

1. Solid Waste Minimization
2. Toxic Chemicals Reduction
3. Energy Conservation
4. Environmental Emissions Reduction
5. Recycle and Reuse
6. Affirmative Procurement
7. Remediation

1. Solid Waste Minimization: Between 1991 and 1999, waste generators achieved approximately an 80 percent volume reduction (760,000 cubic feet per year) of solid, hazardous, and radioactive waste. The Pollution Prevention Program has implemented over 508 pollution prevention projects since 1995 (beginning of formal pollution prevention tracking), eliminating over 490,000 cubic feet of radioactive and hazardous waste, and saving approximately \$130 million in costs for waste disposal. This reduction was primarily due to improved waste generator work practices including: improved employee awareness, substitution of reusable for consumable goods in radiological areas, enhanced work planning, non-hazardous solvent substitution, recovery of radiological areas, and use of new pollution prevention technologies.

2. Toxic Chemicals Reduction: SRS has met the Executive Order 12856 goal to reduce chemical releases by 50 percent by 1999. Reportable toxic chemical releases have been reduced by approximately 2 million pounds since 1987, when the SRS filed its first Toxic Chemical Release Inventory Report to the U.S. Environmental Protection Agency (EPA). The Site's Chemical Commodity Management Center will continue to strive to reduce chemical releases by substituting less hazardous chemicals and integrating chemical use, excess, and procurement activities.

3. Energy Conservation: SRS has adapted a plan to enhance energy efficiency and conservation in all buildings by establishing

an Energy Management Council and implementing a new Energy Services Company contract. SRS's Energy Management Program has achieved the conservation goals mandated by Executive Order 12902, *Energy Efficiency and Water Conservation at Federal Facilities*.

4. Environmental Emissions Reduction: The SRS Air and Water Programs ensure that all emissions to the environment meet regulatory requirements. Strategies are continually identified to meet compliance and environmental As Low As Reasonably Achievable (ALARA) guidelines.

5. Recycle and Reuse: SRS has an ongoing comprehensive recycling program. Since 1994, SRS has recycled more than 17,000 tons of materials through its Salvage Operations and Office Recycle Programs. Examples of materials recycled and their amounts from 1994 to 1999 include:

• Scrap metal	10,762 tons
• Office paper and cardboard	5,332 tons
• Scrap aluminum	287 tons
• Aluminum cans	99 tons
• Lead-acid batteries	210 tons
• Laser printer toner cartridges	55,809 each

6. Affirmative Procurement: This program promotes the purchase and use of products made from recovered and recycled materials. SRS met the DOE Secretarial goal to procure 100 percent of RCRA-specified products, when it was technically and economically feasible, in both 1998 and 1999. SRS has purchased more than \$6.6 million worth of products containing recovered or recycled materials.

7. Remediation: A large part of the Site's current mission is remediation of legacy waste sites. The Pollution Prevention Program identifies techniques to reduce the environmental impacts of existing waste at these sites and the means to minimize the generation of new waste during Site closure and corrective action activi-

ties. SRS strives to reduce cleanup and stabilization waste by 10 percent per year.

The Site has an approved Pollution Prevention in Design Procedure that provides the process, responsibilities, and requirements for inclusion of pollution prevention into the design phase of new facilities or modification to existing facilities. Pollution prevention in design is applied using a value-added, quality-driven, graded approach to project management. When properly applied, the expense of implementing pollution prevention changes during design is offset by the resulting cost savings over the life of the facility. Pollution prevention design activities are generally implemented at the Preliminary Design phase and not during the Preconceptual Design. The alternatives under consideration in this SEIS are at the Preconceptual Design phase. However, a number of early planning efforts have identified specific activities that could be implemented. Examples include the following:

- Benzene abatement: It is anticipated that some type of benzene abatement would be added to the Small Tank Precipitation alternative.
- Recycled solvent: The solvent used in the Solvent Extraction alternative has been identified for recycling.
- Process design: Changes would be implemented to eliminate the potential for spills.
- Recycling of construction material: Stainless steel, paint, and other construction material would be recycled, if possible.

As the design moves from Preconceptual into the Conceptual Design, Preliminary

Design, and finally the Detailed Design phase, considerable effort would be expended to identify opportunities for pollution prevention. A series of worksheets would be developed when the design reaches the Conceptual phase. Anticipated waste streams would be identified, quantified (including costs), and prioritized within a set of established criteria. These worksheets would be generated for all activities during construction, operations, and closure of the facility. Finally, the construction contractor would be selected, based in part on prior pollution prevention practices.

6.4.2 ENERGY CONSERVATION

SRS has an active energy conservation and management program. As stated in Section 6.4.1, SRS has adopted a plan to enhance energy efficiency and conservation in all buildings by establishing an Energy Management Council and implementing a new Energy Services Company contract.

Since the mid-1990s, more than 50 onsite administrative buildings have undergone energy efficiency upgrades. Representative actions include the installation of energy-efficient light fixtures, the use of occupancy sensors in rooms, the use of diode light sticks in exit signs, and the installation of insulating blankets around hot water heaters.

As stated in Section 6.4.1, pollution prevention and energy conservation measures are not specifically identified until DOE reaches the Conceptual Design phase of the project. Currently, SRS is in the Preconceptual Design phase. Regardless of the alternative selected, the incorporation of these types of energy-efficient technologies into facility Conceptual Design, along with the implementation of process efficiencies and waste minimization concepts, will facilitate energy conservation at SRS.

References

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CHAPTER 7. APPLICABLE LAWS, REGULATIONS, AND OTHER REQUIREMENTS

This chapter identifies and summarizes the major laws, regulations, Executive Orders, and U.S. Department of Energy (DOE) Orders that could apply to the Savannah River Site (SRS) salt processing alternatives. Permits or licenses could be required under some of these laws and regulations. DOE would determine the specific requirements for permits or licenses, which would depend on the alternative chosen, after consultation with the appropriate regulating agencies.

Section 7.1 describes the process that DOE will follow to determine if the low-activity salt solution produced under the salt processing alternatives can be considered waste incidental to reprocessing. Section 7.2 discusses the major Federal and State of South Carolina statutes and regulations that impose environmental protection requirements on DOE and that require DOE to obtain a permit, or permits, prior to implementing a given salt processing alternative. Each of the applicable authorities establishes how potential releases of pollutants and radioactive materials are to be controlled or monitored and include requirements for the issuance of permits for new operations or new emission sources. In addition to environmental permit requirements, the authorities may require consultations with various regulators to determine if an action requires the implementation of protective or mitigative measures. Section 7.2 also discusses the environmental permitting process and lists the environmental permits and consultations (Table 7-1) applicable to the salt processing alternatives.

Sections 7.3 and 7.4 address the major Federal regulations and Executive Orders that address issues such as emergency planning, worker safety, and protection of public health and the environment. The Executive Orders clarify issues of national policy and set guidelines under which Federal agencies must act.

DOE implements its responsibilities for protection of public health, safety, and the environment through a series of Departmental Orders (see Section 7.5) that typically are mandatory for operating contractors of DOE-owned facilities.

7.1 Waste Incidental to Reprocessing Determination

DOE Manual 435.1-1 establishes a process for making waste incidental to reprocessing determinations. This process evaluates candidate waste streams to determine if they can be managed as low-level waste (LLW) or transuranic waste (DOE Manual 435.1-1; DOE 1999). Because salt solutions at SRS originated from waste generated by reprocessing of spent nuclear fuel, they meet the source-based definition of high-level waste (HLW). However, under all alternatives in this Supplemental Environmental Impact Statement (SEIS), the low-activity fraction of the salt solution could be appropriately managed as LLW as long as the waste satisfies the waste incidental to reprocessing criteria in DOE Manual 435.1-1.

DOE Manual 435.1-1 describes two processes, a "citation" process and an "evaluation" process, for waste-incidental-to-reprocessing determinations (DOE 1999). The criteria used in the "evaluation" process are based on the treatment of the waste and the characteristics of the disposal form. Wastes can be managed as LLW if they meet the following criteria or other appropriate criteria approved by DOE.

1. Have been processed or will be processed to remove key radionuclides to the maximum extent that is technically and economically practical." DOE Guidance 435.1-1 (DOE 1999) explains that key radionuclides are generally understood to be those radionuclides that are concentration limits in 10 CFR 61.55 (i.e., the long-lived

Table 7-1. Environmental permits and consultations required by law.

Activity/Topic	Law	Requirements	Agency
Site Preparation	Federal Clean Water Act (Section 404)	Stormwater Pollution Prevention Plan for Industrial Activity	SCDHEC ^a
Industrial Waste Disposal	S.C. Pollution Control Act	Permit for Industrial Waste Disposal	SCDHEC
Wastewater Discharges	Federal Clean Water Act S.C. Pollution Control Act	Stormwater Pollution Prevention/Erosion Control Plan for construction activity	SCDHEC
		NPDES Permit(s) for Process Wastewater Discharges	SCDHEC
		Industrial Wastewater Treatment Systems Construction and Operation Permits (if applicable)	SCDHEC
		Sanitary Wastewater Pumping Station Tie-in Construction Permit; Permit to Operate	SCDHEC
Air	Clean Air Act – NESHAP ^b	Rad Emissions - Approval to construct new emission source (if needed)	EPA ^c
		Air Construction and Operation permits - as required (e.g., fire water pumps, diesel generators)	SCDHEC
		General source – stacks, vents, concrete batch plant	SCDHEC
		Air Permit - Prevention of Significant Deterioration (PSD)	SCDHEC
Domestic Water	Safe Drinking Water Act	Construction and operation permits for line to domestic water system	SCDHEC

a. South Carolina Department of Health and Environmental Control
 b. National Emission Standards for Hazardous Air Pollutants
 c. U.S. Environmental Protection Agency
 d. U.S. Fish and Wildlife Service
 e. National Marine Fisheries Service

radionuclides carbon-14, nickel-59, niobium-94, technetium-99, iodine-129, plutonium-241, and curium-242; alpha-emitting transuranic nuclides with half-lives greater than 5 years; and the short-lived radionuclides tritium, cobalt-60, nickel-63, strontium-90, and cesium-137), and any other radionuclides that are important to satisfying the performance objectives of 10 CFR 61, Subpart C (e.g., selenium-79, tin-126, neptunium-237); and

- "2. Will be managed to meet safety requirements comparable to the performance objectives set out in 10 CFR 61, Subpart C, "Performance Objectives;" and"
- "3. Are to be managed, pursuant to DOE's authority under the Atomic Energy Act, as amended, and in accordance with the provisions of Chapter IV of DOE Manual 435.1-1, provided the waste will be incorporated in a solid physical form at a concentration that does not exceed the applicable concentration limits for Class C low-level waste as set out in 10 CFR 61.55, "Waste Classification", or will meet alternative requirements for waste classification and characteristics, as DOE may authorize."

DOE is conducting a research and development program, and is continuing design efforts, to determine the technical and economic feasibility of the Small Tank Precipitation, Ion Exchange, and Solvent Extraction alternatives. Through an evaluation of potential salt processing alternatives, DOE identified potential technologies that would remove key radionuclides. Variations of three of the salt processing technologies being considered (Small Tank Precipitation, Ion Exchange, and Solvent Extraction) have been evaluated previously against the incidental waste criteria. The low-activity salt solution fraction that would be produced using ion exchange has previously been characterized as incidental waste (i.e., non-HLW) (52 FR 5993, February 27, 1987). The low-activity salt solution produced using the small tank precipitation or solvent extraction process is expected to meet the same key

radionuclide removal requirements, as previously analyzed, and the other evaluation determination process.

Implementation of the Direct Disposal in Grout alternative would result in the removal of the key radionuclides, as suggested in DOE Guidance 435.1-1, except for cesium-137. It may be possible for this short-lived radionuclide to be effectively isolated by the combination of a stabilized waste form and engineered barriers for the period (about 400 years) needed for it to decay so that it no longer poses a significant hazard. The long-term performance evaluation (Section 4.2) indicates that the low-activity salt solution produced under the Direct Disposal in Grout alternative meets performance objectives comparable to those in 10 CFR 61, as required to meet the waste incidental to reprocessing criteria in DOE Manual 435.1-1. DOE is currently conducting studies to investigate the technical and economic practicality of these alternatives. Cesium removal from SRS salt solutions at a pilot or production scale, using the Small Tank Precipitation, Ion Exchange, or Solvent Extraction processes, has not been demonstrated. Cesium removal by the Small Tank Precipitation, Ion Exchange, or Solvent Extraction alternatives ultimately could prove to not be technically and economically practical. In such a case, further analysis would be needed to determine whether the criterion requiring key radionuclide removal would be considered met because the key radionuclides, other than cesium, would have been removed to the extent technically and economically practical and the waste could be properly managed as LLW, in accordance with the waste incidental to reprocessing requirements of DOE Manual 435.1-1.

Per DOE Manual 435.1-1, the DOE Field Element Manager is responsible for ensuring that waste incidental to reprocessing determinations are made consistent with either the citation or the evaluation process. A determination made using the evaluation process will include consultation and coordination with the DOE Office of Environmental Management. The U.S. Nuclear Regulatory Commission

(NRC) has participated in regulatory reviews using these evaluation criteria in the past and has expertise that is expected to complement DOE's internal review. Hence, consultation with NRC staff regarding the requirements for the evaluation process is strongly encouraged by DOE (Guidance 435.1-1). DOE plans to consult with NRC regarding an incidental waste determination for the low-activity salt solution. To facilitate the consultations, DOE will provide documentation that the low-activity salt solution satisfies criteria for management as LLW under the waste incidental to reprocessing evaluation process.

7.2 Statutes and Regulations Requiring Permits or Consultations

Environmental regulations require that the owner or operator of a facility obtain permits for the construction and operation of new (water and air) emissions sources and for new domestic drinking water systems. To obtain these permits, the facility operator must apply to the appropriate government agency for a discharge permit for discharges of wastewater to the waters of the state and submit construction plans and specifications for the new emission sources, including new air sources. The environmental permits contain specific conditions with which the permittee must comply during construction and operation of a new emission source, describe pollution abatement and prevention methods to be utilized for reduction of pollutants, and contain emissions limits for pollutants that will be emitted from the facility. Section 7.2.1 discusses the environmental statutes and regulations under which DOE will be required to obtain permits, and Table 7-1 lists the applicable permits.

7.2.1 ENVIRONMENTAL PROTECTION PERMITS

Clean Air Act, as amended, (42 USC 7401 et seq.), and implementing regulations (40 CFR Parts 50-99); South Carolina Pollution Control Act (Section 48-1-30 et seq., SCDHEC Regulation 61-62)

The Clean Air Act, as amended, is intended to "protect and enhance the quality of the Nation's air resources so as to promote the public health and welfare and the productive capacity of its population [42 USC 7401(b)(1)]." Section 118 of the Clean Air Act, as amended, requires each Federal agency, such as DOE, with jurisdiction over any property or facility that might result in the discharge of air pollutants, to comply with "all Federal, State, interstate, and local requirements" with regard to the control and abatement of air pollution.

The Act requires the U.S. Environmental Protection Agency (EPA) to define National Ambient Air Quality Standards as necessary to protect public health, with an adequate margin of safety, from any known or anticipated adverse effects of a regulated pollutant (42 USC 7409). The Act also requires the establishment of national standards of performance for new or modified stationary sources of atmospheric pollutants (42 USC 7411) and requires specific emission increases to be evaluated so as to prevent a significant deterioration in air quality (42 USC 7470). Hazardous air pollutants, including radionuclides, are regulated separately (42 USC 7412). Air emissions are regulated by EPA in 40 CFR Parts 50 through 99. In particular, radionuclide emissions, other than radon from DOE facilities, are regulated under the National Emission Standards for Hazardous Air Pollutants (NESHAP) program (see 40 CFR Part 61, Subpart H).

The EPA has overall authority for the Clean Air Act; however, it delegates primary authority to states that have established air pollution control programs approved by EPA. In South Carolina, EPA has retained authority over radionuclide emissions (40 CFR Part 61) and has delegated to the South Carolina Department of Health and Environmental Control (SCDHEC) the responsibility for the rest of the regulated pollutants under the authority of the South Carolina Pollution Control Act (48-1-10 et seq.) and SCDHEC Air Pollution Control Regulations 61-62.

Construction and operation permits or exemptions will be required for new nonradiological air emission sources (e.g., diesel generators, concrete batch plants) constructed and operated as part of SRS salt processing. The permits will contain operating conditions and effluent limitations for pollutants emitted from the facilities (Table 7-1).

DOE would determine if a NESHAP permit will be required for radiological emissions from any facilities (stacks, process vents, etc.) used in SRS salt processing. As described in 40 CFR Part 61.96, if the effective dose equivalent caused by all emissions from facility operations is projected to be less than 1 percent of the 10 millirem per year NESHAP standard, an application for approval to construct under 40 CFR Part 61.07 is not required to be filed. 40 CFR Part 61.96 also allows DOE to use, with prior EPA approval, methods other than EPA standard methods for estimating the source term for use in calculating the projected dose. If DOE's calculations indicate that the emissions from salt processing will exceed 0.1 millirem per year, DOE will, prior to the start of construction, complete an application for approval to construct under 40 CFR 61.07.

Federal Clean Water Act, as amended (33 USC 1251 et seq.); SC Pollution Control Act (SC Code Section 48-1-10 et seq., 1976) (SCDHEC Regulation 61-9.122 et seq.)

The Clean Water Act (CWA), 33 U.S.C. §§ 1251 et. seq., which originated in 1972 as

amendments to the Federal Water Pollution Control Act, establishes the basic structure for regulating discharges of pollutants to waters of the United States. Enacted to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters," the CWA gave EPA the authority to set effluent standards on an industry basis and continued existing requirements to set water quality standards for all contaminants in surface waters (33 U.S.C. § 1251). The CWA makes it unlawful for any person to discharge any pollutant from a point source into navigable waters of the United States unless a permit is obtained under the Act's National Pollutant Discharge Elimination System (the NPDES permit system). The NPDES system lies at the core of the administration and enforcement of the CWA. The United States government is subject to the terms and prohibitions of the CWA in essentially the same manner as any other person (33 U.S.C. § 1323).

The CWA provides for the delegation by EPA to state governments of many permitting, administrative, and enforcement aspects of the law. In states with the authority to implement CWA programs, EPA still retains oversight responsibilities. EPA has delegated to South Carolina responsibility for administering the NPDES program.

EPA has delegated primary enforcement authority for the CWA and the NPDES Permitting Program to SCDHEC for waters in South Carolina. In 1996, SCDHEC, under the authority of the Pollution Control Act (48-1-10 et seq.) and Regulation 61-9.122, issued NPDES Permit SC0000175, which addresses wastewater discharges to SRS streams, and NPDES permit SCG250162, which addresses general utility water discharges. The permit contains effluent limitations for physical parameters, such as flow and temperature, and for chemical pollutants with which DOE must comply. DOE will apply for a discharge permit for salt processing facility operations, if the process alternative chosen results in discharges to waters of the State (Table 7-1).

Under Section 402(p) of the CWA, EPA established regulations (40 CFR Part 122.26) for issuing permits for storm water discharges associated with industrial activity. Accordingly, SCDHEC has issued a General Permit for Storm Water Discharges Associated with Industrial Activities (Permit No. SCR000000), authorizing DOE to make stormwater discharges to the waters of the State of South Carolina in accordance with effluent limitations, monitoring requirements, and conditions as set forth in the permit. This permit requires preparation and submittal of a Pollution Prevention Plan for all new and existing point-source discharges associated with industrial activity. Accordingly, DOE-Savannah River Operations Office (SR) has developed a Storm Water Pollution Prevention Plan for storm water discharges at SRS. The SRS Storm Water Pollution Prevention Plan would need to be revised to include pollution prevention measures to be implemented for salt processing operations (Table 7-1), if industrial activities are exposed to storm water. SCDHEC has issued a General Permit for storm water discharges from construction activities that are "Associated with Industrial Activity" (Permit No. SCR100000). An approved plan would be needed that includes erosion control and pollution prevention measures to be implemented for construction activities.

Section 404 of the CWA requires that a permit be issued for discharge of dredge or fill material into the waters of the United States. The authority to implement these requirements has been given to the U.S. Army Corps of Engineers. Section 401 of the CWA requires certification that discharges from construction or operation of facilities, including discharges of dredge and fill material into navigable waters, will comply with applicable water standards. This certification, which is granted by SCDHEC, is a prerequisite for the permit under Section 404. DOE does not believe that such a permit will be required for salt processing.

Section 303(d)(1)(C) of the CWA and the EPA implementing regulation (40 CFR 130.7(c)(1)) require the identification of total

maximum daily loads (TMDLs) for waters identified in Section 303(d)(1)(A) of the CWA. On December 8, 2000, EPA published a proposed TMDL for mercury in the Middle and Lower Savannah River Watershed (EPA 2000). The proposed TMDL affects the portion of the Savannah River within the State of Georgia. It does not specify wasteload allocations for South Carolina NPDES-permitted facilities or other pollution sources discharging to portions of the Savannah River Watershed within the State of South Carolina. However, the TMDL does provide a target concentration of mercury to be achieved at the mid-point of the Savannah River, which is the boundary between Georgia and South Carolina. The majority (99 percent) of the mercury loading in the Savannah River Watershed results from air deposition sources. EPA expects that the reductions in mercury deposition needed to reduce levels of mercury in the Savannah River to the TMDL can be achieved by 2010 through full implementation of the current Clean Air Act Maximum Achievable Control Technology requirements (EPA 2000). The proposed TMDL is not expected to affect implementation of the salt processing alternatives because mercury emissions from the proposed facilities would not be limited by these requirements.

Federal Safe Drinking Water Act, as amended [42 USC 300 (F) et seq., implementing regulations 40 CFR Parts 100-149]; South Carolina Safe Drinking Water Act (Title 44-55-10 et seq.), State Primary Drinking Water Regulations, (SCDHEC R.61-58)

The primary objective of the Safe Drinking Water Act (42 USC 300), as amended, is to protect the quality of the public water supplies. Safe Drinking Water Act requirements have been promulgated by EPA in 40 CFR Parts 100 through 149. The implementing regulations, administered by EPA unless delegated to the states, establish standards applicable to public water systems. They promulgate maximum contaminant levels (MCLs) (including those for radionuclides) in public water systems, which are defined as water sys-

tems that serve at least 15 service connections used by year-round residents or regularly serve at least 25 year-round residents. Construction and operation permits would be required for any major new components associated with SRS salt processing activities (Table 7-1). Other programs established by the Safe Drinking Water Act include the Sole Source Aquifer Program, the Wellhead Protection Program, and the Underground Injection Control Program.

As a regulatory practice and policy, the Safe Drinking Water Act MCLs also are used as groundwater protection standards. For example, the regulations specify that the average annual concentration of manmade radionuclides in drinking water shall not produce a dose equivalent to the total body or an internal organ dose greater than 4 millirem (mrem) per year beta-gamma activity. This radionuclide MCL is a primary performance objective for the disposal of the grouted low-activity salt solution produced under the salt processing alternatives.

On December 7, 2000, EPA published revisions to the MCLs for certain radionuclides (65 FR 76708). The new rule includes requirements for uranium, which was not previously regulated, and revisions to monitoring requirements. EPA decided to retain the current standards for combined radium-226 and -228 and gross alpha particle radioactivity. EPA also retained the current MCL for beta particle and photon radioactivity, pending further review. The new standard for uranium will be considered with the other MCLs for radionuclides in assessing impacts to groundwater from the salt processing alternatives.

EPA has delegated primary enforcement authority to SCDHEC for public water systems in South Carolina. Under the authority of the South Carolina Safe Drinking Water Act (44-55-10 *et seq.*), SCDHEC has established a drinking water regulatory program (R.61-58). SCDHEC has also established groundwater and surface water classifications and standards under R. 61-68. Along with the Federal MCLs (40 CFR 141), these South

Carolina water quality standards are the groundwater and surface water performance standards applicable to disposal of the grouted low-activity salt solution.

Resource Conservation and Recovery Act, as amended (Solid Waste Disposal Act) (42 USC 6901 et seq.); South Carolina Hazardous Waste Management Act, Section 44-56-30, South Carolina Hazardous Waste Management Regulations (R.61-79.124 et seq.)

The treatment, storage, or disposal of hazardous and nonhazardous waste is regulated under the Solid Waste Disposal Act, as amended by the Resource Conservation and Recovery Act (RCRA) and the Hazardous and Solid Waste Amendments of 1984. Pursuant to Section 3006 of the Act, any state that seeks to administer and enforce a hazardous waste program pursuant to RCRA may apply for EPA authorization of its program. The EPA regulations implementing RCRA (40 CFR Parts 260 through 280) define hazardous wastes and specify their transportation, handling, treatment, storage, and disposal requirements. EPA has delegated primary enforcement authority to SCDHEC, which has established hazardous waste management requirements under SC Regulation R.61-79.

The regulations imposed on a generator or a treatment, storage, or disposal facility vary according to the type and quantity of material or waste generated, treated, stored, or disposed. The method of treatment, storage, or disposal also affects the extent and complexity of the requirements.

Under Section 3004(u) of RCRA, DOE is required to assess releases from solid waste management units and implement corrective action plans where necessary. The RCRA corrective action requirements for SRS are set forth in the Federal Facility Agreement (FFA) (Section 7.3.2).

The HLW managed in the F- and H-Area Tank Farms is considered mixed waste because it exhibits characteristics of RCRA hazardous waste (i.e., corrosivity and toxicity for

certain metals) and contains source, special nuclear, or by-product material regulated under the Atomic Energy Act. Waste removed from the tank systems will be managed in accordance with applicable RCRA requirements (i.e., treated to meet the land disposal restrictions standards prior to disposal). DOE would demonstrate that any saltstone produced by grouting the low-activity salt solution would meet applicable RCRA standards. The SRS HLW processing facilities (e.g., Tank Farms, Effluent Treatment Facility, Defense Waste Processing Facility) are exempt from the design and operating standards and permitting requirements for hazardous waste management units because they are wastewater treatment units regulated under the CWA [40 CFR 260.10, 264.1(g)(6) and 270.1(c)(2)(v)]. DOE expects that the new processing facilities for the salt processing alternatives also would be permitted as wastewater treatment units under the CWA.

The Z-Area Saltstone Disposal Facility is permitted as an industrial waste disposal facility (SCDHEC 1986). The current permit application is based on the saltstone composition that was expected to result from the In-Tank Precipitation (ITP) process. The permit application would need to be modified to reflect any differences in the composition of the saltstone resulting from any new salt processing technology. One salt processing alternative, Direct Disposal in Grout, would produce a more radioactive saltstone than the others because cesium would not be removed from the salt solution. That saltstone would be equivalent to Class C (versus Class A for the other salt processing alternatives) LLW as defined by NRC regulations (see 10 CFR 61.55). The current vault design would meet NRC regulations for Class C disposal, although the current permit restricts the average curie content of the saltstone to be within Class A limits. NRC regulations require that Class C waste be structurally stable and provided with protection against inadvertent intrusion for 500 years. The depth of burial and structural stability of the saltstone monoliths would provide the requisite protection against inadvertent intrusion. Modifications to the current vaults

would be required under certain salt processing alternatives (e.g., Direct Disposal in Grout).

The Federal Facility Compliance Act (42 USC 6921 et seq.)

The Federal Facility Compliance Act, enacted on October 6, 1992, amended RCRA. The Act waived sovereign immunity for fines and penalties for RCRA violations at Federal facilities. DOE's immunity continues for fines and penalties resulting from land-disposal-restriction storage-prohibition violations for mixed waste, if DOE prepares plans for developing the required treatment capacity for mixed waste stored or generated at each facility and meets other applicable RCRA requirements. Each plan must be approved by the host state or EPA, after consultation with other affected states, and a consent order must be issued by the regulator requiring compliance with the plan. On September 20, 1995, SCDHEC approved the Site Treatment Plan for SRS. SCDHEC issued a consent order, signed by DOE, requiring compliance with the plan on September 29, 1995. DOE provides SCDHEC with annual updates to the information in the SRS Site Treatment Plan. DOE would be required to notify SCDHEC of any new mixed waste streams generated as a result of salt processing activities.

7.2.2 PROTECTION OF BIOLOGICAL, HISTORIC, AND ARCHAEOLOGICAL RESOURCES

The following statutes pertain to protection of endangered or threatened animal and plants, and of historic and cultural resources.

Endangered Species Act, as amended (16 USC 1531 et seq.)

The Endangered Species Act provides a program for the conservation of threatened or endangered species and the ecosystems on which those species rely. All Federal agencies must assess whether the potential impacts of a proposed action could adversely affect threatened or endangered species or their habitat. If so,

the agency must consult with the U.S. Fish and Wildlife Service (part of the U.S. Department of the Interior) and the National Marine Fisheries Service (part of the U.S. Department of Commerce), as required under Section 7 of the Act. The outcome of this consultation may be a biological opinion by the U.S. Fish and Wildlife Service or the National Marine Fisheries Service that states whether the proposed action would jeopardize the continued existence of the species under consideration. If there is a non-jeopardy opinion, but the possibility exists that some individual members of a species might be killed incidentally as a result of the proposed action, the Services can determine that such losses are not prohibited, as long as mitigation measures outlined by the Services are followed. Regulations implementing the Endangered Species Act are codified at 50 CFR Part 15 and 402.

The proposed facilities for the salt processing alternatives are located within fenced, disturbed industrial areas. Proposed salt processing activities would not disturb any threatened or endangered species, would not degrade any critical or sensitive habitat, and would not affect any jurisdictional wetland. Therefore, DOE concludes that no consultation with the U.S. Fish and Wildlife Service or the National Marine Fisheries Service concerning the alternatives considered in this SEIS is required.

Migratory Bird Treaty Act, as amended (16 USC 703 et seq.)

The Migratory Bird Treaty Act, as amended, is intended to protect birds that have common migration patterns between the United States and Canada, Mexico, Japan, and Russia. It regulates the harvesting of migratory birds by specifying things such as the mode of harvesting, hunting seasons, and bag limits. The Act stipulates that it is unlawful at any time, by any means, or in any manner to "kill...any migratory bird." Executive Order 13186 (66 FR 3853; 1/17/01) requires that environmental analyses of Federal actions required by the National Environmental Policy Act (NEPA) or other established environmental review proc-

esses evaluate the effects of actions and agency plans on migratory birds, with emphasis on species of concern. If impacts to migratory birds were expected, DOE would be required to consult with the U.S. Fish and Wildlife Service and to evaluate ways to avoid or minimize these effects in accordance with the U.S. Fish and Wildlife Service Mitigation Policy (46 FR 7644). The proposed facilities for the salt processing alternatives are within fenced industrial areas without habitat suitable for migratory birds. Therefore, DOE concludes that no consultation with the U.S. Fish and Wildlife Service concerning the alternatives considered in this SEIS is required.

Bald and Golden Eagle Protection Act, as amended (16 USC 668-668d)

The Bald and Golden Eagle Protection Act makes it unlawful to take, pursue, molest, or disturb bald and golden eagles, their nests, or their eggs anywhere in the United States (Sections 668, 668c). A permit must be obtained from the U.S. Department of the Interior to relocate a nest that interferes with resource development or recovery operations. The proposed facilities for the salt processing alternatives are within fenced industrial areas without habitat suitable for nesting eagles.

National Historic Preservation Act, as amended (16 USC 470 et seq.)

The National Historic Preservation Act, as amended, provides that sites with significant national historic value be placed on the *National Register of Historic Places*. No permits or certifications are required under the Act. However, if a particular Federal activity could impact an historic property resource, consultation with the Advisory Council on Historic Preservation will usually generate a Memorandum of Agreement, including stipulations that must be followed to minimize adverse impacts. Coordination with the South Carolina State Historic Preservation Officer ensures the proper identification of potentially significant sites and the implementation of appropriate mitigative actions. The proposed facilities for the salt processing alternatives

would be within previously disturbed industrial sites. Therefore, DOE does not expect this Act to apply.

Archaeological Resource Protection Act, as amended (16 USC 470 et seq.)

This Act requires a permit for any excavation or removal of archaeological resources from public or Native American lands. Excavations must be undertaken for the purpose of furthering archaeological knowledge in the public interest, and resources removed are to remain the property of the United States. Consent must be obtained from the Indian Tribe owning lands on which a resource is located before a permit is issued, and the permit must contain terms or conditions requested by the Tribe. The proposed facilities for salt processing alternatives would be within previously disturbed industrial sites. Therefore, DOE does not expect this Act to apply.

Native American Grave Protection and Repatriation Act of 1990 (25 USC 3001)

This law directs the Secretary of the Interior to assume responsibility for repatriation of Federal archaeological collections and collections held by museums receiving Federal funding that are culturally affiliated with Native American Tribes. Major actions to be taken under this law include: (1) establishing a review committee with monitoring and policy-making responsibilities, (2) developing regulations for repatriation, including procedures for identifying lineal descent or cultural affiliation needed for claims, (3) overseeing museum programs designed to meet the inventory requirements and deadlines of this law, and (4) developing procedures to handle unexpected discoveries of graves or grave goods during activities on Federal or tribal lands. The proposed facilities for salt processing alternatives would be within previously disturbed industrial sites. Therefore, DOE does not expect this Act to apply.

American Indian Religious Freedom Act of 1978 (42 USC 1996)

This Act reaffirms Native American religious freedom under the First Amendment and sets U.S. policy to protect and preserve the inherent and constitutional right of Native Americans to believe, express, and exercise their traditional religions. The Act requires that Federal actions avoid interfering with access to sacred locations and traditional resources that are integral to the practice of religion. The proposed facilities for salt processing alternatives would be within previously disturbed industrial sites. Therefore, DOE does not expect this Act to apply.

In conjunction with 1991 studies related to the New Production Reactor, DOE solicited the concerns of Native Americans about religious rights in the Central Savannah River Valley. During this study, three Native American groups – the Yuchi Tribal Organization, the National Council of Muskogee Creek, and the Indian People's Muskogee Tribal Town Confederacy – expressed general concerns about SRS and the Central Savannah River Area, but did not identify specific sites as possessing religious significance. The Yuchi Tribal Organization and the National Council of Muskogee Creek are interested in plant species traditionally used in tribal ceremonies, such as redroot, button snakeroot, and American ginseng (DOE 1991). Redroot and button snakeroot are known to occur on the SRS (Batson, Angerman, and Jones 1985). The proposed facilities for salt processing alternatives would be within previously disturbed industrial sites. Therefore, DOE does not expect this Act to apply.

7.3 Statutes, Regulations, and Guidelines Related to Emergency Planning, Worker Safety, and Protection of Public Health and the Environment

7.3.1 ENVIRONMENTAL PROTECTION

National Environmental Policy Act of 1969, as amended (42 USC 4321 et seq.)

The NEPA establishes a national policy promoting awareness of the environmental consequences of human activity on human health and the environment, and consideration of environmental impacts during the planning and decision-making stages of a project. This Act requires Federal agencies to prepare a detailed statement on the environmental effects of proposed major Federal actions that may significantly affect the quality of the human environment.

This SEIS has been prepared in compliance with NEPA requirements and policies and in accordance with Council on Environmental Quality (40 CFR Parts 1500 through 1508) and DOE (10 CFR Part 1021) regulations for implementing the procedural provisions of NEPA.

Pollution Prevention Act of 1990 (42 USC 13101 et seq.)

The Pollution Prevention Act of 1990 established a national policy for waste management and pollution control that focuses first on source reduction, followed sequentially by environmentally safe recycling, treatment, and disposal. Disposal or releases to the environment should occur only as a last resort. In response, DOE has committed to participate in the Superfund Amendments and Reauthorization Act Section 313, EPA 33/50 Pollution Prevention Program. The goal for facilities already involved in Section 313 compliance is to achieve by 1997 a 33-percent

reduction in the release of 17 priority chemicals from a 1993 baseline. On August 3, 1993, President Clinton issued Executive Order 12856, expanding the 33/50 program such that DOE must reduce its total releases of all toxic chemicals by 50 percent by December 31, 1999. In addition, DOE is requiring each of its sites to establish site-specific goals to reduce the generation of all waste types.

Comprehensive Guideline for Procurement of Products Containing Recovered Materials (40 CFR Part 247)

This guideline is issued under the authority of Section 6002 of RCRA and Executive Order 12783, which set forth requirements for Federal agencies to procure products containing recovered materials for use in their operations, using guidelines established by the EPA. The purpose of these regulations is to promote recycling by using government purchasing to expand markets for recovered materials. RCRA Section 6002 requires that any purchasing agency, when using appropriated funds to procure an item, shall purchase it with the highest percentage of recovered materials practicable. The procurement of materials to be used in the SRS salt processing activities will be conducted in accordance with these regulations.

Toxic Substances Control Act, as amended (USC 2601 et seq.) (40 CFR Part 700 et seq.)

The Toxic Substances Control Act regulates the manufacture, use, treatment, storage, and disposal of certain toxic substances not regulated by RCRA or other statutes, particularly polychlorinated biphenyls (40 CFR Part 761), chlorofluorocarbons (40 CFR Part 762), and asbestos (40 CFR Part 763). DOE does not expect to use these materials under any of the salt processing alternatives.

7.3.2 EMERGENCY PLANNING AND RESPONSE

This section discusses the regulations that address protection of public health and worker safety and require the establishment of emer-

gency plans and coordination with local and Federal agencies related to facility operations. DOE Orders generally set forth the programs and procedures required to implement the requirements of these regulations. See Section 7.5.

Atomic Energy Act of 1954, as amended (42 USC 2011 et seq.)

The Atomic Energy Act of 1954, as amended, authorizes DOE to establish standards to protect health and minimize dangers to life or property with respect to activities under its jurisdiction [42 USC 2201(b)]. Through a series of Orders, DOE has established an extensive system of standards and requirements to promote the safe operation of its facilities.

Section 202(4) of the Energy Reorganization Act of 1974 (42 USC §5842(4)), which amended the Atomic Energy Act, gives the NRC licensing authority over DOE facilities authorized for long-term storage of HLW generated by DOE. DOE (Sullivan 1998) determined that NRC's licensing authority is limited to DOE facilities that are (1) authorized by Congress for the express purpose of long-term storage of HLW, and (2) developed and constructed after the passage of the Energy Reorganization Act. None of the facilities associated with the salt processing alternatives meet both criteria. Although DOE has responsibility for such determinations, the Savannah River Operations Office plans to consult with NRC on the incidental waste determination for the low-activity salt solution as described in Section 7.1.

Atomic Energy Act of 1954, as amended (42 USC 2011 et seq.); Quantities of Radioactive Materials Requiring Consideration of the Need for an Emergency Plan for Responding to a Release (10 CFR Part 30.72 Schedule C)

The list of quantities in Schedule C of 10 CFR 30.72 is the basis for both the public and private sector to determine if the radiological materials they deal with must have an emergency response plan for unscheduled releases. It establishes threshold criteria documents for

DOE Emergency Preparedness Hazard Assessments required by DOE Order 151.1, "Comprehensive Emergency Management System". An emergency response plan addressing salt processing facility operations would be prepared in accordance with this regulation.

The Disaster Relief and Emergency Assistance Amendments of 1988 (42 USC 5121 et seq.), Emergency Management and Assistance (44 CFR Part 351)

These regulations generally include the policies, procedures, and responsibilities of the Federal Emergency Management Agency, NRC, and DOE (44 CFR 351.24) for implementing a Federal Emergency Preparedness Program to include radiological planning and preparedness. An emergency response plan, including radiological planning and preparedness for salt processing facility operations, would need to be prepared and implemented, in accordance with this regulation.

Emergency Planning and Community Right-to-Know Act of 1986 (42 USC 11001 et seq.) (also known as "SARA Title III")

The Emergency Planning and Community Right-to-Know Act of 1986 (also known as "SARA Title III") requires emergency planning and notice to communities and government agencies of the presence and release of specific chemicals. EPA implements this Act under regulations found at 40 CFR Parts 355, 370, and 372. Under Subtitle A of this Act, Federal facilities provide various information (such as inventories of specific chemicals used or stored and releases that occur from these facilities) to the State Emergency Response Commission and the Local Emergency Planning Committee to ensure that emergency plans are sufficient to respond to unplanned releases of hazardous substances. DOE's implementation of the provisions of this Act began voluntarily in 1987, and inventory and annual emissions reporting began in 1988. In addition, DOE requires compliance with SARA Title III as a matter of Departmental policy. DOE submits hazardous chemical in-

ventory reports for SRS to SCDHEC. The chemical inventory could change, depending on the salt processing alternative DOE implements; however, subsequent reports would reflect any change to the inventory.

Transportation of Hazardous Materials (49 USC 5101 et seq.); Hazardous Materials Tables & Communications, Emergency Response Information Requirements (49 CFR Part 172)

The regulatory requirements for marking, labeling, placarding, and documenting hazardous materials shipments are defined in 40 CFR Part 172. This regulation also specifies the requirements for providing hazardous material information and training. Materials shipped to the salt processing facilities would comply with these regulations.

Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended (42 USC 9601 et seq.); National Oil and Hazardous Substance Contingency Plan (40 CFR Part 300 et seq.)

More popularly known as CERCLA or "Superfund," the Act and implementing regulations provide the authority for Federal and state governments to respond directly to hazardous substances incidents. The regulations require reporting of spills, including radioactive materials, to the National Response Center. DOE Orders generally set forth the programs for development of internal procedures for implementing the regulations. DOE would be required to comply with these regulations in the event of spills of hazardous substances at the salt processing facilities.

DOE, SCDHEC, and EPA have signed an FFA to coordinate cleanup at SRS, as required by Section 120 of CERCLA. Section IX of the Agreement sets forth requirements for the SRS HLW tank systems. Design and operating standards for the tank systems are found in Appendix B of the Agreement. DOE has submitted a waste removal plan and schedule for the tank systems that do not meet applicable secondary containment standards. The

approved FFA waste removal schedule appears in Appendix E of the *Savannah River Site High Level Waste System Plan* (WSRC 2000). DOE must provide an annual report on the status of the HLW tank systems being removed from service. After waste removal is completed, the tank systems are available for closure in accordance with general closure strategy for the F- and H-Area waste tank systems (DOE 1996). Implementation of salt processing is essential to meeting DOE's obligations under the FFA. Under the No Action alternative, DOE would continue to store the salt solutions. If salt processing is not operational by 2010, DOE would consider other options, as described in Section 2.3.

Occupational Safety and Health Act of 1970, as amended (29 USC 651 et seq.); Occupational Safety and Health Administration Emergency Response, Hazardous Waste Operations and Worker Right to Know (29 CFR Part 1910 et seq.)

The Occupational Safety and Health Act (29 USC 651) establishes standards to enhance safe and healthful working conditions in places of employment throughout the United States. The Act is administered and enforced by the Occupational Safety and Health Administration (OSHA), a U.S. Department of Labor agency. While OSHA and EPA both have a mandate to reduce exposures to toxic substances, OSHA's jurisdiction is limited to safety and health conditions that exist in the workplace environment. In general, under the Act, it is the duty of each employer to furnish all employees a place of employment free of recognized hazards likely to cause death or serious physical harm. Employees have a duty to comply with the occupational safety and health standards and all rules, regulations, and orders issued under the Act. The OSHA regulations (29 CFR) establish specific standards with which employers must comply to achieve a safe and healthful working environment. This regulation sets down the OSHA requirements for employee safety in a variety of working environments. It addresses employee emergency and fire prevention plans (Section 1910.38), hazardous waste operations

and emergency response (Section 1910.120), and hazard communication (Section 1910.1200) that enable employees to be aware of the dangers they face from hazardous materials at their workplaces. DOE places emphasis on compliance with these regulations at its facilities and prescribes, through DOE Orders, OSHA standards that contractors shall meet, as applicable to their work at government-owned, contractor-operated facilities. DOE keeps and makes available the various records of minor illnesses, injuries, and work-related deaths required by OSHA regulations.

Noise Control Act of 1972, as amended (42 USC 4901 et seq.)

Section 4 of the Noise Control Act of 1972, as amended, directs all Federal agencies to carry out "to the fullest extent within their authority" programs within their jurisdictions in a manner that furthers a national policy of promoting an environment free from noise that jeopardizes health and welfare.

7.4 Executive Orders

The following executive orders would apply to the SRS salt processing activities. DOE Orders generally set forth the programs and procedures required to implement the requirements of the Orders.

Executive Order 11514 (Protection and Enhancement of Environmental Quality)

Executive Order 11514 requires Federal agencies to monitor and control their activities continually to protect and enhance the quality of the environment to develop procedures to ensure the fullest practicable provision of timely public information and understanding of Federal plans and programs with environmental impacts, and to obtain the views of interested parties.

Executive Order 11988 (Floodplain Management)

Executive Order 11988 requires Federal agencies to establish procedures to ensure that the

potential effects of flood hazards and floodplain management are considered for any action undertaken in a floodplain, and that floodplain impacts be avoided to the extent practicable.

Executive Order 11990 (Protection of Wetlands)

Executive Order 11990 requires government agencies to avoid any short- and long-term adverse impacts on wetlands, wherever there is a practicable alternative.

Executive Order 12856 (Right-to-Know Laws and Pollution Prevention Requirements)

Executive Order 12856 requires all Federal agencies to reduce the toxic chemicals entering any waste stream. This order also requires Federal agencies to report toxic chemicals entering waste streams; improve emergency planning, response, and accident notification; and encourage clean technologies and testing of innovative pollution prevention technologies.

Executive Order 12898 (Environmental Justice)

Executive Order 12898 directs Federal agencies to identify and address disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority and low-income populations.

Executive Order 12902 (Energy Efficiency and Water Conservation at Federal Facilities)

Executive Order 12902 requires Federal agencies to develop and implement programs for conservation of energy and water resources.

7.5 DOE Regulations and Orders

Through the authority of the Atomic Energy Act, DOE is responsible for establishing a comprehensive health, safety, and environ-

mental program for its facilities. The regulatory mechanisms through which DOE manages its facilities are the promulgation of regulations and the issuance of DOE Orders. Table 7-2 lists the major DOE Orders applicable to the salt processing alternatives.

The DOE regulations address such areas as energy conservation, administrative requirements and procedures, nuclear safety, and classified information. For purposes of this SEIS, relevant regulations include 10 CFR Part 820, *Procedural Rules for DOE Nuclear Facilities*; 10 CFR Part 830, *Nuclear Safety Management, Contractor and Subcontractor Activities*; 10 CFR Part 835, *Occupational*

Radiation Protection; 10 CFR Part 1021, *Compliance with NEPA*; and 10 CFR Part 1022, *Compliance with Floodplains/Wetlands Environmental Review Requirements*. DOE has enacted occupational radiation protection standards to protect DOE and its contractor employees. These standards are set forth in 10 CFR Part 835, *Occupational Radiation Protection*; the rules in this part establish radiation protection standards, limits, and program requirements for protecting individuals from ionizing radiation resulting from the conduct of DOE activities, including those conducted by DOE contractors. The activity may be, but is not limited to, design, construction, or operation of DOE facilities.

Table 7-2. DOE Orders and Standards relevant to the salt processing alternatives.

151.1A	Comprehensive Emergency Management System
225.1A	Accident Investigation
231.1	Environment, Safety and Health Reporting
232.1A	Occurrence Reporting and Processing of Operations Information
252.1	Technical Standards Program
420.1	Facility Safety
425.1B	Startup and Restart of Nuclear Facilities
430.1A	Life Cycle Asset Management
435.1	Radioactive Waste Management
440.1A	Worker Protection Management for DOE Federal and Contractor Employees
451.1B	National Environmental Policy Act Compliance Program
460.1A	Packaging and Transportation Safety
460.2	Departmental Materials Transportation and Packaging Management
470.1	Safeguards and Security Program
471.1A	Identification and Protection of Unclassified Controlled Nuclear Information
471.2A	Information Security Program
472.1B	Personnel Security Activities
474.1A	Control and Accountability of Nuclear Materials
1270.2B	Safeguards Agreement with the International Atomic Energy Agency
3790.1B	Federal Employee Occupational Safety and Health Program
4330.4B	Maintenance Management Program
4700.1	Project Management System
5400.1	General Environmental Protection Program
5400.5	Radiation Protection of the Public and the Environment
5480.19	Conduct of Operations Requirements for DOE Facilities
5480.20A	Personnel Selection, Qualification, and Training Requirements for DOE Nuclear Facilities
5480.21	Unreviewed Safety Questions
5480.22	Technical Safety Requirements
5480.23	Nuclear Safety Analysis Reports

Applicable Laws, Regulations, and Other Requirements

5632.1C	Protection and Control of Safeguards and Security Interests
5660.1B	Management of Nuclear Materials
6430.1A	General Design Criteria
1020-94	Natural Phenomena Hazards Design and Evaluation Criteria for Department of Energy Facilities
1021-93	Natural Phenomena Hazards Performance Categorization Guidelines for Structures, Systems, and Components
1024-92	Guidelines for Use of Probabilistic Seismic Hazard Curves at Department of Energy Sites for Department of Energy Facilities
1027-92	Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23 Nuclear Safety Analysis Reports
3009-94	Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Safety Analysis Reports
3011-94	Guidance for Preparation of DOE 5480.22 (TSR) and DOE 5480.23 (SAR) Implementation Plans

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- Sullivan, M. A., U.S. Department of Energy, General Counsel, 1998, "Natural Resources Defense Council Petition to Exercise Licensing Authority over Savannah River Site High-Level Waste Tanks," letter to J. T. Greeves, U.S. Nuclear Regulatory Commission, Office of Nuclear Material Safety and Safeguards, Washington, D.C., September 30.
- WSRC (Westinghouse Savannah River Company), 2000, *Savannah River Site High-Level Waste System Plan*, HLW-2000-0019, Rev. 11, Aiken, South Carolina.

APPENDIX A
TECHNOLOGY DESCRIPTIONS

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APPENDIX A. TECHNOLOGY DESCRIPTIONS

A.1 Introduction

The Savannah River Site (SRS) currently stores 34 million gallons of aqueous high-level waste (HLW) in F- and H-Area Tank Farms (Figures A-1 and A-2; see also text box on this page). This waste comprises approximately 2.8 million gallons of insoluble sludge, 15.2 million gallons of solid saltcake, and 16 million gallons of supernatant salt, all contained in 49 large underground steel tanks. The U.S. Department of Energy (DOE) is committed to removing this waste material from the HLW tanks and processing it for final disposal to resolve critical safety and regulatory issues.

DOE has developed processes and facilities to convert the aqueous wastes into environmentally safe forms for long-term storage and final disposal (DOE 1994, 1995). Sludge components of the wastes, which contain most of the radioactive strontium and alpha-emitting actinides (such as plutonium), are washed and treated with sodium hydroxide to reduce the aluminum content, then mixed with glass frit for melting into a glass waste form in the Defense Waste Processing Facility (DWPF). Soluble salt components of the wastes were to be treated in a large waste tank, using a precipitation-sorption process denoted In-Tank Precipitation (ITP), to remove radioactive cesium (principally cesium-137) and other radionuclides for vitrification, along with sludge, in DWPF. The cesium would be precipitated

as an insoluble tetraphenylborate salt, and residual strontium and actinides would be sorbed on a particulate solid, monosodium titanate, to be filtered from the solution for transfer to the DWPF. The low activity salt solution would be fixed in a concrete-like material (saltstone) for onsite disposal in engineered vaults. After interim storage at SRS the waste glass in stainless steel canisters would be shipped to a monitored geologic repository for final disposal.

The sludge processing operations were successfully implemented and immobilization of these wastes in glass at DWPF is in progress. During startup of the ITP process, however, the decomposition of the tetraphenylborate produced benzene in amounts higher than predicted. A comprehensive process review concluded that the tetraphenylborate decomposition and benzene release associated with ITP operation could exceed the design capability of the existing facilities, preventing safety and production requirements being met in a cost-effective manner (see text box page A-4).

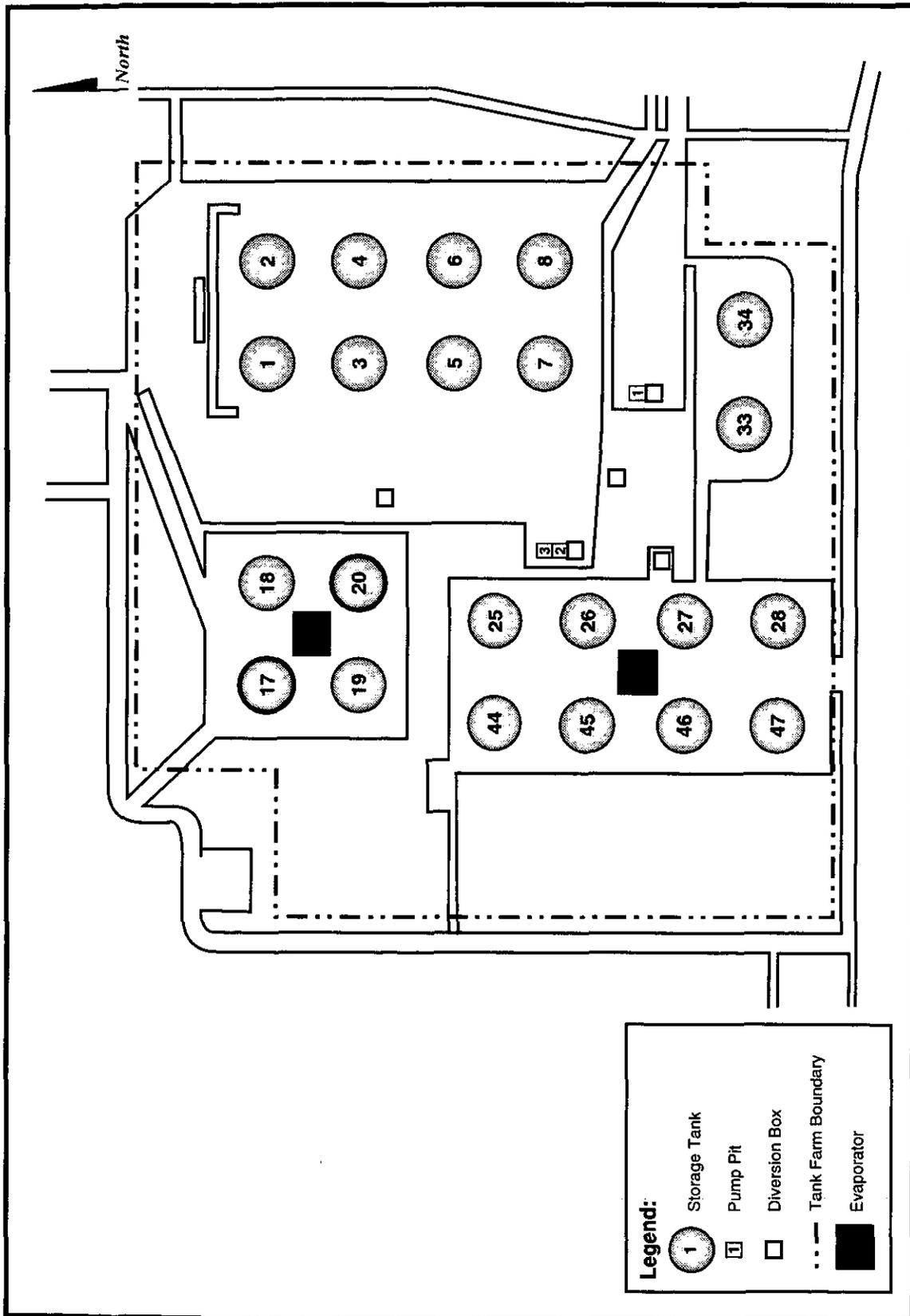
Evaluation of alternative technologies resulted in the identification of four candidates to replace the ITP process (WSRC 1998a):

- Small Tank Tetraphenylborate Precipitation
- Crystalline Silicotitanate Ion Exchange
- Caustic Side (non-elutable) Solvent Extraction
- Direct Disposal (of cesium) in Grout.

Waste Tank Concerns and Commitments

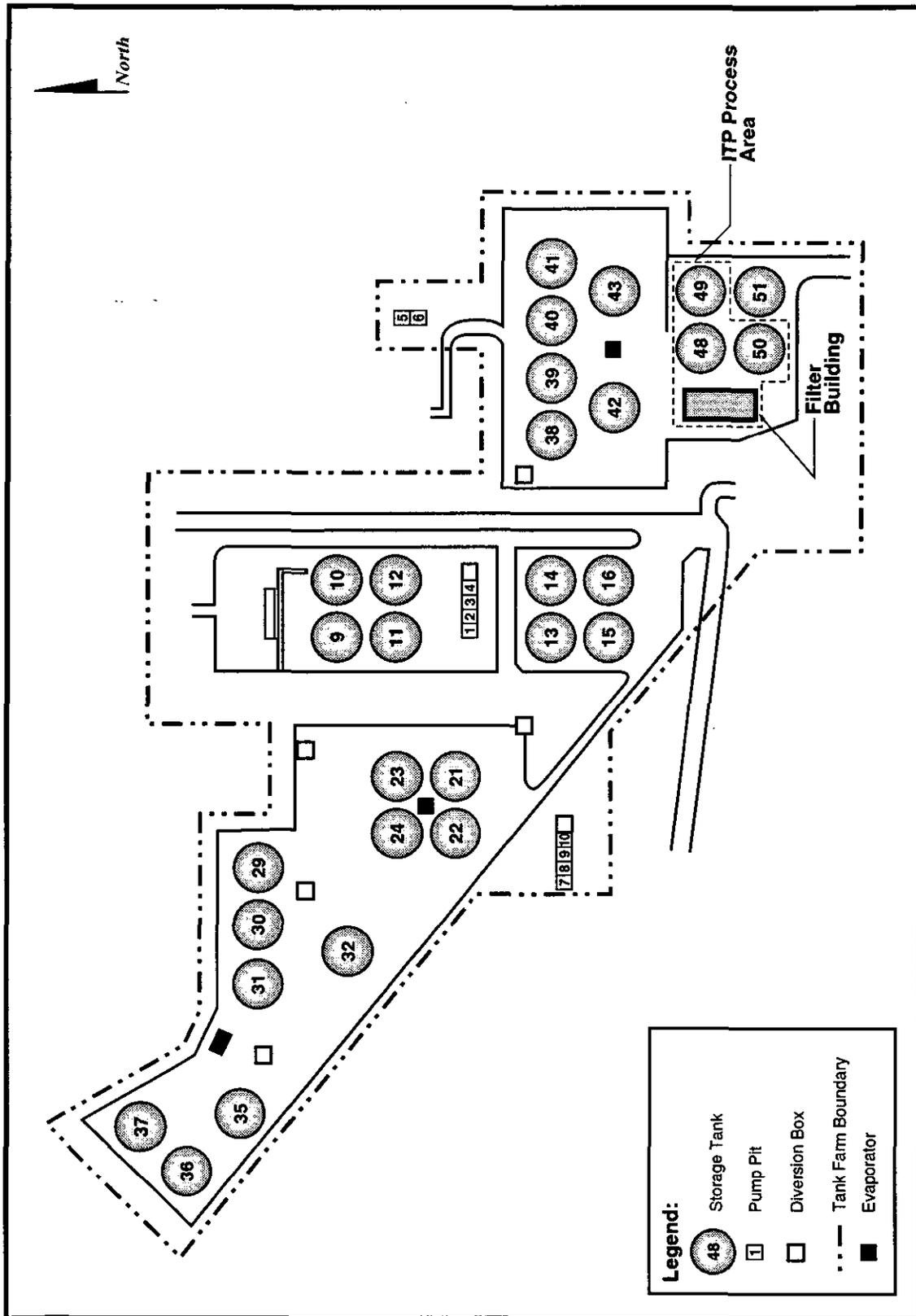
Two of the original 51 HLW storage tanks (numbers 17 and 20) at SRS had waste removed and have been closed. Of the remaining 49 tanks, 10 (numbers 1, 6, 9, 10, 11, 12, 13, 14, 15, and 16) have leaked observable quantities of liquid waste from primary to secondary containment and one tank (number 16) leaked a few tens of gallons of waste to the environment (WSRC 1998a). One other tank (number 19) has cracks in the tank wall above the level of the waste, although no waste has been observed to leak through these cracks. Tanks 1 through 24 do not meet U.S. Environmental Protection Agency (EPA) secondary containment and leak detection standards for storage of hazardous waste, effective January 12, 1987 (40 CFR 264). Removal of wastes and closure of these tanks by 2022 is required by the Federal Facility Agreement (FFA) for SRS entered into by the DOE, EPA, and the South Carolina Department of Health and Environmental Control (SCDHEC) (EPA 1993). All HLW at SRS is land-disposal-restricted waste, prohibited from long-term storage, and must be removed from the HLW tanks by the year 2028 as a result of FFA (WSRC 2000a).

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NW SDA EIS/GR/APP AA-1 Lay F Tank.a1

Figure A-1. General layout of F-Area Tank Farm (Tanks 17 and 20 are closed).



NW SDA EIS/Gnt/App AA-2 Lay H Tank.fai

Figure A-2. General layout of H-Area Tank Farm.

The environmental impacts of constructing and operating facilities for these alternative technologies are being identified and evaluated in this *Salt Processing Alternatives Supplemental Environmental Impact Statement* (SEIS) (DOE 1998a, 1999).

Need for ITP Replacement

Benzene generated during the ITP process results from the decomposition of tetraphenylborate (TPB), which is used to separate soluble radioactive cesium from the HLW salt solution. The cesium is precipitated as an insoluble solid that can be filtered from the waste solution. Under certain conditions the tetraphenylborate is subject to a radiolytic and catalytic decomposition that forms benzene and allows the separated cesium to return to the salt solution. Benzene is a toxic, flammable, and potentially explosive organic substance that must be safely controlled. The redissolution of cesium as a result of tetraphenylborate decomposition must be curtailed to achieve the required decontamination of the salt solution.

Tetraphenylborate decomposition is catalyzed by certain metals in the radioactive waste, notably the fission product palladium. The extent and rate of tetraphenylborate decomposition is affected by the chemical form of the catalyst, and increases with time of exposure to and temperature of the catalyst. Controlled release of benzene from the salt solution, as required to mitigate potential benzene hazards, is promoted by agitation or stirring. Flammability is controlled by maintaining a nitrogen gas cover that excludes oxygen above concentrations that could cause benzene combustion.

The ITP facilities were unsuitable to control tetraphenylborate decomposition and benzene generation because:

- Large volumes and long cycle times allowed excessive tetraphenylborate decomposition before the precipitate could be separated by filtration from the salt solution.
- Adequate temperature control was not possible in the large tank.
- Agitation by slurry pumps produced insufficient mixing.
- Purge of the nitrogen gas cover was inadequate because the large tank was not adaptable to positive pressure or secondary confinement.

These limitations were assessed against requirements for safely processing the large inventory of HLW salt within the time projected for completion of sludge processing in the DWPF. Based on this assessment, DOE concluded that the ITP process could not achieve safety and production requirements for the high-level radioactive waste system.

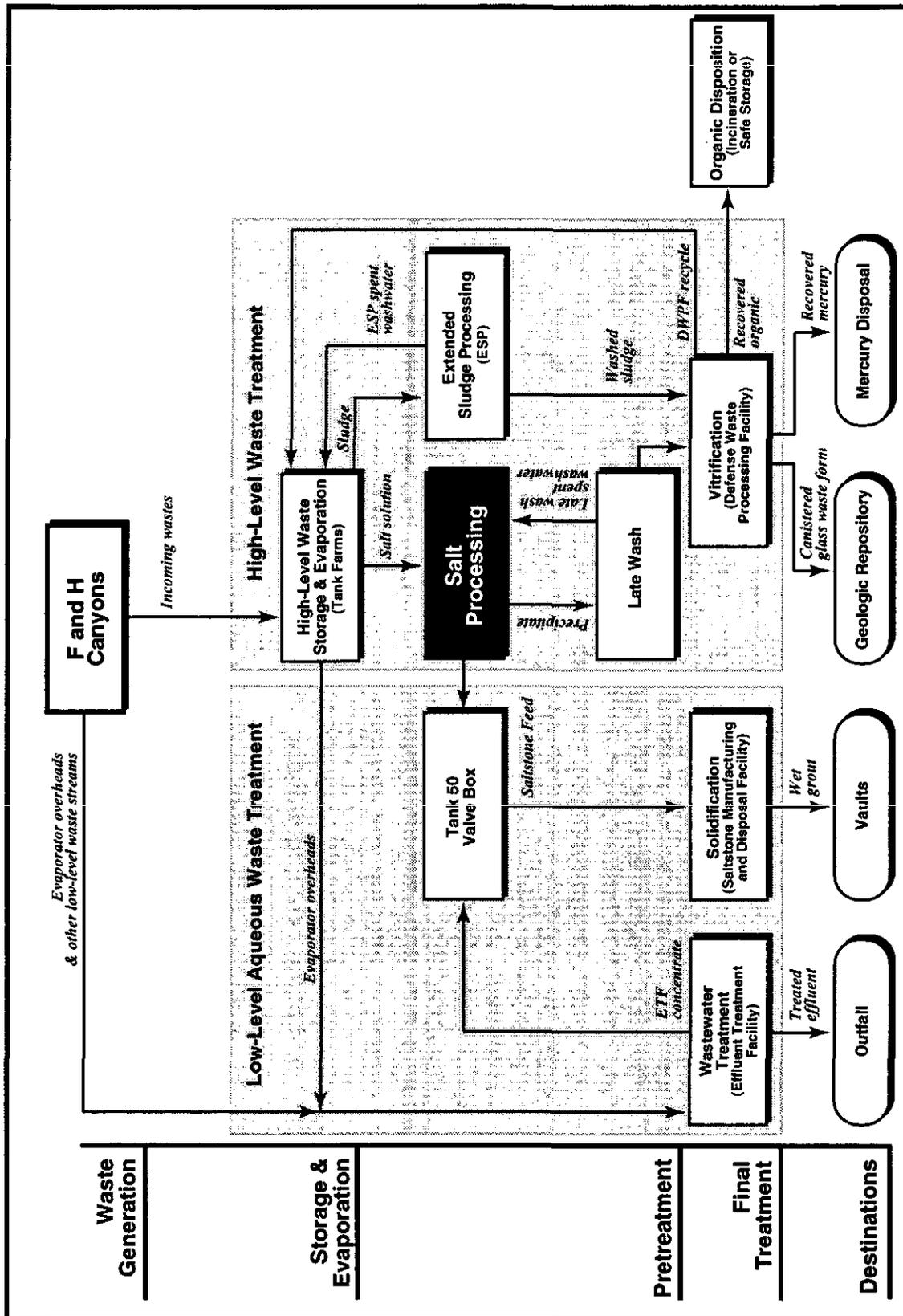
A.2 Current HLW System Configuration

The SRS HLW system was developed to receive and store radioactive wastes in a safe and environmentally sound manner and to convert these wastes into forms suitable for final disposal (DOE 1994). A schematic of the process is shown in Figure A-3 (WSRC 1998b). As planned, sludge components and the highly radioactive soluble constituents recovered from the salt components of the wastes would be immobilized in DWPF as borosilicate glass contained in stainless steel canisters for disposal in a monitored geologic repository. Low activity salt solutions would be immobilized in cementitious form (saltstone) for disposal in onsite vaults. Secondary products from these operations, including mercury derived from sludge processing and benzene released during salt processing operations, would be recovered for appropriate disposition (recycling or destruction). Miscellaneous radioactive and hazardous process wastes would be incorporated into the SRS waste management system for disposal.

A.3 Processes and Facilities

A.3.1 HLW STORAGE AND EVAPORATION

HLW from SRS chemical processing operations is received in the F- and H-Area Tank Farms as an aqueous slurry of insoluble sludge and soluble salts in alkaline solution. The tank farms concentrate (by evaporation of excess water) and store these wastes, pending further processing in other facilities. The sludge component of the alkaline wastes settles to the bottom of the storage tank, and the salt solution is decanted and concentrated by evaporation, leaving a solid saltcake and a concentrated supernatant. Evaporation reduces the volume and mobility of the wastes, enhancing long-term storage. The water driven off by evaporation is processed through the Effluent Treatment Facility (ETF) for decontamination before release to an onsite stream. No water is released from ETF to a stream unless it meets all regulatory criteria.



NW SDA EIS/Grnt/App A/A-3 SRS HLW.a

Figure A-3. SRS high-level waste system configuration.

A.3.2 EXTENDED SLUDGE WASHING

The insoluble sludges accumulated in the tanks are hydraulically slurred and transferred to tank farm facilities for washing with inhibited water to remove soluble salts entrained in the sludge. (Inhibited water contains low concentrations of sodium nitrite and sodium hydroxide to inhibit corrosion of the steel waste tanks.) To reduce the quantity of glass waste formed, sludge with high levels of aluminum is treated with caustic (3 to 5 molar sodium hydroxide) to convert aluminum hydroxide to soluble sodium aluminate, which is washed from the sludge along with other soluble salts. The wash solutions are concentrated by evaporation and returned to the waste tanks as salt waste components. The washed sludge is transferred to DWPF for conversion to the borosilicate glass waste form.

A.3.3 SALT PROCESSING

In the salt processing operations, as originally projected, saltcake in the waste tanks would be redissolved and combined with concentrated supernatant, and the resulting salt solution transferred hydraulically to the ITP facilities. ITP was to be conducted in a large waste tank; tetraphenylborate would be added to the salt solution to coprecipitate radioactive cesium (along with essentially nonradioactive potassium) as an insoluble solid, and a slurry of the particulate solid monosodium titanate would be added to react with residual strontium and actinides by a sorption process. The resulting precipitate solids would be concentrated in the tank and separated by cross-flow filtration before being transferred to DWPF for melting into a glass waste form, along with sludge components of the waste. (Cross-flow filtration is a process in which the solid slurry is passed through porous membrane tubes under pressure to force the salt solution into a surrounding vessel and concentrate the solids in the slurry.) The low activity salt solution recovered by filtration would be immobilized in onsite vaults as saltstone.

A.3.4 DWPF GLASS PROCESSING

If the ITP process were operational, sludge and salt precipitate solids would be transferred as aqueous slurries to DWPF for conversion in a glass melter to the glass waste form. Currently, only sludge is being vitrified at DWPF.

In DWPF, the sludge slurry is acidified and treated chemically to extract mercury before the sludge is sent to the glass melter. The recovered mercury is stored for future disposal. If ITP operated for salt processing, the precipitate slurry would be treated in DWPF, using a hydrolysis process to decompose the tetraphenylborate solids. The hydrolysis reaction would produce an aqueous solution of inorganic salts including the radioactive cesium, several organic products (principally benzene), boric acid, and residual titanate solids. The benzene would be distilled from the mixture, washed, and collected for disposal. To avoid potential explosion hazards from benzene, the tetraphenylborate precipitate would be processed in a carbon dioxide atmosphere. The aqueous residues of the precipitate hydrolysis process would be mixed with sludge and glass frit as feed for the DWPF melter. Molten glass would be poured into stainless steel canisters about 2 feet in diameter by 10 feet long, suitable for interim onsite storage and permanent disposal in a monitored geologic repository.

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Storage of Recycle DWPF Wastes

DWPF operations produce large volumes of recycle wastes, mostly water, returned to the HLW storage tanks. Without a salt processing technology in place, the DWPF sludge-only operation will increase the volume of waste that must be stored in the HLW tanks. Management of existing tank space and equipment would allow DOE to continue sludge-only vitrification in DWPF until about 2010, the projected time for startup of salt processing plant operations (text box page 2-2).

Tank space management would include some or all of the following activities intended to reduce storage requirements in the HLW tanks (WSRC 1999a):

- Continue to evaporate liquid waste in the tanks
- Convert ITP processing tanks 49 and 50 to HLW storage
- Reduce DWPF low-level waste streams sent to the tank farms
- Implement several activities to gain small incremental volumes
- As 2010 approaches, reduce the available emergency space in the tank farms while maintaining the minimum emergency space required by the Authorization Basis.

A.3.5 SALTSTONE PROCESSING

The low activity salt solution from the ITP process would be mixed with a blend of cement, flyash, and slag in the Saltstone Manufacturing and Disposal Facility to produce a grout suitable for disposal in onsite vaults. The grout would be poured into the vaults to solidify into large saltstone monoliths.

As originally designed, the saltstone vaults are near-surface concrete containment structures that serve as forms for the cast saltstone and provide a diffusion barrier to the environment (Wilhite 1986; Wilhite et al. 1989). The vaults, 300 feet in length, 200 feet wide, and about 25 feet high, with 1.5-foot-thick sidewalls, a 2.5-foot base and a 1.5-foot cover, are sized to contain approximately 1.4 million cubic feet (40,000 m³) of saltstone within six subdivided cells of the vault. During decommissioning, clay caps would be placed over the vaults, with drainage systems installed between the caps to reduce the volume of rainwater infiltrating the disposal site.

The grout composition and the vault design were specified to minimize the release rate

of waste components into the surrounding environment (Langton 1988; Wilhite 1986). Performance criteria imposed on the saltstone vaults required that groundwater quality at the disposal site meet drinking water standards. Performance modeling, validated by field tests, demonstrated the capability of the saltstone vaults to meet these standards (Martin Marietta 1992).

A.4 Salt Processing Alternatives

Facility capabilities have been demonstrated and all waste processing operations for the SRS HLW management system are currently operational, with the exception of ITP processing and related late wash of the precipitate. In December 1995, DOE determined that the ITP process was generating benzene at higher rates than expected and operational testing was suspended in March 1996. Benzene is a flammable product of the decomposition of tetraphenylborate added to precipitate cesium from the salt solution. The excess benzene resulted from the decomposition of tetraphenylborate in the processing tank, allowing redissolution of the precipitate before it could be separated by filtration. In concurrence with a Defense Nuclear Facilities Safety Board recommendation, chemical studies were initiated that would better explain the underlying mechanisms for benzene generation and release during the tetraphenylborate precipitation process. These studies demonstrated that the process to remove cesium from the salt solution, as then configured, could not achieve production goals and meet safety requirements for processing the salt wastes.

In early 1998, DOE directed Westinghouse Savannah River Company (WSRC) to initiate a program for evaluation of alternative salt processing technologies. A High-Level Waste Salt Processing Systems Engineering Team (SET) was chartered to identify technologies to replace the ITP process, evaluate the technologies, and recommend a selected technology or technologies to convert the HLW salt solution (supernatant plus dissolved saltcake) to waste forms that could meet regulatory requirements. The SET was composed of WSRC employees with technical support from universities, several na-

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tional laboratories, independent consultants, and the DOE complex.

The initial screening of approximately 140 salt processing technologies options identified 18 for further evaluation. The 18 technologies, grouped by general category (WSRC 1998c), were:

Crystallization

Fractional Crystallization – DWPF Vitrification

Electrochemical Separation

Electrochemical Separation and Destruction – DWPF Vitrification

Ion Exchange

Elutable Ion Exchange – DWPF Vitrification

Acid Side Ion Exchange – DWPF Vitrification

Crystalline Silicotitanate Ion Exchange – DWPF Vitrification

Crystalline Silicotitanate Ion Exchange – New Facility Vitrification

Crystalline Silicotitanate Ion Exchange – Ceramic Waste Form

Zeolite Ion Exchange – DWPF Vitrification

Precipitation

Potassium Removal followed by Tetraphenylborate Precipitation – DWPF Vitrification

Reduced Temperature ITP – DWPF Vitrification

Catalyst Removal ITP – DWPF Vitrification

ITP with Enhanced Safety Features – DWPF Vitrification

Small Tank Tetraphenylborate Precipitation – DWPF Vitrification

Solvent Extraction

Caustic Side Solvent Extraction – DWPF Vitrification

Acid Side Solvent Extraction – DWPF Vitrification

Vitrification

Direct Vitrification

Supernatant Separation – DWPF Vitrification

Direct Disposal of Cesium in Grout – DWPF Vitrification

A.4.1 SCREENING

The SET employed a phased approach, as summarized in Figure A-4. In Phase I, approximately 140 possible technology options were identified to replace ITP, and meet safety and production requirements. Each option was evaluated against a set of screening criteria that established minimum requirements. This initial screening reduced the original 140 options to 18 technologies that were selected for further evaluation.

During Phase II of the technology selection process, the SET performed a preliminary technical and programmatic risk assessment for each of the 18 technologies to establish a short list for in-depth analysis. As part of the Phase II analysis, the SET evaluated preliminary material balances, cycle times, and impacts to the HLW system for each of the 18 technologies. A technical document (WSRC 1998d) provides supporting data and the results of this assessment, which narrowed the list of 18 technologies to four:

- Small Tank Tetraphenylborate Precipitation (Small Tank Precipitation)
- Crystalline Silicotitanate (non-elutable) Ion Exchange (Ion Exchange)
- Caustic Side Solvent Extraction (Solvent Extraction)
- Direct Disposal (of cesium) in Grout (Direct Disposal in Grout).

Phase III of the process evaluated the final four technologies in still greater detail, including life-cycle cost estimates and schedule assessments (WSRC 1998b). Some of the uncertainties and assumptions in the Phase II efforts were resolved in Phase III by additional research, literature review, calculations, and experiments. The facility components of the technologies, such as tanks and transport systems, were described in greater detail. Equipment sizing was refined and used to develop pre-conceptual facility layouts and process flow configurations. The layouts were used to develop project schedules and life-cycle cost estimates. This analysis is docu-

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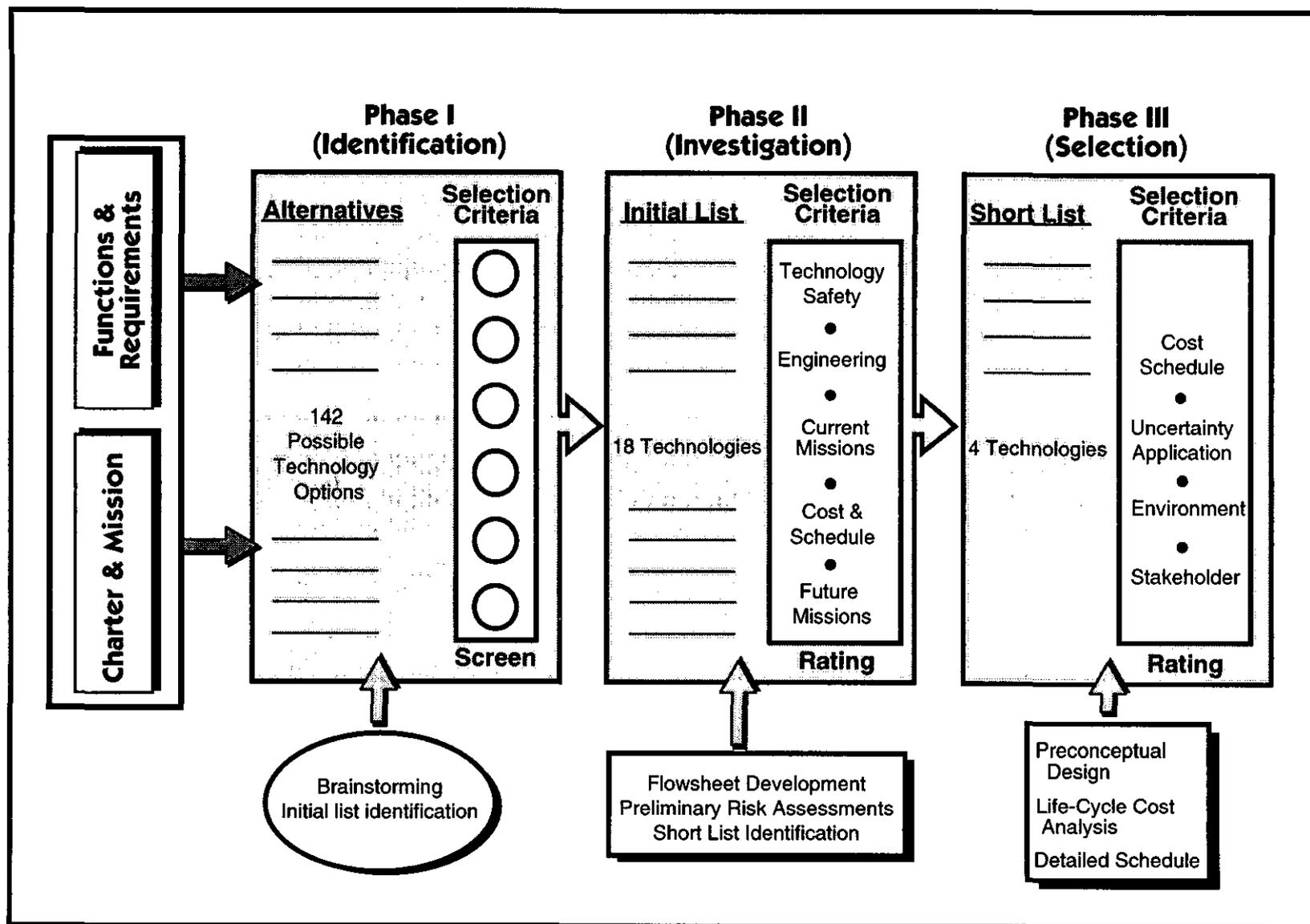


Figure A-4. Phased approach to screening and selecting salt processing technologies.

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mented (WSRC 1998e) and forms the basis for the environmental impact analysis presented in this SEIS.

A.4.2 RECOMMENDATION AND REVIEW

On October 29, 1998, following review by the WSRC Review Panel Team, WSRC recommended to DOE the Small Tank Precipitation process as the most reasonable replacement salt processing technology and the Ion Exchange process as a backup technology (WSRC 1998f).

A DOE Savannah River (SR) Review Team evaluated the WSRC recommendation and concluded that the remaining technical uncertainties for each of the alternatives were too significant to justify selection of a preferred technology (DOE 1998b). The DOE-SR Review Team recommended that additional research and development be conducted to address the key technical uncertainties associated with the two technologies, so that one could be identified as most reasonable. The Review Team agreed with WSRC that one of the four technologies considered in Phase III, Solvent Extraction, should be eliminated from further consideration because of its insufficient technical maturity. The DOE Review Team concluded that the Direct Disposal in Grout alternative should not be eliminated, based on its potential to reduce construction and operating costs and the high confidence in its technology, safety, and feasibility for implementation.

A DOE-Headquarters Independent Review Team concluded that both the Small Tank Precipitation and the Ion Exchange alternatives were technically feasible. This team agreed with the SET that Direct Disposal in Grout should be eliminated from further consideration, because of regulatory issues that had the potential to substantially increase the time required to implement the technology (DOE 1998c). DOE concluded that further investigations of this alternative would not be pursued as long as a cesium-

separation technology could be proved technically and economically practical.

In January 1999, DOE directed WSRC to conduct additional research and development on the Small Tank Precipitation and Ion Exchange alternatives. These additional studies concluded with WSRC maintaining its recommendation to pursue design and construction for the Small Tank Precipitation process (WSRC 1999b,c). WSRC further noted that, with additional development to reduce technical and engineering risk factors, the Ion Exchange process could also prove suitable for SRS, as well as a DOE complex-wide application for salt processing.

During this period, the technology for the Solvent Extraction process advanced independent of the SRS alternative evaluations. This information, coupled with recommendations from the National Research Council of the National Academy of Sciences (NAS 1999, 2000) and improved understanding of tank farm water management issues (WSRC 1999a), led the Department to reconsider the potential to mature and implement this alternative in time to support HLW salt processing needs.

In February 2000, DOE requested WSRC to initiate further development of the Solvent Extraction alternative, aimed at the timely resolution of previously identified problems (DOE 2000). Consequently, the Solvent Extraction technology is included as a reasonable alternative in the SEIS.

A.4.3 PROCESS DESCRIPTIONS

A.4.3.1 Small Tank Tetraphenylborate Precipitation

In the Small Tank Precipitation technology (WSRC 1998e,g,h), the soluble salt components of the wastes would be processed using precipitation-sorption procedures analogous to the ITP process to separate cesium and other soluble constituents from the waste solutions. The process would be conducted as a continuous operation in stirred small tanks (15,000 gallons) with the solution agitated constantly to avoid excessive decomposition of tetraphenylborate and

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accompanying generation of benzene before separation. In the Small Tank Precipitation technology, tetraphenylborate solution would be added to precipitate cesium and potassium, and a slurry of monosodium titanate would be added to sorb residual strontium and actinides from the salt solution. The resulting solids, along with residual sludge, would be concentrated by filtration and washed to remove soluble salts, then treated chemically to convert the precipitate to a non-flammable form for transfer to DWPF. Catalytic decomposition of the precipitate, with removal of the benzene formed, would generate a product stream containing cesium in aqueous solution and strontium and actinides sorbed onto monosodium titanate for vitrification. The low activity salt solution recovered by filtration would be transferred to the Saltstone Manufacturing and Disposal Facility for processing. The wash water would be recycled into the incoming soluble salt solution.

Small Tank Precipitation would be performed in a new facility to be constructed at Site B in S Area. Process flows for the Small Tank Precipitation alternative are shown in Figure A-5. Salt solution would be collected in an H-Area tank and pumped to the Small Tank Precipitation facility. A section of new interarea transfer line would be required to connect the new facility to the existing transfer line. The precipitation process would be conducted in two Continuous Stirred Tank Reactors. Salt solution mixed with tetraphenylborate, monosodium titanate, process water, and recycled wash water in the first tank reactor would flow to the second tank reactor, providing reaction conditions needed to maximize decontamination factors for the precipitation and sorption processes.

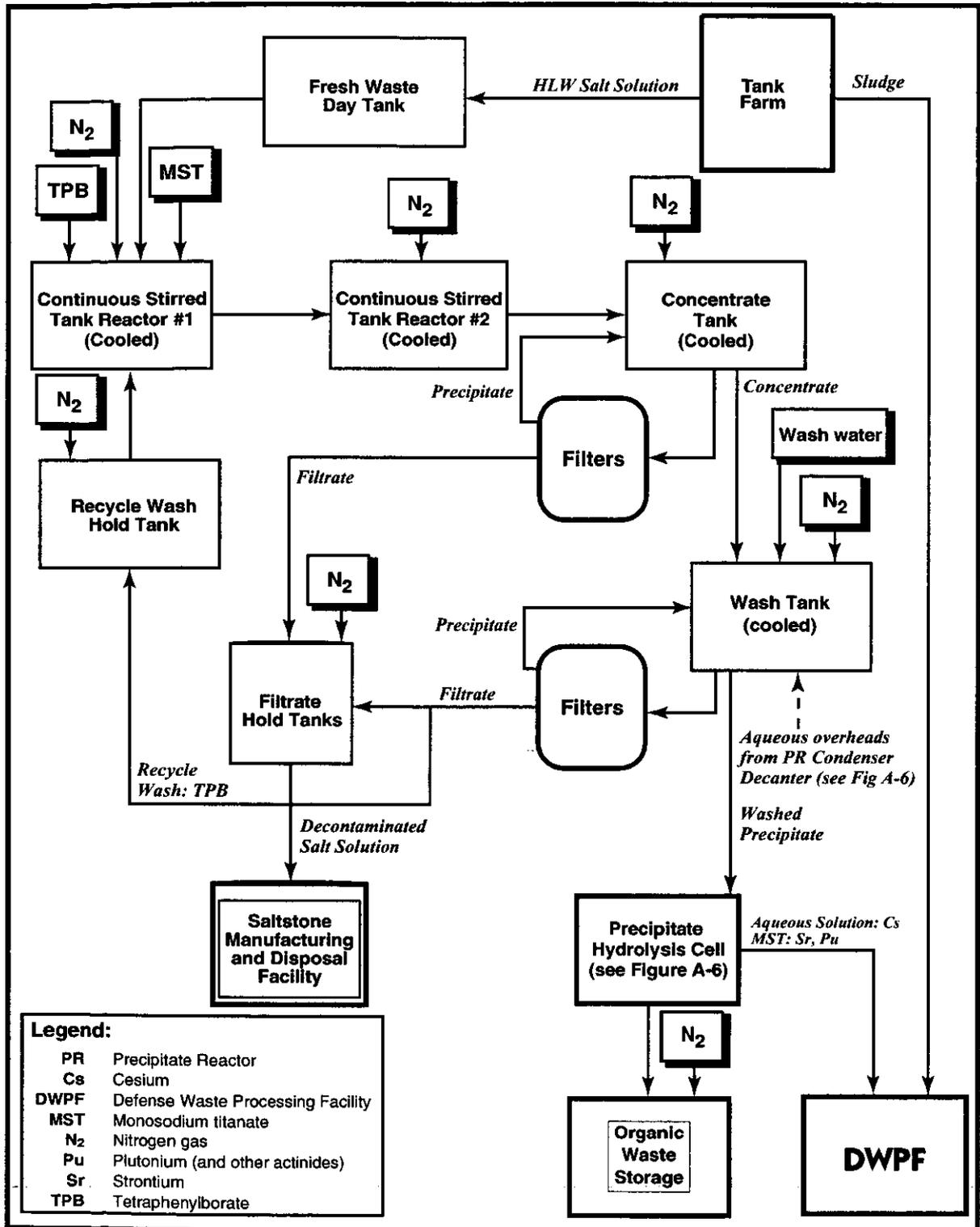
The precipitate slurry, containing about one weight percent tetraphenylborate and monosodium titanate solids, would be transferred continuously from the second tank reactor to a Concentrate Tank, where it would be con-

centrated to about 10 weight percent solids by cross-flow filtration. The resulting filtrate would be pumped to a Filtrate Hold Tank for later transfer to the Saltstone Manufacturing and Disposal Facility for immobilization in the saltstone vaults.

The precipitate slurry accumulated in the Concentrate Tank would be transferred to the Wash Tank for washing in a batch process to remove soluble sodium salts. Spent wash water would be separated from the precipitate by cross-flow filtration. The washed precipitate would be treated in the Precipitate Hydrolysis Cell (PHC) of the facility to eliminate benzene and generate an aqueous product stream termed Precipitate Hydrolysis Aqueous (PHA).

The PHC incorporates process operations formerly assigned to the Salt Processing Cell of DWPF (see text box below). Process flows for the PHC are shown in Figure A-6. In the PHC, the washed precipitate would be combined with a copper nitrate-formic acid solution in the Precipitate Reactor to catalytically decompose the tetraphenylborate precipitate. The Precipitate Reactor would be heated to boiling and the benzene would be removed as it was formed. The benzene and water vaporized during boiling would be condensed in the Precipitate Reactor Condenser, with aqueous and organic condensates separated by decantation for return to the Precipitate Evaporator and Organic Evaporator, respectively. After a period of reflux boiling, the PHA product would be concentrated by distillation, with the aqueous overheads transferred to the Precipitate Wash Tank.

A second evaporation would be conducted in the PHC to ensure that the separated organic was sufficiently decontaminated for transfer outside the containment area. Wash water would be added to the Organic Evaporator and the boiling, evaporation, and decantation cycle would be repeated, with the twice-distilled benzene collected in the Organic Evaporator Condensate Tank for transfer to the Organic Waste Storage Tank.



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Figure A-5. Small Tank Precipitation process flow diagram.

Transfer of DWPF Salt Processing Cell Operations to Small Tank Precipitation Facility

The design basis for the Small Tank Precipitation facility was modified to include the precipitate decomposition operations previously programmed for the DWPF. These operations, to be conducted in a Precipitate Hydrolysis Cell (PHC), had been tested during DWPF nonradioactive process runs, but were not employed during radioactive (sludge only) processing because of the unavailability of ITP feed. Major justifications for transferring the PHC operations to the Small Tank Processing facility are as follows:

- **Safety** – Lessons learned in DWPF design would provide PHC equipment with increased safety and control margins. As redesigned, the equipment would operate under slight positive pressure and low purge rates of inert cover gas.
- **Capacity** – Increased throughputs of PHC equipment would provide Small Tank Precipitation processing capacity needed to match required HLW salt removal schedules, with a substantial reduction in life-cycle processing time and significant cost savings.
- **Flexibility** – The vacated cell in the DWPF would become available for other potentially needed operations, including evaporation of DWPF recycle waste streams to conserve Tank Farm space pending startup of salt processing operations.
- **Organic Disposition** – Precipitate Hydrolysis Cell operations in the Small Tank Precipitation facility would confine generation and disposal of flammable organic byproducts to the process facility. This would avoid buildups of high-boiling organics in DWPF process and ventilation systems, and transfer in DWPF recycle streams to the Tank Farm. Lag storage and transfer to DWPF would be provided for the non-flammable aqueous product of the PHC operations, rather than the flammable tetraphenylborate precipitate product.

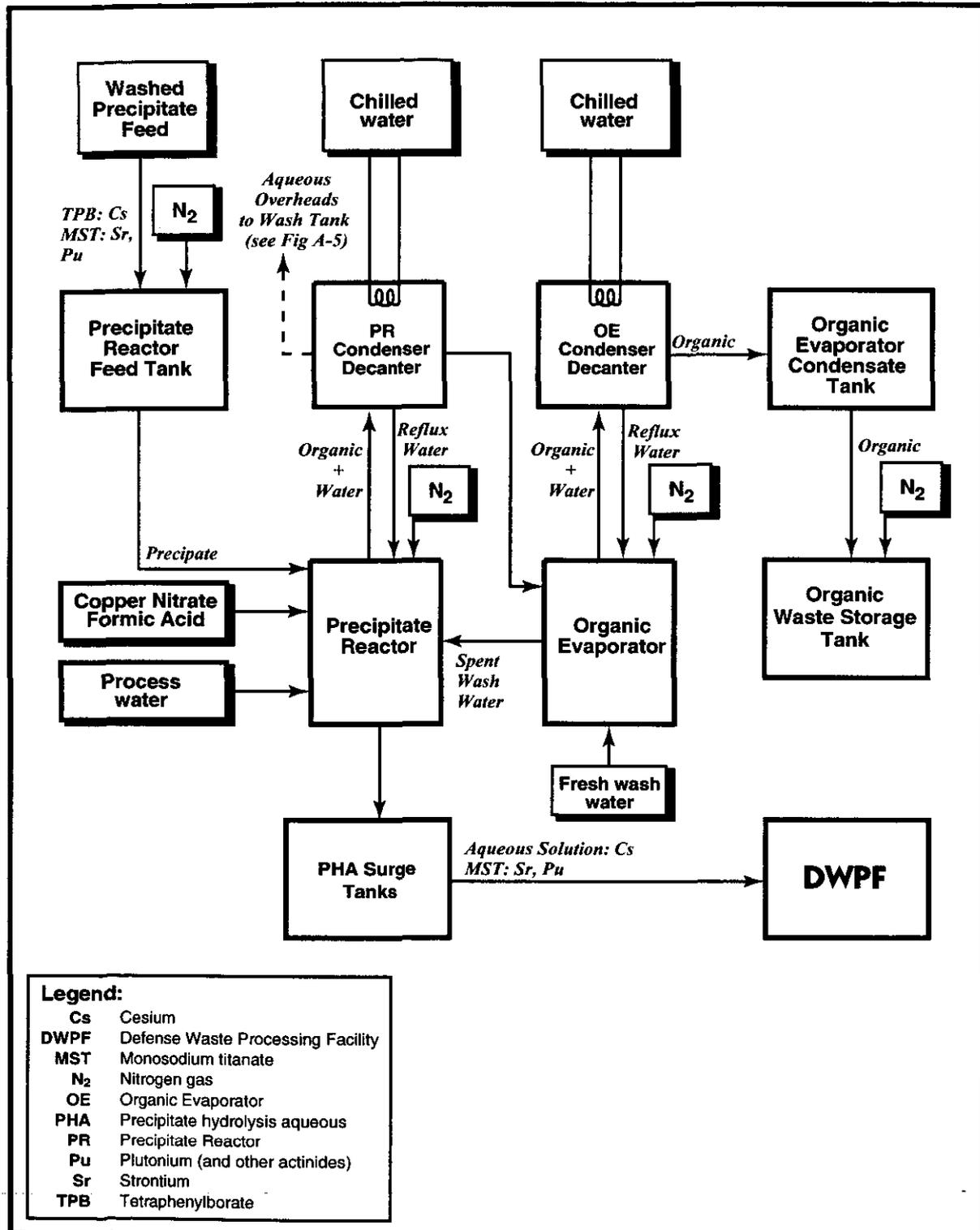
The tetraphenylborate employed in the Small Tank Precipitation process could undergo radiolytic and, under certain conditions, catalytic degradation, producing benzene before the decomposition reactions prescribed in the PHC. The Small Tank Precipitation process would require controlled benzene removal in all steps. Benzene production in the precipitation and washing operations would be limited by the continuous processing of relatively small waste volumes, by a short processing time, and by chilling the process vessels. Accumulation of benzene would be avoided by continuous agitation to prevent retention in the process mixtures and a flowing nitrogen gas blanket to sweep benzene vapors from the system. Benzene formation during precipitate decomposition in the PHC would be controlled by process constraints, with all process vessels purged with nitrogen to maintain oxygen concentrations below combustion limits.

A.4.3.2 Crystalline Silicotitanate Ion Exchange

The Ion Exchange Process (WSRC 1998e,i,j) would employ a crystalline silicotitanate particulate solid (resin) to remove

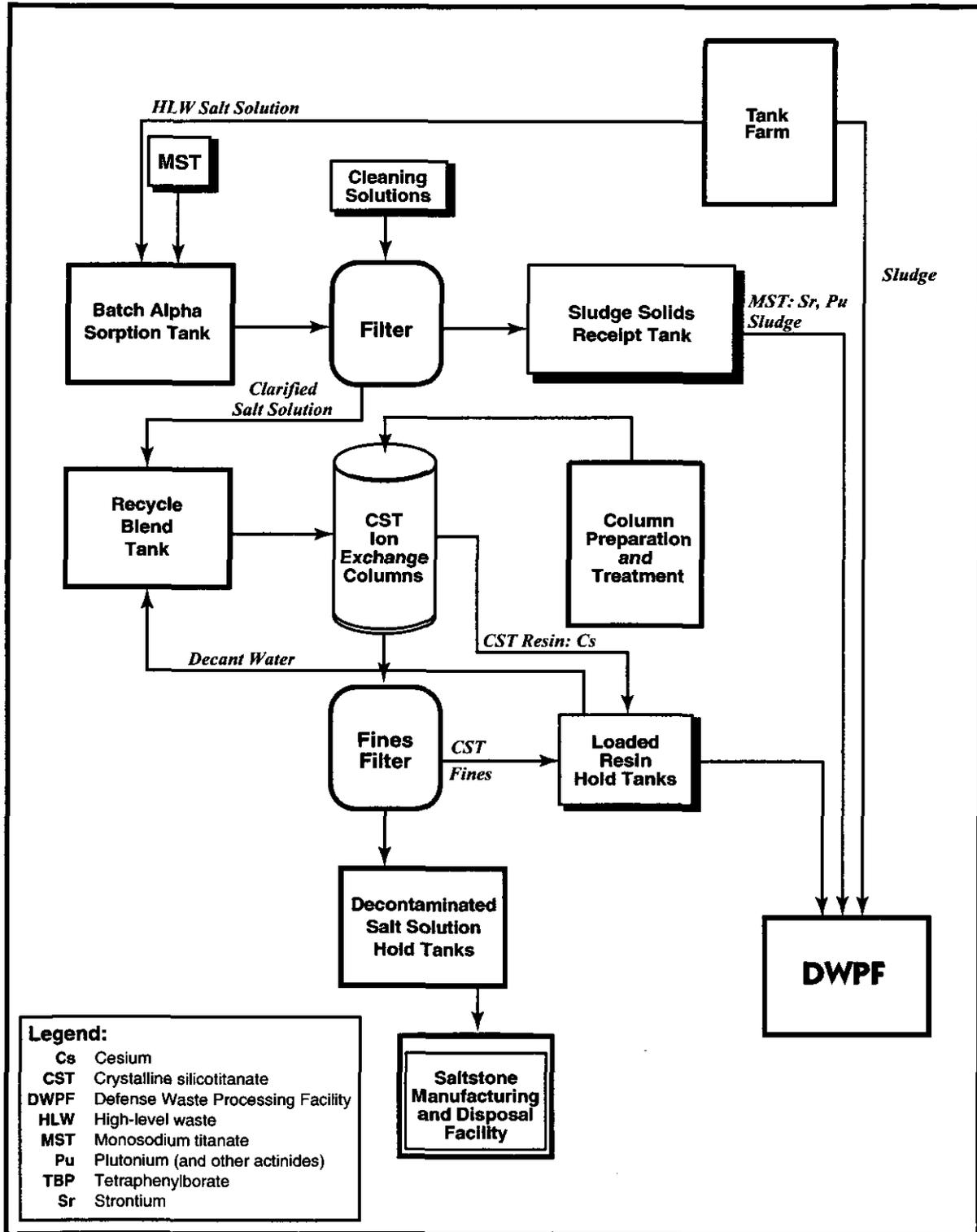
the cesium from the salt solution. In the ion exchange reaction, the radioactive cesium displaces nonradioactive constituents (sodium) of the resin. As in the Small Tank Precipitation process, residual strontium and actinides in the salt solution would be sorbed onto monosodium titanate and, in conjunction with residual sludge, filtered from the salt solution prior to the crystalline silicotitanate ion exchange treatment. The cesium-loaded crystalline silicotitanate resin and the monosodium titanate solids would be transferred to DWPF as slurries to be combined with sludge for incorporation into the glass waste form. Low activity salt solution would be immobilized as saltstone in onsite vaults at the Saltstone Manufacturing and Disposal Facility.

The Ion Exchange process would be performed in a new facility built at Site B in S Area. Process operations are illustrated in the flow diagram in Figure A-7. Salt solution would be pumped from an H-Area tank to the Ion Exchange facility. A new feed line between the existing inter-area transfer line and the Ion Exchange facility would be required for this transfer. In initial feed clarification operations in the batch Alpha Sorption Tank, the salt solution would be mixed with monosodium titanate to sorb soluble strontium and actinides and then filtered by cross-



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Figure A-6. Precipitate Hydrolysis Cell flow diagram for Small Tank Precipitation process.



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Figure A-7. Ion Exchange process flow diagram.

flow filtration to remove monosodium titanate solids and residual sludge. These clarification operations would be necessary to prevent plugging of the ion exchange columns during subsequent processing of the salt solution. The product slurry, washed and concentrated to about 5 weight percent solids, would be pumped through new and existing transfer lines to DWPF as feed for the vitrification process.

After filtration, the clarified salt solution would be transferred to the Recycle Blend Tank in the Ion Exchange facility for dilution with process water, and pumped through a series of four ion exchange columns to remove radioactive cesium. Cesium transfer from the salt solution would take place in the first three columns, with the fourth column in reserve for use when the first column in the series reached saturation (> 90 percent maximum capacity) and was taken out of service. Saturated resin in the column would be flushed with water and pumped as slurry to DWPF. The first ion exchange column would then be replenished with fresh resin and held in reserve (as the fourth column) while cesium ion exchange took place in what had been the second, third, and fourth columns. The cycle would continue with the lead column reaching saturation and the reserve column becoming the last in the series of three operating columns. Low activity salt solution recovered as effluent from the third column would be filtered to prevent any cesium-loaded fine particles from recontaminating the salt solution. The low activity salt solution would be sampled in a Product Holdup Tank prior to transfer to the Decontaminated Salt Solution Hold Tanks, to ensure that requirements for disposal as saltstone were met. The low activity salt solution would be transferred to the Saltstone Manufacturing and Disposal Facility for disposal in onsite vaults. All process wastewater would be recycled and reused.

The Ion Exchange process would result in the accumulation of as much as 15 million curies of cesium within the processing cell.

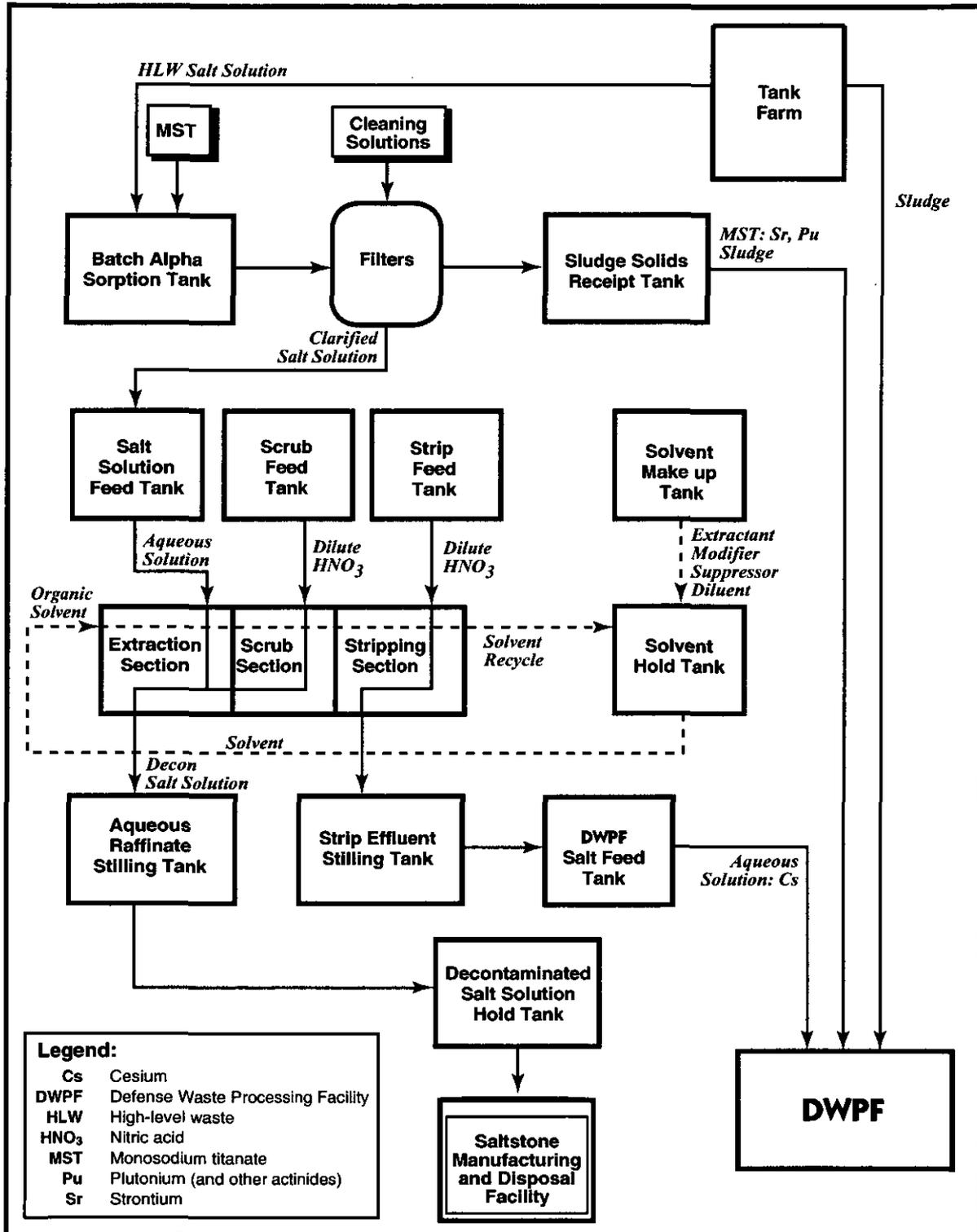
This radioactive loading would necessitate stringent shielding requirements and operational controls because of the generation of hydrogen and other gases.

A.4.3.3 Caustic Side Solvent Extraction

In the Solvent Extraction process (WSRC 1998e, 1999d), radioactive cesium would be separated from the caustic HLW salt solution by extracting it from the aqueous phase into an insoluble organic phase, thereby generating a low activity salt solution for immobilization in saltstone. The separated cesium, recovered from the organic phase by back extraction (stripping) into an acidic aqueous solution, would be transferred to DWPF for incorporation, along with HLW sludge, into the glass waste form. Prior processing of the HLW salt solution by monosodium titanate to remove soluble strontium and actinides, followed by filtration of monosodium titanate solids and residual sludge, would be necessary to meet saltstone acceptance limits and avoid interference of residual solids in the solvent extraction process.

The organic phase into which the cesium would be extracted is a kerosene-like solvent (diluent) containing an organic extractant (termed BoB-CalixC6) and a diluent modifier (typically Cs-7SBT). The extractant is highly specific for cesium, permitting separation from sodium by a factor of 10^4 (10,000) and from potassium by a factor of 10^2 (100). The diluent modifier increases the cesium extraction capability by increasing extractant solubility in the diluent. The subsequent stripping of separated cesium back into an aqueous solution is promoted by addition of a suppressor constituent, typically trioctylamine (TOA), to the organic phase. The TOA also mitigates the deleterious effects of impurities in the aqueous solution. Chemical structures and concentrations of the additions to the diluent organic phase are specified in the text box on page A-18.

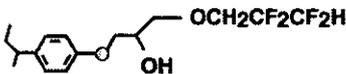
The Solvent Extraction process would be performed in a new facility at Site B in S Area. Process operations are represented by the flow diagram in Figure A-8. In operations similar to



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Figure A-8. Solvent Extraction process flow diagram.

Components of Organic Phase used in Solvent Extraction Process

Chemical Type	Concentration in Solvent	Function
Diluent Blend of alkane hydrocarbons "Isopar® L"	Principal component	Organic phase solvent
Cesium Extractant (with complexed Cs) <div style="text-align: center;">  </div> Calix[4]arene-bis(<i>tert</i> -octylbenzo-crown-6) "BoBCalixC6"	0.01 M	Highly specific Cs extraction into organic phase from caustic aqueous solution
Diluent Modifier <div style="text-align: center;">  </div> Aromatic fluoroalcohol "Cs-7SBT"	0.5 M	Increases extractant strength for Cs, prevents precipitation and third phase formation
Suppressor $N(C_8H_{17})_3$ Trioctylamine "TOA"	0.001 M	Promotes back extraction of Cs from organic to aqueous phase during stripping operation

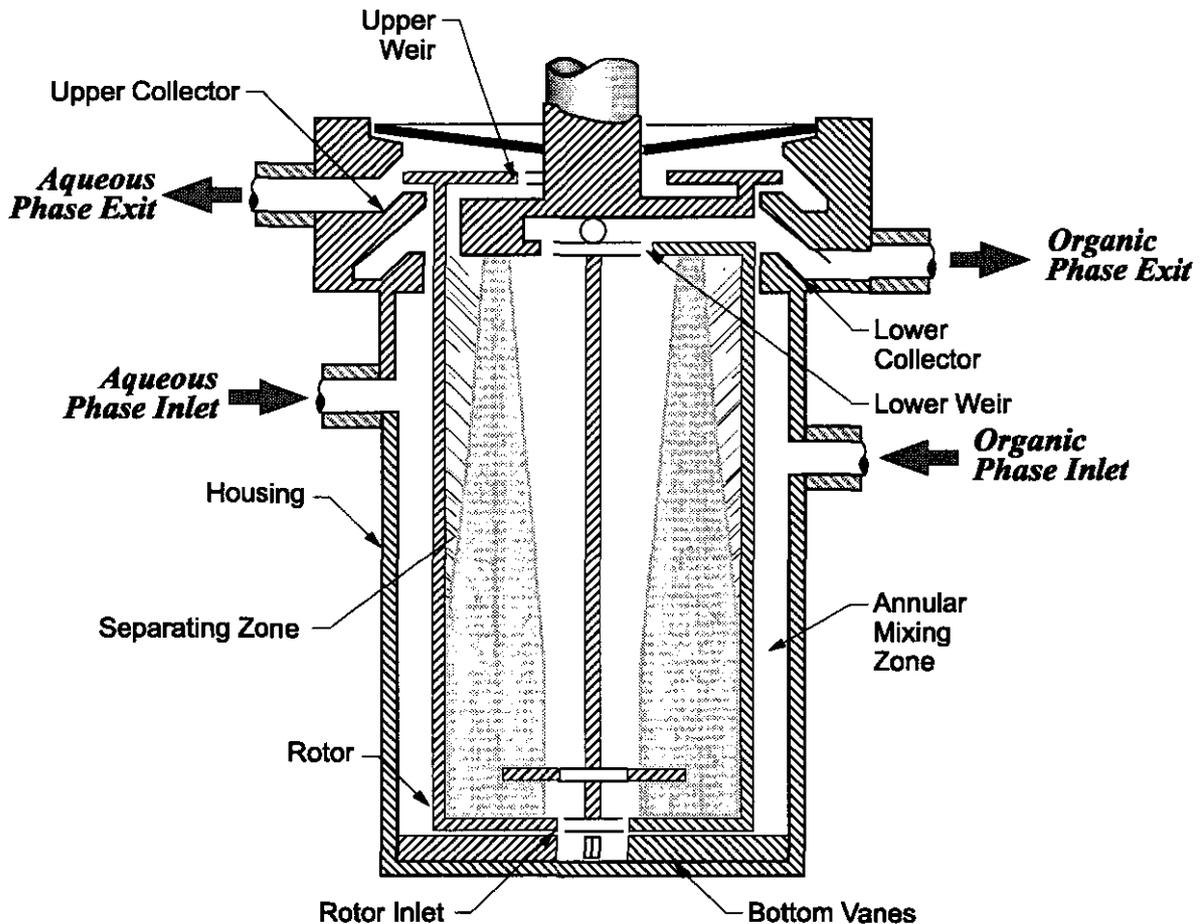
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that for the Ion Exchange process, initial clarification of the salt solution in the Batch Alpha Sorption Tank would remove strontium and actinides by sorption onto monosodium titanate, followed by filtration of the monosodium titanate solids and any residual sludge, for transfer to DWPF. The separation of radioactive cesium from the salt solution by solvent extraction would take place in a multi-stage countercurrent extraction facility. The facility consists typically of an assembly of centrifugal two-phase contactors for extraction of cesium into the organic phase, scrub contactors for removing non-cesium salt constituents from the organic phase, and strip contactors for back extrac-

tion of the cesium into an acidic aqueous stream. The design and operation of the centrifugal contactors is shown in the text box on page A-19.

The cesium-containing caustic salt solution injected into the contactor assembly at the head end of the extraction section (between extraction and scrub sections) would be progressively depleted of cesium as the aqueous phase moves through the extraction contactors, and would emerge at the back end of the extraction section as a salt solution with very low cesium content. The organic phase (solvent), injected at the back end of the extraction section for countercurrent

Centrifugal Contactor Design and Operation



The separation of radioactive cesium from a high-level waste salt solution by solvent extraction utilizes countercurrent centrifugal contactors to provide high surface area interaction between the organic solvent and aqueous solution. These contactors consist of a rapidly rotating inner chamber (rotor) contained within a stationary housing, allowing mixing of organic and aqueous phases as an emulsion in the outer chamber, followed by centrifugal separation of the lesser density organic phase from the greater density aqueous phase in the rotor. The organic and aqueous phases are injected into the housing for transport through an annular mixing zone to an inlet at the bottom of the rotor. Centrifugal separation of the two phases occurs in the rotor as the emulsion flows upward, collected at the top as aqueous phase from the outer circumference and as organic phase from the center of the rotor. For extraction cycles, the cesium is transferred from the caustic aqueous phase to the organic phase and for stripping cycles it is transferred from the organic phase to an acidic aqueous phase during contactor operation.

NW SDA EIS/Grfx/App A/Centrifugal.bi

movement through the contactors, would be progressively concentrated in cesium, scrubbed to remove other salt constituents, then stripped of cesium by contact with a dilute acid aqueous stream. The strip effluent would emerge from the back end of the stripping section as a concentrated-cesium-containing aqueous solution. The organic solvent recovered from the stripping operation would be washed with dilute caustic to remove degradation products, and recycled through the extraction process, with losses made up by replacement. Occasional purging of degraded solvent during washing would generate a low-volume organic waste stream that would be stored for appropriate disposal.

Following solvent extraction separations, both decontaminated salt (raffinate) and concentrated cesium solutions (strip effluent) would be processed through stilling tanks, to float and decant entrained organic (mostly diluent) before transferring the solutions to final disposition. The decontaminated raffinate solution would be consigned to a hold tank for processing to saltstone and the strip effluent solution, assuming no concentration by evaporation, would be transferred to a hold tank for vitrification in DWPF. The wash solutions from the organic solvent cleanup would be processed to saltstone.

A.4.3.4 Direct Disposal in Grout

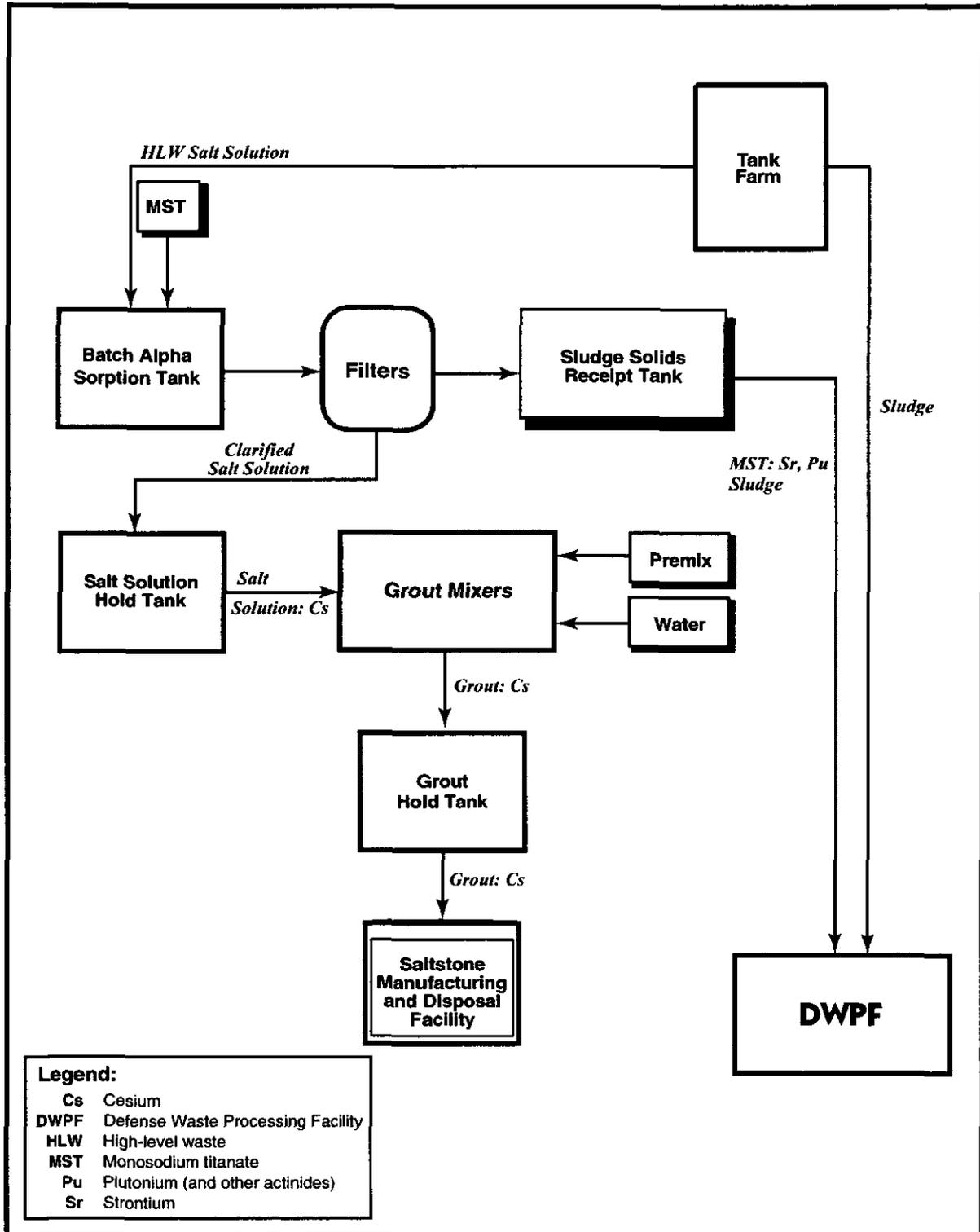
In the Direct Disposal (of cesium) in Grout alternative (WSRC 1998e), the HLW salt solution would be immobilized in saltstone vaults without separation of the radioactive cesium. The saltstone produced would meet acceptance criteria for near-surface disposal of low-level radioactive Class C waste (as defined in 10 CFR 61.55), but would exceed limits for Class A wastes. Treatment of the salt solution to remove strontium and actinides, as well as residual sludge, would still be required to meet restrictions on alpha-emitting radionuclides and HLW constituents in the saltstone.

If saltstone waste containing radioactive cesium was disposed in Z-Area vaults, revision of saltstone disposal procedures would be required. The existing permit issued by SCDHEC requires waste disposed in Z-Area vaults to be within Class C limits as defined in 10 CFR 61.55. SRS practice, established by DOE to minimize long-term environmental impacts, further restricts the overall average concentration of long-lived radionuclides in the Z-Area vaults at or below Class A limits. This restriction does not preclude occasional disposal of waste with higher radionuclide content if it can be shown that the waste would not produce unacceptable radiation exposure to the public, onsite workers, or inadvertent intruders. SCDHEC must be informed if the radiological content of the waste exceeds Class A limits (Martin Marietta 1992).

For the Direct Disposal in Grout alternative, a new facility would be constructed in Z Area, using grout production equipment modified to provide radiation shielding and enable remote operation and maintenance, because of the anticipated radioactive cesium concentrations. Direct Disposal in Grout process operations are illustrated in the flow diagram in Figure A-9. The salt solution would be collected in an H-Area tank and pumped to the Direct Disposal in Grout facility through a new Low Point Drain Tank (LPDT) facility, using the existing inter-area line. The new LPDT would be required to provide adequate shielding for the higher radioactivity in the waste stream than is present in the current feed.

In the new Direct Disposal in Grout facility, salt solution would be fed into a large Batch Alpha Sorption Tank for treatment with monosodium titanate to remove soluble radioactive contaminants other than cesium (strontium and actinides). The monosodium titanate and entrained sludge solids would be separated from the salt solution by cross-flow filtration and washed. The washed solids, collected as slurry in the Sludge Solids Receipt Tank, would be pumped through new and existing transfer lines to the DWPF melter for conversion into the glass waste form. This would be the only Direct Disposal in Grout waste stream incorporated into the DWPF waste glass production operation.

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Figure A-9. Direct Disposal in Grout process flow diagram.

The clarified salt solution resulting from monosodium titanate treatment in the Direct Disposal in Grout facility would be transferred to a Salt Solution Hold Tank to be processed to saltstone.

During saltstone processing, the filtered salt solution would be pumped to a mixer and combined with flyash, cement, and slag to form a batch of grout for disposal in the saltstone vaults. The grout mixture would be pumped to a Grout Hold Tank serving as the feed tank for the Grout Feed Pumps transferring the grout to the saltstone vaults. Thirteen additional vaults would be constructed in Z Area to accommodate Direct Disposal in Grout processing. After each batch of grout was processed and transferred to a vault, the grout transfer lines, Grout Hold Tank, and Grout Feed Pumps would be flushed to remove any residual material for recycle through the process. Direct Disposal in Grout would generate no secondary waste streams.

Chemical composition of the saltstone from the Direct Disposal in Grout process is compared with that from Small Tank Precipitation, Ion Exchange, and Solvent Extraction processes in Table A-1. Expected concentrations of major radionuclides in the saltstone are shown in Table A-2. The values are from an earlier characterization of saltstone, produced for ITP processing of HLW salt solutions (Martin Marietta 1992) and adjusted for dilution by the new salt processing alternatives, based on the sodium concentrations of the saltstone feed streams.

A.4.3.5 Process Inputs and Product Streams

A general objective of the salt processing operations is the disposition of about 80 million gallons of HLW salt solution. The processing rates of the process facilities are specified to maintain a long-term average drawdown of salt solution by about 6 million gallons per year at 75 percent attainment, allowing completion of processing of reconstituted salt solution within about

13 years after facility startup. Processing within this time period is necessary to integrate the high-radioactivity salt waste components into the DWPF vitrification operations for processing with radioactive sludge components of the waste. (See key milestones textbox in Chapter 2). The throughput of all action alternatives is limited to 6 million gallons per year due to the physical constraints of removing waste from the waste tanks.

Process throughput streams for the salt processing alternatives are compared in Table A-3.

The capacity throughputs are somewhat higher than the required long-term average throughputs for Small Tank Precipitation, Ion Exchange, and Solvent Extraction facilities to allow for DWPF outages during melter changeout. The Direct Disposal in Grout facility, not closely coupled to DWPF operation, can operate at capacity throughput equal to the required long-term average throughput (6 million gallons per year).

The product outputs of the process facilities, including high-radioactivity solids slurry or solution to DWPF, processed salt solution to grout, and saltstone generated by the salt processing alternatives, are compared in Table A-4. The Solvent Extraction process would deliver a greater volume of product to DWPF than the other alternative processes because of the high volume of cesium solution (strip effluent) in the product output of that process. Salt solutions to grout and saltstone produced would be about the same for each alternative, with the ratio of saltstone volume produced to salt solution volume uniform at about 1.8.

In addition to the principal product outputs specified in Table A-4, the Small Tank Precipitation process would generate by-product benzene. About 60,000 gallons (200 metric tons) of liquid benzene would be produced annually by decomposition of the tetraphenylborate salt in the process facilities.

In the Small Tank Precipitation process, gaseous benzene would also be generated in the process facilities, to be dispersed into the atmosphere.

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Table A-1. Chemical composition of saltstone for salt processing alternatives.

Component	Composition, weight percent ^a			
	Small Tank Tetraphenylborate Precipitation	Crystalline Silicotitanate Ion Exchange	Caustic Side Solvent Extraction	Direct Disposal in Grout
H ₂ O	33.70	32.88	34.03	32.57
NaNO ₃	6.60	7.60	6.20	8.00
NaOH	1.90	2.20	1.80	2.40
NaNO ₂	1.60	1.90	1.50	2.00
NaAl (OH) ₄	1.20	1.40	0.94	1.40
NaCO ₃	0.65	0.75	0.61	0.79
Na ₂ SO ₄	0.65	0.75	0.61	0.79
Na ₂ C ₂ O ₄	0.07	0.08	0.07	0.09
NaCl	0.05	0.05	0.05	0.06
Na ₃ PO ₄	0.05	0.05	0.05	0.06
Na ₂ SiO ₃	0.03	0.03	0.03	0.03
NH ₄ NO ₃	0.03	0.04	0.03	0.04
NaB (C ₆ H ₅) ₄	0.03	-	-	-
Na ₂ CrO ₄	0.02	0.02	0.02	0.02
NaF	0.02	0.03	0.02	0.03
CaSO ₄	0.02	0.02	0.02	0.02
NaHgO (OH)	(b)	(b)	(b)	(b)
KNO ₃	(b)	(b)	(b)	(b)
Salt Solution Total	46.61	47.80	45.98	48.30
Dry Blend ^c	53.39	52.20	54.02	51.70
Total	100	100	100	100

- a. The values presented are taken from a previous characterization of saltstone produced during ITP processing of HLW salt solution (Martin Marietta 1992), adjusted for dilution in the new salt processing alternatives using sodium concentrations of 4.58 molar for Small Tank Precipitation, 5.31 molar for Ion Exchange, 4.30 molar for Solvent Extraction, and 5.63 molar for Direct Disposal in Grout processing, compared to 4.58 molar for ITP processing.
- b. Expected present; concentration less than 0.01 weight percent.
- c. Dry Blend is cement, flyash, and slag.

Issues associated with gaseous benzene generation have resulted in a number of design features that would reduce or mitigate this problem. Controlled benzene removal, because of flammability concerns, would be accomplished by operating the process vessels with a nitrogen atmosphere. The tank vent systems would be equipped with both primary and backup nitrogen purge systems (WSRC 1998e). The Ion Exchange, Solvent Extraction, and Direct Disposal in Grout processes do not have the same benzene concerns. Rather, the issue for these alternatives is radiolytic decomposition of water into hydrogen and oxygen. Air sweeps of tanks are generally considered sufficient to eliminate the danger of explosions (WSRC 1998i). However, since the consequences of

an explosion are unacceptable, due to the high radioactive loading within the process tanks, the design for Ion Exchange, Solvent Extraction, and Direct Disposal in Grout facilities would include both primary and backup purge systems, comparable to those used in the Small Tank Precipitation facility.

The Solvent Extraction process would also generate a liquid organic waste requiring disposal (WSRC 2000c). The total solvent inventory for the process, consisting primarily of the diluent Isopar[®]L, is projected to be 1,000 gallons. This inventory is conservatively assumed to be replaced once per year. For an operational time of 13 years, the accumulated total volume of solvent requiring disposition would be 13,000 gallons.

Table A-2. Radionuclide content of saltstone for salt processing alternatives.

Radionuclide	Concentration (nCi/g)			
	Small Tank Precipitation	Ion Exchange	Solvent Extraction	Direct Disposal in Grout
Technetium-99	33	38	31	40
Ruthenium-106+d ^a	17	20	16	21
Cesium-137+d ^a	10	12	9	254,000 ^b
Tritium	10	12	9	12
Antimony-125	3.3	3.8	3.1	4.0
Promethium-147	2.0	2.3	1.9	2.4
Samarium-151	1.0	1.2	0.95	1.2
Strontium-90+d ^a	0.35	0.40	0.33	0.42
Europium-154	0.33	0.38	0.31	0.40
Selenium-79	0.16	0.19	0.15	0.20
Europium-155	0.16	0.19	0.15	0.20
Cobalt-60	0.11	0.12	0.10	0.13
Tellurium-125m	0.10	0.12	0.09	0.12
Tin-126+d ^a	0.07	0.08	0.07	0.08
Cesium-134	0.03	0.04	0.03	440
Tin-121m	0.01	0.02	0.01	0.02
Iodine-129	0.01	0.01	0.01	0.01
Nickel-63	0.01	0.01	0.01	0.01
Antimony-126	0.01	0.01	0.01	0.01
Carbon-14	0.003	0.004	0.003	0.004
Cesium-135	0.00002	0.00002	0.00003	0.26
Other beta gamma	3.3	3.8	3.1	4.0
Plutonium-238	0.03	0.03	0.03	0.03
Plutonium-241	0.02	0.02	0.02	0.02
Americium-241	0.07	0.08	0.07	0.08

nCi/g = nanocuries per gram.

a. +d = with daughter product.

b. Cesium-137+d content of the saltstone for Direct Disposal in Grout alternative corresponds to 225 Ci/m³ of cesium-137 (WSRC 1998a,k).**Table A-3.** Salt solution processed.

Alternative	Required processing rate (million gallons) ^a per year	Long-term average throughput capacity (million gallons per year) ^a	Throughput limitation
Small Tank Precipitation	6.9	6.0	Salt removal rate from waste tanks
Ion Exchange	6.9	6.0	Salt removal rate from waste tanks
Solvent Extraction	6.9	6.0	Salt removal rate from waste tanks
Direct Disposal in Grout	6.0	6.0	Salt removal rate from waste tanks

Source: WSRC (1998e).

a. The required processing rate for the salt processing facilities exceeds the long-term average to allow for downtime when DWPF is not operating, except for the Direct Disposal in Grout facility which can operate at the required salt removal rate even when DWPF is not operating.

Table A-4. Product outputs.

Alternative	Annual			Life cycle		
	Solids slurry (and solution) to DWPF (gallons per year)	Salt solution to Grout (million gallons per year)	Grout produced (million gallons per year)	Solids slurry (and solution) to DWPF (million gallons)	Salt solution to Grout (million gallons)	Grout produced (million gallons)
Small Tank Precipitation (13 years) ^a	223,000	8.0	14.5	2.9	104	188
Ion Exchange (13 years) ^b	200,000	6.6	12.0	2.6 ^f	86	156
Solvent Extraction (13 years) ^c	677,000 ^e	7.5	13.5	8.8 ^e	97	175
Direct Disposal in Grout (13 years) ^d	154,000	5.9	10.8	2.0	77	141

a. WSRC (1998l; 2000b).

b. WSRC (1998m).

c. WSRC (1998n; 2000b).

d. WSRC (1998k).

e. Includes 154,000 gal/yr solids slurry and 523,000 gal/yr solution (strip effluent without evaporation) (WSRC 1998e).

f. Includes 2 million gallons monosodium titanate slurry and 600,000 gallons crystalline silicotitanate slurry (WSRC 1998e,m).

Note: Material balance estimates are ± 25 percent.

Radionuclide	Concentration in Saltstone (Ci/m ³)	Concentration Limit (Ci/m ³)		
		Class A	Class B	Class C
Long-Lived Activities				
Technetium-99	0.07	0.3	-	3.0
Iodine-129	0.00002	0.008	-	0.08
Total alpha	0.0002	0.02	-	0.2
Short-Lived Activities				
Tritium	0.02	40	(a)	(a)
Strontium-90	0.0004	0.04	150	7,000
Cesium-137	225	1	44	4,600

a. No limit.

Ci/m³ = curies per cubic meter.

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A.5 Process Facilities

A.5.1 PROCESS BUILDINGS

New shielded process buildings (WSRC 1998e,o) would be constructed for each salt processing alternative. The process buildings for the Small Tank Precipitation, Ion

Exchange, and Solvent Extraction alternatives would be at Site B in S Area and for the Direct Disposal in Grout alternative, in Z Area.

In each case, the process buildings would be constructed of reinforced concrete and include the shielding required for handling highly radioactive materials. The facilities would be sized to

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contain large feed, storage, and product hold tanks to ensure an average processing rate of 25,000 gallons per day of salt solution. The size of the tanks would also serve to decouple or buffer the continuous flows of the Small Tank Precipitation, Ion Exchange, and Solvent Extraction processes from the batch flows of the tank farms, and ensure the capability to process the expected average 6 million gallons-per-year of salt solution.

The building specifications would be similar for each of the four salt processing alternatives. Preliminary design dimensions are provided in Table A-5. The buildings would range from 60 to 70 feet above ground level, with crane maintenance bays up to 110 feet high. They would extend down to as much as 40 feet below ground level, allowing shielded, remotely operated, chemical processing cells to be located partially below grade. Site requirements for each alternative process facility are presented in Table A-6.

Adjacent operating areas above grade would extend around the perimeter of the processing cells and contain chemical feed pumps

and tanks, radioactive and non-radioactive laboratories for sample testing, electrical and mechanical equipment areas, and a truck unloading area. Shielded maintenance areas would be provided for remote equipment laydown, equipment decontamination, and crane maintenance. Figure A-10 presents the floor plan for the Small Tank Precipitation facility, and Figure A-11 presents the elevation for the facility. Figures A-12 and A-13 present the corresponding plans for the Ion Exchange facility, Figures A-14 and A-15 for the Solvent Extraction facility, and Figures A-16 and A-17 for the Direct Disposal in Grout facility.

The process cells would contain equipment required for the respective process alternatives. These include precipitate and sorption reactor tanks; chemical storage, feed, and product hold tanks with associated transfer and sample pumps; pass-through filter assemblages; and grout mixers and transfer equipment. In the case of the Ion Exchange alternative, the ion exchange columns for cesium removal would also be housed in the process cells. In the case of the Solvent Extraction alternative, the centrifugal contactors would be housed in the process cells.

Table A-5. Building specifications for each action alternative.

	Process Alternative ^a			
	Small Tank Precipitation	Ion Exchange	Solvent Extraction	Direct Disposal in Grout
Length, ft.	310	280	300	220
Width, ft.	140	140	120	120
Height, ft.	60 (100 ft. bay)	60 (100 ft. bay)	70 (110 ft. bay)	60 (90 ft. bay)
Depth below grade, ft.	40	40	40	20
Floor Area, ft. ²				
including processing cells	66,000	60,000	62,000	54,000
excluding processing cells	50,000	48,000	48,000	43,000
Volume, ft. ³				
including processing cells	4,500,000	4,200,000	4,500,000	1,800,000
excluding processing cells	4,500,000	3,600,000	3,900,000	1,200,000
Processing cell floor area, ft. ²	16,000	12,000	13,000	11,000
Processing cell volume, ft. ³	640,000	550,000	600,000	570,000

Source: WSRC (1998o, 2000c).

a. Building specifications rounded to two significant figures.

Table A-6. Site requirements for the process building and required support facilities.

Small Tank Precipitation, Ion Exchange, and Solvent Extraction Alternatives	Direct Disposal in Grout Alternative
Clear 23 acres in S Area	Clear 15 acres in Z Area
Construct 5,000 linear feet of access roads	Same
Construct 1,000 linear feet of site roads	Same
Construct a paved parking area for 200 cars (40,000 square feet)	Same
Construct a storm sewer system	Same
Construct site security fence with two vehicle gates	Same
Construct a security fence around the substation	Same
Construct 2,500 feet of sewer line to tie into the existing sewer system	Same
Construct 3,000 feet of water line to tie into the existing potable water system	Construct 2,000 feet of water line
Construct 7,500 feet of power line	Construct 700 feet of power line
Construct a 13.8-kV to 480-V switchyard	Same
Install yard piping for water and sewer distribution systems	Same
Install electrical ductbank distribution system	Same
Install security lighting	Same

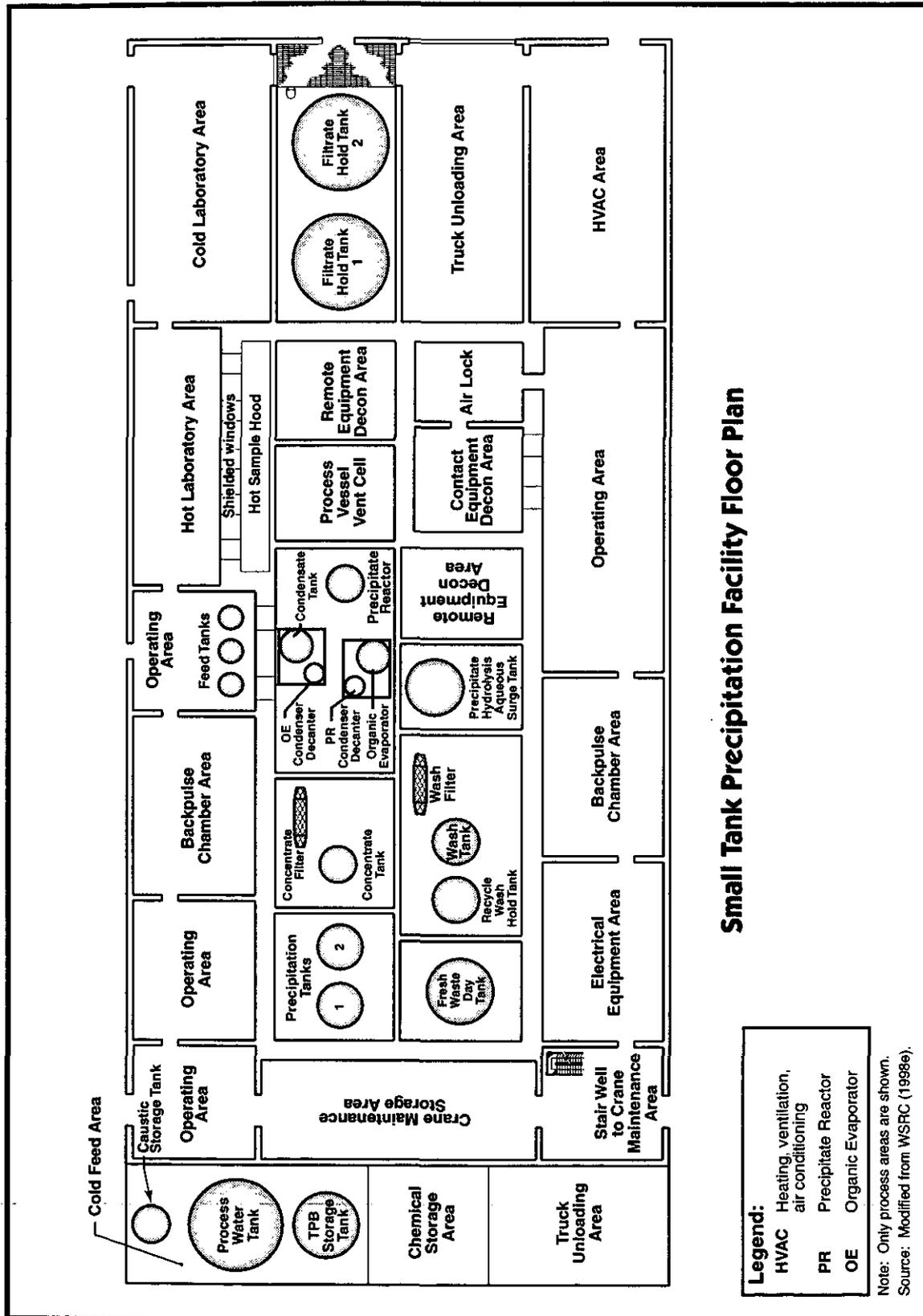
Source: WSRC (1998o).

Sumps with leak detection and collection capability would be provided in the cells. The cells would be protected by concrete cell covers and accessible by a remotely-operated crane. The building configurations would allow crane or manipulator access to all shielded process, maintenance, and sampling areas. The cell components would be designed for remote maintenance, replacement, and later decommissioning.

Safety features for each salt processing alternative incorporated into facility design would include:

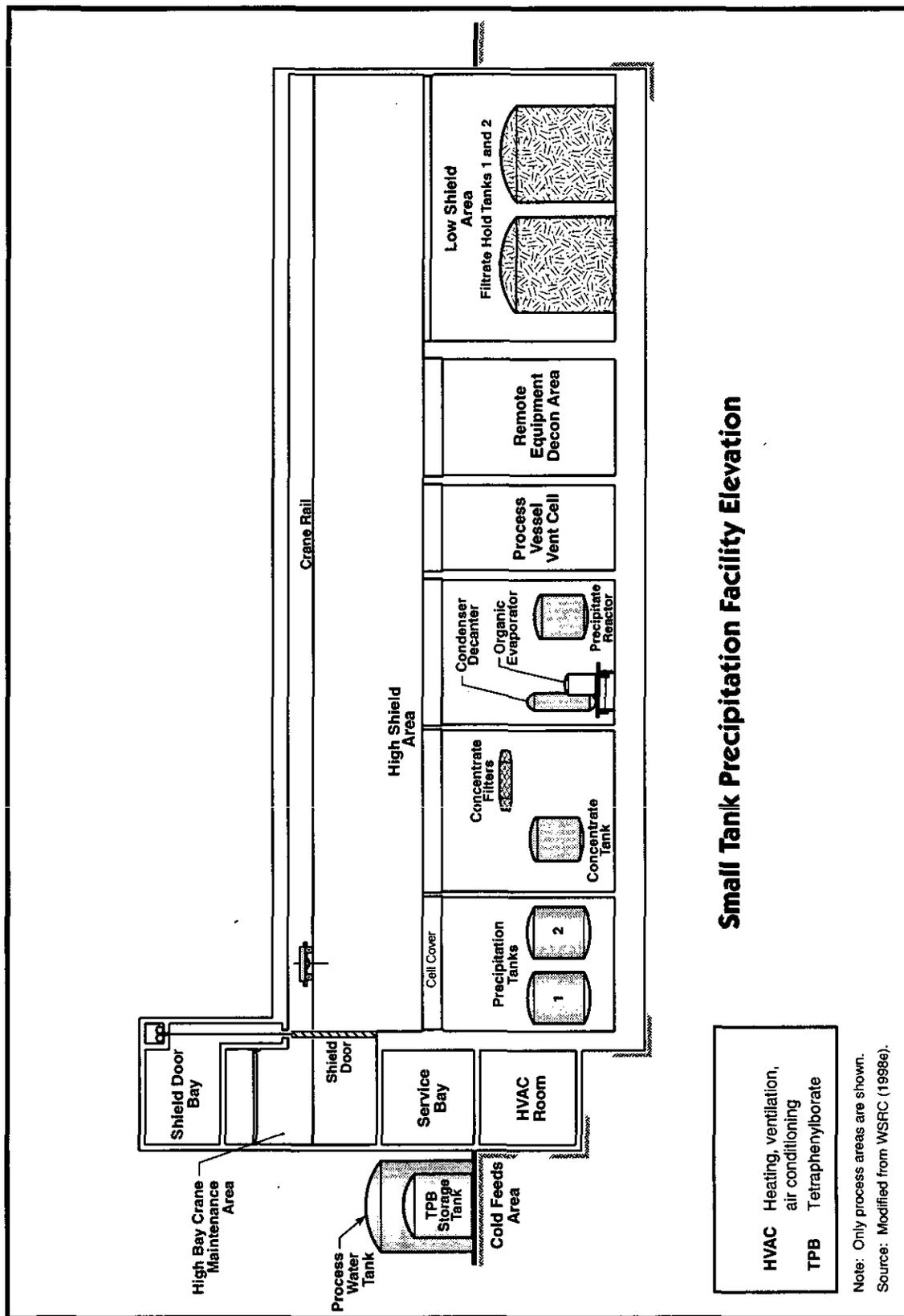
- Systems to detect leaks in processing piping and vessels
- Structurally strengthened process buildings and process cells to protect process vessels and equipment in case of seismic or other natural phenomena hazard events
- Process vessel vent or purge systems
- Systems to cover process vessels with inert gases, to prevent catastrophic fires

- Leak detection systems and engineered safety features, designed to automatically stop the process before material is released to the environment, if a leak is detected
- Primary confinement of process piping and vessels that could withstand natural phenomena hazard events
- Secondary confinement systems, including ventilation systems, designed to prevent or mitigate unscheduled events and to continue operating, even in the event of a loss of power
- Seismically-qualified equipment, including vessels and piping
- Remote operations
- Adequate shielding
- Temperature monitoring systems to alert operators to any loss of cooling for the Small Tank Precipitation, Ion Exchange, or Solvent Extraction processes
- Radiation and airborne contamination monitors.



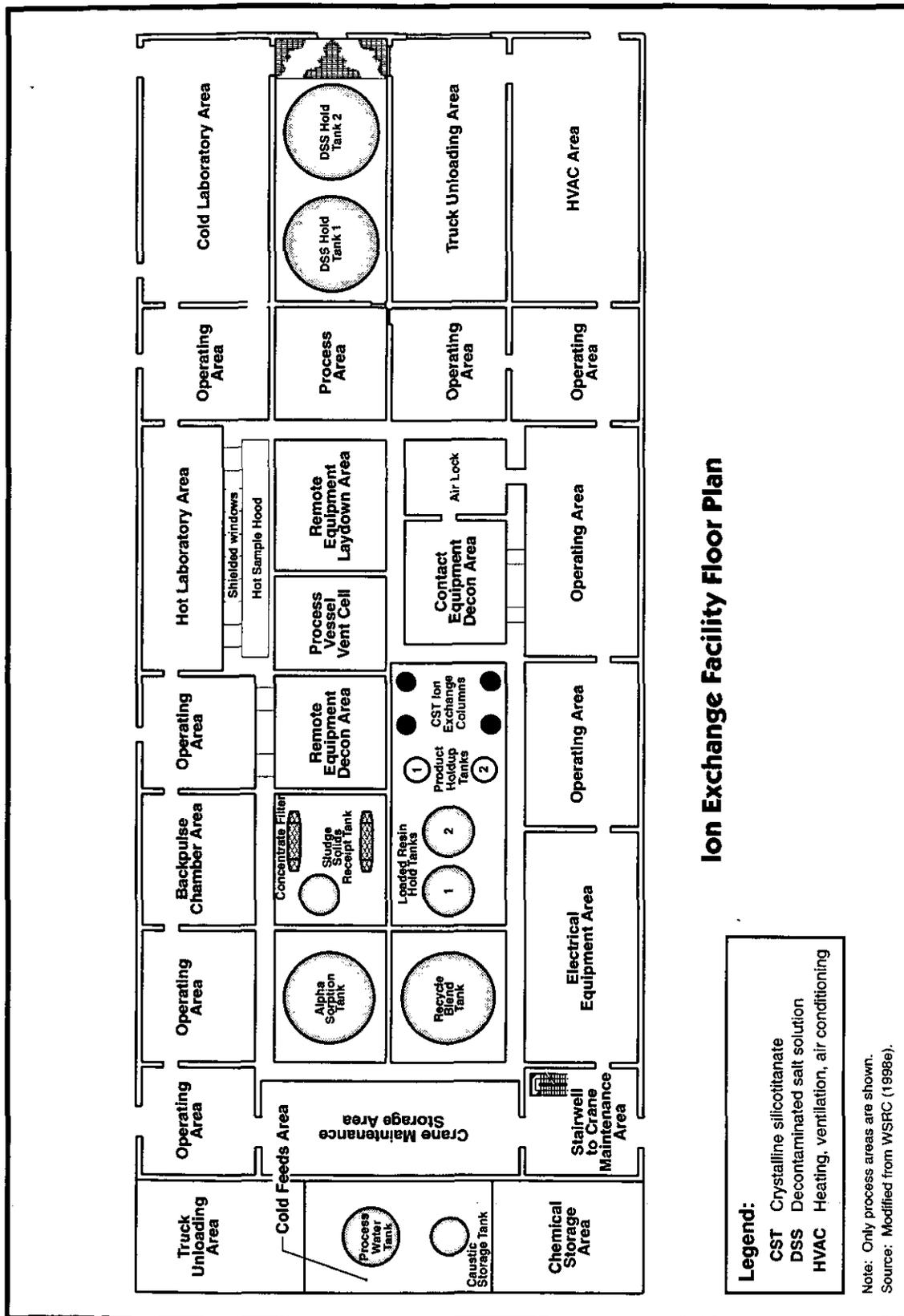
Small Tank Precipitation Facility Floor Plan

Figure A-10. Floor plan for Small Tank Precipitation facility.



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Figure A-11. Elevation Plan for Small Tank Precipitation facility.



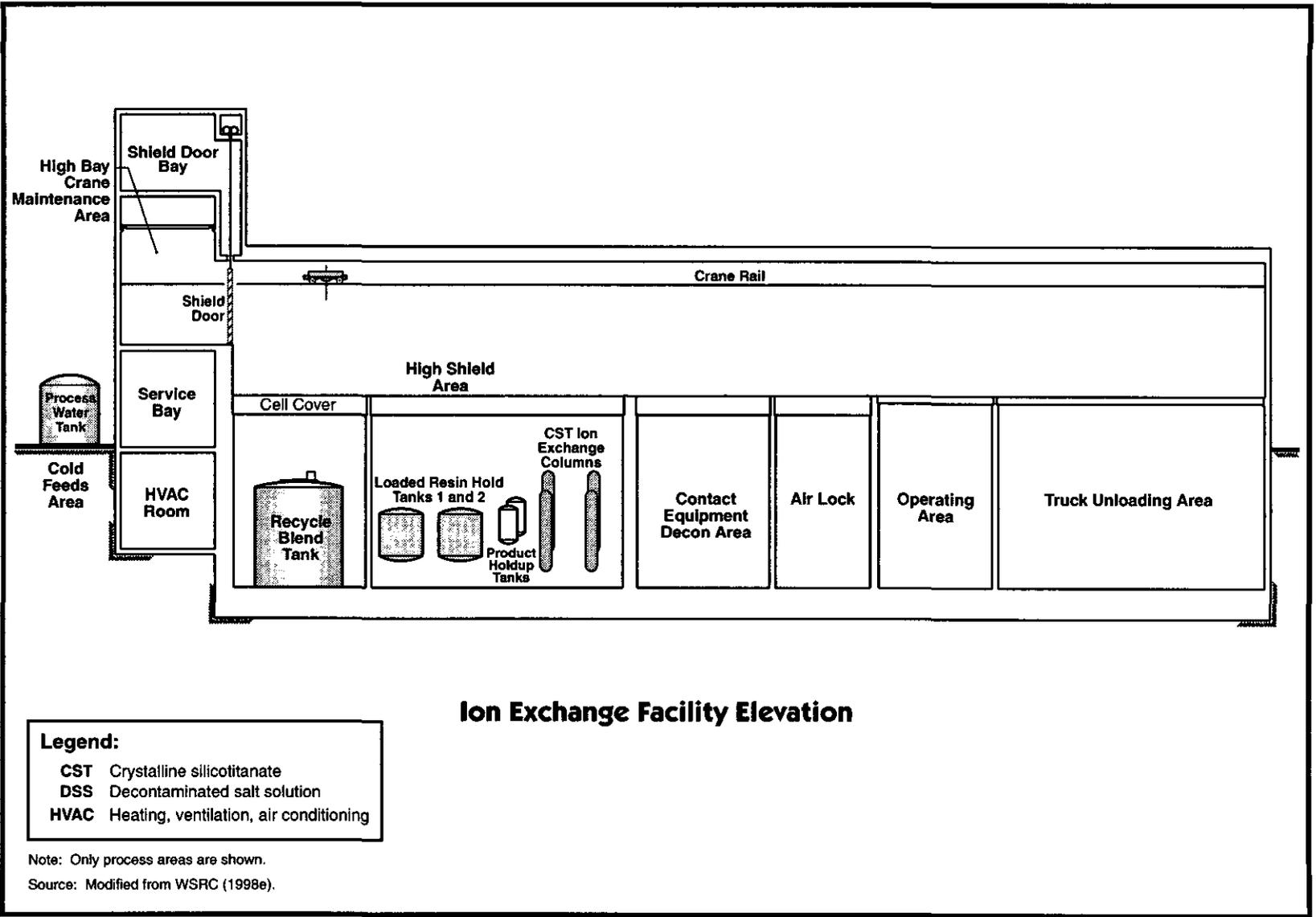
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Ion Exchange Facility Floor Plan

Legend:
 CST Crystalline silicotitanate
 DSS Decontaminated salt solution
 HVAC Heating, ventilation, air conditioning

Note: Only process areas are shown.
 Source: Modified from WSRC (1998e).

Figure A-12. Floor plan for Ion Exchange facility.



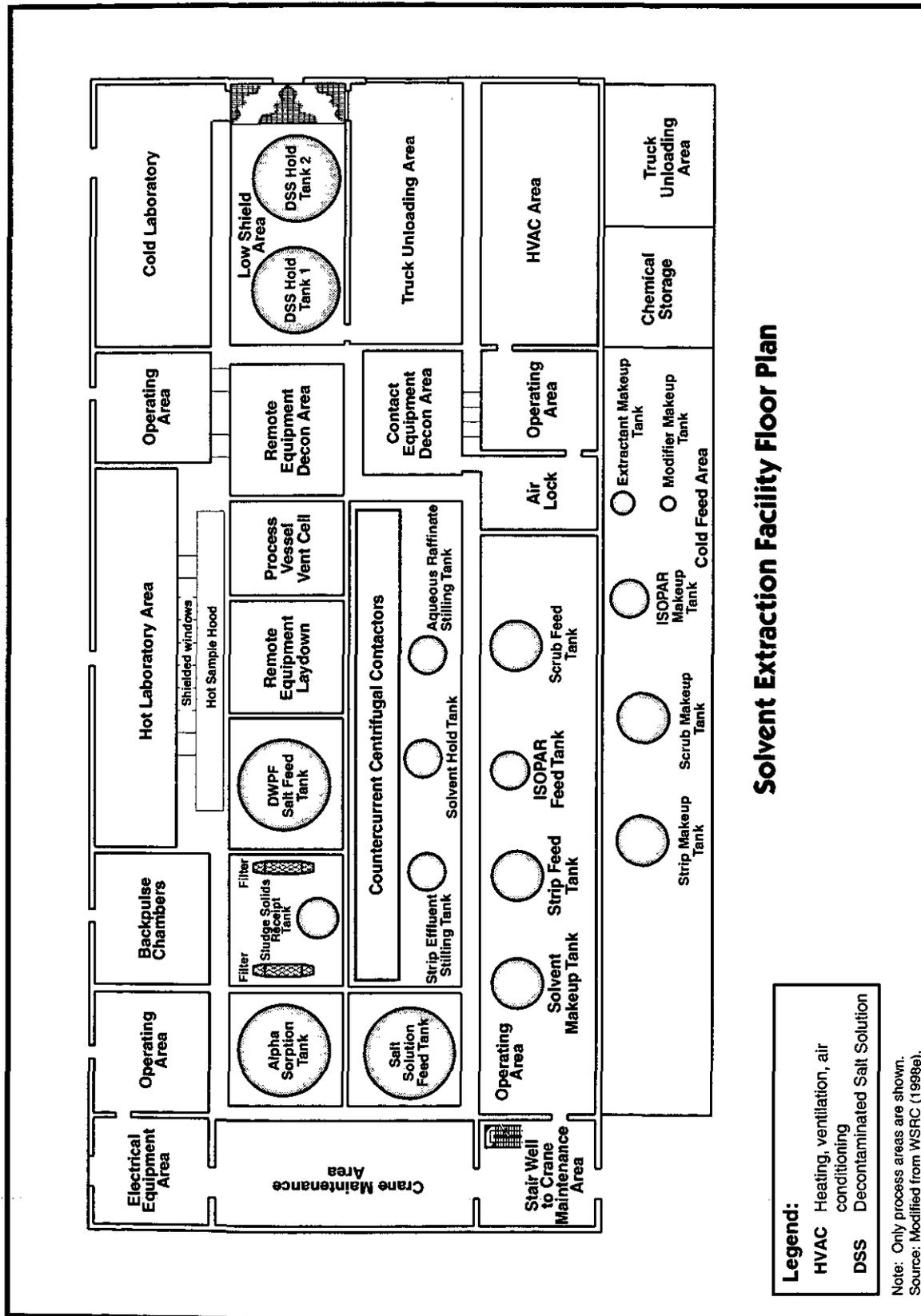
Ion Exchange Facility Elevation

Legend:
 CST Crystalline silicotitanate
 DSS Decontaminated salt solution
 HVAC Heating, ventilation, air conditioning

Note: Only process areas are shown.
 Source: Modified from WSRC (1998e).

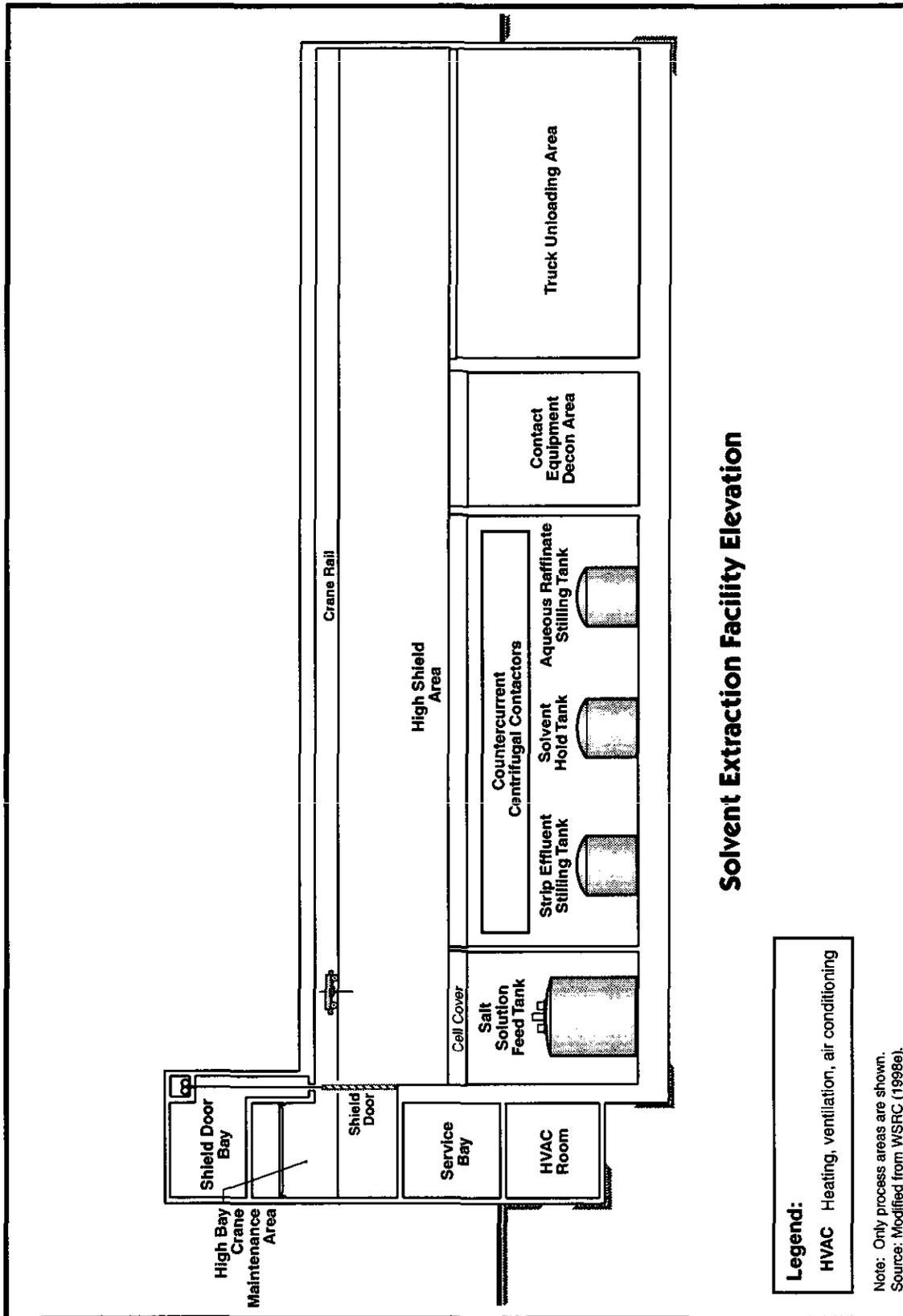
NW SDA EIS/Grfx/App_A/A-13 Elev CST Ion.al

Figure A-13. Elevation plan for Ion Exchange facility.



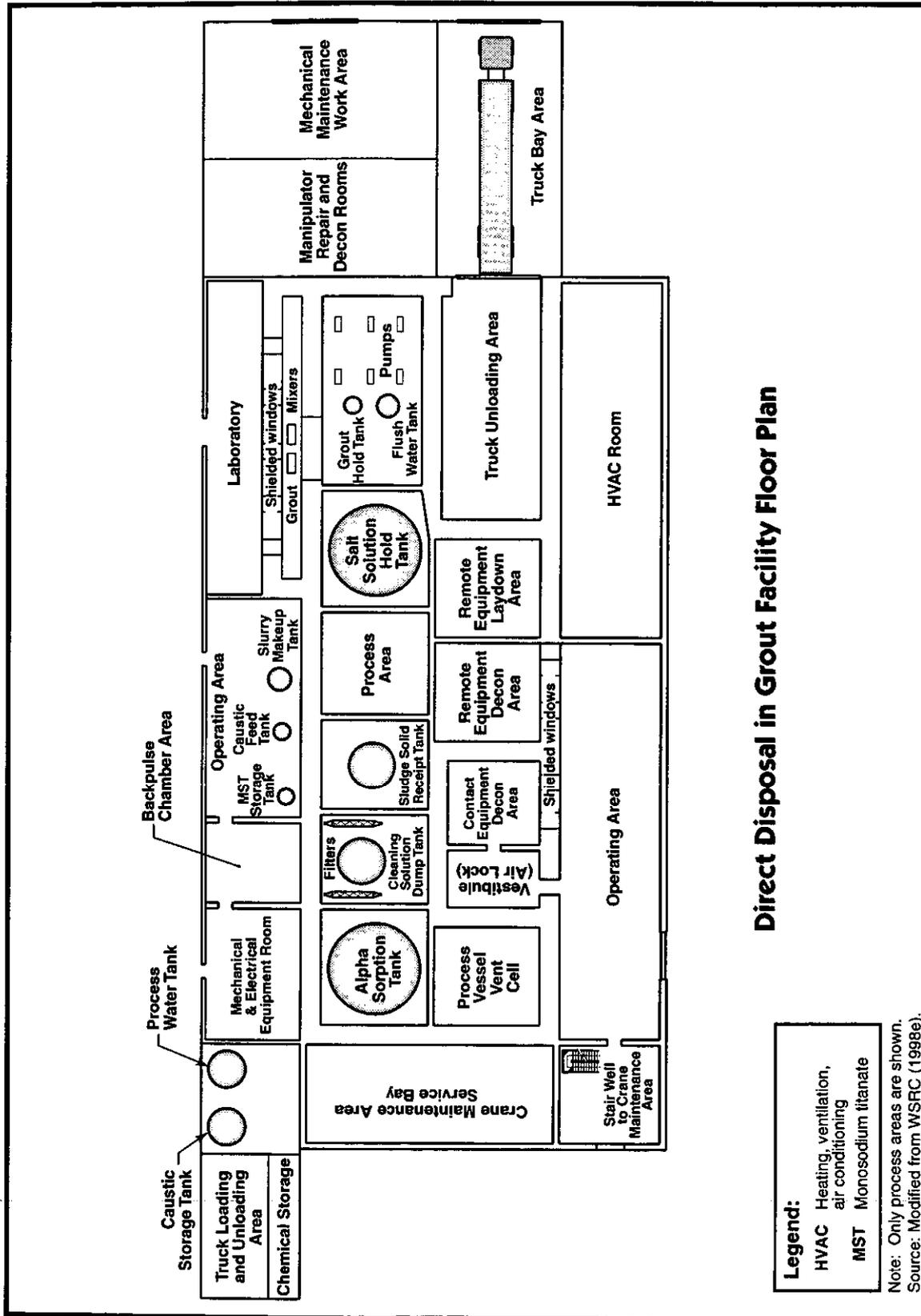
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Figure A-14. Floor plan for Solvent Extraction facility.



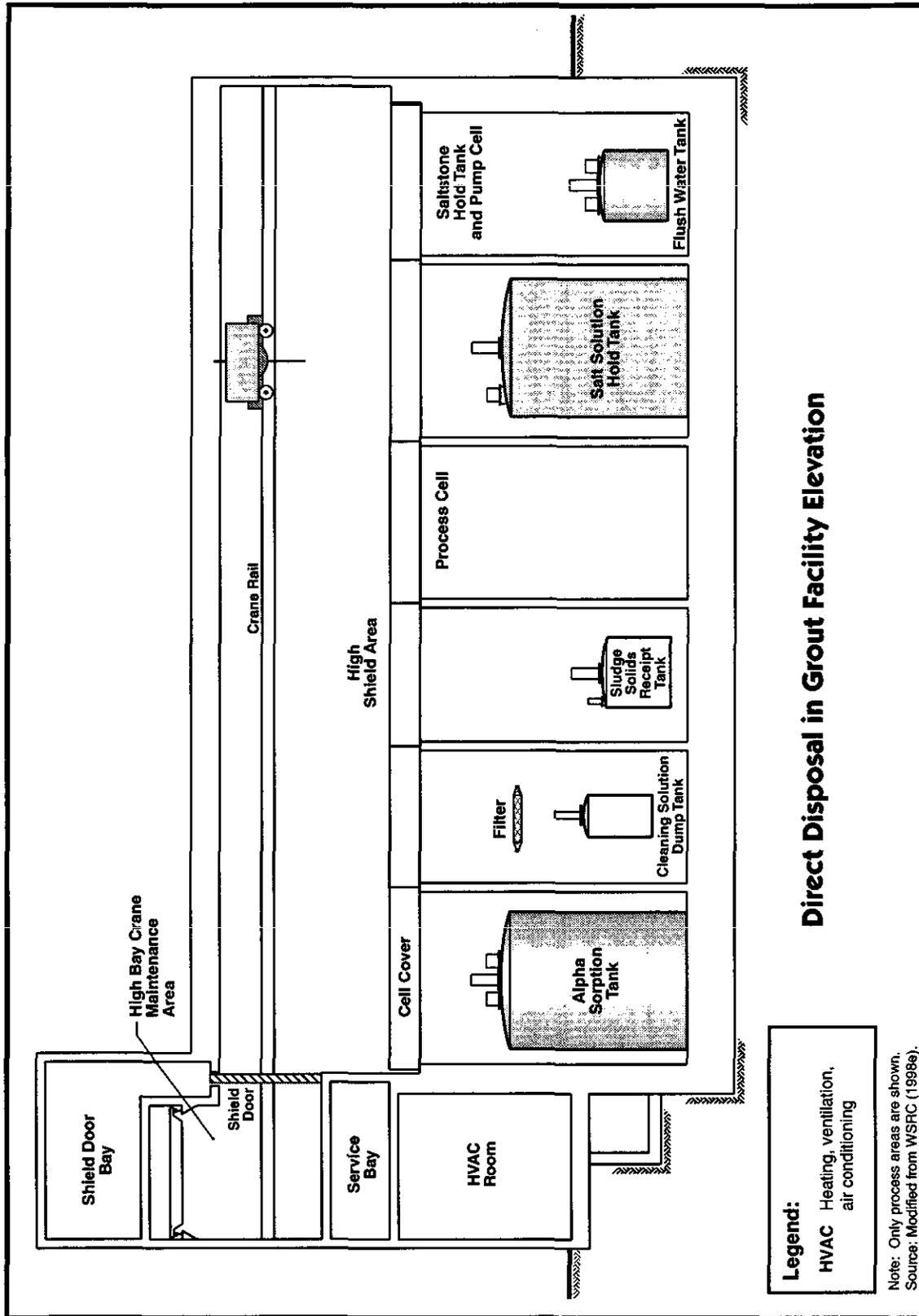
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Figure A-15. Elevation plan for Solvent Extraction facility.



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Figure A-16. Floor plan for Direct Disposal in Grout facility.



NW SDA EIS/Grout/App_AA-17 Dir Disp elev.a

Figure A-17. Elevation plan for Direct Disposal in Grout facility.

A.5.2 TANK REQUIREMENTS

The types and sizes of process and storage tanks and vessels needed for facility operations would depend on the salt processing alternative utilized. Summary listings of the tanks required for the Small Tank Precipitation, Ion Exchange, Solvent Extraction, and Direct Disposal in Grout processes are given in Tables A-7, A-8, A-9, and A-10, respectively (WSRC 2000d). The characteristics of these tanks form the basis for development of accident scenarios and consequences projected in Appendix B.

A.5.3 TRANSFER FACILITIES

New transfer facilities would be required to direct the flow of process streams among the various facilities employed in the salt processing alternatives. These include feed lines to the facilities, transfer lines between facilities, and several valve boxes, diversion boxes, and pump pits directing the stream flows (WSRC 1998o, 2000c). Details of the processing-related transport facilities are described in Table A-11. The integration of these new facilities into existing facilities is illustrated in Figures A-18 through A-21 (WSRC 1998e, 1999c).

A.5.4 SUPPORT FACILITIES

Each alternative would require other support facilities including service, office, and substation buildings. The service building would be a single-story, 21,000-23,700-square-foot steel-framed structure with concrete or brick siding. This building would contain electrical and mechanical maintenance shops, control rooms for the process and for the remote crane, a health physics office, conference room, and offices for operations personnel. The structure would also house two 500-kilowatt (kW) diesel generators and associated equipment (WSRC 1998o). The office building would typically be a 22,500-square-foot single-story structure capable of providing personnel emer-

gency shelter protection. It would house offices, a conference area, cafeteria, and restroom facilities for support personnel (e.g., engineering support, facility management, and clerical staff). The support facilities for each technology would include a process simulator building.

An electrical substation building, encompassing 600 square feet, would be needed for each alternative. A chemical storage area would be located on a concrete slab adjacent to the process building and add approximately 30 feet to the length of the process building. The area would be protected from the elements and contain storage tanks for chemicals used in the process. Dikes would be located around the tanks to contain any potential spills and to prevent inadvertent mixing of chemicals.

A.5.5 SALTSTONE VAULTS

As many as 16 saltstone disposal vaults beyond the currently existing two vaults would be constructed in Z Area to support the salt disposal alternatives (Figure A-22). Nominal dimensions of the additional vaults would be 300 feet long by 200 feet wide by 25 feet high. Each vault would consist of six cells, 100 feet long by 100 feet wide, to contain about 6,600 cubic meters of saltstone grout per cell. Interior and exterior walls would be 18 inches thick and the base slab would be 30 inches thick. The roof slab would be 18 inches thick. The interior floor and walls for each cell would be painted with epoxy to inhibit infiltration of moisture during grout curing. Any voids left in the grout in a cell would be filled with nonradioactive grout prior to final vault closure to help ensure structural integrity. All vaults would be equipped with cameras and lights to monitor filling, and thermocouple assemblies to monitor heat generation during the curing process. The six-cell configuration of the vaults would facilitate a pouring rotation that would meet grout-cooling requirements. As with the existing saltstone vaults, the additional vaults would be considered near-surface containment structures and covered with soil after vault closure for additional shielding.

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Table A-7. Tanks for Small Tank Precipitation Process.

Tank	Tank size (gallons)	Number of tanks	Radioactive	Stream characteristics	Ventilation flow per tank (cfm)
MST Storage Tank	400	1	No	MST	Natural
Process Water Tank	80,000	1	No	Well water	Natural
NaTPB Storage Tank	20,000	1	No	NaTPB solution	100
Copper Nitrate Feed Tank	500	1	No	15 wt% Copper Nitrate	Natural
Formic Acid Feed Tank	500	1	No	90 wt% Formic Acid	Natural
Fresh Waste Day Tank	25,000	1	Yes	Feed	100
Precipitation Tank	15,000	2	Yes	Feed/PPT	10
Concentrate Tank	10,000	1	Yes	PPT	10
Filtrate Hold Tanks	100,000	2	Yes	DSS	10
Wash Tank	10,000	1	Yes	PPT	10
Recycle Wash Hold Tank	10,000	1	Yes	Feed/DSS ^a	10
Precipitate Reactor Feed Tank	10,000	1	Yes	PPT	10
Precipitate Reactor	10,000	1	Yes	PPT/PHA	10
Precipitate Reactor Condenser	610	1	Yes	PHA	(b)
Precipitate Reactor Decanter	610	1	Yes	PHA	(b)
Precipitate Reactor Overheads Tank	7,500	1	Yes	Dilute PHA ^c	10
Precipitate Hydrolysis Aqueous Surge Tank	40,000	1	Yes	PHA	10
Organic Evaporator	1,750	1	Yes	Benzene ^d	10
Organic Evaporator Condenser	610	1	Yes	Benzene ^d	(b)
Organic Evaporator Decanter	610	1	Yes	Benzene ^d	(b)
Organic Evaporator Condensate Tank	1,000	1	Yes	Benzene ^d	(b)
Salt Cell Vent Condenser	310	1	Yes	Benzene ^d	(b)
Organic Waste Storage Tank	40,000	1	Yes	Benzene ^d	10
Cleaning Solution Dump Tanks	1,000	2	Yes	0.01 × PPT ^e	10

DSS = Decontaminated Salt Solution, cfm = cubic feet per minute, PPT = Precipitate slurry, PHA = Precipitate Hydrolysis Aqueous, NaTPB = sodium tetrphenylborate.

- Recycled wash water will hold a diluted DSS but with higher cesium concentration. This stream is conservatively chosen to be feed for radionuclide emissions and DSS for chemical emissions.
- Condensers and decanters do not have independent ventilation. The vapor stream that enters each of these devices includes the nitrogen purge of each of the originating vessels.
- The final processing step in the precipitate reactor concentrates PHA by evaporation. This is the only time the precipitate reactor overheads tank receives any waste. The condensed overheads consists of water and entrained PHA. The amount of entrainment is assumed the same as any other boiling interface, $DF=4.4 \times 10^6$.
- Benzene includes minor quantities of other, heavier organic compounds including biphenyl. The radionuclide concentration in the solution is less than dilute PHA and make an insignificant contribution to radionuclide emissions.
- Cleaning solution is used to clean the cross flow filters and may be contaminated with some dilute mixture of PPT slurry. This stream is conservatively chosen to be 0.01 times the concentrations for PPT slurry.

Table A-8. Tanks for Ion Exchange Process.

Tank	Tank size (gallons)	Number of tanks	Radioactive	Stream characteristics	Ventilation Flow per tank (cfm)
Process Water Tank	20,000	1	No	Well Water	Natural
MST Storage Tank	400	1	No	MST	Natural
Caustic Feed Tank	5,000	1	No	1 M NaOH	100
Resin Make-up Tank/Column Preparation Tank	2,000/ 3,000	1	No	CST	100
Oxalic Acid Feed Tank	200	1	No	2% H ₂ C ₂ O ₄	100
Caustic Feed Tank	500	1	No	1 M NaOH	100
Loaded Resin Hold Tank	15,000	2	Yes	CST	100
Ba-137 Decay Tanks/ Product Holdup Tank	2,000/ 5,000	2	Yes	DSS	100
DSS Hold Tanks	100,000	2	Yes	DSS	100
Resin Hold Tank	10,000	1	Yes	CST Slurry	Existing tank in DWPF ^a
Alpha Sorption Tank	100,000	1	Yes	Feed	100
Recycle Blend Tank	100,000	1	Yes	CSS	100
Sludge Solids Receipt Tank	10,000	1	Yes	Feed/MST Slurry	100
Cleaning Solution Dump Tank	1,000	1	Yes	0.01 × MST Slurry ^b	100
Wash Water Hold Tank	25,000	1	Yes	0.25 × CSS ^c	100
CST Ion Exchange Column	3,000	2	Yes	CST Slurry,	10
	3,000	2	Yes	DSS ^d	10

CSS = Clarified Salt Solution; DSS = Decontaminated Salt Solution; MST = Monosodium Titanate; CST = Crystalline Silicotitanate ion exchange resin, cfm = cubic feet per minute.

- This change at DWPF is not expected to impact DWPF stack emissions.
- Cleaning solution is used to clean the cross flow filters may be contaminated with some dilute mixture of MST slurry. This stream is conservatively chosen to be 0.01 time the concentrations for MST slurry.
- The wash water hold tank will hold wash water from the sludge solids receipt tank. The solution washed from the sludge is CSS, which is diluted by the washed water. The dilution is conservatively chosen to be 0.25.
- Two columns are assumed loaded at any one time and the other two are assumed to contain only DSS-resin slurry.

TC For the Direct Disposal in Grout alternative, in which the grout would contain a large amount of radioactive cesium, special equipment would be used to control contamination during vault filling operations. A 500-cubic-foot-per-minute air flow ventilation system would be equipped with a pre-filter, high-efficiency particulate air (HEPA) filter and fan, and connected ductwork. Radiation monitors and dampers would be included (WSRC 1998e,o).

A.5.6 PILOT PLANT

To achieve pilot scale testing a salt processing process, a pilot plant would be

needed, as specified in Chapter 2 (Section 2.7.6). DOE intends to only construct and operate a Pilot Plant for the selected alternative. However, in the event that DOE decides to demonstrate more than one technology, the Pilot Plant units would be developed and operated in series. Therefore, impacts associated with more than one Pilot Plant would not occur at the same time, but would extend over a longer period. The pilot plant would provide scaled process data, utilizing equipment ranging from 1/100 to 1/10 the size of the full-scale facility (WSRC 2000e). Process streams would consist of real radioactive waste from various HLW tanks to

M4-3
M4-10
M4-11

Table A-9. Tanks for Solvent Extraction Process.

Tank	Tank size (gallons)	Number of tanks	Radioactive	Stream characteristics	Ventilation flow per tank (cfm)
Process Water Tank	20,000	1	No	Well water	Natural
MST Storage Tank	400	1	No	MST	Natural
Caustic Feed Tank	5,000	1	No	1 M NaOH	10
Oxalic Acid Feed Tank	200	1	No	2% H ₂ C ₂ O ₄	10
Caustic Feed Tank	500	1	No	1 M NaOH	10
Caustic Dilution Feed Tank	15,000	1	No	2.0 M caustic	10
Caustic Storage Tank	5,000	1	No	50% caustic	10
Filter Cleaning Caustic Tank	500	1	No	1 M NaOH	10
Caustic Makeup Tank	1,000	1	No	0.5 M NaOH	10
Solvent Wash Solution Makeup Tank	1,000	1	No	0.5 M NaOH	10
Nitrate Acid Feed Tank	1,000	1	No	50% HNO ₃	10
Nitrate Acid Charge Tank	1	1	No	50% HNO ₃	Natural
Strip Feed Tank	4,000	1	No	0.005 M HNO ₃	
Chem Additive Tank	100	1	No	Process water	10
Isopar Makeup Tank	2,000	1	No	Isopar [®] L	10
Isopar Hold Tank	5,000	1	No	Isopar [®] L	10
Isopar Feed Tank	500	1	No	Isopar [®] L	10
Modifier Makeup Tank	500	1	No	1.0 M Cs7SBT in Isopar [®] L	10
Extractant Makeup Tank	50	1	No	0.2 M BobCalix in Isopar [®] L	10
Triethylamine Tank	5	1	No	Triethylamine	10
Solvent Makeup Tank	1,000	1	No	0.01 BobCalix, 0.5 M Cs7SBT, and 0.001 M TOA in Isopar [®] L	10
Alpha Sorption Tank	125,000	1	Yes	Feed	100
Salt Solution Feed Tank	125,000	1	Yes	Clarified salt solution	100
Strip Stages (15)	114	1	Yes	Organic phase	None
Strip Effluent Stilling Tank	500	1	Yes	Strip solution	100
Strip Make-up Tank	25,000	1	Yes	Strip solution	100
Strip Organic Removal Stages (2)	15	1	Yes	Strip solution	100
Wash Water Hold Tank	25,000	1	Yes	~2M Na salt solution, 1/4 dilution of CSS	100
Ba-137 Decay Tanks	2,500	2	Yes	DSS	100
Caustic Solvent Wash Tank	1,000	1	Yes	DSS	100
Solvent Hold Tank	1,000	1	Yes	Organic phase	100

Table A-9. (Continued).

Tank	Tank size (gallons)	Number of tanks	Radioactive	Stream characteristics	Ventilation flow per tank (cfm)
Solvent Wash Tank	1,000	1	Yes	Organic phase	100
Kerosene Still	1,000	1	Yes	Organic phase	None
Kerosene Condensate Tank	1,000	1	Yes	Organic phase	None
Re-alkaline Stages (2)	15	1	Yes	Organic phase	None
Solvent Acid Wash Stages (2)	15	1	Yes	Organic phase	None
Scrub Stages (2)	15	1	Yes	Organic phase	None
Raffinate Organic Removal Stages (2)	15	1	Yes	DSS	None
Extraction Stages (15)	114	1	Yes	Clarified salt solution	None
DWPF Salt Feed Tank	100,000	1	Yes	Strip solution	100
Aqueous Raffinate Stilling Tank	500	1	Yes	DSS	100
DSS Hold Tanks	100,000	2	Yes	DSS	100
Sludge Solids Receipt Tank	10,000	1	Yes	Feed/MST slurry	100
Cleaning Solution Dump Tank	1,000	1	Yes	0.01 × MST slurry ^a	100

CSS = Clarified Salt Solution; DSS = Decontaminated Salt Solution; MST = Monosodium Titanate.

a. Cleaning solution is used to clean the cross flow filters and may be contaminated with some dilute mixture of MST slurry. This stream is conservatively chosen to be 0.01 times the concentrations for MST slurry.

Table A-10. Tanks for Direct Disposal in Grout Process.

Tank	Tank Size (gallons)	Number of Tanks	Radioactive	Stream Characteristics	Ventilation Flow (cfm)
MST Storage Tank (non-rad)	400	1	No	MST	natural
Process Water Tank (non-rad)	5,000	1	No	Well Water	natural
Oxalic Acid Feed Tank (non-rad)	200	1	No	2% H ₂ C ₂ O ₄	natural
Caustic Feed Tank (non-rad)	500	1	No	1M NaOH	100
Caustic Storage Tank (non-rad)	500	1	No	50% NaOH	natural
Alpha Sorption Tank	100,000	1	Yes	Feed	100
Sludge Solids Receipt Tank	10,000	1	Yes	MST Slurry	100
Cleaning Solution Dump Tank	1,000	1	Yes	(a)	100
Salt Solution Hold Tank	100,000	1	Yes	CSS	100
Flush Water Receipt Tank	10,000	1	Yes	CSS ^b	100
Saltstone Hold Tank	500	1	Yes	CSS with gout	100

CSS = Clarified Salt Solution; MST = Monosodium Titanate; cfm = cubic feet per minute.

a. Cleaning solution used to clear cross flow filters may be contaminated with MST slurry. Stream chosen to be 0.01 times concentration for MST slurry.

b. Flush water receipt tank holds water used to flush process lines at the mixer and saltstone hold tank, thus, will contain a diluted form of CSS. This stream is conservatively chosen to be 0.01 times the concentrations for CSS.

Table A-11. New transfer facilities.

Facility	Small Tank Tetraphenylborate Precipitation	Crystalline Silicotitanate Ion Exchange	Caustic Side Solvent Extraction	Direct Disposal in Grout
	Processing facility at Site B ^a	Processing facility at Site B ^a	Processing facility at Site B ^a	Processing facility in Z Area ^a
Interarea feed line from H-Area Tank Farm to new processing facility	Extension of interarea feed line from the H-Area Tank Farm to the processing facility, consisting of a 150-foot-long double-walled pipe ^b , installed 6 feet underground	Same as Small Tank Tetraphenylborate Precipitation Alternative	Same as Small Tank Tetraphenylborate Precipitation Alternative	A feed line from the interarea feed line to the processing facility, consisting of a double-walled pipe ^b , approximately 500 feet long, installed 6 feet underground
Saltstone feed line	A pipe line from the processing facility to the feed line from H-Area Tank Farm to Saltstone Manufacturing and Disposal Facility, connecting at a valve box. Line is a double-walled pipe ^b , approximately 150 feet long, installed 6 feet underground	Same as Small Tank Tetraphenylborate Precipitation Alternative	Same as Small Tank Tetraphenylborate Precipitation Alternative	NA
Vault feed line	A feed line from the Saltstone Manufacturing and Disposal Facility to the vaults consisting of a galvanized carbon steel pipe, 300 feet long, laid in a concrete trench 5 feet deep, 3 feet wide, with 1.5-foot-thick sides and top	Same as Small Tank Tetraphenylborate Precipitation Alternative	Same as Small Tank Tetraphenylborate Precipitation Alternative	A feed line identical in specifications to the Small Tank Tetraphenylborate Precipitation vault feed line that would run from the new grout processing facility to the saltstone vaults
ETF Bottoms Holding Tank	A 50,000-gallon ETF Bottoms Holding Tank constructed between ETF and the Saltstone Manufacturing and Disposal Facility	Same as Small Tank Tetraphenylborate Precipitation Alternative	Same as Small Tank Tetraphenylborate Precipitation Alternative	A 50,000-gallon Bottoms Holding Tank constructed between ETF and the H-Area Tank Farm
Precipitate Hydrolysis Aqueous transfer line	A pipe line from the processing facility to the existing Low Point Pump Pit, connecting with existing feed line to DWPF. Line is a double-walled pipe 2,300 feet long, buried 6 feet below grade	NA	NA	NA

Table A-11. (Continued).

Facility	Small Tank Tetraphenylborate Precipitation	Crystalline Silicotitanate Ion Exchange	Caustic Side Solvent Extraction	Direct Disposal in Grout
Valve box	A valve box constructed between the processing facility and the Saltstone Manufacturing and Disposal Facility, providing tie-in for feed lines from processing facility and ETF	Same as Small Tank Tetraphenylborate Precipitation Alternative	Same as Small Tank Tetraphenylborate Precipitation Alternative	NA
Feed line from ETF to valve box	A feed line from the ETF Bottoms Holding Tank to the new valve box, consisting of a double-walled pipe ^b , approximately 1 mile long, installed 6 feet underground	Same as Small Tank Tetraphenylborate Precipitation Alternative	Same as Small Tank Tetraphenylborate Precipitation Alternative	NA
Low Point Pump Pit	NA	A new Low Point Pump Pit to transfer resin between the processing facility and DWPF	A new Low Point Pump Pit between the processing facility and DWPF to transfer monosodium titanate/sludge slurry	NA
Resin transfer line	NA	A feed line from the processing facility through the new Low Point Pump Pit to the DWPF, consisting of a double-walled pipe ^b , 2,300 feet long, installed 6 feet underground	NA	NA
Monosodium Titanate/Sludge Slurry transfer line	NA	A pipe line from the processing facility to the existing Low Point Pump Pit, connecting with existing feed line to DWPF. Line is a double-walled pipe 2,300 feet long, buried 6 feet below grade	A pipeline from the processing facility through the new Low Point Pump Pit to the DWPF Line is a double-walled pipe, 2,300 feet long, buried 6 feet below grade	NA

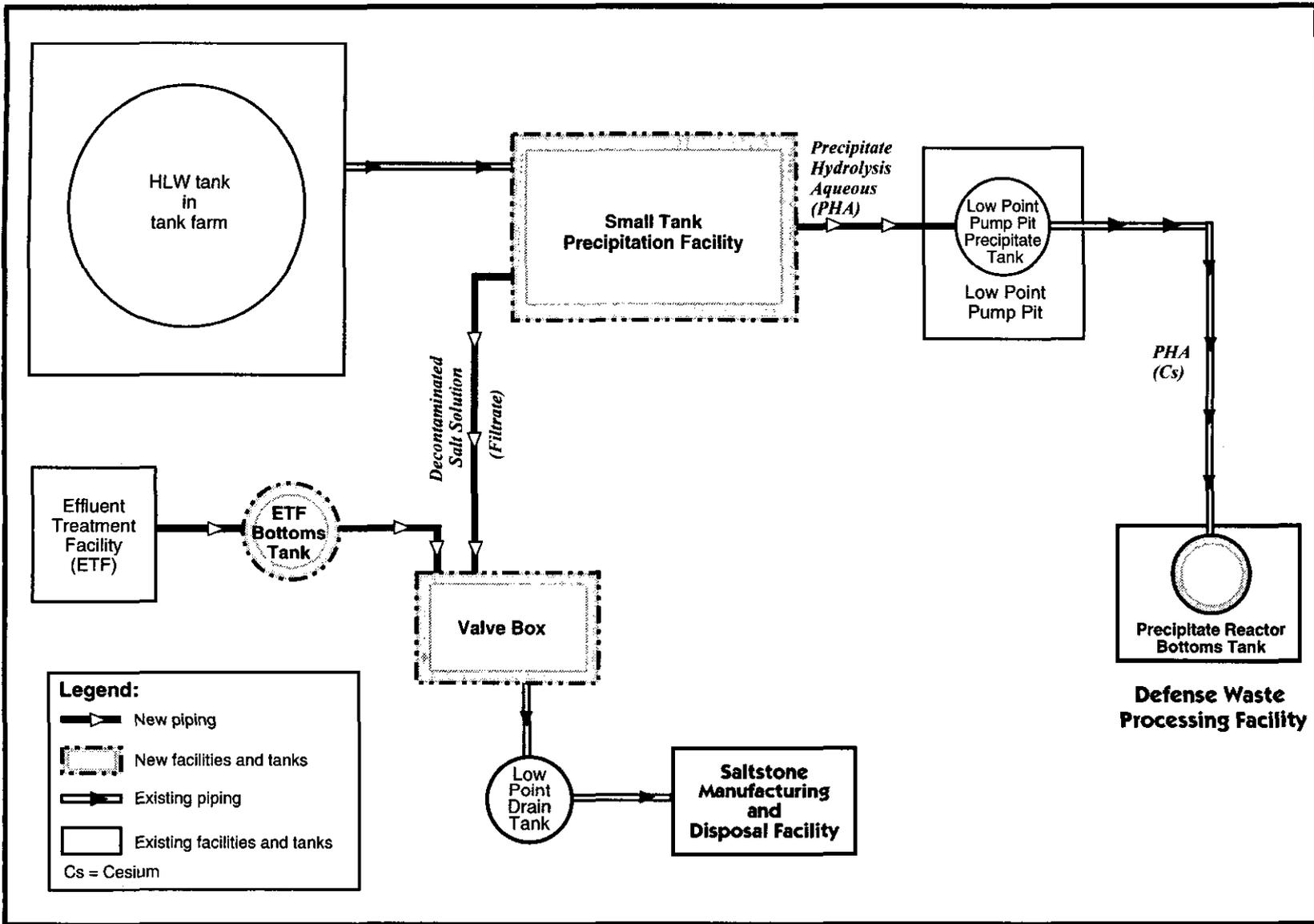
Table A-11. (Continued).

Facility	Small Tank Tetraphenylborate Precipitation	Crystalline Silicotitanate Ion Exchange	Caustic Side Solvent Extraction	Direct Disposal in Grout
Monosodium Titanate/Sludge Receipt Tank in DWPF	NA	A 15,000-gallon tank installed in the DWPF	Same as Crystalline Silicotitanate Ion Exchange	Same as Crystalline Silicotitanate Ion Exchange
Resin Hold tank in DWPF	NA	A 10,000-gallon tank installed in the DWPF	NA	NA
Cesium Strip Effluent transfer line	NA	NA	A pipe line from the processing facility to the existing Low Point Pump Pit connecting with the existing feed line to the DWPF	NA
Cesium Strip Effluent Hold Tank in DWPF	NA	NA	A 10,000-gallon tank installed in the DWPF	NA
Low Point Drain Tank facility	NA	NA	NA	A Low Point Drain Tank Facility to serve transfer lines between the H-Area Tank Farm and the processing facility and between the processing facility and DWPF. It would be used to transfer salt solution to the grout facility and monosodium titanate/sludge slurry to DWPF
Monosodium Titanate/Slurry feed line to DWPF	NA	NA	NA	A feed line from the processing facility through the Low Point Drain Tank Facility to DWPF, consisting of a doubled-walled pipe 1 mile long, installed 6 feet underground

a. See text for description of the proposed facilities.

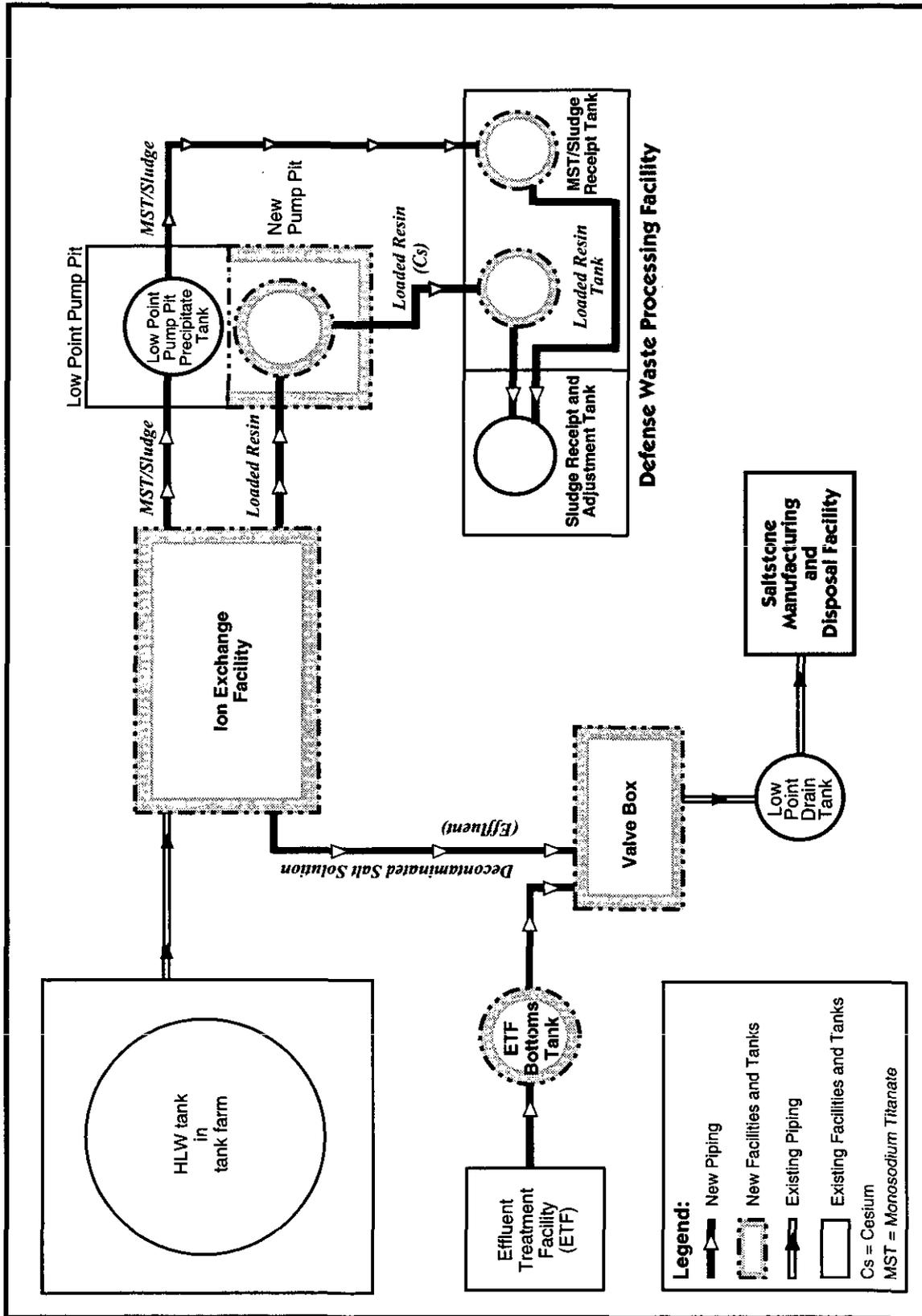
b. All double-walled transfer lines, comprised of 3-in.-diameter, schedule 40 (or 80), Type 304L stainless steel inner pipe and 6-in.-diameter, schedule 40, carbon steel outer pipe.

NA = not applicable.



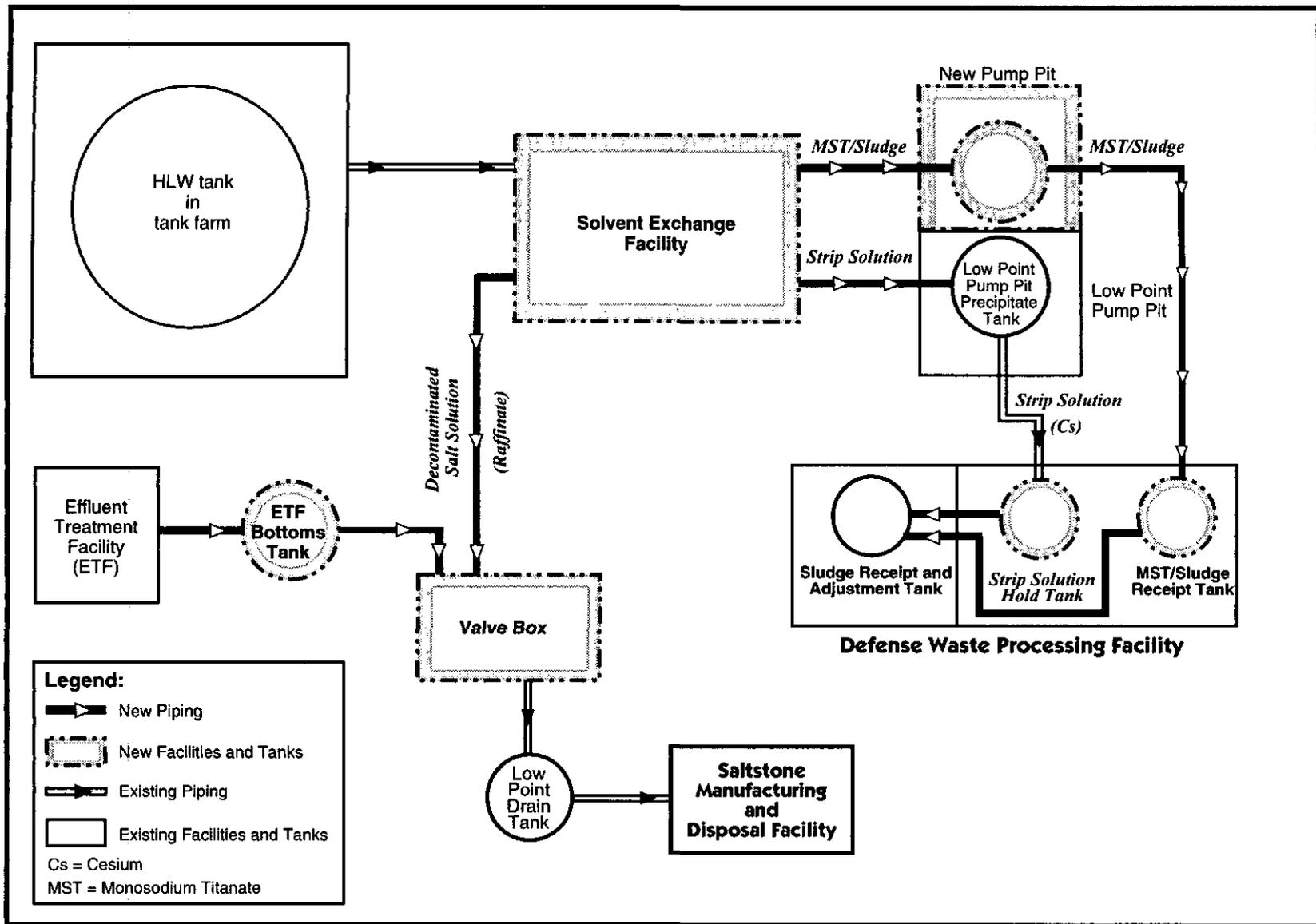
NW SDA EIS/Grfx/App A/A-18 Trans Sm Tank.ai

Figure A-18. Transfer facilities for Small Tank Precipitation alternative.



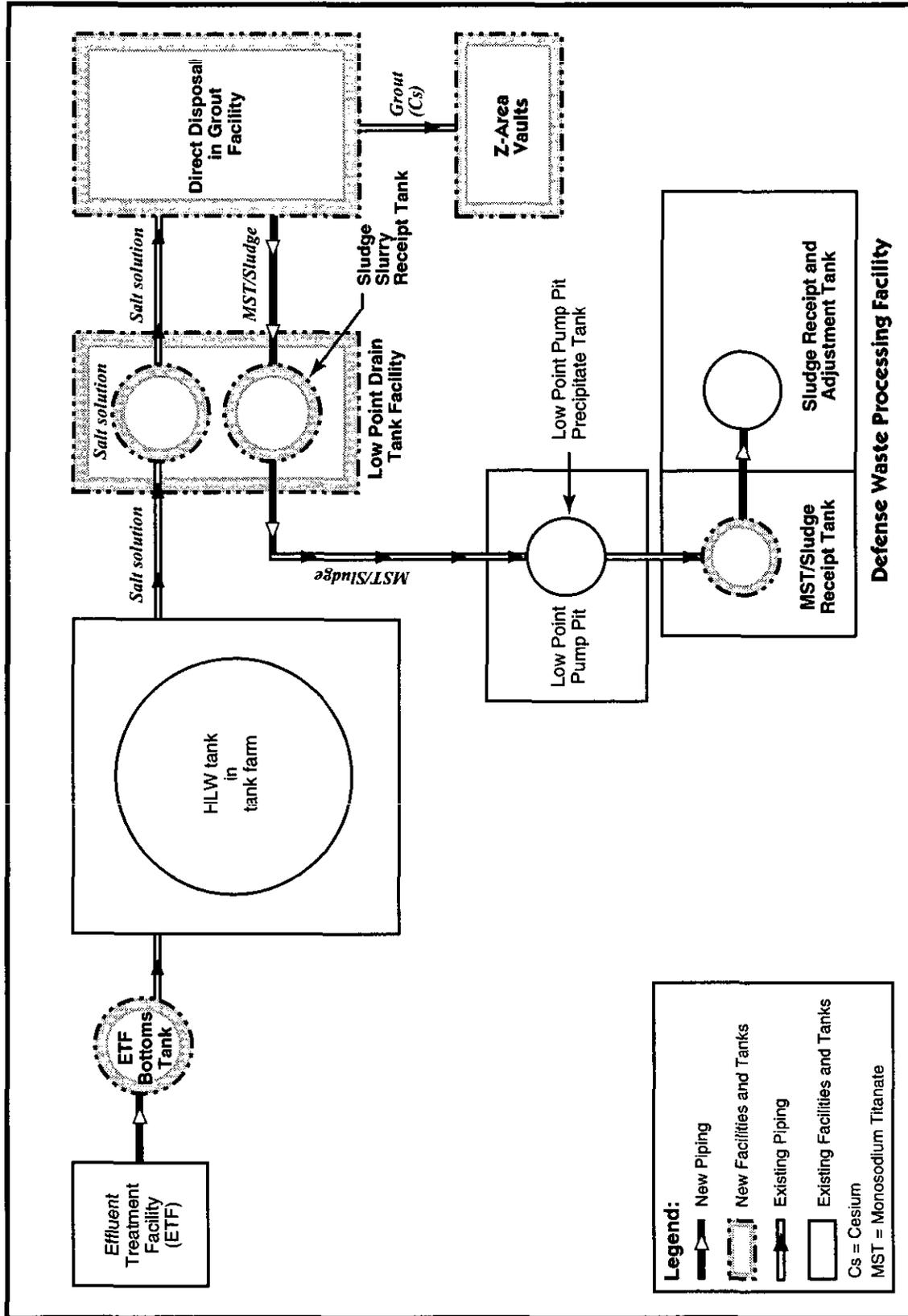
NW SDA EIS/Gmt/App A/A-19 Trans CST.ai

Figure A-19. Transfer facilities for Ion Exchange alternative.



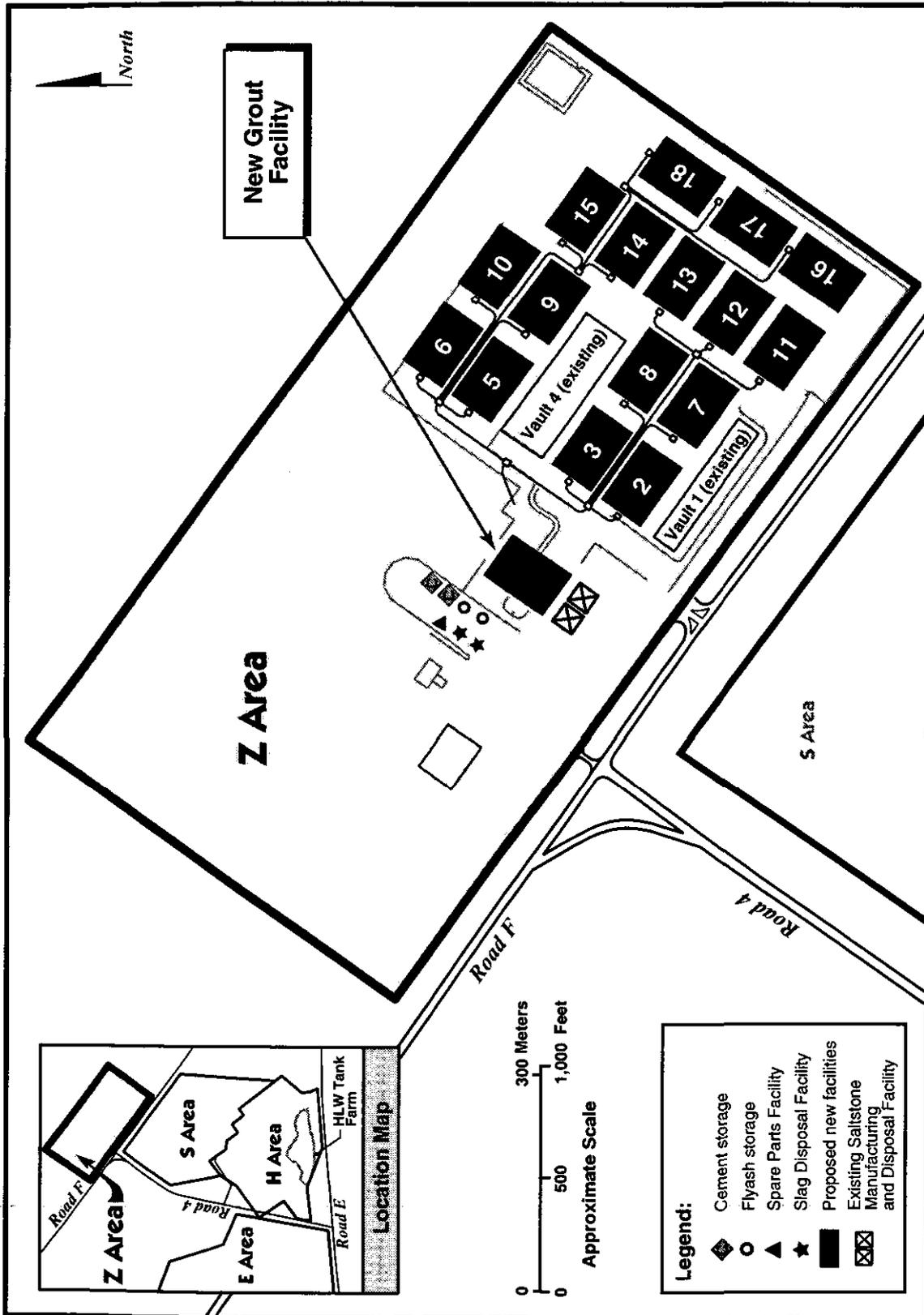
NW SDA EIS/Grb/App A/A-20 Trans CST Solv.al

Figure A-20. Transfer facilities for Solvent Extraction alternative.



NW SDA EIS/Grout/App A/A-21 Trans Dir Disp.a

Figure A-21. Transfer facilities for Direct Disposal in Grout alternative.



NW SDA EIS/Grnt/App_A/A-22 Loc Z Area.ai

Figure A-22. Proposed location of new Grout Facility and saltstone disposal vaults in Z Area.

demonstrate required decontamination factors (DF), as follows:

- Cs-137 DF 40,000
- Sr-90 DF 100 or greater
- Pu-238 DF 10 or greater

Capability for appropriate waste disposal would be required in the pilot plant.

Installation of pilot plant process equipment in the existing Late Wash Facility provided for ITP is projected. The Late Wash Facility has three highly shielded cells designed to contain up to 5,000 gallons of concentrated precipitate slurry, into which salt processing equipment mounted in frames could be installed. If additional shielded space was required, the filter cell previously provided to support ITP operations would be considered.

Test runs designed to demonstrate the process flowsheet for the selected salt processing alternative would be conducted in the pilot plant. Functional process flows would parallel those for the full-scale facility. Major equipment would be tested to confirm vessel sizing and de-sign constraints, and process parameters would be evaluated to ensure satisfactory resolution of problems encountered during process development.

Process demonstrations would be designed to meet the following objectives:

Small Tank Precipitation – Validity of design parameters, as determined by kinetics of cesium precipitation by tetraphenylborate, and strontium and actinide sorption on monosodium titanate; feed stream mixing rates; and excess tetraphenylborate recovery. Resolve processing uncertainties related to the activation of tetraphenylborate decomposition catalysts at operating temperatures, and foam formation.

Major equipment would include:

- Process Feed Tank

Precipitation Tanks (Continuous Stirred Tank Reactors 1 and 2)

- Concentrate Tanks
- Concentrate Filter and Cleaning System
- Filtrate Hold Tank
- Wash Tank
- Wash Filter and Cleaning System
- Precipitate Surge Tank
- Recycle Wash Hold Tank
- Cold Feeds and Facilities
- Laboratory Facilities

Ion Exchange – Resolve key issues, including the kinetics of strontium and actinide sorption onto monosodium titanate; filtration of monosodium titanate solids; the kinetics of cesium removal on crystalline silicotitanate as function of temperature and waste composition; and design parameters for the ion-exchange columns. Resolve processing uncertainties relating to hydrogen generation in the ion-exchange columns at high cesium loadings; desorption of cesium from the crystalline silicotitanate ion exchange resin; resin stability; and extraneous solids formation.

Major equipment would include:

- Alpha Sorption Tank
- Alpha/Sludge Filter and Cleaning System
- Sludge Solids Receipt Tank
- Recycle Blend Tank
- Crystalline Silicotitanate Columns in series (1 ft diam × 16 ft length)
- Loaded Resin Hold Tank
- Decontaminated Salt Solution Hold Tank
- Cold Feeds and Facilities
- Laboratory Facilities

Solvent Extraction – Demonstrate or confirm the kinetics of strontium and actinide sorption onto monosodium titanate with removal by filtration; cesium separation and concentration in centrifugal contactor operation with minimal long-term chemical and radiolytic degradation of solvent; solvent cleanup and recycle capabilities, in-

cluding self purification by back extraction to aqueous phase; and final separation of organics from aqueous raffinate and strip effluent product streams.

Major equipment would include:

Alpha Sorption Tank
 Alpha/Sludge Filter and Cleaning System
 Sludge Solids Receipt Tank
 Salt Solution Feed Tank
 Solvent Extraction Contactors in Series
 Solvent Hold Tank and Cleaning System
 Raffinate Stilling Tank
 Strip Effluent Stilling Tank
 Decontaminated Salt Solution Hold Tank

Direct Disposal in Grout – A requirement for the demonstration of the Direct Disposal in Grout alternative has not been confirmed. Because this technology is better developed than the other alternatives and has been thoroughly demonstrated by the existing Saltstone Manufacturing and Disposal Facility, it is not anticipated that any further demonstration of this technology would be necessary.

A.5.7 DECONTAMINATION AND DECOMMISSIONING

Any new facility would be designed and constructed to limit the generation and dispersion of radioactive and hazardous materials and to facilitate its ultimate decontami-

nation and decommissioning or reuse. Areas of the facility that might become contaminated with radioactive or other hazardous materials under normal or off-normal operating conditions would incorporate design features to simplify their decontamination. Items such as service piping, conduits, and ductwork would be minimized in these areas and arranged to facilitate decontamination. Facility design would include a dedicated area for decontamination of tools and some equipment. Design features that would be incorporated into any of the facilities are described below.

- Modular confinement would be used for radioactive and hazardous materials to preclude contamination of fixed portions of the structure.
- Long runs of buried piping that would carry radioactive or hazardous materials would be minimized to the extent possible, and provisions would be included in the design to allow the inspection of the integrity of joints in buried pipelines. The facility would be designed to facilitate dismantlement, removal, and packaging of contaminated equipment.
- Modular shielding would be used in interior areas to permit modification to larger shielded areas for future use.
- Lifting lugs would be used on equipment to facilitate remote removal from the contaminated process cells.
- The piping systems that would carry hazardous products would be fully drainable.

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APPENDIX B
ACCIDENT ANALYSIS

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APPENDIX B. ACCIDENT ANALYSIS

This Appendix provides detailed information on potential accident scenarios associated with various alternatives for salt processing at the Department of Energy's (DOE) Savannah River Site (SRS). The Appendix provides estimates of the quantity and composition of hazardous materials that could be released in an accident, as well as the consequences to workers and the public. Estimates are given in terms of dose and latent cancer fatalities for radiological releases and of concentration levels for chemical releases.

The primary source of information for the accident analyses is an engineering calculation prepared specifically to document the accident sequences, frequencies, and source terms for the various alternatives. Unless specifically noted, all references in this Appendix are to Cappucci et al. (2000).

B.1 General Accident Information

An accident, as discussed in this Appendix, is an inadvertent release of radiological or chemical hazardous materials as a result of a sequence of one or more probable events. The sequence usually begins with an initiating event, such as a human error, equipment failure, or earthquake, followed by a succession of other events (which could be either dependent on or independent of the initial event), that dictate the accident's progression and the extent of materials released. Initiating events fall into three categories:

- *Internal initiators* – normally originate in and around the facility, but are always a result of facility operations. Examples include equipment or structural failures and human errors.
- *External initiators* – independent of facility operations and normally originate outside the facility. Some external initiators affect the ability of the facility to

maintain its confinement of hazardous materials because of potential structural damage. Examples include helicopter, aircraft, or vehicle crashes, nearby explosions, and toxic chemical releases at nearby facilities that affect worker performance.

- *Natural phenomena initiators* – natural occurrences that are independent of facility operations and occurrences at nearby facilities or operations. Examples include earthquakes, high winds, floods, lightning, and snow. Although natural phenomena initiators are independent of external facilities, their occurrence can involve those facilities and compound the progression of the accident.

The likelihood of an accident occurring and its consequences usually depend on the initiator, the sequence of events, and their frequencies or probabilities. Accidents can be grouped into four categories—anticipated, unlikely, extremely unlikely, and beyond extremely unlikely, as listed in Table B-1. DOE based the frequencies of accidents on safety analyses and historical data about event occurrences.

B.2 Accident Analysis Methods

For the salt processing alternatives, potential accident scenarios that could involve release of both radiological and nonradiological hazardous materials were identified. Section B.2.1 provides information about the various alternatives. Sections B.2.2 and B.2.3 provide details about the specific analysis methods used in this Appendix.

The accident sequences analyzed in this SEIS would occur at frequencies generally greater than once in 1,000,000 years. However, the analysis considered accident sequences with smaller frequencies, if their impacts could provide information important to decision making.

Table B-1. Accident frequency categories.

Accident frequency category	Frequency range	Description
Anticipated	Less than once in 10 years but greater than once in 100 years	Accidents that might occur several times during a facility lifetime
Unlikely	Less than once in 100 years but greater than once in 10,000 years	Accidents that are not likely to occur during a facility lifetime; natural phenomena include Uniform Building Code-level earthquake, maximum wind gust, etc.
Extremely unlikely	Less than once in 10,000 years but greater than once in 1,000,000 years	Accidents that probably will not occur during a facility life cycle; this includes the design-basis accidents.
Beyond extremely unlikely	Less than once in 1,000,000 years	All other accidents.

Source: DOE (1994).

The methods of accident analysis are consistent with the guidance provided by DOE's Office of National Environmental Policy Act (NEPA) Policy and Assistance in *Recommendations for the Preparation of Environmental Assessments and Environmental Impact Statements* (DOE 1993). In addition to the specific guidance on accident analyses, DOE has applied the recommendation to base analysis on realistic, rather than overly conservative, exposure conditions. DOE has also applied the recommendation to use a *sliding scale* approach, which means to provide a level of detail in the analysis of specific issues and their impacts in proportion to their significance.

Recently the Office of NEPA Policy and Assistance issued draft guidance entitled *Analyzing Accidents Under NEPA* (DOE 2000a). It clarifies and supplements the information in the 1993 guidance. DOE has used the guidance's clarifications on the use of the sliding-scale approach, range of accident scenarios, avoidance of compounding conservatisms, frequency, and risk. However, this Appendix does not include the suggestion in the guidance to present direct and indirect effects of post-accident activities. Such analysis would require the development of methodology to measure these impacts in a consistent basis, followed by the integration of this methodology into the specific salt processing accidents analyzed in this Appendix. In light of these circum-

stances and judicious application of the sliding-scale approach, DOE Savannah River Office (SR) considers the evaluation of post-accident cleanup impacts to be both inefficient and minor in comparison to the customary evaluation of human health impacts of potential accidents.

B.2.1 SALT PROCESSING ALTERNATIVES

The accident data in this Appendix are organized by alternative. The accident impacts in Chapter 4 are also organized by alternative to reflect potential accident occurrences for the associated alternative.

DOE proposes to select a technology and design, construct, and operate the required facilities to replace the In-Tank Precipitation (ITP) process to separate the highly radioactive components of high-level waste (HLW) salt solutions from the low-activity components of the salt solution. The new process would be compatible with existing facilities and processes for HLW storage and vitrification and for disposal of low-level waste at the SRS. The alternatives being considered in this SEIS are:

- No Action
- Small Tank Tetraphenylborate Precipitation
- Crystalline Silicotitanate Ion Exchange
- Caustic Side Solvent Extraction

- Direct Disposal in Grout

Each alternative is discussed in detail in Chapter 2 and Appendix A; however, a brief description of each alternative is included here.

No Action Alternative

Under the No Action alternative, DOE would continue current HLW management activities, including tank space management and tank closure, without a process to separate the high-activity and low-activity salt fractions. The Defense Waste Processing Facility (DWPF) would vitrify only sludge from the HLW tanks. Saltcake and supernatant would remain in the HLW tanks, and monitoring activities would continue. Current tank space management projections indicate that, after 2010, additional tank space would be needed to support continued operations and meet tank closure commitments under the No Action alternative.

As soon as DOE determined that a salt processing facility would not be available by 2010, decisions about additional tank space would have to be made. The course of action that DOE would follow cannot be predicted at this time, but available options may include the following, either individually or in combination.

1. Identify additional ways to optimize tank farm operations
2. Reuse tanks scheduled to be closed by 2019
3. Build tanks permitted under wastewater treatment regulations
4. Build tanks permitted under RCRA regulations
5. Suspend operations at DWPF.

Because the No Action alternative is the basis from which each of the proposed alternatives progresses, the hazards associated

with each action alternative are supplemental to those of the No Action alternative. However, through the processing of salt solution, hazards associated with continued storage would decrease over time. Therefore, since the No Action alternative includes only current tank space management operations, which have been evaluated under the NEPA process and in approved safety analysis reports and the activities DOE would pursue during the post tank space management phase have not been determined, this Appendix does not analyze accidents associated with No Action failure of a salt solution hold tank is analyzed in the *High-Level Waste Tank Closure Draft Environmental Impact Statement* (DOE 2000b). The radiological and nonradiological hazards associated with the four action alternatives are evaluated in this Appendix.

Small Tank Precipitation

DOE would construct a new shielded facility to house process equipment to implement this alternative. The Small Tank Precipitation alternative would use the same chemical process as the ITP process to remove high-activity radionuclides from the salt solution. However, radioactive HLW would be processed through the facility in a manner that would control the high benzene generation rates that led DOE to develop an alternative salt processing technology.

Soluble radioactive metal ions (cesium, strontium, uranium, and plutonium) in the salt solution and concentrated supernatant would be precipitated with tetraphenylborate (TPB) or sorbed on monosodium titanate (MST) to form insoluble solids. The resulting solids would be concentrated by filtration and the product slurry treated to yield a non-flammable stream for transfer to DWPF for vitrification. The decontaminated salt solution, containing primarily sodium hydroxide, nitrate, and nitrite would be transferred to the Saltstone Manufacturing and Disposal Facility for disposal as grout.

Ion Exchange

DOE would construct a new shielded facility to house chemical processing equipment (tanks, pumps, filter systems, ion exchange columns) to

implement this alternative. The Ion Exchange process would use crystalline silicotitanate (CST) resin in ion exchange columns to remove cesium from the salt solution. Strontium, plutonium, and uranium would first be removed by adsorption on MST, and the resulting solids would then be transferred to DWPF for vitrification. The cesium-loaded resin would also be transferred to DWPF for vitrification. The low-activity salt solution would be transferred to the Saltstone Manufacturing and Disposal Facility for disposal as grout.

Solvent Extraction

DOE would construct a new shielded facility to house chemical processing equipment (tanks, pumps, filter systems, contactors). The Solvent Extraction process would employ a highly specific organic extractant in a diluent solvent to remove cesium from the caustic salt solution, using centrifugal contactors to provide high surface area interactions between the organic solvent and aqueous solution. The separated cesium would be extracted into an acidic aqueous stream to be transferred as an all-liquid phase to DWPF for vitrification. Prior treatment with MST would remove strontium, uranium, and plutonium from the salt solution for transfer to DWPF. The low-activity salt solution would be transferred to the Saltstone Manufacturing and Disposal Facility for disposal as grout.

Direct Disposal in Grout

DOE would construct a new shielded facility to immobilize the HLW salt solution in grout, without separation of radioactive cesium. Prior treatment with MST would remove strontium, uranium, and plutonium from the salt solution for transfer to DWPF. The cesium-containing solution would be mixed with cement, flyash, and slag for disposal as grout in shielded saltstone vaults in Z Area.

The saltstone waste form generated in this alternative would be required to meet U.S.

Nuclear Regulatory Commission (NRC) Class C low-level waste disposal requirements for near surface disposal.

B.2.2 RADIOLOGICAL HAZARDS

The accidents identified for the salt processing alternatives are described in Section B.3. These descriptions include an approximation of the material at risk (MAR) that would potentially be involved in a given type of accident. Depending on the particular scenario, release fractions have been applied to the MAR to determine the amount of material that could be released to the environment via the air. This amount is referred to as the source term. Source terms are provided as curies of fission products and transuranics. The fission product source term is significantly dominated by radioactive cesium, while plutonium-239 has one of the highest dose factors of the common alpha-emitters found in SRS radiological effluents. Therefore, the analysis used radioactive cesium to represent the fission product source term and plutonium-239 to represent the transuranic source term.

The source terms were calculated by spreadsheet using Microsoft Excel. The Source Term and the Resuspension Source Term were determined using the following formulas.

Source Term: $ST = MAR \times DR \times ARF \times RF \times LPF$, where:

DR = Damage Ratio: fraction of MAR actually impacted by the accident

ARF = Airborne Release Fraction: the coefficient used to estimate the amount of radioactive material suspended in air as an aerosol and thus available for airborne transport due to physical stress from a given accident

LPF = Leak Path Factor: fraction of radionuclides or chemicals in the air transported through some confinement or filtration mechanism.

Resuspension Source Term: $ST_r = MAR \times ARR \times RF$, where:

MAR = Material at Risk: amount of radioactive materials or chemicals available to be acted upon by an event

ARR = Airborne Release Rate: the coefficient used to estimate the amount of material that can be suspended in air and made available for airborne transport under a specific set of induced physical stresses as a function of time.

RF = Respirable Fraction: fraction of airborne radionuclides or chemicals as particles that can be transported through the air and inhaled into the respiratory system

The analysis of airborne releases used the computer code AXAIRQ, which models accidental atmospheric radioactive releases from SRS that are of relatively short duration. AXAIRQ determines the concentration of radiological releases to the atmosphere in every direction around the release location. The code considers the height of the release and wind speed and direction changes in the calculation. AXAIRQ strictly follows the guidance in Regulatory Guide 1.145 (NRC 1982) on accidental releases, and has been verified and validated (Simpkins 1995a and 1995b). Because all considered accidents would occur at either ground level or from a 46-meter stack, the releases for both heights were evaluated using AXAIRQ. In accordance with the regulatory guide, the code considers plume meander and fumigation under certain conditions. Plume rise due to buoyancy or momentum is not available. The program uses a 5-year meteorological database for the SRS, and determines the shortest distance to the Site boundary in each of the 16 compass direction sectors by determining the distance to one of 875 locations along the boundary. The impacts derived from this code used the average, or 50 percent meteorology. The code uses the shortest distance in each sector to calculate the concentration for that sector.

DOE used the computer code PRIMUS, which was developed by the Oak Ridge National Laboratory, to consider decay and

daughter in-growth. PRIMUS determines radionuclide in-growth matrices from user specified sources. In-growth must be considered for radionuclides that are generated from the decay of more than one isotopic chain and their own decay.

Simpkins (1999) provided unit dose conversion factors for the applicable radionuclides for release locations in S and Z Areas. These factors were applied to the airborne source terms from the previously described excel spreadsheet to calculate the doses to various receptors.

For population dose calculations, age-specific breathing rates were applied, but adult dose conversion factors were used. Radiation doses were calculated to the maximally exposed offsite individual (MEI), to the population within 50 miles of the facility, to a noninvolved worker assumed to be 2,100 feet (640 meters) downwind of the facility, to an involved worker assumed to be 328 feet (100 meters) downwind of the facility, and to the onsite population. All doses are committed effective dose equivalents.

After DOE calculated the total radiation dose to the public, it used dose-to-risk conversion factors established by the National Council on Radiation Protection and Measurements (NCRP) to estimate the number of latent cancer fatalities (LCFs) that could result from the calculated exposure. There is inconclusive data that small radiation doses cause cancer; however, to be conservative the NCRP assumes that any amount of radiation has some risk of inducing cancer. DOE has adopted the NCRP factors of 0.0005 LCF for each person-rem of radiation exposure to the general public and 0.0004 LCF for each person-rem of radiation exposure to radiation workers for doses less than 20 rem. For larger doses, when the rate of exposure would be greater than 10 rads per hour, the increased likelihood of LCF is doubled, assuming the body's diminished capability to repair radiation damage (NCRP 1993).

B.2.3 CHEMICAL HAZARDS

For chemically toxic materials, the long-term health consequences of human exposure to haz-

ardous materials are not as well understood as those related to radiation exposure. A determination of potential health effects from exposures to chemically hazardous materials, compared to radiation, is more subjective. Therefore, the consequences from accidents involving hazardous materials are expressed in terms of airborne concentrations at various distances from the accident location, rather than in terms of specific health effects.

To determine potential health effects to workers and the public that could result from accidents involving hazardous materials, the airborne concentrations of such materials released during an accident at varying distances from the point of release were compared to the Emergency Response Planning Guideline (ERPG) values (AIHA 1991). The American Industrial Hygiene Association established these values, which depend on the chemical substance, for the following general severity levels to ensure that necessary emergency actions occur to minimize exposures to humans.

- ERPG-1 Values – Exposure to airborne concentrations greater than ERPG-1 values for a period greater than one hour results in an unacceptable likelihood that a person would experience mild transient adverse health effects (i.e., rash, nausea, headache) or the perception of a clearly defined objectionable odor.
- ERPG-2 Values – Exposure to airborne concentrations greater than ERPG-2 values for a period greater than one hour results in an unacceptable likelihood that a person would experience or develop irreversible or other serious health effects (i.e., organ damage, seizures, pneumonitis) or symptoms that could impair a person's ability to take protective action (i.e., dizziness, confusion, impaired vision).
- ERPG-3 Values – Exposure to airborne concentrations greater than ERPG-3 values for a period greater than one hour

results in an unacceptable likelihood that a person would experience or develop life-threatening health effects (i.e., loss of consciousness, cardiac arrest, respiratory arrest).

B.3 Postulated Accident Scenarios Involving Radioactive Materials

These sections describe the potential accident scenarios associated with each alternative that could involve the release of radioactive materials. The impacts of these scenarios are described in Section B.4.

Several of the accidents identified for a particular alternative are also common to other alternatives. However, they will be discussed individually for each alternative.

B.3.1 SMALL TANK PRECIPITATION

The accidents identified for the Small Tank TPB Precipitation process that result in the release of radiological materials to the environment include:

- Loss of confinement in a process cell
- Beyond design-basis earthquake
- Fire in a process cell
- Benzene explosion in the Precipitate Hydrolysis Cell (PHC)
- Helicopter or aircraft crash
- Benzene explosion in Precipitate Hydrolysis Aqueous (PHA) Surge Tank

B.3.1.1 Loss of Confinement in a Process Cell

Scenario: Mechanical failure or an external event, such as a dropped cell cover or crane mishap, could cause a failure of the primary confinement for a tank or its associated piping. A failure of primary confinement would release material into the process cell. For this event, the entire tank contents at maximum capacity would be released through the rupture. It was assumed

that the release would not be cleaned up for 168 hours (7 days).

The tanks of concern would be the Precipitate Reactor and the PHA Surge Tank. A failure of the Precipitate Reactor or associated piping would release material to the PHC, while a failure of the PHA Surge Tank or associated piping would release material to the PHA Surge Tank process cell. Flammable benzene vapors and hydrogen generated by leaking slurry from the PHA Surge Tank could cause an explosion, if they were allowed to reach flammable concentrations in the presence of an ignition source. A benzene explosion following a PHA Surge Tank loss of confinement event is in the beyond-extremely-unlikely category and is bounded by the benzene explosion in the PHA Surge Tank event discussed in Section B.3.1.6. The precipitate slurry would also be somewhat flammable and, if allowed to reach a combustible state, a large enough ignition source could cause a precipitate fire in the process cell. For this scenario, however, it is assumed that no explosion or fire occurs.

A leak detection system would mitigate the consequences of releases from process tanks and associated piping. This system would be designed to detect the leak and terminate the process, thus minimizing the amount of material that would leak from the system. A shielded secondary confinement system would protect onsite workers from radiological consequences of the leaks.

Probability: The initiating event for the loss of primary confinement of a process tank could be mechanical failure or an external event. External events could cause leaks from tanks or piping. Impacts during cell cover and crane movement are assumed to cause spills from a rupture in the tank or associated piping. It was assumed that there would be 50 feet of piping associated with each tank. The annual frequency of a loss of primary confinement for a process tank was calculated to be 3.4×10^{-2} . Therefore, a loss

of confinement accident would be expected once in 30 years.

Source Term: A dropped cell cover or crane mishap was assumed to damage the affected tank significantly enough to release the entire contents of the tank to the cell. Good engineering practices would be used during design of the process facility to ensure that high-efficiency particulate air (HEPA) filters would be located in a remote part of the facility away from process cells (e.g., event location). DOE would perform regular in-place testing to ensure that installed HEPA filters would have a particle removal efficiency of greater than 99.9 percent. Therefore, the HEPA filters and ventilation system were assumed to be operating due to the physical distance between the filter location and event location, reducing the amount of radioactivity released from the process cell within 99 percent efficiency. The radiological source terms associated with this accident are provided in Table B-2. In addition, a loss of primary confinement for the PHA Surge Tank would release benzene in an uncontrolled manner to the process cell ventilation system. The source terms associated with nonradiological chemical releases are addressed in Section B.5. All releases were postulated to occur from the 46-meter stack.

Table B-2. Source terms for loss of confinement in a process cell of the Small Tank Precipitation facility.

	Source term (Ci)	
	Fission products	Transuranics
Precipitate Reactor	1.1	3.1×10^{-3}
PHA Surge Tank	4.2	0.012

B.3.1.2 Beyond Design-Basis Earthquake

Scenario: The structures for the Small Tank Precipitation process would be designed to withstand Performance Category-3 (PC-3) earthquakes, straight winds, and tornadoes. The PC-3 earthquake is considered to be the bounding Natural Phenomena Hazards (NPH) event. The process vessels, piping, and structures that house the hardware would be designed to withstand

such an earthquake. For the beyond design-basis event, an earthquake slightly stronger than the design-basis earthquake is postulated to occur. This earthquake would cause the primary and secondary confinement to fail, releasing the entire facility inventory into the building. The ventilation system and HEPA filters are also postulated to collapse, resulting in some airborne releases of both transuranic and fission product inventories.

Probability: The structure, primary confinement, and secondary confinement were conservatively assumed to fail due to an earthquake only slightly stronger than the design-basis earthquake of 0.16 g. The annual probability of exceeding a 0.16 g earthquake is 5.0×10^{-4} . Therefore, structural failure of the facility would be expected to occur less than once in 2,000 years.

Source Term: A release of the full inventory from the facility was postulated from collapse of the structure and of the primary and secondary confinement. The airborne source term associated with this accident would consist of 700 curies (Ci) of fission products and 2.0 Ci of transuranics. The release was postulated as a ground-level release.

B.3.1.3 Fire in a Process Cell

Scenario: A fire in any of the process cells could release radiological materials contained in the process vessels. The process would not introduce any combustible materials into the process cells; however, equipment or material that might be left behind during maintenance activities could lead to the initiation of this event. Good engineering practices would be used during design of the processing facility to ensure that HEPA filters would be located in a remote part of the facility away from process cells (e.g., event location). DOE would perform regular in-place testing to ensure that installed HEPA filters would have a particle removal efficiency of greater than 99.9 percent. The fire was assumed to challenge the ventilation

system and process equipment; however, the HEPA filters would be expected to maintain their function due to the physical distance between the filter location and event location and would minimize releases to the environment within 99 percent efficiency. The entire cell inventory was assumed to be at risk. A leak was expected to occur from the fire.

In this scenario, the benzene releases are negligible compared to releases from fires/explosions elsewhere (i.e. Precipitate Hydrolysis Cell) due to the small amount of benzene in the PHA Surge Tank.

Probability: A fire in a process cell was assumed to be limited by the combustible control program, the fire barriers, and the fire department. The annual probability of a fire occurring in a process cell was calculated to be 1.0×10^{-4} . Therefore, a fire in a process cell would be expected to occur once in 10,000 years.

Source Term: The fire was assumed to damage the process vessel enough to cause a leak. The damage was assumed to be equivalent to a 0.5-inch-diameter opening. The leak was assumed to be stopped within 24 hours, allowing the fire department to put out the fire, a response plan to be developed, and implementation of the response plan to control the consequences of the leak. The worst-case scenario would be a fire in the process cell containing the PHA Surge Tank, because this cell has the greatest amount of material. The airborne source term associated with this accident would consist of 37 Ci of fission products and 0.11 Ci of transuranics. Any release was postulated to occur from the 46-meter stack.

B.3.1.4 Benzene Explosion in the PHC

Scenario: Benzene could be introduced into the cell if one of the benzene-containing vessels or piping within the cell developed a leak. An ignition source could then cause a deflagration in the PHC, over-pressurizing the cell and dislodging the cell covers. The cell covers could then fall back into the PHC, striking the Organic Evaporator, Organic Evaporator Condensate Tank, Organic Evaporator Condenser, Organic

Evaporator Decanter, and Salt Cell Vent Condenser and spilling liquid benzene onto the cell floor. Benzene vapors evolving from this spilled inventory could lead to a second PHC deflagration, damaging and releasing the contents of the Precipitate Reactor. This accident assumes that the remaining liquid benzene on the PHC floor would ignite and burn.

The PHC design would incorporate a ventilation system to maintain airflow through the cell and minimize the possibility that benzene could leak into the cell and reach explosive concentrations.

Probability: A benzene explosion in the PHC that damages the cell would have the potential to damage and release the contents of multiple tanks that contain benzene and the Precipitate Reactor. For an explosion to occur, a large explosive benzene vapor cloud must form in the PHC and an ignition source must be present. For an explosive benzene cloud to form, the ventilation system was assumed to fail, eliminating airflow to the PHC, and forcing benzene from the PHC vessels. The annual probability that an explosion would occur in the PHC with damage to the cell was calculated to be 1.01×10^{-5} . Therefore, a benzene explosion would be expected to occur once in 99,000 years.

Source Term: An explosion in the PHC that would damage the cell was assumed to spill the entire contents of multiple tanks that contain benzene, as well as the Precipitate Reactor, which contains radiological material, into the cell. An ensuing fire would consume the benzene, so the accident would only involve radiological releases. HEPA filters are assumed to be damaged, failing to mitigate the release. The airborne source term associated with this accident would consist of 1,800 Ci of fission products and 5.3 Ci of transuranics. The release was postulated to occur from the 46-meter stack.

B.3.1.5 Helicopter or Aircraft Crash

Scenario: External events that could impact the facility include helicopter, aircraft, or vehicle impacts and external fire. According to Capucci (2000), an unmitigated aircraft impact has the potential to release the entire facility inventory. A vehicle impact would be postulated to only release the contents of the vessel impacted and is therefore no different than the loss of confinement events addressed earlier. The building structure would be a PC-3 structure. Therefore, the building would mitigate the consequences from the postulated vehicle crash by protecting the inventory in primary and secondary confinement within the structure. Additionally, segmentation of the process cells would further mitigate the consequences of this external event. However, the PC-3 structure was assumed to experience local structural failure (collapse) from a helicopter crash and full structural failure (collapse) from an aircraft crash. The helicopter crash was assumed to release the inventory in one cell and the aircraft crash was assumed to release the entire building inventory. Both structural failures were assumed to be coincident with fires from ignition of the helicopter or aircraft fuel. The fires would compound the radiological release inventories.

Probability: The most likely causes of releases from the Small Tank Precipitation facility from external events would be impacts from helicopter or aircraft crashes. The frequency of a helicopter crash onto the Small Tank Precipitation facility was calculated to be 4.8×10^{-7} per year, while the frequency of an aircraft impact was calculated to be 3.7×10^{-7} per year. Therefore, a helicopter crash would be expected once in 2,100,000 years and an aircraft impact would be expected once in 2,700,000 years.

Source Term: The Small Tank Precipitation facility would be a PC-3 structure with primary and secondary confinement. The building structure would be expected to withstand vehicle crashes. Benzene and radiological releases would be expected to occur from helicopter or aircraft crashes. However, benzene would be consumed by the ensuing fire, so airborne releases would only include radiological material.

HEPA filters are assumed to be damaged, failing to mitigate the release. The airborne source terms calculated for the various accident scenarios are shown in Table B-3. These releases were postulated as ground-level releases.

Table B-3. Source terms for helicopter or aircraft crashes into the Small Tank Precipitation facility.

	Source term (Ci)	
	Fission Products	Transuranics
<i>Helicopter Crash^a</i>		
Fresh Waste Day Tank Cell	160	0.32
Precipitation Tank Cell	190	0.38
Concentrate Tank Cell	760	2.2
Filtrate Hold Tank Cell	8.8	0.025
Wash Tank Cell	940	2.2
PHA Surge Tank	7,400	22
PHC	2,800	8.3
<i>Aircraft Crash</i>	12,000	35
a. Cappucci 2000.		

B.3.1.6 Benzene Explosion in PHA Surge Tank

Scenario: Degradation of TPB produces benzene that would be released to the vapor space of the PHA Surge Tank. Hydrogen and oxygen are produced from the radiolysis (decomposition) of water, forming a flammable mixture. Because the consequences of such an event are unsatisfactory, the PHA Surge Tank would be equipped with a safety-class nitrogen inerting system. In this scenario, both the primary and backup nitrogen systems are assumed to fail and the failure to go undetected. An ignition source could then cause an explosion (detonation or deflagration) in the vapor space and a subsequent fire. (In a deflagration, the shock wave travels at less than the speed of sound; in a detonation, the shock wave travels faster than the speed of sound.) The tanks and piping would maintain their integrity during

a deflagration, but not during a detonation; therefore, the event was conservatively assumed to be a detonation. It was also conservatively assumed that the detonation in the process tanks or piping would release the entire tank contents. The HEPA filters and ventilation were assumed to be damaged and bypassed, failing to mitigate the release. An explosion in the PHA Surge Tank, because of the amount of material at risk, would bound explosions in all other process tanks.

Probability: A benzene explosion in the PHA Surge Tank has the potential to damage the tank and release the entire tank contents. For an explosion to occur, an ignition source and an explosive gas mixture in the tank vapor space must be present. Failure of a safety-class system further increases the probability of occurrence. The annual probability that an explosion would occur in the PHA Surge Tank was calculated to be 1.84×10^{-8} . Therefore, an explosion in the PHA Surge Tank would be expected to occur once in 54,000,000 years and is not a credible event. Since the likelihood of this event is below the credibility threshold of once in 10,000,000 years, it is not evaluated further in this Appendix.

B.3.2 ION EXCHANGE

The accidents identified for the Ion Exchange process that would result in the release of radiological materials to the environment include:

- Loss of confinement in a process cell
- Beyond design-basis earthquake
- Loss of cooling to the Loaded Resin Hold Tanks (LRHTs)
- Fire in a process cell
- Helicopter or aircraft crash
- Hydrogen explosion in a process cell

B.3.2.1 Loss of Confinement in a Process Cell

Scenario: The tanks of concern are the Alpha Sorption Tank (AST), the LRHTs, and tanks in the Alpha Filter Cell (Washwater Hold Tank,

Sludge Solids Receipt Tank, and Cleaning Solution Dump Tank [CSDT]). Because the material inventory in the CSDT would be small compared to the other vessels in the alpha filter cell, a release from the CSDT would be bounded by releases from the other tanks in the cell. See Section B.3.1.1 for a description of the scenario.

Probability: See Section B.3.1.1 for a discussion of the probability of the event occurring.

Source Term: A dropped cell cover or crane mishap was assumed to damage the affected tank significantly enough to release the entire contents of the tank to the cell. Good engineering practices would be used during design of the process facility to ensure that HEPA filters would be located in a remote part of the facility away from process cells (e.g., event location). DOE would perform regular in-place testing to ensure that installed HEPA filters would have a particle removal efficiency of greater than 99.9 percent. The HEPA filters and ventilation system were assumed to be operating due to the physical distance between the filter location and event location, reducing the amount of radioactivity released from the process cell within 99 percent efficiency. The airborne source terms associated with this accident are shown in Table B-4. The release was postulated to occur from the 46-meter stack.

Table B-4. Source terms for loss of confinement in a process cell of the Ion Exchange facility.

	Source term (Ci)	
	Fission products	Transuranics
AST	0.37	7.2×10^{-4}
Washwater Hold Tank	0.023	4.5×10^{-7}
Sludge Solids Receipt Tank	0.041	0.0064
LRHT	2.3	1.1×10^{-6}

B.3.2.2 Beyond Design-Basis Earthquake

Scenario: The structures for the Ion Exchange process would be designed to with-

stand PC-3 earthquakes, straight winds, and tornadoes. See Section B.3.1.2 for a description of the scenario.

Probability: See Section B.3.1.2 for a discussion of the probability of the event occurring.

Source Term: A release of the full inventory from the facility was postulated from collapse of the structure and of the primary and secondary confinement. HEPA filters are assumed to be damaged, failing to mitigate the release. The airborne source term associated with this accident would consist of 1,100 Ci of fission products and 0.72 Ci of transuranics. The release was postulated as a ground-level release.

B.3.2.3 Loss of Cooling to the LRHTs

Scenario: A loss of cooling water to the LRHTs would allow the decay heat of the fission products to raise the temperature of the liquid phase in the involved tanks enough to boil. It was assumed that the liquid would boil for eight hours. Vapors from the boiling liquid would be vented and filtered through HEPA filters operating with an efficiency of 99 percent. It was assumed that the cooling water coils would be designed so that leakage of radionuclides into the cooling water system would not be credible, thereby eliminating direct releases to the aquatic environment.

Probability: The equipment in this scenario was assumed to be similar to vessels in DWPF. Therefore, frequencies and probabilities for DWPF were used as a basis for evaluation. The initiating events that could lead to loss of cooling would be power failure, human error, or equipment failure. In order for a loss of cooling event to result in damage to the vessel, the loss of cooling was coupled with the failure of pressure and temperature indicators. The frequency was estimated to be 1.9×10^{-4} per year. Therefore, a loss of cooling water to the LRHTs would be expected once in 5,300 years.

Source Term: The source term for this scenario was based on the assumption that 65 gallons of the LRHT inventory and 100 gallons of the first CST column (liquid) inventory would be in-

volved. This assumption was based on an estimation of the liquid mass evaporated by the decay heat of the fission products in eight hours. The airborne source terms associated with this accident are shown in Table B-5. The releases were postulated to occur from the 46-meter stack.

Table B-5. Source terms for loss of cooling event in Ion Exchange facility.

	Source term (Ci)	
	Fission products	Transuranics
LRHTs	0.11	5.3×10^{-8}
CST Column	0.0041	8.1×10^{-8}

B.3.2.4 Fire in a Process Cell

Scenario: See Section B.3.1.3 for a description of the scenario.

Probability: See Section B.3.1.3 for a discussion of probability.

Source Term: The fire was assumed to damage the process vessel sufficiently to cause a leak. The damage was assumed to be equivalent to a 0.5-inch-diameter opening. The leak was assumed to be stopped within 24 hours, allowing for the fire department to put out the fire, a response plan to be developed, and implementation of the response plan to control the leak. The process cells that would bound this accident for Ion Exchange would be the AST Cell, the Alpha Filter Cell, and the CST Columns Cell. The airborne source terms associated with a fire in each of these process cells are provided in Table B-6. Any release was postulated to occur from the 46-meter stack.

Table B-6. Source terms for process cell fires in the Ion Exchange facility.

	Source term (Ci)	
	Fission products	Transuranics
AST Cell	1.6	0.0031
Alpha Filter Cell	0.72	0.072
CST Columns Cell	55	3.6×10^{-5}

B.3.2.5 Helicopter or Aircraft Crash

Scenario: See Section B.3.1.5 for a description of the scenario.

Probability: The most likely causes of releases from the Ion Exchange Facility from external events would be impacts from helicopter or aircraft crashes. See Section B.3.1.5 for a discussion of the probability of either event occurring.

Source Term: The Ion Exchange facility would be a PC-3 structure with primary and secondary confinement. The building structure would be expected to withstand vehicle crashes. Releases would be expected to occur from helicopter or aircraft crashes. HEPA filters are assumed to be damaged, failing to mitigate the release. The source terms calculated for the various accident scenarios are shown in Table B-7. These releases were postulated as ground-level releases.

Table B-7. Source terms for helicopter or aircraft crashes into the Ion Exchange facility.

	Source Term (Ci)	
	Fission Products	Transuranics
<i>Helicopter Crash^a</i>		
AST Cell	5,700	11
Alpha Filter Cell	980	99
CST Columns Cell	75,000	0.050
<i>Aircraft Crash</i>		
	87,000	110

a. Cappucci 2000.

B.3.2.6 Hydrogen Explosion in a Process Cell

Scenario: The decomposition of water as a result of radiolysis leads to the production of hydrogen and oxygen. These flammable gases could accumulate in the vapor space of process vessels and, if left unchecked, could eventually reach the lower flammability limit (LFL) required for an explosion. Failure of the purge system to remove flammable gases, coupled with the presence of an ignition source, could initiate a hydrogen explosion (deflagration or detonation). The tanks of concern include the

AST, the tanks in the Alpha Filter Cell (Sludge Solids Receipt Tank, Washwater Hold Tank, and CSDT), and the tanks in the CST columns cell (LRHTs, the CST Columns, and the Product Holdup Tank). The tanks and piping would maintain their integrity during a deflagration, but not during a detonation; therefore, the event was conservatively assumed to be a detonation. An explosion in a process cell was conservatively assumed to release the contents of all vessels within that cell. Significant damage to the HEPA filters and ventilation system was assumed, allowing for an unmitigated radioactive release from the process cell.

Probability: The process equipment was assumed to be similar to process equipment in DWPF. Therefore, frequencies and probabilities for DWPF were used as a basis for this evaluation. The initiating events for a hydrogen explosion in the tank would be the presence of an ignition source and the presence of the explosive gas mixture. The presence of the explosive gas mixture would be due to the loss of purge to the tank that goes undetected and uncorrected. The annual probability that a hydrogen explosion would occur was calculated to be 4.7×10^{-8} . Therefore, a hydrogen explosion in a process cell would be expected to occur once in 21,000,000 years and is not a credible event. Since the likelihood of this event is below the credibility threshold of once in 10,000,000 years, it is not evaluated further in this Appendix.

B.3.3 SOLVENT EXTRACTION

The accidents identified for the Solvent Extraction alternative that would result in the release of radiological materials to the environment include:

- Loss of confinement in a process cell
- Beyond design-basis earthquake
- Fire in a process cell
- Hydrogen explosion in the Extraction Cell

- Helicopter or aircraft crash
- Hydrogen explosion in a process cell

B.3.3.1 Loss of Confinement in a Process Cell

Scenario: Mechanical failure or an external event, such as a dropped cell cover or crane mishap, could cause a loss of the primary confinement for a tank or its associated piping. A loss of primary confinement would release material into the process cell. The tanks of concern are the AST, the tanks in the Alpha Filter Cell (Washwater Hold Tank, Sludge Solids Receipt Tank, CSDT), the Salt Solution Feed Tank, tanks in the Extraction Cell, and the DWPF Salt Feed Tank. Because the material inventory in the CSDT would be small compared to the other vessels in the Alpha Filter Cell, a release from the CSDT would be bounded by releases from the other tanks in the cell. The Strip Effluent Stilling Tank was assumed to contain the bounding inventory in the Extraction Cell. For this event, the entire contents of the bounding tank at maximum capacity would be released through a leak from the tank or associated piping. It was assumed that the release would not be cleaned up for 168 hours (7 days).

A leak detection system would mitigate the consequences of releases from process tanks and associated piping. This system would be designed to detect the leak and terminate the process, thus minimizing the amount of material that would leak from the system. A shielded secondary confinement system would protect onsite workers from radiological consequences of the leaks.

Probability: The initiating event for the loss of primary confinement of a process tank could be mechanical failure or an external event. External events could cause leaks from tanks or from piping. Impacts during cell cover and crane movement are assumed to cause spills from a rupture in the tank or associated piping. It was assumed there would be 50 feet of piping associated with each tank. The annual frequency of a loss of primary confinement for a process tank was calculated to be 3.4×10^{-2} . Therefore, a loss

of confinement accident would be expected once in 30 years.

Source Term: A dropped cell cover or crane mishap was assumed to damage the affected tank significantly enough to release the entire contents of the tank to the cell. Good engineering practices would be used during design of the process facility to ensure that HEPA filters would be located in a remote part of the facility away from process cells (e.g., event location). DOE would perform regular in-place testing to ensure that installed HEPA filters would have a particle removal efficiency of greater than 99.9 percent. The HEPA filters and ventilation system were assumed to be operating due to the physical distance between the filter location and the event location, reducing the amount of radioactivity released from the process cell within 99 percent efficiency. The airborne source terms associated with this accident are shown in Table B-8. The release was postulated to occur from the 46-meter stack.

B.3.3.2 Beyond Design-Basis Earthquake

Scenario: The structures for the Solvent Extraction process would be designed to withstand PC-3 earthquakes, straight winds, and tornadoes. See Section B.3.1.2 for a description of the scenario.

Table B-8. Source terms for loss of confinement in a process cell of the Solvent Extraction facility.

	Source term (Ci)	
	Fission products	Transuranics
AST	0.46	9.1×10^{-4}
Washwater Hold Tank	0.023	4.5×10^{-7}
Sludge Solids Receipt Tank	0.041	0.0064
Salt Solution Feed Tank	0.46	9.0×10^{-6}
Extraction Cell	0.024	1.8×10^{-9}
DWPF Salt Feed Tank	4.8	3.6×10^{-7}

Probability: See Section B.3.1.2 for a discussion of the probability of the event occurring.

Source Term: A release of the full inventory from the facility was postulated from collapse of the structure and of the primary and secondary confinement. The airborne source term associated with this accident would consist of 580 Ci of fission products and 0.74 Ci of transuranics.

The release was postulated as a ground-level release.

B.3.3.3 Fire in a Process Cell

Scenario: See Section B.3.1.3 for a description of the scenario.

Probability: See Section B.3.1.3 for a discussion of the probability.

Source Term: The fire was assumed to damage the process vessel sufficiently to cause a leak. The damage was assumed to be equivalent to a 0.5-inch-diameter opening. The leak was assumed to be stopped within 24 hours, allowing the fire department to put out the fire, a response plan to be developed, and implementation of the response plan to control the leak. The process cells that would bound this accident for the Solvent Extraction process would be the AST Cell, the Alpha Filter Cell, the Extraction Cell, the DWPF Salt Feed Tank Cell, the Salt Solution Feed Tank Cell, and the Decontaminated Salt Solution (DSS) Hold Tank Cell. The airborne source terms associated with a process cell fire in any of these cells are provided in Table B-9. The releases were postulated to occur from the 46-meter stack.

Scenario: The decomposition of water as a result of radiolysis leads to the production of hydrogen and oxygen. These flammable gases could accumulate in the vapor space of process vessels and, if left unchecked, could eventually reach the LFL required for an explosion. Failure of the purge system and the presence of an ignition source could initiate a hydrogen explosion (deflagration or detonation). The vessels of concern would include the Stripping Effluent

Table B-9. Source terms for process cell fires in the Solvent Extraction facility.

	Source term (Ci)	
	Fission products	Transuranics
AST Cell	1.6	0.0031
Alpha Filter Cell	0.46	0.072
Extraction Cell	0.27	2.0×10^{-8}
DWPF Salt Feed Tank Cell	21	1.6×10^{-6}
Salt Solution Feed Tank Cell	1.6	3.1×10^{-5}
DSS Hold Tank Cell	0.011	3.1×10^{-5}

B.3.3.4 Hydrogen Explosion in the Extraction Cell

Stilling Tank, the Aqueous Raffinate Stilling Tank, and six centrifugal contactors. The vessels were assumed to contain a deflagration, but not a detonation. In a deflagration, the process HEPA filters were assumed to be severely damaged, causing a release from the stack. A detonation would be expected to damage the vessel of concern and release its entire inventory. A hydrogen detonation of any of the vessels would be expected to impact other vessels, due to their co-location in the process cell. To prevent this event, a tank purge or inerting system was assumed to be present. The secondary confinement was assumed to mitigate this event.

Probability: A hydrogen explosion in the process vessels would have the potential to damage the vessels and release all the contents. For this explosion to occur, ignition sources and an explosive gas mixture would have to be present. For explosive gases to be present, the nitrogen purge system was assumed to fail and the failure to be undetected. The detonation in this cell was assumed to release the inventories of all 16 vessels containing radionuclides within that process cell. This would result in an overall hydrogen detonation frequency of 7.6×10^{-7} per year. Therefore, a hydrogen explosion

in the Extraction Cell would be expected once in 1,300,000 years.

Source Term: The hydrogen explosion was assumed to release the entire contents of the Stripping Effluent Stilling Tank, the Aqueous Raffinate Stilling Tank, and six centrifugal contactors within the cell. The HEPA filters and the ventilation system were assumed to be damaged and bypassed, failing to mitigate the release from the process cell. The airborne source term associated with this accident would consist of 357 Ci of fission products and 0.00057 Ci of transuranics. The releases were postulated to occur from the 46-meter stack.

B.3.3.5 Helicopter or Aircraft Crash

Scenario: See Section B.3.1.5 for a discussion of the scenario.

Probability: The most likely causes of releases from the Solvent Extraction facility from external events would be impacts from helicopter or aircraft crashes. See Section B.3.1.5 for a discussion of the probability of such events occurring.

Source Term: The Solvent Extraction facility would be a PC-3 structure with primary and secondary confinement. The building structure would be expected to withstand vehicle crashes. Releases would be expected to occur from helicopter or aircraft crashes. HEPA filters are assumed to be damaged, failing to mitigate the release. The source terms calculated for the various accident scenarios are shown in Table B-10. These releases were postulated as ground-level releases.

B.3.3.6 Hydrogen Explosion in a Process Cell

Scenario: The tanks of concern include the AST, the tanks in the Alpha Filter Cell (Sludge Solids Receipt Tank, Washwater Hold Tank, and CSDT), the Salt Solution Feed Tank, and the DWPF Salt Feed Tank. See Section B.3.2.6 for a description of the scenario.

Table B-10. Source Terms for Helicopter or Aircraft Crashes into the Solvent Extraction facility.

	Source term (Ci)	
	Fission products	Transuranics
<i>Helicopter Crash</i> ^a		
AST Cell	810	1.6
Alpha Filter Cell	110	28
Extraction Cell	62	0.00088
Salt Solution Feed Tank Cell	810	0.016
DSS Hold Tank Cell	4.4	0.013
DWPF Salt Feed Tank Cell	8,350	0.00063
<i>Aircraft Crash</i>	10,000	13

a. Cappucci 2000.

Probability: See Section B.3.2.6 for a discussion of the probability.

B.3.4 DIRECT DISPOSAL IN GROUT

The accidents identified for the Direct Disposal in Grout alternative which could result in the release of radiological materials to the environment include:

- Loss of confinement in a process cell
- Beyond design-basis earthquake
- Fire in a process cell
- Helicopter or aircraft crash
- Hydrogen explosion in a process cell

B.3.4.1 Loss of Confinement in a Process Cell

Scenario: Mechanical failure or an external event, such as a dropped cell cover or crane mishap, could cause a loss of primary confinement for a tank or its associated piping. A loss of primary confinement would release material into the process cell. The tanks of concern are the AST, the Sludge Solids Receipt Tank, the CSDT, the Salt

Solution Hold Tank, and the Saltstone Hold Tank. For this event, the entire tank contents at maximum capacity would be released through a leak from the tank or associated piping. It was assumed that the release would not be cleaned up for 168 hours (7 days).

With the exception of the Saltstone Hold Tank, a leak detection system would mitigate the consequences of releases from process tanks and associated piping. This system would be designed to detect the leak and terminate the process, thus minimizing the amount of material that would leak from the system. Because of the viscous nature of the saltstone grout mixture, a leak detection system might not detect a leak from the Saltstone Hold Tank or piping. However, radiation monitors would be available to detect leakage. The monitors were assumed to be properly positioned and calibrated to ensure detection of a grout mixture leak. A shielded secondary confinement system would protect onsite workers from radiological consequences of leaks from tanks and associated piping. No credit was taken for the leak detection system in the analysis of this event.

Probability: See Section B.3.1.1 for a discussion of the probability of the event occurring.

Source Term: A dropped cell cover or crane mishap was assumed to damage the affected tank significantly enough to release entire inventory to the cell. Good engineering practices would be used during design of the process facility to ensure that HEPA filters would be located in a remote part of the facility away from process cells (e.g., event location). DOE would perform regular in-place testing to ensure that installed HEPA filters would have a particle removal efficiency of greater than 99.9 percent. The HEPA filters and ventilation system were assumed to be operating due to the physical distance between the filter location and event location, reducing the amount released from the process cell within 99 percent efficiency. The airborne source terms associated with this accident are shown in Table B-11. The release was postulated to occur from the 46-meter stack.

Table B-11. Source terms for loss of confinement in a process cell of the Direct Disposal in Grout facility.

	Source term (Ci)	
	Fission products	Transuranics
AST	0.37	7.2×10^{-4}
Sludge Solids Receipt Tank	0.038	0.0020
CSDT	3.8×10^{-5}	2.0×10^{-6}
Salt Solution Hold Tank	0.37	7.2
Saltstone Hold Tank	0.0018	3.6×10^{-8}

B.3.4.2 Beyond Design-Basis Earthquake

Scenario: The structures for the Direct Disposal in Grout process would be designed to withstand PC-3 earthquakes, straight winds, and tornadoes. See Section B.3.1.2 for a description of the scenario.

Probability: See Section B.3.1.2 for a discussion of the probability of the event occurring.

Source Term: A release of the full inventory from the facility was postulated from collapse of the structure and of the primary and secondary confinement. The airborne source term associated with this accident would consist of 77 Ci of fission products and 0.28 Ci of transuranics. The release was postulated as a ground-level release.

B.3.4.3 Fire in a Process Cell

Scenario: See Section B.3.1.3 for a description of the scenario.

Probability: See Section B.3.1.3 for a discussion of the probability of the event occurring.

Source Term: The fire was assumed to damage the process vessel sufficiently to cause a leak. The damage was assumed to be equivalent to a 0.5-inch-diameter opening. The leak was assumed to be stopped

within 24 hours, allowing the fire department to put out the fire, a response plan to be developed, and implementation of the response plan to control the leak. The process cells that would bound this accident for the Direct Disposal in Grout process would be the AST Cell, the Sludge Solids Receipt Tank Cell, and the Salt Solution Hold Tank Cell. Good engineering practices would be used during design of the process facility to ensure that HEPA filters would be located in a remote part of the facility away from process cells (e.g., event location). DOE would perform regular in-place testing to ensure that installed HEPA filters would have a particle removal efficiency of greater than 99.9 percent. HEPA filters would be expected to maintain their function due to the physical distance between the filter location the event location, and would minimize releases to the environment 99 percent efficiency. The airborne source terms associated with a process cell fire in any of these cells are provided in Table B-12. The releases were postulated to occur from the 46-meter stack.

Table B-12. Source terms for process cell fires in the Direct Disposal in Grout facility.

	Source term (Ci)	
	Fission products	Transuranics
AST Cell	1.5	0.0029
Sludge Solids Receipt Tank Cell	0.43	0.023
Salt Solution Hold Tank Cell	1.5	2.9×10^{-5}
Saltstone Hold Tank Cell	0.021	4.0×10^{-7}

B.3.4.4 Helicopter or Aircraft Crash

Scenario: See Section B.3.1.5 for a description of the scenario.

Probability: The most likely causes of releases from the Direct Disposal in Grout facility from external events would be impacts from helicopter or aircraft crashes. See Section B.3.1.5 for a discussion of the probability of the event occurring.

Source Term: The Direct Disposal in Grout facility would be a PC-3 structure with primary and secondary confinement. The building structure would be expected to withstand vehicle crashes. Releases would be expected to occur from helicopter or aircraft crashes. HEPA filters are assumed to be damaged, failing to mitigate the release. The source terms calculated for the various accident scenarios are shown in Table B-13. These releases were postulated as ground-level releases.

Table B-13. Source Terms for helicopter or aircraft crashes into the Direct Disposal in Grout facility.

	Source Term (Ci)	
	Fission Products	Transuranics
<i>Helicopter Crash^a</i>		
AST Cell	5,700	11
Sludge Solids Receipt Tank Cell	590	31
CSDT Cell	0.067	0.0036
Salt Solution Hold Tank Cell	5,700	0.11
Saltstone Hold Tank Cell	3.9	7.6×10^{-5}
<i>Aircraft Crash</i>	1,400	4.8

a. Cappucci 2000.

B.3.4.5 Hydrogen Explosion in a Process Cell

Scenario: The tanks of concern include the AST, the Sludge Solids Receipt Tank, the CSDT, the Salt Solution Hold Tank, and the Saltstone Hold Tank. See Section B.3.2.6 for a description of the scenario.

Probability: See Section B.3.2.6 for a discussion of the probability of the event occurring.

B.4 Accident Impacts Involving Radioactive Materials

This section presents the potential impacts, including LCFs, expected from offsite impacts associated with accident scenarios in-

volving the release of radioactive materials identified in Section B.3.

B.4.1 SMALL TANK PRECIPITATION

Table B-14 provides the radiological impacts to onsite and offsite receptors from the accidents described in Section B.3.1. The accidents are ordered by decreasing frequency.

B.4.2 ION EXCHANGE

Table B-15 provides radiological impacts to onsite and offsite receptors from the accidents described in Section B.3.2. The accidents are ordered by decreasing frequency.

B.4.3 SOLVENT EXTRACTION

Table B-16 provides radiological impacts to onsite and offsite receptors from the accidents described in Section B.3.3. The accidents are ordered by decreasing frequency.

B.4.4 DIRECT DISPOSAL IN GROUT

Table B-17 provides radiological impacts to onsite and offsite receptors from the accidents described in Section B.3.4. The accidents are ordered by decreasing frequency.

B.5 Postulated Accidents Involving Nonradioactive Hazardous Materials

This section summarizes the potential accident scenarios involving nonradioactive hazardous chemicals for the various processes.

B.5.1 SMALL TANK PRECIPITATION

The accidents identified for the Small Tank Precipitation process that result in the release of non-radioactive hazardous materials to the environment include:

- Caustic Tank loss of confinement
- TPB Storage Tank spill
- Organic Evaporator loss of confinement
- PHA Surge Tank loss of confinement

Table B-14. Accident impacts for the Small Tank Precipitation process.

Accident	Annual frequency (frequency category)	Maximally exposed individual (rem) ^a	Maximally exposed individual LCF	Offsite population (person-rem) ^a	Offsite population LCF	Noninvolved worker (rem) ^a	Noninvolved worker LCF	Nonin-volved worker (rem) ^a	Involved worker (rem) ^a	Involved worker LCF	Onsite population (person-rem) ^a	Onsite population LCF
Loss of confinement	3.4×10 ⁻²											
PHA Surge Tank	(Anticipated)	0.0016	8.2×10 ⁻⁷	88	0.044	0.024	9.5×10 ⁻⁵	3.2×10 ⁻⁶	1.3×10 ⁻⁹	0.016	39	0.016
Precipitate Reactor		4.1×10 ⁻⁴	2.0×10 ⁻⁷	22	0.011	0.0060	2.4×10 ⁻⁶	8.0×10 ⁻⁷	3.2×10 ⁻¹⁰	0.0039	9.7	0.0039
Beyond design-basis earthquake	<5.0×10 ⁻⁴ (Unlikely)	0.31	1.5×10 ⁻⁴	16,000	8.0	9.6	0.0038	310	0.12	0.12	9,000	3.6
Fire in a process cell	1.0×10 ⁻⁴ (Unlikely)	0.014	7.2×10 ⁻⁶	780	0.39	0.21	8.5×10 ⁻⁵	2.8×10 ⁻⁵	1.1×10 ⁻⁸	0.14	340	0.14
Benzene explosion in the PHC	1.0×10 ⁻⁵ (Extremely Unlikely)	0.70	3.5×10 ⁻⁴	38,000	19	10	0.0041	0.0014	5.5×10 ⁻⁷	6.7	17,000	6.7
Helicopter Crash	4.8×10 ⁻⁷ (Beyond Extremely Unlikely)	0.049	2.5×10 ⁻⁵	2,600	1.3	1.5	6.2×10 ⁻⁴	49	0.020	0.58	1,400	0.58
Fresh Waste Day Tank Cell		0.059	2.9×10 ⁻⁵	3,100	1.6	1.8	7.4×10 ⁻⁴	59	0.024	0.69	1,700	0.69
Precipitation Tank Cell		0.34	1.7×10 ⁻⁴	18,000	9.0	11	0.0043	340	0.14	4.0	10,000	4.0
Concentrate Tank Cell		0.0039	1.9×10 ⁻⁶	200	0.10	0.12	4.9×10 ⁻⁵	3.9	0.0016	0.046	110	0.046
Filtrate Hold Tank Cell		0.34	1.7×10 ⁻⁴	18,000	9.1	11	0.0043	350	0.14	4.0	10,000	4.0
Wash Tank Cell		3.3	0.0016	170,000	87	100	0.041	3,300	1.3	39	97,000	39
PHA Surge Tank Cell		1.3	6.3×10 ⁻⁴	67,000	33	40	0.016	1,300	0.51	15	37,000	15
PHC		5.4	0.0027	280,000	140	170	0.067	5,400	2.1	63	160,000	63
Aircraft Crash	3.7×10 ⁻⁷ (Beyond Extremely Unlikely)											

a. Refer to the Glossary for the definition of rem and person-rem.

LCF = latent cancer fatality.

PHA = Precipitate Hydrolysis Aqueous.

PHC = Precipitate Hydrolysis Cell.

Table B-15. Accident impacts for the Ion Exchange process.

Accident	Annual frequency (frequency category)	Maximally exposed individual (rem) ^a	Maximally exposed individual LCF	Offsite population (person-rem) ^a	Offsite population LCF	Noninvolved worker (rem) ^a	Noninvolved worker LCF	Involved worker (rem) ^a	Involved worker LCF	Onsite population (person-rem) ^a	Onsite population LCF
Loss of confinement	3.4×10^{-2} (Anticipated)										
AST		9.7×10^{-5}	4.9×10^{-8}	5.2	0.0026	0.0014	5.7×10^{-7}	2.8×10^{-7}	1.1×10^{-10}	2.3	9.3×10^{-4}
Sludge Solids Receipt Tank		8.3×10^{-4}	4.2×10^{-7}	45	0.022	0.012	4.9×10^{-6}	6.4×10^{-8}	2.6×10^{-11}	20	0.0080
Washwater Hold Tank		2.4×10^{-7}	1.2×10^{-10}	0.0013	6.6×10^{-6}	3.6×10^{-6}	1.4×10^{-9}	1.7×10^{-8}	6.9×10^{-12}	0.0057	2.3×10^{-6}
LRHT		1.8×10^{-5}	9.2×10^{-9}	1.0	5.1×10^{-4}	2.8×10^{-4}	1.1×10^{-7}	1.7×10^{-6}	7.0×10^{-10}	0.44	1.8×10^{-4}
Beyond design-basis earthquake	$<5.0 \times 10^{-4}$ (Unlikely)	0.12	5.9×10^{-5}	6,200	3.1	3.7	0.0015	120	0.047	3,500	1.4
Loss of cooling to the LRHTs ^b	1.9×10^{-4} (Unlikely)	9.4×10^{-7}	4.7×10^{-10}	0.052	2.6×10^{-5}	1.4×10^{-5}	5.7×10^{-9}	8.8×10^{-8}	3.5×10^{-11}	0.023	9.0×10^{-6}
Fire in a process cell	1.0×10^{-4} (Unlikely)										
AST cell		4.2×10^{-3}	2.1×10^{-7}	23	0.011	0.0062	2.5×10^{-6}	1.2×10^{-6}	4.8×10^{-10}	10	0.0040
Alpha Filter Cell		0.0094	4.7×10^{-6}	500	0.25	0.14	5.5×10^{-5}	9.1×10^{-7}	3.6×10^{-10}	220	0.089
CST Process Cell		4.4×10^{-4}	2.2×10^{-7}	25	0.012	0.0067	2.7×10^{-6}	4.1×10^{-5}	1.7×10^{-8}	11	0.0043
Helicopter Crash	4.8×10^{-7} (Beyond extremely unlikely)										
AST		0.20	9.8×10^{-5}	10,000	5.2	6.2	0.0025	200	0.079	5,800	2.3
Alpha Filter Cell		1.7	8.5×10^{-4}	89,000	45	53	0.021	1,700	0.68	50,000	20
CST Columns Cell		0.11	5.5×10^{-5}	5,800	2.9	3.5	0.0014	110	0.045	3,300	1.3
Aircraft Crash	3.7×10^{-7} (Beyond extremely unlikely)	2.0	0.0010	110,000	53	63	0.025	2,000	0.81	59,000	24

a. Refer to the Glossary for the definition of rem and person-rem.

b. Combined source terms from the LRHTs and the CST Column were used to determine impacts from the loss of cooling event.

LCF = latent cancer fatality; LRHT = Loaded Resin Hold Tank; AST = Alpha Sorption Tank.

Table B-16. Accident impacts for the Solvent Extraction process.

Accident	Annual frequency (frequency category)	Maximally exposed individual (rem) ^a	Maximally exposed individual LCF	Offsite population (person-rem) ^a	Offsite population LCF	Noninvolved worker (rem) ^a	Noninvolved worker LCF	Involved worker (rem) ^a	Involved worker LCF	Onsite population (person-rem) ^a	Onsite population LCF
Loss of confinement	3.4×10 ⁻² (Anticipated)										
AST		1.2×10 ⁻⁴	6.1×10 ⁻⁸	6.5	0.0033	0.0018	7.1×10 ⁻⁷	3.5×10 ⁻⁷	1.4×10 ⁻¹⁰	2.9	0.0012
Wash Water Hold Tank		2.4×10 ⁻⁷	1.2×10 ⁻¹⁰	0.013	6.6×10 ⁻⁶	3.6×10 ⁻⁶	1.4×10 ⁻⁹	1.7×10 ⁻⁸	6.9×10 ⁻¹²	0.0057	2.3×10 ⁻⁶
Sludge Solids Receipt Tank		8.3×10 ⁻⁴	4.2×10 ⁻⁷	45	0.22	0.012	4.9×10 ⁻⁶	6.4×10 ⁻⁸	2.6×10 ⁻¹¹	20	0.0080
Salt Solution Feed Tank		4.8×10 ⁻⁶	2.4×10 ⁻⁹	0.26	1.3×10 ⁻⁴	7.2×10 ⁻⁵	2.9×10 ⁻⁸	3.4×10 ⁻⁷	1.4×10 ⁻¹⁰	0.11	4.6×10 ⁻⁵
Extraction Cell		1.9×10 ⁻⁷	9.4×10 ⁻¹¹	0.010	5.2×10 ⁻⁶	2.9×10 ⁻⁶	1.1×10 ⁻⁹	1.8×10 ⁻⁸	7.1×10 ⁻¹²	0.0045	1.8×10 ⁻⁶
DWPF Salt Feed Tank		3.8×10 ⁻⁵	1.9×10 ⁻⁸	2.1	0.0010	5.7×10 ⁻⁴	2.3×10 ⁻⁷	3.6×10 ⁻⁶	1.4×10 ⁻⁹	0.91	3.6×10 ⁻⁴
Beyond design-basis earthquake	<5.0×10 ⁻⁴ (Unlikely)	0.12	5.8×10 ⁻⁵	6,100	3.0	3.6	0.0015	120	0.046	3,400	1.4
Fire in a process cell	1.0×10 ⁻⁴ (Unlikely)										
AST Cell		4.2×10 ⁻⁴	2.1×10 ⁻⁷	23	0.011	0.0062	2.5×10 ⁻⁶	1.2×10 ⁻⁶	4.8×10 ⁻¹⁰	10	0.0040
Alpha Filter Cell		0.0094	4.7×10 ⁻⁶	500	0.25	0.14	5.5×10 ⁻⁵	7.2×10 ⁻⁷	2.9×10 ⁻¹⁰	220	0.089
Extraction Cell		2.1×10 ⁻⁶	1.1×10 ⁻⁹	0.012	5.9×10 ⁻⁵	3.2×10 ⁻⁵	1.3×10 ⁻⁸	2.0×10 ⁻⁷	8.0×10 ⁻¹¹	0.051	2.0×10 ⁻⁵
Salt Solution Feed Tank Cell		1.7×10 ⁻⁵	8.3×10 ⁻⁹	0.92	4.6×10 ⁻⁴	2.5×10 ⁻⁴	1.0×10 ⁻⁷	1.2×10 ⁻⁶	4.8×10 ⁻¹⁰	0.40	1.6×10 ⁻⁴
DSS Hold Tank Cell		4.2×10 ⁻⁶	2.1×10 ⁻⁹	0.22	1.1×10 ⁻⁴	6.1×10 ⁻⁵	2.4×10 ⁻⁸	8.3×10 ⁻⁹	3.3×10 ⁻¹²	0.099	4.0×10 ⁻⁵
DWPF Salt Feed Tank Cell		1.6×10 ⁻⁴	8.1×10 ⁻⁸	9.1	0.0045	0.0025	9.9×10 ⁻⁷	1.5×10 ⁻⁵	6.2×10 ⁻⁹	3.9	0.0016
Hydrogen Explosion in the Extraction Cell	7.6×10 ⁻⁷ (Beyond extremely unlikely)	0.0029	1.4×10 ⁻⁶	160	0.081	0.044	1.8×10 ⁻⁵	2.7×10 ⁻⁴	1.1×10 ⁻⁷	70	0.028
Helicopter Crash	4.8×10 ⁻⁷ (Beyond extremely unlikely)										
AST Cell		0.25	1.2×10 ⁻⁴	13,000	6.5	7.7	0.0031	250	0.099	7,200	2.9
Alpha Filter Cell		1.7	8.5×10 ⁻⁴	89,000	45	53	0.021	1,700	0.68	50,000	20
Extraction Cell		7.2×10 ⁻⁴	3.6×10 ⁻⁷	38	0.019	0.023	9.1×10 ⁻⁶	0.74	2.9×10 ⁻⁴	21	0.0085
Salt Solution Feed Tank Cell		0.0099	5.0×10 ⁻⁶	530	0.26	0.32	1.3×10 ⁻⁴	10	0.0041	290	0.12
DSS Hold Tank Cell		0.0019	9.7×10 ⁻⁷	100	0.051	0.061	2.4×10 ⁻⁵	1.9	7.8×10 ⁻⁴	57	0.023
DWPF Salt Feed Tank Cell		0.079	3.9×10 ⁻⁵	4,200	2.1	2.5	0.0010	81	0.032	2,300	0.94
Aircraft Crash	3.7×10 ⁻⁷ (Beyond extremely unlikely)	2.0	0.0010	110,000	54	64	0.026	2,000	0.81	60,000	24

a. Refer to the Glossary for the definition of rem and person-rem.
LCF = latent cancer fatality, AST = Alpha Sorption Tank, DSS = Decontaminated salt solution.

Table B-17. Accident impacts for the Direct Disposal in Grout process.

Accident	Annual frequency (frequency category)	Maximally exposed individual (rem) ^a	Maximally exposed individual LCF	Offsite population (person- rem) ^a	Offsite population LCF	Involved worker (rem) ^a	Involved worker LCF	Noninvolved worker (rem) ^a	Noninvolved worker LCF	Onsite population (person- rem) ^a	Onsite population LCF
Loss of confinement	3.4×10^{-2} (Anticipated)										
AST		9.0×10^{-5}	4.5×10^{-8}	5.3	0.0027	0.0013	5.4×10^{-7}	6.6×10^{-7}	2.6×10^{-10}	1.6	6.3×10^{-4}
Sludge Solids Re- ceipt Tank		2.4×10^{-4}	1.2×10^{-7}	14	0.0072	0.0036	1.5×10^{-6}	7.3×10^{-8}	2.9×10^{-11}	4.2	0.0017
CSDT		2.4×10^{-7}	1.2×10^{-10}	0.014	7.2×10^{-6}	3.6×10^{-6}	1.5×10^{-9}	7.3×10^{-11}	2.9×10^{-14}	0.0042	1.7×10^{-6}
Salt Solution Hold Tank		3.7×10^{-6}	1.9×10^{-9}	0.22	1.1×10^{-4}	5.3×10^{-5}	2.1×10^{-8}	6.6×10^{-7}	2.6×10^{-10}	0.063	2.5×10^{-5}
Saltstone Hold Tank		1.9×10^{-8}	9.3×10^{-12}	0.0011	5.4×10^{-7}	2.7×10^{-7}	1.1×10^{-10}	3.3×10^{-9}	1.3×10^{-12}	3.1×10^{-4}	1.3×10^{-7}
Beyond design-basis earthquake	$< 5.0 \times 10^{-4}$ (Unlikely)	0.042	2.1×10^{-5}	2300	1.1	1.3	5.3×10^{-4}	42	0.017	1000	0.41
Fire in a process cell	1.0×10^{-4} (Unlikely)										
AST Cell		3.6×10^{-4}	1.8×10^{-7}	21	0.011	0.0054	2.2×10^{-6}	2.7×10^{-6}	1.1×10^{-9}	6.3	0.0025
Sludge Solids Re- ceipt Tank Cell		0.0027	1.4×10^{-6}	160	0.081	0.041	1.6×10^{-5}	8.2×10^{-7}	3.3×10^{-10}	48	0.019
Salt Solution Hold Tank Cell		1.5×10^{-5}	7.5×10^{-9}	0.87	4.4×10^{-4}	2.2×10^{-4}	8.6×10^{-8}	2.7×10^{-6}	1.1×10^{-9}	0.25	1.0×10^{-4}
Saltstone Hold Tank Cell		2.1×10^{-7}	1.0×10^{-10}	0.012	6.1×10^{-6}	3.0×10^{-6}	1.2×10^{-9}	3.7×10^{-8}	1.5×10^{-11}	0.0035	1.4×10^{-6}
Helicopter Crash	4.8×10^{-7} (Beyond ex- tremely unlikely)										
AST Cell		0.20	9.8×10^{-5}	11,000	5.3	6.2	0.0025	200	0.079	4800	1.9
Sludge Solids Re- ceipt Tank Cell		0.53	2.7×10^{-4}	29,000	14	17	0.0067	530	0.21	13,000	5.3
CSDT Cell		0.0081	4.0×10^{-6}	430	0.22	0.25	1.0×10^{-4}	8.2	0.0033	200	0.078
Salt Solution Hold Tank Cell		4.8×10^{-5}	2.4×10^{-8}	2.6	0.0013	0.0015	6.1×10^{-7}	0.049	2.0×10^{-5}	1.2	4.7×10^{-4}
Saltstone Hold Tank Cell		5.3×10^{-4}	2.7×10^{-7}	29	0.014	0.017	6.7×10^{-6}	0.53	2.1×10^{-4}	13	0.0053
Aircraft Crash	3.7×10^{-7} (Beyond ex- tremely unlikely)	0.74	3.7×10^{-4}	40000	20	23	0.0093	740	0.30	18,000	7.3

a. Refer to the Glossary for the definition of rem and person-rem.
LCF = latent cancer fatality.
AST = Alpha Sorption Tank.
CSDT = Cleaning Solution Dump Tank.

- Beyond design-basis earthquake
- Organic Waste Storage Tank (OWST) loss of confinement
- Loss of cooling
- Benzene explosion in the OWST

B.5.1.1 Caustic Tank Loss of Confinement

Scenario: The Small Tank Precipitation facility would have 5,000 gallons of 50-percent sodium hydroxide in the Caustic Storage Tank and 500 gallons in the Caustic Feed Tank (CFT). The limiting event considered was the spill of the entire inventory of the 5,000-gallon Caustic Storage Tank.

Probability: A leak or rupture of the tank would have the potential to release the tank contents. Spilling of the tank contents could occur from a leak or rupture of the tank or piping. The overall frequency of a spill from a leak or rupture was estimated to be 3.4×10^{-2} per year, or once in 30 years.

Source Term: The source term was estimated by assuming the sodium hydroxide tank would be full and the entire inventory would be released to a diked area outside the facility. The release rate of 1,030 milligrams per second was assumed to be at ground level.

B.5.1.2 TPB Storage Tank Spill

Scenario: TPB contains a small amount of benzene (up to 650 parts per million). The TPB Storage Tank would be a 20,000-gallon tank located in the Cold Feeds Area, outside the process areas. A spill from the TPB Storage Tank was assumed to occur, which would cause a benzene release. Some typical causes of accidental spills of chemicals would be overflows, transfer errors, and leaks. The most likely initiator would be a valve or flange leak.

There would be a sump and a dike around the TPB Storage Tank large enough to contain the entire contents of the tank, to prevent it from reaching the environment or process areas in case of a leak.

Probability: The frequency of a spill from the TPB Storage Tank was estimated to be 3.4×10^{-2} per year, or once in 30 years.

Source Term: The following assumptions were made in calculating the benzene source term resulting from a spill from the TPB Storage Tank:

- The concentration of benzene in TPB would be 650 parts per million.
- The spill would result in all of the TPB (20,000 gallons) being released to the Cold Feeds Area dike. At 650 parts per million, the total amount of benzene spilled would be 112 pounds (51.0 kilograms).

The benzene release rate from the spill was calculated to be 110,000 milligrams per second. Release of benzene would occur for 7.5 minutes. The release was assumed to occur at ground level.

B.5.1.3 Organic Evaporator Loss of Confinement

Scenario: A failure of the Organic Evaporator or its associated piping would cause a release of benzene into the PHC. For this event, the entire contents of the evaporator were assumed to be released. A number of initiating events could cause a loss of primary confinement of the evaporator (i.e., leaks, ruptures, crane or cell cover impacts).

Probability: The initiating event frequency is similar to all other loss of confinement events evaluated in this Appendix with a frequency of 3.4×10^{-2} per year, or once in 30 years.

Source Term: The hazardous material source term calculated for this event was a release of 7.8×10^5 milligrams per second of benzene.

B.5.1.4 PHA Surge Tank Loss of Confinement

Scenario: A failure of the PHA Surge Tank or its associated piping would cause a release of benzene into the PHA Surge Tank process cell. For this event, the entire contents of the tank were assumed to be released. A number of initiating events could cause a loss of primary confinement of the evaporator (i.e., leaks, ruptures, crane or cell cover impacts).

Probability: The initiating event frequency is similar to all other loss of confinement events evaluated in this Appendix with a frequency of 3.4×10^{-2} per year, or once in 30 years.

Source Term: The hazardous material source term calculated for this event was a release of 0.0013 milligrams per second of benzene.

B.5.1.5 Beyond Design-Basis Earthquake

Scenario: The structures for the Small Tank Precipitation process would be designed to withstand PC-3 earthquakes, straight winds, and tornadoes. The PC-3 earthquake is considered to be the bounding NPH event. The process vessels, piping, and structures that house the hardware would be designed to withstand such an earthquake. For the beyond design-basis event, an earthquake slightly stronger than the design-basis earthquake is postulated to occur. This earthquake would cause the primary and secondary confinement to fail, releasing the entire facility inventory into the building. The ventilation system and HEPA filters are also postulated to collapse, resulting in some airborne releases of benzene.

Probability: The initiating event frequency is similar to all beyond design basis earthquake events evaluated in this Appendix with a frequency of 5.0×10^{-4} per year, or once in 2,000 years.

Source Term: The hazardous material source term calculated for this event was a release of 4,600 milligrams per second of benzene.

B.5.1.6 OWST Loss of Confinement

Scenario: The OWST would be a 40,000-gallon tank located outside the process areas. Leak detection would be provided within the secondary tank to alert operators to leakage from the primary tank. The secondary tank would contain any leakage from the primary tank; however, failure of the secondary tank would allow benzene to be released to the ground outside the tank. This scenario would be considered incredible; however, a more likely release scenario would be the failure of the 2-inch process line during benzene transfers from the PHC to the OWST.

Probability: The frequency of concurrent failures of the primary and secondary tanks was calculated to be 7.4×10^{-8} . Failure of the 2-inch process line, however, was deemed to be credible. Assuming that 700 feet of piping would be associated with the tank, and that the transfer operation would be performed 100 hours per year, the frequency of a large spill from the transfer line was calculated to be 7.0×10^{-6} per year, or once in 140,000 years.

Source Term: A rupture of the transfer line from the PHC to the OWST was assumed to release benzene during the transfer operation. The source term calculated for this release of benzene was 5.6×10^6 milligrams per second.

B.5.1.7 Loss of Cooling

A loss of cooling to the Precipitation, Concentrate, or Wash Tanks would increase the temperature of the liquid phase of the contents of each tank. Benzene generation and releases, due to the radiolytic and catalytic decomposition of TPB, would accelerate. The enhanced benzene evolution would result in a higher benzene concentration in the effluent gas released from these tanks. The effects of a loss of cooling on the Recycle Wash Hold or Filtrate Hold Tanks would be minimal, due to the lack of solids in the liquid phase.

Even with a loss of cooling, the nitrogen flow through the tanks would still maintain the tanks in an inerted condition and would prevent explosions and fires from occurring in the tanks.

The low decay heat rate (approximately 0.005 watts per curie) of the tank contents would mitigate the effects of a loss-of-cooling event. A significant period of time would be required to sufficiently raise the temperature of the tanks to increase benzene generation rates, which would allow operating personnel time to minimize the effects of the accident. In addition, the height of the process stack through which benzene would be released is designed to prevent high concentrations of benzene from reaching onsite workers.

Probability: The frequency of a failure of the cooling water system that would last long enough for process vessels to overheat, resulting in increased benzene emissions, is 6.0×10^{-6} per year, or once in 170,000 years.

Source Term: The following assumptions were made when calculating the benzene source term resulting from a loss of cooling:

- The Small Tank Precipitation facility building stack was assumed to be 46 meters above grade.
- Average exit velocity from the stack would be 10 to 40 meters per second.
- Effluent temperature would be the temperature of the material in the process tanks (45°C).
- The benzene generation per hour would be 50 milligrams per liter of material in the tank.
- Tanks would be at maximum capacity (Precipitation Tanks #1 and #2 – 15,000 gallons each; Concentrate Tank – 10,000 gallons; Wash Tank – 10,000 gallons).

The resulting benzene source term was calculated as 2,600 milligrams per second.

B.5.1.8 Benzene Explosion in OWST

Scenario: Benzene and other organic compounds would normally be present in the OWST. The primary tank would be equipped with a floating roof to restrict organic waste evaporation and to reduce benzene emissions. The primary stainless steel tank would be within a secondary carbon steel tank. To prevent the vapor space from becoming flammable, the OWST would be pressurized with a safety-class nitrogen inerting system. However, the vapor space could become explosive if positive pressure was lost and air leaked into the vessel. With the presence of an ignition source, a deflagration could occur in the tank vapor space and cause the vessel to fail, spilling the liquid benzene inventory into the secondary tank. For this scenario, the secondary tank was also assumed to leak from the force of the explosion.

The OWST would be equipped with a nitrogen purge system and a seismically qualified liquid nitrogen vessel and vaporizer.

Probability: A benzene explosion in the OWST would have the potential to damage and release the entire inventory of benzene. The frequency that an explosion in the tank would occur was calculated to be 1.3×10^{-6} per year, or once in 770,000 years.

Source Term: An explosion of the OWST was assumed to release the entire contents of the primary tank into the secondary tank. The secondary tank was assumed to leak from the force of the primary tank explosion, releasing the entire contents outside the tank. The hazardous material source term was calculated to be 5.2×10^7 milligrams per second of benzene. The release was assumed to occur at ground level.

B.5.2 ION EXCHANGE AND DIRECT DISPOSAL IN GROUT

One bounding chemical accident was evaluated, a CFT loss of confinement that would be com-

mon to both the Ion Exchange and the Direct Disposal in Grout processes.

Scenario: The Ion Exchange facility would have 5,000 gallons of 50-percent sodium hydroxide in the CFT and the Direct Disposal in Grout facility would have 500 gallons of the 50-percent sodium hydroxide solution. Therefore, the limiting event was assumed to be a spill of the entire inventory of the sodium hydroxide tank (5,000 gallons).

Probability: A leak or rupture of the CFT could release the tank contents. The overall frequency of a spill from a leak or rupture was estimated to be 3.4×10^{-2} per year, or once in 30 years.

Source Term: The source term was estimated by conservatively assuming the sodium hydroxide tank would be full and the entire inventory would be released into a diked area outside the building. The release rate of sodium hydroxide was estimated to be 1,030 milligrams per second.

B.5.3 SOLVENT EXTRACTION

The accidents identified for the Solvent Extraction process that result in the release of non-radioactive hazardous materials to the environment include:

- Caustic Tank release
- Caustic Dilution Feed Tank release
- Nitric Acid Feed Tank loss of confinement

B.5.3.1 Caustic Storage Tank Release

Scenario: The Solvent Extraction facility would have sodium hydroxide in the CFT, Filter Cleaning Caustic Tank, Caustic Dilution Feed Tank, Caustic Storage Tank, Caustic Make-up Tank, and Solvent Wash Solution Make-up Tank. The limiting event considered was the spill of the entire inventory of the 5,000-gallon, 50-percent sodium hydroxide Caustic Storage Tank.

Probability: See Section B.5.2 for a discussion of the probability of the event occurring.

Source Term: See Section B.5.2 for a discussion of the source term.

B.5.3.2 Caustic Dilution Feed Tank Loss of Confinement

Scenario: The Solvent Extraction facility would have 15,000 gallons of 2-molar sodium hydroxide in the Caustic Dilution Feed Tank, which would be located in the operating area corridor. For conservatism, the postulated event was assumed to be a spill of the entire inventory, which would be contained in a diked area.

Probability: A leak or rupture of the tank would have the potential for releasing the tank contents. Spilling of the tank contents could occur because of a leak from the tank or piping, or rupture of the tank or piping. The overall frequency of a spill from a leak or rupture was estimated to be 3.4×10^{-2} per year, or once in 30 years.

Source Term: The release of the sodium hydroxide was assumed to be at ground level. The release rate was calculated to be 5,500 milligrams per second.

B.5.3.3 Nitric Acid Feed Tank Loss of Confinement

Scenario: The Solvent Extraction facility would have 1,000 gallons of 50-percent nitric acid in the Nitric Acid Feed Tank located in the Cold Feeds Area outside the main building. For conservatism, the postulated event was assumed to be a spill of the entire inventory, which would be contained in a diked area.

Probability: A leak or rupture of the tank would have the potential for releasing the tank contents. Spilling of the tank contents could occur because of a leak from the tank or piping, or rupture of the tank or piping. The overall frequency of a spill from a leak or rupture was estimated to be 3.4×10^{-2} per year, or once in 30 years.

Source Term: The release of the nitric acid was assumed to be at ground level. The release rate was calculated to be 160 milligrams per second.

B.6 Accident Impacts Involving Nonradioactive Hazardous Materials

As Section B.4 provided for the radiological consequences of identified accidents, this Section provides the potential impacts associated with the release of nonradioactive hazardous materials from the various accident scenarios.

B.6.1 SMALL TANK PRECIPITATION

The accidents described in Section B.5.1 would release hazardous chemicals (sodium hydroxide and benzene). Table B-18 provides atmospheric dispersion factors for two individual receptors: the noninvolved worker and the MEI (Hope 1999). By applying these factors, the maximum concentrations at those receptor locations were calculated. These concentrations are also presented in Table B-18.

The ERPG-1 value (described in Section B.2.3) is 0.5 milligrams per cubic meter (mg/m^3) for sodium hydroxide and 160 mg/m^3 for benzene; therefore, no significant impacts would occur to offsite receptors due to a loss-of-cooling accident or spills from the CFT, the TPB tank, or the Organic Evaporator. By definition, individuals exposed to airborne concentrations below ERPG-1 threshold concentrations would not experience even mild transient adverse health effects or the perception of a clearly defined objectionable odor.

Three of the accidents were shown to exceed the ERPG-2 value of 480 mg/m^3 for benzene concentrations to noninvolved workers. Airborne concentrations from two of these accidents, an explosion in the PHC and OWST loss of confinement, would be below the ERPG-3 value of 3,190 mg/m^3 . By defi-

nition, individuals exposed to airborne concentrations above the ERPG-2 threshold could experience or develop irreversible or other serious health effects or symptoms that may impair their ability to take protective action. Airborne concentrations from the third accident, an explosion in the OWST, would exceed the ERPG-3 value. By definition, individuals exposed to airborne concentrations above the ERPG-3 threshold could experience or develop life-threatening health effects. All three of these accidents are in the extremely unlikely category.

B.6.2 ION EXCHANGE AND DIRECT DISPOSAL IN GROUT

The CFT accident described in Section B.5.2 would release sodium hydroxide at a release rate of 1,030 milligrams per second. Table B-19 provides atmospheric dispersion factors for two individual receptors, the noninvolved worker and the MEI (Hope 1999). By applying these factors, the maximum concentrations at those receptor locations were calculated. These concentrations are also presented in Table B-19.

The ERPG-1 value described in Section B.2.3 is 0.5 mg/m^3 for sodium hydroxide; therefore, no significant impacts would occur to onsite or offsite receptors from this accident. Refer to the discussions in Section B.6.1 on the effects of concentrations below ERPG-1 thresholds.

B.6.3 SOLVENT EXTRACTION

The accidents described in Section B.5.3 would release hazardous chemicals (sodium hydroxide and nitric acid). Table B-20 provides atmospheric dispersion factors for two individual receptors, the noninvolved worker and the MEI (Hope 1999). By applying these factors, the maximum concentrations at those receptor locations were calculated. These concentrations are also presented in Table B-20.

The ERPG-1 value (described in Section B.2.3) is 0.5 mg/m^3 for sodium hydroxide and 2.6 mg/m^3 for nitric acid; therefore, no significant impacts would occur to offsite receptors from these accidents. By definition, individuals exposed to airborne concentrations below

Table B-18. Chemical release concentrations from Small Tank Precipitation process.

Scenario	Frequency (frequency category)	Evaporation release rate (mg/s)	Atmospheric dispersion factor (sec/m ³)		Resultant concentration (mg/m ³) ^{a,b,c,d}		Total atmospheric release (mg)
			Noninvolved worker	MEI	Noninvolved worker	MEI	
Sodium hydroxide							
CFT Loss of Confinement (Anticipated)	3.4×10 ⁻²	1,030	1.7×10 ⁻⁴	5.7×10 ⁻⁷	0.18	5.9×10 ⁻⁴	770
Benzene							
TPB tank spill (Anticipated)	3.4×10 ⁻²	110,000	1.7×10 ⁻⁴	5.7×10 ⁻⁷	18.7	0.06	5.1×10 ⁷
Organic Evaporator Loss of Con- finement (Anticipated)	3.4×10 ⁻²	780,000	1.7×10 ⁻⁴	5.7×10 ⁻⁷	130	0.45	5.7×10 ⁹
PHA Surge Tank Loss of Confinement (Anticipated)	3.4×10 ⁻²	0.0013	1.7×10 ⁻⁴	5.7×10 ⁻⁷	2.2×10 ⁻⁸	7.41×10 ⁻¹⁰	800
Beyond Design-Basis Earthquake (Unlikely)	5.0×10 ⁻⁴	4,600	1.7×10 ⁻⁴	5.7×10 ⁻⁷	0.78	0.0026	1.4×10 ⁷
OWST Loss of Confine- ment (Extremely unlikely)	7.0×10 ⁻⁶	5,600,000	1.7×10 ⁻⁴	5.7×10 ⁻⁷	950	3.2	3.3×10 ⁹
Loss of cool- ing accident (Extremely unlikely)	6.0×10 ⁻⁶	2,600	1.7×10 ⁻⁴	5.7×10 ⁻⁷	0.44	0.0015	7.6×10 ⁷
OWST explo- sion (Extremely unlikely)	1.3×10 ⁻⁶	52,000,000	1.7×10 ⁻⁴	5.7×10 ⁻⁷	8,840	30	9.3×10 ⁹

Source: WSMS 2000.

a. ERPG-1 value (sodium hydroxide) = 0.5 mg/m³.b. ERPG-1 value (benzene) = 160 mg/m³.c. ERPG-2 value (benzene) = 480 mg/m³.d. ERPG-3 value (benzene) = 3190 mg/m³.

mg/s = milligrams per second.

sec/m³ = seconds per cubic meter.mg/m³ = milligrams per cubic meter.

CFT = Caustic Feed Tank, PHA = Precipitate Hydrolysis Aqueous, OWST = Organic Waste Storage Tank.

ERPG-1 threshold concentrations would not experience even mild transient adverse health effects or the perception of a clearly defined objectionable odor. The Caustic Dilution Feed Tank accident would result in concentrations of sodium hydroxide to the noninvolved worker slightly higher than the ERPG-1 values. By definition, individuals exposed to airborne concentrations above

the ERPG-1 threshold may experience mild transient health effects.

B.7 Environmental Justice

In the event of an accidental release of radioactive or hazardous chemical substances, the dispersion of such substances would depend on meteorological conditions, such as wind direc-

tion, at the time. Given the variability of meteorological conditions and the low probability and risk of accidents, an accident would be unlikely to occur that would result

in disproportionately high or adverse human health and environmental impacts to minorities or low-income populations.

Table B-19. Sodium hydroxide release concentrations from Ion Exchange and Direct Disposal in Grout processes.

Scenario	(frequency category)	Evaporation release rate (mg/s)	Atmospheric dispersion factor (sec/m ³)		Resultant concentration (mg/m ³) ^a		Total atmospheric release (mg)
			Noninvolved worker	MEI	Noninvolved worker	MEI	
CFT Loss of Confinement	3.4×10 ⁻² (Anticipated)	1,030	1.7×10 ⁻⁴	5.7×10 ⁻⁷	0.18	5.9×10 ⁻⁴	770

Source: WSMS 2000.
a. ERPG-1 value = 0.5 mg/m³.
mg/s = milligrams per second.
sec/m³ = seconds per cubic meter.
mg/m³ = milligrams per cubic meter.

Table B-20. Chemical release concentrations from Solvent Extraction process.

Scenario	Frequency (frequency category)	Evaporation release rate (mg/s)	Atmospheric dispersion factor (sec/m ³)		Resultant concentration (mg/m ³) ^{a,b,c}		Total atmospheric release (mg)
			Noninvolved worker	MEI	Noninvolved worker	MEI	
Sodium hydroxide							
CFT Loss of Confinement	3.4×10 ⁻² (Anticipated)	1,030	1.7×10 ⁻⁴	5.7×10 ⁻⁷	0.18	5.9×10 ⁻⁴	770
Caustic Dilution Feed Tank Loss of Confinement	3.4×10 ⁻² (Anticipated)	5,470	1.7×10 ⁻⁴	5.7×10 ⁻⁷	0.93	0.0031	5.5×10 ³
Nitric acid							
Nitric Acid Feed Tank Loss of Confinement	3.4×10 ⁻² (Anticipated)	155	1.7×10 ⁻⁴	5.7×10 ⁻⁷	0.026	8.8×10 ⁻⁵	95

Source: WSMS 2000.
a. ERPG-1 value (sodium hydroxide) = 0.5 mg/m³.
b. ERPG-2 value (sodium hydroxide) = 5.0 mg/m³.
c. ERPG-1 value (nitric acid) = 2.6 mg/m³.
mg/s = milligrams per second.
sec/m³ = seconds per cubic meter.
mg/m³ = milligrams per cubic meter.

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APPENDIX C

PUBLIC COMMENTS AND DOE RESPONSE TO COMMENTS

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APPENDIX C

This appendix provides the comments received during the public comment period and the U. S. Department of Energy's (DOE's) responses to them. Letters received are reproduced here. Comments received at the public meetings in Columbia and North Augusta, South Carolina are summarized. The transcripts from the public meetings can be reviewed at the DOE public reading rooms: DOE Freedom of Information Reading Room, Forrestal Building, Room 1E-190, 1000 Independence Avenue, S.W., Washington, D.C., 20585, phone: 202-586-6020, and DOE Public Document Room, University of South Carolina, Aiken Campus, University Library, 2nd Floor, 171 University Parkway, Aiken, SC 29801, Phone: 803-648-6815.

DOE published the *Savannah River Site Salt Processing Alternatives Draft Supplemental Environmental Impact Statement* (DOE/EIS-0082-S2D) in March 2001. DOE held public meetings on the Draft SEIS in North Augusta, South Carolina on May 1, 2001 and in Columbia, South Carolina on May 3, 2001. The 45-day public comment period ended on May 14, 2001.

Court reporters recorded comments and statements made during the four public meeting sessions. In those sessions, nine individuals provided comments or made statements. DOE also received 12 letters on the Draft SEIS by mail. This Appendix presents the comments received and the DOE responses to those comments. If a comment prompted a modification to the EIS, DOE has noted the change and directed the reader to that change.

Many, but not all, of the comments addressed the four issues described in the following paragraphs. In these paragraphs DOE describes issues that were pointed out by several commenters and provides a general response to the issue.

The National Academy of Sciences – National Research Council Committee on Radionuclide Separation Process for High-Level Waste at the Savannah River Site was given the opportunity to comment on this Final SEIS (FSEIS). The Committee chose not to comment on the FSEIS, but instead to comment on the separation alternatives in its report to DOE, which was submitted on June 4, 2001.

No Action Alternative

Commenters questioned the description of the No Action alternative and its impacts. They generally expressed the opinion that the long-term impacts of No Action would be more severe than DOE portrayed qualitatively in the Draft SEIS and asked that the No Action alternative be modified and the long-term impacts analyzed quantitatively. Several commenters suggested that DOE evaluate a scenario that assumed no salt processing alternative could be developed, and evaluate the impacts of leaving salt waste in HLW tanks until the eventual failure of the tanks.

Response: DOE has revised the analysis of the No Action alternative to provide a more quantitative evaluation of the impacts of the No Action alternative over the long term. DOE has added text to the SEIS, and added data to appropriate tables, that compare the long-term impacts of the No Action alternative to the long-term impacts of the action alternatives. DOE evaluated the impacts of the eventual of tank contents to the environment under a tank overflow scenario, and the consequent health impacts to a person drinking the contaminated water from on-site streams and the Savannah River. DOE also addressed the radiation exposure that could result from external exposure to contaminated soil or by consumption of vegetation or animals fed by contaminated water.

Direct Disposal in Grout Alternative

Several commenters questioned the implementation of the Direct Disposal in Grout alternative because in their view it would result in disposal of HLW at the Savannah River Site (SRS). Other commenters asked about DOE's discussions about the Direct Disposal in Grout alternative with the U.S. Environmental Protection Agency (EPA) and the South Carolina Department of Health and Environmental Control (SCDHEC).

Response: Any of the salt processing alternatives would require a determination that residues to be disposed of as low-level wastes are "waste incidental to reprocessing," not HLW. DOE describes the process for determining whether waste is waste incidental to reprocessing in Section 7.1 of the SEIS. The waste-incidental-to-reprocessing analysis would be applied to any salt processing alternative that DOE selected for implementation. If the waste met the criteria for waste incidental to reprocessing, it could be managed as low-level waste or as TRU waste, depending on the nature of the waste. DOE expects that the waste generated under the direct disposal in Grout alternative would be managed as low-level waste. DOE has had preliminary discussions with SCDHEC at the staff level. SCDHEC conveyed to DOE during those discussions that, as long as DOE followed the waste incidental to reprocessing determination process, SCDHEC found the Direct Disposal in Grout alternative to be acceptable in principle.

Waste Management

Commenters asked how wastes that would be generated by the alternatives, particularly benzene and solvents, would be managed.

Response: Currently, incineration is considered the best available treatment technology for benzene and other organic liquid wastes. DOE expects that these wastes would be disposed of by incineration. DOE has not yet determined whether the Consolidated Incineration Facility, a portable vendor-operated facility, or a suitable offsite facility would be used for incineration of these wastes. DOE previously analyzed the impacts of incineration and various alternatives to incineration in the *Final Supplemental Environmental Impact Statement, Defense Waste Processing Facility* (DOE/EIS-0082-S, November 1994). The results of this analysis show that the impacts from the various alternatives to incineration are bounded by the impacts of incineration. The actual treatment facility would be determined during design and construction of the salt processing facility.

Criteria for Selection of the Preferred Alternative

Several commenters asked about the criteria to be used by DOE to select the preferred salt processing technology, and several commenters were especially interested in cost as a criterion.

Response: In addition to reviewing the results of research and development work on the alternative technologies, DOE evaluated each alternative against the following criteria: cost, schedule, technical maturity, technology implementability, environmental impacts, facility interfaces (with existing SRS facilities), process simplicity, process flexibility, and safety. DOE has revised the SEIS (at Section 2.8.3) to incorporate the latest approximate range of costs through construction for each of the alternatives. DOE does not consider the cost estimates available at this time to be reliable enough to be a significant discriminating factor for decision-making. (The National Academy of Sciences final report on SRS salt processing alternatives did not propose criteria for selecting an approach and did not identify a preferred alternative.)

Table C-1. Public Comments on the Draft Salt Processing Alternatives Supplemental EIS

Comment Source Number ^a	Commenter	Page Number
L1	Mr. William Lawless	
L2	South Carolina Budget and Control Board	
L3	Mr. William Lawless	
L4	Mr. William Willoughby	
L5	U. S. Department of the Interior	
L6	Mr. W. Lee Poe, Jr.	
L7	Economic Development Partnership	
L8	Savannah River Site Citizens Advisory Board	
L9	Georgia Department of Natural Resources	
L10	U. S. Environmental Protection Agency	
L11	South Carolina Department of Health and Environmental Control	
L12	Rutgers, The State University of New Jersey	
M1-01, M1-02	Mr. James Hardeman	
M2	No comments were submitted at this meeting session	
M3-01, M3-02	Mr. William Willoughby	
M3-03 through M3-08	Ms. Leslie Miner	
M3-09 through M3-11	Mr. Ernie Chaput	
M3-12 through M3-14	Ms. Karen Hardison	
M3-15 through M3-17	Dr. Mary Kelly	
M3-18, M3-19	Ms. Leslie Miner	
M3-20	Ms. Melinda Holland	
M3-21	Ms. Karen Hardison	
M4-01 through M4-03	Ms. Paula Austin	
M4-05 through M4-08	Mr. John Austin	
M4-09 through M4-11	Ms. Paula Austin	

^a Unique codes were given to each of the letters received and public meeting sessions. L1 is the first letter received and M1 is the afternoon session at North Augusta S.C., M2 is the evening session at North Augusta, S.C., M3 is the afternoon session at Columbia, S.C., and M4 is the evening session at Columbia, S.C. Individual comment are coded L1-01 or M1-01, etc. The 12 letters received are provided in this appendix and complete transcripts of the meetings are available in the DOE Public Document Rooms.

LETTERS

The comment letters DOE received on the Draft Salt Processing Alternatives Supplemental EIS and DOE's responses are provided in the following section. Comments in each letter are identified, and the corresponding responses follow the letter.

----- Forwarded by NEPA/WSRC/Srs on 04/18/01 12:56 PM -----

bill lawless <lawlessw@mail.paine.edu>

To: nepa@mailhub.srs.gov

04/17/01 06:23 PM

cc:

Subject: comments on the salt processing alternatives draft seIs

Please respond to lawlessw

andrew grainger, my comments on the subject dseis follow; if you should have any questions regarding them, please feel free to contact me by email or at 706-821-8340; thanks, bill lawless

1. the acronyms, abbreviations, scientific notation examples, and metric conversion tables at the front of the summary are excellent, and should be duplicated in the full dseis;

L1-1

2. p. s1, para 6: much greater quantities of benzene were produced than "anticipated" should be changed to something more explanatory like: anticipated based on calculations and preliminary small laboratory experiments;

L1-2

3. p. s1, para 6, last line: the statement regarding processing of hlw sludge should be buttressed and clarified for the public; i suggest something like: sludge processing has worked well and as anticipated and has led to the production of x number of canisters as of x date (use the most recent data); also at this point it would help to tell the public how this compares with other similar facilities such as west valley's totals and hanford's totals todate (about 300 and 0 respectively);

L1-3

5/11/2001

4. p. s4 and p. s13: it's confusing to split the columns differently from the rest of the text as done on these 2 pages; i recommend that columns be consistent throughout;

L1-4

5. p. s5: in the event that the beginning of salt processing deadline date of 2010 is not met, it would help the public/decision makers to have an estimate of the consequences for the range of additional canisters that may be needed, the additional costs, and the additional number of years of vitrification that may be required; as is, the public and decision makers may not have a clear idea of the financial and other risks to the public for delaying the decision;

L1-5

6. p. s6: if new tanks may be required by 2010, please specify the date for when a decision to construct them must be made, and for at how much of an estimated cost and for how many new tanks; as in item 5 above, the seis/summary must be clear about the costs to the public for not making a timely decision;

L1-6

7. p. 26, the parenthetical date of 2023 is confusing; my suggestion on how to state it better: i.e., 100 years after 2023;

L1-7

8. p. s5, box, please add: two tanks (tank 20 and tank 17) were formally closed by srs under a plan approved by dhec on dates x and x, respectively;

L1-8

9. p. s9, add a section that reviews the status of the evaporator system at f and h areas and its impact on the tank space and the decision to initiate salt processing;

L1-9

10. p. s11, last sentence in the "no action" section, i would recommend that the word "speculative" be changed to "unlikely";

L1-10

11. p. s16, what would happen to the benzene (and other wastes in the other alternatives) should be stated briefly in this section; i.e., the benzene would be treated on site, sent to a commercial facility, or a decision about treatment would be made by x date; also add how likely and how easily would treatment be under all alternatives;

L1-11

12. p. s30, the no action alternative should consider the possibility of an intank explosion from h-gas, and its consequences;

L1-12

13. both the summary and full dseis should collect the estimated costs for each alternative and locate them in a table early on in the text;

L1-13

14. both the summary and full dseis should include a review of the maturity of the technologies under consideration (where employed by other site/industry/country, etc.);

L1-14

15. full dseis, p. 341, graphic for srs = 0.18 mrem is not clear; i recommend that this be improved by putting the terms "srs 0.18 mrem" inside of a funnel that opens from a wedge of two lines inside of the pie so that it not be as confusing as it is;

L1-15

5/11/2001

Response to Comment Letter L1:

- L1-1 The acronym, abbreviations, and scientific notation will be included in the final SEIS and the Summary
- L1-2 DOE revised the statement as suggested in the comment.
- L1-3 Although sludge-only processing is not in the scope of the salt processing alternatives DOE has indicated the number of canisters produced at SRS through May 2001 (about 1,100). However, DOE believes that the topic should be addressed briefly in the background sections of the SEIS. Comparisons with other DOE vitrification operations are not meaningful because of differences among them, for example, in completion of facilities and composition of waste.
- L1-4 On both pages S-4 and S-13 of the draft SEIS the text box is the end of a section (e.g., Section S.1 on page S-4). DOE believes that the least confusing page layout is to start the next section (Section S.2) immediately below the text box.
- L1-5 The HLW System Plan, Rev 11 (April 2000), indicates that a maximum of 150 fully loaded salt-only canisters can be produced per year. In the event that the salt processing date of 2010 is not met, then the potential exists that up to 150 additional canisters (salt-only) per year would have to be produced for every year lost in the schedule. The cost for additional canister production would be about \$300 million per year. In the event that sludge processing were to be completed prior to the initiation of salt processing, it would take 13 years (at 150 canisters per year) to process all of the salt waste at an approximate cost of \$4 billion in addition to the cost of construction and operation of the salt processing facility. (Note: These costs do not include Federal Repository costs for transportation and disposal). This discussion has been added to S.3, Section 1.2, and Section 2.7.1.
- L1-6 DOE has estimated that a minimum of five years is required to permit and build new HLW storage tanks. Therefore, to meet the 2010 deadline, the permitting process would need to start by 2005. Because of the speculative nature concerning DOE's future course of activities under the No Action alternative, other specifics are unknown.
- L1-7 The comment refers to the discussion of scoping comments which has been replaced in the final SEIS with a discussion of comments on the draft SEIS.
- L1-8 DOE closed tanks 17 and 20 in 1996 and 1997, respectively. DOE believes this information is peripheral to the SEIS and has not changed the text.
- L1-9 The three evaporator systems currently available have sufficient capacity to handle the expected demands of the HLW system once the process and equipment issues associated with the 2H and 3H Evaporator systems are resolved. The three evaporators operating at planned capacity will provide margin to accommodate future system upsets and allow the option to shutdown the 2F Evaporator system at some point in the future.
- L1-10 DOE believes that "speculative" is a more accurate modifier for DOE's future course of action.

Response to Comment Letter L1 (continued):

- L1-11 Currently, incineration is considered the best available treatment technology for benzene and other organic liquid wastes. DOE expects that these wastes would be disposed of by incineration. However, DOE has not yet determined whether the Consolidated Incineration Facility, a portable vendor-operated facility, or a suitable offsite facility would be used for incineration of these wastes. DOE previously analyzed the impacts of incineration and various alternatives to incineration in the *Final Supplemental Environmental Impact Statement, Defense Waste Processing Facility* (DOE/EIS-0082-S, November 1994). The results of this analysis show that the impacts from the various alternatives to incineration are bounded by the impacts of incineration. The actual treatment facility would be determined during design and construction of the salt processing facility.
- L1-12 For the short term under all alternatives, the HLW tanks would be subject to the same potential accident risks as exist for current operations. These are evaluated in approved safety documentation and previous EISs as cited in Section 4.1.13. These impacts would persist over a longer period of time under the No Action alternative. Although DOE has not analyzed hydrogen explosion accidents over the long term, the generation of hydrogen decreases with time and accordingly the probability of a hydrogen explosion accident would also decrease over time.
- L1-13 The revised Section 2.8.3, Cost, incorporates the latest approximate range of costs through construction for each of the SEIS alternatives. DOE does not consider the cost estimates at this time to be reliable enough to be a significant discriminating factor for decision making.
- L1-14 The technical maturity of the salt processing alternatives is among the topics discussed in detail in technical reports cited in Sections 2.6 and 2.8. Because technical maturity is not an important consideration for assessment of environmental impacts, DOE did not repeat this information in the SEIS.
- L1-15 The revised Figure 3-13 addresses the comment in a footnote.

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State Budget and Control Board
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ACKNOWLEDGEMENT

April 30, 2001

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Aiken, South Carolina 29802

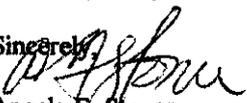
Project Name: Savannah River Site Salt Processing Alternatives Draft Supplemental Environmental Impact Statement March 2001 DOE/EIS-0082-S2D

State Application Identifier: EIS-010402-002
Suspense Date: 6/7/2001

Dear Mr. Grainger:

Receipt of the above referenced project is acknowledged. The Grant Services Unit, Office of State Budget, has initiated an intergovernmental review of this project. You will be notified of the results of this review by the suspense date indicated above. South Carolina state agencies are reminded that if additional budget authorization is needed for this project, three copies of the completed GCR-1 form and two copies of the project proposal must be submitted to this office. This action should be initiated immediately, if required. Please include the State Application Identifier in any correspondence with our office regarding this project. If you have any questions please contact me at 734-0485.

Sincerely,


Angela F. Stoner
Fiscal Manager, Grant Services

Fax (803) 734-0645

Response to Comment Letter L2:

No response required.

NEPA

To: Drew Grainger/DOE/Srs@srs, L Ling/DOE/Srs@Srs
cc:
Subject: additional comment for seis

05/07/01 12:34 PM

----- Forwarded by NEPA/WSRC/Srs on 05/07/01 12:38 PM -----



bill lawless
<lawlessw@mail.pai
ne.edu>

To: nepa@mailhub.srs.gov
cc:
Subject: additional comment for seis

05/01/01 12:07 PM
Please respond to
lawlessw

Mr. Grainger, please find attached an additional comment for the draft
SEIS, thanks, bill lawless


lawless.new.seis.comment

Andrew R. Grainger, NEPA Compliance Officer
U. S. Department of Energy
Savannah River Operations Office
Building 742A, Room 183
Aiken, South Carolina 29802

Subject: Comments on the March 2001 Savannah River Site Salt Processing
Alternatives Draft Supplemental Environmental Impact Statement
(DOE/EIS-0082-S2D)

Dear Mr. Grainger:

Subject: Additional comment on the draft salt processing SEIS:

After consideration of the no-action alternative which would require SRS to build new tanks as needed in the event that no decision on the salt processing alternatives occurs, or in the event that a decision is rendered but no funding or inadequate funding occurs, in my opinion, the likely possibility of this set of circumstances renders the no-action alternative currently in the SEIS unrealistic for the following reasons:

1. DHEC is on record on more than one occasion stipulating that it is unlikely that new HLW tanks will be permitted to be constructed at SRS.
2. If new HLW tanks are precluded, DWPF will have to cease operations, sometime after 2010.
3. If new HLW tanks are precluded, ending the operations of DWPF earlier than the time it takes to remove and vitrify all of the sludge at the bottom of the tanks, where most of the plutonium and actinides are contained, the residual burden of contamination in the HLW tanks after the cessation of operations at SRS means that plutonium and other long-lived actinides will remain in the tanks in addition to the supernate (e.g., fission products including cesium-137).
4. In this more realistic no-action scenario, higher releases of contamination from the tanks to the environment and the public will increase significantly over the next few hundred to thousands of years, compared to the currently presented no-action case.

Therefore, in my opinion, the no-action alternative is unrealistic; a more realistic no-action alternative should be drafted to help the public better understand the gravity of not making a timely choice for one of the salt processing alternatives, or, given that a choice is

L3-1

L3-2

made, not having the chosen alternative adequately funded in time, provoking SRS to propose the construction of new HLW tanks, or the shutdown of DWPF.

Thanks,

W.F. Lawless

L3-2

Response to Comment Letter L3:

- L3-1 DOE is unaware of official documentation from SCDHEC on the feasibility of permitting new HLW tanks at SRS.
- L3-2 DOE has revised the sections on the long-term impacts of the No Action alternative. The Summary, Sections 2.9.2 and 4.2, and Appendix D have been modified to incorporate the results of the analysis of long-term impacts of the No Action alternative. For purposes of analysis, DOE assumes only salt waste remains in the HLW tanks. Section 1.2 includes a discussion of the consequences of a project delay in terms of the cost of producing salt-only canisters.

NEPA

To: Drew Grainger/DOE/Srs@srs, L Ling/DOE/Srs@Srs
cc:
Subject: DOE/EIS-0082-S2D Comments

05/07/01 12:35 PM

----- Forwarded by NEPA/WSRC/Srs on 05/07/01 12:38 PM -----



william willoughby
<willow_II@msn.com>

To: nepa@mailhub.srs.gov
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<lawlessw@mail.paine.edu>, wade waters <wwaters258@aol.com>,
lee poe <leepoe@mindspring.com>, karen patterson
<PattersonK@ttnus.com>, Kelly Dean <kelly.dean@mailhub.srs.gov>
Subject: DOE/EIS-0082-S2D Comments

05/01/01 05:21 PM

Mr. A. Grainger,
Attached are comments on the Salt Processing SEIS.
William Willoughby II
506 Killington Ct

Columbia, SC 29212 DOE EIS-0082-S2D comments.doc

DOE/EIS-0082-S2D 3/2001 comments William Willoughby II

Comments are made on the base documents and would also apply to the summary document where applicable

p 1-4 insert, 4th line from bottom – the sentence should end with “----managed by compaction.”, and the balance of the sentence deleted.

p 2-24, 2nd column, 2nd para; and p 2-25, section 2.8.2, 1st para – do you really mean that **ALL** salt Cs must go into the surplus Pu canisters and there are no low Cs level tanks that after Pu and Sr removal could not go direct to saltstone? How are these paragraphs affected by the reevaluation of surplus scrap Pu disposition?

p 2-35 identify source of dose conversion factors (pCi/vol to mrem)

Table 3-1- does note “d” apply to Cs-137 ?

Tables 3-1,3-3,3-6 uses inconsistent dose conversion factor references and inconsistent dose conversion factors

p 3-45, section 3.9.2, 5th from last line– The sentence should end with “----than incinerated.”, and the balance of the sentence deleted.

p 3-49, section 3.9.6, 2nd line- “ atomic weights” should be “atomic numbers”

Table 4-10 do not understand relation between 50-year committed effective dose equivalent and footnote “a.”; also how does dose conversion here compare with those for Tables 3-1,3-3,3-6 ?

Table 4-30- need an explanation here as why 1000 yr doses are greater than 100 yr doses as well as later in text

L4-1

L4-2

L4-3

L4-4

L4-5

L4-6

L4-7

L4-8

L4-9a

L4-9b

L4-10

Response to Comment Letter L4:

- L4-1 The description of CIF suspension has been revised.
- L4-2 DOE believes it is more cost effective and environmentally acceptable to operate a single processing facility rather than multiple processing facilities tailored to variable levels of cesium removal. Therefore, DOE has evaluated alternatives that either remove or do not remove cesium from the salt component.
- L4-3 DOE has not canceled the Plutonium Immobilization project for disposition of certain quantities of surplus plutonium. Rather, the Secretary of Energy has decided to suspend plutonium immobilization activities because the President's budget for Fiscal Year 2002 and beyond would not simultaneously support the peak construction of the Pit Disassembly and Conversion Facility, the Mixed Oxide Fuel Fabrication Facility, and the Plutonium Immobilization Facility. Delay in implementing the Plutonium Immobilization project would not affect the availability of plutonium for immobilization in DWPF glass, because DOE plans to operate DWPF until all SRS HLW has been vitrified, in about 2023.
- L4-4 The sources of the dose conversion factors (picocuries per volume to millirem) are numerous. References are found in Chapter 4 under the environmental dosimetry calculations (e.g., Simpkins, 1999).
- L4-5 No. Table 3-1 has been corrected.
- L4-6 These tables use different units of measurement and different standards appropriate to the parameter being measured. DOE does not use dose conversion factors in any of these tables.
- L4-7 The sentence has been revised.
- L4-8 The text has been corrected.
- L4-9a Footnote "a" applies to doses associated with the No Action alternative. The footnote will be relocated in Table 4-10 and associated with the Maximum dose heading.
- L4-9b Refer to response to L4-6.
- L4-10 The information in Table 4-30 has been clarified.



United States Department of the Interior

OFFICE OF THE SECRETARY
OFFICE OF ENVIRONMENTAL POLICY AND COMPLIANCE
Richard B. Russell Federal Building
75 Spring Street, S.W.
Atlanta, Georgia 30303

May 4, 2001

ER-01/209

Andrew R. Grainger
NEPA Compliance Officer
Savannah River Site
Building 742-A, Room 185
Aiken, SC 29802

RE: Savannah River Site Salt Processing Alternatives Draft Supplemental EIS

Dear Mr. Grainger:

The Department of the Interior has reviewed the referenced document and has no comments to offer at this time. Thank you for the opportunity to review this material.

Sincerely,

James H. Lee,
Regional Environmental Officer

CC: FWS-ES, RO, Atlanta
OEPC, WASO

L5-1

May 7, 2001
807 E. Rollingwood Rd
Aiken, SC 29801

Mr. Andrew R. Grainger
NEPA Compliance Officer
U. S. Department of Energy
Savannah River Operations Office
Building 742-A, Room 183
Aiken, SC 29801

**Comments on Salt Processing Alternatives SEIS
DOE/EIS-0082-S2D, March 2001**

I would like to provide the following comments on DOE/EIS-0082-S2D.

General Comments:

1. After reviewing the SEIS, I conclude that the environmental consequences of the four salt processing alternatives are low and there is no significant difference between any of the four alternatives. Since there are no significant environmental consequences between the technologies, the decision on technology selection should be made on the easiest technology to implement at the earliest time with the least cost. L6-1
2. Of the four salt processing alternatives Direct Disposal in Grout seems to have the lowest environmental consequences, cost, and time to get it in operation. The technical unknowns in this alternative are least but the political uncertainty, in my judgment, is the highest. I could find no mention of this uncertainty in the SEIS. Please add appropriate text describing the political uncertainty for each alternative. L6-2
3. The SEIS seems to try to write-off the Direct Disposal in Grout Alternative by several sentences by stating the requirement of DOE Order (or what ever it is – it is called different things in different part o the SEIS) 435.1-1 requires further cesium removal meet “technically and economically practical” wording. (One such statement is the one on page 2-7 at the bottom of Section 2.4.) The discussion on page 7-3 seems to be more appropriately cover the requirement and does not specify the need for this constraint. Delete the bias statements and allow Direct Disposal as Grout to compete as an appropriate alternative and be judged with the other alternatives. L6-3
4. The analysis of the No Action Alternative is poor and underestimates the consequences of that action. The SEIS analysis seems to rely on the analyzed consequences from the Tank Closure EIS which is inappropriate since the two No Actions Alternatives are totally different. This EIS should contain the consequences of the alternative described on page 2-4 in Section 2.3 which is to remove all sludge and leave existing tanks with salt waste containing 160,000,000 curies of activity, L6-4

primarily Cs-137. The analogy to the Tank Closure EIS No Action (which contained 200 curies of long lived radionuclides and 9,900 curies of Cs-137 in empty tanks is inappropriate. It is also inappropriate to state "it is clear that the impact to human health resulting from a No Action Alternative would be catastrophic" with no calculated impacts to back up the term catastrophic.

The EIS misses the largest long-term contribution to the risk to the public by assuming all radionuclides will reach the public by moving through the ground to the water table then with delay factors built in with the groundwater to the creek. The delay time allows significant radionuclide decay. The analysis should reflect the SRS precipitation filling the tanks, dissolving the salt, and overflowing to the ground surface and flowing to the surface streams after the HLW tank failure (page 2-45) after a few hundred years. (As is known SRS precipitation rate significantly exceeds infiltration rates.)

5. The impact of the No Action Alternative should be given on the various tables in the Summary and in Sections 4, and 5. The No Action consequences are the motive force to accept one of the Salt Processing Alternatives. As presented in this EIS the consequences cannot be found except by diligent study and they don't show the need for one of the action alternatives.
6. There seems to be some confusion in the EIS on defining this No Action Alternative. Several places the EIS says it may be necessary to "suspend operation of the DWPF" (page 2-4 item 5 in the right hand column). One cannot remove the sludge (as is required by the definition of the No Action Alternative) with the DWPF shutdown. Perhaps "reduce operating rates at the DWPF" is a more appropriate condition.
7. The No Action Alternative Sections 2.3.2 – 2.3.4 also seem to be confused.
 - Section 2.3.2 continues to use existing HLW Tanks 4 – 8 (which are Type I tanks with a capacity of 750,000 gallons and a fill limit of about 650,000 gallons. If four tanks are used, the maximum that could be stored is about 2.6 not 3.75 million gallons. Also these tanks already contain some waste.
 - Section 2.3.3 describes building 6 new Type I (Wastewater Treatment Regulated Tanks). Each Type I tank is designed for a maximum capacity of 750,000 gallons and probably has a fill limit of 650,000 gallons. The section says 800,000 gallons (see page 2-5).
 - Section 2.3.4 describes building 18 new Type III tanks. The text gives a storage capacity of each tank to be 800,000 gallons. Type III tanks have a design capacity of 1.3 million gallons and a fill capacity of probably 1.15 million gallons.
 - The tank capacity requirements given in these three section are inconsistent. Section 2.3.2 gives 3.75 million gallons, Section 2.3.3 provides 4.8 million gallons, and Section 2.3.4 gives 14.4 million gallons capacity

L6-4

L6-5

L6-6

L6-7

These sections should be corrected and expanded to show when this new capacity would be required, when budgeting and licensing would be required and what each would cost.

L6-7

8. The SEIS should identify the Long-Term Stewardship assumptions made in the analysis. I find no mention of these except to maintain surveillance over the Waste Tanks, and the saltstone vaults for 100 years. EISs should identify whatever controls are considered appropriate and the SEIS should start the process of institutionalization of the needed controls. For example, This EIS describes the consequence to people who live on the waste site and dig into the waste with no controls applied after 100 years. I hope DOE plans controls that prevent/minimize those actions. I think other institutional controls are appropriate for the waste sites and they should be identified in the EIS

L6-8

9. The Summary and Sections 1 and 2 each have a Table that is a primer. This is a good idea but the primers contains inconsistencies. Make a single primer table and use it for all sections.

L6-9

Specific Comments:

Number	Page Location	Comment
1	S-1	Add a paragraph following the second paragraph describing how salt cake was formed.
2	S-1	Third full paragraph in right column should mention the 1980's ITP testing and why it was then thought to be viable.
3	S-1	What significance should I place on the bottom paragraph of the right column? ITP had been suspended before the DNFSB determination. Put the paragraph in perspective.
4	S-4	Explain the meaning of "production goals and safety requirements" in the top paragraph.
5	S-4	Need to state why this is a SEIS before the information box.
6	S-5	Include Direct Disposal on Table S-8
7	S-5	Top paragraph in right column says that the number of canisters produced would be "greatly" increased. Quantify the word greatly. From the information I have a several year delay will only marginally increase the number of canisters produced. Even that could be corrected by reducing the canister production rate.
8	S-5	Section S.4 describes a supplement analysis. Provide a reference.
9	S-7	This page couples the Record of Decision to EPA. Is this correct?
10	S-7	In the middle of the right column, DOE established a siting requirement of "within 2,000 feet". Is this siting limit an excludable limit and does it influence site selection? What is the significance/basis of the limit?

L6-10

L6-11

L6-12

L6-13

L6-14

L6-15

L6-16

L6-17

L6-18

L6-19

11	S-7	The bottom full paragraph stated analysis selected four sites. Site A was subsequently excluded. No justification was given. Add it.	L6-20
12	S-13	Precipitate Hydrolysis Aqueous in right column is bolded but not included in Table S-8.	L6-21
13	S-14	The last sentence in Section S.7.4 states SCDHEC is required to be notified if salt stone exceed Class A limits. Where is this requirement and how much waste is involved before this notice must be made?	L6-22
14	S-15 Table S-2	The capacity given in the first two lines for Direct Disposal show the capacity the same. I also understand that all of these throughput rates are based upon 75% availability. Please fix this table so the reader will not think that Direct Disposal is shown operating at 100% attainment.	L6-23
15	S-15 Table S-2	Planned canister production row assumes that adequate funding is made available. I think that qualification should be added to this section. (It seems to be an item discussed each year.)	L6-24
16	S-16	Section S.7.7 needs to state why a new Direct Disposal Building is required.	L6-25
17	S-16	Section S.7.7 should discuss timing and how funding will be justified for each of these new facilities.	L6-26
18	S-18	Fix figure to be more reader friendly. Are the sections marked infiltration a drain or do they cause infiltration? Define the three sump appearing devices (left, center, and right on the drawing) on the figure and where do they drain? Add the word Normal to the bottom Water Table line.	L6-27
19	S-21 thru S-24	Simplify the Table (perhaps break it into several tables) to make it more reader friendly and to show major differences between alternatives. Most of the information presented is not significant.	L6-28
20	S-25	I find the second paragraph under accidents, states No Action is safer than the other alternatives. This doesn't seem correct. Expand paragraph to more properly state why this is true, if it is.	L6-29
21	S-26 thru S-29 & S-30	Same comment apply to Tables S-6 and S-7 as made for Table S-5 in comment 19. Select major parameters and give them and tell readers all of the calculated information is presented in Section 4.	L6-30
22	S-30	Logic described for No Action under General Comment 4 applies here.	L6-31
23	S-31	Table S-7 provides a range of information for each entry with no rationale as to why a range is given.	L6-32
24	S-31	Table S-7 shows the results of Agricultural scenario and Residential scenarios for 100 and 1,000 years. (I expect there is a typo error in the last line – should be 1,000 years not 100 years.) The associated text does not describe what is contained and the intended significance of it.	L6-33

25	1-3	Since this section is the same as in the summary, I offer the same comments as I offered on the Summary (Numbers 1 – 4).	L6-34
26	Sect 2 General	Remove the calculated consequences from section 2. They have been summarized in the Summary and are given in Section 4. (Delete Tables 2-6, 2-7, & 2-8.)	L6-35
27	Sect 2 General	If calculated results are not removed from Section 2 as requested in comment number 26, simplify the tables as requested in comments 19 –21.	L6-36
28	2-1	Add a table with the radioactive nuclides and the chemicals that are in the waste tanks. Might be good to show the variation in the HLW at the same time. I would expect to see the 160 million curies of Cs-137 in such a table (see p4-49).	L6-37
29	2-3	Are Pu judgments based on mass or activity? I would expect Pu-238 to be the largest Pu by activity.	L6-38
30	2-6	First full paragraph on page gives a 5-year schedule for design, permit and construct of four tanks. It is unclear what this refers to. John Renolds told the FG in July that it would require 4 years to do the same thing for wastewater treatment permitted tanks (like the Type I tanks or 5 years for RCRA permitted tanks. Correct this statement to show the estimate for both type tanks.	L6-39
31	2-6	The second paragraph says new tanks would be extremely costly to build. Do not use unsupported terms like “extremely costly”. Provide an estimate for the tanks so the reader will be able to make his/her own judgment.	L6-40
32	2-7	Reference site selection in the bottom paragraph of left column.	L6-41
33	2-11 Table 2-2	The definition of centrifugal contactor should be made more generic. As written it describes the extraction stages but not the strip stages. Centrifugal contactors perform both functions.	L6-42
34	2-15	Include Direct Disposal in Table 2-2.	L6-43
35	2-15	Same comment as #7.	L6-44
36	2-19	Include a sentence or two in the bottom full paragraph telling the reader how the MST precipitate would be handled in Z-Area.	L6-45
37	2-25	Section 2.8.2 should be expanded or omitted because of the budget causing significant delay or canceling the Pu vitrification facility. If that facility is canceled this section has no value, if delayed, will the Pu be available in time to be incorporated into the borosilicate glass from the DWPF.	L6-46
38	2-26	Update the costs described in Section 2.8.3. The costs described are 1998 costs and badly out of date. The FG was told new costs would be available by now but they have not been shared with us.	L6-47
39	Table 2-6	Treatment of No Action is inadequate in Table 2-6. Air pollutants for continued management of No Action are for the entire site not the tank farm. This and other SRS reference footnotes should be reconsidered. Alternative-specific values should be given.	L6-48

40	2-36	Source of the 12 additional LCF couldn't be found. What does the "additional" mean? List total LCF for the Alternative.	L6-49
42	2-39	Table 2-7 is very difficult to get a comparison of alternatives out of. Suggest listing the risk of each accident to Onsite population and totaling the risk. Do the same for off-site population. The sum of the risks for accidents is an appropriate comparator. I have attached an example that shows the risk of accidents to onsite population is greatest for Small Tank and least to Direct Disposal. Ion Exchange and Solvent Extraction are essentially equal and in-between the two extremes.	L6-50
43	2-45	The conclusion of Geologic Resources section seems to be in error. It seems to me that when the No Action tanks fail by collapse and the waste contaminates the soils, that condition would be an impact to geologic resources.	L6-51
44	4-3	It is unclear why tank space optimization for the No Action Alternative stops in 2010. All of the sludge would not have been removed by that time.	L6-52
45	4-4	The call out reference in the last paragraph seems to be in error. Section 4.1.1 does not discuss the 18 tanks. It is discussed in Section 2.3.4.	L6-53
46	4-7	What does the stipulation "previously disturbed area" mean as it is used in the second full paragraph? Please clarify so all of us will understand it.	L6-54
47	4-13	Why is the siting statement in Section 4.1.3.2 significant? Why not locate waste tanks in previously contaminated areas rather than continue to contaminant new land?	L6-55
48	4-15	The air emission statement in the second paragraph for the No Action Alternative does not seem to be correct. As tank space management continues to get tighter and tighter, HLW transfers will increase in frequency and emissions should increase. Long term emissions will also be significantly.	L6-56
49	4-15	The term "slight increases above baseline" for the No Action Alternative should be quantified. Statement seems to be unsubstantiated.	L6-57
50	Pages 4-41-45	Compare the total exposure risk from these accidental releases so the various alternatives can be compared. Similar to comment 42.	L6-58
51	Section 4.2 General	No Action consequences should show up in all of Section 4.2. See General Comment 5.	L6-59
52	Section 4.2 General	Detailed comments on No Action are not provided. Analysis approach seems to be faulted. See General Comments # 4 through 7.	L6-60
53	Chapter 5 General	Add No Action consequence to this section. See General Comment #5.	L6-61

54	5-11	In Table 5-3, quantify salt processing liquid releases. What is "reportable" - footnote d?
55	5-11	Cumulative effect given in this table shows that the four alternatives all will triple the consequence of airborne releases of the remainder of SRS, (both present and projected) combined with Plant Vogtle releases. My judgment tells me there is no way this could be true. I think the values used in this table contain some problem.
56	5-11	Quantify the consequence of liquid releases from salt processing and include in this table.
57	7-3	Discussion in Chapter 7 and in particular on this page does not seem to preclude Direct Disposal in Grout as has been done in other parts of the SEIS.

L6-62

L6-63

L6-64

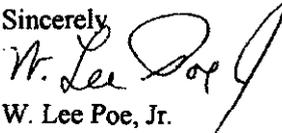
L6-65

I did not review the Appendices in this SEIS. Where they are the source of the information on which I commented, they should be revised as needed.

I hope these comments are useful in reaching a decision that allows salt processing to start as soon as possible. The process should recognize the potential that salt processing will be more difficult and perhaps more expensive than planned and include a pre-planned process to accept the uncertainty and get on with the job. This includes emptying and closing waste tanks, and managing the risks from the salt so it will not significantly impact the safety of future generations downstream from SRS. I consider it imperative to get on with the salt processing. Leaving the salt in the waste tanks longer than necessary would increase the risk to the public and should be minimized.

If I can answer questions or shed additional light on these issues, please call me.

Sincerely



W. Lee Poe, Jr.

Attached is an example table for Accidental Risk for four salt processing alternatives to On Site Population

Attachment to Poe's Comments on Salt Processing SEIS

Accident	Risk of Latent Cancer per Year To On Site Population During Operational Phase			
	Small Tank	Ion Exchange	Solvent Extraction	Direct Disposal
Loss of Confinement Beyond DBE	5.30E-04	2.70E-04	2.70E-04	5.70E-05
Loss of Cooling to Loaded Resin Hold Tank		1.70E-09		
Fire in Process Cell Benzene Explosion	1.50E-05	8.90E-06	8.90E-06	1.90E-06
H ₂ Explosion in Ext. Cell	6.80E-05		2.10E-08	
Helicopter Impact	1.90E-05	9.50E-06	9.60E-06	2.50E-06
Aircraft Impact	2.30E-05	8.80E-06	8.90E-06	2.70E-06
Sodium Hydroxide Release				
Nitric Acid Release				
Benzene Release				
Total Risk	2.46E-03	9.87E-04	9.77E-04	2.74E-04

Response to Comment Letter L6:

- L6-1 DOE agrees with the commenter's conclusion. DOE has established a number of criteria on which a technology selection would be made. The criteria include those requested by the commenter (but in different words): "easiest technology to implement" (technology implementability); "at the earliest time" (schedule); "with the least cost" (cost). However, DOE does not consider the cost estimates at this time to be reliable enough to be a significant discriminating factor for decision making.
- L6-2 The purpose of the SEIS is to describe the environmental impacts of the alternatives for salt processing. Political considerations are beyond the scope of the SEIS.
- L6-3 Section 2.4 has been modified to address this concern. The discussion in Section 7.1 describes DOE's process for making waste incidental to reprocessing determinations. One criterion is that wastes must have been or will be processed to remove key radionuclides to the maximum extent that is technically and economically practical. This criterion must be applied to any technology that would result in management of waste as low-level waste. DOE believes it objectively analyzed all alternatives.
- L6-4 The Summary, Sections 2.9.2 and 4.2, and Appendix D have been modified to incorporate the results of the analysis of long-term impacts of the No Action alternative. For purposes of analysis, DOE assumes only salt waste remains in the HLW tanks and that it reaches onsite streams via surface flow rather than through the groundwater.
- L6-5 The Summary, Sections 2.9.2 and 4.2, and Appendix D have been modified to incorporate the results of an analysis of the long-term impacts of the No Action alternative.
- L6-6 It is DOE's intent to continue operations of DWPF under the No Action alternative until HLW tank space management restrictions dictate otherwise. Section 2.3.1 identifies reduced DWPF production as one method for optimizing tank farm operations. DOE considers suspension of DWPF operations to be an option of last resort.
- L6-7 DOE's attempts at quantification of potential scenarios under the No Action alternative are rough approximations of events that could occur. Section 2.3.2 dealt with five tanks (Tanks 4 through 8) with a gross total capacity of 3.75 million gallons (5 tanks x 750,000 gallons). Nevertheless, DOE adjusted Section 2.3.4 on RCRA - compliant tanks in response to this comment.
- L6-8 For purposes of analysis, DOE conservatively estimates institutional control for no more than 100 years for projection of environmental impacts to persons exposed to radiological release from the salt processing facilities and waste disposal sites.
- L6-9 DOE has corrected the inconsistencies in the primer tables.
- L6-10 DOE has incorporated an explanation of the formation of saltcake.
- L6-11 The SEIS discussed ITP for the purpose of introducing the need for an alternative technology. Therefore, further discussion of the development of the ITP process provides no additional value to this section of the SEIS.
- L6-12 DOE has revised the text to put the paragraph in perspective.

Response to Comment Letter L6 (continued):

- L6-13 These are production goals and safety requirements realized by satisfactory separation of highly radioactive constituents (cesium, strontium, and actinides) from HLW salt solution without excessive tetraphenylborate decomposition (benzene generation).
- L6-14 Refer to the Cover Sheet, S.4 of the Summary or Section 1.3 of the main document for an explanation of the rationale for the Supplemental EIS.
- L6-15 DOE included the Direct Disposal in Grout alternative in Table S-8.
- L6-16 See response to comment L1-5.
- L6-17 References are not provided in the Summary. Refer to Section 1.3 for the reference to the Supplement Analysis.
- L6-18 The Notice of Availability is published by EPA. The Record of Decision is issued by DOE no sooner than 30 days after the Notice of Availability appears.
- L6-19 Site Selection for the Salt Disposition Facility at Savannah River Site (WSRC-RP-99-00517 Rev. A, pg. 4) cites site specific technical requirements as locations within 2000 ft radius of the low point pump pit, the Late Wash facility, or the south end of 221-S (DWPF). Transfer of product slurries at proper solids concentration farther than 2000 ft is impractical because either dilution, which reduces salt processing rate, or an additional costly pump pit would be required.
- L6-20 An explanation for the exclusion of Site A has been included in S.6 and Section 2.5.
- L6-21 The term "precipitate hydrolysis aqueous" has been removed from Summary.
- L6-22 The requirement is found in Industrial Wastewater Permit IWP-217, Z-Area Saltstone Disposal Facility. Section 7.2 provides more detail of the saltstone permit requirements.
- L6-23 Tables S-2, 2-3, and A-3 have been amended to indicate facility throughput for each technology specified at 75% attainment. The throughput of all action alternatives is limited to 6 million gallons per year due to physical constraints on removing waste from the waste tanks. Required capacity throughput for Direct Disposal in Grout facility (6.0 million gallons/year) is less than for the other technologies because the Direct Disposal in Grout facility can operate even if DWPF is in an outage for melter replacement. The other technologies cannot operate if DWPF is in an outage; therefore, they would have to operate at a higher production rate so that the salt processing schedule could be maintained even in the event of DWPF down-time.
- L6-24 The reference is based on the High-Level Waste System Plan (HLW-2000-00019, Rev. 11, pg. 2-50) target case that assumes adequate funding is available. This is noted in Table 2-3.
- L6-25 A new Direct Disposal process building is needed to provide capability for MST treatment to remove Sr and actinides from salt solution before immobilization in grout and to provide enhanced shielding and remote handling for grout processing operations. This has been inserted in Sections S.7.5 and Section 2.7.3.

Response to Comment Letter L6 (continued):

- L6-26 DOE plans to have a salt facility on line by 2010. Projects would be funded through the federal budget process.
- L6-27 The figure has been modified.
- L6-28 The largest impacts for select parameters have been bolded so it is easier for the reader to identify the alternative with the highest impacts.
- L6-29 DOE has clarified that this paragraph refers to the short term No Action alternative. The reader is referred to the long-term No Action alternative in Section S.9.2.
- L6-30 See response to comment L6-28. Accident impacts in Table S-6 are accident consequences, not risks. It is not appropriate to tally consequences to determine a cumulative effect because the accidents would not occur simultaneously.
- L6-31 See response to L6-4.
- L6-32 DOE has eliminated the range of values from Table S-7 and from the EIS. Although the doses listed are quite conservative, the higher doses were retained.
- L6-33 The typographical error has been corrected in Table S-7. A more detailed explanation is found in Chapter 4 and Appendix D of the EIS.
- L6-34 DOE has made changes to Chapter 1 as described in the responses to comments L6-10, -12, and -13. No change was made in response to comment L6-11.
- L6-35 DOE has chosen to leave the tables in Chapter 2. They have been modified as discussed in the response to comment L6-30.
- L6-36 See response to comment L6-35.
- L6-37 DOE has revised the text to indicate that 158 million of 160 million curies is Cs-137. DOE does not believe the additional information requested by the commenter would assist the reader in describing the HLW inventory or differentiating between alternatives.
- L6-38 Pu-238 is greatest by radioactivity, Pu-239 by mass. The commenter's judgement is correct. Both are included in radioactivity tables in the Summary and Chapter 1.
- L6-39 The commenter is correct and the text has been modified in Section 2.3.3.
- DOE has estimated that about 4 years would be required to design, permit under wastewater treatment regulations, and construct 6 waste water storage tanks. This activity would be initiated about 2006.
- L6-40 Cost estimates are not provided because constructing new tanks would not meet purpose and need.
- L6-41 The appropriate reference is given in paragraph 1 of Section 2.5.

Response to Comment Letter L6 (continued):

- L6-42 DOE has revised the definition.
- L6-43 DOE has included Direct Disposal in Table 2-2.
- L6-44 Refer to the response to comment L1-5.
- L6-45 DOE has included the following description: MST processing [to remove strontium and actinides from salt solution prior to Direct Disposal] would be the same as far as the CST Ion Exchange and Solvent Extraction technologies. Equipment required as shown in Figure 2-7 and A-16 would include an alpha sorption tank and filter unit to separate the MST sorbed constituents prior to grouting the cesium-containing salt solution for disposal in saltstone.
- L6-46 See response to comment L4-3.
- L6-47 Refer to response to comment L1-13.
- L6-48 Table 2-6 represents short-term impacts for each of the salt processing alternatives. The short term impacts of the No Action alternative are described in Section 2.9.1. In response to comments L6-4, -5, and -6, DOE has revised the analysis of the long-term impacts of the No Action alternative.
- L6-49 The source of the 0.12 LCF is found in Table 2-6. Additional LCF means the incremental cancers attributable to the operation of the salt processing alternative.
- L6-50 Accident impacts calculated in Table 2-7 are accident consequences, not risk. It is not appropriate to tally consequences to determine a cumulative effect because the accidents would not occur simultaneously. Chapter 4 analyses the impacts of these accident scenarios. Section 2.9.1, Accidents Summary, indicates the highest accident impact to the receptors.
- L6-51 The commenter is correct. DOE has revised Sections 4.2 and 2.9.2 accordingly.
- L6-52 Tank space optimization would continue as long as such activities facilitated the continued operation of DWPF.
- L6-53 The section reference has been corrected.
- L6-54 "Previously disturbed area" means an area used in the past for industrial activities.
- L6-55 The statement in Section 4.1.3.2 refers to DOE's intent to avoid construction in contaminated areas because of the potential radiological exposures to construction and operation workers. Radiological exposure to workers could occur if tanks were to be constructed in radiologically contaminated areas.
- L6-56 Radioactive liquid waste would be returned to the HLW tank farms and treated in waste evaporators. No radioactive liquids would be released to the environment.
- L6-57 Due to the hypothetical nature of the No Action alternative, DOE is unable to quantify the increases above baseline.

Response to Comment Letter L6 (continued):

L6-58 Refer to comment response to L6-50.

L6-59 Refer to comment response to L6-5.

L6-60 Refer to responses to comments L6-4 through L6-7.

L6-61 Refer to response to comment L6-5.

L6-62 Footnote (d) in Table 5-3 has been revised to explain that no radioactive liquids would be released to the environment because they would be returned to the tank farms and treated in the HLW evaporators.

L6-63 Table 5-3 accurately portrays the available data.

L6-64 Refer to response to comment L6-62.

L6-65 Other portions of the SEIS have been revised to be consistent with the discussion in Chapter 7.



Fred E. Humes
Director

May 7, 2001

Andrew Grainger
NEPA Compliance Officer
Savannah River Operations Office
U. S. Department of Energy
Building 730B, Room 2418
Aiken, SC 29802

Attn: Salt Processing Alternatives SEIS

Dear Mr. Grainger:

We are pleased to provide comments on the *Savannah River Site Salt Processing Alternatives Draft Supplemental Environmental Impact Statement (EIS) (DOE/EIS-0082-S2D)* as provided by your letter of March 23, 2001. We have one general comment and four specific comments on this document and SRS high level waste activities.

General Comment: We believe that the approximately 34 million gallons of high level liquid wastes, containing approximately 480 million curies of activity, represent the greatest potential SRS hazard to the offsite public and the environment. As such we have continually supported the removal of these wastes from the aging underground tanks and its placement into the significantly more stable vitrified form. We continue to encourage DOE to accelerate all aspects of the high level waste program to vitrify these wastes at the earliest possible time.

L7-1

Specific Comments:

1. The impacts of the "no action" alternative are significantly understated in the SEIS document. The document narrative states that the no action alternative would lead to eventual failure of the HLW tanks and release of approximately 450 million curies of activity to groundwater and eventually surface water (pages S-29 and 30). On page S-30 the impacts of such a release are described as "catastrophic." This level of concern is not conveyed in Table S-5 (Summary comparison of short-term impacts) or Table S-7 (Summary comparison of long-term impacts). In Table S-5 the comments under the "no action" alternative are "No change" or "minimal." In Table S-7 the "no action" alternative is not included. We recommend that the no action alternative be included in these tables on a basis comparable to the other alternatives, and that the no action alternative be based on the failure of the underground tanks and

L7-2

L7-3

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release of 450 million curies of radioactive waste into the environment. Other tables in the document need to be modified in a similar manner.

L7-3

2. We note that there are no significant differences in the safety and environmental consequences between the four action alternatives. Accordingly, we recommend that DOE select its salt processing alternative on the basis of the following criteria in priority order: (1) earliest schedule for emptying all HLW tanks, (2) highest level of technical surety and (3) cost. As noted in our general comment above, we believe that waste should be removed from the underground tanks at the earliest possible time.

L7-4

3. It is not clear how DOE will evaluate the "Direct Grout" alternative vis-à-vis the other three action alternatives. There has been much discussion of direct grout as "an alternative of last resort" or "the regulatory approval and public acceptance processes may be too difficult." There should be no undue bias against direct grout in the alternative selection process. Selection of the preferred alternative should be on the basis of schedule, technical and cost merit. If there is concern about regulatory approval, we recommend that the regulatory agencies be approached now with a specific proposal so they can provide a definitive response. If public reaction is a concern, consider public input on this SEIS or specifically solicit public input. Without hard data, DOE should not presuppose regulatory or public acceptance of the direct grout option.

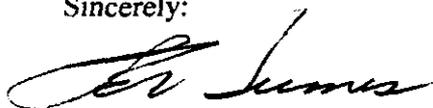
L7-5

4. We recommend that the final SEIS include a discussion of the basis for selecting the alternative(s) included in the preferred alternative.

L7-6

Thank you for the opportunity to comment on this very important document.

Sincerely:



Fred E. Humes

Response to Comment Letter L7:

- L7-1 DOE's goal, and DOE's commitment under the Federal Facility Agreement, is to remove waste from the HLW tanks and place it in a form suitable for safe disposal.
- L7-2 Refer to comment response L3-1. Under the No Action alternative, DOE would process sludge to the extent practicable. For purposes of analysis, DOE assumes only salt waste remains in the HLW tanks. (See response to comment L6-4.)
- L7-3 DOE has added the impacts of the No Action alternative in Tables S-7 and 4-30.
- L7-4 See response to comment L6-1. DOE evaluated each alternative on the following criteria in the process of selecting a preferred alternative: cost, schedule, technical maturity, technology implementability, environmental impacts, facility interfaces, process simplicity, process flexibility, and safety.
- L7-5 See response to comment L6-3.
- L7-6 DOE has discussed the basis for selecting the preferred alternative in Section 2.6.

Savannah River Site CITIZENS ADVISORY BOARD

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May 9, 2001

Mr. Andrew Grainger, NEPA Compliance Officer
U.S. Department of Energy
Savannah River Operations Office
Building 742-A, Room 183
Aiken, S.C. 29802

Subject: Comments on the March 2001 Savannah River Site Salt Processing Alternatives
Draft Supplemental Environmental Impact Statement (DOE/EIS-0082-S2D)

Dear Mr. Grainger:

At the request of the Savannah River Site (SRS) Citizens Advisory Board (CAB) Waste Management Committee, the Salt Team Focus Group (FG) has been asked to review and comment on the March 2001 Salt Processing Alternatives Draft Supplemental Environmental Impact Statement (SEIS). The FG was formed three years ago to evaluate the process used by SRS to select salt processing alternatives and to examine in detail the four alternatives.

During this three-year period, DOE has set numerous milestones associated with salt processing activities and many times, these dates have not been met. Furthermore, DOE's past performance on similar projects is not encouraging.

As DOE states in the SEIS, current operational constraints are already required to enhance storage capacity in the HLW tanks to maintain tank space until 2010. If a salt processing facility is not operational by 2010, then more drastic measures must be implemented, such as the closure of DWPF or the controversial position of building new HLW tanks. The ability of DOE to meet the current schedule to have a salt processing facility operational by 2010, still remains the primary concern of the FG.

In reference to the SEIS, we offer the following comments for your review and consideration:

1. Based upon a review of the data in Table 2-8, the long-term impacts associated with the four action alternatives are very similar. There is no significant difference between any process alternative being considered. Therefore, the Salt Team FG believes DOE should move forward with a decision on a preferred alternative and base the decision on the following criteria (listed in order of preference): (1) most expeditious implementation schedule, (2) technological merit, (3) operational surety, and (4) cost.

2. It is clear to the Salt Team FG that the environmental and safety impacts associated with the No Action alternative is greater than any action alternative. However, the general public may not be able to discern this from reading the SEIS because in many tables an equal comparison of the No Action alternative against the four action alternatives is not made. The No Action alternative should be listed in all comparison tables and a discussion included in the text.

L8-1

L8-2

Page 2, Letter to Mr. Andrew Grainger

3. The SEIS underestimates the consequences of the No Action alternative. In Section 2.3 (page 2-4), the No Action alternative is stated to include the storage of the salt component in the HLW tanks with DWPF vitrifying the sludge. Based upon this description, the HLW tanks will contain approximately 160 million curies. This is the activity level that should be modeled for long-term impacts when the tanks fail. The SEIS incorrectly assumes the removal of most of the waste and inappropriately relies on the consequences described in the tank closure scenario (Tank Closure Draft EIS).

L8-3

4. Calculated impacts are required for the No Action alternative to fully demonstrate to the public the need to select, fully fund, and make operational one of the salt processing alternatives before 2010. The modeling estimates should show the "catastrophic" results as predicted by DOE, but not supported by any calculations. In addition, one aspect not discussed nor explored is the potential for the No Action alternative to release contamination by the filling and overflowing of the failed tanks from rainfall events. The SEIS only assumes that rainfall will fill the tanks and infiltrate to the groundwater, which significantly understates the potential health and environmental impacts. The Salt Team FG recommends that the very likely potential for the failed tanks to release contaminated media to surface run-off be addressed.

L8-4

L8-5

5. The SEIS provides contradictory descriptions of the No Action alternative. DOE can not suspend operation of DWPF, as stated in several places of the SEIS, and still remove sludge from the HLW tanks. However, as described in the EIS, the No Action alternative requires the removal of the sludge component (see page 2-4). Furthermore, the FG believes the "intruder analysis" needs further explanation and specially needs to address the No Action alternative as discussed above (see item #4).

L8-6

L8-7

6. The SEIS needs to provide primary references for all regulatory standards and dose conversions as denoted in data tables. Also, consistency is needed. In some tables, the regulatory limit for the same parameter is referenced to be from DOE Derived Concentration Guides and other times as an EPA proposed primary drinking water standard (for example Uranium-238 in Table 3-1 and Table 3-6).

L8-8

L8-9

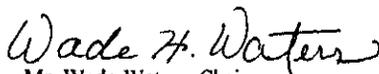
7. It appears to the FG that there may be a bias against Direct Disposal in Grout alternative in the SEIS. The SEIS has several statements that allude to the issue of cesium removal not being technically and economically practical (per DOE Guidance 435.1). The FG believes these statements should be removed from the SEIS and the Direct Disposal in Grout alternative evaluated on its own merits without bias on an equal basis with the other alternatives.

L8-10

As discussed above, the salt processing activity schedule is very important to the Salt Team FG. One way to gain valuable time is for DOE to provide a response to our comments in 30 or 45 days, instead of waiting to include a response in the final SEIS. This expeditious response schedule will provide the FG a head start on understanding the DOE approach to salt processing and circumvent timely dialogue if we wait until the final SEIS is published. Therefore, we request a response to our comments in 45 days or less.

Thank you for the opportunity to offer our comments.

Sincerely,



Mr. Wade Waters, Chair
Waste Management Committee
308 Pinewood Drive
Pooler, GA 31322

Response to Comment Letter L8:

- L8-1 Refer to response to comment L6-1.
- L8-2 DOE has added the impacts of the No Action alternative in Tables S-7 and 4-30.
- L8-3 Refer to responses to comment L3-1 and L7-2
- L8-4 Refer to responses to comment L6-4.
- L8-5 Refer to responses to comment L6-4.
- L8-6 Refer to response to comment L6-6.
- L8-7 *Impacts to trespassers were not considered for the action alternatives because the impacts on a trespasser would be small relative to the impacts for the agricultural scenario which was analyzed for the action alternatives.*

For the No Action alternative, which assumes that the tank tops collapse, DOE did not model the potential exposures to potential future residents in a house built over the HLW tanks. DOE assumed that the collapsed tank tops would preclude building a residence over a tank.

- L8-8 DOE believes that Section 4.1.3.2 describes the primary references requested by the commenter (i.e., Hamby 1992 and NRC 1977).
- L8-9 DOE has applied the appropriate standards for the media discussed in the tables cited by the commenter.
- L8-10 See response to comment L6-3. Section 2.4 has been modified to address this concern. DOE believes it objectively analyzed the impacts of all the alternatives.

----- Forwarded by Drew Grainger/DOE/Srs on 05/16/01 07:27 AM -----

Jim Hardeman <Jim_Hardeman@mail.dnr.state.ga.us>

05/14/01 05:45 PM

To: drew.grainger@mailhub.srs.gov

cc: Jim Setser <Jim_Setser@mail.dnr.state.ga.us>

Subject: Comments re: DOE/EIS-0082-S2D

Drew -

Attached please find comments related to DOE/EIS-0082-S2D, the Savannah River Site Salt Processing Alternatives Draft Supplemental Environmental Impact Statement. I also ask that this e-mail be considered a formal comment on the EIS.

As I indicated in my earlier e-mail, I am disturbed news that we just heard today that DOE has decided not to immobilize plutonium using the Defense Waste Processing Facility (DWPF). If this news is indeed true, the timing of this decision, while the Salt Processing Alternatives SEIS is still out for comment, appears to be suspect, even in the best possible light. The decision not to immobilize (and thus, to no longer require that cesium be separated from salt), coupled with the aggressive schedule for publication of a final EIS (a draft final EIS is scheduled to be transmitted to DOE headquarters less than three (3) weeks after closure of the comment period on the draft EIS) makes it appear that DOE has, in fact, already made a decision regarding the technology to be used for salt processing, and that the NEPA process is mere window dressing.

Thanks again for the opportunity to comment on this document. We trust that DOE will seriously consider our views in this matter.

Jim Hardeman, Manager
Environmental Radiation Program
Georgia Environmental Protection Division
4244 International Parkway, Suite 114
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(404) 362-2675
Fax: (404) 362-2653
E-mail: Jim_Hardeman@mail.dnr.state.ga.us

Attachment: MS Word document "Comments on Salt Treatment Alternatives EIS.doc"

5/16/2001

L9-1

Georgia Department of Natural Resources

4244 International Parkway, Suite 114, Atlanta, Georgia 30354

Lonice C. Barrett, Commissioner
Environmental Protection Division
Harold F. Reheis, Director

May 14, 2001

Mr. Andrew Grainger, NEPA Compliance Officer
Savannah River Operations Office
U.S. Department of Energy
Building 730B, Room 2418
Aiken, SC 29802

Re: Salt Processing Alternatives SEIS (DOE/EIS-0082-S2D)

Dear Mr. Grainger:

The Georgia Environmental Protection Division (EPD) appreciates the opportunity to comment on the Savannah River Site (SRS) Salt Processing Alternatives Draft Supplemental Environmental Impact Statement (SEIS).

As you know, the State of Georgia is opposed to the disposal of high-level radioactive waste onsite at SRS, and has expressed this opposition to the Department of Energy (DOE) and its predecessor agencies many times over the years, dating as far back as the administration of Governor Jimmy Carter. We consider "Direct Disposal in Grout" to be nothing more than onsite disposal of high-level waste, and for this reason, we are strongly opposed to the "Direct Disposal in Grout" option as presented in the SEIS. We also note that both the "No Action" and "Direct Disposal in Grout" alternatives are inconsistent with the "Record of Decision for the Surplus Plutonium Disposition Final Environmental Impact Statement", published in the Federal Register on January 11, 2000 (65 FR 1608). We therefore view both the "No Action" and "Direct Disposal in Grout" alternatives as "Unacceptable", and strongly urge the Department of Energy not to consider either of these alternatives in its technology selection process.

Of the remaining three (3) alternatives, "Small Tank Tetraphenylborate Precipitation" ("Small Tank Precipitation"), "Crystalline Silicotitanate Ion Exchange" ("Ion Exchange"), and "Caustic Side Solvent Extraction" ("Solvent Extraction"), we urge the DOE to select Ion Exchange as the technology of choice for removal of cesium from high-level waste salt at SRS. Ion Exchange appears to have several technical and operational advantages over the other two technologies, including operational simplicity and reduced worker and public radiation doses. In addition, both the Small Tank Precipitation and Solvent Extraction processes generate secondary wastes for which there is currently no identified disposal path.

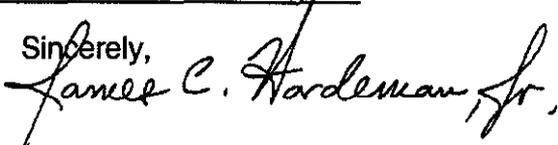
L9-2

L9-3

L9-4

Comments on Salt Processing Alternatives SEIS
May 14, 2001
Page 2 of 2

Thank you again for the opportunity to comment on this document. If you have any questions regarding these comments, please contact me by letter, by telephone at (404) 362-2675, or by electronic mail at Jim_Hardeman@mail.dnr.state.ga.us

Sincerely,


James C. Hardeman, Jr., Manager
Environmental Radiation Program

Response to Comment Letter L9:

- L9-1 DOE has not canceled the Plutonium Immobilization project for disposition of certain quantities of surplus plutonium, nor has DOE selected a technology for HLW salt processing (although this Final SEIS states DOE's preferred alternative). Rather, the Secretary of Energy has decided to suspend plutonium immobilization activities because the President's budget for Fiscal Year 2002 and beyond would not simultaneously support the peak construction of the Pit Disassembly and Conversion Facility, the Mixed Oxide Fuel Fabrication Facility, and the Plutonium Immobilization Facility. In addition, because DOE now anticipates that a salt processing alternative would not be operational until about Fiscal Year 2010, cesium-bearing HLW would not be available to support the immobilization project until that time, if DOE selects a salt processing alternative that would produce cesium-bearing HLW for vitrification. The environmental evaluation in this EIS is an important factor in DOE's selection of a salt processing alternative.
- L9-2 DOE acknowledges the State of Georgia's opinion regarding the Direct Disposal in Grout alternative. Section 7.1 of the EIS describes DOE's process for making waste incidental to reprocessing determinations. Any salt processing alternative that DOE selected for implementation would be subjected to this process which, as described in Section 7.1, would include consultation with the Nuclear Regulatory Commission.
- L9-3 DOE recognizes that the Direct Disposal in Grout alternative would not allow the production of vitrified HLW that would support the plutonium immobilization described in DOE/EIS-0283, Surplus Plutonium Disposition (November 1999), and selected for disposition of certain quantities of plutonium in the Record of Decision (65 FR 1608, January 11, 2000). DOE describes this situation in Section 2.8.3 of the SEIS. Nonetheless, DOE has considered the Direct Disposal in Grout alternative throughout the technology review and evaluation process, as described in the SEIS.
- L9-4 DOE acknowledges the State of Georgia's preference for the Ion Exchange alternative.

EPA R4 DRC

ID:404-562-9598

MAY 15 '01 14:03 No.001 P.01



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 4
ATLANTA FEDERAL CENTER
81 FORSYTH STREET
ATLANTA, GEORGIA 30303-8960

May 15, 2001

4EAD

Mr. Andrew R. Grainger
NEPA Compliance Officer
Savannah River Site
Building 742-A, Room 185
Aiken, SC 29802

**RE: EPA Review and Comments on
Savannah River Site Salt (SRS) Processing Alternatives
Draft Supplemental Environmental Impact Statement (DSEIS)
CEQ No. 010097**

Dear Mr. Grainger:

Pursuant to Section 102(2)(C) of the National Environmental Policy Act (NEPA) and Section 309 of the Clean Air Act, the U.S. Environmental Protection Agency (EPA) has reviewed the subject Draft Supplemental Environmental Impact Statement (DSEIS). The document provides information to educate the public regarding general and project-specific environmental impacts and analysis procedures, and follows the public review and disclosure aspects of the NEPA process. The purpose of this letter is to give you the results of our review of the DSEIS.

The DOE proposes to select a salt processing technology to design, construct, and operate the facilities required to process high-level waste (HLW) salt. The document evaluates alternatives for separating the high-activity and low-activity salt waste from the liquid high-level radioactive waste now stored in underground tanks at SRS. The DSEIS evaluates alternatives for separating high-activity and low-activity fractions of the liquid high-level radioactive waste, which is now stored in underground tanks at SRS. The document evaluates potential environmental impacts of alternatives to the In-Tank Precipitation Process (ITP).

Thank you for the opportunity to comment on this DSEIS. Based on the information provided in the DSEIS, the rating for this document is "BC-2," that is, we have environmental concerns about impacts of the project, and more information is needed. Our concerns are detailed in the attached comments, and primarily pertain to details of potential alternatives.

L10-1

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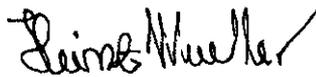
EPA R4 DRC

ID:404-562-9598

MAY 15 '01 14:04 No.001 P.02

Please keep us informed of any technical and/or policy meetings related to this project. If you have any questions or require technical assistance, you may contact Ramona McComney of my staff at (404) 562-9615.

Sincerely,



Heinz J. Mueller, Chief
Office of Environmental Assessment

Enclosure

EPA R4 ORC

ID:404-562-9598

MAY 15 '01 14:04 No.001 P.03

**EPA Comments on
Savannah River Site Salt (SRS) Processing Alternatives
Draft Supplemental Environmental Impact Statement (DSEIS)**

NEPA Process - Distribution of the DSEIS to the public was thorough; it appears that all appropriate federal and state agencies, libraries, citizens groups, and individuals received copies of the document and had the opportunity to comment.

Cumulative Impacts - We note that any new facility would be sited on previously disturbed and developed land, and we appreciate this effort to avoid further impacts to the environment. Section 6.2 lists several environmental media which would be affected by potential emissions from implementation of the alternatives.

L10-2

While it is noted on page 6-6 that air emissions from the new facility would be below applicable limits, it is unclear what the total effects and cumulative impacts of the combined air, groundwater, and waste emissions would be, in conjunction with the other operations already existing at SRS.

L10-3

Alternatives - Four proposed alternatives were developed for the processing of High Level Waste (HLW) remaining from the production of tritium for the U.S. nuclear weapons program. The waste is in alkaline form, and consists of a salt solution and insoluble sludge. Both components contain highly radioactive residues.

For Direct Disposal in Grout (DDG), prior to solidifying the salt solution as grout, monosodium titanate would be used to remove the strontium and actinide to meet saltstone waste acceptance criteria as Low Level Waste. All processes will yield final waste forms to be incorporated in a vitrified glass and saltstone, which is a cement-like mixture. The first process proposed is Small Tank Precipitation. Sorption and precipitation processes would be used to remove the radioactive components, which consists of strontium, plutonium, and cesium. The second process is Ion Exchange. This is a sorption and ion exchange process. The third process is solvent extraction, which consists of sorption and organic extraction. The fourth and last process is Direct Disposal in Grout and consists of sorption.

Sec.2.8.1, page 2-24, states that if the preferred three treatments are deemed not feasible, Direct Disposal in Grout (DDG) would be the next alternative. DOE states on page 2-24 that SCDHEC "...and EPA indicate general acceptance of the Direct Disposal in Grout concept,..." If the DDG Alternative were selected, BPA would need further details. This issue is related to the whole matter of when is waste deemed no longer High-Level, which has yet to be demonstrated by DOE.

L10-4

The amount of curies of Cs-137 of concern [for disposal] for the Ion Exchange Alternative does not appear to be clarified in the tables associated with the discussion [e.g., Table 2-3, 2-4, etc.]. This does not necessarily imply that this should be considered a less preferred alternative. In addition, the amount of waste generated per alternative is not apparent from the information in Table 4-19.

L10-5

L10-6

EPA R4 ORC

ID:404-562-9598

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Table 3-1, P.3-12, contains incorrect MCLs for some radionuclides. The MCL for uranium was finalized in 10/00 at 30 ug/L. The other radionuclides, beta/photon, remain the same as the original 1976 levels, as calculated 4mrem/yr per ICRP2 or NBS69. Likewise, Table 3-6, P.3-22 has incorrect MCLs for some radionuclides. As well the units should be in pCi/L. Please correct all tables to these units [another e.g. Table 3-8].

L10-7

L10-8

The main differences between the alternatives are the amounts of technology that must be developed to construct and operate each facility. Pilot plants will be required for all alternatives except for the DDG option. It must be established that the final waste form resulting from DDG is not High Level Waste and complies with 65 FR 1608, which addresses surplus weapons-grade plutonium. Building specs would be similar for all alternatives, but DDG facility would be somewhat smaller, less costly, less water and electricity usage. Severe accident potential is also less for DDG, and DDG would contribute the smallest amount of liquid high-level waste.

L10-9

Response to Comment Letter L10:

L10-1 DOE has added additional information.

L10-2 No response required.

L10-3 Chapter 6 deals with the impacts associated with the construction and operation of salt processing facilities. Cumulative impacts are presented in Chapter 5. See Tables 5-1 and 5-3 for the cumulative emissions to air and water. Table 5-4 presents cumulative waste generation.

L10-4 Section 2.4 and 2.8 have been modified to address this concern. DOE has identified caustic side solvent extraction as the preferred alternative.

L10-5 Tables 2-3 and 2-4 account for product inputs and outputs. The curie content of the process streams is taken into account in the Chapter 4 analysis of impacts.

L10-6 DOE has revised Table 4-19 in an attempt to clarify waste generation quantities. Each waste type has been reported and compared in its conventional units.

L10-7 Table 3-1 has been revised.

L10-8 Table 3-6 has been updated. The source document reports the values as $\mu\text{ci/ml}$ (microcuries per milliliter), therefore DOE chose to retain the units for ease of comparison.

L10-9 Section 7.1 discusses the process of determining waste incidental to reprocessing.



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May 16, 2001

Andrew R. Grainger
NEPA Compliance Officer
Savannah River Site
Building 742-A, Room 185
Aiken, SC 29802

RE: Savannah River Site Salt Processing Alternatives Draft Supplemental Environmental
Impact Statement; March 2001;(SEIS)(SOE/EIS-0082-S2)

Dear Mr. Grainger:

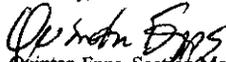
We have reviewed the above referenced draft EIS submitted on March 23, 2001. The South Carolina Department of Health and Environmental Control Bureau of Water administers applicable regulations pertaining to water quality standards and classifications, including 401 Water Quality Certifications. A 401 Water Quality Certification will be required for any part of the proposed work that impacts jurisdictional wetlands or waters of the U.S.

This document describes the stream and wetland resources that will potentially be impacted by the proposed project. In consideration of the site selection, the draft EIS provides an extensive alternatives analysis, which addresses factors such as socioeconomic, traffic volume/service, project costs, cultural resources, waste generation, worker and public health, various environmental resource impacts, and land use in addition to stream and wetlands impacts.

If it is determined that an Army Corps of Engineers 404 permit is required for the proposed project, a South Carolina 401 Water Quality Certification will also be required. The Water Quality Certification may be conditioned to address specific modifications and measures that may be required to further reduce impacts to water resources after a detailed review of project drawings. If required, a final mitigation plan must be reviewed and approved by the Department during the certification process.

Thank you for the opportunity to comment on this project. If you have any questions, please feel free to call John Collum at (803) 898-4179.

Sincerely,


Quinton Epps, Section Manager
Water Quality Certification and
Wetlands Programs Section

SOUTH CAROLINA DEPARTMENT OF HEALTH AND ENVIRONMENTAL CONTROL

Response to Comment Letter L11:

L11-1 There will be no discharges to surface waters and no wetlands will be disturbed, therefore, a 401 Certification will not be required.



Professor Michael Greenberg, Associate Dean of the Faculty &
Director, National Center for Neighborhood and Brownfields Redevelopment
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May 20, 2001

Andrew R. Grainger
NEPA Compliance Officer
U.S. Department of Energy
Savannah River Operations Office
Building 742A, Room 183
Aiken, South Carolina
Attention: Salt processing EIS
(DOE/EIS-0082-S20)
Subject: Economic Impacts of Salt Processing Facility

Dear Mr. Grainger:

On behalf of the Consortium for Risk Evaluation with Stakeholder Participation (CRESP), I am writing this letter to address the social and economic impacts discussed in this EIS report on pages 4-28 and 4-29.

Enclosed you will find the galley pages of a paper that will shortly be published by the Journal of Environmental Management and Planning. The subject of the paper is the interregional economic impacts of the four alternatives being considered for salt processing at the Savannah River site. This is not the final version of the paper, but the only changes would be final editing for spacing. For the record, the results of the full study from which this paper was drawn were submitted to the DOE Savannah River site. So DOE staff, notably John Reynolds, Thomas Heenan, and Howard Gnann, have seen this work. In fact, without their help, the work would not have been possible.

Briefly, CRESP has a grant from DOE to assist stakeholders by evaluating important issues. This salt processing project was identified by Greg Rudy as an important project and the citizen's advisory group has been receiving briefings and reviewing the options. Two of my doctoral students and I reviewed the engineering documents prepared for the DOE and met with the above-mentioned DOE staff to develop cost estimates. These estimates were then converted and inserted into our regional economic simulation model to produce the results summarized in the paper. These estimates are clearly different from those in the EIS because we spent a lot of time reviewing the plans for the projects, and our model is among the most sophisticated in existence

for converting large-scaled engineering projects into estimates of regional jobs, income and other economic measures. Notwithstanding what I have just said, I must refer you to the statement on page 382 (second full paragraph), in which we note that our estimates are based on initial designs, which I am sure you realize could change dramatically as the technologies are refined and tested. Nevertheless, the method used in the EIS to make the estimates is less than desirable.

With this caveat in mind, I'm going to briefly summarize the key findings of the research in bulleted form:

- 1. Assuming that the funds for these projects came from new funds added to the DOE budget rather than from any other existing DOE budget item, then job impacts in the region surrounding the Savannah River site during design range from a high of about 2,900 for ion exchange to a low of 1,400 for grout. During construction, the high is 3,750 for caustic to a low of about 2,600 for grout. And during start-up the range is from 2,300 for caustic to 1,200 for grout. L12-1
- 2. These variations are explained by a number of factors, most notably the different costs of the four technologies; the number of workers and their salary levels; the amount and timing of purchases for building the facilities; and the location of design and testing. All of these are important; however, the last is critical and is the major reason why the caustic and ion exchange technologies do not produce even more local jobs and gross regional product in the host region. In fact, regarding caustic and ion exchange, for the first few years a good deal of the beneficial impact occurs in other regions. L12-2
- 3. The assumption that the funds for this project will be a net addition to the DOE budget is probably overly optimistic. We provide other options, such as DOE cuts all other budgets (environment, defense, energy research) at all of its sites to pay for this project, DOE cuts only environmental budgets at all of its sites to pay for this project, and DOE takes the money for this project from the Savannah River site budget. The results of those payment options are striking. Table 3 from our paper illustrates them with the small tank option. Without doubt, the most distinctive option economically is the one in which the costs for this project are subtracted from other Savannah River site projects. In some years, the host region would suffer a net loss of jobs, because the project is buying equipment, nearly all of which is produced outside the host region. During those years, other regions realize the benefits. Figures 1 and 2 and table 3 illustrate the critically important issue of who pays for the project. L12-3

Overall, our study provides more specific estimates than the current EIS, although we reiterate that these numbers will likely change as the technologies are refined. The important points from regional economic theory that apply to the policy decision are that the cost of the project is not the only thing that matters. Where the technology is designed and tested is critical, and the type (added, substituted) of funding is likely more important than cost in assessing the socioeconomic impacts. L12-4

Methodologically, this study demonstrates that we have the ability to estimate the economic impacts on the host and other regions that include DOE sites. So, for example, Table 4 estimates job impacts in other regions as a result of this project.

L12-4

We conclude by recognizing that health and safety are the most important drivers of this choice. However, if economic impact is important then the estimates provided in the attached paper should provide a more informative set of results and explanation for the results than those in the current EIS.

L12-5

CRESP researchers are extremely interested in the tank wastes and their disposition, and we hope to provide further comments on this important subject in the future.

Regards,



Michael Greenberg
Director, Social and Economic Center, CRESP

cc: Charles Powers

Enclosure: "Regional economic impacts of environmental management of radiological hazards: an initial analysis of a complex problem"

Journal of Environmental Planning and Management, 44(3), 377-390, 2001



Regional Economic Impacts of Environmental Management of Radiological Hazards: An Initial Analysis of a Complex Problem

MICHAEL GREENBERG, DAVID LEWIS & MICHAEL FRISCH

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(Received September 2000; revised December 2000)

ABSTRACT *We conducted an economic analysis of four different billion-plus dollar technological options for managing the salt wastes in the high-level waste tanks at the Savannah River nuclear weapons site (SRS) in South Carolina, USA. While US Department of Energy leadership is appropriately most concerned with health, safety and the environment, the economic implications of the choice cannot be dismissed. Combinations of technologies, where the technology is to be designed and tested, and who pays for it, were considered. With the caveat that the engineering designs are not the final versions and are therefore subject to change, we found that the most expensive technologies to design and build may not produce the most jobs or the greatest gross regional product in the SRS region because a great deal of the design and engineering from prototype to testing will not be done in the host region. Furthermore, in terms of the local economic impacts in the SRS region, this analysis shows that the policy choice regarding the method of funding the project (which budget the money comes from) matters as much as the selection of the remediation technology.*

Introduction

High-level waste (HLW) is the by-product of nuclear fuel reprocessing, in which irradiated fuel and target elements from production reactors are dissolved in acids and chemically processed in order to separate the plutonium and uranium from less toxic materials. The management of this waste is daunting because of the toxicity of the materials, the indefinite period of time some of it will need to be managed and the enormous cost of managing it. While health, safety and cost are obviously the primary considerations for the US Department of Energy (DOE), the regional economic impact of environmental management (EM) choices is important to the surrounding regions, which have a half-century-long history of dependence on the DOE.

There is nothing new about economic impact research: when federal government projects are proposed, the agency is required to estimate the number of jobs and dollars added to the regional economy, and these estimates are included as part of an environmental impact and/or socio-economic impact statement. What is new here is that we did not assume that the surrounding

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region would necessarily benefit economically from the EM project. Using the region surrounding the Savannah River site (SRS) as the focal point, the purpose of this project was to determine: combinations of technologies; the places where the technologies would be designed, tested, constructed and operated; and sources of funding that would lead to increases in jobs and gross regional product (GRP) and combinations that would not.

EM and Regional Economic Contexts

The management of HLW is arguably the most technologically daunting EM problem facing the USA. The public must not be allowed to come into contact with HLW because a great deal of HLW is extremely toxic, containing radionuclides and hazardous chemical agents. Indeed, the Nuclear Waste Policy Act 1982 (42 USCA) requires permanent isolation of these wastes. Much of the waste has a half-life of 50 years, so it needs to be isolated for 100–400 years. Some of the material, such as plutonium, has a half-life of tens of thousands of years, and we do not know how to prevent exposure to it for many centuries.

Ninety-five per cent of the HLW is stored at over 200 tanks at the Hanford (Washington), and Savannah River (South Carolina) weapons sites (Office of Environmental Management, 1995a). The materials in the tanks are a combination of liquids, sludges and solids. The DOE's radioactive waste management strategy has been to stop building more underground storage tanks and instead to transform the highly radioactive elements of the waste into stable and insoluble solids. Some of the DOE's EM plan has been implemented. For example, the DOE built and has been using a vitrification plant (the Defense Waste Processing Facility) at SRS, which blends the solids and sludges with borosilicate glass at 2100° F into a glass matrix and then places it in stainless-steel canisters (US General Accounting Office (US GAO), 1999; Reynolds, J.M., personal communication). However, the DOE has been unable to successfully demonstrate a technology that will separate the high-level and low-level wastes in the tanks without producing other potentially dangerous conditions that cannot be addressed in an economically efficient way (Stakeholder Focus Group of Citizens Advisory Board, 1998; US GAO, 1999).

After exploring 140 technologies, the DOE is focusing on four options, which are described elsewhere in detail (US Environmental Protection Agency, 1985; Stakeholder Focus Group of Citizens Advisory Board, 1998; Reynolds, 1999; US GAO, 1999; Citizens Advisory Board, 2000): (1) small tank precipitation; (2) grout and caesium encapsulation; (3) crystalline silicotitanate ion exchange and vitrification; and (4) caustic side solvent extraction and vitrification.

DOE policy makers cannot ignore the cost and economic benefits of their EM decisions about HLW, for two reasons. First, the costs of HLW management are enormous by any standard. The DOE estimated the costs of clean-up as part of a two-stage process in which more would be spent during the period 1997–2006 to reduce the overall cost during subsequent years. The post-2006 costs range from \$53 billion to \$88 billion over 63 years (2007–2070). The HLW portion is \$33 billion and \$49 billion, i.e. 62% and 56%, respectively (Office of Environmental Management, 1997a, b; Greenberg *et al.*, 1999a). In other words, dealing with HLW will represent the bulk of the so-called 'Cold War mortgage' by the end of environmental risk, the high cost to US taxpayers is one reason for Americans to be concerned about HLW.

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The second reason why the DOE cannot ignore the economics of the issue is that EM investments provide a substantial economic benefit to a few regions in the USA. More specifically, the DOE's EM budget has averaged around \$6 billion during the 1990s (Frisch & Lewis, 2000). About 70% of the DOE's EM budget is spent at the sites in South Carolina, Washington, Colorado, Idaho and Tennessee (Office of Environmental Management, 1995a, b, c). The EM budgets of the Savannah River and Hanford sites each exceed \$1 billion a year. We cannot find any comparable EM investment anywhere in the world. For example, elsewhere we have calculated that the EM budget accounts for 14%, 8% and 17% of the GRP of the regions surrounding the Hanford, Savannah River and Idaho National Engineering and Environmental Laboratory (INEEL) sites (Frisch *et al.*, 1998). Even a modest economic multiplier implies that 15–35% of the economies of these regions is directly and indirectly attributable to the DOE's EM programme. These remarkable proportions are even more salient economic drivers when we consider that defence spending at these sites has plummeted since the end of the Cold War. EM spending has helped compensate for the loss of millions of dollars and jobs that formerly were devoted to developing, building and testing bombs (Greenberg *et al.*, 1999a, b). Studies of news media coverage, interviews with local government officials, including city planners, and a survey of residents of the SRS region all underscore the high priority the local stakeholders attach to the economic impact of the DOE site. In many ways, they consider it as important as EM of the site, and it influences the DOE's credibility (Lowrie *et al.*, 1999, 2000; Williams *et al.*, 1999; Lowrie, 2000).

There are good reasons to be cautious about assuming that any other major on-site project represents a free lunch for the surrounding region that really wants help. One is that these heavily dependent regions have been swinging on an economic pendulum during the last 50 years (Lancaster, 1984; Schill, 1996). Brauer (1995, 1997) argues that the DOE has created a bifurcated labour market in the SRS region, which deters private employers from locating there. Lowrie *et al.* (1999) interviewed 26 local treasurers, comptrollers and chief financial officers in towns and counties near seven major facilities (Oak Ridge, SRS, Hanford, Sandia, Los Alamos, INEEL and Rocky Flats). These sites lost tens of thousands of jobs during the period 1994–99 (Office of Worker and Community Transition, 1999). The picture that emerged was that fluctuating site budgets have caused serious fiscal strains on local governments. Many have sunk money into water and sewer lines, schools and other infrastructure during the period of growth only to find that they are struggling to pay them off as the DOE sites downsize. Many noted that they were not sure that they had sufficient resources to deal with their capital investments, with declining property values and unsold properties, and they questioned their attractiveness to new businesses that would help them diversify their economies (Lowrie *et al.*, 1999).

The 'nuclear mushroom cloud' issue, the most feared toxic symbol, decreases the potential for regional economic development in these regions (Mitchell *et al.*, 1989; Slovic *et al.*, 1991). Regions where bombs were developed, tested and detonated, and where nuclear waste is located, should be expected to suffer from an environmental stigma that would discourage investment and relocation. There is no way of determining how long a stigma effect lingers. There certainly are instances, for example Pittsburgh, Pennsylvania, where the clean-up and redevelopment of an area have led to marked economic growth and the positive

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perception of a community. Yet there is no evidence to suggest what are the long-term implications of being a place where nuclear bombs have been detonated and built, and where nuclear waste is stored. In this regard, we can only hypothesize that the more dependent rural sites where bombs have been developed, built and tested (SRS, Hanford and Nevada Test Site) are clearly at a disadvantage with regard to nuclear-related stigma compared with sites where the effort has been largely focused on science and research (Los Alamos and Sandia).

A third reason to be concerned about the regional economic benefits is that the two regions where nearly all the HLW is located have had a rocky economic road in the recent past, and that road is not expected to improve much in the near future. For example, Table 1 shows that the SRS region has the third lowest per capita income of those we studied, and that its regional population and employment increases are estimated to be relatively smaller than those of any of the others. In essence, the SRS region contains rural counties that never recovered from the decline of cotton and the great migration of African Americans to urban centres. In short, the economic implications of the tank waste investment are more important for the SRS region than the same investment would be in other, more populous, growing and affluent regions.

Furthermore, the more DOE-dependent rural sites, such as SRS, are also at a disadvantage with regard to creating local multiplier effects, compared with less dependent and larger, more urbanized ones. For example, the region centred on the Oak Ridge site is much more populated and urbanized than the one surrounding INEEL (Frisch *et al.*, 1998; Greenberg *et al.*, 1999a). An investment in EM at the Oak Ridge site produces more than 50% more jobs than the same investment in more rural Idaho. This result is due to the lack of forward and backward industrial linkages at the more rural locations (Frisch *et al.*, 1998). That is, the DOE allocates funds to site missions, but many purchases take place outside the region, a good deal of the skilled labour has to be brought into the region, and a lot of the research and development and pilot testing does not take place in these rural regions.

Given this context, we focused on circumstances that would notably impact on regional jobs, GRP and income. If research and development, pilot construction and testing occur in the region, if local construction workers are hired and if products (cement and metal bars, etc.) are purchased in the region, then the region will benefit economically. However, if the technology is developed and pilot-tested outside the region, and if workers and products are mostly brought in from outside the region, then the region will benefit relatively little.

In addition to technology choice, the region will benefit maximally if project costs are paid by funds in addition to the site's budget for other intended activities. This scenario would mean that the US public pays through additional taxes, or another government agency pays by having a smaller budget. If the DOE takes money from its budget, then the other DOE site regions will lose jobs and GRP. So this form of payment for the project, in essence, becomes a tax on the other DOE sites and programmes.

To help unravel which regions gain jobs and GRP from EM of the salt wastes in the HLW tanks at SRS, we selected illustrative combinations of technologies, locations for design and testing and methods of funding. These options are described in the five following questions.

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Table 1. Study regions

Name of region	States (number of counties)	Metropolitan statistical area	Population ($\times 1000$), 2000	Per capita income (\$ $\times 1000$)	Percentage change in employment and population, 2000-15
SRS	Georgia, South Carolina (11)	Augusta-Aiken	647	17.8	Emp. = 11, pop. = 9
Hanford	Washington (7)	Richland-Yakima-Kennewick-Pasco	599	17.7	Emp. = 15, pop. = 13
Oak Ridge	Tennessee (10)	Knoxville	787	20.0	Emp. = 13, pop. = 12
Rocky Flats	Colorado (9)	Denver	2 477	22.9	Emp. = 21, pop. = 24
INEEL	Idaho (7)	Pocatello	248	17.0	Emp. = 22, pop. = 13
Los Alamos/Sandia	New Mexico (7)	Santa Fe	932	20.4	Emp. = 23, pop. = 27
Pantex	Texas (5)	Albuquerque	251	20.4	Emp. = 13, pop. = 13
Nevada Test Site	Nevada, Arizona (4)	Las Vegas	1 447	19.0	Emp. = 30, pop. = 46
Fernald/Mound	Kentucky, Indiana, Ohio (19)	Cincinnati-Hamilton Dayton	3 057	21.4	Emp. = 17, pop. = 13
Headquarters	DC, Maryland, Virginia, West Virginia (26, including cities)	Washington, DC	4 861	24.4	Emp. = 20, pop. = 17
Rest of USA	—	—	256 988	20.6	Emp. = 16, pop. = 14

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- (1) What are the likely economic impacts of the four technologies on the SRS region and the other regions if US taxpayers pay the full cost of the project through a tax increase, raising the overall DOE budget? (We call this the 'new money' option.)
- (2) What are the likely economic impacts if the DOE decides to pay for this project by reducing its defence, science and energy and other budgets across all of its sites? In other words, SRS gains more funding for salt waste management, but other programmes, including some at SRS, lose funding. (We label this the 'DOE zero-sum' question.)
- (3) What are the likely economic impacts if the DOE decides to pay for this project by reducing environmental projects across all of its sites? In other words, SRS gains more funding, but Hanford, Oak Ridge and others lose funding. (We label this the 'DOE EM zero-sum' question.)
- (4) What are the likely economic impacts if no new environmental funding is provided to SRS for this project? In other words, this is a zero-sum game for the SRS region. (We call this the 'SRS zero-sum' question.)
- (5) What are the likely differences in the economic impacts between the four alternative tank waste technologies using the 'all new money' scenario? This question examines the differences between the technologies, independent of the funding issues.

Other options were also plausible, such as zero-sum major EM sites (SRS, Hanford, INEEL and Rocky Flats). The chosen scenarios are representative of what could happen, and are not meant to be definitive. The DOE might choose to implement a hybrid of these alternatives.

In undertaking this analysis, we were aware of two limitations that needed to be noted. We recognized that the engineering cost estimates for the four technologies were the initial set and that these would change as each technology was tested. It is quite possible that the technology that has the best regional economic impact credentials could be eliminated for health, safety, engineering and various other reasons. Secondly, although DOE engineers indicated where the design and testing of each technology were likely to occur, in fact their suggestions might not materialize. Overall, it is important that the reader recognizes that the results are not to be interpreted as final estimates but, rather, are initial estimates that we hope will provoke discussion about the choice of technology, where the project is designed and who pays for it.

Data, Methods and Preliminary Computations

An economic simulation model built by Regional Economic Modeling Inc. (REMI) (1997) was used to determine the implications of the technological alternatives. The simulation model uses a modified national forecast based on estimates developed by the US Bureau of Labor Statistics. It incorporates econometric estimates of the relationships between factors such as population, employment, income, wages, prices, trade and migration by industry and by region in order to produce regional forecasts (Treyz, 1993). In essence, the model allows the user to understand how the forecast would change in response to changes that occur within a region, for example changes in final demand for regional products. In order to measure the regional impacts, the national forecasts are adjusted according to the historical performance of the region from

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1969 to 1996 to generate regional multipliers, regional purchase coefficients, regional trade coefficients and other important characteristics, such as migration and population growth. Because the model is multi-regional, we are able to determine how a change in one region impacts on other regions, which provides a national perspective on the project.

Five key decisions were made about the methods. Briefly, all counties in the primary metropolitan statistical areas of nine regions with major DOE facilities were selected. In addition, headquarters (Washington, DC), and the rest of the USA as an aggregate, were considered as regions. The forecasting period was a second design issue. REMI provides a baseline forecast from 1997 to 2035 based on historical data from 1969 to 1996. However, studies show that estimates that go much beyond a decade deviate substantially from reality because assumptions built into models are no longer valid (Treyz, 1993). Legally, the HLW tanks are to be emptied by 2022. Our analysis begins with the first investments in 2000, but we were reluctant to use the model beyond 15 years, so we chose 2015 as the end of our forecasting period, which provides results for the design, construction, start-up and operating periods. The extent of inter-industry detail was a third design decision. The model has 53 economic sectors, which means that we get considerable detail on purchases from manufacturing sectors of the economy. The development of a baseline to compare with the salt waste-influenced results was the fourth decision. Description of the steps is beyond the scope of this paper (Frisch & Lewis, 2000). The end result was a DOE budget with explicit EM, defence, science and energy, and administrative and other elements that could be altered. In the analyses that follow, the changes are made relative to this derived DOE baseline. That is, the DOE baseline produces employment, GRP, personal income and other output estimates for every year. When we make an explicit change in the DOE budget, the regional economic differences are attributable to the change in the DOE budget because everything else has been held constant within the model. For example, if the DOE baseline forecasts 5000 jobs in a region and a policy modification produces an estimate of 4000 jobs, then the 1000 fewer jobs are attributable to that policy change. The fifth and most difficult set of decisions involved converting the technology plans of the DOE and its contractors into investments in the economy. This required studying the engineering plans and meeting with DOE engineers. We were able to categorize the DOE's investments into 26 labour and 19 capital cost sectors (which themselves are an aggregation of roughly 150 different four-digit standard industrial codes). Another important decision was how to regionalize the design and engineering portion of the budget. Our proportioning of this expenditure by region was based on discussions with SRS engineers. The proportioning of the design and engineering expenditures is a potential source of error. The regionalization of other purchases is based on historical data of the percentage of national production of a particular product or service in a region. These data by region are contained in the regional purchase coefficients that are embedded in the REMI model (Treyz, 1993). This fifth set of decisions was critical to the results of this study.

Results

Before describing the regional economic impacts, a lot can be learned by examining the investments themselves. The aggregate cost (in 1999 dollars) is

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estimated to be \$1.36 billion for the caustic technology, \$1.19 billion for the ion exchange, \$1.08 billion for the small tank system and \$0.91 billion for grout. These differences of up to \$450 million between the technologies were not expected to be proportional in their regional economic impacts because much of the development of the grout and small tank technologies has been at SRS, whereas caustic and particularly the ion technologies have been heavily developed outside the region. The amount of economic leakage out of the region by technology is a critical factor that determines the economic impacts on the SRS region. The percentage of expenditure made in the SRS region, the retention rate, is quite different between the four technologies. Grout, which mostly relies on local products and labour, has a retention rate of 84%, and the small tank technology has a retention rate of 82%, primarily because much of the design and early development has occurred in the SRS region. In contrast, more of the design and construction work for caustic side extraction and ion exchange has taken place outside the SRS region, and so their retention rates are 78% and 65%, respectively. In other words, even though the caustic and ion exchange technologies cost more to design, build and operate, the fact that a lot of the money is spent outside the SRS region means that the economic impact on the SRS region is less than what is implied by looking at the total cost of the project.

Technology Options

Presenting all of the results from the simulations is beyond the scope of this paper. Here we focus on changes in total employment and changes in GRP as measures of economic impacts. Table 2 provides summary results of the new money scenarios, which assume that the US population pays for the technology fully through a tax increase. The tax increase that proportionately distributes the total by region is based on the historical proportion of the taxes paid by each of

Table 2. Economic impacts of four technology options and new money option on SRS region (values are differences from DOE baseline, 1992 constant dollars)

Technology	Average design, 2001-03	Average construction, 2004-07	Average start-up, 2008-09	Percentage difference from small tank, all phases, 2001-09
Small tank				
Employment	2650	3085	1242	—
GRP ^a	90	145	85	—
Grout				
Employment	1417	2606	1167	- 25
GRP ^a	43	112	91	- 26
Ion exchange				
Employment	2927	2863	1539	2
GRP ^a	100	133	119	5
Caustic				
Employment	2157	3749	2287	14
GRP ^a	76	171	161	21

^a In millions of chained 1992 dollars.

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the 12 regions. Over the course of the 9 years, on average there is not much difference between the small tank, ion exchange and caustic technologies in their ability to create jobs and add to GRP. Each creates an average of more than 600 jobs and \$25 million more GRP than grout.

Looking back at the differences in total cost shows that the small tank technology produces more local jobs and greater GRP in the SRS region per unit of cost than do the other three technologies. Small tank costs 16% more than grout, but produces about 25% more jobs. Small tank costs 9% less than ion exchange, but we estimate it to produce almost as many jobs for the region. Similarly, small tank costs 26% less than caustic, but we estimate that the investment in the caustic technology will add only 14% more jobs in the SRS region.

Results averaged over the life of a facility can obscure important variations in the economic impacts. Therefore, we examine differences between the technologies in four phases of the project. The last phase, operations and maintenance, is the most similar across the technologies. There are three reasons for this last outcome: there are significantly fewer leakages out of the regions across technologies for this phase; the amount of additional investment is approximately the same for each technology at this phase; and the model assumptions of national growth and our assumptions regarding the DOE baseline dominate the results. The 1-2% differences between the four technologies in operation and maintenance will not be noticeable in the SRS region.

In essence, the economic differences occur during the design, construction and start-up phases. Table 2 presents the results for each technology and the new money payment option. There is a jump in employment through the design and construction phases, with an equally rapid and steady decline as construction winds down and the start-up phase ensues. The caustic extraction technology is a good one to illustrate the complexity of regional economic impacts. It has the highest overall cost. Yet a lot of up-front design and engineering work is done off-site, notably at Oak Ridge, INEEL and Los Alamos/Sandia, which are estimated to add 480, 710 and 230 jobs, and \$14 million, \$16 million and \$6 million in GRP, respectively, during 2002-04. However, the bulk of the work is done on-site, including the construction of large tanks and engineered systems to support the technology. So, in terms of creating jobs, if the DOE does not need to reallocate money from other projects to pay for this one, i.e. there is new money, then multiple regions will gain jobs and GRP.

Payment Options

The results presented in Table 2 assume that new money is added to the DOE SRS budget, which is likely to be a much better payment arrangement than the SRS region will get. The DOE's overall budget has been under a great deal of pressure since the end of the Cold War, and within that budget the EM budget has been declining relative to the DOE's defence, energy and science budgets (Frisch & Lewis, 2000). Hence, our zero-sum options are probably closer to reality than is the new money one. Using the small tank and ion exchange options as illustrations, Table 3 and Figures 1 and 2 illustrate the impact of the three zero-sum payment scenarios. We can see a scaling down of benefits to the SRS region, depending on the payment option. When we examine the SRS zero-sum funding option, we see a bottoming out, which clearly demonstrates

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Table 3. Payment options, small tank option (values are differences from DOE baseline, 1992 constant dollars)

Payment option	Average design, 2001-03	Average construction, 2004-07	Average start-up, 2008-09	Percentage difference from new money, all 2001-09
New money				
Employment	2650	3085	1242	—
GRP ^a	90	145	85	—
DOE zero-sum				
Employment	2512	2877	1195	-6
GRP ^a	85	137	93	-3
EM zero-sum				
Employment	2310	2573	1127	-14
GRP ^a	77	125	91	-10
SRS zero-sum				
Employment	879	424	638	-77
GRP ^a	21	40	76	-63

^a In millions of chained 1992 dollars.

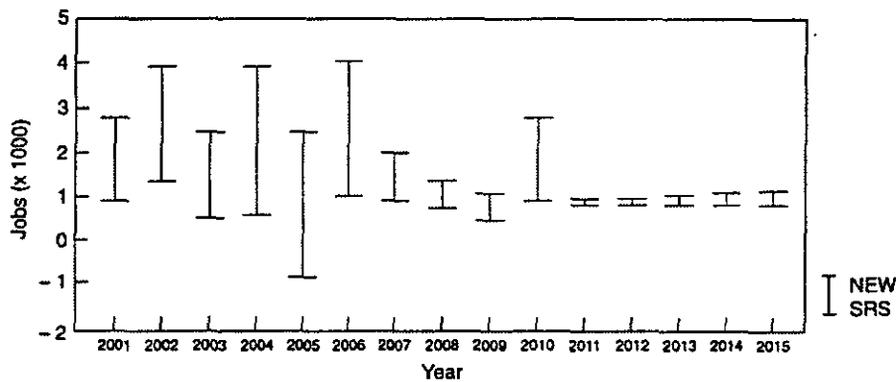


Figure 1. Small tank: new money vs. SRS pays.

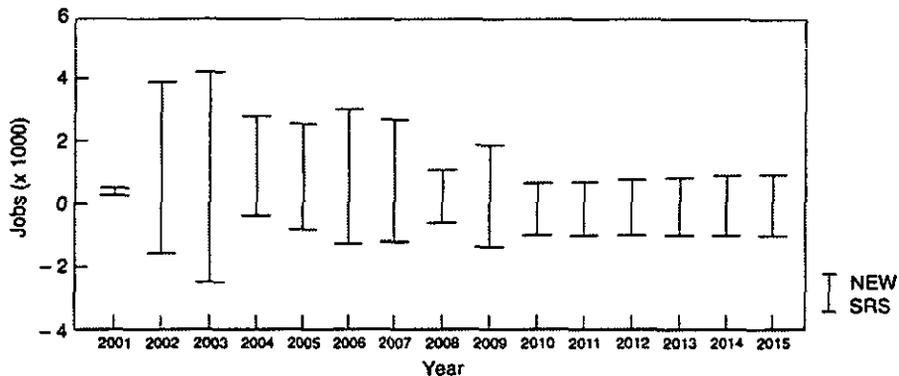


Figure 2. Ion exchange: new money vs. SRS pays.

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the negative economic effects of investment leakage on the SRS regional economy.

The average annual difference in the SRS region of paying for the salt tank clean-up out of the full \$16 billion DOE budget is estimated to be about 100 fewer jobs and \$4 million in GRP, or about 5% of the potential economic impact. The impact of the DOE EM zero-sum option is slightly more serious for the SRS region, estimated annually at 300 jobs and \$9 million less in GRP, or 12% of the total. The larger impact occurs because the SRS region has received about 20% of the EM budget for more than a decade. So, in fact, the SRS site would pay about 20% of the salt waste tank costs out of its existing funding under the EM zero-sum payment option.

The most severe economic impact for the SRS region clearly is the SRS zero-sum option, where the net SRS budget for all purposes is reduced by the amount of the cost of the tank waste project. Table 3 offers two noteworthy insights into this option. One is that the SRS region has an overall annual average job benefit of about 600 jobs, rather than no net job change. This finding is explained by the fact that much of the small tank technological development is on-site, whereas other SRS activities, by comparison, make more purchases of products and labour off-site (Greenberg *et al.*, 1999a; Frisch & Lewis, 2000). In addition, the hiring of many more engineers (many of whom will migrate into the region), paid at a higher rate than the average engineer in the region, will increase demand for upmarket housing, and their substantial disposal income will increase demand for many other services and recreations. However, even this SRS-friendly technology suggests some cause for concern. The simulation suggests that 805 jobs and \$34 million in GRP are estimated to be lost in 2005. According to site plans for the small tank technology, a considerable amount of the budget for that year is for buying steel pipe and other products outside the region, so the retention rate drops and hence the region loses jobs and GRP. In addition, many of the engineers may leave the region as regional demand for their services declines.

Figure 1 illustrates graphically the combination of new money and SRS zero-sum payment options for the small tank option. Before describing the sequence, we should say that we expect the DOE and its contractors to attempt to smooth this forecasted roller-coaster for the period 2001-07. The first 2 years involve building the pilot facility on-site, and so many jobs are created. In 2003, the start of construction of the permanent facility is signalled by off-site purchases, hence local jobs drop. Employment jumps again in 2004 as the products are used to build the facility. However, in 2005 a great deal of money is used to purchase engineered systems, pipe and other products from outside the region, and hence the region loses jobs. A year later, the employment impact peaks to almost 4100 jobs as the construction phase peaks. On-site activities change dramatically after 2006. In 2007, pilot testing and personnel training become the major activities. Training becomes the major activity in 2009. The facility begins operation in 2010. The graph also clearly shows that the real difference to regional economic impact is during design and construction. After 2009, there is little difference in the operational costs by technology, and total operational costs are relatively low compared with construction costs. Hence, the difference in funding mechanism (who pays) does not lead to large differences in impact after 2010.

Figure 2 shows the new money vs. SRS pays options for ion exchange. The

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difference between the best-case scenario (new money funding for the ion exchange technology) and the worst-case scenario (SRS zero-sum funding option for the ion exchange technology) illustrates graphically the dramatic negative effects of economic leakage on the SRS region. The ion exchange technology has the lowest investment retention rate of all four technologies, punctuated by a loss of over 40% of investment during the construction phase. Looking at the salt waste EM problem as an economic issue, Figure 2 is a provocative demonstration of the need to think hard about who pays for this technology, because the SRS region loses employment every year from 2000 to 2015 as a result of the expected site budget absorbing the full costs of this project.

Peak Impacts and Inter-regional Effects: 2006

Clearly, most of the economic impacts of managing salt waste fall within the SRS region. However, there are inter-regional impacts of this SRS-centred EM programme that must be reported in more detail. Table 4 shows these for the small tank option and the four payment options for the peak construction year, 2006, when the site is gaining the most investment. The new money option has almost no impact on the other DOE sites. The job gains in the SRS region are matched by losses in the rest of the USA. The DOE zero-sum option shows losses in the rest of the USA. However, Los Alamos/Sandia, Oak Ridge and the headquarters regions, which have major budget commitments from the DOE defence, energy and science programmes, also lose about 1300 jobs.

The DOE EM zero-sum scenario has more concentrated impacts, falling on Hanford and INEEL; the two relatively poor regions with major EM programmes lose 950 jobs. Oak Ridge, Los Alamos/Sandia, the Nevada Test Site region and Fernald/Mound also each lose over 100 jobs in this peak year. The SRS zero-sum option shows a gain of only 1000 jobs in the region during the peak year. Nearly all the losses are in the rest of the nation.

Table 4. Employment impact by site region, 2006, small tank option
(numbers in table are rounded to nearest 10)

Site region	New money	DOE zero-Sum	EM zero-Sum	SRS zero-Sum
SRS	4100	3850	3500	1000
Hanford	---	-250	-550	---
Oak Ridge	---	-300	-210	-30
Rocky Flats	40	-110	-40	40
INEEL	---	-200	-400	---
Los Alamos	---	-650	-220	10
Sandia				
Pantex	---	-40	---	---
Nevada	10	-70	-140	20
Fernald	30	-60	-170	10
Mound				
Headquarters	---	-330	-260	50
Rest of U.S.	-4600	-2600	-1800	-1400
Total U.S.	-400	-750	-610	-200

Note: ---, Impact is fewer than ± 10 jobs.

Environmental Management of Radiological Hazards 389**Discussion**

The authors of this paper do not have the ability to assess the public health and environmental implications of each of the technologies proposed for the salt wastes in the HLW tanks. Assuming that the DOE's engineering cost estimates are currently reasonable and will become more accurate as design and testing continue, that our sectorizing of them into the economy is accurate, that the regional cost allocations (particularly for engineering services) are realistic and that the historical patterns of trade in the USA captured in the model are appropriate for the near future, then, from an economic perspective, we are able to estimate the impact of each technology on the SRS-centred region and other regions of the USA.

The policy message is not subtle. The assumption that new projects lead to host-region economic benefits is not necessarily true. In an era when budgeting seems to have become a zero-sum game or is close to that reality, a new project is going to be paid for by postponing or eliminating another project. Regional planners need to probe beyond the technological choices because the decisions about where the design and engineering are done and how the project is funded are critical. If the host region pays the full cost of the project by postponing or cancelling other tasks, then the overall net benefit will be reduced, including job and GRP losses in some years. Smoothing out the building process can help flatten the roller-coaster, but it is unrealistic to assume that any of these new technologies can be optimized in the way an off-the-shelf technology could be. Lastly, as practitioners of environmental risk management, it would be remiss of us if we did not conclude by noting that the regional economic benefits are only an important consideration if all four technologies protect public health, safety and the environment.

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Response to Comment Letter L12:

- L12-1 DOE did not attempt to estimate the total number of jobs generated in the region by implementation of the salt processing alternatives, but estimated the number of direct construction and operations jobs that might be created. DOE believes the differences in numbers of construction and operations jobs estimated by CRESP and DOE are attributable to different assumptions used in the analyses. Further, DOE does not believe that the project cost estimates, an important basis for the CRESP analysis, are refined enough to distinguish between the alternatives, with the exception that Direct Disposal appears to be less costly than the other alternatives.
- L12-2 DOE agrees that the results are explained by a number of factors, and that cost of the technologies is an important factor. DOE also agrees that the location of the design and testing functions will affect the local economic impact of the salt processing technology implementation.
- L12-3 DOE agrees that the funding mechanism would be important in determining the local economic impacts. DOE does not assume that funds for any specific project would be in addition to a baseline of SRS funding. Funds for SRS operations are appropriated annually by the Congress, on the basis of the President's budget request and the Congress' own analysis of priorities.
- L12-4 DOE agrees that the CRESP analysis provides more specific evaluations of the economic impacts, and that the data are based on very preliminary design and cost estimates. The CRESP analysis tends to support DOE's evaluation that economic impacts are not a discriminating factor among the alternatives, especially when the preliminary nature of the design and cost estimates is recognized. The scope of this study exceeded what DOE considered to be necessary to understand the potential impacts of the salt processing alternatives.
- L12-5 DOE used several factors to evaluate the alternatives, including cost, schedule, technical maturity, technical implementability, environmental impacts, facility interfaces, process simplicity, process flexibility, and safety.

PUBLIC MEETINGS

The public meetings consisted of brief presentations by DOE on the Draft Supplemental EIS, followed by a question and answer and comment period. In this section, each public meeting speaker's statement is placed in context and paraphrased because some statements are dependent on previous statements and interspersed with other discussion. The transcripts from the meetings can be reviewed at the DOE Public Reading Rooms: DOE Freedom of Information Reading Room, Forrestal Building, Room 1E-190, 1000 Independence Avenue, S.W., Washington, D.C., 20585, phone: 202-586-6020 and DOE Public Document Room, University of South Carolina, Aiken Campus, University Library, 2nd Floor, 171 University Parkway, Aiken, SC 29801, Phone: 803-648-6815.

Paraphrased comments from the meetings and DOE's responses are as follows:

M1-01: One commenter asked that DOE explain the differences in waste generation between the various alternatives, and how waste solvents used in the Solvent Extraction Alternative would be managed.

Response: Waste generation that DOE expects to result from operation of each of the alternatives is shown in Tables 4-18 and 4-19 of the Supplemental EIS. DOE would clean and reuse solvent that would be used in the solvent extraction alternative. Evaluations to date indicate solvent would function as intended for at least one year and perhaps as long as three years. Currently, incineration is considered the best available treatment technology for benzene and other organic liquid wastes. DOE expects that these wastes would be disposed of by incineration. DOE has not yet determined whether the Consolidated Incineration Facility, a portable vendor-operated facility, or a suitable offsite facility would be used for incineration of these wastes. DOE analyzed the impacts of incineration and various alternatives to incineration in the *Final Supplemental Environmental Impact Statement, Defense Waste Processing Facility* (DOE/EIS-0082-S, November 1994). The results of this analysis show that the impacts from the various alternatives to incineration are bounded by the impacts of incineration. The actual treatment facility would be determined during design and construction of the salt processing facility.

M1-02: The commenter asked if there were waste management issues with alternatives other than Solvent Extraction.

Response: Management of benzene that would be generated from operation of the Small Tank Precipitation alternative is also an issue. See also response to M1-01.

M2-01: No public comments were made at meeting M2.

M3-01: A commenter asked how the benzene generated from the Small Tank Precipitation alternative would be managed.

Response: See response to comment M1-02.

M3-02: The commenter asked if selection of the Small Tank Precipitation alternative for implementation would affect DOE's decision on the future of the Consolidated Incineration Facility.

Response: Currently, incineration is considered the best available treatment technology for benzene and other organic liquid wastes. DOE expects that these wastes would be disposed of by incineration. DOE has not yet determined whether the Consolidated Incineration Facility, a portable vendor-operated facility, or a suitable offsite facility would be used for incineration of these wastes. DOE

analyzed the impacts of incineration and various alternatives to incineration in the *Final Supplemental Environmental Impact Statement, Defense Waste Processing Facility* (DOE/EIS-0082-S, November 1994). The results of this analysis show that the impacts from the various alternatives to incineration are bounded by the impacts of incineration. The actual treatment facility would be determined during design and construction of the salt processing facility.

M3-03 and M3-04: One commenter asked if the salt processing alternative selected would account for the possibility of a liquid waste stream from the Mixed Oxide Fuel Fabrication Facility, currently planned for the Savannah River Site. The commenter also asked if the waste stream from the Mixed Oxide Fuel Fabrication Facility would be similar in composition to the HLW to be processed in the proposed salt processing facility.

Response to comments M3-03 and M3-04: The salt processing alternative would be designed to separate the high-activity and low-activity fractions of any waste stream that has been or would be sent to the Savannah River Site HLW tanks for storage. DOE believes a liquid waste stream from the Mixed Oxide Fuel Facility would be similar enough to existing SRS HLW that it could be safely stored in the SRS HLW tanks and managed through the SRS HLW system, including the salt processing alternative. The annual volume of liquid waste from the Mixed Oxide Fuel Facility is expected to be small relative to the annual volumes of waste generated by DWPF and other Site activities. The impact of that waste stream will be considered in more detail in the U.S. Nuclear Regulatory Commission's EIS on the Mixed Oxide Fuel Facility (See Notice of Intent; 66 FR 1394; March 7, 2001).

M3-05 and M3-06: One commenter asked which of the salt processing alternatives would be the most cost effective, and also asked how much had been spent on the In-Tank Precipitation process.

Response to comments M3-05 and M3-06: Based on very preliminary estimates the Direct Disposal in Grout alternative would be the least expensive to construct and operate. DOE spent approximately \$500 million on the In-Tank Precipitation program.

M3-07: One commenter observed that DOE expected that the Direct Disposal in Grout would be the least costly alternative to implement, but that its implementation would necessitate reclassification of the Saltstone Disposal Facility.

Response: The saltstone vaults are designed to the requirements for disposal of Class C low-level waste. The commenter is correct in that DOE would be required to notify the South Carolina Department of Health and Environmental Control if DOE proposed to dispose of waste that exceeded the Class A standards.

M3-08: One commenter wanted to know the half-life of cesium.

Response: The half-life of cesium-137, the dominant radionuclide in SRS salt waste, is 30 years.

M3-09: One commenter asked what discussions had been held with the Environmental Protection Agency and the South Carolina Department of Health and Environmental Control regarding the acceptability of the Direct Disposal in Grout alternative.

Response: Preliminary discussions with regulators (Nuclear Regulatory Commission, SCDHEC, and EPA-Region IV) indicate general acceptance of the Direct Disposal in Grout concept, provided DOE could establish that the final waste form does not require management as HLW. However, if Direct

Disposal in Grout were selected as the preferred alternative, additional discussion with the regulating agencies would be necessary to address regulatory issues.

M3-10 and M3-11: One commenter asked if in the No Action alternative DOE assumed periodic replacement of high-level waste tanks and transfer of waste to new tanks. The commenter also asked if DOE had evaluated in the No Action alternative the failure of HLW tanks and release of HLW to the environment.

Response to comments M3-10 and M3-11: The No Action alternative does not assume that DOE would continue to replace HLW tanks indefinitely if no effective salt processing alternative is found. DOE did not quantitatively evaluate the impacts of the failure of HLW tanks and the release of the contents to the environment in the Draft Supplemental EIS. However, in response to this and other comments, DOE has evaluated the impacts of such a scenario in this Final Supplemental EIS.

M3-12, M3-13, and M3-14: One commenter asked about leaking HLW tanks: how many are leaking now, how many have leaked in the past, what is done with a leaking tank, and in what year did a HLW tank leak to the environment.

Response to Comments M3-12, M3-13, and M3-14: Fifty-one HLW tanks have been constructed at the Savannah River Site, the first in the early 1960s and the last about 1980. Ten of these tanks have had identified leak sites, and only one tank has leaked to the environment (Tank 8, in 1961) and the waste has been removed from that tank. In general, if a leak is identified DOE would lower the waste level in the tank so it was below the leak site. SCDHEC would be notified, as required by the Federal Facility Agreement, and DOE would formulate and implement a plan to stop the leak and clean up any environmental contamination. Because of the radiation environment in tanks, the technology does not exist to repair leak sites. Most of the leaks identified in Savannah River Site have been into the annulus between the primary tank and the secondary containment structure. Collection systems are in place for those tanks that do not have secondary containment.

M3-15: One commenter observed that there were public meetings on the In-Tank Precipitation Process in 1995, and asked what had been done in the interval about precipitation in the HLW tanks.

Response: DOE believes the commenter is referring to public meetings on DOE/EIS-0082-SD, Draft Supplemental Environmental Impact Statement, Defense Waste Processing Facility, which were held in Columbia, South Carolina on September 20, 1994. That Supplemental EIS addressed the proposed operation of the Defense Waste Processing Facility, including the In-Tank Precipitation process. Since that time, DOE has determined that the In-Tank precipitation process cannot meet production goals and safety requirements and is pursuing a technology to replace the In-Tank Precipitation process. Alternative technologies for replacement of the In-Tank Precipitation process are the subject of this Final Supplemental EIS.

M3-16 and M3-17: One commenter expressed the opinion that someone had a lot to answer for, because cleanup is seemingly stopping yet DOE is proceeding with the Mixed Oxide Fuel Fabrication Facility and bringing plutonium from many locations to the Savannah River Site. The commenter asked if DOE had ever planned to remove HLW waste from the HLW tanks.

Response to comments M3-16 and M3-17: The HLW tanks at the Savannah River Site were designed as temporary storage facilities and were never intended for permanent disposal of HLW. DOE and its predecessors began planning for disposal of this HLW more than two decades ago. Cleanup, including nuclear material stabilization and HLW vitrification, is a continuing SRS mission and is not stopping.

M3-18, M3-19, and M3-21: Two commenters expressed opposition to the Mixed Oxide Fuel Fabrication Facility and support for the No Action Alternative in the Salt Processing Alternatives Supplemental EIS. The commenters support the No Action Alternative while the impacts of the potential liquid waste stream from the Mixed Oxide Fuel Fabrication Facility on the Savannah River Site HLW management system is determined.

Response to comments M3-18, M3-19, and M3-21: The purpose and need for DOE action in this SEIS is to achieve the ability to safely process 31.2 million gallons of salt component containing approximately 160 million curies. This need is urgent and predates the proposal for a mixed oxide (MOX) fuel fabrication facility. The notice of intent by the U.S. Nuclear Regulatory Commission to prepare an EIS for a MOX facility was published recently (66 FR 1394; March 7, 2001). At this stage of early planning, DOE does not know if the SRS Tank Farms could or would receive MOX waste. Therefore, DOE must proceed with the salt processing action based on its primary and urgent mission to vitrify the existing waste in the SRS Tank Farms.

M3-20: One commenter asked if there would be a public comment period after the preferred alternative is identified in the Final Salt Disposition Alternatives Supplemental EIS.

Response: Neither the Council on Environmental Quality Regulations implementing the National Environmental Policy Act, nor DOE's regulations implementing NEPA, require a public comment period after a Final EIS (or Final Supplemental EIS) is issued, and DOE does not plan to have such a comment period. DOE may not, however, issue its Record of Decision until 30 days after the Notice of Availability for the Final Supplemental EIS is published in the Federal Register, and members of the public are free to comment during the 30-day period. Generally, DOE addresses any comments received on a Final EIS in its Record of Decision for the EIS.

M4-1 and M4-2: One commenter observed that risk was not a clear discriminator among alternatives and asked what would be the determining factor in the selection process and if DOE was leaning toward one of the alternatives.

Response: DOE has established nine criteria for use in evaluating the salt processing alternatives. These are identified in Section 2.6. There are technical risks associated with each of the alternatives. The research and development process has focused on reducing those risks. There is no one factor that would be the determining factor. At the time of this public meeting, DOE did not have a preferred alternative, but identifies its preferred alternative in this final SEIS.

M4-3, M4-10 and M4-11: One commenter asked if DOE was going to do a pilot demonstration of one or more than one salt processing technology. The commenter also asked about the anticipated operating time of the pilot facility and if a new contractor would be responsible for the pilot facility or only for the construction and operation of the full scale salt processing facility.

Response to comments M4-3, M4-10, and M4-11: As described in Section 4.1.14, DOE has not decided if one or more than one technology would be tested at the pilot scale. DOE plans to operate the pilot plant for a period of 6 to 18 months. DOE has not determined if a new contractor would operate the pilot plant and construct and operate the full-scale facility.

M4-4: One commenter observed that comparing 10 CFR 61.55 Class C waste disposal regulations to the Direct Disposal in Grout alternative may not be appropriate.

Response: DOE has investigated this issue and can find no limit on the quantity of Class C waste that could be placed in a disposal unit (e.g., a disposal cell). The Direct Disposal in Grout alternative

would comply with the waste classification and stability requirements in 10 CFR 61.55 and 10 CFR 61.56. DOE Manual 435.1-1 establishes a process for making waste incidental to reprocessing determinations. This process evaluates candidate waste streams to determine if they can be managed as low-level waste or transuranic waste. Wastes can be managed as low-level waste if they meet specific criteria including being managed pursuant to DOE's authority under the Atomic Energy Act of 1954 and, provided the waste will be incorporated in a solid physical form at a concentration that does not exceed the concentration limits for Class C low-level waste in 10 CFR 61.55. The performance assessment would consider the facility design and location and waste characteristics.

M4-5: One commenter observed that the Ion Exchange alternative seemed to be the simplest and most straightforward alternative and asked if simplicity or relative simplicity was a consideration in the process for selecting a salt processing alternative.

Response: The relative simplicity of the technology is a factor in the technology selection process.

M4-6 and M4-7: One commenter asked where all of the uncertainties with the alternatives were discussed and if bidders on the salt processing facility contract would have access to those uncertainties.

Response to comments M4-6 and M4-7: Uncertainty regarding implementation of the alternatives is a factor in the technology selection process. DOE's evaluations leading to the selection of the preferred alternative will be made available to the public.

M4-8: One commenter observed that the Solvent Extraction alternative was once considered too technically immature to be pursued, and asked what was the maturing process that had made it a reasonable alternative.

Response: The principal developers of the solvent extraction technology had received other funding for their research and development efforts and made considerable progress in developing a stable solvent that performs its functions efficiently for use in the process. Therefore, because other aspects of the technology appear to be mature enough for implementation, DOE has evaluated solvent extraction as a reasonable salt processing alternative.

M4-9: One commenter asked if there were contingencies to free up HLW tank space if the salt processing technology was not operational by 2010.

Response: DOE continues to evaluate contingencies for gaining tank space. These include actions to increase the operational availability of the HLW evaporators, alternatives for management of DWPF recycle waste, and other management efficiencies. Some of the potential actions are described in more detail in Section 2.3 of this Final Supplemental EIS.

M4-10: One commenter asked if DOE intended to try to use existing facilities within SRS for salt processing activities.

Response: DOE does intend to use existing facilities to the extent possible, but each of the action alternatives would require a new facility, which DOE would build on a previously disturbed site in the DWPF area.

M4-11: One commenter asked if the pilot plant would be built and operated by DOE's current contractor or if it would be part of the new salt processing contract.

Response: Contracting questions are outside the scope of the NEPA process.

APPENDIX D

**LONG-TERM PERFORMANCE EVALUATION
FOR THE ACTION ALTERNATIVES**

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APPENDIX D. LONG-TERM PERFORMANCE EVALUATION FOR THE ACTION ALTERNATIVES

This Appendix describes the methodology used by the U.S. Department of Energy (DOE) in determining long-term impacts that could occur from implementation of the action alternatives described in Chapter 2 of this Supplemental Environmental Impact Statement (SEIS). Long-term impacts of the No Action alternative are described in Chapter 4.

The long-term analysis covers that period of time following 100 years of institutional control as specified in DOE Order 435.1 for determining impacts of low-level waste disposal facilities. DOE expects the primary source of long-term impacts to be saltstone disposal in Z Area. In accordance with the requirements of DOE Order 5480.2A, the *Radiological Performance Assessment for the Z-Area Saltstone Facility* (WSRC 1992), referred to as the RPA, was prepared based on the expected chemical composition of the salt solution that would be transferred from the In-Tank Precipitation (ITP) Facility and the Effluent Treatment Facility. As part of this SEIS process, DOE reviewed the RPA to determine how its conclusions could change if the chemical composition of the salt solution changed as a result of the alternatives analyzed in this SEIS, and how information from the RPA could be used to estimate impacts of the alternative salt solutions.

Although new groundwater models for the Savannah River Site (SRS) are currently under development, DOE believes that the methodology used in the RPA provides a reasonable basis for estimating impacts in this SEIS. Therefore, DOE has chosen to use the general methodology of the RPA to the maximum extent practical, making changes only for those parameters that are unique to the proposed new processes and those that were not analyzed in the RPA, such as differing concentrations of salt in the feed solution among alternatives.

D.1 Description of RPA Approach

This section provides a brief overview of the general methodology used to determine impacts in the RPA. The reader is referred to the RPA (WSRC 1992) for additional details.

As stated, the RPA based its analysis on the source term in the salt solution that was expected to be transferred to the Saltstone Manufacturing and Disposal Facility from the ITP and the Effluent Treatment Facilities, with the bulk of the material coming from ITP.

Because the high-level waste (HLW) tanks contain a myriad of fission products, activation products, actinides, and chemicals, the RPA performed a sensitivity analysis to identify those contaminants that would be most likely to present long-term impacts. This was based on a variety of factors, such as the quantity of the material projected to be present in the saltstone, the half-lives of the radiological constituents, and the ability of the saltstone to chemically bind the contaminants to minimize leaching.

The RPA also considered the pathways by which individuals could be exposed in the future to determine which pathways warranted detailed analysis. Based on early estimates, the primary pathways to which a person could be exposed were the following:

- A drinking water scenario where the individual consumes water from a well drilled into the aquifer that contains contaminants from the saltstone. This scenario is not assumed to be possible until at least 100 years post-closure.
- An agricultural scenario, in which an individual unknowingly farms on the soil above the saltstone vaults and constructs a home on the vaults. In this scenario, the individual is assumed to derive half of his vegetable consumption from a garden planted in contaminated soil located over the vaults. The

time spent gardening is assumed to be short (100 hr/yr), compared to the amount of time spent indoors (4000 hr/yr) or farming. Doses from external radiation, inhalation, incidental soil ingestion, and vegetable ingestion are calculated only for indoor residence and outdoor gardening activities. Since the farming activities are assumed to occur over a widespread area that would include uncontaminated and undisturbed soil not subject to irrigation with contaminated water, the meat and milk pathways would not contribute significantly to the individual's dose. DOE expects that the saltstone would remain relatively intact for an extended period of time; therefore, DOE does not believe this scenario would be reasonable until approximately 10,000 years post-closure because, at least until that time, an individual could identify that he was digging into a cementitious material. However, for conservatism, DOE calculated the impacts of the agricultural scenario at 1,000 years post-closure.

- A residential scenario, in which an individual constructs and lives in a permanent residence on the vaults. This scenario has two options: construction at 100 years post-closure and construction at 1,000 years post-closure (evaluated as part of the agricultural scenario). Under the first option, a sufficient layer of soil would be present over the still-intact vaults so that the resident would be unaware that the residence was constructed on the vaults. Under the second option, the saltstone is assumed to have weathered sufficiently so that the resident could construct a residence without being aware of the presence of the saltstone.

The RPA assumed that institutional control would be maintained for 100 years after closure, during which time the land encompassing the saltstone vaults would be managed to prevent erosion or other conditions that would lead to early degradation of the

vaults. The public is also assumed to have no access to Z Area during this time.

The analysis of groundwater impacts is based on PORFLOW-3D, a 3-dimensional finite difference model of flow and transport for both the near field and the far field. The near-field analysis considers flow and transport from the ground surface, through the saltstone, vault, and unsaturated zone, to the water table. The far-field analysis considers flow and transport through the water table and underlying aquifers. The ultimate results of the modeling effort are the maximum concentrations of the contaminants of interest at a point 100 meters downgradient from the downgradient edge of the disposal facility. It is at this "compliance" point that the groundwater quality is compared to water quality standards.

The analysis of doses from other pathways in the agricultural and residential scenarios begins with the calculated concentrations in the saltstone and surrounding soil, to which the appropriate pathway transfer coefficients and dose conversion factors are applied.

The RPA examined the potential impacts of saltstone disposal for the cases in which the saltstone remained intact and in which the saltstone failed structurally. For groundwater modeling, the greater impacts presented in the RPA are associated with failed saltstone. Therefore, this SEIS presents the results associated with failed saltstone.

D.2 Modifications to the RPA Approach for the SEIS Analysis

Because of the extensive nature of the RPA, DOE chose to rely on many of the technical bases presented in it. However, DOE did modify the calculations in the RPA to account for the following:

- the differences in salt solution concentrations for the Ion Exchange alternative, the Solvent Exchange alternative, and the Direct Disposal in Grout alternative from those for

the ITP case (equivalent to the Small Tank Precipitation alternative)

- the difference in number and design of vaults for the current suite of alternatives, compared to the vaults analyzed in the RPA
- the need to calculate groundwater concentrations 1 meter downgradient from the downgradient edge of the disposal facility to be consistent with the SRS Tank Closure EIS. Because Z Area is a low-level waste disposal facility, it is exempt from the Resource Conservation and Recovery Act (RCRA) regulations pertinent to the high-level waste tanks that require an assessment of impacts 1 meter downgradient. The analysis is included to better compare the impacts of the two actions.
- the need to calculate groundwater concentration at the seep lines of nearby streams to determine impacts on ecological resources
- the difference in measured properties of the current formulation of saltstone, compared to those analyzed previously in the RPA.

The saltstone concentrations for analysis in this SEIS were based on the concentrations in the original RPA, adjusted to account for the increase in sodium molarity as projected in the engineering flow sheets (WSRC 1998) for the alternatives. Increased sodium molarity is indicative of increased overall concentrations; the alternatives with higher sodium molarities were assumed to also have higher overall concentrations of other constituents in proportion to the increase in sodium molarity. The concentration of cesium isotopes for the Direct Disposal in Grout alternative was calculated, based on the estimated cesium-137 inventory in the HLW tanks and the volume of saltstone produced. The concentrations of other cesium isotopes were calculated, based on isotopic ratios derived from the RPA. For this SEIS, the

source information from Tables A-1 and A-2 in Appendix A was used.

The methodology used in the RPA for the agricultural and residential scenarios was unchanged and is not repeated in this Appendix. Most of the other changes to calculations in the RPA pertained to groundwater modeling, as discussed in the following section.

D.3 Groundwater Modeling Modifications

The present analysis is based on the results of the detailed peer-reviewed model in the RPA. The results presented there are used here, for conditions at which the RPA calculations and the SEIS are equivalent. For non-equivalent conditions, the RPA results are scaled by use of an analytical model which includes all of the important transport mechanisms. Modifications to the previous study were included to account for changes in the release rate to the water table (Table D-1). These changes would occur because of changes in radionuclide content of the saltstone among the alternatives, because of modifications to saltstone transport parameters established in Langton 1999, and because of a change in the total number of vault cells from the earlier study. Extensions to the previous modeling study were also included to allow for calculation of concentrations at locations other than the compliance point. Specifically, concentrations were calculated for a well 1-meter downgradient of Z Area and for the seep lines of the water table (to McQueen Branch) and Gordon (to Upper Three Runs) aquifers. The seep line aquifer discharge points were taken to be 450 and 1,500 meters, respectively, from the downgradient edge of the facility.

The extension of the previous modeling study was based on the assumption that an analytical model of aquifer transport, which includes the important mechanisms included in the original study, would simulate the relative downgradient concentrations in the aquifer. The model chosen (Pigford et al. 1980) considers three-dimensional dispersion, advection, adsorption, and decay

Table D-1. Modifications to the RPA's parameters for this SEIS.

Parameter	Previous study (RPA)	Small Tank Precipitation	Ion Exchange	Solvent Extraction	Direct Disposal in Grout
Number of cells	174	109	90	101	82
Waste solution sodium molarity	4.6	4.6	5.3	4.3	5.6
Nitrate diffusivity through saltstone, (square centimeters per second)	5.07×10^{-9}	6.00×10^{-8}	6.00×10^{-8}	6.00×10^{-8}	6.00×10^{-8}
Cesium adsorption coefficient in saltstone (milliliters per gram)	2	200	200	200	200

from a continuous release. Continuous release is necessary because of the long-term releases from the facility. This model includes daughter ingrowth and independent transport (i.e., with the daughter's transport parameters), although the contaminants of concern for the present study are not daughter products. The model, as originally presented, calculates concentration as a function of release rate, aquifer velocity, dispersivity (in three dimensions), decay rate, adsorption coefficient, and time. The concentrations are given in terms of distance (longitudinal, lateral, and vertical to aquifer flow) from a point source release. Because of the size of the facility (on the order of a few hundred meters on a side), relative to the downgradient distances of interest (i.e., 1 and 100 meters), it was necessary to modify the point source solution to account for an area source. The point source solution of the original source was generalized to a horizontal area source solution (consistent with the saltstone footprint) by integrating the point source solution over the facility area and dividing by this area. If the area source solution described above is denoted $C_a(x,y,z,t)$ and the solution of the previous detailed model is $C_{rpa}(100,0,0,t_{max})$ (i.e., the maximum concentration at the compliance point), then the concentration as presented here is estimated as:

$$C_s = \frac{C_{rpa}(100,0,0,t_{max}) \times C_a(x,y,z,t)}{C_a(100,0,0,t_{max})}$$

where C = concentration, x = distance along aquifer flow path, y = distance horizontally transverse to aquifer flow, z = vertical distance (all directions measured from the projection of the middle of the downgradient edge of the facility on the water table), and t = time from initial release to water table.

For the conditions analyzed in the RPA ($x = 100\text{m}$, $y = z = 0$, $t = t_{max}$), $C_s = C_{rpa}$), comparing Table D-2 with the results of the RPA illustrates some of the changes from the RPA analysis to this SEIS. The Small Tank Precipitation alternative is most similar to the process analyzed in the RPA; the Direct Disposal in Grout alternative is the least similar. Therefore, the Small Tank Precipitation alternative results would be expected to be most similar to the RPA results, based on the number of vault cells (see Table D-1); with fewer vault cells, the other cesium removal alternatives should result in smaller concentrations at 100 meters. This is the case (Table D-2). Using this reasoning, the Direct Disposal in Grout alternative would also be expected to result in smaller concentrations than the Small Tank Precipitation alternative because it has fewer vault cells. However, in this case, a reduction in the number of vault cells is offset by an increase in solution sodium molarity of Direct Disposal in Grout saltstone (Table D-2). Both alternatives result in slightly lower concentrations than that of the RPA analysis. Note that the RPA did not analyze the concentration of Cs-135; it is a relatively important contributor only to the Direct Disposal in Grout alternative.

Table D-2. Maximum Groundwater concentrations at 1 meter downgradient, 100 meters downgradient, and at the seepage line.^a

		Carbon-14 (picocuries per liter) ^b	Selenium-79 (picocuries per liter) ^b	Technetium-99 (picocuries per liter) ^b	Tin-126 (picocuries per liter) ^b	Iodine-129 (picocuries per liter) ^b	Cesium-135 (picocuries per liter) ^b	Nitrate (milligrams per liter) ^c
<i>1-meter concentrations</i>								
Upper Three Runs Aquifer	Small Tank Precipitation	1.0×10 ⁻⁴	7.0	17	0.0039	0.11	4.0×10 ⁻⁵	56
	Ion Exchange	1.1×10 ⁻⁴	8.2	20	0.0047	0.13	4.5×10 ⁻⁵	66
	Solvent Extraction	9.4×10 ⁻⁵	6.4	15	0.0036	0.10	3.7×10 ⁻⁵	51
	Direct Disposal in Grout	1.2×10 ⁻⁴	8.2	20	0.0046	0.13	0.50	66
Gordon Aquifer	Small Tank Precipitation	6.7×10 ⁻⁴	42	104	0.024	0.68	2.5×10 ⁻⁴	338
	Ion Exchange	6.7×10 ⁻⁴	49	121	0.029	0.82	2.7×10 ⁻⁴	395
	Solvent Extraction	5.6×10 ⁻⁴	38	94	0.022	0.63	2.3×10 ⁻⁴	307
	Direct Disposal in Grout	7.2×10 ⁻⁴	49	120	0.029	0.81	3.1	394
<i>100-meter concentrations</i>								
Upper Three Runs Aquifer	Small Tank Precipitation	8.2×10 ⁻⁶	0.59	1.4	3.0×10 ⁻⁴	0.0096	3.5×10 ⁻⁶	4.8
	Ion Exchange	8.9×10 ⁻⁶	0.63	1.5	3.2×10 ⁻⁴	0.01	3.7×10 ⁻⁶	5.1
	Solvent Extraction	7.5×10 ⁻⁶	0.54	1.3	2.7×10 ⁻⁴	0.0088	3.2×10 ⁻⁶	4.4
	Direct Disposal in Grout	9.6×10 ⁻⁶	0.68	1.7	3.5×10 ⁻⁴	0.011	4.2×10 ⁻²	5.6
Gordon Aquifer	Small Tank Precipitation	5.0×10 ⁻⁵	3.5	8.8	0.0019	0.059	2.2×10 ⁻⁵	29
	Ion Exchange	5.3×10 ⁻⁵	3.8	9.4	0.002	0.063	2.3×10 ⁻⁵	31
	Solvent Extraction	4.5×10 ⁻⁵	3.2	8.0	0.0017	0.054	2.0×10 ⁻⁵	26
	Direct Disposal in Grout RPA ^c	5.8×10 ⁻⁵ 6.0×10 ⁻⁶	4.1 4.4	10 11	0.0022 0.0022	0.069 0.075	0.26 Not calculated	33 36
<i>Seepage concentrations</i>								
McQueen Branch	Small Tank Precipitation	1.9×10 ⁻⁶	0.16	0.42	5.7×10 ⁻⁵	0.0028	9.8×10 ⁻⁷	1.4
	Ion Exchange	2.1×10 ⁻⁶	0.17	0.44	6.1×10 ⁻⁵	0.0029	1.0×10 ⁻⁶	1.5
	Solvent Extraction	1.8×10 ⁻⁶	0.15	0.38	5.2×10 ⁻⁵	0.0029	8.9×10 ⁻⁷	1.3
	Direct Disposal in Grout	2.2×10 ⁻⁶	0.19	0.48	6.6×10 ⁻⁵	0.0032	0.012	1.6
Upper Three Runs	Small Tank Precipitation	2.0×10 ⁻⁶	0.23	0.66	3.9×10 ⁻⁵	0.0045	1.5×10 ⁻⁶	2.2
	Ion Exchange	1.9×10 ⁻⁶	0.23	0.64	3.9×10 ⁻⁵	0.0044	1.5×10 ⁻⁶	2.1
	Solvent Extraction	1.7×10 ⁻⁶	0.20	0.58	3.5×10 ⁻⁵	0.0039	1.3×10 ⁻⁶	1.9
	Direct Disposal in Grout	2.1×10 ⁻⁶	0.25	0.72	4.3×10 ⁻⁵	0.0049	0.017	2.4

Source: WSRC (1992) Table 4.1-6.

- a. The concentrations reported are the maximum for each nuclide and alternative that would occur in the 1,000-year period of analysis. The maximum occurrences are not simultaneous; they would occur at different times during the 1,000-year time period.
- b. Concentrations of radiological constituents are presented in units of picocuries per liter.
- c. Concentrations of nonradiological constituents are presented in units of milligrams per liter.

The number of saltstone vaults is presented in Chapter 2 and Appendix A of this document. The effect of reducing the number of saltstone vaults on the modeling is to decrease the surface area through which precipitation will infiltrate and leach the constituents; the previous study's release rates were therefore multiplied by the ratio of facility surface areas. The saltstone concentration increases with increasing sodium molarity; the previous study's release rates were multiplied by the ratio of molarities. The exception to the latter was for the cesium isotopes in the Direct Disposal in Grout alternative, as described in Chapter 2 and Appendix A of this SEIS.

A recent laboratory study (Langton 1999) indicates that the diffusivity of nitrate through saltstone is greater than that assumed in the previous RPA. This has the potential to increase the nitrate release rate from the saltstone after failure. The RPA showed that the nitrate release has two components: an advective "fracture" release (decreasing over time) from the cracks formed in the grout; and a later "intact" diffusive release from the internal pores of the grout to the fracture planes. Changes in the "intact" diffusive release have been shown to be proportional to the square root of the ratio of diffusivities (Wallace 1986). The time-dependent nitrate release rate indicated in the previous RPA was re-examined in light of the revision in diffusivity indicated in Table D-1. It was found that the initial "fracture" release was larger than the sum of the later "fracture" releases plus the "intact" release. The initial "fracture" release rate, which is independent of diffusivity, was conservatively assumed for this analysis.

The Langton study also indicated an increase in cesium adsorption coefficient in saltstone from that used in the RPA. This increase in saltstone constituent adsorption coefficient results in an approximately linear decrease in cesium concentration in pore water and, therefore, an approximately linear decrease in the cesium release rate.

The values from the Langton study are expected to better represent the conditions for salt processing than the values chosen for the RPA. The former were laboratory measurements of adsorption between the constituents studied (nitrate and cesium) and the saltstone formulae that would be used for this project; the latter were conservatively low choices from a range of literature values describing adsorption of the constituents with concrete not specific to salt processing. Use of the cesium adsorption coefficient suggested by the Langton study, in place of the literature value used in the RPA, will significantly decrease the predicted cesium transport.

All other parameters used in the previous study were used in the present study. Because the previous study only considered a single point (compliance point), a single value of dispersivity for each direction was used. The values used at that location (3 meters for longitudinal, 0.3 meters for transverse) were generalized to other distances by assuming that the ratio of distance to dispersivity is constant. The vertical dispersivity was taken as 2.5×10^{-3} times the longitudinal dispersivity (Buck et al. 1995).

D.4 Results

Table D-2 presents the maximum groundwater concentrations calculated by using the methodology described above. For comparison purposes, the results from the RPA are presented at the 100m compliance point. Table D-3 presents the radiological doses resulting from concentrations of radiological constituents in the groundwater. The source information in these tables was used for the SEIS.

- Table D-4 presents the calculated doses for the agricultural and residential scenarios. For all the scenarios, most of the dose is due to external exposure. External radiation exposures were calculated, based on the same assumptions regarding post-closure conditioning in the vaults used in the RPA. Dose correction factors were derived using an approach that considered a finite size of the excavation, which would not uncover the

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Table D-3. Radiological doses due to consumption of groundwater 1 meter downgradient, 100 meters downgradient, and at the seepiline.

Downgradient		Total (millirem per year)	Carbon-14 (millirem per year)	Selenium-79 (millirem per year)	Technetium-99 (millirem per year)	Tin-126 (millirem per year)	Iodine-129 (millirem per year)	Cesium-135 (millirem per year)
<i>1-meter doses</i>								
Upper Three Runs Aquifer	Small Tank Precipitation	0.080	1.5×10^{-7}	4.3×10^{-2}	1.6×10^{-2}	5.0×10^{-5}	2.2×10^{-2}	2.1×10^{-7}
	Ion Exchange	0.095	1.7×10^{-7}	5.0×10^{-2}	1.9×10^{-2}	6.1×10^{-5}	2.6×10^{-2}	2.3×10^{-7}
	Solvent Extraction	0.074	1.4×10^{-7}	3.9×10^{-2}	1.5×10^{-2}	4.7×10^{-5}	2.0×10^{-2}	1.9×10^{-7}
	Direct Disposal in Grout	0.096	1.8×10^{-7}	5.0×10^{-2}	1.9×10^{-2}	6.0×10^{-5}	2.6×10^{-2}	2.6×10^{-3}
Gordon Aquifer	Small Tank Precipitation	0.49	9.1×10^{-7}	2.6×10^{-1}	9.8×10^{-2}	3.1×10^{-4}	1.4×10^{-1}	1.3×10^{-6}
	Ion Exchange	0.58	1.0×10^{-6}	3.0×10^{-1}	1.2×10^{-1}	3.8×10^{-4}	1.6×10^{-1}	1.4×10^{-6}
	Solvent Extraction	0.45	8.4×10^{-7}	2.3×10^{-1}	8.9×10^{-2}	2.9×10^{-4}	1.3×10^{-1}	1.2×10^{-6}
	Direct Disposal in Grout	0.57	1.1×10^{-6}	3.0×10^{-1}	1.1×10^{-1}	3.8×10^{-4}	1.6×10^{-1}	1.6×10^{-2}
<i>100-meter doses</i>								
Upper Three Runs Aquifer	Small Tank Precipitation	6.8×10^{-3}	1.2×10^{-8}	3.6×10^{-3}	1.4×10^{-3}	3.8×10^{-6}	1.9×10^{-3}	1.8×10^{-8}
	Ion Exchange	7.3×10^{-3}	1.3×10^{-8}	3.8×10^{-3}	1.5×10^{-3}	4.2×10^{-6}	2.1×10^{-3}	2.0×10^{-8}
	Solvent Extraction	6.2×10^{-3}	1.1×10^{-8}	3.3×10^{-3}	1.2×10^{-3}	3.5×10^{-6}	1.8×10^{-3}	1.7×10^{-8}
	Direct Disposal in Grout	7.9×10^{-3}	1.4×10^{-8}	4.2×10^{-3}	1.6×10^{-3}	4.5×10^{-6}	2.2×10^{-3}	2.2×10^{-4}
Gordon Aquifer	Small Tank Precipitation	4.2×10^{-2}	7.4×10^{-8}	2.2×10^{-2}	8.4×10^{-3}	2.5×10^{-5}	1.2×10^{-2}	1.1×10^{-7}
	Ion Exchange	4.4×10^{-2}	8.0×10^{-9}	2.3×10^{-2}	8.9×10^{-3}	2.7×10^{-5}	1.3×10^{-2}	1.2×10^{-7}
	Solvent Extraction	3.8×10^{-2}	6.8×10^{-8}	2.0×10^{-2}	7.6×10^{-3}	2.2×10^{-5}	1.1×10^{-2}	1.1×10^{-7}
	Direct Disposal in Grout	4.8×10^{-2}	8.7×10^{-8}	2.5×10^{-2}	9.7×10^{-3}	2.9×10^{-5}	1.4×10^{-2}	1.3×10^{-3}
<i>Seepiline doses</i>								
McQueen Branch	Small Tank Precipitation	1.9×10^{-3}	2.9×10^{-9}	1.0×10^{-3}	4.0×10^{-4}	7.4×10^{-7}	5.6×10^{-4}	5.1×10^{-9}
	Ion Exchange	2.0×10^{-3}	3.1×10^{-9}	1.0×10^{-3}	4.2×10^{-4}	7.9×10^{-7}	5.9×10^{-4}	5.4×10^{-9}
	Solvent Extraction	1.7×10^{-3}	2.7×10^{-9}	9.0×10^{-4}	3.6×10^{-4}	6.7×10^{-7}	5.0×10^{-4}	4.8×10^{-9}
	Direct Disposal in Grout	2.2×10^{-3}	3.4×10^{-9}	1.1×10^{-3}	4.5×10^{-4}	8.5×10^{-7}	6.4×10^{-4}	6.0×10^{-5}
Upper Three Runs	Small Tank Precipitation	2.9×10^{-3}	2.9×10^{-9}	1.4×10^{-3}	6.3×10^{-4}	5.1×10^{-7}	8.9×10^{-4}	7.8×10^{-9}
	Ion Exchange	1.8×10^{-3}	2.9×10^{-9}	1.4×10^{-3}	6.1×10^{-4}	5.0×10^{-7}	8.7×10^{-4}	7.7×10^{-9}
	Solvent Extraction	2.5×10^{-3}	2.6×10^{-9}	1.2×10^{-3}	5.5×10^{-4}	4.5×10^{-7}	7.8×10^{-4}	7.3×10^{-9}
	Direct Disposal in Grout	3.2×10^{-3}	3.2×10^{-9}	1.5×10^{-3}	6.8×10^{-4}	5.6×10^{-7}	9.7×10^{-4}	8.5×10^{-5}

Table D-4. Radiological doses from the agricultural and residential scenarios.

	Small Tank Precipitation	Ion Exchange	Solvent Extraction	Direct Disposal in Grout	
<i>Agricultural scenario at 1,000 years post-closure^a</i>					
Inhalation while outdoors (millirem per year)	0.010	0.012	0.0096	0.013	
Ingestion of vegetables (millirem per year)	42	49	39	52	
Incidental ingestion of soil (millirem per year)	0.7	0.81	0.66	0.88	
Inhalation while indoors (millirem per year)	0.26	0.3	0.24	0.32	
External radiation while outdoors (millirem per year)	0.33	0.39	0.31	0.41	
External radiation while indoors (millirem per year)	69	80	65	85	
Total (millirem per year)	110	130	110	140	L6-32
<i>Residential scenario at 100 years post-closure^b</i> (millirem per year)	0.11	0.13	0.10	1200 ^c	
<i>Residential scenario at 1,000 years post-closure^{a,b}</i> (millirem per year)	69	80	65	85	
<p>a. Residential scenario at 1,000 years post-closure is also included in the agricultural scenario.</p> <p>b. The external radiation dose and latent cancer fatalities 1,000 years post-closure are higher than that 100 years post-closure because soil cover that would provide adequate shielding would be present 100 years post-closure, but is assumed to have eroded away by 1,000 years post-closure.</p> <p>c. The external dose for the Direct Disposal in Grout alternative in the 100-year scenario is due primarily to cesium-137 (30 year half-life). For all other alternatives and scenarios, the external dose is due primarily to isotopes with long half-lives.</p>					

TC area of an entire vault and would result in a four-fold reduction in external dose relative to the dose from a fully uncovered vault. The differences in the ranges of external doses among alternatives are due to the different concentrations of radionuclides. For the Direct Disposal in Grout alternative's 100-year residential exposure scenario, the external dose is due primarily to cesium-137; for all other alternatives and scenarios, the external dose is due primarily to tin-126 and its decay products.

D.5 Discussion of Uncertainty

In this SEIS, DOE has made assumptions regarding the numerical parameters that affect the calculated impacts. Some uncertainty is associated with the values of these parameters, due to unavailable data and cur-

rent knowledge concerning closure processes and long-term behaviors of materials. The principal parameters that affect modeling results are the following:

- **Saltstone characteristics:** The volume of saltstone and constituent chemical and radionuclide concentrations determine the concentrations of release constituents at any given location. As discussed earlier, the concentrations of the saltstone constituents inventory are based primarily on data previously presented in the RPA and updated with information from more recent engineering flow sheets.
- **Hydraulic conductivity:** The rate of water movement through material is ultimately affected by the hydraulic conductivity of the geologic strata underneath the source. Gen-

erally, the grout or concrete basemat is the limiting layer with regard to water infiltration. Over time, cracks developing in the saltstone increase the hydraulic conductivity dramatically, making more water available to carry contaminants to the aquifer. This increase results in greater doses/concentrations, due to the increased transport of the contaminants.

- **Distribution coefficient:** The distribution coefficient (K_d) affects the rate at which contaminants move through the geologic strata. Large K_d values provide holdup time for short-lived radionuclides.

Vadose zone thickness: The thickness of the geologic strata between the contaminated region and the aquifer does not necessarily reduce the concentration as much as it slows movement of contaminants toward the aquifer. For shorter-lived radionuclides, extra time provided by thicker strata decreases the

activity of the contaminants reaching the aquifer.

- **Distance downgradient to receptor location:** The distance to a given receptor location affects (a) the time at which contaminants will arrive at the receptor location, and (b) the extent of dispersion that occurs. For greater distances, longer travel times will occur, resulting in lower activity values for short-lived radioactive constituents and greater dispersion for all constituents.

DOE recognizes that, over the period of analysis in this SEIS, there is also uncertainty in the structural behaviors of materials and the geologic and hydrogeologic setting of the SRS. DOE realizes that overly conservative assumptions can be used to bound the estimates of impacts; however, this approach could result in masking differences of impacts among alternatives. Therefore, DOE has used assumptions in its modeling analysis that are reasonable, based on current knowledge, to develop meaningful comparisons among alternatives considered.

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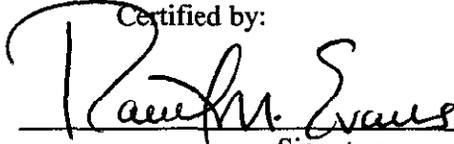
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NEPA DISCLOSURE STATEMENT
FOR
PREPARATION OF THE SAVANNAH RIVER SITE HIGH LEVEL WASTE SALT
PROCESSING ALTERNATIVES SUPPLEMENTAL ENVIRONMENTAL IMPACT
STATEMENT

CEQ Regulations at 40 CFR 1506.5c, which have been adopted by the U. S. Department of Energy (DOE) (10 CFR 1021), require contractors who will prepare an EIS to execute a disclosure statement specifying that they have no financial or other interest in the outcome of the project. The term "financial interest or other interest in the outcome of the project" for purposes of this disclosure is defined in the March 23, 1981, guidance "Forty Most Asked Questions Concerning CEQ's National Environmental Policy Act Regulations," 46 FR 18026-18038 at Question 17(a) and (b).

"Financial or other interest in the outcome of the project" includes "any financial benefit such as a promise of future construction or design work in the project, as well as indirect benefits the contractor is aware of (e.g., if the project would aid proposals sponsored by the firm's other clients)." See 46 FR 18026-18031.

In accordance with these requirements, I hereby certify (or as a representative of my organization, I hereby certify) that, to the best of my knowledge and belief, no facts exist relevant to any past, present or currently planned interests or activities (financial, contractual, organizational or otherwise) which relate to the proposed work and bear on whether I have (or the organization has) a possible conflict of interest with respect to (1) being able to render impartial, technically sound, and objective assistance or advise, or (2) being given an unfair or competitive advantage.

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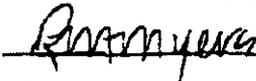
ORGANIZATIONAL CONFLICT OF INTEREST DISCLOSURE STATEMENT
FOR
PREPARATION OF THE SAVANNAH RIVER SITE HIGH LEVEL WASTE SALT
PROCESSING ALTERNATIVES SUPPLEMENTAL ENVIRONMENTAL IMPACT
STATEMENT

No actual or potential conflict of interest or unfair competitive advantage exists with respect to other advisory and assistance services being provided by Zapata Engineering relative to the Salt Disposition Alternatives Supplemental Environmental Impact Project under Subcontract No. GCRB-99-77613-034 between Tetra Tech NUS, Inc. and Zapata Engineering.

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ORGANIZATIONAL CONFLICT OF INTEREST DISCLOSURE STATEMENT
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PREPARATION OF THE SAVANNAH RIVER SITE HIGH LEVEL WASTE SALT
PROCESSING ALTERNATIVES SUPPLEMENTAL ENVIRONMENTAL IMPACT
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No actual or potential conflict of interest or unfair competitive advantage exists with respect to the advisory and assistance services provided by Jason Associates Corporation relative to the Salt Disposition Alternatives Supplemental Environmental Impact Project under Master Agreement No. GCMF-97-77613-002/Task Order Nos. DE-AT09-99SR22042, DE-AT09-99SR22043, and DE-AT09-99SR22043-02 between Tetra Tech NUS, Inc. and Jason Associates Corporation.

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DISTRIBUTION LIST

DOE provided copies of the *Savannah River Site Salt Processing Alternatives Supplemental Environmental Impact Statement* (SEIS) to Federal, state, and local elected and appointed officials and agencies of government; Native American groups; Federal, state, and local environmental and public interest groups; and other organizations and individuals listed below. Copies will be provided to other interested parties upon request as identified in the cover sheet of this SEIS.

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GLOSSARY

Terms in this glossary are defined in accord with customary usage, as presented in the Glossary of Terms used in DOE NEPA Documents, followed as needed by specific usage in the context of this SEIS.

accident

An unplanned sequence of events that results in undesirable consequences.

acid solution

A liquid in which an acid compound is mixed with water. As used in this SEIS, it is an aqueous solution containing a low concentration of nitric acid, used to remove or recover salt constituents from organic phase in the solvent extraction process.

actinide

Any member of the group of elements with atomic numbers from 89 (actinium) to 103 (lawrencium), including uranium and plutonium. All members of this group are radioactive.

adsorption

The adhesion of a substance to the surface of a solid or solid particle.

alternative

A major choice or strategy to address the SEIS "Purpose and Need" statement, as opposed to the engineering options available to achieve the goal of an alternative.

antimony

Metallic element belonging to the nitrogen family (Group Va of the periodic table). The symbol for antimony is Sb; Sb-125 is the principal radioactive isotope of this element present in the HLW tanks at SRS.

applicable or relevant and appropriate requirements (ARARs)

Requirements, including cleanup standards, standards of control, and other substantive environmental protection requirements and criteria for hazardous substances, as specified under Federal and state law and regulations, that must be met when complying with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA).

aqueous phase

Water-based solution of soluble chemical species, generally inorganic salts.

aquifer

A body of rock or sediment that is capable of transmitting groundwater and yielding usable quantities of water to wells or springs.

as low as reasonably achievable (ALARA)

A process by which a graded approach is applied to maintaining dose levels to workers and the public, and releases of radioactive materials to the environment at a rate that is as far below applicable limits as is reasonably achievable.

atomic number

The number of positively charged protons in the nucleus of an atom and the number of electrons on an electrically neutral atom.

average throughput

Volume of salt solution processed per year as restricted by limitations external to a given facility.

back extraction

Transfer of extracted constituent in organic phase to secondary aqueous phase in solvent extraction process. As used in this SEIS, this process serves to recover separated radioactive cesium for delivery to DWPF.

backfill

Material, such as soil or sand, used in refilling an excavation.

background radiation

Radiation from cosmic sources, naturally occurring radioactive materials, including radon (except as a decay product of source or special nuclear material), and global fallout as it exists in the environment from the testing of nuclear explosive devices.

batch process

Process with operations performed on fixed volumes of material requiring specific time period(s) for completion.

benzene

Toxic, flammable organic liquid containing six carbon and six hydrogen atoms (C_6H_6); major decomposition product of tetraphenylborate.

beyond design basis accident (BDBA)

An accident with an annual frequency of occurrence between 1 in 1,000,000 and 1 in 10,000,000 (1.0×10^{-6} and 1.0×10^{-7}).

biodiversity

Pertains to the variety of life (e.g., plants, animals, and other organisms) that inhabits a particular area or region.

biphenyl

Organic solid consisting of two phenyl groups ($C_{12}H_{10}$); minor decomposition product of tetraphenylborate.

blackwater stream

Water in coastal plains, creeks, swamps, and/or rivers that has been imparted a dark or black coloration due to dissolution of naturally occurring organic matter from soils and decaying vegetation.

borosilicate

A form of glass containing silica sand, boric oxide, and soda ash.

borosilicate glass

Refractory glass waste form with high capacity for immobilization of HLW components; representative composition 10 weight percent B₂O₃, 45 weight percent SiO₂, 10 weight percent Na₂O, 35 weight percent waste oxides.

borrow material

Material, such as soil or sand, that is removed from one location and used as fill material in another location.

bounding accident

A hypothetical accident, the calculated consequences of which equal or exceed the consequences of all other potential accidents for a particular activity or facility.

cancer

The name given to a group of diseases characterized by uncontrolled cellular growth.

canister

A container (generally stainless steel) into which immobilized radioactive waste is placed and sealed.

capable fault

In part, a capable fault is one that may have had movement at or near the ground surface at least once within the past 35,000 years, or has had recurring movement within the past 500,000 years. Further definition can be found in 10 CFR 100, Appendix A.

capacity throughput

Maximum volume of salt solution that a facility is designed to process per year.

carbon

Nonmetallic chemical element in Group IVa of the periodic table. The symbol for carbon is C; C-14 is the principal radioactive isotope of this element present in the HLW tanks at SRS.

carcinogen

A radionuclide or nonradiological chemical that has been proven or is suspected to be either a promoter or initiator of cancer in humans or animals.

catalyst

A substance, usually used in small amounts relative to the reactants, that modifies and increases the rate of a chemical reaction without being consumed or produced by the reaction.

catalytic decomposition

A chemical reaction in which a compound is broken down into simpler compounds or elements in the presence of a catalyst.

caustic solution

Alkaline solution containing sodium hydroxide or other light metal hydroxides. SRS HLW solutions are caustic solutions. As used in this SEIS, an aqueous solution containing 3-5 molar concentrations of sodium hydroxide used to convert insoluble aluminum hydroxide in HLW sludge to soluble aluminate form.

cement

A building material made by grinding calcined limestone and clay (silica, lime, and other mineral oxides) to a fine powder, which can be mixed with water and poured to set as a solid mass or used as an ingredient in making mortar or concrete. As used in this SEIS, an ingredient of saltstone.

centrifugal contactor

A device used in the Solvent Extraction salt processing alternative to separate cesium from HLW salt solution. Aqueous waste enters the contactor and is mixed with an organic solvent, which extracts the cesium. The two liquids are then separated by centrifugal force in a rapidly rotating inner chamber of the device.

cesium

Chemical element of Group Ia of the periodic table, the alkali metal group, of which sodium and potassium are also members. The symbol for cesium is Cs; Cs-137, Cs-135, and Cs-134 are the principal radioactive isotopes of this element present in the HLW tanks at SRS.

characterization

The determination of waste composition and properties (by review of process knowledge, nondestructive examination or assay, or sampling and analysis), generally done for the purpose of determining appropriate storage, treatment, handling, transport, and disposal requirements.

chronic exposure

A continuous or intermittent exposure of an organism to a stressor (e.g., a toxic substance or ionizing radiation) over an extended period of time or significant fraction (often 10 percent or more) of the life span of the organism. Generally, chronic exposure is considered to produce only effects that can be observed some time following initial exposure. These may include impaired reproduction or growth, genetic effects, and other effects such as cancer, precancerous lesions, benign tumors, cataracts, skin changes, and congenital defects.

clarification

As used in this SEIS, a process in which small residual volumes of insoluble solids (sludge) are removed from soluble salt solution.

Class A, B, & C low-level waste limits

Waste classification system in 10 CFR 61.55 that prescribes requirements for disposal of low-level radioactive wastes in accordance with the concentrations of radioactive constituents in the wastes.

Code of Federal Regulations (CFR)

A document containing the regulations of Federal executive departments and agencies.

collective effective dose equivalent

The sum of the individual effective dose equivalents received in a given period of time by a specified population from exposure to a specified source of radiation. The units for this are person-rem or person-sievert.

committed dose equivalent

The committed dose in a particular organ or tissue accumulated in a specified period (e.g., 50 years) after intake of a radionuclide.

committed effective dose equivalent

The dose value obtained by (1) multiplying the committed dose equivalents for the organs or tissues that are irradiated and the weighting factors applicable to those organs or tissues, and (2) summing all the resulting products. Committed effective dose equivalent is expressed in units of rem.

conceptual design

The conceptual design phase includes the fundamental decisions that are made regarding the desired chemistry or processing operations to be used, the sequencing of unit operations, the relationship of the process with other operations, and whether batch or continuous processing will be employed.

Often, these decisions must be made preliminary to the collection of any engineering data regarding actual process yields, generation of reaction by-products, or the efficacy of any needed separation steps. The conceptual design phase is also used to determine the economic feasibility of a process.

condensate

Liquid that results from condensing a gas by cooling below its saturation temperature.

condenser-decanter

As used in this SEIS, a process vessel used to separate benzene distilled from a mixture produced by decomposition of tetraphenylborate precipitate. Benzene and water vapors are cooled to immiscible liquids in the condenser and separated by withdrawal of lighter benzene from the top of the decanter.

confining (unit)

A rock layer (or stratum) having very low hydraulic conductivity (or permeability) that restricts the movement of groundwater either into or out of adjacent aquifers.

contaminant

Any gaseous, chemical, or organic material that contaminates (pollutes) air, soil, or water. This term also refers to any hazardous substance that does not occur naturally or that occurs at levels greater than those naturally occurring in the surrounding environment (background).

contamination

As used in this SEIS, the deposition of unwanted radioactive material on the surfaces of structures, areas, objects, or personnel.

continuous process

As used in this SEIS, process conducted in a flowing system to promote mixing, rapid reaction, and separation of radioactive constituents within limited times needed to minimize competitive side reactions (decomposition).

countercurrent extraction

A liquid-liquid extraction process in which the organic and the aqueous process streams in contact flow in opposite directions, progressively concentrating the extracted constituent in one phase while depleting the constituent in the other phase.

crane maintenance area

Shielded space in a process facility that is provided for inspection and repair of overhead crane mechanisms.

criticality

The condition in which a system (including materials such as plutonium) is capable of sustaining a nuclear chain reaction.

crossflow filtration

As used in this SEIS, a process for concentrating precipitate slurry by passing it through a porous metal pipe under pressure to force solution into surrounding pipe.

crystalline

Being, relating to, or composed of crystals.

crystalline silicotitanate

Insoluble granular inorganic solid ($\text{Na}_4\text{SiO}_4 \cdot \text{TiO}_2$) ion exchange material. As used in this SEIS, a specially developed material to provide capability for removal of cesium from acid or alkaline solutions containing high sodium and potassium concentrations.

curie (Ci)

The basic unit used to describe the intensity of radioactivity in a sample of material. A curie is equal to 37 billion disintegrations per second, which is approximately the rate of decay of 1 gram of radium. A curie is also a quantity of any radionuclide that decays at a rate of 37 billion disintegrations per second. A unit of radioactivity equal to 37 billion disintegrations per second (i.e., 37 billion becquerels); also a quantity of any radionuclide or mixture of radionuclides having 1 curie of radioactivity.

decommissioning

The process of removing a facility from operation, followed by decontamination, entombment, dismantlement, or conversion to another use.

decomposition

The process by which a compound is broken down into simpler compounds or elements by chemical or physical reactions.

decontamination

The actions taken to reduce or remove substances that pose a substantial present or potential hazard to human health or the environment, such as radioactive contamination on or in facilities, soil, or equipment. Decontamination processes include washing, chemical action, mechanical cleaning, or other techniques.

decontamination factor

Ratio of initial specific radioactivity to final specific radioactivity resulting from a separations process.

dedicated area

Space in a facility set aside and equipped for a specific function, such as tool and equipment decontamination.

Defense Waste Processing Facility (DWPF) melter

Large ceramic vessel used to incorporate HLW components into molten glass; internally (Joule) heated by electric current flow within the glass melt.

design basis accident (DBA)

An accident postulated for the purpose of establishing functional and performance requirements for safety structures, systems, and components.

design-basis earthquake

The maximum-intensity earthquake that might occur along the fault nearest to a structure. Structures are built to withstand a design-basis earthquake.

diluent

A substance used to dilute. As used in this SEIS, the principal component of organic phase employed to separate constituents from aqueous phase in a solvent extraction process.

diversion boxes

Specialized containment spaces using removable pipe segments (jumpers) to direct the transfer of process streams; usually underground, constructed of reinforced concrete, and sealed with waterproofing compounds or lined with stainless steel.

DOE Orders

Requirements internal to the U.S. Department of Energy (DOE) that establish DOE policy and procedures, including those for compliance with applicable laws.

dosage

The concentration-time profile for exposure to toxicological hazards.

dose (or radiation dose)

A generic term that means absorbed dose, dose equivalent, effective dose equivalent, committed dose equivalent, committed effective dose equivalent, or total effective dose equivalent, as defined elsewhere in this glossary.

dose equivalent

A measure of radiological dose that correlates with biological effect on a common scale for all types of ionizing radiation. Defined as a quantity equal to the absorbed dose in tissue multiplied by a quality factor (the biological effectiveness of a given type of radiation) and all other necessary modifying factors at the location of interest. The unit of dose equivalent is the rem.

drinking water standards

Prescribed limits on chemical, biological, and radionuclide concentrations in groundwater sources of drinking water, expressed as maximum contaminant levels (MCLs).

effective dose equivalent (EDE)

The dose value obtained by multiplying the dose equivalents received by specified tissues or organs by the appropriate weighting factors applicable to the tissues or organs irradiated, and then summing all of the resulting products. It includes the dose from radiation sources internal and external to the body. The effective dose equivalent is expressed in units of rem.

effluent

A waste stream flowing into the atmosphere, surface water, groundwater, or soil. Most frequently, the term applies to wastes discharged to surface waters.

effluent monitoring

Sampling or measuring specific liquid or gaseous effluent streams for the presence of pollutants.

elevation

Vertical cross-section of a facility, showing height requirements for operating areas and process facilities.

elutable ion exchange

Process in which a chemical species is separated from solution by replacement of a constituent of a solid (resin), then removed from the resin by replacement (elution) with another chemical species in solution.

endemic

Native to a particular area or region.

environmental restoration

Cleanup and restoration of sites and decontamination and decommissioning of facilities contaminated with radioactive and/or hazardous substances during past production, accidental releases, or disposal activities.

environmental restoration program

A DOE subprogram concerned with all aspects of assessment and cleanup of both contaminated facilities in use and of sites that are no longer a part of active operations. Remedial actions, most often concerned with contaminated soil and groundwater, and decontamination and decommissioning are responsibilities of this program.

evaporator

A facility that mechanically reduces the water contents in tank waste to concentrate the waste and reduce storage space needs.

exposure pathways

The course a chemical or physical agent takes from the source to the exposed organism. An exposure pathway describes a mechanism by which an individual or population is exposed to chemicals or physical agents at or originating from a release site. Each exposure pathway includes a source or release from a source, an exposure point, and an exposure route. If the exposure point differs from the source, a transport/exposure medium, such as air or water, is also included.

external accident (or initiator)

An accident that is initiated by manmade energy sources not associated with operation of a given facility. Examples include airplane crashes, induced fires, transportation accidents adjacent to a facility, and so forth.

extractant

As used in this SEIS, a component of the solvent used in the solvent extraction process to facilitate the removal of radioactive cesium from HLW salt solution.

facility flowrate

Volume of salt solution processed per unit time under normal operating conditions, as required to meet design performance objectives.

final design

In the final design phase, the emphasis shifts almost completely from the qualitative aspects of the process to the quantitative. Major process vessels are sized, and initial valve counts are often completed. By the end of this phase, a preliminary piping and instrumentation diagram (P&ID) will typically be complete, and broad considerations of facility site design will have been concluded. Opportunities for major process changes are few at this stage, but preliminary cost estimates (on the order of +/- 30%) and economic analyses can be produced.

fission

A nuclear transformation that is typically characterized by the splitting of a heavy nucleus into at least two other nuclei, the emission of one or more neutrons, and the release of a relatively large amount of energy. Fission of heavy nuclei can occur spontaneously or be induced by neutron bombardment.

fission products

Nuclides (fission fragments) formed by the fission of heavy elements, plus the nuclides formed by radioactive decay of the fission fragments.

floodplain

The level area adjoining a river or stream that is sometimes covered by flood water.

flyash

Fine particulate material produced by the combustion of a solid fuel, such as coal, and discharged as an airborne emission or recovered as a byproduct for various commercial uses. As used in this SEIS, an ingredient in saltstone to limit water infiltration by decreasing porosity.

frames

Structural components holding assemblies of centrifugal contactors for installation into a remotely operated shielded process cell.

fresh resin

Condition of an ion exchange solid (resin) before loading with chemical species to be separated from solution.

geologic repository

A deep (on the order of 600 meters [1,928 feet] or more) underground mined array of tunnels used for permanent disposal of radioactive waste.

groundwater

Water occurring beneath the earth's surface in the interstices between soil grains, in fractures, and in porous formations.

grout

A fluid mixture of cement, flyash, slag, and salt solution that hardens into solid form (saltstone).

grout curing

Process for bringing freshly placed grout to required strength and quality by maintaining humidity and temperature at specified levels for a given period of time.

habitat

The sum of environmental conditions in a specific place occupied by animals, plants, and other organisms.

half-life

The time in which half the atoms of a particular radioactive substance disintegrate to another nuclear form. Measured half-lives vary from millionths of a second to billions of years. Also called physical half-life.

hazard index

The sum of several hazard quotients for multiple chemicals and/or multiple exposure pathways. A hazard index of greater than 1.0 is indicative of potential adverse health effects. Health effects could be minor temporary effects or fatal, depending on the chemical and amount of exposure.

hazard quotient

The ratio of an exposure level to a substance to a toxicity reference value selected for risk assessment purposes.

hazardous chemical

A term defined under the Occupational Safety and Health Act and the Emergency Planning and Community Right-to-Know Act as any chemical that is a physical hazard or a health hazard.

hazardous material

A substance or material, including a hazardous substance, which has been determined by the U.S. Secretary of Transportation to be capable of posing an unreasonable risk to health, safety, and property when transported in commerce.

hazardous substance

Any substance that, when released to the environment in an uncontrolled or unpermitted fashion, becomes subject to the reporting and possible response provisions of the Clean Water Act and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).

hazardous waste

A category of waste regulated under the Resource Conservation and Recovery Act (RCRA). To be considered hazardous, a waste must be a solid waste under RCRA and must exhibit at least one of four characteristics described in 40 CFR 261.20 through 40 CFR 261.24 (i.e., ignitability, corrosivity, reactivity, or toxicity) or be specifically listed by the Environmental Protection Agency in 40 CFR 261.31 through 40 CFR 261.33. Source, special nuclear material, and by-product material, as defined by the Atomic Energy Act, are specifically excluded from the definition of solid waste.

heavy metals

Metallic elements with high atomic weights (for example, mercury, chromium, cadmium, arsenic, and lead) that can damage living things at low concentrations and tend to accumulate in the food chain.

HEPA filter (High Efficiency Particulate Air filter)

Gas filter with fibrous medium that produces a particle removal efficiency greater than 99.97 percent.

high-level waste or high-level radioactive waste (HLW)

Defined by statute (the Nuclear Waste Policy Act) to mean the highly radioactive waste material resulting from the reprocessing of spent nuclear fuel, including liquid waste produced directly in reprocessing and any solid material derived from such liquid waste that contains fission products nuclides in sufficient concentrations; and other highly radioactive material that the U.S. Nuclear Regulatory Commission (NRC), consistent with existing law, determines by rule requires permanent isolation. The NRC has not defined "sufficient concentrations" of fission products or identified "other highly radioactive material that requires permanent isolation." The NRC defines HLW to mean irradiated (spent) reactor fuel, as well as liquid waste resulting from the operation of the first cycle solvent extraction system, the concentrated wastes from subsequent extraction cycles in a facility for reprocessing irradiated reactor fuel, and solids into which such liquid wastes have been converted. In this SEIS, "high-level waste" is stored in the F- and H-Area Tank Farms.

HLW components

The HLW from the SRS chemical separations process consists of water soluble salts and insoluble sludges. The sludges settle to the bottom of the HLW tanks. The salt solutions are concentrated by evaporation to reduce their volume, forming a solid saltcake and a concentrated supernatant salt solution in the tanks.

hydrology

The study of water, including groundwater, surface water, and rainfall.

hydrolysis

Decomposition of chemical substance by water. As used in this SEIS, the process by which tetraphenylborate precipitate is catalytically decomposed to benzene and a soluble salt solution of waste constituents that is fed to the DWPF melter.

immobilization

A process (e.g., grouting or vitrification) used to stabilize waste. Stabilizing the waste inhibits the release of waste to the environment.

in situ

A Latin term meaning "in place".

inadvertent intrusion

The inadvertent disturbance of a disposal facility or its immediate environment by a potential future occupant that could result in loss of containment of the waste or exposure of personnel. Inadvertent intrusion is a significant consideration that shall be included either in the design requirements or waste acceptance criteria of a waste disposal facility.

incineration

Controlled burning of solid or liquid wastes to oxidize the combustible constituents and, especially for liquid wastes, to vaporize water so as to reduce waste volume; in this SEIS, the process used to destroy benzene generated from decomposition of tetraphenylborate precipitate in DWPF.

inhibited water

Water to which sodium hydroxide has been added to inhibit corrosion.

institutional control

The control of waste disposal sites or other contaminated sites by human institutions in order to prevent or limit exposures to hazardous materials. Institutional control may be accomplished by (1) active control measures, such as employing security guards and maintaining security fences to restrict site access, and (2) passive control measures, such as using physical markers, deed restrictions, government regulations, and public records and archives to preserve knowledge of the site and prevent inappropriate uses.

In-Tank Precipitation (ITP)

Previously selected process for separation of radioactive cesium and other radioactive constituents from HLW salt solutions by tetraphenylborate precipitation and associated sorption processes, to be replaced by another salt processing alternative that avoids excessive benzene generation.

internal accidents

Accidents that are initiated by man-made energy sources associated with the operation of a given facility. Examples include process explosions, fires, spills, and criticalities.

involved workers

Workers who would be involved in a proposed action (as opposed to workers who would be on the site of a proposed action, but not involved in the action).

iodine

Chemical element of Group VIIa of the periodic table, the halogen group, of which chlorine is a member. The symbol for iodine is I; I-129 is the principal radioactive isotope of this element present in the HLW tanks at SRS.

ion exchange, ion exchange medium (resin)

The process by which salts present as charged ions in water are attached to active groups on and in an ion exchange resin and other ions are discharged into water allowing separation of the two types of ions. Ion exchange resins can be formulated to remove specific chemicals and radionuclides from the salt solutions in the HLW tanks.

isotope

One of two or more atoms with the same number of protons, but different numbers of neutrons, in their nuclei. Thus, carbon-12, carbon-13, and carbon-14 are isotopes of the element carbon; the numbers denote the approximate atomic weights. Isotopes have very nearly the same chemical properties, but often have different physical properties (for example, carbon-12 and -13 are stable, while carbon-14 is radioactive).

jumpers

As used in this SEIS, removable pipe segments used to direct the flow of process streams in transfer operations.

Late Wash Facility

Assemblage of currently inoperative tanks originally intended for washing soluble corrosion inhibitors from tetraphenylborate precipitate stream from ITP to DWPF. Proposed location of Pilot Plant for selected salt processing alternative.

latent cancer fatality

Death from cancer resulting from, and occurring some time after, exposure to ionizing radiation or other carcinogens.

layout plan

Floor plan of facility showing operating areas and typical process equipment.

lifting lug

Projection on a metal part that serves as handle, support, or fitting connection for attachment of a lifting device.

low-level mixed waste (LLMW)

Waste that contains both hazardous waste under RCRA and source, special nuclear, or by-product material subject to the Atomic Energy Act of 1954 (42 USC 2011, et seq.).

low-level waste (LLW)

Radioactive waste that contains typically small amounts of radioactivity and is not classified as, HLW transuranic waste, spent nuclear fuel or by-product tailings from processing uranium or thorium ore.

low point drain tank

Intermediate transfer facility for delivery of high-activity salt solution from a tank farm to the Grout Facility in the Direct Disposal in Grout alternative, and transfer of washed MST and sludge solids from the Grout Facility to DWPF.

macroinvertebrate

Small animal, such as a larval aquatic insect, that is visible to the naked eye and has no vertebral column.

manipulator

Mechanical device for handling operations inside a radiation-shielded area, controlled manually by hand operations outside the shielded area.

maximally exposed individual (MEI)

A hypothetical individual whose location and habits result in the highest total radiological or chemical exposure (and thus dose) from a particular source for all exposure routes (e.g., inhalation, ingestion, direct exposure).

millirad

One thousandth of a rad (sec rad).

millirem

One thousandth of a rem (see rem).

mixed waste

Waste that contains both hazardous material wastes under RCRA and radioactive source, special nuclear, or by-product material subject to the Atomic Energy Act of 1954.

modifier

Component of organic phase added to solvent to enhance separation of a specified constituent in the solvent extraction process.

modular confinement

Containment system consisting of movable, replaceable structural units.

modular shielding

Shielding components assembled from movable, replaceable units.

modular structure

Building constructed of pre-assembled or pre-sized units of a standard design.

module

Self-contained unit that serves as a building block for a structure.

monosodium titanate (MST)

Water-insoluble inorganic substance (NaTiO_3H) used to remove residual actinides (uranium, plutonium) and fission product strontium by sorption from waste salt solutions.

nanocurie

One billionth of a curie (see curie).

natural grade

Elevation of a finished surface for an engineering project; ground level.

natural phenomena accidents

Accidents that are initiated by phenomena such as earthquakes, tornadoes, floods, and so forth.

nitrate

Any member of a class of compounds derived from nitric acid. The nitrates are ionic compounds containing the negative nitrate ion, NO_3^- , and a positive ion, such as sodium (Na) in sodium nitrate (NaNO_3). Sodium nitrate is a major constituent of the salt component in the HLW tanks.

nitrite

Any member of a class of compounds derived from nitrous acid. Salts of nitrous acid are ionic compounds containing the negative nitrite ion, NO_2^- , and a positive ion such as sodium (Na) in sodium nitrite (NaNO_2).

nonelutable ion exchange

Process in which a chemical species is separated from solution by replacement of a constituent of a solid (resin), but is not removed (eluted) from the solid before final disposition.

noninvolved workers

Workers in a fixed population outside the day-to-day process safety management controls of a given facility area. In practice, this fixed population is normally the workers at an independent facility area located a specific distance (often 100 meters) from the reference facility area.

nuclear criticality

A self-sustaining nuclear chain reaction.

nuclide

A general term referring to any one of all known isotopes, both stable (279) and unstable (about 5,000), of the chemical elements.

offsite

Away from the SRS site.

offsite population

For facility accident analyses, the collective sum of individuals located within a 50-mile (80-kilometer) radius of a facility and within the path of the plume with the wind blowing in the most populous direction.

onsite

On the SRS property.

Organic Evaporator

As used in this SEIS, a process vessel provided to decontaminate benzene recovered from the decomposition of tetraphenylborate precipitate. Benzene is washed with water and separated by distillation.

oxalic acid

A water-soluble organic acid, $H_2C_2O_4$, being considered as a cleaning agent to use in spray washing of tanks, because it dissolves sludge and is only moderately aggressive against carbon steel, the material used in construction of the waste tanks.

particulate

Pertains to minute, separate particles. An example of dry particulate is dust.

performance modeling

A systematic mathematical analysis to estimate potential human exposures to hazardous and radioactive substances. It may include specification of potential releases, exposure pathways, effects of facility degradation, transport in the environment, uptake by the affected recipient, and comparison of estimated exposures to regulatory limits or other established performance.

performance objectives

Parameters within which a facility must perform to be considered acceptable.

permanent disposal

For HLW, the term means emplacement in a repository for HLW, spent nuclear fuel, or other highly radioactive material with no foreseeable intent of recovery, whether or not such emplacement permits the recovery of such waste.

permeability

The degree of ease with which water can pass through rock or soil.

person-rem

A unit of collective radiation dose applied to populations or groups of individuals; that is, a unit for expressing the dose when summed across all persons in a specified population or group.

pH

A measure of the relative acidity or alkalinity of a solution. A neutral solution has a pH of 7, acids have a pH of less than 7, and bases have a pH of greater than 7.

picocurie

One trillionth of a curie (see curie).

plutonium

Chemical element of the actinide series in Group IIIb of the periodic table. All isotopes of plutonium are radioactive. The symbol for plutonium is Pu.

population

For risk assessment purposes, population consists of the total potential members of the public or workforce who could be exposed to a possible radiation or chemical dose from an exposure to radionuclides or carcinogenic chemicals.

population dose

The overall dose to population, consisting of the sum of the doses received by individuals in the population.

Precipitate Hydrolysis

As used in this SEIS, a chemical process in which tetraphenylborate precipitate is catalytically decomposed to benzene and a soluble salt solution of waste constituents to be fed to the DWPF water.

Precipitate Hydrolysis Aqueous

As used in this SEIS, the soluble salt solution generated by the precipitate hydrolysis process to be fed to the DWPF melter.

Precipitate Hydrolysis Cell

As used in this SEIS, a shielded enclosure in the Small Tank Precipitation facility that is equipped for tetraphenylborate precipitate decomposition operations.

Precipitate Reactor

As used in this SEIS, a process vessel provided for decomposition of tetraphenylborate precipitate by the precipitate hydrolysis process to eliminate benzene.

precipitate washing

Process in which precipitate solids are washed to remove water-soluble salts and excess sodium tetraphenylborate.

precipitation (chemical)

The formation of an insoluble solid by chemical or physical reaction of constituent in solution.

preconceptual design

The preconceptual design phase includes the early articulation of process objectives, selection of process steps, and determination of constraints.

pump pits

As used in this SEIS, intermediate stations in the waste transfer system equipped with tanks and pumps to maintain the flow of process streams, constructed of reinforced concrete with stainless steel liners for containment of radioactive solutions.

purge system

A method for replacing atmosphere in a containment vessel by an inert gas to prevent the formation of a flammable or explosive mixture.

rad

The special unit of absorbed dose. One rad is equal to an absorbed dose of 100 ergs/gram.

radiation (ionizing radiation)

Alpha particles, beta particles, gamma rays, x-rays, neutrons, high-speed electrons, high-speed protons, and other particles capable of producing ions. Radiation, as it is used here, does not include nonionizing radiation such as radio- or microwaves or visible, infrared, or ultraviolet light.

radiation worker

A worker who is occupationally exposed to ionizing radiation and receives specialized training and radiation monitoring devices to work in such circumstances.

radioactive

Describing a property of some elements having isotopes that spontaneously transform into one or more different nuclides, giving off energy in the process.

radioactive waste

Waste that is managed for its radioactive content.

radioactivity

The property of unstable nuclei in certain atoms of spontaneously emitting ionizing radiation in the form of subatomic particles or electromagnetic energy during nuclear transformations.. The unit of radioactivity is the curie (or becquerel).

radionuclide/isotope

A radionuclide is an unstable isotope that undergoes spontaneous transformation, emitting radiation. An isotope is any of two or more variations of an element in which the nuclei have the same number of protons (i.e., the same atomic number), but different numbers of neutrons so that their atomic masses differ. Isotopes of a single element possess almost identical chemical properties, but often different physical properties.

radiolytic decomposition

A physical process in which a compound is broken down into simpler compounds or elements from the absorption of sufficient radiation energy to break the molecular bonds.

raffinate

Decontaminated salt solution produced by removal of radionuclides from HLW solution, using the solvent extraction process.

reagent

A substance used in a chemical reaction to detect, measure, examine, or produce other substances.

Record of Decision (ROD)

A concise public document that records a Federal agency's decision(s) concerning a proposed action.

reconstituted salt solution

Waste salt solution obtained by dissolving saltcake in water and combining with supernatant salt solution in HLW tanks.

reducing grout

A grout formulated to behave as a chemical reducing agent. A chemical reducing agent is a substance that reduces other substances (i.e., decreases their positive charge or valence) by supplying electrons. The purpose of a reducing grout is to provide long-term chemical durability against leaching of the residual waste by water. Reducing grout could be composed primarily of cement, blast furnace slag, masonry sand, and silica fume.

reinforced concrete

Concrete containing steel bars to increase structural integrity.

rem

A unit of radiation dose that reflects the ability of different types of radiation to damage human tissues and the susceptibility of different tissues to the damage. Rems are a measure of effective dose equivalent. The dose equivalent in rem equals the absorbed dose in rads multiplied by factors that express the biological effectiveness of the radiation producing it.

remote equipment laydown area

Shielded space provided in processing facility for temporary placement and storage of equipment used in facility operation.

risk

Quantitative expression of possible loss that considers both the probability that a hazard causes harm and the consequences of that event.

ruthenium

Chemical element, one of the platinum metals of Group VIII of the periodic table. The symbol for ruthenium is Ru; Ru-106 is the principal radioactive isotope of this element present in the HLW tanks at SRS.

Safety Analysis Report (SAR)

A report, prepared in accordance with DOE Orders 5481.1B and 5480.23, that summarizes the hazards associated with the operation of a particular facility and defines minimum safety requirements.

salt

As used in this SEIS, salt is the soluble component of the radioactive wastes in the HLW tanks. The salt component consists of saltcake and salt supernate containing principally sodium nitrate with radionuclides mainly isotopes of cesium and technetium.

saltcake

Solid crystalline phase of salt component in HLW tanks remaining after the dewatering of salt solution by evaporation.

salt supernatant

Concentrated solution of salt components in HLW tanks after dewatering of primary salt solution by evaporation.

saltstone

Cementitious solid waste form employing blend of cement, flyash, and slag to immobilize low-radioactivity salt solutions for onsite disposal.

saltstone vaults

Near-surface concrete containment structures that are used for disposal of low-level radioactive waste in the form of saltstone. The vaults serve as forms for poured saltstone.

saturated resin

Condition of an ion exchange solid (resin) used to separate a chemical species from solution when no additional quantity of the chemical species can be loaded onto the solid.

scrub

Process stage in a solvent extraction procedure for removing secondary salt constituents from organic phase before recovery of principal constituent.

secondary containment system

Supplementary means for containment of gases or liquids that leak or escape from primary waste process or storage vessels.

seep line

An area where subsurface water or groundwater emerges from the earth and slowly flows over land.

segregation

The process of separating (or keeping separate) individual waste types and/or forms in order to facilitate their cost-effective treatment, storage, and disposal.

seismicity

The phenomena of earth movements; seismic activity. Seismicity is related to the location, size, and rate of occurrence of earthquakes.

selenium

Chemical element in the oxygen family (Group VIa) of the periodic table, closely allied in chemical and physical properties with the elements sulfur and tellurium. The symbol for selenium is Se; Se-79 is the principal radioactive isotope of this element present in the HLW tanks at SRS.

slag

The vitreous material left as a residue by the smelting of metallic ore. As used in this SEIS, a component of saltstone added to reduce release of certain waste constituents (technetium, chromium).

sludge

Component of HLW consisting of the insoluble solids that have settled at the bottom of the HLW storage tanks. Radionuclides present in the sludge include fission products and long-lived actinides.

sodium

Chemical element of Group Ia of the periodic table, the alkali metal group. The symbol for sodium is Na. Sodium salts are a major constituent of the salt component in the HLW tanks.

sodium tetraphenylborate

Organic reagent used in tetraphenylborate precipitation process for removal of radioactive cesium from HLW salt solution. Chemical formula for sodium tetraphenylborate is $\text{Na}(\text{C}_6\text{H}_5)_4\text{B}$.

solids slurry washing

As used in this SEIS, dilution of salt solution in contact with solids, followed by filtration to reduce concentration of soluble salts in slurried solids.

solvent

Substance (usually liquid) capable of dissolving one or more other substances.

solvent extraction

Process for separation of a constituent from an aqueous solution by transfer to an immiscible organic phase. As used in this SEIS, employed to separate radioactive cesium from HLW salt solution.

sorbent

A material that sorbs another substance; i.e. that has the capacity or tendency to assimilate the substance by either absorption or adsorption.

sorption

Assimilation of molecules of one substance by a material in a different phase. Adsorption (sorption on a surface) and absorption (sorption into bulk material) are two types of sorption phenomena.

source material

(a) Uranium, thorium, or any other material that is determined by the U.S. Nuclear Regulatory Commission pursuant to the provisions of the Atomic Energy Act of 1954, Section 61, to be source material; or (b) ores containing one or more of the foregoing materials, in such concentration as the U.S. Nuclear Regulatory Commission may by regulation determine from time-to-time [Atomic Energy Act 11(z)]. Source material is exempt from regulation under the RCRA.

source term

The amount of a specific pollutant (e.g., chemical, radionuclide) emitted or discharged to a particular environmental medium (e.g., air, water) from a source or group of sources. It is usually expressed as a rate (e.g., amount per unit time).

spent nuclear fuel

Fuel that has been withdrawn from a nuclear reactor following irradiation, the constituent elements of which have not been separated.

stabilization

Treatment of waste to protect the environment from contamination. This includes rendering a waste immobile or safe for handling and disposal.

stilling tanks

Process vessels for holdup of decontaminated salt raffinate and concentrated strip effluent from solvent extraction operations to allow floating and removal of entrained organic phase.

strip effluent

As used in this SEIS, the aqueous cesium solution resulting from the back extraction of cesium from the organic phase in the Solvent Extraction salt processing alternative.

stripping

Process operation for recovery of constituents extracted into the organic phase in the solvent extraction operation by contacting the organic phase with a dilute acid stream.

strontium

Chemical element of Group IIa of the periodic table, the alkaline-earth metal group, of which calcium is a member. The symbol for strontium is Sr; Sr-90 is the principal radioactive isotope of this element present in the HLW tanks at SRS.

subsurface

The area below the land surface (including the vadose zone and aquifers).

supernatant salt solution

Saturated solution of salt wastes remaining in waste tanks after dewatering of salt wastes by evaporation.

suppressor

Component of organic phase added to diluent to promote recovery of constituent extracted into organic phase in solvent extraction operations.

tank farm

An installation of multiple adjacent tanks, usually interconnected, for storage of liquid radioactive waste.

technetium

Chemical element, a metal of Group VIIb of the periodic table. All isotopes of technetium are radioactive. The symbol for technetium is Tc; Tc-99 is the principal radioactive isotope of this element present in the HLW tanks at SRS.

tetraphenylborate

Chemical consisting of four phenyl groups attached to boron atom $(C_6H_5)_4 B$. Sodium tetraphenylborate used to separate radioactive cesium from HLW salt solution by precipitation, forming insoluble cesium tetraphenylborate.

Tetraphenylborate Precipitation

Process used to separate cesium, potassium, and ammonium constituents from HLW salt solution by formation of insoluble solids. The process is projected for use in the Small Tank Precipitation salt processing alternative.

tin

Chemical element belonging to the carbon family, Group IVa of the periodic table. The symbol for tin is Sn; Sn-126 is the principal radioactive isotope of this element present in the HLW tanks at SRS.

total effective dose equivalent

The sum of the external dose equivalent (for external exposures) and the committed effective dose equivalent (for internal exposures).

transuranic waste

Waste containing more than 100 nanocuries of alpha-emitting transuranic isotopes, with half-lives greater than 20 years, per gram of waste, except for (a) HLW; (b) waste that the U.S. Department of Energy has determined, with the concurrence of the Administrator of the U.S. Environmental Protection Agency, does not need the degree of isolation required by 40 CFR 191; or (c) waste that the U.S. Nuclear Regulatory Commission has approved for disposal on a case-by-case basis in accordance with 10 CFR 61.

treatment

Any activity that alters the chemical or physical nature of a hazardous waste to reduce its toxicity, volume, or mobility or to render it amenable for transport, storage, or disposal.

tritium

A radioactive isotope of hydrogen whose nucleus contains one proton and two neutrons. The symbol for tritium is H-3. In the HLW tanks at SRS, tritium is usually bound in water molecules, where it replaces one of the ordinary hydrogen atoms.

uranium

Chemical element of the actinide series in Group IIIb of the periodic table. All isotopes of uranium are radioactive. The symbol for uranium is U.

vadose zone

The zone between the land surface and the water table. Saturated bodies, such as perched groundwater, may exist in the vadose zone. Also called the zone of aeration and the unsaturated zone.

valve box

Transfer system component regulating the flow of process streams in a piping system by manual or remote valve adjustment.

vitriification

As used in this SEIS, a method of immobilizing waste (e.g., radioactive, hazardous, and mixed), by melting glass frit and waste into a solid waste form suitable for long-term storage and disposal.

volatile organic compounds (VOCs)

Compounds that readily evaporate and vaporize at normal temperatures and pressures.

waste minimization

An action that economically avoids or reduces the generation of waste by source reduction, reducing the toxicity of hazardous waste, improving energy usage, or recycling.

waste stream

A waste or group of wastes with similar physical form, radiological properties, U. S. Environmental Protection Agency waste codes, or associated land disposal restriction treatment standards. May result from one or more processes or operations.

wetlands

Areas that are inundated or saturated by surface water or groundwater and that typically support vegetation adapted for life in saturated soils. Wetlands generally include swamps, marshes, bogs, and similar areas.

wind rose

A circular diagram showing, for a specific location, the percentage of the time the wind is from each compass direction. A wind rose for use in assessing consequences of airborne releases also shows the frequency of different wind speeds for each compass direction.

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