen.

high-level waste

Liquid waste containing high levels of radioactivity that result from the dissolution and reprocessing of spent or irradiated fuel and target materials or the products from the solidification of high-level liquid waste or the irradiated fuel elements themselves, if discarded without reprocessing.

historic resources

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

hydraulic conductivity

A measure of the ability of a subsurface unit to transmit fluid at a specified pressure and temperature; also, water flow rate in volume per unit time through a unit cross-section under a unit hydraulic gradient. (See hydraulic gradient.)

hydraulic gradient

The difference in hydraulic head divided by a specified distance.

hydraulic (water) head

Height of water with a free surface above a reference elevation.

TC hydric

Characterized by or requiring an abundance of moisture.

hydrologic unit

See aquifer.

hydrology

The science dealing with the properties, distribution, and circulation of natural water systems.

hydrostratigraphic unit (HSU)

Rock or soil body extending laterally for a considerable distance that comprises the framework for a hydrologic unit.

hypolimnion

In a thermally stratified lake, the layer of water below the thermocline.

ichthyoplankton

The early life stages of fish (i.e., eggs and larvae) that spend part of their life cycle as free-floating plankton.

impingement

The process by which aquatic organisms too large to pass through the screens of a water intake system become caught on the screens and are unable to escape.

indigenous labor pool

An area's labor pool composed of workers normally residing in the area who do not leave the area after termination of a construction project.

indurated

Soil or rock compacted and hardened by heat, pressure, and cementation.

initiating event

An event that can begin an accident sequence if followed by system failures or operator errors.

initiator

See initiating event.

intensity (of an earthquake)

A number describing the effects of an earthquake at a particular place, based on its effects on man, on structures built by man, and on the earth's surface.

interbedded

Occurring between beds or lying in a bed parallel to other beds of a different material.

interfluvial

Falling in the area between two streams.

internal events

Events that occur within the reactor or its supporting systems that can result in an accident, such as transients and losses of coolant flow.

invertebrate

Lacking a backbone or spinal column; not vertebrate.

ion exchange

TC | A unit physicochemical process that removes anions and cations from liquid streams (usually water) to purify or decontaminate them.

ionizing radiation

Radiation capable of displacing electrons from atoms or molecules, thereby producing ions.

isotope

An atom of a chemical element with a specific atomic number and atomic mass; isotopes of the same element have the same number of protons but different numbers of neutrons and different atomic masses.

joule

A unit of energy of work equivalent to 1 Watt per second, 0.737 foot-pound, or 4.18 calories.

Jurassic

The middle period of the Mesozoic Era, between 208 and 144 million years ago.

kilometer

A metric unit of length equal to 0.62137 mile or 1,000 meters.

latent fatalities

Fatalities associated with acute and chronic radiation exposure that occur
TC | within 30 years of initial exposure.

layup (dry)

A process used to maintain out-of-service equipment from which liquids have been drained; after the equipment is flushed and dried, heat or dessicants are used to keep it dry and free of condensation.

layup (wet)

A process used to maintain out-of-service chemical or reactor process equipment, during which vessels, pumps, tanks, valves, etc., are filled with corrosion-inhibiting chemicals.

leaf litter

Discarded and decaying tree foliage.

leak-before-break

A concept based on the ability to detect a coolant-system leak and perform an orderly and controlled plant shutdown before any potential exists for catastrophic coolant-system failures. TC

Level-1 PRA

The portion of a nuclear reactor probabilistic risk assessment that involves the analysis of core damage potential.

Level-2 PRA

The portion of a nuclear reactor probabilistic risk assessment that models core damage progression, confinement systems response, and radionuclide release and behavior.

Level-3 PRA

The portion of a nuclear reactor probabilistic risk assessment that evaluates the consequences of a radionuclide release.

light water

In nuclear power terminology, ordinary water (H_2O), in contrast to heavy water, which consists of molecules of deuterium oxide (D_2O); used as a moderator or coolant.

limestone

A sedimentary rock consisting mainly of calcium carbonate (Calcite).

limnetic zones

Generically, the various zones in a thermally stratified lake or reservoir (i.e., hypolimnion, epilimnion, mesolimnion).

linear energy transfer (LET)

TC The spatial energy distribution of radiation deposited per unit length of particle track, expressed as the amount of energy in Mev/μm or Kev/μm.

liters per second (lps)

A metric unit of flow rate equal to 15.85 gallons per minute.

littoral zone

The shore zone of shallow water, sea, or lake depth below which plants do not thrive; a shore or coastal region.

long-lived radionuclides

Radioactive isotopes with half-lives greater than about 30 years.

loss-of-coolant accident (LOCA)

An event that involves a pipe break through which coolant (either primary or secondary) is released.

loss-of-pumping accident (LOPA)

An event that involves failure of the primary system pumps due to flooding from a secondary system LOCA.

low-level waste

Radioactive waste not classified as high-level waste, transuranic waste, spent nuclear fuel, or byproduct material. Radiation level is less than 300 millirem per hour at 7.6 centimeters from an unshielded container; TC contains less than 10 microcuries per gram of TRU contaminants.

macroinvertebrates

Those invertebrates that can be seen by the unaided eye and that are retained in a U.S. Standard sieve (0.595 millimeter).

macrophytes

Aquatic plants visible to the naked eye.

magnitude

A quantity characteristic of the total energy released by an earthquake, as expressed by the Richter scale.

maximum exposed individual

TC A hypothetical person located to receive the maximum possible dose.

megaWatt (MW)

A unit of power equal to 1,000 kiloWatts (KW) or one million (10^6) Watts.

mesolimnion

That part of a body of water between the epilimnion and the hypolimnion. TC

mesotrophic

Providing a moderate amount of nutrition.

metamorphism

Changes in bodily shape or structure; also, changes in qualities or characteristics of soils or rocks. TC

microflora

Plants that cannot be seen by the unaided eye.

migration

The natural travel of a material through the air, soil, or groundwater; also, seasonal movement of animals from one area to another.

moderator

A material used to decelerate neutrons from fission (high) energies to thermal (low) energies.

Naeglaria fowleri

A thermophilic, pathogenic, flagellated amoeba found in warm bodies of water; the causative agent of human amoebic meningoencephalitis. TC

nano

Prefix indicating one thousandth of a micro unit; one billionth; 1 nanocurie = 10^{-9} curie.

National Register of Historic Places

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

natural chemical gradient

The changes in chemical concentrations of ground- or surface waters resulting from contact with soluble minerals or gases (e.g., limestone or carbon dioxide).

natural radiation; natural radioactivity

Also called background radiation, it arises from sources beyond the planet, called cosmic radiation, from radioactive materials that normally exist in rocks and soils and can be part of structures, and from naturally radioactive materials incorporated as part of the human body from the food eaten and the air inhaled that contain these radionuclides.

natural radioactive series

A group of heavy mass elements such as thorium or uranium that undergo sequential natural radioactive decay or disintegration, eventually yielding stable isotopes.

neutron

An uncharged elementary particle with a mass slightly greater than that of the proton, found in the nucleus of every atom heavier than hydrogen-1; a free neutron is unstable and decays with a half-life of about 13 minutes into an electron and a proton.

neutron flux

The product of neutron number density and velocity (energy) giving an apparent number of neutrons flowing through a unit area per unit time.

neutron poison

TC | A chemical (e.g., boron or rare earth solution) injected into a nuclear reactor to absorb neutrons and control reactivity.

NO_x

Refers to the oxides of nitrogen, primarily NO and NO_2. These are produced in the combustion of fossil fuels and can constitute an air pollution problem.

nomenclature

The names used in systematic classification.

nonvolatile beta

Beta-ray emitting radionuclides that are not volatile at ambient
TC | conditions; generally, unidentified beta emitters in a sample of liquid after its evaporation (e.g., strontium-90, barium-140, and cerium-144).

nuclear powerplant

A facility that converts nuclear energy into electrical power. Heat produced by a reactor is used to make steam to drive a turbine connected to an electric generator.

nuclear reaction

A reaction in which an atomic nucleus is transformed into another element, usually with the liberation of energy as radiation.

nuclear reactor

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

nuclide

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

oblique fault

A fault whose strike is inclined (oblique) to the strike of the strata.

off-normal event

An unplanned event that exceeds the range of normal operating parameters, but usually does not have a significant effect within or beyond the SRS boundary. TC

offsite

The area surrounding the Savannah River Site.

oligotrophic

Lacking in plant nutrients and having an abundance of dissolved oxygen throughout.

onsite

The area within the boundaries of the Savannah River Site.

onsite population
(colocated workers)

DOE and contractor employees who are on duty on the SRS, and badged onsite visitors; does not include those located at the affected reactor.

operation at power

A mode of reactor operation in which the reactor is critical and can produce nuclear materials. TC

outage

A term applied to a process unit (i.e., production or power reactor) taken out of operation for repair, maintenance, or other servicing.

outfall

The mouth of a drain, sewer, or pipe as it discharges effluent to a larger water body.

TC ovate

Having an outline like a longitudinal section of an egg with the basal end broader (e.g., ovate leaves).

parts per million (ppm)

The unit commonly used to represent concentration. In air, ppm is usually volume constituent per 1,000,000 volumes of air; in water, a weight per 1,000,000 weight or volume units.

Pascal

A metric unit of pressure; 101,000 Pascals is equal to 14.7 pounds per square inch (psi).

perched

A water-bearing area of small lateral dimensions lying above a more extensive aquifer.

perennial creek

A stream or reach of a stream that flows continuously throughout the year and whose upper surface generally stands lower than the water table in the region adjoining the stream.

periphyton

Organisms that live attached to underwater surfaces.

permeability

Ability of rock or soil to transmit a fluid.

person-rem

The unit of collective radiation dose commitment to a given population; the sum of the individual doses received by a population segment.

pH

A measure of the hydrogen ion concentration in an aqueous solution; specifically, the negative logarithm of the hydrogen ion concentration. Acidic solutions have a pH from 0 to 7; basic solutions have a pH greater than 7. The corresponding measure for heavy water is pD. | TC

physiography

Description of earth surface features, including air, water, and land.

phytoplankton

Planktonic (floating) plants that occur in water.

Piedmont province

Large area forming a plateau at the base of the Appalachian mountains, extending from New Jersey to Alabama.

piezometer

A nonpumping well, generally of small diameter, that is used to measure the elevation of the water table or potentiometric surface (piezometric surface).

piezometric maps

Lines of equal groundwater pressure drawn on a map.

piezometric surface

The surface to which water in an aquifer would rise by hydrostatic head.

plume

The elongated pattern of contaminated air or water originating at a point-source emission, such as a smokestack, or a waste source, such as a hazardous waste disposal site.

plutonium (Pu)

A transuranic, heavy (atomic mass = 244.06), silvery metal with 15 isotopes that is produced by the neutron irradiation of natural uranium. The isotope Pu-239 is the most important isotope, used both in nuclear weapons and commercial nuclear-power applications.

population (biological term)

All the members of a given species that live at a given time in a particular area.

pounds per square inch (psi)

A measure of pressure; atmospheric pressure is about 15 psi.

primary producer

The organisms that occupy the first, and most important, trophic level of the feeding stratum in a food chain of an ecosystem. Primary producers are nearly always green plants, and in water might consist chiefly of unicellular algae.

primary productivity

The yield of food from primary producers available for utilization by higher trophic levels.

primary system

The system that circulates a coolant (water) through the reactor core to remove the heat of reaction; also called the process water or heavy-water system at SRS.

probabilistic risk assessment (PRA)

A comprehensive, logical, and structured methodology to identify and
TC | quantitatively evaluate the likelihood of significant accident sequences and their consequences.

production

TC

Reactor operation at power in which target assemblies are irradiated.

quartzite

Very hard, metamorphosed sandstone.

rad

See radiation absorbed dose.

radiation

The emitted particles or photons from the nuclei of radioactive atoms. Some elements are naturally radioactive; others are induced to become
TC | radioactive by bombardment in a reactor or other particle accelerator. Naturally occurring radiation is indistinguishable from induced radiation
TC | in its characteristics.

radiation absorbed dose (rad)

The basic unit of absorbed dose equal to the absorption of 0.01 joule per kilogram of absorbing material.

radioactivity

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

radioisotopes

Nuclides of the same element (same number of protons in their nuclei) that differ in the number of neutrons and that spontaneously emit particles or electromagnetic radiation. TC

radiometrics

Of, or relating to, the measurement of geologic time by means of the rate of disintegration of radioactive elements.

radionuclide

See nuclide.

radon

Gaseous, radioactive element produced by the radioactive decay of radium. TC

reactivity

A measure of the ability of an assembly of fissionable material to sustain a chain reaction (criticality); values greater than 1.000 correspond to assemblies that are able to sustain a chain reaction, while values less than 1.000 correspond to assemblies that are unable to sustain a chain reaction. It is equal to the ratio of the number of neutrons present at a given time to the number present one generation or lifetime earlier. TC

reactor accident

See accident; design-basis accident; severe accident.

reactor charge

The fuel and target assemblies loaded into specific positions in the reactor to produce the desired product; the reactor positions occupied by the assemblies depend on the product and the types of assemblies used.

reactor-year

A unit of time by which accident and core damage frequency are measured; assumes that more than one reactor can operate during the year (i.e., a calendar year during which three reactors had operated would be the experience equivalent of 3 reactor-years); also assumes that a reactor might not operate continuously for the entire year (i.e., a reactor operating only 60 percent of the calendar year would be the equivalent of 0.6 reactor-year).

receiving waters

Rivers, lakes, oceans, or other bodies of water into which treated or untreated wastewaters are discharged.

rem (Roentgen equivalent man)

The unit of radiation dose for biological absorption; equal to the product of the absorbed dose in rads, a quality factor, and a distribution factor.

reserve requirement

TC A quantity of nuclear materials as prescribed by the Nuclear Weapons Stockpile Memorandum that provides a contingency against unexpected production interruptions or demand surges.

residence time (also retention time)

The period of time during which a substance remains in a designated area.

reverse movement

Movement along a fault surface where the hanging wall has been raised relative to the footwall.

reverse osmosis

A unit physical process that separates electrolytes (dissolved minerals) from a liquid stream (usually water) by application of high pressure, to counteract the normal osmotic flow of a dilute stream to a more concentrated stream when the streams are separated by a semipermeable membrane; used in water and wastewater treatment.

TC

Richter scale

A logarithmic scale for expressing the magnitude of a seismic disturbance in terms of the energy dissipated in it.

risk

Accident frequency coupled with the expected consequences; for severe accidents with high consequences the risk is balanced by the low accident frequency. For this EIS, "risk" is defined quantitatively as the product of the frequency and the consequence.

TC

risk assessment

A process of combining the hazard per unit exposure for a substance with the probable exposure to that substance to produce an estimate of risk or hazard to exposed individuals or the population from that substance.

roentgen (R)

A unit of exposure to ionizing X- or gamma radiation equal to or producing 1 coulomb of charge per cubic meter of air; approximately equal to 1 rad.

roll anchor

A restraint on the primary coolant inlet piping located near the plenum inlet nozzle that restricts uplift of the reactor plenum and top shield.

runoff

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

saltstone

A low-permeability (less than 10^{-7} centimeter per second) mixture of cement/flyash/slag or lime/flyash/slag used to immobilize low-level radioactive or mixed wastes for disposal in Y-Area or Z-Area at SRS.

sandstone

Clastic rock containing large individual particles visible to the unaided eye.

saturation temperature

The temperature at which a liquid will boil at a defined vapor pressure.

Savannah River Site (SRS)

An approximately 800-square-kilometer (198,737-acre), controlled-access area near Aiken, South Carolina, containing industrial facilities that produce nuclear materials for national defense.

schist

Strongly foliated crystalline rock formed by dynamic metamorphism that can be split easily into thin slabs, or flakes.

secondary system

The system that circulates a coolant (water) through a heat exchanger to remove heat from the primary system; also called the cooling water or light-water system at SRS.

sedimentation

The settling of soil and mineral solids.

seepage basin

An unlined excavation in the ground to receive aqueous streams containing chemical and radioactive wastes.

seismic

Pertaining to any earth vibration, especially an earthquake.

seismicity

The tendency for the occurrence of earthquakes.

seston

All particulate matter, living and nonliving, present in water.

severe accident

An accident more severe than the design basis, in terms of fuel damage and releases of radioactivity, that generally involves multiple failures of engineered safety features.

sewage

The total of organic waste and wastewater generated by an industrial establishment or a community.

shale

TC A fissile rock that is formed by the consolidation of clay, mud, or silt; has a finely stratified or laminated structure; and is composed of minerals essentially unaltered since deposition.

short-lived nuclides

TC In the context of waste disposal, radioactive isotopes with half-lives no greater than about 30 years (e.g., cesium-137 and strontium-90).

siltstone

Silt having the texture and composition of shale, but lacking its fine lamination.

Site (or SRS) stream

Any natural stream on the Savannah River Site; surface drainage is via these streams to the Savannah River.

socioeconomic baseline characterization

A description and discussion of the social and economic characteristics of a study area, including a profile of local government, housing supply, land use, and public and private services.

source term

The quantities of materials released during an accident to air or water pathways and the characteristics of the releases (aerosol or gas, height and duration, temperature, etc.); used for determining accident consequences. TC

sparger

A device or a piece of equipment (such as a perforated pipe) through which compressed air or other gas enters a liquid and is used to agitate it, stir it, or remove unwanted dissolved gases by displacement.

special nuclear material

Plutonium, uranium-233, uranium enriched in the isotope 233 or in the isotope 235, and any other material that DOE determines to be special nuclear material.

species diversity

The relative abundance of species in the community.

species richness

The number of species within a community.

stack

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

storage coefficient

Volume of water released from storage in a vertical soil column of 1.0 square meter when the water table declines 1.0 meter. TC

stratigraphy

Division of geology dealing with the definition and description of rocks and soils, both major and minor natural divisions.

strike

The direction or trend that a structural surface (e.g., a bedding or fault plane) takes as it intersects the horizontal.

strike-slip movement

Movement along a fault surface where the movement is horizontal and parallel to the strike of the fault.

succession

Ecological sequence of species in which communities are replaced by communities of a different type, until a climatic climax type of community is reached.

sulfur dioxide (SO_2)

A heavy, pungent, colorless gas (formed in the combustion of coal), which is considered a major air pollutant.

sulfur oxides (SO_x)

Primarily SO_2 and SO_3; common air pollutants.

surface water

All water on the earth's surface, as distinguished from groundwater.

TC syndrome

A collection or aggregate of symptoms.

thermocline

In thermally stratified lakes, the dividing line between the epilimnion and hypolimnion.

thermoluminescent dosimeter (TLD)

TC A radiation detection device that accumulates a dose over a period of time.

transient

TC Events that could cause the temporary production of more heat in the reactor than the cooling system can remove; also characterized as reactivity or power transients.

transmissivity

A measure of a water-bearing unit to transmit fluid; the product of the thickness and the average hydraulic conductivity of a unit. Also, the rate at which water is transmitted through a strip of an aquifer of a unit width under a unit hydraulic gradient at prevailing temperature and pressure.

transuranic (TRU) waste

Without regard to source or form, radioactive waste that at the end of institutional control periods is contaminated with radionuclides of elements higher in the periodical table than uranium with half-lives greater than 20 years in concentrations greater than 100 nCi/g. TC

Triassic

First period of the Mesozoic era; thought to be between 245 and 208 million years ago.

tritium (H-3)

A radioactive isotope of hydrogen, a weak beta emitter with a half-life of 12.3 years.

trophic

Of, pertaining to, or characterized by a specific level in an ecological food chain. TC

unconsolidated

Loosely arranged or unstratified sediment.

updip

See dip.

upthrow

The wall of a fault that has moved relatively upward.

uranium (U)

A heavy (atomic mass = 238.03), silvery-white metal with 14 radioactive isotopes. One of these isotopes, U-235, is most commonly used as fuel for nuclear fission, and another, U-238, is transformed into fissionable Pu-239 following its capture of a neutron in a nuclear reactor. One pound of completely fissioned uranium has the fuel value of over 1,500 tons of coal.

vitrification

A waste treatment process that encapsulates or immobilizes radioactive wastes in a glassy matrix (e.g., borosilicate glass at DWPF) to prevent them from reacting in disposal sites. TC

volatile organic compounds (VOC)

A broad range of organic compounds, often halogenated, that vaporize at ambient or relatively low temperatures, such as benzene, acetone, chloroform, and methyl alcohol.

waste, hazardous (RCRA)

Any solid waste (can also be semisolid or liquid, or contain gaseous material) having the characteristics of ignitability, corrosivity,
TC | toxicity, or (chemical) reactivity, defined by RCRA and identified or listed in 40 CFR 261.

waste, mixed

Waste having both hazardous and radioactive components.

waste, radioactive

Materials from nuclear operations that are radioactive or are contaminated with radioactive materials, and for which use, reuse, or recovery are impractical.

TE | water-quality standards and criteria

Levels of constituents or characteristics according to the water use classification (e.g., drinking water, recreation use, propagation of fish
TC | and aquatic life, and agricultural and industrial use). Standards are legally enforceable; criteria are not.

water table

The upper surface of the groundwater.

TE | wetlands

Land or areas exhibiting the following: hydric soil conditions, saturated or inundated soil during some portion of the year, and plant species tolerant of such conditions; also, areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions.
TC | Wetlands generally include swamps, marshes, bogs, and similar areas.

wetlands community alteration

The change from one association of interacting populations of plants and animals specifically adapted for life in saturated soils to a different association of interacting populations of plants and animals specifically adapted to life in saturated soils.

whole-body dose

Dose resulting from the uniform exposure of all organs and tissues in a human body. (See also effective dose equivalent.)

wind rose

A depiction of wind speed and direction frequency for a given period of time.

zooplankton

Planktonic (floating) animals that serve as food for fish.

χ/Q (Chi/Q)

The relative calculated air concentration due to a specific air release; units are (sec/m^3). For example, $(Ci/m^3)/(Ci/sec) = (sec/m^3)$ or $(gm/m^3)/(gm/sec) = (sec/m^3)$. | TC

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Z

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METRIC SYSTEM

Typically, scientific reports use metric units; therefore, this EIS presents metric units of measure (meters, liters, grams, etc.) rather than the more common U.S. Customary Units (feet, gallons, pounds, etc.). However, for ease of comprehension, DOE has decided to use the Customary Unit for area, "acre," and "River Mile" to denote locations along the length of the Savannah River, in keeping with U.S. Geological Survey practice. The Summary and some sections also provide Customary Units in parentheses for ease of comprehension. TE TE

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

Prefix	Multiplication Factor
mega	1,000,000(10^6)
kilo	1,000(10^3)
hecto	100(10^2)
centi	0.01(10^{-2})
milli	0.001(10^{-3})
micro	0.000001(10^{-6})
nano	0.000000001(10^{-9})
pico	0.000000000001(10^{-12})

TC

See also DOE Order 5900.2 (12/19/80) regarding the use of the metric system of measurement.

The following list presents conversion factors for the metric units used in this EIS as an aid to readers who are more familiar with U.S. Customary Units.

CONVERSION FROM METRIC STANDARDS TO U.S. CUSTOMARY UNITS

Length

1 meter = 3.281 feet = 39.37 inches = 1.094 yards
1 kilometer = 0.6214 mile

Area

1 square meter = 10.76 square feet
1 square kilometer = 0.3861 square mile = 247.1 acres

Volume

1 liter = 61.02 cubic inches = 1.057 quarts
TC | 1 cubic meter = 35.31 cubic feet = 1.308 cubic yards = 264.2 gallons

Discharge

1 cubic meter per second = 35.31 cubic feet per second = 1.585×10^4 gallons per minute

Mass

1 kilogram = 2.205 pounds (mass)
TC | 1 metric ton = 2,205 pounds = 1.1025 (short) tons

Force

1 newton = 0.2248 pound force

Pressure

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

Power

TC | 1 megaWatt = 3.413×10^6 BTU per hour = 1,341 horsepower

Velocity

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

Temperature

°C to °F, °C x 1.8 + 32; Example: 20°C = 20 x 1.8 + 32 = 68°F

LIST OF PREPARERS

NAME	Stuart M. Altman	TC
AFFILIATION	U.S. Department of Energy, Office of Savannah River Restart	
EDUCATION	M.S., Environmental Radiological Health, New York University B.A., Biology, State University of New York at Buffalo	
EXPERIENCE TECHNICAL SPECIALTY	Ten years. Health physics, radiological safety, radiological environmental monitoring, regulatory compliance, emergency preparedness	
EIS RESPONSIBILITY	Principal reviewer of EIS for DOE Headquarters	

NAME	Xavier Ascanio	TC
AFFILIATION	U.S. Department of Energy, Office of Savannah River Restart	
EDUCATION	B.S., Electrical Engineering, Northeastern University	
EXPERIENCE TECHNICAL SPECIALTY	Ten years. U.S. Navy Nuclear Propulsion Program; DOE Defense Production Reactors	
EIS RESPONSIBILITY	Prepared Appendix A for Draft EIS; principal reviewer of Draft EIS for DOE Headquarters	

NAME	Adel A. Bakr	TC
AFFILIATION	NUS Corporation	
EDUCATION	Ph.D., Groundwater Hydrology, New Mexico Institute of Mining and Technology	
EXPERIENCE TECHNICAL SPECIALTY	Twenty seven years. Groundwater hydrology, aquifer property characterization, water resource development, isotope hydrology, contaminant transport property evaluations, field investigations, spatial variability of aquifer properties	
EIS RESPONSIBILITY	Assisted in preparation of Chapter 3	

NAME	Paul J. Behrens
AFFILIATION	NUS Corporation
EDUCATION	M.S., Biology, University of South Florida B.S., Marine Science, Southampton College, Long Island University
EXPERIENCE TECHNICAL SPECIALTY	Fourteen years. NEPA compliance, biology, water resources, environmental monitoring, regulatory compliance
EIS RESPONSIBILITY	Coordinated preparation of Chapters 3, 4, and 5

NAME	Bruce H. Bradford
AFFILIATION	NUS Corporation
EDUCATION	Ph.D., Civil Engineering, Colorado State University M.S., Civil Engineering, University of Missouri B.S., Civil Engineering, University of Missouri
EXPERIENCE TECHNICAL SPECIALTY	Twenty-three years. NEPA compliance, hydrology, hydraulics, water resources, engineering probability, engineering economy
EIS RESPONSIBILITY	Principal Investigator; assisted in preparation of Chapters 1, 2, and 4 and Appendix C

NAME	R. Thayer Broili
AFFILIATION	NUS Corporation
EDUCATION	M.S., Environmental Management, Duke University B.A., English, University of North Carolina
EXPERIENCE TECHNICAL SPECIALITY	Seventeen years. NEPA compliance, regulatory compliance, biology, ecology, water resources, environmental planning, policy, and management
EIS RESPONSIBILITY	Assisted in preparation of Appendix C

NAME	Ronald M. Burd
AFFILIATION	NUS Corporation
EDUCATION	B.S., Chemistry, Lebanon Valley College Graduate studies, Franklin & Marshall College, University of Pittsburgh
EXPERIENCE TECHNICAL SPECIALTY	Forty years. Environmental science, hazardous waste, water and wastewater management, water quality, NEPA assessments and process
EIS RESPONSIBILITY	Deputy Principal Investigator; prepared Summary, Cover Sheet, Foreword, and Sections 1.2, 2.1.4, 2.1.5, 2.2, 2.3, 3.8, 4.1.6, 4.1.7, 4.1.1.8, 4.2, 4.3; reviewed Chapter 1, Section 4.1.5, and Appendixes B and C

TC

NAME	Alfred P. Canepa
AFFILIATION	NUS Corporation
EDUCATION	M.A., Geology, Indiana University B.A., Geology, Bucknell University
EXPERIENCE TECHNICAL SPECIALTY	Fifteen years. Geology, hydrology, soil science, water chemistry, quality assurance, environmental assessments
EIS RESPONSIBILITY	Prepared Sections 3.4.2, 3.7.2, 4.1.1

NAME	Paul Chimah
AFFILIATION	U.S. Department of Energy, Office of Savannah River Restart
EDUCATION	B.S., (Mechanical) Engineering, M. S. University (India)
EXPERIENCE TECHNICAL SPECIALITY	Fifteen years. Nuclear powerplant design, quality assurance, consultant to utilities
EIS RESPONSIBILITY	Principal reviewer of EIS for DOE Headquarters

TC

NAME	Jon A. Cudworth
AFFILIATION	NUS Corporation
EDUCATION	J.D., Thomas M. Cooley Law School M.S., Resource Development, Michigan State University B.S., Resource Development, Michigan State University
EXPERIENCE TECHNICAL SPECIALTY	Thirteen years. Environmental law and regulation
EIS RESPONSIBILITY	Reviewed Chapter 5

NAME	John A. DiMarzio
AFFILIATION	NUS Corporation
EDUCATION	M.S., Geology, The George Washington University B.S., Geology, University of Maryland
EXPERIENCE TECHNICAL SPECIALTY	Five years. Geology, hydrogeology, water quality
EIS RESPONSIBILITY	Reviewed Chapter 3

NAME	Yawar A. Faraz
AFFILIATION	NUS Corporation
EDUCATION	B.S., Nuclear Engineering/Mechanical Engineering, University of Maryland
EXPERIENCE TECHNICAL SPECIALTY	Seven years. Environmental dose assessments, pathway analysis, occupational radiological safety, health physics
EIS RESPONSIBILITY	Prepared transport and dose models, and health effects sections of Chapters 3 and 4

NAME	Kevin T. Folk
AFFILIATION	NUS Corporation
EDUCATION	B.A., Geoenvironmental Studies, Shippensburg University of Pennsylvania
EXPERIENCE TECHNICAL SPECIALTY	One year. Environmental impact assessments, physical and environmental geology, physical geography, applied meteorology, and field ecology
EIS RESPONSIBILITY	Prepared Section 4.1.1.3 and assisted in the preparation of Sections 3.4.2 and 3.7.2

NAME	Robert J. Galbo
AFFILIATION	U.S. Department of Energy, Office of Nuclear Materials Production, Defense Programs
EDUCATION	M.S., Engineering Science, Toledo University B.S., Chemical Engineering, Purdue University
EXPERIENCE TECHNICAL SPECIALTY	Thirty years. Nuclear material supply and demand; nuclear materials production and processing
EIS RESPONSIBILITY	Prepared Appendix A, Nuclear Material Supply/Demand Analysis (Classified), for Draft EIS TC

NAME	Stephen J. Giebel
AFFILIATION	NUS Corporation
EDUCATION	B.S., Biology/Health Physics, Virginia Polytechnic Institute and State University
EXPERIENCE TECHNICAL SPECIALTY	Five years. Environmental health physics and radiological assessments
EIS RESPONSIBILITY	Prepared radiological sections of Chapters 3 and 4

NAME	Morton I. Goldman
AFFILIATION	NUS Corporation
EDUCATION	Sc.D., Massachusetts Institute of Technology M.S., Nuclear Engineering, Massachusetts Institute of Technology M.S., Sanitary Engineering, Massachusetts Institute of Technology B.S., Civil Engineering, New York University
EXPERIENCE TECHNICAL SPECIALTY	Forty years. Corporate Technical Director; senior management of site evaluation, nuclear and radiation safety, environmental assessment. Professional Engineer
EIS RESPONSIBILITY	Primary reviewer of EIS for NUS Corporation

NAME	Arthur B. Gould, Jr.
AFFILIATION	U.S. Department of Energy, Savannah River Operations Office
EDUCATION	M.S., Game Management, Louisiana State University B.S., Wildlife Biology, Auburn University
EXPERIENCE TECHNICAL SPECIALTY	Seventeen years. Wetlands ecology, wildlife biology, botany, environmental assessments, radio telemetry
EIS RESPONSIBILITY	Branch Chief, Environmental Programs Branch; principal reviewer of EIS Chapters 3 and 5, Section 4.1.4, and Appendix B for DOE

NAME	Andrew R. Grainger
AFFILIATION	NUS Corporation
EDUCATION	M.S., Wildlife Ecology, Utah State University B.S., Natural Resources, Cornell University
EXPERIENCE TECHNICAL SPECIALTY	Twelve years. Terrestrial ecology, facility siting, wetlands ecology, endangered species
EIS RESPONSIBILITY	Prepared Sections 3.6.1, 4.1.1.7, and 4.1.6.7

NAME	Glen T. Hanson
AFFILIATION	NUS Corporation
EDUCATION	M.A., Anthropology/Archaeology, Arizona State University B.S., Anthropology/Archaeology, Grand Valley State College
EXPERIENCE TECHNICAL SPECIALTY	Sixteen years. Impacts of construction/operation on archaeological sites
EIS RESPONSIBILITY	Prepared Section 3.1

TC

NAME	Ernest C. Harr, Jr.
AFFILIATION	NUS Corporation
EDUCATION	B.S., Zoology, University of Maryland
EXPERIENCE TECHNICAL SPECIALTY	Twelve years. Radiological impacts to environment/ populations
EIS RESPONSIBILITY	Reviewed Section 4.1.2

NAME	Mary Haughey
AFFILIATION	U.S. Department of Energy, Office of Savannah River Restart
EDUCATION	B.S., (Mechanical) Engineering, University of Connecticut
EXPERIENCE TECHNICAL SPECIALITY	Fourteen years. Design engineer, technical reviewer, and project management
EIS RESPONSIBILITY	Principal reviewer of EIS for DOE Headquarters

TC

NAME	Diane M. Jones
AFFILIATION	NUS Corporation
EDUCATION	B.S., Chemical Engineering, Iowa State University of Science & Technology
EXPERIENCE TECHNICAL SPECIALTY	Five years. Probabilistic risk assessments, reliability/availability/maintainability analyses
EIS RESPONSIBILITY	Principal preparer of subsections related to severe accidents, natural phenomena, and transportation accident release risks in Sections 4.1.3 and 4.1.4

NAME	William E. Joyce
AFFILIATION	NUS Corporation
EDUCATION	B.S., Chemical Engineering, University of Connecticut
EXPERIENCE TECHNICAL SPECIALTY	Twenty-one years. Environmental assessments, radiological dose assessments, transportation impacts
EIS RESPONSIBILITY	Reviewed radiological sections in Chapter 4

NAME	Yong S. Kim
AFFILIATION	NUS Corporation
EDUCATION	Ph.D., Nuclear Engineering, The Catholic University of America S.M., Nuclear Engineering, Massachusetts Institute of Technology B.S., Chemical Engineering, The University of Wisconsin
EXPERIENCE TECHNICAL SPECIALTY	Twenty-nine years. Nuclear analysis of light-water reactors, nuclear criticality analysis, safety analysis, in-core fuel management, computer code development, core design
EIS RESPONSIBILITY	Assisted in preparation of Section 4.1.3.1.2

NAME	Ruth L. Lindsley
AFFILIATION	NUS Corporation
EDUCATION	M.S., Geology, Syracuse University B.S., Geology, College of William & Mary
EXPERIENCE TECHNICAL SPECIALTY	Five years. Hydrogeology, geology, environmental policy
EIS RESPONSIBILITY	Prepared Section 3.4.2 and Section 3.7.2

NAME	Jasper G. Maltese
AFFILIATION	NUS Corporation
EDUCATION	M.S., Operations Research, The George Washington University B.S., Mathematics, Fairleigh Dickinson University
EXPERIENCE TECHNICAL SPECIALTY	Twenty-seven years. Accident analysis, safety analysis reports, operations research, probabilistic models, reliability analysis
EIS RESPONSIBILITY	Coordinated production of Sections 4.1.3 and 4.1.4

NAME	Barton C. Marcy, Jr.
AFFILIATION	NUS Corporation
EDUCATION	M.S., Zoology-Ichthyology, University of Connecticut B.S., Biology, Wake Forest University
EXPERIENCE TECHNICAL SPECIALTY	Twenty-seven years. Environmental impact studies, ichthyoplankton and entrainment studies, aquatic ecology, and marine ecology
EIS RESPONSIBILITY	Principal technical reviewer of EIS for NUS Corporation

NAME	Edward F. Mastal
AFFILIATION	U.S. Department of Energy, Office of Nuclear Energy
EDUCATION	M.B.A., University of Dayton B.A., Physics, LaSalle University
EXPERIENCE TECHNICAL SPECIALTY	Twenty-seven years. Nuclear weapons maintenance, quality assurance, project management, radioactive waste management, program management
EIS RESPONSIBILITY	Chapter 2 plutonium-238 requirements and production alternatives

NAME	Matthew S. McCormick
AFFILIATION	U.S. Department of Energy, Office of Defense Programs
EDUCATION	B.S., Civil Engineering, Montana State University
EXPERIENCE TECHNICAL SPECIALTY	Eight years. Nuclear facility (reactor and non-reactor) safety analysis, reactor operation, radiation protection
TC | EIS RESPONSIBILITY	Principal reviewer of Draft EIS for DOE Headquarters

NAME	Laurie L. Moorhead
AFFILIATION	NUS Corporation
EDUCATION	M.S., Geology, East Carolina University B.S., Geology, East Carolina University
EXPERIENCE TECHNICAL SPECIALTY	Three years. Water quality, environmental assessments, nonpoint and point source water pollution impacts, peat deposits of North Carolina, peat mining impacts and regulations
EIS RESPONSIBILITY	Prepared Sections 3.3.1, 3.3.2, and 3.9 and Appendix B

NAME	Leonard W. Myers
AFFILIATION	U.S. Department of Energy
EDUCATION	B.S., Management Information Systems, University of Maryland
EXPERIENCE TECHNICAL SPECIALTY	Fifteen years. Nuclear materials production operations and planning; nuclear materials supply/demand analysis; integration of materials supply schedules and activities with weapon production schedules and activities
EIS RESPONSIBILITY	Prepared Appendix A for Final EIS

TC

NAME	Steven J. Nathan
AFFILIATION	NUS Corporation
EDUCATION	B.A., Physics, The Johns Hopkins University
EXPERIENCE TECHNICAL SPECIALTY	Twenty-seven years. Nuclear safety analysis, radiological analysis. Professional engineer
EIS RESPONSIBILITY	Principal preparer of Sections 2.1.1, 2.1.2, 2.1.3, 4.1.3.1.4 and 4.1.3.1.5

NAME	James L. Oliver
AFFILIATION	NUS Corporation
EDUCATION	B.S., Biology, Murray State University
EXPERIENCE TECHNICAL SPECIALTY	Eighteen years. Environmental impact assessment, environmental research, project management, limnological studies, thermal effects, entrainment and impingement, ecology
EIS RESPONSIBILITY	Assisted in preparation and review of Chapters 3 and 4 and Appendix C

NAME	Jan A. Radder
AFFILIATION	NUS Corporation
EDUCATION	B.S., Mathematics, Central Connecticut State University
EXPERIENCE TECHNICAL SPECIALTY	Nineteen years. Probabilistic risk assessments, reliability analysis, safety evaluations
EIS RESPONSIBILITY	Assisted in preparation of Sections 2.1.2, 2.1.3, and 4.1.3.1.3

NAME	David L. Reed
AFFILIATION	NUS Corporation
EDUCATION	B.S., Nuclear Engineering, University of Tennessee
EXPERIENCE TECHNICAL SPECIALTY	Sixteen years. Reactor safety, nuclear analysis, transient and accident analysis, core damage mitigation, probabilistic risk assessment, reactor operations
EIS RESPONSIBILITY	Prepared Sections 2.1.2.2, 2.1.2.3, 2.1.3, 4.1.3.1.3, and 4.1.3.1.4

NAME	Richard H. Rustad
AFFILIATION	U.S. Department of Energy, Savannah River Special Projects Office
EDUCATION	M.S., Nuclear Engineering, North Carolina State University B.S., Physics, North Carolina State University
EXPERIENCE TECHNICAL SPECIALTY	Twelve years. Nuclear navy, control room design reviews, Safety Parameter Display System verification and validation, thermal-hydraulics laboratory assistant for nuclear engineering undergraduates
EIS RESPONSIBILITY	Principal reviewer of EIS for U.S. Department of Energy-Savannah River Special Projects Office

NAME	James R. Schinner
AFFILIATION	NUS Corporation
EDUCATION	Ph.D., Wildlife Management, Michigan State University M.S., Zoology, University of Cincinnati B.S., Zoology, University of Cincinnati
EXPERIENCE TECHNICAL SPECIALTY	Seventeen years. Wildlife management, terrestrial ecology, environmental assessments, environmental impact studies
EIS RESPONSIBILITY	Section 4.1.1.5

NAME	Robert L. Schlegel
AFFILIATION	NUS Corporation
EDUCATION	Degree of Nuclear Engineering, Columbia University M.S., Nuclear Engineering, Columbia University B.S., Chemical Engineering, Massachusetts Institute of Technology
EXPERIENCE TECHNICAL SPECIALTY	Twenty-seven years. Radiological dose/health effects assessments, environmental impacts
EIS RESPONSIBILITY	Prepared radiological sections in Chapters 3 and 4

NAME	E. Robert Schmidt
AFFILIATION	NUS Corporation
EDUCATION	M.S., Nuclear Engineering, University of Missouri B.S., Mechanical Engineering, University of Missouri
EXPERIENCE TECHNICAL SPECIALTY	Thirty-one years. Probabilistic risk assessment, reactor safety
EIS RESPONSIBILITY	Reviewed Section 4.1.3, Accident Analysis

NAME	Eric A. Schweitzer
AFFILIATION	NUS Corporation
EDUCATION	M.U.R.P., University of Pittsburgh B.A., Economic Geography, Indiana University
EXPERIENCE TECHNICAL SPECIALTY	Twenty years. Socioeconomics, land use
EIS RESPONSIBILITY	Prepared section on socioeconomics and land use

NAME	Michael Septoff
AFFILIATION	NUS CORPORATION
EDUCATION	M.S., Meteorology/Oceanography, New York University B.S., Meteorology/Oceanography, City College of New York
EXPERIENCE TECHNICAL SPECIALTY	Twenty-five years. Meteorology, oceanography, regulatory complience and permitting, air pollution assessments, risk assessments, noise and cooling tower assessments
EIS RESPONSIBILITY	Chapter 3 and 4

NAME	John O. Shipman
AFFILIATION	NUS Corporation
EDUCATION	B.A., English Literature, Georgetown University
EXPERIENCE TECHNICAL SPECIALTY	Twenty-three years. Publications management; technical writing and editing; environmental assessments and impact statements
EIS RESPONSIBILITY	Technical editor of the EIS

NAME	G. Thomas St. Clair
AFFILIATION	NUS Corporation
EDUCATION	M.S., Environmental Sciences, University of Michigan B.S., Biology, Adrian College
EXPERIENCE TECHNICAL SPECIALTY	Seventeen years. Biology. Regulatory compliance, permitting, waste management
EIS RESPONSIBILITY	Assisted in preparation of waste management sections in Chapters 3 and 4 and Appendix C

NAME	James A. Steckel
AFFILIATION	NUS Corporation
EDUCATION	B.S., Biology, St. Vincent College
EXPERIENCE TECHNICAL SPECIALTY	Seventeen years. Aquatic ecology, water quality, radiochemistry, meteorological and air quality systems, high-level waste environmental assessments, environmental impact statements, quality assurance/ quality engineering
EIS RESPONSIBILITY	Prepared Section 4.1.5. Reviewed Chapter 3

NAME	Patricia K. Stone
AFFILIATION	U.S. Department of Energy, Savannah River Operations Office
EDUCATION	M.S., School of Civil Engineering, Georgia Institute of Technology M.C.P., City Planning, Georgia Institute of Technology B.B.A., Economics, Georgia Southern College A.A., Armstrong State College
EXPERIENCE TECHNICAL SPECIALTY	Twenty years. Environmental engineering and water resources management, compliance with regulations, environmental impact assessments, socioeconomic impact analysis, environmental planning and management
EIS RESPONSIBILITY	DOE-SR Task Manager for EIS preparation; principal reviewer of EIS for DOE-SR Environmental Division

NAME	Mark A. Symborski
AFFILIATION	NUS Corporation
EDUCATION	M.S., Geology, University of Maryland B.S., Geology, University of Maryland B.A., Anthropology, University of Maryland
EXPERIENCE TECHNICAL SPECIALTY	Two years. Surface-water hydrology, groundwater hydrology, water quality, environmental assessments, regulatory analysis
EIS RESPONSIBILITY	Reviewed Section 4.1.1.5

NAME	Seshagiri R. Tammara
AFFILIATION	NUS Corporation
EDUCATION	M.S., Chemical Engineering, University of Maryland M.S., Environmental Engineering, University of Maryland M.S., Chemical Engineering, Osmania University (Hyderbad, India) B.S., Chemical Engineering, Osmania University
EXPERIENCE TECHNICAL SPECIALTY	Fifteen years. Air quality, radiological risk/dose assessments, environmental assessments, cooling tower and thermal/cooling water analyses
EIS RESPONSIBILITY	Submitted inputs to Section 4.1.4.2

NAME	William R. Weiss
AFFILIATION	NUS Corporation
EDUCATION	M.S., Marine Science, University of South Florida B.A., Biology, Eastern College
EXPERIENCE TECHNICAL SPECIALTY	Nineteen years. Aquatic ecology, water quality, environmental impact assessment including thermal and entrainment/impingement effects studies, natural resources management
EIS RESPONSIBILITY	Assisted in preparation and review of Chapters 3 and 4 and Appendix B and C

NAME	William F. Wolff
AFFILIATION	U.S. Department of Energy, Office of Savannah River Restart
EDUCATION	M.S., Physics, U.S. Naval Postgraduate School A.B., Dartmouth College
EXPERIENCE TECHNICAL SPECIALTY	Fifteen years. Physical Sciences Management
EIS RESPONSIBILITY	Principal reviewer of EIS for DOE Headquarters | TC

lighting, and backup diesel generators. Human factors modifications for K-, L-, and P-Reactors address upgrading operating procedures and training to provide knowledge and skills required to handle normal and off-normal operational events.

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COMMENTS:

In its preparation of this Final EIS, DOE considered both written comments sent to DOE and oral and written comments received during public hearings in Savannah, Georgia (May 31, 1990); Columbia, South Carolina (June 5, 1990); and Aiken, South Carolina (June 8, 1990).

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DISTRIBUTION LIST FOR FINAL ENVIRONMENTAL IMPACT STATEMENT
CONTINUED OPERATION OF K-, L-, AND P-REACTORS
SAVANNAH RIVER SITE, DOE/EIS-0147

The following is a list of Congressional, Federal, state, regional, and local agencies and officials, organizations, libraries, DOE public reading rooms, and interested individuals who will receive copies of the Final Environmental Impact Statement on the Continued Operation of K-, L-, and P-Reactors at the Savannah River Site, DOE/EIS-0147. This list includes all individuals who commented on the draft EIS and requested that they receive a copy of the Final EIS. This list does not include the 175 members of the news media who will receive copies of the document.

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A. UNITED STATES CONGRESS

A.1 SENATORS FROM AFFECTED AND ADJOINING STATES

SOUTH CAROLINA

Honorable Strom Thurmond

Honorable Ernest F. Hollings

GEORGIA

Honorable Sam Nunn

Honorable Wyche Fowler, Jr.

A.2 UNITED STATES SENATE COMMITTEES

Honorable Quentin N. Burdick
Chairman, Committee on Environment and Public Works

Honorable John H. Chafee
Ranking Minority Member
Committee on Environment and Public Works

Honorable Sam Nunn
Chairman, Committee on Armed Services

Honorable John Warner
Ranking Minority Member
Committee on Armed Services

Mr. Arnold L. Punaro
Staff Director, Committee on Armed Services

Honorable Robert C. Byrd
Chairman, Committee on Appropriations

Honorable Mark O. Hatfield
Ranking Minority Member
Committee on Appropriations

Honorable John Glenn
Chairman, Committee on Governmental Affairs

Honorable William V. Roth, Jr.
Ranking Minority Member
Committee on Governmental Affairs

Honorable J. Bennett Johnston
Chairman, Committee on Energy and Natural Resources

Honorable James A. McClure
Ranking Minority Member
Committee on Energy and Natural Resources

A.3 UNITED STATES SENATE SUBCOMMITTEES

Honorable J. James Exon
Chairman, Subcommittee on Strategic Forces and Nuclear Deterrence
Committee on Armed Services

Honorable Strom Thurmond
Ranking Minority Member
Subcommittee on Strategic Forces and Nuclear Deterrence
Committee on Armed Services

Honorable J. Bennett Johnston
Chairman, Subcommittee on Energy and Water Development
Committee on Appropriations

Honorable Mark O. Hatfield
Ranking Minority Member
Subcommittee on Energy and Water Development
Committee on Appropriations

Honorable Wendall H. Ford
Chairman, Subcommittee on Energy Research and Development
Committee on Energy and Natural Resources

Honorable Pete V. Domenici
Ranking Minority Member
Subcommittee on Energy Research and Development
Committee on Energy and Natural Resources

A.4 UNITED STATES HOUSE OF REPRESENTATIVES FROM AFFECTED AND ADJOINING STATES

South Carolina

Honorable Butler Derrick

Honorable Floyd Spence

Honorable Arthur Ravenel, Jr.

Georgia

Honorable Lindsay Thomas

Honorable Doug Barnard, Jr.

A.5 UNITED STATES HOUSE OF REPRESENTATIVES FROM OTHER STATES

Honorable Joe Barton

Honorable Michael Bilirakis

Honorable Jack Brooks

Honorable Sonny Callahan

Honorable William E. Dannemeyer

Honorable Jack Fields

Honorable Howard C. Nielson

Honorable Michael G. Oxley

Honorable Don Ritter

A.6 UNITED STATES HOUSE OF REPRESENTATIVES COMMITTEES

Honorable Les Aspin
Chairman, Committee on Armed Services

Honorable William L. Dickinson
Ranking Minority Member
Committee on Armed Services

Honorable John M. Spratt, Jr.
Chairman, DOE Defense Nuclear Facilities Panel
Committee on Armed Services

Honorable Jon Kyl
Ranking Minority Member
DOE Defense Nuclear Facilities Panel
Committee on Armed Services

Honorable John Conyers, Jr.
Chairman, Committee on Government Operations

Honorable Frank Horton
Ranking Minority Member
Committee on Government Operations

Honorable John D. Dingell
Chairman, Committee on Energy and Commerce

Honorable Norman F. Lent
Ranking Minority Member
Committee on Energy and Commerce

Honorable Jamie L. Whitten
Chairman, Committee on Appropriations

Honorable Silvio O. Conte
Ranking Minority Member
Committee on Appropriations

A.7 UNITED STATES HOUSE OF REPRESENTATIVES SUBCOMMITTEES

Honorable Phillip R. Sharp
Chairman, Subcommittee on Energy and Power
Committee on Energy and Commerce

Honorable Carlos J. Moorhead
Ranking Minority Member
Subcommittee on Energy and Power
Committee on Energy and Commerce

Honorable John D. Dingell
Chairman, Subcommittee on
Oversight and Investigations
Committee on Energy and Commerce

Honorable Thomas J. Bliley, Jr.
Ranking Minority Member
Subcommittee on Oversight and
Investigations
Committee on Energy and Commerce

Honorable Les Aspin
Chairman, Subcommittee on
Procurement and Military
Nuclear Systems
Committee on Armed Services

Honorable Jim Courter
Ranking Minority Member
Subcommittee on Procurement
and Military Nuclear Systems
Committee on Armed Services

Mr. Robert E. Schafer
Professional Staff Member
Subcommittee on Procurement
and Military Nuclear Systems
Committee on Armed Services

Honorable Tom Bevill
Chairman, Subcommittee on
Energy and Water Development
Committee on Appropriations

Honorable John T. Myers
Ranking Minority Member
Subcommittee on Energy and
Water Development
Committee on Appropriations

Honorable Mike Synar
Chairman, Subcommittee on
Environment, Energy and
Natural Resources
Committee on Government
Operations

Honorable William F. Clinger, Jr.
Ranking Minority Member
Subcommittee on Environment,
Energy and Natural Resources
Committee on Government
Operations

Honorable James H. Scheuer
Chairman, Subcommittee on Natural
Resources, Agriculture Research
and Environment
Committee on Science, Space and
Technology

Honorable Claudine Schneider
Ranking Minority Member
Subcommittee on Natural
Resources, Agriculture Research
and Environment
Committee on Science, Space and
Technology

B. FEDERAL AGENCIES

B.1 NATIONAL OFFICES

Advisory Council on Historic
Preservation

Dr. Frank Press
President, National Academy of
Sciences

U.S. Nuclear Regulatory
Commission
Office of Nuclear Material
Safety and Safeguards

Director, U.S. Arms Control
and Disarmament Agency

Director, Office of Radiation
Programs
U.S. Environmental Protection
Agency

U.S. Department of Commerce
Deputy Assistant Secretary
Intergovernmental Affairs

U.S. Department of Defense
Headquarters
Director, Environmental Policy
DAEN-ZCE

U.S. Department of Justice
Land and Natural Resources
Division

U.S. Department of Labor
Occupational Safety and Health
Administration

U.S. Department of the Interior
ATTN: Director, Office of Environmental Project Review

Office of the Assistant of the Secretary of Defense (Atomic Energy)
U.S. Department of Defense - Pentagon

Ms. Dinah Bear
General Counsel, Council on Environmental Quality

Mr. Robert Fairweather
Environmental Branch, Natural Resources Division
Office of Management and Budget

Mr. Joseph S. Hezir
Deputy Associate Director
Energy and Science Division
Office of Management and Budget

U.S. Department of State
ATTN: Director, Office of Environmental Protection

Mr. Larry Corcoran
U.S. Department of Justice
Land and Natural Resources Division

Mr. Jim Reisa
Environmental Studies and Toxicology
National Academy of Sciences

Mr. Richard E. Sanderson
Director, Office of Federal Activities
U.S. Environmental Protection Agency

Mr. Kenneth Kumor
National Aeronautics and Space Administration

B.2 REGIONAL OFFICES

Director, National Marine Fisheries Service
Southeast Region

Mr. William Abercrombie
State Conservationist, Soil Conservation Service
U.S. Department of Agriculture

Mr. John E. Alcock
Regional Forester, Southern Regional Office
U.S. Forest Service
U.S. Department of Agriculture

Mr. Roger L. Banks
Field Office Supervisor
Endangered Species Office
U.S. Fish and Wildlife Service
U.S. Department of the Interior

Major General R. M. Bunker
Division Engineer, South Atlantic Division
U.S. Army Corps of Engineers

Mr. Clarence Ham
Charleston District, SAC CO-P
U.S. Army Corps of Engineers

Mr. Rod Cherry
District Chief, Water Resources Division
U.S. Geological Survey

Mr. Ken Clark
Public Affairs Officer
U.S. Nuclear Regulatory Commission, Region II

Mr. David Coleman
Savannah District, SAS-PD-El
U.S. Army Corps of Engineers

Mr. Leonard L. Dowd
Site Coordinator, U.S. General Accounting Office

Mr. Joseph R. Franzmathes
Assistant Regional Administrator, Office of Policy and Management
U.S. Environmental Protection Agency, Region IV

Ms. Loretta Hanks
Director, Office of Congressional Affairs
U.S. Environmental Protection Agency, Region IV

Mr. Larry Hardy
Area Supervisor, Habitat
Conservation Division
National Marine Fisheries
Service

Mr. David Hopkins
DOE Coordinator, Federal
Activities Branch
U.S. Environmental Protection
Agency, Region IV

Mr. Greer C. Tidwell
Administrator
U.S. Environmental Protection
Agency, Region IV

Lt. Colonel James T. Scott
District Engineer, Charleston
District, SAC CO-P
U.S. Army Corps of Engineers

Mr. Arthur G. Linton
Federal Facilities Coordinator
Federal Activities Branch
Office of Policy and
Management
U.S. Environmental Protection
Agency, Region IV

Dr. David E. Clapp
Environmental Health Scientist
Center for Environmental
Health and Injury Control
Centers for Disease Control
U.S. Department of Health and
Human Services

Mr. Steve Gilbert
U.S. Fish and Wildlife Service
U.S. Department of the Interior

Colonel R. V. Locurio
Commander, Corps of Engineers,
Savannah District
ATTN: Planning Division
U.S. Department of the Army

Mr. Frank Redmond
Chief, Federal Activities Branch
Office of Policy and Management
U.S. Environmental Protection
Agency, Region IV

Dr. Gerald Miller
Ecologist, Environmental
Policy Section
Federal Activities Branch
Office of Policy and
Management
U.S. Environmental Protection
Agency, Region IV

Mr. Heinz Mueller
Environmental Policy Section
Federal Activities Branch
Office of Policy and Management
U.S. Environmental Protection
Agency, Region IV

Mr. Charles Oravetz
Protected Species Management
Branch
Chief, Southeast Regional Office
National Marine Fisheries
Service
U.S. Department of Commerce

Mr. Warren T. Parker
Field Office Supervisor
Endangered Species Office
U.S. Fish and Wildlife Service
U.S. Department of the Interior

Mr. James W. Pulliam, Jr.
Regional Director (AE), Office
of the Environment
Fish and Wildlife Service
U.S. Department of the Interior

Mr. David Crosby
U.S. Army Corps of Engineers
Savannah District

B.3 DEPARTMENT OF ENERGY OFFICES

Mr. William H. Young
Assistant Secretary for
Nuclear Energy

Mr. Dominic J. Monetta
Director, Office of New
Production Reactors

Mr. Steven Blush
Director, Office of Nuclear
Safety

Mr. Michael W. Conley
Assistant Inspector General
Office of Assistant Inspector
General for Inspections and
Analysis

Mr. Ben Gannon
Operations and Projects Division
Office of Defense Waste and
Transportation Management

Dr. Jeffrey M. Steele
Office of Naval Reactors

Mr. John E. Scorah
Operations Division, Office of
Nuclear Materials Production

Mr. Virgil Trice
Operations and Projects
Division
Office of Defense Waste and
Transportation Management

Ms. Judith M. DeMaire
Executive Director, Office of
Inspector General

Mr. Richard D. Brooks
Program Manager
USC Department of Archaeology
and Anthropology
Savannah River Operations
Office

Mr. N. C. Aquilina
Manager, Nevada Operations
Office

Mr. Carl A. Mazzola
Site Project Office Director
Stone & Webster Engineering
Corporation
c/o Office of External Affairs
Savannah River Operations
Office

Ms. Debbie Bergquist
Office of Chief Counsel
Idaho Operations Office

Ms. Liz Bracken
Richland Operations Office

Mr. Thomas J. Rowland
Acting Director, West Valley
Project Office
Idaho Operations Office

Mr. Robert M. Carosino
Office of Chief Counsel
Richland Operations Office

Dr. David T. Goldman
Acting Manager, Chicago
Operations Office

Mr. Peter J. Dirkmaat
Radiological Safety Branch
Operational Safety Division
Idaho Operations Office

Mr. B. R. Fritz
Environment, Safety, and
Health Division
Chicago Operations Office

Mr. A. A. Pitrolo
Manager, Idaho Operations
Office

Mr. Roger K. Heusser
Deputy Director, DP-32.1
Office of Classification and
Technology Policy

Mr. Joe LaGrone
Manager, Oak Ridge Operations
Office

Mr. Leo E. Little
Project Manager, Grand
Junction Project Office

Mr. Robert M. Nelson
Rocky Flats Operations Office

Mr. Donald W. Pearman, Jr.
Manager, San Francisco
Operations Office

Mr. B. G. Twining
Manager, Albuquerque
Operations Office

Mr. J. P. Wagoner
Acting Manager, Richland
Operations Office

Mr. David Wilfert
Oak Ridge Operations Office

B.4 NATIONAL LABORATORIES

Battelle-Pacific Northwest
Laboratory
Technical Information
ATTN: Fran Stanley

Dr. Richard Adams
Energy Systems Department
Battelle-Pacific Northwest
Laboratory

Mr. Larry E. Boing
Waste Management Operations
Argonne National Laboratory

Ms. Betty Desimone
Knolls Atomic Power Laboratory

Mr. George Flanagan
Oak Ridge National Laboratory

Mr. Harley Freeman
Battelle-Pacific Northwest
Laboratory

Mr. Frank A. Guevara
Los Alamos National Laboratory

Ms. Shirley Gydesen
Technical Information
Hanford Technical Library
Battelle-Pacific Northwest
Laboratory

Mr. Andrew P. Hull
Safety and Environmental
Protection Division
Brookhaven National Laboratory

Mr. D. W. Lee
Oak Ridge National Laboratory

Mr. Larry Long
Martin-Marietta Energy Systems,
Inc.
Oak Ridge National Laboratory

Mr. Pete Mellinger
Battelle-Pacific Northwest
Laboratory

Mr. C. M. Seabourn
Los Alamos National Laboratory

Ms. Virginia M. Oversby
Earth Sciences Department, L-206
University of California
Lawrence Livermore National
Laboratory

Mr. Thomas Row
Program Director, Nuclear
Waste Program
Oak Ridge National Laboratory

Dr. R. M. Reed
Oak Ridge National Laboratory

Ms. Carol Herzenberg
EES Division
Argonne National Laboratory

Mr. W. A. Mihalco
Environmental Engineering
Radiological Controls and
Engineering
Bettis Atomic Power Laboratory

Mr. J. R. Trabalka
Martin-Marietta Energy Systems,
Inc.
Oak Ridge National Laboratory

Ms. Joan Walsh
Document Library
Knolls Atomic Power Laboratory

Mr. Emmett B. Moore, Jr.
Office of Technology,
Planning, and Analysis
Environmental and Safety Risk
Management
Battelle-Pacific Northwest
Laboratory

Mr. Tim E. Myrick
Radioactive Waste Management
Operations Division
Oak Ridge National Laboratory

Dr. J. R. Naidu
Safety and Environmental
Protection Division
Brookhaven National Laboratory

Ms. Tillie Rickert
Oak Ridge National Laboratory

C. STATE OF SOUTH CAROLINA

C.1 STATEWIDE OFFICES

Honorable Carroll A. Campbell
Governor of South Carolina

Honorable Nick A. Theodore
Lieutenant Governor of South
Carolina

Mr. H. G. Shealy, Chief
Bureau of Radiological Health
South Carolina Department of
Health and Environmental
Control

Mr. Jack Smith
Staff Attorney
South Carolina Coastal Council

Mr. Hank W. Stallworth
Deputy Director
Water Resources Commission

Mr. Eric P. Thompson
Executive Director
Lower Savannah Council of
Governments

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. Alfred H. Vang
Executive Director
Water Resources Commission
State of South Carolina

Dr. Richard N. Winn
Assistant Marine Scientist
Marine Resources Research
Institute
South Carolina Wildlife and
Marine Resources Department

C.5 LOCAL AGENCIES

Director, Aiken County
Planning Commission

Chairman, Allendale County
Council

President, Barnwell Chamber of
Commerce

Chairman, Barnwell County
Council

City Administrator, City of
North Augusta

Chairman, Jackson Town Council

Mr. W. Scott Barnes
County Administrator, Aiken
County

Ms. Elizabeth S. Benton
Assistant Superintendent for
Administrative Area 4
Aiken County Public Schools

Dr. Joseph R. Brooks
Superintendent, Aiken County
Public Schools

Mr. J. Carrol Busbee
Director, Public Safety Office
City of Aiken

Ms. Sara B. Ridout
City Clerk, City of Aiken

Mr. Fred B. Cavanaugh, Jr.
Aiken City Council
Mayor Pro tem

Mr. Ralph F. Cullinan
Aiken County Council

Mr. Tim Dangerfield
Governmental Affairs
Greater Aiken Chamber of
Commerce

Mr. Bobby R. Mauney
Coordinator, Aiken County
Civil Defense

Mr. William D. Moss, Jr.
General Manager, Beaufort-Jasper
Water & Sewer Authority

Ms. June H. Murff
President, Greater Aiken
Chamber of Commerce

Mr. George Nelson
President, Chamber of Commerce
of Greater North Augusta

Mr. Charles O. Peyton
Chairman of the Board
Beaufort-Jasper Water & Sewer Authority

Mrs. Peggy Reinhart
c/o Barnwell County Office Building

Mr. Don Rothwell
Aiken County Young Republicans

Mr. Carrol H. Warner
Chairman, Aiken County Council

Mr. Ed Saxon
Beaufort-Jasper Water & Sewer Authority

Mr. W. J. Wall, Jr.
Chairman, Allendale City Council

Mr. Roland Windham
City Manager, City of Aiken

Mr. Dean Hunter
City Manager, City of Beaufort

C.6 LOCAL OFFICIALS

Honorable Thomas B. Brady
Mayor of Williston

Honorable Thomas Greene
Mayor of North Augusta

Honorable William Holmes
Mayor of Allendale

Honorable Carroll J. Johnson
Mayor of Blackville

Honorable E. T. Moore
Mayor of Snelling

Honorable Mason J. Rollo
Mayor of Jackson

Honorable H. Creech Sanders
Mayor of Barnwell

Honorable Randy W. Shaw
Mayor of New Ellenton

Honorable David M. Taub
Mayor of Beaufort

Honorable H. Odell Weeks
Mayor of Aiken

D. STATE OF GEORGIA

D.1 STATEWIDE OFFICES

Honorable Joe Frank Harris
Governor of Georgia

Honorable Zell Miller
Lieutenant Governor of Georgia

Honorable Michael Bowers
Attorney General

Mr. C. H. Badger
Administrator, Georgia State Clearinghouse Office of Planning and Budget

Mr. Rick Stancil
Press Secretary, Office of the Governor

D.2 STATE LEGISLATORS

SENATORS

Honorable Frank A. Albert

Honorable Thomas F. Allgood

Honorable Jake Pollard, Jr.

HOUSE OF REPRESENTATIVES

Honorable George M. Brown

Honorable Donald E. Cheeks

Honorable Jack Connell

Honorable Bobby Harris

Honorable William S. Jackson

Honorable Mike Padgett

Honorable Charles Thomas

Honorable Charles W. Walker

D.3 STATE AGENCIES

Public Information Officer
Georgia State Department of Defense
Civil Defense Division

Industrial and Domestic Water Supply Commission
Water Operations Director

Mr. Lonice Barrett
Commissioner, Georgia Department of Natural Resources

Mr. Jim Hardeman
Environmental Radiation Programs
Environmental Protection Division
Georgia Department of Natural Resources

Mr. Harold Reheis
Director, Georgia Department of Natural Resources

Mr. Fred Lehman
Program Manager, Surface Water Supply
Georgia Department of Natural Resources

Mr. J. L. Setser
Program Coordination Branch
Environmental Radiation Programs
Environmental Protection Division
Georgia Department of Natural Resources

D.4 LOCAL AGENCIES

President, Augusta City Council

Director, Augusta-Richmond County Planning Commission

County Administrator, Burke County

Chairman, Burke County Commissioners
Burke County Courthouse

Burke County Emergency Management Agency
ATTN: Chief Porterfield

Director, Central Savannah River Area Planning and Development Commission

Executive Vice President
Chamber of Commerce of Greater Augusta

Chairman, Chatham County Commission

County Administrator, Richmond County

President, Savannah Area Chamber of Commerce

Mr. A. K. Hasan
Augusta City Council

Mr. Albert M. Hodge, Jr.
Metro Augusta Chamber of Commerce

Mr. Ken Matthews
Savannah Area Chamber of Commerce
Resources and Environment Committee

Mr. Tim Maund, Director
CSRA Planning and Development Commission

Mr. Dean Moss
Beaufort-Jasper Water and Sewer Authority

Mr. Larry Stuber
Savannah Area Chamber of Commerce

D.5 LOCAL OFFICIALS

Honorable Charles A. DeVaney
Mayor of Augusta

Honorable George L. DeLoach
Mayor of Waynesboro

Honorable John P. Rousakis
Mayor of Savannah

E. ENVIRONMENTAL AND PUBLIC INTEREST GROUPS

E.1 NATIONAL

Council for a Livable World

Defenders of Wildlife

Environmental Defense Fund, Inc.

Environmental Policy Institute

League of Women Voters of the United States

National Audubon Society

National Wildlife Federation

Natural Resources Defense Council, Inc.

The Nature Conservancy

Sierra Club

Sierra Club Foundation

Mr. Steven Aftergood
Senior Research Analyst
Federation of American Scientists

Mr. David Albright
Federation of American Scientists

Mr. James E. Beard
Friends of the Earth

Ms. Annette Chmielewski
Environmental Defense Fund Inc.

Mr. Daryl Kimball
Physicians for Social Responsibility

Dr. Thomas B. Cochran
Natural Resources Defense Council, Inc.

Dr. Milton Hoenig
Scientific Director
Nuclear Control Institute

Mr. Jim Launib
Natural Resources Defense Council

Mr. Paul Leventhal
President
Nuclear Control Institute

Ms. Peg Stevenson
Greenpeace USA, Inc.

Ms. Alice Thomas
Natural Resources Defense Council

Chris Zimmer
Greenpeace USA, Inc.

Ms. Melinda Kassen
Staff Attorney
Environmental Defense Fund

Mr. Daniel Hirsch
Committee to Bridge the Gap

E.2 SOUTH CAROLINA

National Audubon Society
South Carolina Chapter

Carolina Peace Resource Center

Chairperson, Central Savannah
River Area Health Project

Piedmont Organic Movement

Executive Director
The South Carolina Wildlife
Federation

Ms. Becky Allen
Greenpeace USA, Inc.

Mrs. Mary Allstrom
Children's Vigil/World Summit
for Children

Ms. Kathy A. Brown
South Carolina Wildlife
Federation

Mr. Brett Bursey
Grass Roots Organizing
Workshop

Mr. B. A. Bursey
Federation for Progress
Southern Regional Office

Mrs. Elizabeth S. Christensen
Aiken County Republican Party

Ms. Catherine N. Coleman
RESULTS

Mr. David B. Gohagan
Energy Research Foundation

Ms. Genevieve D. Compton
Young Environmentalists for a
Living and Loving Earth

Mr. Brian Costner
Energy Research Foundation

Mr. John P. Dawkins
Earth First/Greenpeace/Young
Environmentalists for a Living
and Loving Earth

Mr. Art Dexter
Prayer for Peace

Miss Anastasia K. Eddins
IRMO Direct Environmental
Action

Mr. Edward V. Fenton
National Association of
Radiation Survivors

Dr. Howard T. Gilchrist
Friends of the Savannah River
Site

Mr. Kevin A. Gray
Coalition for Human
Development & Program
Change/SC Rainbow Coalition

Ms. Rebecca Hardee
Energy Research Foundation

Ms. Frances Close Hart
Board Chairperson
Energy Research Foundation

Mr. Marcus B. Hightower
Young Environmentalists for a
Living and Loving Earth

Miss Charlice G. Hurst
Young Environmentalists for a
Living and Loving Earth

Dr. Albert E. Jabs
Lutheran Human Relations

Mr. J. David Jameson
Economic Development
Partnership

Mrs. Sue Jane Johnson
Grass Roots Organizing
Workshop

Mr. Anthony A. Jones
Ironworkers Local Union #709

Dr. Mary T. Kelly
League of Women Voters of
South Carolina

Miss Sally A. Koch
Students for the Ethical
Treatment of Animals

Mr. Terrence Larimar
National Audubon Society

Mr. G. L. Locklear
South Carolina Organic
Association

Mr. Michael Lowe
Greenpeace USA, Inc./Palmetto
Alliance

Mr. Michael F. Lowe
Energy Research Foundation

Mr. Glenn E. Lynn
Vice President
Ironworkers Local Union #709

Ms. Renee Marvin
Greenpeace USA, Inc.

Mr. Keith McKenney
Economic Development
Partnership

Mr. Vernon E. Mundy
Body of Christ

Ms. Maureen A. Nery
Piedmont Peace Resource Center

Mr. Daniel L. Sobel
Earth First

Miss Mary Niedzwiecki
Prayers for Peace Group

Mr. Nelson Rivers, III
National Association for the
Advancement of Colored People

Ms. Meagan R. Rosser
Young Environmentalists for a
Living and Loving Earth

Ms. Tricia D. Simpson
Students for the Ethical
Treatment of Animals

Mr. Bryan L. Spigner
Citizen/SETA/IDEA

Dr. Mitchell J. Wolin
South Carolina Eye Institute

Miss Heather Lynn Swallows
Students for the Ethical
Treatment of Animals

Ms. Ruth Thomas
President
Environmentalists, Inc.

Ms. Marjorie R. Trifon
RESULTS/Children's Vigil/World
Summit for Children

Mr. Merll Truesdale
Grass Roots Organizing
Workshop

Dr. Zoe G. Tsagos
League of Women Voters of
Northern Beaufort County

Ms. Lolita T. Watson
League of Women Voters of
Northern Beaufort County

Mr. Tommy B. Wessinger
Chairman, Economic Development
Partnership

Ms. Margaret L. West
League of Women Voters of
South Carolina

Mrs. Carol Winans
League of Women Voters of
Georgetown County

E.3 GEORGIA

Mr. Carlos Alonzo
Greenpeace USA, Inc.

Ms. Amy Conley
Greenpeace USA, Inc.

Ms. Nancy Ancrom
Network for Constructive Evolution

Elements Magazine

Georgians Against Nuclear
Energy

Mr. James A. Abbott
Students for Environmental
Awareness

Mrs. Lawrence Barroll
Trustees Garden Club

Mr. Edward D. Arnold
Physicians for Social
Responsibility-Atlanta

Mr. Woodrow A. Bell
Plumbers & Steamfitters Local
Union #150

Ms. Cheryl Ann Brackin
Coastal Citizens for a Clean
Environment

Ms. Pamela Blockey-O'Brien
International Fellowship of
Reconciliation and National
Clergy and Laity Concerned

Ms. Susan Boes
SANE/FREEZE

Mr. Jeff Bridgers
Coordinator, Citizens For
Clean Air

Ms. Eliza O. Everette
Greenpeace USA, Inc.

Ms. Virginia Brown
League of Women Voters of
Georgia

Ms. Jean O. Brown
Coastal Citizens for a Clean
Environment

Mr. Kip C. Campbell
Greenpeace USA, Inc.

Mr. Tom Clements
Greenpeace USA, Inc.

Mr. Timothy J. Connor
Energy Research Foundation

Ms. Lynn A. Corliss
Coastal Citizens for a Clean
Environment

Ms. Audrey J. Doukas
Sierra Club

Mr. Neil Dulohery
Vice Chairman, Students for
Environmental Awareness

Mr. Moses Dunn
Labor Union #1137

Dr. Daniel M. Everett
Athens Peace Coalition

Ms. Amanda W. Everette
Greenpeace USA, Inc.

Mr. Edward E. Floyd
Local Union #1137

Dr. Adam O. Goldstein
Physicians for Social
Responsibility

Dr. Judith E. Gordon
Nuclear Coordinator
South Carolina Chapter of
Sierra Club

Mr. Charles I. Hardigree
Plumbers & Steamfitters Local
Union #150

Mr. A. K. Hasan
Friends of the Savannah River
Site

Ms. Cheryl D. Jay
Coastal Citizens for a Clean
Environment

Ms. Alison L. Jones
Students for Environmental
Awareness

Mrs. Doris G. Jorden
League of Women Voters

Ms. Judy Jennings
Coastal Group - Sierra Club

Ms. Nancy Kaiser
Southern States Energy Board

Ms. Deborah A. Kearney
Coastal Citizens for a Clean
Environment

Mr. G. Robert Kerr
The Georgia Conservancy

Dr. Harry L. Keyserling
Physicians for Social
Responsibility
Atlanta Chapter

Mrs. Joan O. King
20/20 Vision

Ms. Kathryn L. Kyker
Athens Peace Coalition

Mr. Edgar West
Ironworkers Local Union #709

Miss Geraldine LeMay
League of Women Voters of Georgia

Mr. William S. Lewis
Coastal Citizens for a Clean Environment

Mr. John X. Linnehan
Metanoia Community

Ms. Martina W. Linnehan
Metanoia Community

Dr. Paul F. Milner
Physicians for Social Responsibility

Mr. Frederick Nadelman
Coastal Citizens for a Clean Environment

Mr. Hans Neuhauser
Coastal Director
The Georgia Conservancy

Mr. John R. Petrov
Lassiter High School Rescue Club

Mr. Robert G. Randall, II
From Trident to Life Campaign
Glynn Environmental Coalition
Peaceweavers

Mr. Doug Shoemaker
Greenpeace USA, Inc.

Mr. John M. Ravage
Greenpeace USA, Inc.
World Wildlife Federation
Clean Air Council

Ms. J. Y. Shorthouse
Georgians Against Nuclear Energy

Ms. Rebecca R. Shortland
Editor, Georgia Water Line
The Georgia Conservancy

Ms. Melanie K. Smith
Athens Peace Coalition

Ms. Ellen Spears
SANE/FREEZE: Campaign for Global Security

Ms. Pamela F. Staines
Coastal Citizens for a Clean Environment

Mr. Scott A. Starling
Athens Peace Coalition

Dr. Herbert A. Summers, Jr.
Coastal Citizens for a Clean Environment

Mr. Payton H. Ward, Jr.
Ironworkers Local Union #709

Mr. Warren E. Whipple
Greenpeace USA, Inc.

E.4 OTHER STATES

Ms. Leigh A. Benson
Labat-Anderson Inc.

Mr. Tim Connor
Hanford Education Action League

Mr. Karl Ford
Ecology of Environment

Mr. James C. Loomis
Cetacean Relations Society

Mr. William H. Jonas
Spearpoint Consulting

Mr. Travis P. Wagner
Labat-Anderson, Inc.

Mr. Gordon Thompson
Institute for Resource and Security Studies

F. OTHER GROUPS AND INDIVIDUALS

F.1 SOUTH CAROLINA

Airam, Inc.

Mr. W. Barry Adams

Earth Sciences and Resources Institute
University of South Carolina

Envirodyne Engineers, Inc.

Mr. and Mrs. Park C. Aitken

Mr. Shahrough Akhavi

Mrs. Ruth Alexander

Dr. Robert E. Alexander

Ms. Dorothy Allen

Dr. Joan Altekruse

Ms. Ilene Altman

Miss Shannon S. Amick

Mr. Michael Anaclerio

Mr. William D. Anderson, Jr.

Mr. Kenneth B. Anderson, P.E.

Mr. R. J. Ascherl

Ms. Catherine D. Badgett

Mrs. Cindy Ball

Dr. Bruce Ballard

Miss Melissa Ballard

Ms. Dana Ballentine

Mr. Sid Ballentine

Mr. Scott Bandoroff

Mr. John L. Barnes, Jr.

Mr. Edwin L. Barnhart

Mrs. Peter Bartoldus

Mr. and Mrs. William C. Bateman, II

Ms. Lois Battle

Dr. John C. Beard Jr.

Dr. W. P. Bebbington

Ms. Kim Beeland

Mr. Gary A. Benda

Ms. Sue Berkowitz

Ms. Patsy Bianchi

Miss Carol P. Black

Ms. Donna A. Black

Mrs. Cheryl R. Black

Dr. Albert L. Blackwell

Mr. Chris Blake

Ms. Linda Bledsoe

Ms. Pearlious M. Bledsoe

Mr. Dan Blount

Dr. Paul Blowers

Ms. Kathleen M. Bolen

Mr. Don Bolger

Mr. T. Michael Boliver

Mr. Bob Bolton

Mr. Ronald B. Bolton

Ms. Vicki F. Bolton

Ms. Virginia Bonwitt

Ms. Denise H. Bost

Mr. James S. Bourne, III

Ms. Janie Bowen

Ms. Stacy R. Bowen

Ms. Shirley H. Bowers

Mr. Donald B. Bowman

Mr. William R. Bowman

Mr. Allen E. Boyles

Ms. Janet M. Boyleston

The Reverend Risher Brabham

Mr. Robert Bradford

Ms. Deborah Bradford

Mr. James Bradley, Jr.

Mr. S. Matthew Breeden

Mrs. Patricia Blaney Bright

Mr. Wade M. Brodie

Ms. Barbara Brooks

Mr. Robert A. Brooks

Ms. Zoey Brookshire

Ms. Lawrine Brown

Ms. Beverly Bruck

Ms. Leslie Bruno

Ms. Chandlee Bryan

Mrs. Gayle Bumgarner

Mr. Robert J. Bundy

Mr. W. H. Burckhalter

Ms. Peggy D. Burnett

Ms. Elizabeth Burns

Ms. Evelyn J. Bush

Ms. Helen H. Butler

Mr. Barry S. Butler

Mr. John Cagle

Dr. F. Andy Carhartt

Ms. Myra F. Carter

Ms. Sharon Carter

Ms. Frieda Carter

Mr. Chris Caver

Mr. James S. Chandler, Jr.

Mr. Hammie L. Chaplin

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G.3 GEORGIA

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H. STATE SINGLE POINTS OF CONTACT

Mr. Dean Olson
Director, Management & Program
Analysis Division
Department of Finance &
Administration
Sante Fe, NM

Mr. Joseph Grillesbie
Manager, State Clearinghouse
Office of Intergovenmental
Service
Little Rock, AR

Mr. Thomas C. Adams
Office of Budget and Planning
Office of the Governor
Austin, TX

Mr. Marlan Baucum
Office of Federal State
Programs
Department of Planning and
Policy
Jackson, MS

Mrs. Chrys Baggett
Director, Department of
Administration
Raleigh, NC

Mr. Danny L. Cromer
State Single Point of Contact
Grant Service, Office of the
Governor
Nashville, TN

Mrs. Donna J. Snowden
Alabama State Clearinghouse
Department of Economic &
Community Affairs
Montgomery, AL

Mr. Charles Brown
State Planning Office
Nashville, TN

LIST OF APPENDIXES

A. Analysis of Nuclear Materials Production Options (Classified)

B. *Studies and Monitoring*

C. Responses to Public Comments on Draft Environmental Impact Statement, Continued Operation of K-, L-, and P-Reactors

APPENDIX A
UNCLASSIFIED SUMMARY

ANALYSIS OF NUCLEAR MATERIALS PRODUCTION OPTIONS

Appendix A (which is classified) contains quantitative projections for nuclear materials requirements based on the 1990 Nuclear Weapons Stockpile Memorandum, descriptions of the production complex, and analyses of the capabilities of alternative production sources to meet the requirements. Appendix A also includes an analysis of a potential reduced-need scenario. In addition, Appendix A examines delaying the resumption of production at one or more reactors, including delaying the resumption of production at K-Reactor until the completion of a cooling tower. TC

APPENDIX B

STUDIES AND MONITORING

Since 1951, the U.S. Department of Energy (DOE) and its predecessor agencies have conducted an intensive environmental surveillance program at the Savannah River Site (SRS). This program consists of monitoring effluents from SRS facilities, measuring radionuclide concentrations in the environs, assessing the ecological health of the overall SRS environment, and determining SRS compliance with applicable State and Federal standards. Analytical studies yield measurements and assessments of the impacts of operation (DOE, 1987a). DOE reports the results of this environmental program annually to the public (e.g., Mikol et al., 1988; Zeigler et al., 1987). These reports contain parameters measured, collection methods, and analytical procedures for all measurements of the various media studied. The report for 1988 (Davis, Martin, and Todd, 1989) provides the primary information for this appendix. | TE

B.1 SRS MONITORING PROGRAMS

The SRS environmental surveillance program consists of extensive radiological and nonradiological monitoring. The Environmental Monitoring Section of the Operating Contractor's Environmental and Health Protection Department coordinates SRS monitoring programs; the Environmental Protection Section coordinates regulatory compliance. The Savannah River Laboratory (SRL), the Savannah River Ecology Laboratory (SREL), and the Savannah River Forest Station (SRFS), all of which are located on the SRS, also conduct independent research programs. Section B.1.1 describes the routine radiological monitoring program at the Site. Section B.1.2 describes the routine nonradiological program. Section B.1.3 discusses special surveys or nonroutine environmental studies, and Section B.1.4 highlights other research and environmental programs. Section B.1.5 discusses recent epidemiological studies of the SRS worker population.

B.1.1 RADIOLOGICAL MONITORING PROGRAMS

The SRS environmental monitoring program for radioactivity is comprehensive both in areal extent and in the variety of media sampled. Samples are collected annually from a 5,180-square-kilometer area on and in the immediate vicinity of SRS as well as from an additional 77,700-square-kilometer area (DOE, 1987a). Table B-1 lists the various media sampled in the SRS radiological monitoring program. The South Carolina Department of Health and Environmental Control (SCDHEC) conducts independent radiological monitoring programs for air, surface waters, and groundwaters, both on and off the Site; the Georgia Department of Natural Resources (GDNR) conducts offsite radiological monitoring.

B.1.1.1 Air

Concentrations of radioactive materials in the atmosphere are measured by continuous samplers at 6 onsite monitoring stations, 13 perimeter stations, and 12 stations approximately 40 kilometers from the center of the SRS.

Table B-1. Types of Samples Analyzed in the Radiological Monitoring Program[a]

Air	Wildlife
Thermoluminescent dosimeters	Fish, crabs, and oysters
Surface waters	Deer and hogs
Rivers	Furbearers (i.e., opossums, foxes, raccoons)
Streams	Turtles, ducks
Seepage basins	Rainwater
Groundwater	Vegetation
TE Drinking water	Soil
Milk and food (i.e., eggs, chickens, meats, fruits, grains)	Sediment

a. Modified from Davis, Martin, and Todd, 1989.

Continuous sampling within each 30-degree sector around the SRS is affected by the locations of the perimeter and 40-kilometer-radius stations. Figure B-1 shows the locations of these stations. Samples are analyzed for gross alpha, nonvolatile beta, gamma-emitting isotopes, tritium, and radioactive isotopes of strontium, plutonium, and iodine. Reference or control stations for determining background radiological levels from natural sources and worldwide fallout are located in Savannah and Macon, Georgia, and in Columbia and Greenville, South Carolina.

Thermoluminescent dosimeters (TLDs) are used to measure environmental gamma radiation intensity continuously on the SRS and in the surrounding area. A total of 452 stations monitor a 20,720-square-kilometer area in the SRS vicinity. In 1989, 12 stations were added around the SRS perimeter to monitor gamma and tritium concentrations. These 12 stations, which are part of the Weather Information and Display (WIND) system computers, can transmit data at 6-minute intervals in an emergency response.

B.1.1.2 Surface Water

The SRS is drained by several small creeks that flow in a southwesterly direction until they join the Savannah River. The streams are sampled continuously by paddlewheel samplers at 35 locations and are monitored for radioactivity in effluent discharges. The samples are collected weekly and analyzed for alpha, nonvolatile beta, tritium, and other specific radionuclides. Figure B-2 is a map of radiological sampling stations. Similarly, the Savannah River is sampled weekly and analyzed for gross alpha, nonvolatile beta, tritium, and radioisotopes of strontium, uranium/plutonium, TE and cesium. There are six sampling locations along the river above, adjacent to, and below SRS. Figure B-3 is a map of Savannah River radiological monitoring stations.

Seepage basins on the SRS are monitored quarterly via grab samples, which are analyzed for gross alpha and beta, tritium, strontium, uranium, plutonium, and gamma-emitting radionuclides.

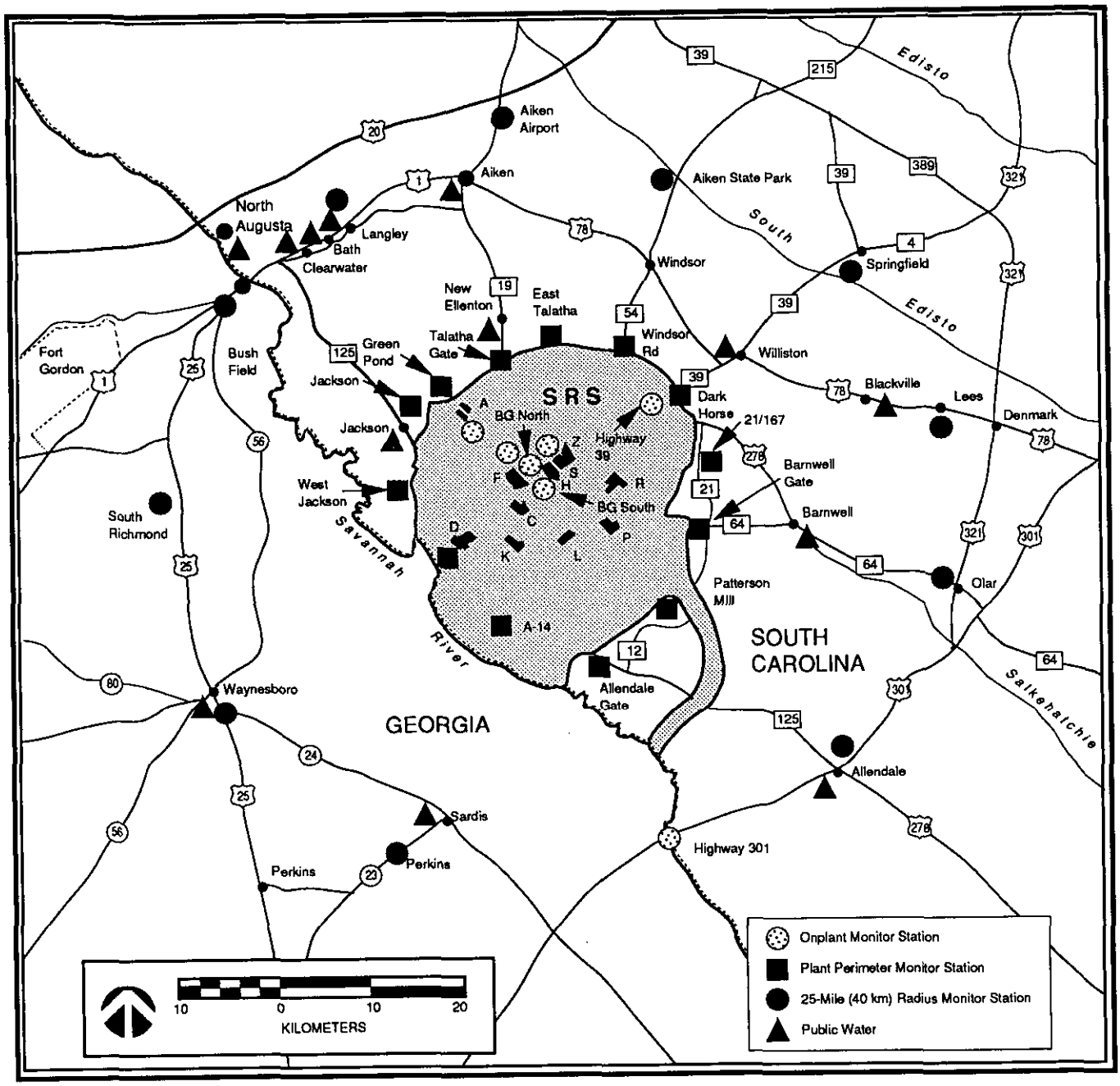
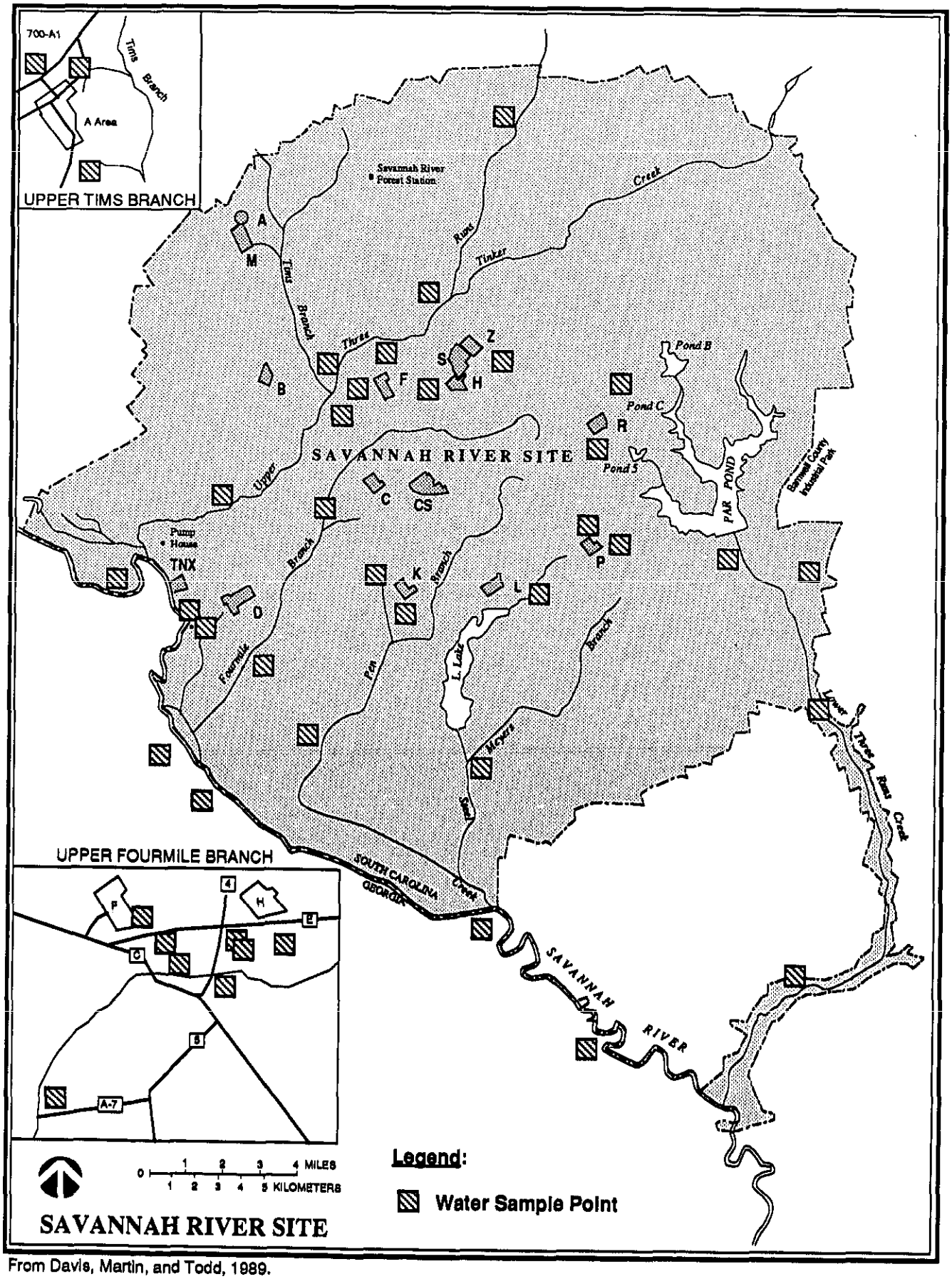
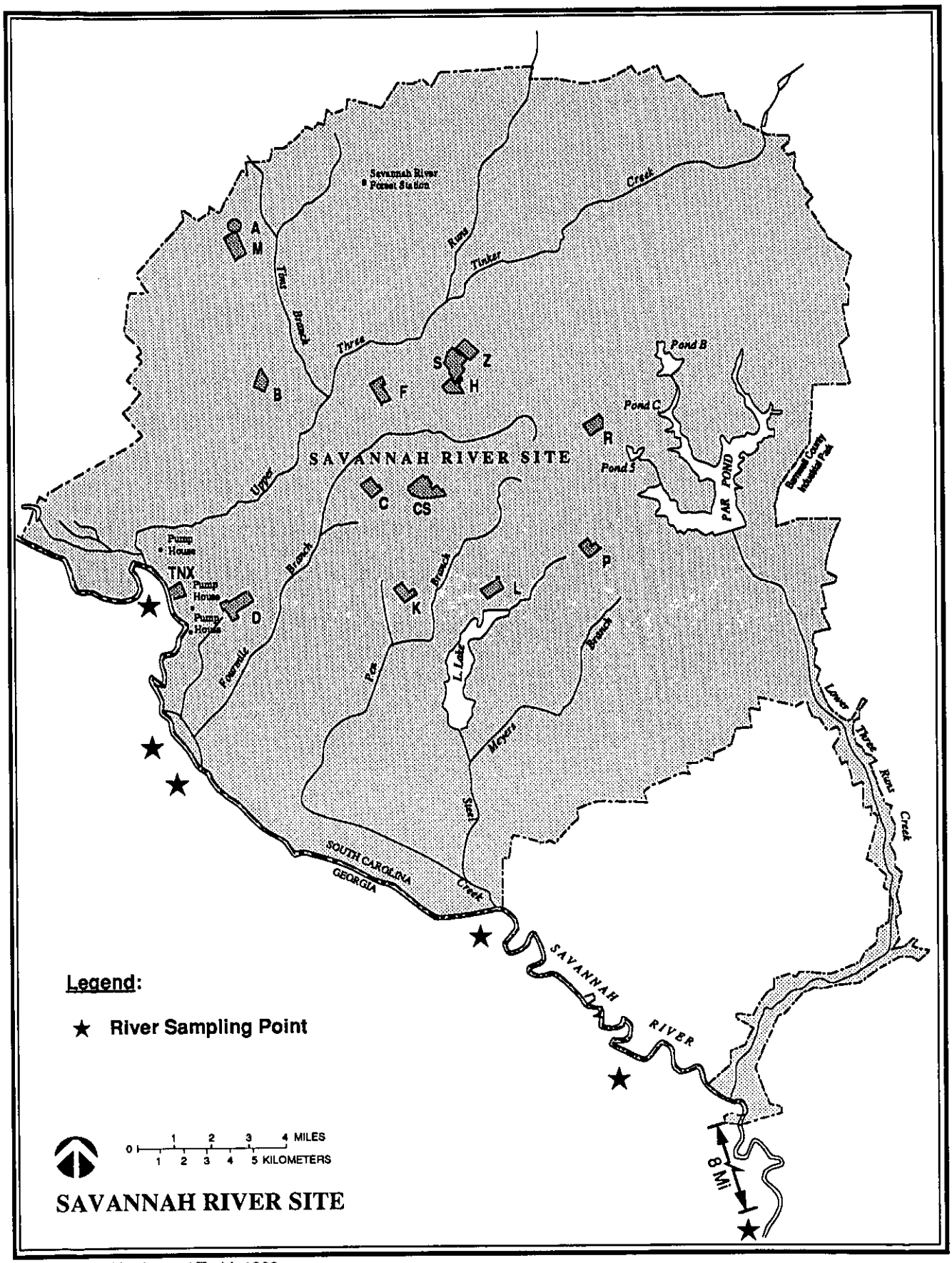


Figure B-1. Locations of the Air Monitoring Stations.



From Davis, Martin, and Todd, 1989.

Figure B-2. Stream Sample Locations on SRS.



From Davis, Martin, and Todd, 1989.

Figure B-3. River Sampling Locations for Radiological Monitoring.

B.1.1.3 Groundwater

The radiological groundwater monitoring program began in the 1950s and has grown steadily to include an extensive well network. Most wells are sampled at least quarterly, and selected wells are monitored for gross alpha, nonvolatile beta, and tritium. The groundwater monitoring program has expanded since 1984 to address the needs identified in the Resource Conservation and Recovery Act (RCRA), as amended, piezometer data for geohydrologic characterization, and contaminant plume migration at various locations, as needed.

B.1.1.4 Drinking Water

Spot samples of drinking water are collected from 14 surrounding towns and 30 onsite facilities. The onsite facilities are sampled at least quarterly, although some are sampled monthly. The samples are analyzed for gross alpha, nonvolatile beta, and tritium. In addition, treated water and raw water are sampled daily at three water-treatment plants that withdraw from the Savannah River: the Cherokee Hill Water Treatment Plant at Port Wentworth, Georgia; the Beaufort-Jasper Water Treatment Plant at Hardeeville, South Carolina; and the North Augusta Water Treatment Plant at North Augusta, South Carolina. The North Augusta plant, located upstream of the SRS, serves as a control. Samples from these plants are analyzed for gross alpha, nonvolatile beta, and tritium.

B.1.1.5 Milk

Biweekly samples of milk are collected from five dairies within a 40-kilometer radius of the Site and from area-produced inventories of a major local distributor. Samples are measured for cesium-137, iodine-131, and tritium; on a quarterly basis, samples are analyzed for strontium-90.

B.1.1.6 Food

Farm products such as leafy vegetables, fruit, grain, poultry, and eggs are collected from 14 localities in the six-county area surrounding the SRS. Six of these localities are at the SRS perimeter and eight are within a 40-kilometer radius. Collards collected from Columbia, South Carolina, serve as a control. All food items are analyzed for gamma-emitting radionuclides, tritium, strontium-90, uranium/plutonium (nonspecific), plutonium-238, and plutonium-239.

B.1.1.7 Wildlife

Fish are collected from the Savannah River above, adjacent to, and below SRS as well as at the river mouth in Savannah, Georgia. Fish are also taken from SRS streams and ponds and from Lake Thurmond (control). Specimens are analyzed for alpha-, beta-, and gamma-emitting radionuclides. Crabs and oysters from the mouth of the river are also analyzed for alpha-, beta-, and gamma-emitting radionuclides.

TE SRS conducts annual hunts to control the onsite deer and hog population and to minimize animal-vehicle accidents. Field analyses for cesium-137 are

performed at the hunt site before the game is released to the hunter. Additional samples of flesh, thyroid, spleen, kidney, liver, and muscle are removed from 5 to 10 percent of the animals for analysis for strontium-90, cesium-137, and tritium.

Although they are not hunted on the Site, furbearers such as foxes, raccoons, and opossums are trapped and analyzed for gamma-emitting radionuclides. Beaver trapped by SRFS for population control are monitored for radioactivity with a Geiger-Mueller (G-M) detector.

Ducks are routinely trapped at Par Pond and Pond B on SRS for analysis of gamma-emitting radionuclides. Turtles are also trapped both on and off the Site as part of ongoing SREL research that studies migratory patterns. Trapped turtles are surveyed with a G-M detector for radioactivity.

B.1.1.8 Rainwater

Samples of rainwater are collected monthly at the ambient air monitoring stations and analyzed for gross alpha, nonvolatile beta, gamma-emitting isotopes, tritium, strontium, plutonium, and radioisotopes of plutonium and strontium. In addition, quarterly samples are collected from the four ambient air reference stations in Columbia and Greenville, South Carolina, and in Savannah and Macon, Georgia.

B.1.1.9 Vegetation

Grass samples are collected quarterly onsite and at the SRS perimeter, as well as from 40- and 160-kilometer radii. Onsite samples are collected specifically from seepage and retention basin areas and from the Radioactive Burial Ground. All samples are analyzed for gross alpha and beta, strontium-89 and -90, tritium, and gamma-emitting radionuclides.

B.1.1.10 Soil

Soil samples are collected annually from uncultivated areas at each of four quadrants around SRS. Two control sites (Clinton, South Carolina, and Savannah, Georgia) are approximately 160 kilometers from SRS. Samples are analyzed for strontium-90, plutonium-238, plutonium-239, and gamma-emitting radionuclides.

B.1.1.11 Sediment

Since 1975, floodplain sediments have been collected on an annual basis from the Savannah River. Two locations each are sampled annually above, adjacent to, and below SRS (refer to Figure B-3). Since 1977, sediment samples from nine SRS stream locations have been monitored on an annual basis. All samples are analyzed for strontium-90, plutonium-238 and -239, and gamma-emitting radionuclides.

B.1.2 NONRADIOLOGICAL MONITORING PROGRAMS

The nonradiological monitoring program at SRS is coordinated by the Environmental Monitoring Section of the Operating Contractor's Environmental

TE |and Health Protection Department, assisted by a subcontractor with the routine operations, both on and off SRS. Table B-2 lists the various media sampled in the nonradiological program. Independent nonradiological monitoring is also performed by SCDHEC and GDNR.

Table B-2. Samples Analyzed in the Nonradiological Program[a]

Air	Drinking water
Surface water	Sediment
Rivers	Rivers
Streams	Streams
Groundwater	Fish

a. Modified from Davis, Martin, and Todd, 1989.

B.1.2.1 Air

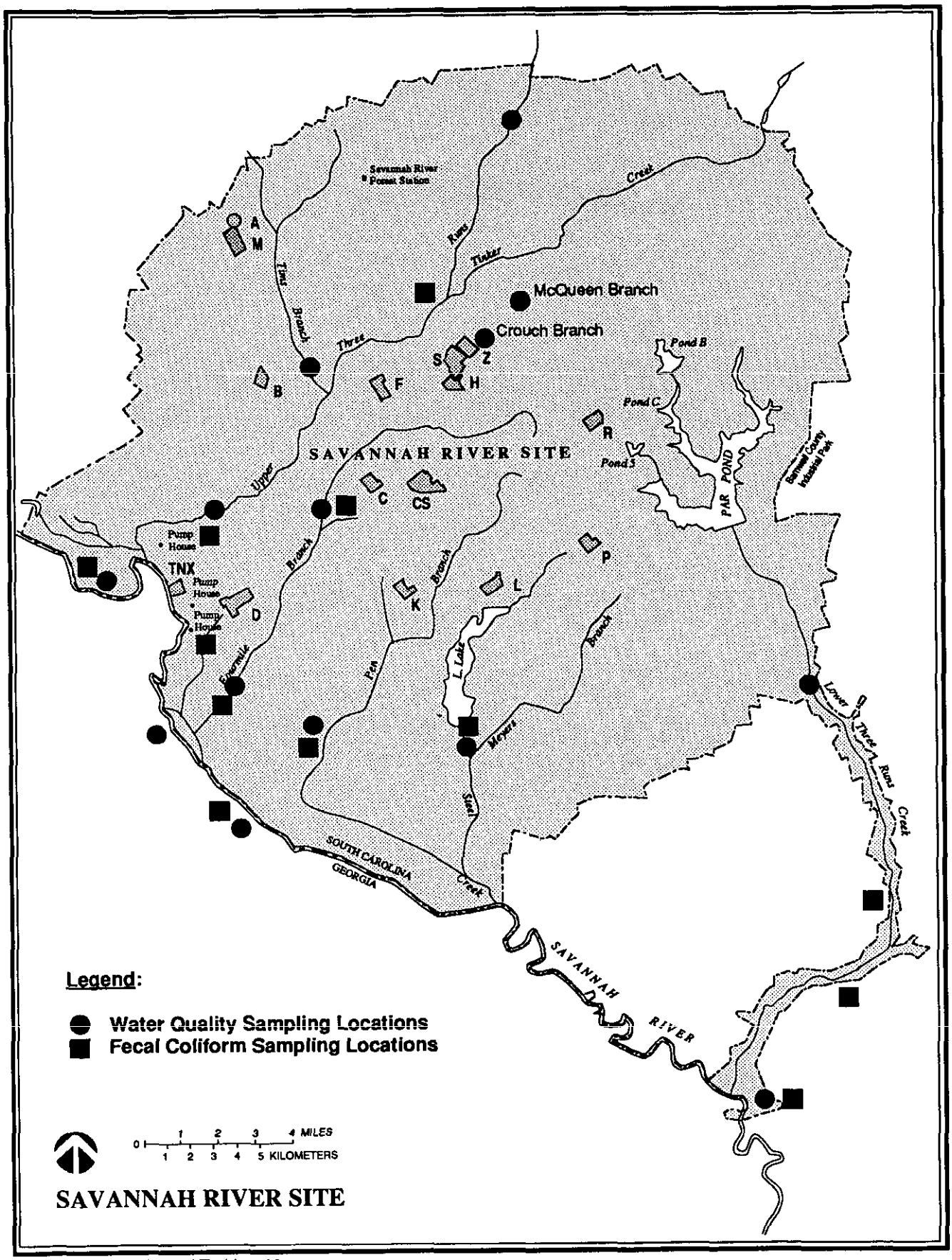
Five onsite coal-fired powerplants (in A-, D-, H-, K-, and P-Areas) and six other onsite process stacks (four in M-Area and two in P- and H-Areas) are monitored for nonradiological air emissions. Along with the independent monitoring programs of SCDHEC and GDNR, SRS maintains its own nonradiological program. Ambient air quality is monitored at five onsite stations having continuous sampling for sulfur dioxide, nitrogen oxides, and ozone. Total suspended particulates are monitored every 6 days over a 24-hour period.

B.1.2.2 Surface Water

SRS has 71 active outfalls that are monitored for temperature, pH, total nonfilterable residue, oil and grease, and/or fecal coliform. Some outfalls are also monitored for pesticides and organic chemicals. In addition to monitoring at the outfalls, six stations along the onsite streams and three along the Savannah River are maintained. The river stations are above,
TE |adjacent to, and below SRS operations. Figure B-4 shows the nonradiological water quality sampling locations. Conductivity, dissolved oxygen, temperature, and pH are measured in the field at these stations on a weekly basis. Laboratory measurements include fecal coliform and various metals and nonmetals. Continuous samples at all river and onsite stream locations are obtained by paddlewheel samplers. The six onsite stream locations are monitored on a monthly basis for the parameters listed above. SCDHEC maintains four monitoring stations, which are sampled monthly, along the onsite streams.

B.1.2.3 River and Stream Temperature Surveys

A consent order between DOE and SCDHEC established an ongoing comprehensive study of thermal effects from SRS operations on South Carolina waters. Seasonal temperature profile surveys are conducted on the Savannah River and onsite streams. The U.S. Geological Survey (USGS) maintains continuous temperature-monitoring stations at the mouth of each SRS stream.



From Davis, Martin, and Todd, 1989.

Figure B-4. Water Quality Sampling Locations for Nonradiological Monitoring.

B.1.2.4 Groundwater

Groundwater wells are maintained onsite for routine and special nonradiological monitoring. Most wells are sampled quarterly with field measurements of pH, temperature, conductivity, and water depth. A comprehensive chemical analysis is conducted every 2 years; wells are sampled on an annual basis for suspected contaminants (e.g., sulfate is collected from wells near coal piles). The frequency for additional sampling of a particular constitutent depends on its concentration and any other special request for regulatory compliance by the U.S. Environmental Protection Agency (EPA) and SCDHEC.

B.1.2.5 Drinking Water

Most onsite drinking water is obtained from groundwater from the deeper Black Creek-Middendorf Formations or the shallower Congaree-McBean Formations. Although D-Area currently receives treated Savannah River water, further plans call for conversion to a system that draws groundwater from wells. All 30 onsite systems are monitored daily for residual chlorine and chlorocarbons. Fecal coliform analyses are conducted either daily, weekly, or monthly, depending on the size of the water system. In addition, samples from the 16 largest systems are analyzed for an extensive list of chemical and physical parameters by a certified offsite laboratory to ensure DOE compliance with EPA and State limits.

B.1.2.6 Sediment

A sampling program has been maintained since 1976 to monitor pesticides and herbicides in river and SRS stream floodplain sediment. Water and sediment samples are collected annually from seven onsite stream locations and two river stations to be analyzed for pesticides, herbicides, and polychlorinated biphenyls (PCBs).

B.1.2.7 Fish

Mercury, pesticides, and herbicides from industrial and agricultural sources upriver from SRS were detected in 1971 in fish taken from the Savannah River. Since that time, mercury analyses have continued; an annual collection is now maintained. Fish trapped on and off the Site are selected randomly for whole-fish mercury analyses.

B.1.3 SPECIAL SURVEYS AND PROGRAMS (NONROUTINE)

This section discusses the types of special radiological and nonradiological sampling conducted by SRS in response to unexpected or accidental releases of radioactive materials or to chemical spills. It also discusses examples of special surveys conducted to monitor the environmental effects of SRS effluents. It also presents examples of recent special radiological studies of radiological surveys conducted in the past, and of ongoing nonradiological programs.

B.1.3.1 Recent Radiological Surveys

In the event of nonroutine radioactive releases, special environmental surveys are performed to assess the potential risk to the public. Such surveys can include sampling of all media such as process air and water, vegetation, SRS streams and Savannah River water, soil, and ambient air. In 1988, the following special radiological surveys were performed at SRS and in the immediate vicinity:

1. Upper Three Runs Creek Special Survey

   In October 1988, a radiological survey of Upper Three Runs Creek and H-Area was completed. The study objective was to document baseline information before the November 1988 startup of the Effluent Treatment Facility in H-Area. Floodplain sediment and vegetation samples were collected at six locations along Upper Three Runs Creek to determine gamma radiation levels.

2. Savannah River Swamp Survey

   In the 1960s, a portion of the Savannah River Swamp was contaminated with cesium-137 and cobalt-60 due to leakage from a failed fuel element. In 1974, SRS established 10 sampling stations to monitor radioactivity; sampling occurred annually until 1977. Since that time, sampling has occurred at 5-year intervals because the change in radiation levels measured on an annual basis was insignificant. The 1988 survey represents the most recent monitoring effort; TLD gamma-radiation measurements were made of vegetation, soil, and fish.

3. Lower Three Runs Creek Special Survey

   Before the construction of Par Pond in 1958, R-Area discharged radioactive effluents directly to Lower Three Runs Creek. In 1971, a gamma radiation monitoring survey was conducted of the water, vegetation, soil, fish, and air along Lower Three Runs Creek. Surveys were repeated in 1982 and in 1988.

B.1.3.2 Other Radiological Surveys

Historically, several special radiological surveys have been conducted on the Site in response to accidental releases to the air and water; for example:

1. R-Area Comprehensive Survey

   In 1957, a failed experimental fuel element in the 105-R emergency basin discharged radioactive material to nearby seepage basins. These basins and the groundwater have been monitored during special surveys since that time; the most recent survey was in 1986. Any outcropping of activity and the identity of any new areas of contamination are noted by the surveys.

2. R-Area Old and New Canal Surveys

In 1987, two special radiological surveys were conducted along the "old" and the "new" R-Area canals. Soil samples were analyzed for radiation, and TLDs were installed to monitor atmospheric gamma radiation.

3. Aiken Municipal Airport Ambient Air Study

Particulate samples from large (approximately 10,000 cubic meters) air volumes are collected by ambient air stations at the Aiken Municipal Airport. In 1988, samples were collected every 2 to 3 days and analyzed on high-sensitivity gamma detectors at SRL. Samples were also collected in 1986 in response to the Chernobyl incident.

B.1.3.3 Nonradiological Special Surveys

Special, nonroutine surveys are conducted by SRS in response to unexpected chemical and oil spills. A sitewide procedure (the Spill Prevention Control and Countermeasure Plan) ensures the prompt reporting of oil and chemical spills to a Spill Coordinator who is responsible for reporting spills to the proper authorities (SCDHEC, EPA, DOE).

Another example of special nonradiological surveys conducted on Site is the ongoing Savannah River water-quality monitoring by the Academy of Natural Sciences of Philadelphia. Since 1951, the Division of Environmental Research at the Academy has surveyed the aquatic environment of the river above and below SRS. The overall objective is to assess the effects of SRS effluent on the general river health. This monitoring consists of a comprehensive survey of the aquatic biota (algae, macrophytes, insects, and fish) and water chemistry.

B.1.4 RESEARCH AND ENVIRONMENTAL PROGRAMS

In 1972, SRS was designated the nation's first National Environmental Research Park (NERP). SRS has been used as an outdoor environmental laboratory by visiting university scientists in cooperation with SRL, SREL, and SRFS. These facilities, through the NERP program, also offer a rare opportunity for undergraduate and graduate students to participate in meaningful environmental research while completing university degree requirements. Data, information, and surveys gathered through the extensive environmental programs of the onsite laboratories are published in scientific literature and presented at professional meetings throughout the nation. In 1988, 10 research programs were conducted on SRS as a part of the NERP program; they include a baseline investigation for comparison of wetland bacteria on SRS with that of the Okefenokee Swamp, Georgia; a comparison of the feeding behavior of SRS wading birds with that in the Okefenokee Swamp and the Belle Baruch Long Term Ecological Research Site at North Inlet in South Carolina; and a comparison of the cesium-binding capacity of SRS soils with that at Los Alamos, New Mexico, and Bikini Atoll. Many ongoing research activities at SRL, SREL, and SRFS are related to environmental effects of SRS activities as well as to the elucidation of basic environmental principles.

B.1.4.1 Savannah River Laboratory

SRL consists of two divisions that contribute to environmental research activities - the Environmental Technology Division and the Environmental Sciences Division. The Environmental Technology Division contributed to emergency response planning efforts in 1988 in the form of programs for radiometrics development, radionuclide effluent studies, and atmospheric research.

The Environmental Sciences Division has performed other environmental studies including permit compliance studies of L-Lake and Steel Creek, the meeting of EIS requirements, and the development of an extensive waste management and groundwater protection program. The groundwater protection program includes the SRS Aquifer Characterization Study, continuation of the SRS Baseline Hydrologic Investigation, and modelling of SRS groundwater flow. Special studies address the fate and effect of SRS pollutants using remote sensing surveys, transport and cycling of tritium in the environment, microbiology of the SRS deep subsurface, and a sitewide seismic survey.

B.1.4.2 Savannah River Ecology Laboratory

SREL, operated by the University of Georgia under contract to DOE, has conducted independent environmental research activities at SRS since 1954. Programs are broadly divided into three areas of concentration - wetlands research, biogeochemical research, and studies related to wildlife and environmental stresses associated with SRS activities. Some examples of ongoing research topics include the effects of flooding on bald cypress growth rates, zooplankton community development at L-Lake, genetic alterations in a population of slider turtles due to radionuclide exposure, biogeochemistry of coal piles and ash basins, and the management of artificial foraging ponds at Kathwood Lake for wood storks.

B.1.4.3 Savannah River Forest Station

SRFS has conducted the onsite forest management program since 1952, when an interagency agreement was reached between the Atomic Energy Commission (a predecessor to DOE) and the U.S. Forest Service. SRFS manages a large area of SRS for timber production and sales. It also manages some of SRS for environmental protection, such as those areas that serve as quality habitat for the endangered red-cockaded woodpecker. Other environmental programs include managing areas for native wildlife protection and for the prevention of erosion. SRFS also conducts separate research activities on reforestation and pine seedling development techniques.

B.1.5 *EPIDEMIOLOGICAL STUDIES*

In 1983, DOE assembled a panel of experts to evaluate the need to conduct epidemiological studies on the risk of delayed health effects from SRS operations to local human populations as an addition to previous studies. The panel reviewed past and ongoing studies and developed a list of potential additional studies for future consideration. DOE decided, on the panel's

advice, to continue funding of particular, ongoing industry-wide health and mortality studies being conducted by the Oak Ridge Associated Universities (ORAU).

A study then underway on this topic (Sauer, 1984) attempted to assess the possible influence of radiation from SRS operations on health by examining county mortality rates in Georgia and South Carolina as a function of distance from SRS. The study examined Beaufort and Jasper Counties separately to identify the influence, if any, of the consumption of water from the Savannah River. The study focused on specific cancer mortality data, as well as deaths due to cogenital anomalies or birth defects, "early infancy," and stroke and cardiovascular diseases. The report concludes "no clear association of risk of death has been identified for those living in counties close to SRP, as compared with those living farther away and with the U.S."

The National Cancer Institute/National Institutes of Health (NCI/NIH) recently reported the results of an extensive study of cancer mortality in populations living near operating nuclear facilities in the United States, including the SRS (Jablon et al., 1990). The study used available county mortality data for the period from 1950 to 1984 to compare counties that contain nuclear reactors and adjacent counties with control counties, matched on the basis of a number of ethnic and socioeconomic factors. Comparisons were to be made for selected age groups and by time period (i.e., before and after startup).

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C-02-04
A-34-05
A-63-05
L-02-02
L-71-04
C-15-04

The report summary states: "From the evidence available, this study has found no suggestion that nuclear facilities may be linked causally with excess deaths from leukemia or from other cancers in populations living nearby. Studies in the United Kingdom had found increased mortality from leukemia in children near two nuclear fuel reprocessing complexes and two nuclear weapons plants. Examinations of similar installations in the United States failed to find such increases."

The American Journal of Industrial Medicine published the most recently completed study of the SRS worker population (Cragle et al., 1988), in which the sampled population included 9,860 caucasian male workers at SRS. This first-phase study examined overall and specific causes of deaths through 1980 for all workers first employed at the Site between 1952 and 1974, without regard to radiation or chemical exposures to individual workers.

The study population of 9,860 current and former workers was characterized based on the type of employment as hourly (6,687), salaried (2,745), or combined (i.e., had worked both as hourly and salaried employees) (428) as a substitute for socioeconomic status. Other categorizations were based on the date of first employment as pre-1955 or post-1955, and on the total length of employment (less than 5 years, 5 or more but less than 15 years, and more than 15 years).

The results of examining the normalized vital statistics for these workers.as a group in comparison to the general population displayed the expected "healthy worker" effect with lower death rates from all causes and all cancers than the population at large for hourly and salaried workers. The combined workers displayed no significant differences in death rates from all

causes and all cancers, although cancer death rates of salaried employees were somewhat elevated over the general population. However, significant differences in death rates were evident when the data were divided further by length of employment and date of first employment.

In the group of hourly workers hired before 1955, the segment employed between 5 and 15 years showed a statistically significant increase in deaths from some type of leukemias - 6 observed versus 2.18 expected. The group of hourly workers employed for more than 15 years showed more than expected, but not statistically so, deaths from leukemia and other causes. No other employment group or period showed any statistically significant increments in cancer mortality rates.

For followup on the leukemia cases in the hourly worker group, the investigators added 389 members of the "combined" group who had started as hourly employees. Of the 14 leukemia deaths that occurred in these groups, four were identified as a type (chronic lymphocytic leukemia) generally ackowledged to be not related to radiation exposure. The radiation monitoring data for those dying of leukemia indicated that none exceeded the 5-rem-per-year limit in any year of employment, and the group averaged about 380 millirem per year per capita (range: 21 to 880 millirem per year); cumulative (combined both external and internal) doses over the SRS employment period ranged from 115 millirem to 19.33 rem (the latter accumulated over a 25.6-year employment period). L-02-02 S-03-01 C-02-04 A-34-05 A-63-05 L-71-04 C-15-04

The results of this first-phase study do not permit a conclusion relating the leukemia deaths to radiation exposure. A case-control study of these leukemia cases is under way to assess exposures to radiation and chemicals to determine whether the cases are related to those factors. Some of these leukemia cases had regular or occasional exposures to solvents during their employment at SRS, and all had been employed elsewhere before beginning work at SRS, for an average of 16.5 years. The types of work done by these individuals in their pre-SRS employment will also be investigated. The results of the followup studies are not expected before the end of 1991.

B.2 REACTOR MONITORING PROGRAMS

Most of the sitewide monitoring programs described in Section B.1 provide information directly applicable to K-, L-, and P-Reactor operation. This section describes the monitoring programs as a group as they apply to the operations of K-, L-, and P-Reactors and the reactor areas.

B.2.1 K-REACTOR AREA

Aside from routine monitoring for National Pollutant Discharge Elimination System (NPDES) permit compliance, temperature profiles have been prepared for Pen Branch in past years. Studies for the prediction of thermal discharge impacts and for impingement/entrainment effects for compliance with the Federal Water Pollution Control Act of 1972 have been conducted (Du Pont, 1989; DOE, 1987b).

Radiological monitoring of the K-Area surface waters consists of determining tritium concentrations in the K-Area Containment Basin and Indian Grave Branch. Seepage basins in K-Area that allow migration of tritium to Pen Branch are also monitored for radioactivity.

Sections B.1.1 and B.1.2 describe the existing SRS air quality monitoring programs for K-Area.

Groundwater in the K-Area is monitored for gross alpha, nonvolatile beta, total radium, tritium, and heavy metals at the acid/caustic basin, the ash basin, the burning/rubble pit, the coal pile runoff containment basin, the disassembly basin, the K-Reactor seepage basin, the retention basin, and the sludge land application site.

Vegetation (grass), collected routinely near the seepage and retention basins in K-Area, is analyzed for gross alpha, nonvolatile beta, and strontium-89 and -90.

A recently completed special seismic investigation noted the existence of the northeasterly trending Pen Branch Fault, which runs across SRS near K- and P-Reactors. The fault has been documented based on core and geophysical data collected in the last 30 years from onsite wells. The SRS geological research program now includes an evaluation of the Pen Branch Fault and its dimensions, its relationship to the regional geologic setting, its magnitude, and its time of movement.

B.2.2 L-REACTOR AREA

Routine, nonradiological monitoring of Steel Creek is regulated by the SRS NPDES permit and is conducted by the Operating Contractor. A special temperature profile survey of Steel Creek was completed in 1988; a study for the prediction of thermal discharge effects due to the operation of L-Reactor
TE is ongoing (Du Pont, 1988). Since 1982, the Academy of Natural Sciences of Philadelphia has conducted nonradiological water-quality sampling and biological surveys in Steel Creek. Other monitoring includes a station maintained by SCDHEC along the creek.

Routine radiological monitoring is conducted for Steel Creek below L-Lake and for the L-Area seepage basin, as described in Section B.1.1. Releases from P-Area basin are also monitored in Steel Creek above L-Lake.

Sections B.1.1 and B.1.2 describe the air quality monitoring programs for L-Area.

Groundwater is routinely monitored for the constituents listed in Section B.2.1 at the following L-Area locations: the acid/caustic basin, the burning/rubble pit, the disassembly basin, the oil and chemical basin, and the seepage basin.

Other media sampled in L-Area include vegetation (grass), which is collected from the vicinity of the L-Area seepage and retention basins for gross alpha,

nonvolatile beta, and strontium-89 and -90 analyses. The establishment and progression of submerged aquatic vegetation, planted in 1987 along the shores of L-Lake, is monitored routinely. Other successional changes in and around L-Lake as well as biogeochemical lake cycling and microbial processes are monitored. Aerial surveys of the Savannah River Swamp and the Steel Creek delta determine the distribution of wood storks on SRS.

B.2.3 P-REACTOR AREA

Par Pond, before overflowing to Lower Three Runs Creek, receives P-Reactor heat exchanger cooling water and other effluents from P-Area as well as all storm sewer outfalls from the deactivated R-Area and a few storm sewers from P-Area. The monitoring of these nonradiological releases is regulated through the SRS NPDES permit. In 1985, thermal effluent effects in Par Pond were studied for compliance with the Federal Water Pollution Control Act of 1972 (Du Pont, 1985). TE

Radiological releases (tritium) from the P-Area Seepage Basin migrate to Steel Creek, which is sampled as described in Section B.2.2. Sections B.1.1 and B.1.2 describe the radiological and nonradiological air quality monitoring programs for P-Area.

Groundwater from P-Area is monitored for the constituents listed in Section B.2.1 in the acid/caustic basin, the burning/rubble pit, the coal pile runoff containment basin, the disassembly basin, and the seepage basin.

Ducks captured at Par Pond and Pond B are analyzed routinely for gamma-emitting radionuclides. The biogeochemical cycling of Pond B is under investigation. Grass samples collected near P-Reactor are measured for gross alpha, nonvolatile beta, and strontium-89 and -90 concentrations.

In 1988, during a special radiological survey of Lower Three Runs Creek, floodplain soil samples were analyzed for gamma-emitting radionuclides and plutonium. Vegetation, fish, and invertebrates were also analyzed for gamma-emitting radionuclides, and TLDs were placed aboveground to monitor gamma radiation levels.

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TC Sauer, H. I., 1984. Mortality Trends in Counties Near the Savannah River Plant, 1949-1978, prepared for E. I. du Pont de Nemours and Company, Inc., Savannah River Laboratory, Aiken, South Carolina.

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APPENDIX C

RESPONSES TO PUBLIC COMMENTS ON DRAFT ENVIRONMENTAL IMPACT STATEMENT CONTINUED OPERATION OF K-, L-, AND P-REACTORS

The U.S. Department of Energy (DOE) published the Draft Environmental Impact Statement (EIS) on Continued Operation of K-, L-, and P-Reactors (DOE/EIS-0147D) in May 1990. DOE announced the availability of the document for public review and comment in the Federal Register on May 11, 1990 (55 FR 19773); this initiated the 45-day comment period. Three public hearings were held to receive oral and written comments on the Draft EIS: Savannah, Georgia, on May 31, 1990; Columbia, South Carolina, on June 5, 1990; and Aiken, South Carolina, on June 8, 1990. The public comment period officially ended on June 25, 1990. This Final EIS is available for review in DOE reading rooms located in Washington, D.C., and Aiken, South Carolina, and is being distributed to individuals, public agencies, and Federal and state officials who commented on the Draft EIS and others on the DOE mailing list.

During the comment period, 235 persons presented comments at the three public hearings: 66 in Savannah, 73 in Columbia, and 96 in Aiken. DOE also received 85 letters related to the Draft EIS through the mail. Of the 85 letters, 3 were from Federal agencies, 3 were from agencies and offices of the State of South Carolina, and 1 was from an agency of the State of Georgia.

This appendix to the Final EIS includes transcripts of the oral presentations made at public hearings, copies of the written statements submitted to DOE at public hearings, and copies of all comment letters received by DOE through the mail. It also presents the DOE responses. If a statement or comment prompted a revision to the EIS, DOE has identified the revision by a vertical line (change bar) in the margin and the applicable comment letter-number designation. Tables C-1 to C-4 list government agencies, elected and other officials, private organizations, and individuals, respectively, who submitted comments on the Draft EIS; these tables direct the reader to the applicable comments in Tables C-5 through C-8 and the DOE responses.

The comments and statements reflected a number of specific and general issues about the EIS. The following sections summarize the major issues raised by the public and agencies, and the DOE responses. The U.S. Environmental Protection Agency (EPA) gave the Draft EIS a rating of EC-2, which means that EPA had environmental concerns, for which DOE needs to consider the implementation of corrective actions or mitigation measures, and that the Draft EIS did not provide sufficient information for EPA to assess fully the environmental impacts. DOE has addressed these concerns by providing descriptions of corrective or mitigative measures in this Final EIS, and by providing the additional information required (please see Letter L-78).

NEED FOR MATERIAL

COMMENTS

A number of commentors questioned the need for tritium and other nuclear materials, based primarily on the changes in world affairs and the arms limitation treaties under negotiation. Commentors also criticized the public unavailability of Appendix A to the EIS, the classified appendix that discusses the production capabilities of the SRS reactors and other production alternatives and the needs for defense nuclear material. Following are the major categories of these comments:

- The lack of need for tritium based on current changes in the world geopolitical situation
- The outdated Nuclear Weapons Stockpile Memorandum (NWSM) used as the basis for establishing need in the Draft EIS
- The unavailability of Appendix A to the public - [one commentor has filed a Freedom of Information Act (FOIA) request for Appendix A]
- The need for plutonium-238 and the adequacy of the analysis supporting the production of plutonium-238 at SRS

RESPONSE

DOE acknowledges the developments that are reducing tensions among major world powers. However, these developments are still progressing and the President has determined that the United States must maintain, for the foreseeable future, a nuclear deterrent. This commitment to maintain an adequate deterrent includes the continued maintenance and improvement of nuclear weapons.

The quantitative need for tritium (and other nuclear materials) is determined annually. A committee representing Government agencies that produce and use the materials develops estimates of their needs on an annual basis. The committee makes recommendations to the National Security Council and the President, who must approve them. The most recent NWSM was approved by President Bush on July 12, 1990; Appendix A (which is classified) of the Final EIS discusses the need for the production of nuclear materials and evaluates the production capabilities of various options to meet the need based on this NWSM. Appendix A also includes an analysis of a potential reduced-need scenario. The EIS covers a range of options for the production of needed materials.

The analysis in the classified Appendix A of the need for the production of tritium to meet two demand cases, one derived from the most recent NWSM and the other from the potential reduced-need scenario, and of the alternatives for meeting those requirements, is provided for the information of the decisionmaker, and for other qualified people who meet security requirements. The classified appendix also considers the need for the production of tritium

to meet an alternative demand case, derived from an extrapolation based on arms control negotiations and budget constraints presently being considered for the next NWSM.

The requirements for plutonium-238 are determined primarily by the National Aeronautics and Space Administration and the Department of Defense, which consider the feasibility of employing alternative power sources for their missions. DOE, as the supplying agency, determines inventory requirements based on quantity and purity specifications and delivery schedules. Based on these needs and specifications, DOE has determined that the only reasonable production alternative is the use of the SRS reactors.

CLEANUP OF SITE CONTAMINATION

COMMENTS

A number of commentors expressed the view that the Savannah River Site (SRS) should focus on the cleanup of existing contamination and wastes at the site, rather than create new wastes by resuming production at SRS reactors. Frequently associated with these comments were suggestions that funding for nuclear materials production should be diverted for this purpose, and that jobs lost due to termination of reactor operation could be transferred to the restoration program.

RESPONSE

DOE is committed to a program of environmental restoration of its sites, including SRS. This program is already under way and is funded independently of the decision on continued reactor operation. The DOE Environmental Restoration and Waste Management Five-Year Plan (DOE/S-0070) describes this program, and other EISs (Waste Management for Groundwater Protection, DOE-EIS/0120; Defense Waste Processing Facility, DOE-EIS/0082) describe waste management activities at the SRS. Reallocation of nuclear materials production funds, if it were consistent with the need for continued operation of SRS reactors, would not materially speed up site restoration, which is proceeding at a pace determined primarily by the governing regulatory processes and the rate of technology development and deployment.

With regard to the opportunities for jobs for reactor operation and maintenance personnel in restoration activities, the skills of such specialized employees might not be readily transferable to site restoration activities, which require their own unique skills.

RADIOACTIVITY IN THE OFFSITE ENVIRONMENT

COMMENTS

A number of comments expressed concern about radioactive contamination of the offsite environment as a consequence of previous and continuing releases from

SRS operations, and the impacts of such releases on the health of the population surrounding and downstream of the SRS. Specific comments were raised about:

- The incidence of cancer in the SRS vicinity
- The history of prior discharges from the SRS and their consequences
- The cumulative risks from past and continuing operation
- The potential increase in radioactive contamination of the Beaufort-Jasper water supply

RESPONSE

Studies to date of the populations potentially affected by SRS emissions have not identified any excess of cancers related to those emissions, including the most recent, an independent study by the National Cancer Institute/National Institute of Health (Jablon et al., 1990).

DOE has assembled the historic data on radioactive emissions to air and water from SRS since its inception. Assuming current environmental transport and demographic parameters to apply to these prior discharges, estimates were made of the cumulated doses to a hypothetical individual who resided permanently at the most exposed SRS boundary location, as well as to the surrounding population and downstream water users over this period. That information, which shows (for example) a cumulated dose of less than 20 millirem over the 36-year period to a hypothetical Beaufort-Jasper water consumer (compared to the EPA Drinking Water Standard of 4 millirem per year), has been added to Section 3.7.1.2 of the EIS.

The Draft EIS identified the intent of DOE to apply to the South Carolina Department of Health and Environmental Control (SCDHEC) for a National Pollutant Discharge Elimination System (NPDES) permit for direct discharge of disassembly-basin purge water contamination with tritium, consistent with the DOE objective to stop using the soil as a disposal medium. In the absence of any viable process for the removal of tritium from such waters, as a consequence of this proposal (and the discontinuance of the use of seepage basins in the F- and H-Areas), the radioactive decay afforded by onsite groundwater transit time would no longer exist and an increase in the quantity of tritium in liquid wastes reaching the Savannah River would occur. However, the concentrations in the water consumed by Port Wentworth and Beaufort-Jasper users would remain a small fraction of that permitted by EPA drinking water standards.

In their respective comments, EPA indicated that DOE should eliminate the use of the seepage basins, SCDHEC indicated that DOE could continue to use the basins if certain conditions were met, and downriver water users objected to any increase in exposure, no matter how small. As a result of these comments, DOE will continue to discharge to the seepage basins while reexamining options for the discharge of disassembly-basin purge water in collaboration with EPA, SCDHEC, and affected water users, including options for reducing the discharges, or possibly eliminating the need to discharge altogether. In

response to these comments, DOE has revised Section 4.1.2 of the EIS to present a comparison of the offsite doses associated with discharge to seepage basins, direct discharge to onsite streams, and evaporation, which are the three options for handling disassembly-basin purge water.

REACTOR SAFETY AND RISK ASSESSMENT

COMMENTS

A large number of comments were raised with regard to the safety of reactor operation at SRS. Frequent areas of comment included:

- The age of the reactors and their lack of conformance with NRC requirements for commercial nuclear powerplants, including a containment dome
- The need to complete all safety upgrades before resuming production
- The need for independent oversight of reactor safety concerns
- Completion of the probabilistic risk assessment (PRA) and its peer review before the resumption of production
- The ability of the reactors to withstand severe earthquakes
- The likelihood of severe accidents and the risks to public health and the environment
- The adequacy of emergency planning

RESPONSE

While it is true that the SRS reactors are about 35 years old, they have been continually upgraded and modernized over the years. They are currently undergoing extensive modifications and safety upgrades, the most significant of which will be completed before the resumption of production. A comprehensive examination of the primary cooling system and other systems important to the safe functioning of these reactors has revealed no mechanism that would limit their useful life. Although continued aging might reduce their availability, K-, L-, and P-Reactors should be able to meet production requirements for tritium and plutonium-238, and will ensure the capability to produce nuclear materials as necessary, at least until replacement production capability has been demonstrated. All systems have or will have undergone thorough testing before production is resumed, and the readiness of the reactors to resume production will be reviewed not only by Secretary of Energy Watkins, but by the independent Defense Nuclear Facilities Safety Board (DNFSB). Section 2.1.3 describes the functions and authority of the DNFSB and other outside oversight groups.

DOE will not resume production before completing all safety upgrades necessary to achieve an acceptable level of safety. The priority assigned to each

safety upgrade is related to its contribution to overall risk reduction and its feasibility. Secretary of Energy Watkins has noted on several occasions that the reactors will not resume operation until he is satisfied about their safety. The independent DNFSB, which was established by the Congress in PL 100-456, will provide independent oversight of the safety of the SRS reactors and an autonomous judgment of their readiness to operate.

DOE is not required by law to follow NRC standards for commercial reactors. However, DOE does follow NRC standards that are appropriate for SRS reactor types, isolated locations, and uses. Nuclear power reactors operating at high pressures [more than 140 kilograms per square centimeter (2,000 pounds per square inch)] and temperatures [more than 260°C (500°F)] are surrounded by a pressure containment building (dome) to retain the high-pressure steam and radioactivity that potentially could be released in the unlikely event of severe accidents. The SRS reactors operate at a low temperature [about 102°C (215°F)] and pressure [about 0.35 kilogram per square centimeter (5 pounds per square inch)] and use a "confinement" system to retain almost all of the more dangerous radionuclides that might be released. With the high degree of isolation afforded by the SRS location [about 11 kilometers (7 miles) from the nearest site boundary], compared to that of a commercial power reactor [as little as 0.8 kilometer (0.5 mile)], and the low coolant energy of these reactors, the risks to the public from their operation are small. Adding a pressure containment dome to these reactors would cost more than $900 million per reactor and would yield only a small reduction in risk for extremely improbable accidents.

Preliminary information from the PRA being prepared for the SRS reactors has been used in evaluations of the safety upgrades and is used in the risk assessment presented in Section 4.1.3 of the EIS. The Level-1 phase of that PRA has undergone peer review, and the other phases are expected to receive such review, including review by the DNFSB. NRC, which recently imposed a requirement on each commercial nuclear powerplant for a partial PRA, which is called an Independent Plant Evaluation (IPE), does not require these plants to defer operation at power until the completion of their IPEs.

Concerns expressed about the ability of SRS reactors to withstand the effects of a strong earthquake have resulted in further upgrades of specific structures and components to withstand an earthquake with an acceleration of 0.2g, twice the estimated peak ground acceleration felt in the SRS area during the Charleston earthquake of 1886. These upgrades will be completed before resumption of production by SRS reactors. Section 2.1.3.2.1 discusses the effects of applying different seismic methodologies to determine public risk.

A number of comments referred to the likelihood of severe accidents at the SRS reactors, and their health and environmental consequences for the region. The accident at the Chernobyl reactor involved an explosive self-destruction of the entire reactor core followed by combustion of the graphite (carbon) moderator. The nuclear physics of the SRS reactors do not permit the explosive self-destruct mechanism, and they are moderated and cooled by heavy water, which does not burn. Because of these fundamental nuclear and physical-chemical differences, an accident of the type that occurred at Chernobyl cannot happen at SRS. However, DOE recognizes that there is a very small potential for severe reactor accidents that could result in large

releases of radioactivity to the environment. To protect the public in such events, emergency plans, which are regularly practiced to ensure their effectiveness if needed, have been established with local and state authorities.

COOLING WATER EFFECTS AND WETLANDS IMPACTS

COMMENTS

A number of commentors observed that the resumption of production at the K-Reactor before the completion of the cooling tower currently under construction would result in thermal discharges in violation of state water-quality criteria and would result in the loss of wetlands habitat that had recovered during the past several years. These and related comment areas included:

- The suggestion that the resumption of production at K-Reactor be deferred until the cooling tower is operating
- Suggestions that DOE provide wetlands mitigation for those areas impacted by thermal discharges
- A request that DOE provide plans for elimination of fish kills due to thermal discharges of L- and P-Reactors
- Several requests for additional consideration of impacts due to entrainment and impingement of fish and other aquatic populations

RESPONSE

DOE may operate K-Reactor under a SCDHEC Consent Order until the end of December 1992, when the cooling tower must be operational (Alternative Cooling Water Systems, DOE/EIS-0121). Sections 4.5 and 5.2.5 of the EIS discuss the issuance of the Consent Order, subsequent DOE actions to ensure compliance, and pending litigation.

The EIS evaluates, as a subset of the preferred alternative, the option of deferring resumption of production at K-Reactor until the cooling tower is operating. DOE recognizes that resumption of production before the completion of the cooling tower will result in the loss of 670 acres of wetlands for a currently indeterminate period into the future (see Section 4.1.1.6.2.1). Section 4.5.7.1 of the EIS discusses possible mitigation options and commits DOE to implement wetlands mitigation based on evaluation of impacts associated with the resumption of production. DOE policy is to preserve and protect wetlands resources at SRS in accordance with the national goal of no net loss of wetlands. DOE will implement mitigation to achieve this goal, especially in the event of unavoidable adverse impacts to SRS wetlands.

Under terms of a settlement agreement with SCDHEC on June 5, 1990, DOE has submitted a Remedial Action Plan for the mitigation of fish kills due to thermal discharges from L- and P-Reactors, as described in Section 4.1.1.4 of the EIS. The proposed plan is currently under review by SCDHEC. Section 4.1.1.2 addresses impacts and Section 4.5 addresses mitigation options.

In the past, DOE has performed a number of assessments on impacts of entrainment and impingement as a result of SRS reactor operations on fish and other aquatic populations in the Savannah River. These Section 316(b) Demonstrations, which were submitted to regulatory agencies, have not shown significant impacts to aquatic resources. DOE has committed to conduct additional studies during 1991 to assess entrainment impacts and the need for mitigation.

WORKER HEALTH AND SAFETY

COMMENTS

Several commentors questioned whether SRS employees were aware of the hazards associated with their work and called for the release of SRS worker health and dose records.

RESPONSE

DOE informs SRS employees of any hazards associated with their jobs, through an extensive training program. DOE also maintains exposure monitoring programs for all SRS employees. The results of an examination of SRS worker mortality records were published in 1988, as noted in Appendix B. In March 1990, Energy Secretary Watkins announced that DOE will turn over responsibility for research on long-term health effects on workers at DOE facilities to the Department of Health and Human Services, and directed that worker health and exposure data be released. DOE released the first series of exposure data to independent investigators in July 1990. Current and past workers can examine their exposure records at any time.

NEPA PROCEDURE COMMENTS

COMMENTS

DOE received a few comments on the framework provided for the presentation of actions and alternatives. These comments focused on two issues:

- The designation of the proposed action as "continued operation" rather than "restart" of the K-, L-, and P-Reactors
- The appropriateness of the identification of the "no-action" alternative

RESPONSE

Reactor operation covers the span from cold shutdown through power ascension to full power operation. An extended outage of the reactors for modifications implies that they are "in operation," which is consistent with the manner in which commercial nuclear powerplants are considered by the NRC. Nuclear powerplants, even when in extended outages for major modifications, are considered by NRC to be "in operation," and remain under the limitations imposed by their operating licenses.

In situations where there is an ongoing program initiated under existing legislation and regulations, "the 'no action' alternative may be thought of in terms of continuing with the present course of action until that action is changed" (46 CFR 18027, as amended; "Forty Most Asked Questions Concerning CEQ's National Environmental Policy Act Regulations"). In this instance, the "present course of action" is the continued operation of K-, L-, and P-Reactors. As a practical matter, the analyses in the EIS would not change regardless of the alternative designated as "no action," because the analysis of not operating the reactors is presented (as Alternatives 2 and 3) in Sections 2.2 and 2.3 as the termination of operation of one or more reactors in the immediate future.

Table C-1. Government Agencies Commenting on Draft Environmental Impact Statement

Comment No.	Agency	Representative	Page No.
L-83	U.S. Department of Commerce, Habitat Conservation Division	Andreas Mager, Jr., Assistant Regional Director	C-332
L-84	U.S. Department of the Interior, Office of Environment	Jonathan P. Deason, Director	C-335
L-78	U.S. Environmental Protection Agency, Region IV	Frank M. Redmond	C-300
L-45	South Carolina Department of Health and Environmental Control	Robert W. King, Jr., Assistant Deputy Commissioner, Environmental Quality Control	C-153
L-46	South Carolina Water Resources Commission, Surface Water Division	Danny L. Johnson, Director	C-157
L-80	South Carolina Wildlife and Marine Resources Department	James A. Timmerman, Jr., Executive Director	C-326
S-6	Beaufort-Jasper Water and Sewer Authority	Dean Moss, General Manager	C-369
L-49	Beaufort-Jasper Water & Sewer Authority	William D. Moss, Jr., General Manager	C-176
L-85	City of Savannah, Georgia, Facilities Maintenance Department	Harry Jue, Water Operations Director	C-340

Table C-2. Elected and Other Officials Commenting on Draft Environmental Impact Statement

Comment No.	Official	Office	Page No.
A-5	Hon. Fred Cavanaugh	Mayor Pro Tem, City of Aiken, South Carolina	C-788
L-63	Hon. Fred Cavanaugh	Mayor Pro Tem, City of Aiken, South Carolina	C-225
A-4	Hon. Ralph Cullinan	Aiken County Council; Lower Savannah Council of Governments	C-785
A-95	Hon. Butler C. Derrick	United States House of Representatives	C-1030
A-32	Hon. A. K. Hasan	City Council of Augusta, Georgia; Richmond County Board of Commissioners	C-890
L-67	Dean D. Hunter, Jr.	City Manager, City of Beaufort, South Carolina	C-252
C-2	Hon. Harriet Keyserling	Representative, South Carolina Legislature	C-529
C-35	Hon. Ernie Passailaigue	Senator, South Carolina Legislature	C-712
A-3	Hon. Irene Rudnick	Representative, South Carolina Legislature	C-784
S-2	Hon. Lindsay Thomas	United States House of Representatives	C-346
A-92	Hon. Strom Thurmond	United States Senate	C-1026
C-1	Hon. Candy Waites	Representative, South Carolina Legislature	C-516
A-1	Hon. Odell Weeks	Mayor, Aiken, South Carolina	C-782
L-79	Dennis B. Wilson	Minority Counsel, Committee on Energy and Commerce, U.S. House of Representatives	C-322

Table C-3. Private Organizations Commenting on Draft Environmental Impact Statement

Comment No.	Organization	Representative	Page No.
L-55	A. B. Beverage Company, Inc.	Robert S. Westmoreland, Sales Administrator	C-192
A-15	Aiken County Republican Party	Elizabeth Christensen	C-829
A-46	Aiken Technical College	Dr. Paul Blowers	C-924
A-70	Athens Peace Coalition	Dr. Daniel Everett	C-985
A-78	Athens Peace Coalition	Melanie Smith	C-997
S-51	Cetacean Relations Society	James Loomis, Director	C-490
L-61	Cetacean Relations Society	Jim Loomis, Director	C-217
S-4	Coastal Citizens for a Clean Environment	Cheryl Brackin	C-352
S-27	Coastal Citizens for a Clean Environment	Cheryl Jay	C-422
S-12	Coastal Citizens for a Clean Environment	Dr. Deborah Kearney	C-397
S-43	Coastal Citizens for a Clean Environment	William Lewis	C-479
S-40	Coastal Citizens for a Clean Environment	Frederick Nadelman	C-470
S-53	Coastal Citizens for a Clean Environment; Pastoral Care Network for Social Responsibility	Herbert Summers, Jr.	C-495
S-46	Coastal Group Sierra Club	Judy Jennings	C-483
A-26	Consumer Fuels Corporation	Clifton McClure	C-850

Table C-3. Private Organizations Commenting on Draft Environmental Impact Statement

Comment No.	Organization	Representative	Page No.
S-31	Energy Research Foundation	Tim Connor	C-432
A-8	Energy Research Foundation	Brian Costner, Director	C-813
L-48	Energy Research Foundation	Brian Costner, Director	C-165
C-30	Energy Research Foundation	Robert Guild	C-701
L-44	Energy Research Foundation	Frances Close Hart	C-103
C-3	Environmental Policy Institute	James Beard, Director, Nuclear Weapons Project	C-536
L-47	Federation of American Scientists	Steven Aftergood, Senior Research Analyst	C-162
A-6	Federation of American Scientists	David Albright, Staff Scientist	C-791
S-8	From Trident to Life Campaign; Glenn Environmental Coalition	Robert Randall	C-375
S-11	Georgia Conservancy	Rebecca R. Shortland	C-394
A-2	Greater Aiken Chamber of Commerce	Timothy Simmons, Chairman of the Board	C-783
S-29	Greenpeace Action	Thomas Clements	C-427
L-69	Greenpeace Action	Tom Clements	C-255
S-28	Greenpeace Action	Warren Whipple	C-424
C-66	Greenpeace Action	Warren Whipple	C-769

Table C-3. Private Organizations Commenting on Draft Environmental Impact Statement

Comment No.	Organization	Representative	Page No.
A-54	Greenpeace Action	Warren Whipple	C-946
A-57	Greenpeace	William Bowman	C-953
S-17	Greenpeace	Amanda W. Everette	C-406
S-14	Greenpeace	Eliza O. Everette	C-401
C-4	Institute for Resource and Security Studies; Energy Research Foundation	Dr. Gordon Thompson, Executive Director	C-541
S-5	International Fellowship of Reconciliation; National Clergy and Laity Concerned; Atlanta Clergy and Laity Concerned	Pamela Blockey-O'Brien	C-353
C-54	Irmo Direct Environment Action	Anastasia Eddins	C-748
A-22	Laborers Local Union No. 1137	Warren Hills, President	C-844
C-5	League of Women Voters of South Carolina	Marge West, President	C-571
C-22	Lutheran Human Relations	Dr. Albert Jabs, Volunteer Director	C-683
A-51	Lutheran Human Relations	Dr. Albert Jabs, Volunteer Director	C-933
S-9	Metanoia Community; From Trident to Life Campaign	John Linnehan	C-390
A-45	Metro Augusta Chamber of Commerce	Albert Hodge, President	C-923
L-75	MHB Technical Associates	Steven C. Sholly, Senior Consultant	C-278

Table C-3. Private Organizations Commenting on Draft Environmental Impact Statement

Comment No.	Organization	Representative	Page No.
A-7	Natural Resources Defense Council	Dr. Thomas B. Cochran, Senior Staff Scientist	C-801
L-37	Nuclear Control Institute	Dr. Milton M. Hoenig	C-77
S-18	Peace Nexus	Rosanne Kiely	C-407
A-17	Physicians for Social Responsibility	Edward Arnold, Executive Director, Atlanta Chapter	C-833
A-34	Physicians for Social Responsibility	Dr. Adam Goldstein, President, Augusta Chapter	C-894
A-31	Physicians for Social Responsibility	Dr. Paul Milner, Augusta Chapter	C-888
C-26	Providence Home Women's Shelter	Kathy Riley, Director	C-694
L-58	Public Citizen Litigation Group	Suzanne S. La Pierre, Attorney	C-196
C-6	Results	Marjorie Trifon	C-575
A-55	R&H Maxon	Greg Ryberg	C-949
S-1	Savannah Area Chamber of Commerce	Larry Stuber, Chairman, Natural Resources and Environmental Council	C-344
C-21	South Carolina Coalition on Human Developmentand Progressive Change; South Carolina Rainbow Coalition	Kevin Gray	C-681
A-18	St. Pris Campaign for Global Security	Ellen Spears	C-835

Table C-3. Private Organizations Commenting on Draft Environmental Impact Statement

Comment No.	Organization	Representative	Page No.
C-53	Students for the Ethical Treatment of Animals	Heather Lynn Swallows	C-747
L-32	Synergistic Dynamics, Inc.	John C. Snedeker	C-69
C-48	World Summit for Children	Catherine Coleman	C-739
C-20	Young Environmentalists for a Living and Loving Earth	Genevieve Compton	C-679
C-37	Young Environmentalists for a Living and Loving Earth	Charlice Hurst	C-718
C-49	Young Environmentalists for a Living and Loving Earth	Megan Rosser	C-740

Table C-4. Individuals Commenting on Draft Environmental Impact Statement

Comment	Name	Page
A-73	James Abbott	C-989
S-56	Shelly Ainsworth	C-500
L-33	Park Aitken	C-72
L-5	Shahrough Akhavi	C-33
S-7	Lee Alexander	C-373
L-12	Becky Allen	C-42
C-7	Mary Allstrom	C-579
L-82	Charles H. Badger	C-331
S-48	Michael Balazs	C-485
L-34	Mrs. Peter Bartholdus	C-74
A-29	John Beard	C-885
C-12	Paul Beck	C-592
S-52	Susan Bloomfield	C-493
L-16	Virginia M. Bonwitt	C-50
A-12	Sam Booher	C-821
S-55	Charles Botton	C-499
C-72	James Bourne	C-779
A-64	Jeffrey Bowman	C-971
A-80	William Bradley	C-1002
L-42	Cathy Bradshaw	C-101
C-43	Matthew Breeden	C-729
S-62	Janiece C. Brodhead	C-510
A-67	Joseph Brodie	C-979
C-52	Kathy Brown	C-745

Table C-4. Individuals Commenting on Draft Environmental Impact Statement (continued)

Comment	Name	Page
L-25	Jean Brown	C-60
L-71	Beverly L. Bruck and David I. Bruck	C-263
A-33	Kip Campbell	C-892
L-26	Fred Christensen	C-61
A-41	James Clark, Jr.	C-915
L-23	Robin Coad	C-58
L-50	Robert P. Colborn	C-182
A-36	Amy Conley	C-905
L-57	Helen S. Cranman, Barbara Frappier, and Herman L. Cranman	C-195
A-23	Anna Dangerfield	C-845
A-24	Tim Dangerfield	C-847
A-66	Paul Daugherty	C-977
A-74	Christopher DeBarr	C-990
S-59	Susan Delaney	C-507
A-21	Art Dexter	C-842
L-53	James W. Dodd and Mary S. Dodd	C-189
L-54	Susan F. Dodd	C-191
C-27	Nora Elkin	C-696
L-9	Paul B. Eubank	C-38
L-64	Rita Fellers	C-229
A-60	William Russ Ferrara	C-959
S-15	Robert Logan Ferrelle	C-402
A-81	Dr. David Filler	C-1003

Table C-4. Individuals Commenting on Draft Environmental Impact Statement (continued)

Comment	Name	Page
A-62	Dr. Davis Folsom	C-966
A-63	Kathy Folsom	C-968
L-36	Craig Ford	C-76
C-9	Sarah Fox	C-581
L-70	Karolyn A. Freeman	C-262
C-41	Elaine Frick	C-725
L-13	Lee R. Gandee	C-43
S-57	Gary Garrett	C-503
S-58	Ruth Garrett	C-506
L-10	Hal Gerber	C-39
C-38	Claude Gilbert	C-720
S-64	Benjamin J. Goggins	C-512
S-65	Wendy R. Goggins	C-513
C-45	Robert Hallman	C-733
L-3	Michael Hardwick	C-31
C-16	Leslie Harris	C-674
S-3	Helen Y. Harrison	C-349
C-23	Jerry Henderson	C-687
A-68	Thomas Henry	C-981
L-15	Merilyn Hiller	C-47
L-24	Trish Hobbs	C-59
C-32	William Holliday	C-706
A-14	John Hopkins	C-827

Table C-4. Individuals Commenting on Draft Environmental Impact Statement (continued)

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C-51	Helen Hudson	C-743
A-13	Richard W. Hunt	C-825
L-30	Richard W. Hunt	C-66
C-11	Mal Hyman	C-590
S-45	Stuart Johnson	C-482
C-56	Sue Jane Johnson	C-750
A-20	Dr. William Johnston	C-840
A-72	Alison Jones	C-988
C-70	Guy Jones	C-776
C-8	Dr. Natalie Hevener Kaufman	C-580
A-9	Joan King	C-816
A-84	Tom King	C-1009
A-10	Virginia King	C-818
L-18	Charles and Marie Kline	C-52
L-14	Diana G. Knight	C-45
A-82	Ronald Knotts, Sr.	C-1005
L-41	Jenny Koenig	C-100
S-37	Lorraine Koenn	C-465
L-1	Betty Krumrei	C-28
A-79	Franklin Kurtz	C-1000
L-52	Adele Kushner	C-186
A-77	Kathryn Kyker	C-995
A-43	McDonald Law	C-921

Table C-4. Individuals Commenting on Draft Environmental Impact Statement (continued)

Comment	Name	Page
A-42	William Lawless	C-918
L-51	Gregory P. Ledford	C-184
L-56	Betsey M. Lescoe	C-193
S-20	Martina Linnehan	C-411
L-72	William A. Lochstet	C-265
A-85	Christopher Lusting	C-1011
S-34	Bill Lynes	C-461
S-35	Constancia Lynes	C-463
S-41	Chris MacMillan	C-474
C-64	Sanders MacMillan	C-767
S-60	Evangelin Mamalakis	C-508
S-54	Bill Mareska	C-497
S-36	Robert Marshall	C-464
A-71	Arthur Martin	C-987
C-17	Corry Mason	C-675
L-29	Mark Mathis	C-65
A-16	John McClanathan	C-831
L-11	Catherine McFadden	C-40
S-21	John McKinnon	C-412
A-56	Henry D. McMaster	C-951
A-86	Lois McMillan	C-1013
A-38	Karen McNay	C-907

Table C-4. Individuals Commenting on Draft Environmental Impact Statement (continued)

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L-35	Lynn H. Medcalf	C-75
S-61	Lana Miller	C-509
C-19	Leslie Minerd	C-678
L-17	R. R. Mole	C-51
A-19	Victor Montenyohl	C-838
L-39	Regina B. Moody	C-96
A-39	Jenna Moran	C-908
C-15	Dr. Karl Z. Morgan	C-598
S-26	Melinda Stone Morton	C-419
C-28	Melinda Stone Morton	C-697
C-10	Fred Muller	C-582
A-52	Fred Muller	C-936
A-30	Vernon Mundy	C-886
S-42	Michael Myers	C-477
S-30	John Neal	C-431
C-36	Maureen Nery	C-714
L-65	Gary Michael Newberry, Lynne Van Gould, Susan E. Watts, Murphy A. Cooper, III, Wanda Andrews, James F. Bass, Jr., Gregory A. Smith, Barry Van Gould, Maureen A. O'Reilly, Eloise R. Dudley, Marguerite B. Durham, Betrotha W. Harris, Eddie E. Harris	C-236
S-49	Chuck Niemeyer	C-486
A-94	Mary Niedzwiecki	C-1029
S-25	Ann O'Brien	C-418

Table C-4. Individuals Commenting on Draft Environmental Impact Statement (continued)

Comment	Name	Page
S-63	Helen P. O'Brien	C-511
L-8	James Oginski	C-37
L-2	Edith Kendrick Osmanski	C-29
C-65	Robert Osmer	C-768
A-11	Robert F. Overman	C-819
L-76	James N. Paglieri	C-285
L-68	Mr. & Mrs. Peter W. Payette	C-253
C-55	Nancy Peeples	C-749
L-73	Tacey Penland	C-273
C-60	Brian Pennington	C-759
A-28	Philip Permar	C-883
L-59	Petition	C-209
C-62	Luke Phillips	C-761
C-33	Lyn Phillips	C-708
S-19	Suzanne Plowden	C-409
L-7	Jennifer Porter	C-36
A-37	Nathan Price	C-906
S-38	Wyatt Pringle, Jr.	C-466
A-91	Dale Prout	C-1025
S-66	John M. Ravage	C-514
C-34	Pauline Reimers	C-709
A-40	Felicia Rensberger	C-913
C-68	David Reynolds	C-774

Table C-4. Individuals Commenting on Draft Environmental Impact Statement (continued)

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A-61	Dr. Stanley Rich	C-962
L-38	Sally P. Richardson	C-95
C-13	Camille Riley	C-594
A-65	Mark Roberts	C-972
L-28	Robert Rosenblum	C-63
L-22	Bea Rosewell	C-57
C-71	Sue Rosser	C-777
S-39	Barbara Rudolph	C-467
A-48	Barbara Rustad	C-929
L-62	J. Paul Rutter, III	C-222
A-25	Betty Ryberg	C-849
C-46	Sarah Schechter-Schoeman	C-735
A-49	Craig Schenck	C-930
A-27	Sam Schillaci	C-881
A-69	Glen Schlafer	C-983
A-87	Janet Schlafer	C-1016
L-40	David R. Schumacher	C-98
C-18	Dr. Peter Sederberg	C-676
A-83	Mary Lou Seymour	C-1007
S-23	Doug Shoemaker	C-415
A-53	Doug Shoemaker	C-944
C-50	Wendy Shough	C-742
S-24	Julisa Skeels	C-417

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L-6	Melanie Smith	C-35
A-78	Melanie Smith	C-997
C-73	Daniel L. Sobell	C-780
L-66	Jonathan M. Somers	C-238
L-81	Meredith J. Sorensen	C-330
C-31	Charlotte Speaker	C-705
S-44	Daniel Stainback	C-481
A-35	Glenn Stark	C-903
A-76	Scott Starling	C-993
C-39	William Starnes	C-722
C-25	Ken Stauffer	C-691
L-4	Col. Charles W. Stockell	C-32
L-43	Henry A. Stone	C-102
L-27	Mrs. R. A. Stowe	C-62
C-42	Thomas Summer	C-727
L-31	Sandra Tannenbaum	C-68
A-44	Tracy Tarleton	C-922
S-47	Joan Taylor	C-484
C-57	Peter Tepley	C-754
S-13	Elizabeth B. Terry	C-399
S-16	Michael H. Terry	C-404
C-14	Elvira Thompson	C-596
A-50	Elvira Thompson	C-931

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S-32	Moses Todd	C-454
C-67	Moses Todd	C-771
A-90	Moses Todd	C-1023
L-60	Jane Tollison and Virginia Robards	C-215
S-33	Patricia Tousignant	C-457
C-58	Merrill Truesdale	C-756
A-88	Mark Tucker	C-1017
C-29	Regina Turetzky	C-700
C-59	Andrew Craig Varner	C-758
A-89	Andrew Craig Varner	C-1019
L-20	Julia Vereen	C-55
C-61	William Voegele	C-760
C-44	Ervin Wagner, Sr.	C-730
L-19	Jan Wallis	C-54
A-47	Sinkler Warley, Jr.	C-926
C-69	Maxine Warshauer	C-775
C-63	David Watring	C-765
A-58	Cathy Williamson	C-954
A-59	Russell Williamson	C-956
L-74	Harry E. Wilson	C-276
C-24	Carol Winans	C-689
S-10	Charles F. Winchester	C-393
S-22	Laura Lee Winchester	C-414

Table C-4. Individuals Commenting on Draft Environmental Impact Statement (continued)

Comment	Name	Page
C-47	Dr. Mitchell Wolin	C-738
L-77	Gerald Woodcock	C-296
A-75	Bill Wright	C-992
C-40	Donna Wright	C-724
L-21	Geoff Young	C-56
A-93	Donald B. Zippler	C-1028
S-50	James Zorn	C-489

Table C-5. DOE Responses to Comments on Draft EIS

Comment Number	Comment	Response
L-1	COMMENTS OF MRS. BETTY KRUMREI 6 N. Calibogue Cay Rd. Hilton Head, SC 29928 Mr. Frank R. McCoy, III Acting Director, SR Restart Special Projects Office P.O. Box A Aiken, SC 29802 Dear Mr. McCoy:	
L-01-01	I was quite surprised to receive your letter of May 3, 1990, along with the copy of the DEIS. When I wrote my initial objections to the restart of the Savannah River Plant Reactors, I had no idea I would be a party to such a monstrous boondoggle. I can't even imagine how many hours went into the compilation of this "book", and the cost of paper and manhours and postage, all courtesy of taxpayers like me, makes my poor heart flutter..... The purpose of this letter is to ask you to please take my name off your mailing list immediately. This will not by any means dim my interest in stopping the restart of the Reactors, but it may ease my mind just a little bit. Thank you for your prompt attention to my request. Sincerely, Mrs. Betty Krumrei	Comments noted. (Note: As requested, Mrs. Krumrei's name has been deleted from the mailing list.)

Table C-5. DOE Responses to Comments on Draft EIS

Comment Number	Comment	Response
L-2	COMMENTS OF EDITH KENDRICK OSMANSKI P.O. Box 656 Beaufort, South Carolina 29902 The Hon. James D. Watkins Secretary of Energy Washington, D.C. Dear Mr. Secretary:	
L-02-01	Please spare Beaufort County, S.C. further contamination from The Savannah River Project. We do not need Tritium.	The Department of Energy produces tritium (and other nuclear materials) as directed by the Nuclear Weapons Stockpile Memorandum (NWSM), which determines the need for defense materials, and which is approved by the President. The most recent NWSM, approved by President Bush on July 12, 1990, was used in calculating the demand for new production of tritium in Appendix A. In addition, Appendix A considers the demand for new production based on a potential reduced-need scenario for tritium. Because detailed information on defense need involves national security information, nuclear material requirements and the production capabilities required to meet these demands are discussed in a classified appendix (Appendix A) of the EIS. This classified appendix was not distributed with the main document, but will be considered by DOE decisionmakers; it is available to those meeting security requirements. Unclassified information from Appendix A is included in Section 1.2 of the EIS.
L-02-02	Beaufort County is down river and down wind from The Savannah River Site. When volunteering with Hospice for five years I learned that there is an inordinate number of cancer cases in this area. In fact my husband and two immediate neighbors, all now deceased, had cancer. I fervently hope that you will decide not to restart the K-, L-, and P-Reactors. As Norman Cousins says with regard to human values in his book Head First: "The real division ... is between those who attach primary importance to human life and those who view their own discipline as sovereign."	Section 4.1.2 of the EIS addresses the potential additional risk to human health resulting from the continued operation of K-, L-, and P-Reactors. Section 4.1.6 addresses cumulative impacts and health risks from SRS and nearby facilities. The health effects of past operations have been (and are being) evaluated by independent agencies, as described in Appendix B; no significant health impacts on the general public have been identified. Section 3.7 (Tables 3-13 and 3-14) and annual environmental monitoring reports issued by DOE describe the extent of contamination from prior SRS operations. Section 4.1 presents projected

Table C-5. DOE Responses to Comments on Draft EIS

Comment Number	Comment	Response
	The DEIS (Draft Environmental Impact Statement) which was recently sent to me from The Department of Energy, is impressive only for its bulk (one inch thick and eight by eleven inches). So many times people are told that something is quite safe only to find later that much damage has been done. Thank you for your careful consideration of the Savannah River Site. Yours Truly, Edith Kendrick Osmanski	environmental impacts from continued reactor operation.

Table C-5. DOE Responses to Comments on Draft EIS

Comment Number	Comment	Response
L-3	COMMENTS OF MICHAEL HARDWICK 1229 Evans Rd Aiken, S.C. 29801 Mr. S. R. Wright Dir. Environmental Division U.S. Dept of Energy Savannah River operations office P.O. Box A Aiken, S.C. 29802 Dear Mr. Wright, Thank you for the DEIS copy. I have read it in some detail. I am not dissuaded from the belief that a restart at SRS will be more expensive both short and long term because of Population and	
L-03-01	population growth pressures on extraordinary safety requirements.	DOE takes safety measures to protect individuals both on- and offsite, as discussed in Section 2.1 of the EIS.
L-03-02	Also, I believe the "Policy" on separation of Utility and Federal facility use should be tested at the highest levels of the Political System. I don't believe other countries world-wide would or do sustain the dual cost burden of separate reactor facilities in situations where a facility can do both jobs.	Section 2.4.6 of the EIS discusses the production of nuclear materials from commercial reactors.
L-03-03	Also, I did not see an analysis of Tritium requirement for a 75% weapons arsenal possibility. Perhaps a restart will not be required before one of the other more remote Federal reactors could be put into operation. Sincerely, Michael Hardwick 1229 Evans Rd Aiken, S.C. 29801	Section 1.2 of the EIS discusses the process for determining the need for defense materials and the DOE role in that process. The size of the nuclear weapons arsenal is beyond the scope of this EIS. Please see the response to Comment L-02-01 on the need for tritium. Section 2.4 discusses alternative methods for tritium production.

Table C-5. DOE Responses to Comments on Draft EIS

Comment Number	Comment	Response
L-4	COMMENTS OF COL. CHARLES W. STOCKELL 6 Sea Gull Drive Beaufort, South Carolina 29902 Department of Energy Savannah River Operations Office PO Box A Aiken, S.C. 29802 Gentlemen: I have only one comment concerning the operation of the Savannah River Plant reactors: Let's get on with it and restart all reactors! The government has listened patiently to many different attacks on SRP, most of which were fanciful and some downright ridiculous. All that has been sifted and much time spent in satisfying the adverse comments made in large part by people who know little about nuclear production and the safety features built into an American facility. As a Soviet specialist for forty years, I can assure you that the KGB, in particular its Disinformatsiya division, must have had a good laugh over the specious protests which closed the plants operations and forced a series of re-examinations.	
L-04-01	This nation needs its vital nuclear production. The Soviet military threat to the Free World has not yet lessened and in any case, strong core defenses will always be needed. Too, we need the research and technological improvements coming out of operation of such a facility. Our civilian contractors and our governmental agencies dealing with SRP have always had an excellent record of concern and safety. Let us now get on with the job. Sincerely, Charles Stockell	Comments noted.

Table C-5. DOE Responses to Comments on Draft EIS

Comment Number	Comment	Response
L-5	COMMENTS OF SHAHROUGH AKHAVI 2931 Duncan Street Columbia, SC 29205 Mr. S. R. Wright Director, Environmental Division US Department of Energy Savannah River Operations Office Post Office Box A Aiken, SC 29802 Dear Mr. Wright: I am writing to protest the plan of the Department of Energy to restart the K-, P-, and L-Reactors at SRP — as announced by Secretary Watkins on 1 May 1990. DOE has released a Draft Environmental Impact Statement purporting to lay to rest the concerns of citizens that structural and other weaknesses pertaining to SRP reactors have been addressed. Yet, this EIS does not direct its attention to the restart program; instead, it has been couched generally in terms of "continuing operations." Therefore, the EIS does not adequately account for many of the concerns that have previously been raised over the scheduled restart of the above reactors.	
L-05-01		DOE considers the SRS reactors to be in operation during the current modification period, just as commercial nuclear powerplants in extended outages for major modifications are considered by NRC to be in operation and remain under their operating licenses in a cold shutdown mode. Section 2.1 and the Summary have been revised to define "continued operation." Chapter 4 addresses, analyzes fully, and bounds the environmental impacts of the continued operation of K-, L-, and P-Reactors, including the resumption of production after an extended outage.
L-05-02	Given the fact that many of the safety enhancements that were supposed to have been implemented have not in fact been realized, I am very disturbed at the seeming willfulness motivating DOE's 1 May announcement. Secretary Watkins, himself, has candidly indicated that the program of safety enhancements has not been completed. Indeed, he could do no less than acknowledge this, in view of the internal DOE report — the so-called SRP Tiger Team report — of 26 April 1990. This report has raised a number of disturbing questions about specific safety enhancements that have not been executed. At the same time, citizens are mindful that the DOE has had a woeful reputation for living up to commitments to rectify major deficiencies in the operation of SRP.	Sections 2.1.2.7 and 2.1.2.8.2 of the EIS address the concerns expressed about reactor safety and the reactor modifications to be completed as safety enhancements both before and after resuming production. As stated by Secretary Watkins on several occasions: "restart of any of the SR reactors will not be authorized until I am personally satisfied that they can be operated safely" (Memo, Secretary of Energy Watkins to Secretary of Defense Cheney, April 1989). The independent Defense Nuclear Facilities Safety Board (DNFSB) will also provide its judgment on the readiness of the reactors to resume production; DOE

Table C-5. DOE Responses to Comments on Draft EIS

Comment Number	Comment	Response
		has added Section 2.1.3.3 to describe the functions and powers of the DNFSB, and some of its recent recommendations. DOE has revised Section 2.1.3.1.3 to discuss the Tiger Team findings. The June 1990 report Tiger Team Assessment of the Savannah River Site (DOE/EH-0133) addresses SRS activities other than the reactors.
L-05-03	Additionally, if Secretary Watkins's announcement is followed up, DOE will be in violation of the Federal Clean Water Act, specifically, its provisions for thermal discharge. For these reactors will begin operating even before the K-reactor cooling tower -- projected for completion in 1992 -- becomes functional.	DOE may operate K-Reactor under a Consent Order (84-4-W) from the South Carolina Department of Health and Environmental Control. DOE is expediting the construction of the cooling tower. See the revisions to Section 2.1.6 of the EIS. L- and P-Reactors use cooling lakes to cool thermal discharges through NPDES outfalls. These systems are independent of the K-Reactor cooling mechanisms. Section 5.2.5 of the EIS contains details of the Consent Order.
L-05-04	Finally, surely the changes in international relations should tell us that an even more cautious approach toward restart is warranted. What can be the justification for rushing back into SRP operations in the light of the collapse of the Soviet military alliance? Against whom will we be using the plutonium and tritium that SRP produces? There are full-scale START and conventional arms talks that are progressing in Geneva and Vienna, respectively. These talks have excellent prospects for agreements that will advance the national security interests of this country toward levels long dreamed-of by our national leaders. It is a disgrace to argue that these reactors need to be restarted despite the fact that safety enhancements have not been achieved, despite the fact that federal law will be violated, despite the sensationally positive developments in world politics, and despite Secretary Watkins own characterization that SRP operations have placed citizens under the "sword of Damocles." I urge you to let these concerns be known to decision-makers within DOE. We need more judicious leadership on nuclear policy, not leadership that puts its head in the sand when faced with dangers that its own members have presented for all to see. Sincerely yours, Shahrough Akhavi	Please see the response to Comment L-02-01 on the need for tritium and other nuclear materials.

Table C-5. DOE Responses to Comments on Draft EIS

Comment Number	Comment	Response
L-6	COMMENTS OF MELANIE SMITH 2430 Cherokee Rd #24 Athens Ga 30605	
	Mr. Wright,	
L-06-01	I have read with great interest the draft environmental impact statement. I feel any further production of tritium and plutonium for nuclear weapons to be totally unnecessary. I feel the Department of Energy is greatly inflating its need for tritium in an atmosphere of impending world peace and nuclear weapons reductions.	The EIS discusses the need for tritium in Chapter 1 and Appendix A (which is classified). Please see the response to Comment L-02-01 on the need for tritium and other nuclear materials.
L-06-02	There is the further issue of the nuclear waste produced as a by - product of tritium and plutonium production. There is close to one hundred acres of nuclear waste buried at the Savannah River Site presently. Further production of tritium and plutonium will create yet more waste. Why make a bad situation worse?	DOE has committed to the environmental restoration of its sites, including SRS; environmental restoration is funded independently of reactor operation. Other EISs (Waste Management Activities for Groundwater Protection, DOE-EIS/0120, and Defense Waste Processing Facility, DOE-EIS-0082) ar the DOE Environmental Restoration and Waste Management Plan (DOE/S-0070) describe waste management activities at SRS in detail. The proposed DOE programmatic EIS on Waste Management and Environmental Restoration will provide a complex-wide assessment of available options. DOE will manage SRS wastes from continued operation in accordance with the requirements of EPA, SCDHEC, ar DOE Orders, as described in Section 2.1 and Chapter 5 of this EIS.
L-06-03	To say there is virtually no environmental impact in restarting K-, P- and L-reactors is absolutely ludicrous. Sincerely Melanie Smith 2430 Cherokee Rd #24 Athens Ga 30605	Section 4.1 of the EIS addresses, analyzes fully, and bounds the environmental impacts of the continued operation of K-, L-, and P-Reactors, including the resumption of production after an extended outage.

Table C-5. DOE Responses to Comments on Draft EIS

Comment Number	Comment	Response
L-7	COMMENTS OF JENNIFER PORTER 1490 s Milledge Athens GA 30605	
	Dear Mr. Wright, I have recently read the environmental impact statement concerning the Savannah River Plant.	
L-07-01	My main concern is the uncontained nuclear waste which already exists. I do not feel that anymore toxic waste should even be considered to be produced.	All radioactive waste storage and disposal at SRS i conducted in accordance with EPA and DOE requirements, as described in Sections 2.1, 3.8, ar 4.1.6 and in Chapter 5.
L-07-02	In my opinion the EIS document was vague & did not give me the information in which to allow me to have any feelings of justification to re-open the Savannah River Plant. Thank You, Jennifer Porter 1490 s Milledge Athens GA 30605	Please see the response to Comment L-06-03 on environmental impacts.

Table C-5. DOE Responses to Comments on Draft EIS

Comment Number	Comment	Response
L-8	COMMENTS OF JAMES OGINSKI	
	Dear Mr. Wright,	
L-08-01	I enjoyed reading the EIS rough draft for SRP. The one issue which I found lacking was how to deal with the radioactive waste already created, what to speak of new waste which will created by a restart. Instead of creating a bigger mess which will adversely effect Americans for generations to come, why not focus on cleaning up the mess we have already made. Sincerely, James Oginski	Please see the response to Comment L-06-02 on waste management and environmental restoration.

Table C-5. DOE Responses to Comments on Draft EIS

Comment Number	Comment	Response
L-9	COMMENTS OF PAUL B. EUBANK 185 Athens Rd. Winterville, GA 30683	
	Dear Mr. Wright:	
	Thank you for the Environmental Impact Statement on the Continued Operation of the SRP, dated May 1990.	
L-09-01	By giving me the figures thru this publication of what you (they/it) haven't done, it will be possible to determine what you have already done. Don't do any more. Correct what has already been done, i.e., environmental pollution.	Please see the response to Comment L-06-02 on waste management and environmental restoration.
	Sincerely, Paul B. Eubank 185 Athens Rd. Winterville, GA 30683	

Table C-5. DOE Responses to Comments on Draft EIS

Comment Number	Comment	Response
L-10	COMMENTS OF HAL GERBER 401 No. Cromwell Rd., Apt. F-4 Savannah, Georgia 31410	
	Dear Mr. Wright	
	Re - Sav'h River Plant Restart	
L-10-01	If the by products of what you make have a half-life of 500 years, I can only assume the shelf life of the item would be the same — Or does tritium have a short life span?	The half-life of plutonium-238 is 88 years; the half-life of plutonium-239 is 24,110 years; the half-life of tritium is 12.3 years.
L-10-02	Has consumption gone up?	Please see the response to Comment L-02-01 on the need for tritium and other nuclear materials.
L-10-03	Can we really use all 30,000 atomic devices (now in stock) in a 30 minute war w/any aggressor? Who would be the aggressor? Big Red seems to have its own problems. I ask these questions because I will be unable to attend either of your forums here in Savannah.	The need for nuclear weapons is outside the scope of this EIS.
L-10-04	As Savannah River plus all other sites are so "Hot" lets clean them up or bury them in concrete. We have enough weapons to kill the world at least twice over. What economic or military sense does it make? I would deeply appreciate the courtesy of your reply. Sincerely Yours Hal Gerber	Please see the response to Comment L-06-02 on waste management and environmental restoration.

Table C-5. DOE Responses to Comments on Draft EIS

Comment Number	Comment	Response
L-11	COMMENTS OF MRS. SAMUEL MCFADDEN Box 618 Pawleys Island, South Carolina 29585	
	Dear Mr. Wright	
	I am writing you to urge the federal Energy Department not to restart the Nuclear reactors at the Savannah River Site.	
L-11-01	The Energy Department admits this action would bring further risk to human health and has already severely contaminated our environment. Most of the world to-day is drastically becoming more peaceful and aware of the dire consequences if we don't. I am really more afraid of our policies and their long term effects than "enemy countries".	Please see the response to Comment L-02-02 on health risks.
L-11-02	You have not convinced us we need more tritium. I am not alone in my opinion. I am enclosing a News clipping reporting that fifty four prominent Americans are requesting the halt of production of nuclear weapons ingredients.	Please see the response to Comment L-02-01 on the need for tritium.
	The Sun News, Myrtle Beach, S.C. **Briefly** **Prominent Americans ask nuclear arms production halt** • WASHINGTON – Fifty-four prominent Americans, including two former CIA directors, have sent a letter to President Bush and Soviet President Mikhail Gorbachev appealing to them to halt the production of nuclear weapons ingredients.	

Table C-5. DOE Responses to Comments on Draft EIS

Comment Number	Comment	Response
	The letter said nuclear missiles scrapped under U.S.-Soviet arms control agreements could provide all the ingredients the two sides might need for new nuclear weapons. Former Secretary of State Cyrus Vance, former Defense Secretary Robert McNamara and former CIA directors William Colby and Stansfield Turner were among the signers.	
	I would like this news item and my letter put in the record. Sincerely Yours, Catherine McFadden (Note: A copy of the letter cited in the news article was submitted by Dr. Milton M. Hoenig along with his comments on the Draft EIS. Refer to Comment L-37.)	

Table C-5. DOE Responses to Comments on Draft EIS

Comment Number	Comment	Response
L-12	COMMENTS OF BECKY ALLEN 123 Old Cedar Pt. Chapin, SC 29036	
	Mr. Wright	
L-12-01	Why do you want to spend almost 2 billion dollars that will cause more Environmental harm and cancers? We want to live! Don't destroy us, please!!!	Please see the responses to Comments L-06-03 on the environmental consequences of continued operation and L-02-02 on health risks.
	Green Peace Supporter Becky Allen	

Table C-5. DOE Responses to Comments on Draft EIS

Comment Number	Comment	Response
L-13	COMMENTS OF LEE R. GANDEE 327 Carpenter Street W Columbia, SC 29169 Mr. S. R. Wright Director, Environmental Division U.S. Department of Energy Savannah River Operations Office P.O. Box A Aiken, SC 29802 Dear Mr. Wright: I cannot attend the public hearing on the Draft EIS, but I wish to express my outrage that the Savannah River Plant is even being considered for reopening.	
L-13-01	I have a friend who for years has told me of the slipshod, incompetent, uncaring and negligent operation of this death trap, and I am informed by an authority whose veracity and competence I trust fully that it already has contaminated the waters of the Savannah River, the Aquifers, and even the adjacent coast to the mouth of the Savannah River, and created an environmental disaster area that extends into Georgia and Florida, once the truth of the extent of contamination becomes public.	Please see the responses to Comments L-06-03 on the environmental consequences of operating K-, L-, and P-Reactors, L-02-02 on health risks, and L-06-02 on waste management and environmental restoration.
L-13-02	Moreover, the plant is another Chernobyl just waiting to happen,	The nuclear and physical-chemical characteristics of SRS reactors are fundamentally different from those of the Chernobyl reactors. DOE does recognize the very small potential for a reactor accident resulting in releases of radionuclides to the environment. Section 4.1.3 of the EIS discusses accidents, including design-basis and severe accidents; Table 2-3 summarizes accident risks.
L-13-03	and there is no need for more tritium and more atomic weapons.	Please see the response to Comment L-02-01 on the need for tritium. The need for nuclear weapons is beyond the scope of this EIS.

Table C-5. DOE Responses to Comments on Draft EIS

Comment Number	Comment	Response
	I say shut it down, and never let it reopen, or share the guilt for the doom it threatens! Sincerely, Lee R. Gandee	

Table C-5. DOE Responses to Comments on Draft EIS

Comment Number	Comment	Response
L-14	COMMENTS OF DIANA G. KNIGHT 1738 Walthour Road Savannah, GA 31410	
	Dear Mr. Wright:	
L-14-01	As a biologist and a concerned citizen, I would like to bring up a few concerns of mine on the start up of the Savannah River Plant. Firstly, why do we need to produce more nuclear weapons with the changes in Eastern Europe and the bilateral cutbacks in nuclear missile systems. A nuclear war is not able to be won regardless of what the military and the government have to say otherwise. This insane nuclear buildup has got to come to an immediate halt and the Savannah River Plant would be an ideal place to start.	Please see the response to Comment L-02-01 on the need for tritium; however, the need for nuclear weapons is beyond the scope of this EIS.
L-14-02	Secondly, the aged reactors at the Savannah River plant have surpassed their expected lifetime. They are similar to the Cheronobyl reactor in that they don't have containment domes or adequate fire safety mechanisms.	No life-limiting mechanisms for these reactors have been found (see Section 2.1.2.3.2). The nuclear and physical design of these reactors is fundamentally different from that of the Chernobyl reactors. Section 4.5.1 of the EIS discusses containment dome considerations. The Chernobyl reactor was moderated with combustible graphite; SRS reactors use heavy water, which does not burn. The core damage frequency from fire (1.4×10^{-7} per reactor-year; see Section 4.1.3.2.2) indicates that adequate fire safety mechanisms already exist at SRS. Section 2.1.2.3.1 of the EIS describes fire safety enhancements. Also, please see the response to Comment L-13-02 on Chernobyl.
L-14-03	Thirdly, clean up of the Savannah River Plant is already expected to take decades and cost billions. Money spent on restarting the unsafe and unneeded old reactors should be spent on cleaning up the mess the best 40 years of bomb production has created. As an average citizen, I am against nuclear weapons and the environmental destruction bomb production wreaks on our area. Do <u>not</u> <u>restart</u> the Savannah River Plant to make more nuclear weapons.	Please see the response to Comment L-06-02 on waste management and environmental restoration.

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Comment Number	Comment	Response
	Sincerely, Diana G. Knight 1738 Walthour Rd. Savannah, GA 31410	

Table C-5. DOE Responses to Comments on Draft EIS

Comment Number	Comment	Response
L-15	COMMENTS OF MERILYN HILLER 65 Gale Terrace Rochester, NY 14610 Mr. S. R. Wright, Director Environmental Division U. S. Department of Energy Savannah River Operations Office P. O. Box A Aiken, SC 29802 Dear Mr. Wright: I wish to raise some questions in connection with the Draft EIS for Continued Operation of K, L and P reactors at the Savannah River site.	
L-15-01	1) Considering that the Tuscaloosa aquifer, which supplies drinking water to Atlanta and other parts of SE U. S., is already contaminated by toxic chemicals from the Savannah River Plant (SRP), what assurances does the public have that the radioactive wastes now stored there, and those that would be produced by restarting the reactors, will not also seep into the aquifer?	Atlanta receives its drinking water from surface-water sources (the Chattahoochee River and Lake Lanier), and not from the Tuscaloosa aquifer. The Black Creek-Middendorf Formation in South Carolina, which was once known as the Tuscaloosa aquifer, discharges to the Savannah River in the vicinity of SRS, as described in Section 3.4.2 of the EIS. This aquifer is not believed to be hydraulically continuous with the formation of that name in Georgia. The toxic chemical contamination of that aquifer was caused by chlorinated hydrocarbons, which are confined within the SRS boundary, and are currently being removed by recovery wells and an air stripper. The Black Creek-Middendorf aquifer lies 400-900 feet below the surface of SRS and is generally protected by several impermeable clay or other lithologic formations. Monitoring wells have been installed in the aquifer to detect any type of contamination. Over the 35-year SRS operating period, no radioactive contamination has been detected offsite in the Black Creek-Middendorf aquifer as a result of past operations, and none is expected from continuing reactor operation. (Please see the EIS on Waste Management for Groundwater Protection, DOE/EIS-0120).

Table C-5. DOE Responses to Comments on Draft EIS

Comment Number	Comment	Response
L-15-02	2) Have comprehensive studies promised earlier this year by the Department of Energy (DOE) on the public health and environmental consequences of the program to "clean up and modernize" SRP been completed? Have open forums been held as also promised on the future of the nuclear weapons industry? Why is there not a provision for major recovery and clean up of the radioactive and toxic chemical waste at the site before planning to produce more? What part of the EIS addresses the cumulative waste load, i.e. that produced by restarting the reactors added to what is already there?	Studies of cleaning up and modernizing SRS are under way. Environmental impacts are reported routinely in annual SRS Environmental Monitoring Reports. Also, please see the response to Comment L-06-02 on the EIS for waste management and environmental restoration. DOE has committed to the preparation of a programmatic EIS on modernization of the nuclear weapons complex. Two previous EISs [Waste Management Activities for Groundwater Protection (DOE/EIS-0120) and Defense Waste Processing Facility (DOE/EIS-0082)] discuss these activities. DOE also has a nationwide Environmental Restoration and Waste Management 5-year Plan (DOE/S-0070), is implementing its provisions, and is planning to prepare a programmatic EIS on Environmental Restoration and Waste Management. Section 3.8 of the EIS discusses the waste load at SRS. Section 4.1.6 discusses other cumulative impacts.
L-15-03	3) In light of a 1989 study released by the National Academy of sciences showing the risks from low-level radiation to be four times greater than previously believed and of such research as that of Rosalie Bertell (No Immediate Danger), why does equating a plant release to that of "background" radiation make the release an "acceptable risk"? Why aren't the cumulative effects of all radiation exposures addressed? What is the rationale for accepting even ONE additional death from exposure to radiation from SRP?	The comparison of exposure from operating K-, L-, and P-Reactors with exposure to background radiation exposure is intended to provide a perspective. Section 4.1.6.4.14 of the EIS discusses the cumulative effects of all radiation exposures. The calculated number of excess cancer fatalities to the population within 80 kilometers (50 miles) of SRS due to continued reactor operation is 0.0171 per year.
L-15-04	I note that three public hearings on the EIS are scheduled. All of these hearings are to be held near the SRP. In my view, there should be additional public hearing convened in major cities throughout the U. S., especially in the SE. Because of the broad environmental impact of the activities at SRP; one which does not have geographical boundaries, and because of the huge cost of clean up and/or restarting production, more hearings are justified. This is not just a local issue.	DOE published a notification of the public comment period in the Federal Register, and conducted public hearings in the area most likely to be affected by routine or accidental releases. DOE solicits written comments from the general public.

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Comment Number	Comment	Response
L-15-05	In conclusion, as weapons already in our nuclear arsenal are dismantled under provisions of existing and pending agreements, I urge that tritium be reclaimed to provide a ready-made supply.	Please see the response to Comment L-02-01 on the need for tritium.
L-15-06	The nuclear weapons industry must study and pursue "recycling" as assiduously as citizens are urged to do with their daily trash. Restarting reactors K, L and P would not then be necessary.	Recycling is being performed. DOE has revised Section 1.2 of the EIS to discuss the recycling of materials from retired weapons. Appendix A considers the supply of materials from recycling in the analysis of the need for production of nuclear materials.
L-15-07	Neither is it necessary to restart these reactors for our "defense" since the U. S. (and the Soviets) already have many times over the number of nuclear weapons required to destroy each other. More nuclear weapons will not "defend" us any better but will hasten the poisoning of our earth.	The need for nuclear weapons is beyond the scope of this EIS.

Sincerely,

(Ms) Merilyn Hiller

cc: Frank Horton (R-NY)
Les Aucoin (D-OR)
Dan Reichler (NRDC)

Table C-5. DOE Responses to Comments on Draft EIS

Comment Number	Comment	Response
L-16	COMMENTS OF VIRGINIA M. BONWITT 4 Hollyberry Lane Hilton Head Island S.C. 29928 Mr. S.R. Wright U.S. Department Energy Savannah River Operations Office P.O. Box A Aiken, S.C. 29802 Dear Sir:	
L-16-01	Are current forecasts of nuclear material needs correct? The need for nuclear material should have changed due to progress in Eastern Europe and the bilateral cutbacks in missile systems. The need to build and maintain nation's nuclear weapons stockpile has been reduced. I support proposed action alternative #3. Advantage: Reduction of hazardous/ mixed waste and low level/ high level radioactive waste. Reduction of expense involved in waste treatment methods. This money is needed for clean up of existing waste. Reduction of negative impact on environment. More is not better! Sincerely, Virginia M. Bonwitt 4 Hollyberry Lane Hilton Head Island S.C. 29928	Please see the response to Comment L-02-01 on the need for tritium and other nuclear materials. This need is based on the requirements in the latest Nuclear Weapons Stockpile Memorandum, which President Bush approved on July 12, 1990. In addition, a potential reduced-need scenario was evaluated, and is considered in the EIS.

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Comment Number	Comment	Response
L-17	COMMENTS OF R. R. MOLE 20 Field Sparrow Road Hilton Head, S.C. 29926 Stephen R. Wright U.S. DOE Box A, Aiken, SC 29802 Dear Mr. Wright, I write in <u>opposition</u> to the restarting of K, L & P reactors on the Savannah River.	
L-17-01	Common sense should tell us - even the workers whose jobs are threatened - that to proceed to produce these deadly chemicals is out of the question. Asbestos workers certainly regretted their workplace and wished they had sought employment elsewhere. Some things must be faced to save all of our lives. Please oppose the restarting, I pray. Sincerely, Mrs. R. R. Mole	Through an extensive training program, DOE ensures that SRS workers are aware of any potential hazards associated with their jobs. DOE also maintains exposure monitoring programs for all SRS employees.

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Comment Number	Comment	Response
L-18	COMMENTS OF CHARLES AND MARIE KLINE 8 Bear Island Rd. Hilton Head Island, S.C. 29926 Stephen R. Wright Director, Environmental Div. US Dept, of Energy Savannah River Operations Office PO Box A Aiken, S.C. 29802 Mr. Wright, We understand through the media that the restarting of L, K, and P reactors at the Savannah River Site, is under serious consideration. We must register our strongest opposition to such a move, from an environmental view, as well as economic and ethical ones. The economic price is perhaps not the priority at this point in time, but obviously looms large by many millions(no- billions) of dollars, both now and in the future. This is only one of the prices to be paid by future generations.	
L-18-01	Tritium and plutonium production is obviously intended (at least primarily) for nuclear weaponry. Why is this channel being followed in today's climate of international peace efforts including arms control progress and of course- world-wide recognition of the horror of nuclear war?	Please see the response to Comment L-02-01 on the need for tritium. While there is no current need to produce weapons-grade plutonium, such a need could arise in the future.
L-18-02	The environmental effects of these reactor start-ups surely threatens to repeat past experiences our country and others have gone through via leakages, misc. accidents, mis-management, etc. Nuclear reactors not only threaten our local areas now, but the future contamination realities of waste storage are specific and mind-boggling. We are all only too familiar with the effects of air, ground, water pollution, without adding in the incalculable nuclear waste long-range effects. Nuclear plants and facilities for peaceful purposes such as the generation of electric power, seem to be our destiny (and no doubt our cross); however, nuclear use for weaponry seems completely	Please see the responses to Comments L-02-02 on past and projected health risks and environmental contamination, L-07-01 on radioactive waste management, and L-06-02 on waste management and environmental restoration.

Table C-5. DOE Responses to Comments on Draft EIS

Comment Number	Comment	Response
	unconscionable. It is a cruel betrayal of our hopes for a peaceful world. Indeed it raises serious reflections on our civilizations' continued existance. PLEASE... no Savannah Site start-up. Sincerely, Charles and Marie Kline	

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Comment Number	Comment	Response
L-19	COMMENTS OF JAN WALLIS 26 Cygnet Ct. Hilton Head, SC	
	Dear Sir,	
	I cannot attend the hearings - I am not a scientist. But I beg you not to restart the Savannah River reactors.	
L-19-01	Our government could not "watch dog" the savings & loans - They certainly can't safeguard hazardous wastes - Please don't destroy the future of South Carolina with long-life chemicals of death.	Please see the response to Comment L-06-02 on waste management and environmental restoration.
	Yours truly, Jan Wallis 26 Cygnet Ct. Hilton Head, SC	

Table C-5. DOE Responses to Comments on Draft EIS

Comment Number	Comment	Response
L-20	COMMENTS OF JULIA VEREEN Rt 2, Box 257A Comer, GA 30609	
	Dear Mr. Wright, I am concerned about the Department of Energy's announcement about a tentative restart of the K-, P-, and L-reactors at the Savannah River Plant in late 1990-91.	
L-20-01	It is my understanding that many safety issues have yet to be dealt with!	Please see the response to Comment L-05-02 on reactor safety.
L-20-02	I do not understand how the DOE can justify the restart of the K-reactor when the cooling tower will not be completed until 1992. Won't that violate the Clean Water Act thermal discharge standards?!?	Please see the response to Comment L-05-03 on the K-Reactor cooling tower.
L-20-03	What will it take for us to use extreme caution and follow the strictest safety measures when dealing with these reactors? Will it take an event like that at Chernobyl in the Southern United States?	Please see the response to Comment L-13-02 on the differences between the reactors at Chernobyl and SRS.
L-20-04	We must have a thorough, accurate and public analysis in an Environmental Impact Statement. Please, the earth will survive ... with or <u>without</u> us! Thank you, Julia Vereen	DOE considers this EIS to be a thorough and accurate analysis of the environmental issues associated with continued operation of K-, L-, and P-Reactors.

Table C-5. DOE Responses to Comments on Draft EIS

Comment Number	Comment	Response
L-21	COMMENTS OF GEOFF YOUNG 370 Alberta Terr Apt 6 Atl Ga 30305	
	Dear Mr Wright, I am writing out of concern about the reopening of the Savannah River Nuclear Plant. I urge the department to reconsider by answering these questions.	
L-21-01	Is the plant safe to reopen?	Please see the response to Comment L-05-02 on reactor safety.
L-21-02	Wouldn't the DOE be violating the Clean Water Act thermal discharge standards by continuing operations without the cooling tower necessary?	Please see the response to Comment L-05-03 on the K-Reactor cooling tower.
L-21-03	Wouldn't the production of tritium contradict the recent arms control agreements and Congress' movement to cut funds for weapon systems?	Please see the response to Comment L-02-01 on the need for tritium.
L-21-04	What about the possibility of a disaster equal or greater than Chernobyl? The reopening would not be positive for US politics or the environment, which is of greater importance.	Please see the response to Comment L-13-02 on the differences between the reactors at Chernobyl and SRS.
	Thank you, Geoff Young 370 Alberta Terr Apt 6 Atl Ga 30305	

Table C-5. DOE Responses to Comments on Draft EIS

Comment Number	Comment	Response
L-22	COMMENTS OF BEA ROSEWELL BLUFFTON	
	Sir -	
	Firewalking in Mt. Saint Helens would be safer than restarting the SRS reactors. - you know it, I know it, my family and nabors know it!	
L-22-01	NO MORE CONTAMINATION!	Please see the response to Comment L-06-02 on waste management and environmental restoration.
	Just clean up the mess already known and shut down the facility so my grandchildren don't have to experience the plutonium-related	
L-22-02	effects of CANCER.	Please see the response to Comment L-02-02 on health risks.
	World peace depends on peaceful people, not any nuclear deterrent. Thanks.	
	Bea Rosewell Bluffton	

Table C-5. DOE Responses to Comments on Draft EIS

Comment Number	Comment	Response
L-23	COMMENTS OF ROBIN COAD	
	Dear Mr. Wright,	
L-23-01	I am writing in opposition to the reopening of the Savannah River Nuclear Plant, and its use for the production of tritium. Doesn't the reopening contradict recent arms control agreements and Congress' movement to cut funds for weapon systems. The funds used would better be suited for clean up of already existing nuclear waste at the Savannah River Plant.	Please see the responses to Comments L-02-01 on the need for tritium and L-06-02 on waste management and environmental restoration.
L-23-02	The DOE needs to address the environmental issues before supporting the production of more nuclear weapons. Thank you, Robin Coad	Please see the response to Comment L-06-03 on the environmental consequences of continued operation. The need for the production of nuclear weapons is beyond the scope of this EIS.

Table C-5. DOE Responses to Comments on Draft EIS

Comment Number	Comment	Response
L-24	COMMENTS OF TRISH HOBBS 325 E. Paces Ferry Rd. Apt. 8 Atlanta, Ga. 30305	
	Mr. S. R. Wright Director Environmental Division (DOE) Savannah River Operations P.O. Box A Aiken, SC 29802	
	Dear Mr. Wright,	
L-24-01	I am writing in concern about the reopening of the Savannah River Nuclear Plant. I am confused & troubled that this plant, if reopened, will be used for the production of tritium. This production would contradict the recent arms control agreements, as well as Congress' movement to cut funds for weapon systems. These cuts would effect the need for tritium. Have you considered this?	The NWSM, which defines the need for nuclear materials, considers arms control agreements. Please see the response to Comment L-02-01 on the need for tritium.
L-24-02	Wouldn't the funds to reopen the Savannah River Nuclear Plant be more properly used if they went to clean up already existing waste.	Please see the response to Comment L-06-02 on waste management and environmental restoration.
L-24-03	I was born and raised in this state and feel it is my obligation to ask the DOE these questions when the department is going to continue to overlook and break guidelines and laws they created.	DOE is fully committed to comply with all applicable Federal and state environmental regulations. Also, please see Chapter 5 for a list of Federal and state environmental requirements.
L-24-04	I urge the department to ask and answer questions concerning the justification of this reopening. Is this plant safe to open? The DOE's track record for correcting safety problems is poor.	Please see the response to Comment L-05-02 on reactor safety.
L-24-05	Wouldn't the DOE be violating the Clean Water Act thermal discharge standards by continuing operations without the cooling tower necessary? And once again wouldn't the production of tritium contradict the recent arms control agreement.	Please see the response to Comment L-05-03 on the K-Reactor cooling tower.
L-24-06	The States of Georgia & South Carolina do not deserve the threat of the possible recreation of Chernobyl.	Please see the response to Comment L-13-02 on the differences between the reactors at Chernobyl and SRS.
	Thank you, Trish Hobbs	

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Comment Number	Comment	Response
L-25	COMMENTS OF JEAN BROWN 443 Tattnall St. Savannah, Georgia 31401	
	Dear Mr. Wright, I attended the DOE hearings in Savannah on May 31 re the re-start of SRS. My previous conclusions that such a move would be un-conscionable have been strengtened.	
L-25-01	In light of the stockpile of nuclear weapons and nuclear materials we already have, we do not need any more. In light of the very real danger of unprecedented catastrophe, it would be a crime against humanity of monstrous proportion if the plant is re-started.	Please see the response to Comment L-02-01 on the need for tritium and other nuclear materials. The need for nuclear weapons is beyond the scope of this EIS.
L-25-02	With the disaster in the Soviet Union still creating news, with all the information available on the terrible possibilities, with the pleas of American citizens filling the newspaper, how can you look yourself in the mirror and call for a re-start? Have you no soul? Will the name Wright join that of Hitler and Stalin in the annals of time? I guess if the plant closes permanently (Pray God that it does) you will have to find other work. So did the directors of the gas chambers. Sincerely, Jean Brown 443 Tattnall St. Savannah, Georgia 31401	Please see the response to Comment L-13-02 on the differences between the reactors at Chernobyl and SRS.

Table C-5. DOE Responses to Comments on Draft EIS

Comment Number	Comment	Response
L-26	COMMENTS OF FRED CHRISTENSEN 3 Ivy Circle Aiken, S.C. 29801 Mr. Steve Wright, Director Environmental Division Savannah River Operations Office PO Box A Aiken, SC 29802 Dear Sir:	
L-26-01	May I offer the following for possible inclusion in public comments on the EIS for the restart of the Savannah River reactors. While we all pray that the cold war is over, we can not risk unilateral disarmament while Russia retains both a massive thermonuclear stockpile and the plants and facilities to maintain and rapidly expand the number and quality of these weapons of mass destruction. We all appreciate the recent improvements in safety measures in the DOE weapons facilities, and we hope that such measures will be promptly taken to satisfactory end points including the expeditious construction of the new contained NPR. But in the meantime, we must operate the DOE weapons facilities as best we can in the interest of national survival. I own about a mile of SRS fence on the north side of the plant. I can see the 200 Area stacks from my farm. I spent some twenty five years on the duPont engineering staff at (then) SRP; during this time I wrote the first SAR for the SRP reactors. I both know the risks and would likely suffer more than most from an accident at SRS. With this background I urge you to be as careful as you can, but please get about the business of maintaining our vital thermonuclear stockpile. Sincerely, Fred Christensen	Comments noted.

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Comment Number	Comment	Response
L-27	COMMENTS OF MRS. R. A. STOWE P.O. Box 626 Greer, S.C. 29652 Mr S. R. Wright Dear Sir! Dept. of Energy Environmental Impact Statement Statement for Continued operation of K. L. and P-Reactors Savannah Ga. - plant - to Continued Operation of K. L. & P.R.	
L-27-01	You have given us the "pleasure to express our self"! in comments & requests for copies of the Deis & What is the Danger of the K-L. and P-Reactors of the "Savannah River operations"! & of Danger of the people! Who "Work there"! "our families"!! that work there and their "Life is "at Stake"! "Our Dear Lord"! Holds their future! tho the Environmental impact seems to be "Very"! "dangerous"! We don't know what this final EIS. Will be for "We all we know "What Danger"! is in Reading the News papers & of all the Consequences of all the Danger! Danger! that is in the Impact! I hope that you see fit to close all these Dagners for "our Sons Sake! "All I have in this World"! I am 79 yrs old Lady! My Son is all I have to live for and "my Good Lord"! to help me thru "Troubles & trials"! like "I am to night" if the "Reactor"! should "Blow & Kill all those wonderful faithful workers & Homes Broken! Please! please! Consider Lives that has been so faithful trying to make a Better Life & Home for their Wife & Chidlren! "please Consider"! God holds us in his Hands! and We all realize "Danger"! our "God" our family of "Love"! Working to make a Better Home! Living to be at old age enjoying our family Thank you for letting us have this opportunity to speak our comments of Life! Health! family of Love & Happiness With our "Good Lord! to help us thru and Save all our people S.R. plant. Thank you! God Bless! a Mother	Please see the response to Comment L-06-03 on the impacts of continued operation.

Table C-5. DOE Responses to Comments on Draft EIS

Comment Number	Comment	Response
L-28	COMMENTS OF ROBERT ROSENBLUM Attorney at Law 218 West State Street, Suite 101 Savannah, Georgia 31401	
	S. R. Wright Director Environmental Division U. S. Department of Energy Savannah River Operations Office P.O. Box A Aiken, SC 29802	
	Re: Reactor Operation EIS	
	Dear Mr. Wright:	
L-28-01	Since I was unable to attend the May 31, 1990 public hearing on the draft EIS for the K, L and P reactors at SRP, I ask that these written comments be considered. First, we do not need to produce more tritium. The present supply can be recycled to maintain a credible nuclear deterrent	Please see the responses to Comments L-02-01 on the need for tritium and L-15-06 on recycling tritium.
L-28-02	Second, the old reactors at SRP do not have containment domes nor are there adequate fire safety mechanisms.	Section 2.1 describes the safety modifications to the SRS reactors and the changes in procedures, staffing, and training. Also, please see the response to Comment L-14-02 on containment domes and fire safety mechanisms.
L-28-03	Since people are fallible, accidents happen like the one at Chernobyl.	Please see the response to Comment L-13-02 on the fundamental differences between SRS and Chernobyl reactors. The PRA for K-, L-, and P-Reactors contains human error factors; see Section 2.1.3.1.2 of the EIS.
L-28-04	Third, what money is available should be spent on cleaning up the environment around SRP. The saying "clean as you go" applies to our environment.	Please see the response to Comment L-06-02 on SRS waste management and environmental restoration.
L-28-05	Since DOE has already announced that it finds its draft EIS sound and intends to restart the reactors regardless of public comment, it seems that the hearings are a sham, which are being offered because the law requires them. It does not appear that DOE is independently	The purpose of an EIS is to assess the potential impacts of proposed agency actions. DOE is required to consider all substantive comments on the Draft EIS in its preparation of the Final EIS (40 CFR

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	considering the need to restart these reactors, but is rather being used by DOD to make it look like the decision was made by neutral experts, so the majority of the public will accept this outcome. DOD may succeed with this ploy, but those of us who live around SRP are not fooled and, ultimately, all of us will pay for this short-sightedness and stubbornness. Very truly yours, Robert Rosenblum RR/slc	1500-1508). DOE will announce its decision on the proposed action in its Record of Decision.

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Comment Number	Comment	Response
L-29	COMMENTS OF MARK MATHIS 370 F Alberta Ter. Apt 7 Atlanta, Ga 30305	
	Dear Mr. Wright	
L-29-01	I am writing in concern about the reopening of the Savannah River Nuclear Plant. I do not understand the reopening of this plant for the production of tritium. This production would contradict the recent arms control agreements and Congress' movement to cut funds for weapon systems These cuts would affect the need for tritium.	Please see the response to Comment L-02-01 on the need for tritium.
L-29-02	Have you considered these issues? Furthermore wouldn't funds used for the reopening be better used for cleaning up already existing waste?	Please see the response to Comment L-06-02 on waste management and environmental restoration.
	Thank you!	
	Mark Mathis 370 F Alberta Ter. Apt 7 Atlanta, Ga 30305	

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Comment Number	Comment	Response
L-30	COMMENTS OF RICHARD W. HUNT 1208 Crestview Drive North Augusta, SC 29841 June 7, 1990 Mr. S. R. Wright, Director Environmental Division U.S. Department of Energy Savannah River Operations Office P. O. Box A Aiken, South Carolina 29802 Re: Draft Environmental Impact Statement Continued Operation of K-, L-, and P-Reactors Savannah River Site, Aiken, South Carolina COMMENTS * Individual	
L-30-01	Cursory review of the Department's EIS indicates that a broad based analysis has been made of the impact on the environment. The statement also contains a detailed analysis of present needs for operational reactors to meet our nation's requirements. Alternatives for partial implementation of continued operation have been assessed in brief but comprehensive terms. As an individual with over four decades of professional work in the nuclear and chemical industries I fully approve of the proposed Draft Environmental Impact Statement issued May 1990 by the U.S. Department of Energy. In deference to those who disagree with the plans outlined may I suggest that, given the charge by the Presidentially approved Nuclear Weapons Stockpile Memorandum, this proposal addresses its responsibilities in a most commendable manner. In particular I am impressed with the public risk Evaluation Tables which deliniate common risks vs. those arising from continued operation of SRS reactors. All opposed to nuclear production would do well to further examine this data. The risks are negligible when compared to the everyday risks of normal life.	Comments noted.
L-30-02	My personal view and hope is that prompt restart of reactors need not and should not await issuance of a final statement of impact. The need is clear. The job is progressing at a less than desirable	Energy Secretary Watkins has committed to the issuance of this EIS before a decision on whether the reactors should resume production.

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Comment Number	Comment	Response
	pace due in part to the well-known syndrome of "Paralysis by Analysis". Let's on with the job and with the confidence of the traditional American work ethic. Thank you for consideration of my personal views. Sincerely, Richard Hunt	

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Comment Number	Comment	Response
L-31	COMMENTS OF SANDRA TANNENBAUM 105B Springwoods Lake Point Columbia, SC 29223 June 6, 1990 Mr. Stephen R. Wright, Dir. Environmental Division U.S. Dept. of Energy Savannah River Operations Office P. O. Box A Aiken, S. C. 29802 Dear Mr. Wright: As I was unable to attend the hearings in Columbia this week, I am writing to you concerning my views on the restarting of the Savannah River Site.	
L-31-01	I feel very strongly that it is in the best interests of the people of South Carolina, of this nation, and of this world, that production of tritium an plutonium be limited. I am convenced that our nation does not need additional qualities of these materials at this time. To restart the Savannah River Site would be to increase the danger to the health of ourselves and our environment, and to thwart the efforts to end the cold war and world tensions.	Please see the response to Comment L-02-01 on the need for tritium and other nuclear materials.
	Thank you for listening, and for seriously considering the grave consequences of ignoring safety and world peace issues. Sincerely, Sandra Tannenbaum	

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Comment Number	Comment	Response
L-32	COMMENTS OF JOHN C. SNEDEKER Synergistic Dynamics, Inc. 400-F Johnny Mercer Boulevard Savannah, GA 31410 June 9, 1990 Mr. S. R. Wright, Director Environmental Division U.S. DEPARTMENT OF ENERGY Box A Aiken, S.C. 29802 Re: Reactor Operations EIS Dear Mr. Wright:	
L-32-01	We have reviewed the DRAFT EIS titled "Continued Operation of K, L and P Reactors, Savannah River Site, Aiken, South Carolina" and wish to submit our comments for the record. We understand that the purpose of the DEIS is to assess the environmental impacts of continued operation of the reactors. We also understand that it is DOE's intent, consistent with the procedures set forth in the National Environmental Policy Act (NEPA), to solicit comments on the adequacy of the DEIS and the issues addressed therein. The DEIS is, in our opinion, entirely adequate, professionally prepared and comprehensive in scope. The EIS scoping process and the public inputs into the hearings and writing comments have long since departed from the intent of NEPA, and have, instead, become a forum for political statements and radical protest. Such comments have overwhelmed -- in tone and volume -- those that stay within the boundaries of the EIS process. It is, of course, within the discretionary authority of the hearing officers and others in positions of authority to disregard such extraneous inputs; however, as the "activists" have become more sophisticated in their presentations and tactics, their ability to influence elected officials at the local, State and even	Comments noted.

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Comment Number	Comment	Response
	the Federal level has become a factor that must be dealt with. There are otherwise responsible public officials and civic leaders in Savannah who mouth some of the same rhetoric as the "activists", uncritically accepting press releases from organizations such as Greenpeace as proof that DOE and its operating contractors willfully violate the law and standards of safety. Organized groups opposed to nuclear weapons, nuclear power and nuclear research have managed to create a climate of fear and uncertainty that could have significant and potentially damaging impacts on the future security of the United States. This situation concerns us greatly; therefore, with your indulgence, we too, shall depart from the intent of NEPA, and introduce comments extraneous to the scope of the DEIS. Even though the World is currently enjoying the apparent demise of International Communism as a de-stabilizing force throughout the World and threat to peace, this is by no means a time to abandon or dismantle the military and industrial capability that has brought about this happy state of affairs. The United States was virtually defenseless in 1941. Despite the massive losses sustained at Pearl Harbor and in the Philippines, the Country was able to mobilize its productive capacity in a matter of months to replace the assets that had been lost, and to go on to increase its military strength until it overwhelmed the enemy. Lead times were short in those days. New aircraft could be designed, tooled, constructed, flight tested, manufactured in large numbers and deployed into combat in a few short years. Naval vessels were built in even shorter periods of time, and merchant ships were launched within weeks of keel-laying. Munitions were produced in huge quantities within months from the signing of a contract. Those conditions no longer prevail. The United States and its allies must continue to have a credible nuclear deterrent for the foreseeable future. Tritium is a perishable component of the nuclear force, and must be periodically replenished. If the SRS reactors are not restarted — relatively soon — the credibility of the US as a nuclear-equipped force will deteriorate. The number of weapons in our arsenal will become meaningless if they are no longer effective. Such a condition would be extremely destabilizing, and would invite adventurism from a variety of countries not similarly handicapped.	

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	There are legitimate environmental and safety concerns that must be addressed before and after the reactors are restarted. There have been lapses in judgment and violations of operating procedures at the SRS and at other nuclear weapons facilities; these conditions must and can be corrected. The Navy's nuclear propulsion and weapons programs have had outstanding records of safety and reliability. We are reassured that ADM Watkins is bringing the discipline and professionalism of the Naval Reactors Program to DOE and its production facilities. We are reassured that Westinghouse, a major participant in the Navy's nuclear programs for many years, is the operating contractor at SRS. Please approve the DEIS. Very truly yours, John C. Snedeker President	

Table C-5. DOE Responses to Comments on Draft EIS

Comment Number	Comment	Response
L-33	COMMENTS OF PARK AITKEN	
	June 11,1990	
	Dear Mr. Wright:	
L-33-01	I want the funds used for restart used for air pollution (protecting the ozone layer), soil and water pollution, mass transportation. Tritium is obsolete. Oil will be depleted in 45 years.	Comments noted.
	I, also, want this letter by Chief Seattle to President Franklin Pierce in 1855 read by someone in the Dept. of Energy:	
	Every part of the earth is sacred to my people. Every shining pine needle, every sandy shore, every mist in the dark woods, every clearing and humming insect is holy in the memory and experience of my people. The white man..... is a stranger who comes in the night and takes from the land whatever he needs. The earth is not his brother but his enemy, and when he has conquered it, he moves on. He leaves his father's graves, and his children's birthright is forgotten... all things share the same breath - the beasts, the trees, the man. The white man does not seem to notice the air he breathes. Like a man dying for many days, he is numb to the stench.... What is man without the beasts? If all the beasts were gone, men would die from great lonliness of spirit, for whatever happens to the beasts also happens to man. All things are connected. Whatever befalls the earth befalls the sons of earth..... The whites too shall pass - perhaps sooner than other tribes. Continue to contaminate your bed and you will one night suffocate in your own waste. When the buffalo are all slaughtered, the wild horses all tamed, the secret corners of the forest heavy with the scent of many men, and the view of the ripe hills blotted by talking wires, where is the thicket? Gone. Where is the eagle? Gone. And what is it to say good-by to the swift pony and the hunt, the end of living and the beginning of surviving.	

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Comment Number	Comment	Response
	Sincerely, Park Aitken 6600 Rivers Ave. 203 N. Charleston, S. Carolina 29418	

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Comment Number	Comment	Response
L-34	COMMENTS OF MRS. PETER BARTHOLDUS 15 St. George Road Hilton Head, SC 29928 May 25, 1990 Dear Sir: As a resident of Hilton Head Island I wish to protest the re-opening of the Savannah River Plant. There are many of us that live on this Island that moved from another Island in New York, Long Island, which also had a dangerous nuclear plant, Shoreham. We succeeded in keeping that plant from opening. There was absolutely no way an effective evacuation route, should there have been an accident, could have been accomplished. I feel this is the situation on Hilton Head.	
L-34-01	And to no ones surprise, the pollution coming from the facility has been a health hazard for years.	Please see the response to Comment L-02-02 on health risks.
	The cost for this plant is not justified. We need funds for so many worth while projects, not for the production of death. Please consider my plea, I remain, Sincerely, Mrs. Peter Bartholdus	

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Comment Number	Comment	Response
L-35	COMMENTS OF LYNN H. MEDCALF	
	June 5, 1990 Mr. S. R. Wright, Director Environmental Division U.S. Department of Energy Savannah River Operations P.O. Box A Aiken, SC 29802	
	Dear Sir,	
L-35-01	I understand that there are current plans to restart three of the reactors- K, L, and P by December of 1990. This letter is to encourage you to halt those plans. The production of tritium has proven harmful for the residents of Aiken, as well as our environment.	Please see the response to Comment L-02-02 on health risks.
L-35-02	I also understand that almost $2 billion has been spent to restart these production reactors. During this era of cold war tensions easing, it seems rather foolish to be spending this much money on nuclear weapons production.	The need for nuclear weapons is beyond the scope of this EIS.
L-35-03	I cannot express enough my wish for the production of tritium and plutonium to be slowed and eventually ended altogether. There is no need for us to continue to produce more nuclear weapons when we have just finished negotiating to phase out weapons that we have already produced.	Please see the response to Comment L-02-01 on the need for tritium and other nuclear materials.
	I will be unable to attend the hearings on the Environmental Impact Statement, but from my understanding, it has been made clear that the restart of these reactors serves to further destroy the environment and pose	
L-35-04	even more danger to the citizens of Aiken by way of more cases of cancer. Please take this letter as one of protest from a concerned voter.	Please see the response to Comment L-02-02 on health risks. Chapter 4 of the EIS presents information on environmental effects.
	Lynn H. Medcalf	

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Comment Number	Comment	Response
L-36	COMMENTS OF CRAIG FORD	
	S. R. Wright, Director - Environmental Division U.S. Department of Energy Savannah River Operations Office Post Office Box A Aiken, SC 29802	
	Mr. Wright:	
	I am writing this letter to protest against the reactor restart at Savannah River Plant. There is no need to restart the reactors, and continue the environmental and health problems they cause.	
L-36-01	It is time for change and SRP's time has come and gone. The world's political and social climate has changed. The world needs more nuclear weapons about as much as the people of the CSRA need radioactive waste related cancers.	Please see the response to Comments L-02-01 on the need for tritium and L-02-02 on health risks. The need for nuclear weapons is beyond the scope of this EIS.
	I can only hope the Department of Energy will be able to develop the wisdom needed to do what is truly right for the American public.	
	Thank you,	
	Craig Ford	

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Comment Number	Comment	Response
L-37	COMMENTS OF DR. MILTON M. HOENIG Nuclear Control Institute 1000 Connecticut Ave. NW Suite 704 Washington, SC 20036 June 7, 1990 Mr. S. R. Wright Director Environmental Division U.S. Department of Energy Savannah River Operations Office P.O. Box A Aiken, South Carolina 29802 Mr. Wright: On behalf of Nuclear Control Institute, I am submitting the enclosed comments on the Department of Energy (DOE) Draft Environmental Impact (DEIS), "Continued Operation of K-, L-, and P-Reactors, Savannah River Site, Aiken, South Carolina" (DOE/EIS-0147D). Sincerely, Dr. Milton M. Hoenig Scientific Director Encl.	

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	COMMENTS	
	The Nuclear Control Institute (NCI), a non-profit, public policy research organization in Washington, D.C., is concerned with reducing the world's nuclear arsenals and halting the spread of nuclear weapons. At this time of greatly reduced tensions between the superpowers, the U.S. is proposing to resume the production of tritium, a key material in nuclear weapons, after a complete shutdown of the production reactors at the Savannah River Site (SRS) since the summer of 1988 for attempted safety improvements. The Institute is submitting the following comments on the Department of Energy (DOE) Draft Environmental Impact Statement (DEIS), "Continued Operation of K-, L-, and P-Reactors, Savannah River Site, Aiken, South Carolina" (DOE/EIS-0147D), May 1990.	
	The Question of Need for Continued Production	
L-37-01	In the Nuclear Control Institute's view, the question of need is the paramount issue in assessing the environmental impact of the restart and continued operation of the Savannah River military production reactors. Since the shutdown at Savannah River, the U.S. has managed to maintain its nuclear deterrent without operation of the Savannah River reactors, despite tritium's steady decay. According to the DEIS (p. 3): > During FY 1989 and 1990, DOE and DOD implemented several initiatives that allowed DOE to meet the base requirement for tritium while the SRS production reactors were shut down. These initiatives included the use of tritium process inventories and coordination between DOE and DOD to meet current needs with smaller inventories. Already in April 1989 eleven eminent scientists stated in an NCI-sponsored paper on solving the military tritium problem that it was possible to continue in this way without new tritium production for an extended period of time (at least five years) without endangering U.S. national security.* The paper, which was written before the present thaw in U.S.-Soviet relations and the dramatic political changes in Eastern Europe, called for more efficient	Please see Section 1.2 of the EIS and the response to Comment L-02-01 on the need for tritium.

* "America's Non-Existent Nuclear 'Crisis'," Bethe et. al., Outposts Page, Washington Post, April 16, 1989. (See Appendix.)

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	management of the tritium already produced and the recycling of tritium from warheads already scheduled for retirement while prospects for a START agreement and other nuclear arms reductions were being negotiated.	
L-37-02	With a START agreement now nearing completion and post-START discussions already underway, the likelihood of substantial reductions in strategic nuclear is great. There is no need to restart Savannah River if tritium requirements can be met from warhead retirements, including tactical weapons made obsolete by changing political conditions in Europe. As a contingency against unforseen events, repair work and safety upgrades could be completed to bring the shutdown Savannah River reactors to cold standby, ready to resume tritium production if necessary.	Please see the responses to Comments L-02-01 on the need for tritium and L-15-06 on recycling. In addition, a potential reduced-need scenario was evaluated in Appendix A, and is considered in the EIS. Continued operation (the proposed action) includes the placement of one or more reactors in cold standby after the completion of the current upgrades and tests and an analysis of their capability if the materials requirements can be met. In any event, DOE would consider placing these reactors in cold standby after new production capability has been demonstrated.
L-37-03	The treatment of the need question in the unclassified DEIS is cursory. According to the DEIS (p.1-1), the classified Appendix A "provides a quantitative discussion of the need to produce nuclear materials," as well as a discussion of the impacts of the termination of one, two or all three reactors in the immediate future, and other production options.	DOE has revised Section 1.2 of the EIS to clarify the nature of the information in Appendix A.
L-37-04	It is time to take the cloak of secrecy off the question of need. Enough is known to the public already about the materials requirements of the nuclear weapons stockpile and the capabilities of the production reactors to make continued classification of this information unnecessary and detrimental in the midst of an important public debate. As it stands, the DEIS is unbalanced because of an excessive emphasis on the need to operate the Savannah River reactors to produce plutonium-238 for NASA space missions (p.1-3). The limited capacity required for plutonium-238 production is available in other DOE research and test facilities (see discussion below). It is disingenuous for DOE to hide behind our civil space program to justify the operation of the military production reactors.	The need for materials other than plutonium-238 for NASA space missions is appropriately classified. The EIS includes as much information on need as possible in an unclassified document. The need expressed by the proposed action is only partially based on space program requirements. See the revised Section 1.2 of the EIS.
L-37-05	Even if declassified, it is doubtful whether Appendix A would be found to spell out in detail the changed nuclear material production needs arising from stockpile scenarios that include substantial warhead reductions. This deficiency should be corrected: materials production requirements for a number of possible arms reductions scenarios should be made part of the DEIS. As it stands, the DEIS recognizes (p.1-3) that "the potential exists that material	Please see the response to Comment L-16-01 on the timeliness of the requirements analysis.

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	requirements could decrease in the future due to the changing world geopolitical situation (e.g., potential Strategic Arms Reduction Talks Treaties; potential reduction of U.S. tactical presence in the North Atlantic Treaty Organization) and budget constraints." Yet, the DEIS states (p. 1-3) that because "it is not likely that the requirements for the near term will change significantly," the current Nuclear Weapons Stockpile Memorandum (1989-1994) "remains the basis for this EIS."	
L-37-06	Such a pessimistic assumption on the part of the DEIS does not take into account the potential for rapid political change that the world now faces and the opportunity that is available now for not resuming nuclear materials production at Savannah River. Letter to Presidents Bush and Gorbachev on Halting Production The unique opportunity that now exits for a mutual halt in nuclear weapons materials production recently has been brought to the attention of Presidents Bush and Gorbachev in a pre-Summit letter to the two Presidents from 54 diplomats, scientists and other experts. The signers of the letter include a former Secretary of State, a former Secretary of Defense, two former CIA directors, and seven Nobel laureates. The letter urges both Presidents "to consider the desirability and feasibility of a complete nuclear weapons materials production halt at this time. The halt need not await a complicated formal agreement. It can be achieved by reciprocal unilateral steps." The complete text of the letter to the Presidents and the biographies of the signers are contained in the Appendix. The Option to Terminate Savannah River Reactor Operation As described in Section 4.3 of the DEIS (p.4-131), a proposed alternative to the continued operation of K-,L-, and P-Reactors would be to terminate their operation in the immediate future and maintain them on cold standby. In NCI's view, world events are now dictating that this alternative is the most appropriate course of action at SRS since sufficient tritium to maintain the nuclear weapons stockpile would be recovered from negotiated and unilateral warhead retirements. This action to avoid the continued operation of the old and potentially unsafe SRS production reactors would have the minimum environmental impact.	Please see the response to Comment L-16-01 on the timeliness of the requirements analysis. Section 1.2 of the EIS discusses the need for reactor production capability and its responsiveness to the changing world geopolitical situation.

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L-37-07	NCI's view is that the currently planned safety upgrades should be completed at Savannah River before the reactors are placed on cold standby. The DEIS assumes that currently planned upgrade activities would be be discontinued if DOE decided to terminate one or more reactors at SRS in the immediate future (see DEIS pp.4-129, 4-131). This would be unwise should tritium production have to be restarted in case of a national emergency. The EIS should be altered to require completion of all currently planned safety upgrades before the reactors are placed on cold standby. Alternative Sources of Isotopes for Non-Weapons Purposes In the absence of Savannah River operation, the relatively small quantities of materials that were produced in the Savannah River military reactors for non-weapons purposes could be acquired from other sources. It behooves to more thoroughly evaluate alternative sources of tritium for non-weapons R&D and commercial and medical applications, plutonium-238 for NASA space program power sources, cardiac pacemakers, U.S. Navy missions and DOE applications, and other isotopes, such as californium-252, americium-242, krypton-85 and cobalt-60.	The proposed action includes the scenario described in this comment. DOE has revised Section 2.1 of the EIS to clarify that the proposed action enables DOE to operate K-, L-, and P-Reactors in a manner that best meets current and future needs. The proposed action bounds the impacts of continuing upgrades. As stated in Sections 2.2 and 2.3, DOE would discontinue currently planned upgrade activities under the termination alternative.
L-37-08	U.S. requirements for civilian R&D and for commercial and medical applications, which amounts to some 100 kilograms per year, could be purchased from Canada whose Darlington facility has the capacity to recover about two kilograms of tritium per year from the recycled heavy water moderator of that nation's CANDU power reactors.	DOE recognizes that this possibility exists.
L-37-09	Other isotopes including plutonium-238 could be produced in DOE-owned test and research reactors. Among the reactors that could be adapated for this purpose are the 250 megawatt-thermal Advanced Test Reactor (ATR) at the Idaho National Engineering Laboratory and the 400 megawatt-thermal Fast Flux Test Facility (FFTF) at the Hanford Reservation. The capacity of the ATR, for example, would be adequate to produce the 30 kilograms of new plutonium-238 that are needed in the near-term (see DEIS, p.1-3) without severely limiting other activities at the reactor.	Section 2.4 of the EIS describes the alternatives for producing plutonium-238.

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	Conclusion	
L-37-10	The DEIS for the restart and continued operation of the Savannah River production reactors should be revised to take into account the emerging consequences of the rapidly thawing cold war. As the 54 diplomats, scientists and other experts state in their pre-Summit letter to Presidents Bush and Gorbachev, enough materials could be recovered from retired weapons to "make additional production a costly redundancy."	DOE has revised Appendix A and Section 1.2 of the EIS to clarify that the NWSM, which is issued annually, considers changes in the world geopolitical situation and how this might affect future requirements for nuclear materials as specified in the annual NWSM.

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NUCLEAR CONTROL INSTITUTE

1000 CONNECTICUT AVE NW SUITE 704 WASHINGTON DC 20036 202-822-8444

May 23, 1990

President George H. Bush
The White House
Washington, D.C.

President Mikhail S. Gorbachev
The Kremlin
Moscow, U.S.S.R.

Dear Presidents Bush and Gorbachev:

We wish to call to your attention a unique opportunity that is made possible by your historic efforts to halt and reverse the nuclear arms race. Unless it is grasped promptly, however, it is likely to recede rapidly.

With large reductions in strategic and tactical nuclear weapons under active consideration, the United States and the Soviet Union, either by agreement or by reciprocal unilateral action, have the opportunity to avoid the further operation of old, potentially unsafe nuclear reactors for production of weapons materials and to avoid the spending of billions on replacement reactors.

We write in the hope that, in connection with the forthcoming summit, you will consider steps to realize such a remarkable achievement.

The window of opportunity is fast closing, however, as the United States prepares to restart its weapons production reactors, all of which have been shut down for safety reasons since June 1988, and to construct new production reactors. A principal impetus for these plans is the continuing production of weapons materials in Soviet military reactors during this period. While the Soviet side has announced a timetable for shutdown of its production reactors by the year 2000, this timetable is not reassuring to the U.S. side, which sees itself at a disadvantage because of the involuntary shutdown of its reactors while Soviet production continues.

Surely this unrelenting race to produce yet more ingredients for nuclear weapons---plutonium and tritium---deserves serious reexamination in light of the progress being made to end the nuclear arms race.

Strategies for stopping the spread and reversing the growth of nuclear arms

Paul L. Leventhal, Chairman; Steven A. Bradford; David Cohen; Rear Admiral Thomas D. Davies (USN Ret); Denis A. Hayes; Julian Keating; Sharon Tanzer Leventhal; Roger Mattson; Dr. Theodore B. Ta
BOARD OF DIRECTORS

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	Presidents Bush and Gorbachev May 23, 1990 Page Two Unless one side or the other actually contemplates increases in its stockpile of weapons, a credible case cannot be made for further production of plutonium. With a shelf life of thousands of years, plutonium is salvageable from retired weapons for possible reuse in replacement warheads. For the same reason, each side already has acted unilaterally to halt further production of highly enriched uranium, the other long-lived fissionable material, for use in weapons. The issue of tritium production is somewhat more complicated because, unlike plutonium and highly enriched uranium, tritium decays relatively rapidly---over dozens of years. Its production must be continued to maintain the size of a nuclear arsenal. No fresh tritium need be produced, however, if warheads utilizing tritium are retired at a rate that keeps pace with or exceeds tritium's decay. Under those circumstances, tritium recovered from retired warheads would be sufficient to replenish tritium in the remaining warheads for many years. A key consideration, therefore, is whether there are likely to be agreed or unilateral reductions in nuclear weapons in the immediate future that will make additional tritium production by either side unnecessary. Major arms reduction initiatives are now moving forward, beyond the progress already made by the INF agreement and by unilateral actions. A START treaty, in combination with budgetary limitations on new deployments, will likely reduce the U.S. and Soviet strategic stockpiles by as much as several thousand warheads on each side. Even more substantial reductions in strategic weapons are being explored in post-START discussions already underway. In addition, deep reductions in tactical nuclear weapons, negotiated or unilateral, now appear imminent as the result of political changes in Europe. The retirement of some 3,000 U.S. tactical nuclear weapons and of larger numbers of comparable Soviet weapons seems possible as pressure builds for removal of at least the land-based nuclear missile and artillery warheads from German territory. And growing sentiment for elimination of naval tactical nuclear weapons eventually could lead to the retirement of several thousand additional warheads. These reductions would create a sizable tritium reserve on both sides to sustain remaining warheads and would make additional production a costly redundancy. Even now, the amount of tritium in the U.S. weapons inventory is sufficient to meet tritium requirements of 3,000 warheads for 35 years and 1,000 warheads for more than 50 years. We assume that a similar sufficiency to maintain an effective deterrent exists on the Soviet side.	

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	Presidents Bush and Gorbachev May 23, 1990 Page Three We urge you both, therefore, to consider the desirability and the feasibility of a complete nuclear weapons materials production halt at this time. The halt need not await a complicated formal agreement. It can be achieved by reciprocal unilateral steps. The Soviet Union need only accelerate its timetable for a shutdown of all production reactors, effective immediately or in the near future. The United States need only defer plans for start-up of its production reactors and for construction of new production reactors. Each side could maintain a number of production reactors on "cold stand-by" status as a contingency against a breakdown in the ongoing arms reduction process. Such reciprocal, unilateral action could be verified immediately by satellite surveillance of shut-down reactors. Talks could begin on other verification and on-site inspection arrangements necessary to make possible a long-term production halt. An immediate production halt would provide substantial domestic and international benefits without adverse military impact. Beyond avoiding the continued operation of aging, potentially unsafe production reactors and the building of costly replacements, the superpowers clearly would be signaling their intent to forego expansion of their nuclear arsenals and, indeed, to proceed with serious reductions over the next several decades. Yet, even if the arms-reduction process breaks down, or does not produce deep cuts that keep pace with tritium's steady decay, each side will still be in a position to restart the production reactors held on cold stand-by and to construct new reactors, if necessary. Conversely, missing the present opportunity to achieve a production halt imposes a number of risks and costs, including those associated with continued production activities that could only feed the nuclear arms race and inspire other nations to follow suit. We hope, therefore, that you will explore this additional pathway to peace while the present opportunity lasts.	

Table C-5. DOE Responses to Comments on Draft EIS

Comment Number	Comment	Response
	Presidents Bush and Gorbachev May 23, 1990 Page Four Sincerely, Hans A. Bethe, Nicolaas Bloembergen, Peter Bradford George Bunn, David Cohen, William E. Colby Thomas D. Davies, Jonathan Dean, Paul Doty Freeman J. Dyson, Ralph Earle, Philip J. Farley Herman Feshbach, Val F. Fitch, Randall Forsberg Richard L. Garwin, Victor Gilinsky, Roswell L. Gilpatric Sheldon Lee Glashow, Marvin L. Goldberger, Kurt Gottfried Eldon V.C. Greenberg, Denis A. Hayes, Dudley Herschbach William A. Higinbotham, Milton Hoenig, Robert C. Johansen	

Table C-5. DOE Responses to Comments on Draft EIS

Comment Number	Comment	Response
	Presidents Bush and Gorbachev May 23, 1990 Page Five Vera Kistiakowsky, Julian Koenig, Betty G. Lall Leon M. Lederman, Paul Leventhal, Franklin Long John H. Manly, J. Carson Mark, Jessica T. Mathews Robert S. McNamara, Marvin Miller, Philip Morrison Russell W. Peterson, Edward M. Purcell, George W. Rathjens Stanley Resor, John B. Rhinelander, Roger Richter Gerard C. Smith, John D. Steinbruner, Theodore B. Taylor Kosta Tsipis, Stansfield Turner, Cyrus Vance Victor F. Weisskopf, Jerome Wiesner, Robert R. Wilson	

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NUCLEAR CONTROL INSTITUTE

[illegible]

LETTER TO PRESIDENTS BUSH AND GORBACHEV

Signers*

Hans A. Bethe, 1967 Nobel Laureate in physics, formerly headed the Theoretical Division at Los Alamos National Laboratory and is emeritus professor of physics at Cornell University.

Nicolaas Bloembergen, 1981 Nobel Laureate in physics, is a professor of physics at Harvard University and is president-elect of the American Physical Society.

Peter Bradford is a former commissioner of the U.S. Nuclear Regulatory Commission.

George Bunn is a member of the Stanford Center for International Security and Arms Control, and formerly served as deputy chairman of the U.S. Nuclear Non-Proliferation Treaty delegation and as general counsel of the Arms Control and Disarmament Agency.

David Cohen is president of the Professionals' Coalition for Nuclear Arms Control and a former president of Common Cause.

William E. Colby is a former director of central intelligence.

Thomas D. Davies, Rear Admiral USN (Ret.), served as assistant director of the Arms Control and Disarmament Agency, where he headed the Nuclear Non-Proliferation Bureau and chaired the U.S. delegations in treaty negotiations with the Soviet Union on a comprehensive nuclear test ban and on environmental warfare.

Jonathan Dean, an arms control advisor to the Union of Concerned Scientists, headed the U.S. delegation in the Mutual and Balanced Force Reductions negotiations.

Paul Doty is a professor of public policy at the Kennedy School of Government and professor emeritus of biochemistry at Harvard University.

Freeman J. Dyson, professor of physics at the Institute for Advanced Study, has been a frequent consultant to the Defense Department and the Arms Control and Disarmament Agency.

* Current titles and affiliations for personal identification purposes only.

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BOARD OF DIRECTORS

Table C-5. DOE Responses to Comments on Draft EIS

Comment Number	Comment	Response
	Ralph Earle is consultant and chairman of the National Advisory Board of the Lawyers Alliance for Nuclear Arms Control. He formerly served as Director of the Arms Control and Disarmament Agency and as chairman of the U.S. SALT II delegation.	
	Philip J. Farley, member of the Stanford Center for International Security and Arms Control, was Director of Politico-Military Affairs at the State Department, Deputy Director of the Arms Control and Disarmament Agency and alternate chairman of the U.S. SALT I delegation.	
	Herman Feshbach, former chairman of the nuclear-science advisory committee of the National Science Foundation and former president of the American Physical Society and the American Academy for the Advancement of Science, is institute professor emeritus of physics at MIT.	
	Val L. Fitch, 1980 Nobel Laureate in physics and professor of physics at Princeton University, was a presidential advisor on science policy and arms control in the Nixon administration and a past president of the American Physical Society.	
	Randall Forsberg is executive director of the Institute for Defense and Disarmament Studies.	
	Richard L. Garwin, a member of the President's Science Advisory Committee under Presidents Kennedy, Johnson and Nixon, as well as of the Defense Science Board advisory to the Secretary of Defense, is an IBM Fellow and science advisor to the director of research of IBM Corporation.	
	Victor Gilinsky, a consultant, previously served as commissioner of the U.S. Nuclear Regulatory Commission and as head of the Physical Science Department at RAND.	
	Roswell L. Gilpatric, an attorney, served as Deputy Secretary of Defense under Presidents Kennedy and Johnson.	
	Sheldon Lee Glashow, 1979 Nobel Laureate in physics, is Mellon Professor of the Sciences at Harvard University.	
	Marvin Goldberger is director of the Institute for Advanced Study and a former president of the California Institute of Technology. He chaired the committee on international security and arms control of the National Academy of Sciences.	
	Kurt Gottfried, is professor of physics and nuclear studies at Cornell University and a member of the Department of Energy's High-Energy Physics Advisory Panel.	
	Eldon V.C. Greenberg, an attorney, served as general counsel of the National Oceanic and Atmospheric Administration and is of counsel to the Nuclear Control Institute.	
	Denis A. Hayes, is chairman and CEO of Earth Day 1990 and a former director of the U.S. Solar Energy Research Institute.	
	Dudley Herschbach, 1986 Nobel Laureate in chemistry, is a professor of chemistry at Harvard University.	

Table C-5. DOE Responses to Comments on Draft EIS

Comment Number	Comment	Response
	William Higinbotham, former head of the Technical Support Organization of the Department of Nuclear Energy at Brookhaven National Laboratory, is a consultant on nuclear materials management. **Milton Hoenig**, a physicist, is scientific director of the Nuclear Control Institute and previously served in the Nuclear Non-Proliferation Bureau of the Arms Control and Disarmament Agency. **Robert C. Johansen** is a director of graduate studies of the Institute for International Peace Studies at the University of Notre Dame. **Vera Kistiakowsky** is professor of physics at the Massachusetts Institute of Technology. **Julian Koenig** is president of Julian Koenig, Inc. and was a founding partner of Pappert, Koenig, and Lois, a New York firm, where he originated the name, "Earth Day," and engaged in commercial, political and public interest advertising. **Betty G. Lall** is director of verification studies of the Council on Economic Priorities. **Leon M. Lederman**, 1988 Nobel Laureate in physics, formerly headed the Fermi National Laboratory and is a professor of physics at the University of Chicago. **Paul Leventhal**, president of the Nuclear Control Institute, previously served as staff director of the Senate Nuclear Regulation Subcommittee and as special counsel of the Senate Government Operations Committee. **Franklin Long**, adjunct professor of chemistry and social sciences at the University of California, Irvine and emeritus professor of chemistry at Cornell University, served as research supervisor of the National Defense Research Committee from 1942 to 1945 and as Assistant Director of the Arms Control and Disarmament Agency. **John H. Manly** served as group leader (1943-1945) and technical associate director (1945-1951) at the Los Alamos National Laboratory. **J. Carson Mark** served as head of the Theoretical Division of Los Alamos National Laboratory and has served on the U.S. Nuclear Regulatory Commission Advisory Committee on Reactor Safeguards and on the Science Advisory Board of the U.S. Air Force. **Jessica T. Mathews** is vice president of the World Resources Institute. **Robert McNamara** served as Secretary of Defense under Presidents Kennedy and Johnson and as president of the World Bank. **Marvin Miller**, a consultant to the Arms Control and Disarmament Agency, is senior research scientist with the Department of Nuclear Engineering and the Center for International Studies at MIT. **Philip Morrison** is emeritus institute professor of physics at the Massachusetts Institute of Technology.	

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Comment Number	Comment	Response
	Russell W. Peterson, vice-chairman of the Better World Society and president emeritus of the Audubon Society, is a former director of the Congressional Office of Technology Assessment. **Edward M. Purcell**, 1952 Nobel Laureate in physics, is emeritus professor of physics at Harvard University. **George W. Rathjens**, professor of political science at MIT, was chief scientist in the Defense Advanced Research Projects Agency and in the Office of Special Assistant to the President for Science and Technology. **Stanley Resor**, a former Secretary of the Army, is chairman of the National Advisory Committee of the Lawyer's Alliance for Nuclear Arms Control. **John B. Rhinelander**, a partner of Shaw, Pittman, Potts, Trowbridge and Rhinelander, formerly was deputy legal advisor at the State Department and legal advisor to the SALT I delegation. **Roger Richter**, president of the Continental Arbitrage Corp., is a former nuclear safeguards inspector of the International Atomic Energy Agency. **Gerard C. Smith**, chairman of the Arms Control Association, served as chairman of the U.S. SALT I delegation and later as Special Representative and Ambassador-at-Large for Non-Proliferation Matters. **John D. Steinbruner** is director of foreign policy studies at the Brookings Institution. **Theodore Taylor**, a consulting physicist, is a former nuclear weapons designer at Los Alamos and former deputy director (scientific) of the Defense Atomic Support Agency. **Kosta Tsipis** is director of the Program in Science and Technology for International Security at the Massachusetts Institute of Technology. **Stansfield Turner**, Admiral USN (Ret.), is a former U.S. director of central intelligence. **Cyrus Vance** was Secretary of State during the Carter Administration. **Victor Weisskopf**, former group leader of the Los Alamos National Laboratory and former director of CERN (the European Center for Nuclear Research), is emeritus institute professor of physics at MIT. **Jerome B. Wiesner**, president emeritus of the Massachusetts Institute of Technology, chaired President Johnson's Science Advisory Committee and the Congressional Office of Technology Assessment. **Robert R. Wilson**, director emeritus of the Fermi National Laboratory and professor emeritus of physics at Cornell University, was the wartime head of the Research Division of Los Alamos National Laboratory.	

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	The Washington Post SUNDAY, APRIL 16, 1989 NUCLEAR CONTROL INSTITUTE OUTPOSTS *This week, following reports of Soviet cutbacks in production of weapon-grade uranium and plutonium, 11 American scientists propose a halt in U.S. production of all nuclear weapons materials—including tritium, a critical warhead component—while arms-reduction talks continue, without the need for any new reactors or any compromise in national security.* ATOMIC WEAPONS America's Non-Existent Nuclear 'Crisis' NEW PRODUCTION of tritium for U.S. nuclear weapons has been at a standstill since the spring of 1988, when the Department of Energy's reactors at the Savannah River plant were completely shut down as a result of safety concerns. Since those reactors are the sole source of supply of tritium for nuclear weapons, officials of the Departments of Defense and Energy and some members of Congress have stated that production must be resumed in at least one Savannah River reactor this year or our national security will be endangered; they view a longer halt as tantamount to "unilateral disarmament." This concern is based on tritium's relatively rapid radioactive decay, necessitating its regular replacement in warheads. DOE also has asked for over $300 million in FY 1990 to prepare for construction of two new production reactors with an estimated cost of $7.5 billion. The reactors, to be completed in 10 years, would supply 150 percent of DOE's perceived future tritium requirements for nuclear weapons. They also would be capable of producing weapon-grade plutonium. It is our considered view that there is no critical shortage of tritium today and that claims of an imminent "crisis" distort the true situation. Congress and the American people should not be stampeded into resurrecting the Savannah River reactors and building costly new reactors. Instead, the existing tritium supply should be put to more efficient use to meet the nation's military needs in the near-term and proposals for new production should be reevaluated. There are a number of important reasons to take this cautious approach. • Tritium, because of its decay rate, is a wasting asset; it makes no sense to produce more than is now needed or to fund facilities capable of producing very much more than will be needed. Plutonium, on the other hand, is long-lived and is in ample supply without new production to meet current weapons requirements. • Enough tritium exists in present inventory to sustain a fully adequate weapons stockpile, probably for at least five years without new production, if the possible effects of different management arrangements and the possible use of tritium from weapons scheduled for retirement or held in storage are taken into account. Congress needs to obtain complete information on these options from the Departments of Defense and Energy. • In view of the fact that the leaders of the United States and the Soviet Union have agreed in principle that their nuclear arsenals are much too large, a continuation of the present halt and a delay in proceeding with new production facilities would allow time to ascertain whether the ongoing Strategic Arms Reduction (START) Talks and other arms reduction initiatives will result in significantly reduced tritium requirements. • If prospects for a START agreement are realized, there would be an opportunity to reassess the need for new tritium production capacity and to take advantage of substantial reductions in the size and cost of new facilities if they are required. • If it turns out that these arms-reduction opportunities will not be realized, and a new production reactor is eventually needed, plans of the kind currently proposed could be resurrected. The delay of a few years entailed by this approach would not erode the nuclear-deterrent power the nation now possesses, nor pose any other risk to national security. It should be understood that with a stockpile of over 20,000 nuclear warheads, any reference to a "crisis" in tritium supply is quite inappropriate. • We believe a new production reactor can be built in five years, rather than 10, once planning activities are completed. A great deal more is known now about reactor design and safety than was known in the 1950s, and much time and money can be saved if construction proceeds efficiently after thorough planning and safety and environmental review. • The nation is now faced with strict limitations on federal spending because of the imperative to cut the budget deficit. Very large sums will be required to upgrade elements of the weapons-production complex to achieve improvements in safety, pollution control and efficiency, as well as to proceed with the necessary cleanup of environmental pollution resulting from 40 years of past operations. Monies now being requested for the construction of new production capacity should be applied, for at least the next few years, to such other purposes. **Maintaining the Arsenal** Tritium, a man-made radioactive isotope of hydrogen, is an essential element in modern, "boosted" nuclear warheads. The fusion of a few grams of tritium with a naturally occurring hydrogen isotope called deuterium provides a burst of neutrons at the crucial moment to amplify ("boost") the yield in fission weapons or in the fission triggers of thermonuclear weapons. Boosted warheads thus weigh less, are more compact and efficient and have lower cost. We are heavily dependent on boosting, and the Soviets use it as well. Because tritium decays at a rate of 5.5 percent annually (it has a half-life of 12.5 years), the tritium "reservoirs" of U.S. nuclear warheads must be refilled regularly to maintain the weap-	

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ons' explosive yield. The reservoirs are filled initially with a supply of tritium in excess of what is needed for the weapon to operate properly. When the excess runs down, the reservoir is exchanged for a new one. The surviving tritium in the old reservoir is recovered, purified and recycled. Tritium replenishment cycles vary for different types of warheads: It has been reported that weapons currently in the stockpile have a four- to six-year cycle, whereas the new generation of submarine-launched missiles may be charged for 10 years or more.

Provided that the essential minimum amount of tritium remains in the weapon system, it will still produce the certified yield. The size of the charge determines only the length of time the weapon may remain in the field. To provide a six-year service life after a fresh filling, the tritium loading must have an excess of at least 40 percent over the minimum amount. An eight-year service life requires an excess of 57 percent; 10 years requires approximately 75 percent above the minimum.

A Crisis Mentality

In testimony before the Senate Armed Services Committee, Troy E. Wade, DOE acting assistant secretary for defense programs, said it would be necessary to restart one Savannah River reactor by the end of the year, since by then the need for new tritium would become critical. Earlier, Robert B. Barker, assistant to the secretary of defense for atomic energy, was quoted as warning that delaying restart of the reactors would be tantamount to "unilateral nuclear disarmament." These assertions have led to expressions of congressional concern. Yet a recent internal Pentagon study, reported in The Boston Globe, concludes that there is an adequate supply of tritium for 18 months to two years with no alterations in resupply of weapons or any additional production.

There are a number of straightforward means that could be adopted to stretch out the period for which a given reserve supply of tritium would be adequate. The most obvious and immediately effective step would be to reconsider existing plans for tritium service life. Suppose, for example, that the current schedule calls for refilling a large number of weapons for a six-year service life. According to Troy Wade's testimony, there is only enough tritium on hand to continue the refilling operation for about one year. However, simply by changing to a three-year service life, for which the required excess in the filling is only 18 percent rather than 40, the required amount of additional tritium would be cut in half and the supply extended from one year to two years. For weapons with a service life longer than six years, the extension of inventory would be even greater.

These options would entail a doubling (or more) of the work load at facilities handling the refills. But the increase would take effect gradually and would not be difficult to prepare for. The increased number of reservoirs to be handled also would raise operating costs in the field. But this would be offset by the net savings realized from deferring new tritium production costs.

There are a number of other potential sources of tritium that could be used to avert a short-range tritium supply problem. Among these are: the 500 or so warheads to be withdrawn under the INF Treaty, along with the Pershing 1A missiles to be retired from Germany; the warheads from the Poseidon submarines retired since 1985, along with additional warheads from the two scheduled for retirement in 1989 to abide by the SALT limits; the bombs removed from the B52G bombers converted to conventional missions; some 400 enhanced radiation warheads now in storage (if their large tritium supplies have been kept intact); and the recovery of tritium from used heavy water moderators in storage at Savannah River. All these and similar sources should be exploited before it is concluded that there is any imminent "crisis."

Finally, it should be noted that if the present halt in tritium production were continued for an extended period, the weapons stockpile eventually would have to be reduced at a rate similar to the decrease in the amount of tritium on hand—that is, at the decay rate of about 5.5 percent a year. For about the first five years, such a reduction in weapons is roughly equivalent to the cuts that have been discussed in the START negotiations. Should negotiations continue beyond START with the objective of establishing a minimum effective nuclear deterrent, there would be no need to resume new tritium production for many years. In fact, the United States now has enough tritium in its 23,000 nuclear warheads to support a force of 6,000 strategic warheads for longer than 20 years and a force of 1,000 warheads for some 50 years.

But what if the START and other initiatives fail? As a worst-case scenario, suppose that the United States were to refrain from producing any tritium for five years and that at the end of that time there were no clear prospect of any arms-control agreement. We might then decide that it was essential to build up our nuclear arsenal. Would we then face a crisis in tritium supply?

No. Because even then, other sources would be available. During the non-production period, we presumably would have prepared at least one Savannah River reactor for restart. Operating even at half power, it could supply enough tritium to sustain the arsenal at its present level during the approximately five years required to complete a new production reactor. In the unlikely event that none of the remaining Savannah River reactors can be restarted safely, there are a number of other possible sources: The N reactor at Hanford, now undergoing renovation; the DOE test reactors in Idaho; and even the expedient of commercial power reactors, for which tritium target technology is now under development. Also, tritium might be acquired from France, Britain or possibly Canada.

Recommendations and Reality

Preparations now underway for construction of new production reactors should be deferred to allow Congress to become fully informed about the country's actual needs and to allow time for the START process to produce results.

The United States should not now resume production of nuclear weapon materials that are not needed and can serve only to further stimulate the arms race. Instead, it should move toward a mutual halt in the production of nuclear materials for weapons.

While the present halt in production remains in effect, the United States should consider offering not to restart the Savannah River reactors or to begin construction of new production reactors for a designated period of time to give the Soviet Union the opportunity to reciprocate. The two sides may be able to proceed to a mutual halt in production of tritium and fissionable materials for weapons by a series of reciprocal steps. A mutual production halt could be monitored by national technical means and on-site inspections, supplemented by international and bilateral safeguards on civilian reactors. Such a halt is possible in the context of a START agreement and agreements on deep cuts beyond START accompanied by verification of delivery systems and warheads destroyed and retained.

The United States and the Soviet Union should not let pass an extraordinary opportunity to achieve a mutual end to the production of nuclear materials for weapons. For its part, the United States can exercise restraint and turn the present production shutdown to advantage. It should not be stampeded into premature resumption of tritium production or construction of new production capacity. If we exercise restraint, the arms reduction process can flourish.

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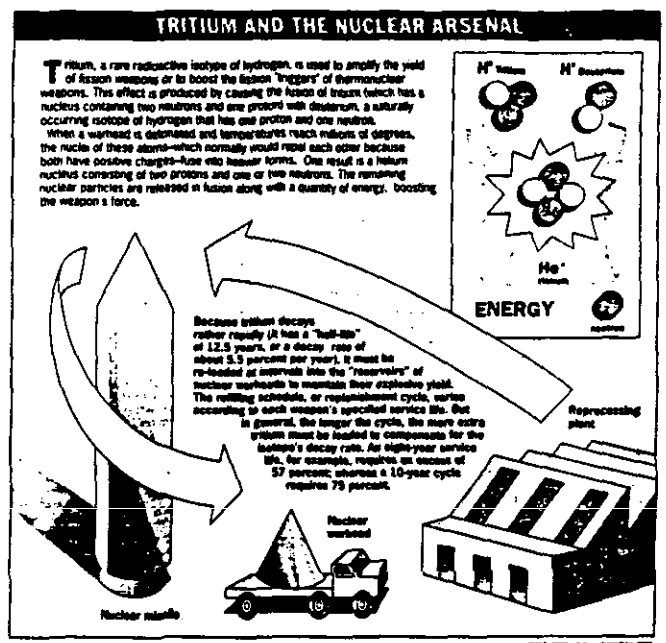

The Authors

The following scientists have signed the tritium policy paper, prepared in collaboration with the Nuclear Control Institute in Washington, from which the above article is adapted:

- Hans Bethe, a 1967 Nobel Prize winner in physics, formerly headed the theoretical-physics division at Los Alamos National Laboratory and is emeritus professor of physics at Cornell University.
- Freeman Dyson, professor of physics at Princeton's Institute for Advanced Study, has been a frequent consultant to the Defense Department and the U.S. Arms Control and Disarmament Agency (ACDA).
- Herman Feshbach, former chairman of the nuclear-science advisory committee of the National Science Foundation and former president of the American Physical Society and an American Academy of Arts and Sciences, is emeritus institute professor of physics at the Massachusetts Institute of Technology.
- Val Fitch, a 1980 Nobel Prize winner in physics and professor of physics at Princeton University, was a presidential advisor on science policy and arms control in the Nixon administration.
- Marvin Goldberger, former president of the California Institute of Technology and now director of Princeton's Institute for Advanced Study, chaired the committee on international security and arms control of the National Academy of Sciences.
- Kurt Gottfried, professor of physics and nuclear studies at Cornell, was an officer of the American Physical Society and a consultant to the Department of Energy's high-energy-physics advisory board.
- Milton Hoenig, a physicist and scientific director of the Nuclear Control Institute, was at ACDA during the Carter administration.
- Franklin Long, professor emeritus of chemistry at Cornell, was research supervisor of the National Defense Research Committee from 1942 to 1945 and assistant director of ACDA under President Kennedy.
- J. Carson Mark, former leader of the theoretical-physics division of Los Alamos National Laboratory, serves as a consultant to Los Alamos and other government agencies.
- George Rathjens, professor of political science at MIT, was chief scientist in the Defense Advanced Research Projects Agency and in the Office of Special Assistant to the President for Science and Technology.
- Victor Weisskopf, former group leader at Los Alamos National Laboratory and former director of CERN (the European Center for Nuclear Research), is emeritus institute professor of physics at MIT.

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Comment Number	Comment	Response
L-38	COMMENTS OF SALLY P. RICHARDSON 2341 Mars Hill Road Watkinsville, GA 30677 (404) 543-2881	
	June 16, 1990	
L-38-01	Dear Fellow Lover of what is clean & decent & beautiful: I & EVERYONE WITH WHOM I TALK IS STRONGLY OPPOSED TO THE RESTARTING OF THE SAVANNAH RIVER NUCLEAR REACTORS.THIS IS TRULY AN OBSCENE & DESTRUCTIVE WORK & EVERYONE NOT BLINDED BY FALSEHOOD FEELS THE TRUTH OF THIS IN HIS GUTS.WE ARE ONE HUMAN RACE & INDIVISIBLE ALSO FROM THE EARTH & NATURE. LET US BEGIN HEALING ALL WOUNDS WE HAVE INFLICTED UPON ONE ANOTHER. THANK YOU FOR READING.	Comments noted.
	S. P. Richardson	

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Comment Number	Comment	Response
L-39	COMMENTS OF REGINA B. MOODY 6223 Westshore Road Columbia, S.C. 29206 June 18, 1990 Mr. S.R.Wright, Director Environmental Division U.S.Department of Energy Savannah River Operations Office P.O. Box A Aiken, S.C. 29802 Dear Sir: As I sat in the Columbia audience at the June 5, 1990, public hearing on the draft EIS, I felt grateful that our laws demand such input from citizens ——both those highly informed about technical aspects and those who "merely" speak from the heart.	
L-39-01	I am one more South Carolinian who says PLEASE CONTINUE TO EXAMINE THE OPTIONS TO RESTART OF THE K-, L- and P- REACTORS AT THE SAVANNAH RIVER SITE. Please maintain these three aging reactors in cold standby and investigate alternative means of producing tritium. How can this country's defense needs not be reexamined in the light of East European political and social changes and the Soviet's nuclear arms initiatives? DOE MUST NOT OPERATE out of a January 1989, document on "defense preparedness!" This is an irrational basis for taking actions that are so clearly environmentally unsound. (And, I believe, also politically unnecessary.)	DOE has reexamined the options for the production of tritium in Section 1.2 of the Final EIS, in response to the new NWSM signed by President Bush on July 12, 1990. Also, please see the response to Comment L-02-01 on the need for tritium.
L-39-02	DOE MUST COMPLY WITH THE SAME ENVIRONMENTAL LEGISLATION THAT GOVERNS COMMERCIAL NUCLEAR POWER FACILITIES! Violation of state and federal water quality laws is unacceptable, for example. As a teacher in the public schools of South Carolina, I beg you to make decisions on the basis of a reasoned, honest appraisal of the data. THe Savannah River Site is operated with insufficient knowledge of the environmental and human health dangers. Clean up of the mistakes of the past forty years must be the priority! Do	In general, DOE is subject to the same environmental laws as commercial nuclear facilities. Also, please see the response to Comment L-05-03.

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L-39-03	not continue to heap wastes on top of wastes and expect the earth to heal itself with the inadequate help of human containment engineering. Who do you project will manage, operate, and GUARD this facility into the next century and beyond? When the present personnel retires, who are the bright, young minds who will give their lives and careers to the production of nuclear weapons? And if not the bright, young minds, then, will those of less ability and vision become the watchdogs? I have no confidence in the on-going competence of manpower this monstrous site requires. It is insanity to count indefinitely on a work force coming through South Carolina schools, arriving at adulthood, and submitting to the dangers of employment and living in the shadow of SRS. If you have indeed read this letter, thank you, and may you show wisdom and courage in your actions. Sincerely, Regina B. Moody	Please see the response to Comment L-06-02 on waste management and environmental restoration.

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Comment Number	Comment	Response
L-40	COMMENTS OF DAVID R. SCHUMACHER P O Box 41 Aiken SC 29802 Mr. S.R. Wright Director Environmental Division U.S. Department of Energy Savannah River Operations Office P.O. Box A Aiken, S.C. 29802 Dear Mr. Wright, I attended the DOE public hearing in Aiken, S.C. on June 8th Friday. I listened to the pros and cons for restarting the nuclear reactor. I could only stay for an hour due to preplanned family matters. While I was there many people voiced their opinions the mayor, the president of the Chamber of Commerce, a S.C. representative, a scientist from the plant, a city councilman and environmentalists I have no technical facts only beliefs from my heart.	
L-40-01	Many people believe we should have the weapons to deter any aggression. These people are needed to balance out the optimists like me. When the plant was first built here everyone had their beliefs and knowledge to make that decision. I am glad because the plant brought me many friends and neighbors I cherish dearly. Many years have passed and our beliefs and knowledge has expanded. Our enemy seems to change everyday. We have plenty of weapons to deter and even whip out the enemy and/or aggressor. I understand that these nuclear weapons will last through yours and my children and grandchildren. Why than do we need to stockpile more of these weapons?? The world seems to get smalller each day. Someone needs to extend their hand first let it be us.	The need for nuclear weapons is beyond the scope of this EIS.
	We rave about the United States technilogy being one of the tops in the world. I am sure it could be used to create new jobs and new forms of energy. I know everyone gives you their opinion and solution so I'll end it here.	

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Comment Number	Comment	Response
	Thanks for taking the time and hearing this guys heart. From a friend and hopefully parent and grandparent to be someday. Yours truly, David R. Schumacher c.c. President George Bush Tom Clements Southeastern Nuclear Campaigner	

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Comment Number	Comment	Response
L-41	COMMENTS OF JENNY KOENIG 651 Belgrave Lane Tucker, GA 30084 Director of Environment Division Mr. S.R. Wright U.S. Department of Energy Savannah River Operations Office P.O. Box A Aiken, SC 29802 June 15, 1990 Mr. Wright,	
L-41-01	I am writing to say that I want the Savannah River Plant closed. There is not only the absence of need for new reactors to be opened, but also the absence of need for the plant itself. Nuclear weapons can dystroy the earth on which we live, and there is no need for such creations to exist in today's world. The Cold War is over - we can rest easy that we are not under threat of hostile attack - we can stop the buildup of our nuclear arsenal.	Please see the responses to Comments L-02-01 on the need for tritium; Section 1.2 of the EIS has been revised to clarify that the NWSM, which is issued annually, considers changes in the world geopolitical situation.
L-41-02	The plant poses a serious health risk to the general population. Not only does it increase the hazards of nuclear annihilation, but the surrounding water is so full of radiation that the water is "dead" - there are no life forms existing. Cancer rates for the area are higher than in other areas.	Please see the responses to Comment L-02-02 on health risks. Also, please see Sections 4.1.1.2, 4.1.1.3, and 4.1.2.2 of the EIS.
	Please close the plant. In the spirit of peace, in the absence of need, and for the health of America's people. Please respond to my letter. Sincerely, Jenny Koenig Jenny Koenig 651 Belgrave Lane Tucker, GA 30084	

Table C-5. DOE Responses to Comments on Draft EIS

Comment Number	Comment	Response
L-42	COMMENTS OF CATHY BRADSHAW 206 Hurt Street N.E. Inman Park Atlanta, GA 30307 524-4190 June 16, 1990 Mr. S. R. Wright Director, Environmental Div U S DOE Savannah River Op Office P O Box A Aiken, SC 39802 Dear Mr Wright: I am very opposed to plans to restart the K-reactor at SRP.	
L-42-01	Please record me and my family of 4 of being in full opposition to these plans.	Comments noted.
	Sincerely, Catherine C Bradshaw	

Table C-5. DOE Responses to Comments on Draft EIS

Comment Number	Comment	Response
L-43	COMMENTS OF HENRY A. STONE 1880 Route 64 Ionia, NY 14475 6/2/90	
	Dear Mr. Wright,	
	I want you to know that as an American taxpayer and potential victim of nuclear war, I object most strongly to the reopening of the Savanah River reactor.	
L-43-01	I understand that the purpose of reopening the reactor is to "maintain the nuclear weapons stockpile." But what is the purpose of that? To prolong the Cold War? To further contaminate the aquifer with radioactive waste?	Please see the response to Comment L-15-01 on groundwater contamination.
L-43-02	We no longer need to build nuclear weapons. And we no longer want the risk to the environment.	Please see the response to Comment L-06-03 on environmental impacts. The need for nuclear weapons is beyond the scope of this EIS.
	Sincerely,	
	Henry A. Stone	

Table C-5. DOE Responses to Comments on Draft EIS

Comment Number	Comment	Response
L-44	COMMENTS OF FRANCES CLOSE HART ENERGY RESEARCH FOUNDATION 537 HARDEN STREET COLUMBIA, SOUTH CAROLINA 29205 June 20, 1990 Mr. Stephen R. Wright, Director Environmental Division US Department of Energy Savannah River Operations Office Post Office Box A Aiken, South Carolina 29802 Dear Mr. Wright, Please find enclosed comments of the draft Environmental Impact Statement for "Continued Operation of K-, L-, and P-Reactors" at Savannah River Plant. The comments are submitted on behalf of Energy Research Foundation and the Institute for Resource and Security Studies. I also enclose a copy of some comments which were sent to me anonymously. I thought they were good comments, so I am sending them to you officially and would like to have them considered as part of our comments on the draft. Thank you very much. Sincerely, Frances Close Hart	

Table C-5. DOE Responses to Comments on Draft EIS

Comment Number	Comment	Response
	[In addition to the responses to comments presented here, DOE has responded to the comments of Dr. Gordon R. Thompson in the responses to comments submitted at the hearing in Columbia, South Carolina, on June 5, 1990 (see Comment C-4). DOE also responds here to the "anonymous" comments submitted by Ms. Hart.	

Table C-5. DOE Responses to Comments on Draft EIS

Comment Number	Comment	Response

COMMENTS ON THE US DEPARTMENT OF ENERGY'S
MAY 1990 DRAFT EIS ON "CONTINUED OPERATION OF
K-, L-, AND P-REACTORS, SAVANNAH RIVER SITE"

Submitted by

Gordon R. Thompson

on behalf of

Institute for Resource and Security Studies, Cambridge, Massachusetts

and

Energy Research Foundation, Columbia, South Carolina

Comments completed: 18 June 1990

Institute for Resource and Security Studies
27 Ellsworth Avenue, Cambridge, Massachusetts 02139, USA
Phone: (617) 491-5177 *Fax:* (617) 491-6904

Table C-5. DOE Responses to Comments on Draft EIS

Comment Number	Comment	Response
	About These Comments	
	This document contains comments on a draft environmental impact statement (EIS) prepared by the US Department of Energy (DOE). Interim comments (verbal and written) by this author were offered at the DOE's public hearing in Columbia, South Carolina, on 5 June 1990.	
	These comments do not purport to be exhaustive. Thus, an absence of comment cannot be construed as an endorsement of relevant parts of the draft EIS.	
	About the Author	
	Dr. Gordon Thompson is a technical and policy analyst active in the areas of energy, the environment, international security, and sustainable society. He is currently the Executive Director of the Institute for Resource and Security Studies, Cambridge, Massachusetts.	
	About the Institute for Resource and Security Studies (IRSS)	
	The IRSS is an independent, non-profit Massachusetts corporation. It was founded in 1984 to conduct research and public education on the efficient use of resources, protection of the environment, and the furtherance of international peace and security. The institute currently has active programs on: the risks associated with nuclear power facilities; nuclear and conventional arms control; the restraint of nuclear weapons proliferation; and sustainable development.	
	Summary of Key Points	
L-44-01	* The draft EIS breaks a long-standing tradition of DOE and its predecessors, in that it admits the potential for a severe accident at a Savannah River reactor, possibly leading to many deaths and injuries (both onsite and offsite).	The comment is incorrect. The Final EIS on L-Reactor Operation (DOE/EIS-0108) identified the potential for severe accidents and risks to the public.
L-44-02	* Nevertheless, the draft EIS's findings as to the risk of such an accident are not reliable because: (i) they are based on unpublished and incomplete studies; (ii) there are inherent difficulties in probabilistic risk assessment; and (iii) they rely on assumptions which may lead to an under-estimation of accident risk.	DOE has responded to these assertions in the responses to Comments L-44-16 through L-44-18.

Table C-5. DOE Responses to Comments on Draft EIS

Comment Number		Comment	Response
L-44-03	*	DOE proposes to restart the reactors with known safety deficiencies; the draft EIS does not provide defensible arguments for this policy, either case-by-case or generally.	Please see the response to Comment L-05-02 on reactor safety.
L-44-04	*	The need for tritium and other materials is addressed only in a classified appendix, which appears not to adequately account for actual and potential reductions in the US nuclear arsenal; this unnecessary secrecy further prevents the public from judging if the risk of a reactor accident should be tolerated on "national security" grounds.	Please see the response to Comment L-02-01 on the need for tritium and the availability of Appendix A to those who meet security requirements.
L-44-05	*	There is no recognition of the possibility of a negotiated ban on production of plutonium for nuclear weapons.	Please see the response to Comment L-02-01 on Appendix A. The need for nuclear weapons is beyond the scope of this EIS. Please see the response to Comment L-44-37.
L-44-06	*	There is no analysis of the potential for systematically reducing accident risk by operating the reactors at low power and low fuel burnup.	One objective of an EIS is to bound the potential impacts of the proposed action; risks from operation at lower power levels would be smaller than those presented in the EIS. DOE has modified Section 4.1.3.1 on reactor accidents to state that these risks would be smaller than, and are bounded by, the risks of full-power operation. In addition, in Section 4.1.3.1.5 of the EIS, the subsections entitled Reduced-Power Operation and Multiple-Reactor Operation discuss reduced-power effects and the effects of multiple reactors. Also, Section 2.1.2.7 discusses low fuel burnup.
L-44-07	*	The option of placing the reactors on cold standby is inadequately addressed in the draft EIS, although that option may be able to simultaneously: (i) eliminate the risk of a reactor accident: (ii) meet "national security" objectives; and (iii) allow an orderly transition in the number of site employees.	The condition described is "cold shutdown," as defined in the EIS. DOE has revised Section 2.1 to clarify that options such as cold standby are included in the proposed action as needed to best meet the requirements established in the then-current NWSM.

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L-44-08	1. <u>Scope of These Comments</u> * These comments focus primarily upon the potential for adverse human health effects or environmental degradation arising from accidental releases of radioactivity from the SRS reactors. * That potential is affected by the mode of operation of the reactors, which is in turn affected by the need for tritium or other materials. * Thus, the public cannot give informed consent to the risk of reactor operation unless it is fully and accurately informed about: (i) the nature of the risk; (ii) alternative modes of reactor operation and their implications for risk; and (iii) the "national security" justification for materials production. * These comments address the extent to which the draft EIS provides such full and accurate information; in some instances the nature of the missing information is illustrated here by selected data or findings from other studies.	DOE addresses these comments in subsequent responses to this letter.
	2. <u>General Observations</u>	
L-44-09	* The title of the draft EIS refers to "continued operation" of the reactors, despite the long period of shutdown and the many ongoing plant changes; the title of the final EIS should refer to "resumed operation".	Please see the response to Comment L-05-01 on continued reactor operation.

Table C-5. DOE Responses to Comments on Draft EIS

Comment Number		Comment	Response
L-44-10	*	The draft EIS refers to many activities which are "planned for" or "scheduled for" completion before reactor restart; such statements are unacceptably vague, and could be construed as evasive.	DOE has revised Section 2.1.2 of the EIS to state which modifications will be completed before the resumption of production.
L-44-11	*	A National Research Council report (Meserve et al, 1987) recommended that DOE "revise its Orders so that they specify requirements clearly and establish deadlines"; the draft EIS provides no schedule for implementing that recommendation, promising only that "DOE will complete development of criteria" for Orders before reactor restart (see page 2-50 of: DOE, 1990).	DOE will complete the criteria development for Order revision, as stated in Section 2.1.3.1.1 of the EIS. In addition, DOE has established a program to ensure that the Operating Contractor complies with those DOE Orders necessary to the safe operation of the reactors.
L-44-12	*	The draft EIS is often poorly documented (eg, sections 4.5.4 and 4.5.5 of: DOE, 1990) or provides citations to other literature which is poorly documented (eg, Westinghouse, 1990).	DOE has amended Sections 4.5.4 and 4.5.5 to include specific references, which are available along with other references in the Public Reading Rooms. The citations are sufficient for members of the public to retrieve these references from the Public Reading Rooms.
	*	This inadequate level of documentation is probably related to DOE's common practice of hiding information from the public via unjustified classification or via abuse of the unclassified controlled nuclear information (UCNI) designation.	
	*	As a result of the above-mentioned deficiencies, and other deficiencies mentioned in these comments, the draft EIS does not provide information sufficient for the public to give informed consent to the risk of reactor operation.	
	3.	A Historical Perspective	
	*	The SRS reactors were built to resist the blast effects of nuclear attack, but originally had no confinement system whatever (Thompson, 1987).	
	*	In the early years, emergency procedures covered air raids and external radioactive contamination as well as reactor accidents (St. John et al, 1958).	
	*	The potential for a reactor accident which could lead to many offsite deaths was recognized in the early years, but this information was not published (St. John et al, 1958).	

Table C-5. DOE Responses to Comments on Draft EIS

Comment Number	Comment	Response
	* Filters were added to the reactor building ventilation system in 1960-61, and other safety improvements have been added over the years (see Exhibit 1); this indicates a growing awareness (within DOE and its predecessors) of the accident potential of these reactors.	
L-44-13	* DOE and its predecessors have for many years failed to fully inform the public about the reactors' accident potential; that omission is illustrated by DOE's May 1984 EIS for restart of L-reactor (DOE, 1984).	Please see the response to Comment L-44-01.
L-44-14	* The present draft EIS, although deficient in many respects, does publicly admit the potential for a severe reactor accident which leads to a substantial offsite release of radioactivity and, potentially, to many deaths and injuries.	Section 4.1.3.1.5 of the EIS presents the risks of severe reactor accidents.
L-44-15	* DOE's greater openness about accident potential comes at a time when the US nuclear arsenal is being reduced unilaterally or by negotiation; yet, DOE remains obsessively secretive about the need for tritium and other materials.	Please see the response to Comment L-02-01 on the need for tritium and classification of information.
	4. <u>DOE's Probabilistic Risk Assessment (PRA)</u>	
	* A PRA is being prepared for the SRS reactors and a draft Level 1 study has been submitted to DOE; completion of the Level 1 study is anticipated prior to restart, while completion of the Level 2 and Level 3 studies will occur after restart.	
L-44-16	* DOE has refused to publicly release the draft Level 1 PRA, thus precluding open, critical review of its methods and assumptions. * Although the PRA is incomplete and its draft is not publicly available, PRA-type risk estimates (Levels 1 through 3) are presented in the draft EIS, drawn from an almost undocumented report (Westinghouse, 1990). * Experience with application of PRA techniques to light-water reactors clearly shows the vital role of open publication and critical review in detecting faulty PRA assumptions and methodology; since the risk estimates in the draft EIS have not been subjected to this process, they cannot be regarded as reliable.	The Level-1 PRA has been completed and will be released to the public when the UCNI review has been completed. The Level-1 PRA has already undergone a peer review by groups of PRA experts, and will continue to undergo peer review for future revisions. Section 2.1.3.1.2 has been revised to discuss these groups. The Level-2 and -3 PRA, while not yet complete, did provide an adequate basis for the risk estimates contained in the Safety Information Document (SID).

Table C-5. DOE Responses to Comments on Draft EIS

Comment Number	Comment	Response
L-44-17	* There are inherent difficulties in conducting a nuclear reactor PRA; as a result, PRA findings are deficient in the following respects (Hirsch et al, 1989): (i) the uncertainty of the results tends to be grossly under-estimated; (ii) there is a tendency to systematically under-estimate the influence of those risk contributors which are accounted for; and (iii) a variety of risk contributors (such as sabotage) are not accounted for.	DOE acknowledges the uncertainties inherent in PRA analyses. However, the SRS PRA encompasses the best available estimates of uncertainty and is considered conservative (i.e., it does not "systemically under-estimate the influence of those risk contributors which are accounted for."). DOE has revised Section 4.1.3.1.5 to include a discussion on uncertainty. DOE agrees that PRAs generally do not quantify risk due to sabotage, nor does the SRS PRA. Sabotage is considered in the security contractor's safeguards and security programs. (See Section 2.1.5.)
L-44-18	* Findings from the PRA for the SRS reactors will be further limited in their reliability because: (i) this reactor type is unique; and (ii) there is a very limited base of operating experience (about 110 reactor-years) in comparison to that for commercial reactors (over 1400 reactor-years in the USA). 5. <u>Accident Risk According to the Draft EIS</u> * Risk estimates equivalent to PRA Level 3 are presented in the draft EIS; Exhibit 2 illustrates those estimates. * Exhibit 2 shows a probability of about 10^{-4} per reactor-year that a reactor accident will lead to 100 or more offsite cancer fatalities; this implies that, if 3 reactors are run for 10 years, the probability of such an outcome will be 0.3%.	The SRS Reactor PRA uses commercial reactor data (including human factors experience) if they are relevant; the SRS PRA benefits from the commonality of most of the systems in the SRS reactors. Commercial nuclear plants tend to be not of "standardized design," even those with reactors built by the same vendor. Thus, the 1,400 reactor-years cited are not necessarily applicable to the PRAs of all commercial nuclear plants.
L-44-19	* The type of presentation used in Exhibit 2 merges probabilities of a wide variety of types and does not show the many uncertainties involved; it is, therefore, misleading. * One factor heavily influencing risk estimates of the type shown in Exhibit 2 is the probability of a severe core damage accident; Exhibit 3 shows that just one PRA modification (use of a different earthquake assessment) could raise this probability by a factor of 4.	Combining probabilities of events of different types is a valid methodology; the individual event probabilities for all release categories are too voluminous to include in the EIS, but they are in the Safety Information Document which is referenced in the EIS as WSRC, 1990. Also, please see response to Comment L-44-17 on uncertainty.

Table C-5. DOE Responses to Comments on Draft EIS

Comment Number		Comment	Response
L-44-20	*	The draft EIS does not show an uncertainty range for its estimates of risk; Exhibit 4 illustrates this lack by showing the uncertainty range (itself questionable) in one estimate of core damage probability for the Peach Bottom commercial reactors.	DOE has rewritten Section 2.1.3.1.2 of the EIS to include the Level-1 PRA core damage frequencies and the range of uncertainty. DOE also has changed Section 4.1.3.1.5 to include a discussion on uncertainty.
L-44-21	*	Accident consequence estimates presented in the draft EIS assume that people could be evacuated from within a 20-mile radius of the affected reactor, starting 2-4 hours after a release begins, with an average evacuation speed of 1-2.5 mph (see Table 4-33 of: DOE, 1990); however, there is no current planning for such an extensive evacuation (see the emergency planning discussion at pp. 3-61 to 3-65 of: DOE, 1990).	DOE disagrees that there are no plans for an evacuation as used in the consequence assessment. Current emergency planning consists not only of plans at SRS, but also planning by the States. The assumptions used for the consequence assessment represent a reasonable, yet conservative, set of parameters. DOE has changed Section 4.1.3.1.5 of the EIS to include a discussion of evacuation speed and distance assumptions.
	*	There are about 48,000 people living within 20 miles of the site (see Exhibit 5) and several major communities within that distance or just beyond (see Exhibit 6); their rapid and complete evacuation may present substantial problems.	
L-44-22	*	The draft EIS should, but does not, show the geographic extent of potential human injury or environmental degradation resulting from a release of radioactivity; that extent is illustrated by computer-derived estimates shown in Exhibits 7 and 8 (a map of ground contamination from the Chernobyl accident is shown in Exhibit 9, for comparison).	Section 4.1.3.1.4 of the EIS presents the extent of potential human injury from radioactivity released from design-basis accidents in terms of median doses to hypothetical individuals at the SRS boundary, consistent with the approach to environmental analyses of accidents at commercial reactors. Section 4.1.3.1.5 presents the consequences for severe accidents in terms of risk of prompt and delayed fatalities to individuals and to the population within 500 miles of the SRS. Also, please see the response to Comment L-13-02 on Chernobyl.
L-44-23	*	Exhibits 7 and 8 were based on a hypothetical release of 50% of iodine and cesium isotopes; Exhibit 10 suggests that this assumption was reasonable, although it was challenged by DOE at the time (Webb, 1987).	As presented in the Safety Information Document (WSRC, 1990), which is referenced in the EIS, the eight release categories referred to in Exhibit 10 have a combined probability of less than 1×10^{-5}, or less than 5 percent of the total core damage probability. The corresponding releases have been included in the accident consequences reported in the EIS, weighted in accordance with their respective probabilities of occurrence.

Table C-5. DOE Responses to Comments on Draft EIS

Comment Number		Comment	Response
L-44-24	*	Draft EIS findings such as those shown in Exhibit 2 are based on old assumptions about the effects of low doses of radiation; use of contemporary assumptions (such as those provided in the BEIR V report) could increase estimated risk by a factor of more than 2 (see page 4-84 of: DOE, 1990.)	As noted in the Consequence Assessment subsection of Section 4.1.3.1.5 of the EIS, the MACCS estimates of latent cancer fatalities were adjusted up by a factor of 2.1.
L-44-25	*	The draft EIS does not account for a recently published study linking pre-conception paternal exposure to childhood leukemia (Gardner et al, 1990); this may be pertinent to risk arising from accidents at the SRS reactors or from routine site operations.	The cited study provides no basis for relating risks of childhood leukemia to potential preconception paternal radiation-worker exposures, either from accidents or routine SRS operations (see Section B.1.5).
L-44-26	*	The estimated low contribution of fires to severe core damage frequency (see Exhibit 3) arouses skepticism; for example one wonders if it accounts for sesmically induced fires (Prassinos, 1988).	The analysis of severe accidents induced by fire does not include the contribution of seismically induced fires. DOE does not believe that seismically induced fires would contribute significantly to the frequency or consequences of seismically induced severe accidents.
L-44-27	*	A Westinghouse review has said that SRS "will not be able to show compliance with the Title 10, CFR, Part 100 criteria using models and assumptions currently defined as acceptable practice in the commercial LWR field" (Westinghouse, 1989b); this statement needs to be reconciled with DBA dose projections in the draft EIS (see Table 4-23 of: DOE, 1990).	For any design-basis accident, the SRS reactors meet the requirements of 10 CFR 100.
	6.	Known Safety Deficiencies and Reactor Restart	
L-44-28	*	Secretary of Energy Watkins is reported to have said (State, 1989): "The fragility of the antique reactors at Savannah River is going to be hanging over our heads like the Sword of Damocles until the year 2005".	Please see the response to Comment L-05-02 on reactor safety.
	*	Notwithstanding the safety improvements shown in Exhibit 1, it is widely agreed that the reactors suffer from basic design weaknesses, aging problems, and a history of poor maintenance and operating standards.	
	*	Several reviews have identified and, to some extent, prioritized a wide variety of needed safety improvements; for example, a recent Westinghouse review recommended and	

Table C-5. DOE Responses to Comments on Draft EIS

Comment Number		Comment	Response
		prioritized 50 safety improvements, and provided limited qualitative arguments for each recommendation (Westinghouse, 1989b).	
L-44-29	*	The draft EIS describes safety improvements scheduled for completion before restart or subsequently; it does not provide coherent supporting arguments as to why these particular improvements have been selected or why some are to be deferred until after restart (see the vague discussion of safety philosophy at pp. 2-57 to 2-58 of: DOE, 1990).	Sections 2.1.2.8.2 and 2.1.3.2.1 of the EIS discuss the Restart Issue Management Plan (RIMP), which identifies issues that must be addressed before the resumption of production, including those identified in the Westinghouse Independent Safety Review; in addition, DOE has revised Section 2.1.2.7 to discuss the Reactor Safety Improvement Program (RSIP), which establishes priorities for items to be addressed after the resumption of production. Also, please see the response to Comment L-44-10.
	*	There is no stipulation as to which improvements must be completed prior to restart, and as to the schedule on which post-restart improvements must be implemented (see related comment under "General Observations"); without such stipulation, the EIS dos not provide the full and accurate information which the public interest demands.	
L-44-30	*	The SRS reactors, even after planned improvements, will not meet many relevant NRC standards for commercial reactors; a systematic comparison of SRS safety standards with those of the NRC should (but does not) appear in the draft EIS.	DOE uses or adapts many NRC standards for commercial light-water reactors if they are relevant to heavy water reactors. Sections 2.1.3.1.1 and 2.1.3.1.2 have been revised to reflect the DOE Orders containing these standards. A detailed comparison of these standards is not useful in an assessment of the environmental impacts of continued operation, because the impacts described in the EIS (Section 4.1) are based on the reactors as they are built and as they are operated to the DOE standards that have been applied.
L-44-31	*	The Defense Nuclear Facilities Safety Board has found that DOE standards relevant to health and safety issues are incomplete or otherwise inadequate (DNFSB, 1990a); apparently, most of these deficiencies will not be corrected prior to restart (see comment on DOE Orders under "General Observations").	DOE will complete the criteria development for Order revision, as stated in Section 2.1.3.1.1 of the EIS.
L-44-32	*	The Defense Nuclear Facilities Safety Board has recommended that DOE determine and specify standards for training of plant operators and supervisors (DNFSB, 1990b); DOE's response to those recommendations makes it clear that important training deficiencies will not be rectified prior to restart (ERF, 1990).	Section 2.1.2.8 of the EIS describes the reactor operating organization and practices, including training requirements, which the DNFSB also reviewed. The Federal Register (55 FR 9487 and 55 FR 7022) has published the DNFSB recommendations.

Table C-5. DOE Responses to Comments on Draft EIS

Comment Number	Comment	Response
L-44-33	* Reactor operation has traditionally been a low-status occupation at the SRS, although in some respects the expectations for performance of SRS reactor operators exceed those for commercial reactor operators (Westinghouse, 1989b). * The slow rate of progress of operator training is illustrated by Westinghouse's recent introduction of "a program to ensure all reactor operators possess requisite reading comprehension skills" (Kaspar, 1990).	Section 2.1.2.8.3 of the EIS describes the upgrading of operating practices, including training program development and implementation.
L-44-34	* As an illustration of DOE's incoherent policy on safety modifications, the addition of fourth emergency cooling system line will mean that "the existing flood control capacity of the reactor building sump pumps could be marginal" (see page 2-30 of: DOE, 1990); yet, upgrading of the sump pump capability will be deferred until after restart, in contravention of a previous Westinghouse recommendation (Westinghouse, 1989b).	The earlier recommendation was to ensure adequate and reliable sump pump operation considering credible break sizes and ECS flow requirements, and is a requirement before the resumption of production. The long-term upgrade will ensure adequate and reliable sump pump operation after a design-basis LOCA, which is not considered credible.
	7. <u>The Need for Tritium and Other Materials</u>	
L-44-35	* Analysis of need appears in a classified appendix, thus precluding critical review of its assumptions and preventing the public from reaching an informed judgment about the "national security" justification for reactor restart. * Production of plutonium-238 is not vital to national security, and can employ other reactors (such as FFTF). * Long-term maintenance of a fixed nuclear arsenal would require tritium production sufficient to compensate for tritium decay; Exhibit 11 shows the rate of decay. * The US nuclear arsenal is becoming smaller, and this trend is likely to continue; its estimated size has shrunk from 22,500 weapons in mid-1989 (see Exhibit 12) to 20,750 weapons in mid-1990, a 7.8% decrease (Norris and Arkin, 1990). * The target list under the Single Integrated Operational Plan (SIOP) was reduced during the 1980s (see Exhibit 13); ongoing international developments can be expected to lead to further reductions. * Use of a fraction of the warheads in the US or Soviet nuclear arsenals would cause terrible damage, as shown in Exhibits 14	Please see the response to Comment L-02-01 on the need for tritium and other nuclear materials. The production of plutonium-238 in SRS reactors is a continuation of previous adjunct production activity at SRS, and the EIS considers it in that perspective. DOE can no longer support the use of FFTF as a testing facility for breeder reactor components, and examined the feasibility of producing plutonium-238 as a possible alternative function. As described in Section 2.4.4 of the EIS, the examination disclosed that plutonium-238 production at FFTF would (1) cost substantially more than at SRS for reactor operation and for the construction of facilities to extract and purify the product; (2) produce a product of lower purity than is possible at SRS; and (3) require a longer time to provide the quantities of material required. On this basis, FFTF is not considered to be a reasonable alternative for meeting the needs.

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Comment Number	Comment	Response
	and 15; incidentally, this damage could legitimately be considered to be a potential environmental impact arising from operation of the SRS reactors.	
	* The current US tritium inventory is apparently about 100kg, so that tritium production of about 5.6 kg per year would support a fixed arsenal; as shown in Exhibit 16, the full production capability of the three available SRS reactors substantially exceeds that amount.	
L-44-36	* The draft EIS claims that operation of all three SRS reactors is necessary; this strongly suggests that the EIS's classified need analysis fails to account for actual and potential reductions in the US nuclear arsenal.	Section 1.2 of the EIS discusses the need for reactor production capability and its responsiveness to the changing world geopolitical situation.
L-44-37	* The draft EIS does not recognize the possibility of a negotiated ban on production of plutonium for nuclear weapons, although such a ban would have implications which should be reflected in an EIS.	Any negotiated ban on plutonium for nuclear weapons would not affect the analysis in the EIS because there is no current requirement for such plutonium production by SRS reactors.
	8. Options for Reducing Accident Risk	
L-44-38	* The draft EIS contains a very limited discussion of some potential plant modifications which might reduce risk, but does not discuss risk-reducing options which affect the mode of reactor operation; this omission may be related to DOE's refusal to publicly discuss the need issue.	Please see the response to Comment L-44-06 on bounding impacts, reactor operating levels, and risks.
	* Sections 4.5.4 and 4.5.5 of the draft EIS illustrate its inadequate treatment of risk-reducing options; these sections are sketchy and undocumented (see related comment under "General Observations").	
L-44-39	* Risk-reducing options which affect the mode of reactor operation include: (i) operation at reduced power; (ii) driving fuel to a low burnup; and (iii) reducing capacity factor.	DOE agrees.
L-44-40	* As illustrated by Exhibit 16, use of options (i) and (iii) is compatible with producing tritium sufficient to maintain a fixed US nuclear arsenal.	Appendix A of the EIS discusses the production of tritium to meet the requirements of the current NWSM.

Table C-5. DOE Responses to Comments on Draft EIS

Comment Number	Comment	Response
L-44-41	* Low-power operation will, other factors being equal, somewhat reduce the probability of a severe accident by increasing safety margins; also, the quantity of iodine and other short-lived isotopes released during an accident will be roughly proportional to the power level, thus reducing onsite and offsite consequences.	DOE agrees. See Section 4.1.3.1.5 under Reduced Power Operation.
L-44-42	* If fuel is driven to a lower burnup, the quantity of cesium and other long-lived isotopes released during an accident will be reduced, thus reducing accident consequences; there will be some increase in operating costs.	DOE agrees.
L-44-43	* A reduced capacity factor would allow more opportunities for preventive maintenance, testing, and training, thus somewhat reducing the probability of a severe accident.	DOE agrees.
	9. The Cold Standby Option	
L-44-44	* The draft EIS provides a sketchy discussion of this option for one, two or three reactors (see pp 2-65 to 2-66 of: DOE, 1990).	Please see the response to Comment L-44-07 on cold shutdown.
	* That discussion proposes the immediate discontinuation of plant upgrades and the termination of most personnel, both at the reactors and at the associated fuel/target fabrication and reprocessing facilities.	
L-44-45	* On national security grounds, it could be considered more appropriate to complete all planned upgrades and to maintain a reduced but more than skeleton staff; this would allow a rapid resumption of operation should that prove necessary.	Because this state of readiness is bounded by the analysis presented in the EIS, it could be employed as appropriate in the changing world geopolitical situation.
	* Such a cold standby option could eliminate the risk of a reactor accident, while allowing tritium production to be resumed quickly whenever needed; in light of ongoing reductions in the US nuclear arsenal, it appears that this option could meet both the traditional "national security" objectives as well as the objective of protecting public health and safety.	
	* The drastic standby option outlined in the draft EIS would lead to the rapid loss (if all three reactors go to cold standby) of about 9,600 jobs, or about half the present SRS workforce (see page 2-65 of: DOE, 1990).	

Table C-5. DOE Responses to Comments on Draft EIS

Comment Number	Comment	Response
	* The more prudent cold standby option outlined here would lead to a more gradual and smaller reduction in the number of jobs; it may be possible to smooth the employment transition even further by transferring personnel to an accelerated program to clean up the site and decommission the C- and R-reactors.	
	* It may, in any case, not be wise for local communities to rely upon site employment continuing at the present level; in the Safety Analysis Report it is estimated that the SRS work force will decline to about 8,500 to 9,000 people in the mid-1990s (Westinghouse, 1989a).	
L-44-46	* DOE's failure to carefully consider the cold standby option is the most important deficiency in the draft EIS; that failure constitutes a neglect of DOE's responsibilities in terms of national security, public health and safety, environmental protection, and the economic well-being of local communities.	Please see the response to Comment L-44-45.

Table C-5. DOE Responses to Comments on Draft EIS

Comment Number	Comment	Response
	10. References	
	(Ball and Toth, 1990) Desmond Ball and Robert C. Toth, "Revising the SIOP: Taking War Fighting to Dangerous Extremes", **International Security**, Spring 1990, pp. 65-92.	
	(Church et al, 1983) John P. Church and 8 other authors, **Safety Analysis of Savannah River Production Reactor Operation** (Deleted Version), September 1983.	
	(Cochran et al, 1987) Thomas B. Cochran and 3 other authors, **US Nuclear Warhead Production**, Ballinger Publishing Company, 1987.	
	(Daugherty et al, 1986) William Daugherty and 2 other authors, "The Consequences of 'Limited' Nuclear Attacks on the United States", **International Security**, Spring 1986, pp. 3-45.	
	(DNFSB, 1990a) Defense Nuclear Facilities Safety Board, "[Recommendation 90-2]: DOE High Priority Defense Nuclear Facilities; Design, Construction, Operation and Decommissioning Standards", **Federal Register**, Volume 55, pp. 9487-9488.	
	(DNFSB, 1990b) Defense Nuclear Facilities Safety Board, "[Recommendation 90-1], Restart of K, L, and P Reactors at DOE Savannah River Site, Georgia", **Federal Register**, Volume 55, pp. 7022-7023.	
	(DOE, 1984) US Department of Energy, **Final Environmental Impact Statement, L-Reactor Operation, Savannah River Plant, Aiken, SC**, May 1984 (3 volumes).	
	(DOE, 1987) US Department of Energy, **Health and Environmental Consequences of the Chernobyl Nuclear Power Plant Accident**, DOE/ER-0332, June 1987.	
	(DOE, 1990) US Department of Energy, **Draft Environmental Impact Statement: Continued Operation of K-,L-, P-Reactors, Savannah River Site, Aiken, South Carolina**, DOE/EIS-0147D, May 1990.	

Table C-5. DOE Responses to Comments on Draft EIS

Comment Number	Comment	Response
	(ERF, 1990) Energy Research Foundation, Columbia, SC, and National Resources Defense Council, Washington, DC, comments submitted 14May 1990 on the Secretary of Energy's Response to: DNFSB, 1990b.	
	(Gardner et al, 1990) Martin J. Gardner, "Results of case-control study of leukemia and lymphoma among young people near Sellafield nuclear plant in West Cumbria", **British Medical Journal**, 17 February 1990, pp 423-429 (and companion paper at pp 429-434).	
	(Hirsch et al, 1989) H. Hirsch and 3 other authors, **IAEA Safety Targets and Probabilistic Risk Assessment, Greenpeace International**, August 1989.	
	(Kaspar, 1990) P.W. Kaspar, DOE Savannah River Operations Office, letter of 4 June 1990 to James S. Moore, President, Westinghouse Savannah River Company, regarding Westinghouse's award fee.	
	(Levi et al, 1987/88) Barbara G. Levi and 2 other authors, "Civilian Casualties from 'Limited' Nuclear Attacks on the Soviet Union", **International Security**, Winter 1987/88, pp. 168-189.	
	(Meserve et al, 1987) Richard A. Meserve et al, **Safety Issues at the Defense Production Reactors**, National Academy Press, 1987.	
	(NCI/AAAS, 1989) Nuclear Control Institute and American Academy of Arts and Sciences, **The Tritium Factor** (Proceedings of a workshop held in December 1988), published 1989.	
	(Norris and Arkin, 1989) Robert S. Norris and William M. Arkin (editors), "Nuclear Notebook", **Bulletin of the Atomic Scientists**, June 1989, pp. 48-49.	
	(Norris and Arkin, 1990) Robert S. Norris and William M. Arkin (editors), "Nuclear Notebook", **Bulletin of the Atomic Scientists**, June 1990, pp. 47-48.	

Table C-5. DOE Responses to Comments on Draft EIS

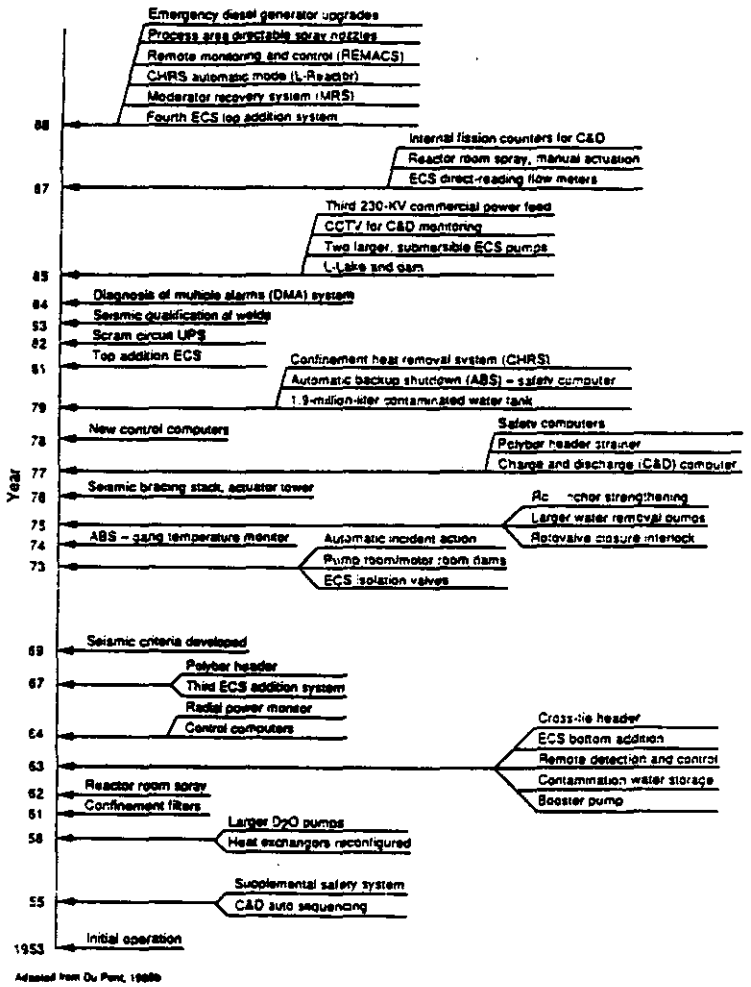
Comment Number	Comment	Response
	(NRC, 1989) US Nuclear Regulatory Commission, **Severe Accident Risks: An Assessment for Five US Nuclear Power Plants**, NUREG-1150 (Draft), 2 Volumes, June 1989.	
	(Prassinos, 1988) Peter G. Prassinos, **Evaluation of External Hazards to Nuclear Power Plants in the United States**, US Nuclear Regulatory Commission report NUREG/CR-5042 (Supplement 1), April 1988.	
	(St. John et al, 1958) D.S. St. John and 3 other authors, **Supplementary Reactor Safety Determination, Savannah River Plant**, DPST-58-101, January 1958 (Declassified, May 1987).	
	(State, 1989) "DOE director backs restart of reactors", **The State** (newspaper), Columbia, South Carolina, 26 August 1989.	
	(Thompson, 1987) Gordon Thompson, **Implications of Severe Reactor Accidents at the Savannah River Plant**, testimony to the County Council, Richland County, South Carolina, 27 January 1987.	
	(Webb, 1987) Robert C. Webb, DOE Savannah River Operations Office, letter of 12 June 1987 to Raymond E. McKay Jr, Chairman of Richland County Council, with enclosed comments on: Thompson, 1987.	
	(Westinghouse, 1989a) Westinghouse Savannah River Company, **Savannah River Site Production Reactor Safety Analysis Report, L Production Reactor**, 17 July 1989.	
	(Westinghouse, 1989b) W.H. Arnold et al, **Westinghouse Independent Safety Review of Savannah River Production Reactors**, 1 April 1989.	
	(Westinghouse, 1990) Westinghouse Savannah River Company, **Reactor Operation Safety Information Document (U)**,WSRC-RP-89-820, publicly released on 27 April 1990.	

Table C-5. DOE Responses to Comments on Draft EIS

Comment Number	Comment	Response

Exhibit 1

Source: DOE, 1990



Adapted from Du Pont, 1988b

Figure 4-3. Reactor Safety Milestones.

Table C-5. DOE Responses to Comments on Draft EIS

Comment Number	Comment	Response

Exhibit 2
Source: DOE, 1990

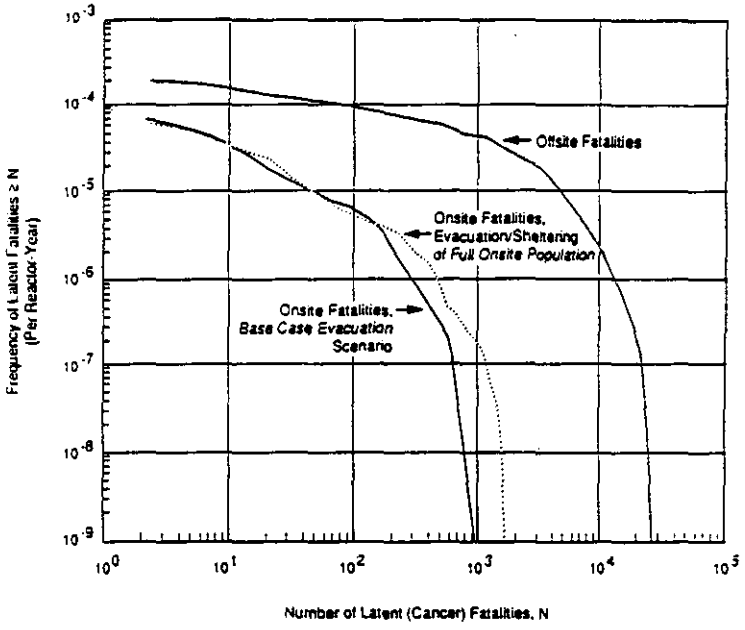


Figure 4-8. Frequency of Latent (Cancer) Fatalities Due to Severe Accidents.

Table C-5. DOE Responses to Comments on Draft EIS

Comment Number	Comment	Response

Exhibit 3

Estimated Probability of a Severe Core Damage Accident at a Savannah River Reactor (per reactor-year)

	Estimate[a] in Draft EIS	Possible Estimate[b] Using Livermore Earthquake Prediction
Internal Events	1.2×10^{-4}	1.2×10^{-4}
Earthquakes	6.8×10^{-5}	6.8×10^{-4}
Fires	1.4×10^{-7}	1.4×10^{-7}
TOTAL	2.0×10^{-4}	8.0×10^{-4}

Notes:

(a) Estimate from: Table 4-26 of DOE, 1990

(b) This estimate assumes that the use of an earthquake frequency assessment prepared at the Lawrence Livermore National Laboratory would increase the estimated probability of earthquake-induced sequences by a factor of 10, a possibility mentioned at page 2-60 of: DOE, 1990.

Table C-5. DOE Responses to Comments on Draft EIS

Comment Number	Comment	Response

Exhibit 4

Source: NRC, 1989

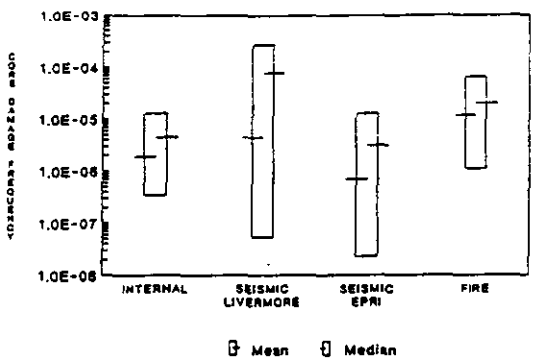


Figure 8.9 Peach Bottom external events, core damage frequency ranges (5th and 95th percentiles).

Table C-5. DOE Responses to Comments on Draft EIS

Comment Number	Comment	Response

Exhibit 5
Source: Westinghouse, 1989 a

SRS Production Reactor SAR

07/17/89

TABLE 2.1-9

POPULATION DISTRIBUTION WITHIN 50 MILES OF SITE
IN 1990
(BASED ON 1980 CENSUS)

Sector	Total Population	Miles from SRS Site 0-10	10-20	20-30	30-40	40-50
N	33,483	2	4,218	9,404	5,513	14,346
NNE	17,164	1	784	1,723	4,333	10,323
NE	24,172	0	4,970	3,174	5,451	10,577
ENE	59,253	2	1,290	6,570	5,807	45,584
E	30,154	1	8,580	7,215	8,904	5,459
ESE	9,627	38	1,894	2,212	2,692	2,791
SE	22,382	48	737	6,486	6,522	8,589
SSE	6,691	47	469	1,215	1,215	3,745
S	13,538	6	561	1,524	7,608	3,839
SSW	13,942	0	1,209	2,438	6,979	3,315
SW	8,583	0	1,055	2,104	2,316	3,108
WSW	19,789	0	986	8,281	1,682	8,840
W	20,552	68	731	8,777	2,886	8,090
WNW	169,999	318	2.502	117,626	39,191	10,362
NW	125,252	119	6.362	100,190	16,787	1,794
NNW	56,569	342	10.895	30,590	7,190	7,552
Total	631,155	992	47,243	309,529	125,076	148,315

Comment Number	Comment	Response

Exhibit 6
Source: Westinghouse, 1989a

SRS Production Reactor SAR

07/17/89

TABLE 2.1-7

URBAN CENTERS (POPULATION GREATER THAN 2,500) WITHIN 50 MILES OF THE SRS SITE, 1986 DATA

Population Center	County	State	Distance[a]	Sector	Population
Augusta[b]	Richmond	GA	25.0	WNW	45,440
Aiken	Aiken	SC	19.5	NNW	18,290
North Augusta	Aiken	SC	23.4	NW	16,290
Orangeburg	Orangeburg	SC	47.5	ENE	15,420
Waynesboro	Burke	GA	25.8	WSW	6,080
Barnwell	Barnwell	SC	16.4	ESE	5,960
Denmark	Bamberg	SC	28.9	E	4,460
Grovetown	Columbia	GA	34.2	WNW	4,320
Allendale	Allendale	SC	27.3	SE	4,220
Batesburg	Lexington	SC	43.3	N	4,120
Sylvania	Screven	GA	37.0	S	4,120
Bamberg	Bamberg	SC	35.2	E	3,740
Millen	Jenkens	GA	31.6	SW	3,660
Williston	Barnwell	SC	15.0	ENE	3,440
Hampton	Hampton	SC	41.3	SE	3,200
New Ellenton	Aiken	SC	9.4	NNW	3,170
Saluda	Saluda	SC	49.7	N	2,990
Blackville	Barnwell	SC	22.2	ENE	2,930
Louisville	Jefferson	GA	48.6	WSW	2,800
Edgefield	Edgefield	SC	38.8	NNW	2,740
Johnston	Edgefield	SC	38.9	NNW	2,650
Wrens	Jefferson	GA	43.8	W	2,540

(a) Approximate distance from the center of the SRS site to nearest edge of urban center.

(b) Central city of an urbanized area (Augusta, GA-SC, SMSA, which includes Columbia and Richmond counties in Georgia and Aiken County, SC; population, 327,372 in 1980).

Table C-5. DOE Responses to Comments on Draft EIS

Comment Number	Comment	Response

Exhibit 7

Source: Thompson, 1987

Potential Area Where Thyroid Inhalation Dose Would Exceed 100 rem Following a Severe Accident at an SRP Reactor

(50% release of iodine isotopes, class D atmospheric stability)

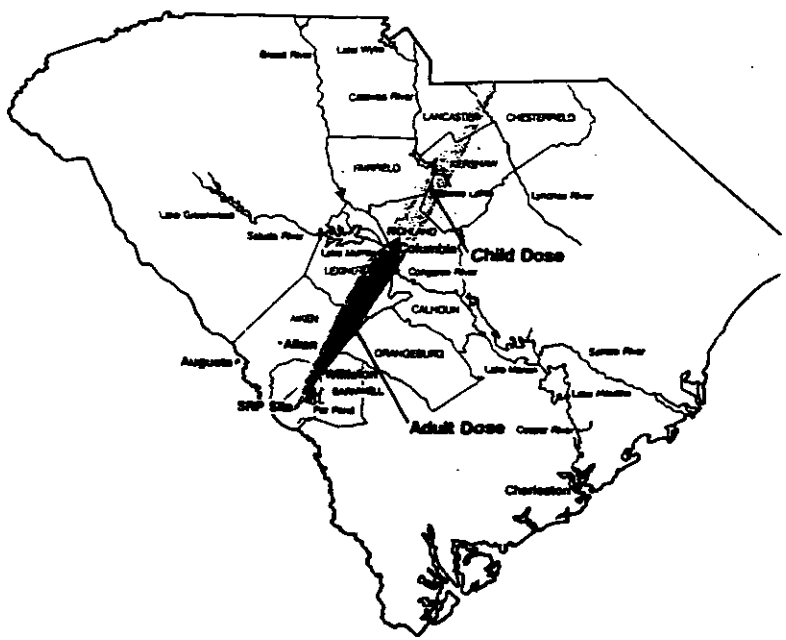


Table C-5. DOE Responses to Comments on Draft EIS

Comment Number	Comment	Response

Exhibit 8

Source: Thompson, 1987

Potential Area Where Whole Body Dose from Land Contamination Would Exceed 10 rem over 30 Years Following a Severe Accident at an SRP Reactor

(50% release of cesium isotopes, class D atmospheric stability)

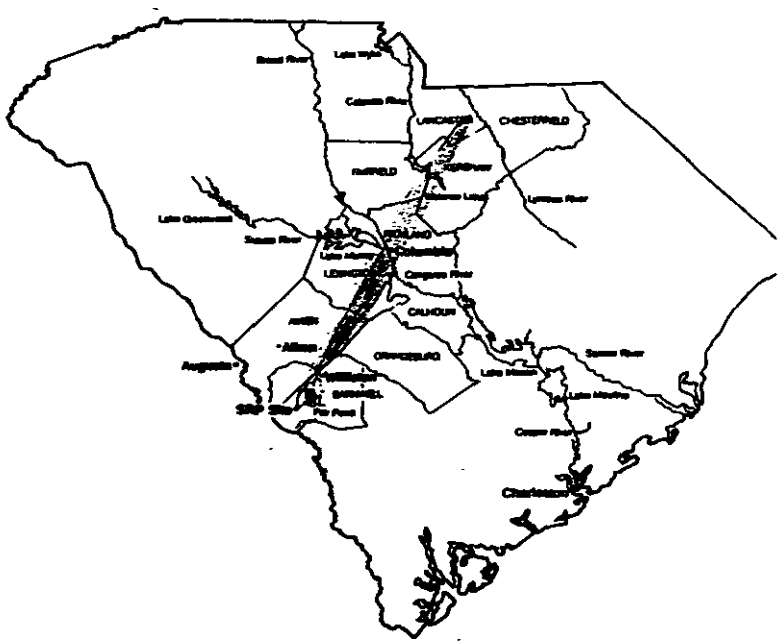


Table C-5. DOE Responses to Comments on Draft EIS

Comment Number	Comment	Response

Exhibit 9
Source: DOE, 1987

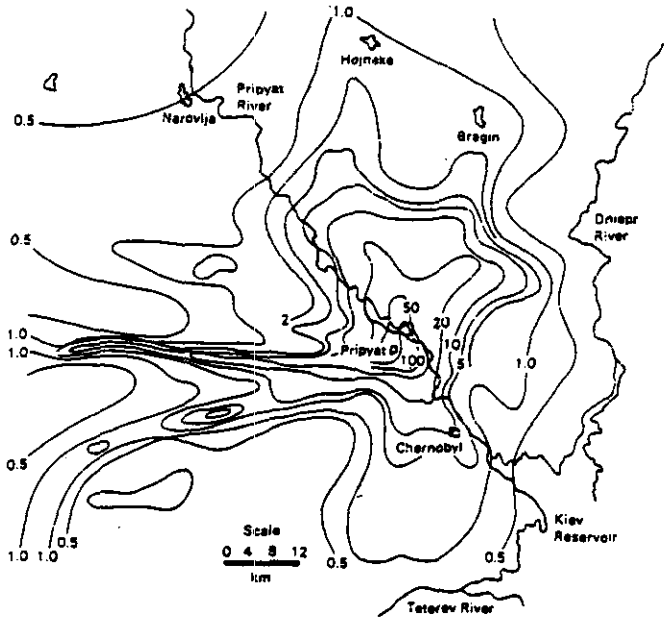


FIGURE 5.2. External Gamma-Exposure-Rate Levels (mR/hr) in the Vicinity of Chernobyl on May 29, 1986. Taken from USSR (1986).

Table C-5. DOE Responses to Comments on Draft EIS

Comment Number	Comment	Response

Exhibit 10

Estimated Iodine and Cesium Release Fractions for a Severe Accident at a Savannah River Reactor: Dominant Release Categories

Release Category	Iodine Release (%)	Cesium Release (%)
2b	99	71
4b	66	43
5	94	66
5a	94	66
10	74	45
10a	74	45
11	64	36
11a	64	36

Notes:

(a) Estimates are from: Table 4-32 of DOE, 1990.
(b) That source shows 26 release categories, representing 26 types of hypothetical accident.
(c) The 8 release categories shown here (the "dominant release categories") are those in which more than 1% of iodine and of cesium isotopes is released.
(d) Releases are the % of the core inventory of radioisotopes which is estimated to be released to the environment.

Table C-5. DOE Responses to Comments on Draft EIS

Comment Number	Comment	Response

Exhibit 11

Tritium Decay

* Half-life: 12.3 years
* Fraction decayed annually: 5.6 percent
* Fraction remaining after given decay period:

Decay Period (years)	Fraction Remaining
0	1.0
10	0.57
20	0.32
30	0.18
40	0.10
50	0.06

Table C-5. DOE Responses to Comments on Draft EIS

Comment Number	Comment	Response

Exhibit 12

Estimated US Nuclear Weapons Stockpile (June 1989)[a]

Inventory:

Weapon Type	Number of Weapons
Bombs:	6,800
Air-defense missiles:	400
Artillery and demolitions:	2,100
Antisubmarine weapons:	1,700
Intermediate and short range missiles:	1,500
Submarine-launched ballistic missiles:	5,500
Intercontinental ballistic missiles:	2,500
Cruise missiles:	2,200
TOTAL:	22,500[b]

Distribution:

(i) By Function:

* Strategic forces: 59 percent
* Tactical forces: 41 percent

(ii) By Service:

* Air Force: 44 percent
* Navy/Marines: 41 percent
* Army: 15 percent

Notes:
(a) Estimates are from: Norris and Arkin, 1989.
(b) Differs from sum of column due to rounding.

Table C-5. DOE Responses to Comments on Draft EIS

Comment Number	Comment	Response

Exhibit 13

Source: Ball and Toth, 1990

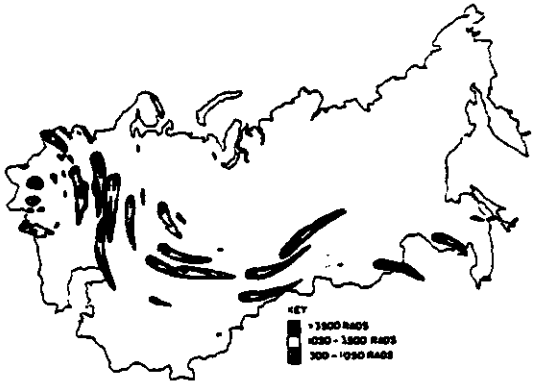
Table 1. The Evolution of the SIOP, 1960–88.		
SIOP-62	Approved by the Secretary of Defense in December 1960, and took effect January 15, 1961.	"Optimum mix" of counterforce and urban-industrial targets. No reserves, options, or withholds.
SIOP-63	Took effect August 1, 1962.	The "No-Cities" version of counterforce strategy. Four major attack options (MAOs), plus sub-options and withholds.
SIOP-5	Took effect January 1, 1976. Initial guidance provided by NSDM-242 (January 17, 1974) and NUWEP-1 (April 4, 1974).	Concept of "escalation control." 25,000 targets in the National Strategic Target Data Base (NSTDB) at the outset of SIOP-5. SIOP divided into Major Attack Options (MAOs), Selective Attack Options (SAOs), Limited Nuclear Options (LNOs), and Regional Nuclear Options (RNOs); and four target categories: Soviet nuclear forces, other military targets (OMT), Soviet leadership, and economic-industrial (E/I) targets. The latter category divided into economic recovery targets and war-supporting industry. Strategic Reserve Force.
	Nuclear Targeting Policy Review (NTPR), 1977–79.	
	PD-59, July 25, 1980, and NUWEP-80, October 1980, given effect in SIOP-5F, October 1, 1981.	50,000 targets in the NSTDB (including 25,000 OMT; 15,000 E/I; more than 5000 leadership; and 2500 strategic nuclear targets).
SIOP-6	Initial guidance provided by NSDD-13, October 1981, and NUWEP-82, July 1982. Took effect October 1, 1983.	Concept of "protracted nuclear war." Increasing emphasis on targeting Soviet leadership and relocatable targets through successive revision of SIOP-6. Elimination of the counter-recovery mission. Drastic culling of the NSTDB to 14,000 targets in 1987.
SIOP-6F	Initial guidance provided by NUWEP-87, October 1987. Guidance confirmed in NSM-12, June 1988. Took effect October 1, 1988.	Emphasis on destruction of the Soviet leadership (including prompt counter-leadership options) and relocatable targets (RTs). Development of "adaptive target planning."

Table C-5. DOE Responses to Comments on Draft EIS

Comment Number	Comment	Response

Exhibit 14
Source: Levi et al. 1987/88

FIGURE 2. Fallout Pattern
October Counterforce Attack on Soviet Strategic Nuclear Targets



Notes:

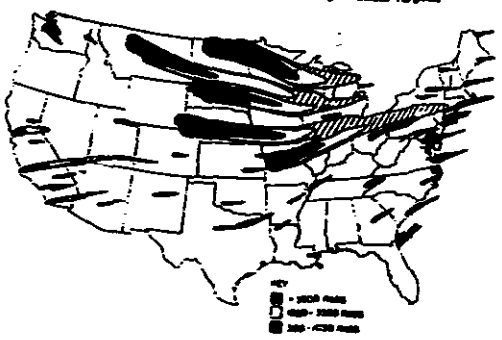
(a) The assumed attack involves the use of 4100 warheads on 1700 targets.
(b) These authors estimate that 15-32 million deaths would result from this attack, with 7-25 million additional injuries.

Table C-5. DOE Responses to Comments on Draft EIS

Comment Number	Comment	Response

Exhibit 25
Source: Daugherty et al, 1986

Figure 11 Fallout Patterns (February Attack on U.S. Strategic Nuclear Targets)



Notes:

(a) The assumed attack involves the use of 2800 warheads on 1200 targets.
(b) These authors estimate that 13-34 million deaths would result from this attack, with a total number of casualties of 25-64 million.

Table C-5. DOE Responses to Comments on Draft EIS

Comment Number	Comment	Response

Exhibit 16

Potential Tritium Production by Existing Savannah River Reactors

Assumptions:

* 1/80 g tritium produced per MW-day of thermal energy generated. (NCI/AAAS, 1989)
* Number of reactors available: 3
* Reactors dedicated to tritium production.
* Full power level per reactor: 2400 MW (thermal) (Church et al, 1983)
* Typical capacity factor when in full production: 80 percent (Cochran et al, 1987)

Potential Production:

(i) Full Production Capability
(Full power level, 80 percent capacity factor)

Tritium production: 26.3 kg/yr.

(ii) Reduced Capability
(1/3 of full power level, 50 percent capacity factor)

Tritium Production: 5.5 kg/yr.

Table C-5. DOE Responses to Comments on Draft EIS

Comment Number	Comment	Response
	ANONYMOUS COMMENTS	
	EIS FOR THE CONTINUED OPERATION OF THE K, L, AND P-REACTORS AT SRS	
	EIS SCOPE ISSUES	
L-44-47	The EIS clearly states that the continued operation of the SRS reactors requires the operation of fuel and target process facilities and that these facilities would not be needed if the reactors were not operated. Further, many of these facilities are of the same age as the reactors but have not been subject to the same level of independent review and upgrading prior to their restart. However, the EIS does not describe these facilities, their compliance status or accident risks nor does it discuss any alternatives to their continued operation. This is a major deficiency in the EIS since these facilities process radioactive and hazardous materials and are a source of significant environmental releases, dangerous wastes and potential accidents that could release toxic materials. Further, as discussed under "NEPA Process Issues" DOE's actions relative to the production of plutonium-238 raise serious questions about the credibility of the evaluation of alternatives in this EIS. Since the fuel and target process facilities are not discussed in any detail it is not possible for the public to judge whether DOE has adequately considered the reasonable alternatives.	Section 4.1.6 of the EIS describes the releases from these support facilities and their contributions to the cumulative effects of continued reactor operation. DOE will prepare an EIS that includes more detail on the environmental impacts of support facilities.
	NEPA PROCESS ISSUES	
	1. In a letter dated January 29, 1990 to Congressman Bevill, Chairman of the Subcommittee on Energy and Water Development, Secretary Watkins proposed to shutdown the FFTF reactor on April 1, 1990 and produce plutonium-238 at Savannah River rather than at the FFTF which is the only DOE reactor that was designed and constructed to meet modern safety and environmental standards. In this same letter the Secretary promised to "address" the production of plutonium-238 in the EIS for contined operation of the Savannah River reactors.	

Table C-5. DOE Responses to Comments on Draft EIS

Comment Number	Comment	Response
L-44-48	Based on this correspondence, it is clear that the decision to shut down the FFTF, which is an alternative to the production of plutonium-238 at Savannah River, was made before the EIS for the continued operation of the Savannah River reactors was even completed, much less published. This is a clear violation of the intent, if not the letter of the law since the purpose of NEPA is to assure a thorough public review of all reasonable alternatives and their environmental impacts before any major Federal action. Shut down of the only viable alternative is clearly a major Federal decision. Subsequent correspondence[1] and testimony[2] indicates that DOE is continuing to vigorously pursue this plan and fully intends to preclude the FFTF alternative for the production of plutonium-238. These actions by DOE demonstrate that the EIS, at least in this case, is intended to paper-over previous decisions rather than to present a fair evaluation of alternatives for public review before the decision is made.	DOE has examined the feasibility of using the FFTF as an alternative to the SRS reactors, as described in Section 2.4.
L-44-49	The evaluation of alternatives for the production of defense nuclear materials is classified and not included in the EIS. However, DOE's actions in the case of plutonium-238 production raise serious doubt about the validity of these evaluations which are not available for public review. Therefore, DOE is requested to provide for public review and comment a comprehensive unclassified version of their evaluation of alternatives for acquisition of defense nuclear materials including the environmental impacts associated with these alternatives. It is clearly possible to describe the capability, cost and environmental impacts of these various alternatives in an unclassified manner by reference to a unit or goal production capacity since DOE has frequently described the NPR options in this manner. TECHNICAL ISSUES 1. Safety and Environmental Standards - The EIS on page 2-49 casually mentions that "The NAS/NAE concluded that DOE needs to revise its Orders to specify clear requirements and deadlines for implementation." It then goes on to say that "Before resuming production DOE will complete development of critieria to ensure that Orders are consistent with the recognized attributes of clarity, prescriptiveness, uniformity, technical soundness, and timeliness." This is the ultimate in	Please see the response to Comment L-02-01 on Appendix A.

Table C-5. DOE Responses to Comments on Draft EIS

Comment Number	Comment	Response
	bureaucratic horse puckey. What's needed before the reactors are restarted are the real safety and environmental requirements DOE plans to use not the directions on how to write them! DOE has not told anywhere near the whole story about this problem in the EIS because their record clearly shows that there is no basis to believe that DOE will fix this critical problem in a timely manner. The real truth is that shortly after the accident at Chernobyl former Secretary Herrington asked the National Academies of Science and Engineering to provide an independent assessement of the safety of DOE's reactors. Their first report[4] addressed the safety of DOE's defense production reactors and raised serveral fundamental issues. Namely: - That DOE has not clearly specified the safety requirements to be imposed by its Departmental Orders, has not applied these Orders uniformly to its reactors and has failed to implement them in a timely manner, and - That DOE's safety oversight function was "ingrown" and did not make effective use of the knowledge available elsewhere in the nuclear community. This second issue was the impetus for DOE to create its ad hoc Advisory Committee for Nuclear Facility Safety and Congress to establish permanent external oversight for DOE's defense nuclear facilities - the Defense Nuclear Facility Safety Board. While strengthening the safety oversight of DOE's reactors has been a step in the right direction - today, more than four years after Chernobyl DOE has still not clearly specified the safety requirements to be applied. The failure to resolve this problem is not because the external oversight has been timid in pointing out the need to correct the situation. Quite the contrary is true. There have been repeated, unambiguous recommendations to promptly fix this problem by three different external review boards. For example:	

Table C-5. DOE Responses to Comments on Draft EIS

Comment Number	Comment	Response
	- The lack of clear standards was the very first item addressed by the National Academies of Science and Engineering in the executive summary of their 1987 report. They stated "The stated safety objective for the defense production reactors is the achievement of a level of safety comparable to commerical power plants. However, the committee found a high degree of confusion both within DOE and among the contractor staff concerning the safety objective. The committee concludes that the Department has not clearly articulated, documented, or implemented any specific safety objective for its reactors. While the Committee does not criticize the objective of comparability per se, the Department's approach is so imprecise that it fails to provide a clear benchmark against which to determine whether comparability is being achieved." In regard to DOE Orders they said - "The committee recommends that the Department revise its Orders so that they specify requirements clearly and establish deadlines and budget funds for implementation." Note that EIS talks about preparing criteria to write new Orders but for the three years since this report DOE has ignored the recommendation to budget enough funds to fix the problem. In the body of the report the National Academies cite numerous examples such as "In several instances the requirement in an Order refers to an NRC or industry standard but is either so qualified or so ambiguous as to raise doubt as to whether the standard is actually applicable," and "DOE Order 5480.4 specifically addresses the question of standards. It identifies five sets of industry codes as mandatory environment, safety and health standards that DOE contractors are required to meet as a matter of policy, but only if and when DOE determines that their application would increase safety. The committee could find no formal documentation that such a finding had ever been made." A year later DOE's Advisory Committee on Nuclear Facility Safety was requested to review the plans for restarting the Savannah River Reactors. Again they found that safety criteria had not been clearly specified.	

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L-44-53	4. Resolution of Open Safety Issues - The EIS discusses safety issues raised by the ACNFS and NAS/NAE and the creation of the Restart Issue Management Program to track the resolution of open safety issues. However, there is no mention of issues raised by the DNFSB created by Section 312(5) of Public Law 100-456. Because the assessment of risk to the public is critically dependent on how these issues are resolved and which are still unresolved at restart, the EIS must include a complete list of all these issues with an explanation of each and evidence that the organization who raised the issue has accepted the resolution or concurs that resolution can be deferred. Further DOE should not be permitted to restart any of the reactors until the Defense Nuclear Facility Safety Board (DNFSB) has reported to Congress that: - Their open issues with respect to reactor operator training at SRS are resolved. - The safety standards to be applied are clearly defined and documented, compliance with these standards has been independently verified to their satisfaction and any deviations from NRC's accepted practice under these standards has been reviewed and accepted by the DNFSB. - They have reviewed and accepted the conclusions of the RIMP Issue Management Committee (page 2-38 of the EIS) which detemines which modifications must be implemented before restart and which can be deferred until later. - Other issues that may have been identified as a result of their reviews of the SRS reactors have been resolved to their satisfaction.	Please see the response to Comment L-05-02 on safety oversight.
L-44-54	5. Configuration Verification - On page 2-59 the EIS mentions the ACNFS concern that the use of a small sample might not identify the problems. DOE's response is that plant lineups and startup tests will verify status and system functions before startup. This is a totally inadequate response. Plant lineups and startup tests check only the active functions of active components. They do nothing to verify the passive safety functions which are equally or more important and can only be verified through extensive inspections and quality control	DOE has changed Section 2.1.3.2.1 of the EIS to address the ACNFS concern on configuration verification.

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	records. For example, testing may detect a fuse that is undersized if it blows but never an over size fuse that could cause failure of a safety related piece of equipment. Electrical separation, fire barriers, special seals required to protect essential equipment from harsh environments during an accident and many other passive safety features will not be checked by "plant lineups and startup tests". The ACNFS is right to be concerned about this issue. DOE should not be allowed to use "small samples" to verify such complex, diverse and critical safety features. If sampling is to be used to verify the configuration of features that are not covered by startup tests detailed sampling plans based on valid statistical concepts and random sampling in homogenous populations with pre-specified inspection attributes and acceptance criteria must be implemented. Further, such sampling plans must be reviewed and accepted by the DNFSB.	
6.	Exposure to the Public from Reactor Accidents - The EIS states (page 4-70 in Table 4-23) that the maximum probable 2 hour whole-body dose to a person at the SRS boundary from the design basis accident (DBA) is 2.2 rem and that the maximum probable 2-hour thyroid dose is 0.75 rem. The obvious implication is that these values are well within the NRC limits of 25 rem whole-body dose and 300 rem thyroid dose as specified in Title 10, CFR, Part 100. However, the Westinghouse Independent Safety Review (WISR) of the Savannah River production reactors[3] states on page 31: "The available analyses indicate that the whole body-dose criterion (25 rem in two hours) is exceeded by a factor of 9 and the thyroid-dose criterion (300 rem in two hours) is exceeded by a factor of greater than 3. Independent analyses have confirmed that these numbers are approximately correct. These analyses also indicate that compliance with the thyroid-dose limits can be shown, using assumptions and models at the limits of those currently acceptable. However, compliance with the whole-body dose criterion cannot be shown using any combination of assumptions and models within the intent of Title 10, CFR, Part 100. A factor of approximately 3 still remains	

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	between acceptable exposures and the lowest values calculated because of the inability of the confinement to retain noble gases. Thus, it is the subcommittee's finding that SRP will not be able to show compliance with Title 10, CFR, Part 100 criteria using models and assumptions currently defined as acceptable practice in the commercial LWR field."	
L-44-55	It is obvious from the findings of the WISR subcommitte that DOE has used much less conservative models and assumptions to produce results that appear to comply with Title 10, CFR, Part 100. The difference is a reduction by a factor of 34 for the whole-body dose and 3600 for thyroid dose. Further, the results are presented in a manner that may have been intended to lead the reader to draw an erroneous conclusion with respect to compliance with Title 10, CFR, Part 100. If this were not the case why are the industry standard yardsticks of whole-body and thyroid dose used throughout the report without any discussion of the differences in the models or assumptions used? While DOE is not responsible for the conclusions drawn by others, they must be held accountable to present the risks to the public in a clear, unabmiguous manner that can be readily compared with well established standards. There is a very fine line between deceit and presenting complex information in a manner that is likely to lead even a knowledgeable reviewer to draw the wrong conclusion. In this case DOE appears to have crossed that line which casts serious doubt about the credibility of other technically complex information in the EIS. This is unacceptable and must be corrected.	As described in Section 4.1.3.1.4 of the EIS, the consequences of design-basis accidents are analyzed to determine the most probable accident consequences, using the same NRC models and assumptions as those used in accident analyses in the environmental reports and impact statements prepared for commercial nuclear powerplants. The environmental transport models and assumptions are those associated with expected or "typical" conditions that are intended to provide an estimate of the most probable or median accident consequences. These assumptions differ from the "maximizing" transport parameters selected in a Safety Analysis Report to assess the capability of a nuclear facility to meet the siting criteria of 10 CFR 100. Section 4.1.3.1.4 clearly identifies the dose consequences as "median," not as "maximum" values, and makes no comparison to the dose criteria of 10 CFR 100. Those criteria are applied appropriately to the design-basis accidents, as analyzed in the SAR, in accordance with DOE Orders.
L-44-56	7. Severe Accident Analysis - The EIS states in Table 5-1 on page 5-5 that the "median incremental probability of a latent cancer fatality to the hypothetical individual at the SRS boundary" for the DBA is 9×10^{-4}. It then states in the same table that there "are no significant health risks". However, in Table 4-37 on page 4-95 it states that the average cancer fatality rate in the U.S. is 2×10^{-3} per year. This implies that a DBA at the SRS would increase this individual's cancer risk by 45 percent which is very significant. The 9×10^{-4} cancer risk number doesn't appear anywhere else in the report so there is no way to check which is the correct conclusion.	Table S-1 and the Multiple-Reactor Operation subsection of Section 4.1.3.1.4 present the median hypothetical individual latent cancer risk of 0.0002 from a design-basis accident. Because this would be a one-time risk, the appropriate comparison is to the average lifetime risk of cancer mortality of 0.16, as presented in Section 4.1.7 of the EIS. Thus, the median design-basis accident risk represents an increase of about 0.6 percent in the hypothetical individual's lifetime risk of dying from cancer.

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L-44-57	The assessment of accident risks in the EIS relies heavily on Probabilistic Risk Assessments (PRA) yet the EIS says the PRA work will not be completed before restart (page 4-27). It says instead of the real PRA the results are based on a "special study" in reference WSRC 1990. If this "special study" is to be relied upon as the basis for the restart decision it should be reviewed and accepted by the DNFSB. What is the difference between it and the real PRA which is not done? How do we know the real PRA won't show the risks to be much larger? This is totally unacceptable.	The study performed for the EIS took Level-1 results (summarized in Section 4.1.3.1.5), analyzed the effects of upgrades and modifications on the core-damage frequency, and incorporated the current state of knowledge on Levels 2 and 3 to get estimates of reactor risk. The comparison of results shows the estimated decrease in core damage frequency due to upgrades and modifications. When the Level-2 and -3 PRA is completed, the expected results should indicate somewhat higher risk than those presented in the EIS because the PRA will not have accounted for upgrades and modifications, as explained in Section 4.1.3.1.5.
L-44-58	8. Fire Protection - The fire started by a candle at TVA's Browns Ferry plant demonstrated the inadequacies of the fire protection standards in existence at that time to assure the safety of nuclear reactors. As a result the NRC issued Appendix R to Title 10, CFR, Part 50 which required major modifications to all operating nuclear power plants. Title 10, CFR, Part 50.48 issued in November of 1980 set very strict schedules for implementation of these fire protection modifications. The starting point for these modifications was a fire hazards analysis which identified the vulnerabilities to fire and how critical equipment would be protected to assure safe shutdown of the reactor. Further, Title 10, CFR, Part 50.48 required "Those fire protection features that involve revisions to administrative controls, manpower changes and training, shall be implemented within 30 days after ... [November, 19, 1980]". The EIS talks about plans to do a fire hazards analysis and make a number of administrative and manpower changes that were required to be implemented 10 years ago on all commerical nuclear power plants. Further, there is no discussion about the schedule for implementation of many of the fire protection modifications or the extent to which these modifications will meet Appendix R requirements. This is totally inadequate. While it can be argued that some of the NRC requirements developed for LWR's are not applicable to the Savannah River reactors due to difference in design this is clearly not the	Section 2.1.2.3.1 of the EIS describes the fire protection upgrades. The estimated contribution to total core damage frequency from a fire is negligible, about 1.4×10^{-7} per reactor-year (see Section 4.1.3.2), or less than 0.1 percent of the total core damage frequency from severe accidents.

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	case for fire protection. As a minimum the EIS must include a detailed discussion of the compliance status with respect to Appendix R and the schedule for correction of those areas which do not comply. For example, on page 2-31 the EIS states that alternate safe shutdown panels to provide critical information following a fire will be installed at some time after restart. The NRC requires that these panels be capable of shutting down the reactor and keeping it cooled, not just monitoring it as it overheats. Further these panels must have isolation devices that can eliminate the adverse effects of electrical short circuits caused by the fire. This issue is far too important to the public health and safety to be covered with the few casual comments provided in this EIS.	
L-44-59	9. Cooling Water - The EIS provides a brief description of the cooling water supply and some modifications to enhance its reliability. However, there is no discussion of the extent to which the cooling water supply meets general design criteria #44, #45 and #46 in Appendix A of Title 10, CFR, part 50 or the ability to assure cooling under "station blackout" conditions. Since a reliable source of cooling water is such a critical feature to prevent and mitigate accidents more information must be provided to enable informed judgments about the risks involved in continued operation of these reactors.	The severe accident analysis in Section 4.1.3.1.5 of the EIS provides risk information that includes a failure of the cooling water system, as designed, under station blackout conditions.
L-44-60	10. Diesel Generators - The commercial nuclear industry has experienced great difficulty in maintaining the required high reliability of emergency diesel generators. As a result the NRC has established extensive requirements for initial and periodic testing of all emergency diesel generators. The EIS describes a number of modifications to improve the reliability of the diesel generators at Savannah River. However, there is no discussion of the testing and acceptance standards to be applied, the extent to which they differ from NRC standards and how they relate to the diesel generator availability assumed in the analysis of risks provided in the EIS. This is a major deficiency in the EIS since emergency electric power is so critical to accident prevention and mitigation.	DOE has considered the reliability of the diesel generators in the PRA. The EIS determines the radiological risks on and off the Site due to severe accidents. To determine these risks, best estimates for the reliability and availability of the two diesel generators are based on SRS experience with 35 unanticipated demands rather than 870 test demands, in which diesel performance is better due to advance preparation. Unavailability, which contributes less than 10 percent to failure to start, is not significant with regard to risk.
L-44-61	11. Purging of Basin Water - The EIS states on page 2-26 that "disassembly-basin water" is periodically purged through deionizer beds then discharged to a low-level seepage basin and that this process results in the release of approximately	The potential redirection of the processed disassembly-basin purge water from the current use of seepage basins to an NPDES-permitted outfall, as described in Section 4.1.2 of the EIS, is being

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	11,700 curies per year of tritium to the environment (Table 4-6 on page 4-26). DOE proposes on page 4-24 to increase these discharges almost 50% by discharging the purge water directly to surface water rather than to the seepage basin where the release is reduce by decay. DOE should either recover the tritium for use of at least provide hold-up for decay as is done now. Given the other risks with continued operation of the SRS reactors it is totally unacceptable to intentionally increase radioactive releases. Note that this proposed action by DOE requires an NPDES as discussed on page 2-26.	reevaluated in response to public comments to eliminate this source of groundwater contamination. As indicated in Section 4.1.2.3.5 of the EIS, continuing the use of the seepage basins would result in decreased public exposure to tritium. Section 4.5.3 of the EIS indicates that moderator detritiation cannot be justified on a dose-aversion basis, using NRC guidance on ALARA waste management practices (NRC Regulatory Guide 1.110).
L-44-62	12. Fabrication of Plutonium-238 Heat Sources - The EIS, on page 2-7, gives a very brief description of the process facilities at SRS that will also be operated as a result of this EIS. This section includes the statement "or further processing (e.g., plutonium-238 heat source fabrication)". However, neither the atmospheric or liquid release tables on pages 4-122 through 4-125 show any Pu-238 in the "Fabrication" column. Since Pu-238 has a very high specific activity and is quite toxic much more information is necessary about the facilities planned to be used for fabrication of these heat sources. When	The fabrication facilities listed in Tables 4-44 and 4-45 are the fuel and target fabrication processes in the 300-M Area, as noted in the footnotes to these tables. Plutonium-238 is processed in the 200-Area; the releases from the PuFF are included in the cited tables for that area. Section 4.1.6 describes the cumulative impacts.
L-44-63	were these facilities built? What has been their history of releases? Have there been any independent reviews of their safety? Do they meet the current safety and environmental standards? If not what modifications are needed, how much will it cost to achieve compliance and how does this effect the schedule that was stated on page 2-3 as the "primary" consideration is selecting SRS for this mission?	DOE is describing and evaluating the refurbishment of the PuFF in a separate environmental assessment; neither the refurbishment (with a 2-year schedule) nor the operation of this facility should have a significant impact. This document is currently in preparation (DOE Draft Environmental Assessment for Refurbishment and Operation of Plutonium-238 Non-Reactor Processing Facilities, Savannah River Site, June 1990).
L-44-64	13. Ultrasonic Inspection - Page 2-20 of the EIS implies that DOE is doing more ultrasonic inspections of the reactor vessels than required by Section XI of the ASME code. This would be true if DOE had been doing them from the beginning which they have not. The ASME code is based on a complete base line inspection before operations followed by periodic, partial inspections that result in 100% coverage every 10 years. The purpose of DOE's 5-year plan is to avoid doing the 100% base line inspection before restart. This is unacceptable.	DOE has revised Section 2.1.2.3.2 of the EIS to clarify the discussion of ultrasonic testing. Although the Section XI requirements are based on the existence of a preoperational baseline inspection, these requirements did not exist when the SRS reactor vessels were fabricated and installed.

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L-44-65	14. Positive Valve Position Indication - One of the pre-restart modifications described on page 2-29 is "confirming open or closed signals for essential ECS valves". The TMI accident was caused by valve whose signal indicated that it was closed when in fact it was stuck open. Positive valve position indication which gives the correct position even if the valve internals are stuck or broken is absolutely essential for all safety related valves. Just "confirming signals" is not enough as clearly demonstrated by TMI.	DOE has clarified Section 2.1.2.5.1 to indicate confirmation of valve signals (i.e., verification that the position matches the signal).
L-44-66	15. Reactor Building Flooding - Page 2-51 states that a fourth ECS line will be added to each reactor before restart to enhance reactor safety. However, page 2-30 states that as a result of this change the "existing flood control capacity of the reactor building sump pumps could be marginal". Adequate sump pump capacity is absolutely essential to avoid a severe accident due to a loss of circulation in the primary system. To solve the problem they just created DOE plans to increase the flood control capacity but not until some unspecified time after restart. This is totally unacceptable.	The addition of the fourth ECS line ensures cooling for a wider range of LOCAs and provides greater flexibility for ECS operation. Without the additional line, accident procedures call for operator action to throttle the ECS to match sump pump removal capacity. An evaluation is under way to determine if changes to this procedure are needed. The circumstances for exceeding current flood control capability are a double-ended guillotine break in a large process-water pipe, an actuation of all four ECS lines (normally only two would receive signals), a failure of the operator to recognize high flow and a failure to throttle ECS flow, and a failure of a sump pump. The probability of these combined events is sufficiently low to justify modifications to sump capacity in the long term.
L-44-67	16. Electrical Separation - Page 2-33 under miscellaneous upgrades to be done later states "the firing circuits for redundant supplementary safety system valves will be separated and isolated to achieve independence in the circuits". Achieving the required degree of protection and separation of safety circuits has been one of the most difficult and expensive areas for commercial nuclear power plants in complying with 10CFR50 Appendix R (fire protection). This undoubtedly is also a difficult compliance problem for plants as old as the SRS reactors. However, the entire safety analysis depends on eliminating common mode failures and fire is clearly a common mode threat unless safety circuits are adequately protected or separated. Whenever electrical separation problems are encountered in commercial reactors immediate action is taken to	The supplementary safety system has two separate trains of pumps and injection ports, and achieves separation because either train is sufficient. Separation of the valve firing circuits is an enhancement because the normal signal to the valve would have to fail to require actuation of the firing circuits.

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	fix the problem or shutdown until it is fixed. How can DOE plan to operate with known electrical separation problems in safety systems? How thoroughly have the safety related electrical systems been inspected for separation problems?	
L-44-68	17. Control Room Staffing - Page 2-38 states that at least one member of the shift supervisory team must have a science or engineering degree when starting up the reactor with an unirradiated charge. What about startups with irradiated charges? The problem that caused the current extended shutdown was a restart with an old, irradiated charge not a new, unirradiated core. There should be a degreed operator in the control room at all times. Doesn't DOE ever learn from its mistakes?	The sentence referred to in this comment also requires a degreed supervisor if the reactor contains heat-generating assemblies, i.e., irradiated charges.
L-44-69	18. Production of Plutonium-238 - On page 1-3 of the EIS DOE lists the amount of Pu-238 in inventory and the near term needs of several specific programs and concludes that the SRS reactors are "the only facilities capable of meeting these near-term needs". On page 2-3 the EIS states that the decision to use SRS for Pu-238 production was made "primarily because of schedule requirements". However, the EIS doesn't provide any information or even a reference related to the required Pu-238 delivery dates to meet the missions listed, the schedule for producing Pu-238 in the SRS reactors or the schedule analysis that led to the conclusion that the alternatives could not meet these requirements. This is unacceptable and must be corrected.	Please see the response to Comment L-48-30 on near-term mission schedules.

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	REFERENCES	
	1. DOE letter from James D. Watkins, Secretary of Energy to the Honorable Tom Bevill, Chairman, Subcommittee on Energy and Water Development, dated February 26, 1990	
	2. Testimony of William H. Young, Asst. Secretary for Nuclear Energy, USDOE before the House Subcommittee on Energy, Research and Development on March 7, 1990	
	3. Westinghouse Independent Safety Review of Savannah River Production Reactors, W. H. Arnold Chairman, dated April 1, 1989	
	4. "Safety Issues at the Defense Production Reactors", Commission of Engineering and Technical Systems, National Research Council, National Academy Press, 1987.	
	5. DNFSB letter from J. T. Conway, Chairman to J. D. Watkins, Secretary of Energy dated February, 22, 1990, Subject: Recommendations related to qualification standards for reactor operators.	
	6. DNFSB letter from J. T. Conway, Chairman to J. D. Watkins, Secretary of Energy dated March 8, 1990, Subject: Recommendations related to DOE Orders and the extent to which commerical standards are applied to DOE facilities.	

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L-45	COMMENTS OF ROBERT W. KING, JR. SOUTH CAROLINA DHEC 2600 BULL STREET COLUMBIA, SOUTH CAROLINA 29201 June 21, 1990 Mr. S. R. Wright Director, Environmental Division U.S.D.O.E. Savannah River Operations Office P.O. Box A Aiken, South Carolina 29802 Dear Mr. Wright: The following are comments concerning the Draft Environmental Impact Statement for Continued Operation of K, L, and P Reactors:	
L-45-01	1. The document does not address the result of the different order and schedules for restarting the K, L, and P Reactors. The effect of the thermal discharges of each reactor is different, i.e., K Reactor cooling tower will not be constructed until 1993 and possibility of fish kills at Parr Pond and L Lake. It should address which order and schedule for each reactor restart would have the least environmental impact.	The EIS presents all reactor-specific environmental impacts, including those for K-Reactor with and without a cooling tower. Appendix A (classified) analyzes the case of delaying K-Reactor until the cooling tower becomes operational. DOE has revised Sections 1.2 and 2.1 to clarify its intent to schedule production runs and outages of each reactor to meet the requirements established by the most recent NWSM.
L-45-02	2. It does not mention that the 316a for P Reactor is conditionally approved based on no fish kills. There is currently an enforcement order for SRS to mitigate fish kills during reactor operation. 3. Fuel and target assemblies are stored in a water-filled disassembly basin to permit decay of short-lived, unwanted radioactive products prior to shipment to the separations area. The assemblies are rinsed with light water and minimize tritiated heavy water contamination of the disassembly basins. "Discharge assemblies carry a thin liquid film from the reactor vessel that contains activated corrosion products, particulate activities,	A settlement agreement with SCDHEC on fish kills in the thermal discharges of L- and P-Reactors was executed on June 6, 1990. DOE submitted a report to SCDHEC on July 5 that discussed options DOE can pursue to mitigate fish kills. DOE has modified Section 4.5.6 of the EIS to provide information on measures to mitigate fish kills and a schedule of implementation after approval of these measures by SCDHEC. Section 4.1.1.4 has been revised to reflect these developments.

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	tritium, and other radioisotopes that can escape from irradiated assemblies. In the basin, assembly corrosion and component processing add to the contamination of the water." (Pg. 2-26). Disassembly-basin water is periodically purged to the seepage basins, where according to the SRS Environmental Report for 1988, WSRC-RP-89-59-1, seepage basin tritium concentrations range from 160,000 pCi/l to 290,000, pCi/l.	
L-45-03	A. DOE should investigate alternative options of surface decontamination of fuel and target assemblies prior to positioning in the disassembly basin to limit tritium contamination. B. DOE should evaluate component processing procedures in order to limit operator exposure and frequency of disassembly-basin water discharge. C. DOE should explore the feasibility of concentrating or treating tritiated disassembly-basin water to decrease effluent volumes. D. DOE should examine alternate disposal options for disassembly water effluent, i.e., solidification, or the feasibility of recycling filtered/processed basin water into the primary cooling system.	DOE has expanded Section 4.5.3 to include alternative surface decontamination methods for discharged assemblies and other abatement methods. Also, a comparison of doses from three options for handling disassembly-basin purge water has been added to Section 4.1.2.3.5. DOE regularly evaluates alternative component processing procedures to limit operator exposure (and hence the required frequency of basin-water purges) as part of its occupational ALARA program, which reexamines the potential for reduction of all worker radiation exposures. No technology is capable of "treating or concentrating" the minute quantities of tritiated water present in the disassembly-basin light water at costs that are close to reasonable. As discussed in the revised Section 4.5.3 of the EIS, a plant to detritiate the reactor moderator, which would be more cost-effective than treating the basin water, would cost an estimated 400 times the NRC guidelines for benefit-adjusted effluent reduction costs. Solidification would require the separation of tritiated water (which is not economically reasonable) before its incorporation in a solid matrix to avoid solidifying large volumes of ordinary water. Recycling processed light water from the disassembly basins into the heavy water reactor coolant is not an option. The only feasible options to the current method of discharging to seepage basins are direct discharge to surface waters and the evaporation of the purge water volume, with the direct release of tritium to the atmosphere, which has been added to Section 4.1.2 of

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		the EIS. Neither of these direct release options provides any period for tritium decay, as provided by the groundwater travel time.
	4. Section 4.1.2.2. Wastewater Discharges of Radioactivity of the referenced document suggests that the periodic discharge of deionized liquids to the reactor seepage basins would result in the migration of tritium and trace amounts of other radionuclides to groundwater. Pursuant to R.61-68.D.(5), the numeric standards for Class GB groundwater mixing zone is granted by the Department. To qualify for a mixing zone the facility will have to demonstrate to the Department the following: A. reasonable measures have been taken or binding commitments are made to minimize the addition of contaminants to groundwater and/or control the migration of contaminants in groundwater; and B. the groundwater in question is confined to the uppermost aquifer which has little or no potential of being an Underground Source of Drinking Water, and discharges or will discharge to surface waters without contravening the surface water standards set forth in this regulation; and C. the contaminant(s) in question occurs on the property of the applicant, and there is minimum possibility for groundwater withdrawals (present or future) to create drawdown such that contaminants would flow off-site; and D. the contaminants or combination of contaminants in question are not dangerously toxic, mobile, or persistent.	
L-45-04	The referenced document does not include sufficient technical data to facilitate evaluation for compliance with these requirements. If you have any questions concerning the above comments, please do not hesitate to contact me.	As indicated in Section 4.1.2 of the EIS, DOE is reevaluating the options for the current method of discharging disassembly-basin purge water to seepage basins. DOE will continue to discuss alternative disposal options for disassembly-basin purge water with SCDHEC and EPA Region IV.

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	Sincerely, Robert W. King, Jr. Assistant Deputy Commissioner Environmental Quality Control	

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L-46	COMMENTS OF DANNY L. JOHNSON SOUTH CAROLINA WATER RESOURCES COMMISSION 1201 MAIN STREET, SUITE 1100 COLUMBIA, S.C. 29201 June 22, 1990 Mr. S. R. Wright Director, Environmental Division U.S. Department of Energy Savannah River Operations Office P.O. Box A Aiken, South Carolina 29802 Dear Mr. Wright: Thank you for the opportunity to review the Draft Environmental Impact Statement on the "Continued Operation of K-, L-, and P-Reactors" at the Savannah River Site. We have comments specifically related to surface water usage and impacts to wetlands. Surface Water Usage The surface water comments are associated with Chapter 3 - Affected Environment, 3.1.2.4.2 Surface Water Hydrology, 3.1.2.4.2.1 Savannah River and Chapter 4 - Environmental Consequences, 4.1.1.2 Surface Water Usage.	
L-46-01	(1) SAIC (1989) was cited as computing the 7Q10 at Savannah River at Jackson to be 132.5 cubic meters per second (4680 cfs). In this cite, no support documentation was provided on the computation of the 7Q10 estimate. The South Carolina and Georgia Districts of the United States Geological Survey have also computed the 7Q10 of the Savannah River, both of which vary from the SAIC estimate. The South Carolina Water Resources Commission (Commission) has also estimated low flows for all South Carolina streams including the Savannah River. The Commission published Report No. 166, Magnitude and Frequency of Low Streamflows in South Carolina in June 1989, (copy enclosed) and estimated the 7Q10 to be 122.6 cubic meters	The SAIC document that was referenced in the DEIS and supplied the support documentation was placed in the public reading rooms.

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	per second (4330 cfs). This estimate was based on 15 years of data from 1973 through the 1987 climatic years (April 1 through March 31) using a Log-Boughton distribution. Through climatic year 1987, Savannah River at Augusta had 34 years of record and an estimated 7Q10 of 129.1 cubic meters per second (4560 cfs). Thus, the computed 7Q10 for the Savannah River at Jackson is less than the 7Q10 at Augusta which has a drainage area 290 square miles smaller than that at Jackson. This difference is believed to be due to the differences in the period of record between the two stations, primarily the short period of record at Jackson. Instead of using the Savannah River at Jackson gage, the Commission recommends that the Savannah River at Augusta gage be used in the computation of low flow estimates and scaling up the 7Q10 based on low-flow data from the intervening basin. Based on low-flow information available from the Commission and US Geological Survey in South Carolina, the 7Q10 runoff coefficients in the 290 square mile intervening basin range from 0.1 to 0.4 cfs per square mile. Assuming cross- correlation of 7Q10 conditions between the release from Lake Thurmond and the flow from the intervening basin, a 7Q10 could be computed. The Commission believes that the method used in Commission Report 166, referenced above, provides an improved estimate of the 7Q10 compared to the SAIC estimate. In any case, the Commission suggests that the method and period of record be stated which were used to compute the 7Q10. More importantly a standard method should be agreed upon for the uniform computation of low-flow statistics and that one number be used by those involved in regulating and managing the Savannah River. The Commission would be willing to assist in this matter if needed.	
L-46-02	(2) While the 7Q10 has relevance under NPDES permitting programs administered by the South Carolina Department of Health and Environmental Control, 7Q10 has limited application in regards to water withdrawal or supply. The Commission would recommend that the historical, minimum daily flow be used to determine the extent of effect of the cooling water withdrawal. Also important is the sequence of minimum consecutive day low flows. This information is available for the Savannah River	DOE agrees that the 7Q10 value is not the appropriate low-flow indicator for establishing the bounding effects on aquatic ecology that result from water withdrawals for reactor operation. DOE has revised Section 4.1.1.2 to base these effects on the minimum Savannah River flows required to enable pumping of cooling water for the operation of three and two reactors (138 and 117 cubic meters per

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	from the Commission and can be found in Commission Report No. 166. Prior to 1986, the minimum flow release from Lake Thurmond was 152.9 cubic meters per second (5,400 cfs). However, as a result of the extreme drought in the Savannah River basin from 1986 through 1989, and the lack of a drought managment plan by the USCOE, the new minimum flow became 102 cubic meters per second (3600 cfs). From January 1988 through June 1989, the minimum weekly average release from Lake Thurmond never exceeded 102 cubic meters per second (3600 cfs). The minimum daily flow and the entire family of low-flows is dependent upon the operation and releases by the USCOE from Lake Thurmond. Because of this fact, and the importance of the flow in the Savannah River for both cooling water for the reactors and other downstream uses, it is imperative that a workable operational model be used to mitigate adverse environmental impacts associated with drought. The implementation of the the Savannah River Basin Drought Contingency Plan of the USCOE in no way guarantees the minimum flow of 102 cubic meters per second (3600 cfs), just as the previous minimum of 152.9 cubic meters per second (5,400 cfs) could not be guaranteed in the drought of record. The future recurrence of such a severe drought following future growth and increased water demands of upstream consumptive water users will increase the effects of drought in the basin. The Commission is currently developing a basin-wide water budget and reservoir operation model. Completion of the model is anticipated during 1991. The model includes the upstream lakes of Jocassee, Keowee, Hartwell, Russell and Thurmond. The USCOE Savannah River Basin Drought contingency Plan considers only the operation of the three USCOE lakes. Further, the model under development by the Commission will include flow forecasting capability from the National Weather Service Extended Streamflow Prediction (ESP) model. The model will also use sophisticated operating rules to optimize multiobjective management in the basin, including hydropower production and water quality below Augusta. The model is being developed with the assistance of the Savannah River Basin Technical Advisory Committee which is	second, respectively). The historic minimum daily flow and the sequence of minimum daily flows were not considered in establishing the new basis for comparison because this flow is below that necessary to enable reactor operation.

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	comprised of federal agencies, state natural resource agencies from South Carolina and Georgia, public utilities and local units of government. Dr. Todd Crawford represents the SRS on this important committee. Further, the Integrated Environmental Management Conference held at USC Aiken last year supported the concept of such a model in managing the Savannah River Site. The Westinghouse-Savannah River Company has also been supportive of the Water Resources Forecasting Services (WARFS) Initiative of the National Weather Service to implement the ESP model in the Savannah River basin as a part of the Commission's model. These efforts speak to the importance of utilizing this model in the development of the final environmental impact statement for continued operation of the reactors.	
L-46-03	The Commission recommends that consideration be given to the utilization of the model in the development of any final environmental impact statement concerned with water withdrawals from the Savannah River for cooling of the K, L and P Reactors at the Savannah River Site. Further, a discussion of the use of such a model should be considered for inclusion in Chapter 4, Environmental Consequences, 4.1.3.2, Natural Phenomena Affecting Risk. In this section, no consideration is given to drought. Under such extended low-flow conditions as	DOE recognizes and supports the development of the model for the Savannah River basin, which is scheduled for completion during 1991. However, the model is not considered essential to the continued safe operation of the reactors because procedures for alerting reactor operators of impending low flow conditions and taking the appropriate actions at the pumphouse are already in effect.
L-46-04	those in 1988 and 1989, the withdrawal of 24 or 14.5 cubic meters per second would amount to 24 and 14 percent, of the minimum low-flow of 102 cubic meters per second (3600 cfs). Under such extrement low-flow conditions, an emergency contingency plan should be included in 4.1.3.2, Natural Phenomena Affecting Risk, in order to predict and mitigate adverse environmental impacts associated with the withdrawal.	Section 4.1.3.2 of the EIS describes those phenomena that might affect the likelihood or magnitude of reactor accidents. Low river flow could affect the impacts of normal operation on the river, or cause a shutdown of production operations due to the unavailability of cooling water, but that condition would not be a contributor to reactor accident risk. Section 4.1.1.2 of the EIS describes the impacts of low flow.
	Wetlands	
	(1) Extensive thermal and scouring damage to wetlands systems at the Savannah River Site is well documented. The Thermal Mitigation Study of 1984 estimates 900 acres in the Four Mile Creek areas, 400 acres in the Pen Branch area, and 400 acres in the Beaver Creek area have been impacted, for a total of 1700 acres. The Environmental Protection Agency estimated in 1986 that 1827 acres were impacted at C- and K- reactors as well as 382 acres at D-Area (Final EIS, Alternative Cooling Water	

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	Systems; October 1987). It is now widely recognized that wetland areas serve numerous beneficial functions including floodpeak reduction, water quality improvement, and wildlife habitat. Additionally, wetland loss of this scale might be expected to affect some local climate characteristics.	
L-46-05	EPA estimates that 1500 of the impacted acres can successfully regenerate at the C- and K- reactors as can a major percentage of the D-area. We recommend that compensatory mitigation be undertaken which would facilitate expected revegetation and replace the acreage not expected to regenerate. Mitigation should be based on replacement of functional values, should be in-kind and on-site whenever possible, and should have adequate long-term monitoring provisions. The above recommendations are in accord with the recommendations of the Governor's Freshwater Wetlands Forum. A copy of the Forum's Report is enclosed.	DOE has added a discussion of wetlands mitigation options to Section 4.5.
L-46-06	(2) If restart of the K-reactor is found to be necessary, we recommend that this action be postponed until the proposed cooling tower is functional and the facility is in compliance with the Clean Water Act and State Water Quality Standards. This step would appear to eliminate both thermal and scouring effects destructive to wetlands. Further, any compensatory mitigation plan for the site should address the expected loss of wetland function due to blowdown form the cooling tower.	Section 2.1 has been revised to clarify that DOE proposes to continue to operate K-, L-, and P-Reactors to meet the requirements established in the most recent NWSM. Also, please see the response to Comment L-45-01 on reactor startup schedule. No appreciable loss of previously unimpacted wetlands is expected to result from blowdown from this cooling tower. Section 4.1.1.6.2.1 of the EIS discusses wetlands impact from K-Reactor operation.
	Please contact me if you have any questions regarding these comments or if the Commission can assist in this important matter. Sincerely, Danny L. Johnson Director, Surface Water Division Doc: SRS-EIS Enclosure	

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L-47	COMMENTS OF STEVEN AFTERGOOD FEDERATION OF AMERICAN SCIENTISTS 307 MASSACHUSETTS AVENUE, N.E. WASHINGTON, D.C. 20002 (202) 546-3300	
	June 22, 1990	
	Mr. Stephen R. Wright, Director Environmental Division U.S. Department of Energy Savannah River Operations Office Post Office Box A Aiken, South Carolina 29802	
	RE: DEIS on Savannah River Site	
	Dear Mr. Wright:	
	I am writing with a comment on the Draft Environmental Impact Statement on "Continued Operation of K-, L-, and P-Reactors, Savannah River Site," (DOE/EIS-0147D).	
	I believe that the Statement of Need (Section 1.2) overstates the demand for plutonium-238. Specifically:	
L-47-01	a) NASA officials have indicated that the plutonium-238 fuel for the CRAF and Cassini missions has already been produced. Therefore the fuel requirements for these missions should not be cited as evidence of need for new production of additional Pu-238.	CRAF mission requirements will be met from existing inventory, after scrap material is reprocessed. The current inventory does not satisfy assay requirements for the Cassini mission. Newly produced material is required to raise the average assay level of available material to satisfy the thermal and electrical power requirements for the Cassini mission.
L-47-02	b) There are no other funded NASA missions that will require plutonium-238.	While no other funded NASA missions currently exist that will require plutonium-238, a number of NASA and DOD missions are in the conceptual design stage or are being considered for which plutonium-238-powered radioisotope thermoelectric generators will be the enabling or enhancing technology. DOE must take such user agency planning into account because

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		of the long lead time associated with the production of plutonium-238. The time required for target fabrication, irradiation, cooling, processing, and placing it in a usable form necessitates that a moderate amount of material be in inventory to meet the mission deployment schedules in advance of full mission funding. The inventory essentially will be depleted after production of the CRAF and Cassini mission power supplies. It is prudent material management to replenish and maintain a national strategic inventory of quality plutonium-238 to meet future mission requirements.
L-47-03	c) NASA officials have indicated that the CRAF mission may not require Pu-238 at all, and that solar power may suffice in this case.	NASA has provided requirements to the Nuclear Weapons Council for radioisotope thermoelectric generators, which include requirements for the CRAF mission, and DOE is proceeding to meet those requirements.
L-47-04	d) The "U.S. Navy mission" requiring Pu-238 was to require 21 kilograms of fuel, not 25.5 kilograms as stated on page 1-3, according to a conversation I had with a representative of the Nuclear Weapons Council.	The Navy mission material requirements reflected in the Draft EIS represents revised needs from those presented in the 1989 Nuclear Weapons Council report. The more recent Nuclear Weapons Council study (October 1990), which DOE references in Section 1.2 of the EIS, has revised these requirements to 22 kilograms.
L-47-05	e) The Navy would not confirm that this mission had been fully funded or that it was in fact going to proceed as planned. Therefore this mission should not be cited as evidence of need for additional Pu-238 production. A careful examination of the demands for new production of plutonium-238 asserted by the DEIS shows no verifiable requirement for more plutonium-238 than has already been produced. Therefore, the hazards associated with further production of plutonium-238 are not justified by any verifiable demand.	The Nuclear Weapons Council study of October 1990, which is referenced in Section 1.2 of the EIS, indicated that DOE should be prepared to provide plutonium-238 for the referenced Navy mission. While the timing and final decision on mission funding might or might not be resolved, DOE has received a formal request to ensure that material exists to meet the mission requirements; consequently, the material requirement must be factored into inventory management and production decisions.

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	Thank you for your consideration of these comments. Please contact me if you have any questions about them. Sincerely, Steven Aftergood Senior Research Analyst	

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L-48	COMMENTS OF BRIAN COSTNER ENERGY RESEARCH FOUNDATION 537 HADEN STREET COLUMBIA, SOUTH CAROLINA 29205 June 15, 1990 Mr. S. R. Wright, Director Environmental Division U.S. Department of Energy Savannah River Operations Office Post Office Box A Aiken, South Carolina 29802 Mr. Wright, I would like to have the following written comments considered in the evaluation of the Department of Energy's [DOE's] May, 1990 Draft Environmental Impact Statement [DEIS], "Continued Operation of K-, L-, and P-Reactors, Savannah River Site, Aiken, South Carolina", DOE/EIS-0147D. These are in addition to the oral comments I offered at the public hearing in Aiken, SC on June 8, 1990. As several persons have pointed out, there are serious inadequacies in this DEIS. At a time when DOE is trying to restore its public credibility, the release of such a poor document is a step in the wrong direction. I urge you to give consideration to these commentors' remarks and to answer them in a new DEIS. This new DEIS should be released with ample time for public comment, including at least 30 days notice before any public hearing. I will focus my remarks on three areas: the question of "continued operation" v. reactor restart, the socioeconomic impact of Savannah River [SR] operations, and the need for the proposed action. In no way should my not addressing other issues be construed as acceptance of statements made in the DEIS. <u>"Continued Operation" v. Reactor Restart</u>	
L-48-01	DOE's insistence that this EIS is on "Continued Operation" of the SR reactors highlights the unwillingness of the Department to encourage	Please see the response to Comment L-05-01 on continued operation.

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	open discussion of the significant issues at hand. Having chosen this phrase, it seems clear that the DEIS downplays relevant events in order to avoid admitting that the major action underway is, in fact, the restart program.	
	The DEIS misleads the public in its description of the events leading to the shut down of the SR reactors. In the foreword, the document states that, "DOE started P-Reactor following resolution of the seismic concerns. After this startup, the Operating Contractor and DOE jointly decided that further improvements in operation and management were necessary. These improvements are being made and verified." (at page v, paragraph 4)	
L-48-02	This description dramatically understates the significance of the events that led to the shut down. It does not adequately describe the management problems within DOE and its contractors, the serious lapses in safety performance and environmental protection that have plagued SR operations, or the poor condition of the physical facilities at the time of the shut down. Why?	DOE has revised the fourth paragraph on page v of the Foreword to address the comment. Section 4.1.3.1.1 of the EIS provides a full discussion of the events.
	The DEIS even goes so far as to suggest that "[t]hree SRS reactors (K, L, and P) are operational....These reactors currently produce..." (at page 1-1, paragraph 4) Any such indication that the reactors are currently capable of production is completely out of accord with every other review of these reactors. By what standards and by whom have these reactors been deemed operational? If they	
L-48-03	are operational, why are they not operating? What is the most recent date on which each of these reactors produced nuclear materials?	Please see the response to Comment L-05-01 on continued operation. The most recent period during which each of these reactors produced nuclear material was in the spring of 1988.
	Further, the DEIS de-emphasizes the significance of programs implemented since the shut down. This is inconsistent with DOE's attempts to rally behind these programs in its congressional and public relations efforts. In the months since the shut down, statements by DOE and Westinghouse officials have consistently tried to convey the message that business would not continue as usual. Dramatic efforts have been made to convince the Congress, the media and the public that a significant change in the management and operations at SR is taking place. Why then does this DEIS use the phrase "Continued Operation"?	

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L-48-04	Perhaps one reason is DOE's concern with its choice of the no action alternative. The DEIS defines "no action" as "the continuation of a present course of action (i.e., no change from a current level of management intensity or current management direction)." (at page 2-4, paragraph 1) The DEIS describes, as one of its alternatives, to "[c]ontinue to operate K-, L-, and P-Reactors at SRS to produce nuclear materials...This is the preferred alternative...and represents no change from the current situation (i.e., no action)." (at page 2-1, paragraph 1) Yet when the notice of intent to prepare this EIS was first published, the no action alternative was to "[t]erminate K-, L-, and P-Reactors operation consistent with other production options (i.e., the so-called No Action alternative)." (Federal Register, Vol. 54, No. 53, March 21, 1989, page 11562) Even though the DEIS states that "[t]his EIS will be completed prior to any decision on the startup of K-, L- or P-Reactor..." (at page vi, paragraph 1), at some time between the filing of the notice of intent and the release of this DEIS, the "present course of action" changed drastically. This raises several questions which should be answered in a revised DEIS:	The CEQ has stated that there are two distinct interpretations of "no action." One involves situations in which there is an ongoing program initiated under existing legislation and regulations. In these cases, "no action" is "no change" from current management direction. "Therefore, the 'no action' alternative may be thought of in terms of continuing with the present course of action until that action is changed" ("Forty Most Asked Questions Concerning CEQ's National Environmental Policy Act Regulations, 46 FR 18027). Because extended outages for modifications are part of reactor operation (and recognized as such by the NRC for its licensees), the resumption of production following such an outage is also part of the continuing operation of the reactors.
L-48-05	1) Why was the no action alternative changed from that listed in the notice of intent to that included in this DEIS?	The Notice of Intent announced the DOE intention to prepare an EIS and invited the public to participate in a scoping process to define issues to be evaluated in the EIS. DOE considered public comments received during the scoping process in its planning for the EIS. DOE prepared an Implementation Plan to record the results of scoping and provide guidance in the preparation of the EIS. The Implementation Plan, which was made available to the public on request, defined the alternatives, including no action, that the EIS would evaluate. Also, please see the response to Comment L-48-04 on no action.

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L-48-06	2) What is meant by "any decision" and how does this significant redefinition of the no action alternative not constitute a decision?	"Any decision" refers to the choice of one of the alternatives presented in the EIS and published in the Record of Decision.
L-48-07	3) Which decisions(s) is (are) being delayed until after completion of the EIS?	The Record of Decision, to be published no sooner than 30 days after the publication of the Final EIS, will document the DOE decision on the alternatives presented.
L-48-08	4) How does Secretary Watkins' May 1 announcement of a proposed restart schedule not constitute a decision?	The announcement did not constitute a decision to start up the reactors. Rather, it was a proposed schedule for preparing the reactors for production.
L-48-09	5) If the reactors are not now operating, and were not operating when this EIS began, how can the no action alternative be to "continue to operate K-, L-, and P-Reactors"?	Please see the responses to Comments L-05-01 on continued operation and L-48-04 on no action.
L-48-10	6) Given the definition of the no action alternative at the time of scoping for this EIS, how is the redefinition of this alternative consistent with the findings of the scoping period?	Please see the response to Comment L-48-04 on no action.
L-48-11	7) How does the establishment of offices dedicated to the restart of the reactors both within DOE and the operating contractor not reflect a significant change from the previous level of management intensity or directions? Several statements within the DEIS hint at the significance of the current restart effort. For instance, the DEIS states that "[i]nternal and external reviews of existing practices have resulted in a number of ongoing modifications in both systems and operating practices for these reactors." (at page 2-8, paragraph 1) Given that the establishment of external reviews of SR operations is a relatively recent occurrence and that these reviews have resulted in significant changes in plant operations, how and by whom was it determined that these reviews constitute no change in management	The reorganizations of the DOE and WSRC entities responsible for reactor operation were made in response to internal and external evaluations of organizational effectiveness in achieving the unchanged goal of resuming reactor production as soon as safety-related concerns were resolved.

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	intensity or direction? Further, how and by whom was it determined that implementation of these modifications in both systems and operating practices constitutes "no action" for the purposes of this EIS?	
L-48-12	The distinction between an EIS on continued operation and an EIS on reactor restart is significant. The public's ability to meaningfully participate in the decision-making process has been hampered by DOE's refusal to expose the restart program to the EIS process in a timely manner. The result is that DOE has committed nearly $2 billion and two years of activity by thousands of workers to a program that may not be needed and that may have negative long-term impacts to the environment. On October 19, 1988, the Energy Research Foundation, the Natural Resources Defense Council, and Greenpeace, USA requested that then-Secretary of Energy John Herrington begin an EIS on the proposed restart of the SR reactors. It was clear to us that the restart effort would constitute a major federal action. DOE initially did not agree to prepare an EIS, and, instead, claimed that national security would be jeopardized if the reactors were not restarted within a few months. A national security crisis has not emerged. In fact, relations between the United States and the Soviet Union have improved dramatically while the reactors have been shut down.	DOE disagrees. The information as related to continued operation and reactor restart would be the same, as would the alternatives and the environmental impacts. The public has had ample opportunity to comment on the proposed action and the alternatives under the NEPA process.
L-48-13	The EIS should have begun before commitments to the restart program were made. Only then could the EIS have fairly considered the alternatives and allowed for meaningful public participation. As it stands today, the public appears to have been asked to comment on a decision that has already been made.	Please see the response to Comment L-05-01 on continued operation. In December 1989, Secretary Watkins informed the Congressional Armed Services Committees in a letter that "because the decisionmaking process will be enhanced by the information and opportunity for public comment presented by the EIS, the Department will complete the EIS before it makes any decision to resume operating the defense production reactors at the Savannah River Site."
	Socioeconomic Impact of Savannah River Operations	
L-48-14	The DEIS examines the socioeconomic impact of SR operations very selectively. As a result, the public is not provided with an	DOE has expanded Section 3.2.5 of the EIS to provide additional socioeconomic information.

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	understandable analysis of the interaction between SR operations and the surrounding community. In additional to certain demographic descriptions, the DEIS offers little more than three statements regarding socioeconomic impacts. These are: 1) "The SRS has contributed substantially to the rise in the standard of living in the Site region. The FY 1989 SRS operating budget was $3.2 billion, and the FY 1990 budget is nearly $3.7 billion." (at page 3-8, paragraph 5) 2) "...termination of K-, L-, and P-Reactor operation would result in the loss of an estimated 9,600 jobs at SRS." (at page 4-131, paragraph 5) 3) "Termination would sharply reduce direct expenditures by DOE for local purchases and wages and salaries. There would be a consequent secondary loss to the local economy of a large number of jobs, as well as taxes to local and state governments, due to the reduction in staffing and wages at SRS." (at page 4-132, paragraph 1) No effort is made to clarify the significance of these statements, nor is any effort made to explain their basis. These statements are merely assertions and depict a very narrow interpretation of the available data. At the very least, a revised DEIS should answer the following:	
L-48-15	1) How much have SR operations contributed to the increased standard of living in the region? How have SR operations affected property values, rental rates and overall inflation in the surrounding communities?	Section 3.2.5 of the EIS describes the economy of the SRS area.
L-48-16	2) How much of the SRS operating budget goes into the local economy?	The SRS operating budget pays for labor, materials, and equipment. DOE estimates that 15 percent of total costs are for materials, 75 percent for labor, and the remainder for equipment. For a large manufacturing complex, expenditures for labor and materials generally go into the local economy; equipment is generally purchased from outside the area. Labor expenditures need to be adjusted for taxes, social security withholding, and savings. This is generally about 30 percent of the total payroll. Thus, a general estimate of the amount of the SRS budget going into the local area is about 70 percent.

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L-48-17	3) What is the relationship between the demands placed on local governments to provide services (education, water and sewer service, health care, public safety, etc.) for SR employees and tax revenues generated by SR operations?	If the K-, L-, and P-Reactors resume production, no changes should occur at SRS that would impact the fiscal structures of the counties, cities, and school districts. Thus, the existing relationship between demand for services and revenues for SRS employees and their families will not change. If there are changes in the workforce, corresponding changes in the local communities can be assumed.
L-48-18	4) What will be the effect of restarting the SR reactors on the existing workforce? How many of the 9,600 employees threatened with job loss if the reactors are not restarted will continue to be employed after restart? Will the job descriptions of any of these employees change after restart? If so, how?	After the resumption of production at all three reactors, there would be some reduction in the workforce, primarily subcontractor personnel assigned to special tasks and project personnel engaged in physical modifications. An assessment of workforce requirements and skills needed for long-term operation is under way. Specific changes to job descriptions are not available.
L-48-19	5) Why goes the DEIS not consider other employment options for the 9,600 workers threatened with job loss (such as transferring workers to accelerated cleanup or decontamination and decommissioning projects)?	The scope of this EIS is the continued operation of the three reactors. Other activities and their employment needs and skill requirements are beyond the scope of this EIS. However, the skills of the reactor workers are not necessarily totally transferrable to the skills required for cleanup or decontamination.
	<u>Need for the Proposed Action</u>	
L-48-20	The very notion that an EIS can be fairly completed without allowing the public to consider the need for the project is contrary to good policy-making. If the EIS is to weigh the costs and benefits of the proposed action, then the need cannot be hidden away and marked as an absolute variable. The DEIS presents several conclusions about the need for restarting the SR reactors. The remainder of my comments highlight some of these conclusions and request that certain questions be answered in a revised DEIS.	Please see to the response to Comment L-02-01 on need.

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	"Current forecasts of nuclear material needs indicate..." (at page 1-1, paragraph 5)	
L-48-21	1) How current are the forecasts for each nuclear material under consideration?	President Bush approved the most recent NWSM on July 12, 1990. DOE has revised Appendix A and Section 1.2 of the EIS, and has incorporated changes that are consistent with the July 1990 NWSM. In addition, a potential reduced-need scenario was evaluated, and is considered in the EIS. The plutonium-238 requirement was defined in a memorandum from Charles M. Herzfeld, Chairman, Nuclear Weapons Council. DOE refers to this memorandum in Section 1.2 of the Final EIS. Also please see the response to Comment L-02-01 on need.
L-48-22	2) Do the forecasts for tritium requirements for nuclear weapons take into account the substantial changes in the need for this material that have taken place since January 19, 1989?	Yes.
	"Many factors are considered in the development of the NWSM, including...the status of the nuclear material production and fabrication facilities." (at page 1-2, paragraph 5)	
L-48-23	1) What was the status of the nuclear material production and fabrication facilities considered to be at the time the current NWSM was signed? How and by whom was this determination made?	Detailed information on the derivation of the NWSM or on the determinations made are beyond the scope of this EIS.
	2) Does the NWSM signed by President Reagan on January 19, 1989 assume the capability to operate K-, L- and P-reactors?	
	3) If the NWSM assumes K-, L- or P-reactors are capable of operating, what power level(s) does it assume?	
	4) Did DOE acknowledge that this EIS should be completed and that outstanding safety issues should be resolved prior to the NWSM being signed?	
	"Issuance of the 1990-1995 NWSM...is expected in the near future." (at page 1-2, paragraph 5)	
	1) Will the results of the EIS, or of ongoing safety reviews, be considered in determining the status of nuclear material production and fabrication facilities in the 1990-1995 NWSM?	

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L-48-24	2) If the 1990-1995 NWSM is completed prior to completion of this EIS, will Appendix A of this EIS be re-examined in light of the new NWSM?	Yes. The President approved the 1990-1995 NWSM on July 12, 1990; DOE has updated Appendix A of the EIS.
L-48-25	3) What factors have led to the delay of issuance of this NWSM?	Any such factors are beyond the scope of this EIS.
	"In addition to the material required by the NWSM, there is a need for relatively small quantities of nuclear materials for other applications..." (at page 1-3, paragraph 2)	
L-48-26	1) How much tritium is needed for non-weapons research and development? for commerical and medical applications?	Historically, commercial sales are about 200 grams per year; 100 grams are used for nonweapons research and development.
L-48-27	2) What is the demand for californium-252, americium-242, krypton-85, and cobalt-60?	At present, there is no demand for these isotopes; however, ensuring the capability to meet the material requirements established in the NWSM enables DOE to satisfy requests for these materials.
	3) Can demand for these materials be met without restart of the SR reactors?	
	4) How many Savannah River reactors operating at what power level and for how long would be required to meet the need for these materials?	
	5) How significant is production of these materials considered to be in determining the need for the proposed action of this EIS?	
L-48-28	"At present, DOE has approximately 59 kilograms of plutonium-238 in inventory. Approximately 71.1 kilograms of plutonium-238 are needed in the near term....The SRS reactors are considered to be the only facilities capable of meeting these near-term needs." (at pages 1-3, paragraph 4)	DOE has revised Section 1.2 to reflect recent changes in plutonium-238 requirements.
L-48-29	1) Does this EIS consider alternative methods of fueling satellites, specifically solar power? If not, why not?	The DOE role is to supply the quantities of requested materials for missions identified by the user agencies. The material requirements defined by the mission specialists in the respective agencies reflect their judgments as addressed in their mission documents or EISs with respect to the applicability of solar or other alternative power sources for these missions, and are beyond the scope of this EIS.

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L-48-30	2) What does "near-term" refer to? What are the scheduling requirements for each of the projects listed?	"Near-term" refers to the current budget planning cycle of FY 1990 to FY 1995. The CRAF and Cassini NASA spacecraft are scheduled for launch in August 1995 and April 1996, respectively. Plutonium-238 will be removed from inventory in August 1990 and continue through 1994 to support these missions. The DOE program requires withdrawal from inventory in FY 1990 and 1991. The DOD mission would require withdrawal of inventory in FY 1991, 1992, and 1993.
L-48-31	3) Why is 17.9 kilograms needed in the working inventory? Why not 18? or 15? or 5? "Although not currently anticipated, a need for the production of weapons-grade plutonium in SRS reactors could develop in the future." (at page 1-3, paragraph 5)	The working inventory consists of manufacturing process pipelines, annual inventory decay, process waste, scrap generation and recycle, safety and qualification test units, and allowance for manufacturing efficiencies. These values are based upon prior experience and are estimated for each separate production process.
L-48-32	1) How significantly does the "not currently anticipated" need for weapons-grade plutonium figure into the need for the proposed action? "DOE has evaluated several other alternatives to the production of the required quantities of tritium in SRS reactors....there are no reasonable alternatives to the continued operation of K-, L-, and P-Reactors to meet nuclear materials requirements..." (at page 2-1, paragraph 4 thru page 2-3, paragraph 5)	Because there is no currently defined requirement to provide new plutonium-239, it is not a significant factor in the need for the continued operation of the SRS reactors.
L-48-33	1) Could any of these alternatives satisfy requirements for that tritium not required by the NWSM?	The quantities of tritium required for nonweapons purposes could be produced by other reactors, but at a penalty in cost; other penalties would also be incurred. Therefore, these alternatives are not considered reasonable because continued operation of the SRS reactors would still be necessary to meet the requirements of the NWSM.
L-48-34	2) When comparing the costs and time involved in making alternative production capacity available to the preferred alternative, was the substantial investment of money and time already put into the SR restart program a consideration?	No.

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L-48-35	3) Has an analysis been done to determine whether or not changes in the U.S. nuclear arsenal since signing of the January, 1989 NWSM affect tritium production requirements? If so, what was the outcome of the analysis? If not, why not? "Primarily because of schedule requirements for National Aeronautics and Space Administration projects and a classified Navy mission, continuing the production of plutonium-238 in SRS reactors is the only reasonable alternative." (at page 2-3, paragraph 3)	Please see the response to Comment L-48-21 on the NWSM.
L-48-36	1) What are the schedule requirements referred to in this statement?	Please see the response to Comment L-48-30 on schedules.
L-48-37	2) Have any of these schedule requirements changed since work on this EIS began?	The scheduled requirements have changed; see the revised Section 1.2.
L-48-38	3) At what time would the existing plutonium-238 supply be exhausted given current schedule requirements?	The current inventory of quality, specification-grade material would be exhausted by 1993.
L-48-39	4) What would be the schedule delays incurred by using alternative production sources?	There are no reasonable alternatives to produce new plutonium-238 on schedule to meet current requirements.
L-48-40	5) Were methods of reducing plutonium requirements in these programs examined, including the use of solar power and methods of conservation?	Yes. Also, please see the response to Comment L-48-29 on the DOE role.
L-48-41	6) Were all potential sources of existing plutonium-238 considered?	Yes.
L-48-42	7) How many Savannah River reactors operating at what power level(s) and for how long would be required to meet these requirements for plutonium-238? Thank you for consideration of these comments. I look forward to hearing the Department's response to these and other comments offered on the DEIS. Sincerely, Brian Costner Director	One reactor operating at a 50-percent power level would produce an estimated 15 kilograms of plutonium-238 annually. That production rate on a long-term basis would meet plutonium-238 material requirements.

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Comment Number	Comment	Response
L-49	COMMENTS OF WILLIAM D. MOSS, JR. BEAUFORT-JASPER WATER & SEWER AUTHORITY P.O. DRAWER 2149 BEAUFORT, S.C. 29901-2149 (803) 524-7322 • (803) 726-4915 • (803) 757-2667 FAX (803) 726-6346 June 25, 1990 Mr. S. R. Wright U.S. Department of Energy Savannah River Operations Office Post Office Box A Aiken, South Carolina 29802 Dear Mr. Wright: This letter is written to offer the comments of the Beaufort-Jasper Water and Sewer Authority on the Draft Environmental Impact Statement (E.I.S.) concerning the continued operation of the K, L, and P reactors at the Savannah River site. We provided verbal testimony at the public hearing held on May 31, 1990 in Savannah, Georgia, and this letter is a re-statement and elaboration of the points we made on that occasion. On May 8, 1989 we provided you a letter outlining, in response to D.O.E.'s request, those issues we felt should be addressed in the E.I.S.. A copy of this letter is attached. We have reviewed the draft E.I.S. and in general did not find the document responsive to the issues we raised in that letter.	
L-49-01	The first issue we raised concerned the health effects of low level radiation and the steps necessary to reduce/minimize the release of radiation to the Savannah River. The report, in our opinion, does not adequately address this issue and in fact, we learn from the document that D.O.E. proposes to increase the amount of radiation released to the Savannah River rather than reduce it.	The EIS addresses the issue of low-level radiation exposure in several sections: Section 3.7.1 describes the radiation environment in the SRS vicinity and the minute contribution made by SRS to that environment; Section 4.1.2 describes the expected minor radiological impacts of reactor operation, including the dose commitments to individuals and nearby and downstream population groups and the consequent calculated health effects; Section 4.1.6 presents the cumulative radiological

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Comment Number	Comment	Response
		impacts of all facilities on and adjacent to the SRS; and Appendix B describes the monitoring programs for low-level radiation in the environment, and epidemiological studies on the risks from SRS operations. Also, please see the responses to Comments L-02-02 on health risk and L-06-03 on environmental impacts. As a result of comments on the draft EIS from EPA, other agencies, and the public, DOE is reevaluating options for the disposal of disassembly-basin purge water. Section 4.1.2.3 of the EIS demonstrates that continuing the use of the seepage basins would result in lower public exposure to tritium than would direct discharge; Section 4.5.3 indicates that moderator detritiation cannot be justified on a dose-aversion basis.
L-49-02	The second issue involved the effects of plant operations on the River at times of extended low flows. The E.I.S. argues that such low flows (102-130 cms) do not create problems for plant operations. There is no discussion of the relative environmental impact of accidents or releases on a very low flow situation as opposed to a high flow or normal flow situations.	Historically, releases during low-flow conditions in the Savannah River have not had a materially greater effect on downstream users than the effect that occurs during normal flow periods. Concentrations of tritium from SRS releases are substantially below the EPA drinking-water standard of 4.0 millirem/year under these conditions. The concentration of tritium in the river is a function of river flow and the quantities released from reactors and support facilities at SRS. Both of these quantities will vary from year to year, as described in the annual Environmental Monitoring Reports for SRS, which are cited in the EIS. However, at river flows below about 117 cubic meters per second at the Site, pumping cooling water to operate more than one reactor at SRS is not possible (Section 3.4.1.2), thus limiting tritium potentially discharged from the Site. Reactor accidents do not produce direct releases of radioactive materials to the river.

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L-49-03	The third issue involved the impact of restart on the small streams and particularly the potential for scouring and flushing of pollutants into the River as restart occurs. This issue is not addressed at all. In general, the conclusion of the E.I.S. regarding the water quality of the Savannah River and the down stream drinking water users is: 1. Radioactive pollutants particularly tritium, are being and will continue to be released into the River system, but the levels are low and therefore acceptable.	Section 4.1.2.4 describes the small quantities of cesium-137 flushed into the Savannah River by the cooling water discharged from each of the reactors.
L-49-04	2. Drinking water users at Beaufort-Jasper and Port Wentworth are receiving a steady concentration of radioactive tritium in their water supply but these levels are below current drinking water standards and are therefore acceptable. 3. A change in operating procedures will increase the 25 year average annual liquid release of radioactivity 2.4 times from 7,100 Ci/yr. to 17,100 Ci/yr. but levels are still low and therefore this increase is acceptable. In a general sense, the Beaufort-Jasper Water and Sewer Authority believes that the E.I.S. does not make the case that continued and particularly increased discharges of radioactive pollutants to the Savannah River is either necessary or desirable. It treats the continued liquid release of 11,600 curies per year of tritium to the water supply as an inescapable, inevitable consequence of continued reactor operation.	The calculated risk from drinking water taken from the Savannah River without tritium removal from current and new facilities is an additional 0.0038 fatal cancer per year (or 1 additional cancer fatality every 260 years) in the water-using population of 317,000 to be served in the future in Port Wentworth and Beaufort-Jasper (Sections 3.4.1.4 and 3.7.1.2 of the EIS). An average U.S. population of this size would be expected to have about 600 cancer deaths <u>each</u> year from all causes.
L-49-05	D.O.E. may in fact be able to show that the cost of eliminating this radioactive discharge is so great and the resulting reduction in health risk so small that it is not reasonable to attempt. The E.I.S. however, does not do this and therefore no evaluation of cost vs benefit is possible.	Section 4.5.3 of the EIS describes the processes considered for detritiation of the heavy-water coolant/moderator, which is the source of the reactor-origin tritium discharges, their estimated costs, and the dose-reduction benefits. As that section indicates, the cost per unit collective dose (and health risk) averted greatly exceeds the guidelines used by NRC to judge the need for reductions in effluents from commercial powerplants (10 CFR 50, Appendix I; NRC Regulatory Guide 1.110).

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L-49-06	The Savannah River is the only dependable long term water supply available to the residents of Beaufort and Jasper Counties, South Carolina. The D.O.E. Savannah River facilities constitute the single greatest potential threat to this resource. The E.I.S. however fails to discuss in understandable terms the risk to the water quality from nuclear accidents. We are unable to draw conclusions from the document about what would happen to the water supply, if for example, a Chernoble type accident were to occur. Again, this risk may be small, or the impact minor but the document does not explain. This is of special concern to us since, if the River were contaminated for any length of time, we could not withdraw water and the 50,000+ people dependant upon this supply would be without drinking water. Could this happen?	As described in Section 4.1.3 of the EIS, there is no credible risk to water quality from SRS reactor accidents, because any potential liquid releases would be retained in lined basins on SRS. The Chernobyl reactor was constructed with a combustible graphite moderator, which burned as a consequence of the accident and dispersed radioactivity to the air and ground. Because of the fundamental differences between SRS and Chernobyl reactors, a similar accident is physically impossible at the SRS reactors, which are moderated with heavy water.
	In conclusion, while the draft E.I.S. is a comprehensive and generally thorough document, it does not, in the Authority's opinion, adequately address the situation of the down stream water users. We request therefore that the document be amended to show the following information and discuss the following issues.	
L-49-07	1. The document should contain a comparison chart and discuss the radioactivity levels in the Savannah River from stations above the plant (Augusta) and stations below the plant (Beaufort-Jasper and Port Wentworth). This information is available in D.O.E. files. It should additionally project the increased tritium concentration in the Beaufort-Jasper Water and Sewer Authority's water supply from continued operations with direct discharge.	DOE has added the requested information to Section 3.7.1.2, Table 3-11.
L-49-08	2. The document should contain an analysis of the costs of installing and operating a wastewater treatment facility to remove tritium from the disassembly basin purge water discharge.	Please see the response to Comment L-49-05 on detritiation.
L-49-09	3. The document should contain an analysis of the impacts on the Savannah River and the down stream water supply of a serious accident at the reactors. This analysis should be written in an understandable fashion and should specifically address the length of time the River might be contaminated.	Please see the response to Comment L-49-06 on accidents. An unlikely release of contaminants from SRS would take an estimated 1.5 to 3 days to reach the Beaufort-Jasper intakes and an equal time to pass this point, depending on the volume of the release, its dispersion or mixing rate in the river, the river flow velocity, and tidal effects in the lower reaches of the river.

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Comment Number	Comment	Response
L-49-10	As a final note we hereby formally express our opposition to D.O.E.'s announced intention as discussed on page 4-24 of the draft E.I.S. to change the discharge of disassembly basin purge water from seepage ponds to the surface stream system. D.O.E. should be committed to reducing the level of radioactive pollution in the water supply not increasing it. Thank you for the opportunity of making these comments. Sincerely, William D. Moss, Jr. General Manager WDM:mm	The revised Section 4.1.2 discusses the discharge of disassembly-basin purge water to reactor seepage basins. Also please see the response to Comment L-49-01 on tritium discharges.

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Comment Number	Comment	Response
	c.c. Board Members Honorable Strom Thurmond Honorable Ernest F. Hollings Honorable Carroll A. Campbell, Jr. Honorable Arthur Ravenel, Jr. Senator James M. Waddell, Jr. Representative Harriet Keyserling Representative Holly Cork Representative Juanita White Mr. William Bowen, Chairman, Beaufort County Council Mr. David P. Lowther, Chairman, Jasper County Council Mr. J. C. Smoak, Mayor, Town of Hardeeville Mr. Joseph Malphrus, Mayor, Town of Ridgeland Wholesale Customers Mr. Alfred Vang, Executive Director, S.C. Water Resources Commission Mr. Michael Jarrett, Commissioner, S.C. Dept. of Health and Environmental Control Mr. James A. Joy, III, S.C. Department of Health and Envrionmental Control Mr. William C. Rowell, S.C. Department of Health and Environmental Control Ms. Becky Shortland, Executive Assistant, The Georgia Conservancy	

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Comment Number	Comment	Response
L-50	COMMENTS OF ROBERT P. COLBORN June 20, 1990 P.O. Box 466 Bluffton, SC 29910 Mr. S. R. Wright Director of Environment U. S. Dept. of Energy Savannah River Operations P.O. Box A Aiken, SC 29802 Dear Mr. Wright:	
L-50-01	I am writing to express my opinion on the possible restart of the reactors at the Savannah River Plant. I attended the morning session at the recent hearing at the Desoto Hilton in Savannah, but did not speak. Quite frankly, I was embarrased by the lack of courtesy and decorum of many of the speakers. In spite of the rude behavior exhibited, the issue of the restart is what's important. I would like to register my opposition to such an action. About the only qualification I have to discuss this issue is the fact that I am a member of the human race, and a resident of this planet. The time has come to realize we are <u>all</u> members of this human race, and <u>all</u> residents of the planet, regardless of the differences that seem to divide us. Nationalities, races, religions, in-groups, out-groups...all these concepts pale in the face of death. I am trying to reduce this issue to its simplest. Forget science, forget technology, forget ecology, forget politics. This is just plain common sense - surely which enough of us have in the final analysis. It doesn't make sense to kill ourselves!	Comments noted.

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	I'm sure your job is very difficult, and I must thank you for being accessible to all who have something to say on this very important issue. I know you're a member of the human race and you'll do the best you can. With best regards, Robert P. Colborn	

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Comment Number	Comment	Response
L-51	COMMENTS OF GREGORY P. LEDFORD	
	June 19, 1990	
	Mr. S.R. Wright Director, Environment Division U.S. Dept. of Energy Savannah River Operations Office P.O. Box A Aiken, S.C. 29802	
	Dear Mr. Wright:	
	The purpose of my letter is to state my concerns about the continued operation of the Savannah River Nuclear Plant K-, L-, and P reactors. It is my understanding that this plant's purpose is to produce fuel for the creation of nuclear weapons.	
L-51-01	I have major concerns, which from my perspective support the closing of the reactors at the Savannah River Plant. The first concern relates to the safety of the plant's reactors, and the environmental impacts resulting from their operation. Available documentation has indicated that the plant has consistently failed to meet various safety and environmental standards established by the Clean Water Act and Nuclear Regulatory Commission (NRC).	Please see the responses to Comments L-05-02 on safety, L-06-03 on environmental impacts, and L-24-03 and L-39-02 on compliance with environmental standards.
L-51-02	Specifically, the super heated water that is dispersed into the river is significantly higher then what is allowable under the Clean Water Act. Additionally, it has been documented that NRC safety standards have, on several occasions, been compromised in order to allow the plant to continue operation. No facility should be allowed to operate outside of established laws and standards that have been designed to protect the general public and the environment regardless of the end product being produced.	The SRS does not discharge "super-heated water" directly into the Savannah River. By the time discharge water reaches the river, it has cooled to levels that meet SCDHEC thermal water-quality criteria. NRC safety standards, by law, do not apply to DOE reactors. Also, please see the responses to Comments L-05-03 on operation of K-Reactor under a Consent Order and L-24-03 on compliance with laws, standards, and regulations.
L-51-03	The second concern is also very serious and holds the potential for having a catastrophic impact on the environment. I am referring to the fact that the plant rests directly on top of the Tuscaloosa Aquifer, which is the largest aquifer on the east coast and provides	Please see the response to Comment L-15-01 on groundwater impacts.

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	water for much of the southeast United States. Studies have indicated that there is a real possibility for contamination resulting from the wastes produced by the Savannah River Plant's reactors, which are stored on-site in some cases, leaking into the	
L-51-04	aquifer and contaminating this critical water resource. There is also documented evidence of small ground animals contaminated with Strontium 90 on the plant reservation having escaped to nearby farms, which in these cases could end up in the food chain.	As described in Appendix B of the EIS, DOE routinely monitors offsite foods, vegetation, water, milk, and other materials and reports the results annually in environmental monitoring reports. These reports are available to the public and to regulatory agencies.
	In summation, the threat to the environment is too great a risk to take in order to continue to produce nuclear weapons fuel at the	
L-51-05	Savannah River Plant K-, L-, and P reactors. The United States already is in possession of more than 35,000 nuclear warheads, which would destroy the planet many times over. This prospect in itself should be enough to warn us against continued manufacture of these devices and the fuel that feeds them. However, even beyond the direct nuclear weapons threat lies a much more insidious threat, and that is the irreparable damage that can be done to the environment by our own hand if the Savannah River Nuclear Plant is allowed to continue its operations.	Please see the response to Comment L-02-01 on the need for tritium. The need for nuclear weapons is beyond the scope of this EIS.
	Thank you for your consideration in this matter. It is incumbent upon us all to look beyond conventional issues of war and toward issues related to a war to save our planet from environmental suicide.	
	Sincerely,	
	Gregory P. Ledford	

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Comment Number	Comment	Response
L-52	COMMENTS OF ADELE KUSHNER Rt 2 Box 182A Alto, Ga 30510 June 20, 1990 Mr. Stephen R. Wright, Director Environmental Division U.S. Department of Energy Savannah River Operations Office P.O. Box A Aiken, South Carolina 29802 Dear Mr. Wright: I see four health reasons for supporting Alternative 3, terminating operation of K-, L- and P- reactors in the immediate future.	
L-52-01	1. Health effects on residents downwind and downstream of the Savannah River Site: When the health effects from both normal operations and accidental releases of radioactive materials are added to releases of toxic chemicals, although not shown clearly in the EIS report, the result is additional cases of cancer in the general population. I would like to know how DOE arrived at its limits of 100 millirem per year from all pathways and 10 millirem per year from air pathway only (p. 4-121). Evidence in two new books shows that low levels of radiation will cause more cancers, per unit of radiation, than will large doses, and that evidence of human birth defects caused by low-level radiation has been hidden from the public.	Table 2-3 of the EIS summarizes the additional risks of cancer fatalities due to SRS normal emissions and accidental releases. As noted in Section 4.1.7, studies of the SRS region have not identified unusual cancer mortality rates attributable to SRS operations. The dose limits presented in the EIS are from the cited references: DOE Order 5400.5 ("Radiation Protection of the Public and the Environment") and EPA NESHAPS (40 CFR 61, Subpart H) for emissions of radionuclides by DOE facilities. The EIS addresses the issue of low-level radiation in Sections 3.7.1 and 4.1.6. Appendix B describes epidemiological studies on the risks from SRS operations.

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L-52-02	One incident is the meltdown of nuclear rods at SRP in November and December 1970 and the resulting increase in radioactivity and in infant mortality in South Carolina from January 1971 through September 1971. The two books are John Gofman, Radiation-Induced Cancer from Low-Dose Exposure: An IndependentAnalysis (San Francisco, Committee for Nuclear Responsibility, P.O. Box 11207, San Francisco, CA 94101, 1990), and Jay M. Gould and Benjamin A. Goldman, Deadly Deceit: Low-Level Radiation, High-Level Cover-Up (New York, Four Walls Eight Windows Press, P.O. Box 548, Village Station, New York 10015, 1990).	Neither the melting of a source-rod during its discharge from a reactor in November 1970, nor the limited clad and fuel melting damage on one assembly in December 1970 (see Table 4-15) resulted in releases of radioactivity at SRS that exceeded normal discharge standards. Deadly Deceit by Gould and Goldman provides no credible evidence of an increase in either environmental radioactivity or infant mortality attributable to such an occurrence.
L-52-03	2. Health effects on people served by the Tuscaloosa Aquifer: Many South Carolina and Georgia residents get their drinking water from this major aquifer. I have seen reports of chemical contamination already in the water from leaks in chemical storage areas on the Savannah River Site. In addition, "low-level" radioactive waste is stored in leaking containers just above this aquifer. Contamination of this water source should be curtailed immediately. Certainly no additional contamination should be permitted. Estimates of risk from this source should be included in the final EIS.	Please see the response to Comment L-15-01 on groundwater impacts.
L-52-04	3. Health effects along transportation routes for radioactive materials being shipped in and out of the Savannah River Site: One accidental spill of radioactive materials in a population center or on a heavily-traveled road could result in contamination of large numbers of people. Estimates of risk from this source should be included in the final EIS.	Section 4.1.4 of the EIS discusses radiological impacts of transportation spills or accidents. Tables 4-40 and 4-41 list transportation risks.
L-52-05	4. Evidence of fish kills is attributed to thermal discharge only; is it possible that there are other causes, such as chemical discharge into the water? Loss of wood stork habitat, emissions from coal-fired power plants, discharge of tritium-contaminated water into groundwater, and the storage of low-level radioactive and hazardous waste in inappropriate containers (cardboard boxes!) — all these items add up to severe impact on the environment, to the detriment of all life forms.	There is no scientific evidence that occasional fish kills in Par Pond and L-Lake are due to causes other than thermal discharges. DOE monitors such kills closely, and makes information about them available to the public in annual environmental reports. Section 4.5 of the EIS discusses mitigation options for fish kills.
L-52-06	In addition there is the larger question of our need for these radioactive materials. The Soviet "bloc" does not exist any more; the Soviet Union shows no sign of being a military threat. Therefore the reason for building nuclear weapons has disappeared.	Please see the response to Comment L-02-01 on the need for tritium. The need for nuclear weapons is beyond the scope of this EIS.

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	Even if this were not true, the start of a nuclear exchange would threaten the lives of all of us. True national security stems from healthy, safe, productive citizens, each with a home, food, health care, education and job. National security should mean secure neighborhoods. Our tax dollars should not be spent to add another case of cancer to a defenseless populace. I therefore urge you to act to decommission all the reactors at the Savannah River Site, for the health and safety of the American public. Thank you for this opportunity to comment. Sincerely yours, Adele Kushner	

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Comment Number	Comment	Response
L-53	COMMENTS OF JAMES W. DODD MARY S. DODD June 19, 1990 S. R. Wright, Director Environmental Division U.S. D.o.E. Savannah River Operations Office P.O. Box A Aiden, S.C. 29802 Attn: Reactor Operation EIS Dear Sir: After attending open hearings in Aiken of June 9th and listening to recommendations on the draft EIS and we urge the DOE to either maintain the present situation (i.e., no action) or, preferably, to close the plant forever and clean up the area for the following reasons: 1. The present state of U.S. Soviet ralations where we have signed a treaty to reduce the number of warheads over the next few years.	
L-53-01	2. The materials in those warheads can be recycled in the event of future need.	Please see the response to Comment L-15-06 on recycling.
L-53-02	3. In CLR 1022 the DOE indicates that there may be a danger to the floodplains and surface water of the Savannah River.	Please see the response to Comment L-06-03 on environmental impacts. Also, see Sections 4.1.1.2, 4.1.1.3, 4.1.1.4, 4.1.1.6, 4.1.2.2, and 4.1.6 of the EIS.
L-53-03	4. The physical and moral problems of radioactive waste disposal has not changed since the plant was shut down.	Please see the response to Comment L-07-01 on radioactive waste management.
L-53-04	5. The cost to the American taxpayer to produce, maintain, and regulate this unnecessary material.	Please see the response to Comment L-02-01 on the need for tritium and other nuclear materials.
	In brief, at this stage of our history, American owns enough of the materials produced at the Savannah River Plant. We are headed towards peace, the Cold War is over. If we must, at some point in	

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L-53-05	the future, the materials which we own can be recycled. I realize that the people of Aiken, S.C. would lose some 16,000 jobs but the health and economic welfare of all Americans should weigh equally. Sincerely, James W. Dodd Mary S. Dodd 1939 Mt. Vernon Pl. Dunwoody, Ga. 30338	The estimated job loss at SRS as a result of terminating the operation of all three reactors would be 9,600. Section 3.2 of the EIS discusses socioeconomic matters.

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Comment Number	Comment	Response
L-54	COMMENTS OF SUSAN F. DODD	
	June 18, 1990 Mr. S. R. Wright, Director Environmental Division US Dept. of Energy Savannah River Operations Office P.O. Box A Aiken, SC 29802 Dear Mr. Wright:	
L-54-01	I would like to urge you to **not** restart the Savannah River Plant. Nuclear weapons are going to be a thing of the past very soon, and their safety record is terrible. As a taxpayer and voter I want to let you know that I am completely opposed to opening that place. It's an albatross thorn in the side of Georgia Power. There's no reason for us to pay for Georgia Power's mistaken judgement. NO MORE PLUTONIUM BOMBS!	The Savannah River Site is owned by the U.S. Department of Energy, not by Georgia Power Company.
	Sincerely, Susan F. Dodd	

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L-55	COMMENTS OF ROBERT S. WESTMORELAND	
	June 20, 1990	
	Mr. S. R. Wright, Director Environmental Division U. S. Department of Energy P. O. Box A Aiken, SC 29802	
	Re: "Reactor Operation EIS"	
	Dear Mr. Wright,	
L-55-01	We at A. B. Beverage Co., Inc. in Aiken are in full support of the Reactors continued operation at the Savannah River Site. We feel that it is best for Aiken, South Carolina, and the Nation. It is vital for a strong defense of this nation. Having a strong defense is a main part of why there is relatively peaceful atmosphere throughout the world today.	Comments noted.
	Sincerely,	
	Robert S. Westmoreland Sales Administrator	
	RSW/sc	

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L-56	COMMENTS OF BETSEY M. LESCOE	
	6/14/90	
	Dear Mr. Right,	
L-56-01	This letter contains some of my views on the restarting of the nuclear reactors at the Savannah River Site.	Comments noted.
	I am opposed to the reactors being opened again.	
	The financial fear some people seem to have if the reactors do not start, can be dealt with. Many serious people are studying plans for the conversion of military industries to other industries. Conversion is more than a shift away from all things military. Socially useful goods and services in transportation, housing, health, energy, education and communications can be our goal. The Savannah River Site and its leaders have a chance to be in the forefront of this change.	
	Here are addresses of 3 economic conversion resource guides:	
	Center for Economic Conversion 222 C View St Mountain View, CA 94041 (415) 968-8798	
	Natl' Commission for Economic Conversion & Disarmament Seymour Melman Box 15025 Washington, DC 20003 (202) 544-5059	
	Jobs with Peace Campaign 76 Summer St Boston, MA 02110 (617) 338-5783	
L-56-02	My second opinion is that we do not need to produce tritium for bombs when our government is working towards dismantling them. Further production is not needed at this time.	Please see the response to Comment L-02-01 on the need for tritium.

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L-56-03	My last concern is the health issue for workers at the plant, nearby residents and the world community. I live in Athens, Georgia, work as a nurse and have two small children still at home. The hazards of producing tritium are well known. These hazards need not be forced on people again in South Carolina, Georgia and the world community. This is a time in history to stop producing tritium. The poisons to our water supply and our bodies need not to restarted. May I write again - now is the opportunity for the leaders of the Savannah River Site to seriously consider conversion and become the leaders people will praise for many years. Do not restart the reactors. Sincerely, Betsey M. Lescoe 131 Soule St. Athens, GA. 30605 (404) 546-0056	Section 4.1.2.6 of the EIS discusses the calculated health effects to onsite workers and the offsite population from radiation and radioactive releases. Appendix B discusses epidemiological studies of the workers and the neighboring population. Please see the response to Comment L-02-02 on health risks.

Table C-5. DOE Responses to Comments on Draft EIS

Comment Number	Comment	Response
L-57	COMMENTS OF HELEN S. CRANMAN BARBARA FRAPPIER HERMAN L. CRANMAN	
	Mr. Wright,	
L-57-01	We are <u>against</u> the re-starting of the "Reactor Operation" Helen S. Cranman Barbara Frappier Herman L. Cranman	Comment noted.

Table C-5. DOE Responses to Comments on Draft EIS

Comment Number	Comment	Response
L-58	COMMENTS OF SUZANNE S. LA PIERRE ATTORNEY FOR PUBLIC CITIZEN Public Citizen Litigation Group Suite 700 2000 P Street N.W. Washington, D.C. 20036 (202) 785-3704 Mr. Stephen R. Wright, Director Environmental Division U. S. Department of Energy Savannah River Operations Office Post Office Box A Aiken, South Carolina 29802 June 25, 1990 Re: Draft Environmental Impact Statement, Continued Operation of K-, L-, and P-Reactors, Savannah River Site, Aiken, South Carolina Dear Sir: We have reviewed the Draft Environmental Impact Statement ("DEIS") for the proposed "continued operation" of the K-, L-, and P-reactors at the Savannah River Site ("SRS") and have noted a number of deficiencies which render the document inadequate under the statutory requirements of the National Environmental Policy Act ("NEPA"), 42 U.S.C. §§ 4321-4370a, and the Council on Environmental Quality ("CEQ") implementing guidelines, 40 C.F.R. § 1500 et seq. Summarized below are our major concerns. I. The Department of Energy ("DOE") has failed to establish the "need" for the proposed action.	
L-58-01	Perhaps the most glaring deficiency in the DEIS is the DOE's failure to establish and address the "need" for the proposed action in light of the information available to the agency with respect to the nation's current and projected nuclear weapons policy. The DOE	President Bush approved the most recent NWSM on July 12, 1990. DOE has revised Appendix A and Section 1.2 of the EIS. In addition, Appendix A now contains a reduced-demand case.

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	admits that the proposed action, i.e., restart of the three reactors, is premised on a determination of need made during the waning days of the Reagan administration and including a projection four years into the future, i.e., through FY 1994. DEIS at 1-3. The DOE further admits that "the potential for significant reductions to [these] material requirements exists," and that an updated projection of these needs, spanning the years 1990-1995, is in the process of preparation with expectations that it will be completed "in the near future". Id. Nevertheless, the DOE explicitly states that the soon to be superceded Nuclear Weapons Stockpile Memorandum ("NWSM") "remains the basis for the analysis in this EIS." Id. Because the DOE has admittedly relied upon outdated information which overstates the need for the production of nuclear materials, it has failed to establish the need for the proposed restart of the SRS reactors. Until current information is used as a basis for the proposed action, any DEIS purportedly addressing the environmental consequences of the activity is necessarily inadequate. Moreover, the public's ability to offer any constructive comments on the proposed action is further stymied by the agency's withholding of even the admittedly outdated data upon which the needs projection utilized in the DEIS is based. See DEIS at 1-2, A-1 ("Appendix A, which is classified, contains quantitative projections for nuclear materials requirements, descriptions of the processing complex, and analyses of the capabilities of alternative production sources to meet the requirements." Id. at 1-2.) A comprehensive environmental assessment of the action even as proposed by the agency can not be made without this information.[1]	
L-58-02		Please see the response to Comment L-02-01 on Appendix A.

[1] While the DOE states that it bears responsibility "for developing and maintaining a capability to produce nuclear materials for the defense of the United States," and it is further "authorized to provide certain non-defense nuclear materials," it has failed to disclose what the country's current needs in fact are. Rather, the agency has included them in "Appendix A" to the DEIS, which has been withheld from the public as "classified" material. See DEIS at 1-2. Public Citizen has filed a request under the Freedom of Information Act, 5 U.S.C. § 552 (1982) & Supp. V (1987) and DOE's regulations implementing the Act, 10 C.F.R. § 1004, seeking access to these materials. See June 23, 1990 letter to Freedom of Information Officer, Exhibit ("Exh.") A.

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	II. The DEIS does not adequately discuss alternatives to the proposed action.	
L-58-03	The DOE's failure to use current information in identifying the need for the proposed restart of the SRS reactors not only strains the credibility of the agency's decision-making prowess, but it also improperly circumscribes the discussion of the proposed project alternatives. An adequate discussion of alternatives necessarily depends on the demonstrated need for tritium. If the actual demand is other than that now postulated by the DOE, numerous alternative methods of satisfying the actual requirements, not currently mentioned in the DEIS,	Please see the response to Comment L-02-01 on the need for tritium. DOE considered the alternatives in the light of the 1990 NWSM and the reduced-demand case.
L-58-04	e.g., recycling of nuclear materials from obsolete weapons or variations in maintaining one or more of the reactors in "cold standby" status, may be available. The environmental effects of all these alternatives must be given meaningful consideration in the DEIS if the document is to satisfy NEPA's requirements. Without up to date information on the "need" issue, there is no basis for the DOE's conclusion that "there are no reasonable alternatives to the continued operation of K-, L-, and P-reactors to meet nuclear materials requirements." DEIS at 2-3.	Please see the response to Comment L-15-06 on recycling.
L-58-05	The DOE's "no reasonable alternatives" attitude has engendered a totally inadequate discussion of even those limited alternatives cited in the DEIS. Initially, the agency errs in equating the proposed action with the "no action" alternative. Id. at 2-4. Although none of the reactors are currently operating, the DOE contends that the proposed restart constitutes the status quo. Building on this erroneous premise, the DEIS then fails to consider the true no-action alternative, i.e., continued shutdown, in violation of the CEQ implementing guidelines. See 40 C.F.R. § 1502.14(d).	The EIS also considers termination of operation of all three reactors.
L-58-06	Furthermore, the DEIS fails to give any serious consideration to the alternatives actually proposed in the draft. For example, the DOE dismisses the alternative of terminating the operations of one or two of the reactors with the conclusion that "the production capacity of two SRS reactors is insufficient to meet the projected requirements for nuclear materials," despite its acknowledgment that current projections of need have not yet been formulated. DEIS at 2-63. The DEIS invokes the same rationale for rejecting the	Please see the response to Comment L-48-04 on no action.

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L-58-07	alternative calling for termination of all three reactors. Id. at 2-66. The discussion of "Other Production Options" has also admittedly not "been analyzed in detail," once again on the basis of the outdated need projections. Id. Under the relevant CEQ guidelines, the discussion of alternatives "is the heart of the environmental impact statement." 40 C.F.R § 1502.14. Because the DEIS in this case fails to "[r]igorously explore and objectively evaluate all reasonable alternatives" to the proposed action or to "[d]evote substantial treatment to each alternate ... so that reviewers may evaluate their comparative merits," it does not satisfy the agency's responsibilities under NEPA. See id. at § 1502.14(a), (b).	Please see the response to Comment L-02-01 on the need for tritium and other nuclear materials.
	III. The DEIS proposes to restart the SRS reactors in the absence of any reliable estimates of the risks attendant upon operation of the facilities and despite known safety problems.	
L-58-08	The DEIS contains an inadequate discussion of the safety issues associated with the proposed restart of the SRS reactors. For example, while the document purports to address the safety concerns and technical recommendations included in a joint report prepared by the National Academy of Sciences ("NAS") and the National Academy of Engineering ("NAE") on the SRS reactors in the wake of the Chernobyl accident, it nevertheless concludes that restart can occur prior to the implementation of many of the NAS/NAE's fundamental proposals. See DEIS at 2-47-55.	Please see the response to Comment L-05-02 on reactor safety.
L-58-09	In this vein, the DOE states a commitment to the use of "probabilistic risk assessment ('PRA')" methodology in "evaluating the ways in which failures in components, systems,and human performance can propagate; estimating the likelihood of alternative failure sequences that can lead to significant consequences; and calculating the consequences associated with a defined accident sequence and probability," but expressly acknowledges that the PRA process will not be finished prior to the proposed restart date. Id. at 2-51-52. "The PRA is part of the continuing safety improvement process; it is not scheduled for completion before the resumption of production." Id. at 2-52. Similarly, with respect to the NAS/NAE's concerns about severe accidents at the site, the DOE states that it "has initiated a	Please see the responses to Comments L-05-02 on reactor safety and L-44-16 on the availability of the PRA. The NRC does not require commercial nuclear powerplants to complete a PRA (or "Independent Plant Evaluation") before operating at power. As indicated in Sections 2.1.3 and 4.1.3 of the EIS, the information gained during the preparation of the PRA has been included in the plans for safety upgrades in both reactor hardware and procedures.

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	program to implement the recommendations," but that it "is not scheduled for completion before the resumption of production..." Id. Specifically, neither the experimental program designed "to develop more information about elements of severe accident behavior that are specific to the SRS reactors," nor the full-fledged "Severe Accident Assessment Program" designed to develop "accident management procedures to aid the operators in making decisions on possible courses of action," will be completed before the DOE intends to restart the SRS reactors. Id. at 2-52-53.	
L-58-10	The DOE takes the same position with respect to a number of the other recommendations enunciated in the NAS/NAE report. While on the one hand acknowledging the importance of the issues, the agency characterizes implementation of the proposals as part of "the continuing safety improvement process," which need not be completed prior to restarting the reactors. See id. at 2-53-54 (a study of the impact on confinement systems from a severe accident, the possibility of explosive mixtures from hydrogen generation in the event of core melting, and certain improvements in emergency training procedures and quality assurance programs will not be completed before operations are resumed).	Please see the response to Comment L-05-02 on reactor safety.
	In the absence of a completed PRA process, and in light of the known safety problems associated with restarting the SRS reactors which the agency admits will not be corrected prior to resumption of operations, there is no justification for the DOE's proposed action. At a minimum, the PRA Level I-III process should be completed and all of the safety recommendations proposed by the NAS/NAE and the Advisory Committee on Nuclear Facility Safety implemented before any decision to restart the reactors is seriously considered.	
	IV. The DEIS fails to consider the impacts of resuming operations at the SRS in the broader context of the DOE's nuclear weapons modernization plans.	
L-58-11	The proposal to restart the SRS reactors cannot be viewed in isolation from the DOE's overall nuclear weapons program. The DOE is currently preparing a comprehensive "modernization" plan for its entire nuclear weapons complex, which is expected to identify the plant capacities the agency believes it will require to meet future nuclear materials needs. See "Statement by Congressman David Skaggs, Skaggs Amendment to Withhold Funding for PRMP," Exh. B	The continued operation of the SRS reactors is proposed to meet the requirements established by the most recent NWSM, and considers a potential reduced-need scenario, as identified in Section 1.2 of the EIS.

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	hereto. The DOE expects to submit this plan to Congress along with its proposed budget early in 1991. Id.	
L-58-12	Despite the relatively imminent publication of this comprehensive plan, however, the DEIS fails to address how the proposed restart of the SRS reactors comports with the plan's objectives. No decision to restart the SRS reactors can reasonably be made in the absence of this analysis. Before irretrievably committing the enormous resources necessary to implement the proposed action and possibly foreclosing future options, the DOE must evaluate the proposal within the broader context of its overall modernization plans. The United States House of Representatives has recently recognized the importance of this integrated approach to decisions involving nuclear weapons facilities in voting to postpone the availability of funds for the Plutonium Recovery Modification Project proposed for the DOE's Rocky Flats facility until publication of the DOE's master plan. See "House Votes to Withhold Funds for Nuclear Plant," The Washington Post, p. A14 (June 20, 1990), Exh. C. Responsible decision-making and the wise utilization of resources requires that the DOE adopt the same approach with respect to the proposed resumption of operations at the SRS.	The modernization plan, which is now known as the reconfiguration plan, will be the subject of a separate EIS.
L-58-13	The DEIS is also deficient in its consideration of the SRS restart proposal as it affects the proposed Waste Isolation Pilot Project ("WIPP"). While the draft states that some of the nuclear wastes generated by resumed operations at the SRS will be processed for offsite disposal at the WIPP, it fails to acknowledge the nascent status of that facility. See DEIS at 3-61. Before the WIPP can even open, the DOE must obtain a "no-migration variance" permit from the Environmental Protection Agency and Congress must pass legislation transferring the land proposed for the facility from another federal agency to the DOE. See "Energy Department Falters on A-Arms Production," The Washington Post, p. A10 (June 9, 1990), Exh. D. There is no guarantee that the facility will receive the necessary approvals or ever become fully operational. The DEIS' reliance on this facility as a potential repository for wastes generated at the SRS is unfounded and represents yet a further proposal made in the absence of consideration of the DOE's overall nuclear weapons program.	DOE has not conditioned the resumption of production at SRS reactors on the availability of the WIPP. Although that facility is expected eventually to be able to accept SRS TRU wastes, SRS can provide the interim retrievable storage for such wastes needed until WIPP or an alternative becomes available.

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	CONCLUSION The DOE's DEIS on the proposed restart of the nuclear reactors at the SRS fails to satisfy the agency's obligations under NEPA. The agency's failure to substantiate the need for the proposed action precludes any meaningful analysis of the project or the proposed alternatives. The DOE should complete the PRA process, implement the safety recommendations identified in the NAS/NAE report on the SRS reactors, await completion of the agency's comprehensive modernization plan for its nuclear weapons complex, and then prepare a revised DEIS on the proposed project which addresses all the salient issues. See 40 C.F.R. § 1502.9(a). Sincerely, Suzanne S. La Pierre Attorney for Public Citizen Enclosures cc: Rep. David E. Skaggs (D. Colo.) [Ms. La Pierre attached two documents to her written statement, a letter to the DOE FOIA officer, and a statement made by Congressman David Skaggs (D-CO) to the House of Representatives on June 19, 1990.]	

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	June, 23, 1990 Freedom of Information Officer Department of Energy Savannah River Operations Office P.O. Box A Aiken, South Carolina 29802 Re: Freedom of Information Request Dear Sir/Madam: This is a request pursuant to the Freedom of Information Act, 5 U.S.C. § 552 et seq., and the Department of Energy's ("DOE's") regulations implementing the Act, 10 C.F.R. § 1004, on behalf of Public Citizen. To assist you in processing this request, I have hereafter briefly summarized the salient facts and the materials which we seek. In May 1990, the DOE released a draft environmental impact statement ("DEIS") on the "Continued Operation of K-, L-, and P-Reactors, Savannah River Site ("SRS"), Aiken, South Carolina, for review and comment by the public. As part of the DEIS, the agency identified two appendices. See DEIS at xvii; id. at A-1, B-1-17. Although Appendix A "provides a quantitative discussion of the need to produce nuclear materials, including impacts of termination of one or two reactors in the immediate future, termination of K-, L-, and P-Reactors in the immediate future, and other production options," and thus contains information essential for evaluating the need for proposed action and the attendant environmental impacts, the agency has withheld the materials included in the Appendix stating that they are "classified." See id. at 1-1, 1-2, A-1. On behalf of Public Citizen, I request a copy of all the materials constituting Appendix A to the aforementioned DEIS. In addition, to the extent the following documents are not part of Appendix A, I also request the DOE to provide Public Citizen with copies of the Nuclear Weapons Stockpile Memorandum ("NWSM") approved by President Reagan on January 19, 1989 and the 1990-1995 NWSM, as identified on page 1-3 of the DEIS, as well as all documents, memoranda, studies, reports, or other records within the DOE's	

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	possession which are part of, or relate to, the "probabalistic risk assessment" ("PRA") for the SRS production reactors as discussed on pages 2-51-52 and 4-72 of the DEIS. I also request a waiver of fees associated with the processing of this FOIA request. See 5 U.S.C. § 552(a) (4) (A); 10 C.F.R. § 1004.9(a) (8). Public Citizen is a non-profit organization that publishes Public Citizen magazine, which has over 45,000 subscribers, many of which are universities and libraries that will circulate this information to their patrons. Disclosure of the requested information would contribute significantly to public understanding of the government's decision-making process in pursuing its nuclear weapons agenda. Moreover, Public Citizen has no commercial interest in the requested information. See id. Thank you in advance for your assistance. I will expect a response from you within 10 days as the law provides. See 10 C.F.R. § 1004.5(d). Very truly yours, Suzanne S. La Pierre Attorney for Public Citizen	

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	STATEMENT BY CONGRESSMAN DAVID SKAGGS SKAGGS AMENDMENT TO WITHHOLD FUNDING FOR PRMP June 19, 1990 Mr. Speaker, I am offering a amendment that would keep the Department of Energy (DOE) from using funds in the bill to start work on its proposed Plutonium Recovery Modification Project (PRMP) at the Rocky Flats Plant in my district until 30 days after Congress receives DOE's revised weapons complex "modernization" plan. DOE expects to submit this plan with its budget early next year. I supported the Schroeder amendment that we just voted on, to cut all funding in the bill for PRMP, because of some serious questions I and many people in Colorado have about PRMP. Since that amendment failed, I am offering an amendment that would not remove funds, but would instead put a fence around those funds until Congress receives DOE's revised modernization report. I believe that this approach is an appropriate one that gives Congress some assurances that what DOE does on PRMP will be consistent with its long-term modernization plans. My amendment would keep DOE from proceeding with design and procurement for the PRMP facility before it finishes its overall plan for the future of the weapons complex, and before Congress gets a chance to review that plan. It's important for us to see the modernization plan first because the plan is supposed to lay out the plant capacities DOE thinks it will require to meet future nuclear materials needs, and what changes will be needed in the design of the weapons complex. This is especially important because DOE's first version of the plan, issued early in 1989, called for closing Rocky Flats entirely and moving its functions elsewhere. DOE's modernization plan should enable an answer to the questions: Does it make sense to put a new, billion-dollar facility at a site you plan to move out of? And, if not, what are you going to do? Move out of Rocky Flats, and build PRMP elsewhere? Or, stay at Rocky Flats for the long-term, and build PRMP there? We in Congress need the answers at the <u>outset</u> of projects like PRMP, not later down the road, after a few hundred million have been spent.	

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	As I have mentioned before, there are also some other troubling aspects to the proposed PRMP project: 1. Costs have risen by over 60% since last year; 2. DOE documents state that they've assessed the need for PRMP based on the assumption that no START treaties will be signed. Obviously, these documents were written before we knew the Cold War was winding down. But since Presidents Bush and Gorbachev signed conceptual agreements on the first START treaty just eighteen days ago, this assumption is out of date, and so may be the entire PRMP project; and, 3. PRMP is being designed to use technologies that are still not fully proven at production scale operations. My amendment to put a "hold" on PRMP would give DOE the time to reexamine the project and deal with these multiple problems having to do with project costs and justification. It also makes sure that Congress and DOE proceed with PRMP only after we know the whole picture, after we see the modernization plan, after we have the proper context for a billion dollar decision. This "hold" costs us very little, but it gives Congress and DOE a valuable chance to reevaluate this project. I would like to thank Energy and Water Subcommittee Chairman Bevill for all the help he has given me in fashioning this amendment and for his support on the amendment. He and his subcommittee have done an excellent job on this bill, which I support.	

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	A14 Wednesday, June 20, 1990 The Washington Post	

House Votes to Withhold Funds for Nuclear Plant

Master Plan on Weapons Program Required

By Dan Morgan and Mike Ybarra
Washington Post Staff Writers

The House voted 413 to 7 yesterday to withhold funds for a proposed plutonium reprocessing plant at Rocky Flats, Colo., until the administration completes a comprehensive long-term plan for rehabilitating its nuclear weapons program.

The restrictions, contained in an amendment to the fiscal 1991 energy and water appropriations bill, were offered by Rep. David E. Skaggs (D-Colo.) and amount to a compromise with the administration. The Department of Energy has argued that the reprocessing plant will provide a medium-term solution to the problem of handling the nation's plutonium wastes while it wrestles with ways to handle them beyond the year 2010.

The main bill, the first appropriations measure to reach the floor this year, passed on a vote of 355 to 59 late yesterday, with strong support from dozens of districts that will benefit from its public works and science projects.

Earlier, Republicans made a futile effort to strip out provisions that establish Democratic-supported budget guidelines for all this year's appropriations bills. The guidelines, contained in a budget resolution passed earlier by the House but not the Senate, slash defense spending by $30 billion and reallocate about $16.1 billion to initiatives in child care, health, veterans services and other areas.

The two key procedural votes went against the Republicans 260 to 157 and 276 to 136, generally along party lines. Also defeated easily were a series of proposals to cut the bill across the board by 10.5 percent, 5 percent and finally 2 percent.

While many members sympathize with Colorado's difficulties with the Rocky Flats facility, many also worry that other states could be adversely affected if plutonium reprocessing remains blocked.

Before approving the Skaggs amendment, the House refused to kill $65 million in planning and design money for the plant, as proposed in an amendment offered by Rep. Patricia Schroeder (D-Colo.). The vote was 278 to 142.

The new plant would recover plutonium from nuclear waste and scrap, as well as from decommissioned nuclear weapons. It would replace an aging plant where reprocessing activities have been halted, and the administration says it would sharply reduce radiation exposure of plutonium workers.

But Skaggs and Schroeder argued that it made no sense to proceed until the administration has completed a master plan for modernizing nuclear activities. DOE officials said this plan, begun under pressure from environmental groups, will be ready early next year.

On a voice vote, the House also passed an amendment offered by Rep. James H. Scheuer (D-N.Y.) adding $1 million to a small program aimed at reducing U.S. exports of bomb-grade enriched uranium that could fall into terrorists' hands. It reprocesses highly enriched uranium into lower-grade material that can still be used in research reactors in several European countries, but cannot be used for bombs. The Scheuer amendment would also offer technical assistance to foreign importers in converting reactors to use the lower-grade fuel.

Staff writer Thomas W. Lippman contributed to this report.

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	A10 Saturday, June 9, 1990 The Washington Post **Energy Dept. Falters On A-Arms Production** *Target Dates for 3 Projects May Not Be Met* By Thomas W. Lippman Washington Post Staff Writer Under relentless pressure from environmental groups, legislators and its scientific advisers, the Energy Department appears to be faltering in its drive to resume full operation of its weapons manufacturing complex. Recent developments have raised new questions about the department's ability to meet target dates for three critical projects: resuming plutonium processing at the Rocky Flats, Colo., plant; opening a nuclear waste storage facility in New Mexico known as the Waste Isolation Pilot Project (WIPP), and restarting the nuclear reactors at the Savannah River, S.C., plant. • Failure to restart Rocky Flats and Savannah River would undermine the Energy Department's ability to meet the Defense Department's nuclear weapons production targets later this year, according to DOE officials and members of Congress. • This week, Energy Secretary James D. Watkins's Advisory Committee on Nuclear Facility Safety strongly urged a delay of at least six months in restarting Rocky Flats, and questioned the advisability of operating the facility at all. • Rocky Flats, outside Denver, produces plutonium triggers for nuclear weapons. It has been plagued by environmental and safety problems, including discovery of 42 pounds of potentially lethal plutonium in the plant's ventilation ducts. • EG&G Corp., the contractor that took over operation of Rocky Flats after its plutonium processing line was shut down in December, has proposed to restart by July 1. But the advisory committee told Watkins that "many problems remain in attitudes, in procedures development, in training, in waste management and in cleanup." The committee, chaired by former nuclear regulatory commissioner John F. Ahearne, called for "wholesale retraining and testing of the Rocky Flats work force." It said plutonium in the ducts "should be removed. . . This will be a time-consuming chore which could significantly delay the resumption of plutonium processing operations." The next day another committee, the Defense Nuclear Facilities Safety Board, recommended that the Rocky Flats restart be postponed until the Energy Department has demonstrated that the "fissile material"—plutonium—will not explode or otherwise injure workers at the plant. By law, the Energy Department has 45 days to respond to this board's report. If the board is not satisfied with the response, it can take its findings to President Bush. Watkins responded by ordering an "operational readiness review" of Rocky Flats. He said that would include technical inspections and public hearings and should take six weeks. Watkins reiterated that whenever production demands clash with safety concerns, safety will prevail. But the review order did not address another Rocky Flats problem raised by Ahearne: what to do with the plant's waste. Ahearne said the plant would have to shut down again less than six months after restart when it reaches waste storage limits imposed by Colorado. The Energy Department wants to move Rocky Flats waste to storage in salt caverns at WIPP. But before WIPP can open, the department needs a permit from the Environmental Protection Agency, known as a "no-migration variance," and legislation from Congress that would give it land owned by another federal agency. Sen. Pete V. Domenici (R-N.M.) is opposing the legislation, for economic and environmental reasons. The proposed EPA permit has been "taking heavy fire at public hearings in New Mexico." Watkins wrote EPA Administrator William K. Reilly in December asking quick action on the permit request. In a handwritten postscript, he said, "Bill: This is my top priority." But Reilly responded that "there are certain necessary regulatory steps that we have to complete" and that the variance petition raises "technically and legally complex issues." EPA has never granted a petition of the type sought by DOE. At a public hearing last month, an environmental group made public an internal EPA memorandum warning that wastes of the type generated at Rocky Flats might explode because of a gas buildup. James D. Werner, the Natural Resources Defense Council engineer who disclosed the memo, said yesterday that "EPA will have very serious problems" in certifying that the wastes would not "migrate" beyond the storage caverns. Meanwhile, testimony at public hearings about the environmental impact of restarting the Savannah River reactors, the nation's only source of the radioactive gas tritium used to boost explosive power of warheads, made clear that environmental groups will sue on several grounds if the Energy Department proceeds. The department set January as its target for restarting one of the three reactors shut down for safety reasons since 1988.	

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L-59	A PETITION [CONTAINING 85 NAMES]	
	TO: Mr. S. R. Wright, Director Environmental Division U.S. Department of Energy	
L-59-01	We, the undersigned, note with pleasure that South Carolina's Savannah River Plant has been closed because it has been releasing toxic contaminants, and that a decision will be made on June 25 as to whether or not the plant should remain closed.	The SRS has been in operation continually since its beginning about 35 years ago. During that period, elements of the Site have been shut down for modifications or for lack of need over varying periods of time. For (approximately) the past 2 years, K-, L-, and P-Reactors have been shut down for modifications. This EIS deals with the continued operation of those reactors. DOE plans to publish the Record of Decision on the continued operation of K-, L-, and P-Reactors no sooner than 30 days after a notice is published in the Federal Register on the filing of the Final EIS with the U.S. Environmental Protection Agency.
L-59-02	In view of international developments, there is no longer a need to increase our nuclear weapons stockpile. Because re-opening the plant will add to the radioactive contamination of the surrounding environment, we urge you to take all necessary steps to assure that the Savannah River Plant remains closed.	The need for nuclear weapons is beyond the scope of this EIS. Also, please see the response to Comment L-06-02 on waste management and environmental restoration.

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DOE/EIS-0147D
L- 59

[PETITION]

JUN 22 RECD

TO: Mr. S. R. Wright, Director
Environmental Division
U.S. Department of Energy

We, the undersigned, note with pleasure that South Carolina's Savannah River Plant has been closed because it has been releasing toxic contaminants, and that a decision will be made on June 25 as to whether or not the plant should remain closed. In view of recent international developments, there is no longer a need to increase our nuclear weapons stockpile. Because re-opening the plant will add to the radioactive contamination of the surrounding environment, we urge you to take all necessary steps to assure that the Savannah River Plant remains closed.

Betty White 3593 Monroe Ave, Pittsford NY 14534
[illegible] [illegible] [illegible]
Mary Jordan 114 Wolf Drive East Rochester NY 14445
Marilyn Miller 65 Hale Terr. Rochester NY 14610
[illegible] [illegible] [illegible] NY 14624
Patricia Adler 4141 East Ave Rch NY 14610
[illegible] Adler 4141 East Ave 14610
[illegible] 4814 Warner 14626
Elaine Valentine 54 West Church St, Fairport, NY 14450
TIMOTHY J. HAY 21 E. JEFFERSON CIRCLE [illegible] NY 14
KRISTEN GLEASON 216 LINDEN ST. ROCHESTER NY 14620
[illegible] [illegible] 24 Dorset Rd Pittsford NY 14534
Brian Sawyer 8 Washington Ave NY 14534
Otto Merell 7 West Bloomfield Rd. Pittsford NY 145
Sean Daiwell 20 Bay Colony Dr. Pittsford NY 145
[illegible]
Sandra Hattenday [illegible] Monroe NY 14516
Solange Cicero Arnold 111 East Ave #733 Rochester NY 146
Jay Arnold 111 EAST AVE #733 Rochester NY 146

Table C-5. DOE Responses to Comments on Draft EIS

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	PETITION TO: Mr. S. R. Wright, Director Environmental Division U.S. Department of Energy We, the undersigned, note with pleasure that South Carolina's Savannah River Plant has been closed because it has been releasing toxic contaminants, and that a decision will be made on June 25 as to whether or not the plant should remain closed. In view of recent international developments, there is no longer a need to increase our nuclear weapons stockpile. Because re-opening the plant will add to the radioactive contamination of the surrounding environment, we urge you to take all necessary steps to assure that the Savannah River Plant remains closed. [illegible] 65 Rolland Rd Pittsford NY 14534 Susan Pearman 234 West Ave E Rochester NY 14445 Megan Reich 215 East Brook Rd Pittsford Russell Wagner 37 Shire Oaks Dr. Pittsford 14534 Eugene E. Rogers 20 Church St. Pittsford, NY 14534 [illegible] 3 [illegible] Rd [illegible] [illegible] 25 [illegible] [illegible] [illegible] 324 [illegible] Rd Brockport 14420 [illegible] 283 [illegible] Rd 14472 Roofi Tabir 14 Wood Stone Rise 14534 Nor Helen 24 Remsdeen Dr Pittsford 14534 Sally Chamberlin 7 Boughton Ave Pittsford 14534 [illegible] 88 Pleasant St Webster 14580 Robert Walter 52 Rodney St, Rochester 14607 [illegible] 70 Cunningham Rd 14534 [illegible] 195 Rolland Rd Pittsford 14534 Robert [illegible] 200 Monteroy Rd Roch 14617 [illegible]	

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Naina Khanna 14 Lancashire Way Pitt 14534
Megan Stamis 74 Copperwoods Pittsford 14534
Jen Clark 24 Chatham Wds. Pittsford 14534
Laura Myers 23 Santa Dr Pittsford 14534
Andrea Smith 5 Red Oak Lane Pittsford 14534
Ann McGlmsey 381 Woodland Road Pittsford 14534
Ruth Gilbey 1201 Genesee Park Blvd R.L NY 14619
Stephanie Taylor 241 OXFORD STREET Roch NY 14607
[illegible] 10 Stonegate Ln Pittsford 14534
Melissa Jackson 20 Carriage Cl Pittsford 14534
Nancy Khanna 14 Lancashire Way Pitt 14534
Vanessa Kaye 18 Round Trail Dr Pittsford 14534
[illegible] 2 Stonegate Ln Pittsford
Jeremy Meyer 6 Washington Ave Pittsford
[illegible] 14 ELMBROOK DR. PITTSFORD
[illegible] 31 Dutton Point Pittsford 14534
Becky Clark 24 Chatham Woods Pittsford 14534
Jennifer Clark 24 Chatham Woods Pittsford 14534
Chris Clark 24 Chatham Woods Pittsford 14534

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Caroline [illegible] 23 Sarle Dr. Pittsford N.Y. 14534
Kathy [illegible] 127 Dver [illegible] Rochester N.Y. 14621
Geoffrey Schmidt Prospect Hill Rd Yorkville NY 13495
John Veeder 195 Woodland Rd " " "
Vania Tseng 17 Thornwood Cir Pittsford, NY
Bach Peer 273 West Squaw Dr - Rochester, NY 1462
Becky Samuell 412 S. Lincoln Rd E. Rochester NY 1444
Cathy Scunzosi 11 Hoeksen Rd Pittsford N.Y 14534
Scott Kimmey 46 Dover St. Glen Falls N.Y. 12801
Monika Eulckert 23 Old Lyme Rd, Pittsford, NY 1453
Elizabeth Ayers 73 Sant [illegible] Pittsford N.Y.
Eric Mattie 264 Woodland Rd.
Daniel Kane Greenville Pitt N.Y.
Jacqueline Domin 32 Norton St. Honeoye Falls NY
Julie Bailey 2 Cranough Lane, Rochester NY 146
Yette Rogers 47 Northfield Gate Pittsford NY 14534
Michelle HAWKS 144 Harwood circle, Roch. 14623
Carole Sarmer 28 Buckland Dr. Pittsford NY 14534
Kathleen P. Fratta 198 Click Ave Roch NY 146

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Susan Hilmit 384 Meadowlark Rd. Clifford, N.J. 14
Doug Sheppard 1180 Bay St. Roch NY 14609
Jack Tosch 133 Kilbourn Rd. Roch NY 14618
Olivia Dolan 115 Rosewood Ter. Roch. N.Y. 14609
Judy Drum 4095 East Ave. Roch NY 14
Richard Lontang 205 Rutgers St., Roch, N.Y. 14607
Jonia Dunn 39 Cursenary Circle
Earl Coby 224 Elm St. Roch, NC 2
Melanie Moon 105 S Washington St. Rochester, NY 1460

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Comment Number	Comment	Response
L-60	COMMENTS OF JANE TOLLISON AND VIRGINIA ROBARDS	
	This is our third presentation to be submitted for publication without amendment in regards to the department of energy's environmental impact statement:	
L-60-01	We noticed that you did not address need, intentionally ignoring it, an item that many speakers have voiced a major concern for. After examining the DOE's EIS for the SRP, we find that the need for peace (synonymous with noncontamination) is overlooked - that the necessity for producing nuclear weapons, which would contaminate the American land that we love, is a given. We do not accept the given assumption that SRP is desired or needed. We do not accept nuclear weapons as the deterrent to differences in ideology; therefore, the entire premise on which the facility exists - that there is a need - is a false one.	The need for nuclear weapons is beyond the scope of this EIS.
	Any industry which impacts negatively, that is, not naturally, on the environmental state prior to the industrialization of this nation has no need to be, especially an industry that affects living things molecularly. The plant's products and by-products are offensive to our world's creatures because they introduce abnormality to them. The creation of abnormality is illogical, and this is a reason the production of nuclear weapons at SRP must cease and the plant be decomissioned from any use: the changes that it brings to life and within the confines and surrounding areas of SRP are unacceptable to a viable and knowledgeable citizenry.	
	For the third time we request that SRP be decommissioned and decontaminated without further pollution of land, air, and water. Whatever is environmentally unsound is detrimental to life and therefore should cease.	
	You say the defense department determines the need to make weapons of such deadly calibre. We object to the Nazi mentality of "we just follow orders to destroy." Your negligence will kill us, but then so will your success.	

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Comment Number	Comment	Response
	Sincerely, Jane Tollison Virgina Robards	

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Comment Number	Comment	Response
L-61	COMMENTS OF JIM LOOMIS	
	Department of Energy	
	Re: DEIS regarding Savannah Reactor Startup;	
	Gentlemen;	
L-61-01	My name is Jim Loomis. I spoke for stopping all plutonium production and going to cold standby and disassembling all such capabilities in the year 2000 if conditions permit at the Savannah, Georgia public input hearing regarding the Deis: Reactor startup.	Comments noted.
	I am the director of the Cetacean Relations Society on the Island of Maui in Hawaii. I have been asked to speak on the behalf of slightly more than a trillion cetaceans over 60 million years representing a quadrillion whale years who regret that they are unable to physically attend this meeting but would like to register their considered opinions. It is this: Flukes against Nukes!	
	How can I presume to speak for Whales, you might ask, who are ever so much wiser than I? Gentlemen, I am a spokesman captive of the dolphins as they are entertainment captives of us in the oceanariums. I question their judgement in selecting me too, but here I am.	
	Though it has been my fervent wish to speak against the Savanah Blight for years, I knew nothing of this DEIS public hearing before this morning when I was driving to the Savanah Newspaper for a front page picture of myself, my associate Lana Miller, author of "Call of The Dolphin" and our car which is painted with a wrap around halo headed red, white and blue colored dolphin and "USA tour 89 to Save the Dolphin." As the picture and story describe, we were in Savanah to look for two dolphins, Joe and Rosie, who were released to the wild three years ago.	
	My life with Whales and Dolphins is the subject of Lana's book Chapter 20, Titled, "Living the Dolphin Lifestyle." Chapter 19 is called "Joe and Rosie Calling." Do you regard this as a strangefluke that our search for Joe and Rosie brings me as the next chapter to speak for them against Nukes? I do. My book,	

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Comment Number	Comment	Response
	STRANGEFLUKE is a history of 20 such dolphin and whale guidance incidents that I call "strangeflukes". Another such STRANGEFLUKE is that the day after completing a three month USA tour in 79 with a 120 foot hot air smiling whale balloon FLO to publicise the plight of the whales culminating in a white house appearance with President Carter and Japan's premier Ohira as covered in Life Magazine, I discovered the Anti-Nukes march was the following day, The next chapter. And being captain of the tour then, I created a huge red banner—FLUKES AGAINST NUKES—and our smiling FLO thus adorned led that parade. Having thus established in the most rigorous scientific manner my role as willing but captive spokesman for the whales, I continue. I speak for 60 million years of cetacean evolution producing the largest creature, the largest brain and the greatest largesse:—the Blue whale, The Sperm whale and the Dolphin. My organization through grants for 14 years has pursued ways to enhance relationships between human and Cetaceans. I have just spent a month swimming with wild dolpohins in the Bahamas. Though my specialty is skindiving to 100 feet with Pods of humans playing music generated by the changing body position distances and motion as a human/cetacean body language mode offering for their recognition I must say that not harpooning, or taking their food, or netting or plutoniumly radiating them to death are wonderful ways of allowing there to be cetaceans whose relations we can then enhance. The wisdom of this insight leads me to repeat: FLUKES AGAINST NUKES. NOW! Whale Conservation action dated from that year 1979; let us hope Life Conservation, i.e., No Nukes, no more plutonium, dates from this year. Please excuse my anger or seeming disrespect. I believe we are all doing our best this second, but new seconds continue to follow with the option of our changing course lest we arrive at where we are headed: A TOXIC UNLIVEABVLE PLANET!. May we all rise to this occasion. Peace will have enormous challenges for us all. To give up the further creation of plutonium monsters is only the first step. But we must take it NOW! Eternity is asking you to stand and be counted now. Now! For life! For	

Table C-5. DOE Responses to Comments on Draft EIS

Comment Number	Comment	Response
	millenia of unimaginable growth in peaceful, cooperative directions AND DIMENSIONS. Shut down Savanah! Don't let one second of worry about the jobless, including you, stay your decision. One half second is O.K. ABSOLUTELY NO FURTHER CREATION OF PLUTONIUM. Show us you can clean up your mess and we'll talk about it then. You clean up your room children, we'll talk about ice cream! That man after only a few hundred years of technological evolution would risk the Habitat destruction of these ancient creatures in the name of "national Security" must reflect upon our unspeakable arrogance, near total confusion regarding true priorities and unparalled shortsightedness. Sufficient plutonium to kill these large creatures and the sea's smallest, the phytophora, that dwell in the top two inches and provide most of our oxygen has already been dumped into the sea in barrels of lifetime 20 years over twenty years ago. The whales would like to politely suggest that these barrels assuring our common doom be located, recovered and sealed in ceramic using all available manpower and technology and at the greatest speed. That the Department of Energy would be wasting this historically irreversibly crucial time asking for public input on decisions they have already made for "national Security" reasons——when superpower leaders have agreed upon the end of the arms race shows either that the military industrial complex runs Bush and the world, or that the chain of command is broken or dangerously sluggish and irresponsive. To debate "How much more Plutonium to create" when the issue is "How to protect ourselves and all living beings from what has already been created?" is to indulge in Neroesque leisures only permitted the certifiably insane. That the DOE would even suggest an environmental impact statement procedure let alone purporting no environmental impact when we are talking about the most dangerously toxic location on the planet whose cleansing would require more than the entire toxic waste superfund is to create a cognitive dissonance so extreme it must be the tonalities of deliberate evil or a vision measured in microseconds or being generous, next week's paycheck. How much longer will the dreams of the many be countermanded by the nightmares of the few? On planet earth, this week, nothing more important is happening than that the south rise up against this	

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Comment Number	Comment	Response
	abomination that the North has placed in your backyard. These hearings on the Savanah reactor are of historical significance. Will peace get a chance? Will the million forms of life beside our own be heard, be considered in your equations of "National Security?" Nothing has been more destructive of Democracy than this absorption of the Monolithic DOE into the Military Industrial bureaucracy. I had a personal interview with Pres. Eisenhower in the whitehosue in 56. He spoke of this concern. He was right. I know what Eisenhower would say to this DEis. And I know what Einstein would say. And I know what most of you would say if you didn't think your job depended upon it. Think Globally now. Act locally now. Quit the imagined dictates of your lousy job and do the right thing. I hold a masters in mathematics, taught in the University of california and have taught Einstein's relativity for ten years. I have watched the beautiful questions and mathematical apparatus reveal the amazing relationship of energy to mass as a sole consequence of the constancy of the speed of light. This energy form is surely part of man's destiny. But it is for starship drive and manufacturing in outer space where there are not currents of air or water to distribute it. Into the watery flesh of air breathing creatures. WAKE UP NOW! Say NO to Savanah startup and yes to shutdown of all plutonium creating devices. Wrong planet. Right time to act for all of life. Last month President Bush journeyed to Florida to give a "Thousand points of Light" award to "Reef Relief" for their efforts in protecting the reef. The Next week the Navy announced they would be bombing within a mile of this area of America's last living fast dying reef to test three new classes of exotic weapons before they became operational. Pardon? Crying in frustration is justified. Do it. Then phone the white House and tell their Man. Then get on TV under some pretext and ask people to call the Pres. Give them the number. We did. In two weeks, the Navy called it off. Till we aren't looking. Keep looking. President Bush, please phone the DOE now and call off anymore creation of plutonium. EITHER YOU ARE LYING OR THEY AREN'T GETTING YOUR MESSAGE.	

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Comment Number	Comment	Response
	Surely our deep lack of gentlemanlyness is being clothed and hidden by some paralyzingly difficult indistinguishable form of unwarranted respectability. Jim Loomis Director The Cetaceans Relations Society POB 958 Paia, Maui Hawaii, 96779	

Table C-5. DOE Responses to Comments on Draft EIS

Comment Number	Comment	Response
L-62	COMMENTS OF J. PAUL RUTTER, III 806 RIVER VIEW DRIVE NORTH AUGUSTA, SC 29841 June 14, 1990 Mr. S.R. Wright Director Environmental Division U.S. Department of Energy Savannah River Operations Office P.O. Box A Aiken, SC 29802 Dear Sir, The enclosed is a copy of a current letter to my Senator, Senator Thurmond, concerning the Nuclear Plant at SRS. After reading the environmental Impact Statement on the issue I have serious questions concerning why we are going to start the tritium manufacture again. If it matters, I am in favor of closing the entire Savannah River Site to Nuclear measures. With all the money spent just to get the plant ready for production, we don't need to waste any	
L-62-01	more. The tax money should be used for research of non-fossil fuels. If you have any questions please let me know. Sincerely, J. Paul Rutter, III	Alternative uses of funds unrelated to the purpose and need for the proposed action are outside the scope of the EIS. Please see the response to Comment L-02-01 on the need for tritium.

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Comment Number	Comment	Response
	J. Paul Rutter, III 806 River View Drive North Augusta, SC 29841 June 14, 1990 The Honorable Strom Thurmond United States Senate Senate Office Building Washington, D.C. Dear Senator Thurmond, I want to let you know of my concern for the nuclear industry here in Aiken County, South Carolina and the entire world, since the world feels the effects of Aiken's nuclear activities. I am scared! Yes, scared of the fall out from nuclear catastrophies and the by-products from the development of tritium. The waste from the production lasts forever in relative terms to human longevity here on planet earth. We continue to manufacture the products, yet we do not have any methods for its disposal. I am worried about the damage to our community from tritium and it's by-products. Senator Thurmond, I don't speak as one who has been influenced by the press or the current popular cause to support. I spent six years in the Navy serving on board nuclear submarines as an engineer. I attended the Navy's nuclear power school. I know nuclear theory, its practices, strengths and its weaknesses. One of my former bosses is now the head of the Energy Commission. My nuclear background is the same as Admiral Watkins. There are so many ex-nukes that do not support nuclear power. Of the Navy "nukes" I know, they are scared of nuclear power too; but because they now have families, they have to provide support for them in some manner so they work at the Savannah River Site. We have spent almost 2 billion dollars getting the plant ready to produce tritium. That money could have been spent in the research of non-fossil fuels for our needs.	

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Comment Number	Comment	Response
	Being an ex-Navy man, I can appreciate the need for a strong defense. I believe that Reagan and his strong America tactics caused the Soviet bloc to tumble. But that's just it! They have tumbled. They are down. They can not afford to spend the money on defense and their general populations needs. We do not need to spend the money in the same manner either. Lessen the money going to Nuclear projects and we solve so many problems. Just sit back, be open minded for a moment and think of what we can do. My career and my other family member's careers probably depend on the plant being here in operation but we try to be bigger than worrying about just ourselves, just our generation. We need to perserve our humanity and our world. Please be brave and help with preventing the plant from starting back up. If I can help you in any capacity in this area please let me know. Sincerely, J. Paul Rutter, III	

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Comment Number	Comment	Response
L-63	COMMENTS OF FRED CAVANAUGH	
	Aiken Speaker A-5 June 13, 1990	
	Steve,	
L-63-01	Attached are comments I made at the morning session of the EIS hearing in Aiken S.C. (6/8/90). I spoke as an Aiken City Councilman and Mayor ProTem. Please make my comments a part of the official record. I want to be sure I'm heard on this matter.	Comments noted.
	Any questions please call me 5-3440.	
	Thanks, Fred Cavanaugh 5 Burgundy Rd Aiken, S.C., 29801	
	[Responses to Mr. Cavanaugh's comments are given in Aiken statement A-05]	

Table C-5. DOE Responses to Comments on Draft EIS

Comment Number	Comment	Response
	6/8/90 DOE Hearing on the EIS to Re-Start Reactors Mr. Chairman, Committee Members and Ladies and Gentlemen, My name is Fred Cavanaugh and I'm here to speak not only as a resident of the City of Aiken, but as a husband and the father of two young boys, a city councilman and Mayor Pro Tem of the Aiken City Concil, and as an employee of the Westinghouse Savannah River Co. Our family moved to Aiken in April 1953. We thought Aiken was a wonderful place to live then and now in 1990 we think it's an even better place to live and raise our family. My family is the most important thing to me on this earth. Believe me if I felt this area was environmentally unsafe or for another reason I wouldn't be sitting here now. To me one of the greatest testimonies that indicates the confidence in the Westinghouse Savannah River Co. and the safety at SRS is the fact that Aiken continues to grow, large numbers of retirees remain in Aiken and people continue to come to SRS to work. As Mayor Pro Tem I'm privileged to represent over 18,000 residents of Aiken. While I don't propose to speak for each one of them I can say that I have never had one person tell me that they oppose the SRS and or reactor restart. On the other hand I've had many residents express their support to SRS. Without question the vast majority of Aiken residents, including me, support the Savannah River Site and the reactor restarts as soon as the Dept. of Energy and the Westinghouse Savannah River Co. concur on the startup date. Mr. Chairman, I have neither heard nor seen any technically defensible reasons why these reactors should not be re-started. This site has been in operation now for almost 40 years and there has been <u>no</u> proven, factual negative effect on the environmental health of either the employees or the public in surrounding towns. While some people will try scare tactics, and comparisons with non-similar reactors, the same people are also willing to risk the disarmament of our country, I'm glad to see that our President, his administration, the Dept. of Energy and those that speak in support of re-start are not willing for our country to be open to this risk.	

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Comment Number	Comment	Response
	The facts are clear, the U.S. Nuclear defensive strength has been one of the most important factors for peace in the last fifteen (15) years. Our country, thank God, is still the leader of the free worth and must continue to be for many reasons. But, to be the leader we must continue to have a strong nuclear deterent - a deterent we hope and pray will never be used. I'd like to take a moment and address the area of safety. From an industrial safety standpoint, facts distributed in Oct. 1988 stated that an employee at SRS was approximately 20 times less likely to suffer personal injury than one would be at a typical commercial nuclear reactor power plant. Also, that one at SRS was approximately 3 times safer than at another typical DOE site. Concerning nuclear safety the records indicate that during the entire 38+ years of service at SRS there has never been an incident that put our surrounding communities at risk. And there has never been an injury or death related to a nuclear incident. This is a marvelous safety record. And if it's compared to others such as 50,000 traffic deaths a year, or an estimate of 5,000,000 children who smoke and are now living in our country who will die from smoke related disease this safety performance becomes even more important and significant. Yes, the facts prove that you and I are more likely to be injured in our cars going to and from the SRS than we are at work there. Likewise, the facts show that one receives more radiation exposure from natural causes each year, by a vast amount, than they would by working at or near SRS. Page 3-50 of the EIS Report shows on average we would get approximately 361.1 MREM from natural and medical causes compared to 0.1 MREM from SRS. Mr. Chairman and Secretary Watkins, this community has worked harmoniously with the SRS for almost 40 years, and SRS employees have been important citizens to this community, it has been a very good relationship, and we look forward to it continuing with no ill effects. I ask you to study the facts, and make your decisions based on the facts, and not the rhetoric and innuendos that you'll hear. Our nation needs these reactors up and running, our community supports it. Our country must continue to maintain a strong nuclear deterent.	

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	Thank you for the opportunity to express my thoughts. As one speaker said (The world is changing and one reason may be the strong nuclear deterant that the U.S. has had - lets not give it up)	

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Comment Number	Comment	Response
L-64	COMMENTS OF RITA A. FELLERS, M.S. DEPARTMENT OF GEOGRAPHY UNIVERSITY OF NORTH CAROLINA AT CHAPEL HILL CB # 3220 CHAPEL HILL, NORTH CAROLINA 27599-3220	
	COMMENTS ON THE DRAFT ENVIRONMENTAL IMPACT STATEMENT CONTINUED OPERATION OF K-, L-, AND P-REACTORS, SRP	
	Failure to Resolve the Atmospheric Pollution Issue	
	In my testimony at the Scoping Hearings for this Environmental Impact Statement, I detailed extensively several facts concerning atmospheric pollution emanating from SRP:	
L-64-01	1) Emissions plumes originating from SRP have been detected hundreds of kilometers from the facility.	DOE conducts thorough, extensive radiological and nonradiological monitoring of more than 8,000 square miles of the SRS environs, and reports the impacts to public health and the environment annually in the Savannah River Site Environmental Report. See Section 3.5.4 of the EIS.
L-64-02	2) Particulates, such as the finely divided uranium and plutonium particulates emitted from the chemical separations facilities as well as the carbon-14 emitted routinely from K, L and P Reactors, behave much differently in the atmosphere than gases due to the lee eddy effect on slopes lee to SRP. This is likely to cause greater than average concentrations of radioactive particulates on leeward slopes throughout South Carolina and Georgia.	The SRS monitoring program (please see the response to Comment L-64-01) considers these effects.
L-64-03	3) Wherever such particulates accumulate, a long lasting risk to the public health is also accumulating; however, to date no regionwide environmental surveys documenting particulate contamination have been released for public review. We do not know, in fact, whether such studies have ever been performed.	Section 4.1.2 discusses radiological releases projected to result from continued reactor operation.
L-64-04	4) Large quantities of such particles have been released over the operating history of the facility, and the Draft Environmental Impact Statement makes it clear that DOE intends to continue doing so.	Table 3-13 of the EIS presents cumulative releases of airborne particulates over the operating history of SRS.

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Comment Number	Comment	Response
L-64-05	Consequently, it is clear that a comprehensive, rigorous regionwide environmental monitoring assessment needs to be made to determine which areas are indeed receiving quantities of particulates sufficient to cause concern. Nowhere in the Draft Environmental Impact Statement (DOE/EIS 0147D) is there any indication that such a study will be undertaken, in spite of the fact that I and others called for the study during the Scoping Hearings. On page 3-31 the Draft EIS notes, The general patterns of airflow (and the nature of the terrain) governs transport direction and speed, whereas small-scale, random eddying of the atmosphere (i.e., turbulence) governs the diffusion of airborne material. Turbulence is indicated by atmospheric stability classification. Based on measurements by onsite instruments, the atmosphere in the SRS region is unstable approximately 45 percent of the time; it is neutral 30 percent of the time; and it is stable about 25 percent of the time. The SRP operators readily acknowledge the existence of turbulence and eddying, but they make no mention of the obvious fact that SRP emissions will not be restricted to the SRP site when returning to earth. Further, as the documentation concerning the lee eddy effect demonstrated, much eddy activity is not small-scale, nor is it random. It does, however, significantly affect the rate at which particulates deposit from the plume to the earth's surface where they can be inhaled and ingested by the general population. The testimony I submitted at the Scoping Hearing for this EIS listed three SRP technical reports which documented transport up to 100 km from the site (Pepper and Kern, 1976; Crawford et al., 1977; and Carlson and Garrett, 1982). Reports documenting transport of such distances are in fact much more numerous than these. Yet, the Draft Environmental Impact Statement neither acknowledges nor denies that there has been substantial offsite fallout transport. It simply ignores the issue. DOE is not proposing to make any effort to inventory the total areawide contamination pattern and map it. In spite of this, atmospheric emissions which DOE expects the K, L and P reactors to release to restricted areas are much higher than those permitted by commercial reactors by very large factors. Releases of unidentified beta-gamma sources, presumed by DOE to be	Please see the response to Comment L-64-03 on atmospheric releases.

Table C-5. DOE Responses to Comments on Draft EIS

Comment Number	Comment	Response
L-64-06	mostly strontium-90, are 41 times the allowed annual restricted-area release limits for three electric-generating reactors. Unidentified alpha releases (assumed to be plutonium-239) are expected to be 22 times the limits permitted for electric power reactors. Krypton-85 (metastable) releases amount to a huge 32,848 times those permitted by three power reactors, a difference of 5 orders of magnitude. Below, Table I lists the concentration values permitted by 10 CFR 20, Appendix B, illustrates multiplying by the factor of 6.3 x 100,000,000 ml (10 CFR § 20.103, footnote 3, p. 263) to obtain quarterly restricted-area limits, multiplies x 4 to obtain annual limits and multiplies again x 3 to obtain a limit for three reactors.	The 10 CFR 20 limits cited are for determining quarterly inhalation limits by workers in controlled areas, and are incorrectly applied to atmospheric emissions projected from the SRS reactors. These emissions benefit from atmospheric dilution factors that yield concentrations of radionuclides at and beyond the Site boundary, which are significantly below applicable limits, as described in Sections 4.1.2 and 4.1.6 of the EIS. Please see attached Table 1.
L-64-07	Especially in light of the tremendously high releases DOE expects K, L and P reactors to emit, the Department of Energy has an obligation to the people of South Carolina and Georgia to see that a rigorous regionwide assessment of soil-deposited particulates of SRP origin is performed, and a detailed map of the contamination executed, before it considers restarting the decrepit K, L and P Reactors. It is unconscionable that DOE would consider restarting these unsafe radiaoctive relics and compounding the regionwide contamination problem, before it has any idea what the dimensions of that problem actually are. Widespread contamination has been documented around Denver, Colorado consequent to Rocky Flats operation; around Fernauld, Ohio consequent to Feed Materials operation; and around Richland, Washington and the Columbia River Valley consequent to the operation of the Hanford site. To go blindly forward in South Carolina as if such a contamination pattern were not there is nothing short of blatant disregard for public health and safety.	Please see the response to Comments L-64-03 on atmospheric releases and L-64-06 on 10 CFR 20 limits.
L-64-08	The Draft EIS also failed to address the issue of additional emissions from the F and H chemical separators and other facilities which would increase were K, L and P reactors brought back online.	Section 4.1.6 of the EIS describes cumulative releases and their impacts.

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Comment Number	Comment	Response
	<u>Health Effects From K, L and P Reactor Operations</u>	
	The Draft EIS, on page 4-32, states that the BEIR V report quantifies that risks of fatal cancers in the general public would be higher by "three or four times" the factors used in BEIR III (1980). It notes that the EPA standard, which is 3.3 times the BEIR III factors, was used to quantify risks of fatal cancers in this study, and therefore the revisions compelled by BEIR V should not be far from the current estimates. It also states that the EPA risk estimator was 400 cancer deaths per 1,000,000 person-rem.	
L-64-09	These remarks underestimate the factors which BEIR V reports. BEIR reports, "[I]f 100,000 persons of all ages received a whole body dose of . . 10 rad of gamma radiation in a single brief exposure, about 800 extra cancer deaths would be expected to occur during their remaining lifetimes . . " (BEIR V, p. 162). 10 rad times 100,000 persons = 1,000,000 person-rem. This is twice the EPA estimate. Table 4-4 of BEIR V compares the two lifetime risk estimates from the BEIR III and BEIR V reports, and reports that leukemia risks are 4.4 to 5 times that of BEIR III, while nonleukemia effects are 4.8-18.3 times the two BEIR III models for males, and 4.6-12.7 times the BEIR III models for females. The Draft EIS does not state whether it was employing the absolute risk or the relative risk models from BEIR III. If it was employing the absolute risk models, then BEIR V would be yielding estimates 18 times greater for males and 12 times greater for females, over the BEIR III lifetime cancer risks. These differences in the factors force the conclusion that estimated cancer risks resulting from the restart of K, L, and P reactors are probably severely underestimated, in spite of the use of the EPA formula.	Section 4.1.2.6 of the EIS describes the relationship of the health risk estimator used in this EIS to the value recommended by BEIR V.
L-64-10	Because the formula for calculating total person-rems also depends on atmospheric diffusion models discussed above, an additional source of major error is introduced. In general, the atmospheric diffusion models heavily underestimate pollutant concentrations. Thus, person-rems delivered to the population will be much higher than anticipated by these atmospheric models.	The atmospheric diffusion models used for calculating the radiation doses were developed for the nuclear industry. Modifications were made to meet SRS-specific requirements.

Table C-5. DOE Responses to Comments on Draft EIS

Comment Number	Comment	Response
L-64-11	For these two important reasons, we cannot accept the estimates of lifetime fatal cancer risk to the general population as being anywhere near reasonable. The estimates contained in the Draft EIS are likely to be many factors too small. Conclusion Until the Department of Energy is willing to conduct the necessary regionwide soil survey, and appropriately revise its meterological and fatal cancer risk models, it cannot be trusted to make any reliable statements concerning consequent pollution and public health impact.	As noted in the response to Comment L-64-06, the estimates of offsite exposures made in the comment table are incorrect, as is Comment L-64-09 on the interpretation of BEIR V risks applied in this EIS, as described in Section 4.1.2.6. Accordingly, DOE is not persuaded by the commenter that population cancer risks are unreasonably underestimated.
L-64-12	Without an approximately accurate rendering of actual person-rems, the cost per person-rem of upgrades in safety equipment such as containment and confinement systems cannot be made. The Department should not be permitted to reopen these dangerous reactors with such emissions so high they would be illegal in any other context, while complaining that safety upgrades are too expensive, based on totally inadequate pollution dispersion and population exposure models. Literature Cited Carlson, D. C. and Garrett, A. J. Comparison of simulated to actual plutonium deposition at the Savannah River Plant. DP-MS-82-86. Aiken, S.C.: Savannah River Plant, 1982. Crawford, T. V., et al. Atmospheric transport of radionuclides. DP-MS-77-116. Aiken, S.C.: Savannah River Laboratory, 1977. Pepper, D. W. and Kern, C. D. Modeling the dispersion of atmospheric pollution using cubic spline and chapeau functions. DP-MS-76-83, Aiken, S.C.: Savannah River Laboratory, 1976. Committee on the Biological Effects of Ionizing Radiation, Health Effects of Exposure to Low Levels of Ionizing Radiation (BEIR V), Washington, D.C.: National Academy Press, 1990. Draft Environmental Impact Statement, Continued Operation of K-, L- and P-Reactors, Savannah River Site, Aiken, South Carolina. DOE/EIS-01470 May 1990.	The estimate of collective dose (from which cancer risks are derived) is judged to be the best estimate consistent with current modeling technology. Further, the transport models are generally validated by the results of the extensive monitoring program indicated in the response to L-64-01.

TABLE 1

Nuclide	10 CFR 20 Permitted Concentration	x 6.3 x 10^8 ml (§20.103) = Quarterly Limit per Reactor	x 4 = Annual Limit	x 3 Reactors = Total Annual Limit	Listed Expected Annual Releases*	Differences
^{3}H	2×10^{-3} uCi/ml	1,260,000 uCi = 1.26 Ci	5.04 Ci	15.12 Ci	197,000 Ci (1.97×10^5)	13,029 times the limit, an error of 4 orders of magnitude.
^{14}C	4×10^{-6} uCi/ml	2,250 uCi = 0.00252 Ci	0.01008 Ci	0.03024 Ci	4.17×10^1 (41.7 Ci)	1,379 times the limit; off by 3 orders of magnitude.
^{41}Ar	2×10^{-6} uCi/ml	1,260 uCi = 0.00126 Ci	0.00504 Ci	0.01512 Ci	5.7×10^4 Ci	3,769,841 times the limit; off by 6 orders of magnitude.
^{85m}Kr	6×10^{-6} uCi/ml	3,780 uCi = 0.00378 Ci	0.01512 Ci	0.04536 Ci	1.49×10^3 Ci	32,848 times the limit; off by 4 order of magnitude.
^{87}Kr	1×10^{-6} uCi/ml	630 uCi = 0.00063 Ci	0.00252 Ci	0.01008 Ci	1.03×10^3 Ci	102,182 times the limit; off by 5 orders of magnitude.
^{88}Kr	1×10^{-6} uCi/ml	630 uCi = 0.00063 Ci	0.00252 Ci	0.01008 Ci	1.55×10^3 Ci	153,770 times the limit; off by 5 orders of magnitude.
^{131}I	9×10^{-9} uCi/ml (assuming soluble form)	5.67 uCi = 0.00000567 Ci	0.00002268 Ci	0.00006804 Ci	8.6×10^3	126 times the limit; off by 2 orders of magnitude.
^{133}Xe	1×10^{-5} uCi/ml	6,300 uCi = 0.0063 Ci	0.0252 Ci	0.0756 Ci	6.3×10^3 Ci	83,3333 times the limit; off by 4 orders of magnitude.
^{135}Xe	4×10^{-6} uCi/ml	2,520 uCi = 0.00252 Ci	0.01008 Ci	0.03024 Ci	2.29×10^3	75,727 times the limit; off by 4 orders of magnitude

TABLE 1 (Con't)

Nuclide	10 CFR 20 Permitted Concentration	x 6.3 x 10^8 ml (§20.103) = Quarterly Limit per Reactor	x 4 = Annual Limit	x 3 Reactors = Total Annual Limit	Listed Expected Annual Releases*	Differences
Un-Id. B-G (^{90}Sr assumed)	1 x 10^{-9} uCi/ml (assuming soluble form)	0.63 uCi = 0.00000063 Ci (6.3×10^{-7})	0.00000252 Ci (2.52×10^{-6})	0.00000756 Ci (7.56×10^{-6})	3.13 x 10^{-4}	41 times the limit; off by one order of magnitude.
Un-Id. Alpha (^{239}Pu assumed)	4 x 10^{-11} uCi/ml (assuming insoluble form)	0.0252 uCi = 2.52 x 10^{-8} Ci	0.0000001008 Ci (1.008×10^{-7})	0.0000003024 Ci (3.024×10^{-7})	6.61 x 10^{-6}	21.85 times the limit. Off by one order of magnitude.

* As listed in Draft Environmental Impact Statement (DOE/EIS 0147D), p. 4-21.

Table C-5. DOE Responses to Comments on Draft EIS

Comment Number	Comment	Response
L-65	COMMENTS OF GARY MICHAEL NEWBERRY LYNNE VAN GOULD SUSAN E. WATTS MURPHY A. COOPER, III WANDA ANDREWS JAMES F. BASS, JR. GREGORY A. SMITH BARRY VAN GOULD MAUREEN A. O'REILLY ELOISE R. DUDLEY MARGUERITE B. DURHAM BETROTHA W. HARRIS EDDIE E. HARRIS June 22, 1990 Mr. S. R. Wright, Director Environmental Division U. S. Department of Energy Savannah River Operations Office Post Office Box A Aiken, South Carolina 29802 Dear Mr. Wright: Restarting the antique nuclear reactors at the Savannah River Plant is imprudent and irrational.	
L-65-01	A restart is irrational because production of additional nuclear weapons material is unnecessary. The United States has over 23,000 active nuclear warheads, a 100 metric ton stockpile of plutonium, and a 25 to 35 year functional supply of tritium. Nuclear deterrents can be maintained for decades without further production. Furthermore, in view of the inexorable, positive changes in the Soviet bloc and the bilateral cutbacks in nuclear missile systems, it has never been clearer that there is absolutely no need to produce more nuclear weapons.	Please see the response to Comment L-02-01 on the need for tritium. The need for nuclear weapons is beyond the scope of this EIS.

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Comment Number	Comment	Response
L-65-02	A restart is imprudent because the aged Chernobyl-type reactors at Savannah River Plant have surpassed their expected lifetime. Among the most serious concerns we have about the plant include: leaking liquid waste containers, errors and failures in radiation monitoring equipment, aging of the reactors, lack of containment in the event of a reactor accident, inadequate fire detection and control, poor management and oversight practices, unacceptable levels of radioactive gases released into the atmosphere, off-site environmental contamination as far away as Skidaway and Tybee Islands, and the undeniable acute threat to our underground aquifer from the 16 million cubic feet of high-level radioactive waste stored in deteriorating underground tanks. Although the permanent shutdown of two of the reactors was a step in the right direction, the facility is so plagued with design flaws and safety problems that all five reactors must be permanently closed. The Environmental Impact Statement is shortsighted and unsound, and we staunchly oppose the proposed reactor restarts. Respectfully submitted, Gary Michael Newberry Lynne Van Gould Susan E. Watts Murphy A. Cooper, III Wanda Andrews James F. Bass, Jr. Gregory A. Smith Barry Van Gould Maureen A. O'Reilly Eloise R. Dudley Marguerite B. Durham Betrotha W. Harris Eddie E. Harris	Please see the response to Comment L-13-02 on the fundamental differences between SRS and Chernobyl reactors. Section 2.1.2.5 of the EIS discusses safety; Section 3.9 discusses emergency planning; Section 4.1.2 describes radiological impacts of reactor operations; and Appendix B describes SRS monitoring programs.

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Comment Number	Comment	Response
L-66	Comments Regarding the Draft Environmental Impact Statement for Continuing Operation of K-, L-, and P-Reactors at Savannah River DOE/EIS-0147D Prepared by Jonathan M. Somers 1588 Edinburgh Drive Tucker, Georgia 30084 June 1990	

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Comment Number	Comment	Response
	COMMENTS OF JONATHAN M. SOMERS 1588 EDINBURGH DRIVE TUCKER, GEORGIA 30084 JUNE, 1990	
	This testimony has been prepared in response to the Draft Environmental Impact Statement issued by the Department of Energy regarding the continuing operation of the reactors at DOE's Savannah River Facility.	
	The DEIS presents a thorough explanation of the processes which are involved in the operation of the reactors, as well as the impact which said operations will have upon the environment. With regards to the specific factual information contained in the DEIS, this testimony includes a supplemental document which outlines the various inconsistencies, omissions, and other problems with the DEIS as presented. In perspective with the DEIS as a whole, these problems are relatively minor, and the final EIS could easily be amended to correct for these.	
	However, these relatively minor problems should not obscure the fact that there are several fundamentally-incorrect assumptions which guided the authors of the DEIS. Before evaluating the detailed analysis of the DEIS, it is far more important to decide whether the stated objectives of the DEIS are reasonable and correct, and then determine whether the DEIS itself meets its objectives.	
L-66-01	The title of the DEIS itself suggests a fatal flaw in its underlying philosophy. It implies that operation of the reactors at Savannah River is a continuing operation. This is not the case.	Please see the response to Comment L-05-01 on continuing operation.
	From page 1-1 of the DEIS: "The purpose of the proposed action is to continue to produce tritium and plutonium-238 to meet nuclear materials production requirements and to provide the capability to produce other nuclear materials, such as plutonium-239." This makes the false implication that tritium and plutonium are being produced at SR right now. They are not, as is stated in the cover letter supplied with the DEIS: "The three reactors... are currently on an extended outage..." If the true intent of the DEIS is to continue operation of the reactors as they exist at present, then this would mean continuing the current extended outage.	

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Comment Number	Comment	Response
	Public demand for the DEIS was to assess the consequences of restart of reactor operations: the insertion of fuel and target rods into the reactor vessels, the operation of primary and secondary coolant loops, the processing of irradiated assemblies, the monitoring and control of each facility, and so on. The DOE should be ashamed that it expected the public to accept reactor operations as an presently-ongoing process. One example which is most embarassing to the DOE can be found on page 2-35 of the DEIS, to wit: "The 100-plus reactor-years of operation at SRS provide a firm basis for reliable operation. Systems and equipment are maintained and replaced, as appropriate, to support reliable operation of the reactors. Reactor operators, maintenance personnel, and inspection personnel are trained to conduct normal operating activities according to written procedures. This provides confidence that the reactors will operate reliably and prevent accidents."	
L-66-02	It provides no such confidence at all. In fact, it provides confidence that future operation of the reactors will be riddled with the same unplanned and extended outages, operator errors, monitoring failures, and other crises which have plagued Savannah River for decades. Were the operators of P-Reactor on August 7, 1988, following "normal operating activities according to written procedures" when they continued to remove the control rods from the reactor even though they were getting results which did not match their calculations? If anything, the 100 plus reactor-years of operation are a track record to be avoided like the plague.	DOE has changed the text in Section 2.1.2.7 to indicate that the experience provides a basis for predictable operation.
L-66-03	With regards to the need specified by the DOE for operation of the reactors, it should be pointed out that the current Stockpile Memorandum was authored in a radically different political landscape. Clearly an assessment of current defense nuclear materials needs is a prerequisite to restart of the reactor operations at Savannah River. It is difficult to comment on this aspect of the DEIS without access to confidential information. However, it is clear that the production levels needed to maintain the current inventory are meaningless if that inventory exceeds our Nation's actual defense requirements, and our actual defense requirements are quite simply not known at present.	Please see the response to Comment L-02-01 on the need for tritium. President Bush approved the current NWSM on July 12, 1990.

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Comment Number	Comment	Response
L-66-04	On page 1-3, the DEIS states that the current NWSM is used as the basis for analysis because of "the long lead time, following enactment of a treaty, before recycled materials from retired weapons would become available". This suggests that no weapons are presently being retired. In fact, the Navy has recently retired a number of now-obsolete nuclear weapons from its arsenal, and while the nature of these weapons and the inventory of tritium (if any) they may contain is probably classified, the total omission of this retirement from the DEIS suggests that this resource has not been explored. It should be pointed out that while DOE has, in the past, attempted to present itself as the chef who simply cooks whatever order is given to it by the President (via the Stockpile Memorandum), this DEIS identifies the Secretary of the Department of Energy as one of the co-originators of the Stockpile Memorandum (p. 1-2). Therefore, it would seem that DOE has a more active role in the establishment of defense needs than was previously stated. As for non-defense needs, the legal debate over the recent Galileo mission turned up a report from a JPL study which was commissioned by NASA for the mission. JPL's findings concluded that the use of Pu-238 for that mission could have been eliminated by using newer lightweight, high-yield solar photovoltaics. The conclusion by DOE that Pu-238 is needed for space applications may be premature; certainly similar feasability studies should be conducted for the Cassini, CRAF, and the undesignated Navy mission before this conclusion is made. While there are other undisputed needs for nuclear materials in medical, commercial, and research applications, the extremely small volumes of materials required (as well as their lack of time constraints) make the alternatives to Savannah River more attractive. For example, although commercial reactors cannot be used to produce tritium for defense purposes, they might be used to produce tritium for non-defense applications; the DEIS makes no claim to the contrary.	Please see the response to Comment L-15-06 on recycling.
L-66-05	Another fundamental assumption that DOE makes in the DEIS is that there are two categories of safety measures: those that are prerequisites to restart of the reactors, and those that are not scheduled for completion until after reactor restart. In all,	See the response to Comment L-05-02 on reactor safety.

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Comment Number	Comment	Response
	Section 2 of the DEIS identifies thirteen categories of technical safety modifications and a plethora of management policy changes which are not considered essential to restart by DOE. This is yet another embarassment to DOE. It is a clear statement that DOE can and will operate its reactors without taking all possible safety precautions — implying that certain kinds of safety are "nonessential." There can be no "nonessential" safety measures. While this would be embarassing if the omissions were confined to "minor" technical items, it is disastrous in the case of two policy changes which should have been prerequisites not only to restart but also to the completion of this EIS. The first of these policy changes was recommended to DOE by the National Academy of Sciences and the National Academy of Engineering. NAS/NAE recommended that DOE clarify its safety objective for reactor operation so that the Department could achieve and maintain the desired level of safety. On page 2-49, DOE states that the NAS/NAE recommendation will be implemented "independent of	
L-66-06	resumption of production". DOE will therefore operate the reactors without defining an acceptable level of safety. In fact, this definition should have been created prior to this EIS process, and the completion of the EIS without it is a serious flaw in the underlying philosophy of the EIS process.	Please see the responses to Comments L-05-02 and L-44-29 on reactor safety and safety improvements.
L-66-07	The second (and very similar) policy change originated from DOE's own Advisiory Committee on Nuclear Facilities Safety. The ACNFS criticized DOE for bringing the reactors to an acceptable level of safety without defining that level. DOE has responded by forming a committee to identify and evaluate safety concerns at the reactor facilities. However, the findings of this committee will not be part of this EIS. While DOE has indicated that most problems will be resolved prior to restart, it has effectively side-stepped the public review process by removing the committee's findings from the scope of the EIS. Before this or any EIS can be accepted by the public, DOE must clearly resolve these three fundamental problems: (1) that the no-action alternative is **not** continued operation of the reactors, (2) that the need for nuclear materials has **not** been clearly established, and (3) that there is **no such thing** as a nonessential	The safety improvement process starts with ensuring an acceptable level of safety, then making periodic upgrades to increase that level of safety. The SRS reactors will not resume production until they have established this acceptable level of safety. The upgrades and modifications scheduled for completion before the resumption of production are those necessary to establish this acceptable level of safety. Some upgrades and modifications are not necessary to establish on acceptable level, but rather to build on that level. DOE is not sure which committee the comment refers to, but the ACNFS and the DNFSB have provided input to DOE in determining the acceptable level of safety. In performing these duties, they have access to a broad range of information, including findings from other

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	safety measure. If these three problems can be resolved — and this seems unlikely — then the specific items which are identified in the accompanying document must also be addressed.	committees. Section 2.1.3 of the EIS discusses external oversight issues. Also, please see the response to Comment L-05-02.
	1. DEMAND FOR PLUTONIUM-238	
	Page 1-3 refers to the demand for plutonium-238 for space and military applications. However, a JPL study in connection with the recently-lauched Galileo mission indicated that solar photovoltaics could be substituted for plutonium-238 RTGs with no impact upon that mission's objectives. If photovoltaics were used for the NASA CRAF and Cassini missions, the remaining demand for plutonium-238 as outlined in the DEIS would be as follows:	
	DOE applications 6.1 kg Unspecified U.S. Navy mission 25.5 kg Working inventory 17.9 kg TOTAL 49.5 kg	
	The DEIS states that approximately 59 kg of plutonium-238 are in the present inventory. Therefore, more than enough Pu-238 exists at present to support these requirements. It is also unclear from the	
L-66-08	DEIS why 71.1 kg of Pu-238 must be produced if 17.9 kg is simply going to remain in working inventory. If this working inventory were available for use, then one of the two NASA missions could retain its present Pu-238 RTG configuration and only one mission	Please see the response to Comment L-48-31 on plutonium-238 inventory.
L-66-09	would require retrofit for photovoltaics. The final EIS should adequately and fully address alternatives to Pu-238 RTGs for these missions.	Please see the response to Comment L-48-42 on identified needs for plutonium-238.
	2. DEMAND FOR TRITIUM	
L-66-10	One of the fundamental premises of the DEIS is that the option of producing tritium in a commercial reactor is not considered viable because it contradicts current U.S. policy. However, that policy is specifically intended to separate commercial uses of nuclear materials from defense uses of nuclear materials. In the strictest sense, this could be interpreted as a two-way street, i.e. nuclear materials which are ultimately intended for use in commercial applications should not be produced in military reactor programs.	Please see the response to Comment L-02-01 on the need for tritium. National policy does prohibit commercial reactors from providing nuclear materials for weapons use.
	While this is not likely to be a point of debate in treaty negotiation and enforcement, it could be argued from an economic	

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	standpoint that the government is effectively and improperly subsidizing civilian industrial concerns under the auspices of the nuclear weapons production budget, as those industrial concerns would otherwise have to develop their own reactor programs (at substantially greater expense than that which they presenly pay to obtain the same materials) to meet their own production requirements.	
L-66-11	The DEIS does not itemize the demand for tritium for weapons purposes vs. commercial purposes (indeed, it does not state the total tritium demand at all). The final EIS must identify the demand for tritium for nonmilitary applications and explain why this portion of the overall demand cannot be met through production in commercial reactors, possibly with assistance from the civilian arm of the DOE in the design of targets for commercial reactors.	Please see the response to Comment L-48-26 on commercial and research and development needs for tritium.
L-66-12	With regards to the military portion of the demand for tritium, it is absurd that the DEIS should rely on the 1989 NWSM for the basis of its analysis. The production of nuclear materials without the prior establishment of the need for those materials in a serious offense, especially when present needs are so clearly diminished from the needs envisioned in January of 1989.	President Bush approved the most recent NWSM on July 12, 1990.
L-66-13	The DEIS also does not reflect what impact the ongoing retirement of obsolete weapons has upon the current inventory. If this is treated in the classified appendix, it should be stated as such in the body of the document. The final EIS should clearly state the impact of ongoing weapons retirement.	Please see the response to Comment L-15-06 on recycling.
	3. THE "NO ACTION" ALTERNATIVE	
L-66-14	On page 2-4, the DEIS defines the no-action alternative as "no change from a current level of management intensity or current management direction". The DEIS then proceeds to elaborate on the changes of management practices which will be made to improve oversight and supervision of reactor operations. Section 2.1.2.8.1 plainly identifies "the procedural modifications being implemented before the resumption of production and as part of the continuing improvement process in the areas of human performance and management systems." These include additional personnel, new structures in the management and oversight of the facility, procedural revisions, and so on. Other references	The definition of "no-action" is taken from the CEQ "Forty Most Asked Questions Concerning CEQ's National Environmental Policy Act Regulations" (46 FR 18027); please see the response to Comment L-48-04 on the definition of "no-action."

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	to management additions and improvements also exist throughout the document. Clearly this cannot be interpreted as "no action".	
	4. FIRE DETECTION AND SUPPRESSION	
L-66-15	Pages 2-16 states that a comprehensive program will be instituted "to assess fire risk and identify and additional necessary detection and suppression systems". This assessment should have been completed prior to the release of this DEIS. The EIS cannot properly be completed without this information.	Section 2.1.2.3.1 of the EIS describes the current status of the reactor fire protection systems, and of the project plan for completion before the resumption of production. The SRS fire protection program is a continuing activity.
	5. CORROSION PREVENTION IN COOLANT LOOPS	
L-66-16	Pages 2-19 states that "periodic injections of nitric acid are necessary" to prevent degradation of aluminum and stainless steel in the coolant loops carrying heavy water. However, no indication is given as to whether this is an automated process or a manual process, nor as to what management practice provides assurance that these injections are carried out as required. The EIS should clarify the intervals between injections and the engineering and management procedures involved in conducting these injections.	The comment refers to a routine water-chemistry management practice that does not affect the risk of accidents or influence effluents. The inclusion of this detailed plant operating information in the EIS would not add materially to the information required by the decisionmaker or the public.
	6. ULTRASONIC TESTING	
L-66-17	Also on page 2-19, the DEIS states that "inspection of K-Reactor is under way." The inspection of K-Reactor should have been completed prior to authoring of this DEIS, and should be completed prior to the release of the final EIS.	The status of UT inspections of the SRS reactor vessels has been updated in the EIS. Section 2.1.2.3.2 of the EIS discusses reactor safety.
	Futhermore, the DEIS is particularly vague about its findings, and states:	
	> Some **geometric indications** associated with the original tank fabrication welds were observed. Although these are not flaws or cracks, the Operating Contractor has proceeded with UT for K-Reactor before resuming production. This will ensure tank structural integrity and provide additional confirmation of the P-Reactor findings. [Emphasis added.]	
L-66-18	The DEIS does not define a "geometric indication", and the term is not in widespread use among structural engineers. Further clarification of the exact nature of these findings is essential.	DOE has revised Section 2.1.2.3.2 to read "geometric reflectors." In addition, DOE has expanded the discussion of ultrasonic testing to describe the outcome of K- and P-Reactor tests.

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	Furthermore, the results of K-Reactor inspection will only ensure tank structual integrity if said results find no flaws or cracks; it is folly to assume the nature of the results prior to completion of the testing. Finally, no matter what the outcome of the K-Reactor tests may be, they provide absolutely no "additional confirmation of the P-Reactor findings"; there is no causal relationship between the testing of one reactor vessel and the status of another.	
	7. ONGOING SAFETY IMPROVEMENTS	
L-66-19	A number of safety measures are not planned for completion before the resumption of production. The suggestion that some safety measures are not important enough to complete prior to production is ridiculous and must be stamped out. These measures include: From page 2-20: "New lubricating oil systems for the reactor coolant pumps and their associated AC and DC motors are planned, but not scheduled for completion before the resumption of production..." From page 2-22/23: "...27 new monitoring thimbles will be installed in each reactor..." From page 2-23: "...improved incident monitoring circuitry ...will help to eliminate the vulnerability to single failures that can initiate multiple spurious and misleading alarms..." From page 2-23: "...installation of state-of-the-art, processor-based calculators for all three reactors..." From page 2-24: "The disassembly monorails will be upgraded to meet current American National Standards Institute (ANSI) standards..." From page 2-24: "Existing relays and the computer that controls charge and discharge machine operations will be replaced..." From page 2-29: "Additional modifications to the diesel-driven ECS booster pump will consist of instrumentation and control room alarms...and a strainer bypass line..."	The implementation of safety measures is a continuing process. All safety measures are important; however, some have priority over others. Consequently, the accomplishment of some safety actions is appropriate after the resumption of production. Please see the responses to Comments L-05-02 on reactor safety and L-44-29 on safety improvements.

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Comment Number	Comment	Response
	From page 2-31: "...modifications are planned to provide seismically-qualified equipment to monitor essential reactor parameters outside each reactor control room." From page 2-32: "Various diesel generators are to upgraded through the installation of additional fuel and lubricating oil supplies..." From page 2-32: "The reliability of the REDS will be improved by the replacement of emergency bus feeder cables..." From page 2-32: "Reactor instrumentation loads will be removed from the emergency buses and transferred to existing, rebuilt motor-generator sets that will have new backup batteries." From page 2-33: "An emergency power load sequencer will be installed to connect safety equipment automatically to the emergency buses." From page 2-33: "Miscellaneous upgrades: Automatic transfer switches will be replaced with new switches; the firing circuits for redundant supplementary safety system valves will be separated and isolated to achieve independance in the circuits; the two emergency diesel generators will receive reliability improvements through the replacement or upgrade of such support systems as the diesel governor, lubricating oil, fuel oil systems, and the generator control system."	
	8. APPROVED OUTFALLS	
L-66-20	While it is admirable that SRS intends to apply for NPDES permits as stated on page 2-26, SRS has not yet applied and these permits have not yet been granted. Therefore the statement is virtually without content.	As a result of comments received on this issue in the DEIS, DOE is reevaluating tritium disposal options while continuing to use reactor seepage basins for the disposal of disassembly-basin purge water. DOE would require an NPDES permit if, after this reevaluation, it negotiates the use of direct discharge with EPA and SCDHEC. Please see Section 2.1.2.3.8 and the response to Comment L-45-03 on the discharge of purge water.

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Comment Number	Comment	Response
	9. RELIABLE OPERATION	
L-66-21	DOE should remove this paragraph from page 2-35 and the DEIS with all possible haste. The 100-plus reactor-years of operation at SRS have been far from trouble-free. If anything, this establishes a firm track record which should have us all expecting annual reactor incidents upon resumption of production.	Please see the response to Comment L-66-02 on predictable operation.
	10. DOE STAFFING	
L-66-22	Page 2-44 states that DOE hopes to provide four Area Engineers for each reactor area. No statement about the number of personnel to be present prior to restart is made. The final EIS should specifiy the number of DOE Area Engineers required prior to restart of any given reactor. In the absence of this information, it is logical to require four engineers per area prior to restart — which seems not to be the case at present.	DOE has revised Section 2.1.2.8.1 and Figure 2-9 to discuss the reactor shift personnel complement.
	11. NAS/NAE RECOMMENDATIONS	
	From page 2-49: "Independant of resumption of production, DOE is developing a department statement for the identification and application of safety objectives that will draw on available information from the NRC, the International Atomic Energy Agency, and other applicable sources."	
L-66-23	One is left with the impression that DOE is laughing behind the backs of the NAS and the NAE. The NAS/NAE recommendations are meaningless if they are considered secondary to the operation of the facility and the production of weapons materials. These goals should not only be completed prior to resumption of production — they should be completed prior to formulation of the final EIS, as their definition is pivotal to the assessments made in the EIS. Also from page 2-49: "The NAS/NAE concluded that DOE needs to revise its Orders to specify clear requirements and deadlines for implementation." Ironically, DOE claims that it plans to do so, but has set no clear requirement or deadline for completion of the task.	The safety improvements being made are responsive to the NAS/NAE recommendations. Please see the responses to Comments L-05-02 and L-44-29 on reactor safety and safety improvements.

Table C-5. DOE Responses to Comments on Draft EIS

Comment Number	Comment	Response
L-66-24	Page 2-51 states that the NAS/NAE report identifies concerns over reactor aging. DOE's response seems only to concern the three reactors at SRP which are capable of operation. The final EIS should also identify any acute aging phenomena which are observable at the two inoperable reactors at Savannah River, and address whether these phenomena (if any) apply to the remaining three reactors.	As indicated in Section 2.1.2.3.2 of the EIS, DOE has found no life-limiting mechanisms in the SRS reactors. There are no useful data to be obtained from C- and R-Reactors on aging issues because they no longer receive thermal stresses or neutron exposure.
L-66-25	While it is commendable that DOE plans to complete first portion of the Probabilistic Risk Assessment prior to resumption of production, this should have been completed prior to the release of the DEIS and the final PRA should be completed prior to the release of the final EIS, with its findings incorporated into the EIS. Likewise, the SAAP should be a fundamental prerequisite of the resumption of production.	Please see the response to Comment L-58-09 on the PRA.
	12. ACNFS RECOMMENDATIONS	
L-66-26	Just as the NAS/NAE chastised DOE for failing to define acceptable safety criteria, the ACNFS accused DOE of attempting "...to bring the reactors to an acceptable level of safety without defining that level" (p. 2-57). While DOE plans to require the RIMP Issue Management Committee to complete a review of all safety issues prior to resumption of production, this review should properly have been completed prior to release of this DEIS and should be concluded prior to release of the final EIS.	Please see the response to Comment L-05-02 on reactor safety. In addition, the RIMP is an ongoing process that prioritizes safety issues, including any new issues identified during testing activities performed after publication of the Record of Decision.
L-66-27	The paragraph regarding the ACNFS recommendation over ultrasonic testing reads: "The Operating Contractor performs UT and visual inspections, which is an ongoing program." The ACNFS comment was a reaction to the K-Reactor restart strategy document, and so it is ironic to note that UT of K-Reactor has not yet been completed.	Section 2.1.2.3.2 of the EIS has been expanded to present the current status of the UT program. As noted in that section, the UT inspections of K- and P-Reactor have been completed, and that of L-Reactor began during the fall of 1990.
	13. GASEOUS RELEASE MONITORING	
L-66-28	Page 2-62 states that "All gaseous radioactive releases through the K-, L-, and P-Reactor stacks are monitored continuously." This is a debatable issue, since radiation monitors have occasionally escaped mandated inspections, frequently swayed out of calibration, and even failed. The final EIS should address the need for management assurance that radiation monitors are regularly inspected to assure reliable and accurate operation.	The monitoring of release points for atmospheric releases is required to meet applicable EPA monitoring requirements defined under 40 CFR 61.93 (b). DOE continues to work with EPA to ensure compliance with applicable requirements.

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Comment Number	Comment	Response
	14. OTHER TECHNOLOGIES	
L-66-29	In the discussion of other potential sources of tritium, a fallacy exists in the DOE's argument against a linear accelerator. The claim is made that the linear accelerator is an energy-intensive process, requiring 900 megaWatts of electrical power; this is contrasted to the 175 megaWatts require for the operation of the three SRS reactors. However, the DEIS fails to note the three SRS reactors also require enriched fuel as a neutron source, and that considerable potential energy is released in the burnup of this fuel which accounts for a large portion of the discrepancy. In effect, the linear accelerator requires primarily electric power to produce neutons, while the SRS process requires enriched fuel to produce neutrons (with the additional overhead of electric energy to circulate coolant through the reactor core). The net energy consumption of the SRS reactors should be computed as the sum of the raw electrical energy consumption plus the energy which could be obtained from burning the enriched fuel in a conventional reactor.	The comparison was based on direct electric power consumption as an indicator of the level of direct utility service support required by each alternative. The reactor fuel-cycle electric energy support can be estimated by assuming the uranium fuel-cycle environmental data promulgated by NRC in 10 CFR 51.20, Table 5-3, to be applicable to the SRS reactors. As that table indicates, the fuel-cycle electrical energy required per reference (1,000 Mwe, or about 3,100 Mwt) LWR reactor year is about 5 percent of the LWRs electricity output, or about 50 Mwe. With an assumed maximum power level of 3,000 Mwt for an SRS reactor, the fuel-cycle estimated electrical energy requirement, on this basis, would be 50 Mwe or less.
L-66-30	The DEIS unfairly dimisses the prospect of cryogenically isolating tritium from contaminated water streams. Although this source is probably not sufficient to meet the entire tritium demand, the exploration of the technology on larger scales is certainly a worthwhile activity as a parallel effort. In the long term, it could complement the operation of reactors (at substantially lower overall cost) as a tritium source, perhaps eliminating the need for one or more reactors. Futhermore, research into this area would certainly improve DOE's image, since the demand for tritium seems ridiculous to the general public when tritium is being released to the streams and even to the atmosphere on a frequent basis.	DOE intends to continue research into tritium production technologies and detritiation methods, as described in Section 4.5.3 of the EIS. (Baumgarten, 1983, which is cited in Chapter 4 of the EIS, contains information on the Sulzer process for detritiation.)
	15. SOCIOECONOMICS	
	Page 4-2 asserts: "For the most part, the socioeconomic effects of continued operation would be beneficial. SRS has contributed substantially to the rise in the standard of living in the region. The SRS budget for Fiscal Year 1989 was about $3.2 billion; the FY 1990 budget is nearly $3.7 billion."	

Table C-5. DOE Responses to Comments on Draft EIS

Comment Number	Comment	Response
L-66-31	The rise in the standard of living in the region is not without expense. In general, a rise in standard of living can be viewed as beneficial when the population of the area and of the nation as a whole benefit from the production of new wealth (in the form of goods, services, property development, et cetera). At Savannah River, no new wealth is produced; the wealth is forcibly taken from the taxpayers of the rest of the nation. In effect, the affluence of the region is subsidized at the expense of the rest of the Nation. No material goods or other direct benefits arise from the operation of the Savannah River reactors. The only justification for their operation is the national defense, and the concrete form of this justificatin (the NWSM) is classified and hidden from the eyes of its alleged benefactors.	DOE has investigated socioeconomic effects more fully and has included the information in the Final EIS. Also, please see the responses to Comments L-48-15, L-48-16, and L-48-17 on socioeconomics, and Section 3.2.5 of the EIS.
	16. OCCUPATIONAL DOSES Page 4-34 asserts that "The use of the health-risk estimator presented in Section 4.1.2.6 would result in an excess cancer risk of 0.02 fatality per reactor-year in that workforce." This would suggest that the aforementioned 100 reactor-years of reliable operation have a probability of unity for causing 2 fatalities in the work force.	
L-66-32	It is also very unorthodox to perform mathematics on dose commitments by evenly dividing the total exposure by the number of workers to obtain an average per-person dose, since it is very rare for an entire populus of workers to receive identical doses. Given the widely-varying duties of the range of employees, their differing proximities to potential "hot spots", and the fact that the 400 people working in a reactor area are present in shifts (not simultaneously), it is likely that most employees received substantially less-than-average doses while a very few received substantially greater-than-average doses.	For stochastic effects such as cancer, the consequences of exposure are conventionally determined by using the collective dose commitment. The EIS also presents the average individual dose and the annual limit to provide a basis for comparison, because there is no guidance on weighted individual exposures.

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Comment Number	Comment	Response
L-67	COMMENTS OF DEAN D. HUNTER, JR. CITY OF BEAUFORT POST OFFICE BOX 1167 BEAUFORT, SOUTH CAROLINA 29901 (803)525-7070 FAX NO. (803)525-7013 June 25, 1990 Mr. Stephen R. Wright Director Environmental Division U.S. Dept. of Energy Savannah River Operations Office P. O. Box A Aiken, SC 29802 RE: Reactor Operations EIS Dear Mr. Wright:	
L-67-01	On behalf of the City of Beaufort, I would like to express concern and objection to the start-up of the reactor operation until such time as there has been complete assurance that the domestic water supply for the City of Beaufort will not be contaminated or pose any health or environmental problem for the citizens and other water customers.	Sections 4.1.2 and 4.1.6 of the EIS present the health effects to downriver water users (Beaufort-Jasper). The concentrations of radionuclides in Savannah River drinking water are a small fraction of EPA standards. Also, please see the responses to the comments in Letter L-49.
	Sincerely, Dean D. Hunter, Jr. City Manager bwg cc: Mayor/Council	

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Comment Number	Comment	Response
L-68	COMMENTS OF MR. AND MRS. PETER W. PAYETTE	
	Director of Environmental Division June 21, 1990 U.S. Dept. of Energy Reactor Operation E.I.S. Dear Mr. Wright	
L-68-01	I am confident that nuclear waste is destroying the world environment-water-air-ground and killing our people in this country. The greatest danger is the massive environment contamination at SRS at the present time. Forty five (45) years of waste production of Radioactive material and we have not found a sure or good way to dispose of it. I personally believe (knew) that area's in our country that are contamined with all the Radioactive waste can not or will not be cleaned up. It may be moved some where	Please see the response to Comment L-07-01 on radioactive waste management.
L-68-02	else at great expense, but is that cleaning up? Just look at the reports comming in from all over our country, of the contamination - Rocky Flats, Colo - Savannah River - Ohio - New Mexico - Idaho and the list could go on and on. Man, oh! man will some body lead us out of this crazy nuclear weapon's production before it destroys us! We need a leader to realize the problems it is causing and to stop throwing money at (DOE) the department of energy (waste) in its continuation of nuclear weapon's. The House of Representative's passed the fiscal 1991 spending bill of 2.3 billion for production of nuclear weapons material at all DOE plants by a vote of 355-59. Is this spending good for the country? The world has changed. No more Cold War and I think alot of people are tired of hearing the old statement better "Dead than Red".	Please see the response to Comment L-06-02 on waste management and environmental restoration.
	Let's start thinking of our Grand and Great-Grand children and not leave this mistake for them to solve (if they are still alive.)	
L-68-03	We are told that we face a critical shortage of tritium, but who know's? Does anyone in our country really know how much we have? Remember a little Col. North was selling weapon's to our suppose enemy and from our President on down no one knew what he was doing (It could have been nuclear weapon's) so how can people believe now that we need more tritium. It must be the jobs and large salaries for some people.	Please see the response to Comment L-02-01 on the need for tritium.

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Comment Number	Comment	Response
	If we let our present H-Bombs sit for 30 years with no more tritium replaced in the bombs and they lost 90% of their explosiveness, these "Horrible Weapon's" would still have enough force to vaporize large cities and life. Wasn't the Atomic bomb's used on Japan destructive enough? Before someone says I don't know what I'm talking about, what about the letter that was sent to President Bush and Soviet President Gorbachev urging them to consider a complete nuclear materials production halt (on May 23, 1990). It was signed by seven Nobel laureates, two former Cabinet secretaries, two former director of the Central Intelligence Agency (CIA) and several leading negotiators of past arms-control agreements and others who played substantial roles in the developement of the U.S. Nuclear arsenal. Do fifty-four (54) of the top scientists and diplomats in this country know what they are trying to do? I believe they do! Later years from now every body you talk to will say they knew what some of us are now stating about all the dangers to our people and the massive environment contamination being done. I hate the statement that the anti-nuclear coalition is the least qualified body on which to base a nuclear policy for this Country. Who is qualified? Is it our nuclear war experts? We have them, you know and we have never been in a Nuclear War. The main issue is that it is time to try and stop destroying our country and calling it National Security. Sincerely, Mr. and Mrs. Peter W. Payette 1393 Old Barnwell Rd. Aiken, S.C 29801	

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Comment Number	Comment	Response
L-69	COMMENTS OF TOM CLEMENTS Written Comments on the Draft EIS on Restart of the Savannah River Plant Reactors Greenpeace Action 20 13th Street Suite 100 Atlanta, GA 30309 404-876-8256 June 24, 1990 As the comment period closes on the Draft Environmental Impact Statement on RESTART of the aging nuclear reactors at the Savannah River Plant, I would like to make a few comments about the EIS and the just-concluded hearing process. At the three hearings on the restart EIS, the public spoke out overwhelmimgly against the restart and continued operation of the SRP reactors. The count was approximately 190 against restart and only 30 or so in favor. Only two people in Columbia, S.C. and Savannah, GA spoke in favor of restart. About 30 people in Aiken, S.C. spoke in favor of restart and most of those people who thus spoke had some form of political or economic tie with the operation of SRP. So, it seems, that the general public has had enough of building more bombs, while it is a single special interest group, bound by greed and power, that backs the further operation of the SRP reactors. Besides being a referendum which can't be ignored by Secretary Watkins or the preparers of the EIS, the hearings were a signal of a change in the public consciousness. Even in Aiken, home of the Bomb Plant, people just wouldn't go out to support something they know is no longer justifiable on military, economic, or environmental grounds. People who make their living from operation of SRP finally realize that a changing world is coming, that the role of SRP is bound to change. And we, environmental and disarmament groups, stand in support of workers in their right to job protection as the DOE complex is scaled down. We also stand in support of legislation in Congress to promote economic diversification in communities around DOE facilities.	

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Comment Number	Comment	Response
	It is now very clear that a growing public voice is speaking out against more nuclear weapons. It is also becoming clearer that DOE workers have an ally in environmental and disarmament groups who are leading the effort to make the Department of Energy truly that and not the Department of Nuclear Weapons Production.	
L-69-01	The hearings on the Draft EIS were held on extremely short notice, not giving those interested in the document time enough to prepare comment. The hearing schedule was printed in the Federal Register on May 11, 1990 and the first hearing began less than three weeks later on May 31, 1990. This amount of time was insufficient if the DOE was intent on getting input from as many people as possible who have interest in this issue. I hereby request that DOE give a much longer notification period in the future. I would also like to know how the time between the announcement's appearance in the Federal Register and the first hearing compares with other DOE EISs and those of other U.S. government departments.	DOE followed the CEQ regulations on implementing the procedural provisions of NEPA (40 CFR 1500-1508) on the time required for placing announcements in the Federal Register and news media, and holding the hearings. CEQ requires a 15-day minimum limit [40 CFR 1506(c)(2]. In this case, DOE provided 20 days.
L-69-02	I must add that on May 1, 1990, Secretary of Energy Watkins prejudiced the EIS document on restart by announcing that the K-reactor would be restarted in December, 1990. Secretary Watkins' premature announcement of restart, without regard for the EIS process, was an affirmation that he would not take the EIS nor public comments on it into consideration before making any type of decision on restart. I find it quite disturbing that the secretary has circumvented the EIS process and request that he withdraw his May 1 restart announcement.	DOE has not yet decided to continue to operate the SRS reactors, but is proposing to do so. SRS is continuing an ongoing program to upgrade the safety of reactor operation in a wide variety of areas, many of which are described in the EIS. No sooner than 30 days after the completion of the EIS, the DOE decisionmaker will decide whether to continue to operate the SRS reactors; and will issue a Record of Decision in the Federal Register. In addition, the DOE decisionmaker will not authorize the resumption of production of nuclear materials until he has determined the satisfactory completion of the safety upgrades and modifications planned for completion before the resumption of production. Please see the response to Comment L-05-02 on consideration of safety concerns.
	The EIS is a very general document and does not cover the environmental impacts of reactor operation or conditions of operation in much depth. The document reads as if it were prepared just in order that something be presented which could be called an EIS. The following are some observations about the EIS:	
L-69-03	1) The "need question" must be discussed more fully. DOE has classified the discussion on the need for tritium and plutonium, refusing to present any information at all about the supply of those materials. The EIS should openly discuss the need question in light of a changing world situation and the impact of arms control	Please see the responses to Comments L-02-01 on the need for tritium and other nuclear materials and L-37-10 on the changing world geopolitical situation.

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	negotaitions. Rather than basing this discussion on a static Nuclear Weapons Stockpile Memorandum (NWSM), the EIS should take into account the very real possibility that the NWSM will change in the short term in order to reflect a drastic downturn in need for more nuclear materials.	
L-69-04	2) The EIS must be expanded in its discussion of standards of operation. Standards under which the reactors are to be operated are vaguely discussed, leaving the reader the impression that there are no standards which the DOE is following. The reactors should, before restart, be able to meet commercial nuclear power standards as specified by the Nuclear Regulatory Commission. Though exempt at this moment form NRC standards, DOE has stated that it is trying to reach NRC standards, but the EIS does not give any type of clear picture as to how and when NRC standards are to be met.	Please see the response to Comment L-44-30 on NRC standards.
L-69-05	A number of other federal bodies, including the Advisory Committee on Nuclear Facilities Safety, the Defense Nuclear Facility Safety Board, the DOE Tiger Team, the National Academy of Sciences (report after Chernobyl accident), and the General Accounting Office have all made comments about operation standards. Particular emphasis has been put on reactor operator standards. The EIS does not adequately discuss how the recommendations of the above-named bodies will be met nor when they will be met. The EIS, therefore, should contain a full discussion of what those bodies have recommended and how and when those recommendations will be met.	DOE has expanded Section 2.1.3 of the EIS to address this comment; this section discusses responses to comments from external oversight organizations. Section 2.1.2 discusses many upgrades and modifications that are related to these responses.
L-69-06	The recommendations of the other federal bodies mentioned above are critical to the safe operation of the SRP reactors. In addition to discussing operator training standards and conduct, the EIS must also discuss the following areas (to name a few) in more detail, with an analysis of the recommendations and implementation plans suggested by the above-named federal bodies: a) seismic upgrades, b) need for containment domes, c) fire safety standards, with special attention to air filter systems, and d) diesel generator standards.	DOE believes that these items are discussed with the level of detail appropriate for an EIS.
L-69-07	The DOE should clearly state that the reactors will not be returned to operation until all recommendations of the above-mentioned bodies are met. Any recommendations not met at time of restart should be clearly listed in the EIS, with a timetable of when they will be implemented. The DOE must certify to Congress	Please see the response to Comment L-05-02 on reactor safety.

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Comment Number	Comment	Response
	that all recommendation have been met prior to restart, and the EIS must discuss how that certification will be determined. (The above-mentioned bodies should also independently certify to Congress that their recommendations have been met.)	
L-69-08	3) The Probabilistic Risk Assessment (PRA) must be completed and released to the public for review before restart. The EIS should discuss the review process for the PRA and how the recommendations of the previously mentioned bodies effect the prepartion and validity of the PRA.	Please see the response to Comment L-44-16 on the PRA.
L-69-09	4) The EIS must fully discuss the standards under which ultrasonic testing is being done on the reactor vessel and pipe welds. The DOE has recommended that UT testing be done on a certain schedule, but it appears that this schedule is not being met. Since the reactors and welds have not undergone a 100% UT test during their entire lifetime, the EIS must discuss why the DOE is not going to meet their inspection standard prior to restart. In order to meet even the DOE goal for UT inspection - once every 5 years - means that a 100% test is long overdue. Therefore, to meet the DOE standard and in order to give a baseline by which to judge future UT tests, the DOE must complete a 100% UT test on the vessels and all pipe welds	DOE uses American Society of Mechanical Engineers (ASME) Section XI Boiler and Pressure Vessel Code for UT testing, and adheres to the ASME-recommended schedule. DOE has updated Section 2.1.2.3.2 of the EIS to expand the discussion of ultrasonic testing.
L-69-10	prior to restart. Once again, the EIS must address how the DOE UT testing program squares with the recommendations of the previously mentioned government bodies. Why is the DOE not meeting its own standard prior to restart?	Please see the response to Comment L-66-27 on ultrasonic testing.
L-69-11	5) The EIS is lacking in a discussion of support facilities necessary for reactor operation. It is absolutely critical that all non-reactor facilities necessary for operation of the reactors be discussed in the EIS. This primarily includes the fuel and target fabrication facilities. Depending on how many of the reactors are operating, if any, and at what power level, the support facilities will, obviously, be effected. The EIS does not fully discuss the impact of reactor operation or non-operation on these facilities.	Section 4.1.6 of the EIS describes the cumulative impacts of all support facilities, and provides an upper bound to those impacts. If the reactors did not resume production, DOE would continue to operate the nonfabrication facilities to process spent fuels and to process and dispose of waste. DOE will prepare an EIS that includes more detail on the environmental impacts of support facilities.
L-69-12	6) The impact of the lawsuit against operation of K-reactor without a cooling tower must be expanded. It is likely that a lawsuit against operation of the K-reactor will force the DOE to postpone restart of that reactor until after the cooling tower is finished. The impact of a successful lawsuit on restart must be discussed.	DOE is operating SRS under the terms of a Consent Order (84-4-W) to its NPDES permit issued by SCDHEC. DOE has revised Section 5.2.5 to discuss the current status of the lawsuit.

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Comment Number	Comment	Response
L-69-13	7) Due to the possible placement of the reactors in cold stanby in the very near future, the EIS must discuss how and when an EIS on reactor decontamination and decommissioning (D & D) will begin. The EIS must look to the future more and lay groundwork for the imminent D & D of all the reactors. This discussion must be expanded under discussion of alternative three.	When the need for the reactors no longer exists, DOE will prepare appropriate NEPA documentation for the decontamination and decommissioning of these facilities. It is not considered under Alternative 3 because the reactors are to be maintained in cold standby, not decommissioned.
L-69-14	8) The EIS must be changed to be a restart EIS, not just an EIS on continued operation. Just as there is an office at DOE on reactor restart, there must be an EIS on restart. The DOE has admitted, through its creation of a restart office, that the reactors are not in operation and that restart is the issue. Without addressing all issues associated with restart, and not just "continued" operation, the DOE is setting itself up for legal action by doing an incomplete EIS.	Please see the response to Comment L-05-01 on continued reactor operation.
L-69-15	9) All accidents that are discussed must address accidents involving both tritium targets and plutonium fuel. All scenarios for accidents during loading, operation, or other handling of target elements or fuel must be covered by the EIS. Accidents which are graver in magnitude than discussed in the EIS must be covered as well. It is likely that core releases of larger magnitude than discussed are possible, and those accidnets must be discussed.	The discussion of severe accidents in Section 4.1.3 includes the full range of core releases and their associated probabilities. Section 4.1.3.1.4 discusses the effects of releases from other core loadings.
L-69-16	I stand in support of alternative three - placement of the reactors on cold standby - and urge the DOE to more fully consider this alternative. With the dissolution of the Warsaw Pact and the excellent possibility of far-reaching arms control treaties, the need for more nuclear materials is rapidly decreasing (not that they were ever needed!). DOE should face the changes going on in the world and not restart the reactors.	Please see the response to Comment L-02-01 on the need for tritium and other nuclear materials.

Respectfully Submitted,

Tom Clements
Southeastern Nuclear Campaigner
Greenpeace Action

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Comment Number	Comment	Response
	ADDITIONAL COMMENTS OF TOM CLEMENTS GREENPEACE ACTION 20 13TH STREET SUITE 100 ATLANTA, GEORGIA 30309	
	July 4, 1990	
	Mr. S. R. Wright Director, Environmental Division U.S. Department of Energy Savannah River Operations Office P.O. Box A Aiken, S.C. 29802	
	Dear Mr. Wright;	
	I request that you admit the following brief inquiries into the record concerning the Draft Environmental Impact Statement on restart of the Savannah River Plant reactors.	
L-69-17	1) On page 1-3 of the Draft EIS, it is stated that "approximately 71.1 kilograms of plutonium-238 are needed in the near term." I would like to know how many missions for which a plutonium-238 need is stated have been authorized or funded by Congress or any other federal agency. Of the "currently identified missions", especially a "U.S. Navy mission," which have been authorized and funded by Congress or appropriate agencies? Is the need for plutonium-238 actually demonstrated?	DOE has revised Section 1.2 to respond to the commentor's questions.
L-69-18	The EIS should clearly state which missions involving plutonium-238 are authorized and funded and which missions are merely on the wish-list of particular agency or military branch. Discounting wish-list projects, what is the alledged need for plutonium-238?	DOE has revised Section 1.2 to respond to the commentor's questions.
L-69-19	2) What is the actual demand for "other isotpes" (p. 1-3) and can this demand be satisfied from sources other than the SRP reactors? How has this demand been dteermined?	DOE has revised Section 1.2 to respond to the commentor's questions.

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Comment Number	Comment	Response
L-69-20	3) On page 1-4 it is stated that "a need for the production of weapons-grade plutonium in SRS reactors could develop in the future." Given all the dramatic changes in Europe and the Soviet Union, the fact that the United States is "awash" in plutonium, and the impact of warhead retirement on plutonium stockpiles, the EIS should clearly discuss how a "need" for weapons-grade plutonium could possibly "develop" in the future. Sincerely, Tom Clements	As stated in Section 1.2 of the EIS, the need for weapons-grade plutonium is not anticipated at present, and near-term continued operation of the SRS reactors is intended to meet the needs for tritium. However, prudence suggests that equally dramatic changes are possible, if not likely, in these or other areas of the world, which might create a future need for plutonium.

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Comment Number	Comment	Response
L-70	COMMENTS OF KAROLYN A. FREEMAN 507 WOODROW STREET COLUMBIA, SOUTH CAROLINA 29205 JUNE 22, 1990	
	Mr. S. R. Wright Director Environment Division U. S. Department of Energy Savannah River Operations Office P. O. Box A Aiken, South Carolina 29802	
	Dear Mr. Wright:	
L-70-01	I am not the member of any radical group such as GreenPeace (although I am a Southern Baptist); however, I feel compelled to make a comment on the possible continued operation of the K-, L-, and P-Reactors at the SRS.	Comment noted.
	South Carolina and South Carolinians are not expendable. Georgia and Georgians are not expendable. We never have been. It is just that the Federal government always thought we were. World history is being made before our eyes every day. Today, for example, Checkpoint Charlie was retired to a Cold War museum. I believe the time has come to retire SRS as well.	
	I would like to receive a copy of the DEIS when it is available. Thank you.	
	Sincerely, Karolyn A. Freeman	

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Comment Number	Comment	Response
L-71	COMMENTS OF DAVID I. BRUCK 2209 MARION STREET COLUMBIA, SC 29201 15 JUNE 1990	
	Mr. S. R. Wright, Director Environmental Division U.S. Department of Energy Savannah River Operations Office P.O. Box A Aiken, SC 29802	
	Dear Mr. Wright:	
L-71-01	We would like to submit a few comments on the draft EIS. While this document is intended to assess the real and potential environmental impacts of operating the three reactors and discuss safety considerations, there is a sickening feeling that the decision has already been made to restart.	Please see the response to Comment L-69-02 on the decision for continued operation.
L-71-02	Legitimate concerns of the public laid out at last year's public hearings have not been addressed. Couching the "need to produce nuclear materials" as "classified" in Appendix A is unacceptable.	The comment refers to the scoping meetings, held in April 1989; DOE has addressed substantive issues presented during those meetings, and has prepared the EIS accordingly.
L-71-03	Nowhere in the document has the recent arms reduction and its implications been discussed.	Please see the response to Comment L-02-01 on need. Section 1.2 discusses potential decreases in material requirements.
L-71-04	To discuss the health effects to populations on and off site without independent epidemiological studies does not make sense. No basic data is provided in the EIS on which calculations and suppositions can be checked.	Section B.1.5 of the EIS contains updated information on epidemiological studies.
L-71-05	To raise the plutonium maximum permissible concentrations in order to comply with safety measures is unethical.	This EIS uses the current maximum permissable concentration (MPC). There is no current DOE proposal to raise MPC values for plutonium.

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Comment Number	Comment	Response
L-71-06	And, lastly, the risks posed by future operations at Savannah River cannot be separated from the accumulating risk to populations exposed to radiation releases from the site for over three decades. The Savannah River operations are responsible for the radioactivity and other contaminants they put into the environment. A decision to go ahead with reactor restart at Savannah River invlolves a conscious decision to add to the radiation exposure and health risk of the people who will be exposed. To make the decision for more nuclear weapons while risking the health our land and people in no way contributes to our national security. Sincerely Beverly L. Bruck David I. Bruck cc: Energy Research Foundation	Please see the response to Comment L-02-02 on the health risks of past and present operation.

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Comment Number	Comment	Response
L-72	COMMENTS OF WILLIAM A. LOCHSTET 20 JUNE 1990 Mr. S. R. Wright Director Environmental Division U.S. Department of Energy Savannah River Operations Office P.O. Box A, Aiken South Carolina, 29802 Dear Mr. Wright Enclosed are my comments on the Draft Environmental Impact Statement, Continued Operation of K-, L-, and P-Reactors, Savannah River Site, Aiken, South Carolina, DOE/EIS-0147D. Please note that the opinions and calculations presented here do not necessarily reflect the position of the University of Pittsburgh at Johnstown.	
L-72-01	There is an obvious error in section 4.1.2.7. This section takes information on the annual average occupational dose to assert that the maximum individual dose is within the 5,000 millirem per year limit. The maximum value cannot be determined from the average.	Section 4.1.2.7 has been modified to indicate that the DOE limit is presented for comparison, because there is no guidance for average exposure. Table 4-14 has been revised to include maximum individual doses.
	Sincerely, William A. Lochstet,	

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Comment Number	Comment	Response
	ENVIRONMENTAL CONSEQUENCES OF AND ALTERNATIVES TO SRS REACTOR OPERATION BY WM. A. LOCHSTET THE UNIVERSITY OF PITTSBURGH AT JOHNSTOWN* JUNE 1990	
	The Department of Energy (DOE) has prepared a Draft Environmental Impact Statement on the resumption of operation of the K, L and P reactors at the Savannah River Site (SRS), DOE/EIS-0147D, (DOE 1990). There are five similar reactors, the C, K, L, P, and R reactors, located at the SRS, near the Savannah River in southwestern South Carolina. These reactors began operating at different dates between 1953 and 1955. The presence of cracks in the C reactor vessel has eliminated it from consideration for further operation. The R reactor was placed in standby status in 1964 and has been allowed to deteriorate. Furthermore, many components have been removed as replacements for the other reactors, thus precluding its operation (DOE 1984). The other reactors have been shut down since the summer of 1988.	
	Need	
L-72-02	The main purpose for restarting the SRS reactors is for the production of tritium, which is used to boost the yield of fission warheads and the fission triggers of thermonuclear warheads (Mark 1988). The present U.S. inventory of tritium is about 100 kg (Albright 1989). Since this isotope is radioactive with a half life of about 12.3 years, in one year about 5.5% will decay. Thus, about 10 kg has decayed since the cessation of reactor operations in 1988. The department has met its needs since then by more efficient management of the inventory (Albright 1989). In addition, some tritium has been available from the decommissioning of warheads under the INF treaty. In addition, the anticipated START treaty is expected to lead to further decommissioning. The joint Bush-Gorbachev statement of 1 June on strategic nuclear weapons calls for a treaty to be completed by the end of 1990 that would limit each country of 6000 warheads deployed (New York Times 1990).	Please see the response Comment L-02-01 on the need for tritium.
	*Affiliation for identification purposes only.	

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	At present there are almost 9,000 such warheads (Norris & Arkin 1990). If each warhead contained the same amount of tritium, which they do not, this would suggest that there will be no need for additional production for at least five years, by which time, further reductions may be possible.	
L-72-03	DOE is not responsible for determining the need for tritium (DOE 1990). However, the analysis of such a need is required by the National Environmental Policy Act of 1969 (NEPA). To that extent, the Department of Defense (DoD) should join with DOE in the preparation of the final EIS on this proposed action.	DOE is responsible for operating K-, L-, and P-Reactors. Please see the response to Comment L-02-01 on the need for tritium.
L-72-04	As is indicated above, the present tritium inventory is decreasing at a rate of about 5.5 kg per year through radioactive decay. Since the operation of a reactor such as those at SRS produce about 1/80 gram of tritium for each megawatt-day of operation (Miller 1989), and the SRS reactors operate at a nominal power of 2400 MW for an irradiation cycle of 200 days (Cochran 1987), each of these reactors can produce 6 kg to perhaps 10 kg of tritium each year. With all reactors operating, this represents a dramatic increase in the inventory, which should be justified.	Please see the response to Comment L-02-01 on the need for tritium.
	Alternative	
L-72-05	Commercial nuclear reactors employ boron compounds to absorb neutrons in control rods, burnable poison rods, and dissolved in the reactor coolant. If this boron were replaced by lithium-6, the control function of neutron absorption could be combined with the irradiation of lithium to produce tritium. If the burnable poison rods of a typical 1000 MWe pressurized water reactor (PWR) were fabricated of lithium, highly enriched in lithium-6, approximately one kg of tritium would be produced per year (Miller 1989). There are the equivalent of about 66,000 MWe of operating commercial PWR capacity in the US. This is enough to produce 60 kg of tritium each year, without operation of the K,L, or P reactors. In this case, the support facilities in the M-area could be used for rod fabrication, as would the F and H-area separations facilities for extraction of the product from irradiated elements. Transportation to and from the appropriate reactors would also be required. The DOE states in section 2.4.6 that this option is "contrary to the long-standing national policy to separate the commercial	Section 2.4.6 of the EIS discusses the alternative for production of tritium by commercial facilities. While the conversion suggestion might be technically feasible, it would require research and development, relicensing of the commercial reactors, and cooperation of the utility owners; in addition, it would be contrary to national policy.

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Comment Number	Comment	Response
L-72-06	nuclear reactor program from the nuclear weapons production program." (DOE 1990). It should be noted that these programs are not separated at the Hanford N reactor, which produced both plutonium for weapons and steam for electricity for many years. This policy of separation was instituted in a very different historical context. The atomic energy act of 1954 came the year after the first Soviet H-bomb explosion. J.R. Oppenheimer was being stripped of his security clearance, and Senator J. McCarthy was busy investigating, At that time it was much more important to keep all information concerning the production plants and their capacities very secret. Today there are satellites which produce detailed pictures of these facilities for all to examine. In addition, general information about reactors in most countries is now part of general public knowledge. This policy also came about when the SRS production reactors were being built, and a new atomic energy act was needed to permit the construction of the first commercial reactors. Also, at that time, the main concern was to safeguard the production of plutonium. The issue with tritium is quite different than plutonium. Now, 36 years later, it is time for DOE to ask the Congress if this policy should be continued, or changed.	N-Reactor at the DOE Hanford Reservation is not a commercial reactor; however, it did provide steam for commercial electric generation. No national policy prohibits such actions. The converse does apply; commercial reactors cannot provide nuclear materials to DOE for weapons use.
	Accident Water	
	In the event of a Loss of Coolant Accident (LOCA) or a Loss of Pumping Accident (LOPA), the Emergency Cooling System (ECS) would be used to provide water to cool the core with a flow rate up to 1,200 liters per second. This water is expected to flood the reactor building, and is therefore removed by the Water Removal and Storage (WRS) system, which pumps water from the reactor building sumps into a 225,000 liter underground tank which overflows into a 1.9 million liter tank, which in turn overflows into a 190 million liter earthen basin (DOE 1990). In response to criticism by the NAS/NAE, DOE is installing a lining for this basin. The NAS/NAE study specifically indicates that in the case of a LOCA or LOPA, if there is fuel failure, iodine will be carried by the water to the earthen basin and released to the atmosphere, which is a violation of the fundamental safety philosophy of confinement (NAS/NAE 1987). At the maximum flow rate, the two tanks would overflow into the basin in less than one hour. Furthermore, the basin would overflow in less than three days. Clearly, an alternative is needed.	
	The construction of a 3.8 million liter tank is suggested, along with the capability to recirculate and cool this water.	

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L-72-07	Without recirculation, any tank will overflow as is indicated above. If one considers an accident which occurs at full power of 3000 MWT, and calculates the total decay heat which must be removed in the first 24 hours it is about 2×10^{12} joules. This would raise the temperature of the 5.92 million liters of water in these tanks by 70 degrees C. Further heating could likely cause the water to boil. This water could then be pumped back into the ECS via one of the primary coolant heat exchangers which has coolant water flow. The idea is to patch together a residual heat removal system. In 24 hours it should be possible to determine the cause of the LOCA or LOPA and generate an appropriate valve alignment for this purpose. Since such a system would prevent the escape of fission products resulting in an estimated 450 person-rem, one can justify spending $450,000 on this (DOE 1990). The 3.8 million liter tank would cost about $200,000. A return pipe and a pump would also be necessary. It is suggested to use one of the six primary coolant pumps which could be removed from the inoperable C or R reactors. It is expected that this could all be accomplished for less than $450,000, and would provide more complete confinement.	DOE is installing a covered basin liner to contain fission products. In addition, the moderator recovery system will perform the function described for small leaks, and the ECCS will remove decay heat by direct cooling if the process water pumps flood out.
	Fuel Source	
L-72-08	The DOE sets out to describe the cumulative impacts of restart of the K, L, and P reactors, as is required by CEQ regulations, but only mentions support facilities at SRS (DOE 1990). In particular, no mention is made of the infrastructure needed to supply uranium fuel for the reactors. Typical operation with Mark 22 fuel and target assemblies, containing U-235 enriched to 75% is at 24000 MWT (Cochran 1987). It shall be assumed that each reactor operates at this power for half of each year (or any other combination leading to 2400 x 182 MW-days). This would require the fissioning of 308 kg of U-235. Since natural uranium contains 0.71% of this isotope, and with the enrichment plants operating at 0.2% tails assay, then 60,000 kg of natural uranium is required to support each reactor for one year. Since the average uranium mill operates at 96% efficiency, 63,000 kg must be mined, leaving 2,500 kg in the mill tailings for each reactor year. It has been pointed out that the thorium in the mill tailings decays to radium-226, which in turn decays to radon-222, which is a health hazard (Pohl 1976). The uranium-238 in the mill tailings	The EIS describes the cumulative impacts of existing and planned on- and offsite (within 16 kilometers) facilities. Radon emissions from fuel supply facilities do not materially change these impacts. The concerns expressed about the uranium supply elements of the SRS reactor fuel cycle are greatly exaggerated by integrating the releases and health risks from radon over a period of millions of years, while risks to individuals are, by definition, restricted to a lifetime at maximum. In examinations of the effects of uranium fuel requirements for power reactors both by NRC and EPA, each agency has identified the health risks to be small. In 1982, an NRC Atomic Licensing and Appeal Board decision (ALAB-701, November 1982) stated that radon releases associated with such requirements are "...a minute fraction of the radon that is released into the atmosphere from other sources...." and that

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	also decays through several steps to radon-222 and should be considered, as was noted by the NRC in GESMO (NRC 1976). The total decay of the uranium and thorium in the mill tailings necessary to supply one reactor for one year is 3.6×10^{11} curies of radon-222. Because radon-222 has a half life of only 3.8 days, some radon-222 atoms decay before escaping from the tailings pile into the atmosphere. Some recent mill tailings piles have 0.6 m of dirt covering. In this case, the EPA estimate is that about 1/20 of the 1.8×10^{10} curies of radon reach the atmosphere. The population at risk is taken to be the Untied States stabilized at its present number and distribution, for simplicity. The NRC has suggested that the release of 4,800 curies of radon-222 from a western mine site, would result in 0.023 excess deaths in the present population (NRC 1977). Applying this to the estimated radon release, results in 86,000 deaths per reactor per year of operation. That means 260,000 for all three reactors for each year, or 2,600,000 deaths for ten years of operation as is being considered. It should be noted that these deaths will occur over a long time governed by the 4.5 billion year half life of U-238. The impacts would be different if the reactors operate more or less than 2400 x 182 MW-days each year.	the "... Incremental health risk to the population stemming from the fuel cycle emissions (if indeed there is any) is vanishingly small...." In its rulemaking under 40 CFR 61 for existing operating uranium mill tailings (54 FR 51679, December 15, 1989), EPA has stated that "the lifetime fatal cancer risk to the most exposed individual is 3×10^{-5} from the twelve licensed piles that are either operating or on standby. Uranium mill tailings are estimated to cause 0.004 fatal cancers per year, approximately 1 case every 250 years to the 2 million persons within 80 km of the tailings piles," and "based on these factors, EPA has concluded that the baseline risks are acceptable."
L-72-09	The consideration of these environmental effects of providing fuel for a reactor is not a new issue, and has been dealt with at some length previously. The amount of radon introduced into the environment from this source will be a minute fraction of the total radon present from all sources, just as the radiation dose to residents of South Carolina and Georgia due to operation of the SRS are a small fraction of the total radiation exposure of this population. Nonetheless, DOE has taken the task of calculating the maximum individual dose and total population dose for operation of SRS and VEGP together, and presents this information in section 4.1.6.4.14 and table 4-47 (DOE 1990). In performing this evaluation, the DOE has adopted the linear, no threshold model for the relationship between radiation exposure and cancer incidence. DOE has further endorsed the concept of adding up the total population dose regardless of how small the individual dose may be. This model should also be applied to all radiation exposures associated with the action proposed here.	Section 4.1.6 of the EIS discusses cumulative impacts.

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	The NRC does not take this position with regard to radon emissions from uranium mills. The NRC evaluations are not applicable here because their calculations compare the singular benefit of electricity production with the costs of producing that energy. The benefits of SRS are much broader in scope and very different in quality even though some of the costs are similar in character. Some evaluations refuse to assess costs beyond a particular time period, such as a thousand years. Such an escape has no basis in science. The mill tailings do not go away, and we have the responsibility, under NEPA, to make the best estimate of the effects that is technically possible. Conclusion Several issues related to restart of the SRS production reactors have been discussed, including the need for the tritium product. The alternative of using reactors other than those at SRS has been examined. If the SRS reactors are to be operated, the suggestion for an alternative safety system modification should be considered. Finally, one environmental impact of SRS reactor operation has been estimated within the limited data available on SRS operations. There are many other issues related to operation of the production reactors which should also be discussed, but will not be included here. I hope that these issues can be addressed in the final EIS. References Albright, D. and J. Beard, 1989. "The Tritium Follies." Bulletin of the Atomic Scientists, Vol. 45, Nov 1989, pp 42-45. Cochran, T.B., W.M. Arkin, R.S. Norris, and M.M. Hoenig, 1987. Nuclear Weapons Databook, Volume III, U.S. Nuclear Warhead Facility Profiles, Ballinger, Cambridge MA. DOE, 1984. Final Environmental Impact Statement, L Reactor Operation, Savannah River Plant, DOE/EIA-0108, Washington, DC.	

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	DOE, 1990. Draft Environmental Impact Statement, Continued Operation of K-, L-, and P-Reactors, Savannah River Site, Aiken, South Carolina, DOE/EIS-0147D, Washington, DC.	
	EPA, 1973. Environmental Analysis of The Uranium Fuel Cycle, Part I - Fuel Supply, EPA-520/9-73-003-B, Washington, DC.	
	Mark, J.C., T.D. Davies, M.M. Hoening, and P.L. Leventhal, 1988. "The Tritium Factor as a Forcing Function in Nuclear Arms Reduction Talks," Science, Vol 241, 2 Sept. 1988, pp 1166-1168.	
	Miller, M., 1989. "Verifications and Safeguards Considerations" in The Tritium Factor, Nuclear Control Institute and The American Academy of Arts and Sciences, Washington, DC.	
	NAS/NAE, 1987. Safety Issues at the Defense Production Reactors, A Report to the U.S. Department of Energy, National Academy Press, Washington, DC.	
	New York Times, 1990. "Text of the Agreement On Long-Range Arms," p 8, 2 June 1990.	
	Norris, R.S., and W.M. Arkin, 1990. "Nuclear Notebook," Bulletin of the Atomic Scientists, Vol 46, p 48, June 1990.	
	NRC, 1976. Final Generic Environmental Statement on the Use of Recycled Plutonium in Mixed Oxide Fuel in Light Water Cooled Reactors, GESMO, NUREG-0002, Washington, DC.	
	NRC, 1977. Health Effects Attributable to Coal and Nuclear Fuel Cycle Alternatives, NUREG-0332, Draft, Washington, DC.	
	Pohl, R.O. 1976. "Health Effects from Uranium Mining," Search, Vol 7, pp 345-350.	

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Comment Number	Comment	Response
L-73	TACEY PENLAND 172 DORSET DRIVE COLUMBIA, SC 29210 JUNE 24, 1990 Mr. S. R. Wright Director Environmental Division Dept. of Energy, Savannah River Operations Office PO Box A Aiken, SC 29802 Mr. Wright: I would like to go on record as being opposed to the reactor restart at SRP.	
L-73-01	I attended both sessions of hearings on the draft EIS held here in Columbia on June 5. I did not speak at that time because I wanted to listen to what others had to say. I had received a fair amount of information concerning the restart during weeks prior to the hearings from various sources, pro and con, but mainly from those opposed to the restart. I feel this is because, if one is in favor of restart, there is no need to publish or voice his opinion because the decision to restart is one the DOE has already assumed.	Please see the responses to Comments L-28-05 on public comments and L-69-02 on the decision for continued operation.
	At these hearings I heard USC professors of politics, world affairs, and zoology voice opposition. I heard a pharmacist who writes "many more" prescriptions for cancer drugs in the counties surrounding SRP than elsewhere voice opposition. Harriet Kyserling, rep. from Beaufort County spoke concerns over the drinking water there from the Savannah River. The League of Women Voters, Greenpeace, a minister, a social worker, mothers and fathers voiced opposition. A great number of students voiced opposition. I heard only two proponents of the restart; one was an employee at SRP, and the other was a WWII and Vietnam veteran. He deserves a great deal of credit for defending our country, but when he stated "there are worse things than radiation" he lost his credibility with me. What is worse than food and water that makes you sick, or soil that will no longer grow food or trees or support life in any form?	

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	Needless to say, several things about this whole situation have bothered me:	
L-73-02	(1) That several groups had to sue in order to get the DOE to publish an EIS. It seems to me that one of our government's utmost concerns should be the welfare of its people, inclusive of the defense of its people. However, must the environmental and public health of South Carolinians (as well as the rest of the nation) be	DOE had committed to prepare an EIS before the plaintiffs filed the lawsuit. The Federal Court in the District of Columbia dismissed the lawsuit without prejudice on July 9, 1990.
L-73-03	sacrificed for defense? No, I don't think so. The failure of the DOE to answer fundamental safety questions concerning SRP does little to assure the average American that the DOE has our best interests at heart.	Please see the response to Comment L-05-02 on safety.
L-73-04	(2) That there seems to be such urgency to restart at least one reactor by Dec. 1990, and the others soon afterward in 1991. If the threat from abroad is so great that safety concerns have to be pushed aside, shouldn't we as citizens be entitled to that information? With 23 to 24 thousand warheads now stockpiled, I do not see the justification to produce more nuclear weapons, even with the 5% per year loss of the tritium. If the need for availability of new weapons could become so great, than why not place the reactors on cold standby while maximizing the cleanup efforts?	Please see the response to Comment L-02-01 on the need for tritium. The need for nuclear weapons is beyond the scope of this EIS.
L-73-05	(3) That the EIS is more a justification for the DOE's #1 goal, reactor restart, rather than, as the name implies it should be, an Environmental Impact Statement. Where is the information on the environment, such as the effect on the land should a meltdown occur, the number of people who would have to be evacuated, etc.?	Please see the response to Comment L-06-03 on environmental impacts.
	(4) That the politically and financially poor state of South Carolina is being dumped on by the rest of the nation, and most of us don't even realize it is happening. The economic impact of not restarting the reactors could well be made up for by the need for cleanup.	
	The more I read and learned about this situation, the more uneasy I grew. I couldn't sleep for nights following the hearings because I was so troubled. We have in every sense of the word raped the planet Earth now for centuries. Those of us living during this time are challenged to reverse that trend. We can no longer afford our helter-skelter attitude toward the world in which we live. Our mistakes will come back to haunt us, or those coming after us.	

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	I continue to be very troubled about events surrounding SRP, but I am hopeful about the outcome for three reasons: (1) Groups such as Natural Resources Defense Council, Energy Research Foundation and Greenpeace who have caring, politically active voices large enough to make a difference. (2) The fact that individuals can make a difference, not just by writing letters, but by talking to others and letting them know the facts, by getting others interested in the decisions being made for us instead of by us, and by letting the elected officials know where we stand and what we do support and what we don't. (3) There is a God, a caring, compassionate God who gave us the Earth to take care of and preserve. No, I do not know His plan for us, but I do know that I can't sit idly by while we destroy the world around us. Our environment has the wonderful ability to regenerate, but it has been the low man on the totem pole for too long. I challenge you to take stock of the things around you that you take for granted every day. Think of your children and then their children. If you think it is just South Carolina that will lose because of the restart at SRP, think again. The world is not that large. Sincerely, Tacey Penland	

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Comment Number	Comment	Response
L-74	STATEMENT OF HARRY E. WILSON 2120 N CALLOW AVE BREMERTON, WA 98312-2908 25 JUNE 1990	
	Mr. S. R. Wright Director Environmental Division Department of Energy Savannah River Operations Office P.O. Box A Aiken, SC 29802	
	Dear Sir	
	Thank you for the opportunity to comment on the Draft Environmental Impact Statement on the Continued Operation of K-, L-, and P-Reactors Savannah River Site, Aiken, South Carolina.	
L-74-01	I believe that Alternative 2 with K and L Reactors shut down and P Reactor operation would be the best alternative. With the lessening of world tension, Tritium production should be scaled back.	Please see the response to Comment L-02-01 on the need for tritium.
L-74-02	The loss of wetlands mentioned on page 4-11 is unacceptable in any alternative with out mitigation.	DOE is proceeding with the construction of the K-Reactor cooling tower, which will mitigate thermal and flow effects and accelerate the recovery of floodplains and wetlands. As a result of comments on the Draft EIS, DOE has added a discussion of wetlands mitigation options to Section 4.5.
L-74-03	Page 4-18, Nonradioactive Solid Waste, why is their no mention of recycling other the RCRA items?	DOE is developing waste recycling programs as part of its waste management and environmental restoration program. Please see the response to Comment L-06-02 on waste management and environmental restoration.
L-74-04	Page 4-97, Seismic Events, did the New Madrid earthquake (1811-12) affect the area? I realize that this might be hard to determine.	New Madrid suffered three shocks with Modified Mercalli Intensities (MMI) of XI to XII. These shocks were felt throughout the central and eastern

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	Thank you for your time and consideration. Sincerely Harry E Wilson 2120 N Callow Ave Bremerton, WA 98312-2908	United States, an area of more than 2 million square miles. The epicenter was 850 km (530 miles) from the present SRS. The estimated ground acceleration at the Site was 0.05g.

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Comment Number	Comment	Response
L-75	STATEMENT OF STEVEN C. SHOLLY 25 June 1990 Mr. Stephen R. Wright, Director Environmental Division U.S. Department of Energy Savannah River Operations Office Post Office Box A Aiken, SC 29802 Dear Mr. Wright: Please accept these comments on DOE/EIS-0147D, Draft Environmental Impact Statement: Continued Operation of K-, L-, and P-Reactors, Savannah River Site, Aiken, South Carolina, May 1990. I only recently was provided a copy of an associate of mine, therefore my review of the DEIS was limited and my comments thereon will necessarily be brief. Given this situation, I have focused my review efforts on the operational risk information presented in the DEIS. An overall comment which I have regarding the risk estimates provided in the DEIS is that none of the details of the analysis are provided. It is well recognized in the risk assessment community that independent peer review is essential to assuring the adequacy of risk estimates. I suggest that such peer review is equally essential in this case. Accordingly, I recommend that the PRA documentation which underlies the risk estimates summarized in the	
L-75-01	DEIS be provided as a supplement to the DEIS and subjected to peer review and public comment prior to finalizing the EIS.	Please see the response to Comment L-44-16 on PRA peer review.
	Another significant matter regarding the risk estimates concerns the lack of an uncertainty analysis. The need for expression of uncertainties in risk estimates is widely recognized, and given the developments in the state-of-the-art in recent years the lack of an uncertainty analysis in the DEIS is not justified. Indeed, with only 110 reactor-years of operating experience (only	
L-75-02	about four times the experience available when the WASH-1400 analysis was performed in 1975 for commercial reactors), the level	Please see the response to Comment L-44-17 on uncertainty analysis.

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	of uncertainty is not going to be trivial. Futhermore, although the DEIS makes no differentiation of risk among the K-, L-, and P-Reactors, it seems wholly unlikely that the reactors are identical in all important respects. Design changes, including temporary modifications ("T-mods") and repairs over the years, would appear likely to have resulted in non-trivial design differences among the K-, L-, and P-Reactors. Such differences would lead to uncertainty in the risk estimates. Other sources of risk uncertainties include modeling uncertainty, source term estimate uncertainty, consequence estimate uncertainty, and simple parameter variabilities which are unavoidable (e.g., concrete strength in the confinement structure).	
L-75-03	The magnitude of uncertainty in risk estimates is a critical input to decision makers, and I find the lack of an uncertainty assessment in the DEIS to be ill-considered and unjustified. The point estimate values are important, but without an uncertainty expression they are relatively uninformative concerning risk. (Moreover, the reader is not informed about the nature of the point estimates provided — Are they means or medians of a distribution? Are they the product of mean values? Are they "point estimates" to which no statistical meaning can be attached? What is their nature?)	DOE has revised Sections 2.1.3.1.2 and 4.1.3.1.5 to clarify the nature of the point estimates. Section 4.1.3.1.5 includes information on uncertainty.
L-75-04	I found the scope of the risk assessment of the continued operation of the K-, L-, and P-Reactors to be limited to plant operation, but including certain accidents occurring at shutdown during fuel movement. Such a scope of analysis is common in reactor risk assessments, but it is also well recognized as incomplete. It is apparent, for example, that accidents can occur during shutdown without fuel movement in progress, and that the risk posed by such accidents cannot be dismissed as a minor contributor a priori. Such accidents have been found in recent studies of shutdown accidents at commercial nucler power plants to be potentially important to risk due to less stringent operating requirements (Technical Specification Limiting Conditions for Operation are relaxed in cold shutdown if refueling is not in progress), reduced coolant inventory due to mid-loop operation, unavailability of equipment due to maintenance activity, and unavailability of containment isolation due to large penetrations being open for maintenance. Thus, the risk estimates presented in the DEIS are incomplete unless shutdown accidents (apart from refueling activities) are analyzed. Moreover, the risk posed by continued operation of the K-, L-, and P-Reactors is not limited to operation alone. If the reactors	The applicability of the recently completed commercial nuclear reactor shutdown accident studies to the SRS reactors is quite limited. For example, coolant inventory for SRS reactors does not have to be reduced, as it would for commercial reactors. If a long maintenance outage occurs, SRS fuel and target assemblies would be removed and processed for the product, rather than be allowed to remain in the reactor. Further, the SRS reactor confinement system is always running as long as heat-generating assemblies are in the reactor. Commercial reactors often will open their containments during maintenance outages, with irradiated fuel in the reactors.

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L-75-05	are operated, the spent fuel and irradiated target assemblies will need to be reprocessed in order to extract tritium and plutonium-238. Some risks are attendant upon reprocessing activities, and these risks are part and parcel of continued operation of the K-, L-, and P-Reactors. Accordingly, since the risks posed by reprocessing activities cannot be dismissed from consideration a priori, these risks need to be calculated and portrayed in the Final EIS. Appropriate application of PRA techniques (including consideration of external events and containment capabilities) should be used in this assessment. (I note that some analysis has been done of the transportation risks; DEIS, pages 4-101 to 4-107. This analysis should be expanded in scope and broadened to include the full back end of the fuel cycle, including reprocessing plant accident risks.) Finally, the DEIS states (at page 4-72): "Negligible risk" initiators were not considered in the analysis. Although such initiators might be more probable than others that are considered, the quantity of radioactive materials released would be far less than that from the less probable but more severe accidents that are analyzed. For example, criticality due to a reloading error can occur only if a large number of errors are made and remain undetected. This accident is slightly more likely to occur with plutonium production charge than with a tritium production charge but, due to the low inventory of radionuclides, is still a negligible contributor to risk. Such statements can be made with some justification for commercial nuclear power plants due to a wealth of operating experience as well as a number of analyses of more common but low consequence accidents (such as refueling accidents and design basis accidents). No such studies or extensive operating experience is	Section 4.1.6 of the EIS discusses the cumulative impacts of the operation of K-, L-, and P-Reactors and existing and planned support facilities. The Final EIS includes the occupational and population doses associated with these facilities. DOE will prepare an EIS that includes more detail on the environmental impacts of support facilities.
L-75-06	cited in the DEIS fo Savannah River production reactors. I suggest that some sort of conservative bounding sensitivity study be performed to ascertain the extent to which the bases for the statement cited above remain robust. Alternatively, a risk asessment of the so-called "negligible risk initiators" could be performed directly without resorting to the sensitivity study. Without performing some sort of analysis such as is suggested here, one cannot have a great deal of confidence that assumptions such as	Please see the responses to Comments L-44-16 on the PRA, L-44-18 on DOE operating experience, and L-75-04 on the applicability of commercial reactor shutdown accident studies.

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	those made above are correct. (Indeed, it had long been assumed that shutdown accidents for commercial reactors posed negligible risks, only to have the first few detailed studies of such accidents suggest that this assumption was not accurate.) Aside from these more general comments, I have a number of specific comments which are elaborated on in the following paragraphs.	
	Operator Stress Level for Manual Initiation of MRS	
L-75-07	The DEIS states that manual actuation of the moderator recovery system (MRS) in the event of a small LOCA is a "low-stress decision" because unnecessary actuation of MRS has no undesirable consequences (DEIS, page 4-73). This may well be true, but it is not the full measure of operator stress in the event of an accident. Stress is a response to stimulus, and in this case the stressor may be the fact that the small LOCA event occurred at all. With an estimated initiating event frequency of one in 178 per reactor-year (DEIS, page 4-75) a small LOCA is sufficiently unlikely that operators would not expect to see one during their career. Accordingly, the occurrence of a small LOCA might itself be a stressful event (abeit perhaps moderately stressful). I suggest that a more detailed analysis be performed of this possibility, with particular attention paid to performance shaping factors as recommended in the Swain and Guttman HRA handbook (NUREG/CR-1280).	The term "low-stress decision" is meant to be descriptive when used in relation to "high-stress decision," but both terms are used in the context that an accident initiator has occurred. "Low-stress" is not meant to dismiss the fact that some stressor has started a chain of requirements for operator action. The analyses used as a basis for the EIS statements are detailed, and, in fact, do use appropriate performance-shaping factors from the Swain and Guttman HRA handbook.
	Scope of Transient Initiating Events Considered	
L-75-08	The only transient initiating events mentioned in the DEIS as having been considered in the severe accident analysis are reactivity and power transients. Surely other transients are possible. The DEIS argues that loss of offsite power transients are not significant for the K-, L-, and P-Reactors, and this may well be so given the unique design of the reactors. However, the discussion of loss of offsite power transients raises the question of whether the reactors may be vulnerable to dependent failures of DC power supplies. There may well be other plant-specific transients possible as accident initiators at the K-, L-, and P-Reactors. Such plant-specific transient are recognized as important contributors to	DOE has expanded Section 4.1.3.1.5 of the EIS to consider transient initiating events in more detail; see the subsection on Probability Assessment.

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	core damage frequency at commercial reactors, and there is no obvious reason to assume that they are absent from the design of the K-, L-, and P-Reactors. I recommend that a thorough-going search be conducted for plant-specific transients in the designs of the K-, L-, and P-Reactors, and that the results of this search be incorporated into updated risk estimates in the final EIS.	
	Loss of Heat Sink Accidents (LOHSA)	
L-75-09	With an initiating event frequency of 1.2×10^{-4} and a core damage frequency contribution of 9.9×10^{-6} per reactor-year, this means that one LOHSA in 12 goes to core melt. This is a very tiny safety margin for such a well-recognized event. This result suggests that there may be merit in exploring the possibilities of plant upgrades to reduce the vulnerability of the K-, L-, and P-Reactors to LOHSA events.	DOE has expanded Section 4.1.3.1.5 of the EIS to describe the LOHSA in more detail. See the subsection on Probability Assessment.
	Seismic Events	
L-75-10	The seismic PRA relies entirely on the EPRI seismic hazard study methodology (DEIS, page 4-97). As you are no doubt aware, the NRC has sponsored the development of a similar methodology by the Lawrence Livermore National Laboratory, as well as a comparison of the EPRI and LLNL methodologies. My personal opinion is that the LLNL methology is more defensible. Personal opinion aside, however, both methods are recognized by NRC as viable, and the NRC used both methods to calculate core damage frequency from seismic events in NUREG-1150. I believe that such a comparison has merit for the risk assessment of the K-, L-, and P-Reactors. Accordingly, I recommend that the LLNL seismic hazard methodology be used to estimate seismic hazard at the Savannah River site, and that appropriate risk calculations be performed using the resulting hazard curves as a possible display of uncertainty in the seismic risk estimates. The comparison of the results between the EPRI and LLNL hazard curves should be part of the final EIS. This suggestion is particularly important since the LLNL hazard curves can produce higher risk estimates than the EPRI curves, and even with the EPRI curves seismic events are important contributors core damage frequency for the K-, L-, and P-Reactors (contributing 35% of the core damage frequency from all causes).	The EIS (Section 2.1.3.2.1) has been modified to note that the PRA will include seismic risk results from both seismic hazard curves.

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	Source Term Calculations	
L-75-11	Source term calculations were stated to have been performed with a modified version of the CONTAIN code referred to as CONTAIN/SR (DEIS, page 4-79). It should be explained to the reader that the CONTAIN code does not perform primary system thermal-hydraulics calculations, but rather takes the output from a thermal-hydraulics code and calculates containment loads and source terms based on the input code values and assumptions about containment failure pressure. The final EIS should identify the primary thermal-hydraulics code which was used for the risk calculations as well as pertinent analytical assumptions used in both the thermal-hydraulics analysis and the containment analysis (e.g., confinement failure pressure). Any benchmarking of the thermal-hydraulics code and the CONTAIN/SR code against standard problems should be identified and discussed to allow the technically inclined reader to better evaluate the modifications which have been made to the code. In addition, the modifications to CONTAIN should be described in order that their appropriateness can be assessed.	The Reactor Operation Safety Information Document (SID) (WSRC, 1990), which is referenced in the EIS and is available in the Public Document Rooms, describes the computer codes used.
	Containment Event Trees	
L-75-12	Containment event trees (CETs) represent the bridge between plant damage states and release categories in the Savannah River Plant risk assessment. However, only the CET for Plant Damage State 1 (PDS-1) is actually provided in the DEIS. Even in this case, no explanation is provided of the bases for the top events used in the CET nor for the numeric values used to quantify the CET. The final EIS should provide the CETs for all Plant Damage States and a discussion of the bases for the numerical values used in the quantification of the CETs.	Readers seeking information with more detail than that in the EIS can refer to the Safety Information Document (SID). The SID includes a Confinement Event Tree (CET) for each Plant Damage State (PDS), along with the branch probabilities used to quantify the CETs. To provide PDS groupings, the SID also discusses the development of the CETs and the selection of the top events.
	Consequence Analysis	
L-75-13	The only consequences which are quantified in the DEIS are prompt (early) fatalities, latent cancer fatalities, and population bone marrow dose (DEIS, Figures 4-7, 4-8, and 4-9). However, it is well known that the MACCS code performs a variety of other consequence calculations. The environmental impact of severe accidents is not limited to early and late fatalities and dose versus distance impacts, although these are potentially important measures of environmental impact. The final EIS should provide the	The MACCS will calculate such consequences as costs of intermediate relocation, farm product disposal, and land decontamination/interdiction costs; the inputs required to calculate these consequences are so subjective, and the algorithm used for the calculations is so rudimentary, that the outputs would not be particularly meaningful or defensible. Supporting studies for the EIS, including the Safety

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	full variety of consequence results (land contamination areas, economic consequences, early fatality radius, etc.). The opportunity to review and comment on the DEIS was appreciated. Please include me on your mailing list for future environmental and risk documentation related to the K-, L-, and P-Reactors. Sincerely, Steven C. Sholly Senior Consultant	Information Document (WSRC, 1990), discuss other measures of risk. The full-scope PRA will cover land contamination and economic costs in the context of severe accident analysis.

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L-76	STATEMENT OF JAMES N. PAGLIERI 1734 HORN AVE. RICHLAND, WA 99352 JUNE 22, 1990	
	Mr. Stephen R. Wright, Director Environmental Division U.S. Department of Energy Savannah River Operations Office P.O. Box A Aiken, SC 29802	
	Dear Mr. Wright:	
	The report "Draft Environmental Impact Statement, Continued Operation of K-, L-, and P-Reactors, Savannah River Site, Aiken, South Carolina" (DOE/EIS-0147D, May 1990) was reviewed. Operation of the existing defense reactors for tritium production after upgrading should be the course of action until replacement production capacity is available. However, production and processing of Pu-238 should be done at the FFTF/FMEF. Comments and questions on the EIS are provided as a concerned citizen:	
L-76-01	Pg. S-5 The processing facility for Pu-238 and the associated upgrades (use of materials, etc.) is not addressed.	Please see the response to Comments L-44-62 and L-44-63 on plutonium-238 processing facilities.
L-76-02	Pg. 1-3 The statement is made that "Issuance of the 1990-1995 NWSM has been delayed, but is expected in the near future." The 1990-1995 Nuclear Weapons Stockpile Memorandum (NWSM) should be issued prior to issuance of the EIS since the document establishes the primary need for operating the Savannah River reactors and is the basis for the EIS.	The current NWSM was signed on July 12, 1990. The requirements established in that document are reflected in Appendix A of the EIS (which is classified) and summarized in Section 1.2.
L-76-03	Pg. 1-3 The expected need dates should be given for the various missions involving the Pu-238 stockpile.	Please see the response to Comment L-47-02 on the need for plutonium-238.
L-76-04	Pgs 1-3 & 1-4 Will full power operation of the Savannah River reactors satisfy expected intermediate term needs for Pu-238? This is not addressed.	Please see the response to Comment L-48-42 on power level requirements.

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L-76-05	Pgs. 1-3 & 1-4 Full power operation of the Savannah River reactors may not be possible because of new power limits that are yet to be established (pp 2-36 & 2-51). If the power limits are set at less than full power (for example, 50%) can Pu-238 needs be met?	Please see the response to Comment L-48-42 on required operating levels to meet production needs.
L-76-06	Pg. 1-4 The statement is made on page 1-4 that "DOE has confirmed that a demand for plutonium-238 that will exceed the DOE supply in the early 1990's." If the need for tritium decreases due to arms agreements and the Savannah River plants are run at less than full power, how will Pu-238 needs be met?	Please see the response to Comment L-48-42 on required operating levels to meet production needs.
L-76-07	Pgs. 2-3 & 2-70 The statement is made on p.2-3 in discussing the option of Pu-238 production/processing at FFTF/FMEF, that "Primarily because of schedule requirements for National Aeronautics and Space Administration projects and a classified Navy mission, continuing the production of plutonium-238 in SRS reactors is the only reasonable alternative." This conclusion is tenuous. If a working inventory was not maintained, the existing near term needs can be met out of the existing 59kg Pu-238 inventory (p.1-3) except for a 12kg shortfall. This shortfall would at most result in possible deferral of only one of a number of missions. The deferral of a single potential future mission out of many missions is not convincing justification as the primary reason for the very major decision of ruling out FFTF/FMEF. Also, the restart date for the SRS plants is not known with certainty due to the number of upgrades to be completed, the final EIS which is yet to be issued, potential delays due to lawsuits, etc.	Please see the responses to Comments L-47-01 on the adequacy of the plutonium-238 inventory and L-48-31 on the working inventory.
L-76-08	Pg. 2-1 The statement is made that the SRS reactors would meet the tritium and Pu-238 needs until proposed replacement reactors are available and fully demonstrated. This conclusion is questionable since the SRS reactors will then be approximately fifty years old. Consequently, to assure an adequate supply of Pu-238, FFTF/FMEF should be used for production/processing of Pu-238. As stated on page 19 of the report "Implementation Plan for the New Production Reactor Capacity, Environmental Impact Statement" (DOE/NP-0003), "Although these reactors have undergone safety enhancements, there is an increasing risk to assurance of reliable production capacity."	As described in Section 2.1.2.3 of the EIS, no life-limiting mechanisms have been identified in SRS reactors. Further, as noted in the response to Comment L-48-42, DOE can meet plutonium-238 requirements with only one of the three SRS reactors operating at 50 percent of full power, which represents the only production option that can meet the users' schedules.

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L-76-09	Ch. 2 The current age of the SRS facilities for processing Pu-238 should be stated.	The HB-Line was originally constructed in 1954, and modified in 1960 and 1965. When this facility became obsolete, it was replaced in the early 1980s with a new and separate facility, which was constructed in three phases. Phase I, the Scrap Recovery Facility, and Phase III, the Plutonium Oxide Facility, were completed and were operated between 1985 and 1987. Phase II, the Neptunium Oxide Facility, was completed but has not been operated with radioactive material. All HB-Line facilities have been maintained in a state of operational readiness. The Actinide Billet Fabrication and PuFF Facilities were constructed in 1960 and the mid-1970s, respectively. They were operated until the early 1980s, when they were shut down and officially placed in a "standby readiness" mode.
L-76-10	Ch. 2 The upgrades to the SRS Pu-238 processing facilities should be described including identification of the nature and extent of the upgrades.	Please see the response to Comment L-44-63 on plutonium-238 processing facilities.
L-76-11	Ch. 2 The overall total scope of ongoing and planned work that will not have been completed prior to startup is very large. An estimated schedule for the completion of each item needs to be given so that the acceptability of deferring the work until after startup can be assessed. Also, the EIS should include a statement regarding the acceptability of the total bulk of work that will not be completed by startup.	Please see the response to Comment L-44-29 on upgrades.
L-76-12	Pg. 2-16 In the statement "At present, the SRS reactors are being qualified to seismic criteria that have been accepted by the U.S. Nuclear Regulatory Commission (NRC) for commercial nuclear plants licensed before 1974." clarify whether the criteria is currently accepted by the NRC for plants older than 1974.	DOE has modified Section 2.1.2.3.1 to indicate that the criteria are accepted by the NRC for reactors licensed before 1974.
L-76-13	Pg. 2-16 Is seismic qualification upgrading of additional items needed in addition to the three items listed? If yes, the items should be identified and a statement made on whether the upgrades will be completed prior to startup.	DOE has modified Section 2.1.2.3.1 to indicate that modifications are planned after the resumption of production.

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L-76-14	Pgs. 2-19 & 2-20 Have any UT inspections been performed on L reactor and if not are any planned prior to startup? If none will have been performed prior to startup, justification should be given as to why this is acceptable.	As stated in Section 2.1.2.3.2 of the EIS, UT inspection of the L-Reactor tank began in the fall of 1990.
L-76-15	Pg. 2-23 Justification should be given for not implementing the improved incident monitoring system. Why is the "...vulnerability to single failures that can initiate multiple spurious and misleading alarms in the reactor control room." acceptable?	Please see the response to Comment L-37-07 on upgrades.
L-76-16	Pg. 2-23 Are storage racks and hangers for new and irradiated fuel designed to assure criticality safety by sustaining natural phenomena such as earthquake and tornado?	Yes.
L-76-17	Pg. 2-24 Section 2.1.2.3.6 "Fuel Disassembly and Storage" does not mention criticality safety.	As pointed out in the previous comment, storage racks and hangers are designed to maintain a noncritical geometry even under adverse conditions. In addition, there are administrative controls for moving and processing assemblies. Monitoring systems detect and alert personnel if a criticality occurs.
L-76-18	Pg. 2-31 Section 2.1.2.6.1 "Electric Power" discusses use of transformers. Do the transformers contain the carcinogen PCB and if so what is the schedule for replacement of the PCBs? A fire involving the transformers could spread the PCBs and have unacceptable consequences.	Some or all of the SRS transformers contain PCBs. At present, a sampling and analysis program is determining exactly how many. Five hundred of the 1,200 SRS transformers have been sampled; the samples have been analyzed and PCB concentrations of 50 to 500 (contaminated range) have been detected. Some of the larger transformers have bushings; analyses of samples from a few of these bushings have detected PCB concentrations.
L-76-19	Pg. 2-52 & 4-76 Justification for not completing Levels 2 and 3 of the PRA prior to startup needs to be stated.	The NRC recently (NRC Generic Letter 88-20) required the commercial power industry to have an Independent Plant Evaluation (IPE) performed for each commercial reactor. This IPE can be satisfied by completion of a full-scope Level-1 PRA for internal events, and a Containment System Performance study, which can best be described as a limited-scope Level-2 PRA. There is no requirement for the reactor to shut down until the IPE analysis is complete; in fact, a licensee

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		has 3 years in which to complete the IPE. Although PRA is a useful analytical tool, it is not a prerequisite for reactor operation.
L-76-20	Pgs. 2-50 through 2-55 Justification must be given of the acceptability for each of the National Academy of Sciences/National Academy of Engineering (NAS/NAE) recommendations that will not be implemented prior to startup (e.g., the increased potential for hydrogen buildup due to confinement system improvements, training on PRA lessons learned, etc.).	Please see the response to Comment L-37-07 on upgrades.
L-76-21	Pg. 2-54 The NAS/NAE recommendation to reprogram the simulator to provide simulation of severe accident conditions is not explicitly addressed.	The NAS/NAE recommendation was to expand the use of the simulator to train operators in abnormal condition control procedures, not to reprogram the simulator for severe accidents. Only precursors and initiating events can be simulated. The full range of design-basis accidents, such as LOCAs, are simulated; for these, the operators use the abnormal condition control procedures, as recommended. There are no recommendations to simulate severe accidents such as core melts with operator training simulators either at SRS or in commercial nuclear plants.
L-76-22	Pgs. 2-67 through 2-69 The significant benefit of selling N-Reactor steam for an estimated income of approximately $100 million per year was not mentioned.	N-Reactor is not a reasonable alternative to continued operation of the SRS reactors, for the reasons stated in Section 2.4.2; the factor identified in the comment (steam sales) does not change the DOE conclusion.
L-76-23	Pg. 2-67 A significant amount of the N-reactor new core design for highly enriched uranium (HEU) has already been prepared and reviewed but is not acknowledged in the report.	Section 2.4.2 of the EIS considers new core design factors.
L-76-24	Pgs. 2-67 & 2-68 Almost all of the most time consuming tasks for N-reactor could be done in parallel, rather than having to be done in series as stated in the text, thereby reducing the estimated restart time given in the EIS.	Section 2.4.2 of the EIS acknowledges the ability to perform some tasks in parallel rather than in series.
L-76-25	Pg. 2-69 The EIS does not discuss the alternative of Pu-238 production at FFTF with processing at SRS. Compared with use of the old and potentially unreliable SRS reactors this would increase the confidence level of meeting interim and long term needs for Pu-238.	The DEIS did not discuss this alternative because DOE had dismissed it in early studies as an unreasonable alternative that would increase costs and delay product delivery. The FFTF targets would

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		use an encapsulation material that is not compatible with the processes used to fabricate and reprocess the targets at SRS. To provide this capability at SRS would require major, costly modifications to the SRS reprocessing facilities, which could not be completed on a schedule to meet user needs.
L-76-26	Pg. 2-69 The costs for transporting Pu-238 produced at SRS to FMEF for fabrication of RTG's is not addresed. The transportation costs would be esentially nonexistent if the Pu-238 was produced/processed at Hanford.	Transportation costs for plutonium-238 from SRS to Hanford are not a significant factor; these costs would be substantially less, however, than the costs for transporting irradiated target assemblies from Hanford to SRS for reprocessing, as proposed in Comment L-76-25.
L-76-27	Pg. 2-69 A more definitive estimate should be given for the cost of upgrading the SRS Pu-238 processing facilities. The EIS states that the SRS cost is "quite small (several tens of millions of dollars)". Does this mean approximately $40 million? Forty million dollars for SRS is "less than" but not "quite small" compared with $120 million for FMEF.	The estimated cost to upgrade the plutonium-238 processing facilities is about $18 million in capital costs, with about an equal amount in operating costs, for a total of about $36 million. This total does not include such startup costs as operator training, procedure development, readiness reviews, and walkthroughs.
L-76-28	Pg. 2-69 A description of the upgrades to the SRS processing/encapulation facilities is not given in the EIS.	Please see the response to Comment L-44-63 on plutonium-238 processing facilities.
L-76-29	Pg. 2-69 The annual cost of operating FFTF would be less than $85 million rather than the $115 million figure given in the EIS. FFTF has been operated the last four years at an annual cost of $85 million including a significant amount for new fuel development.	The current $85 million annual operating budget does not include the costs of procuring and enriching the uranium fuel and fabricating the fuel in the Fuel Assembly Area of the FMEF; these are the primary cost factors that will increase FFTF operating costs in the future to about $115 million per year.
L-76-30	Pg. 2-70 The EIS ignores alternate current and future potential significant sources of income and unfairly assigns the entire operating cost of the FFTF to Pu-238 production. Current income sources include materials irradiation testing and isotope production. Potential future sources of income include continuation of current work, conversion of nuclear waste to a safer form (estimated to result in a potential one billion dollar savings), neutralization of nuclear weapons by converting bomb materials to reactor fuel, expanded special isotope production (estimated to become a $3 billion dollar business in the U.S. by 1995), generation	The only firm, major, long-term mission identified for the FFTF/FMEF complex was the plutonium-238 mission, which would absorb operating costs. Even with an optimistic assumption that other potential users would contribute as much as 50 percent of the operating costs for the FFTF/FMEF complex, the estimated cost for producing a gram of plutonium-238 powder at the FFTF/FMEF complex is more than twice the SRS production cost.

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	of electricity, fast breeder reactor technology research and development, etc.	
L-76-31	Pg. 2-70 The inaccurate statement is made that "...the production of plutonium-238 in the SRS reactors would not result in additional operating costs above those for defense materials production". The incremental cost due to Pu-238 production should be given. For example, if some reactor locations are used for Pu-238 and cannot be used for tritium production this would be a cost. Also, there will be associated handling costs.	The statement in the EIS is correct. Components of the reactor lattice do not affect reactor operating costs.
L-76-32	Pg. 2-70 Additional criteria that should be included in the evaluation of where Pu-238 is to be produced/processed are safety considerations, dependability, and facility longevity. For example, the FFTF is the only DOE reactor which was built and reviewed to Nuclear Regulatory Commission (NRC) requirements. The Fuels Materials and Examination Facility (FMEF) adjacent to FFTF is also a modern facility that meets all current safety requirements. This contrasts with the SRS reactors which were built 40 years ago, are based on old designs (e.g., there is no containment dome), and are currently shut down to fix safety problems.	The incremental risk associated with plutonium-238 production is presented in Sections 4.1.3 and 4.1.6 of the EIS. Also, please see the response to Comment L-76-08 on reactor life.
L-76-33	Pgs. 2-69 & 2-70 The EIS does not consider the impacts of the decision to produce/process Pu-238 at Savannah River rather than at Hanford (impacts on the environment, U.S. capabilities, etc). Without the Pu-238 assignment, DOE has stated that there is no identified mission for FFTF and the facility should be immediately terminated. The consequences with respect to FFTF/FMEF of the decision to do the Pu-238 work at Savannah River should be addressed in this EIS (DOE/EIS-0147D). Addressing the impacts in a later EIS on termination of FFTF would be too late as the decision on where to do the Pu-238 work will have already been made. Some of the impacts of the decision to do the Pu-238 work at SRS with the resulting termination of FFTF are: • Environmental impacts such as disposal of several hundred thousand gallons of radioactive sodium • Construction of fuel offload/storage facilities and a solution to the issue of ultimate disposal of the fuel • Termination costs exceeding $400 million • (Approximately 1100 jobs lost	The consideration of producing plutonium-238 at SRS is based primarily on the fact that no other alternative, including the FFTF/FMEF complex, could produce this material on a schedule to meet user needs. All supporting facilities from fuel fabrication through processing are operable at SRS, and the staff is experienced in handling plutonium-238 operations and material. When DOE proposes to decommission and decontaminate the FFTF, it will complete the appropriate environmental documentation and will evaluate the impacts listed. DOE will consider all the points listed in this comment in the decisionmaking process associated with the FFTF/FMEF complex.

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	• Unilateral termination of international agreements to complete ongoing materials testing with potential for significant negative impact on future international energy agreements, such as Japanese financial support for the Supercollider • Significant loss of U.S. fast breeder program and advanced reactor research, development, and testing capabilities • Loss of materials testing capabilities for fusion and space applications that are unique in the world • Loss of a very significant producer of radioisotopes at a time when the U.S. imports more than 90% of its medical isotope supply • Loss of U.S. capability for radioactive waste conversion to a less hazardous form • Loss of the only U.S. facility where nuclear weapons neutralization by converting bomb materials to fuel is practical • Loss of a U.S. backup for Pu-238 production (If FFTF were the primary producer the SRS reactors could provide a backup) • Loss of capability to test large steam generators for electrical production by a fast reactor • Loss of one of the world's few Centers of Excellence according to the Japanese	
L-76-34	Pg. 2-70 Clarify whether the SRS Pu-236 impurity level is at discharge or after fabrication. The FFTF Pu-236 level of 5.5 ppm is stated for immediately after reactor discharge; however, the value of importance to the end user is the 3.5 ppm after fabrication. The SRS and FFTF values should be compared for the same rather than different conditions.	At discharge, the SRS product has an average plutonium-236 content of about 1.3 parts per million, based on actual production operations.
L-76-35	Pg. 2-70 Several analyses by organizations outside of Hanford that are not involved with FFTF operations have concluded that 10ppm Pu-236 is acceptable for almost all applications.	All current users of plutonium-238 power supplies specify the plutonium-236 content to be less than 2 parts per million. Higher levels are not acceptable to users because higher radiation levels will produce negative impacts on sensitive instrumentation and significantly increase personnel radiation doses. For some missions radiation levels could be mitigated by additional shielding; however, the added weight of the shielding would not be practical, especially for NASA, a major user of

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		plutonium-238 for interplanetary space exploration missions. This is also true for the manned missions to the Moon and Mars (part of the President's Space Exploration Initiative), during which personnel dose could be a primary concern. For some missions, plutonium-236 levels must be kept below 1 part per million.
L-76-36	Pgs. 2-74 & 4-2 The Table 2-3 entry "Socioeconomics" and Section 4.1.1.1 "Land Use and Socioeconomics" should address the loss of approximately 1100 jobs resulting from the decision to do the Pu-238 work at SRS and the consequent shutdown of FFTF.	The plutonium-238 production mission has always resided at SRS. DOE evaluated the option of doing this work at FFTF to supplement its primary mission as a test reactor. DOE evaluated the socioeconomic merits and impacts of FFTF operations at the outset of that program. Also, please see the responses to Comments L-76-29 and L-76-30.
L-76-37	Pg. 2-82 The upgrades to the reactor and processing facilities should be added to the Table 2-3 "Comparison of Impacts of Alternatives" entry on "Commitment of Resources".	Please see the response to Comment L-44-63 on plutonium-238 facilities.
L-76-38	Pg. 3-1 Identify the specific building(s) by number that will be used for processing Pu-238.	The numbers are not included in the EIS because building identification by number is not required for an assessment of environmental impacts. The building numbers are 221-H and 235-F.
L-76-39	Pgs. 3-15 through 3-21 The Probable Maximum Flood (PMF) should be addressed in Section 3.4.1.2 "Surface-Water Hydrology".	Section 4.1.3.2 of the EIS presents information on historical flooding events. Probable maximum flood is used in emergency spillway design, and is not germane to a description of the affected environment.
L-76-40	Pg. 3-27 The statement is made that meteorology is an important factor in the assessment of the consequences of postulated reactor accidents. "Meteorology is also very important in assuring that facility designs will sustain natural phenomena and should be given additional emphasis in this section.	Section 4.1.3.2.3 contains the requested information.
L-76-41	Pg. 3-27 & 3-31 The projected 100-year rainfall or snow accumulation is not discussed.	The requested information has been added to Section 3.5.2.3.
L-76-42	Pg. 3-31 Hail storms are not mentioned.	The requested information has been added to Section 3.5.3.2.

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Comment Number	Comment	Response
L-76-43	Pg. 4-1 The environmental impacts of upgrading the Pu-238 processing facilities and operations involving Pu-238 at Savannah River are not addressed. For example, if the decision had been made to produce and process the Pu-238 at Hanford, Savannah River impacts would be less.	Please see the response to Comment L-44-63 on plutonium-238 processing facilities.
L-76-44	Pg. 4-1 Psychological impacts are not addressed in Chapter 4 "Environmental Consequences". Psychological impacts will be addressed in the EIS for the New Production Reactors (DOE/NP-0003 pages 21 and 24). Forty-eight comments were received on the NPR Implementation Plan to add this topic.	There is no scientific consensus on a methodology for predicting adverse psychological impacts on individuals or population groups. No basis has been established for such analyses in the scoping process for this EIS, nor is an analysis of the psychological impacts of the fear of risk required by NEPA.
L-76-45	Pg. 4-36 Accident prevention, potential types of accidents and consequences of accidents in the upgraded Pu-238 processing/ fabrication facilities are not discussed and should be added.	Please see the response to Comment L-44-63 on plutonium-238 processing facilities.
L-76-46	Pg. 4-36 Accidental criticality ex-reactor is not discussed for the SRS reactor facilities or the Pu-238 facilities.	Please see the response to Comment L-44-63 on plutonium-238 processing facilities.
L-76-47	Pgs. 4-36 through 4-71 A statement needs to be added identifying the limiting organ with respect to radiation dose from accidents.	Values for effective dose equivalent and for thyroid dose provide sufficient information for judging risks and are consistent with NRC practices.
L-76-48	Pg. 4-97 Natural phenomena impacts on the upgraded Pu-238 processing facility is not addressed.	Please see the response to Comment L-44-63 on plutonium-238 processing facilities.
L-76-49	Pg. 4-97 Has the UCRL-15910-Interim report "Design and Evaluation Guidelines for DOE Facilities Subjected to Natural Phenomena Hazards", Oct. 1989, and related reports, been applied to the SRS reactors and processing facilities?	The referenced report is not directly applicable to reactors. To the extent the site-specific hazard curves are applicable for SRS facilities, they are considered in hazard assessments. DOE reports related to reactor design are applied as appropriate.
L-76-50	Pg. 4-99 The height in feet of the Savannah River reactors and processing facilities above the maximum flood should be stated. This cannot be determined from Section 2.1.2.1 to which the reader is referred.	K-, L-, and P-Reactors are 46, 40, and 60 meters respectively, above the maximum flood (36 meters MSL). Support facilities are from 10 to 71 meters above the maximum flood. The D-Area pumphouse intakes are at about 30 meters and would be flooded during a maximum flood.
L-76-51	Pg. 4-112 Section 4.1.6.1 "Existing SRS Support Facilities" should describe upgrades to the Pu-238 processing/fabrication facilities.	Please see the response to Comment L-44-63 on plutonium-238 processing facilities.

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Comment Number	Comment	Response
L-76-52	— The length of time for public review and comment on the EIS was marginal considering the length of the report, complexity and importance of the issues involved, and the amount of technical detail in the report. Sincerely, James N. Paglieri	DOE has followed CEQ regulations in relation to the minimum review and comment period (i.e., 45 days).

Comment Number	Comment	Response
L-77	STATEMENT OF GERALD WOODCOCK June 24, 1990 Mr. Stephen R. Wright, Director Environmental Division U. S. Department of Energy Savannah River Operations Office Post Office Box A Aiken, South Carolina 29802 Dear Mr. Wright: My name is Gerald Woodcock. I hold a BS degree in Industrial Technology, and an MBA in finance. For the past 16 years I have been employed by Westinghouse Hanford in a variety of professional, managerial and administrative positions. I am on the Board of Directors of several civic organizations. I am currently finishing a term of office as Chairman of the Eastern Washington Section of the American Nuclear Society, which has over 400 members and an annual budget of over $30,000. I have reviewed those sections of the Draft Environmental Impact Statement for the continued operation of the Savannah River reactors. I have attached comments for those areas of the report in which I have some competence. I am only too painfully aware of the political warfare surrounding both the restart of the Savannah River reactors, and the larger issue of New Production Reactors. I had hoped to discover in this document an objective, scholarly evaluation of all options surrounding the restart of the Savannah River reactors. I was disappointed. It is not without cause that the American public has developed a deep mistrust of nuclear technology in general, and the Department of Energy in particular. For as long as DOE continues to permit political considerations to influence analyses of options involving multiple sites, that mistrust will continue to have a basis in fact. Documents so tainted become "lightning rods," inviting the	

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Comment Number	Comment	Response
	wrath of GAO, OMB, and Congressional committees and staff. Their incredulity at the lack of sound bases for our conclusions fuels public mistrust, to our continuing detriment. I would have thought that past experience should have impressed that lesson upon us by now. I have not deliberately set out to offend, but I cannot emphasize too strongly the blatant inequities discussed in my comments. Sincerely, Gerald Woodcock, MBA 1851 Alder Richland, Wa. 99352	

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Comment Number	Comment	Response
	SAVANNAH RIVER DRAFT EIS Comments	
	Page Comment	
L-77-01	2-66 Sec. 2.4: It is absolutely unconscionable that a document of this nature should fail to thoroughly consider the conversion of WNP-1. In the face of Adm. Watkins' statements regarding the technical viability of the option together with its well-defined cost and schedule advantages, lack of serious discussion of this alternative can only be ascribed to petty political considerations. That such considerations should influence an objective discussion in a document of this nature calls into serious question the credibility of the entire work, and makes manifest the self-interest of the authors.	The WNP-1 could not be converted in time to meet the DOE near-term mission goals. DOE will consider this conversion in the EIS being prepared for the New Production Reactor capacity.
L-77-02	2-66 Sec. 2.4.1: The schedule for conversion of WNP-1 has been reviewed numerous times by agencies both within and without DOE. A six-year schedcule is not only credible but fully defensible, and supported by highly conservative assumptions. Therefore, if project funding were provided by FY1991, beneficial use would occur during FY 1997, and tritium	Even a 6-year schedule for conversion would not meet DOE near-term goals.
L-77-03	extraction would begin one year later, or the fall of CY 1997. Furthermore, there is a strong and documented potential for project acceleration to a five- or even a four-year basis.	DOE could begin extracting tritium approximately 1 year after resumption of production at an SRS reactor.
L-77-04	The Office of NPR has stated as official DOE policy that WNP-1 conversion is a reasonable "contingency." The third sentence is a direct contradiction of that policy.	This statement is true with regard to NPR, but not for K-, L-, and P-Reactors.
	2-67 Last line: This has all the appearance of an "escape clause." It appears that in making this statement, the authors hope to justify the fact that they have not seriously considered any of the NPR alternatives.	
L-77-05	However, any substantial upset to the SR restart schedule, whether technological, fiscal, legislative or institutional, would quite rapidly put SR restart plans on a parity with the shortest NPR alternative, and perhaps with the longer-scheduled alternatives as well.	Section 2.4.1 of the EIS presents information on new production reactors.

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Comment Number	Comment	Response
	Moreover, the threat of challenges-at-law by intervenors, and the potential for adverse judicial rulings resulting from those challenges, are very real considerations. Their reality is underscored by the declared intent of several intervenor organizations' public pronouncements of their intent to file suits at the critical moment when the plants are poised to restart, and the fact that as of this writing, the first of these suits has already been filed.	
L-77-06	2-67 Top para.: "...7 to 10-year schedule" is in error. As stated above, a six-year schedule has been shown to be very achievable, and actions necessary to shorten the schedule further have been identified.	Please see the response to Comment L-77-02 on the inability of a 6-year schedule to meet near-term needs.
L-77-07	2-67 Sec. 2.4.2, first bullet: Whose estimate? The best estimate by N Reactor people is 1 1/2 years. Substitution of the authors' judgment for that of the people who would be responsible for bringing N Reactor back on-line is not appropriate.	The DOE Office of Defense Programs prepared the estimate, based on information provided by DOE-Richland Operations Office.
	2-67 Sec. 2.4.2, second bullet: Two commercial vendors support the schedule.	
L-77-08	2-68 Bottom para.: Successful restart of N Reactor does <u>not</u> entail <u>significant</u> technological risk. Considering the respective operating records of the Savannah River reactors as contrasted with N Reactor, the evidence is conclusive that N has the more favorable operating record. The last sentence is highly subjective, and not supported by facts.	The risk referred to is one of technical feasibility and schedule compliance.
	<u>SUMMARY</u>	
	On pages v. and vi., the document states its intention to serve the purposes of NEPA and CEQ. By almost totally ignoring one highly viable option (WPN-1), and by substantially misstating facts and engaging in unjustifiably negative editorializing regarding another (N Reactor), this document fails utterly in that regard.	
	Gerald Woodcock June 23, 1990	

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Comment Number	Comment	Response
L-78	COMMENTS OF FRANK M. REDMOND UNITED STATES ENVIRONMENTAL PROTECTION AGENCY REGION IV 345 COURTLAND STREET, N.E. ATLANTA, GEORGIA 30365 JUL 02 1990 4PM-FAB/DM Mr. Stephen R. Wright, Director Environmental Division U.S. Department of Energy Savannah River Operations Office P.O. Box A Aiken, South Carolina 29802 Subject: Draft Environmental Impact Statement; Continued Operation of the K-, L-, and P-Reactors, Savannah River Site, Aiken, South Carolina; ERP No.: D-DOE-E00004-SC Dear Mr. Wright: Pursuant to Section 309 of the Clean Air Act and Section 102(2)(C) of the National Environmental Policy Act (NEPA), the U.S. Environmental Protection Agency (EPA) has reviewed the above referenced Draft Environmental Impact Statement (DEIS). Based on this review we have the following general comments concerning the document and proposed actions. We also have attached a list of detailed comments. Our main area of concern relates to the impact of the continued operation of the facilities on the water resources of the area. Continuation of past operational procedures for K-, L-, and P-Reactors would allow continued adverse impact to occur to the groundwater, surface water, and wetlands of the Savannah River Site (SRS). The contamination of the area groundwater from the restart and continued operation of the reactors continues to be a concern to EPA. We feel that the groundwater impacts of restarting these reactors are inadequately covered in the DEIS. Section 2.1.2.3.8 indicates that restarting the reactors will include the continued	

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Comment Number	Comment	Response
L-78-01	use of the disassembly basins and associated seepage basins for the storage and disposal of liquid radioactive wastes. As we discussed in our letter to you, dated June 26, 1987, concerning the DEIS for Waste Management Activities for Groundwater Protection at SRP, we	As described in Section 2.1.2.3.6 of the EIS, the disassembly basins are used as processing areas, not for waste storage.
L-78-02	continue to recommend that appropriate alternatives be pursued to eliminate this practice. Groundwater monitoring wells near the assembly basins at the reactors have shown that the groundwater is contaminated with tritium at very high levels in the immediate vicinity of these basins.	As a result of comments on the draft EIS from EPA, other agencies, and the public, DOE is reevaluating options for the disposal of disassembly-basin purge water. Section 4.1.2.3 of the EIS demonstrates that continuing the use of the seepage basins would result in lower public exposure to tritium than would direct discharge; Section 4.5.3 indicates that moderator detritiation cannot be justified on a dose-aversion basis.
L-78-03	In some groundwater monitoring wells the level of tritium contamination is four orders of magnitude above the drinking water standard, or Maximum Contaminate Level (SRS Environmental Report for 1988, Westinghouse Savannah River Co., Contract #DE-AC09-88SR18035). The best indication of the environmental impact of restarting these reactors is the documentation of impacts of past operations upon the groundwater. Unfortunately, the extent of groundwater contamination associated with these sites has not been completely investigated, therefore, the total impacts of past activities is unknown. Complete information concerning groundwater contamination of the site should be provided. This information must be provided for onsite areas as well as at the site boundary.	DOE recognizes that tritium levels in perched groundwater adjacent to the seepage basins exceed the community water supply MCL standards of 40 CFR 141. However, this is not a regulatory constraint, and the effect is of limited health concern because the shallow groundwater aquifer (1) is onsite and not accessible to the public, (2) is not used for either a potable or a nonpotable water supply onsite or offsite, and (3) has not impacted site flora or fauna. Sections 3.7.1.2 and 4.1.6.4.14 of the EIS present the extent of tritium and other radionuclide contamination in the vicinity of the seepage basins. The Environmental Information Document, Reactor Seepage Basins (DPST-85-707; Pekkala et al., 1987) presents complete documentation. The annual Environmental Report for the SRS, which is available to the public, presents the latest data yearly. This EIS analyzes the impacts of continued reactor operation. Such sitewide groundwater contamination, including cumulative impacts, which is due to prior reactor and nonreactor operation, will not be affected by continued reactor operation. See Section 4.1.6.4.5 of the EIS. This information, much of which was presented in the Waste Management Activities FEIS (DOE/EIS-0120; 1987), is included in this EIS by reference to that document and to the Annual Environmental Reports, and is augmented by existing compliance reports to SCDHEC and EPA.

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Comment Number	Comment	Response
L-78-04	Additionally, the potential impact to groundwater involves the groundwater leaching of constituents of concern from solid waste streams which originate from trenches where wastes from the operation of the reactors and separation areas were disposed. These groundwater impacts, along with mitigation options, need to be more fully discussed in the Final Environmental Impact Statement (FEIS).	Section 3.7.1.2 of the EIS addresses groundwater contamination below the burial grounds associated with this comment. The alternative currently under construction is a new, low-level radioactive waste storage/disposal facility. Mitigation is established through the closure of the burial ground. Also, DOE analyzed groundwater impacts from the operation of the low-level waste burial ground, their mitigation, and alternatives for the replacement of that facility, in DOE/EIS-0120 (1987), which is referenced in this EIS.
L-78-05	Another concern to EPA is that the operation of these reactors have caused adverse impacts to the aquatic systems of the area. According to the DEIS, continued operation of these reactors will continue to impact over 500 acres of wetlands on the SRS. This impact is primarily related to the extreme temperatures and flows associated with the cooling water discharges. The high scouring flows associated with the K-Reactor discharges have caused reduction of bottomland hardwood forests and sediment loads have caused elimination of the original forest vegetation. The FEIS should outline proposals to mitigate for the wetland impacts.	DOE has revised Section 4.5.7 to include a discussion of wetlands mitigation options. DOE will implement any selected option(s) through interaction with regulatory agencies.
L-78-06	Additional impacts to aquatic life occur from the reactor operations. Large temperature increases associated with the cooling water discharges have caused numerous large fish kills during the restart of reactor facilities. Proposals to eliminate these fish kills should be included in the FEIS.	On June 6, 1990, SCDHEC issued an executed settlement agreement with DOE on fish kills in Pond C and L-Lake. As required, DOE submitted a report to SCDHEC on July 5, 1990, describing options for avoiding future fish kills, identifying the selected options and mitigation to be pursued, and providing a schedule for implementation. DOE has included this information in Section 4.1 of the Final EIS. Also, DOE has modified Section 4.5 to provide information on measures to mitigate fish kills.
L-78-07	Any current proposals or agreements to mitigate the impacts of the cooling waters of L- and P-Reactors should also be discussed.	In addition to mitigation on fish kills, as discussed in the response to Comment L-78-06, DOE discusses thermal mitigation fully in the Final EIS on L-Reactor Operation (DOE/EIS-0108; 1984), the 316a studies, and the Comprehensive Cooling Water Study (DP-1739-1; 1987). Section 4.5.7 of the EIS

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Comment Number	Comment	Response
		discusses thermal mitigation. L-Reactor must be shut down as required to ensure compliance with thermal limits.
L-78-08	The impacts of water withdrawal from area waters for K-Reactor cooling purposes also cause adverse impacts. Significant fish and aquatic life losses occur through entrainment and impingement during this activity. EPA considers these impacts to the aquatic resources of the area to be undesirable and opportunities for mitigation or reduction of these impacts should be discussed in the FEIS.	DOE describes the impacts of cooling water withdrawals from the Savannah River in the Final EIS on Alternative Cooling Water Systems, Savannah River Plant (DOE/EIS-0121; 1987), and summarizes these impacts in in Chapter 4 of this EIS. The absence of significant impacts of past impingement and entrainment losses on fish and other aquatic populations in the river has been confirmed in Section 316(b) demonstration and other extensive river studies submitted to SCDHEC and EPA; in addition, the start of cooling-tower operation for K-Reactor will further reduce total SRS intake withdrawal rates and potential impacts on river fish populations. DOE has committed to additional studies to continue the assessment of entrainment impacts from SRS intake withdrawal and low river flows. DOE has modified Section 4.5.6 to include a description of this continuing river study to assess mitigation options.
L-78-09	An additional issue that needs clarification concerns the National Emission Standard for Hazardous Air Pollutant (NESHAP) requirements for the site. In Chapter 5 of the DEIS, DOE indicates that, with the possible exception of the K-Reactor cooling tower, NESHAP approval will not be required prior to the reactor startup. This interpretation is correct since NESHAP approval is only required for new source construction or modification. Since the reactors in question are existing sources, NESHAP approval will not be required prior to restart.	Section 5.2.7 of the EIS has been reworded to reflect the fact that EPA revised its NESHAP rule after SRS submitted a request for approval for construction of the K-Reactor cooling tower. The revised rule waives the approval requirement for new or modified sources, such as the tower, that have low offsite impact.
L-78-10	Although this approval will not be required, SRS should verify that all applicable release points associated with the reactors will be monitored for radionuclide emissions in accordance with the provisions of 40 C.F.R § 61.93(b) before restart of the reactors. As required by NESHAP regulations and stated in our letter to DOE, dated January, 26, 1990, EPA is awaiting additional information and a DOE evaluation of the need for preconstruction approval before processing the K-Reactor cooling tower NESHAP application.	DOE continues to work with EPA to ensure compliance with NESHAP requirements.

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Comment Number	Comment	Response
L-78-11	The DEIS describes a limited number of alternatives for supplying the materials necessary from the Department of Energy's (DOE) SRS facility. Due to the classified nature of the information used in the decision process, it is difficult to evaluate DOE's determination that the preferred alternative is the only alternative that meets the stated production criteria. However, due to the environmental consequences of the proposed action, we suggest that DOE investigate an alternative that would involve addressing many of the proposed environmental impacts with corrective actions and mitigation. Specifically, an alternative that utilizes K-Reactor in a manner that would prevent the destruction of reestablished wetland vegetation and minimizes the lethal effects caused by the discharge of >73°C once-through cooling water to area surface waters, is very desirable from an environmental standpoint. We urge DOE to consider an alternative that utilizes other SRS reactors to meet short term tritium production needs until K-Reactor cooling towers are completed.	DOE has based the need for continued operation of these reactors on the requirements, including a potential reduced-need scenario, discussed in Appendix A. DOE has examined the feasibility of meeting the requirements imposed by the most recent NWSM while delaying the resumption of K-Reactor production until the cooling tower is operational. DOE is expediting the construction of the cooling tower. See the revisions to Section 2.1.6 of the EIS. DOE has revised Sections 1.2 and 2.1 to clarify its intent to schedule production runs and outages of each reactor to meet the requirements established by the most recent NWSM. Also, please see the response to Comment L-02-01 on the need for tritium.
L-78-12	Section 1502.14 of the NEPA states that the lead agency should "rigorously explore and objectively evaluate all reasonable alternatives" and "include appropriate mitigation measures not already included in the proposed action". We feel that DEIS does not include this type of an evaluation of mitigation options to reduce the environmental impacts of the alternatives examined. This evaluation should be included in the FEIS.	Section 4.5.7 of the EIS discusses alternative mitigation measures that are not included in the proposed action. DOE has provided additional information on mitigation options in the Final EIS. DOE believes it has addressed all reasonable alternatives for mitigation.
L-78-13	Based on the above mentioned concerns and those expressed in the detailed comments section, EPA assigns a rating of EC-2 to this DEIS. This means that EPA has identified impacts that should be avoided in order to fully protect the environment. Corrective measures may require changes to the preferred alternative or application of mitigation measures that can reduce the environmental impact. Also, the DEIS does not contain sufficient information for EPA to fully assess environmental impacts that should be avoided. EPA will continue to work with DOE to reduce these impacts and explore acceptable solutions.	Please see the response to Comment L-78-12.
	We appreciate the opportunity to review this document. If you have any questions please call me or David Melgaard of my staff at (404) 347-3776 or (FTS) 257-3776.	

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Comment Number	Comment	Response
	Sincerely, Frank M. Redmond, Chief Federal Activities Branch Attachment, Detailed Comments CC: J. Leonard Ledbetter, GADNR R. Lewis Shaw, SCDHEC	

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	DETAILED COMMENTS	
	Wetland and Surface Water Issues	
L-78-14	Section 5.6.2 - The report states specifically of its support of the presidents goal of "No Net Loss" of wetlands in addition to compliance with 10 CFR 1022.15 concerning the design or modification of actions to minimize potential harm to or within wetlands or floodplains. The section further states that continued operation of the reactors will result in the destruction of some wetland vegetation but that this action should not result in the permanent loss of wetlands. We are concerned about this statement because it implies that the temporal loss of wetlands is not important, and in this case, we disagree. Temporal loss in the case of SRS has lasted for some 40 years with no planned closing date in sight. Efforts should be initiated to restore degraded or destroyed wetlands to meet the "No Net Loss" goal.	Please see the response to Comment L-78-05 on wetlands mitigation.
L-78-15	Remote sensing studies of the SRS conducted during the period of reactor outages showed rapid colonization or revegetation of exposed mudflats and sandbar islands of the Savannah River swamp system. This included the reestablishment of woody vegetation after a reactor shutdown of several months. However, when production resumes, using the once-through cooling systems, the wetland vegetation will again be destroyed in these areas of reestablishment. Methods to prevent this destruction should be	Please see the responses to Comments L-78-11 and L-78-12 on alternatives.
L-78-16	proposed. DOE should investigate a possible alternative that would utilize other SRS reactors for short term tritium production and delay the operation of K-Reactor until the cooling tower is completed. Mitigation measures should be proposed to assist in the recovery of previously impacted wetland areas.	Please see the response to Comment L-45-01 on reactor restart sequence.
	Page 2-77	
L-78-17	The indication is that wetland losses in Steel Creek are unknown. These losses should be quantified for the FEIS and mitigation options described.	Wetlands losses in Steel Creek are discussed in the Final EIS on L-Reactor Operation (DOE/EIS-0108; 1984), the Comprehensive Cooling Water Study (DP-1739-1; 1987), and the Reactor Operation Environmental Information Document (WSRC-89-816; 1989). As predicted, increased flow in Steel Creek eroded channels between the dam and the delta, and

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Comment Number	Comment	Response
		resulted in losses of some successional plant species that had established since the cessation of thermal discharges in 1968. Increased water input into the delta resulted in a shift toward more hydric herbaceous species; successional woody plant species have been impacted in a few areas. There is no clear evidence that additional cyprus-tupelo mortality occurred after the resumption of L-Reactor operations in 1985. In addition, substantial year-to-year variation was observed in plant communities, which appeared to be attributable to the timing and magnitude of river flooding, rather than to thermal effects. These studies were reported initially in the Section 316a Demonstration Compliance Report (Du Pont, 1988; DP-1766). Tables 4-2 and 4-3 list changes in wetland vegetation classes in the Steel Creek Corridor and delta/swamp, respectively. Mitigation of wetlands on Steel Creek is not currently under consideration because L-Lake is the mitigation and no substantive losses have been identified. The situation is being monitored pursuant to the L-Reactor EIS commitments.
	Page 4-9	
L-78-18	The discussion of the biological studies of L Lake should also address the possible problems of the unusual numbers of the pathogenic Naeglaria fowleri, an aquatic protozoan. While the unusually high populations reported in the June 1988 316(a) report may be a short lived event due to the start up of the lake, it is a possible problem that warrants future monitoring and consideration in future actions.	DOE believes that operation of L-Reactor could cause increases in populations of pathogenic Naegleria fowleri based on previous observations and studies in L-Lake. DOE will continue its present monitoring programs and consider study results in determining the need for any future actions. A recent report ("Effect of Thermal Additions on the Density and Distribution of Thermophilic Amoebae and Pathogenic Naegleria fowleri in a Newly-Created Cooling Lake," Tyndall et al., in Applied and Environmental Microbiology, Vol. 55, No. 3, pp. 722-732) presents the results of the studies cited above. Section 4.1.1.4.2 of the EIS has been revised to reflect this information.
	Page 4-9	
L-78-19	The discussion should address the change in thermal loading on the L Lake due to the change in reactor operations from plutonium production to tritium production. The discussion should elaborate on the problems of production limits due to the thermal limits on	Reactor operation at a given power level would cause the same thermal loading on L-Lake regardless of the charge used. DOE is not considering any additional cooling mitigation options or studies for L-Reactor,

Table C-5. DOE Responses to Comments on Draft EIS

Comment Number	Comment	Response
	the lake. Are additional cooling actions being considered to allow more flexible operation of L-Reactor?	unless extended thermal stratificationwere to occur during the winter as a result of tritium production. Regardless of the charge used, DOE will continue L-Reactor operation in compliance with the requirements of the NPDES permit.
	Page 4-41	
L-78-20	A commitment to eliminate the fish kills associated with the start up of L- and P- reactors should be included and discussed. The FEIS should discuss any studies of operations or actions which have been taken to reduce or minimize the thermal shocks that occur to the aquatic community during reactor start-up.	Please see the response to Comment L-78-06 on fish kills.
	Groundwater Issues	
	3.7.1.2. p. 3-53. para 2	
L-78-21	The radionuclide content of groundwater is important for this review. The results of the groundwater monitoring program would well have been a useful inclusion, rather than a reference.	Please see the response to Comment L-78-03 on groundwater data.
	3.7.2.2. p. 3-55. para 3/4	
L-78-22	Groundwater beneath the SRS is extensively monitored (900 monitoring wells) for radioactive and nonradioactive contaminants. No specific data were presented. However, about half the radioactive, nonradioactive, and mixed-waste sites for which groundwater monitoring data exist have some contaminants that exceed the EPA drinking-water standards. Again, more data should be included in the FEIS.	The data requested for groundwater contaminants exceeding EPA drinking-water standards are reported in Annual Environmental Reports, which are available to the public and which have been provided to SCDHEC and EPA in connection with ongoing compliance proceedings not associated with reactor operation. Also, please see the response to Comment L-78-03.
	4.1.1.3., P. 4-6, para 1 and 2	
L-78-23	A total of 4,378 m^3/day of groundwater are withdrawn from the Black Creek/Middendorf Formation in the K-, L-, and P- areas. This is 76 percent of the capacity (5,767 m^3/day) of this aquifer, which indicates that the formation can sustain the required pumping rate under present conditions.	The capacity of the aquifer as cited in this comment (5,767 cubic meters/day) is incorrect; as the EIS indicates, that is the daily yield of a single well. The correct aquifer yield is identified in the referenced paragraph as about 54,430 cubic

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Comment Number	Comment	Response
		meters per day, and the cumulative reactor area withdrawal rate represents only about 8 percent of the aquifer capacity.
	4.1.2, p. 4-19, para 3	
L-78-24	It is stated in the last line of this paragraph that groundwater contamination beneath the site does not reach off site sources. This should be well established and documented.	Section 4.1.2 has been corrected to note that no radiological contaminants in groundwater beneath SRS have reached offsite groundwater sources (as documented in the Annual Environmental Report). Groundwater contaminants from the reactor seepage basins outcrop to a surface stream, and subsequently are transported offsite with surface water.
	4.1.2.2, p. 4-22, para 6	
L-78-25	Only at the P-Reactor basins are migration times long enough to allow significant tritium decay before reaching an outcrop (30 years-19 percent will remain). Migration from the K-Area basin to Indian Grave Branch (6 years - 71 percent will remain) and from the L-Reactor basin to L-Lake (5 years - 76 percent will remain) are not sufficiently long to allow for significant tritium decay.	The decay associated with these travel times is correct. However, the reduction in actual releases, as determined from monitoring of groundwater outcrops, is greater than these modeled values would indicate. Section 4.1.2.3.5, which DOE has added to the EIS, compares doses from alternative purge-water disposal options. It demonstrates that the liquid pathway population doses with the use of seepage basins are less than 50 percent of those that would occur from direct discharges.
	Waste Issues	
	Page 3-61	
L-78-26	The discussion on Waste Management Capacity is inadequate. Available capacity for additional waste should be identified and shown to be adequate to handle the waste volumes listed in Table 3-12. The items that are identified as actions needed to alleviate waste capacity problems should be explained in greater detail. The EIS should present dates on which the operation of these new facilities becomes critical to the continued operation of the reactors (It is implied that the reactors can and should be restarted without them). Although not discussed here, DOE has previously indicated that the generation of RCRA Land Disposal Restricted (LDR) wastes are of critical concern to the continued operation of reactor separation facilities. Of particular concern is the continued operation of the high-level waste tanks, some of which the EIS concedes are near the end of their useful life. The EIS should identify the specific tanks that are near the end of their useful life, and give schedules for taking them out of service. It should further be shown how this schedule	DOE and the appropriate agencies are addressing the waste management issues identified in this comment through other regulatory forums. Because of the complexity of these issues and the current state of negotiations, this response identifies the regulatory forums through which specific issues are being addressed. The SRS is currently negotiating a Federal Facilities Compliance Agreement to resolve alleged violations of RCRA storage prohibitions for certain radioactive mixed-waste streams that are being maintained in storage because no treatment capacity exists within the DOE weapons complex. This agreement will establish (a) permit application submittal dates for each hazardous waste treatment and disposal facility discussed in Section 4.1.6.1 of the EIS, (b) operation startup dates for each

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	is impacted by the various options under consideration in this EIS. Each of the new facilities under design/construction should be addressed in a similar fashion (Including the CIF and Y-Area disposal facility). The discussion on support facilities (pp. 4-112 thru 116) does not adequately address this issue.	facility, (c) treatment or disposal capacity for each facility, and (d) dates for removing the backlog of waste currently in storage. The Waste Management for Groundwater Protection EIS (DOE/EIS-0120) assesses available waste storage/ disposal capacity and the need for new disposal facilities in detail. Sections 3.8, 4.1.1.8, 4.1.2.8, 4.1.2.9, 4.1.2.10, 4.1.2.11, and 4.1.2.12 of this EIS discuss waste management as it relates to continued operation of the SRS reactors. DOE is also negotiating a CERCLA Section 120 Interagency Agreement with SCDHEC and EPA that will establish the protocol and schedule for hazardous waste cleanup at the SRS. Among the provisions in this agreement are requirements for the prevention and mitigation of releases or potential releases from the radioactive high-level waste tank farms. The agreement will also establish requirements and schedules for the remediation of tank system(s) that are removed from service. After the agreement has been signed by all negotiating parties, it will undergo public review and comment.
	3.8.1 and 3.8.4	
L-78-27	A Table that relates what waste treatment method(s) (Section 3.8.4) will be applied to each type of waste (Section 3.8.1) would be useful and should be included.	DOE has added Table 3-17 to the EIS to relate waste treatment methods to waste types.
	Page 4-2	
L-78-28	It would seem that the Termination Operation Alternative would require less future land for waste disposal since no "new" waste would be generated.	DOE agrees. Additional land would be required only in the case of waste disposal after decontamination and decommissioning of facilities.
	4.1.6.2.3/.4/.5/.6/.7, pp 4-114 to 4-116	
L-78-29	From information provided, additional area on the site to be dedicated to waste disposal and storage including Y- Z-, and G- Area waste sites and the new horizontal/mixed waste disposal facility, will total 500 acres or more. These facilities are scheduled to begin operations between 1990 and 1993. The total land area committed to new support facilities is about 700 acres, all on site. IF additional land use is justified, it should be considered an additional impact of reactor operations.	The examples given represent planned land use related to the operation of SRS reactors and other onsite facilities. No other land use is anticipated at this time.

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	Radiation and Safety Issues	
	3.7.1.1, Paragraph 5	
L-78-30	The dose rate listed on the last line of this paragraph (240 mrem/yr) is not properly identified. NCRP Report 94 lists the following dose equivalents (Section 7.4.5) that result from internally deposited radionuclides: 35 mrem/yr to gonads and other soft tissue; 110 mrem/yr to bone substances; and 50 mrem/yr to bone marrow. In addition, NCRP reports the dose equivalent to the bronchial epithelium to be 2400 mrem/yr, primarily from radon daughter products. The 240 mrem/yr reported here in the EIS is, we believe, intended to be the effective dose equivalent from all internal emitters, for which we compute to be 235 mrem/yr.	DOE has corrected Section 3.7.1.1 of the EIS to indicate that all doses presented in the EIS that are not specified otherwise are, in fact, effective dose equivalents.
	3.7.1.1, p. 3-49	
L-78-31	Are the internal doses presented on this page effective dose equivalent? They should be better defined.	Yes. Please see the response to Comment L-78-30 on effective dose equivalents.
	3.7.1.2, Table 3-9	
L-78-32	The dose from radon in homes, a lung dose, is being added to whole body doses. This is not appropriate unless it has been multiplied by a weighting factor which then becomes its contribution to the effective dose equivalent.	Please see the response to Comment L-78-30 on effective dose equivalents. Effective dose equivalents are obtained by the use of weighting factors.
	3.7.1.2, p 3-51, line 30	
L-78-33	External terrestrial background is shielded by buildings, but the FEIS should explain how it is shielded by the body.	DOE has revised Section 3.7.1.2 as follows: "Shielding of any kind can reduce terrestrial and cosmic radiation doses by about 28 millirem per year each, a 20-percent reduction (NCRP94, 1987)."
	3.7.1.2, p 3-52, para 1	
L-78-34	Express these population dose rates as collective effective dose equivalents (person-rem) and supply the 80 km population data.	All doses not otherwise specified are effective dose equivalents (see the response to Comment L-78-30). In 1980 the population within 80 km was 589,803 (Section 3.2.3.2); thus, the collective effective dose equivalent to that population from recent SRS operations was about 30 person-rem per year. Similarly, the average individual dose of about 0.06

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Comment Number	Comment	Response
		mrem per year for the current Port Wentworth and Beaufort-Jasper river-water-consuming population of about 71,000 (Section 3.7.1.2) would yield a collective effective dose equivalent to that population of about 4 person-rem per year.
	p 3-52, para 3	
L-78-35	The gamma radiation measures on the site in 1983, 73 mrem/yr. is about twice the background dose rate reported for the vicinity of the site, 35 mrem/yr, or the previous page. Is this within natural variation?	No. The measured values on the SRS of about 70 millirem per year include terrestrial and cosmic radiation components of the background dose (in addition to the substantially smaller site contribution); as stated in Section 3.7.1.2, "the average unshielded external terrestrial background" (emphasis added) in the SRS vicinity is about 35 millirem per year. Thus, cosmic radiation (and the SRS contribution) rather than "natural variation" accounts for the difference. DOE has revised Section 3.7.1.2 accordingly.
	p 3-52, para 4	
L-78-36	Although Ar-41 contributes little exposure to persons offsite, it is the other significant radionuclide released to the atmosphere at SRS and has been measured on site (EPA 520/5-84-012) and should be included for completeness.	As reported in the Annual Environmental Reports, the noble gas argon-41 contributes about 30 to 40 percent of the maximum hypothetical individual exposure at the SRS boundary. Section 3.7.1.2 of the EIS reports argon-41 doses.
	3.7.1.2., Table 3-11	
L-78-37	The concentration for tritium in drinking water, 0.6 pCi/ml, is. probably about background. The tritium background in milk and free water content of food is probably about the same as drinking water. Thus, these results reflect tritium contamination.	DOE has revised this table (now Table 3-12) to reflect average as well as maximum measured values of tritium in drinking water, milk, and food samples.
	3.8.2, Table 3-12	
L-78-38	The curie amounts of each of these wastes should also be listed. Volumes can easily change, its the radioactivity that's important.	DOE has revised Tables 3-15 and 3-16 to list quantities of radioactive waste in curies.
	4.1.2, p 4-19	
L-78-39	The assessment utilizes ICRP-30 dose conversion factors and site-specific parameters, which is good. However, the model usedwas not described nor were the parameters provided. Thus, a review of the assessment could not be performed. More information should be provided.	Section 4.1.2 and 4.1.6 of the EIS identify the models used for the dose assessments as those usedby the NRC to calculate offsite doses; these sections also provide references for the codes and the parameters used in the assessments, as well as for

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Comment Number	Comment	Response
	4.1.2.3.1, para 2 It should be noted that the impact due to the three reactors is not limited to their operations, but must include the impact resulting from operating all support facilities. This is done later in Chapter 4.	more detailed dose results of interest to specialists.
L-78-40	Also, it is inappropriate to compare the dose resulting from reactor operation to the EPA limit of 10 mrem/yr to the maximum exposed individual. This limit should be related to all operations on the site.	DOE recognizes that the standards of 40 CFR 61 apply to the total of airborne emissions from SRS; because the EIS does not constitute a compliance document, the comparison of the reactor emissions to the 10-millirem-per-year dose was intended to provide a perspective of the minor contribution of the reactors to this total. DOE has revised the text to clarify that the 10-millirem-per-year limit is for the entire Site. Table 4-47 in the EIS lists the total contributions of all SRS operations and neighboring facilities to the airborne dose; this total is less than 7 percent of the 10-millirem-per-year EPA limit.
	4.1.2.3.3/4, pp. 4-25 to 4-27	
L-78-41	Table 4-6 and 4-7 show the average annual release of tritium via seepage basins and direct discharge. Tables 4-8 and 4-9 show the average annual doses that result from these discharges. The doses should be proportional to the discharges, e.g., the tritium released via direct discharge (17,100 Ci) is 2.4 times that released via the seepage basins (7,110 Ci). The collective dose is proportional to these releases (9.4/3.7=2.5); however, the dose of the maximum exposed indivudal is not proportional (0.16/0.03=5.3). This appears to be inconsistent.	The individual doses listed in Draft EIS Table 4-9 include contributions by nuclides other than tritium for direct discharge; the collective doses listed in Tables 4-8 and 4-9 are essentially all due to tritium. These comparisons in the Draft EIS were derived from the Waste Management EIS (DOE/EIS-0120). In the Final EIS, DOE has updated the assessment in Section 4.1.2.3.5 to include a comparison of the direct discharge and evaporation options to the current method of discharge to seepage basins. The referenced tables have been eliminated or replaced; see Table 4-13.
	4.1.2.4	
L-78-42	All calculations and assumptions concerning cobalt-60 and cesium-137 in the Savannah River and site streams generally appear accurate and reasonable. However, in paragraph 2 on page 4-30 it states that the average Cs-137 concentration in the river below SRS is less that 0.5 percent of the EPA drinking water standard of 200 pCi/L. In the previous paragraph, the concentration range is listed as 0.05 to 0.2 pCi/L, which is only 0.1 percent at maximum.	DOE has changed the text in Section 4.1.2.4 to state that currect and future annual average cesium-137 concentrations should remain at or below 0.5 percent of the EPA standard during reactor operation.

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Comment Number	Comment	Response
	4.1.2.5, p 4-31	
L-78-43	Too many significant figures are used in Table 4-12. Only two significant figures, at most, are justified. The same comment applies to many of the tables in this report.	DOE has modified this and other tables, if appropriate, to provide only two significant figures.
	4.1.2.5, p 4-32 para 2	
L-78-44	The dose rate that results from operating the three reactors cannot be compared to the EPA limit of 10 mrem/yr as the limit relates to the whole SRS operation.	Please see the response to Comment L-78-40 on dose contributions from reactors.
	4.1.2.6, para 1	
L-78-45	The EPA risk factor, 4×10^{-4} cancer deaths per person-rem, is for low-LET radiation only.	The collective effective dose equivalents from SRS discharges are essentially all from low-LET radiation.
	4.1.2.7, para 2	
L-78-46	The DOE exposure limit of 5 rem/yr does not refer to an average annual individual dose (140 mrem/yr) as implied. Actual measured individual occupational doses should be reported here with range and distributions of these doses.	As noted, the personnel exposure guideline used by DOE for whole-body radiation dose equivalent is 5 rem per year; the guideline set by the Operating Contractor for the SRS is 3 rem per year. From 1952 to 1989, DOE and SRS guidelines were exceeded 2 and 48 times, respectively. Section 4.1.2.7 contains additional information.
	4.1.2.8/.9/.10/.11/.12, pp 4-35 to 4-36	
L-78-47	It would be useful to list the curie quantities of radionuclides present in these various wastes instead of supplying only their volumes.	Please see the response to Comment L-78-38 on radioactive waste quantities. DOE has revised Tables 3-15 and 3-16 to provide quantities in curies and in waste volumes.
	4.1.2.8, para 3	
L-78-48	Again, monitoring well water results were not presented. Some discussion of the contaminant levels would be useful.	DOE has revised Section 4.1.2.8 to cite appropriate reference documents.
	4.1.2.9	
L-78-49	How are low-level liquid radioactive wastes treated in the ETF?	The low-level liquid wastes are filtered, and then undergo oil removal, ion exchange, reverse osmosis, carbon filtration, and mercury removal processes in the F- and H-Area ETF.

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Comment Number	Comment	Response
	4.1.3.1.1, p 4-37 para 3	
L-78-50	Again, it is not appropriate to compare the dose to the maximum exposed individual due to tritium releases from the K-area to the EPA limit of 10 mrem/yr which is the limit for the whole SRS. Granted, this is a very small dose rate, however, much larger tritium releases occur at other site facilities.	Please see the response to Comment L-78-40 on dose contributions from reactors.
	p. 4-43, para 5	
L-78-51	What type carbon was placed in service in 1976 that better retains organic iodides? What are the chemical forms of iodine released and what are their percentages?	Carbon coimpregnated with triethylene diamine (TEDA) and potassium iodide was placed in service beginning in 1976. The chemical form of iodine released depends greatly on the fuel burnup of the individual accident sequence, and cannot be characterized as a given percentage. The carbon beds retain both elemental iodine and organic iodides effectively.
	4.1.3.1.3, p 4-51 para 4	
L-78-52	Has a time table been established for the implementation of the safety improvements that will not be completed prior to the resumption of production? This information should be discussed in the EIS.	Section 2.1 of the EIS presents a general schedule of safety modifications, indicating those that will be completed both before and after the resumption of production. DOE has revised Section 2.1.2.8.2 of the EIS to discuss the Restart Issue Management Program (RIMP), which identifies those issues that must be addressed before the resumption of production (also see Section 2.1.3.2.1). Section 2.1.2.7 describes the Reactor Safety Improvement Program (RSIP) process, which determines the priority and schedule process for the implementation of safety improvements that are not scheduled for completion before the resumption of production. The safety improvement process starts with ensuring an acceptable level of safety, then making periodic upgrades to increase that level of safety. The SRS reactors will not resume production until they have established an acceptable level of safety. Upgrades and modifications scheduled for completion prior to the resumption of production are those necessary to establish an acceptable level of safety. Some

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		upgrades and modifications are not necessary to establish an acceptable level, but rather to build on that level.
	4.1.3.1.4, pp 4-61-4-62	
L-78-53	If tritium is released as the result of a dropped fuel assembly, its decay during the 14-hour delay period will be insignificant and the 0.0246 percent factor will not apply.	As stated in Section 4.1.3.1.4, "0.0246 percent" refers to the fraction of the core fission product inventory that would be released, not tritium. Significant quantities of tritium are not released as a result of a dropped fuel assembly, which would contain only minor quantities of fission product tritium and tritium in the moderator-coolant carryover on assembly surfaces.
	4.1.3.1.5, p 4-73 para 5	
L-78-54	A loss of river water accident would be treated somewhat differently for P-Reactor which uses Par Pond for cooling rather than the river, although pumping is still required. It is assumed that a LORWA at K-Reactor would be easier to cope with after the recirculating cooling tower becomes operational.	The PRA internal events analysis is based on K-Reactor, which uses the Savannah River as its primary source of secondary cooling water. For P-Reactor, the primary source of secondary cooling water is Par Pond. In either case, the accident is a loss of secondary cooling water, so the case for P-Reactor would not be treated differently. The loss-of-river-water accident might be easier to cope with for K-Reactor with a cooling tower, but the risk reduction associated with the tower is not expected to be significant.
	4.1.3.1.5	
L-78-55	Recriticality of the molten fuel material after a core-melt accident has not been properly addressed.	DOE has incorporated recriticality in the severe accident analysis in Section 4.1.3.1.5. The Reactor Operation Safety Informational Document (WSRC, 1990) discusses recriticality and other core melt progression and confinement system response phenomena.
	4.1.3.5	
L-78-56	Although Ar-41 does not occur in the reactor core inventory, a significant quantity of Ar-41 does exist in the reactor outside the core, is released during routine reactor operations, and produces the second largest off-site exposure (second only to tritium from site airborne releases). Thus, during a severe reactor accident, wouldn't there be a high probability for the release of large quantities of Ar-41 and shouldn't this be included in a severe accident scenario? Argon-41 was not considered in any accident assessment.	The only quantities of argon-41 available for release from a reactor are those produced in the air stream moving past the reactor vessel by escaping excess neutrons while the reactor is at power. In a severe accident, no argon-41 would be produced or available for release in amounts greater than those produced in normal at-power operation.

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Comment Number	Comment	Response
	4.1.3.1.5, pp 4-84 to 4-86	
L-78-57	Risks computed earlier for reactor accident assessments used the BEIR III risk factor, 1.9×10^{-4} per person-rem. For this EIS, the risks were increased by the factor 2.1 (4.0/1.9) to be in agreement with the EPA. The latest risk factor recommended in BEIR V is about twice that used in these calculations, however, considering the large uncertainties associated with these analyses, the conclusion that this factor of 2 is not significant is probably accurate.	Comment noted.
	p 4.95, Table 4-36	
L-78-58	There was difficulty reproducing K-reactor risks with the information provided. More details including the 1.6 km and 16 km populations should be provided.	DOE has revised Table 4-36 to enable the reproduction of the risks to the 1.6- and 16-kilometer populations.
	4.1.4.1, p 4-101 para 3	
L-78-59	All liquid chlorine used for water purification should be replaced as quickly as possible with sodium hypochlorite NaOCl.	See Section 4.1.4.1 of the EIS. Replacement of liquid chlorine will reduce potential hazards associated with transportation, handling, and storage of gaseous chlorine used to make liquid chlorine.
	4.1.4.2.2, p. 4-104	
L-78-60	Radiological impacts related to transportation accidents are small compared to other risks at the site.	DOE agrees.
	p 4-106, Table 4-41	
L-78-61	The column headings in this Table are confusing. Columns 3 through 6 are titled "risk", but have "dose" units. The risk heading should be removed as there are doses. From footnote b, We would assume that risk can be computed from the information in the Table; e.g., the risk of TRU drum failure and fire would be $1.5 \times 10^{-5} \times 6.4 \times 10^{-1} = 1 \times 10^{-5}$. Also, there are too many significant figures used. This is a common practice throughout this report.	DOE has revised Table 4-41. DOE agrees with the EPA calculation. The stated assumption based on footnote b is correct. The number of significant figures has been reduced in this table and other tables, if appropriate. Also, please see the response to Comment L-78-43.

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	4.1.6.2.1 p 4-114	
L-78-62	Because most tritium released at the SRS is from the Tritium Facility, the implementation of the Replacement Tritium Facility should be coordinated with reactor start up, considering it will substantially reduce airborne releases. Eliminating the use of mercury will also be beneficial.	The RTF is being constructed, and is scheduled to begin operation in late 1990. The use of mercury will be eliminated.
	4.1.6.2.2. p 4-114	
L-78-63	The 30,000 Ci/yr of tritium discharged from the Effluent Treatment Facility (ETF) is about 2.6 times that released per year to surface streams from the three reactors. (See table 4-5, p. 4-23). Thus determining the impact of reactor operations must include the contributions from all support facilities.	All new and planned support facilities are included in the assessment of cumulative impacts in Section 4.1.6. DOE will prepare an EIS that includes more detail on the environmental impacts of support facilities.
	4.1.6.4.13. p 4. 4-120	
L-78-64	As discussed earlier in the report (Section 4.1.2.4), about 0.5 Ci of Cs-137 is released per year due to resuspension from the on site stream beds, of which about 0.36 Ci is from the streams servicing the three reactors. These releases contribute an insignificant impact on the down stream population. Cobalt-60 produces even less of an impact because of its radioactive decay. Strontium-90 was not included in these discussions, although it has been released to on site streams, has a long half life (29 years), and may be expected to move downstream to the Savannah River via resuspension. The dose rate to off site populations from strontium-90 release is probably less than that caused by cesium-137, but some assessment should be included.	No substantial inventory of strontium-90 of reactor origin has been identified in onsite stream beds. The Annual Environmental Reports report the strontium-90 released to onsite streams from discontinued F- and H-Area seepage basin outcrops; this makes a very small contribution to maximum individual and collective doses. For example, in 1988 strontium-90 in liquid releases contributed 1.5 percent of the maxumum individual dose (compared to 87.3 percent from cesium-137) and less than 3 percent of the collective dose (compared to 31.5 percent from cesium-137). The EIS does not include this release because reactor operation has no effect on it.
	4.1.6.4.14. Tables 4-44 and 4-45	
L-78-65	The data in these tables show that radionuclide releases from the three reactors are much less than that from the support facilities. Using tritium as an example, since it causes by far the greatest impact to off site populations, the three reactors contribute only about 35 percent of the atmospheric tritium and only about 19 percent of the released via the water pathway. Thus, an accurate assessment of the impact of resuming production at SRS must include not only the releases at all supporting facilities but also those	The impacts of present and anticipated supporting facilities are included in the cumulative impacts discussed in Section 4.1.6. Also, please see the responses to Comments L-78-40 and L-78-63 on reactor support facility doses.

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	that are planned to begin operation in the near future. These results can then appropriately be compared to the EPA limit of 10 mrem/yr.	
L-78-66	Also, we assume that when the Replacement Tritium Facility (RTF) becomes operational in late 1990, the release of tritium from "Separataions" will be significantly reduced, and the total tritium released per year from SRS will be less than the 5.52×10^5 Ci listed.	When RTF becomes operational, DOE will provide new tritium release information in the Annual Environmental Reports.
	Table 4-47, p. 4-127 and p 4-121, para 4	
L-78-67	There was minimal mention of the EPA's NESHAP for radionuclide in this document, except for a statement in the last paragraph of Chapter 5 that refers to meeting the 10 mrem/yr dose limit to the maximum exposed individual. The doses calculated in this EIS for the SRS should be compared to those reported by the EPA in the EIS for NESHAP, and any significant difference reconciled. For example, the total dose rates given at the bottom of table 4-47 on page 4-127 are not properly identified. We assume the 1.25 mrem/yr dose is the effective dose equivalent to the maximum exposed individual and the 97 person-rem is the collective effective dose equivalent to the 80 km population. Multiplying these by the risk factor, 4×10^{-4} deaths per person-rem, yield the risks listed in paragraph 4 on page 4-121. However in the EPA EIS Risk Assessment for NESHAP, EPA/520/1-89-006-1 (September 1989), the dose equivalent to the maximum exposed individual and the collective dose equivalent to the 80-km population are listed for specific organs in Table 2.6-2, page 2-55, in Volume 2. Multiplying these organ dose equivalents by the ICRP weighting factors (W_t) yield an effective dose equivalent to the maximum exposed individual of 2.6 mrem/yr and a collective effective dose equivalent of about 550 person-rem/yr for the 80-km population. These doses are 2 and 5 times, respectively greater than these listed in Table 4-47 of the EIS for the Savannah River Site. Can these differences be reconciled? The results of both assessments indicate that compliance with 40 CFR 61 will be achieved when the reactors resume operation.	The EIS describes and references NRC nuclear-industry-accepted codes used to calculate maximum individual and population doses from SRS operations, and the source and transport parameters used to obtain these doses. DOE agrees that the use of either methodology will achieve compliance with 40 CFR 61. Please see the responses to Comments L-78-30 on effective dose rates and L-78-39 on dose modeling.

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Comment Number	Comment	Response
	4.5.4, p 4-137, para 4	
L-78-68	Would Argon-41 be released in such a core-melt accident?	Yes, but the amount of argon-41 would be insignificant. Please see the response to Comment L-78-56 on argon-41.
	Page 5-12	
L-78-69	DOE incorrectly states that EPA is currently reviewing the required NESHAP request for construction of the K-Reactor cooling tower. EPA is not reviewing this request since we have not been notified by DOE of the need for preconstruction approval.	DOE has revised Section 5.2.7 accordingly.
	Miscellaneous Comments	
	Page v	
L-78-70	Fourth paragraph leaves the incorrect impression that P reactor is running now. We understand that no reactors are currently operating.	DOE acknowledges that no reactors are producing nuclear materials at present. The Foreword has been revised to reflect this condition.
	2.1.2.3.2	
L-78-71	An analysis of the remaining operating life of each reactor should be completed prior to restart.	A number of analyses have been performed, as described in Section 2.1.2.3.2. Results of activities to address reactor aging have not identified any life-limiting mechanisms for the three SRS reactors.
	Page 2-65	
L-78-72	The point should be made that terminating operation and placing in standby now would not stop waste production now. Targets from past production runs remain to be processed (which will produce waste) and waste from past production runs is still being aged and will not be completely processed for disposal for up to 15 years.	DOE agrees, and has modified Section 2.3 accordingly.
	3.4.1.2.4, p. 3-21, line 1	
L-78-73	No gauging station is shown on Lower Three Runs Creek in Figure 3-7.	The figure has been changed to include the cited gauging station and others referenced in Section 3.4.1.2.

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Comment Number	Comment	Response
	3.4.1.4. p. 3-24. line 1	
L-78-74	Note that Savannah River water below SRP is not used for irrigation.	The sentence has been revised to remove any ambiguity.
	3.9. p 3-64. para 4. line 2	
L-78-75	Table 3-13 should be Table 3-14	The tables have been renumbered.
	3.9. p 3-65. para 3	
L-78-76	A monthly phone line check may not be sufficient. The operation of the phone between the OCC-A and TSC should also be checked for transmission often for any type of service disturbance, e.g., high wind, icing, etc.	Upgrading of the facilities and equipment in the OCC-A is planned in Fiscal Year 1991. This will include communications equipment; procedures affected by the upgrades will be revised. The frequency of phone line checks will be reevaluated to determine if monthly checks are adequate; if they are not, the frequency will be increased,

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L-79	STATEMENT OF DENNIS B. WILSON U.S. HOUSE OF REPRESENTATIVES COMMITTEE ON ENERGY AND COMMERCE ROOM 2125, RAYBURN HOUSE OFFICE BUILDING WASHINGTON, DC 20515 July 2, 1990 Mr. S. R. Wright Director, Environmental Division U.S. Department of Energy Savannah River Operations Office Post Office Box A Aiken, South Carolina 29802 Dear Mr. Wright: Enclosed please find a letter written to Secretary of Energy James Watkins by eleven Republican Members of the House of Representatives's Committee on Energy and Commerce, commenting on the Draft Environmental Impact Statement for the restart of the production reactors at the Savannah River Site. I ask, on their behalf, that this letter be placed in the public docket for this matter and the comments be considered to the extent practicable in the preparation of the Final Environmental Impact Statement. Very truly yours, Dennis B. Wilson Minority Counsel Enclosure	

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	June 28, 1990 Admiral James D. Watkins, Retired Secretary of Energy U.S. Department of Energy 1000 Independence Avenue, S.W. Washington, D.C. 20585 Dear Admiral Watkins:	
L-79-01	By a letter dated May 3, 1990, the Department of Energy (DOE) requested comments on the draft Environmental Impact Statement (EIS) for the Continued Operations of the K-, L-, and P-Reactors at the Savannah River Site, near Aiken, South Carolina. We believe DOE has adequately reviewed the possible impacts to the environment and to the surrounding population if the reactors are restarted. <u>Importance of the Savannah River Site Production Reactors</u> The maintenance of the nuclear deterrent requires DOE to assure continued production of vitally important nuclear materials. Among the most important of these materials is tritium, a radioactive isotope of hydrogen. Tritium is essential for the proper functioning of all America's modern nuclear weapons; without it, the weapons simply do not work. Unfortunately, tritium occurs in only tiny quantities in nature and must be produced artificially. Tritium also has a relatively short radiological half-life of 12.6 years; thus it decays at a rate of about 5.5% per year. Tritium reservoirs in nuclear weapons must, therefore, be periodically replenished and the fresh tritium to do this must be artificially produced. Since the early 1950's, the United States has relied on the operation of heavy-water production reactors at the Savannah River Site to produce sufficient quantities of tritium for weapons. This reliance continues to this day. It is, therefore, imperative to restart these reactors as soon as upgrades are in place to ensure the safety of the restart and continued operations. Furthermore, DOE must maintain these reactors in as safe an operating condition as possible until other alternatives, such as the completion of a New Production Reactor, are completed, and the existing production reactors can be retired from service.	Comments noted.

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	The Draft Environmental Impact Statement The draft EIS assesses potential impacts to the environment if all three reactors are restarted, as well as potential environmental impacts of terminating operations at one, two, or all three of the reactors. The Draft EIS concluded that termination of operations at all three reactors is not feasible at this time, since closure of the reactors would certainly adversely impact the nuclear weapons program. Further, the Draft EIS summarizes the additional training, safety, management, and technical functions implemented as a result of your increased emphasis on safety and the environment at all DOE installations. In our estimation, DOE has analyzed every reasonably conceivable scenario while operating K-, L-, and P- reactors at partial-and full-power. Based on calculations by DOE personnel, there will be little or no environmental consequence as a result of restart and continued operations of the Savannah River Site reactors. We are sure that 35 years of operation of the production reactors at the Savannah River Site gave DOE analysts considerable data on which to base predictions of what the environmental impacts of restarting those reactors will be. In closing, we commend you for your continued commitment to environment, safety and health at the Defense Nuclear Facilities. Sincerely, Norman F. Lent Ranking Republican Member Committee on Energy and Commerce Carlos J. Moorhead Ranking Republican Member Subcommittee on Energy and Power Committee on Energy and Commerce William E. Dannemeyer Member Committee on Energy and Commerce Don Ritter Member Committee on Energy and Commerce	

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Comment Number	Comment	Response
	Thomas J. Bliley, Jr. Member Committee on Energy and Commerce	
	Jack Fields Member Committee on Energy and Commerce	
	Michael G. Oxley Member Committee on Energy and Commerce	
	Howard C. Nielson Member Committee on Energy and Commerce	
	Michael Bilirakis Member Committee on Energy and Commerce	
	Joe Barton Member Committee on Energy and Commerce	
	Sonny Callahan Member Committee on Energy and Commerce	

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Comment Number	Comment	Response
L-80	STATEMENT OF JAMES A. TIMMERMAN, JR. SOUTH CAROLINA WILDLIFE & MARINE RESOURCES DEPARTMENT P.O. BOX 167 COLUMBIA, SOUTH CAROLINA 29202 July 3, 1990 Mr. Frank R. McCoy, III Acting Director, SR Restart Special Projects Office Department of Energy Savannah River Operations Office P.O. Box A Aiken, SC 29802 REF: Draft EIS, Continued Operation of K-, L- and P-Reactors, Savannah River Site, Aiken, South Carolina Dear Mr. McCoy: Personnel with the South Carolina Wildlife and Marine Resources Department have reviewed the above referenced public notice and offer the following comments. The Department of Energy (DOE) proposes to continue to operate K-, L- and P-Reactors to meet nuclear material production needs. Other alternatives that are discussed, but not recommended, by DOE include a) termination of operation of one or two reactors at SRS in the immediate future and maintain in cold standby b) terminate operation of K-, L- and P-Reactors and maintain all in standby status and c) other production options available to DOE off-site. The following comments relate only to impacts of operation on fish and wildlife resources.	
L-80-01	Thermal effects on aquatic biota, especially fishes, are a concern of our Department. Cooling lake construction on Steel Creek (L-Reactor discharge) and Lower Three Runs Creek (P-Reactor discharge) have moderated negative thermal impacts, although the document states that intermittent fish kills occur in these	DOE is expediting the construction of the K-Reactor cooling tower, which will mitigate thermal and flow effects and accelerate the recovery of floodplains, wetlands, and other aquatic habitat in Pen Branch. See the revisions in Section 2.1.6 of the EIS.

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	impoundments (L-Lake and Parr Pond) during plant operations. Currently, K-Reactor discharges into Pen Branch, and fish life is absent from Pen Branch during discharge due to thermal impacts. DOE has decided to construct and operate recirculating cooling tower for K-Reactor "subject to the authorization and appropriation of funds by Congress". Installation of these cooling towers would improve the severely degraded aquatic habitat conditions that currently exist in Pen Branch during K-Reactor discharge.	
L-80-02	Entrainment of ichthyoplankton by DOE cooling water intakes is another major area of concern. At the plant site, the average stream flow of the Savannah River is 10,000 cubic feet per second (cfs). During the period 1985-1988, the lowest annual average stream flow was 3,788 cfs. The minimum stream flow needed at the site is 4,872 cfs with all reactors operating. With all 3 reactors running, 847 cfs is withdrawn for cooling which is approximately 18 % of the $7Q_{10}$ flow of 4,708 cfs. If recirculating cooling towers are constructed for K-Reactor, water withdrawal will decrease to 512 cfs. In 1983-1985, average entrainment of fish larvae was 18 million. American shad, blueback herring, crappie and sunfish were the most common types of larvae entrained. Entrainment of fish eggs averaged 9 million, of which 73% were American shad or striped bass. With all three reactors in operation, based on 1983-1985 data, it is estimated that under current water withdrawal regimes, 10.7% of all ichthyoplankton passing the pumps are entrained. The percent loss would increase during low stream flow years. These losses of eggs and larvae are significant detriments to the Savannah River fishery. Entrainment impacts would decline once recirculating cooling towers are installed for K-Reactor.	Please see the response to Comment L-78-08 on cooling water intake entrainment.
L-80-03	Our Department is also very concerned about adverse impacts to wetland and wildlife resources. How water resulting from cooling K-Reactor when it operates drains into an area of about 1,000 acres of wetlands. Most of these wetlands, 630 acres, have already been impacted by hot water discharged during the 35 years that the	Please see the response to Comment L-80-01 on the K-Reactor cooling tower.
L-80-04	K-Reactor has been in operation. Approximately 10 to 12 acres of additional damage would be prevented by the tower for every year the reactor is operated and if current plans for restart and retirement of the reactor are followed a total of approximately 100 acres would be preserved.	DOE is expediting the construction of the K-Reactor cooling tower. Under the expedited schedule, the maximum period that K-Reactor could operate without a cooling tower is 2 years, of which 6 months would involve outages for recharge and maintenance. Thus, less than 18 acres of additional wetlands would be damaged.

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Comment Number	Comment	Response
L-80-05	In reference to the "L" Lake and reactor, our Department was involved in negotiating a mitigation plan with DOE approximately 5 years ago. A proposed mitigation plan was submitted to the Department of Energy and U.S. Fish and Wildlife Service for review, but has yet to be implemented. We had requested that approximately 4,000 acres of land outside the security area be dedicated to the acres of land outside the security area to be dedicated to the Wildlife Management Area Program as part of the mitigation. Other mitigation aspects included dedication of timber stands to old growth within the security area. The Department's primary emphasis was placed on the 4,000 acre tract and its inclusion in the Wildlife Management Area Program.	As part of the mitigation measures identified in the L-Reactor EIS (DOE/EIS-0108, 1984), an L-Reactor Mitigation Team was formed. Its purpose was to identify appropriate mitigation for habitat impacts associated with the construction and operation of the 1,000-acre cooling lake for L-Reactor. The team consisted of representatives from the U.S. Fish and Wildlife Service, the U.S. Forest Service, DOE, the South Carolina Wildlife and Marine Resources Department, Du Pont Company, the Savannah River Ecology Laboratory (University of Georgia), and NUS Corporation. The cited 4,000-acre tract is a component of a plan (Plan A), which is one of two major plans presented for Mitigation Team consideration. Plan A is not considered to be the team-preferred plan, as documented in the letter of April 22, 1989 (S. R. Wright to Roger L. Banks, Field Supervisor, U.S. Fish and Wildlife Service). DOE has received no response to this letter and, therefore, no final interagency mitigation plan has been established.
L-80-06	In terms of the P-Reactor, the Department is not aware of any effort to mitigate the adverse impacts on wildlife resources resulting from the operation of this reactor.	DOE conducted comprehensive Section 316(a) Demonstration studies for P-Reactor during 1984 and 1985; Section 4.1.1.4.3 of the EIS discusses the results of these studies. The studies demonstrated the maintenance of a Balanced Biological Community (BBC) in Par Pond, the recirculating cooling water reservoir for the reactor, and that the thermal effects on aquatic biota are highly localized near the discharge point. SCDHEC concurred with this conclusion as well as the determination that the operation of P-Reactor poses no threat to the continued existence of the BBC, but stipulated that thermally caused fish kills that occasionally occur in precooler Pond C be eliminated. On June 6, 1990, SCDHEC issued an executed settlement agreement with DOE on fish kills in Pond C. This agreement

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		requires DOE to submit a report to SCDHEC describing options for avoiding future fish kills, identifying the selected options to be pursued, and providing a schedule for implementation. On July 5, 1990, as required by the settlement agreement, DOE submitted to SCHDHEC a Remedial Action Plan regarding options for avoiding future fish kills. Upon SCDHEC review and approval, DOE will undertake the selected options in accordance with the approved schedule. Section 4.5 of the EIS has been revised to include potential mitigation measures for fish kills.
L-80-07	In conclusion, the continuing operation of the K-, L- and P-Reactors would result in significant adverse impacts on fish and wildlife resources, and important wetland habitats. The full and complete mitigation of these adverse impacts should be thoroughly addressed in the EIS. The necessary mitigation should be implemented prior to re-start of the reactors. Sincerely, James A. Timmerman, Jr. Executive Director JATjr:RED/kah cc: Brock Conrad	DOE has provided additional information on mitigation options in Section 4.5.7 of the Final EIS. DOE believes it has addressed all reasonable alternatives for mitigation.

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Comment Number	Comment	Response
L-81	STATEMENT OF MEREDITH J. SORENSEN 44 HARVEST ROAD FAIRPORT, N.Y. 14450 June 27, 1990 S. Wright, Director Environmental Division U.S. Dept of Energy Savannah River Operations Office P.O. Box A Aiken, S.C. 29802 Dear Mr. Wright:	
L-81-01	I oppose reopening the Savannah River Nuclear Plant. Our earth is contaminated enough without the Savannah River Nuclear Plant adding to it. Sincerely, Meredith J. Sorensen	Comment noted.

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Comment Number	Comment	Response
L-82	STATEMENT OF CHARLES H. BADGER ADMINISTRATOR, GEORGIA STATE CLEARINGHOUSE OFFICE OF PLANNING AND BUDGET 270 WASHINGTON ST., S.W. ATLANTA, GEORGIA, 30334 Frank R. McCoy, III DOE/Savannah River Operations Office Post Office Box A Aiken, South Carolina 29802 DATE: June 25, 1990 SUBJECT: RESULTS OF STATE LEVEL REVIEW APPLICANT: DOE/SAVANNAH RIVER OPERSTIONS OFFICE PROJECT: DEIS/SAVANNAH RIVER SITE STATE APPLICATION IDENTIFIER: GA 90 05 08-012 FEDERAL ID NUMBER: DOE/EIS-01470	
L-82-01	The State level review of the above referenced document has been completed. As a result of the environmental review process, the activity this document was prepared for has been found to be consistent with State social, economic, physical goals, policies, plans, and programs with which the State is concerned. Additional Comments: None.	Comments noted.

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Comment Number	Comment	Response
L-83	UNITED STATES DEPARTMENT OF COMMERCE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION NATIONAL MARINE FISHERIES SERVICE SOUTHEAST REGIONAL OFFICE 9450 KOGER BOULEVARD ST. PETERSBURG, FLORIDA 33702 June 12, 1990 Mr. Stephen R. Wright Director, Environmental Division U.S. Department of Energy Savannah River Operations Office P.O. Box A Aiken, South Carolina 29802 Dear Mr. Wright: The National Marine Fisheries Service (NMFS) has reviewed the Draft Environmental Impact Statement (DEIS) for Continued Operation of K-, L-, and P-Reactors, Savannah River Site, Aiken, South Carolina (DOE/EIS-0147D). The following comments are provided for your consideration. <u>General Comments</u>	
L-83-01	The DEIS does not adequately address impacts associated with the operation of the K-, L-, and P-Reactors on anadromous fishery resources. The Savannah River receives discharges from six tributaries from the Savannah River Site. According to the DEIS, egg and larvae samples taken during the period 1983 to 1985 were dominated by clupeids, including anadromous American shad and blueback herring. We are concerned that certain operational aspects of the reactors, as identified in Table 2-3 on Pages 2-74 through 2-82 of the DEIS, may adversely impact these resources. Areas of concern include:	Table 2-3 summarizes the impacts of concerns 1 through 4 of the comment. More detailed information is presented in the EIS sections cited below.
L-83-02	1. Withdrawal of water from the Savannah River;	Sections 4.1.1.2 and 4.1.6.4.3 of the EIS address impacts of surface-water withdrawal.

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L-83-03	2. Loss of anadromous fish eggs and larvae by impingement and entrainment;	Sections 4.1.1.2 and 4.1.6.4.3 of the EIS address impacts from impingement and entrainment.
L-83-04	3. Thermal discharge and its effect on anadromous fish eggs and larvae; and	Sections 4.1.1.4 and 4.1.6.4.4 address thermal discharge impacts.
L-83-05	4. Wetland losses.	Section 4.1.1.6.2 and 4.1.6.4.8 address wetlands impacts.
L-83-06	The NMFS supports efforts by the South Carolina Department of Health & Environmental Control (SCDHEC) in developing a mitigation plan to reduce thermal impacts of reactor operations. The cooperative effort of the Department of Energy (DOE) and the Fish and Wildlife Service (FWS) to mitigate effects of adverse impacts on fish and wildlife resources is also recognized as a positive component of the operation. In view of our responsibility to preserve and protect anadromous fishery resources, we believe that our participation in these efforts is warranted. Accordingly, we recommend that existing and planned mitigation efforts be fully coordinated with us.	DOE acknowledges the role of the National Marine Fisheries Service (NMFS) in the preservation and protection of anadromous fishery resources under the Anadromous Fish Conservation Act. The absence of significant impacts of past SRS operations on anadromous fish in the Savannah River has been confirmed in Section 316(b) Demonstrations and other extensive river studies submitted to SCDHEC and EPA; this issue has been addressed in the EIS. DOE is committed to conduct additional studies in 1991 in the river to address the current effects of SRS operations. These studies will be used to determine mitigation requirements. DOE will coordinate any mitigation efforts relating to anadromous fish resources with NMFS.
L-83-07	Based on information provided in the DEIS, coordination regarding the endangered shortnose sturgeon has not occurred since 1983. The FEIS should be updated to include the present status of this species in the project area. Potential impacts associated with the various alternatives under consideration also should be addressed in light of any new information attained.	DOE assessed the status of the endangered shortnose sturgeon and the potential for impacts from SRS operations in the Final EIS on Alternative Cooling Water Systems, Savannah River Plant (DOE/EIS-0121), and summarizes this assessment in Chapter 3 of this EIS. The absence of significant impacts to populations of this endangered species in the river has been confirmed in Section 316(b) Demonstrations and other extensive river studies submitted to

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		SCDHEC and EPA. DOE is committed to conduct additional studies in 1991 in the river to address the current effects of SRS operations. These studies will be used to determine mitigation requirements. DOE will consult with NMFS regarding any new information that might come from these additional studies related to the present status of shortnose sturgeon in the vicinity of the SRS.
	Specific Comments	
L-83-08	Page 3-34, Paragraph 3. This paragraph should be expanded in the FEIS to include the recommendations contained in the SCDHEC mitigation plan. This additional information would enable the reader to better assess potential effects of the various alternatives on anadromous fish.	DOE has modified the EIS to provide a more detailed description of the mitigation measure implemented for D-Area cooling water discharge.
L-83-09	Page 3-39, Table 3-8 and Page 3-47, Paragraph 2. The biological assessment of the potential effects of reactor operation on the shortnose sturgeon in the Savannah River should be updated to include the current status of the species and anticipated impacts of the various alternatives.	Please see the response to Comment L-83-07 on shortnose sturgeon.
L-83-10	Page 3-40, Paragraph 4. We recommend that this paragraph be expanded in the FEIS to provide a summary of the "post thermal impacts on the Savannah River and Savannah River swamp forest" rather than simply reference other documents. This would provide a better basis on which to assess impacts described in the FEIS.	Section 3.6.2.1 of the EIS includes the current status of aquatic flora and fauna in the river and swamp; Sections 4.1.1.4 through 4.1.1.6 describe impacts to these areas.
L-83-11	Page 5-10, Paragraph 3. The NMFS should be included as a participant with the DOE and FWS in the assessment and development of mitigation needs for offsetting adverse impacts to anadromous fish resources.	DOE will include NMFS in the assessment and development of any mitigation plans related to anadromous fish resources.
	We appreciate this opportunity to provide comments. Sincerely yours, Andreas Mager, Jr. Assistant Regional Director Habitat Conservation Division	

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Comment Number	Comment	Response
L-84	UNITED STATES DEPARTMENT OF THE INTERIOR OFFICE OF THE SECRETARY WASHINGTON, D.C. 20240 ER 90/445 Mr. S. R. Wright Director, Environmental Division U.S. Department of Energy Savannah River Operations Office P.O. Box A Aiken, South Carolina 29802 Dear Mr. Wright: The Department of the Interior has reviewed the draft environmental impact statement for Continued Operations of K-, L-, and P-Reactors, Savannah River Site, Aiken County, South Carolina and has the following comments. General	
L-84-01	The document is well written and clearly describes the environmental impacts resulting from the preferred alternative as well as a number of other alternatives. However, there is little or no discussion in the document of possible mitigation options to avoid, minimize, rectify or compensate for projected wetland, thermal, and entrainment/impingement impacts. In addition, we were unable to evaluate the Department of Energy's determination that the preferred alternative is the only alternative which meets the stated production needs, since the data supporting that decision are located in a classified appendix.	DOE has provided additional information on mitigation options in Section 4.5 of the Final EIS. Appendix A is classified, but Section 1.2 provides an unclassified discussion of the need.
	Alternatives	
L-84-02	We do not agree that the preferred alternative also represents the No Action alternative. The reactors have been inoperative for at least two years and their restart does not represent continuation of a present course of action. The terms "continued operation" and "restart" of K-, L-, and P-Reactors appear to be used	Please see the response to Comment L-05-01 on continued operation.

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	interchangeably throughout the document. In reality, these reactors have been shut down (inactive) for at least two years. Restart would result in a host of environmental impacts which are clearly described in the Environmental Consequences section of the document. We believe the No Action alternative is not restart of these reactors, but rather maintenance of the status quo (i.e., maintenance of these reactors in an inoperative mode). Section 2.1	
L-84-03	should be revised to indicate the no-action alternative is maintenance of the reactors in a shutdown condition.	Please see the response to Comment L-05-01 on continued operation.
L-84-04	At least one other alternative, i.e., restart of L- and P-Reactors, with a delayed restart of K-Reactor until the recirculating cooling tower is completed, should be analyzed as a less environmentally damaging alternative. Expedited construction of the K-Reactor cooling tower should also be explored. This alternative presents significant reduction in thermal, impingement and entrainment and wetland loss impacts.	Please see the response to L-45-01 on reactor operation and need for materials. DOE is expediting the construction of the cooling tower. See the revisions to Section 2.1.6 of the EIS.
L-84-05	The draft environmental impact statement does not discuss the status of L-Lake mitigation. In February 1988, our Fish and Wildlife Service (Service) forwarded the final report of the L-Reactor Habitat Mitigation Study conducted under Cooperative Agreement No. DE-A109-84SR14031 between the Service and the Department of Energy. That report contained a recommended mitigation plan. To date, the Department of Energy has not responded to the recommendation in the report. The resultant continued mitigation deficit for L-Lake is an appropriate topic for resolution through this environmental impact statement process, since the preferred alternative includes restart and/or continued operation of L-Reactor and L-Lake. A discussion of the status of the recommended mitigation was during the scoping process for this draft statement.	Section 4.5.7 of the EIS presents the current status of the mitigation resulting from the construction and operation of the L-Reactor thermal mitigation alternative.
	Environmental Consequences	
L-84-06	This chapter of the document highlights immediate and continued wetland losses and alterations of significant wetlands acreage associated with the preferred alternative. The final statement should discuss measures to mitigate these impacts. Specifically, the final statement should identify measures to avoid, minimize, rectify and compensate for changes in wetland acreage and quality.	DOE has provided additional information on mitigation options in Section 4.5.7 of the Final EIS. DOE will implement the selected option(s) through interaction with regulatory agencies.

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L-84-07	The draft statement also fails to discuss measures to reduce or compensate for the high rates of impingement and entrainment of aquatic organisms. The Service in cooperation with the States of South Carolina and Georgia, has targeted restoration of anadromous species in the Savannah River as a major goal. American shad and other anadromous fish have lost traditional spawning range through dam construction above the Savannah River Site. Entrainment of eggs and larvae at the site, in the quantity reported in the draft statement, is an additional impact on anadromous species. The final statement should describe mitigation to reduce entrainment of eggs and larvae during operations.	Please see the response to Comment L-78-08 on entrainment. Also, see additional information on mitigation options in Section 4.5 of the EIS.
	Thermal Discharge	
	Thermal discharge into Pen Branch and entrainment/impingement of aquatic organisms associated with operating K-Reactor in a once-through-cooling mode constitute a majority of the overall environmental impacts of the proposed action.	
L-84-08	Discussions of mitigation, including overall wetland mitigation, the status of L-Lake mitigation, and reduction or compensation for entrainment and impingement, should also be included in the final statement.	Please see the responses to Comments L-78-08 on entrainment, L-78-05 on wetlands mitigation, and L-78-07 on L-Lake mitigation. Also, see the revisions to Section 4.5 of the EIS.
	K-Reactor Operation	
L-84-09	We disagree with the statement that the effect of entrainment of fish eggs and larvae should be minimal and restricted to local fish populations. A high percentage of entrained eggs and larvae are American shad which spawn up to the New Savannah Bluff Lock and Dam (NSBLD) and more recently, up to the Augusta Diversion Dam. The Service has initiated a nationwide effort to restock fish. As part of this program, the Service has initiated a program to actively lock these fish above the NSBLD. In that the demersal eggs and larvae of this species have a long ichthyoplankton stage, entrainment at the intake probably include eggs and larvae of shad spawning all the way up to Augusta. In previous documents, operation was reported to entrain 19 percent of all the eggs and larvae passing in the Savannah River, at full operation. We do not consider this quantity to be "minimal" entrainment.	The EIS estimates the amount of annual entrainment to average approximately 10.8 percent of the ichthyoplankton passing the SRS, based on studies conducted in 1983-1985. The absence of significant impacts of past entrainment and impingement losses on fish and other aquatic populations in the river has been confirmed in Section 316(b) Demonstrations and other extensive river studies submitted to SCDHEC and EPA. DOE is committed to conduct additional entrainment studies in the Savannah River to address the current effects of SRS operations. These studies will be used to determine any necessary mitigation measures.

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L-84-10	The final statement should indicate the average flow in Pen Branch represents an approximately 480 percent increase in flow over normal flows when K-Reactor operates in the once-through cooling mode (11.3 cubic meters per second).	Section 3.4.1.2.2 of the EIS presents the natural stream flow values for Pen Branch as 0.1 to 0.3 cubic meter per second; thus, the contribution from once-through K-Reactor operation represents between 38 and 113 times the natural flow. Section 4.1.1.4.1 states that the contribution to Pen Branch from K-Reactor after the cooling tower begins operation will be reduced to about 1.2 cubic meters per second, or between 4 and 12 times the natural flow.
	P-Reactor Operation	
L-84-11	Compliance with pollution discharge permit requirements does not guarantee insignificant water quality impacts. We disagree with the conclusion in Section 4.1.1.5 that "...the continued operation of K-, L-, and P-Reactors should have insignificant effects on the water quality of Pen Branch and Indian Grave Branch, L-Lake and Steel Creek, and Par Pond and Lower Three Rivers Creek, respectively." We fail to see how this conclusion was reached in light of documented fish kills in the Pond C arm of Par Pond and in L-Lake and documented water temperatures in excess of 20 degrees C above ambient in Pen Branch.	The referenced discussion relates to chemical water quality, not to thermal conditions. However, Section 316(a) Demonstration studies conducted in Par Pond and L-Lake demonstrate the maintenance and the development and maintenance, respectively, of a balanced biological community (BBC) in these water bodies. Also, a Predictive Section 316(a) Demonstration conducted for K-Reactor projects the development and maintenance of a BBC for Pen Branch as a result of mitigation with a cooling tower.
	Steel Creek	
L-84-12	The shift noted from bottomland hardwoods to emergent wetlands in the Steel Creek corridor and delta should be detailed further, particularly since this trend is projected to continue as a result of the proposed action. The conversion of bottomland hardwood to other wetland types is generally considered undesirable. The rate of occurrence of this conversion, as well as the ecosystem implications of this conversion, should be detailed in the final statement.	Please see the response to Comment L-78-17 on wetlands. The bottomland hardwood areas in question are not mature, but rather are areas that revegetated during the extended L-Reactor outage from 1968 to 1985. Therefore, the bottomland hardwood areas subject to conversion are more similar to a tall scrub-shrub area than to a mature hardwood forest. Tables 4-2 and 4-3 list changes in wetlands vegetation classes in the Steel Creek corridor and delta/swamp, respectively.
	Cumulative Impacts	
L-84-13	The final statement should include a cumulative impact analysis of entrainment and impingement of fish, eggs and larvae, especially American shad.	DOE has modified Section 4.1.6.4.3 of the EIS to include a cumulative analysis of entrainment and impingement.

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	We hope these comments will be helpful to you. Sincerely, Jonathan P. Deason Director Office of Environmental Affairs	

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Comment Number	Comment	Response
L-85	CITY OF SAVANNAH, GEORGIA FACILITIES MAINTENANCE DEPARTMENT P.O. BOX 1027 SAVANNAH, GEORGIA 31402 August 6, 1990 Mr. S. R. Wright U.S. Department of Energy Savannah River Operations of Fire Post Office Box A Aiken, South Carolina 29802 Dear Mr. Wright: As water purveyors, the 1990s will be a period of dramatic changes for the water works industry. The past decades' concerns with exposures to toxic chemicals, as illustrated by the superfund cleanup program and waste disposal controls, will be matched by present concerns over the condition of our drinking water supplies. Recent amendments to the Federal Safe Water Drinking Act have resulted in significant changes in drinking water quality of the potable drinking water supplies in this nation. With the challenges that confront us as cited above, the City of Savannah Water Operations Department is providing comments which express our concerns with the restart and continued operation of the K, L, and P reactors at the Savannah River Plant. Specifically our concerns are as follows:	
L-85-01	1) With the present and future amendments to the Safe Drinking Water Act lowering the maximum contaminant levels (MCL) of certain contaminants presently regulated and estalishing drinking water standards for an additional 83 parameters, the water purveyors and our customers find it difficult that EPA is proposing raising the drinking water standard for Tritium from 20,000 pCi/l to 90,000 pCi/l. This information was obtained from your quarterly report to our utility summarizing the analyses of the monthly composite water samples from the plant. Your objectives should concentrate on lowering Tritium levels rather than increasing the levels in the Savannah River.	The basic drinking-water standard for radionuclides [40 CFR 141.16(a)] is expressed in terms of an annual dose equivalent of 4 millirem, rather than concentrations. Any change by EPA in the tritium concentration in water corresponding to this dose standard would be the result of applying the most

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		current information on the factors used to convert concentration to dose. In any event, SRS discharges of tritium yield concentrations in Savannah River water well below the current limit (see Tables 3-11 and 3-12 of the EIS). Any decision by DOE on changes in discharges of tritium, as discussed in Section 4.1.2, will be made independently of an EPA decision on changes in drinking-water standards for tritium.
L-85-02	2) Watershed protection restricts activities that have the potential to contaminate surface drinking water supply sources. As water purveyors, we have the responsibility to preserve and improve raw water quality by identifying and controlling contamination sources in the watershed. The Savannah Water Operations Department does not agree with D.O.E. that the continued and projected increase in radioactive discharges as a result of the restart of subject reactors are in the best interest of watershed protection for this community.	The only changes in liquid discharges to the Savannah River would occur (1) if the discharge of disassembly-basin purge water to approved NPDES outfalls were to be implemented rather than currently using the reactor seepage basins for such discharges, and (2) from the replacement of the F- & H-Area seepage basins by the Effluent Treatment Facility, which discharges processed, tritiated water to surface streams, as described in Sections 2.1.2, 3.7.1, and 4.1.2 of the EIS. Both of these changes are responsive to the EPA desire to eliminate the use of seepage basins. However, the elimination of the decay period afforded by the underground transit time to onsite streams with seepage basin use would increase the quantities of tritium reaching the river, although the maximum individual dose to downstream users from either approach would be a small fraction of the EPA drinking-water standard. These alternatives for discharge of surge water are being reevaluated as a consequence of the comments received by DOE, as discussed in Section 4.1.2 of the EIS.
	3) According to the 1985 Annual Report prepared by the Department of Energy for the Savannah River Plant, the concentration of Radionuclide Tritium in the finished water at the I & D Facility ranges from a high of 4300 to 2300 pCi/l. The average Tritium concentration downriver of the Savannah River Plant (SRP) was	

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	3700 pCi/l. According to the report, the 1985 average Tritium concentration was slightly higher than the 3300 pci/l detected in 1984. The report indicated that this increase was the result of a 22% reduction in the river flow in 1985. Therefore, according to the report, there was less dilution of the released	
L-85-03	Tritium from SRP. Based on the facts cited above, has D.O.E. determined the level or increase in radioactive Tritium in the Savannah River should the river flow be reduced to 3600 cfs as a result of the past drought cycles of the Savannah River Basin?	The concentration of tritium in the Savannah River is a function of both river flow and the quantities released from reactors and support facilities at SRS. Both of these quantities will vary from year to year. Table 4-45 of the EIS indicates a total SRS liquid release of about 7.4×10^4 curies per year based on the average for the 1984-1986 period. Dilution of this quantity in a mean annual flow of 3,600 cubic feet per second would result in a mean annual concentration of about 23,000 picocuries per liter. However, flow at this rate would not permit pumping of water for more than one reactor operation. Also, please see the response to Comment L-49-02 on low flow.
	4) At this time, we cannot enter into any discussions as to the whys and why nots of the National Defense requirements of this nation. The D.O.E. environmental impact statement (EIS) briefly discusses that there are future potentials for decreases in the nuclear materials requirements due to the changing world geopolitical situations. The E.I.S. also discusses, briefly, the possibility of utilization of recycled materials from retired weapons to satisfy the future nuclear materials requirement. As for the impacts on the Savannah River	
L-85-04	Communities from the startups of subject reactors, we feel that the above should be explored more throughly.	Please see the responses to Comments L-02-01 on the need for tritium and other nuclear materials, and L-15-06 on recycling.
	The communities of the Savannah River Basin are most fortunate in having the Savannah River as an abundant, viable water resource for their present and future needs. As other communities in this nation and North Georgia compete for water use allocation of their dwindling surface supplies, the Savannah River remains a virtually untapped resource. Although remote, accidents will occur. An	
L-85-05	accident at the D.O.E. Facility will have an immediate and lasting impact on the communities in Southeast Georgia. The health and livelihood of thousands will be affected by any accident. These risks are too great for us to ignore or pass on to our customers.	Please see the response to Comment L-49-06 on accidents and their impacts on water resources

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	With regard to the interest of the water supply customers in the Savannah River area, we oppose any activities by D.O.E. which would change or alter the water quality of the Savannah River and in particular the finished water quality of the Savannah Treatment Facilities. We appreciate your cooperation in this matter. Very Respectfully, Harry Jue Water Operations Director HJ/hc cc: Ed Hagin A.A. Mendonsa Elizabeth Stewart Honorable Lindsey Thomas	

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