

Savannah River Site

Salt Processing Alternatives

Final Supplemental

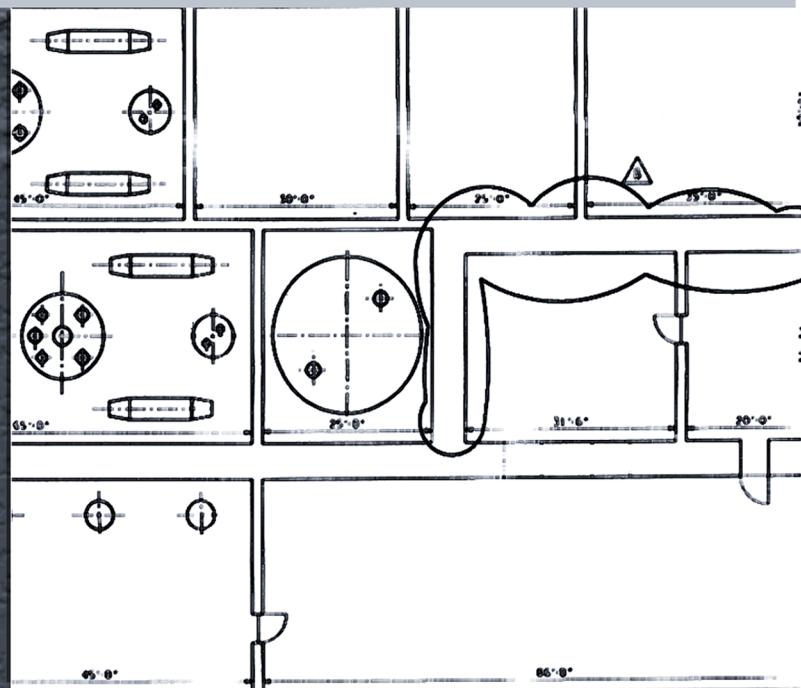
Environmental

Impact Statement

U.S. Department of Energy
Savannah River Operations Office
Aiken, South Carolina

June 2001

DOE/EIS-0082-S2



COVER SHEET

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

TITLE: Savannah River Site Salt Processing Alternatives Supplemental Environmental Impact Statement (DOE/EIS-0082-S2)

CONTACT: For additional information on this supplemental environmental impact statement (SEIS), write or call:

Andrew R. Grainger, NEPA Compliance Officer
U.S. Department of Energy
Savannah River Operations Office
Building 730-B, Room 2418
Aiken, South Carolina 29802
Attention: Salt Processing SEIS
Local and Nationwide Telephone:
(800) 881-7292
Email: nepa@SRS.gov

CONTACT: For general information on DOE's National Environmental Policy Act (NEPA) process, write or call:

Ms. Carol M. Borgstrom, Director
Office of NEPA Policy and Compliance
U.S. Department of Energy, EH-42
1000 Independence Avenue, S.W.
Washington, D.C. 20585-0119
Telephone: (202) 586-4600 or
leave a message at (800) 472-2756

TC |

The SEIS will be available on the internet at: [//tis.eh.doe.gov/nepa/docs/docs.htm](http://tis.eh.doe.gov/nepa/docs/docs.htm).

ABSTRACT: DOE prepared this SEIS on alternatives for separating the high-activity fraction from the low-activity fraction of the high-level radioactive waste salt solutions now stored in underground tanks at the Savannah River Site (SRS) near Aiken, South Carolina. The high-activity fraction of the high-level waste (HLW) salt solution would then be vitrified in the Defense Waste Processing Facility (DWPF) and stored until it could be disposed of as HLW in a geologic repository. The low-activity fraction would be disposed of as low-level waste (saltstone) in vaults at SRS.

A process to separate the high-activity and low-activity waste fractions of the HLW salt solutions is needed to replace the In-Tank Precipitation (ITP) process which, as presently configured, cannot achieve production goals and safety requirements for processing HLW. This SEIS analyzes the impacts of constructing and operating facilities for four alternative processing technologies – Small Tank Precipitation, Ion Exchange, Solvent Extraction, and Direct Disposal in Grout – and the No Action Alternative. Solvent Extraction is DOE's preferred alternative. Sites for locating processing facilities within S and Z Areas at SRS are identified.

| TC

Because replacing the ITP process constitutes a substantial change to the HLW salt processing operation of the DWPF, as evaluated in a 1994 SEIS (DOE/SEIS-0082-S) to the 1982 DWPF EIS (DOE/EIS-0082), DOE prepared this second SEIS to evaluate the potential environmental impacts of alternatives to the ITP process.

PUBLIC INVOLVEMENT: DOE issued the Draft Salt Processing Alternatives SEIS on March 23, 2001 and held a public comment period on the Draft SEIS through May 14, 2001. In preparing the Final SEIS, DOE considered comments received via mail, fax, and electronic mail and transcribed comments made at public meetings held in North Augusta, South Carolina, on May 1, 2001, and Columbia, South Carolina, on May 3, 2001.

| TC

FOREWORD

The U.S. Department of Energy (DOE) published a Notice of Intent (NOI) on February 22, 1999, to prepare this supplemental environmental impact statement (SEIS). DOE prepared this SEIS on alternatives for separating the high-activity fraction from the low-activity fraction of the radioactive high-level waste (HLW) salt solution now stored in underground tanks at the Savannah River Site (SRS) near Aiken, South Carolina. The high-activity fraction of the HLW salt solution waste would then be vitrified in the Defense Waste Processing Facility and stored until it could be disposed of as high-level waste in a geologic repository. The low-activity fraction would be disposed of as low-level waste (salt-stone) in vaults at SRS.

A process to separate the high-activity and low-activity waste fractions of the high-level waste salt solutions is needed to replace the In-Tank Precipitation (ITP) process which, as presently configured, cannot achieve production goals and safety requirements for processing high-level waste. This SEIS analyzes the impacts of constructing and operating four alternative processing technologies – Small Tank Precipitation, Ion Exchange, Solvent Extraction, and Direct Disposal in Grout – and the No Action Alternative. The Solvent Extraction Alternative is DOE's preferred alternative. Because replacing the ITP process constitutes a substantial change to the HLW salt processing operation of the Defense Waste Processing Facility, as evaluated in a 1994 SEIS (DOE/SEIS-0082-S) to the 1982 Defense Waste Processing Facility EIS (DOE/EIS-0082), DOE prepared this second SEIS to evaluate the potential environmental impacts of alternatives to the ITP process.

A Notice of Availability for the Draft SEIS was published in the Federal Register on March 30, 2001. Public meetings to discuss and receive comments on the Draft SEIS were held at the North Augusta Community Center in North Augusta, South Carolina on May 1, 2001 and at the Holiday Inn Coliseum in Co-

lumbia, South Carolina on May 3, 2001. The public comment period ended May 14, 2001. In the public meetings nine individuals commented on the Draft SEIS. During the 45-day comment period DOE received 12 letters commenting on the Draft SEIS. A summary of the comments received during the public comment period for this SEIS, and DOE's responses are included in Appendix C.

Transcripts of public testimony, copies of comment letters, responses to those comments, and reference materials cited in the SEIS are available for review in the DOE Public Reading Room, University of South Carolina at Aiken, Gregg-Graniteville Library, University Parkway, Aiken, South Carolina.

DOE has prepared this SEIS in accordance with the National Environmental Policy Act (NEPA) regulations of the Council on Environmental Quality (40 CFR 1500-1508) and DOE NEPA Implementing Procedures (10 CFR 1021). This SEIS identifies the methods used for analyses and the scientific and other sources of information consulted. In addition, results available from ongoing studies are incorporated directly or summarized and referenced. The organization of the SEIS is as follows:

- Chapter 1 describes the background and purpose and need for DOE action regarding salt processing at SRS.
- Chapter 2 describes the proposed action and the alternatives that DOE is evaluating.
- Chapter 3 describes the SRS environment as it relates to the alternatives described in Chapter 2.
- Chapter 4 assesses the potential environmental impacts of the alternatives.

TC

TC

- Chapter 5 discusses the cumulative impacts of salt processing in relation to other past, present, and reasonably foreseeable future activities at SRS, and in the surrounding region.
- Chapter 6 identifies irreversible and irretrievable resource commitments.
- Chapter 7 discusses applicable statutes, state and Federal regulations, and DOE Orders, and agreements.
- Appendix A describes the facilities and processes that would be used for each of the alternatives.
- Appendix B discusses the methods used for accident analysis and the results of the analysis.
- Appendix C presents the comments received on the draft SEIS and DOE's responses to those comments.
- Appendix D gives the methods and the results of long-term performance modeling that was used to evaluate the impacts of salt processing alternatives.

TC

Change Bars

Change bars beside text in this SEIS indicate a substantive change from the Draft SEIS. If the change was made in response to a comment received on the Draft SEIS, the comment number is as listed in Appendix C. If the change was a technical change made by DOE, the bar is marked "TC."

TABLE OF CONTENTS

<u>Section</u>	<u>Page</u>
COVER SHEET.....	iii
FOREWORD	v
ACRONYMS, ABBREVIATIONS, AND USE OF SCIENTIFIC NOTATION.....	xv
CHAPTER 1. BACKGROUND AND PURPOSE AND NEED FOR ACTION	1-1
1.1 Background	1-1
1.2 Purpose and Need for Action	1-4
1.3 SEIS Overview	1-5
1.3.1 Scope	1-5
1.3.2 Organization.....	1-6
1.3.3 Stakeholder Participation	1-6
1.4 Related Information.....	1-7
1.4.1 NEPA Documents	1-7
1.4.2 Other Relevant Documents	1-8
References	1-15
CHAPTER 2. PROPOSED ACTION AND ALTERNATIVES.....	2-1
2.1 Proposed Action	2-1
2.2 Inventory and Schedule for Processing of High-Level Waste Salt	2-1
2.3 No Action Alternative	2-3
2.3.1 Identify Additional Ways to Optimize Tank Farm Operations	2-4
2.3.2 Reuse Tanks Scheduled to be Closed By 2019	2-5
2.3.3 Build Tanks Permitted Under Wastewater Treatment Regulations	2-5
2.3.4 Build Tanks Permitted Under RCRA Regulations.....	2-5
2.3.5 Suspend Operations at DWPF.....	2-6
2.4 Selection of Salt Processing Technologies for Evaluation as Alternatives	2-6
2.5 Salt Processing Facility Site Identification.....	2-6
2.6 Salt Processing Alternatives	2-7
2.6.1 Small Tank Precipitation.....	2-11
2.6.2 Ion Exchange.....	2-14
2.6.3 Solvent Extraction.....	2-14
2.6.4 Direct Disposal in Grout	2-14
2.7 Salt Processing Facilities.....	2-18
2.7.1 Process Inputs and Processing Requirements	2-18
2.7.2 Product Outputs.....	2-18
2.7.3 Process Facilities	2-19
2.7.4 Support Facilities	2-20
2.7.5 Saltstone Vaults.....	2-20
2.7.6 Pilot Plant.....	2-21
2.7.7 Facility Decontamination and Decommissioning	2-23
2.8 Other Decision-Making Factors	2-24
2.8.1 National Academy of Sciences Review Committees Final Reports	2-24
2.8.1.1 Committee on Cesium Processing Alternatives for High- Level Waste at the Savannah River Site	2-24
2.8.1.2 Committee on Radionuclide Separation Processes for High- Level Waste at the Savannah River Site	2-26

TABLE OF CONTENTS (Continued)

<u>Section</u>	<u>Page</u>
2.8.2 Defense Nuclear facilities Safety Board Recommendation 2001-1.....	2-27
2.8.3 Self-Protecting HLW Canisters	2-27
2.8.4 Cost.....	2-28
2.9 Comparison of Alternatives	2-28
2.9.1 Short-Term Impacts	2-28
2.9.2 Long-Term Impacts	2-46
References	2-54
CHAPTER 3. AFFECTED ENVIRONMENT.....	3-1
3.1 Geologic Setting and Seismicity	3-4
3.1.1 General Geology.....	3-4
3.1.2 Subsurface Features.....	3-4
3.1.3 Seismicity	3-4
3.2 Water Resources	3-9
3.2.1 Surface Water	3-9
3.2.2 Groundwater Resources.....	3-13
3.2.2.1 Groundwater Features	3-13
3.2.2.2 Groundwater Use	3-18
3.2.2.3 Hydrogeology	3-18
3.2.2.4 Groundwater Quality	3-22
3.3 Air Resources.....	3-22
3.3.1 Meteorology.....	3-22
3.3.1.1 Local Climatology	3-22
3.3.1.2 Severe Weather.....	3-24
3.3.2 Air quality.....	3-24
3.3.2.1 Nonradiological Air Quality.....	3-24
3.3.2.2 Radiological Air Quality	3-27
3.4 Ecological Resources	3-31
3.4.1 Natural Communities of the Savannah River Site	3-31
3.4.2 Ecological Communities Potentially Affected by Development and Operation of Salt Processing Facilities.....	3-33
3.5 Land Use	3-34
3.6 Socioeconomics and Environmental Justice	3-35
3.6.1 Socioeconomics	3-35
3.6.2 Environmental Justice.....	3-36
3.7 Cultural Resources	3-37
3.8 Public and Worker Health.....	3-37
3.8.1 Public Radiological Health	3-40
3.8.2 Public Nonradiological Health	3-42
3.8.3 Worker Radiological Health	3-42
3.8.4 Worker Nonradiological Health	3-43
3.9 Waste and Hazardous Materials Management.....	3-43
3.9.1 Low-Level Radioactive Waste	3-45
3.9.2 Mixed Low-Level Waste	3-45
3.9.2 Mixed Low-Level Waste	3-46
3.9.3 High-Level Waste.....	3-46
3.9.4 Sanitary Waste	3-50

TABLE OF CONTENTS (Continued)

<u>Section</u>	<u>Page</u>
3.9.5 Hazardous Waste.....	3-50
3.9.6 Transuranic and Alpha Waste	3-50
3.9.7 Hazardous Chemicals.....	3-50
3.10 Energy and Utilities.....	3-51
References.....	3-52
CHAPTER 4. ENVIRONMENTAL IMPACTS.....	4-1
4.1 Short-Term Impacts.....	4-2
4.1.1 Geologic Resources.....	4-2
4.1.2 Water Resources.....	4-4
4.1.2.1 Surface Water.....	4-4
4.1.2.2 Groundwater Resources	4-6
4.1.3 Air Resources	4-8
4.1.3.1 Nonradiological Emissions	4-8
4.1.3.2 Radiological Emissions.....	4-15
4.1.4 Worker and Public Health.....	4-17
4.1.4.1 Nonradiological Health Effects.....	4-18
4.1.4.2 Radiological Health Effects	4-19
4.1.4.3 Occupational Health and Safety.....	4-22
4.1.5 Environmental Justice	4-22
4.1.5.1 Background	4-23
4.1.5.2 Methodology	4-24
4.1.6 Ecological Resources	4-26
4.1.7 Land Use	4-28
4.1.8 Socioeconomics.....	4-29
4.1.9 Cultural Resources	4-30
4.1.10 Traffic and Transportation	4-30
4.1.11 Waste Generation	4-33
4.1.11.1 Wastes from Salt Processing.....	4-33
4.1.11.2 Secondary Waste.....	4-34
4.1.12 Utilities and Energy.....	4-37
4.1.12.1 Water Use.....	4-39
4.1.12.2 Electricity Use.....	4-39
4.1.12.3 Steam Use	4-39
4.1.12.4 Fuel Use	4-40
4.1.13 Accident Analysis	4-40
4.1.14 Pilot Plant.....	4-46
4.1.14.1 Geologic Resources	4-47
4.1.14.2 Water Resources	4-47
4.1.14.3 Air Resources.....	4-48
4.1.14.4 Worker and Public Health.....	4-48
4.1.14.5 Environmental Justice	4-48
4.1.14.6 Ecological Resources	4-48
4.1.14.7 Land Use	4-49
4.1.14.8 Socioeconomics	4-49
4.1.14.9 Cultural Resources	4-49
4.1.14.10 Traffic and Transportation	4-49

TABLE OF CONTENTS (Continued)

<u>Section</u>	<u>Page</u>
4.1.14.11 Waste Generation	4-49
4.1.14.12 Utilities and Energy	4-50
4.2 Long-Term Impacts	4-50
4.2.1 Geologic Resources	4-52
4.2.2 Water Resources	4-52
4.2.2.1 Surface Water	4-52
4.2.2.2 Groundwater	4-55
4.2.3 Ecological Resources.....	4-57
4.2.3.1 Radiological Contaminants	4-57
4.2.3.2 Nonradiological Contaminants	4-59
4.2.4 Land Use.....	4-61
4.2.5 Public Health	4-61
References	4-65
CHAPTER 5. CUMULATIVE IMPACTS	5-1
5.1 Air Resources.....	5-8
5.2 Water Resources	5-10
5.3 Public and Worker Health.....	5-10
5.4 Waste Generation and Disposal Capacity	5-12
5.5 Utilities and Energy	5-13
5.6 Long-Term Cumulative Impacts.....	5-14
References	5-16
CHAPTER 6. RESOURCE COMMITMENTS	6-1
6.1 Unavoidable Adverse Impacts	6-1
6.1.1 Operating-Life Impacts.....	6-1
6.1.2 Long-Term Impacts	6-4
6.2 Relationship Between Local Short-Term Uses of the Environment and the Maintenance and Enhancement of Long-Term Productivity	6-5
6.3 Irreversible and Irretrievable Resource Commitments	6-6
6.4 Waste Minimization, Pollution Prevention, and Energy Conservation	6-7
6.4.1 Waste Minimization and Pollution Prevention.....	6-7
6.4.2 Energy Conservation	6-10
References	6-11
CHAPTER 7. APPLICABLE LAWS, REGULATIONS, AND OTHER REQUIREMENTS ...	7-1
7.1 Waste Incidental to Reprocessing Determination.....	7-1
7.2 Statutes and Regulations Requiring Permits or Consultations.....	7-4
7.2.1 Environmental Protection Permits.....	7-4
7.2.2 Protection of Biological, Historic, and Archaeological Resources.....	7-8
7.3 Statutes, Regulations, and Guidelines Related to Emergency Planning, Worker Safety, and Protection of Public Health and the Environment.....	7-11
7.3.1 Environmental Protection	7-11
7.3.2 Emergency Planning and Response.....	7-11
7.4 Executive Orders.....	7-14
7.5 DOE Regulations and Orders.....	7-14
References	7-16

TABLE OF CONTENTS (Continued)

List of Appendices

- | | |
|------------|--|
| APPENDIX A | - TECHNOLOGY DESCRIPTIONS |
| APPENDIX B | - ACCIDENT ANALYSIS |
| APPENDIX C | - PUBLIC COMMENTS AND DOE RESPONSE TO COMMENTS |
| APPENDIX D | - LONG-TERM PERFORMANCE EVALUATION |

LIST OF PREPARERS.....	LP-1
CONTRACTOR DISCLOSURE STATEMENT	CDS-1
DISTRIBUTION LIST	DL-1
GLOSSARY.....	GL-1
INDEX	IN-1

List of Tables

<u>Table</u>	<u>Page</u>
1-1 Primer of Technical Terms (other scientific terms are defined in the glossary)	1-11
2-1 Comparison of salt processing alternatives.....	2-11
2-2 Primer of technical terms (other scientific terms are defined in the glossary).....	2-12
2-3 Inputs and processing requirements for the salt processing alternatives.....	2-19
2-4 Product outputs for the salt processing alternatives	2-20
2-5 Building specifications for each action alternative	2-21
2-6 Summary comparison of incremental life-cycle impacts to the SRS baseline by salt processing alternative. Values in bold indicate greatest impact for a particular parameter.....	2-29
2-7 Comparison of accident impacts among alternatives	2-41
2-8 Summary comparison of long-term impacts by salt processing alternative. Bolded values indicate greatest impacts for a particular parameter	2-50
3-1 SRS stream water quality (onsite downstream locations)	3-12
3-2 Annual liquid releases by source for 1997 (including direct and seepage basin migration releases)	3-13
3-3 Liquid radioactive releases by outfall/facility and comparison of annual average radionuclide concentrations to DOE derived concentration guides	3-14
3-4 Potential F and H Area contributors of contamination to Upper Three Runs and Fourmile Branch	3-17
3-5 Soil formations of the Floridan aquifer system in F and H Areas.....	3-21
3-6 H Area maximum reported groundwater parameters in excess of regulatory and SRS limits	3-23
3-7 S Area maximum reported groundwater parameters in excess of regulatory and SRS limits	3-24
3-8 Z Area maximum reported groundwater parameters in excess of regulatory and SRS limits	3-24
3-9 SCDHEC ambient air monitoring data for 1997.....	3-26
3-10 Criteria and toxic/hazardous air pollutant emissions from SRS (1997)	3-26

TABLE OF CONTENTS (Continued)**List of Tables (Continued)**

<u>Table</u>	<u>Page</u>
3-11 SRS baseline air quality for maximum potential emissions and observed ambient concentrations	3-27
3-12 Radiological atmospheric releases by operational group for 1997	3-28
3-13 Radioactivity in air at the SRS boundary and at a 100-mile radius during 1997 (picocuries per cubic meter)	3-31
3-14 Population projections and percent of region of influence	3-36
3-15 General racial characteristics of population in the Savannah River Site region of influence	3-37
3-16 General poverty characteristics of populations in the Savannah River Site region of influence	3-40
3-17 SRS annual individual and collective radiation doses	3-44
3-18 Potential occupational safety and health hazards and associated exposure limits	3-44
3-19 Comparison of injury and illness incident rates for SRS construction to general industry construction	3-44
3-20 Comparison of injury and illness incident rates for SRS operations to private industry and manufacturing	3-45
3-21 Total waste generation forecast for SRS (cubic meters)	3-46
3-22 Planned and existing waste storage facilities	3-47
3-23 Planned and existing waste treatment processes and facilities	3-48
3-24 Planned and existing waste disposal facilities	3-49
4-1 Impact to SRS land from each of the proposed action alternatives	4-3
4-2 Total annual wastewater generation and as a percentage of available treatment capacity for all salt processing action alternatives	4-7
4-3 Expected sources of air emissions from construction activities for all alternatives	4-9
4-4 Estimated nonradiological air emissions (tons per year) from construction activities associated with all alternatives	4-9
4-5 Estimated maximum incremental increases of air concentrations (micrograms per cubic meter) of SCDHEC-regulated nonradiological air pollutants at the SRS boundary from construction activities associated with all salt processing alternatives	4-10
4-6 Expected sources of air emissions during salt processing for the four action alternatives	4-11
4-7 Estimated nonradiological air emissions (tons per year) from routine operations for salt processing alternatives	4-12
4-8 Estimated maximum increases in air concentrations (micrograms per cubic meter) and percent of standard of SCDHEC-regulated nonradiological air pollutants at the SRS boundary from salt processing alternatives	4-14
4-9 Annual radionuclide emissions (curies/year) resulting from operations	4-16
4-10 Annual doses from radiological air emissions from salt processing activities presented as 50-year committed effective dose equivalents	4-17
4-11 Estimated maximum concentration in milligrams per cubic meter (mg/m^3) of air pollutants to the noninvolved worker from facility air emissions	4-20
4-12 Estimated public and occupational radiological doses and health impacts from atmospheric emissions during operations	4-21

TABLE OF CONTENTS (Continued)

List of Tables (Continued)

<u>Table</u>		<u>Page</u>
4-13	Estimated total recordable cases and lost workdays annually and for the life cycle of each alternative	4-23
4-14	Peak and attenuated noise (in dBA) levels expected from operation of construction equipment.....	4-28
4-15	Estimated salt processing employment by alternative	4-29
4-16	Material shipments (totals for the construction and operation phases) and transportation impacts associated with the salt processing alternatives.....	4-32
4-17	Worker transportation impacts associated with the salt processing alternatives.....	4-33
4-18	Maximum annual waste generation for the salt processing action alternatives	4-36
4-19	Total estimated waste generation for the salt processing action alternatives.....	4-36
4-20	Estimated project total energy and utilities use for the salt processing alternatives	4-38
4-21	Estimated consequences of accidents involving nonradioactive hazardous materials.....	4-42
4-22	Estimated accident consequences for the Small Tank Precipitation process	4-43
4-23	Estimated accident consequences for the Ion Exchange process	4-44
4-24	Estimated accident consequences for the Solvent Extraction process	4-45
4-25	Estimated accident consequences for the Direct Disposal in Grout process.....	4-46
4-26	Maximum dose and health effects from concentrations of radionuclides in groundwater 1 meter and 100 meters downgradient of Z Area vaults and at the seepline.....	4-54
4-27	Maximum nonradiological contaminant concentrations (mg/L) in groundwater 1 meter and 100 meters downgradient and at the seepline.....	4-55
4-28	Maximum concentrations of radiological contaminants in seepline groundwater compared to ORNL screening guidelines (pCi/L)	4-58
4-29	Maximum concentrations of nitrate in seepline groundwater compared to ecotoxicity guidelines (mg/L)	4-60
4-30	Summary comparison of long-term human exposure scenarios and health effects	4-63
5-1	Estimated maximum nonradiological cumulative ground-level concentrations of criteria and toxic pollutants (micrograms per cubic meter) at the SRS boundary.....	5-9
5-2	Estimated average annual cumulative radiological doses and resulting health effects to offsite population from airborne emissions.....	5-10
5-3	Estimated average annual cumulative radiological doses and resulting health effects to offsite population and facility workers	5-11
5-4	Estimated cumulative waste generation from SRS concurrent activities (cubic meters).....	5-13
5-5	Estimated average annual cumulative utility consumption	5-14
6-1	Total estimated waste generation for the salt processing action alternatives.....	6-3
6-2	Estimated project total energy, utilities, and material use for the salt processing alternatives	6-8
7-1	Environmental permits and consultations required by law	7-2
7-2	DOE Orders and Standards relevant to the salt processing alternatives	7-15

TABLE OF CONTENTS (Continued)

List of Figures

<u>Figure</u>		<u>Page</u>
1-1	Savannah River Site map with F, H, S, and Z Areas highlighted.....	1-2
2-1	Process Flow for High-Level Waste at the Savannah River Site.....	2-2
2-2	Potential salt processing facility sites in S Area	2-8
2-3	Proposed location of new Grout Facility and saltstone disposal vaults in Z Area	2-9
2-4	Small Tank Precipitation process flow diagram	2-13
2-5	Ion Exchange process flow diagram.....	2-15
2-6	Solvent Extraction process flow diagram.....	2-16
2-7	Direct Disposal in Grout process flow diagram.....	2-17
2-8	Cross-section diagram of vault closure concept	2-22
3-1	Surface elevation and direction of surface drainage in the vicinity of S Area	3-2
3-2	Surface elevation and direction of surface drainage in the vicinity of Z Area	3-3
3-3	Generalized location of Savannah River Site and its relationship to physiographic provinces of southeastern United States	3-5
3-4	Generalized geologic and aquifer units in SRS region	3-6
3-5	Soil series in H, S, and Z Areas	3-7
3-6	Savannah River Site, showing fault lines and locations of onsite earthquakes and their years of occurrence.....	3-8
3-7	Savannah River Site, showing 100-year floodplain and major stream systems	3-11
3-8	Radiological surface water sampling locations	3-16
3-9	Average groundwater elevation and direction of flow in the vicinity of S Area	3-19
3-10	Average groundwater elevation and direction of flow in the vicinity of Z Area.....	3-20
3-11	Distribution of minority population by census tracts in the SRS region of analysis	3-38
3-12	Low income census tracts in the SRS region of analysis	3-39
3-13	Major sources of radiation exposure in the vicinity of the Savannah River Site.....	3-41

**ABBREVIATIONS, ACRONYMS, MEASUREMENT
ABBREVIATIONS,
USE OF SCIENTIFIC NOTATION, AND
METRIC CONVERSION CHART**

Abbreviations and Acronyms

ALARA	as low as reasonably achievable
AST	alpha sorption tank
CBD	chronic beryllium disease
CCME	Canadian Council of Ministries of the Environment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CEQ	Council on Environmental Quality
CFT	caustic feed tank
CFR	Code of Federal Regulations
CIF	Consolidated Incineration Facility
CSDT	clearing solution dump tank
CSS	clarified salt solution
CST	crystalline silicotitanate
TC	
CWA	Clean Water Act
DCG	Derived Concentration Guide
D&D	decontamination and decommissioning
DOE	U.S. Department of Energy
DOE-SR	DOE-Savannah River Operations Office
DF	decontamination factor
DNFSB	Defense Nuclear Facilities Safety Board
DSS	decontaminated salt solution
DWPF	Defense Waste Processing Facility
EIS	environmental impact statement
EPA	U.S. Environmental Protection Agency
ERPG	Early Response Planning Guideline
ETF	Effluent Treatment Facility
FDM	Fugitive Dust Model
FFA	Federal Facility Agreement
FR	Federal Register

FY	fiscal year
HEPA	high-efficiency particulate air (filter)
HLW	high-level waste
IRIS	Integrated Risk Information System
ISC3	Industrial Source Complex – Short Term
ITP	In-Tank Precipitation
LCF	latent cancer fatality
LFL	lower flammability limit
LLW	low-level waste
LPDT	low point drain tank
LRHT	loaded resin hold tank
LWD	lost workdays
MCL	Maximum contaminant limit
MEI	Maximally exposed (offsite) individual
MST	monosodium titanate
NEPA	National Environmental Policy Act
NESHAP	National Emission Standards for Hazardous Air Pollutants
TC	
NPDES	National Pollutant Discharge Elimination System
NPH	Natural phenomena hazards
NRC	U.S. Nuclear Regulatory Commission
ORNL	Oak Ridge National Laboratory
OSHA	Occupational Safety and Health Administration
OWST	organic waste storage tank
PEL	Permissible exposure limit
PHA	Precipitate Hydrolysis Aqueous
PHC	precipitate hydrolysis cell
PPT	precipitate slurry
PSD	prevention of significant deterioration
PUREX	Plutonium uranium extraction
RCRA	Resource Conservation and Recovery Act
ROD	Record of Decision
RPA	Radiological Performance Assessment
SCDHEC	South Carolina Department of Health and Environmental Control
SCE&G	South Carolina Electric & Gas

SEIS	Supplemental Environmental Impact Statement
SET	Systems Engineering Team
SRI	SRS National Resource Management & Research Institute
SRS	Savannah River Site
SSRT	sludge solids receipt tank
TC	
TOA	triocetylamine
TPB	tetraphenylborate
TRC	total recordable cases
TSP	total suspended particulates
TWA	time-weighted average
VOC	volatile organic compound
WSRC	Westinghouse Savannah River Company

Abbreviations for Measurements

cfm	cubic feet per minute
cfs	cubic feet per second = 448.8 gallons per minute = 0.02832 cubic meter per second
cm	centimeter
ci/m ³	curie per cubic meter
ft	feet
gpm	gallons per minute
hr/yr	hour per year
kg	kilogram
kW	kilowatt
L	liter = 0.2642 gallon
lb	pound = 0.4536 kilogram
msl	mean sea level
m ³	cubic meter
µCi	microcurie
µg	microgram
µm	micrometer
mg	milligram
mg/kg/day	milligram per kilogram per day
mg/L	milligram per liter
mg/m ³	milligrams per cubic meter
mg/s	milligrams per second
mrem	millirem
nCi	nanocurie
PM ₁₀	particulate matter less than 10 microns in diameter
pCi	picocurie

pCi/L	picocurie per liter
rad/d	rad per day
rem	rem
sec/m ³	seconds per cubic meter
yr	year
°C	degrees Celsius = $5/9$ (degrees Fahrenheit – 32)
°F	degrees Fahrenheit = $32 + 9/5$ (degrees Celsius)

Use of Scientific Notation

Very small and very large numbers are sometimes written using “scientific notation” or “E-notation,” rather than as decimals or fractions. Both types of notation use exponents to indicate the power of 10 as a multiplier (i.e., 10^n , or the number 10 multiplied by itself “n” times; 10^{-n} , or the reciprocal of the number 10 multiplied by itself “n” times).

For example: $10^3 = 10 \times 10 \times 10 = 1,000$

$$10^{-3} = \frac{1}{10 \times 10 \times 10} = 0.001$$

In scientific notation, large numbers are written as a decimal between 1 and 10 multiplied by the appropriate power of 10:

4,900 is written $4.9 \times 10^3 = 4.9 \times 10 \times 10 \times 10 = 4.9 \times 1,000 = 4,900$

0.049 is written 4.9×10^{-2}

1,490,000 or 1.49 million is written 1.49×10^6

A positive exponent indicates a number larger than or equal to one; a negative exponent indicates a number less than one.

In some cases, a slightly different notation (“E-notation”) is used, where “ $\times 10$ ” is replaced by “E” and the exponent is not superscripted. Using the above examples:

$$4,900 = 4.9 \times 10^3 = 4.9\text{E+}03$$

$$0.049 = 4.9 \times 10^{-2} = 4.9\text{E-}02$$

$$1,490,000 = 1.49 \times 10^6 = 1.49\text{E+}06$$

Metric Conversion Chart

To convert into metric			To convert out of metric		
If you know	Multiply by	To get	If you know	Multiply by	To get
Length					
inches	2.54	centimeters	centimeters	0.3937	inches
feet	30.48	centimeters	centimeters	0.0328	feet
feet	0.3048	meters	meters	3.281	feet
yards	0.9144	meters	meters	1.0936	yards
miles	1.60934	kilometers	kilometers	0.6214	miles
Area					
sq. inches	6.4516	sq. centimeters	sq. centimeters	0.155	sq. inches
sq. feet	0.092903	sq. meters	sq. meters	10.7639	sq. feet
sq. yards	0.8361	sq. meters	sq. meters	1.196	sq. yards
acres	0.0040469	sq. kilometers	sq. kilometers	247.1	acres
sq. miles	2.58999	sq. kilometers	sq. kilometers	0.3861	sq. miles
Volume					
fluid ounces	29.574	milliliters	milliliters	0.0338	fluid ounces
gallons	3.7854	liters	liters	0.26417	gallons
cubic feet	0.028317	cubic meters	cubic meters	35.315	cubic feet
cubic yards	0.76455	cubic meters	cubic meters	1.308	cubic yards
Weight					
ounces	28.3495	grams	grams	0.03527	ounces
pounds	0.4536	kilograms	kilograms	2.2046	pounds
short tons	0.90718	metric tons	metric tons	1.1023	short tons
Temperature					
Fahrenheit	Subtract 32 then multiply by 5/9ths	Celsius	Celsius	Multiply by 9/5ths, then add 32	Fahrenheit

Metric Prefixes

Prefix	Symbol	Multiplication Factor
exa-	E	$1\ 000\ 000\ 000\ 000\ 000\ 000 = 10^{18}$
peta-	P	$1\ 000\ 000\ 000\ 000\ 000 = 10^{15}$
tera-	T	$1\ 000\ 000\ 000\ 000 = 10^{12}$
giga-	G	$1\ 000\ 000\ 000 = 10^9$
mega-	M	$1\ 000\ 000 = 10^6$
kilo-	k	$1\ 000 = 10^3$
centi-	c	$0.01 = 10^{-2}$
milli-	m	$0.001 = 10^{-3}$
micro-	μ	$0.000\ 001 = 10^{-6}$
nano-	n	$0.000\ 000\ 001 = 10^{-9}$
pico-	p	$0.000\ 000\ 000\ 001 = 10^{-12}$
femto-	f	$0.000\ 000\ 000\ 000\ 001 = 10^{-15}$
atto-	a	$0.000\ 000\ 000\ 000\ 000\ 001 = 10^{-18}$