



Appendix B

B.1 ALPHA VITRIFICATION FACILITY

OBJECTIVE:

The alpha vitrification facility would provide treatment of nonmixed and mixed alpha waste (10 to 100 nanocuries of transuranics per gram of waste) and nonmixed and mixed transuranic waste (greater than 100 nanocuries of transuranics per gram of waste). The facility would have the ability to open drums of waste, perform size reduction, produce a glass waste form suitable for disposal, and treat secondary wastes.

DESCRIPTION:

An alpha vitrification facility would treat nonmixed and mixed alpha waste and transuranic waste. The facility would have three main activities: preparation of waste for treatment, primary waste treatment, and secondary waste treatment.

The alpha vitrification facility would be located in E-Area. The facility would accept drummed waste that has first been processed through the transuranic waste characterization/certification facility. In most cases the solid waste would be removed from the drum, sorted by size, and shredded as needed to meet the vitrification unit requirements. This would be accomplished using shredding shears and/or bandsaws. If the radioactivity levels of the waste were too high to maintain worker radiation levels as low as reasonably achievable, the intact drum would be shredded without removing the waste. Wastes would be combined with frit and additives and sent to the thermal pretreatment unit. Under alternative C, the facility would crush concrete culverts and sort concrete rubble to separate alpha-contaminated rubble from reusable non-contaminated rubble. Culverts that are not contaminated could be reused or disposed of. A small amount of contaminated soil (mixed waste soils) could be used as a frit substitute in the vitrification process in an effort to recycle waste materials. The decision to use mixed waste soils as frit would be based on the requirements for the final glass waste form.

The facility would include a thermal pretreatment unit to reduce the carbon content of the waste in order to increase the quality of glass produced during vitrification, prevent glass melt burping, and ensure Resource Conservation and Recovery Act (RCRA) thermal treatment requirements are met. The waste residue, or ash, would be vitrified (i.e., fused into a solid waste matrix) in a high temperature melter. Gases produced during the vitrification process would be sent through an afterburner and an offgas treatment system. The afterburner would destroy remaining organic compounds to meet RCRA standards prior to treatment in an offgas system. The offgas system would filter the gases to minimize the release of the remaining hazardous constituents or particulates to the atmosphere. Liquids generated by the offgas system would be evaporated and recondensed. The condensed evaporator overheads would be sent to a dedicated wastewater treatment unit for the treatment of mercury, trace radionuclides, and other remaining hazardous materials. The closedloop system would ensure that water would be returned to the offgas system for reuse. The concentrate remaining after the liquid was evaporated would be treated using stabilization techniques (Hess

1994a).

PROJECT-SPECIFIC ACTIONS:

	Min.	Exp.	Max.
No Action			
A			
B			
C			

Under the no-action alternative and alternative A, the alpha vitrification facility would not be constructed.

	Min.	Exp.	Max.
No Action			
A			
B			
C			

Under alternative B, only nonmetallic mixed-alpha waste, plutonium-238 waste and high-activity plutonium-239 waste would be vitrified in the facility. Where possible, metals would be separated from the plutonium-238 waste to remove the potential for gas generation problems. In order to keep radiation exposure to workers as low as reasonably achievable, it may not always be possible to sort the wastes. Therefore, some drums may be shredded unopened, resulting in metals in the melter. The output would be packages of transuranic waste that would be sent offsite for disposal at the Waste Isolation Pilot Plant.

	Min.	Exp.	Max.
No Action			
A			
B			
C			

Under alternative C, prior to the operation of the alpha vitrification facility, alpha waste would be direct disposed or treated in the Consolidated Incineration Facility. Once operating, the remaining alpha and transuranic waste volume would be vitrified. A minor portion of the output (less than 10 percent) would be packages of alpha waste that would be sent to shallow land disposal or to RCRA-permitted disposal onsite. Most of the output would be packages of transuranic waste that would be disposed offsite at the Waste Isolation Pilot Plant.

	Min.	Exp.	Max.
No Action			
A			
B			
C			

In both alternatives B and C, the vitrified and stabilized waste forms would be sent back to the transuranic waste characterization/certification facility for final certification before disposal.

The vitrification of solid waste would achieve an average volume reduction ratio of 15 to 1. Liquid

waste would achieve an average volume reduction of 75 to 1. For alternative C, the solid waste feed stream would contain appreciable quantities of metal, yet it is assumed that vitrification would still achieve an average volume reduction ratio of 15 to 1. This is because shredding bulky material would eliminate voids and secondary liquid waste generated in the offgas system when thermally treating metals would be much lower than that generated when combustible material is processed (Hess 1994a).

The amounts and types of waste that would be treated in the alpha vitrification facility for each alternative and forecast is presented in Table B.11.

Table B.1-1. The amounts and types of waste that would be treated in the alpha vitrification facility for each alternative (cubic meters).a,b

	Min.	Exp.	Max.
		NA	
A	NA	NA	NA
B	5,127 m ³ total 416 m ³ /yr	7,052 m ³ total 559 m ³ /yr	233,770 m ³ total 19,388 m ³ /yr
	Primarily nonmetallic alpha wastealpha waste and plutoniumplutonium-238 waste c		
C	10,528 m ³ total 853 m ³ /yr	14,847 m ³ total 1,177 m ³ /yr	385,741 m ³ total 34,901 m ³ /yr
	All alpha and transuranic wastetransuranic wastes		

a. Source: Hess (1995a).

b. To convert to cubic feet, multiply by 35.31.

c. Metals would be removed when possible. The waste stream containing metals would be, for the most part, entirely metal, but other waste streams would not be free of metals because drums often cannot be opened and sorted due to high radiation levels.

B.2 AQUEOUS AND ORGANIC WASTE STORAGE TANKS

OBJECTIVE:

The aqueous and organic waste storage tanks would provide storage capacity for liquid mixed wastes.

DESCRIPTION:

DOE would need to construct two series of 114-cubic meter (30,000-gallon) tanks in EArea. One

tank series would store mixed aqueous wastes, while the second tank series would store mixed organic wastes. The aqueous waste tanks would be similar in design and construction to the 114 cubic meter (30,000-gallon) solvent tanks planned in H-Area but would be installed above grade. The organic waste tanks would be single-walled tanks constructed in below-grade vaults. Each tank would be provided with a leak-detection system, secondary containment, leak-collection sump, overflow protection, waste agitation pumps, vent filtration system, and inspection ports. Each tank would be secured to a concrete pad or to anchors that would serve as a supporting foundation.

PROJECT-SPECIFIC ACTIONS:

	Min.	Exp.	Max.
No Action			
A			
B			
C			

Under the no-action alternative, DOE would need to store large volumes of mixed aqueous and organic wastes. DOE would add new tanks as needed to accommodate expected aqueous and organic liquid waste generation over the next 30 years (Table B.2-1).

Based on DOE's 30-year expected waste forecast, approximately 4,850 cubic meters (1.28106 gallons) of mixed aqueous waste would be generated over the 30-year period. The initial tank would reach capacity in 1995. To accommodate mixed aqueous waste generation, DOE would need to build an additional one or two tanks (depending on waste generation rates) every year for the entire 30-year period. Accordingly, a total of forty-three 114-cubic meter (30,000-gallon) tanks would need to be constructed (Hess 1994b).

Based on DOE's 30-year expected waste forecast, approximately 2,900 cubic meters (7.68105 gallons) of mixed organic waste would be generated over the 30-year period. The initial tank would reach capacity in 2000, and the second tank would reach capacity in the year 2001. Four additional tanks would need to be constructed by the year 2003, and a new tank would need to be constructed every year until 2018.

From 2018 until 2024, a new tank would need to be constructed every 1 or 2 years. A total of twenty-six 114-cubic meter (30,000-gallon) tanks would need to be constructed over the entire 30-year period (Hess 1994b).

	Min.	Exp.	Max.
No Action			
A			
B			
C			

For each of the other alternatives, adequate treatment capacity would be available for the mixed aqueous and organic liquid waste volumes in all waste forecasts. No additional tanks would be required.

Table B.2-1. New tanks needed to accommodate estimated aqueous and organic liquid waste forecast.a,b

	Min.	Exp.	Max.
		4,850 m ³ aqueous waste 43 tanks 2,900 m ³ organic waste 25 tanks	
A	Aqueous and organic wasteorganic waste storage tanksorganic waste storage tanks would not be required.	Aqueous and organic waste storage tanks would not be required.	Aqueous and organic waste storage tanks would not be required.
B	Aqueous and organic waste tanks would not be required.	Aqueous and organic waste tanks would not be required.	Aqueous and organic waste tanks would not be required.
C	Aqueous and organic waste storage tanks would not be required.	Aqueous and organic waste storage tanks would not be required.	Aqueous and organic waste storage tanks would not be required.

a. Source: Hess (1994b).

b. To convert to gallons, multiply by 264.2.

B.3 BURIAL GROUND SOLVENT TANKS

OBJECTIVE:

Burial Ground Solvent Tanks S23 through S30 store spent solvent waste generated by the plutonium-uranium extraction (PUREX) process that takes place in Savannah River Site (SRS) separations facilities. Liquid waste solvent tanks S33 through S36 would be constructed in H-Area to provide replacement storage capacity for these wastes in October 1996, by which time the existing solvent tanks must be removed from service.

DESCRIPTION:

There are eight interim-status storage tanks in E-Area, of which two, S29 and S30, are currently used to store mixed solvent wastes. Each tank is constructed of steel and can hold 95 cubic meters (25,000 gallons) of waste. Each tank rests on four steel saddles on top of a concrete slab. The slab slopes to a sump that collects liquid that could escape from the tank. These tanks are used to store spent solvent (predominately tributyl phosphate and nparaffin) from the PUREX process (enriched uranium recovery process). This radioactive solvent may also contain varying concentrations of lead, mercury, silver, benzene, trichloroethylene, other organics, and an inorganic

layer. Future PUREX solvent waste generated from the separations facilities would be radioactive but would not contain metal or organic contaminants in sufficient concentrations to classify the solvent as a mixed waste under RCRA. Mixed and low-level radioactive PUREX solvent wastes would be managed in the same manner (WSRC 1990a).

Tanks S29 and S30 reach the end of their allowable service life in October 1996. At that time, replacement tanks would be required to extend storage capacity. DOE plans to construct four 114-cubic meter (30,000-gallon) tanks in H-Area to replace Tanks S29 and S30. The replacement tanks would be buried, double-walled, and constructed of cathodically protected carbon steel. Each tank would have a leak-detection system, leak-collection sump, overfill protection, waste agitation pumps, common vent filtration system, and inspection ports. Each tank would be secured to a concrete anchor or pad that would serve as a supporting foundation and protect against flotation. Each tank's vent would be piped into a common stack or filter to capture volatile organic compounds and radionuclides (WSRC 1993a). The RCRA interim status storage capacity would be transferred from the existing solvent tanks to the four new tanks (WSRC 1994a).

PROJECT-SPECIFIC ACTIONS:

	Min.	Exp.	Max.
No Action			
A			
B			
C			

Under each of the alternatives, the contents of the E-Area solvent tanks would be transferred to the four H-Area 114cubic meter (30,000 gallon) tanks for storage [total capacity is 450 cubic meters (1.2'105 gallons)]. Table B.3-1 presents the volume of waste that would be stored. The tanks currently store 120 cubic meters (31,700 gallons) of waste, and it is projected that an additional 307 cubic meters (81,200 gallons) of solvent waste would be generated over the next 30 years, as follows: 54.5 cubic meters (14,400 gallons) in 1995 from the closure of tanks S23-S28, 15 cubic meters (4,000 gallons) in 1997 from the closure of tanks S29 and S30; 151 cubic meters (40,000 gallons) in 2003 and 87 cubic meters (23,000 gallons) in 2005 from deinventory of the SRS separations facilities (Hess 1994c).

Table B.3-1. Estimated volume of waste stored in Burial Ground Solvent Tanks (cubic meters).a,b

	Min.	Exp.	Max.
		427 m ³ (max storage)	
A	327 m ³ (max storage) 137 m ³ (storage in 2024)	327 m ³ (max storage) 137 m ³ (storage in 2024)	327 m ³ (max storage) 137 m ³ (storage in 2024)
B	327 m ³ (max storage) 137 m ³ (storage in 2024)	327 m ³ (max storage) 137 m ³ (storage in 2024)	327 m ³ (max storage) 137 m ³ (storage in 2024)
C	327 m ³ (max storage) 137 m ³ (storage in 2024)	327 m ³ (max storage) 137 m ³ (storage in 2024)	327 m ³ (max storage) 137 m ³ (storage in 2024)

a. Source: Hess (1994b).

b. To convert to gallons, multiply by 264.2.

B.4 COMPACTORS

OBJECTIVE:

Compactors provide a method to reduce the volume of low-level waste, thereby increasing disposal capacity.

DESCRIPTION:

Low-activity waste is compacted in low-level waste compactors in either H-Area, M-Area or L-Area (WSRC 1993b, c). The H-Area compactor receives job.control waste from separations facilities, Waste Management, Facilities and Services, Reactors, Tritium, the Defense Waste Processing Facility and Laboratories (WSRC 1994b). The M-Area compactor processes primarily uranium-contaminated job.control waste from M-Area facilities (WSRC 1993b). The L-Area compactor compacts tritiated waste generated in reactor facilities (K-, L-, P-, R-, C-, and 400-D-Areas).

The H-Area compactor and the M-Area compactor are enclosed steel-box-container compactors with vented high efficiency particulate air filter systems. Both compactors receive 90 cubic feet steel containers of low-level waste. The steel container is placed into an enclosed compactor unit and its contents compacted. Cardboard boxes containing low-level waste are manually added to the steel container and the contents recompressed. This process is repeated until the compactor compression efficiency limit is reached. The box compactor compression efficiency ratio is 4 to 1 (Hess 1994a).

The L-Area compactor is a Container Products model that includes the compactor, exhaust pre-filters, and high efficiency particulate air filters. The compactor exhaust moves through a duct into the main building exhaust and discharges from a permitted stack. The compactor reduces the volume of bagged waste into 21-inch cardboard boxes that are then placed into steel box containers for disposal. The LArea compactor compression efficiency ratio is 4 to 1.

Under the no-action alternative and alternative A, DOE would operate the existing compactors at their maximum capacities from the years 1995 until 2024 to compact low-activity jobcontrol waste. Under alternative B, it is assumed that DOE would operate the compactor only in 1995. DOE would ship low-activity job.control waste offsite for treatment by a commercial vendor beginning in fiscal year 1996. Under alternative C, DOE would operate the compactors in 1995 at their maximum capacities. In 1996, assuming the Consolidated Incineration Facility begins operation, DOE would treat incinerable job.control waste at that facility. DOE would continue to compact waste that does not meet the Consolidated Incineration Facility waste acceptance criteria; this material is assumed to be 10 percent of the low-activity job.control waste in a given year. Under alternative C, the existing compactors would cease operation in the year 2005. DOE would then vitrify low-activity job.control waste at the non-alpha vitrification facility which would begin operation in 2006.

PROJECT-SPECIFIC ACTIONS:

Low-level waste management activities for the existing compactors are shown in Table B.4-1.

Table B.4-1. Estimated volumes of waste compacted for each alternative (cubic meters).a,b

	Min.	Exp.	Max.
		119,490 m ³ total 3,983 m ³ /yr	
A	119,490 m ³ total 3,983 m ³ /yr	119,490 m ³ total 3,983 m ³ /yr	119,490 m ³ total 3,983 m ³ /yr
B	3,983 m ³ total	3,983 m ³ total	3,983 m ³ total
C	15,260 m ³ total 950 to 3,983 m ³ /yr	18,438 m ³ total 1,199 to 3,983 m ³ /yr	19,079 m ³ total 1,281 to 3,983 m ³ /yr

a. Source: Hess (1994b).

b. To convert to cubic feet, multiply by 35.31.

B.5 CONSOLIDATED INCINERATION FACILITY

OBJECTIVE:

The Consolidated Incineration Facility would provide incineration capability for a wide range of combustible hazardous, mixed, and lowlevel wastes. This facility represents the consolidation of several separate SRS incineration initiatives:

- a hazardous waste incinerator that would have provided incineration capability for SRS solid and liquid hazardous wastes
- a Defense Waste Processing Facility benzene incinerator that would have provided dedicated incineration capability for the benzene generated by the highlevel waste processing activities at the Defense Waste Processing Facility
- a hazardous waste incinerator upgrade that would accept SRS solid and liquid mixed wastes as well as solid and liquid nonhazardous, radioactive wastes

Further discussion of these initiatives and the basis for development of the Consolidated Incineration Facility can be found in the *Savannah River Site Consolidated Incineration Facility Mission Need and Design Capacity Review* (WSRC 1993c).

The U.S. Department of Energy (DOE) agreed to continue its "fresh look" at operating the Consolidated Incineration Facility in this environmental impact statement (eis). Emissions and doses to workers and the public from various waste-burning scenarios are presented independently in this appendix chapter. These Consolidated Incineration Facility emissions have been included in the analyses of each alternative and waste forecast in the eis.

DESCRIPTION:

Incineration was selected because it was the Resource Conservation and Recovery Act (RCRA)-specified technology or the best demonstrated available technology for many SRS hazardous and mixed wastes, and it would provide cost-effective volume reduction for lowlevel radioactive wastes. The Consolidated Incineration Facility would include processes to stabilize the incinerator solid waste residues (ash) and offgas-scrubber-blowdown liquid with cement into a form known as ashcrete for onsite disposal in accordance with applicable regulations. A permit application to include stabilization of the incinerator offgas-scrubber-blowdown liquid in the ashcrete process has been submitted to applicable regulatory agencies.

Under the Federal Facility Compliance Act, DOE is required to develop sitespecific plans to treat mixed wastes to the standards established under RCRA. Incineration is required by the U.S. Environmental Protection Agency (EPA) Land Disposal Restrictions regulations for the treatment of certain SRS mixed wastes. The *SRS Proposed Site Treatment Plan* (WSRC 1995) identified five SRS mixed waste streams for which treatment by the Consolidated Incineration Facility was determined to be the preferred option:

- Radiologically-contaminated solvents
- Solvent-contaminated debris
- Incinerable toxic characteristic material
- Defense Waste Processing Facility benzene
- Mixed waste oil - sitewide

These wastes were included in the Consolidated Incineration Facility design basis waste groups (WSRC 1990b). The proposed site treatment plan identified nine additional mixed waste streams that were not included in the design basis waste groups but for which the Consolidated Incineration Facility was the preferred option:

- Filter paper take-up rolls
- Mark 15 filter paper
- Paints and thinners
- Job control waste containing solvent-contaminated wipes
- Tributyl phosphate and nparaffin
- Spent filter cartridges and carbon filter media
- Mixed waste from laboratory samples
- Wastewater from transuranic drum dewatering
- Plastic/lead/cadmium raschig rings

DOE's site treatment plan options analyses also identified incineration at SRS as the preferred treatment option for limited quantities of mixed waste generated by Naval Reactors Program sites (approximately 18 cubic meters over a 5year forecast period). Incineration of these wastes has been included in the analyses of this eis.

Final decisions regarding the treatment of these wastes will be made in conjunction with ongoing negotiations with the State of South Carolina pursuant to the Federal Facility Compliance Act. Incineration at the Consolidated Incineration Facility for the design basis waste groups was considered in an Environmental Assessment (DOE 1992) and Finding of No Significant Impact (57

FR 61402) that established the NEPA basis for construction of the Consolidated Incineration Facility.

The Consolidated Incineration Facility main process building (Building 261-H) would include areas for solid waste receipt; solid waste handling; a rotary kiln incineration system, including incinerator ash removal and treatment, and offgas cleaning; and the necessary control room and support service facilities. A system to solidify incinerator ash and offgas-scrubber-blowdown would also be installed before operation.

The Consolidated Incineration Facility would process both liquid and solid wastes. Solid waste would be delivered in cardboard boxes manually loaded onto a conveyor. The boxes would pass through a portal monitor to determine if the radiation rate of the box contents was below the maximum Consolidated Incineration Facility waste acceptance criteria of 10 millirem per hour at 3 inches. The boxes would be x-rayed to ensure that materials unacceptable to the incineration process were not present. Waste boxes would be assayed to ensure that their curie content was in agreement with the waste manifest. Boxes would be stored on the conveyor system before being fed to the incinerator.

Liquid waste would be transported to the Consolidated Incineration Facility by various methods. Radioactive organic waste (benzene) would be piped directly from the Defense Waste Processing Facility for incineration. Other liquid wastes would be transported in carboys, drums, or tanker trucks to the Consolidated Incineration Facility tank farm which consists of five tanks: a 25-cubic meter (6,500-gallon) aqueous waste tank, two 16-cubic meter (4,200-gallon) blend tanks, a 25-cubic meter (6,500-gallon) spare tank, and a 48-cubic meter (12,600-gallon) fuel oil tank. Dikes (secondary containment) to contain accidental spills would be provided around the waste tanks, fuel oil tank, and the truck unloading pads. Liquids collected in sumps in the diked areas would be analyzed for contamination. If contamination was found, the liquid would be pumped into the aqueous waste tank for processing in the incinerator. Liquid wastes from the tank farm would be blended to provide a solution with a heating value, viscosity, and an ash and chlorine content that would achieve stable combustion in the rotary kiln. Aqueous waste may be blended with other liquids for incineration or be evaporated in the incinerator, depending on the heating value of the liquid and free water content. Additional Consolidated Incineration Facility-related components would include a propane storage tank and two standby diesel generators.

The incinerator system consists of a rotary kiln primary incineration chamber and a secondary combustion chamber. The system is designed to ensure a 99.99 percent destruction and removal efficiency for each principle organic hazardous constituent in accordance with RCRA regulations.

The secondary combustion chamber offgas (exhaust) would be treated by a wet scrubbing system for acid gas control and particulate removal to meet environmental regulations. The offgas system consists of a quench system for temperature reduction; a free-jet scrubber; a cyclone separator; a mist eliminator; a reheater; high efficiency particulate air filters; induced draft fans; and an exhaust stack. The offgas wet scrubber liquid chemistry would be controlled to maintain suspended solids and chlorine concentration limits. Concentration limits would be maintained by emptying and refilling the offgas wet scrubber storage tank. The scrubber liquid blowdown would be solidified in cement, in the same manner as the incinerator ash, at the ashcrete stabilization unit.

High efficiency particulate air filters are provided for the container handling kiln feed, ashout areas exhaust vents, and the kiln seal shroud exhaust. Stack monitoring equipment is installed to monitor the discharge of chemical and radiological materials.

The Consolidated Incineration Facility is expected to achieve a net volume reduction of 11 to 1 for lowlevel job.control waste, 8 to 1 for other types of solid waste, and 40 to 1 for liquid waste, even considering the increase in volume due to secondary waste stabilization. DOE would operate the Consolidated Incineration Facility within design and permit mechanical and thermal utilization limits. The mechanical design utilization is based on a combination of waste throughput, waste forms, and material handling requirements to physically accommodate waste material feed. The thermal utilization is based on the amount of heat that can be safely and effectively dissipated from the incinerator.

Mechanical utilization limit is the hourly throughput rating. The annual operating capacity of the Consolidated Incineration Facility for liquid waste would be approximately 4,630 cubic meters (1.63105 cubic feet) per year at 70 percent attainment and for solid waste, approximately 17,830 cubic meters (6.3105 cubic feet) per year at 50 percent attainment (WSRC 1993c). The incinerator liquidwastefeedssystem design is based on a high heating value (i.e., organics) liquid waste flow rate of 687 pounds per hour and low heating value (i.e., aqueous) liquid waste flow rate of 950 pounds per hour. The incinerator is designed to incinerate an annual average of 720 pounds per hour of solid waste, based on the total heating value and ash content of the solid waste (WSRC 1993d). Modifications to the

Consolidated Incineration Facility's waste handling systems are assumed to increase the solids handling capacity to the following:

- 961 pounds per hour for alternative B.- minimum waste forecast
- 2,285 pounds per hour for alternative A - expected waste forecast
- 11,251 pounds per hour for alternative A - maximum waste forecast

The ashout and ash stabilization systems would also be modified for alternative A (all waste forecasts) and alternative B.- minimum waste forecast to handle the larger throughputs associated with soils incineration (Blankenhorn 1995).

Thermal utilization limits are expressed in terms of British thermal units (amount of energy required to raise the temperature of one pound of water from 58.5 degrees Fahrenheit to 59.5 degrees Fahrenheit) per hour. The maximum feed rate is determined by the combined heat release of the waste forms and auxiliary fuel oil. The maximum thermal release rating for the Consolidated Incineration Facility rotary kiln system is limited to about 13 million British thermal units per hour. The maximum thermal release rating for the secondary combustion chamber is about 5 million British thermal units per hour. The Consolidated Incineration Facility is limited to an approximate thermal capacity of 18 million British thermal units per hour.

DOE has submitted a permit application to operate the Consolidated Incineration Facility to segregate and incinerate listed hazardous and mixed wastes separately from characteristic-only hazardous wastes and nonhazardous wastes. It is assumed that treating hazardous, mixed, and mixed alpha waste in the Consolidated Incineration Facility would result in 70 percent secondary waste disposal in RCRA-permitted disposal vaults and 30 percent secondary waste disposal in shallow land disposal. It is also assumed that low-level and non-mixed alpha waste treatment would result in 100 percent secondary waste disposal in shallow land disposal.

PROJECT-SPECIFIC ACTIONS:

The volumes of waste that would be treated by the Consolidated Incineration Facility for each alternative and waste forecast are shown in Table B.5-1. The table also identifies the percentage of the Consolidated Incineration Facility's mechanical or thermal operating limits (whichever is most critical) represented by the waste feeds evaluated for each alternative and forecast.

	Min.	Exp.	Max.
No Action			
A			
B			
C			

Under the no-action alternative, the Consolidated Incineration Facility would not operate.

	Min.	Exp.	Max.
No Action			
A			
B			
C			

Alternative A - For all three waste forecasts, hazardous and mixed wastes would be treated at the Consolidated Incineration Facility. Mixed wastes would include mixed waste requiring size reduction, Defense Waste Processing Facility benzene, organic liquid, radioactive oil, PUREX solvent, paint wastes, composite filters, aqueous liquids, organic and inorganic sludges, contaminated soils, and spent decontamination solution from the containment building. Hazardous waste would include composite filters, paint waste, organic liquids, and aqueous liquids.

The Consolidated Incineration Facility capacity for treating soils is limited by the feed, ash-out, and ash stabilization system. The rotary kiln and offgas system are capable of treating large volumes of soil because the thermal energy requirements and offgas flow rates for soil are much less than for combustible solids and liquids. Under alternative A, DOE would modify the Consolidated Incineration Facility by the year 2006 to process large volumes of mixed waste soil by installing new feed, material handling, ash-out, and ash stabilization systems to treat approximately 750 cubic meters (26,500 cubic feet) to 13,900 cubic meters (4.9105 cubic feet) of soils per year (Hess 1995a). The Consolidated Incineration Facility is expected to achieve a net volume increase of 1 to 3 for soils due to the increase in volume resulting from secondary waste stabilization.

Under the maximum waste forecast, spent decontamination solutions from the containment building would not go directly to the Consolidated Incineration Facility because volumes would be too large and would require treatment by a wastewater treatment facility. Solid (1 percent) and liquid (5 percent) residuals from the wastewater treatment process would be incinerated.

	Min.	Exp.	Max.
No Action			
A			
B			
C			

Alternative B - For all three waste forecasts, hazardous, mixed, and low-level wastes would be treated at the Consolidated Incineration Facility. Mixed wastes would include mixed waste requiring size reduction, Defense Waste Processing

Facility benzene, organic liquid, radioactive oil, PUREX solvent, paint wastes, composite filters, aqueous liquids, and spent decontamination solution from the containment building. Hazardous waste would include composite filters, paint waste, organic liquids, and aqueous liquids. Low-level waste would include low-activity and tritiated job control wastes.

Under the minimum waste forecast, mixed waste soils and sludges would be incinerated because there is insufficient volume of these wastes to warrant construction of other facilities. DOE would modify the Consolidated Incineration Facility by 2006 to process large volumes of soil by installing new feed, material handling, ash-out, and ash stabilization systems to treat approximately 750 cubic meters (26,500 cubic feet) per year of soils (Hess 1995a).

Under the maximum waste forecast, spent decontamination solutions from the containment building would not go directly to the Consolidated Incineration Facility because volumes would be too large and would require treatment by a wastewater treatment facility. Solid (1 percent) and liquid (5 percent) residuals from the wastewater treatment process would be incinerated.

	Min.	Exp.	Max.
No Action			
A			
B			
C			

Alternative C - Hazardous, mixed, alpha, and low-level wastes would be treated at the Consolidated Incineration Facility. Mixed wastes would include mixed waste requiring size reduction, Defense Waste Processing Facility benzene, organic liquid, radioactive oil, PUREX solvent, paint wastes, composite filters, and aqueous liquids. Hazardous waste would include composite filters, paint waste, organic liquids, and aqueous liquids. Alpha waste would include mixed and nonmixed wastes. Low-level waste would include low-activity and tritiated job control wastes. The Consolidated Incineration Facility would cease operating in 2005 in this alternative.

SUMMARY OF IMPACTS:

The consequences of the incineration of hazardous, mixed, and low-level radioactive wastes at the Consolidated Incineration Facility under alternative B are described in Table B.5-2. Alternative B provides bounding impacts with respect to operations of the Consolidated Incineration Facility because the facility would operate throughout the 30-year analysis period (compared to alternative C in which the facility would be replaced by the non-alpha vitrification facility in 2006) and would burn low-level, hazardous, and mixed wastes (compared to only hazardous and mixed wastes under alternative A). The impacts resulting from the incineration of hazardous and mixed wastes have been identified separately from those associated with incineration of low-level wastes.

Table B.5-1. Average annual and total estimated volumes of waste incinerated for each alternative. The Consolidated Incineration Facility would operate for the 30-year period of analysis in alternatives A and B, and cease operation in 2005 in alternative C.

Min.	Exp.	Max.
	The Consolidated Incineration Facility would not operate under the no-action alternative.	

A	<p>Solids (337 m³ per year) 5,214 m³ mixed 4,561 m³ hazardous</p> <p>Liquids (1,188 m³ per year) 29,480 m³ mixed 4,967 m³ hazardous</p> <p>Soils (754 m³ per year) 14,324 m³ mixed</p> <p>74% of solids handling capacity^b</p> <p>23% of aqueous liquids capacity^c</p> <p>40% of organic liquids capacity^d</p>	<p>Solids (654 m³ per year) 10,633 m³ mixed 8,346 m³ hazardous</p> <p>Liquids (2,008 m³ per year) 49,436 m³ mixed 8,809 m³ hazardous</p> <p>Soils (2,790 m³ per year) 52,999 m³ mixed</p> <p>85% of solids handling capacity^b</p> <p>37% of aqueous liquids capacity^c</p> <p>77% of organic liquids capacity^d</p>	<p>Solids (964 m³ per year) (3%) 15,346 m³ mixed 12,617 m³ hazardous</p> <p>Liquids (1,234 m³ per year) 22,793 m³ mixed 12,990 m³ hazardous</p> <p>Soils (13,897 m³ per year) 264,036 m³ mixed</p> <p>85% of solids handling capacity^b</p> <p>15% of aqueous liquids capacity^c</p> <p>61% of organic liquids capacity^d</p>
B	<p>Solids (7,317 m³ per year) 178,329 m³ low-level 19,743 m³ mixed 14,121 m³ hazardous</p> <p>Liquids (937 m³ per year) 22,210 m³ mixed 4,967 m³ hazardous</p> <p>Soils (780 m³ per year) 14,324 m³ mixed</p> <p>84% of solids handling capacity^b</p> <p>18% of aqueous liquids capacity^c</p> <p>29% of organic liquids capacity^d</p>	<p>Solids (9,456 m³ per year) 213,536 m³ low-level 33,594 m³ mixed 27,090 m³ hazardous</p> <p>Liquids (1,572 m³ per year) 36,784 m³ mixed 8,809 m³ hazardous</p> <p>78% of CIF thermal capacity^e</p>	<p>Solids (15,412 m³ per year) 307,468 m³ low-level 99,901 m³ mixed 39,589 m³ hazardous</p> <p>Liquids (1,179 m³ per year) 21,201 m³ mixed 12,990 m³ hazardous</p> <p>98% of CIF thermal capacity^e</p>
C	<p>Solids (6,746 m³ per year) 56,605 m³ low-level 7,042 m³ mixed 3,497 m³ hazardous 318 m³ alpha</p> <p>Liquids (708 m³ per year) 3,379 m³ mixed 3,703 m³ hazardous</p> <p>41% of CIF thermal capacity^e</p>	<p>Solids (8,961 m³ per year) 72,718 m³ low-level 11,999 m³ mixed 4,199 m³ hazardous 694 m³ alpha</p> <p>Liquids (861 m³ per year) 4,100 m³ mixed 4,507 m³ hazardous</p> <p>56% of CIF thermal capacity^e</p>	<p>Solids (15,064 m³ per year) 79,311 m³ low-level 65,993 m³ mixed 4,658 m³ hazardous 680 m³ alpha</p> <p>Liquids (1,095 m³ per year) 6,167 m³ mixed 4,779 m³ hazardous</p> <p>89% of CIF thermal capacity^e</p>

a. Source: Hess (1995a,b); Blankenhorn (1995).

b. Percent of Consolidated Incineration Facility annual mechanical operating capacity for solids (including soils).

c. Percent of Consolidated Incineration Facility annual mechanical operating capacity for aqueous liquids.

d. Percent of Consolidated Incineration Facility annual mechanical operating capacity for organic liquids.

e. Percent of Consolidated Incineration Facility annual thermal operating capacity.

Table B.5-2. Summary of impacts from the operation of the Consolidated Incineration Facility (CIF) under alternative B.a

Minimum Waste Forecast	Expected Waste Forecast	Maximum Waste Forecast
Stabilized ash and blowdown disposal volumes		
<u>MW/HW_{b,c}</u>	<u>MW/HW</u>	<u>MW/HW</u>
33,518 m ³ to RCRA-permitted disposal	6,108 m ³ to RCRA-permitted disposal	12,803 m ³ to RCRA-permitted disposal
14,366 m ³ to shallow land disposal	2,618 m ³ to shallow land disposal	5,488 m ³ to shallow land disposal
<u>LLW_d</u>	<u>LLW</u>	<u>LLW</u>
16,212 m ³ to shallow land disposal	19,412 m ³ to shallow land disposal	27,952 m ³ to shallow land disposal
Auxiliary fuel oil consumption^e		
<u>MW/HW</u>	<u>MW/HW</u>	<u>MW/HW</u>
134×106 pounds	111×106 pounds	85×106 pounds
<u>LLW</u>	<u>LLW</u>	<u>LLW</u>
13.2×106 pounds	15.8×106 pounds	22.8×106 pounds
Non-radiological air emissions^f		
Annual average probability of excess latent cancers to offsite residents due to CIF operations		
1.7×10 ⁻¹⁰	2.7×10 ⁻¹⁰	2.0×10 ⁻¹⁰
Calculated maximum 8-hour average air pollutant concentrations at 100 meters (328 feet) and 640 meters (2,100 feet)		
Well below Occupational Safety and Health Administration permissible exposure levels		
Radiological air emissions		
Average annual radiological dose and resulting health effectshealth effects to the publicg		
Offsite maximally exposed individual		
<u>MW/HW</u>	<u>MW/HW</u>	<u>MW/HW</u>
0.00352 millirem	0.00452 millirem	0.00783 millirem
1.76×10 ⁻⁹ probability of an excess fatal cancer	2.26×10 ⁻⁹ probability of an excess fatal cancer	3.91×10 ⁻⁹ probability of an excess fatal cancer
<u>LLW</u>	<u>LLW</u>	<u>LLW</u>
0.00528 millirem	0.00641 millirem	0.0159 millirem
2.64×10 ⁻⁹ probability of an excess fatal cancer	3.21×10 ⁻⁹ probability of an excess fatal cancer	7.97×10 ⁻⁹ probability of an excess fatal cancer
<u>Total</u>	<u>Total</u>	<u>Total</u>
0.00880 millirem	0.0109 millirem	0.0237 millirem
4.40×10 ⁻⁹ probability of an excess fatal cancer	5.47×10 ⁻⁹ probability of an excess fatal cancer	1.19×10 ⁻⁸ probability of an excess fatal cancer

Offsite Population		
<u>MW/HW</u>	<u>MW/HW</u>	<u>MW/HW</u>
0.207 person-rem	0.268 person-rem	0.466 person-rem
1.03×10^{-4} number of additional fatal cancers	1.34×10^{-4} number of additional fatal cancers	2.33×10^{-4} number of additional fatal cancers
<u>LLW</u>	<u>LLW</u>	<u>LLW</u>
0.313 person-rem	0.379 person-rem	0.783 person-rem
1.57×10^{-4} number of additional fatal cancers	1.90×10^{-4} number of additional fatal cancers	3.91×10^{-4} number of additional fatal cancers
<u>Total</u>	<u>Total</u>	<u>Total</u>
0.520 person-rem	0.647 person-rem	1.25 person-rem
2.60×10^{-4} number of additional fatal cancers	3.24×10^{-4} number of additional fatal cancers	6.24×10^{-4} number of additional fatal cancers

Table B.5-2. (continued).

Minimum Waste Forecast	Expected Waste Forecast	Maximum Waste Forecast
Radiological air emissions		
Average annual radiological dose and resulting health effects to uninvolved workers		
640 meter uninvolved worker		
<u>MW/HW</u>	<u>MW/HW</u>	<u>MW/HW</u>
0.0693 millirem	0.0900 millirem	0.157 millirem
3.47×10^{-8} probability of an excess fatal cancer	4.50×10^{-8} probability of an excess fatal cancer	7.84×10^{-8} probability of an excess fatal cancer
<u>LLW</u>	<u>LLW</u>	<u>LLW</u>
0.106 millirem	0.127 millirem	0.179 millirem
5.28×10^{-8} probability of an excess fatal cancer	6.33×10^{-8} probability of an excess fatal cancer	8.97×10^{-8} probability of an excess fatal cancer
<u>Total</u>	<u>Total</u>	<u>Total</u>
0.0175 millirem	0.217 millirem	0.336 millirem
8.75×10^{-8} probability of an excess fatal cancer	1.08×10^{-7} probability of an excess fatal cancer	1.68×10^{-7} probability of an excess fatal cancer
100 meter uninvolved worker		

<u>MW/HW</u>	<u>MW/HW</u>	<u>MW/HW</u>
0.200 person-rem	0.260 person-rem	0.452 person-rem
1.00×10^{-7} number of additional fatal cancers	1.30×10^{-7} number of additional fatal cancers	2.26×10^{-7} number of additional fatal cancers
<u>LLW</u>	<u>LLW</u>	<u>LLW</u>
0.302 person-rem	0.366 person-rem	0.666 person-rem
1.51×10^{-7} number of additional fatal cancers	1.83×10^{-7} number of additional fatal cancers	3.33×10^{-7} number of additional fatal cancers
<u>Total</u>	<u>Total</u>	<u>Total</u>
0.502 person-rem	0.626 person-rem	1.12 person-rem
2.51×10^{-7} number of additional fatal cancers	3.13×10^{-7} number of additional fatal cancers	5.59×10^{-7} number of additional fatal cancers
Direct exposure^h		
Average annual radiological dose and resulting health effects to involved workers		
<u>Maximally exposed individual</u>		
<u>MW/HW</u>	<u>MW/HW</u>	<u>MW/HW</u>
112 millirem	146 millirem	256 millirem
4.48×10^{-5} probability of an excess fatal cancer	5.84×10^{-5} probability of an excess fatal cancer	1.02×10^{-4} probability of an excess fatal cancer
<u>LLW</u>	<u>LLW</u>	<u>LLW</u>
169 millirem	205 millirem	234 millirem
6.77×10^{-5} probability of an excess fatal cancer	8.19×10^{-5} probability of an excess fatal cancer	9.37×10^{-5} probability of an excess fatal cancer
<u>Total</u>	<u>Total</u>	<u>Total</u>
281 millirem	351 millirem	490 millirem
1.13×10^{-4} probability of an excess fatal cancer	1.40×10^{-4} probability of an excess fatal cancer	1.96×10^{-4} probability of an excess fatal cancer

Table B.5-2. (continued).

Minimum Waste Forecast	Expected Waste Forecast	Maximum Waste Forecast
Average annual involved worker population dose ⁱ		

<u>MW/HW</u> 2.91 person-rem 0.00117 number of additional fatal cancers	<u>MW/HW</u> 3.80 person-rem 0.00152 number of additional fatal cancers	<u>MW/HW</u> 6.66 person-rem 0.00266 number of additional fatal cancers
<u>LLW</u> 4.40 person-rem 0.00176 number of additional fatal cancers	<u>LLW</u> 5.32 person-rem 0.00213 number of additional fatal cancers	<u>LLW</u> 6.09 person-rem 0.00244 number of additional fatal cancers
<u>Total</u> 7.31 person-rem 0.00293 number of additional fatal cancers	<u>Total</u> 9.12 person-rem 0.00365 number of additional fatal cancers	<u>Total</u> 12.8 person-rem 0.00510 number of additional fatal cancers

a. Source: Hess (1995b). Waste disposal volumes and fuel consumption are for the entire 30-year analysis period.

b. MW/HW = mixed waste/hazardous waste.

c. Stabilized ash and blowdown volumes assume that 70 percent of hazardous/mixed waste residues require RCRA-permitted disposal, 30 percent can be sent to shallow land disposal.

d. LLW = low-level waste.

e. Auxiliary fuel oil consumption based on categorization of each waste type by soils, solids, and high and low Btu content liquids. Fuel oil consumption is calculated based on each waste category being incinerated separately.

f. Includes emissions of dioxins (Mullholland et al. 1994) and products of incomplete combustion from the Consolidated Incineration Facility.

g. Average annual dose and probability of fatal cancer obtained by dividing the 30-year dose and associated probability by 29.

h. Direct exposure scaled to cesium-137. Direct exposure is normalized to the expected case average exposure provided by Hess (1994d).

i. Number of additional fatal cancers are per year of Consolidated Incineration Facility operation.

B.6 CONTAINMENT BUILDING (HAZARDOUS WASTE/MIXED WASTE TREATMENT BUILDING)

OBJECTIVE:

At one time, the Hazardous Waste/Mixed Waste Treatment Building project was to provide a RCRA-permitted facility for the treatment of hazardous and mixed wastes that could not be treated to meet land disposal restrictions standards in other existing or planned facilities at SRS. The Hazardous Waste/Mixed Waste Treatment Building would have provided a facility in which wastes were processed into waste forms suitable for disposal. The facility would have also repackaged some waste

streams for shipment to other SRS treatment facilities such as the Consolidated Incineration Facility. Changes in the applicable regulatory requirements and to the mission of SRS have prompted DOE to re-evaluate the current scope and design of the Hazardous Waste/Mixed Waste Treatment Building. This facility has not yet been constructed.

Many treatment processes originally planned for the treatment building could be performed in existing SRS facilities in accordance with RCRA containment building regulations. Design features of a containment building include:

- walls, floor, and roof to prevent exposure to the elements
- primary barrier, such as the floor of a process area, or process tankage that is resistant to the hazardous materials contained therein
- secondary containment system, in addition to the primary barrier, for hazardous liquid materials (the containment building itself may act as secondary containment to the tanks within)
- leak detection system between the primary barrier and secondary containment system
- liquid collection and removal system

A containment building (as defined by RCRA) must be constructed and operated to:

- ensure that the containment building is maintained free of cracks, corrosion, or other defects that could allow hazardous materials to escape
- control the inventory of hazardous material within the containment walls so that the height of the containment wall is not exceeded
- provide a decontamination area for personnel and equipment to prevent spreading hazardous materials outside the containment building
- control fugitive emissions
- promptly repair conditions that could result in a release of hazardous waste

DESCRIPTION:

The *SRS Proposed Site Treatment Plan* identified several preferred treatment options that could be carried out in existing SRS facilities in accordance with RCRA containment building standards. These treatment options include:

- two 90-day generator treatments at the Savannah River Technology Center that would discharge treatment residuals to the Mixed Waste Storage Tanks
- macroencapsulation (in a welded stainless steel box) of silver saddles at a separations canyon building
- macroencapsulation (by polymer coating) of mixed waste lead and contaminated debris by an onsite vendor at an unspecified location
- macroencapsulation (in a welded stainless steel box) at the tritium facilities of mercury-contaminated equipment and a mercury-contaminated recorder
- size reduction of filter paper take-up rolls in preparation for treatment at the Consolidated Incineration Facility
- decontamination and macroencapsulation (in a welded stainless steel box) of high-level waste sludge and supernatant-contaminated debris at the Building 299-H decontamination facility that would discharge spent decontamination solutions to the high-level waste tank farms.

Low volume and/or one-time generation wastes would be treated at existing SRS facilities as indicated in the SRS draft site treatment plan. Approximately 1,703 cubic meters (4.49×10^5 gallons) of mixed waste would be treated at these facilities, 63 percent of which would be high-level waste sludge and supernatant-contaminated debris that requires decontamination or macroencapsulation. The 30-year waste forecast for this EIS identified larger quantities of mixed waste than those anticipated in the 5-year waste forecast used to develop the SRS proposed site treatment plan. As a result of the increased volume, a dedicated waste management facility has been proposed to treat mixed waste lead.

DOE proposes in this EIS to construct a containment building as a self-contained facility to accommodate waste quantities too large to be managed within existing SRS facilities or for which an existing facility that conforms to RCRA containment building standards cannot be identified. The EIS has identified several additional treatments that could be performed in such a containment building. These include:

- physical and chemical decontamination of debris, equipment, and nonradioactive lead wastes
- macroencapsulation (in a welded stainless steel box) of debris
- macroencapsulation (by polymer coating) of radioactive lead
- wet chemical oxidation of reactive metals
- roasting and retorting of mercury-contaminated equipment and amalgamation of the elemental mercury

DOE proposes to construct a containment building for the decontamination and treatment of hazardous and/or mixed wastes. This building would begin operation in 2006. The activities to be conducted in the containment building are identical under alternatives A and B. Under alternative C, the containment building would operate differently.

	Min.	Exp.	Max.
No Action			
A			
B			
C			

Alternatives A and B

Under alternatives A and B, the containment building would be designed with five separate processing bays. The activities to be conducted in each of the bays are as follows: (1) container opening/content sorting, (2) size reduction, (3) decontamination, (4) macroencapsulation, and (5) repackaging/waste characterization. Each bay would contain the necessary equipment to conduct the respective activities. Waste would be processed through each bay as was necessary to properly handle each individual waste type. If processing associated with a particular bay is not required for a specific waste, the bay would be bypassed.

The container opening/content sorting bay would contain equipment to help facilitate the opening of mixed waste containers. Once the container was opened, the contents would be removed and hand sorted by size. Materials that need to be further reduced in size for treatment/decontamination would be separated from those that are already small enough for treatment/decontamination. Mixed wastes would be sorted using gloveboxes. Wastes requiring size reduction would be sent to the size

reduction bay. This bay would contain equipment such as shredder shears and bandsaws that would be used to reduce the size of waste for subsequent processing.

Mixed waste such as bulk equipment and debris would be decontaminated in the decontamination bay using technologies such as degreasing, water washing, and/or carbon dioxide blasting. This bay would contain the necessary equipment to implement the selected decontamination technologies. Spent decontamination solutions would be collected in a tank truck for treatment onsite. Mixed wastes that are decontaminated (i.e., the hazardous component of the waste has been removed) would be reclassified as low-activity equipment waste and would be managed in accordance with the proposed alternatives for that treatability group. Wastes that are not decontaminated would continue on to the macroencapsulation bay for further processing.

Two types of macroencapsulation would be conducted in the macroencapsulation bay. The first macroencapsulation process would be for debris and bulk equipment that could not be successfully decontaminated. The debris and bulk equipment would be macroencapsulated by packaging it in stainless steel boxes that would then be welded shut. The second macroencapsulation process would be for mixed waste lead, debris, and bulk equipment. The lead would not have been sent to the decontamination bay in the previous step, but, rather would be sent directly from the container opening/content sorting bay or the size reduction bay to the macroencapsulation bay. The lead, debris and bulk equipment would be macroencapsulated by coating the surface with a polymer. Mixed waste that is macroencapsulated would be able to be disposed in RCRA-permitted disposal vaults because it would meet the applicable land disposal restriction treatment standards under the debris rule.

The fifth bay would be the packaging bay. This bay would house equipment to facilitate the packaging of waste into a waste container. Wastes would either be packaged for onsite disposal as a mixed waste (i.e., if macroencapsulated) or packaged for transportation to the applicable low-level waste facility for further processing if successfully decontaminated (Hess 1994a).

For alternatives A and B, it is estimated that approximately 80 percent of the incoming debris and bulk equipment waste would be successfully decontaminated and that 20 percent would need to be macroencapsulated prior to disposal. Additionally, it is estimated that the quantity of spent decontamination solutions generated during decontamination procedures would be equal to 50 percent of the influent waste volume (Hess 1994b).

	Min.	Exp.	Max.
No Action			
A			
B			
C			

Alternative C

The major differences between the containment building proposed under alternative C and that proposed under alternatives A and B are the inclusion of:

- roasting, retorting, and amalgamation (see glossary) of mercury and mercury-contaminated wastes
- wet chemical oxidation of reactive metals
- debris and equipment that could not be decontaminated would be transferred to the non-alpha vitrification facility instead of treated by macroencapsulation
- nonradioactive materials would be separated into lead and non-lead components by a combination of physical and

- chemical separation techniques
- radioactive lead would be treated at the non-alpha vitrification facility instead of macroencapsulated by polymer coating at the containment building

The containment building would process both hazardous and mixed wastes under alternative C.

Under alternative C, the containment building would be designed with six separate processing bays as follows: (1) container opening/content sorting, (2) size reduction/physical separation, (3) roasting/retorting and amalgamation, (4) wet chemical oxidation, (5) decontamination, and (6) repackaging/waste characterization. As discussed for alternatives A and B, waste would be processed through each bay as necessary to properly handle each individual type of waste. If processing associated with a particular bay is not required for a specific waste, the bay would be bypassed. Each bay would contain the necessary equipment to conduct the respective activities.

The container opening/content sorting bay and the size reduction/physical separation bay would have the same function as discussed above. Hazardous and mixed waste containers would be opened and their contents sorted by size. Hazardous wastes would be sorted on tables, while mixed wastes would be sorted using glove boxes. Wastes requiring size reduction would be sent to the size reduction/physical separation bay. Additionally, hazardous waste that contains lead would be separated into lead and nonlead components by cutting or disassembling the lead-containing waste items (e.g., removing lead components such as solder or washers from a piece of equipment). After sorting, dismantling, and/or size reduction, hazardous waste lead would not be further processed in the containment building; instead, it would be sent directly to the last bay for repackaging (Hess 1994a).

Approximately 48 cubic meters (1,700 cubic feet) of pumps that contain mercury would be sent to the third bay for roasting and retorting. The mercury that is captured during the process and additional elemental mercury wastes would be amalgamated to meet the land disposal restrictions treatment standards. The amalgamated mercury would be approximately 1 cubic meter (264 gallons) in volume and would be able to be disposed of at the RCRA-permitted disposal vaults. The metal pumps would be reclassified as a low-level waste and would need no further treatment (Hess 1994b).

Approximately 5 cubic meters (170 cubic feet) of the hazardous and mixed waste metal debris that would be sent to the containment building contains reactive metals. This waste would be treated in the fourth bay by wet chemical oxidation to eliminate the reactivity in accordance with the land disposal restrictions treatment standards. Liquid residuals that are generated during the wet chemical oxidation process, approximately 15 cubic meters (530 cubic feet), would be collected in a tank truck for treatment at the non-alpha vitrification facility (Hess 1994b).

Bulk equipment and debris would be decontaminated in the fifth bay using technologies such as degreasing, water washing, and/or carbon dioxide blasting. No hazardous lead wastes would be sent to the decontamination bay. Decontamination solutions would be collected in a tank truck for treatment at the non-alpha vitrification facility. Mixed wastes that are successfully decontaminated (i.e., the hazardous component of the waste has been removed) would be reclassified as low-activity equipment waste and managed in accordance with the proposed alternatives for that treatability group. Hazardous wastes that are successfully decontaminated would be recycled. Wastes that are not successfully decontaminated would require further onsite processing.

Wastes would be packaged in the sixth bay. This bay would have equipment to facilitate the

packaging of waste from the various bays into a waste container. Mixed wastes that are successfully treated and/or decontaminated (i.e., the hazardous component of the waste has been removed) and the pumps that were roasted/retorted would be reclassified as low-level waste and would be packaged for transport to an onsite low-level waste disposal facility. Amalgamated mercury would be packaged for disposal at RCRA-permitted disposal vaults. Mixed wastes that are not treated and/or decontaminated (i.e., the hazardous component of the waste still remains), hazardous wastes that are not decontaminated, and the dismantled lead hazardous wastes would be repackaged for further processing onsite. Hazardous waste metals that are decontaminated would be reused onsite as a substitute for a new product or would be sold as scrap (Hess 1994a).

Under alternative C, it is estimated that approximately 80 percent of the hazardous and mixed waste would be able to be decontaminated. It is estimated that the quantity of spent decontamination solutions generated during decontamination procedures for both hazardous and mixed wastes would be equal to 50 percent of the influent waste volume to the decontamination unit (Hess 1994b).

PROJECT-SPECIFIC ACTIONS:

	Min.	Exp.	Max.
No Action			
A			
B			
C			

Under the no-action alternative, the containment building would not be constructed.

For each alternative, Table B.6-1 presents the volume of wastes to be decontaminated and macroencapsulated.

	Min.	Exp.	Max.
No Action			
A			
B			
C			

Alternative A - For each forecast, only mixed waste would be treated in the containment building. The following mixed waste treatability groups would be processed: glass debris, metal debris, equipment, lead, heterogeneous debris, inorganic debris, organic debris, and composite filters.

	Min.	Exp.	Max.
No Action			
A			
B			
C			

Alternative B - Only mixed waste would be treated in the containment building. The following mixed waste treatability groups would be processed: glass debris, metal debris, bulk equipment, lead, heterogeneous debris, inorganic debris, and organic debris.

In the maximum forecasts of alternatives A and B, the volume of spent decontamination solution would exceed the available treatment capacity for this waste at the Consolidated Incineration Facility.

The containment building would be modified to include a wastewater treatment unit to treat the spent decontamination solutions. The wastewater treatment process would result in a liquid residual, a solid residual, and the remainder which would be discharged to a National Pollutant Discharge Elimination System permitted outfall. The liquid and solid residuals from the wastewater treatment unit would be treated at the Consolidated Incineration Facility.

	Min.	Exp.	Max.
No Action			
A			
B			
C			

Alternative C - Both hazardous waste and mixed waste would be processed in the containment building. Hazardous waste treatability groups to be decontaminated and/or treated include metal debris (some of which is reactive), bulk equipment, and lead. Mixed waste treatability groups to be decontaminated and/or treated include metal debris (some of which is reactive), bulk equipment, elemental mercury and mercury-contaminated process equipment.

Table B.6-1. Waste that would be treated between the years 2006 and 2024 in the containment building under each alternative (cubic meters).a,b

	Min.	Exp.	Max.
		the containment building containment building would not be constructed	
A	40,601 m ³ decontaminated (2,136 m ³ annually) 9,439 m ³ macroencapsulated (497 m ³ annually)	76,983 m ³ decontaminated (4,052 m ³ annually) 18,419 m ³ macroencapsulated (969 m ³ annually)	275,684 m ³ decontaminated (14,510 m ³ annually) 62,803 m ³ macroencapsulated (3,305 m ³ annually) mixed waste mixed waste only
	mixed waste mixed waste only	mixed waste mixed waste only	137,842 m ³ decontamination solution 6,892 m ³ liquid residual 1,378 m ³ solid residual 129,572 m ³ discharged to outfall

B	26,062 m ³ decontaminated (1,372 m ³ annually)	51,680 m ³ decontaminated (2,720 m ³ annually)	185,468 m ³ decontaminated (11,000 m ³ annually)
	6,531 m ³ macroencapsulated (344 m ³ annually)	13,358 m ³ macroencapsulated (703 m ³ annually)	39,896 m ³ macroencapsulated (2,350 m ³ annually)
	mixed wastemixed waste only	mixed wastemixed waste only	mixed wastemixed waste only
			92,734 m ³ decontamination solution 4,637 m ³ liquid residual 927 m ³ solid residual 87,170 m ³ discharged to outfall
C	11,120 m ³ MW decontaminated ^d (586 m ³ annually)	23,409 m ³ MW decontaminated ^d (1,233 m ³ annually)	86,088 m ³ MW decontaminated ^d (4,700 m ³ annually)
	3,977 m ³ HW decontaminated ^d (209 m ³ annually)	13,743 m ³ HW decontaminated ^d (723 m ³ annually)	24,325 m ³ HW decontaminated ^d (1,280 m ³ annually)

a. Source: Hess (1995a).

b. To convert to gallons, multiply by 264.2.

c. Treated in the Consolidated Incineration Facility.

d. Waste volumes MW = mixed waste; HW = hazardous waste.

B.7 DEFENSE WASTE PROCESSING FACILITY

OBJECTIVE:

The Defense Waste Processing Facility is a system for treatment of high-level radioactive waste at SRS. Defense Waste Processing Facility refers to high-level waste pre-treatment processes, the Vitrification Facility, Saltstone Manufacturing and Disposal, radioactive glass waste storage facilities, and associated support facilities. The process used to recover uranium and plutonium from production reactor fuel and target assemblies in the chemical separations areas at SRS resulted in liquid high-level radioactive waste. This waste, which now amounts to approximately 131 million liters (3.46×10⁷ gallons), is stored in underground tanks in the F- and H-Areas near the center of SRS. After its introduction into the tanks, the high-level waste settles, separating into a sludge layer at the bottom of the tanks and an upper layer of soluble salts dissolved in water (supernatant). The evaporation of the supernatant creates a third waste form, crystallized saltcake, in the tanks. See the *Final Supplemental Environmental Impact Statement Defense Waste Processing Facility* (DOE

1994a) for details.

The Defense Waste Processing Facility is designed to incorporate the highly radioactive waste constituents into borosilicate glass in a process called vitrification and seal the radioactive glass in stainless steel canisters for eventual disposal at a permanent Federal repository located deep within a stable geologic (e.g., rock) formation.

DESCRIPTION:

The Defense Waste Processing Facility system includes processes and associated facilities and structures located in H-, S-, and Z-Areas near the center of SRS. The major parts of the Defense Waste Processing Facility system are listed below:

Pre-treatment (H-Area) - Pre-treatment processes and associated facilities to prepare highlevel waste for incorporation into glass at the Vitrification Facility, including:

- Extended Sludge Processing - a washing process, carried out in selected HArea high-level waste tanks, to remove aluminum hydroxide and soluble salts from the high-level waste sludge. The facility is built, and the process is presently being tested.
- In-Tank Precipitation - a process in HArea to remove cesium through precipitation with sodium tetraphenylborate and strontium and plutonium through sorption onto the sodium titanate solids from the highly radioactive salt solution. The precipitate would be treated by the late wash process; the low radioactivity salt solution that remains would be sent to the Saltstone Manufacturing and Disposal Facility. The In-Tank Precipitation facility is constructed, and testing is nearly complete.
- Late Wash - a process to wash the highly radioactive precipitate resulting from In-Tank Precipitation to remove a chemical (sodium nitrite) that could potentially interfere with operations in the Vitrification Facility. This HArea facility is presently being designed and constructed.

Vitrification Facility and associated support facilities and structures (S-Area) - These facilities include:

- Vitrification Facility - a large building that contains processing equipment to immobilize the highly radioactive sludge and precipitate portions of the high-level waste in borosilicate glass. The sludge and precipitate are treated chemically, mixed with frit (finely ground glass), melted, and poured into stainless steel canisters that are then welded shut. The facility is presently constructed and undergoing startup testing.
- Glass Waste Storage Buildings - buildings for interim storage of the radioactive glass waste canisters in highly shielded concrete vaults located below ground level. One building is completed; one building is in the planning stage.
- Chemical Waste Treatment Facility - an industrial waste treatment facility that neutralizes nonradioactive wastewater from bulk chemical storage areas and nonradioactive process areas of the Vitrification Facility. This facility is constructed and in operation.
- Failed Equipment Storage Vaults - shielded concrete vaults that would be used for interim storage of failed melters and possibly other process equipment that are too radioactive to allow disposal at existing onsite disposal facilities. These vaults would be used until permanent disposal facilities can be developed. Two vaults are nearly constructed; four more vaults are planned for the near future. DOE estimates that a total of approximately 14 vaults would be needed to accommodate wastes generated during the 24-year operating period covered under the Defense Waste Processing Facility Supplemental eis.
- Organic Waste Storage Tank - A 568,000-liter (150,000-gallon) capacity aboveground tank that stores liquid organic waste consisting mostly of benzene. During radioactive operations, the tank would store hazardous and low-level radioactive waste that would be a byproduct of the vitrification process as a result of processing high-level radioactive precipitate from the InTank Precipitation process. The tank is constructed and stores nonradioactive liquid organic waste generated during startup testing of the Vitrification Facility.

Saltstone Manufacturing and Disposal (Z-Area) - Facilities to treat and dispose of the low radioactivity salt solution resulting from the In-Tank Precipitation pre-treatment process, including:

- Saltstone Manufacturing Plant - a processing plant that blends the low radioactivity salt solution with cement, slag, and flyash to create a mixture that hardens into a concrete-like material called saltstone. The plant is constructed and in operation to treat liquid waste residuals from the F/H-Area Effluent Treatment Facility, an existing wastewater treatment facility that serves the tank farms. The plant is ready for treatment of the low radioactivity salt solution produced by In-Tank Precipitation.
- Saltstone Disposal Vaults - large concrete disposal vaults into which the mixture of salt solution, flyash, slag, and cement that is prepared at the Saltstone Manufacturing Plant is pumped. After cells in the vault are filled, they are sealed with concrete. Eventually, the vaults will be covered with soil, and an engineered cap constructed of clay and other materials will be installed over the vaults to reduce infiltration by rainwater and leaching of contaminants into the groundwater. Two vaults have been constructed. DOE estimates that 13 more vaults would be constructed over the life of the facility (DOE 1994a).

Note that the treatment, storage, and disposal facilities described as part of Defense Waste Processing Facility are not considered in this EIS.

PROJECT-SPECIFIC ACTIONS:

	Min.	Exp.	Max.
No Action			
A			
B			
C			

Under each alternative, the Defense Waste Processing Facility would operate until 2018 to process high-level waste stored at SRS.

B.8 E-Area VAULTS

OBJECTIVE:

The E-Area vaults would provide disposal and storage for solid, low-level, nonhazardous wastes to support continuing SRS operations. As presently planned, the facility would include three types of structures for four designated waste categories: low-activity waste vaults would receive one type of waste; the long-lived waste storage buildings would accept wastes containing isotopes with half-lives that exceed the performance criteria for disposal; a third type of structure divided in two parts, intermediate-level nontritium vaults and intermediate-level tritium vaults, would receive two categories of waste.

DOE Order 5820.2A, "Radioactive Waste Management," establishes performance criteria for the disposal of low-level wastes. A radiological performance assessment is required to ensure that the waste inventory and the proposed disposal method provide reasonable assurance that the performance objectives would be met. The radiological performance assessment projects the migration of radionuclides from the disposed waste to the environment and estimates the resulting dose to people. DOE has completed the radiological performance assessment for the E-Area vaults and has incorporated the results into the waste acceptance criteria to define maximum radionuclide inventory limits that are acceptable for disposal. DOE would construct additional vaults of the current designs

or alternate designs that can be demonstrated to achieve the performance objectives.

For purposes of analysis in this EIS, low-level wastes that are not stabilized prior to disposal (except for suspect soils and naval hardware) would be certified to meet the waste acceptance criteria for disposal in the low-level waste vaults. The analyses do not distinguish between the waste forms that are sent to vault disposal. It was assumed that the impacts were a function only of the volume of waste disposal (the number of low-activity waste and intermediate-level waste vaults) for each alternative.

DESCRIPTION:

The *Waste Management Activities for Groundwater Protection Final Environmental Impact Statement* (DOE 1987) and its Record of Decision (53 FR 7557) identified vaults as one of several projectspecific technologies considered for new disposal/storage facilities for low-level radioactive waste. One of the actions was construction of a new "vault design" low-level radioactive waste facility in EArea adjacent to the existing Low-Level Radioactive Waste Disposal Facility.

The E-Area vaults are centrally located between the two chemical separation areas (F-Area and H-Area) near the center of SRS and consist of three types of facilities. Below-grade concrete vaults (referred to as intermediate-level waste vaults) would be used for disposal of containerized intermediate-activity tritiated and nontritiated waste. Above-grade concrete vaults (referred to as low-activity waste vaults) would be used for disposal of containerized low-activity waste. On-grade buildings (referred to as longlived waste storage buildings) would be used for storage of containerized spent deionizer resins and other long-lived wastes.

Intermediate-Level Waste Vaults

An intermediate-level nontritium vault is a concrete structure approximately 58 meters (189 feet) long, 15 meters (48 feet) wide, and 9 meters (29 feet) deep with a seven-cell configuration. Exterior walls are 0.76 meters (2-1/2 feet) thick; and interior walls forming the cells are 0.46 meter (1 1/2 feet) thick. Walls are structurally mated to a base slab, which is approximately 0.76 meter (2 1/2 feet) thick and extends past the outside of the exterior walls approximately 0.6 meter (2 feet) (WSRC 1994c). An intermediate-level nontritium vault has approximately 4,400 cubic meters (1.55×10⁵ cubic feet) of usable waste disposal capacity (Hess 1995b).

An intermediate-level tritium vault is structurally identical to the intermediate-level nontritium vault except for length and depth. The intermediate-level tritium vault is 2 feet deeper and approximately 57 feet long with a two-cell configuration. The intermediate-level tritium vault has approximately 400 cubic meters (14,000 cubic feet) of usable waste disposal capacity (Hess 1995b). One of the intermediate-level tritium vault cells has been fitted with a silo storage system designed to house tritium crucibles.

Shielding blocks and raincovers are provided during cell loading operations. Reinforced concrete blocks are positioned across the width of a cell to provide personnel shielding from the radioactive materials within the cell. The raincover is a roof-truss-type of steel structure that fits around the cells' walls to completely cover the cell opening. Raincovers are installed on a cell until interim closure is accomplished.

Waste containers placed in an intermediate-level vault cell would be encapsulated in grout.

Successive grout layers are cured before installing additional waste containers. A permanent roof slab of reinforced concrete that completely covers the vault cells would be installed after the cells in a vault have been filled. Final closure would be performed after vaults were filled by placing an earthen cover with an engineered clay cap over the entire vault area (WSRC 1994c).

At this time, one intermediate-level nontritium vault and one intermediate-level tritium vault have each been constructed. It is assumed that future intermediate-level vaults would be constructed in a combined single vault configuration of nine cells housing both tritiated and non-tritiated intermediate-activity waste (Hess 1994e). The vault construction would be identical to the intermediate-activity nontritium vaults except that the structure would be approximately 75 meters (246 feet) long. No silos would be provided for tritium crucibles. The usable disposal capacity of each vault would be approximately 5,300 cubic meters (1.87×10^5 cubic feet).

Low-Activity Waste Vaults

The low-activity waste vaults are concrete structures approximately 200 meters (643 feet) long by 44 meters (145 feet) wide by 8 meters (27 feet) deep. Each vault contains 12 cells with approximately 30,500 cubic meters (1.07×10^6 cubic feet) of usable waste disposal capacity. At this time, one low-activity waste vault has been constructed. End, side, and interior walls of each module are 0.61 meter (2 feet) thick. The low-activity waste vault walls are structurally mated to the footers, and the floor slabs are poured between and on top of the footers.

Low-activity waste vaults have a permanent 41-centimeter (16-inch) thick, poured-in-place concrete roof to prevent the infiltration of rainwater and are constructed on poured-in-place concrete pads with sidewalls. When the vaults are filled to capacity, a closure cap would be used to cover the concrete roof to further reduce the infiltration of water. Each cell within the vault has a means of collecting and removing water that enters the vault.

Low-activity waste to be disposed of would be containerized and stacked using an extendible boom forklift. Low-activity waste would be packaged in various approved containers such as steel boxes and Department of Transportation-approved drums. Packaging and stacking would be similar to the engineered low-level trench operation for low-activity waste (see Appendix B.27).

Each low-activity waste vault would be closed in stages. Individual cells would be closed, then the entire vault area would be closed. Low-activity waste vault final closure consists of placing an earthen cover with an engineered clay cap over the entire vault area (WSRC 1994c).

Long-Lived Waste Storage Buildings

The long-lived waste storage buildings would be built on-grade and consist of a poured-in-place concrete slab covered by a steel, pre-engineered, single-span building. The floor slab would be 15 meters (50 feet) square, and the building would be approximately 18 meters (60 feet) square and 6.1 meters (20 feet) high. The floor slab would be 0.3 meter (1 foot) thick with integral deep footings and surface containment curbs around each side. The building would extend past the concrete floor slab on each side. This area would be covered with compacted, crushed stone on three sides, and the fourth side would be covered with a poured-in-place, reinforced concrete pad. This pad would provide an access ramp for vehicle travel into the long-lived waste storage building.

Process water deionizers from Reactors would be stored in the long-lived waste storage building that

has been constructed in the E-Area. These deionizers contain carbon-14 which has a half-life of 5,600 years (WSRC 1994b). The building would be able to store a total of 140 cubic meters (4,839 cubic feet) of waste. Wastes would be placed using a forklift and would be containerized and provided with adequate shielding. DOE plans to build additional storage buildings as needed (WSRC 1993b).

After long-lived waste storage buildings are filled with waste containers, the equipment and personnel access doors would be closed and locked. Long-lived waste storage buildings would not be permanent disposal facilities (WSRC 1994c). The disposition of the long-lived waste has not been determined and would be subject to a subsequent National Environmental Policy Act (NEPA) evaluation. Long-lived wastes would continue to be stored for the duration of the 30-year analysis period for each alternative and forecast considered in this EIS.

PROJECT-SPECIFIC ACTIONS:

	Min.	Exp.	Max.
No Action			
A			
B			
C			

Under the no-action alternative, the E-Area vaults would be used for disposal of low-activity and intermediate-activity wastes. Low-activity wastes planned for disposal in the E-Area vaults include low-activity job control waste, offsite job control waste, low-activity equipment waste, and low-activity soils. Nonmixed alpha waste would also be segregated for disposal in low-activity waste vaults. Intermediate-activity wastes planned for disposal in vaults include tritiated job control waste, tritiated soils, tritiated equipment wastes, and intermediate-activity job control waste. Long-lived waste would be stored in the long-lived waste storage building.

	Min.	Exp.	Max.
No Action			
A			
B			
C			

Under alternative A, the E-Area vaults would be used for disposal of the same low-level waste identified under the no-action alternative.

	Min.	Exp.	Max.
No Action			
A			
B			
C			

Under alternative B, the E-Area vaults would be used for disposal of low-activity job control waste, offsite job control waste, low-activity soils, low-activity equipment, intermediate-activity job control waste, tritiated job control waste, intermediate-activity equipment, tritiated equipment, tritiated soils, and compacted low-level waste. Nonmixed alpha waste would also be segregated for disposal in low-activity waste vaults. Low-activity job control and equipment waste treated by offsite commercial vendors would also be returned to SRS for disposal in the low-activity waste vaults.

	Min.	Exp.	Max.
No Action			
A			
B			
C			

Under alternative C, the E-Area vaults would be used for disposal of the same waste as indicated under alternative B, except for off-site commercial vendor-treated low-activity job control and equipment waste, from the year 1995 to 2005. After 2006, when the non-alpha vitrification facility begins operation, all low-level waste would be disposed of by shallow land disposal.

Estimated volumes for long-lived waste storage and low-level waste vault disposal for each alternative are presented in Tables B.8-1 and B.8-2.

Table B.8-1. Estimated volumes and number of additional buildings required for storing long-lived waste under each alternative.a

	Min.	Exp.	Max.
		3,333 m ³ 24 buildings	
A	1,033 m ³ 7 buildings	3,333 m ³ 24 buildings	4,672 m ³ 34 buildings
B	1,033 m ³ 7 buildings	3,333 m ³ 24 buildings	4,672 m ³ 34 buildings
C	1,033 m ³ 7 buildings	3,333 m ³ 24 buildings	4,672 m ³ 34 buildings

a. Source: Hess (1994b).

Table B.8-2. Estimated volumes of low-level waste and number of additional vaults required for each alternative (cubic meters).a

Min.	Exp.	Max.
	351,099 m ³ 10 low-activity waste vaults	
	28,912 m ³ 5 intermediate-level waste vaults	

A	254,254 m ³ 9 low-activity waste vaults	356,767 m ³ 12 low-activity waste vaults	933,637 m ³ 31 low-activity waste vaults
	15,045 m ³ 2 intermediate-level waste vaults	28,912 m ³ 5 intermediate-level waste vaults	166,201 m ³ 31 intermediate-level waste vaults
B	45,546 m ³ 1 low-activity waste vaults	61,471 m ³ 1 low-activity waste vaults	250,595 m ³ 8 low-activity waste vaults
	13,878 m ³ 2 intermediate-level waste vaults	27,013 m ³ 5 intermediate-level waste vaults	48,730 m ³ 9 intermediate-level waste vaults
C	70,672 m ³ 2 low-activity waste vaults	86,170 m ³ 2 low-activity waste vaults	168,499 m ³ 5 low-activity waste vaults
	5,831 m ³ 1 intermediate-level waste vaults	10,953 m ³ 2 intermediate-level waste vaults	16,032 m ³ 3 intermediate-level waste vaults

a. Source: Hess (1995b).

B.9 EXPERIMENTAL TRANSURANIC WASTE ASSAY FACILITY/ WASTE CERTIFICATION FACILITY

OBJECTIVE:

The Experimental Transuranic Waste Assay Facility, which is not currently operating, is designed to weigh, assay, and x-ray drums of alpha waste to ensure they are properly packaged to meet the waste acceptance criteria of the transuranic waste storage pads, low-activity waste vaults, or RCRA-permitted disposal vaults. The Waste Certification Facility provides certification capabilities for disposal of nonmixed and mixed alpha waste (10 to 100 nanocuries of transuranic activity per gram). The Experimental Transuranic Waste Assay Facility/Waste Certification Facility is designed to accept only vented 55-gallon drums of waste.

DESCRIPTION:

The Experimental Transuranic Waste Assay Facility/Waste Certification Facility would ensure that SRS transuranic waste meet the acceptance criteria established by the Waste Isolation Pilot Plant. The criteria identify the numerous requirements that must be met to allow transuranic waste to be disposed at the Waste Isolation Pilot Plant, including but not limited to packaging, waste characterization, and radiological content.

The overall facility is housed in a metal building in E-Area. The facility was constructed in two parts. The Experimental Transuranic Waste Assay Facility portion is 15 meters (50 feet) wide by 9.1 meters (30 feet) long and 4.3 meters (14 feet) high. The assay bay has the capacity to temporarily hold a 100-drum backlog of waste while operating. The facility handles one drum at a time. Each drum is xrayed to see if proper waste forms have been packaged and weighed to assist assay calculation. The drum is

assayed for alpha radioactivity measured in nanocuries per gram of waste. The weight of the container is subtracted from the weight of the container plus contents to ensure that the assay calculation is done on the waste only (WSRC 1992a).

The Waste Certification Facility portion has a packaging bay measuring 10 meters (33 feet) wide, 16 meters (53 feet) long, and 9 meters (30 feet) high and side offices that are 4.6 meters (15 feet) wide, 5.2 meters (17 feet) long, and 4.3 meters (14 feet) high. The facility was originally designed to certify and band drums in 7-drum arrays and load them for shipment to the Waste Isolation Pilot Plant. The packaging bay is equipped with an 18-metric-ton (20-ton) bridge crane for the loading operations. The packaging bay has the capacity to temporarily hold a 56-drum backlog while operating (WSRC 1992a).

A ventilation system for the facility provides a once-through air source. The assay and packaging bays each have individual air supply systems. The exhaust system that is common to both facilities includes high efficiency particulate air filters and a stack. The assay bay and the packaging bay each have washdown capabilities that drain to collection sumps and are emptied by a pump (WSRC 1992a).

PROJECT-SPECIFIC ACTIONS:

Table B.9-1 presents the volume of waste that would be processed through the Experimental Transuranic Waste Assay Facility/Waste Certification Facility for each alternative.

	Min.	Exp.	Max.
No Action			
A			
B			
C			

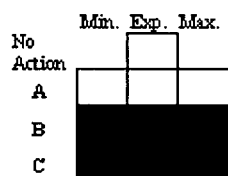
Under the no-action alternative, the facility would x-ray, weigh, and assay waste 55- and 83-gallon drums. The assay would be performed to check generator packaging and to certify drums of alpha waste for vault disposal. The overall throughput of the facility would range from 14 to 116 cubic meters (3,700 to 30,600 gallons) per year.

	Min.	Exp.	Max.
No Action			
A			
B			
C			

For all waste forecasts of alternative A, the facility would assay, treat, and certify the nonmixed and mixed alpha waste for disposal until the transuranic waste characterization/certification facility began operation in 2007. The average throughput of the facility would range from 67 to 192 cubic meters (15,900 to 51,800 gallons) per year.

The majority of the mixed alpha waste would be considered hazardous debris in accordance with RCRA land disposal restrictions. DOE would request a treatability variance for macroencapsulation of the mixed alpha waste that was not classified as hazardous debris. The mixed alpha waste would be macroencapsulated by welding the lids of the steel drums. The Waste Certification Facility would be modified to include a drum welding unit to treat the mixed alpha waste and certify this waste for

disposal in RCRA-permitted vaults. The nonmixed alpha waste would also be certified in the Waste Certification Facility in accordance with the acceptance criteria of the low-activity waste vaults.



Under alternatives B and C, the facility would not operate.

Table B.9-1. Volume of waste that would be processed through the Experimental Transuranic Waste Assay Facility/Waste Certification Facility for each alternative (cubic meters).a,b

	Min.	Exp.	Max.
		40 m ³ per year (1,216 m ³ total)	
A	67 m ³ per year until 2007 (801 m ³ total)	108 m ³ per year until 2007 (1,303 m ³ total)	192 m ³ per year until 2007 (2,302 m ³ total)
B	Would not operate	Would not operate	Would not operate
C	Would not operate	Would not operate	Would not operate

a. Source: Hess (1995a).

b. To convert to gallons, multiply by 264.2

B.10 F/H-Area EFFLUENT TREATMENT FACILITY

OBJECTIVE:

The F/H-Area Effluent Treatment Facility is a permitted industrial wastewater treatment facility that decontaminates and treats low-level process water and stormwater contaminated with radioactive and/or chemical constituents. Routine influents accepted by the F/H-Area Effluent Treatment Facility are primarily evaporator condensate from the chemical separations facilities and the tank farms. Approximately 34 percent of the influent to the F/H-Area Effluent Treatment Facility comes from F-Area sources, including the separations facility, cooling and stormwater retention basins, evaporator overheads, and laboratory liquid waste. Influent from H-Area comprise approximately 48 percent of the influent and include the separations facility, cooling and stormwater retention basins, evaporator condensate, tritium laboratory liquid waste, water inside the In-Tank Precipitation dike (an embankment designed to control water runoff), and laboratory liquid waste. The remaining 18 percent of the influent consists of Defense Waste Processing Facility recycle water generated from nonradioactive chemical testing, rainwater and process water, investigation-derived waste from

groundwater monitoring wells, and laboratory waste. Roughly 76,000 cubic meters (2.0×10⁷ gallons) per year of wastewater is currently treated at the F/H-Area Effluent Treatment Facility (Todaro 1994). The chemical and radiological constituents of the influent wastewater are presented in Table B.10-1. The contaminants which the F/H-Area Effluent Treatment Facility removes from the influent stream are concentrated into 1 to 2 percent of the original volume. The F/H-Area Effluent Treatment Facility concentrate is pumped to Tank 50H for eventual disposal at the Z-Area Saltstone Manufacturing and Disposal Facility (WSRC 1994a). The decontaminated wastewater is discharged to Upper Three Runs.

The F/H-Area Effluent Treatment Facility was built to replace the old F- and H-Area seepage basins, which, under the 1984 Hazardous and Solid Waste Amendments to RCRA, could not be used after 1988. NEPA documentation (MemotoFile) was completed in 1986 for construction and operation of the F/H-Area Effluent Treatment Facility. F/H-Area Effluent Treatment Facility operations began in October 1988 (Wiggins 1992).

DESCRIPTION:

The F/H-Area Effluent Treatment Facility process is diagrammed in Figure B.10-1. The facility consists of process wastewater tanks, treated water tanks, double-lined storage basins, and a 0.9cubic-meter-per-minute (235gallon-per-minute) water treatment facility (WSRC 1994d). Dilute wastewater streams from various generators at SRS are discharged into process sewers, which drain by gravity to the F- and H-Area lift stations, from which they are pumped to the F/H-Area Effluent Treatment Facility. As previously stated, most of the wastewater influent comes primarily from evaporator condensate generated at the F/H-Area separations areas and tank farms. Another minor contributor is rainwater that collects in various dikes located in radiological areas and near chemical tanks. The separations areas and high-level waste processes require monitoring of non-contact cooling water before it is discharged to the environment to ensure that it is not radioactively contaminated (WSRC 1994e). Radioactively contaminated water is diverted to one of four large, lined basins. Water in the basins is segregated depending on its source and degree of contamination (DOE 1986a). Historically, such diversions occur infrequently. Each diversion is evaluated on a case-by-case basis to determine the proper handling (WSRC 1994e).

Figure B.10-1. F/H-Area Effluent Treatment Facility (ETF).

The F/H-Area Effluent Treatment Facility decontaminates wastewater through a series of steps consisting of pH adjustment, sub.micron filtration, heavy-metal and organic adsorption, reverse osmosis, and ion exchange. The treatment steps concentrate the contaminants into a smaller volume of secondary waste, which is then further concentrated by evaporation. The waste concentrate is eventually disposed of in the Z-Area Saltstone Manufacturing and Disposal Facility. The treated effluent is analyzed to ensure that it has been properly decontaminated and discharged to Upper Three Runs through permitted outfall H-016 (DOE 1986b) if it meets the National Pollutant Discharge Elimination System discharge criteria. The effluent's chemical content is regulated by the F/H-Area Effluent Treatment Facility Wastewater Permit, and the discharge radionuclide limits are set by DOE Order 5400.5, "Radiation Protection of the Public and the Environment."

PROJECT-SPECIFIC ACTIONS:

	Min.	Exp.	Max.
No Action			
A			
B			
C			

Under each alternative, the F/H-Area Effluent Treatment Facility would continue to treat low-level radioactively contaminated wastewater. The expected forecast wastewater flow into the F/H-Area Effluent Treatment Facility from current F and H-Area operations (based on historical data) is approximately 62,000 cubic meters per year, or 1.8×10^6 cubic meters over the 30-year analysis period. The volume of F- and H-Area wastewater to be treated at the Effluent Treatment Facility is approximately 14.7×10^6 cubic meters over 30 years for the maximum forecast and 9.3×10^5 cubic meters over 30 years for the minimum forecast (Todaro 1994). An increased volume of waste is expected due to the projected increase in environmental restoration activities and operation of the Defense Waste Processing Facility over a 30-year period. Investigation-derived wastes from environmental restoration activities (aqueous liquids from groundwater monitoring wells), which would be treated at the F/H-Area Effluent Treatment Facility, are currently projected at approximately 27,838 cubic meters (7.35×10^6 gallons) over the 30-year period (Hess 1995a) for the expected waste forecast. For the maximum waste forecast, the volume of investigation-derived wastes to be treated at the F/H-Area Effluent Treatment Facility is estimated to be approximately 44,800 cubic meters (1.18×10^7 gallons) over the 30-year period. For the minimum waste forecast, the volume of investigation-derived wastes to be treated at the F/H-Area Effluent Treatment Facility is estimated to be approximately 3,964 cubic meters (1.05×10^6 gallons) over the 30-year period. The Defense Waste Processing Facility is expected to generate approximately 37.8 cubic meters (10,000 gallons) per day of recycle wastewater (at 75 percent attainment) or 22.7 cubic meters (6,000 gallons) per day at 45 percent attainment after radioactive operations have begun. The Defense Waste Processing Facility wastewater would be processed by the tank farm evaporators and the overheads treated at the F/H-Area Effluent Treatment Facility. During nonradioactive startup testing, the Defense Waste Processing Facility is expected to generate approximately 18.9 cubic meters (5,000 gallons) per day of wastewater to be treated directly at the F/H-Area Effluent Treatment Facility. Table B.102 presents additional volumes of wastewater to be treated at the F/H-Area Effluent Treatment Facility as a result of Defense Waste Processing Facility recycle and investigation-derived wastes from groundwater monitoring well operations.

Table B.10-1. Chemical and radioactive constituents currently treated at the F/H-Area Effluent Treatment Facility.a

Chemical Constituents	Radioactive Constituents
MercuryMercury	Gross alpha radioactivity
Chromium	Nonvolatile beta/gamma radioactivity
Copper	(Dissolved) tritiumtritium
Lead	CesiumCesium-137

Zinc
Silver
Aluminum
Iron
Nitrate
Magnesium
Arsenic
Cadmium
Selenium
Silicon
Sulfur
Chlorine

a. Source: WSRC (1994d).

Table B.10-2. Additional volume of wastewater to be treated at the F/H-Area Effluent Treatment Facility over the 30-year analysis period (cubic meters).a,b

	Min.	Exp.	Max.
		358,966 m ³	
A	335,092 m ³	358,966 m ³	375,883 m ³
B.	335,092 m ³	358,966 m ³	375,883 m ³
C	335,092 m ³	358,966 m ³	375,883 m ³

a. Source: Todaro (1994); Hess (1995a).

b. To convert to gallons, multiply by 264.2.

B.11 HAZARDOUS WASTE/MIXED WASTE DISPOSAL VAULTS

OBJECTIVE:

DOE Order 5820.2A establishes performance objectives for the disposal of low-level wastes, including mixed low-level wastes. A radiological performance assessment is required to ensure that the waste inventory and the proposed disposal method provide reasonable assurance that the performance objectives of DOE Order 5820.2A will be met. The radiological performance assessment projects the migration of radionuclides from the disposed waste to the environment and estimates the resulting dose to man. DOE has submitted a RCRA permit application to the South Carolina Department of Health and Environmental Control (SCDHEC) requesting permission to construct 10 Hazardous Waste/Mixed Waste Disposal Vaults. A radiological performance assessment

will be prepared at a later date to determine the performance of the Hazardous Waste/Mixed Waste Disposal Vault design and establish waste acceptance criteria defining the maximum radionuclide inventory limits that are acceptable for disposal. Based on results from the radiological performance assessment, DOE could determine that alternative disposal methods meeting RCRA design specifications would also achieve the performance objectives of DOE Order 5820.2A for certain SRS mixed wastes. For purposes of analysis in this EIS, RCRA disposal capacity has been based on the current Hazardous Waste/Mixed Waste Disposal Vault's design, which conforms to the joint design guidance for mixed waste land disposal facilities issued by EPA and the Nuclear Regulatory Commission in 1987.

DESCRIPTION:

RCRA-permitted disposal vaults were addressed in the *Waste Management Activities for Groundwater Protection Final EIS*, and DOE decided to construct and operate these vaults (53 FR 7557; March 2, 1988). Since then, DOE has submitted a RCRA permit application to SCDHEC to construct 10 Hazardous Waste/Mixed Waste Disposal Vaults in the central portion of SRS about 0.80 kilometer

(0.5 mile) northeast of F-Area. Once the permit application is approved by SCDHEC, the vaults would be constructed and operated. They would be above-grade reinforced concrete vaults designed for the permanent disposal of hazardous and mixed waste generated at various locations throughout SRS. The disposal vaults would be permitted as landfills in accordance with 40 CFR 264, Subpart N, and designated as Buildings 645-1G through 645-10G.

The approximate outside dimensions of each vault would be 62 meters (205 feet) long by 14 meters (46.5 feet) wide by 7.8 meters (25.7 feet) high. Each vault would contain four individual waste cells which could each contain 300 concrete disposal containers or 2,250 55-gallon drums. This is equivalent to a capacity of 2.3 acre-feet or a usable capacity of approximately 2,300 cubic meters (81,200 cubic feet) (Hess 1994e). Wastes would meet land disposal restriction standards prior to placement in the Hazardous Waste/Mixed Waste Disposal Vaults. Liquid wastes would not be disposed in these vaults. Each vault would contain a leachate collection system, leak detection system, and primary and secondary containment high-density polyethylene liners. The waste would be placed in the cells using a crane and a closed circuit camera/monitoring system. The waste would generally be transported to the vaults in either concrete containers or 55-gallon drums. During the time that waste is being placed in the vault, each individual waste cell would be covered with temporary steel covers. Once each individual vault was filled, a permanent reinforced concrete cap would be added to the structure. After the last vault is sealed, the area surrounding the vaults would be backfilled with soil to the top of the roofs. A cover of low permeability material would be constructed over the top of the soil backfill and the vaults.

Wastes planned for disposal in the Hazardous Waste/Mixed Waste Disposal Vaults would include vitrified mixed wastes from the M-Area Vendor Treatment Facility; stabilized ash and blowdown wastes from the Consolidated Incineration Facility; macroencapsulated wastes from the containment building; gold traps, safety/control rods, In-Tank Precipitation filters, Defense Waste Processing Facility late wash filters, and mercury-contaminated process equipment; and vitrified wastes from the alpha and nonalpha vitrification facilities.

PROJECT-SPECIFIC ACTIONS:

	Min.	Exp.	Max.
No Action			
A			
B			
C			

Under the no-action alternative, RCRA-permitted disposal would only be used for the disposal of mixed waste. Mixed waste planned for disposal includes vitrified wastes from the M-Area Vendor Treatment Facility, gold traps, safety/control rods, In-Tank Precipitation filters, and Defense Waste Processing Facility late wash filters. In-Tank Precipitation and Defense Waste Processing Facility late wash filters would not be disposed of immediately because they must be stored for a period of time prior to disposal to allow for offgassing.

Due to the limited amount of treatment under the no-action alternative, only 2,182 cubic meters (77,000 cubic feet) of mixed waste would be suitable for placement in RCRA-permitted disposal over the 30-year analysis period. Because each vault has a usable capacity of 2,300 cubic meters (81,200 cubic feet), a single vault would be sufficient to meet onsite disposal capacity requirements under the no-action alternative. This vault would begin accepting waste in 2002.

	Min.	Exp.	Max.
No Action			
A			
B			
C			

Under each of the action alternatives, DOE plans to treat both hazardous and mixed waste (including alpha waste containing 10 to 100 nanocuries per gram transuranics) onsite and send residuals to onsite RCRA-permitted disposal. DOE would build additional vaults as needed to provide for RCRA-permitted disposal capacity needs. The additional vaults would be identical in construction to the initial vault.

	Min.	Exp.	Max.
No Action			
A			
B			
C			

Wastes that would be placed in the vaults under alternative A include vitrified wastes from the M-Area Vendor Treatment Facility; stabilized ash and blowdown wastes from the Consolidated Incineration Facility; macroencapsulated mixed wastes treated in the containment building; gold traps, safety/control rods, In-Tank Precipitation and Defense Waste Processing Facility late wash filters, and mercury-contaminated process equipment; and macroencapsulated mixed alpha wastes.

	Min.	Exp.	Max.
No Action			
A			
B			
C			

Wastes planned for RCRA-permitted disposal under alternative B include vitrified wastes from the M-Area Vendor Treatment Facility; stabilized ash and blowdown wastes from the Consolidated Incineration Facility; macroencapsulated mixed wastes treated in the containment building; gold traps, safety/control rods, In-Tank Precipitation and Defense Waste Processing Facility late wash filters, and mercury-contaminated process equipment; vitrified soils and sludges from the non-alpha vitrification facility; and macroencapsulated mixed alpha wastes.

	Min.	Exp.	Max.
No Action			
A			
B			
C			

Wastes planned for RCRA-permitted disposal under alternative C include vitrified wastes from the M-Area Vendor Treatment Facility; stabilized ash and blowdown wastes from the Consolidated Incineration Facility; gold traps, safety/control rods, and In-Tank Precipitation and Defense Waste Processing Facility late wash filters; amalgamated radioactive mercury; vitrified hazardous and mixed wastes from the non-alpha vitrification facility; macroencapsulated mixed alpha wastes; and vitrified mixed wastes containing 10 to 100 nanocuries per gram transuranics from the alpha vitrification facility.

Table B.11-1 presents the different volumes of waste that would be disposed and the number of vaults required for each alternative.

Table B.11-1. Estimated volumes of hazardous and mixed wastes and the number of vaults required for each alternative (cubic meters).a,b

	Min.	Exp.	Max.
		2,182 m ³ 1 vault	
A	46,260 m ³ 21 vaults	140,025 m ³ 61 vaults	797,796 m ³ 347 vaults
B	44,734 m ³ 20 vaults	47,570 m ³ 21 vaults	220,513 m ³ 96 vaults
C	21,803 m ³ 10 vaults	90,223 m ³ 40 vaults	254,698 m ³ 111 vaults

- a. Source: Hess (1995a).
 - b. To convert to gallons, multiply by 264.2.
-

B.12 HAZARDOUS WASTE STORAGE FACILITIES

OBJECTIVE:

The hazardous waste storage facilities would provide storage capacity for SRS containerized hazardous wastes in accordance with RCRA requirements.

DESCRIPTION:

Hazardous wastes generated at various locations throughout SRS are stored in three RCRA-permitted hazardous waste storage buildings and on three interim status storage pads in B. and N Areas. These locations are collectively referred to as the Hazardous Waste Storage Facility. For RCRA permitting purposes Building 645-2N is included in the Hazardous Waste Storage Facility permit. However, since Building 645-2N is used for the storage of mixed waste, it is discussed under mixed waste storage in Appendix B.16.

The three RCRA-permitted hazardous waste storage buildings are Buildings 710-B, 645-N, and 645-4N. Buildings 710-B and 645-4N are completely enclosed structures with metal roofs and sides. Building 645-N is a partially enclosed metal building; two sides of the building are sheet metal while the remaining two sides are enclosed by a chain-link fence with gates. Usable storage capacities of each of the hazardous waste storage buildings are as follows: Building 710-B, 146 cubic meters (5,200 cubic feet); Building 645-N, 171 cubic meters (6,000 cubic feet); and Building 645-4N, 426 cubic meters (15,000 cubic feet) (WSRC 1993e). The three buildings rest on impervious concrete slabs. Building 645-N and Building 710-B are divided into waste storage cells that have concrete curb containment systems. Building 645-4N has a single bay with a concrete curb containment system. In Buildings 645-N and 645-4N, the floor of each storage cell (or, for Building 645-4N, the floor in general) slopes toward an individual sump for the collection of released liquids. Hazardous waste is stored primarily in 55-gallon Department of Transportation-approved drums. However, metal storage boxes may be used to store solid wastes. Containers are stored on wooden pallets, and the boxes have metal risers to elevate them off the floor. Once DOE has accumulated enough containers, they are transported to an offsite RCRA treatment and disposal facility.

The Solid Waste Storage Pads are open storage areas located on the asphalt pads within the fenced area of N-Area. Waste Pad 1 is located between Building 645-2N and Building 645-4N; Waste Pad 2 is located between Building 645-4N and 645-N; and Waste Pad 3 is located east of Building 645-N. Hazardous waste is stored in 55-gallon Department of Transportation-approved drums or in metal boxes. Only solid wastes are stored on the Solid Waste Storage Pads. The combined usable storage capacity of the Solid Waste Storage Pads is 1,758 cubic meters (62,000 cubic feet) (WSRC 1993e). The asphalt pads are sloped to drain rainwater; the containers are placed on pallets and the metal boxes have risers to prevent rainwater from coming into contact with them. Once DOE has accumulated enough containers, they are transported to an offsite RCRA treatment and disposal facility.

Hazardous wastes are also stored in the interim status storage building, Building 316-M. The building is essentially an above-grade concrete pad with a pavilion-like structure surrounded by a chain-link fence. The pad is curbed on three sides; the fourth side is built to a sufficient elevation to ensure drainage to static sumps within the pad. Hazardous waste is containerized in 55gallon drums. The building measures 37 meters (120 feet) by 15 meters (50 feet) with an actual storage area of 30 meters (100 feet) by 12 meters (40 feet). The building has maximum usable capacity of 117 cubic meters (4,100 cubic feet).

Hazardous wastes stored in the Hazardous Waste Storage Facility and Building 316-M include, but, are not limited to the following: lead; organic, inorganic, heterogeneous, glass, and metal debris; equipment; composite filters; paint wastes; organic sludges and liquids; soils; inorganic sludges; still bottoms from onsite solvent distillation; and melt waste from the onsite lead melter.

PROJECT-SPECIFIC ACTIONS:

	Min.	Exp.	Max.
No Action			
A			
B			
C			

Under the no-action alternative, hazardous wastes would continue to be sent offsite for treatment and disposal. Therefore, additional hazardous waste storage would not be required.

	Min.	Exp.	Max.
No Action			
A			
B			
C			

Alternatives A and B - All hazardous wastes would be sent offsite for treatment and disposal or would be incinerated onsite. Accordingly, additional hazardous waste storage would not be required.

	Min.	Exp.	Max.		Min.	Exp.	Max.		Min.	Exp.	Max.
No Action				No Action				No Action			
A				A				A			
B				B				B			
C				C				C			

Alternative C - All hazardous wastes would be sent offsite for treatment and disposal or treated onsite at the containment building, Consolidated Incineration Facility, or non-alpha vitrification facility. Accordingly, additional hazardous waste storage would not be required.

B.13 HIGH-LEVEL WASTE TANK FARMS

OBJECTIVE:

In F- and H-Areas there are a total of 50 active waste tanks designed to store liquid high-level waste. These tanks and associated equipment are known as the F- and H-Area tank farms. The primary purpose of the tank farms is to receive and store liquid high-level waste until the waste can be treated into a form suitable for final disposal. Liquid high-level waste is an aqueous slurry that contains soluble salts and insoluble sludges, each of which has high levels of radionuclides. Tables B.13-1 and B.13-2 present the chemical and radionuclide composition of the high-level radioactive waste. The potential environmental impacts of storing high-level waste in the tank farms were evaluated in the *Double-Shell Tanks for Defense High-Level Radioactive Waste Storage, Environmental Impact Statement* (DOE 1980).

Approximately 130,600 cubic meters (3.45×10^7 gallons) of liquid high-level waste are currently contained in the 50 waste tanks (WSRC 1994f). Collectively, the tanks are at greater than 90 percent of usable capacity. During the next 30 years, DOE's primary objective for its high-level waste program is to remove the waste from the tanks without adequate secondary containment and prepare it for vitrification at the Defense Waste Processing Facility (WSRC 1994g). The potential environmental impacts of operating the Defense Waste Processing Facility and associated high-level waste facilities as they are presently designed were examined in the *Final Supplemental Environmental Impact Statement, Defense Waste Processing Facility* (DOE 1994a).

Additionally, DOE is obligated under the Federal Facility Agreement executed by DOE, EPA, and SCDHEC in 1993 to remove from service those tanks that do not meet secondary containment standards, that leak, or that have leaked. Of the 50 tanks in service at SRS, 23 do not meet criteria specified in the Federal Facility Agreement for leak detection and secondary containment; these tanks have been scheduled for waste removal (WSRC 1993f).

DESCRIPTION:

The high-level waste tank farms include 51 large underground storage tanks, 4 evaporators (only 2 are operational), transfer pipelines, 14 diversion boxes, 13 pump pits, and associated tanks, pumps, and piping for transferring the waste (WSRC 1991). Tank 16 is empty and will remain so. Tank 16 closure will be addressed under the SRS RCRA Facility Investigation program. The tank farm equipment and processes are permitted by SCDHEC as an industrial wastewater facility under permit number 17,424-IW. Tank 50 is permitted separately under an industrial wastewater treatment permit. Twenty-two of the active tanks are located in F-Area, and 28 are in HArea (WSRC 1991). Figure B.13-1 lists the status and contents of each individual highlevel waste tank.

Figure B.13-2 is a general description of tank farm processes. The tank farms receive waste from a number of sources, primarily in F- and H-Areas. The wastes were produced as the result of the separation of useful products from spent aluminum-clad nuclear fuel and targets. SRS currently generates small amounts of high-level waste as a result of limited production activities. The separations facilities generate two waste streams which are sent to the tank farms: (1) high-heat waste, which contains most of the radionuclides and must be aged in a high-heat waste tank before evaporation, and (2) low-heat waste, which contains a lower concentration of radionuclides and can be sent directly to an evaporator feed tank. A smaller percentage of the total influent to the tank farms is generated from other SRS facilities, including:

- Receiving Basin for Offsite Fuel/Resin Regeneration Facility
- Savannah River Technology Center

- H-Area Maintenance Facility
- Reactor areas (filter backwash)
- F/H-Area Effluent Treatment Facility
- Recycle wastewater from the Defense Waste Processing Facility, when it becomes operational

The supernatant contains mostly sodium salts and soluble metal compounds (mercury, chromium, lead, silver, and barium) with the main radioactive constituent being an isotope of cesium and strontium (WSRC 1992b). To save tank space, supernatant is processed through large evaporators to remove the water, which reduces the liquid volume by approximately 75 percent (WSRC 1994e). The purpose of evaporating the supernatant is to concentrate and immobilize the waste as crystallized salt. Within the evaporator, the supernatant is heated to the boiling point of its aqueous component which induces a vapor phase (called evaporator overheads). The evaporator overheads are condensed and monitored to ensure that they do not contain excessive amounts of radionuclides. If necessary, the overheads pass through a cesium removal column to remove radioactive cesium. Following condensing and monitoring, the evaporator overheads are sent to the F/H-Area Effluent Treatment Facility for final treatment and discharge (WSRC 1991). The concentrated waste remaining after evaporation is transferred to another tank, where it forms into a saltcake. The salt would be processed by In-Tank Precipitation when it becomes operational, where the soluble radioactive metal ions (cesium, strontium, uranium, and plutonium) would be precipitated using sodium tetraphenylborate or adsorbed on monosodium titanate to form insoluble solids. The resulting slurry would be filtered and the solids concentrated. The concentrated precipitate would be sent to the Defense Waste Processing Facility for vitrification, and the filtrate would be transferred to the Saltstone Manufacturing and Disposal Facility for disposition in grout (WSRC 1994d). Refer to the *Final Supplemental Environmental Impact Statement, Defense Waste Processing Facility* for a detailed discussion of In-Tank Precipitation.

Each tank farm has two single-stage, bent-tube evaporators that concentrate wastes. Of these four evaporators, only two (2H and 2F) are currently operating. The other two (1H and 1F) will no longer be operated due to equipment failures and estimated amounts of waste that would come from the separations facilities. The Replacement High-Level Waste Evaporator is currently scheduled for startup in May 1999. Without the Replacement High-Level Waste Evaporator, the tank farm would run out of required tank space, which would force the Defense Waste Processing Facility to stop vitrifying high-level waste. A project description of the Replacement High-Level Waste Evaporator included in this appendix provides a detailed discussion of this facility.

The primary role of the 2H Evaporator is to evaporate the 221-H separations facility's lowheat waste stream, the Receiving Basin for Offsite Fuel waste, the planned Defense Waste Processing Facility recycle stream, and Extended Sludge Processing washwater. The Defense Waste Processing Facility recycle [projected at 5,700 to 13,600 cubic meters (1.5 to 3.6×10⁶ gallons) per year] and Extended Sludge Processing washwater would add large volumes of waste to the tank farms and evaporators.

Further, the Defense Waste Processing Facility recycle stream cannot be "turned off" in the event of evaporator problems. Therefore, at least 11,400 cubic meters (3.0×10⁶ gallons) of available tank space must be available prior to the startup of the Defense Waste Processing Facility, in addition to the 4,900 cubic meters (1.3×10⁶ gallons) of emergency spare tank capacity required should a waste tank fail. Current projections indicate that approximately 12,500 cubic meters (3.3×10⁶ gallons) of tank space would be available at the startup of the Defense Waste Processing Facility operations, and available tank space would remain between 9,000 and 16,000 cubic meters (2.4 and 4.2×10⁶ gallons) during the Defense Waste Processing Facility's operative years (WSRC 1994e).

The primary role of the 2F Evaporator is to evaporate the 221-F separations facility's low-heat waste, high-heat waste, and the 8,000-cubic meter (2.1×10⁶ gallon) backlog of F-Area high-heat waste in Tanks 33 and 34. Once the backlog is evaporated, the 2F evaporator will become the primary high-heat waste evaporator for F- and H-Area and assist the H-Area evaporator with the Defense Waste Processing Facility recycle and Extended Sludge Processing washwater streams (WSRC 1994e).

The 2H and 2F evaporators are each 2.4 meters (8 feet) in diameter and approximately 4.6 to 5 meters (15 to 16.5 feet) tall with an operating capacity of 6.8 cubic meters (1,800 gallons) (WSRC 1991). Each stainless-steel evaporator contains a heater tube bundle; two steam lifts, which remove the waste concentrate from the evaporator; a de-entrainer, which removes water droplets; a warming coil, which helps prevent salt crystallization within the evaporator; and two steam lances, which also inhibit salt crystallization (WSRC 1991). The evaporator systems also consist of a mercury collection tank, a cesium removal pump tank and column, a supernatant collection and diverting tank (2F only), and a waste concentrate transfer system.

In approximately 10 years of operation (1982 through 1993), the maximum amount of evaporator supernatant generated annually from the 2F and 2H evaporators combined was approximately 27,300 cubic meters (7.2×10⁶ gallons) (Campbell 1994a). The rate at which the evaporator overheads are generated depends on the heat transfer rate of the evaporator system, the dissolved solids content of the wastewater feed, and the dissolved solids content maintained within the evaporator pot. Waste forecasts were calculated assuming scheduled downtime of the evaporators.

Several tanks are used for purposes other than waste storage: Tanks 22, 48, and 49 are used for In-Tank Precipitation; Tanks 40, 42, and 51 are used for Extended Sludge Processing; and Tank 50 is used as the feed tank for the Z-Area Saltstone Manufacturing and Disposal Facility.

The high-level waste tanks are built of carbon steel and reinforced concrete using one of four designs. DOE plans to remove the high-level waste from the old tanks and transfer it to newer tanks (Type III) with secondary containment. Of the 50 tanks currently in use, 23 (Types I, II, and IV designs) do not meet criteria for leak detection and secondary containment, and 27 tanks (Type III design) do meet these criteria (WSRC 1994g). Table B.13-3 describes each type of tank by the following features: construction dates, capacity, key design features, and the percentage of total waste volume and radioactivity. The *Double-Shell Tanks for Defense High-Level Radioactive Waste Storage Environmental Impact Statement* contains a detailed discussion of tank designs.

Ventilation systems for the waste storage tanks vary; some have no active ventilation, while others maintain negative pressure (approximately -0.5 inches of water) on the structure to ensure that the direction of unfiltered air flow is into the potentially contaminated structure. For most tank systems, the exhaust air is treated to remove moisture, heated to prevent condensation at the filters, filtered by high efficiency particulate air filters, and monitored for radioactive particulates prior to release into the atmosphere. Exhaust ventilation systems for other waste-handling operations in the tank farms use an air-mover system, high efficiency particulate air filtration, and monitoring for radioactive particulates prior to release into the atmosphere (WSRC 1994h).

The 50 waste tanks currently in use at SRS have a limited service life. The tanks are susceptible to general corrosion, nitrate-induced stress corrosion cracking, and pitting and corrosion. The concentrations and volumes of incoming wastes are controlled to prevent corrosion of the carbon

steel tanks. Requirements for accepting waste into the tank farms for storage and evaporation are determined by a number of safety and regulatory factors. These are specified in a document which discusses tank farm waste acceptance criteria, and specifies limits for incoming waste (WSRC 1994i).

In the history of the tank farms, nine of the tanks have leaked detectable quantities of waste from the primary tank to secondary containment with no release to the environment. A tenth tank, Tank 20, has known cracks above the level of the stored liquid; however, no waste has been identified leaking through these cracks (WSRC 1994d). A history of tank leakage and spills is presented in Table B.13-4.

Twentythree out of the 50 tanks currently in use (Tanks 1 through 24 except for Tank 16) and their ancillary equipment do not meet secondary containment requirements (WSRC 1993f).

According to the Federal Facility Agreement executed by DOE, EPA, and SCDHEC, liquid high-level waste tanks that do not meet the standards set forth in the Agreement may be used for continued storage of their current waste inventories. However, these waste tanks are required to be placed on a schedule for removal from service (WSRC 1993f).

According to the waste removal plan, salt would be removed from the Type III tanks first, and these tanks would be reused to support tank farm evaporator operations and to process Defense Waste Processing Facility recycle wastewater. The first sludge tanks to be emptied would be old design tanks, which would then be removed from service. The waste removal program includes removing salt and sludge by mechanical agitators, cleaning the tank interior by spray washing the floor and walls, and steam/water cleaning the tank annulus if necessary (WSRC 1994g). Waste removal equipment consists of slurry pump support structures above the tank top; slurry pumps (typically three for salt tanks and four for sludge tanks); water and electrical service to the slurry pumps; motor and instrument controls; tank sampling equipment; and interior tank washwater piping and spray nozzles (WSRC 1994g).

Each tank is currently being fitted with waste removal equipment, including slurry pumps and transfer jets. According to current operating plans and projected funding, by 2018 DOE expects that the high-level wastes at SRS would have been processed into borosilicate glass, and the tanks would be empty (DOE 1994a). This schedule is based on successful completion of several key activities that must be accomplished before waste removal can begin. These include operation of the in-service evaporators, restart and operation of Extended Sludge Processing, startup and operation of In-Tank Precipitation, and startup and operation of the Defense Waste Processing Facility (WSRC 1993f).

PROJECT-SPECIFIC ACTIONS:

	Min.	Exp.	Max.
No			
Action			
A			
B			
C			

Under each alternative, the tank farms would continue to receive waste (including Defense Waste Processing Facility recycle wastewater), in Type III tanks, operate the evaporators to reduce the volume of waste, construct and begin operation of the Replacement High-Level Waste Evaporator, proceed with waste removal operations as required by the Federal Facility Agreement, and build no

new tanks. Table B.13-5 presents volumes of waste to be stored and treated for each alternative.

Table B.13-1. Typical chemical composition of SRS liquid high-level waste.

Component	Sludge ^{a,b} , percent by weight	Supernatant ^c , percent by weight
Sodium nitrate	2.83	48.8
Sodium nitrite	-	12.2
Sodium hydroxide	3.28	13.3
Sodium carbonate	-	5.21
Sodium tetrahydroxo aluminum ion	-	11.1
Sodium sulfate, anhydrous	-	5.99
Sodium fluoride	-	0.18
Sodium chloride	-	0.37
Sodium metasilicate	-	0.14
Sodium chromate	-	0.16
Nickel (II) hydroxide	1.94	-
MercuryMercury (II) oxide	1.6	-
Uranyl hydroxide	3.4	-
Iron oxide	30.1	-
Aluminum oxide	32.9	-
Manganese oxide	0.51	-
Silicon oxide	5.9	-
Zeolite	3.7	-

a. Source: WSRC (1992b).

b. Analysis of insoluble solids (dry basis).

c. Analysis of soluble solids (dry basis).

Table B.13-2. Typical radionuclide content of combined supernatant, salt, and sludge in tanks in the F- and H-Area tank farms (curies per liter).^a

Radionuclide	F-Area tanks			H-Area tanks		
	Composite	Sample highest value	Sample lowest value	Composite	Sample highest value	Sample lowest value

TritiumTritium	-	-	-	0.00108	-	-
Strontium-89	0.0232	0.291	-	0.0248	5.02	-
Strontium-90	0.951	47.6	0.00145	1.54	9.25	2.91×10-4
Yttrium-90	0.951	47.6	0.00145	1.53	9.25	2.91×10-4
Yttrium-91	0.0396	0.502	-	0.0449	0.925	-
Zirconium-95	0.0608	0.766	-	0.0766	1.51	-
Niobium-95	0.135	1.66	-	0.166	3.17	-
Ruthenium-106	0.0254	0.206	2.51×10-6	0.0925	1.35	-
Rhodium-106	0.0254	0.206	2.51×10-6	0.0925	1.35	-
CesiumCesium-137	1.03	3.43	0.0661	1.51	3.43	0.0114
Barium-237	0.951	3.17	0.0608	1.40	3.17	0.0103
Cerium-144	0.370	2.91	-	1.14	1.93	-
Praeseodymium-144	0.370	2.91	-	1.14	1.93	-
Promethium-147	0.262	1.72	4.76×10-4	0.978	10.30	2.40×10-5
Uranium-235	2.22×10-8	1.61×10-7	1.48×10-9	8.72×10-9	9.78×10-8	1.19×10-10
Uranium-238	8.72×10-7	7.66×10-6	1.66×10-8	5.55×10-8	1.03×10-6	1.85×10-11
PlutoniumPlutonium-238	4.49×10-5	6.08×10-4	-	0.0243	0.106	-
PlutoniumPlutonium-239	2.59×10-4	0.00203	4.23×10-6	2.32×10-4	7.66×10-4	2.59×10-8
PlutoniumPlutonium-240	7.93×10-5	5.55×10-4	8.98×10-7	-	-	-
PlutoniumPlutonium-241	-	-	-	0.0251	-	-
Americium-241	-	-	-	3.17×10-6	-	-
Curium-244	0.00225	0.00248	-	2.22×10-5	2.54×10-4	-

a. Source: WSRC (1992b).

Table B.13-3. F- and H-Area high-level waste tank features.a

Tank type	Construction date	Capacity of each tank	Key design features	Percent of total waste stored in this tank type	Percent of total radioactive content stored in this tank type
I	1951-1953	2.8×10 ⁶ liters (7.4×10 ⁵ gallons)	1.5 meter (5-foot) high secondary containment pans Active waste cooling systems	12	27

II	1955-1956	4×10 ⁶ liters (1.06×10 ⁶ gallons)	1.5 meter (5-foot) high secondary containment pans Active waste cooling systems	4	8
III	1967-1981	4.9×10 ⁶ liters (1.3×10 ⁶ gallons)	Full height secondary containment Active waste cooling system	77	64
IV	1958-1963	4.9×10 ⁶ liters (1.3×10 ⁶ gallons)	Single steel tank, no secondary containment No active waste cooling systems	7	<1

a. Sources: Main (1991); Wells (1994).

Table B.13-4. High-level waste tank leakage and spill history.

Tank Number	Tank Type	Date	Occurrence
1-9	I	-	Leakage from primary tank to secondary containment with no release to the environment ^a
8	I	1961	Fill-line encasement leaked approximately 5,700 liters (1,500 gallons), causing soil contamination and potential groundwatergroundwater contamination ^a
16	II	1972	Leakage of approximately a few tens of gallons from secondary containment to the environment ^b
13	II	1983	Spill of approximately 380 liters (100 gallons) ^c
37	III	1989	Transfer line leaked approximately 225 kilograms (500 pounds) of concentrated (after volume reduction in evaporator) waste ^d

a. Source: Odum (1976).

b. Source: Poe (1974).

c. Source: Boore et al. (1986).

d. Source: WSRC (1992c).

Note: These leak sites have been cleaned up or stabilized to prevent the further spread of contamination and are monitored by groundwater monitoring wells established under SRS's extensive groundwater monitoring program. Remediation and environmental restoration of contaminated sites at the F- and H-Area Tank Farms will be undertaken when waste removal plans for the tanks are completed and surplus facility deactivation and decommissioning plans are developed.

Table B.13-5. Volumes of waste to be stored and treated at the F- and H-Area high-level waste tank farms (cubic meters).a,b,c,d

	Min.	Exp.	Max.
		130,581 m ³ existing inventory 22,212 m ³ new waste	
A	130,581 m ³ existing inventory 12,099 m ³ new waste	130,581 m ³ existing inventory 22,212 m ³ new waste	130,581 m ³ existing inventory 27,077 m ³ new waste ^e .
B	130,581 m ³ existing inventory 12,099 m ³ new waste	130,581 m ³ existing inventory 22,212 m ³ new waste	130,581 m ³ existing inventory 27,077 m ³ new waste
C	130,581 m ³ existing inventory 12,099 m ³ new waste	130,581 m ³ existing inventory 22,212 m ³ new waste	130,581 m ³ existing inventory 27,077 m ³ new waste

a. Source: Hess (1994f, g); WSRC (1994f).

b. To convert to gallons, multiply by 264.2.

c. Waste volumes are not additive because newly generated waste volume would be reduced by approximately 75 percent via evaporation.

d. Under all alternatives, the Replacement High-Level Waste Evaporator would begin operation in May 1999.

e. The 30-year maximum waste forecast indicates that, in order to empty the tanks as planned by the year 2018, the existing evaporators would have to be operated at higher rates.

B.14 M-Area AIR STRIPPER

OBJECTIVE:

The M-Area Air Stripper treats the M-Area groundwater plume that is contaminated with organic solvents as part of environmental restoration.

DESCRIPTION:

The M-Area Air Stripper (also called the M-1 Air Stripper), located at Building 323M, is part of the pump-and-treat remedial action system designed to remove organic solvents from a groundwater contaminant plume beneath MArea. Volatile organic compounds of concern include trichloroethylene and tetrachloroethylene. The system consists of an air stripper, 11 recovery wells, an air blower, an effluent-discharge pump, an instrument air system, a control building, and associated piping, instrumentation, and controls. The average water feed rate to the air stripper is approximately 1.9 cubic meters (500 gallons) per minute. The National Pollutant Discharge Elimination System permit requires the treated effluent to have a concentration of not more than 5 parts per billion each of trichloroethylene and tetrachloroethylene. Concentrations of volatile organic compounds in the treated effluent have consistently been less than the detection limit of 1 part per billion. A 20-inch line transports treated effluent from the air stripper to Outfall M-005 in accordance with National Pollutant Discharge Elimination System permit criteria.

During construction of groundwater monitoring wells, DOE generates well development water; during routine sampling of SRS groundwater monitoring wells, DOE generates well purge water. DOE collects the development and purge water (investigation-derived waste) in a tank truck and transports it to the MArea Air Stripper for treatment.

PROJECT-SPECIFIC ACTIONS:

	Min.	Exp.	Max.
No Action			
A			
B			
C			

Table B.141 presents volumes of hazardous investigation-derived waste from groundwater monitoring wells to be treated in the MArea Air Stripper under each alternative. These volumes represent a very small portion of the throughput of the M-Area Air Stripper; between 5,000 and 32,000 cubic meters (1.32×10^6 and 8.45×10^6 gallons) over 30 years versus approximately 13,000 cubic meters (3.43×10^6 gallons) per minute of groundwater.

Table B.14-1. Volumes of investigation-derived waste from groundwater monitoring wells to be treated in the M-Area Air Stripper (cubic meters).b

	Min.	Exp.	Max.
		31,233 m ³ c	
A	5,369 m ³ d	31,233 m ³	31,495 m ³ e
B	5,369 m ³	31,233 m ³	31,495 m ³
C	5,369 m ³	31,233 m ³	31,495 m ³

a. Source: Hess (1995a).

b. To convert to gallons, multiply by 264.2.

c. The initial annual amount would be 800 cubic meters (2.11×10^5 gallons). Due to the increase in groundwater monitoring well activities under environmental restoration, the annual quantity would increase to 1,286 cubic meters (3.4×10^5 gallons).

d. The annual amount would vary from 124 cubic meters (32,800 gallons) to 528 cubic meters (139,000 gallons) and would average 179 cubic meters (47,300 gallons).

TC

e. The annual amount would vary from 806 cubic meters (2.13×10^5 gallons) to 1,297 cubic meters (3.43×10^5 gallons) and would average 1,050 cubic meters (277×10^5 gallons) per year.

B.15 M-Area VENDOR TREATMENT FACILITY

OBJECTIVE:

The M-Area Vendor Treatment Facility would provide a vitrification process to treat M-Area electroplating wastes to meet the land disposal restrictions criteria. The wastes to be treated include the following six waste streams which were the basis of the initial treatability studies and procurement of the vitrification subcontractor:

- M-Area plating-line sludge from supernatant treatment
- M-Area high-nickel plating-line sludge
- M-Area sludge treatability samples
- Mark 15 filtercake
- Plating-line sump material
- Nickel plating-line solution

The potential impacts of treating these six waste streams were considered in an Environmental Assessment (DOE 1994b) and a Finding of No Significant Impact issued in August 1994. These six mixed waste streams constitute approximately 2,471 cubic meters (87,300 cubic feet) of mixed waste (Hess 1995a).

Under the Federal Facility Compliance Act, DOE must develop site-specific plans for the treatment of mixed wastes to the standards established by RCRA. The *SRS Proposed Site Treatment Plan* identified two additional types of mixed waste for which treatment by the M-Area Vendor Treatment Facility was determined to be the preferred option:

- uranium/chromium solution
- soils from spill remediation

These mixed wastes streams [approximately 18 cubic meters (635 cubic feet)] would be introduced directly to the vitrification unit. The treatment of these two additional wastes would not appreciably alter the processes or timeframe for operation of the M-Area Vendor Treatment Facility. Final decisions regarding the treatment of these wastes would be made in conjunction with ongoing negotiations with the State of South Carolina pursuant to the Federal Facility Compliance Act.

DESCRIPTION:

The M-Area Vendor Treatment Facility would be a temporary vitrification facility; it has not yet been constructed. Its operation would be linked to the existing M-Area Liquid Effluent Treatment Facility to treat the electroplating sludges stored in the Process Waste Interim Treatment/Storage Facility tanks, waste flushes from the tanks, and drummed wastewater sludge stored in the M-Area mixed waste storage building. The wastes would be blended in existing M-Area tanks. Stabilizing chemicals and glass-forming materials would be added to the mixture, which would then be fed to the vitrification unit.

The offgas scrubber liquid from the vitrification unit would be treated by the M-Area Liquid Effluent Treatment Facility, which discharges to Outfall M-004 in accordance with National Pollutant Discharge Elimination System permit limits. M-Area Liquid Effluent Treatment Facility filtercake and filter media generated from the treatment of the offgas scrubber liquid effluent would be returned to the Process Waste Interim Treatment/Storage Facility tanks for blending with other waste feed to the vitrification unit.

Molten glass from the vitrification unit would be discharged either directly to 71-gallon drums or to a gem-making machine. The gem-making machine consists of a gob cutter that cuts the glass stream into small balls of glass that drop onto a steel cooling disk where they harden to form glass gems with a flattened marble appearance. The gems are then dropped from the cooling disk into a hopper or 71-gallon drum.

The vitrification unit is sized to treat the entire volume of design-basis wastes in one year. It is anticipated that the 3.03×10^6 kilograms (6.26×10^5 pounds) of M-Area wastes would be reduced to 1.12×10^6 kilograms (5.09×10^5 pounds) of glass. A total waste volume reduction of approximately 83 percent would be expected (WSRC 1994j).

PROJECT-SPECIFIC ACTIONS:

	Min.	Exp.	Max.
No Action			
A			
B			
C			

Under the noaction alternative, the facility would treat the original six waste streams.

	Min.	Exp.	Max.
No Action			
A			
B			
C			

Under each alternative except the no-action alternative, the MArea Vendor Treatment Facility would treat the six original waste streams and two additional waste streams as described in the Objective section (WSRC 1995).

B.16 MIXED WASTE STORAGE FACILITIES

OBJECTIVE:

The mixed waste storage facilities would provide storage capacity for SRS containerized mixed wastes in accordance with RCRA and DOE Order 5820.2A requirements.

DESCRIPTION:

DOE would store containerized mixed waste in Building 645-2N, Building 643-29E, Building 643-43E, Building 316-M, and on the 315-4M storage pad and Waste Storage Pads 20 through 22. Each of these mixed waste container storage facilities is discussed below.

Three buildings are used to store mixed waste at SRS. Building 645-2N is a RCRA-permitted facility and is located in the Hazardous Waste Storage Facility in N-Area. Building 645-2N is a steel-framed building with sheet metal siding and an impervious concrete floor. The building is divided into four waste storage cells, and each cell has a concrete dike containment system. The floor of each storage cell slopes toward an individual sump for the collection of released liquids. The actual storage area for the four cells combined is approximately 60 meters (196 feet) by 14 meters (46 feet). The building has usable storage capacity of approximately 558 cubic meters (19,700 cubic feet) (WSRC 1994k). Mixed waste is primarily containerized in 55-gallon drums or steel boxes. The 55-gallon drums are used to store both liquid and solid wastes; metal storage boxes are used to store only solid wastes. Containers are stored on wooden pallets, and the boxes have metal risers which elevate the bottoms of the containers off the floor.

Two of the mixed waste storage buildings, Building 643-29E and Building 643-43E, have interim status and are located in EArea. Building 643-43E was constructed under the approved "General Plant Project" Categorical Exclusion (CX 9004020, Project S-2842, October 5, 1990). The buildings are similar in design and construction; only the dimensions are different. The buildings are metal structures with I-beam frames, sheet metal roofing, partial sheet metal siding, and concrete pad floors. The outside walls of each building consist of chain-link fencing from the ground to a height of about 1.5 meters (5 feet). The concrete pads are surrounded by reinforced concrete dikes to provide secondary containment. In Building 643-29E, the floor slopes towards a sump to collect released liquids or other liquids that enter the storage area. The floor in Building 643-43E is level. Mixed waste is stored in 55gallon drums and metal storage boxes; if necessary, concrete culverts are used for shielding. Waste containers are elevated off the floor to prevent the container bottoms from contacting accumulated liquids on the floor. Drums are placed on pallets and the metal boxes are constructed with metal risers. Other containers such as culverts are also elevated using devices such as pallets, risers, or wooden or metal blocks. Building 643-29E is 18 meters (60 feet) by 18 meters (60 feet) in size with an actual storage area of 15 meters (50 feet) by 15 meters (50 feet). The maximum usable storage capacity is 62 cubic meters (2,200 cubic feet) (Hess 1995a). Building 643-43E measures 49 meters (160 feet) by 18 meters (60 feet) in size with an actual storage area of 46

meters (150 feet) by 15 meters (50 feet) and a maximum usable storage capacity of 619 cubic meters (21,900 cubic feet) (WSRC 1994k).

Mixed waste is also stored in an interim status storage building (Building 316-M) in M-Area. The building is essentially an above-grade concrete pad with a pavilion-like structure surrounded by a chain-link fence. The pad is curbed on three sides with the fourth side built to a sufficient elevation to ensure drainage to static sumps within the pad. Mixed waste management practices in the M-Area building are similar to management practices in the N- and E-Area storage buildings. Mixed waste is primarily containerized in 55gallon drums or steel boxes. The building measures 37 meters (120 feet) by 15 meters (50 feet) with an actual storage area of 30 meters (100 feet) by 12 meters (40 feet) and a maximum usable capacity of 117 cubic meters (4,100 cubic feet) (WSRC 1994k).

Three above-grade concrete pads in E-Area would be used to store mixed waste. DOE has submitted (in May 1992) a permit application for Waste Storage Pads 20, 21, and 22. Each waste storage pad consists of a concrete pad enclosed by a chain link fence but exposed to the elements. To contain leaks and direct rainwater, the waste storage pads have curbs and sloped foundations that drain to sumps. Mixed waste would be stored in 55-gallon drums and carbon steel boxes; concrete culverts and casks are used for shielding. Only solid waste forms would be stored on the waste storage pads. The pad dimensions are: Pad 20 [46 meters by 18 inches (150 feet by 60 feet)], Pad 21 [46 meters by 16 meters (150 feet by 54 feet)], and Pad 22 [52 meters by 16 meters (170 feet by 54 feet)]. The pads have a combined usable storage capacity of 2,056 cubic meters (72,600 cubic feet) (Hess 1995a).

DOE has submitted a RCRA permit application requesting interim status for a storage pad in M-Area, Pad 315-4M, that would be used to store containerized vitrified mixed wastes from the M-Area Vendor Treatment Facility and stabilized ash and blowdown wastes from the Consolidated Incineration Facility. Pad 315-4M is a concrete pad that is completely fenced and exposed to the elements. The combination of curbing and a sloped foundation prevents run-on and directs rainwater to a stormwater drain that empties to Outfall M001 in accordance with National Pollutant Discharge Elimination System permit limits. Mixed wastes are stored in 55gallon drums, carbon steel boxes, and 71-gallon square steel drums. The pad measures 41 meters (135 feet) by 61 meters (200 feet) with an actual storage area of 41 meters (134 feet) by 61 meters (199 feet) and a maximum usable capacity of 2,271 cubic meters (80,000 cubic feet) (WSRC 1994k).

PROJECT-SPECIFIC ACTIONS:

	Mid.	Exp.	Max.
No Action			
A			
B			
C			

Under the no-action alternative, mixed non-alpha waste that is currently stored on the transuranic waste storage pads (i.e., waste with less than 10 nanocuries per gram of transuranics) would be transferred to Waste Storage Pads 20, 21, and 22. Due to DOE's limited capacity to treat mixed waste, the majority of mixed wastes would continue to be stored under the no-action alternative. RCRA-permitted disposal capacity would not be available until the year 2002. Accordingly, mixed waste that ultimately would be disposed in the RCRA-permitted disposal vault would continue to be stored in the mixed waste storage buildings and pads until the vault is ready to receive waste.

The expected waste generation forecast indicates that approximately 1.84×10^5 cubic meters (6.49×10^6 cubic feet) of containerized mixed waste would be placed in RCRA storage over the next 30 years. The mixed waste storage buildings and pads (645-2N, 643-29E, 64343E, 316-M, 315-4M and Pads 20 through 22) would reach capacity by the year 1998. In order to accommodate future mixed waste storage needs, DOE plans to build additional mixed waste storage buildings as needed. Building 64343E would serve as the prototype for future buildings. Each building would have a usable storage capacity of 619 cubic meters (22,000 cubic feet). Approximately 291 additional mixed waste storage buildings would be needed over the next 30 years (Hess 1995a).

Under the no-action alternative, Pad 315-4M would be used to store containerized vitrified mixed wastes from the M-Area Vendor Treatment Facility. These wastes would be stored on the Pad until RCRA-permitted disposal became available in the year 2002.

In order to accommodate future mixed waste storage needs prior to the availability of treatment and disposal capacity, DOE would build additional mixed waste storage buildings as needed. Table B.161 presents the maximum storage requirements, and the year they would be needed.

Table B.16-1. Mixed waste storage requirements for each alternative.a

	Min.	Exp.	Max.
		291 additional buildings (limited treatment)	
A	45 additional buildings in 2008	79 additional buildings in 2005	757 additional buildings in 2005
B	39 additional buildings in 2008	79 additional buildings in 2005	652 additional buildings in 2005
C	39 additional buildings in 2008	79 additional buildings in 2005	652 additional buildings in 2005

a. Source: Hess (1995a).

	Min.	Exp.	Max.
No Action			
A			
B			
C			

Under alternatives A, B, and C, Pad 3154M would be used to store containerized vitrified mixed wastes from the MArea Vendor Treatment Facility and stabilized ash and blowdown wastes from the Consolidated Incineration Facility. These wastes would be stored on the Pad until RCRA-permitted disposal became available in the year 2002. Storage capacity on Pad 3154M is sufficient to accommodate these wastes until disposal capacity becomes available. The maximum volume stored would be reached in the year 2001 for each alternative. Table B.162 presents maximum storage

volumes.

Table B.16-2. Estimated amount of mixed waste that would be stored on Pad 3154M (cubic meters).a,b

	Min.	Exp.	Max.
		2,271 m ³	
A	679 m ³	733 m ³	2,271 m ³
B	938 m ³	1,102 m ³	2,271 m ³
C	938 m ³	1,102 m ³	2,271 m ³

a. Source: Hess (1995a).

b. To convert to cubic feet, multiply by 35.31.

B.17 NEW WASTE TRANSFER FACILITY NEW WASTE TRANSFER FACILITY

OBJECTIVE:

The New Waste Transfer Facility is designed to be a highly reliable and flexible receipt and distribution point for the Defense Waste Processing Facility recycle and inter-tank farm waste streams (WSRC 1994e). No processing would occur in the New Waste Transfer Facility (WSRC 1993f).

The New Waste Transfer Facility (also referred to as H-Diversion Box-8) was built to replace the operation of H-Diversion Box-2 and would allow H-Diversion Box-2 to serve only assigned tanks involved in waste removal operations. The New Waste Transfer Facility is currently scheduled to be connected to the Defense Waste Processing Facility and the tank farm in mid-1995 and begin operation in late 1995.

The New Waste Transfer Facility was constructed as a categorical exclusion under then-current NEPA guidelines (52 FR 47662). The startup date is scheduled for November 1995 (WSRC 1994e).

DESCRIPTION:

The New Waste Transfer Facility consists of five adjacent cells: four each contain one pump tank and serve as pump pits; the fifth cell is a large diversion box. The pump pits and diversion box would be housed in one section of the building, and a second section would contain the local instrumentation and operations equipment and controls. The facility would be equipped with an enclosed overhead crane/camera system for remote maintenance (WSRC 1992d). The facility would handle transfers between the Defense Waste Processing Facility and the H-Area tank farm, between the F-Area tank farm and H-Area tank farm, between the F/H-Area Effluent Treatment Facility and H-Area tank farm, and intra-tank transfers within the H-Area tank farm (WSRC 1993g).

The New Waste Transfer Facility is expected to handle the following waste streams:

- High-heat waste (i.e., liquid high-level waste that contains a major portion of radioactivity)
- Low-heat waste (i.e., liquid high-level waste that contains a reduced concentration of radionuclides)
- High-heat and low-heat supernatant
- Aged high-heat and low-heat waste sludge slurries
- Reconstituted salt (re-dissolved salt)
- In-Tank Precipitation washwater
- Extended Sludge Processing washwater
- Defense Waste Processing Facility late wash process washwater
- Defense Waste Processing Facility aqueous recycle waste from the vitrification facility
- Receiving Basin for Offsite Fuel wastewater (WSRC 1993g)

The ventilation system for pump tanks and pump tank cells includes a discharged high efficiency particulate air filter that removes airborne radionuclides from the air passing over the pump pits and through the pump tanks and diversion box. The filter equipment is housed in a separate concrete-shielded building. An emergency diesel generator would serve as backup if the main power supply were interrupted (WSRC 1993g).

PROJECT-SPECIFIC ACTIONS:

	Min.	Exp.	Max.
No			
Action			
A			
B			
C			

Under each alternative, the New Waste Transfer Facility would begin operation according to the planned schedule to facilitate liquid high-level waste transfers between the Defense Waste Processing Facility and the F- and H-Area tank farms.

B.18 NON-ALPHA VITRIFICATION FACILITY

OBJECTIVE:

The non-alpha vitrification facility would provide treatment for liquid, soil, and sludge wastes, primarily resulting from environmental restoration and/or decontamination and decommissioning

activities, for which treatment capacity is not otherwise available at SRS.

DESCRIPTION:

DOE would construct a non-alpha vitrification facility for the treatment of mixed, hazardous, and lowlevel wastes under alternative C and the expected and maximum forecasts of alternative B. It would not be built under the no-action alternative, alternative A, or the minimum forecast of alternative B. The facility is targeted to begin operating in the year 2006. Activities that would be conducted in the non-alpha vitrification facility can generally be broken down into three steps: preparation of wastes for treatment; vitrification; and treatment of byproducts generated during the vitrification process. Each of these steps is discussed in more detail below.

In the first step, waste containers would be opened and the soils and concrete would be sorted. In alternative B, the containerized waste would consist solely of sludges. In alternative C, solid and liquid wastes would also be treated. Therefore, an additional process in alternative C would be to shred the solid wastes to approximately 1/8 inch in size using shredder shears and/or bandsaws. Soils and concrete would be processed through a sorting operation to separate contaminated and uncontaminated materials. Concrete waste forms would be ball-milled and then sorted. Soils and concrete that were uncontaminated would be reused onsite as backfill, and the contaminated soils and concrete would be vitrified. It is expected that 60 percent of the mixed waste and low-activity waste soils and concrete would be vitrified, and the remaining 40 percent would be used as backfill. For suspect soils, it is expected that 40 percent would be vitrified, and the remaining 60 percent would be used as backfill. Frit and additives would be added to the waste, and the mixture would be sent to the thermal pretreatment unit (Hess 1994a).

The first phase of vitrification is thermal pretreatment. During thermal pretreatment, the carbon content of the waste would be reduced in order to produce a higher-quality glass matrix. Then the waste would be vitrified (i.e., fused into a solid waste matrix) in a high temperature melter. Gases produced during the vitrification process would be sent through an afterburner and an offgas treatment system. The afterburner would destroy remaining hazardous organic compounds prior to treatment in the offgas system. The offgas system would scrub the gases to minimize the release of remaining hazardous constituents or particulates to the atmosphere. Liquids generated by the offgas system would be evaporated and recondensed. The condensed overheads would be sent to a dedicated wastewater treatment unit for the treatment of mercury, trace radionuclides, and other materials. The closed-loop wastewater treatment system would ensure that once treated, the wastewater would be returned to the offgas system for reuse. Vitrified wastes would be sent either to RCRA-permitted disposal vaults or to shallow land disposal. It is assumed that 50 percent of the treated mixed and hazardous wastes would require RCRA-permitted disposal, and the remaining 50 percent could be disposed of as low-level waste (Hess 1994a).

PROJECT-SPECIFIC ACTIONS:

	Min.	Exp.	Max.
No Action			
A			
B			
C			

Under the no-action alternative and each waste forecast of alternative A, the facility would not be constructed.

	Min.	Exp.	Max.
No Action			
A			
B			
C			

For the expected and maximum waste forecasts of alternative B, only mixed wastes would be treated in the non-alpha vitrification facility. The mixed waste treatability groups to be processed include soils, organic sludge, and inorganic sludge. Table B.181 presents the volumes that would be treated.

For the expected waste forecast of alternative B, the feed rate to the non-alpha vitrification facility would be approximately 302 cubic meters (10,700 cubic feet) per year of sludges and approximately 2,790 cubic meters (98,500 cubic feet) per year of soils.

For the maximum waste forecast of alternative B, the feed rate to the non-alpha vitrification facility would be approximately 400 cubic meters (14,100 cubic feet) per year of sludges and approximately 15,000 cubic meters (5.30×10^5 cubic feet) per year of soils.

	Min.	Exp.	Max.
No Action			
A			
B			
C			

For the minimum waste forecast of alternative B, the non-alpha vitrification facility would not be built. Insufficient waste volumes were forecasted for the minimum case to warrant construction of the non-alpha vitrification facility. Mixed waste soils and sludges would be incinerated at the Consolidated Incineration Facility after modifications to accommodate the treatment of such materials.

	Min.	Exp.	Max.
No Action			
A			
B			
C			

For each waste forecast of alternative C, hazardous, mixed, and low-level wastes would be treated in the non-alpha vitrification facility. Hazardous wastes to be treated include metal debris, equipment, and lead wastes that were not successfully decontaminated in the containment building; soils; inorganic, organic, heterogeneous, and glass debris; organic and inorganic sludges; and organic and inorganic liquids. Mixed wastes to be treated include metal debris and equipment wastes that were not successfully decontaminated in the containment building; spent decontamination solutions and wet chemical oxidation residuals from the containment building; glass, heterogeneous, inorganic, and organic debris; lead; benzene waste from the Defense Waste Processing Facility; aqueous and organic liquids; radioactive oil; PUREX solvent; paint wastes; composite filters; soils; organic and inorganic sludge; and mercury-contaminated material. Low-level wastes to be treated include low-activity soils, suspect soils, low-activity job-control waste; job-control waste from offsite generators; tritiated soils; tritiated job-control waste; tritiated equipment; intermediate-activity job-control waste; and low-

activity equipment (Hess 1994a).

For the expected waste forecast of alternative C, the combined feed rate to the non-alpha vitrification facility would average approximately 11,832 cubic meters (4.18×10^5 cubic feet) per year of soils, 17,975 cubic meters (6.35×10^5 cubic feet) per year of solids, and 2,873 cubic meters (1.01×10^5 cubic feet) per year of liquids (Hess 1995a).

For the minimum waste forecast, the combined feed rate to the non-alpha vitrification facility would be approximately 2,450 cubic meters (86,500 cubic feet) per year of soils, 13,115 cubic meters (4.63×10^5 cubic feet) per year of solids, and 808 cubic meters (28,500 cubic feet) per year of liquids (Hess 1995a).

For the maximum waste forecast, the combined feed rate to the non-alpha vitrification facility would be approximately 45,945 cubic meters (1.62×10^6 cubic feet) per year of soils, 33,397 cubic meters (1.18×10^6 per year of solids, and 4,633 cubic meters (1.64×10^5 per year of liquids (Hess 1995a).

Table B.18-1. Volumes of waste that would be treated in the non-alpha vitrification facility (cubic meters).a,b

	Min.	Exp.	Max.
		Not constructed	
A	Not constructed	Not constructed	Not constructed
B	Not constructed	88,331 m3 soil/concrete sorted 5,174 m3 sludge vitrified (302 m3 annually) 52,999 m3 soil vitrified (2,790 m3 annually) mixed wastemixed wastes only	440,060 m3 soil/concrete sorted 7,451 m3 sludge vitrified (400 m3 annually) 264,036 m3 soil vitrified (15,000 m3 annually) mixed wastemixed wastes only
C	34,897 m3 soil/concrete sorted (23,873 m3 mixed; 11,024 m3 low-level) Vitrified: 59,654 m3 mixed 37,860 m3 hazardous 213,566 m3 low-level	125,510 m3 soil/concrete sorted (88,331 m3 mixed; 37,179 m3 low-level) Vitrified: 141,020 m3 mixed 211,271 m3 hazardous 268,639 m3 low-level	1,019,845 m3 soil/concrete sorted (440,098 m3 mixed; 579,747 m3 low-level) Vitrified: 457,405 m3 mixed 395,795 m3 hazardous 742,319 m3 low-level

a. Source: Hess (1995a).

b. To convert to gallons multiply by 264.2; to convert to cubic feet multiply by 35.31.

c. Mixed would include 14,324 m3 of soil; 33,970 m3 of solids; 11,360 m3 of liquids.

Hazardous would include 26,932 m3 of soil; 6,933 m3 of solids; 3,995 m3 of liquids.

Low-level would include 5,292 m3 of soil, 208,274 m3 of solids; no liquids.

d. Mixed would include 52,999 m³ of soil; 69,472 m³ of solids; 18,549 m³ of liquids.

Hazardous would include 152,815 m³ of soil; 22,417 m³ of solids; 36,039 m³ of liquids.

Low-level would include 19,001 m³ of soil, 249,638 m³ of solids; no liquids.

e. Mixed would include 264,059 m³ of soil; 132,453 m³ of solids; 60,893 m³ of liquids.

Hazardous would include 330,501 m³ of soil; 38,167 m³ of solids; 27,127 m³ of liquids.

Low-level would include 278,397 m³ of soil, 463,922 m³ of solids; no liquids.

B.19 LOW-LEVEL WASTE SMELTER

OBJECTIVE:

In this eis the decontamination of low-activity equipment waste would be done by offsite commercial facilities because such facilities are currently available to perform the treatment required.

DESCRIPTION:

DOE would ship low-activity equipment waste to an offsite facility which uses a standard smelter process for decontamination. The equipment waste would be smelted to separate the pure metallic fraction from the slag that would contain impurities, including the majority of the radionuclides. It is assumed that 90 percent of the low-activity equipment waste volume would be recovered as metal suitable for reuse, and 10 percent of the incoming waste volume would be slag. The slag would be formed into blocks and packaged for shipment back to SRS for disposal. Because slag is a stable waste form, and the radionuclides would be fixed in the waste matrix, the slag residues could be sent to shallow land disposal.

DOE would ship offsite low-activity equipment waste (including low-activity equipment waste resulting from the decontamination of mixed wastes at the containment building) for decontamination in alternatives B and C. Less waste volume would be available for decontamination under alternative C due to the diminished role of the containment building in that alternative (Hess 1994a, h).

For purposes of assessment, the offsite decontamination facility was assumed to be located in Oak Ridge, Tennessee. In terms of transportation and surrounding population, this location is representative of the range of possible locations.

PROJECT-SPECIFIC ACTIONS:

The volumes of low-activity equipment waste sent offsite for decontamination by smelting for each alternative and waste forecast are shown in Table B.19-1.

Table B.19-1. Estimated volumes of low-level waste smelted for each alternative.a,b

	Min.	Exp.	Max.
		None	
A	None	None	None
B	9,838 m ³	17,965 m ³	53,792 m ³
C	5,894 m ³	10,501 m ³	27,556 m ³

a. Source: Hess (1995a).

b. To convert to cubic feet, multiply by 35.31.

B.20 OFFSITE LOW-LEVEL WASTE VOLUME REDUCTION

OBJECTIVE:

Offsite commercial vendor facilities have been designated for the treatment and repackaging of SRS lowactivity wastes because such facilities are currently available. This commercial volume reduction capability could be used to more efficiently utilize low-level waste disposal capacity before a facility that provided the same treatment capability could be constructed and commence operations at SRS.

DESCRIPTION:

DOE would ship low-activity job-control and equipment waste to an offsite facility for volume reduction. The low-level waste would be treated or repackaged to make more efficient use of low-level waste disposal capacity or to meet the waste acceptance criteria for treatment at the Consolidated Incineration Facility at SRS. It is assumed that 50 percent of the low-activity job control waste generated each year would be transferred to a commercial vendor who would perform the following:

- 60 percent supercompacted (an average of volume reduction 8 to 1; varies from 12 to 1 for job-control waste to 4 to 1 for bulk equipment)
- 20 percent reduced in size and repackaged for treatment at the Consolidated Incineration Facility (30 percent volume reduction from repackaging; 8 to 1 volume reduction for the Consolidated Incineration Facility)
- 10 percent incinerated at the vendor facility followed by supercompaction of the ash (100 to 1 volume reduction)
- 5 percent reduced in size and repackaged for disposal (30 percent volume reduction)
- 5 percent undergoing metal melt followed by supercompaction (20 to 1 volume reduction)

DOE would also ship 50 percent of the low-activity equipment waste generated each year to a commercial vendor for supercompaction (8 to 1 volume reduction). The treated wastes would be returned to SRS for disposal in the low-activity waste vaults with the exception of the metal melt

waste which would be sent to shallow land disposal.

PROJECT-SPECIFIC ACTIONS:

	Min.	Exp.	Max.
No Action			
A			
B			
C			

DOE would utilize commercial vendors for volume reduction of low-level waste under alternative B only. Assuming that contracts are executed based on the responses to the request for proposal, DOE would begin offsite shipments of low-activity waste in fiscal year 1996 at which time it is assumed that the existing SRS compactors would cease operation.

Uncompacted wastes placed in the low-activity waste vault prior to October 1995 would be stored for retrieval and processing by the commercial vendor.

For purposes of assessment, the offsite volume reduction facility was assumed to be located in Oak Ridge, Tennessee. In terms of transportation and surrounding population, this location is representative of the range of possible locations.

The volumes of low-activity waste sent offsite for treatment and repackaging for each alternative and waste forecast are shown in Table B.20-1.

SUMMARY OF IMPACTS:

The consequences of the offsite treatment of low-level radioactive wastes are expected to be small. Treatment of SRS low-activity waste is not expected to result in exceedance of the vendor's permitted emissions limits. DOE would only ship wastes that conform to the vendor's waste acceptance criteria. SRS wastes are not expected to contain radionuclides that are not already being processed in the waste feed currently being treated by the vendor. Compliance with the vendor's waste acceptance criteria will ensure that the SRS radionuclide distributions are adequately considered in the vendor's permits and licenses.

The request for proposal specifies that the vendor must have existing contracts for volume reduction of low-level waste and that the SRS waste cannot exceed 50 percent of the vendor's treatment capacity. It is expected that the SRS wastes will comprise approximately 25 percent of the vendor's total operating capacity. The request for proposal also stipulates that the vendor must start treating SRS waste within three months of contract award. As such, it is expected that the vendor will utilize idle capacity since three months would not be sufficient time to develop new capacity to support treatment of SRS waste (Hess 1995c).

Table B.20-1. Volumes of low-activity waste that would be treated offsite (cubic meters).a,b

	Min.	Exp.	Max.
		None	
A	None	None	None
B	158,350 m ³ job control waste 95,010 m ³ supercompacted 31,670 m ³ repackaged for CIF ^c 15,835 m ³ incinerated 7,918 m ³ repackaged for disposal 7,918 m ³ metal melt/ supercompacted 14,906 m ³ equipment waste supercompacted 5,970 m ³ /year average	186,671 m ³ job control waste 112,002 m ³ supercompacted 37,334 m ³ repackaged for CIF ^c 18,667 m ³ incinerated 9,334 m ³ repackaged for disposal 9,334 m ³ metal melt/ supercompacted 27,220 m ³ equipment waste supercompacted 7,380 m ³ /year average	210,269 m ³ job control waste 126,161 m ³ supercompacted 42,054 m ³ repackaged for CIF ^c 21,027 m ³ incinerated 10,513 m ³ repackaged for disposal 10,513 m ³ metal melt/ supercompacted 81,503 m ³ equipment waste supercompacted 10,060 m ³ /year average
C	None	None	None

a. Source: Hess (1995a).

b. To convert to gallons multiply by 264.2; to convert to cubic feet multiply by 35.31.

c. Consolidated Incineration Facility.

Operational impacts associated with these offsite facilities are presented in the Traffic and Transportation and Occupational and Public Health Section of Chapter 4 (4.4.11 and 4.4.12) and Appendix E (Sections 3.0 and 4.0).

B.21 OFFSITE MIXED WASTE TReAtMENTS

OBJECTIVE:

Offsite commercial or DOE-operated treatment facilities have been designated for treatment of mixed wastes generated at SRS when an offsite facility currently exists that could perform the treatment required or when a planned offsite treatment facility would be available before a facility that provided the same treatment capability could be constructed and commence operations at SRS.

DESCRIPTION:

The *SRS Proposed Site Treatment Plan* evaluated existing commercial and existing or proposed DOEoperated treatment facilities (both onsite and offsite) in its options analysis to arrive at a preferred option for each mixed waste. Offsite commercial and DOE-operated facilities were identified as the preferred options for several SRS mixed wastes.

The Waste Engineering Development Facility at the Idaho National Engineering Laboratory was

identified as the preferred option for treating SRS mercury and mercury-contaminated mixed waste. A small quantity of elemental liquid mercury [less than 1 cubic meter (35 cubic feet)] would be shipped to the Waste Engineering Development Facility's amalgamation unit. The mercury waste would be treated by amalgamation (the combination of liquid elemental mercury with inorganic reagents such as copper, zinc, nickel, gold or sulfur that results in a semi-solid amalgam and thereby reduces potential emissions of mercury vapor into the air). Amalgamation is the treatment standard specified for such radioactive mercury waste. DOE would also ship a small quantity [less than 2 cubic meters (71 cubic feet)] of mercury-contaminated waste (rocks, dirt, sand, concrete, and glass) generated from cleaning Tank E3-1 in H-Area. This waste would be treated at the Waste Engineering Development Facility's stabilization unit by immobilizing the mercury in a grout matrix. Both the amalgamated mercury and the stabilized mercury-contaminated waste would be returned to SRS for disposal. The amalgamated mercury would be sent to RCRA-permitted disposal, and the stabilized mercury-contaminated waste would be sent to shallow land disposal.

DOE has generated a small amount [0.8 cubic meter (28 cubic feet)] of calcium metal waste. This waste would be shipped to the Los Alamos National Laboratory for treatment using the Reactive Metals Skid, a mobile treatment unit. The treatment would involve controlled wet oxidation to eliminate the reactivity of the calcium in metallic form. Treatment residuals would be returned to SRS for disposal.

DOE anticipates generating a limited quantity [less than 60 cubic meters (2,100 cubic feet)] of radioactively contaminated PCB wastes over the 30-year analysis period of this EIS. These wastes would be shipped to a commercial facility for treatment to destroy the PCB fraction. The radioactively contaminated residuals from the treatment process would be returned to SRS for shallow land disposal.

The *SRS Proposed Site Treatment Plan* assumed that half of the existing inventory and forecast waste generation of mixed waste lead would consist of lead that could be decontaminated and reused. DOE identified a commercial facility that could perform the required decontamination procedures. The commercial facility would decontaminate the lead using an acid bath. It is assumed that this process would be able to successfully decontaminate 80 percent of the lead. The decontaminated lead would be sold for reuse. Lead that could not be decontaminated would be stabilized and returned to SRS for disposal. The spent acid solutions from the decontamination process would be neutralized, volume reduced, stabilized, and then returned to SRS for disposal.

PROJECT-SPECIFIC ACTIONS:

	Min.	Exp.	Max.
No Action			
A			
B			
C			

No-Action - Offsite mixed waste treatment facilities would not be used under the no-action alternative.

	Min.	Exp.	Max.
No Action			
A			
B			
C			

Alternatives A and B - The offsite mixed waste treatment would be identical for alternatives A and B expected waste forecasts.

DOE would ship radioactively contaminated PCB wastes to a commercial facility for treatment of the PCB fraction. The waste shipments would total approximately 2 cubic meters (71 cubic feet) per year for a total of 56 cubic meters (2,000 cubic feet) over the 30-year period. Residuals from the treatment process [approximately 7 cubic meters (250 cubic feet) over the 30-year period] would be returned to SRS for shallow land disposal.

DOE would ship 3,010 cubic meters (1.06×10^5 cubic feet) of mixed waste lead to the commercial facility for decontamination. The waste shipments would total approximately 119 cubic meters (4,200 cubic feet) per year. Lead that could not be decontaminated and spent decontamination solutions [a total of 602 cubic meters (21,000 cubic feet) over the 30-year period] would be stabilized and returned to SRS for RCRA-permitted disposal.

Small quantities [approximately 2 cubic meters (70.6 cubic feet)] of mercury and mercury-contaminated waste would be shipped to the Waste Engineering Development Facility at the Idaho National Engineering Laboratory. Residuals from the treatment processes would be returned to SRS for disposal.

A small amount [0.8 cubic meter (28 cubic feet)] of calcium metal waste would be shipped to the Los Alamos National Laboratory. Residuals from treatment using the Reactive Metals Skid would be returned to SRS for disposal (Hess 1995a).

	Min.	Exp.	Max.
No Action			
A			
B			
C			

For the minimum waste forecast, PCB wastes, mercury wastes, and calcium metal wastes would be the same as described in the expected waste forecast.

Under alternatives A and B, DOE would ship 1,316 cubic meters (46,500 cubic feet) of mixed waste lead to the commercial facility for decontamination. The waste shipments would total approximately 41 cubic meters (1,450 cubic feet) per year. Lead that could not be decontaminated and spent decontamination solutions [a total of 263 cubic meters (9,300 cubic feet) over the 30-year period] would be stabilized and returned to SRS for disposal (Hess 1995a).

	Min.	Exp.	Max.
No Action			
A			
B			
C			

For the maximum waste forecast, mercury wastes and calcium metal wastes would be managed as described in the expected waste forecast.

DOE would ship radioactively contaminated PCB wastes to a commercial facility for treatment of the

PCB fraction. The waste shipments would total approximately 2 cubic meters (71 cubic feet) per year for a total of 55 cubic meters (1,900 cubic feet) over the 30-year period. Residuals from the treatment process [approximately 7 cubic meters (250 cubic feet) over the 30-year period] would be returned to SRS for shallow land disposal.

DOE would ship 7,675 cubic meters (2.71×10⁵ feet) of mixed waste lead to the commercial facility for decontamination. The waste shipments would total approximately 780 cubic meters (27,500 cubic feet) per year from the years 2000 to 2005 and approximately 152 cubic meters (5,400 cubic feet) per year from the years 2006 to 2024. Lead that could not be decontaminated and spent decontamination solutions [a total of 1,535 cubic meters (54,200 cubic feet) over the 30-year period] would be stabilized and returned to SRS for disposal.

	Min.	Exp.	Max.
No			
Action			
A			
B			
C			

Alternative C - For each waste forecast of alternative C, offsite mixed waste treatment facilities would be utilized as described for alternatives A and B except that no wastes would be shipped offsite to the Waste Engineering Development Facility at the Idaho National Engineering Laboratory. Mercury-contaminated waste would be vitrified at the non-alpha vitrification facility, and mercury waste would be amalgamated at the containment building under alternative C.

B.22 ORGANIC WASTE STORAGE TANK

OBJECTIVE:

The Organic Waste Storage Tank provides RCRA storage for organic waste generated from high-level waste processing at the Defense Waste Processing Facility.

DESCRIPTION:

Beginning in 1996, a 570-cubic meter (150,000-gallon) stainless steel tank would be used for the storage of mixed organic waste generated from the Defense Waste Processing Facility. This tank is referred to as the Organic Waste Storage Tank and is located in the 200-S Area. The tank has a double-seal internal floating roof in addition to a fixed dome roof. The tank vapor space would be filled with nitrogen gas, an inert gas, to prevent ignition. A full-height carbon steel outer vessel would serve as secondary containment for the tank. Waste would be transferred to the tank from the Defense Waste Processing Facility via a welded steel overhead line. Mixed organic waste to be stored in the tank would consist mostly of benzene (80 to 90 percent) and other aromatic compounds, with small amounts of mercury (WSRC 1993h).

PROJECT-SPECIFIC ACTIONS:

	Mid.	Exp.	Max.
No Action			
A			
B			
C			

No Action - Based on DOE's 30-year expected waste forecast, approximately 151 cubic meters (5,300 cubic feet) of organic waste would be generated every year from 1996 to 2,014 for a total of 2,793 cubic meters (98,600 cubic feet). Under the no-action alternative, DOE plans to continue to store this organic waste. Therefore, the storage capacity of the existing 570-cubic meter (150,000-gallon) tank would be sufficient for approximately 4 years. To accommodate mixed organic waste generation, DOE would build additional organic waste storage tanks identical to the existing tank. Accordingly, 4 additional 570-cubic meter (150,000-gallon) organic waste storage tanks would need to be constructed in S-Area over the 30-year period (Hess 1995a).

	Min.	Exp.	Max.
No Action			
A			
B			
C			

Alternatives A, B, and C - The amount of mixed organic waste generated would be the same for each waste forecast and is the same as described under the no-action alternative. Under alternatives A, B, and C, DOE would treat the mixed organic waste; therefore, the existing 570-cubic meter (150,000-gallon) tank would provide sufficient storage capacity over the next 30 years. No additional tanks would need to be constructed.

B.23 PROCESS WASTE INTERIM TREATMENT/STORAGE FACILITY

OBJECTIVE:

The Process Waste Interim Treatment/Storage Facility was built to store the wastewater slurry generated by the M-Area Liquid Effluent Treatment Facility process until a concentrated wastewater treatment process was developed. This vitrification treatment process is to be provided by a commercial vendor, the M-Area Vendor Treatment Facility (Appendix B.15). The treatment facility is currently being permitted, and when it has been constructed and placed in operation, it would treat the wastes currently stored in the Process Waste Interim Treatment/Storage Facility tanks.

DESCRIPTION:

The M-Area Liquid Effluent Treatment Facility was built to treat M-Area waste acids, caustics, and rinse waters. The M-Area Liquid Effluent Treatment Facility is an industrial wastewater treatment facility that includes three linked treatment facilities: the Dilute Effluent Treatment Facility; the Chemical Transfer Facility; and the Process Waste Interim Treatment/Storage Facility. The Dilute Effluent Treatment Facility (Building 341-M) consists of wastewater equalization, physical/chemical precipitation, flocculation, and pressure filtration process equipment. The filtercake resulting from the precipitation and filtration processes is transported to the Chemical Transfer Facility in dedicated

55gallon drums. The Chemical Transfer Facility originally treated concentrated process wastewater and plating-line solutions prior to transfer to the Process Waste Interim Treatment/Storage Facility tanks, but presently it only slurries the Dilute Effluent Treatment Facility filtercake for pipeline transfer to the tanks.

The M-Area Process Waste Interim Treatment/Storage Facility tanks are used for storing concentrated mixed wastes (i.e., electroplating sludge) from the M-Area Liquid Effluent Treatment Facility. These tanks have been granted interim status under RCRA. The Process Waste Interim Treatment/Storage Facility consists of six 132-cubic meter (35,000-gallon) tanks and four 1,900-cubic meter (500,000gallon) tanks (WSRC 1992e).

The 132-cubic meter (35,000-gallon) tanks are single-shelled, welded-steel tanks and are located inside Building 3411M. Building 341-1M consists of a single reinforced concrete pad with steel walls and a roof. To contain leaks and gather accumulated liquids, the concrete pad is diked and slopes towards a sump. The tanks are mounted horizontally on steel saddle support structures to prevent them from coming into contact with accumulated liquids.

The 1,900-cubic meter (500,000-gallon) tanks are double-walled welded-steel tanks that have been field constructed on individual reinforced concrete pads. These tanks are outside. The double-walled construction would contain releases due to tank failure. Additionally, each tank is designed to overflow to one of the other tanks (WSRC 1992e).

PROJECT-SPECIFIC ACTIONS:

	Min.	Exp.	Max.
No Action			
A			
B			
C			

Under the no-action alternative and for all waste forecasts of alternatives A, B, and C, the M-Area Process Waste Interim Treatment/Storage Facility tanks would continue to store concentrated mixed wastes from the M-Area Liquid Effluent Treatment Facility. The Process Waste Interim Treatment/Storage Facility tanks would be used to prepare the waste feed to the M-Area Vendor Treatment Facility and to store offgasscrubberblowdown liquid from the vitrification unit prior to treatment at the M-Area Liquid Effluent Treatment Facility. The existing tanks would provide sufficient storage capacity under all alternatives.

B.24 RECYCLING UNITS

RECYCLING UNIT: Silver Recovery

OBJECTIVE:

The silver recovery system is located in Building 725-N and extracts silver from waste photographic fixative solutions used to develop X-rays films and silk screens. The silver is extracted using ion exchange technology (Nelson 1993).

DESCRIPTION:

Waste solutions flow by gravity from a 18.93-liter (5-gallon) storage vessel into the first of two ion exchange cartridges connected in series to ensure that silver solutions are not accidentally discharged. Each ion exchange cartridge contains a core of iron powder or steel wool which acts as an ion exchange media when the silver-containing solutions are passed through. The waste solutions drain through the first cartridge into the second one. The first (primary) ion exchange cartridge is removed from the process line when it is saturated with silver. The second ion exchange cartridge is then moved to the primary cartridge location, and its original place filled with a fresh ion exchange cartridge (WSRC No date).

The treated fixative solution is discharged to the N-Area sanitary sewer at an average rate of 0.022 liters (0.01 gallons) per minute with a peak discharge of 0.131 liters (0.03 gallons) per minute. Rinse water is also generated when spent ion exchange cartridge cores are flushed. Periodically, the rinse water discharges through the spent ion exchange cartridge and into the silver recovery unit at 0.379 liters (0.1 gallons) per minute (Stewart 1992). After the spent cores are rinsed, dried, packaged, they are shipped offsite for recovery of precious metals (WSRC No date).

PROJECT-SPECIFIC ACTIONS:

	Min.	Exp.	Max.
No			
Action			
A			
B			
C			

Under each alternative, the facility would operate as described.

RECYCLING UNIT: Lead Melter**OBJECTIVE:**

The lead melter melts and recycles scrap lead that is not radioactively contaminated (WSRC 1992f).

DESCRIPTION:

The lead melter is located in Building 711-4N.

The furnace consists of two pots which hold 4,082.4 kilograms (9,000 pounds) and 3,175.2 kilograms (7,000 pounds) of scrap lead, respectively. The furnace operates at least weekly for batch processing of scrap lead. It uses Number 2 Fuel Oil (Dukes 1994). The molten lead is reconfigured for new uses and/or stored. The recycled lead can be used as radiation shielding, counterweights, or for other purposes (WSRC 1993i).

Particulates and vapors generated during lead melting, from both the lead and the fuel combustion exhaust, are contained within the furnace and discharged through a high efficiency particulate air pre-filter and filter to the atmosphere. Lead and particulate emissions are estimated to be between 2.43×10^{-8} and 4.86×10^{-8} metric tons per year (2.68×10^{-8} and 5.36×10^{-8} tons per year). Fugitive lead emissions (those not discharged out a stack but escaping through doors, windows, etc.) from melting

and pouring are estimated at between 3.25×10^{-5} and 6.43×10^{-5} metric tons per year (3.58×10^5 and 7.14×10^{-5} tons per year) (Dukes 1994). Residue from melting operations is regulated as hazardous waste and is managed in a satellite accumulation area prior to onsite permitted storage. Approximately 0.21 cubic meter (7 cubic feet) of residue are generated per month.

PROJECT-SPECIFIC ACTIONS:

	Min.	Exp.	Max.
No Action			
A			
B			
C			

Under each alternative, the facility would operate as described.

RECYCLING UNIT: Solvent Reclamation**OBJECTIVE:**

Solvent reclamation units distill waste solvents and condense the reclaimed solvents for future use.

DESCRIPTION:

Five solvent reclamation units exist at SRS. Two are located in building 725-2N, while three are portable and are transported to various locations throughout SRS (WSRC 1992g). Each solvent reclamation unit is composed of a 28.39-liter (7.5 gallon) electrically powered still. The still is filled with waste solvent and heated to the boiling temperature of the solvent to be reclaimed. Solvent vapors are captured within a unit-contained condenser and cooled with a recycled antifreeze and water mixture. The condensed solvent flows into a clean solvent drum. The duration of distillation for each 28.39-liter (7.5 gallon) batch is approximately 4 hours (WSRC 1993i).

Each solvent distillation vessel is sealed to prevent vapor releases to the atmosphere. Vapor effluent from the reclaimed solvent container is treated with air-phased activated carbon units which are periodically inspected for solvent saturation. Discharges of volatile organic compounds to the atmosphere are estimate at 0.005 kilograms (0.01 pounds) per hour of operation per unit (WSRC 1992g).

Waste solvent residue is cleaned from the stills, containerized, and managed in a satellite accumulation area prior to onsite permitted storage. Coolant solution is collected in a holding tank and reused (WSRC 1993i).

PROJECT-SPECIFIC ACTIONS:

	Min.	Exp.	Max.
No Action			
A			
B			
C			

Under each alternative, the facility would operate as described.

RECYCLING UNIT: Refrigerant Gas Recovery and Recycling**OBJECTIVE:**

These closedloop systems recover and reuse chlorofluorocarbons and hydrochlorofluorocarbons without venting to the atmosphere (WSRC 1993i). Equipment that uses refrigerant gases is recharged with one of these units. Gases are also reclaimed from decommissioned cooling equipment prior to disposal (Hess 1994i).

DESCRIPTION:

There are 71 refrigerant gas recovery and recycling units at SRS (Hess 1994j). These portable units are based in Buildings 711-5N and 716-N; however, they are used throughout SRS. The process of reclaiming the refrigerants involves attaching a refrigerant gas recovery unit to the equipment being recharged. The refrigerant gas is released into the unit's sealed recovery system. The warm gas is forced at high velocity into a oil/acid separator where oils, acids, and particulates (e.g., copper chips) drop to the bottom of the separator. The separated, cleaned vapors then pass through a compressor and condenser to form a liquid refrigerant. The liquid is then cooled to between 1.7 and 4.4 °C. The cooling promotes drying of the liquid and air separation. The reclaimed refrigerant is stored within the unit (Hess 1994j). Storage capacity is 13.61 kilograms (30 pounds) or 40.82 kilograms (90 pounds), depending on the unit. Recycled refrigerant, stored within the unit, is used to recharge the cooling equipment (Hess 1994i).

Refrigerant recycling units are closed loop-systems; therefore, no refrigerant gas emissions are released (Hess 1994i). Oil, acid, and particulates separated from waste gas are removed from the separating unit and managed as waste oil (a nonhazardous waste), which is burned for energy recovery in an SRS powerhouse boiler (Harvey 1994).

PROJECT-SPECIFIC ACTIONS:

	Min.	Exp.	Max.
No			
Action			
A			
B			
C			

Under each alternative, the facility would operate as described.

RECYCLING UNIT: Vacuum Stripping Facility**OBJECTIVE:**

This portable stripping device is used to abrade contaminated surface coatings from materials (Miller 1994a).

DESCRIPTION:

The vacuum stripping facility is located in Building 728-N. Vacuum stripping pneumatically propels aluminum oxide grit at the surface to be decontaminated. The surface is abraded by the impact of the

grit. The grit and dislodged material are vacuumed from the surface immediately. The unit separates contaminated material and shattered grit from the intact grit and reuses the intact grit in the decontamination process (Miller 1994a).

Particulates generated during decontamination are captured in a dust filter. The waste captured in the dust filter is stabilized with an agent such as concrete if the waste is finely powdered and managed as low-level waste. A secondary high efficiency particulate air filter is installed on the stripper to prevent releases to the atmosphere (Hess 1994k). The building is also equipped with high efficiency particulate air filters to further ensure contaminants are not released to the atmosphere.

The rate at which high efficiency particulate air filters are used and the volume of waste from the dust filter depends on the size and level of contamination of the equipment being decontaminated. The volume of job-control waste depends on the number of jobs at the facility. Based on the equipment to be decontaminated during the first quarter of Fiscal Year 1995, the waste estimate is 0.01 cubic meters (0.35 cubic feet) of removed contamination and unusable grit (excludes stabilizing agent volume) and 0.453 cubic meters (16 cubic feet) of job-control waste (Miller 1994b). The volume of unusable grit generated is estimated at 0.002 cubic meters (0.07 cubic feet) per day (Miller 1994a).

PROJECT-SPECIFIC ACTIONS:

	Min.	Exp.	Max.
No Action			
A			
B			
C			

Under each alternative, the facility would operate as described.

RECYCLING UNIT: Carbon Dioxide Blasting Facility

OBJECTIVE:

The carbon dioxide blasting facility would be located in C-Area (Miller 1994b) and is scheduled to be in operation by the second quarter of fiscal year 1995 (Miller 1994a). This facility uses solid carbon dioxide pellets (i.e., dry ice) to remove surface contaminants without degrading the surface (Hess 1994k).

DESCRIPTION:

The carbon dioxide facility would produce solid dry ice pellets and pneumatically propel them at the contaminated surface. Upon contact, the pellets flash into the gaseous phase, simultaneously purging contaminants from the microscopic pores on the surface. Large particles are also dislodged by this flashing action. This nondestructive technology can be used on delicate materials and equipment (Hess 1994k).

Carbon dioxide and contaminant emissions are captured by the two sets of high efficiency particulate air filters installed in the enclosure (Miller 1994a). The wastes generated during the decontamination are spent high efficiency particulate air filters from the carbon dioxide blaster enclosure, removed material that does not reach the high efficiency particulate air filters, and job-control waste (i.e., protective clothing, radiological survey swipes, etc.). The spent high efficiency particulate air

filters would be managed as low-level or mixed waste, depending on the equipment decontaminated. The decontamination of lead equipment would yield mixed waste, while the decontamination of steel equipment would yield low-level waste (Miller 1994c). Larger particles of foreign material which do not reach the high efficiency particulate air filters would be vacuumed from the blaster's enclosure, stored, and disposed of as low-level or mixed waste (Hess 1994k).

The number of high efficiency particulate air filters and volume of large contamination particles generated depends on the size and contamination level of the equipment decontaminated. The volume of job-control waste depends on the production level for the facility. Based on the equipment to be decontaminated during the second quarter of fiscal year 1995, waste generation is estimated at 0.03 cubic meters (1.1 cubic feet) of mixed waste and 0.23 cubic meters (8.1 cubic feet) of low-level job-control waste during that time (Miller 1994c).

PROJECT-SPECIFIC ACTIONS:

	Min.	Exp.	Max.
No			
Action			
A			
B			
C			

Under each alternative, the facility would operate as described.

RECYCLING UNIT: Kelly Decontamination Facility

OBJECTIVE:

The Kelly decontamination unit is portable and would be used at various locations throughout SRS to decontaminate floors and installed equipment; it would be housed in C-Area (Miller 1994b). This decontamination system would use superheated water to pressure-clean contaminated surfaces (Miller 1994a).

DESCRIPTION:

Water and contaminated materials would be collected by the unit and treated through a separator and a demister/high efficiency particulate air filter. The Kelly unit generates 3.03 liters (0.8 gallons) per minute (Miller 1994a). The wastes generated would be liquid radioactive waste that would be transferred to 211-F for eventual transfer to the F- and H-Area tank farms and a filtercake that would be dewatered and stabilized prior to being placed in a 2.6-cubic-meter (90-cubic-foot) box and managed as low-level waste (Miller 1994c).

PROJECT-SPECIFIC ACTIONS:

	Min.	Exp.	Max.
No			
Action			
A			
B			
C			

Under each alternative, the facility would operate as described.

B.25 REPLACEMENT HIGH-LEVEL WASTE EVAPORATOR

OBJECTIVE:

The Replacement High-Level Waste Evaporator is currently in the design and construction phase. It is being built so that liquid high-level waste can be processed in the future to meet waste tank capacity requirements. Of the four existing evaporators at SRS, only two are operational; the Replacement High-Level Waste Evaporator is needed to meet the demand for waste evaporation and subsequent processing at the Defense Waste Processing Facility. Once operational, the new evaporator would have more than twice the design capacity of each of the 2H and 2F evaporators and would be able to process the Defense Waste Processing Facility recycle waste stream in addition to high-heat waste (i.e., waste that contains high levels of radioactivity). Without the Replacement High-Level Waste Evaporator, the tank farms would run out of required tank space, and the Defense Waste Processing Facility would be forced to stop processing high-level waste (WSRC 1993f).

Construction of the Replacement High-Level Waste Evaporator was initiated and is continuing as a categorical exclusion under then-current DOE NEPA guidelines (52 FR 47662). Regulatory oversight for the project was originally provided under RCRA and continues under the provisions identified in Industrial Wastewater Permit number 17,424-IW for F/HArea tank farms. The planned startup date for the Replacement High-Level Waste Evaporator is May 1999 (WSRC 1994h).

DESCRIPTION:

Figure B.25-1 is a simplified process diagram of the Replacement High-Level Waste Evaporator. The Replacement High-Level Waste Evaporator, like the existing evaporators, could be described as a large pot in which the waste is heated by a bundle of bent tube steam coils. The evaporator will be constructed of stainless steel, approximately 4.3 meters (14 feet) in diameter and 8.2 meters (27 feet), contained in a reinforced concrete building. Liquid supernatant would be transferred to the evaporator from an evaporator feed tank. Within the evaporator, the supernatant would be heated to its boiling point, forming a vapor phase called "overheads." The overheads would be condensed and monitored to ensure that they contain no unexpected excessive amounts of entrained (captured) radionuclides. Following condensing and monitoring, the overheads would be transferred to the F/HArea Effluent Treatment Facility for further treatment. The concentrated supernatant in the evaporator pot would be transferred to an evaporator receipt tank (WSRC 1994d).

The Replacement High-Level Waste Evaporator is expected to process 13,815 cubic meters (3.6×10^6 gallons) of overheads per year (Campbell 1994a). Comparatively, the 2H and 2F evaporators have historically had a maximum annual overhead process rate of 12,900 and 14,000 cubic meters (3.4×10^6 and 3.7×10^6 gallons), respectively (Campbell 1994b).

Replacement High-Level Waste Evaporator design improvements over the existing evaporators include material changes in the heater tube bundle, elimination of deentrainment equipment and the cesium removal column because of improvements in deentrainment efficiency (WSRC 1991).

PROJECT-SPECIFIC ACTIONS:

	Min.	Exp.	Max.
No			
Action			
A			
B			
C			

Under each alternative, DOE would continue construction and begin operation of the Replacement High-Level Waste Evaporator. The operational rate of the Replacement High-Level Waste Evaporator would not change as a result of the reduced volumes anticipated in the minimum waste forecast or the increased volumes anticipated in the maximum waste forecast.

B.26 SAVANNAH RIVER TECHNOLOGY CENTER**MIXED WASTE STORAGE TANKS****OBJECTIVE:**

The Mixed Waste Storage Tanks provide storage and treatment capacity for wastewater from the low-activity drain system and high-activity drain system that support research, development, and analytical programs at the Savannah River Technology Center (SRTC).

DESCRIPTION:

Ten interim status steel storage tanks are located below grade in concrete vaults at the Savannah River Technology Center in Building 776-2A. Seven tanks each have a capacity of 22 cubic meters (5,900 gallons) and three tanks each have a capacity of 14 cubic meters (3,670 gallons) (WSRC 1992h). These tanks are used to store liquid radioactive waste that could potentially be hazardous (hence mixed waste) due to corrosivity or toxicity for chromium, lead, mercury, or benzene.

Waste is segregated in the tanks by its radiological levels: high-activity (greater than 1,000 disintegrations per minute per milliliter alpha or beta-gamma activity) and low-activity (less than 1,000 disintegrations per minute per milliliter alpha or beta-gamma activity). When a tank is full it is sampled and analyzed for radioactivity and selected hazardous constituents. If the contents are determined to be nonhazardous, waste is transferred to the separation facility in F-Area. If the contents are determined to be hazardous, the waste is treated in the tank prior to transfer to F-Area.

If the waste is hazardous because of corrosivity, it would be made nonhazardous by adjusting the pH with an appropriate neutralizer. The waste would be treated by sorption on an appropriate ion exchange medium to remove the hazardous constituent(s) of chromium, lead, mercury and/or benzene. The ion exchange process can only remove chromium in the trivalent form (chromium III). If chromium were present in the hexavalent form (chromium VI), the waste would first be pretreated to convert the chromium VI to chromium III. This could be done by adding a reducing agent to the tank. After treatment, the waste would be transferred to the separation facility in F-Area (WSRC 1992h).

PROJECT-SPECIFIC ACTIONS:

	Min.	Exp.	Max.
No Action			
A			
B			
C			

Under each of the alternatives, DOE would continue to receive, store, and treat via ion exchange liquid mixed wastes in the Savannah River Technology Center Mixed Waste Storage Tanks. If required, the waste would also be treated by neutralization and/or chromium reduction. It is expected that 75 cubic meters (2,600 cubic feet) per year of high-activity waste and 75 cubic meters (2,600 cubic feet) per year of low-activity waste would be generated and managed at the Savannah River Technology Center Mixed Waste Storage Tanks (WSRC 1995). Because the waste is treated as it is generated, the 10 existing Savannah River Technology Center Mixed Waste Storage Tanks would have sufficient capacity for the 30-year analysis period. The treated wastewater would be transferred to the separation facility in FArea and has been included in the liquid high-level waste volume forecasted for that facility.

B.27 SHALLOW LAND DISPOSAL**OBJECTIVE:**

In general, shallow land disposal in this eis refers to trench disposal.

DOE Order 5820.2A establishes performance objectives for the disposal of low-level wastes. A radiological performance assessment is required to ensure that the waste inventory and the proposed disposal method provide reasonable assurance that the performance objectives will be met. The radiological performance assessment projects the migration of radionuclides from the disposed waste to the environment and estimates the resulting dose to man. DOE has completed a radiological performance assessment for trench disposal of suspect soils (as part of the radiological performance assessment for the E-Area vaults). DOE anticipates that naval reactor hardware will be deemed suitable for shallow land disposal after additional data on the composition and configuration of the waste forms is obtained and can be incorporated in the radiological performance assessment. Stabilized waste forms resulting from the proposed treatment activities (i.e., vitrification and incineration) would be evaluated against the DOE Order 5820.2A performance objectives. Radiological performance assessments for these stabilized low-level wastes (wastes in which the radionuclides have been immobilized in a cement or glass matrix or encapsulated) are expected to demonstrate that shallow land disposal achieves the performance objectives of DOE Order 5820.2A.

For purposes of analysis in this eis, stabilized waste forms and selected low-level wastes (suspect soils and naval hardware) are assumed to be suitable for shallow land disposal. The analyses provide groundwater concentrations as a result of shallow land disposal of suspect soils based on the radiological performance assessment's unit concentration factors and the eis waste inventories. DOE expects that the releases resulting from the disposal of stabilized wastes and naval hardware in slit trenches would be comparable to those for unstabilized suspect soils and would comply with performance objectives specified by DOE Order 5820.2A. Therefore, for purposes of defining the alternatives in this eis, DOE has assumed shallow land disposal for these wastes.

DESCRIPTION:

Shallow land disposal (or trenches) was described in the *Final Environmental Impact Statement, Waste Management Operations* (ERDA 1977). Shallow land disposal (or shallow land burial) was also described in the *Waste Management Activities for Groundwater Protection Environmental Impact Statement* and identified as an acceptable technology for low-level waste under the preferred "combination" alternative. Shallow land disposal has continued in the Low-Level Radioactive Waste Disposal Facility and is expected to continue at the E-Area vault site for some lowlevel wastes (e.g., suspect soil and low-activity equipment that is too large for disposal in the EArea vaults).

Radioactive waste disposal activities in the Low-Level Radioactive Waste Disposal Facility (see Figure 333) commenced in 1972 and continue to the present. Areas within the Low-Level Radioactive Waste Disposal Facility include:

- engineered low-level trenches for disposal of containerized low-activity waste and suspect soils
- greater confinement disposal boreholes and engineered trenches for disposal of intermediateactivity waste that is compatible with trench disposal
- slit trenches for disposal of containerized intermediate-activity waste, bulky noncontainerized low-activity waste, loose soil and rubble, and containerized offsite wastes

Engineered low-level trenches are basically large open pits in which low-activity waste boxes are placed. The engineered low-level trenches are several acres in size and are approximately 6.7 meters (22 feet) deep. The other dimensions are adjusted to maximize use of burial space. The engineered low-level trenches have sloped sides and floor, allowing rainwater to flow to a collection sump. Once the trench is full of boxes, it is backfilled and covered with a minimum of 1.8 meters (6 feet) of soil. Soil that is suspected to be contaminated and cannot economically be demonstrated to be uncontaminated (i.e., suspect soil) is used as backfill material in engineered low-level trenches. To date three engineered low-level trenches have been filled and a fourth trench is currently receiving only suspect soils (Hess 1995b).

Greater confinement disposal boreholes have been augered to a depth of about 9.1 meters (30 feet) and are lined with fiberglass (with the exception of one borehole which is lined with steel). The boreholes are encased within a 0.3-meter (1-foot) thick concrete annulus. Waste in the borehole is stabilized by grouting around the waste to fill voids. After the boreholes are filled, clay caps are placed over them. Each greater confinement disposal borehole is monitored for leaching of radionuclides into the surrounding medium. Existing boreholes have reached capacity, and construction of additional boreholes is not anticipated.

Greater confinement disposal engineered trenches are constructed of reinforced concrete and consist of four cells. A trench is approximately 30 meters (100 feet) long and 15 meters (50 feet) wide with four cells each 8 meters (25 feet) long and 15 meters (50 feet) wide with a disposal capacity of approximately 850 cubic meters (30,000 cubic feet) per cell. When a cell is not being used, steel covers are placed over it to minimize rainwater intrusion. Additionally, drainage channels direct water away from the trench. The trench has a leachate collection system to collect rainwater that may enter the cells (WSRC 1993b). The greater confinement disposal engineered trench has a capacity of 3,400 cubic meters (1.2×10⁵ cubic feet) and is filled to 75 percent of capacity. There is 850 cubic

meters (30,000 cubic feet) of capacity remaining. DOE discontinued disposal of low-level waste in this engineered trench on March 31, 1995, and has no future plans to use the remaining capacity or construct additional engineered trenches (Hess 1995b).

Slit trenches are 6.1 to 9.4 meters (20 to 30 feet) wide, 6.7 meters (22 feet) deep, and up to 300 meters (985 feet) long (WSRC 1994b). Shortly after waste is placed in a slit trench, it is covered with soil to control radiation exposure and to reduce the potential for spread of contamination through airborne releases (WSRC 1993b, 1994b). Once a trench is filled with waste, it is backfilled with a minimum of 1.8 to 2.4 meters (6 to 8 feet) of soil to reduce surface radiation dose rates to less than 5 millirem per hour, to reduce the potential for spread of contamination, and to minimize plant and animal intrusion into the waste (WSRC 1993b). For analysis purposes in the eis, it is assumed that a slit trench has a nominal capacity of approximately 1,100 cubic meters (38,852 cubic feet) based upon trench dimensions of 6.1 meters (20 feet) wide, 6.1 meters (20 feet) deep, and 30 meters (100 feet) long.

DOE discontinued disposal of containerized low-level waste in the greater confinement disposal engineered trench and an engineered low-level trench on March 31, 1995. In September 1994, DOE began to use concrete vaults referred to as the low-activity waste vaults for disposal of containerized low-activity waste. In February 1995, DOE began to use concrete vaults referred to as intermediate-level waste vaults for disposal of intermediate-activity waste (Hess 1995b).

Naval reactor core barrels and reactor components are stored on gravel pads in the Low-Level Radioactive Waste Disposal Facility. The gravel pads have a total storage capacity of 697 square meters (7,500 square feet). If DOE determines that reactor component containers satisfy the performance objectives of DOE Order 5820.2A, these component containers would also be sent to shallow land disposal (WSRC 1994l).

PROJECT-SPECIFIC ACTIONS:

Table B.27-1 presents low-level waste management activities for shallow land disposal.

Table B.27-1. Total waste requiring shallow land disposal and number of slit trenches (cubic meters).a,b

	Min.	Exp.	Max.
		30,876 m ³ total 29 trenches	
A	26,808 m ³ total 25 trenches	79,723 m ³ total 73 trenches	708,025 m ³ total 644 trenches
B	39,737 m ³ total 37 trenches	63,316 m ³ total 58 trenches	407,362 m ³ total 371 trenches
C	49,250 m ³ total 45 trenches	134,579 m ³ total 123 trenches	632,753 m ³ total 576 trenches

a. Source: Hess (1995a).

b. To convert to cubic feet, multiply by 35.31.

	Mid.	Exp.	Max.
No Action			
A			
B			
C			

Under the no-action alternative, DOE would send suspect soils, naval hardware, and stabilized residuals from treatment of radioactive PCBs to shallow land disposal.

	Min.	Exp.	Max.
No Action			
A			
B			
C			

For each waste forecast of alternative A, DOE would send stabilized ash and blowdown from the Consolidated Incineration Facility and waste listed under the no-action alternative to shallow land disposal.

	Mid.	Exp.	Max.
No Action			
A			
B			
C			

Under alternative B - expected and maximum waste forecasts, DOE would send For wastes from the non-alpha vitrification facility, stabilized residuals from the offsite smelter and metal melt, and waste listed under alternative A to shallow land disposal.

	Mid.	Exp.	Max.
No Action			
A			
B			
C			

For alternative B - minimum waste forecast, DOE would dispose of the same waste as under alternative B expected and maximum waste forecasts, except for vitrified wastes from the non-alpha vitrification facility, by shallow land disposal. The non-alpha vitrification facility would not operate under the minimum waste forecast alternative B due to insufficient waste volume to warrant it.

	Mid.	Exp.	Max.
No Action			
A			
B			
C			

Under alternative C, DOE would send waste listed for alternative B - expected and maximum waste forecasts, except for residuals from the offsite metal melt, and vitrified waste from the alpha

vitrification facility to shallow land disposal.

B.28 SOIL SORT FACILITY

OBJECTIVE:

The soil sort facility would provide a process to determine whether soils are contaminated and segregate uncontaminated soils for reuse, reducing the volume of soil that would require treatment and/or disposal.

DESCRIPTION:

The soil sort facility would be a mobile assembly of standard sand-and-gravel handling equipment coupled with instrumentation for monitoring radiation, which would allow contaminated material transported along a conveyor system to be diverted from uncontaminated material. The ability to locate small particles of radioactive material dispersed throughout the soil would allow contaminants to be isolated and removed. No sorting of tritiated soils would be performed due to the lack of effective monitoring.

DOE anticipates that a soil sort facility sorting efficiency would yield a separation ratio of 60 percent contaminated to 40 percent uncontaminated soils for mixed waste soils and low-activity waste soils and 40 percent contaminated to 60 percent uncontaminated soils for suspect soils. Uncontaminated soils would be reused onsite as backfill (Hess 1994b).

PROJECT -SPECIFIC ACTIONS:

	Min.	Exp.	Max.
No Action			
A			
B			
C			

Under the no-action alternative, DOE would not construct or operate the mobile soil sort facility.

	Min.	Exp.	Max.
No Action			
A			
B			
C			

The mobile soil sort facility would be constructed and operated only for mixed waste soils under alternative A. The facility would commence operations in 2006.

	Min.	Exp.	Max.
No Action			
A			
B			
C			

Low-activity waste soil and suspect soil would be segregated under alternative B. The facility would commence operations in 1996. Because the nonalpha vitrification facility would not be required for the minimum waste forecast under alternative B, the soil sort facility would also process mixed waste soils under that scenario, beginning in 2006.

	Min.	Exp.	Max.
No Action			
A			
B			
C			

Under alternative C, the soil sort facility would not operate because the mixed and low-level waste soils would be treated at the non-alpha vitrification facility, which includes a soil sorting capability.

Under each alternative, estimated volumes of low-level and mixed waste processed by the soil sort facility are shown in Table B.281.

Table B.28-1. Estimated volumes of soil sorted for each alternative (cubic meters).a,b

	Min.	Exp.	Max.
		Facility not constructed	
A	23,873 m3 of mixed waste mixed waste soils 1,257 m3 per year	88,331 m3 of mixed waste mixed waste soils 4,650 m3 per year	440,060 m3 of mixed waste mixed waste soils 23,161 m3 per year
B	19,192 m3 of low-level waste soils 322 to 2,806 m3 per year 23,873 m3 of mixed waste mixed waste soils 1,257 m3 per year	48,489 m3 of low-level waste soils 294 to 2,542 m3 per year	776,707 m3 of low-level waste soils 2,193 to 31,906 m3 per year
C	Facility not constructed	Facility not constructed	Facility not constructed

a. Source: Hess (1995a).

b. To convert to cubic feet, multiply by 35.31.

B.29 SUPERCOMPACTOR

OBJECTIVE:

DOE is pursuing treatment options to reduce the volume of low-level wastes to more efficiently use the disposal capacity of the low-level waste vaults. In the draft eis, DOE proposed to construct and operate an onsite supercompactor to accept equipment and additional job-control wastes that could

not be compacted at the existing SRS compactor facilities. DOE has since determined that treatment capacity for many of these wastes is currently available through commercial vendors. Contracting with an offsite commercial vendor would allow DOE to obtain treatment capacity for its low-level wastes sooner than construction of an onsite facility (a contract could be executed by fiscal year 1996 as opposed to 2006 before beginning operations of an onsite facility). Details of the proposed commercial vendor treatments for low-level waste can be found in Appendix B.20. Although the commercial vendor treatment has replaced the onsite supercompactor in the proposed configuration for alternative B, DOE may need to develop onsite treatment capability in lieu of using commercial vendors in the future. Therefore, the waste volumes that could be treated in an onsite supercompactor facility and the associated impacts are presented in this appendix.

DESCRIPTION:

The supercompactor would be located in E-Area and use high compression to exert significant pressure on compactible waste. The compaction efficiency of existing compactors is approximately 4 to 1, whereas the supercompactor could achieve compaction efficiencies of 12 to 1, for job-control waste (Hess 1994a). The system would consist of the following: compaction press, with mold to hold container during size reduction; hydraulic module to operate the press and auxiliary components; ventilation sub-system to control potentially radioactive dust generated during compaction; conveyor system to load and unload containers; liquid collection systems; sealed shipping container for final disposal; and auxiliary components and features to prepare waste for supercompaction. Liquid wastes from the supercompactor would be collected for treatment at the Consolidated Incineration Facility.

PROJECT-SPECIFIC ACTIONS:

In the draft eis, DOE proposed to construct and operate an onsite supercompactor under alternative B. DOE proposed to operate the facility from the years 2006 to 2024 to supercompact low-level waste comprised of low-activity job-control waste, tritiated job-control waste, and low-activity equipment.

Table B.29-1 presents annual and 30-year estimated volumes of low-level waste for the supercompactor facility as proposed under alternative B of the draft eis.

Table B.29-1. Estimated volumes of supercompacted low-level waste for each alternative as proposed in the draft eis (cubic meters).a,b,c

	Min.	Exp.	Max.
		None	
A	None	None	None
B	84,805 m ³ 4,463 m ³ per year	108,285 m ³ 5,699 m ³ per year	229,418 m ³ 12,075 m ³ per year
C	None	None	None

a. Source: Hess (1994b).

b. To convert to cubic feet, multiply by 35.31.

c. Details of the proposed commercial vendor treatments for low-level waste in the final eis are in Appendix B.20.

SUMMARY OF IMPACTS:

The consequences of the supercompaction of low-level radioactive wastes at a new onsite facility were evaluated under alternative B of the draft eis. In the final eis, DOE has determined that treatment of low-level wastes can be obtained in a more timely and cost-effective manner by utilizing commercial vendors. Although it is not proposed as an action under any of the alternatives in the final eis, DOE may need to develop an onsite supercompaction facility in lieu of using commercial vendors in the future. The consequences associated with this onsite treatment activity are described in Table B.29-2, based on the waste volumes considered for supercompaction in the draft eis.

Table B.29-2. Summary of impacts from the operation of an onsite supercompactor as proposed in the draft eis.a

Minimum Waste Forecast	Expected Waste Forecast	Maximum Waste Forecast
Waste disposal volumes^b		
9,069 m ³ to LAW ^c vault disposal	13,129 m ³ to LAW vault disposal	32,392 m ³ to LAW vault disposal
Radiological air emissions		
Average annual radiological dose and resulting health effects to the public^d		
Maximally exposed individual		
2.46×10 ⁻⁵ millirem	6.79×10 ⁻⁵ millirem	0.00293 millirem
1.23×10 ⁻¹¹ probability of an excess fatal cancer	3.39×10 ⁻¹¹ probability of an excess fatal cancer	1.47×10 ⁻⁹ probability of an excess fatal cancer
Average annual population dose^e		
9.58×10 ⁻⁴ person-rem	0.00266 person-rem	0.115 person-rem
4.79×10 ⁻⁷ number of additional fatal cancers	1.33×10 ⁻⁶ number of additional fatal cancers	5.76×10 ⁻⁵ number of additional fatal cancers
Average annual radiological dose and resulting health effects to uninvolved workers		
640 meter uninvolved worker		
5.84×10 ⁻⁴ millirem	0.00161 millirem	0.070 millirem
2.92×10 ⁻¹⁰ probability of an excess fatal cancers	8.05×10 ⁻¹⁰ probability of an excess fatal cancer	3.50×10 ⁻⁸ probability of an excess fatal cancer
100 meter uninvolved worker		
0.0176 person-rem	0.0484 person-rem	2.09 person-rem
8.79×10 ⁻⁹ probability of a n excess fatal cancer	2.42×10 ⁻⁸ number of additional fatal cancers	1.05×10 ⁻⁶ number of additional fatal cancers
Direct exposure^f		
Average annual radiological dose and resulting health effects to involved workers		
Maximally exposed individual^g		
0.79 millirem	1.00 millirem	1.69 millirem
3.16×10 ⁻⁷ probability of an excess fatal cancer	4.00×10 ⁻⁷ probability of an excess fatal cancer	6.77×10 ⁻⁷ probability of an excess fatal cancer
Average annual involved worker population dose		
5.53 person-rem	7.00 person-rem	18.6 person-rem

0.00221 number of additional fatal cancers

0.00280 number of additional fatal cancers

0.00744 number of additional fatal cancers

a. Source: Hess (1994b).

b. Compacted waste disposal volumes are for the entire 30-year analysis period.

c. LAW = low activity waste.

d. Average annual dose and probability of fatal cancer obtained by dividing the total dose during the period of interest in this eis and associated probability by the years of actual operation (i.e., 19 years).

e. Number of additional fatal cancers are per year of Consolidated Incineration Incineration Facility Consolidated Incineration Facility operation.

f. Direct exposure to involved workers is scaled to cesium cesium-cesium-137. Direct exposure is normalized to the expected forecast average exposure provided by Hess (1994d).

g. Maximum exposure is assumed to be equal to the average worker exposure provided by Hess (1994d).

B.30 TRANSURANIC WASTE STORAGE PADS

OBJECTIVE:

The transuranic waste storage pads provide retrievable storage for nonmixed and mixed alpha waste (10 to 100 nanocuries per gram) and transuranic waste (greater than 100 nanocuries per gram). The waste stored on the transuranic pads is generated at the Savannah River Technology Center, F-Area laboratories, the 235-F Plutonium Fabrication Facility, and the F- and H-Area separations facilities. Future storage needs also include alpha and transuranic wastes that would be generated by decontamination and decommissioning and environmental restoration activities.

DESCRIPTION:

Storage

The alpha and transuranic wastes are packaged, handled, and stored according to the quantity of nuclear material present and RCRA hazardous waste constituents present (i.e., as mixed waste). The waste is packaged in 55-gallon drums; carbon steel, concrete or polyethylene boxes; concrete culverts; or special containers.

DOE packages job-control waste in 55-gallon drums with carbon filter vents. The drums are assayed following packaging and categorized as less than or greater than 0.5 curies per package. The drums that are less than 0.5 curies per drum are placed directly on the transuranic pads for storage. The drums with greater than 0.5 curies are placed inside concrete culverts (because of the radiological activity) before being placed on the transuranic pads. The bulk waste is packaged in carbon steel, concrete, or polyethylene boxes or special containers where internal shielding may be used for greater than 0.5 curies per package. Transuranic waste that has a surface dose rate of greater than 200 millirem per hour per container is handled remotely. Remote-handled waste is packaged in concrete culverts for storage at the transuranic waste storage pads. The remotehandled waste comprises a very

small percentage of the overall transuranic waste at SRS.

There are currently 19 transuranic waste storage pads in E-Area. Each pad is a reinforced concrete slab that slopes to the center and drains to one end where a sump is located. Pads' 1 and 2 dimensions are

15 meters by 38 meters (50 feet by 125 feet) and Pads' 14 through 19 are 18 meters by 49 meters (60 feet by 160 feet) (WSRC 1994k).

Pads 1 through 5 are full of waste containers and covered with 0.3 meter (1 foot) of soil, a polyvinyl chloride top, and an additional 0.9 meter (3 feet) of soil which is seeded with grass. The mounds over Pads 1 through 4 are coated with an asphalt spray to control erosion. Pad 6 is full of waste containers and partially mounded by earth. The mounded soil provides shielding from the stored radionuclides and protects the waste from weather and human intrusion.

Pads 7 through 13, 18 and 19 are open-access pads with various types of containers configured without aisles. Pads 14 through 17 have weather enclosures to provide protection from rain for the stored waste drums until treatment and disposal. The enclosures are leak-proof with ultraviolet light protection, high wind load resistance, and no center supports. These pads would store only drums of waste. Pads 18 and 19 store only boxes of nonmixed transuranic waste at this time (WSRC 1994k).

Reconfiguration

Pads 7 through 13 have no aisles because SRS has been granted a variance to RCRA aisle spacing and labeling requirements until the containers are accessible. Pads 14 through 17 are not part of the variance and DOE has committed to providing aisles between the waste stored on these pads by 1998.

DOE would implement an alpha and transuranic waste storage strategy to reconfigure the containers on Pads 7 through 17 to meet RCRA interim status storage requirements, where applicable, and maximize the available space on the transuranic waste pads for future storage. DOE would transfer the non-alpha mixed wastes (i.e., wastes with less than 10 nanocuries per gram of transuranics) currently stored on the transuranic pads to other storage pads to provide additional space for alpha and transuranic wastes. The new configuration would include placing containers, other than drums, stacked one high on Pads 7 through 13 and stacking drums three high on Pads 14 through 17. As a result, DOE anticipates needing the space on Pads 18 and 19 to make up for the loss in storage capacity from providing aisles on Pads 14 through 17. As part of the storage strategy DOE is evaluating the use of reactor buildings as storage locations for the alpha and transuranic waste, but technical and regulatory considerations associated with the use of those facilities have not yet been addressed. Therefore, this EIS analysis assumes only pad storage for the alpha and transuranic waste (WSRC 1994m).

Retrieval

The retrieval portion of the facility's operations involve the removal of 55- or 83-gallon transuranic drums from the mounded Pads 2 through 6. The transuranic waste drums stored on these pads are about to reach their 20-year storage life based on the calculations for the mounded storage configuration (WSRC 1994m). The retrieval program would be conducted with equipment designed to extract the drums from the mounds.

The earthen mounds cover a close array of 55-gallon drums, stacked two high, sitting on the concrete

pad. A weather enclosure would be erected over the pad prior to initiating retrieval. The soil would be removed from the mounds, exposing the drums. Each drum would be individually removed from the stack. The drums would be vented and purged of any gases that may have generated from waste material decomposition as a result of radiological contamination. The vented drums would then be placed in an overpack container fitted with a carbon composite filter to prevent future gas accumulation. Pads 2 through 6 would remain in service for transuranic waste storage following the retrieval operation. Pad 1 would not be retrieved because the waste is stored inside concrete culverts that are expected to provide adequate storage during the 30-year analysis period (WSRC 1994m).

PROJECT-SPECIFIC ACTIONS:

	Min.	Exp.	Max.
No Action			
A			
B			
C			

Under the no-action alternative, the transuranic waste storage pads would store the nonmixed and mixed alpha waste and transuranic waste. The retrieval operation would begin in 1997 or 1998, and waste would be rearranged to conform with RCRA requirements and to maximize storage space on the existing pads.

In 1998, additional pads would be needed to increase the storage capacity. A total of 19 additional pads would be required by the year 2024 (Hess 1995a).

For each waste forecast, alternatives A, B, and C would be identical to the no-action except that the amount of additional waste storage capacity would vary according to the transuranic and alpha waste treatment and disposal activities proposed for each alternative. Table B.30-1 presents the number of transuranic waste storage pads required for each alternative.

Table B.30-1. Number of additional transuranic waste storage pads that would be required under each alternative.a

	Min.	Exp.	Max.
		19 additional pads by 2024	
A	3 additional pad by 2006	12 additional pads by 2006	1,168 additional pads by 2006
B	2 additional pads by 2005	10 additional pads by 2006	1,168 additional pads by 2006
C	2 additional pads by 2004	11 additional pads by 2006	1,166 additional pads by 2006

a. Source: Hess (1995a).

B.31 TRANSURANIC WASTE CHARACTERIZATION/ CERTIFICATION FACILITY

OBJECTIVES:

The transuranic waste characterization/certification facility would provide extensive containerized waste processing and certification capabilities. The facility would have the ability to open various containers (e.g., boxes, culverts, or drums); assay, examine, sort, decontaminate the alpha and transuranic wastes; reduce large wastes to 55-gallon-drum size; weld; and certify containers for disposal.

DESCRIPTION:

A transuranic waste characterization/certification facility would characterize and certify nonmixed and mixed alpha (10 to 100 nanocuries per gram) and transuranic wastes (greater than 100 nanocuries per gram). The facility would begin operation in 2007. The facility would prepare transuranic and alpha waste for treatment, macroencapsulate mixed alpha waste, and certify transuranic and alpha waste for disposal.

The transuranic waste characterization/certification facility would be located in EArea adjacent to the alpha vitrification facility. The facility would use nondestructive assay and examination techniques to characterize the waste, open transuranic boxes, reduce the size of the waste, repackage waste in 55-gallon drums for direct disposal or processing by the alpha vitrification facility, and perform a second nondestructive assay and examination to confirm packaging. A 30 percent reduction in waste volume would be realized during repackaging except for transuranic waste to be disposed of at the Waste Isolation Pilot Plant under alternative A. Nondestructive assays (before and after repackaging) would be performed using alpha and neutron detectors. Nondestructive examinations (before and after repackaging) would be performed by real-time x-ray, much like the machines in airports, to identify the contents of the drum. The facility would also have the ability to vent and purge drums that had been stored in culverts and were not vented and purged during drum retrieval activities (Hess 1994a).

PROJECT-SPECIFIC ACTIONS

	Min.	Exp.	Max.
No Action			
A			
B			
C			

Under the no-action alternative, the facility would be not constructed.

	Min.	Exp.	Max.
No Action			
A			
B			
C			

Under alternative A, the transuranic waste characterization/certification facility would segregate the alpha and transuranic waste according to the following four waste categories:

- nonmixed alpha waste
- mixed alpha waste
- plutonium-238 transuranic waste
- plutonium-239 transuranic waste

A 30 percent reduction in alpha waste and transuranic waste processed after 2018 and kept in storage at SRS would be realized. No reduction would be realized for transuranic waste processed for disposal at the Waste Isolation Pilot Plant (2008 - 2018).

The second nondestructive assay and examination would be performed on vented drums to determine if the waste form (i.e., nonmixed and mixed alpha waste, or plutonium-238 or -239 transuranic waste) meets the applicable waste acceptance criteria. In alternative A, waste could be certified as packaged; repackaged and certified; or repackaged, treated (encapsulated), and certified for disposal. A drum of waste, regardless of its waste category, could be rejected from the second nondestructive assay and examination and be reprocessed in the transuranic waste characterization/certification facility so the waste form meets the waste acceptance criteria of the appropriate disposal facility.

The nonmixed alpha waste would be repackaged and disposed of at the low-activity waste vaults. Most of the mixed alpha waste would be considered hazardous debris in accordance with RCRA land disposal restrictions. DOE would request a treatability variance to macroencapsulate the mixed alpha waste that was not classified as hazardous debris. The mixed alpha waste would be macroencapsulated in steel drums by welding on the lids and sent to RCRA-permitted disposal.

Transuranic waste is identical in composition to alpha waste but has a higher activity (greater than 100 nanocuries per gram) from radiological contamination. The waste would be categorized solely on the dominant radioisotope content (i.e., plutonium-238 or -239) for shipping purposes. DOE would package the transuranic waste to meet the Waste Isolation Pilot Plant waste acceptance criteria.

	Min.	Exp.	Max.
No Action			
A			
B			
C			

In alternative B, the alpha and transuranic waste would initially be segregated into four categories as in alternative A. In addition, the mixed alpha waste and plutonium-238 transuranic wastes would be

further divided into metallic and nonmetallic waste subcategories. The metallic mixed alpha waste would be macroencapsulated and sent to RCRA-permitted disposal vaults. The plutonium-238 transuranic waste metal would be packaged for disposal at the Waste Isolation Pilot Plant. The nonmetallic mixed alpha and plutonium-238 transuranic waste would be sent to the alpha vitrification facility for treatment. The nonmixed alpha waste would be repackaged and disposed at the low-activity waste vaults. Plutonium-239 waste would be segregated into high- and low-activity fractions. High-activity plutonium-239 transuranic waste would be sent to the alpha-vitrification facility for treatment. Low-activity plutonium-239 transuranic wastes would be packaged to meet the Waste Isolation Pilot Plant waste acceptance criteria. In alternative B, approximately one-third of the transuranic and alpha waste would be repackaged and sent to the alpha vitrification facility for further treatment.

	Min.	Exp.	Max.
No Action			
A			
B			
C			

In alternative C, the alpha and transuranic waste would initially be segregated into four categories as described in alternative A. Metal would be removed during sorting to decontaminate, recycle, and reuse. A third nondestructive assay and examination unit would certify decontaminated metal for reuse. Alpha and transuranic metal that could not be decontaminated would be repackaged in 55-gallon drums, along with the other waste categories, to be sent to the alpha vitrification facility for treatment.

Table B.311 presents the volume of waste to be processed in the transuranic waste characterization/certification facility for each alternative.

Table B.31-1. Volume of waste that would be processed in the transuranic waste characterization/ certification facility for each alternative (cubic meters).a,b

	Min.	Exp.	Max.
		Not constructed	
A	15,040 m ³ total ~ 1,219 m ³ /yr macro = 26 m ³ /yr (315 m ³ total)	21,209 m ³ total ~ 1,681 m ³ /yr macro = 35 m ³ /yr (445 m ³ total)	551,083 m ³ total ~ 45,706 m ³ /yr macro = 13,118 m ³ /yr (158,160 m ³ total)
B	15,040 m ³ total ~ 1,219 m ³ /yr macro = 32 m ³ /yr (358 m ³ total)	21,210 m ³ total ~ 1,681 m ³ /yr macro = 41 m ³ /yr (520 m ³ total)	551,083 m ³ total ~ 45,706 m ³ /yr macro = 4,251 m ³ /yr (51,250 m ³ total)
C	15,040 m ³ total ~ 1,219 m ³ /yr macro = 0	21,210 m ³ total ~ 1,681 m ³ /yr macro = 0	551,083 m ³ total ~ 45,706 m ³ /yr macro = 0

- a. Source: Hess (1995a).
 - b. To convert to cubic feet, multiply by 35.31.
 - c. Macroencapsulated.
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B.32 References

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Appendix C

C.1 Cost Methodology

This section describes the methodology used to determine life-cycle costs for comparison of alternative treatment, storage, and disposal facilities. Life-cycle costs include preliminary planning, design, construction, operation, secondary waste disposal, and post-operation decommissioning. These costs are distributed along a timeline, and then converted to an equivalent cost in terms of the current value of money. Major components of life-cycle costs include building, equipment, operation and support manpower, and secondary waste disposal costs. The purpose of the cost model is to provide data that can differentiate between treatment options. The cost model consistently applies the same assumptions, such as labor cost rates, building square-footage costs, and others, to the estimating process. Conceptual design estimates for planned facilities and actual estimates for existing facilities are used where possible. For the purpose of this environmental impact statement (eis), the U.S. Department of Energy (DOE) developed cost assumptions using Westinghouse Savannah River Company standard estimating techniques. For appropriate comparison, DOE assumed that treatment facilities that do not already exist would be located onsite. Each facility estimate includes option-specific costs for the major equipment, the number of man-hours per year required to operate the facility, the facility start-up date, the operating life of the facility, and the required design basis throughput.

Projected facility costs and manpower requirements differ between the draft and final eis. This is due to the following factors: a refinement of the parameters that determine operating manpower, building, and equipment costs; a correction to the scope of no-action alternative costs to make them consistent with the other alternative - waste forecast estimates; and new initiatives in alternative B that lowered facility costs for this alternative. In addition, the costing methodology bases construction manpower requirements on building and equipment costs; therefore, both operating and construction employment differ between draft and final eis. This, in turn, affects projections of socioeconomic and traffic impacts. Cost differences are shown in Table C-1. The cost analysis was changed to be consistent with the *Baseline Environmental Management Report* (DOE 1995) developed by DOE to ensure consistent reporting on estimating future facility construction and operation costs. This report is used to establish future budgetary requirements for the DOE complex.

Table C-1. Estimated cost of facilities for each alternative and waste forecast in the draft and final eis.

	Minimum	Expected	Maximum
No action		Draft: $\$1.0 \times 10^9$ Final: $\$6.9 \times 10^9$	
A	Draft: $\$4.5 \times 10^9$ Final: $\$4.2 \times 10^9$	Draft: $\$7.9 \times 10^9$ Final: $\$6.9 \times 10^9$	Draft: $\$30 \times 10^9$ Final: $\$24 \times 10^9$
B	Draft: $\$5.0 \times 10^9$ Final: $\$4.2 \times 10^9$	Draft: $\$7.7 \times 10^9$ Final: $\$6.9 \times 10^9$	Draft: $\$22 \times 10^9$ Final: $\$20 \times 10^9$
C	Draft: $\$3.7 \times 10^9$ Final: $\$3.8 \times 10^9$	Draft: $\$5.7 \times 10^9$ Final: $\$5.6 \times 10^9$	Draft: $\$17 \times 10^9$ Final: $\$18 \times 10^9$

In most instances, the estimates are based on facilities for which there has been little, if any, conceptual design. The estimates were prepared only for the purpose of identifying salient cost differences between technologies. These facility estimates are not sufficiently mature to be used for budgeting purposes.

C.1.1 RELATIONSHIP TO SRS DRAFT SITE TReAtMENT PLAN COST METHODOLOGY

The cost model developed for the *SRS Draft Site Treatment Plan* (DOE 1994a) was used as a basis for the eis cost model. The major difference between the two models is the difference in scope of the two efforts. The draft sit treatment plan proposes specific treatments over the next 5 years for a known mixed waste inventory. This eis examines alternatives for treating, storing, and disposing of wastes that would be generated over the next 30 years and investigates the consequences of each alternative. The eis cost analyses consider low-level, hazardous, mixed, and transuranic wastes; the site treatment plan deals only with mixed wastes. The uncertainties in this eis that affect the modelling of costs include the waste forecasts (amounts of waste generated), schedules (treatment need dates), and availability of funds.

C.1.2 APPLICATION OF COST METHODOLOGY FOR OPTIONS SELECTION

Process and materials descriptions were developed for full treatment, storage, and disposal options evaluated in the in-depth analysis in Section 2.3 of this eis. From these descriptions, a list of the required processing equipment, the sizes and types of buildings needed, and the necessary support equipment was developed. To provide equivalent comparisons of the options, it was initially assumed that 1,000 cubic meters (35,300 cubic feet) of waste would be processed per year by each facility. The costs for processing equipment, buildings, and support equipment were developed using Savannah River Site (SRS) experience and information from a waste management facilities cost report (Feizollahi and Shropshire 1992) prepared for the DOE Idaho National Engineering Laboratory. The manpower requirements were estimated with the COSTPRO (Hess 1994a) program used by Westinghouse Savannah River Company for estimating onsite work.

Because the in-depth options analysis evaluated individual treatability groups, it was not sufficiently broad to identify an integrated system of treatment, storage, and disposal facilities for the entire SRS. The in-depth options analysis was supplemented with a second analysis that considered the availability of excess capacity in existing facilities and the environmental advantages and economies of scale achieved by expanding planned facilities to accommodate additional treatability groups that would otherwise require other stand-alone treatment, storage, and disposal facilities. The cost to dispose of secondary waste was developed from existing SRS facilities and included in the cost model.

As an example, Table C2 (and Figure C-1) illustrates the economies of scale for the non-alpha vitrification facility. It displays the total cost and the total and incremental cost per unit volume of throughput. The calculation procedure is described in detail in Section C.2. The table indicates that unit costs decreases from approximately \$7,700 to \$2,000 per cubic meter when annual throughput increases from 1,000 to 5,000 cubic meters.

Table C-2. Economies of scale for the non-alpha vitrification facility

Annual throughput (cubic meters)	Total throughput (cubic meters) ^b	Life-cycle cost (\$1,000)	Total Unit Cost (\$ per cubic meter) ^c	Incremental Unit Cost (\$ per cubic meter) ^c
1,000	19,000	146,501	7,711	7,711
2,000	38,000	159,190	4,189	668
3,000	57,000	171,881	3,015	668
4,000	76,000	184,573	2,429	668

5,000	95,000	197,267	2,082	668
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a. Source: Hess (1995).

b. To convert to cubic feet, multiply by 35.31.

c. To convert to \$ per cubic feet, divide by 35.31.

Figure C-1.

C.1.3 APPLICATION OF COST METHODOLOGY FOR ALTERNATIVE TReaTMENT, STORAGE, AND DISPOSAL SCENARIOS

Facility costs vary with the amount of waste treated per year. Therefore, the cost model used for this eis for equipment and buildings based on a 1,000 cubic meter (35,300 cubic feet) annual throughput was modified to account for the actual volume of waste the facility would be required to treat annually. The estimates from the Idaho National Engineering Laboratory facilities cost report were used as the basis for this part of the model. The equipment and facility descriptions in the Idaho National Engineering Laboratory report were examined to see how closely they matched the specifications of the treatments and processes described in this eis. The Idaho National Engineering Laboratory estimates were modified as required to match the specifications in this eis. Linear and exponential curves were fit to the Idaho National Engineering Laboratory costs versus capacity estimates. The linear model closely matched the data, so it was used. For further cost development, both equipment and building costs were defined as the coefficient (cost per cubic meter of waste processed) times the annual volume of waste plus a fixed cost. The coefficients and fixed values come from calculations that determine those values which provide the best fit between actual Idaho National Engineering Laboratory data and the linear (straight line) approximation (i.e., $\text{cost} = \text{cost coefficient} \times \text{yearly volume} + \text{fixed cost}$). The COSTPRO model facility operating labor hours were also developed into a linear model. ($\text{Annual labor} = \text{labor coefficient} \times \text{yearly volume} + \text{fixed labor}$; Tables C-3, C-4, and C-5 list the fixed values and coefficients developed for equipment cost, building cost, and labor, respectively.)

The costs for storage and disposal facilities, most of which do not have equipment costs, were developed differently. The labor hours on a per-cubic-meter basis were developed with COSTPRO. The cost to build each facility was estimated by assuming that new facilities would hold the same amount of waste as existing facilities, dividing the waste that would need to be stored or disposed of by the facility volume capacity, and multiplying the resulting number of facilities needed by the cost of completed existing facilities.

Table C-3. Examples of equipment cost factors for waste management facilities considered in this analysis.

Facility	Fixed cost (\$1,000)	Cost coefficient (\$1,000/cubic meter/year) ^b
Off-site treatment and disposal	11,257	0.0699
Containment building - macroencapsulationmacroencapsulation	3,259	0.0385
Off-site smelter	10,521	0.2597
Transuranic waste characterization/certification facility	14,112	0.0396
Soil sort facility	10,983	0.2101
Containment building - decontamination	1,302	0.0035

Off-site low-level waste volume reduction	4,981	0.0265
Non-alpha vitrification facility	13,570	0.3361
Alpha vitrification facility	25,102	0.0840

a. Source: Hess (1995).

b. To convert to \$1,000 per cubic foot per year, divide by 35.31.

Table C-4. Examples of building cost factors for waste management facilities considered in this analysis.

Facility	Fixed cost (\$1,000)	Cost coefficient (\$1,000/cubic meter/year) ^b
Off-site treatment and disposal	3,259	0.0241
Containment building - macroencapsulation	3,459	0.0243
Off-site smelter	8,744	0.2824
Transuranic waste characterization/certification facility	11,891	0.0396
Soil sort facility	2,470	0.0611
Containment building - decontamination	832	0.0120
Off-site low-level waste volume reduction	1,776	0.0040
Non-alpha vitrification facility	9,298	0.2403
Alpha vitrification facility	23,683	0.1123

a. Source: Hess (1995).

b. To convert to \$1,000 per cubic foot per year, divide by 35.31.

Table C-5. Examples of annual labor cost factors for waste management facilities considered in this analysis.

Facility	Fixed labor (manhours/year)	Labor coefficient (manhours/year/cubic meter) ^b
Off-site treatment and disposal	21,145	0.0699
Containment building - macroencapsulation	15,688	0.0385
Off-site smelter	52,581	0.2597
Transuranic waste characterization/certification facility	42,332	0.0396
Soil sort facility	14,196	0.2101

Containment building - decontamination	27,996	0.0035
Supercompactor	7,027	0.0265
Non-alpha vitrification facility	31,796	0.3361
Alpha vitrification facility	37,478	0.0840

a. Source: Hess (1995).

b. To convert to manhours per year per cubic foot, divide by 35.31.

C.1.4 SPECIAL CONSIDERATIONS FOR COST CALCULATIONS

DOE decided to assign costs to wastes with required treatments differently than to wastes for which treatment was optional. In the cost model, wastes with required treatments were assigned both the fixed costs for treatment and the variable costs associated with their specific volume (including equipment, building, and labor costs). The wastes with optional treatments were only assigned the variable costs associated with their additional volume. This methodology assumed that these wastes would use the excess capacity in facilities built to support required treatments. It also burdened wastes with specified treatments more than wastes with optional treatments.

A spreadsheet was developed for each alternative/forecast which listed the individual treatability groups and the options for treatment and disposal. The waste volume assigned to each option was entered along with the yearly fixed programmatic costs, the variable waste costs, and the volume reduction ratio achievable by that treatment option for the specific waste type. The variable waste costs included the cost to dispose of the secondary waste produced by the treatment. These inputs were summed and averaged over the 30-year analysis period and put into a specific treatment cost model. The total waste to be processed was averaged over the operating period of the facility for the sizing, costing, and operating manpower calculations. Based on waste volume, fixed costs, variable costs, volume reduction ratio, the facility operating period, and the input dates for design start and operations start, the treatment cost model calculated the equipment and building costs, total operating manhours, the pre-project costs, the total estimated cost to build the facility, the costs to decommission and dispose of the facility after all the waste has been treated, and the secondary waste disposal costs. The various costs were distributed over the appropriate time periods. The costs were then escalated and discounted to get a life-cycle cost, the present worth cost for the treatment option, and a cost per cubic meter of input waste. Costs calculated in the treatment cost model were returned to the spreadsheet for summation, which yielded the total option cost. The specifics of how these calculations were performed are discussed in Section C.2.

Another spreadsheet calculated the manpower required for each facility. Engineering, operation, and support manpower were included over all phases of the life cycle. The life cycle includes pre-project planning, design and construction operations, and facility decontamination and decommissioning. A master labor spreadsheet collected the individual facility manpower calculations and generated totals for each treatment, storage, and disposal alternative.

C.2 Typical Cost Estimate

This section describes the calculation procedure for determining life-cycle cost. For illustration, each component is explained and calculated for the non-alpha vitrification facility (Hess 1994b, 1995).

Each component of the cost is calculated in units of thousands of dollars and shown as a total dollar value in parenthesis. The values have been rounded to the nearest thousand following calculation; they do not always equal the sum or product of the listed values.

C.2.1 TOTAL FACILITY COST

The total facility cost consists of pre-project costs, design and construction costs, contingency costs, operating costs, and post-operation costs. Escalation and discount rates are applied to the costs as they are incurred to determine life-cycle costs.

Each step of the calculation is illustrated for a typical facility. The cost factors for the non-alpha vitrification facility are presented in Table C-6.

C.2.1.1 Assumptions

The cost estimates are based on the following assumptions:

- Annual manpower (manhours/year) is calculated using the COSTPRO program and the assumption from the in-depth options analysis that 1,000 cubic meters (35,300 cubic feet) per year of waste would be processed through each facility.
- A uniform, fully burdened labor rate of \$75/manhour in 1994 dollars is assumed for all workers for all activities, including design, construction, operation, and decontamination and decommissioning. The labor rate includes salary, benefits, and indirect expenditures (i.e., overhead).
- The year in which project planning and preconceptual design start occurs is assumed for each facility to be 2 years before the detailed design and construction start.
- The operation start is the year in which the facility would begin operating.
- The operation period, in years, is the length of time the facility would be operating.
- The facility waste volume (throughput in cubic meters per year) is calculated from the total volume to be treated averaged over the operational period of the facility. Averaging the waste volume defines a realistic design capacity for the equipment and building, not the peak waste generation rates.
- The manner in which the treated waste would ultimately be disposed is based on the disposal cost (calculated in dollars per cubic meter; to convert to dollars per cubic foot, divide by 35.31). The variable costs include the cost to build and operate the final disposal facilities.
- A volume reduction ratio (x:1) is used for each specific waste through each specific facility. The final disposal volume (after volume reduction) is multiplied times the disposal costs per unit volume of waste and added to the facility costs as a portion of the facility life-cycle costs.

Table C-6. Total facility cost for the non-alpha vitrification facility

Throughput (cubic meters/year)	3,063
Equipment cost (Table C-2)	
Variable cost (\$1,000/cubic meter/year)	0.3361
Fixed cost (\$1,000)	13,570
Building cost (Table C-3)	
Variable cost (\$1,000/cubic meter/year)	0.2403
Fixed cost (\$1,000)	9,298

Annual operating manpower (Table C-4)	
Variable labor (manhours/cubic meter/year)	0.3361
Fixed labor (manhours/year)	31,796
Annual waste type support manpower (manhours/year) ^a	38,848
Labor rate (\$1,000/manhour)	0.075
Is a RCRA ^b Part A Permit required?	No
Is a RCRA Part B Permit required?	Yes
Detailed design and construction start (year)	2002
Operation start (year)	2006
Operation period (years)	19
Disposal cost (\$1,000/cubic meter)	7.636
Volume reduction ratio (x:1)	7.43 ^c

a. Administrative and other support personnel.

b. Resource Conservation and Recovery Act.

c. A weighted average of volume reduction ratios for each waste type based upon experience with vitrification facilities.

C.2.1.2 Construction Costs

Construction costs consist of equipment costs, building costs, field indirect costs (e.g., auxiliary support personnel), field direct costs (e.g., temporary construction facilities), field and design engineering costs, construction management, and project management costs.

Equipment cost (EC) EC =	Cost coefficient Throughput Fixed cost	$[0.3361] \div$ $[3,063] +$ $[13,570] =$ 14,600 (or \$14,600,000)
Building cost (BC) BC =	Cost coefficient Throughput Fixed Cost	$[0.2403] \div$ $[3,063] +$ $[9,298] =$ 10,034 (or \$10,034,000)
Field indirect cost (FIC) FIC =	8 percent Equipment cost	$[0.08] \div$ $[14,600] =$ 1,168 (or \$1,168,000)
Field direct cost (FDC) FDC =	14 percent Building cost	$[0.14] \div$ $[10,034] =$ 1,405 (or \$1,405,000)
Engineering cost (ENG C) ENG C =	22 percent Equipment and building cost	$[0.22] \div$ $[14,600 + 10,034] =$ 5,419 (or \$5,419,000)

Construction management cost (CMC)		
CMC =	7 percent Equipment and building cost	$[0.07] \div$ $[14,600 + 10,034] =$ 1,724 (or \$1,724,000)
Project management cost (PMC)		
PMC =	9 percent Equipment and building cost	$[0.09] \div$ $[14,600 + 10,034] =$ 2,217 (or \$2,217,000)
Total construction cost (TCC)		
TCC =	Equipment cost Building cost Field indirect cost Field direct cost Engineering cost Construction management cost Project management cost	$[14,600] +$ $[10,034] +$ $[1,168] +$ $[1,405] +$ $[5,419] +$ $[1,724] +$ $[2,217] =$ 36,567 (or \$36,567,000)

C.2.1.3 Total Estimated Cost (TEC)

Total estimated cost is construction cost plus contingency (C). The contingency is the funding required to give an 80-percent confidence level that the project will be completed within the estimated funding and schedule. Estimates done at the conceptual planning level are typically ± 40 percent. For this effort a contingency of 35 percent of the construction cost was used.

Contingency (C)		
C =	35 percent total construction cost	$[0.35] \div$ $[36,567] =$ 12,799 (or \$12,799,000)
Total estimated cost (TEC)		
TEC =	Construction cost Contingency	$[36,567] +$ $[12,799] =$ 49,366 (or \$49,366,000)

C.2.1.4 Pre-Project Costs

Based on experience with projects at SRS, the planning costs for project definition and implementation of DOE Order 4700, "Project Management System" requirements were estimated as 5 percent of the total estimated cost, as calculated above, and preconceptual design costs were estimated as 10 percent of the total estimated cost.

Planning cost (PLANC)		[0.05] ÷
PLANC =	5 percent	
	Total estimated cost	[49,366] =
		2,468 (or \$2,468,000)

Preconceptual design cost (PDC)		[0.10] ÷
PDC =	10 percent	
	Total estimated cost	[49,366] =
		4,937 (or \$4,937,000)

The permitting costs are based on an estimate of the need for new permits or required modifications to existing permits. A Resource Conservation and Recovery Act (RCRA) Part A permit or modification is estimated to cost \$150,000. A RCRA Part B permit is estimated to cost \$1,500,000.

Permitting cost (PC)		
PC =	Resource Conservation and Recovery Act Part B permit	1,500 (or \$1,500,000)

Costs associated with preparation for operations (e.g., a procedure document) are estimated to be \$150,000.

Preparation for operations costs (POC)		
POC =		150 (or \$150,000)

Pre-project cost (PPC)	Planning cost	[2,468] +
PPC =	Preconceptual design cost	[4,937] +
	Permitting cost	[1,500] +
	Preparation for operation cost	[150] =
		9,055 (or \$9,055,000)

C.2.1.5 Facility Operating Costs

Two types of manpower requirements are considered. Operating manpower consists of personnel who actually operate the facility as estimated by the linear model developed from the COSTPRO program. Waste type support manpower includes administrative and other support personnel based on a distribution of these requirements to each waste type as reported in *FY 1993 SRS Waste Cost Analysis* (Taylor, McDonnell, and Harley 1993).

Annual operating manpower (AOM)	Labor coefficient	[0.3361] ÷
AOM =	Throughput	[3,063] +
	Fixed labor	[31,796] =
		32,826 (manhours per year)

Operating manpower cost (OMC)	Annual operating manpower	[32.826] ÷
OMC =	Labor rate in \$1,000/hour	[0.075] ÷
	Facility operation period	[19] =
		46,777 (or \$46,777,000)

Annual waste type support
manpower (AWTSM)

AWTSM =

Fixed amount

[38,848] =

38,848 (manhours per year)

Waste type support

manpower cost (WTSMC)

WTSMC =

Annual waste type support manpower

Labor rate in \$1,000/hour

Facility operation period

[38,848] ÷

[0.075] ÷

[19] =

55,358 (or \$55,358,000)

Utilities costs vary from 4 percent to 20 percent of the operating manpower cost. The variance is the following function of the equipment cost: $F = 1 + 4 \div$

equipment cost ÷

maximum equipment cost. The maximum equipment cost of the facilities identified in this eis is 14,882 (or \$14,882,000).

Utilities cost (UC)

UC =

4 percent

Equipment cost factor

Operating manpower cost

[0.04]

[1+4 ÷

14,600 ÷

14,882] ÷

[46,777] =

9,214 (or \$9,214,000)

Material requirements cost

(MRC)

MRC =

60 percent

Operating manpower cost

[0.60] ÷

[46,777] =

28,066 (or \$28,066,000)

Maintenance cost (MC)

MC =

36 percent

Operating manpower cost

[0.36] ÷

[46,777] =

16,839 (or \$16,839,000)

Secondary waste disposal

cost (SWDC)

SWDC =

Throughput

Operating period

Disposal cost

Volume reduction ratio

[3,063] ÷

[19] ÷

[7.636] ÷

[7.43] =

59,810 (or \$59,810,000)

Total facility operating cost (TFOC) TFOC =	Operating manpower cost	[46,777] +
	Waste type support manpower cost	[55,358] +
	Utilities cost	[9,214] +
	Material requirements cost	[28,066] +
	Maintenance cost	[16,839] +
	Secondary waste disposal cost	[59,810] = 216,064 (or \$216,064,000)

C.2.1.6 Post-Operation Costs

The cost of decontamination and decommissioning the facility following its useful life is estimated as 80 percent of the initial equipment and building costs.

Post-operation cost (POC) POC =	80 percent Equipment and building cost	[0.80] ÷ [14,600 + 10,034] = 19,707 (or \$19,707,000)
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C.2.1.7 Total Unescalated Costs

Total unescalated cost (TUC) TUC =	Pre-project costs	[9,055] +
	Construction costs	[36,567] +
	Contingency costs	[12,799] +
	Facility operation costs	[216,064] +
	Post-operations costs	[19,707] = 294,192 (or \$294,192,000)

C.2.2 COST DISTRIBUTION

Annual pre-project cost (APPC) APPC =	Pre-project cost	[9,055] ÷
	Years prior to detailed design and construction start	[2] = 4,527 (or \$4,527,000) for each year, 2000 and 2001

Annual total estimated cost (ATEC) ATEC =	Total estimated cost Period from detailed design and construction start to operation start	[49,366] ÷ [4] = 12,341 (or \$12,341,000) for each year, 2002 through 2005
Annual facility operation cost (AFOC) AFOC =	Facility operation cost Period of operation	[216,064] ÷ [19] = 11,371 (or \$11,371,000) for each year, 2006 through 2024
Annual post-operation cost (APOC) APOC =	Post-operation cost Years following operations	[19,707] ÷ [3] = 6,569 (or \$6,569,000) for each year, 2025 through 2027

Unescalated costs (based on the value of money in 1994), escalated costs, and discounted costs are listed by year in Table C-7.

C.2.3 ESCALATION

The escalation rates were taken from the DOE guidelines (DOE 1994b) for future-year estimating. The escalation rates are typically 3 percent, with the exception of 2.9 percent and 3.1 percent for fiscal year 1995 and fiscal year 1998, respectively.

Escalation factors are calculated as the previous year's escalation factor compounded by the appropriate escalation rate. For example, the escalation rate in 2000 is 3 percent. Therefore, the 2001 escalation factor is the 2000 factor (1.194) times 1.03 or 1.230. The escalated costs are the product of the unescalated cost and the corresponding escalation factor (Table C-7).

Table C-7. Cost distribution for the non-alpha vitrification facility

Year	Unescalated cost (\$1,000)	Escalation factor	Escalated cost (\$1,000)	Discount factor at 6 percent	Discounted cost (\$1,000)
------	-------------------------------	----------------------	-----------------------------	---------------------------------	------------------------------

1994		1.000		1.000	
1995		1.029		0.943	
1996		1.06		0.890	
1997		1.092		0.840	
1998		1.126		0.792	
1999		1.159		0.747	
2000	4,527	1.194	5,046	0.705	3,811
2001	4,527	1.230	5,568	0.665	3,703
2002	12,341	1.267	15,634	0.627	9,809
2003	12,341	1.305	16,103	0.592	9,531
2004	12,341	1.344	16,586	0.558	9,261
2005	12,341	1.384	17,083	0.527	8,999
2006	11,371	1.426	16,212	0.497	8,057
2007	11,371	1.469	16,699	0.469	7,829
2008	11,371	1.513	17,200	0.442	7,607
2009	11,371	1.558	17,716	0.417	7,392
2010	11,371	1.605	18,247	0.394	7,183
2011	11,371	1.653	18,795	0.371	6,980
2012	11,371	1.702	19,359	0.350	6,782
2013	11,371	1.754	19,939	0.331	6,590
2014	11,371	1.806	20,537	0.312	6,404
2015	11,371	1.86	21,154	0.294	6,222
2016	11,371	1.916	21,788	0.278	6,046
2017	11,371	1.974	22,442	0.262	5,875
2018	11,371	2.033	23,115	0.247	5,709
2019	11,371	2.094	23,809	0.233	5,547
2020	11,371	2.157	24,523	0.220	5,390
2021	11,371	2.221	25,259	0.207	5,238
2022	11,371	2.288	26,016	0.196	5,090
2023	11,371	2.357	26,797	0.185	4,946
2024	11,371	2.427	27,601	0.174	4,806
2025	6,569	2.500	16,423	0.164	2,698
2026	6,569	2.575	16,916	0.155	2,621
2027	6,569	2.652	17,423	0.146	2,547
TOTAL	294,192		534,348		172,674

C.2.4 DISCOUNTING

Discounting is the determination of the present cost of future payments. The present cost is less than the future payment because the money could be invested with some rate of return and be worth more later. The rate of return is assumed to remain constant at 6 percent per year; this rate is judged to be consistent with current prime lending rates and long-term rates of return.

Discounting is calculated in a manner similar to escalation; the previous factor is discounted by the appropriate discount rate. For example, the discount factor for 2001 is the 2000 factor (0.705) divided by 1.06 or 0.665. Discounted costs are the product of the escalated cost and the discount factor (Table C7). Figure C-2 presents a graphic representation of the discounted, unescalated, and escalated costs.

C.3 Cost of Facilities

Costs for proposed facilities are presented for each alternative and waste forecast (Table C-8). The costs include those for pre-project, design and construction (except for existing facilities, which have already incurred design/construction costs), operation and maintenance, secondary waste disposal and facility decontamination and decommissioning. They are expressed as present 1994 costs and are based on draft site treatment plan escalation (approximately 3 percent) and a 6-percent discount rate.

Table C-8. Cost of facilities in the SRS Waste Management eis (\$ million).

			Alternative	
Facility	Forecast	A	B	C
Waste soil sort (new)	Minimum	52.6	54.0	53.6
	Expected	56.2	58.2	58.1
	Maximum	73.8	113.7	103.4
Offsite low-level waste volume	Minimum	b	57.1	
reduction	Expected		58.4	
	Maximum		62.0	
Offsite treatment and disposal	Minimum	2,462.3	2,350.6	2,009.7
	Expected	4,637.3	4,419.3	2,418.6
	Maximum	7,404.7	7,109.6	2,798.6
Non-alpha vitrificationvitrification (new)	Minimum			194.7
	Expected		172.7	299.6
	Maximum		565.6	660.6

Alpha vitrification/vitrification (new)	Minimum		246.0	248.3
	Expected		246.8	250.2
	Maximum		359.3	416.4
Transuranic waste characterization/ certification (new)	Minimum	121.9	121.9	121.9
	Expected	120.7	120.7	120.7
	Maximum	129.0	129.0	129.0
Consolidated Incineration Facility	Minimum	125.9	296.9	115.7
	Expected	206.9	353.6	143.1
	Maximum	691.5	525.2	249.2
Low-activity waste vaults (periodic requirements)	Minimum	264.4	21.5	83.4
	Expected	340.8	32.5	103.1
	Maximum	848.2	105.1	197.8
Intermediate-level vaults (periodic requirement)	Minimum	144.0	117.6	33.6
	Expected	192.2	192.3	77.4
	Maximum	684.1	436.7	100.1
Low-level waste non-vault disposal (periodic requirement)	Minimum	62.9	58.9	62.3
	Expected	78.3	62.3	86.7
	Maximum	294.6	92.8	317.4
Long-lived storage (periodic requirement)	Minimum	33.0	33.0	33.1
	Expected	33.8	33.8	33.8
	Maximum	34.2	34.3	34.3
Transuranic waste storage (periodic requirement)	Minimum	39.4	16.5	25.1
	Expected	105.4	106.0	107.2
	Maximum	5,900.0	5,898.2	5,816.7

Table C-8. (continued).

Facility	Forecast	A	Alternative	
			B	C
Offsite smeltersmelter	Minimum		214.2	214.1
	Expected		214.6	214.3
	Maximum		216.4	215.1
Offsite lead decontamination	Minimum	117.3	117.3	117.0
	Expected	210.7	210.7	210.7
	Maximum	472.2	472.2	472.2
Waste Isolation Pilot PlantWaste Isolation Pilot Plant	Minimum	276.7	127.1	72.6
	Expected	357.1	152.3	77.0
	Maximum	4,287.5	1,896.7	496.1
RCRA-permitted disposal vaults	Minimum	81.4	98.0	264.0
	Expected	92.6	121.0	1,128.6
	Maximum	1,405.9	562.5	4,448.1
CompactorsCompactors	Minimum	117.1	24.0	31.3
	Expected	117.1	24.0	33.4
	Maximum	50.9	22.5	32.4
M-Area air stripper	Minimum	0.003	0.003	0.003
	Expected	0.016	0.016	0.016
	Maximum	0.017	0.017	0.017
Containment building (new) Containment building	Minimum	145.0	134.4	49.1
	Expected	177.2	159.1	49.2
	Maximum	336.4	254.1	49.3
Mixed waste storage (periodic requirement)	Minimum	125.0	112.8	111.7
	Expected	208.8	208.8	208.9
	Maximum	1,826.6	1,583.9	1,574.1
Total	Minimum	4,168.9	4,201.7	3,841.0
	Expected	6,935.3	6,947.2	5,620.7
	Maximum	24,439.6	20,439.9	18,110.9

a. Source: Hess (1995).

b. Shaded areas indicate the alternatives that do not use the facility.

C.4 References

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Appendix D

SUMMARY

This appendix to the Waste Management Environmental Impact Statement (eis) provides summaries of innovative and emerging technologies being evaluated at Savannah River Site (SRS) and other locations that have the potential for treating hazardous, radioactive, or mixed (hazardous and radioactive) wastes at SRS. This eis considered 85 technologies, many of which were screened out during the options analysis process described in Section 2.3 of this eis. This appendix discusses many of those technologies that were eliminated from detailed consideration in Section 2.3 as well as some developing technologies that were not considered in Section 2.3.

Many of these technologies are either not commercially available, have not undergone demonstrations for the waste types at SRS, or have not been shown to be either economically or technically viable (i.e., have not achieved engineering breakthrough). However, some of the 26 emerging technologies described in this appendix may prove viable in the future and may be chosen for more detailed design and operations analyses based on the outcome of demonstrations. The in-depth options analysis used to select treatment technologies was biased towards choosing proven solutions to U.S. Department of Energy (DOE) waste management issues. As other technologies mature, these may warrant consideration.

The technologies summarized here treat contaminated matrices that contain plastic, paper (and other forest products), metals, aqueous liquids, and organic liquids. These waste matrices are generated through activities such as site operations, decontamination and decommissioning, or environmental restoration. Some technologies have been available for years, but application of the technology to waste management would be considered innovative.

The treatment summaries were prepared from a number of literature sources and interviews and have been grouped by categories of waste treatment: (1) biological, (2) chemical, (3) physical, (4) stabilization, and (5) thermal.

D.1 Background

This appendix provides summaries of 52 innovative and emerging technologies that have the potential for treating hazardous, radioactive, or mixed (hazardous and radioactive) wastes at SRS. Eighty-five technologies were considered, many of which were screened out during the options analysis process described in Section 2.3 of the eis. Table D-1 defines each of the technologies and identifies its purpose (volume reduction, stabilization, or decontamination). For the most part, the technologies discussed in this appendix are not commercially available, have not undergone full-scale demonstrations for the waste types present at SRS, or have not been shown to be either economically or technically viable. However, many of the emerging technologies described in this appendix may prove viable in the future and may be chosen for more detailed design and operations analyses based on the outcome of fullscale demonstrations, other commercial applications, or use by the U.S. Department of Energy (DOE) on similar wastes.

Section 2.3 of the eis evaluated 85 processes and technologies in 5 treatment categories. The treatment categories used in the prescreening process (biological, chemical, physical, stabilization, and thermal) are also used in this appendix for consistency. The treatment categories include both conventional and emerging processes and technologies. Some examples of conventional processes include evaporation, compaction, storage, and incineration. These types of processes are not addressed in this appendix. Examples of innovative technologies include electrodialysis, plasma torch, supercritical water oxidation, and white rot fungus. These types of innovative and emerging technologies are addressed in detail in this appendix.

Table D-2 provides a comparison of 26 innovative technologies included in Section 2.3 with those in Appendix D. Several of the process technologies identified in Section 2.3 are subdivided into more discrete technologies discussed in

Appendix D. For example, Section 2.3 identified the technology process of fluidized bed incineration (number 13 on Table D-2); Appendix D identifies two specific subtypes of fluidized bed incineration. Appendix D also identifies six emerging technologies [acoustic barrier particle separator (D.5.1), high-energy electron irradiation (D.5.8), gas-phase chemical reduction (D.4.4), nitrate to ammonia and ceramic process (D.4.5), electrochemical oxidation (D.4.12), and mediated electrochemical oxidation (D.4.13)] that are not specifically addressed in Section 2.3.

Innovative technologies for treating radioactive, hazardous, and mixed wastes are currently being developed and demonstrated by DOE and the U.S. Environmental Protection Agency (EPA). DOE demonstrations generally focus on radioactive and mixed waste treatments and are funded by the DOE Office of Technology Development (EM-50) through the Mixed Waste and Landfill Focus Areas. Technologies are developed and demonstrated at the eight national laboratories.

EPA technology demonstrations are supported by the Risk Reduction Engineering Laboratory and the Superfund Innovative Treatment Evaluation program. Most Superfund Innovative Treatment Evaluation demonstrations focus on hazardous wastes generated at Superfund sites. Many of the technologies evaluated by the Superfund Innovative Treatment Evaluation program may be applicable to radioactive and mixed wastes.

SRS generates large quantities of solid low-level radioactive waste, and currently utilizes vault or shallow land disposal. Most solid low-level radioactive waste is job-control waste, a fraction of which is compacted on site prior to vault disposal. Several technologies described in this appendix can potentially be used to reduce the volume and stabilize solid low-level radioactive waste. Stabilization would minimize potential radionuclide migration following direct shallow land disposal. Hazardous wastes generated at SRS include organic and aqueous liquids, most of which are treated and taken off site for disposal. Mixed wastes, which include most of the matrices described above, are being stored until adequate treatment and disposal capacity is identified at SRS or offsite.

Wastes containing greater than 100 nanocuries per gram of transuranic alpha-emitting radionuclides with half-lives greater than 20 years are considered transuranic wastes. These wastes pose special handling, storage, and disposal problems due to the inhalation and ingestion risks posed by alpha particles and to long half-lives and potential criticality concerns from plutonium radionuclides. DOE plans to ship transuranic wastes for disposal at the Waste Isolation Pilot Plant, located near Carlsbad, New Mexico. The earliest projected date for the Waste Isolation Pilot Plant to begin disposing of these wastes is 1998. Although transuranic wastes are not required by law to be treated or stabilized, treatment and conversion of these wastes to a stabilized waste form (such as glass or slag) could reduce the volume of the wastes and minimize potential releases and human and environmental exposures during onsite storage, prior to disposal at the Waste Isolation Pilot Plant. Disposal of mixed transuranic wastes at the Waste Isolation Pilot Plant is dependent on a Resource Conservation and Recovery Act (RCRA) no-migration petition being granted by the State of New Mexico and EPA.

DOE is currently funding several technology development projects at SRS through the Savannah River Technology Center and the Vendor Forum program, both of which are managed by the Westinghouse Savannah River Company. Many Savannah River Technology Center projects are conducted jointly with universities (such as Clemson University and Georgia Institute of Technology) and industrial partners. Innovative technology programs funded at SRS include plasma arc treatment of solid low-level radioactive waste, vitrification of various waste forms using a portable vitrification unit, noble metal reclamation from electronic components, dechlorinating radioactive polychlorinated biphenyls (PCBs) in a solid matrix, extraction of uranium from contaminated soil, treatment of tritiated oils and groundwater, acoustic wave treatment, and waste stabilization using several different binders.

EPA and DOE recently collaborated at SRS on a Superfund Innovative Treatment Evaluation project to demonstrate the feasibility of treating contaminated groundwater with an electron beam. Contaminated groundwater was pumped past the beam to determine destruction efficiencies of hazardous organics at different electron beam dose rates.

Table D-1. Technologies considered for treatment of SRS waste.

Technology purpose			
1 ^a	2 ^b	3 ^c	Technology and description
	—		Abrasive blasting - a process in which solids such as sand or dry ice pellets in a pressurized fluid matrix are sprayed against a radiologically contaminated surface to decontaminate the surface.
		—	Acid/base digestion, solids dissolution - a process to dissolve solids in an acid/base bath in the presence of a metal catalyst to remove contaminants. The dissolved metal solution would then be treated via chemical precipitation for removal of the metal.
—		—	Asphalt based microencapsulation - a thermally driven process to dewater a waste and trap the residual solids in a liquid asphalt matrix that solidifies for disposal.
		—	Absorption - the transfer of contamination that is mixed with one phase into another phase.
		—	Aerobic biotreatment - the use of aerobic bacteria in a bioreactor to remove aromatic organic contaminants from soils, sediments, and sludges.
		—	Alkaline chlorination - an emerging application of the dechlorination technology. The technology involves dechlorination of halogenated compounds such as polychlorinated biphenyls and other chlorinated compounds by a substitution reaction. The secondary wastes from the reaction require disposal.
		—	Activated sludge - the use of an activated sludge material like an activated charcoal for the removal of organic materials from wastes.
		—	Anaerobic digestion - the use of nonaerobic bacteria (i.e., bacteria that do not require oxygen) in a bioreactor for the consumption of specific organic contaminants from aqueous wastes.
—		—	Advanced electrical reactor - a graphite electrode DC arc furnace in which two electrodes are attached to the waste being processed. A plasma arc is generated between the electrodes that generates 1700°C temperatures, causing the soil/metal mixture to be stratified into a metal phase, a glass phase, and a gas phase. The phases are separated and treated separately.
		—	Air stripping - used for the removal of volatile organic compounds from aqueous waste streams. The liquid waste is intimately contacted with air resulting in mass transfer of the organic compound from liquid phase to the gas phase.
		—	Amalgamation - the property of mercury in which it unites or alloys with other metals. This is used in the tritium production process where gold traps remove mercury.
		—	Alkali metal dechlorination - an emerging application of the dechlorination technology. The technology involves dechlorination of halogenated compounds such as polychlorinated biphenyls and other chlorinated compounds by a substitution reaction. The secondary wastes from the reaction require disposal.
		—	Alkali metal/polyethylene glycol - an emerging application of the dechlorination technology. The technology involves dechlorination of halogenated compounds such as polychlorinated biphenyls and other chlorinated compounds by a substitution reaction. The secondary wastes from the reaction require disposal.
		—	Blast furnaces - used together with reverberatory furnaces for the removal of lead from excavated materials. Also see smelting.

Table D-1. (continued).

Technology purpose			
1	2	3	Technology and description
		—	Bio-reclamation - or bioremediation is a normally in situ process whereby biological agents that degrade hydrocarbons are mixed with organically contaminated soil to remove these contaminants from the soil.
		—	Carbon adsorption - the use of a bed of granular activated carbon or charcoal for the removal of chlorinated hydrocarbons, aromatic solvents, and fuels from an aqueous waste.
		—	Circulation bed combustion - uses high velocity air to entrain circulating solids and create a highly turbulent combustion zone that destroys toxic hydrocarbons such as PCBs.
		—	Catalytic dehydrochlorination - an emerging application of the dechlorination technology. The technology involves dechlorination of halogenated compounds such as polychlorinated biphenyls and other chlorinated compounds by a substitution reaction. The secondary wastes from the reaction require disposal.
		—	Cementation - a process in which contaminated wastewaterwastewater is mixed with cement to solidify and stabilize the contaminants for storage.
		—	Centrifugation - the use of a centrifuge to separate solids from a liquid waste for further processing.
		—	Chemical hydrolysis - the use of a reactive chemical species in water to detoxify or neutralize the hazardous constituents. This is usually used for the recovery of spent solvents.
		—	Chelation - an ion exchangeion exchange process in which the exchange media possesses unusually high selectivity for certain cations.
		—	Chemical oxidation/reduction - the use of a variety of oxidation or reduction processes for the removal of contaminants from waste materials/processes.
		—	Compaction - the use of a mechanical device, normally hydraulically operated, to reduce the volume of waste before its disposal. CompactorsCompactors generate less than 1,000 tons of compressive force.
		—	Chemical precipitation - removes dissolved hazardous metal species from water to permit conventional water disposal through a permitted outfall. The solution is mixed with chemical additives that cause the generation of insoluble compounds of the metal which can then be filtered.
		—	Crystallization - the removal of dissolved solids from solution by subcooling the solution either directly or indirectly to a temperature lower than the pure component freezing point of the dissolved solid. This may be accomplished with or without the addition of a diluent solvent.
		—	Dissolved air flotation - an adsorptive-bubble separation method in which dissolved air is used for the removal of solid particulate contaminants.
		—	Distillation - a process for the removal of solid contaminants from solution by separating the constituents of the liquid mixture via partial vaporization of the mixture and the separate recovery of the vapor and the solid contaminant residue.

Table D-1. (continued).

Technology purpose			
1	2	3	Technology and description
		–	Electrodialysis - a process for the removal of dissolved ionic contaminants from solution by pumping the solution through very narrow compartments that are separated by alternating charged cation-exchange and anion-exchange electrode membranes which are selectively permeable to positive and negative ions, respectively.
		–	Evaporation - the removal of water via vaporization from aqueous solutions of nonvolatile substances, thus leaving the residual contaminant for further processing for disposal.
		–	Fluidized bed incinerator - an incinerator in which the solid waste particles are held in suspension via the injection of air at the bottom of the bed (complete destruction of the waste) or an incinerator in which a bed of limestone material is held in suspension as waste is incinerated to induce chemical capture to form stable compounds which can be readily disposed of.
		–	Filtration - the process in which fluid is passed through a medium which traps and thus removes solid particles from the fluid stream.
		–	Flocculation - the use of fine particles that are anionically or cationically charged for ion removal that aggregate into a larger mass, that can be filtered out, as the ion exchangeion exchange process occurs.
		–	High temperature metal recovery - the use of smelting or blast furnaces for the recovery of metals such as lead.
		–	Heavy media separation - a process that takes advantage of the presence of a waste constituent that is heavier than the others by using any of a number of available methodologies for segregation of the heavier constituent.
	–		High pressure water steam/spray - used for the decontamination of surfaces having loosely held contamination. One of these methods is commonly known as hydrolazing.
		–	Industrial boilers - used for the burning of permitted organic wasteorganic wastes for energy recovery.
		–	Ion exchangeIon exchange - a process in which a bed of solid resin material carrying an ionic charge (+ or -) accompanied by displaceable ions of opposite charge is used to displace metal ions dissolved in the solution flowing through the resin bed, thus removing the metals from the solution.
		–	Industrial kilns - see industrial boilers above.
		–	Lime-based pozzolans - a solidification and stabilization process that takes advantage of siliceous or aluminous materials that react chemically with lime at ordinary temperatures in the presence of moisture to produce a strong cement. The process is used for contaminated soilssoils, sludges, ashes, and other similar wastes.
		–	Liquid/liquid extraction - a process for separating components in solution via the transfer of mass from one immiscible liquid phase into a second immiscible liquid phase.
		–	Liquid injection incinerators - an incinerator used for the destruction of liquid organic wasteorganic wastes only.
		–	MacroencapsulationMacroencapsulation - the coating or containing of a solid waste form with another material to stabilize the waste form.

Table D-1. (continued).

Technology purpose			
1	2	3	Technology and description
–		–	Molten glass - the product resulting from the vitrification process where waste solids are exposed to high temperatures. The molten glass is allowed to cool to a homogeneous, nonleachable solid for disposal.
–		–	Microwave solidification - a process which uses microwave energy to heat and melt homogeneous wet or dry solids into a vitrified final waste form that possesses high-density and leach-resistant attributes.
		–	Molten salt destruction - a process for destruction of organic waste constituents where the waste is injected into a molten bed of salt along with an oxidizing gas such as air. The organics are destroyed and the residual molten salts are drained and dissolved in water for further processing.
		–	Neutralization - normally the addition of an acid to an alkaline solution to initiate the precipitation of contaminants.
		–	Oxidation by hydrogen peroxide - an organic contaminant removal process that uses hydrogen peroxide to oxidize the contaminants for removal.
		–	Oil/water separation - the process by which a mechanical device removes oil from water by taking advantage of the density difference that causes it to float on water.
		–	Ozonation - a chemical oxidation process in which ozone, an oxidizing agent, is added to a waste to oxidize organic materials into carbon dioxide and water vapor. This offgas would be passed through a carbon bed for the removal of generated volatile organic vapors.
–		–	Polymerization - a thermally driven process to dewater a waste and trap the residual solids in a liquid polymer matrix that solidifies for disposal.
		–	Phase separation - any process that takes advantage of the presence of two phases in a waste stream or waste product to segregate one of the phases from the other.
–		–	Plasma arc torch - used as the heat source for a vitrification process in which the waste is fed into a centrifuge in which the plasma torch is installed, where it is uniformly heated and mixed.
–		–	Pyrolysis - the use of extremely high temperatures for the destruction of organic contaminants and the fusion of inorganic waste into a homogeneous, nonleachable glass matrix.
		–	Rotating biocontactors - a bioremediation process in which the biological reactor body rotates to enhance the mixing and contact of the waste with the biological agents.
–			Recycle - the process by which any substance, material, or object is processed for reuse.
–			Repackaging/containerize - the process by which waste is resorted and placed in containers that result in increased space-efficiency and cost-effectiveness for disposal.
–		–	Rotary kiln incinerator - an incinerator that uses a rotating kiln body for the burning of the waste material being fed.
		–	Reverse osmosis - separates hazardous constituents from a solution by forcing the water to flow through a membrane by applying a pressure greater than the normal osmotic pressure.

Table D-1. (continued).

Technology purpose			
1	2	3	Technology and description
		—	Roasting/retorting - the oxidation and driving off of solid contaminants via the use of high temperatures.
		—	Super critical extraction - a process for the extraction of organic contaminants from waste products via the use of a reactor in which the temperature and pressure are elevated to values greater than the triple point of water.
		—	Solvent extraction - a process whereby solvents or liquefied gases (such as propane or carbon dioxide) are used to extract organics from sludges, contaminated soils, and waste water.
	—		Sealing - the process that is used to trap surface contamination to a surface from which it is not readily removable. The surface is coated with a matrix that seals the contamination in place.
		—	Sedimentation - the partial separation or concentration of suspended solid waste particles from a liquid by gravity settling.
		—	Soil flushing/washing - a process in which water and chemical additives are added to contaminated soil to produce a slurry feed to a scrubbing machine that removes contaminated silts and clay from granular soil particles.
	—		Scarification/grinding/planing - the use of a high speed rotating mechanical device for the removal of fixed surface contamination.
—			Shredding/size reduction - the process by which a shredder is used to cut contaminated paper, plastics, cardboard, etc. into smaller pieces to provide volume reduction prior to disposal.
		—	Smelting - used to treat stainless steel for the removal of radionuclides. The stainless steel is fed into reverberatory or blast furnaces with additives which serve to separate the radionuclides from the slag, leaving clean metal.
		—	Sorption - the selective transfer of one or more solutes or contaminants from a fluid phase to a batch of rigid particles.
	—		Spalling - the use of a mechanical impact device to chip away a contaminated surface. The surface is spalled to a depth that is no longer contaminated and the chipped debris is disposed of.
—			Sorting/reclassifying - the process by which waste is sorted to optimize the way in which it is disposed to provide for the most space efficient and cost effective packaging of the waste.
		—	Steam stripping - the use of superheated steam to oxidize complex organic compounds to carbon monoxide, carbon dioxide, water, hydrogen, and methane. The destruction of the organics is then completed at high temperature using an electrically heated reactor.
		—	Supercritical water oxidation - an aqueous phase oxidation treatment in which organic waste, organic waste, water, and an oxidant (air or oxygen) are combined in a tubular reactor at temperatures above the critical point of water.
—			Supercompaction - the use of a compactor that has a capacity of greater than 1,000 tons compressive force for increased volume reduction and the compaction of items not effectively compacted by a normal compactor.

Table D-1. (continued).

Technology purpose			
1	2	3	Technology and description
		–	Thermal desorption - a process used for the removal of organics from sludges at a temperature of 350 - 600°F which is high enough to volatilize the organics for adsorption capture but low enough to prevent the emission of significant quantities of metals that can occur with incineration/incineration.
		–	UV photolysis - a process that removes organic contaminants from aqueous waste streams via the use of ultra-violet radiation to oxidize the contaminants.
	–		Vibratory finishing - the use of a mechanical vibratory tool for the decontamination of surfaces having fixed contamination.
–		–	Vitrification - a high temperature process by which waste is treated in a furnace at temperatures which drive off organics for further treatment and reduce the inorganic waste to a homogeneous, nonleachable glass slag that is discharged into a mold or drum for disposal.
		–	Wet air oxidation - a process in which the waste is heated and passed, along with compressed air, into an oxidation reactor where oxidation of the organic contaminants takes place.
		–	White rot fungus - a lignin-degrading fungi that is used to inoculate organic materials which are mechanically mixed with contaminated soils to break down the contaminants.
	–		Water washing/spraying - the use of low pressure water to rinse contaminated surfaces for the removal of loosely held contamination.

a. Volume reduction.

b. Decontamination.

c. Immobilization/stabilization.

Table D-2. Comparison of Section 2.3 process technologies and Appendix D technologies.

Section 2.3	Corresponding Appendix D
Type/Technology	Type/Technology
1. Physical/Electrodialysis	Physical/Electrodialysis
2. Physical/Evaporation	Chemical/Evaporation and Catalytic Oxidation
3. Physical/Sedimentation and Flocculation	Physical/Binding, Precipitation, and Physical Separation
4. Physical/High Pressure H2O Steam/Spray	Physical/Pressure Washing and Hydraulic Jetting
5. Physical/Ion Exchange	Chemical/Resorcinol-Formaldehyde Ion Exchange Resin
6. Physical/Soil Flushing/Washing	Physical/Soil Washing
7. Physical/Steam Stripping	Physical/Steam Reforming
8. Physical/Filtration	Physical/Chemical Treatment, and Ultrafiltration; Heavy Metals and Radionuclide Polishing Filter; Membrane Microfiltration

9. Stabilization/Lime-Based Pozzolans	Stabilization/Pozzolaric Solidification
10. Stabilization/Polymerization	Stabilization/Polyethylene Encapsulation Stabilization/Vinyl/Ester Styrene Solidification
11. Stabilization/Vitrification Vitrification	Thermal/Electric Melter Vitrification Vitrification Thermal/Stirred Melter Vitrification Thermal/Modular Vitrification Thermal/In-Situ Vitrification Thermal//Vortec Process
12. Thermal/Advanced Electrical Reactor	Thermal/Graphite Electrode DC Arc Furnace Thermal/Packed Bed Reactor, Silent Discharge Plasma Apparatus
13. Thermal/Fluidized Bed Incinerator	Thermal/Fluidized Bed Cyclonic Agglomerating Incinerator Thermal/Catalytic Combustion in a Fluidized Bed Reactor
14. Thermal/High Temperature Metal Recovery	Thermal/Quantum-Catalytic Extraction Process
15. Thermal/Molten Glass	Thermal/Electric Melter Vitrification Vitrification Thermal/Stirred Melter Vitrification Thermal/Modular Vitrification
16. Thermal/Molten Salt Destruction	Thermal/Molten Salt Oxidation and Destruction Process
17. Thermal/Infrared Incinerators	Thermal/Infrared Thermal Destruction
18. Thermal/Circulating Bed Combustion	Thermal/Cyclonic Furnace
19. Thermal/Supercritical Water Oxidation	Chemical/Supercritical Water Oxidation
20. Thermal/Wet Air Oxidation	Thermal/Wet Air Oxidation
21. Biological/Aerobic Biotreatment	Biological/Bioscrubber Biological/Biosorption
22. Biological/White Rot Fungus	Biological/White Rot Fungus
23. Chemical/Alkali Metal Dechlorination, Alkali metal/ Polyethylene glycol	Chemical/Dechlorination
24. Chemical/Catalytic Dehydrochlorination	Chemical/Aqueous Phase Catalytic Exchange Evaporation and Catalytic Oxidation Biocatalytic Destruction
25. Chemical/Crystallization	Physical/Freeze Crystallization
26. Chemical/Ultraviolet Photolysis	Physical/Ultraviolet Oxidation

D.2 Introduction

Table D-3 provides summary information by technology type, technology, the development status of the technology, the type of waste that can be treated by the technology, and the waste form generated by the technology for all technologies addressed in this appendix. Most of these technologies are still at the bench, pilot, or demonstration stage of development and are not commercially available. The technologies summarized here treat contaminated matrices that contain plastic, paper (and other forest products), metals, aqueous liquids, and organic liquids. These waste matrices are generated through activities such as site operations, decontamination and decommissioning, or environmental restoration. Some technologies, such as vitrification and plasma furnaces, have been available for years. Vitrification of liquid high-level radioactive waste is a proven technology.

The treatment summaries were prepared from a number of literature sources and interviews and have been grouped by categories of waste treatment: (1) biological, (2) chemical, (3) physical, (4) stabilization, and (5) thermal.

D.3 Biological Treatment Technologies

Biological treatment methods have been used to treat organic wastes for years. These methods rely on microorganisms to degrade organic compounds to simpler compounds (such as carbon dioxide and water). Sanitary waste water treatment plants rely on biological methods to treat domestic waste water prior to its discharge to surface water. Several industrial wastewaters (such as phenolic and pulp and paper wastes) are also treated using biological methods. Complete degradation (mineralization) of complex hydrocarbons (such as PCBs or polyaromatic hydrocarbons) is more difficult to achieve. Degradation rates are controlled by energy available from breaking chemical bonds and factors affecting enzymatic activity (such as water solubility, pH, temperature, and metals concentration). In general, biological treatment methods are effective for many simple, water-soluble organics. Biological treatment of aqueous-phase organics in industrial wastes often results in the production of sludges contaminated with heavy metals (such as cadmium and lead). These technologies are generally most effective for relatively homogeneous wastes in dilute aqueous solutions.

Innovative approaches to biological treatments include in situ treatment of contaminated groundwater by alternating aerobic (in the presence of oxygen) and anaerobic (without oxygen) conditions using microorganisms (such as white rot fungus, which may be more effective for hydrophobic compounds), and special techniques (such as special reactor vessels, co-substrates, and nutrients) to select microorganisms for optimal degradation rates of compounds that are difficult to treat.

D.3.1 BIOSCRUBBER

The bioscrubber technology removes organic contaminants in air streams from soil, water, or air decontamination processes and is especially suited to wastes containing dilute aromatic solvents at relatively constant concentrations. The bioscrubber technology digests trace organic emissions using a filter with an activated carbon medium that supports microbial growth. The bioactive medium converts diluted organics into carbon dioxide, water, and other nonhazardous compounds. The filter provides biomass removal, nutrient supplement, and moisture addition. Recently developed bioscrubbers have a potential biodegradation efficiency 40 to 80 times greater than existing filters. A disadvantage of the bioscrubber is its inability to treat high concentrations of aromatics at a high capacity, as required by systems at SRS. A pilot-scale unit with a 4cubicfootperminute capacity is currently being field tested for the EPA's Superfund Innovative Treatment Evaluation Emerging Technology Program. The bench-scale bioscrubbers successfully removed trace concentrations of toluene at greater than a 95 percent removal efficiency (EPA 1993).

D.3.2 BIOSORPTION

Biosorption is a process by which specialized bacteria are used to biosorb radionuclides and metals. Biosorption consists of the separation and volume-reduction of dilute aqueous-phase radionuclides, metals, and nitrate salts. Liquids and salts are fed to a bioreaction system where radionuclides and metals are concentrated and supernated through biosorption by specialized bacteria. The microorganisms are grown in a bioreactor and are recycled to a biosorption tank where they are mixed with the liquids and salts. Microorganisms biosorb the metals and radionuclides and are removed by filtration to generate a biomass sludge that can be volume-reduced and stabilized through incineration or vitrification. The filtrate, which contains nitrate salts, organics, and low levels of metals, flows to the bioreactor where the nitrate salts are reduced to nitrogen gas and bicarbonate solution and any remaining metals are further adsorbed by the bacteria. After filtration, the effluent from the bioreactor is a salt solution. The process is anticipated to be safe (the system operates at standard temperature and pressure with natural bacteria), energy-efficient, and cost-effective. Uncertainties include potential toxic effects of radionuclides and metals on the bacteria and the volume and characteristics of the sludge. Biosorption of residual underground tank surrogate waste has been demonstrated in the laboratory and is currently in scale-up design for field demonstration at the Idaho National Engineering Laboratory (DOE 1993, 1994a, b).

D.3.3 WHITE ROT FUNGUS

White rot fungus (*Phanerochaete chrysosporium*) is used to degrade a variety of carbon-based contaminants, including PCBs, chlorinated solvents, hydrocarbons, and cyanide. The naturally occurring fungi degrade the contaminants to byproducts, such as inorganic salts, carbon dioxide and water. The ability of this fungus to biodegrade contaminants can be attributed, at least in part, to its natural lignin-degrading system that it uses to decay fallen trees to provide its primary food source, cellulose.

In order to support sustained degradation of chemicals, a carbon source for the fungi must be present and readily available. Examples of bulking agents that can serve as a carbon source include wood chips, corn cobs, and other complex carbohydrates. Degradation rates increase with pollutant chemical concentration, and the toxicity of the chemicals rarely affects the fungi. The microorganisms are able to survive and grow in many adverse conditions and substances, including used 20-weight motor oil and coal-tar-contaminated soils.

A waste treatment system based on white rot fungus can degrade many recalcitrant environmental organic pollutants. The white rot fungus treatment method offers the ability to treat a wide variety of chemical organic pollutants. This treatment method is still in research and development stages. However, experimental results indicate that high degradation of many common pollutants (including pesticides, herbicides, and dyes) is possible. However, the application of this technology to radioactive and mixed wastes may be limited due to potential radiological effects on the white rot fungus organism.

Bench-scale testing of white rot fungus treatment was conducted under a cooperative agreement with the EPA (Connors, no date; Bumpus et al. 1989).

D.4 Chemical Treatment Technology

Chemical treatment methods have traditionally been used to treat virtually all types of wastes. These methods can be applied to hazardous, radioactive, and mixed wastes and are compatible with liquids, solids, sludges, and gases.

There are two basic types of chemical treatment methods, chemical extraction and chemical destruction. Chemical extraction technologies separate the contaminants from the waste, while chemical destruction technologies either destroy the hazardous constituent or remove the hazardous characteristic. The type of chemical treatment method applied to a waste stream depends on its physical and chemical properties, regulatory requirements, secondary waste disposal options, and performance assessments.

Innovative approaches to chemical treatment include oxidation/reduction methods (such as supercritical water oxidation, ultraviolet oxidation, and low-temperature reduction of nitrate in ammonia) and the use of newly developed ion exchange resins.

Electrochemical treatment is a direct oxidation/reduction process that is used to treat liquid wastes containing recoverable metals or cyanide. This process involves immersing cathodes and anodes in a waste liquid and introducing a direct electric current. Electrolytic recovery of single metal species can be high and may yield pure or nearly pure forms. Process times are a function of variables such as purity desired, electrode potential, and current, electrode surface area, ionic concentrations, and agitation.

DOE is developing innovative electrochemical treatment processes to demonstrate oxidation of organics and the biocatalytic destruction of nitrate and nitrite salts.

D.4.1 AQUEOUS-PHASE CATALYTIC EXCHANGE FOR DETRITIATION OF WATER

The aqueous-phase catalytic exchange method was originally used to remove organics from waste streams in closed-

environment systems. Aqueous-phase catalysis is also applicable to the detritiation of aqueous wastes, and experiments have shown that this process may be able to lower contaminated groundwater tritium levels by two orders of magnitude with an acceptable catalyst bed lifetime. DOE has recently proposed an expansion of its testing of aqueous-phase catalysis. A catalyst manufactured in the United States will be evaluated for use in detritiation of waste water from SRS and other DOE facilities. Performance comparisons will be made with a Canadian-manufactured catalyst (Sturm 1994).

D.4.2 BIOLOGICAL/CHEMICAL TReATMENT

The biological/chemical treatment technology involves a two-stage process to treat wastes contaminated with organics and metals. The process includes chemical leaching of the waste to remove metals (this is similar to soil-washing techniques or mixed ore metals extraction) and bioremediation to remove organics and metals. The process results in an end product of recovered, salable metal or metal salts, biodegraded organic compounds, and stabilized residues. The incoming waste is first exposed to the leaching solution and filtered to separate oversized particles. The leaching solution disassociates metal compounds from the waste. The metal compounds form metal ions in the aqueous leachate and can be removed by liquid ion exchange, resin ion exchange, or oxidation/reduction. After the metals are extracted, the slurried waste is allowed to settle and neutralize. Next, the slurry is transferred to a bioreactor where micronutrients are added to support microbial growth and initiate biodegradation. The residual leaching solution and biodegradable organic compounds are aerobically degraded in the bioreactor. The combined metal leaching and bioremediation processes may be less expensive than separate processes. For treatment of organic compounds, chemical treatment may facilitate biological treatment, especially for PCBs. Bench-scale tests conducted for the EPA's Superfund Innovative Treatment Evaluation Emerging Technology Programs show that a variety of heavy metals and organic pollutants can be remediated by the process. Pilot-scale testing of the process is being conducted (EPA 1993).

D.4.3 DECHLORINATION

The Dechlor/KGME process involves the dechlorination of liquid-phase halogenated compounds, particularly PCBs. KGME, a proprietary reagent, is the active species in a nucleophilic substitution reaction in which the chlorine atoms on the halogenated compounds are replaced with fragments of the reagent. The products of the reaction are a substituted aromatic compound (which is no longer a PCB aroclor) and an inorganic chloride salt. These secondary wastes require treatment and disposal.

KGME is the potassium derivative of 2-methoxyethanol (glyme) and is generated in situ by adding stoichiometric quantities of potassium hydroxide (KOH) and glyme. The KOH and glyme are added to a reactor vessel along with the contaminated waste. The KGME is formed by slowly raising the temperature of the reaction mixture to about 110 °C, although higher temperatures can be beneficial.

The reaction product mixture is a fairly viscous solution containing reaction products and the unreacted excess reagent. After this mixture has cooled to about 93°C (199°F), water is added to help quench the reaction and extract the inorganic salts from the organic phase.

The DeChlor/KGME process is applicable to liquid-phase halogenated aromatic compounds, including PCBs, chlorobenzenes, polychlorinated dibenzodioxins, and polychlorinated dibenzofurans. Waste streams containing from less than 1 to up to 1,000,000 parts per million (100 percent) of PCBs can be treated. Laboratory tests have shown destruction removal efficiencies greater than 99.98 percent for materials containing 220,000 parts per million of PCBs (22 percent).

DOE has recently proposed to evaluate this process for treating solid waste contaminated with PCBs and radioactivity. Although this technology has been demonstrated for treatment of liquid PCB wastes, it has not been demonstrated for treating porous, fine-grained solids contaminated with PCBs.

PCB-contaminated radioactive wastes are currently stored at several DOE facilities. Due to the capacity limitations of the Oak Ridge incinerator regulated by the Toxic Substances Control Act and RCRA, the mixed wastes will be stored for more than 10 years before they can be disposed of. The Consolidated Incineration Facility at SRS is not permitted to

incinerate PCB wastes; however, this is a viable option. The Dechlor/KGME process may be an alternative to incineration and long-term storage. However, some secondary wastes would still require disposal.

Laboratory testing will be conducted with nonradioactive surrogate materials, and if the results are acceptable, additional testing will be performed on representative radioactive waste samples. Pilot-scale testing of the Dechlor/KGME process can then be carried out to evaluate the efficiency of PCB destruction and the suitability of the process for treating nonradioactive surrogate waste (EPA 1991).

D.4.4 GAS-PHASE CHEMICAL REDUCTION

The gas-phase chemical reduction process uses a gas-phase reduction reaction of hydrogen with organic compounds at elevated temperatures. The process occurs at elevated temperatures to convert aqueous and oily hazardous contaminants to a gaseous, hydrocarbon-rich product. A mixture of atomized waste, steam, and hydrogen is injected into a specially designed reactor. The hydrogen must be specially handled to prevent any potential for explosion. The mixture swirls down the outer reactor wall and passes a series of electric heaters that raise the temperature to 850°C (1,562°F). The reduction reaction occurs as the gases travel toward the scrubber where hydrogen chloride, heat, water, and particulates partition out.

Gas-phase chemical reduction is suitable for the treatment of PCBs, dioxins, and chlorinated solvents. Demonstration tests were performed on wastewater containing an average PCB concentration of 4,600 parts per million and waste oil containing an average of 24.5 percent PCBs. Destructive removal efficiencies of 99.9999 percent were attained during the test runs that were conducted for the EPA's Superfund Innovative Treatment Evaluation Demonstration Program at a Toxic Substances Control Act/RCRA permitted landfill (EPA 1993).

D.4.5 NITRATE TO AMMONIA AND CERAMIC PROCESS

The nitrate to ammonia and ceramic process is used to destroy nitrates present in aqueous, mixed wastes. The process products are an insoluble ceramic waste form and ammonia, which can be further processed through a catalyst bed to produce nitrogen and water vapor. This technology includes a low-temperature process for the reduction of nitrate to ammonia gas in a stirred ethylene glycol-cooled reactor. The process uses an active aluminum (from commercial or scrap sources) to convert nitrate to ammonia gas with the liberation of heat. Silica is added to the reactor, depending on the sodium content of the waste. The aluminum-silica-based solids precipitate to the bottom of the reactor and are further processed by dewatering, calcination, pressing, and sintering into a ceramic waste form. The process results in a 70 percent volume reduction; however, the process is highly exothermic, so safety controls are required, and an inert gas is required to prevent a potential explosive reaction between the ammonia and hydrogen produced in the reactor.

Bench-top experiments at the Hanford Site have confirmed that the nitrate to ammonia and ceramic process will reduce the nitrate present in aqueous waste to ammonia and hydrated alumina. When silica is added, the reactor product can be used to produce an alumina-silica-based ceramic. Bench-top experiments also demonstrated process dependence on feed constituents and reaction rates. Determination of properties of the waste, such as leachability, is continuing (DOE 1994b).

D.4.6 RESORCINOL-FORMALDEHYDE ION EXCHANGE RESIN

Resorcinol-formaldehyde ion exchange resin beds can be used to remove ionic radionuclides (such as cesium) from high-level radioactive supernatant at 10 times the capacity of baseline phenol-formaldehyde resin beds. Resorcinol-formaldehyde ion exchange resin technology is applicable to highlevel wastes that contain high-alkalinity, cesium-supernatant salt solutions. The cesium in the waste is the result of reprocessing spent nuclear power reactor fuels. High-level waste supernatant can be processed through ion exchange columns where cesium undergoes selective sorption in the resorcinol-formaldehyde ion exchange resin and is effectively removed from the waste. After the columns become saturated, they can be removed from service so the cesium can be eluted from the resin with acid. The concentrated

cesium can be sent for vitrification, while the regenerated column can be returned to service. The high-level radioactive supernatant that was originally sent through the ion exchange columns can then be stabilized. Spent exhausted resin can be rigorously eluted to lower its cesium content, followed by incineration or chemical destruction. Resorcinol-formaldehyde ion exchange resin has 10 times the capacity of baseline resins, and no volatile organic compounds are formed from radiolysis; however, offgas treatment may be necessary due to the formation of small quantities of hydrogen gas. This technology is fairly limited in its application. Additional contaminants, such as actinides, strontium-90, and mercury must be removed prior to stabilization of the supernatant.

Bench-scale testing has shown that resorcinol-formaldehyde ion exchange resin appears useful over a wide range of concentrations and temperatures. A system prototype is being developed for demonstration at the Hanford Site (DOE 1994a).

D.4.7 SUPERCRITICAL WATER OXIDATION

Supercritical water oxidation is an aqueous-phase oxidation treatment for organic wastes in which organic waste, water, and an oxidant (such as air or oxygen) are combined in a tubular reactor at temperatures and pressures above the critical point of water. The organic constituents are reduced to water, carbon dioxide, and various biodegradable acids. The process occurs above the critical point of water because the water in the liquid waste becomes an excellent solvent for the organic materials contained in the waste.

Supercritical water oxidation is a closed loop system with very small secondary waste generation. Although this process occurs at mild temperatures [400 to 650°C (752 to 1,202°F)] compared to incineration [1,000 to 1,200°C (1,832 to 2,191°F)], the high pressure creates a need for additional process containment, especially when treating radioactive waste. The process is limited to dilute liquid wastes and has not been demonstrated on solid wastes. This treatment method has been tested with a bench-scale system, using cutting oil containing a simulated radionuclide. During bench-scale testing, oxidation efficiencies greater than 99.99 percent were achieved; however, the resulting solid effluent contained levels of the simulated radionuclide that suggest that actual treatment effluent would require further treatment as a radiological hazard. DOE has completed benchscale testing using mixed waste surrogates, and has begun designing the hazardous waste pilot plant. The hazardous waste pilot plant will be used to identify additional technology needs and to demonstrate currently available technology using hazardous and surrogate mixed waste (DOE 1993, 1994c).

D.4.8 WET AIR OXIDATION

The wet air oxidation process is a treatment method used to destroy organic contaminants in liquid waste streams. Oxidizing organic substances can degrade them into carbon dioxide and water. The waste is heated and passed, along with compressed air, into the oxidation reactor where the chemical reactions take place.

Commercially available wet air oxidation methods are limited to treating dilute (less than 10 percent by weight organics) liquid wastes; however, the addition of a metal catalyst can drastically alter the treatability of the waste. A metal catalyst may allow degradation of halogenated aromatic compounds (such as PCBs) and condensed-ring compounds. A method that uses a metal catalyst to assist in the waste treatment process is currently being bench-scale tested for hazardous, radioactive, and mixed wastes. This method has been successful in treating liquid wastes as well as solid wastes. The benchscale studies have been performed using a batch oxidation reactor and a continuous oxidation reactor; both showing promising results.

The bench-scale tests have proven that sufficient oxidation rates can be achieved using wet oxidation methods with the addition of a metal catalyst. Experiments showed that oxidation rates for organic solids are highly dependent on surface area of the solid and the interfacial contact area in the reaction vessels; therefore, efficient mixing is very important. A scheme has been identified to allow separation of radioactive and toxic metals from the process solution (DOE 1993; Wilks 1989).

D.4.9 WET CHEMICAL OXIDATION (ACID DIGESTION)

Wet chemical oxidation uses nitric acid, air, and a catalyst to oxidize liquid and solid organic wastes. The wet chemical oxidation, or acid digestion, process is currently under investigation at SRS for its applicability for treating hazardous and mixed wastes. An advantage of such a process is that it requires only moderate temperatures and pressures; however, several parameters are still under investigation. Research on operating temperatures and catalyst and oxidant concentrations must be completed before initiating feasibility studies on the various applications. Early experiments, however, showed promising results for treating specific waste types.

Because this technology is still in initial bench-scale development, the applicability of the system to a variety of wastes is difficult to predict. Theoretically, however, this process should be able to successfully treat many hazardous, low-level radioactive, and mixed wastes. The current system could produce large amounts of secondary waste products, such as spent acids, that would require additional treatment (DOE 1993; Apte 1993).

D.4.10 EVAPORATION AND CATALYTIC OXIDATION

The evaporation and catalytic oxidation system treats a variety of hazardous liquid wastes by reducing the waste volume and oxidizing volatile contaminants. The proprietary technology combines evaporation with catalytic oxidation to concentrate and destroy contaminants, producing a nontoxic product condensate. The system consists of (1) an evaporator that reduces the influent volume, (2) a catalytic oxidizer that oxidizes the volatile contaminants in the vapor, (3) a scrubber that removes acid gases produced during oxidation, and (4) a condenser that condenses the vapor leaving the scrubber. The treatment would be most effective on liquid wastes containing mixtures of metals, volatile and nonvolatile organics, volatile inorganics, and radionuclides. The technology destroys contaminants and produces a nontoxic product condensate without using expensive reagents or increasing the volume of the total waste. A pilot-scale facility at the Clemson Technical Center has been developed for treating radioactive, hazardous, and mixed wastes under EPA's Superfund Innovative Treatment Evaluation Demonstration Program. Secondary wastes streams such as evaporator bottoms and sludges would still require disposal. Limitations include potential heavy metal effects on catalysts and a fairly narrow applicability. A commercial system is in operation in Hong Kong (EPA 1993).

D.4.11 BIOCATALYTIC DESTRUCTION

DOE is developing an enzyme-based reactor system to treat aqueous mixed and low-level radioactive wastes that have high nitrate and nitrite concentrations. The process involves the use of both electrical potential and enzymes to convert the nitrates and nitrites to nitrogen and water. The use of enzymes generates large specific catalytic activity without the need for additional chemical reagents or the production of secondary waste streams.

Removal of nitrates and nitrites from aqueous mixed waste and low-level radioactive waste by the biocatalytic destruction process can be used to pretreat waste in preparation for stabilization by solidification. Laboratory testing, consisting of immobilization of enzymes necessary for reducing nitrates to nitrogen and water, is being conducted by DOE's Argonne National Laboratory (DOE 1994b).

D.4.12 ELECTROCHEMICAL OXIDATION

Electrochemical treatment of hazardous, mixed, and low-level radioactive waste is a direct oxidation process. Oxidation of the organic constituents of the waste can occur in the electrochemical cell through two methods. The process can take place at the cell anode by direct oxidation or with the addition of an oxidizing agent to react with the organics in the cell. This process is limited to the treatment of relatively homogeneous liquid wastes and has been limited to lab-scale demonstrations. Pilotscale and commercial systems are being developed, and large-scale experiments using a

commercially available industrial electrochemical cell have been performed at Lawrence Livermore National Laboratory. A bench-scale electrochemical oxidation unit for destroying waste benzene was developed and demonstrated at SRS (Moghissi et al. 1993; DOE 1993).

D.4.13 MEDIATED ELECTROCHEMICAL OXIDATION

Mediated electrochemical oxidation is a method that was originally developed to treat an insoluble form of plutonium, and it later proved to be an effective method to treat combustible materials. The process utilizes a strong oxidizing agent (a form of silver), which chemically destroys combustible materials and converts the waste into carbon dioxide and water. Mediated electrochemical oxidation can effectively dissolve metals, has a very efficient destruction rate, and operates at near-ambient conditions. The process could produce a secondary waste containing a form of silver that would pose disposal problems.

Bench-scale and pilot-scale testing at DOE's Rocky Flats Plant have shown that the mediated electrochemical oxidation process is capable of achieving high destruction efficiencies for selected, nonradioactive surrogate materials (Moghissi et al. 1993).

D.5 Physical Treatment Technologies

Physical treatment methods are diverse and rely on physical properties, such as electromagnetic or particulate radiation, high pressure, or gravity. Innovative physical treatment technologies include the use of sound waves to separate particulates from aqueous-phase liquids, the use of electron beams to treat hazardous organics in groundwater, the use of pressure filters to remove metals and radionuclides, and the use of precipitation following coagulation and chemical binding. Several physical treatment technologies, such as the electron beam and filtration methods, are energy intensive.

D.5.1 ACOUSTIC BARRIER PARTICULATE SEPARATOR

This technology is a treatment method for high-temperature, high-throughput offgas streams. The offgas is injected into the separation chamber where an acoustic wave is produced and directed against the flow of the gas. The acoustic wave causes particulates in the offgas to move opposite the gas flow and toward the chamber wall. There, the particulates collect and precipitate into a collection hopper and are removed from the system. Applications include the separation and removal of particles. The process has the potential for high removal efficiencies at high throughput; however, high temperatures must be maintained for condensation and particulate precipitation. Additional treatment, such as the use of high efficiency particulate air filters, may be necessary for some wastes. A pilot-scale system is currently in the design and construction phase under EPA's Superfund Innovative Treatment Evaluation Emerging Technology Program (EPA 1993).

D.5.2 CHEMICAL BINDING/PRECIPITATION/PHYSICAL SEPARATION OF RADIONUCLIDES

Chemical binding/precipitation/physical separation of radionuclides is an innovative technology used to treat contaminated low-level radioactive and mixed waste water, sludges, and soils. The treatment combines a chemical binding process and a physical separation process. The initial step of the combined treatment process involves rapid mixing of the waste with a fine powder containing reactive binding agents, such as complex oxides. The binding agents react with most of the radionuclides and heavy metals in the waste by absorption, adsorption, or chemisorption. The reactions yield precipitates or coagulum in the processed slurry.

Water is then separated from the solids. This involves a two-stage process that combines clarifier technology,

microfiltration (to separate solid material by particle size and density), and dewatering using a sand filter. The resulting waste contains radionuclides, heavy metals, and other solids that can be stabilized for disposal. The demonstrated technology should produce a dewatered sludge that meets toxicity characteristic leaching procedure criteria; however, adding reagents tends to increase the production of waste product. This process may be limited by the quality of the water separated from the solids. Demonstrations under EPA's Superfund Innovative Treatment Evaluation Demonstration Program are expected to show the technology's applicability to wastes containing radium, thorium, uranium, man-made radionuclides, and heavy metals (EPA 1993).

D.5.3 CHEMICAL TReaTMENT AND ULTRAFILTRATION

The chemical treatment and ultrafiltration process is used to remove trace concentrations of dissolved metals from waste water. The process produces a volume-reduced water stream that can be treated ultimately for disposal. Waste water is passed through a prefilter to remove suspended particles. The prefiltered waste water is sent to a conditioning tank for pH adjustment and addition of water-soluble macromolecular compounds that form complexes with heavy metal ions. Next, a polyelectrolyte is added to achieve metal particle enlargement by forming metal-polymer complexes. The chemically treated waste water is circulated through a cross-flow ultrafiltration membrane. The filtered water is drawn off, while the contaminants are recycled through the ultrafiltration membrane until the desired concentration is reached. The concentrated stream can be withdrawn for further treatment, such as solidification. Initial bench and pilot-scale tests were successful; however, field demonstrations at Chalk River Laboratories, Ontario, indicated that pretreatment methods need further evaluation.

DOE is currently considering alternative methods of waste water pretreatment for ultrafiltration, including the use of water-soluble chelating polymers for actinide removal and the use of reagents and polymeric materials that exhibit selectivity for cations of heavy metals. Bench-scale tests have been conducted at DOE's Rocky Flats Plant in collaboration with the EPA's Superfund Innovative Treatment Evaluation Demonstration Program (EPA 1992a).

D.5.4 HeaVY METALS AND RADIONUCLIDE POLISHING FILTER

The heavy metals and radionuclide polishing filter uses a colloidal sorption method to remove ionic colloidal, complexed, and chelated heavy metal radionuclides from waste water streams. This technology must be combined with an oxidation process in order to treat waste water that is also contaminated with hydrocarbons, hazardous organics, or radioactive mixed wastes. This technology consists of a colloidal sorption unit that contains a high-efficiency, inorganic, pressure-controlled filter bed. Pollutants are removed from the waste water via surface sorption and chemical complexing in which trace inorganics, metals, transuranic, and low-level wastes can be efficiently treated. The polishing filter can be used for batch or continuous flow processing. Bench tests at DOE's Rocky Flats Plant were conducted for the removal of uranium-234 and -238, plutonium-239, and americium-241 with successful results; however, a measurable analysis was not possible due to the low activity levels of the radionuclide. Bench-scale testing is being conducted under EPA's Superfund Innovative Treatment Evaluation Demonstration Program in collaboration with DOE's Rocky Flats Plant (EPA 1993).

D.5.5 MEMBRANE MICROFILTRATION

The membrane microfiltration system is designed to remove solid particles from liquid wastes. Specifically, this technology can treat hazardous waste suspensions and process wastewaters containing heavy metals. The system uses an automatic pressure filter with a special Tyvek filter material (Tyvek T980) made of spunbonded olefin. The material is a thin, durable plastic fabric with tiny openings that allow water and smaller particles (less than one-ten-millionth meter in diameter) to pass, while larger particles accumulate on the filter to form a filtercake. The filtercake can be collected for further treatment prior to disposal. This technology is best suited for liquid waste containing less than 5,000 parts per million solids; however, the system is capable of treating wastes containing volatile organics because the system is enclosed. The technology was demonstrated with encouraging results, including removal efficiencies from 99.75 to 99.99 percent and filtercake that passed RCRA toxicity characteristic leaching procedure standards. The technology is being

demonstrated under the EPA's Superfund Innovative Treatment Evaluation Demonstration Program at the Palmerton Zinc Superfund Site (EPA 1993).

D.5.6 ELECTRODIALYSIS

This technology is used for metals recovery in aqueous liquid wastes generated in a production process. Electrodialysis uses membrane technology for selective removal of contaminants from a liquid waste. The liquid waste is usually aqueous with contaminants in ionic form. A direct current electrical potential is used to selectively transport the ions through a membrane where the ionic contaminants can be collected for further treatment.

This technology is not appropriate for treating liquid organic wastes; however, recovery of hazardous metals such as cadmium, nickel, zinc, copper, and chromium is possible. Limitations include operating in a batch mode using reagent-grade chemicals. Electrodialysis technology is commercially available and several membrane technologies suitable for use with an electrodialysis system are being developed under EPA's Superfund Innovative Treatment Evaluation Emerging Technology and Demonstration program (Apte 1993; DOE 1993).

D.5.7 FREEZE CRYSTALLIZATION

Freeze crystallization technology is based on differences in the freezing points of waste components. During freeze crystallization, a liquid waste is cooled using a refrigerant. As the phase changes from liquid to solid, crystals of solvent and contaminant solutes form separately. These crystals can then be gravity separated.

Freeze crystallization can be used to treat liquid mixed wastes containing inorganics, organics, heavy metals, and radionuclides in which the freezing temperatures of the various constituents differ significantly. The technology offers some advantages over other processes. For example, the process offers high decontamination and volume reduction factors, it requires no additives, and it operates at low temperatures and pressures, making it intrinsically safe. However, the technology is limited to those wastes that contain contaminants that crystallize easily. This project is being developed for DOE applications and is in the small pilot-scale development and demonstration stage. The technology will be demonstrated at the proprietor's pilot plant in Raleigh, North Carolina (DOE 1994b).

D.5.8 HIGH-ENERGY ELECTRON IRRADIATION

Electron irradiation process equipment consists of an electron accelerator that accelerates a beam of electrons to 95 percent of the speed of light. The beam is directed into a thin stream of waste water or sludge where free radicals are produced to react with the hazardous organics. Although the electron beam is a form of ionizing radiation, the process does not produce activated radioisotopes.

High-energy electron irradiation of aqueous solutions and sludges removes various hazardous organic compounds from aqueous wastes containing 8 percent solids. The process of irradiation produces large quantities of free radicals in the form of aqueous electrons, hydrogen radicals, and hydroxyl radicals. The hydroxyl ions can recombine to form hydrogen peroxide. These very reactive chemical species react with organic contaminants, oxidizing them to nontoxic byproducts, such as carbon dioxide, water, and salts.

Electron irradiation may be suitable for the treatment of halocarbons, aromatics, and nitrates. Disadvantages of this process include high power requirements and interferences from solids. The process produces low concentrations of aldehydes and formic acid; however, at these concentrations those compounds are not toxic. Both a full-scale facility and a mobile demonstration unit have been developed. The process is currently being demonstrated for the treatment of volatile organic compounds at SRS through EPA's Superfund Innovative Treatment Evaluation Demonstration Program. In addition, DOE's Los Alamos National Laboratory is evaluating the suitability of electron irradiation for treating aqueous mixed wastes and sludges contaminated with organics and nitrates (DOE 1994b; EPA 1993, 1994).

D.5.9 ULTRAVIOLET OXIDATION

Ultraviolet oxidation uses ultraviolet radiation, ozone, and hydrogen peroxide to destroy toxic organic compounds in water. Ultraviolet oxidation is a common treatment for industrial and municipal waste water. Although commercial systems are available for dilute waste forms, destruction of high organic concentrations requires additional oxidizing agents, such as ozone and hydrogen peroxide. Ultraviolet radiation breaks down the hydrogen peroxide to products that chemically convert organic materials into carbon dioxide and water. This technology operates at near-ambient conditions and generates a very small amount of secondary waste but operates at a slower destruction rate than other technologies. System demonstrations with contaminated groundwater met regulatory standards for volatile organic compounds.

Pilot-scale demonstrations were completed under the EPA's Superfund Innovative Treatment Evaluation Demonstration Program. The technology is fully commercial and is used by various industries as well as DOE for site cleanup activities. The units operate at waste flow rates ranging from 5 to 1,050 gallons per minute (EPA 1993).

D.5.10 PRESSURE WASHING AND HYDRAULIC JETTING

Pressure washing and hydraulic jetting decontamination techniques effectively remove surface contamination from solid materials. These techniques are applicable for decontamination of equipment and in the recovery of reusable or recyclable materials.

Pressure washing consists of a combination of pressurized water washing and chemical cleaning. During pressure washing, an alkaline solvent is used to remove the surface oxide, and an acidic solvent is used to dissolve any remaining residue. Liquid wastes produced from this process can be concentrated into a sludge waste form for further treatment.

The hydraulic jetting process uses a high-pressure hydrolaser to remove surface contaminants. An abrasive additive can be used to remove more persistent contaminants. This process produces a secondary liquid waste that requires further treatment by solidification.

SRS plans to demonstrate washing and jetting technologies for the treatment of low-level lead shielding. The decontaminated lead shielding can be released for reuse, while the process liquid wastes would be concentrated and solidified into a waste form that meets toxicity characteristic leaching procedure standards (Scientific Ecology Group, Inc. 1993).

D.5.11 SOIL-WASHING

Soil-washing consists of deagglomeration, density separation, particle-sizing, and water-rinsing of contaminated soils. Process water can be containerized, recirculated, and treated to remove suspended and dissolved contaminants. Soil washing technologies are being tested using bench-scale commercial equipment to provide equipment costs and operating estimates. Experiments are also being conducted to develop secondary soil treatment technologies that reduce contaminant levels below the levels already achievable with standard attrition, extraction, and leaching procedures.

The soil-washing process has been used to separate uranium from soil at the Fernald Environmental Management Project. The multi-phase soil-washing process begins with a soil and leachate mixture, which is fed into an attrition scrubber to solubilize the uranium from the soil. Next, the mixture flows into a mineral jig where fine uranium particles and contaminated solutions are separated from the soil. The contaminated materials overflow from the jig while the clean soils exit from the bottom. The bottom soils are then screened and washed to remove any uranium residuals. The overflow slurry is collected for appropriate disposal. The bench-scale unit can treat both solid and liquid wastes. Each waste form, however, must be fed into the attrition scrubber separately. Limitations of this technology include handling and disposal of

secondary wastes. A bench-scale soil-washing demonstration is being planned at SRS, and several demonstrations are being conducted by the EPA's Superfund Innovative Treatment Evaluation Demonstration Program (EPA 1993).

D.5.12 STeam REFORMING

Steam reforming consists of a waste evaporation system in which liquid or slurried low-level radioactive and mixed wastes are gasified by exposure to super-heated steam. The gasified organic materials are sent to an electrically heated detoxification reactor where they are converted to nontoxic vapors by thermal decomposition. The detoxified gases are then fed to adsorber beds to remove trace organics, metals, and halogens and are oxidized to carbon dioxide and water and vented to the atmosphere. Steam reforming is currently being tested for its applicability to mixed wastes and may prove to be a viable alternative to incineration. A current project includes demonstration tests corroborated by Sandia National Laboratories and Synthetica Technologies. The project focuses on destruction of organics, nitrate decomposition, and mercury processing and uses a commercial steam reforming unit. Commercial steam reforming has been shown to destroy most of the organic solvents and polymeric organics commonly found in mixed wastes.

A commercial steam reforming unit, the synthetic detoxifier, is currently being tested at SRS. The SRS system has produced destruction and removal efficiencies greater than 99.9 percent for simulated benzene wastes; however, carbon formations caused prohibitive pressure drops in the system. The current acceptable waste is limited to low-heating-value organics because of carbon limitations. Waste acceptance may also be limited to aqueous liquids and small, dry, heterogeneous solids (DOE 1993, 1994a, b).

D.6 Stabilization Technologies

Stabilization and solidification treatment methods are used to immobilize radionuclides and other hazardous inorganic compounds (such as heavy metals) using matrices (such as low sulfur cement or other grouting compounds, polyethylene and other thermoplastics, or bitumen). Stabilization and solidification can effectively immobilize wastes, and costs are lower than other methods, such as vitrification and plasma arc technologies. The primary disadvantage is that waste volumes are increased by the addition of the binding agent. Also, the final waste form is not as leach-resistant as glass or slag. Although cement can result in an effective stabilization matrix, a lack of effective process and quality controls can cause major problems (e.g., failure to cure properly). Both the Oak Ridge Reservation and the Rocky Flats Plant experienced incidents when mixtures of waste and cement failed to cure properly.

At SRS, liquid low-level radioactive waste is currently being stabilized in a grout matrix at the Saltstone Facility. Stabilization is also being considered at SRS for wastes (such as ash and blowdown) from the Consolidated Incineration Facility.

D.6.1 POLYETHYLENE ENCAPSULATION

High-level and low-level mixed wastes containing heavy metals and chloride salts that cannot be stabilized by incineration or vitrification may be incorporated into the polyethylene encapsulation system. Encapsulation technologies provide a physical matrix to stabilize wastes, and are generally not affected by chemical reactions with the waste. Polymeric encapsulation can be used to stabilize a variety of wastes, including incinerator ash, sludges, aqueous concentrates, dry solids, and ion exchange resins. The result is a final waste form that exhibits extremely low leachability characteristics. During polyethylene encapsulation, the pretreated waste, binder, and additives are precisely metered and volumetrically fed to a polyethylene single-screw extruder, which produces the final waste form. Optimization of the polymer matrix is achieved by adjusting density, molecular weight, and melt index. The process extrudes a molten, homogeneous mixture of waste and polyethylene binder into a suitable mold. A transient infrared spectrometer system is used to confirm waste loading.

The technology was successfully applied to the treatment of hazardous and mixed wastes, such as sodium nitrate salt and

sludges. Limitations include potential matrix effects by wastes containing excess water, potential biological reactions, potential hydrogen gas generation, and potential fire hazards in closed spaces. Recently, a full-scale demonstration was successfully completed at Brookhaven National Laboratory (DOE 1994b).

D.6.2 POZZOLANIC SOLIDIFICATION AND STABILIZATION

Pozzolanic solidification and stabilization is a technology used to treat soils, sludges, and liquid wastes that are contaminated with organics and metal-bearing wastes. The technology uses a proprietary reagent that chemically bonds with contaminants in the waste. The waste and reagent mixture is combined with a pozzolanic cement mixture to form a stable matrix. Prior to processing, the waste must be characterized for treatability to determine the type and quantities of reagents used in the process. The process begins with waste material sizing during which large debris is removed from the waste. The waste is mixed with the proprietary reagent in a high-shear mixer; then pozzolanic, cementitious materials are added. Limitations include potential setup problems with the waste and reagent mixtures. The technology has been commercially applied to treat wastes contaminated with organics and mixed wastes, and DOE's Brookhaven National Laboratory is continuing testing and demonstration of solidification technologies (EPA 1993).

D.6.3 VINYL ESTER STYRENE SOLIDIFICATION

Vinyl ester styrene solidification has been demonstrated commercially for the emulsification of ion exchange resins. The binder is pulled down through the resin packing bed with a vacuum, and the binder is allowed to solidify into a matrix that will pass toxicity characteristic leaching procedure testing. The emulsified waste forms have been accepted for burial at various sites, and DOE's Hanford Site has recently approved a vinyl ester waste form for inclusion on the Waste Form Acceptance List. DOE plans to demonstrate the viability of vinyl ester styrene solidification for low-level silver-coated packing material (Diversified Technologies 1993).

D.7 Thermal Treatment Technologies

Thermal treatment technologies use moderate or high temperatures to vaporize organics or high temperatures to convert organic waste constituents primarily to carbon dioxide and water vapor. Inorganic waste constituents (such as heavy metals and radionuclides) are concentrated into secondary wastes (such as ash, slag, glass, or blowdown) or captured in offgas treatment systems (such as high-efficiency particulate air filters or baghouses). Some volatile compounds are emitted through the stack. Removal efficiencies for metals are dependent on the chemical and thermodynamic properties of the element or compound. Mercury and cesium are considered volatile metals. Incineration technologies (such as rotary kilns and controlled air systems) have been used traditionally to destroy the organic portion of hazardous wastes, and incineration is the EPA-specified best demonstrated available technology for many hazardous organics (such as solvents and PCBs).

Alternatives to conventional incineration methods are being considered for treating wastes containing metals and radionuclides, including alpha-contaminated and transuranic wastes. Innovative technologies for these types of wastes include vitrification (which immobilizes inorganic contaminants in a glass matrix), plasma arc technology (which uses extremely high temperatures to produce a molten slag), and molten salt oxidation (which oxidizes organics into a molten salt solution). Vitrification and plasma arc technologies generally require secondary combustion chambers to destroy hazardous organics. These technologies have the advantage of producing final waste forms that are extremely leach-resistant, with very small environmental effects following final disposal. Disadvantages include high costs of startup and operation. In some cases, a combination of conventional and innovative technologies can be appropriate, such as vitrifying radionuclide-contaminated ash from a conventional incinerator.

DOE is supporting two full-scale vitrification projects at SRS: (1) the Defense Waste Processing Facility, a joule-heated melter which will be used to vitrify high level wastes, and (2) the M-Area Vendor Treatment Facility, which will be used to vitrify electroplating sludges contaminated with radionuclides. Research and development projects related to

vitrification are ongoing at SRS, universities (such as Clemson University), and other outside facilities. Plasma arc technology is being demonstrated at the Idaho National Engineering Laboratory, where soils and metals contaminated with transuranic radionuclides will be converted into a glassy slag. Studies related to molten salt oxidation are ongoing at Lawrence Livermore National Laboratory.

At SRS, thermal treatment technologies would be effective in reducing the volume of solid low-level radioactive waste, such as job-control waste, prior to final disposal. Alternative technologies (such as vitrification and plasma arc technology) would be effective in treating and stabilizing other waste forms (such as liquids and sludges and metal-bearing wastes).

D.7.1 FLAME ReaCTOR

The flame reactor is a patented, hydrocarbon-fueled, flash-smelting system that treats residues and wastes that contain metals. The reactor operates at temperatures exceeding 2,000 °C, at a capacity of 1 to 3 tons per hour. The wastes are processed with reducing gas that is produced by the combustion of solid or gaseous hydrocarbon fuels. Volatile metals are captured in a product dust collection system, while nonvolatile metals are separated as a molten alloy or encapsulated in the slag. Organic compounds are destroyed by thermal decomposition.

The unit has a high waste throughput; however, the wastes must be dry and fine enough that the reducing reaction can occur rapidly or efficiency of metal recovery is decreased. The flame reactor technology is applicable to specific waste forms, such as granular solids, soil, flue dusts, slag, and sludges containing heavy metals. The end products are a glass-like slag that passes the toxicity characterization leaching procedure criteria and a potentially recyclable heavy metal oxide. The technology is being developed under the EPA's Superfund Innovative Treatment Evaluation Demonstration Program (EPA 1992a, b, 1993).

D.7.2 THERMAL DESORPTION PROCESS

The thermal desorption process is a low-temperature thermal and physical separation process designed to separate organic contaminants from soils, sludges, and other media without decomposition. Contaminated solids are fed into an externally heated rotary dryer where temperatures range from 400 to 500 °C. A recirculatory inert carrier gas that is maintained at less than 4 percent oxygen to prevent combustion is used to transport volatilized contaminants from the dryer. Solids leaving the dryer are -sprayed with cooling water to help reduce dusting. The inert carrier gas is treated to remove and recover particulates, organic vapors, and water vapors. Organic vapors are condensed and treated separately; water is treated by carbon adsorption and used to cool and reduce dusting from treated solids or is discharged.

A full-scale system is being used to treat soils contaminated with PCBs. The system can treat up to 240 tons of soil per day and reduce it to a concentration of less than 2 parts per million. Two laboratoryscale systems are being used to treat hazardous and mixed wastes. A 7-ton-per-day soil treatment pilot-scale facility is also being used to treat different types of PCB contaminated soils under the EPA's Superfund Innovative Treatment Evaluation Demonstration Program.

The technology advantages include low temperature operation and treatment levels below 1 part per million. Disadvantages include concentrations of extremely hazardous organic compounds, generation of incomplete combustion products (such as dioxin), and the need to transport and/or treat recovered organic liquids (EPA 1993).

D.7.3 UNVENTED THERMAL PROCESS

The unvented thermal process is a high-temperature treatment process that destroys organic contaminants without releasing gaseous combustion products to the environment. The primary treatment unit is a fluidized-bed processor. The processor contains a bed of calcined limestone, which reacts with the offgases produced during the oxidation of organic constituents in the waste. Such gases include carbon dioxide, sulfur dioxide, and hydrogen dioxide. The resulting water

vapor is collected and removed through a condenser, and the remaining gases (mostly nitrogen) are mixed with oxygen and returned to the oxidizer. The spent resin from the fluidized bed can then be treated and stabilized.

This process does not release gas from the system and so could attain better public acceptance than conventional thermal treatment technologies. Remaining hazardous byproducts would be mixed with cement-making materials to form a solid cement.

The unvented system favors certain types of wastes, depending on the availability of oxygen and emission limits. Potential wastes include those containing chlorinated hydrocarbons, solid and liquid mixed wastes, and hospital wastes. Mixed waste treatment is suited to the unvented system because it prevents radionuclide emissions.

The unvented thermal process for treating mixed wastes is under development at Argonne National Laboratories. The laboratory-scale experiments have not been completed. Work remains on sorption kinetics and recyclability of the limestone bed as well as verification of total organic destruction. The unvented thermal process could be viable for future use (International Incineration Conference 1993; DOE 1993).

D.7.4 MOLTEN SALT OXIDATION AND DESTRUCTION PROCESS

The molten salt oxidation and destruction process is a two-stage process for treating hazardous and mixed wastes by destroying the organic constituent of the waste. The treatment method involves injection of the waste into a molten bed of salt (specifically, a mixture of sodium-, potassium-, and lithium-carbonates). This pyrolysis stage is designed to operate at between 700 and 950 °C depending on the type of salt and the ash content of the waste. Oxidation occurs in the molten-salt bed because of the injection of an oxidizing gas (such as air) into the waste and molten salt mixture. This oxidation stage can occur at greater than 700 °C, if necessary. Heteroatom constituents of the waste (such as sodium chloride) are retained in the melt. Radioactive actinides are also retained in the melt. The lower operating temperature of this process (compared to incineration at 1,000 to 1,200 °C) decreases actinide volatilization. At the end of a run, the molten salt is drained out of the reactor and dissolved in water. The oxides and stable salts of the actinides precipitate and are filtered out for disposal as low-level radioactive or hazardous waste.

Treatable wastes that are appropriate for this method include organic liquids containing chlorinated solvents and PCBs, combustible low-ash solids, organic sludges, explosives, chemical warfare agents, rubbers, and plastics. Process uncertainties that must be resolved include the effects of ash and stable salt buildup on melt stability and spent salt processing, retention of particulates in the molten salt bed, and the process's tolerance to variations in operating conditions.

Although this system is not commercially available, it does exist as a pilot-scale project at the Lawrence Livermore National Laboratory. A conceptual design report for a full-scale demonstration facility has been issued. Construction is expected to start in 1996 (Moghissi et al. 1993; DOE 1993).

D.7.5 QUANTUM-CATALYTIC EXTRACTION PROCESS

The quantum-catalytic extraction process is a proprietary technology that allows organic and inorganic wastes to be recycled into useful resources of commercial value. The process involves the destruction of hazardous components and controlled partitioning of radionuclides into a solid, nonleachable waste form. The technology consists of a molten metal bath that acts as a catalyst and a solvent that breaks the molecular bonds of the waste compounds. Upon introduction into the molten metal bath, the waste dissociates into its constituent elements and goes into metal solution. Once the constituent elements are dissolved, proprietary co-reactants are added to enable reformation and partitioning of desired products. The catalytic processing unit (the reactor that holds the molten metal bath) can handle most waste forms, including gases, pumpable liquids and slurries, fine solids, and bulk solids. The process is also equipped with an offgas system and allows injection of co-feeds (such as oxygen) to enhance oxidation of radioactive components.

Bench-scale experiments were conducted using surrogate radioactive materials to demonstrate the oxidation and

partitioning of the radionuclides between the metal and vitreous phases and to optimize operating conditions. Decontamination of the metal was greater than 99 percent, and detection of trace amounts of surrogate radionuclides was limited by the analytical detection limit. The quantum-catalytic extraction process is currently being bench-tested to demonstrate ion exchange resin processing capabilities.

Technology development and demonstration efforts are being conducted under a DOE Planned Research and Development Agreement. The scope of work includes theoretical design of quantum-catalytic extraction process systems, radionuclide partitioning, optimization of the vitreous phase for stabilization of radionuclides, testing of waste regulated by RCRA, and conceptual design and development for treatment and recycling of heavily contaminated scrap metal.

A demonstration facility is under development at DOE's Oak Ridge Reservation. The demonstration facility targets the disposal of mixed waste that is regulated under RCRA land disposal restrictions and the Federal Facilities Compliance Act (Herbst et al. 1994; DOE 1994b).

D.7.6 INFRARED THERMAL DESTRUCTION

Infrared thermal destruction uses electrically powered silicon carbide rods to heat organic wastes to combustion temperatures. Any remaining combustibles must be incinerated in an afterburner. The technology is suitable for treating soils and sediments with organic contaminants and liquid wastes after pre-mixing with sand or soil.

The process consists of three components: (1) an electric-powered infrared primary chamber, (2) a gasfired secondary combustion chamber, and (3) an emissions control system. Waste is fed to the primary chamber where it is heated to 1,000°C by exposure to infrared radiant heat. A blower delivers air to the chamber to control the oxidation rate of the waste feed. Ash material from the primary chamber is quenched and conveyed to a hopper for later sampling and subsequent disposal. Volatile gases from the primary chamber flow to the secondary chamber where they undergo further oxidation at higher temperatures and a longer residence time. Gases from the secondary chamber are sent through an emissions control system for particulate separation and neutralization.

The system is capable of high throughput, but at a cost of high-power consumption. Process uncertainties requiring resolution include emission control system inefficiencies and retention of lead in the incinerated ash. Demonstrations have shown that the process should be capable of meeting RCRA and Toxic Substances Control Act standards for particulate and air emissions and PCB remediation.

Two evaluations of the infrared thermal destruction system were conducted under EPA's Superfund Innovative Treatment Evaluation Demonstration Program. Organics, PCBs, and metals were the target waste compounds during the full-scale demonstration at the Peak Oil Site in Tampa, Florida, and a pilot-scale demonstration at the Rose Township Demolition Road Superfund Site in Michigan (EPA 1993).

D.7.7 PLASMA HEARTH PROCESS

Plasma technologies use a flowing gas between two electrodes to stabilize an electrical discharge, or arc. As an electric current flows through the plasma, energy is dissipated in the form of heat and light, resulting in joule heating of the process materials, forming a leach-resistant slag that can be modified by adding such materials as soil. The plasma hearth process relies on a stationary, refractory-lined primary chamber to produce and contain the high temperatures necessary for producing the slag.

The plasma hearth process begins when the waste, either solid or liquid, is fed into the primary plasma chamber where the heat from the plasma torch allows the organic compounds in the waste to be volatilized, oxidized, pyrolyzed, or decomposed. The remaining inorganic material is then fed to the secondary combustion chamber for high-temperature melting, producing a molten slag. Cooling and solidification of the slag provide a nonleachable high-integrity waste form. Offgas volumes are lower than those from conventional incineration units.

The plasma hearth process has undergone bench-scale testing by DOE at Argonne National Laboratories West and is currently undergoing demonstration-scale testing at Ukiah, California, to evaluate potential treatment of solid mixed wastes.

Advantages of plasma technologies include the ability to feed high amounts of metal-bearing wastes, including whole drums. The resulting slag requires no additional stabilization. The technology is extremely robust and can accept waste forms, including papers, plastics, metals, soils, liquids, and sludges. Based on these characteristics, very small characterization data are needed. In non-plasma vitrification technologies, combustion of the paper and plastics can produce soot and result in offgas problems (unless a primary burner is placed upstream of the vitrification unit).

A proof-of-principle demonstration has established the process's ability to treat a wide range of waste types in a single processing step that results in a final vitrified form. Ongoing projects for the plasma hearth process involve major hardware development and the determination of the level of characterization required of mixed waste prior to processing. The plasma hearth process is being developed at DOE's Idaho National Engineering Laboratory (International Incineration Conference 1994; DOE 1994b).

D.7.8 PLASMA ARC CENTRIFUGAL TREATMENT

The plasma arc centrifugal treatment furnace uses the plasma arc process with an internal rotating drum to treat hazardous, mixed, and transuranic wastes. In this process, the waste is fed into a molten bath (1,650 °C) created by a plasma arc torch. The feed material and molten slag are held in the primary chamber by centrifugal force. Within the plasma furnace, all water and organic waste material are volatilized. The organic material is also fully oxidized to carbon dioxide, water vapor, and acid gases, including sulfur dioxide and hydrochloric acid vapor.

Offgas is then treated by conventional treatment methods. Offgas streams pass through a wet filter to remove heat, humidity, and dust. Next, the offgas is treated in a caustic wet scrubber to remove sulfur oxides and halogen acids, a catalyst bed oxidizes nitric acid to nitrogen dioxide, and a catalytic wet scrubber removes nitrogen dioxide from the offgas. Finally, the cleansed gas stream passes through charcoal and high efficiency particulate air filters before being exhausted to the atmosphere. Nonvolatile waste material is fully oxidized and uniformly melted by the high-power electric arc and collected as molten slag which is then discharged as a nonleachable homogeneous glassy residue. The centrifugal action of the furnace keeps the slag toward the inner walls of the furnace until the rotation is slowed, which allows the slag to move toward the center. The slag then drains from the center of the furnace and is collected in a mold or a drum and allowed to cool and solidify.

This technology has been demonstrated to be applicable for the treatment of various waste types and forms, including hazardous, mixed, and transuranic wastes containing heavy metals and organic contaminants. Demonstration results showed a minimum destructive removal efficiency greater than 99.99 percent, organic and inorganic material concentrations that met toxicity concentration leaching procedure standards, and offgas treatment that exceeded regulatory standards.

A full-scale demonstration of this process is being planned for the Idaho National Engineering Laboratory to remediate soils and debris contaminated with transuranic radionuclides.

SRS has plans to demonstrate a small-scale arc melter vitrification system that would meet all regulatory low-level mixed waste disposal requirements. The system provided will be used to establish operating costs and offgas/secondary waste characteristics for further evaluation and analysis. The operating temperatures of the plasma arc system are expected to allow a variety of low-level mixed wastes to be vitrified in a way that minimizes secondary waste generation and allows regulatory approved disposal of the resulting glassy slag (Feizollahi and Shropshire 1994; International Incineration Conference 1993, 1994; DOE 1993; EPA 1993, 1992c).

D.7.9 GRAPHITE ELECTRODE DC ARC FURNACE

The graphite electrode DC arc furnace has been demonstrated to be a useful alternative in processing lowlevel radioactive and mixed wastes that contain a high-weight-fraction of metals. The graphite electrode DC arc delivers thermal energy, using an arc of ionized gas (plasma), that is developed between two electrodes attached to the material being processed. Temperatures in excess of 1,700 °C are generated by the process, which causes the soil and metal mixture to be stratified into a metal phase, a glass phase, and a gas phase. The final metal and glass waste forms are highly densified. The high temperatures in the vicinity of the DC arc also serve to destroy organics, which results in greatly reduced offgas production relative to combustion treatments. A bench-scale furnace was successfully demonstrated for the DOE's Pacific Northwest Laboratory using a variety of soil mixtures containing metals, combustibles, sludges, and high-vapor-pressure metals. A pilot-scale furnace has been constructed, which includes provisions for containing alpha-emitting radionuclides, continuous waste processing, and the capability to separate the glass phase from the metal phase. Process uncertainties that evolved from the bench-scale testing include graphite electrode consumption and offgas system operations (International Incineration Conference 1993; DOE 1993).

D.7.10 PACKED BED ReaCTOR/SILENT DISCHARGE PLASMA APPARATUS

The packed bed reactor/silent discharge plasma apparatus is a two-stage oxidation system for destroying hazardous liquid wastes. The system may also be applicable for the destruction of PCB contaminated mixed waste. The treatment method combines a thermal oxidation process in an excess air stream and a process to destroy the organic constituents from the reactor exhaust. The packed bed reactor provides thermal oxidation, and the silent discharge plasma unit provides the organic destruction. The plasma unit is operated at ambient temperature and pressure.

Most hazardous waste destruction occurs in the packed bed reactor by heat provided externally (that is, without an open flame). The reactor exhaust is treated in a cold plasma that is generated by electrical discharges in the silent discharge plasma unit. The contents of the plasma include hydroxide and phosphite radicals that react with the organics in the exhaust.

Uncertainties encountered during recent bench-scale tests include the proper packed bed reactor construction materials to resist corrosion and a silent discharge plasma dielectric that is capable of increased reactor exhaust flow.

Bench-scale tests have predicted a destruction removal efficiency greater than 99.9 percent for PCBs using this combined system for treating liquid waste. The production of hydroxide gas through the oxidation process could, however, cause severe corrosion problems if the current system is operated for an extended period of time. This could also produce a secondary waste containing corrosion byproducts contaminated with other potential waste constituents, such as tritium. Changes to the current system to help alleviate these problems are being studied at SRS's soil vapor extraction installation and Los Alamos National Laboratory (International Incineration Conference 1994).

D.7.11 ELECTRIC MELTER VITRIFICATION

Vitrification processes convert contaminated materials into oxide glasses. Suitable feed materials include frit, soils, sediments, and sludges. One vitrification process uses an electric melter to generate the heat needed to create molten glass; this is currently under development for pilot-scale tests. The melter is being evaluated on its ability to determine offgas composition, and to treat wastes using glass compositions that are tailored to the particular type of waste being treated.

In an electric melter, the glass can be kept molten through joule heating because the molten glass is an ionic conductor of relatively high electrical resistivity. As waste is fed into the vitrification unit from the top, the molten glass phase in the center of the unit heats the cold feed. Such a unit has a thick layer of cold feed product on top of the molten glass, which acts as a counter-flow scrubber that limits volatile emissions. This is an advantage over the exposed molten glass surfaces of fossil fuel melters.

The electric melter is expected to treat hazardous, mixed, and low-level radioactive wastes that have lower emissions of toxic offgases than conventional vitrification fossil fuel melters. The Defense Waste Processing Facility at SRS is a full-scale, joule-heated, vitrification unit that will immobilize high-level waste within a stable borosilicate glass matrix. An electric melter for vitrifying nonradioactive, hazardous wastes is being developed under the EPA's Superfund Innovative Treatment Evaluation Emerging Technology Program (EPA 1992d, 1993).

D.7.12 STIRRED MELTER VITRIFICATION

The Savannah River Technology Center has tested the application of a newly developed stirred tank melter for treatment and vitrification of mixed and low-level radioactive wastes (i.e., cesium-contaminated ion exchange resins). Two major problems in existing ion exchange resin melters led to the new technology development. First, the resins had a tendency to form a crust on the surface of the melt, allowing the cesium more opportunity to volatilize due to the increased time needed for the waste feed to be incorporated into the melt. Second, the organic resin caused significant reducing conditions in the melt which could increase the volatility of alkali metals (such as cesium) and affect glass quality.

The stirred melter could eliminate these problems. Because the melter is equipped with an impeller to agitate the melt, the crust formation could be reduced by continuous mixing and drawing of the surface into the melt. Increased oxygen exchange between the melt and the vapors above the surface of the melt could also reduce the negative effects of a reduced melt and could lower the amount of volatilized cesium and alkali metals.

Test results from a study conducted by Clemson University, in collaboration with DOE, show that vitrification of ion exchange resins, mixed, and low-level wastes in a stirred tank melter is operationally feasible (International Incineration Conference 1993, 1994; Moghissi and Benda 1991).

D.7.13 MODULAR VITRIFICATION

The modular vitrification technology is a vitrification process developed to stabilize mixed and low-level radioactive waste.

The system is composed of several stages to treat the various waste forms. First, aqueous wastes, sludges, and slurries enter an evaporator to eliminate excess water from the waste feed. Next the dried solids from the evaporator as well as other solids enter a two-section melter. The upper section, a gasification plenum, contains the solid waste, which feeds the lower section. In the lower cold-wall crucible, molten glass supplies heat to evaporate residual water from the waste and gasifies the organic constituents. The heat also melts the inorganic components, which dissolve into the glass matrix.

Next, vitrified waste is formed and allowed to cool into solidified glass marbles. The marble form is used because of its convenience in handling, sampling, and annealing. Molten liquid metals are also tapped from the crucible and formed into metal cubes. Offgases are treated using conventional methods. Additional testing is necessary to verify system design parameters and to ensure compliance with all air emissions and other regulatory requirements.

Applicable waste forms for the modular vitrification system include dry active wastes, ion exchange resins, inorganic sludges and slurries, and mixed wastes. Full-scale testing and commercial operation of the system by VECTRA Technologies and Batelle Memorial Institute are expected in 1995 (Mason, no date; EPA 1992d).

D.7.14 VORTEC PROCESS

The vortec process is an oxidation and vitrification process for the remediation of soils, sediments, and sludges that are contaminated with organics and heavy metals. In the first step of the process, the slurried waste stream is introduced into a

vertical vortex precombustor where water is vaporized, and the oxidation of organics is initiated. The waste stream is then fed to a counter-rotating vortex combustor, which provides suspension heating of the waste and secondary combustion of volatiles emitted from the precombustor. The preheated solid materials are delivered to a cyclone melter where they are separated to the chamber walls to form a vitrified waste product. The vitrified product and process exhaust gases are separated; after which, the exhaust gases are sent to process heat recovery and pollution control subsystems. The advantages of the vortec process include the ability to process waste contaminated with organics and heavy metals, recycle the pollution-control-system waste, and provide a vitrified product that passes toxicity characterization leaching procedure standards. A 20-ton-per-day, pilot-scale facility, located at an EPA-funded site, has operated successfully since 1988, producing a vitrified product that passes toxicity characterization leaching procedure standards. Transport systems are currently being designed for the treatment of DOE mixed wastes (EPA 1993).

D.7.15 IN SITU SOIL VITRIFICATION

In situ soil vitrification uses an electric current to melt and stabilize inorganic waste components while destroying organic waste components by pyrolysis. The process begins by inserting an array of electrodes into the ground. A starter path for electrical current is provided by placing flaked graphite and frit on the ground surface between the electrodes (because of the low initial conductivity of the soil). As power is applied, the melt travels downward into the soil at a slow rate. The final waste form consists of a vitrified monolith with positive strength and leachability characteristics. Offgases are captured in a hood that is maintained at a negative pressure. Offgas treatment consists of quenching, scrubbing, mist elimination, heating, particulate filtration, and activated carbon adsorption.

The in situ soil vitrification process has successfully destroyed organic pollutants by pyrolysis and incorporated inorganic pollutants within a glass-like vitrified mass. The process, however, is limited by the physical characteristics of the soil (including void volume size, soil chemistry, rubble content, and the amount of combustible organics in the soil). The process has been operated in pilot-scale and full-scale tests at DOE's Hanford Site, Oak Ridge National Laboratory, and Idaho National Engineering Laboratory (EPA 1993).

D.7.16 ReaCTIVE ADDITIVE STABILIZATION PROCESS

The reactive additive stabilization process uses a high-surface-area additive to enhance the vitrification of SRS nickel electroplating sludges and incinerator wastes.

The additive used in the reactive additive stabilization process is a reactive high-surface-area silica. This additive was found to increase bonding of the waste species by increasing the solubility and tolerance of borosilicate and soda-lime-silica glass formulations. The silica also lowers the glassification temperature and allows large waste volume reductions due to increased waste loadings. The final glass is in compliance with applicable EPA standards.

The reactive additive stabilization process increases the rates of dissolution and retention of hazardous, mixed, and heavy metal species in the vitrified product. Volatility concerns are reduced because the reactive additive stabilization process lowers the melting temperatures of the waste due to the addition of the highly reactive, high-surface-area silica additive. The process typically reduces the waste volume by 86 to 97 percent and thus maximizes cost savings.

The reactive additive stabilization process is an acceptable method for vitrifying radioactive materials, transuranic wastes, incinerator ash, waste sludges, and other solid and aqueous wastes. Laboratory-scale studies at SRS have demonstrated that the reactive additive stabilization process is a viable process for treating hazardous and mixed wastes by achieving large waste-loading percentages, large volume-reduction percentages, and large cost savings (Moghissi et al. 1993).

D.7.17 CYCLONIC FURNACE

The cyclonic furnace is designed to treat solid, liquid, soil slurry, or gaseous wastes by high-temperature combustion and

vitrification. The high turbulence in the combustion chamber helps ensure that temperatures are high enough (1,300 to 1,650°C) to melt high-ash-content feed material. Highly contaminated inorganic hazardous wastes and soils that contain heavy metals and organic constituents are the primary waste forms targeted by this technology. The processes can also be applied to mixed wastes containing lower-volatility radionuclides, such as strontium and transuranic elements.

The waste that enters the cyclonic furnace is melted, and the organics are destroyed in the resulting gas phase or in the molten slag layer that forms on the inner wall of the furnace barrel. Organics, heavy metals, and radionuclides are captured in the slag that exits the furnace from a tap at the cyclone throat. The slag then solidifies, rendering its hazardous constituents nonleachable.

This technology has been tested in pilot-scale demonstrations. Results showed that almost 95 percent of the noncombustible synthetic soil matrix is incorporated into the slag, and simulated radionuclides are immobilized. Current demonstrations are being performed under the EPA's Superfund Innovative Treatment Evaluation Demonstration Program (Roy 1992a, b; EPA 1993).

D.7.18 FLUIDIZED BED CYCLONIC AGGLOMERATING INCINERATOR

Fluidized bed technology uses a catalyst to facilitate complete destruction of hazardous species at low temperatures. The fluidized bed cyclonic agglomerating incinerator consists of a two-stage process in which solid, liquid, and gaseous organic wastes can be efficiently destroyed while solid, nonvolatile inorganic contaminants can be agglomerated into a pellet-sized, vitrified waste form. In the first stage, a fluidized bed reactor operates as a low-temperature desorption unit or a high-temperature agglomeration unit. Fuel, oxidant, and waste is fed to the fluidized bed reactor where the waste undergoes rapid gasification and combustion. Inorganic and metallic solids will be agglomerated into glassy pellets that will meet the requirements of the toxicity characteristic leaching procedure. Gases from the fluidized bed (which consist of products of both complete and incomplete combustion) are fed to the second stage of the process (which consists of a cyclonic combustor that will oxidize carbon monoxide and organics to carbon dioxide and water). Volatilized metals are collected in a downstream scrubber. This technology has undergone bench-scale demonstration. Toxicity characteristic leaching procedure test results, however, have been inconclusive to date. Design and construction of a pilot plant were completed, and testing is in progress.

The low operating temperatures of the fluidized bed process are not conducive to nitrogen oxide formation. Volatilization of radionuclides and heavy metals and acidic offgas can be treated in situ. Offgases can be treated with high efficiency particulate air filters. Fluidized bed technology is compatible with a wide range of wastes, including combustible and non-combustible solids, liquids, and sludges. From these wastes, the fluidized bed produces a secondary solid waste from catalyst attrition that requires further treatment. These solids are collected and solidified by other methods (e.g., polymer solidification, microwave solidification, or cementation) to produce a final waste form.

DOE and EPA are currently developing hybrid fluidization systems, such as the fluidized bed cyclonic agglomeration. Los Alamos National Laboratory is researching new techniques for monitoring radionuclides and heavy metals in the offgas stream. DOE is considering a project to demonstrate the feasibility of a fluidized bed unit to treat a radioactive solvent waste. The unit under consideration will include a patented combustion process that captures contaminants in-bed and prevents the formation of glass deposits as seen with conventional combustion techniques (EPA 1993).

D.7.19 CATALYTIC COMBUSTION IN A FLUIDIZED BED ReaCTOR

Catalytic combustion in a fluidized bed reactor is a low-temperature (525 to 600 °C) treatment for lowlevel mixed waste; it is currently in an active research and development stage. The anticipated waste for this process, however, is one primarily made of cellulosic matter, such as paper, latex, wood, and polyvinyl chlorides. Such wastes present processing problems because some compounds thermally degrade to yield toxic byproducts. For example, polyvinyl chloride degradation produces hydrochloric acid vapors, which can react to form chlorinated hydrocarbons. The addition of sorbants may, therefore, be required to implement in situ capture of chlorinated hydrocarbons.

Several advantages are offered by combining flameless fluidized bed combustion with catalytic afterburning, rather than by using high-temperature incineration. Two advantages are elimination of (1) the need for refractory lining in the reactor and (2) the emission of radioactive material from the fluidized bed. Radioactive material generally does not volatilize at temperatures below 800 °C.

Research at the Colorado School of Mines has been conducted to determine the catalysts that best contribute to the destruction of toxic (chemically hazardous) waste material. Tests have shown that catalysts containing chromia are the most successful in achieving high destruction and removal percentages. Research has also shown that this method could be a viable alternative method for volumetric reduction of low-level mixed waste. The studies have also shown that these methods may be applicable to transuranic wastes (Murray 1993; International Incineration Conference 1994).

D.7.20 MICROWAVE SOLIDIFICATION

Microwave solidification uses microwave energy to heat and melt homogeneous wet or dry solids into a vitrified final waste form that possesses high-density and leach-resistant attributes. The system includes an "in-drum" melting cavity that isolates the molten waste and the drum from the process equipment. Glass-forming frit is added to the waste contained in the drum, which is then exposed to high-energy microwaves to produce a vitrified final waste form that is suitable for land disposal. Advantages of microwave processing over conventional thermal treatment include an elimination of the need for heating elements or electrodes in direct contact with the waste, potential to reduce volatile radionuclide emissions, and a significant volume reduction.

The process is energy efficient and controllable because of direct coupling between the microwave energy and the waste. The results of bench-scale experiments at DOE's Rocky Flats Plant are encouraging and support the potential use of microwave technology in the production of vitrified waste forms. Further work is being done to optimize critical process parameters, including waste loading and borax concentration in the glass-forming frit (International Incineration Conference 1994; DOE 1994b).

D.7.21 MIXED WASTE TReatMENT PROCESS

The mixed waste treatment process treats contaminated soils by separating the hazardous and radioactive contaminants into organic and inorganic phases. This process is an integration of individually demonstrated technologies, including thermal desorption, gravity separation, water treatment, and chelant extraction. The initial treatment step involves sizing the incoming waste, after which volatile organics are removed by indirectly heating the waste in a rotating chamber. The volatilized organics and water are separately condensed, and the volatile organics are decanted for further treatment and disposal. The waste is rehydrated and inorganic constituents are removed by gravity separation, chemical precipitation, and chelant extraction. Gravity separation is used to separate higher density particles, a potassium ferrite formulation is added to precipitate radionuclides, and the insoluble radionuclides are removed through chelant extraction. The chelant solution then passes through an ion exchange resin to remove the radionuclides and is recycled to the process. The contaminants from all waste processes are collected as concentrates for recovery or disposal.

This technology has been developed for processing soil contaminated with organics, inorganics, and radioactive material. Bench-scale and pilot-scale testing for individual components of the treatment process is ongoing under EPA's Superfund Innovative Treatment Evaluation Emerging Technology Program using DOE, U.S. Department of Defense, and commercial wastes. Thermal separation has been shown to remove and recover PCBs, gravity separation of radionuclides has been successfully demonstrated, and chelant extraction has long treated surface contamination in the nuclear industry (EPA 1993).

Table D-3. Summary of emerging technologies.

Technology type	Technology	Development status ^a	Waste type ^b	Waste form
Biological	Bioscrubber	Bench	Off-gas/Organics	Liquid and Gas
Biological	Biosorption	Pilot	HLW/Mixed	Supernatant/Saltcake
Biological	White Rot Fungus	Bench	Carbon-Based	Solid and Liquid
Chemical	Aqueous Phase Catalytic Exchange	Bench	Tritiated Water	Liquid
Chemical	Biological/Chemical Treatment	Pilot	Heavy Metal	Solid
Chemical	Dechlorinization	Bench	Mixed/PCB	Solid and Soil
Chemical	Gas-Phase Chemical Reduction	Full	PCBs, Dioxins	Liquid and Sludge
Chemical	Nitrate to Ammonia and Ceramic Process	Bench	Mixed	Aqueous
Chemical	Resorcinol-Formaldehyde Ion Exchange Resin	Bench	HLW	Supernatant
Chemical	Supercritical Water Oxidation	Bench	Mixed	Solid and Liquid
Chemical	Wet Air Oxidation	Bench	LLW/Mixed	Solid and Liquid
Chemical	Wet Chemical Oxidation (Acid Digestion)	Bench	Mixed	Solid and Liquid
Chemical	Evaporation and Catalytic Oxidation	Full	VOC/PCB/Mixed	Solid and Sludge
Chemical	Biocatalytic Destruction	Bench	LLW/Mixed	Aqueous
Chemical	Electrochemical Oxidation	Pilot	Mixed	Solid and Liquid
Chemical	Mediated Electrochemical Oxidation	Pilot	Mixed	Solid and Oils
Physical	Acoustic Barrier Particulate Separator	Pilot	Off-Gas	Particulate
Physical	Chemical Binding/Precipitation/Physical Separation	Pilot	LLW/Mixed	Water/Sludge/Soil
Physical	Chemical Treatment and Ultrafiltration	Pilot	Heavy Metal	Liquid
Physical	Heavy Metals and Radionuclide Polishing Filter	Bench	LLW/Heavy Metal	Liquid
Physical	Membrane Microfiltration	Pilot	Heavy Metal	Solid and Liquid
Physical	Electrodialysis	Full	Metals	Liquid
Physical	Freeze Crystallization	Pilot	Mixed	Liquid
Physical	High-Energy Electron Irradiation	Full	Organics	Liquid and Sludge
Physical	Ultraviolet Oxidation	Full	Organics	Liquid
Physical	Pressure Washing and Hydraulic Jetting	Full	LLW	Solid
Physical	Soil Washing	Bench	LLW	Solid and Soil
Physical	Steam Reforming	Full	Mixed	Solid/Liquid/Sludge
Stabilization	Polyethylene Encapsulation	Full	Mixed	Solid and Sludge
Stabilization	Pozzolanic Solidification and Stabilization	Full	LLW/Mixed	Solid and Sludge
Stabilization	Vinyl Ester Styrene Solidification	Full	LLW/Mixed	Solid
Thermal	Flame Reactor	Full	Organics/Metals	Solid/Sludge/Soil

Thermal	Thermal Desorption Process	Full	LLW/Mixed	Liquid
Thermal	Unvented Thermal Process	Bench	Mixed	Solid and Liquid
Thermal	Molten Salt Oxidation and Destruction Process	Pilot	Mixed	Solid and Liquid
Thermal	Quantum-Catalytic Extraction Process	Bench	Mixed/Metals	Solid/Liquid/Gas
Thermal	Infrared Thermal Destruction	Full	Organic/Metal	Solid/Liquid
Thermal	Plasma Hearth Process	Bench	LLW/TRU/Mixed	Solid and Liquid
Thermal	Plasma Arc Centrifugal Treatment	Pilot	Mixed	Solid/Liquid/Gas

Table D-3. (continued).

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Technology type	Technology	Development status ^a	Waste type ^b	Waste form
Thermal	Graphite Electrode DC Arc Furnace	Pilot	LLW/TRU/Mixed	Solid
Thermal	Packed Bed Reactor/Silent Discharge Plasma Apparatus	Bench	PCB/Mixed	Liquid
Thermal	Electric Melter Vitrification	Bench	HLW/LLW/Mixed	Solid and Sludge
Thermal	Stirred Melter Vitrification	Bench	LLW/Mixed	Solid and Sludge
Thermal	Modular Vitrification	Pilot	LLW/Mixed	Solid and Sludge
Thermal	Vortec Process	Pilot	Mixed	Solid and Liquid
Thermal	In Situ Soil Vitrification	Full	TRU/Mixed	Buried and Soil
Thermal	Reactive Additive Stabilization Process	Bench	Mixed/LLW/TRU	Solid and Liquid
Thermal	Cyclonic Furnace	Pilot	Mixed	Solid/Liquid/Gas
Thermal	Fluidized Bed Cyclonic Agglomerating Incinerator	Pilot	Mixed	Solid/Liquid/Gas
Thermal	Catalytic Combustion in a Fluidized Bed Reactor	Bench	Mixed	Solid and Liquid
Thermal	Microwave Solidification	Pilot	Mixed	Wet and Dry Solids
Various	Mixed Waste Treatment Process	Pilot	Mixed	Soil

a. Bench - Technology is being proven on a bench-scale level.

Pilot - Technology has been proven on a bench-scale level and is being tested and evaluated on a pilot-scale level.

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Full - Technology is being demonstrated for full-scale commercial or government application.

b. HLW = High-level radioactive waste.

LLW = Low-level radioactive waste.

PCB = Polychlorinated biphenyls.

TRU = Transuranic.

VOC = Volatile organic compounds.

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c. DC = Direct current.

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Appendix E

SECTION 1

WATER RESOURCES

Table E.1-1. 1993 analytical data for National Pollutant Discharge Elimination System Outfall M₁004 (M-Area Liquid Effluent Treatment Facility)-Permit SC#0000175.a,b

Parameter	Units ^c	Permit limits ^d	DMR ^e results	
			Minimum ^f	Maximum ^f
pH	Standard unit	6.0-10.0 ^g	6.8	7.8
Nitrate (as N)	mg/L	RR ^h	51.1	1,700
Phosphate	mg/L	RR	0.238	17.3
Suspended solids	mg/L	31/60 ⁱ	1	14
Oil and Grease	mg/L	RR	<1	11.9
Uranium	mg/L	RR	<0.02	0.128
Lead	mg/L	0.43/0.69 ⁱ	<0.0012	0.0225
Nickel	mg/L	1.23/2.46 ⁱ	<0.012	<0.3
Silver	mg/L	0.009/0.018 ⁱ	<0.0005	<0.0025
Chromium	mg/L	0.62/1.24 ⁱ	<0.02	<0.1
Aluminum	mg/L	3.2/6.43 ⁱ	<0.05	1.3
Copper	mg/L	0.21/0.42 ⁱ	<0.004	0.03
Zinc	mg/L	0.32/0.64 ⁱ	<0.01	0.085
Cyanide	mg/L	0.62/1.24 ⁱ	<0.005	<0.005
Cadmium	mg/L	0.05/0.1 ⁱ	<0.01	<0.05
Gross Alpha Radioactivity	pCi/L	----- j	0.306 ^k	4.99 ^k
Nonvolatile (dissolved) Beta Radioactivity	pCi/L	----- j	0.408 ^k	5.33 ^k
Tritium	pCi/L	----- j	303 ^k	1,560 ^k

a. Source: Arnett (1994).

b. Parameters are those DOE routinely measures as a regulatory requirement or as a part of ongoing monitoring programs.

c. mg/L = milligrams per liter; a measure of concentration equivalent to the weight/volume ratio.

pCi/L = picocuries per liter; a unit of radioactivity; one trillionth of a curie.

d. Limits imposed by SCDHEC NPDES Permit SC#0000175.

e. 1993 results reported to SCDHEC on the monthly Discharge Monitoring Report (DMR).

f. The minimum concentration was the minimum concentration found in samples analyzed in 1993. The maximum concentration is the highest single result found during the 1993 sampling events.

g. First number is the minimum acceptable pH while the second number is the maximum acceptable pH.

h. RR = measure and report.

i. First number represents the daily average limit while the second number represents the daily maximum limit.

j. Radioactive limits are not included on the NPDES Permit.

k. Collected near the mouth of Tim's Branch, downstream of M-Area.

Table E.1-2. 1993 analytical data for National Pollutant Discharge Elimination System Outfall H₂O16 (F/H-Area Effluent Treatment Facility)-Permit SC#0000175.a,b

Parameters	units ^c	Permit limits ^d	DMR ^e results	
			Minimum ^f	Maximum ^f
pH	Standard units	6.0-9.0 ^g	6.4	9.0
Temperature	°C	32.2	14	30
BOD5	mg/L	20/40 ^{h,i}	<1	5
Nitrate (as N)	mg/L	RR ^j	1.78	66
Ammonia as Nitrogen	mg/L	20/RR	<0.01	0.15
Suspended Solids	mg/L	30/60 ⁱ	<1	2
Oil and Grease	mg/L	10/15 ⁱ	<1	10.1
Uranium	mg/L	RR	<0.02	<0.1
Lead	mg/L	0.29/0.58 ⁱ	<0.0005	0.0094
Nickel	mg/L	RR	<0.03	<0.05
Mercury	mg/L	0.045/0.175 ⁱ	<0.0001	<0.0005
Chromium	mg/L	1.71/2.77 ⁱ	<0.02	<0.03
Aluminum	mg/L	RR	<0.05	0.053
Copper	mg/L	1.45/2.07 ⁱ	<0.01	0.013
Zinc	mg/L	1.48/2.61 ⁱ	<0.01	0.414
Manganese	mg/L	RR	<0.005	0.0343
Total Chlorine	mg/L	RR	<0.01	0.37
Gross Alpha Radioactivity	pCi/L	----- ^k	0.53 ^h	3.90 ^h

Nonvolatile (dissolved) Beta Radioactivity	pCi/L	----- k	0.497 ^h	3.94 ^h
Tritium	pCi/L	----- k	607 ^h	13,200 ^h
Strontium-89,90	pCi/L	----- k	<DL ⁱ	0.783 ^h
Uranium/Plutonium	pCi/L	----- k	<DL	0.298 ^h

a. Source: Arnett (1994).

b. Parameters are those DOE routinely measures as a regulatory requirement or as a part of ongoing monitoring programs.

c. mg/L= milligrams per liter; a measure of concentration equivalent to the weight/volume ratio.

pCi/L= picocuries per liter; a unit of radioactivity; one trillionth of a curie.

d. Limits imposed by the SCDHEC NPDES Permit SC#0000175.

e. 1993 results reported to SCDHEC on the monthly Discharge Monitoring Report (DMR).

f. The minimum concentration is the minimum concentration found in samples analyzed in 1993. The maximum concentration is the highest single result found during the 1993 sampling events.

g First number is the minimum acceptable pH while the second number is the maximum acceptable pH.

h. Collected downstream of Outfall H-016 on Upper Three Runs near Road C.

i. First number represents the monthly average limit while the second number represents the daily maximum limit.

j. RR = measure and report.

k. Radioactive limits are not included on the NPDES Permit.

l. <DL = analytical result less than the test procedure detection limit.

Table E.1-3. Water quality in Beaver Creek Dam on SRS (calendar year 1992).a,b

Parameter	Unit of measure ^c	MCL _{d,e} or DCG ^f	Minimum ^g	Maximum ^g
Aluminum	mg/L	0.05-0.2 ^h	3.59	4.14
Ammonia	mg/L	NA ^{i,j}	0.048	0.40
Cadmium	mg/L	0.005 ^d	<0.00004	0.0025
Calcium	mg/L	NA	2.68	4.41
Cesium-137	pCi/L	120		
Chloride	mg/L	250 ^h	2.4	8.6
Chromium	mg/L	0.1 ^d	<0.0004	0.0668
Copper	mg/L	1.3 ^k	<0.0004	0.014

Dissolved oxygen	mg/L	>5.0 ⁱ	5.8	10.0
Fecal coliform	Colonies per 100 ml	1,000 ⁱ	3	22
Gross alpha radioactivity	pCi/L	15 ^d	<DL	1.15
Iron	mg/L	0.3 ^h	0.567	3.81
Lead	mg/L	0.015 ^k	<0.0004	0.015
Magnesium	mg/L	NA	1.02	1.82
Manganese	mg/L	0.05 ^h	<0.0004	0.412
Nickel	mg/L	0.1 ^{d,e}	<0.0004	0.015
Nonvolatile (dissolved) beta radioactivity	pCi/L	50 ^d	0.5	5.8
pH	pH units	6.5-8.5 ^h	6.2	7.6
Phosphate	mg/L	NA	<0.01	1.5
Sodium	mg/L	NA	3.83	10.6
Sulfate	mg/L	250 ^h	3.98	13.1
Suspended solids	mg/L	NA	1.0	31.8
Temperature	°C	32.2 ^m	14.5	34
Tritium	pCi/L	20,000 ^{d,e}	0.05	228
Zinc	mg/L	5 ^h	<0.0004	0.017

a. Sources: Wike et al. (1994); Cummins, Martin, and Todd (1991).

b. Parameters are those DOE routinely measures as a regulatory requirement or as part of ongoing monitoring programs.

c. mg/L = milligrams per liter; a measure of concentration equivalent to the weight/volume ratio.

pCi/L = picocuries per liter; a picocurie is a unit of radioactivity; one trillionth of a curie.

d. Maximum Contaminant Level (MCL), EPA National Primary Drinking Water Standards (40 CFR Part 141). See glossary.

e. Maximum Contaminant Level, SCDHEC (1976). See glossary.

f. DOE Derived Concentration Guides (DCGs) for water (DOE Order 5400.5). DCG values are based on committed effective doses of 4 millirem per year for consistency with drinking water MCL of 4 millirem per year. See glossary.

g. Minimum concentrations of samples taken at the downstream monitoring station. The maximum listed concentration is the highest single result found during one sampling event. Less than (<) indicates concentration below analysis detection limit (DL).

h. Secondary Maximum Contaminant Level (SMCL), EPA National Secondary Drinking Water Regulations (40 CFR Part 143).

i. NA = none applicable.

j. Depends on pH and temperature.

k. Action level for lead and copper.

l. WQS = water quality standard. See glossary.

m. Shall not exceed weekly average of 32.2°C (90°F) after mixing nor rise more than 2.8°C (5°F) in 1 week unless appropriate temperature criterion mixing zone has been established.

Table E.1-4. Water quality in Fourmile Branch on SRS (calendar year 1993).a,b

Parameter	Unit of measurec	MCL ^{d,e} or DCG ^f	Minimumg	Maximumg
Aluminum	mg/L	0.05-0.2 ^h	0.08	0.34
Ammonia	mg/L	NA ^{i,j}	ND ^k	0.04
Cadmium	mg/L	0.005 ^d	ND	ND
Calcium	mg/L	NA	2.24	3.35
Cesium-137	pCi/L	120	8.44	19.4
Chemical oxygen demand	mg/L	NA	ND	ND
Chloride	mg/L	250 ^h	2	5
Chromium	mg/L	0.1 ^d	ND	ND
Copper	mg/L	1.3 ^l	ND	ND
Dissolved oxygen	mg/L	>5.0 ^m	6.4	11.3
Fecal coliform	Colonies per 100 ml	1,000 ^m	23	440
Gross alpha radioactivity	pCi/L	15 ^d	0.073	2.68
Iron	mg/L	0.3 ^h	0.364	1.14
Lead	mg/L	0.015 ^l	ND	0.003
Magnesium	mg/L	NA	0.565	0.636
Manganese	mg/L	0.05 ^h	0.079	0.104
Mercury	mg/L	0.002 ^{d,e}	ND	ND
Nickel	mg/L	0.1 ^d	ND	ND
Nitrite/Nitrate (as nitrogen)	mg/L	10 ^d	1.42	2.85
Nonvolatile (dissolved) beta radioactivity	pCi/L	50 ^d	20.5	43.5
pH	pH units	6.5-8.5 ^h	5.7	7.7
Phosphate	mg/L	NA	ND	ND
Sodium	mg/L	NA	6.29	10.6
Strontium-89/90	pCi/L	-	10.3	15.3
Sulfate	mg/L	250 ^h	4	9
Suspended solids	mg/L	NA	2	9

Temperature	°C	32.2 ⁿ	10	25.5
Total dissolved solids	mg/L	500 ^h	40	78
Tritium	pCi/L	20,000 ^{d,e}	33,600	68,900
Zinc	mg/L	5 ^h	ND	0.011

a. Source: Arnett (1994).

b. Parameters are those DOE routinely measures as a regulatory requirement or as part of ongoing monitoring programs.

c. mg/L = milligrams per liter; a measure of concentration equivalent to the weight/volume ratio.

pCi/L = picocuries per liter; a picocurie is a unit of radioactivity; one trillionth of a curie.

d. Maximum Contaminant Level (MCL), EPA National Primary Drinking Water Standards (40 CFR Part 141).
See glossary.

e. Maximum Contaminant Level, SCDHEC (1976). See glossary.

f. DOE Derived Concentration Guides (DCGs) for water (DOE Order 5400.5). DCG values are based on committed effective doses of 4 millirem per year for consistency with drinking water MCL of 4 millirem per year. See glossary.

g. Minimum concentrations of samples taken at the downstream monitoring station. The maximum listed concentration is the highest single result found during one sampling event.

h. Secondary Maximum Contaminant Level (SMCL), EPA National Secondary Drinking Water Regulations (40 CFR Part 143).

i. NA = none applicable.

j. Depends on pH and temperature.

k. ND = none detected.

l. Action level for lead and copper.

m. WQS = water quality standard. See glossary.

n. Shall not exceed weekly average of 32.2°C (90°F) after mixing nor rise more than 2.8°C (5°F) in 1 week unless appropriate temperature criterion mixing zone has been established.

Table E.1-5. Water quality in Pen Branch on SRS (calendar year 1993).a,b

Parameter	Unit of measure ^c	MCL ^{d,e} or DCG ^f	Minimum ^g	Maximum ^g
Aluminum	mg/L	0.05-0.2 ^h	0.096	0.398
Ammonia	mg/L	NA ^{i,j}	ND ^k	0.09
Cadmium	mg/L	0.005 ^d	ND	ND
Calcium	mg/L	NA	0.976	5.03
Chemical oxygen demand	mg/L	NA	ND	ND
Chloride	mg/L	250 ^h	3	10
Chromium	mg/L	0.1 ^d	ND	ND
Copper	mg/L	1.3 ^l	0.041	0.098
Dissolved oxygen	mg/L	>5.0 ^m	6.3	10.6
Fecal coliform	Colonies per 100 ml	1,000 ^m	18	320
Gross alpha radioactivity	pCi/L	15 ^d	<DL ⁿ	1.27
Iron	mg/L	0.3 ^h	0.361	0.705
Lead	mg/L	0.015 ^l	ND	0.002
Magnesium	mg/L	NA	0.71	1.08
Manganese	mg/L	0.05 ^h	0.038	0.096
Mercury	mg/L	0.002 ^{d,e}	ND	ND
Nickel	mg/L	0.1 ^d	ND	ND
Nitrite/Nitrate (as nitrogen)	mg/L	10 ^d	0.15	0.26
Nonvolatile (dissolved) beta radioactivity	pCi/L	50 ^d	0.368	2.86
pH	pH units	6.5-8.5 ^h	5.9	7.8
Phosphate	mg/L	NA	ND	0.04
Sodium	mg/L	NA	3.49	9.35
Strontium-89/90	pCi/L	-	<DL	0.49
Sulfate	mg/L	250 ^h	4	7
Suspended solids	mg/L	NA	2	12
Temperature	°C	32.2 ^o	10.3	26.5
Total dissolved solids	mg/L	500 ^h	42	79
Tritium	pCi/L	20,000 ^{d,e}	17,200	65,000
Zinc	mg/L	5 ^h	ND	0.012

a. Source: Arnett (1994).

b. Parameters are those DOE routinely measures as a regulatory requirement or as part of ongoing monitoring programs.

c. mg/L = milligrams per liter; a measure of concentration equivalent to the weight/volume ratio.

pCi/L = picocuries per liter; a picocurie is a unit of radioactivity; one trillionth of a curie.

d. Maximum Contaminant Level (MCL), EPA National Primary Drinking Water Standards (40 CFR Part 141).

See glossary.

e. Maximum Contaminant Level, SCDHEC (1976). See glossary.

f. DOE Derived Concentration Guides (DCGs) for water (DOE Order 5400.5). DCG values are based on committed effective doses of 4 millirem per year for consistency with drinking water MCL of 4 millirem per year. See glossary.

g. Minimum concentrations of samples taken at the downstream monitoring station. The maximum listed concentration is the highest single result found during one sampling event.

h. Secondary Maximum Contaminant Level (SMCL), EPA National Secondary Drinking Water Regulations (40 CFR Part 143).

i. NA = none applicable.

j. Depends on pH and temperature.

k. ND = none detected.

l. Action level for lead and copper.

m. WQS = water quality standard. See glossary.

n. Less than (<) indicates concentration below analysis detection limit (DL).

o. Shall not exceed weekly average of 32.2°C (90°F) after mixing nor rise more than 2.8°C (5°F) in 1 week unless appropriate temperature criterion mixing zone has been established.

Table E.1-6. Water quality in Steel Creek on SRS (calendar year 1993).a,b

Parameter	Unit of measure	MCL ^{d,e} or DCG ^f	Minimum ^g	Maximum ^g
Aluminum	mg/L	0.05-0.2 ^h	ND ⁱ	0.138
Ammonia	mg/L	NA ^{j,k}	ND	0.05
Cadmium	mg/L	0.005 ^d	ND	ND
Calcium	mg/L	NA	1.92	2.28
Cesium-137	pCi/L	120	3.75	3.75
Chemical oxygen demand	mg/L	NA	ND	ND
Chloride	mg/L	250 ^h	4	9
Chromium	mg/L	0.1 ^d	ND	ND
Copper	mg/L	1.3 ^l	ND	ND
Dissolved oxygen	mg/L	>5.0 ^m	6.4	11.4
Fecal coliform	Colonies per 100 ml	1,000 ^m	2	142
Gross alpha radioactivity	pCi/L	15 ^d	<DL ⁿ	1.22

Iron	mg/L	0.3 ^h	0.053	0.224
Lead	mg/L	0.015 ^l	ND	0.004
Magnesium	mg/L	NA	0.947	1.16
Manganese	mg/L	0.05 ^k	ND	0.024
Mercury	mg/L	0.002 ^{d,e}	ND	ND
Nickel	mg/L	0.1 ^d	ND	ND
Nitrite/Nitrate (as nitrogen)	mg/L	10 ^d	ND	0.17
Nonvolatile (dissolved) beta radioactivity	pCi/L	50 ^d	0.688	2.79
pH	pH units	6.5-8.5 ^h	5.9	7.9
Phosphate	mg/L	NA	ND	ND
Sodium	mg/L	NA	5.44	8.53
Strontium-90	pCi/L	8 ^f	<DL	0.818
Sulfate	mg/L	250 ^h	4	6
Suspended solids	mg/L	NA	ND	5
Temperature	°C	32.2°	10.2	29.6
Total dissolved solids	mg/L	500 ^h	39	67
Tritium	pCi/L	20,000 ^{d,e}	4,130	6,200
Zinc	mg/L	5 ^h	ND	0.014

a. Source: Arnett (1994).

b. Parameters are those DOE routinely measures as a regulatory requirement or as part of ongoing monitoring programs.

c. mg/L = milligrams per liter; a measure of concentration equivalent to the weight/volume ratio.

pCi/L = picocuries per liter; a picocuries is a unit of radioactivity; one trillionth of a curie.

d. Maximum Contaminant Level (MCL), EPA National Primary Drinking Water Standards (40 CFR Part 141).

See glossary.

e. Maximum Contaminant Level, SCDHEC (1976). See glossary.

f. DOE Derived Concentration Guides (DCGs) for water (DOE Order 5400.5). DCG values are based on committed effective doses of 4 millirem per year for consistency with drinking water MCL of 4 millirem per year. See glossary.

g. Minimum concentrations of samples taken at the downstream monitoring station. The maximum listed concentration is the highest single result found during one sampling event.

h. Secondary Maximum Contaminant Level (SMCL), EPA National Secondary Drinking Water Regulations (40 CFR Part 143).

i. ND = none detected.

j. NA = none applicable.

k. Depends on pH and temperature.

l. Action level for lead and copper.

m. WQS = water quality standard. See glossary.

n. Less than (<) indicates concentration below analysis detection limit (DL).

o. Shall not exceed weekly average of 32.2°C (90°F) after mixing nor rise more than 2.8°C (5°F) in 1 week unless appropriate temperature criterion mixing zone has been established.

Table E.1-7. Water quality in Lower Three Runs on SRS (calendar year 1993).a,b

Parameter	Unit of measure ^c	MCL ^{d,e} or DCG ^f	Minimum ^g	Maximum ^g
Aluminum	mg/L	0.05-0.2 ^h	ND ⁱ	0.092
Ammonia	mg/L	NA ^{j,k}	ND	0.06
Cadmium	mg/L	0.005 ^d	ND	ND
Calcium	mg/L	NA	5.63	12.8
Chemical oxygen demand	mg/L	NA	ND	ND
Chloride	mg/L	250 ^h	3	5
Chromium	mg/L	0.1 ^d	ND	ND
Copper	mg/L	1.3 ^l	ND	ND
Dissolved oxygen	mg/L	>5.0 ^m	6.7	10.2
Fecal coliform	pCi/L	1,000 ^m	72	12,200
Gross alpha radioactivity	mg/L	15 ^d	<DL ⁿ	0.69
Iron	mg/L	0.3 ^h	0.138	0.275
Lead	mg/L	0.015 ^l	ND	0.002
Magnesium	mg/L	NA	0.553	0.79
Manganese	mg/L	0.05 ^h	ND	0.024
Mercury	mg/L	0.002 ^{d,e}	ND	ND
Nickel	mg/L	0.1 ^d	ND	ND
Nitrite/Nitrate (as nitrogen)	mg/L	10 ^d	ND	0.18
Nonvolatile (dissolved) beta radioactivity	pCi/L	50 ^d	1.16	3.43
pH	pH units	6.5-8.5 ^h	5.9	7.5
Phosphate	mg/L	NA	ND	ND
Sodium	mg/L	NA	1.97	2.98
Strontium-90	pCi/L	8 ^f	<DL	0.048
Sulfate	mg/L	250 ^h	2	4
Suspended solids	mg/L	NA	ND	10

Temperature	°C	32.2 ^o	10.3	26.0
Total dissolved solids	mg/L	500 ^h	33	69
Tritium	pCi/L	20,000 ^{d,e}	131	907
Zinc	mg/L	5 ^h	ND	0.031

a. Source: Arnett (1994).

b. Parameters are those DOE routinely measures as a regulatory requirement or as part of ongoing monitoring programs.

c. mg/L = milligrams per liter; a measure of concentration equivalent to the weight/volume ratio.

pCi/L = picocuries per liter; a picocurie is a unit of radioactivity; one trillionth of a curie.

d. Maximum Contaminant Level (MCL), EPA National Primary Drinking Water Standards (40 CFR Part 141).
See glossary.

e. Maximum Contaminant Level, SCDHEC (1976). See glossary.

f. DOE Derived Concentration Guides (DCGs) for water (DOE 5400.5). DCG values are based on committed effective doses of 4 millirem per year for consistency with drinking water MCL of 4 millirem per year. See glossary.

g. Minimum concentrations of samples taken at the downstream monitoring station. The maximum listed concentration is the highest single result found during one sampling event.

h. Secondary Maximum Contaminant Level (SMCL), EPA National Secondary Drinking Water Regulations (40 CFR Part 143).

i. ND = none detected.

j. NA = none applicable.

k. Depends on pH and temperature.

l. Action level for lead and copper.

m. WQS = water quality standard. See glossary.

n. Less than (<) indicates concentration below analysis detection limit (DL).

o. Shall not exceed weekly average of 32.2°C (90°F) after mixing nor rise more than 2.8°C (5°F) in 1 week unless appropriate temperature criterion mixing zone has been established.

SECTION 2

AIR QUALITY

Table E.2-1. Results of SRS modeling for toxic air pollutants (micrograms per cubic meter of air).a,b

Pollutant	Maximum allowable concentration (µg/m ³)	Concentration at SRS boundary (µg/m ³)	Percent of standard ^c
Low Toxicity Category			
Acetonitrile	1,750.00	0.00018	0.00
Ammonium Chloride	250.00	0.02379	0.01
Antimony	2.50	0.00112	0.04
Chlorine	75.00	7.63023	10.17
Cyanide	125.00	0.00000	0.00
Ethanolamine	200.00	0.00101	0.00
Formic Acid	225.00	2.41990	1.08
Furfural	200.00	0.00180	0.00
Hydrochloric Acid (Hydrogen Chloride)	175.00	1.05622	0.60
Hydrogen Cyanide	250.00	0.12935	0.05
Methyl Ethyl Ketone (2-Butone)	14,750.00	5.12159	0.03
Methyl Methacrylate	10,250.00	0.00002	0.00
Methylene Chloride	8,750.00	10.46781	0.12
Methyl Tert-Butyl Ether	(d)	0.49390	NA ^e
Naphthalene	1,250.00	0.00452	0.00
Nitric Acid	125.00	50.95952	40.77
Phosphoric Acid	25.00	0.46236	1.85
Styrene	5,325.00	0.00079	0.00
Trichloroethylene	6,750.00	6.43130	0.10
Moderate Toxicity Category			
Acetaldehyde	1,800.00	0.00180	0.00
Acrylamide	0.30	0.00180	0.60
Aldicarb	6.00	0.00737	0.12
Cresol	220.00	0.00180	0.00
Cumene	9.00	0.00110	0.01
p-Dichlorobenzene	4,500.00	0.00180	0.00
Diethanolamine	129.00	0.00364	0.00

Diethyl Phthalate	50.00	0.02569	0.05
Ethyl Benzene	4,350.00	0.58773	0.01
Ethyl Chloride	26,400.00	0.00007	0.00
Ethylene Dibromide	770.00	0.00180	0.00
Furfuryl Alcohol	400.00	0.00037	0.00
1,6-Diisocyanatehexamethylene	0.34	0.00110	0.32
Hydrogen Sulfide	140.00	0.20149	0.14
Hydroquinone	20.00	0.00010	0.00
Isophorone	250.00	0.00154	0.00
Maleic Anhydride	10.00	0.00180	0.02

Table E.2-1. (continued).

Pollutant	Maximum allowable concentration ($\mu\text{g}/\text{m}^3$)	Concentration at SRS boundary ($\mu\text{g}/\text{m}^3$)	Percent of standard ^c
Methyl Isobutyl Ketone	2,050.00	2.96016	0.14
Oxalic Acid	10.00	0.00026	0.00
Pentachlorophenol	5.00	0.00180	0.04
Phenol	190.00	0.02745	0.01
Phosgene (Carbonyl Chloride)	4.00	0.00180	0.05
Phosphorus (Yellow or White)	0.50	0.00013	0.03
Sodium Hydroxide	20.00	0.00940	0.05
Sulfuric Acid	10.00	0.00951	0.10
Tetrachloroethylene	3,350.00	2.00935	0.06
Xylene	4,350.00	39.36740	0.90
m-Xylene	4,350.00	0.00180	0.00
o-Xylene	4,350.00	0.00181	0.00
p-Xylene	4,350.00	0.00180	0.00
High Toxicity Category			
Acetophenone	(d)	0.00180	NA
Acrolein	1.25	0.01585	1.27
Acrylic Acid	147.50	0.00182	0.00
Acrylonitrile	22.50	0.01646	0.07
Aniline	50.00	0.00180	0.00
Arsenic	1.00	0.00191	0.19

Benzene	150.00	31.71134	21.14
Benzidine	(d)	0.00180	NA
Benzotrachloride	300.00	0.00180	0.00
Benzyl Chloride	25.00	0.00180	0.01
Beryllium	0.01	0.00000	0.00
Biphenyl	6.00	0.00138	0.02
Bis (chloromethyl) Ether	0.03	0.00180	6.00
Bromoform	25.85	0.00475	0.02
Cadmium Oxide	0.25	0.02136	8.54
Cadmium	0.25	0.00028	0.11
Carbon Disulfide	150.00	0.00208	0.00
Carbon Tetrachloride	150.00	0.00209	0.00
Catechol	297.00	0.00009	0.00
Chlordane	2.50	0.00181	0.07
Chlorobenzene	1,725.00	0.00209	0.00
Chloroform	250.00	4.95658	1.98
Chloromethyl Methyl Ether	(d)	0.00180	NA
Cobalt	0.25	0.20628	82.51
2,4-Dichlorophenoxy Acetic Acid	50.00	0.00180	0.00

Table E.2-1. (continued).

Pollutant	Maximum allowable concentration (µg/m3)	Concentration at SRS boundary (µg/m3)	Percent of standard ^c
Dibutyl Phthalate	25.00	0.13246	0.53
3,3-Dichlorobenzidine	0.15	0.00180	1.20
1,3-Dichloropropene	7.00	0.00208	0.03
Diethyl Phthalate	25.00	0.00000	0.00
3,3-Dimethoxybenzidine	0.30	0.00180	0.60
3,3-Dimethylbenzidine	(d)	0.00180	NA
Dimethylformamide	149.50	0.00024	0.00
Dimethyl Phthalate	25.00	0.00180	0.01
Dimethyl Sulfate	2.50	0.00180	0.07
2,4-Dinitrophenol	(d)	0.00180	NA
2,4-Dinitrotoluene	1.50	0.00180	0.12

Dioxane	450.00	0.00184	0.00
1,2-Diphenyl Hydrazine	(d)	0.00180	NA
Epichlorohydrin	50.00	0.00180	0.00
1,2-Butylene Oxide	(d)	0.00877	NA
Ethylene Dichloride	200.00	0.00183	0.00
Ethylene Glycol	650.00	0.19536	0.03
Ethylene Oxide	10.00	0.00180	0.02
Ethylene Thiourea	(d)	0.00180	NA
Ethylenimine	5.00	0.01802	0.36
1,1-Dichloroethane	2,025.00	0.00116	0.00
Formaldehyde	7.50	0.00269	0.04
Glycol Ethers	(d)	0.00031	NA
Heptachlor	2.50	0.00737	0.29
Hexachlorobenzene	(d)	0.00180	NA
Hexachlorobutadiene	1.20	0.00180	0.15
Hexachlorocyclopentadiene	0.50	0.00180	0.36
Hexachloroethane	48.50	0.00180	0.00
Hexachloronapthalene	1.00	0.00000	0.00
Hexane	200.00	0.20551	0.10
Hydrazine	0.50	0.00180	0.36
Lindane	2.50	0.00180	0.07
Manganese Oxide	25.00	0.00066	0.00
Manganese	25.00	0.82129	3.29
Mercury	0.25	0.01393	5.57
Methyl Alcohol	1,310.00	2.87804	0.22
Methoxychlor	50.00	0.00180	0.00
Methyl Bromide	100.00	0.00158	0.00
Methyl Chloride	515.00	0.00200	0.00

Table E.2-1. (continued).

Pollutant	Maximum allowable concentration ($\mu\text{g}/\text{m}^3$)	Concentration at SRS boundary ($\mu\text{g}/\text{m}^3$)	Percent of standard ^c
1,1,1-Trichloroethane	9,550.00	80.83216	0.85
Methyl Hydrazine	1.75	0.00180	0.10

Methyl Iodide	58.00	0.00180	0.00
Curene	1.10	0.00180	0.16
Nickel Oxide	5.00	0.00183	0.04
Nickel	0.50	0.27106	54.21
Nitrobenzene	25.00	0.00314	0.01
p-Nitrophenol	0.00	0.00180	NA
2-Nitropropane	182.00	0.00180	0.00
Parathion	0.50	0.00737	1.47
Pentachloronitrobenzene	(d)	0.00180	NA
Phthalic Anhydride	30.30	0.00180	0.01
Polycyclic Organic Matter	160.00	0.00000	0.00
Propylene Dichloride	1,750.00	0.00079	0.00
Selenium	1.00	0.00000	0.00
Tetrachlorinated Dibenzo-p-Dioxins	0.00	0.00000	NA
1,1,2,2-Tetrachloroethane	35.00	0.00208	0.01
Toluene	200.00	9.27688	0.46
Toxaphene	2.50	0.00737	0.29
1,1,2-Trichloroethane	273.00	0.01646	0.01
2,4,6-Trichlorophenol	(d)	0.00180	NA
Triethylamine	207.00	0.00010	0.00
Vinyl Acetate	176.00	0.05518	0.03
Vinyl Chloride	50.00	0.00183	0.00
1,1-Dichloroethylene	99.00	0.00180	0.00

a. Source: WSRC (1993).

b. Concentrations are based on maximum potential emissions.

c. Percent of standard = $\frac{\text{Concentration at SRS boundary}}{\text{Maximum allowable concentration}} \times 100$

d. No standard established by regulatory agency.

e. NA - not applicable.

Table E.2-2. Comparison of potential worker annual exposure to OSHA permissible exposure limits under alternative A (micrograms per cubic meter of air).a

		Expected forecast receptor locations		Minimum forecast receptor locations		Maximum forecast receptor locations	
Pollutant	OSHA PEL ^b	100 meters ^c	640 meters	100 meters	640 meters	100 meters	640 meters
M-Area Vendor							
Nitrogen dioxide	9,000	37.45	43.70	37.45	43.70	37.45	43.70
Sulfur dioxide	1.3×10 ⁴	1.65	1.92	1.65	1.92	1.65	1.92
PM10 ^d	5,000	1.97	2.30	1.97	2.30	1.97	2.30
Bld waste hazardous waste storage)							
Total suspended particulates	1.5×10 ⁴	25.13	10.56	13.10	5.51	41.28	17.36
PM10	5,000	8.79	3.70	4.49	1.89	14.54	6.11
Bldg. 645-2N (mixed waste mixed waste storage)							
Total suspended particulates	1.5×10 ⁴	6.60	2.78	1.78	0.75	32.84	13.81
PM10	5,000	2.32	0.97	0.62	0.26	11.50	4.84
Soil sort facilities							
Total suspended particulates	1.5×10 ⁴	11.00	4.63	0.31	0.13	54.74	23.02
PM10	5,000	3.84	1.61	0.11	0.05	1.92	0.81
(Four) new solvent tanks							
Vinyl chloride	2,600	5.08	3.95	3.78	2.94	4.29	3.34
1,1 Dichloroethane	N/A ^e	0.38	0.30	0.29	0.22	0.33	0.25
Methyl ethyl Ketone	5.9×10 ⁵	22.00	17.11	16.39	12.75	18.61	14.48
Chloroform	9,780	2.36	1.84	1.76	1.37	2.00	1.56
Carbon tetrachloride	1.26×10 ⁴	0.19	0.15	0.14	0.11	0.16	0.13
Benzene	3,250	3.08	2.40	2.29	1.78	2.61	2.03
1,2 Dichloroethane	N/A	0.13	0.10	0.09	0.07	0.11	0.08
Trichloroethane	2.7×10 ⁵	0.12	0.09	0.09	0.07	0.10	0.08
Tetrachloroethylene	1.7×10 ⁵	0.03	0.02	0.02	0.02	0.02	0.02
Chlorobenzene	3.5×10 ⁵	0.02	0.01	0.01	0.01	0.01	0.01
Transuranic waste characterization/certification facility							
Vinyl chloride	2,600	0.02	0.01	0.01	0.01	0.39	0.34
1,1 Dichloroethane	N/A	0.001	9.8×10 ⁻⁴	8.1×10 ⁻⁴	7.0×10 ⁻⁴	0.30	0.25

Methyl ethyl ketone	5.9×10 ⁵	0.07	0.06	0.05	0.04	1.70	1.46
Chloroform	9,780	0.01	0.01	0.01	0.00	0.18	0.16
Carbon tetrachloride	1.26×10 ⁴	5.6×10 ⁻⁴	4.8×10 ⁻⁴	4.0×10 ⁻⁴	3.5×10 ⁻⁴	0.015	0.013
Benzene	3,250	0.009	0.008	0.007	0.006	0.237	0.204
1,2 Dichloroethane	N/A	3.8×10 ⁻⁴	3.2×10 ⁻⁴	2.7×10 ⁻⁴	2.3×10 ⁻⁴	0.010	0.008
Trichloroethane	2.7×10 ⁵	3.6×10 ⁻⁴	3.1×10 ⁻⁴	2.5×10 ⁻⁴	2.2×10 ⁻⁴	0.009	0.008
Tetrachloroethylene	1.7×10 ⁵	7.9×10 ⁻⁵	6.8×10 ⁻⁵	5.6×10 ⁻⁵	4.8×10 ⁻⁵	0.002	0.002
Chlorobenzene	3.5×10 ⁵	5.0×10 ⁻⁵	4.3×10 ⁻⁵	3.5×10 ⁻⁵	3.0×10 ⁻⁵	0.001	0.001
Containment building							
Total suspended particulates	1.5×10 ⁴	4.34	2.64	2.28	1.38	15.41	9.36
PM10	5,000	4.34	2.64	2.28	1.38	15.41	9.36

Table E.2-2. (continued).

Pollutant	OSHA PEL ^b	Expected forecast receptor locations		Minimum forecast receptor locations		Maximum forecast receptor locations	
		100 meters ^c	640 meters	100 meters	640 meters	100 meters	640 meters
Vinyl chloride	2,600	0.24	0.15	0.13	0.08	1.08	0.66
1,1 Dichloroethane	N/A	0.02	0.01	0.01	0.01	0.08	0.05
Methyl ethyl ketone	5.9×10 ⁵	26.40	16.04	25.46	15.47	32.38	19.68
Chloroform	9,780	0.11	0.07	0.06	0.04	0.50	0.31
Carbon tetrachloride	1.26×10 ⁴	0.01	0.01	0.005	0.003	0.04	0.02
Benzene	3,250	0.15	0.08	0.06	0.04	0.66	0.40
1,2 Dichloroethane	N/A	0.006	0.004	0.003	0.002	0.03	0.02
Trichloroethane	2.7×10 ⁵	0.006	0.004	0.003	0.002	0.03	0.02
Tetrachloroethylene	1.7×10 ⁵	0.001	7.4×10 ⁻⁴	5.4×10 ⁻⁴	3.3×10 ⁻⁴	0.006	0.003
Chlorobenzene	3.5×10 ⁵	7.6×10 ⁻⁴	4.6×10 ⁻⁴	3.4×10 ⁻⁴	2.1×10 ⁻⁴	0.004	0.002

a. Source: NIOSH (1990).

b. OSHA PEL - Occupational Safety and Health Administration Permissible Exposure Limits.

c. To convert to feet multiply by 3.281.

d. Particulate matter less than 10 microns in diameter.

e. Not Applicable - No OSHA PEL assigned - Exposure should be kept as low as possible.

Table E.2-3. Comparison of potential worker exposure to OSHA permissible exposure limits under alternative C (micrograms per cubic meter of air).a

		Expected forecast receptor locations		Minimum forecast receptor locations		Maximum forecast receptor locations	
Facility/Pollutant	OSHA PEL ^b	100 meters ^c	640 meters	100 meters	640 meters	100 meters	640 meters
M-Area Vendor							
Nitrogen dioxide	9,000	37.45	43.70	37.45	43.70	37.30	43.52
Sulfur dioxide	1.3×104	1.65	1.92	1.65	1.92	1.65	1.92
PM10d	5,000	1.97	2.30	1.97	2.30	1.97	2.30
Bldg. 645-2N (mixed waste mixed waste storage)							
Total suspended particulates	15,000	6.60	2.78	1.78	0.75	32.84	13.81
PM10	5,000	2.32	0.97	0.62	0.26	11.50	4.84
Soil sort facilities							
Total suspended particulates	15,000	15.63	6.57	4.34	1.83	75.38	31.69
PM10	5,000	5.47	2.30	1.52	0.64	26.38	11.09
(Four) new solvent tanks							
Vinyl chloride	2,600	3.99	3.10	3.92	3.05	4.17	3.24
1,1 Dichloroethane	N/Ae	0.30	0.23	0.30	0.23	0.32	0.25
Methyl ethyl ketone	5.9×105	17.28	13.44	17.00	13.22	18.06	14.04
Chloroform	9,780	1.86	1.44	1.82	1.42	1.94	1.51
Carbon tetrachloride	1.26×104	0.15	0.12	0.15	0.11	0.16	0.12
Benzene	3,250	2.42	1.88	2.38	1.85	2.53	1.97
1,2 Dichloroethane	N/A	0.10	0.08	0.10	0.08	0.10	0.08
Trichloroethane	2.7×105	0.09	0.07	0.09	0.07	0.10	0.08
Tetrachloroethylene	1.7×105	0.02	0.02	0.02	0.02	0.02	0.02
Chlorobenzene	3.5×105	0.01	0.01	0.01	0.01	0.01	0.01

Transuranic waste characterization/ certification facility							
Vinyl chloride	2,600	0.015	0.013	0.011	0.009	0.389	0.335
1,1 Dichloroethane	N/A	0.001	0.001	0.001	0.001	0.029	0.025
Methyl ethyl ketone	5.9×10 ⁵	0.065	0.056	0.046	0.040	1.687	1.450
Chloroform	9,780	0.007	0.006	0.005	0.004	0.181	0.155
Carbon tetrachloride	1.26×10 ⁴	5.6×10 ⁻⁴	4.8×10 ⁻⁴	4.0×10 ⁻⁴	3.4×10 ⁻⁴	0.015	0.013
Benzene	3,250	0.009	0.008	0.006	0.006	0.236	0.203
1,2 Dichloroethane	N/A	3.7×10 ⁻⁴	3.2×10 ⁻⁴	2.7×10 ⁻⁴	2.3×10 ⁻⁴	0.010	0.008
Trichloroethane	2.7×10 ⁵	3.5×10 ⁻⁴	3.0×10 ⁻⁴	2.5×10 ⁻⁴	2.2×10 ⁻⁴	0.009	0.008
Tetrachloroethylene	1.7×10 ⁵	7.9×10 ⁻⁵	6.8×10 ⁻⁵	5.6×10 ⁻⁵	4.8×10 ⁻⁵	0.002	0.002
Chlorobenzene	3.5×10 ⁵	4.9×10 ⁻⁵	4.2×10 ⁻⁵	3.5×10 ⁻⁵	3.0×10 ⁻⁵	0.001	0.001
Containment building							
Vinyl chloride	2,600	0.059	0.036	0.028	0.017	0.219	0.133
1,1 Dichloroethane	N/A	0.004	0.003	0.002	0.001	0.017	0.010
Methyl ethyl ketone	5.9×10 ⁵	24.91	15.13	24.65	14.98	26.21	15.92
Chloroform	9,780	0.028	0.017	0.013	0.008	0.102	0.062
Carbon tetrachloride	1.26×10 ⁴	0.002	0.001	0.001	6.5×10 ⁻⁴	0.008	0.005
Benzene	3,250	0.036	0.022	0.017	0.010	0.133	0.081
1,2 Dichloroethane	N/A	0.001	9.0×10 ⁻⁴	7.1×10 ⁻⁴	4.3×10 ⁻⁴	0.005	0.003
Trichloroethane	2.7×10 ⁵	0.004	0.002	0.002	9.2×10 ⁻⁴	0.011	0.007
Tetrachloroethylene	1.7×10 ⁵	8.1×10 ⁻⁴	4.9×10 ⁻⁴	3.4×10 ⁻⁴	2.1×10 ⁻⁴	0.002	0.001
Chlorobenzene	3.5×10 ⁵	5.1×10 ⁻⁴	3.1×10 ⁻⁴	2.1×10 ⁻⁴	1.3×10 ⁻⁴	0.002	9.3×10 ⁻⁴

Table E.2-3. (continued).

		Expected forecast receptor locations		Minimum forecast receptor locations		Maximum forecast receptor locations	
Facility/Pollutant	OSHA PEL ^b	100 meters ^c	640 meters	100 meters	640 meters	100 meters	640 meters
Non-alpha vitrification							
Total suspended particulates	1.5×10 ⁴	1.5×10 ⁻⁹	0.215	4.4×10 ⁻¹⁰	0.065	7.2×10 ⁻⁹	1.056
PM10	5,000	1.5×10 ⁻⁹	0.215	4.4×10 ⁻¹⁰	0.065	7.2×10 ⁻⁹	1.056

Nitrogen oxides	9,000	3.2×10^{-9}	0.478	9.7×10^{-10}	0.143	1.6×10^{-8}	2.344
Sulfur dioxide	1.3×10^4	2.0×10^{-11}	0.003	6.1×10^{-12}	9.0×10^{-4}	1.0×10^{-10}	0.015
Carbon monoxide	4.0×10^4	2.9×10^{-12}	4.3×10^{-4}	8.7×10^{-13}	1.3×10^{-4}	1.4×10^{-11}	0.002
Lead	100	3.0×10^{-12}	4.4×10^{-4}	8.9×10^{-13}	1.3×10^{-4}	1.5×10^{-11}	0.002
Acetaldehyde	1.8×10^5	5.9×10^{-13}	8.7×10^{-5}	3.0×10^{-13}	4.5×10^{-5}	1.3×10^{-12}	1.9×10^{-4}
Acrylamide	30	5.9×10^{-13}	8.7×10^{-5}	3.0×10^{-13}	4.5×10^{-5}	1.3×10^{-12}	1.9×10^{-4}
Acrylonitrile	4,420	5.9×10^{-13}	8.7×10^{-5}	3.0×10^{-13}	4.5×10^{-5}	1.3×10^{-12}	1.9×10^{-4}
Arsenic pentoxide	10	2.9×10^{-12}	4.3×10^{-4}	1.5×10^{-12}	2.2×10^{-4}	6.5×10^{-12}	9.6×10^{-4}
Asbestos	0.2 fibers/m ³	6.6×10^{-14}	9.8×10^{-6}	1.6×10^{-14}	2.3×10^{-6}	1.8×10^{-13}	2.6×10^{-5}
Benzene	3,250	7.1×10^{-11}	0.010	3.6×10^{-11}	0.005	1.6×10^{-10}	0.023
Benzidine	N/A	5.9×10^{-13}	8.7×10^{-5}	3.0×10^{-13}	4.5×10^{-5}	1.3×10^{-12}	1.9×10^{-4}
Bis(chloromethyl)ether	N/A	5.9×10^{-13}	8.7×10^{-5}	3.0×10^{-13}	4.5×10^{-5}	1.3×10^{-12}	1.9×10^{-4}
Bromoform	5,000	5.9×10^{-13}	8.7×10^{-5}	3.0×10^{-13}	4.5×10^{-5}	1.3×10^{-12}	1.9×10^{-4}
Carbon tetrachloride	1.2×10^4	5.9×10^{-13}	8.7×10^{-5}	3.0×10^{-13}	4.5×10^{-5}	1.3×10^{-12}	1.9×10^{-4}
Chlordane	500f	5.9×10^{-13}	8.7×10^{-5}	3.0×10^{-13}	4.5×10^{-5}	1.3×10^{-12}	1.9×10^{-4}
Chloroform	9,780	5.9×10^{-13}	8.7×10^{-5}	3.0×10^{-13}	4.5×10^{-5}	1.3×10^{-12}	1.9×10^{-4}
Cr(+6) Compounds	50f	2.0×10^{-14}	2.9×10^{-6}	1.0×10^{-14}	1.5×10^{-6}	4.4×10^{-14}	6.5×10^{-6}
Formaldehyde	1,224	5.9×10^{-13}	8.7×10^{-5}	3.0×10^{-13}	4.5×10^{-5}	1.3×10^{-12}	1.9×10^{-4}
Heptachlor	500	1.5×10^{-12}	2.2×10^{-4}	7.6×10^{-13}	1.1×10^{-4}	2.2×10^{-12}	4.8×10^{-4}
Hexachlorobenzene	N/A	5.9×10^{-13}	8.7×10^{-5}	3.0×10^{-13}	4.5×10^{-5}	1.3×10^{-12}	1.9×10^{-4}
Hexachlorobutadiene	210f	5.9×10^{-13}	8.7×10^{-5}	3.0×10^{-13}	4.5×10^{-5}	1.3×10^{-12}	1.9×10^{-4}
Hydrazine	100	5.9×10^{-13}	8.7×10^{-5}	3.0×10^{-13}	4.5×10^{-5}	1.3×10^{-12}	1.9×10^{-4}
Nickel oxide	1,000	3.3×10^{-11}	0.005	7.9×10^{-12}	0.001	8.9×10^{-11}	0.013
1,1,2,2-Tetrachloroethane	7,000	1.2×10^{-11}	0.002	6.1×10^{-12}	8.9×10^{-4}	2.6×10^{-11}	0.004
1,1,2-Trichloroethane	4.5×10^4	5.9×10^{-13}	8.7×10^{-5}	3.0×10^{-13}	4.5×10^{-5}	1.3×10^{-12}	1.9×10^{-4}
Toxaphene	500	1.5×10^{-12}	2.2×10^{-4}	7.6×10^{-13}	1.1×10^{-4}	3.2×10^{-12}	4.8×10^{-4}
Alpha vitrification							
Total suspended particulates	1.5×10^4	8.2×10^{-10}	0.12	4.9×10^{-10}	0.07	2.1×10^{-8}	3.06
PM10	5,000	8.2×10^{-10}	0.12	4.9×10^{-10}	0.07	2.1×10^{-8}	3.06
Nitrogen oxides	9,000	1.8×10^{-9}	0.27	1.1×10^{-9}	0.16	4.6×10^{-8}	6.78
Sulfur dioxide	1.3×10^4	1.1×10^{-11}	0.002	6.8×10^{-12}	0.001	2.9×10^{-11}	0.004
Carbon monoxide	4.0×10^4	1.6×10^{-12}	2.4×10^{-4}	9.7×10^{-13}	1.44×10^{-4}	4.1×10^{-11}	0.01
Lead	100	1.7×10^{-12}	2.45×10^{-4}	1.0×10^{-12}	1.47×10^{-4}	4.2×10^{-11}	0.01
Asbestos	0.2 fibers/m ³	6.6×10^{-15}	9.8×10^{-7}	4.0×10^{-15}	5.9×10^{-7}	1.7×10^{-13}	2.5×10^{-5}
Nickel oxide	1,000	3.3×10^{-12}	4.9×10^{-4}	2.0×10^{-12}	2.93×10^{-4}	8.4×10^{-10}	0.01

a. Source: NIOSH (1990).

b. OSHA PEL - Occupational Safety and Health Administration permissible exposure limits.

c. To convert to feet multiply by 3.281.

d. Particulate matter less than 10 microns in diameter.

e. N/A = not applicable. No OSHA PEL assigned. Exposure should be kept as low as possible.

f. Threshold limit value, time-weighted average (ACGIH 1993).

Table E.2-4. Comparison of potential worker exposure to OSHA permissible exposure limits under alternative B (micrograms per cubic meter of air).

		Expected forecast receptor locations			Minimum forecast receptor locations			Maximum forecast receptor locations	
Pollutant	OSHA PEL ^b	100 meters ^c	640 meters		100 meters	640 meters		100 meters	640 meters
M-Area Vendor									
Nitrogen dioxide	9,000	37.45	43.70		37.45	43.70		37.30	43.52
Sulfur dioxide	1.3×10 ⁻⁴	1.65	1.92		1.65	1.92		1.65	1.92
PM10 ^d	5,000	1.97	2.30		1.97	2.30		1.97	2.30
Bldg. 645-N (hazardous waste storage)									
Total suspended particulates	1.5×10 ⁴	25.13	10.56		13.10	5.51		41.28	17.36
PM10	5,000	8.79	3.70		4.49	1.89		14.54	6.11
Bldg. 645-2N (mixed waste mixed waste storage)									
Total suspended particulates	15,000	6.60	2.78		1.78	0.75		32.84	13.81
PM10	5,000	2.32	0.97		0.62	0.26		11.50	4.84
Soil sort facilities									
Total suspended particulates	15,000	10.79	4.54		3.39	1.43		64.79	27.24
PM10	5,000	3.77	1.58		1.19	0.50		22.61	9.51
(Four) new solvent tanks									
Vinyl chloride	2,600	4.71	3.66		4.28	3.33		4.25	3.31
1,1 Dichloroethane	N/A ^e	0.36	0.28		0.32	0.25		0.32	0.25
Methyl ethyl ketone	5.9×10 ⁵	20.39	15.86		18.56	14.43		18.39	14.30
Chloroform	9,780	2.19	1.70		1.99	1.55		1.98	1.54
Carbon tetrachloride	1.26×10 ⁴	0.18	0.14		0.16	0.12		0.16	0.12
Benzene	3,250	2.86	2.22		2.60	2.02		2.58	2.00
1,2 Dichloroethane	N/A	0.12	0.09		0.11	0.08		0.11	0.08

Trichloroethane	2.7×10 ⁵	0.11	0.09		0.10	0.08		0.10	0.08
Tetrachloroethylene	1.7×10 ⁵	0.02	0.02		0.02	0.02		0.02	0.02
Chlorobenzene	3.5×10 ⁵	0.02	0.01		0.01	0.01		0.01	0.01
Transuranic waste characterization/ certification facility									
Vinyl chloride	2,600	0.02	0.01		0.01	0.009		0.39	0.33
1,1 Dichloroethane	N/A	0.001	9.7×10 ⁻⁴		8.0×10 ⁻⁴	6.9×10 ⁻⁴		0.29	0.25
Methyl ethyl Ketone	5.9×10 ⁵	0.07	0.06		0.05	0.04		1.69	1.45
Chloroform	9,780	0.007	0.006		0.005	0.004		0.18	0.16
Carbon tetrachloride	1.26×10 ⁴	5.6×10 ⁻⁴	4.8×10 ⁻⁴		3.9×10 ⁻⁴	3.4×10 ⁻⁴		0.01	0.01
Benzene	3,250	0.009	0.008		0.006	0.006		0.24	0.20
1,2 Dichloroethane	N/A	3.7×10 ⁻⁴	3.2×10 ⁻⁴		2.7×10 ⁻⁴	2.3×10 ⁻⁴		0.010	0.008
Trichloroethane	2.7×10 ⁵	3.5×10 ⁻⁴	3.1×10 ⁻⁴		2.5×10 ⁻⁴	2.2×10 ⁻⁴		0.009	0.008
Tetrachloroethylene	1.7×10 ⁵	7.9×10 ⁻⁵	6.8×10 ⁻⁵		5.6×10 ⁻⁵	4.8×10 ⁻⁵		0.002	0.002
Chlorobenzene	3.5×10 ⁵	5.0×10 ⁻⁵	4.3×10 ⁻⁵		3.5×10 ⁻⁵	3.0×10 ⁻⁵		0.001	0.001
Containment building									
Total suspended particulates	1.5×10 ⁴	2.96	1.80		1.48	0.90		10.26	6.23
PM10	5,000	2.96	1.80		1.48	0.90		10.26	6.23
Vinyl chloride	2,600	0.17	0.10		0.08	0.05		0.74	0.45
1,1 Dichloroethane	N/A	0.01	0.01		0.01	15.25		29.82	0.03
Methyl ethyl Ketone	5.9×10 ⁵	25.77	15.66		25.10	0.22		3.22	18.12
Chloroform	9,780	0.08	0.05		0.04	0.02		0.34	0.21
Carbon tetrachloride	1.26×10 ⁴	0.01	0.004		0.003	0.002		0.03	0.02
Benzene	3,250	0.10	0.06		0.05	0.03		0.45	0.27
1,2 Dichloroethane	N/A	0.004	0.003		0.002	0.001		0.02	0.01
Trichloroethane	2.7×10 ⁵	0.004	0.002		0.002	0.001		0.02	0.01
Tetrachloroethylene	1.7×10 ⁵	7.8×10 ⁻⁴	4.7×10 ⁻⁴		3.7×10 ⁻⁴	2.2×10 ⁻⁴		3.9×10 ⁻³	2.4×10 ⁻³
Chlorobenzene	3.5×10 ⁵	4.9×10 ⁻⁴	3.0×10 ⁻⁴		2.3×10 ⁻⁴	1.4×10 ⁻⁴		2.4×10 ⁻³	1.5×10 ⁻³

Table E.2-4. (continued).

Pollutant	OSHA PELb	Expected forecast receptor locations		Minimum forecast receptor locations		Maximum forecast receptor locations	
		100 metersc	640 meters	100 meters	640 meters	100 meters	640 meters
Non-alpha vitrification							

Total suspended particulates	1.5×10 ⁴	1.5×10 ⁻⁹	0.23	no vit ^f	no vit.	7.6×10 ⁻⁹	1.11
PM10	5,000	1.5×10 ⁻⁹	0.23	no vit.	no vit.	7.6×10 ⁻⁹	1.11
Nitrogen oxides	9,000	3.4×10 ⁻⁹	0.50	no vit.	no vit.	1.7×10 ⁻⁸	2.47
Sulfur dioxide	1.3×10 ⁴	2.1×10 ⁻¹¹	0.003	no vit.	no vit.	1.1×10 ⁻¹⁰	0.02
Carbon monoxide	4.0×10 ⁴	3.1×10 ⁻¹²	4.5×10 ⁻⁴	no vit.	no vit.	1.5×10 ⁻¹¹	0.002
Lead	100	3.1×10 ⁻¹²	4.6×10 ⁻⁴	no vit.	no vit.	1.5×10 ⁻¹¹	0.002
Acetaldehyde	1.8×10 ⁵	3.8×10 ⁻¹⁴	5.6×10 ⁻⁶	no vit.	no vit.	5.0×10 ⁻¹⁴	7.4×10 ⁻⁶
Acrylamide	30	3.8×10 ⁻¹⁴	5.6×10 ⁻⁶	no vit.	no vit.	5.0×10 ⁻¹⁴	7.4×10 ⁻⁶
Acrylonitrile	4,420	3.8×10 ⁻¹⁴	5.6×10 ⁻⁶	no vit.	no vit.	5.0×10 ⁻¹⁴	7.4×10 ⁻⁶
Arsenic pentoxide	10	1.9×10 ⁻¹³	2.8×10 ⁻⁵	no vit.	no vit.	2.5×10 ⁻¹³	3.7×10 ⁻⁵
Asbestos	0.2 fibers/ m ³	1.3×10 ⁻¹⁴	1.9×10 ⁻⁶	no vit.	no vit.	6.1×10 ⁻¹⁴	9.1×10 ⁻⁶
Benzene	3,250	4.5×10 ⁻¹²	6.7×10 ⁻⁴	no vit.	no vit.	6.0×10 ⁻¹²	8.9×10 ⁻⁴
Benzidine	N/A	3.8×10 ⁻¹⁴	5.6×10 ⁻⁶	no vit.	no vit.	5.0×10 ⁻¹⁴	7.4×10 ⁻⁶
Bis(chloromethyl)ether	N/A	3.8×10 ⁻¹⁴	5.6×10 ⁻⁶	no vit.	no vit.	5.0×10 ⁻¹⁴	7.4×10 ⁻⁶
Bromoform	5,000	3.8×10 ⁻¹⁴	5.6×10 ⁻⁶	no vit.	no vit.	5.0×10 ⁻¹⁴	7.4×10 ⁻⁶
Carbon tetrachloride	1.26×10 ⁴	3.8×10 ⁻¹⁴	5.6×10 ⁻⁶	no vit.	no vit.	5.0×10 ⁻¹⁴	7.4×10 ⁻⁶
Chlordane	500g	3.8×10 ⁻¹⁴	5.6×10 ⁻⁶	no vit.	no vit.	5.0×10 ⁻¹⁴	7.4×10 ⁻⁶
Chloroform	9,780	3.8×10 ⁻¹⁴	5.6×10 ⁻⁶	no vit.	no vit.	5.0×10 ⁻¹⁴	7.4×10 ⁻⁶
Cr(+6) Compounds	50g	1.3×10 ⁻¹⁵	1.9×10 ⁻⁷	no vit.	no vit.	1.7×10 ⁻¹⁵	2.5×10 ⁻⁷
Formaldehyde	1,224	3.8×10 ⁻¹⁴	5.6×10 ⁻⁶	no vit.	no vit.	5.0×10 ⁻¹⁴	7.4×10 ⁻⁶
Heptachlor	500	9.4×10 ⁻¹⁴	1.4×10 ⁻⁵	no vit.	no vit.	1.3×10 ⁻¹³	1.8×10 ⁻⁵
Hexachlorobenzene	N/A	3.8×10 ⁻¹⁴	5.6×10 ⁻⁶	no vit.	no vit.	5.0×10 ⁻¹⁴	7.4×10 ⁻⁶
Hexachlorobutadiene	210f	3.8×10 ⁻¹⁴	5.6×10 ⁻⁶	no vit.	no vit.	5.0×10 ⁻¹⁴	7.4×10 ⁻⁶
Hydrazine	100	3.8×10 ⁻¹⁴	5.6×10 ⁻⁶	no vit.	no vit.	5.0×10 ⁻¹⁴	7.4×10 ⁻⁶
Nickel oxide	1,000	6.3×10 ⁻¹²	9.3×10 ⁻⁴	no vit.	no vit.	3.1×10 ⁻¹¹	4.5×10 ⁻³
1,1,2,2-Tetrachloroethane	7,000	7.5×10 ⁻¹³	1.1×10 ⁻⁴	no vit.	no vit.	1.0×10 ⁻¹²	1.5×10 ⁻³
1,1,2-Trichloroethane	4.5×10 ⁴	3.8×10 ⁻¹⁴	5.6×10 ⁻⁶	no vit.	no vit.	5.0×10 ⁻¹⁴	7.4×10 ⁻⁶
Toxaphene	500	9.4×10 ⁻¹⁴	1.4×10 ⁻⁵	no vit.	no vit.	1.3×10 ⁻¹³	1.8×10 ⁻⁵
Alpha vitrification							

Table E.2-5. Maximum SRS boundary-line concentrations of carcinogens without risk factors (micrograms per cubic meter).^{a,b}

	Alternative A			Alternative B			Alternative C		
	Expected	Minimum	Maximum	Expected	Minimum	Maximum	Expected	Minimum	Maximum
Lead	1.0E-05	1.0E-05	1.0E-05	3.0E-05	3.0E-05	6.0E-05	2.5E-05	1.9E-05	6.6E-05
Dioxane	1.6E-07	9.9E-08	1.2E-07	1.4E-07	6.8E-08	1.2E-07	4.6E-07	2.4E-07	1.0E-06
Ethylene dibromide	4.1E-07	2.5E-07	3.1E-07	3.5E-07	1.7E-07	3.0E-07	1.1E-06	5.9E-07	2.5E-06
Ethylene dichloride	4.1E-07	2.5E-07	3.1E-07	3.5E-07	1.7E-07	3.0E-07	1.1E-06	5.9E-07	2.5E-06
Parathion	4.1E-07	2.5E-07	3.1E-07	3.5E-07	1.7E-07	3.0E-07	1.1E-06	5.9E-07	2.5E-06
Aniline	1.6E-07	9.9E-08	1.2E-07	1.4E-07	6.8E-08	1.2E-07	4.6E-07	2.4E-07	1.0E-06
Cresols	1.6E-07	9.9E-08	1.2E-07	1.4E-07	6.8E-08	1.2E-07	4.6E-07	2.4E-07	1.0E-06
Chloromethyl methyl Ether	1.45E-07	2.41E-08	8.77E-08	1.4E-07	6.8E-08	1.2E-07	4.6E-07	2.4E-07	1.0E-06
3, 3-Dichlorobenzidene	1.6E-07	9.9E-08	1.2E-07	1.4E-07	6.8E-08	1.2E-07	4.6E-07	2.4E-07	1.0E-06
1, 2-Diphenylhydrazine	1.6E-07	9.9E-08	1.2E-07	1.4E-07	6.8E-08	1.2E-07	4.6E-07	2.4E-07	1.0E-06
2, 4-Dinitrotoluene	1.6E-07	9.9E-08	1.2E-07	1.4E-07	6.8E-08	1.2E-07	4.6E-07	2.4E-07	1.0E-06
Methyl iodide	1.45E-07	2.41E-08	8.77E-08	1.4E-07	6.8E-08	1.2E-07	4.6E-07	2.4E-07	1.0E-06
Pentachlorophenol	1.6E-07	9.9E-08	1.2E-07	1.4E-07	6.8E-08	1.2E-07	4.6E-07	2.4E-07	1.0E-06
Benzyl chloride	1.0E-04	1.0E-04	1.0E-04	8.0E-08	4.1E-08	4.4E-07	4.6E-07	2.4E-07	1.0E-06

a. Source: EPA (1994).

b. Integrated Risk Information System (IRIS) contains EPA health risk information for Class A, B, and C (suspected, probable, and possible) carcinogens.

TC

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SECTION 3

TRAFFIC AND TRANSPORTATION

Table E.3-1. Hazardous waste shipments during 30-year period of interest.

			Waste forecast			Alternative A			Alternative B			Alternative C			
	Waste	Shipping container	Container s per truck	Min. volume (m ³) ^a	Exp. ^b volume (m ³)	Max. volume (m ³)	Min. shipments	Exp. shipments	Max. shipments	Min. shipments	Exp. shipments	Max. shipments	Min. shipments	Exp. shipments	Max. shipments
TE	ONSITE SHIPMENTS ^c														
	Inorganic debris	90 cu. ft. box	6	4,280	8,283	11,489	280	541	751	280	541	751	280	541	751
	Soils	45 cu. ft. box	10	146,784	282,935	465,392	11,468	22,106	36,361	11,468	22,106	36,361	11,468	22,106	36,361
	Filters	45 cu. ft. box	1	2,267	4,285	6,495	17,71	3,348	5,074	1,771	3,348	5,074	1,771	3,348	5,074
TC	Aqueous liquids	3000 gal. truck	1	8,206	35,943	38,345	714	3,142	3,376	714	3,142	3,376	714	3,142	3,376
	Organic debris	90 cu. ft. box	1	28	28	28	11	11	11	11	11	11	11	11	11
	Organic sludge	55 gal. drum	1	2,327	4,545	6,867	11,635	22,725	34,335	11,635	22,725	34,335	11,635	22,725	34,335
	Heterogeneous debris	90 cu. ft. box	2	6,188	11,690	15,642	1,213	2,292	3,067	1,213	2,292	3,067	1,213	2,292	3,067
	Lead	22.5 cu. ft. box	1	2,764	5,266	7,725	4,339	8,267	12,127	4,339	8,267	12,127	4,339	8,267	12,127
	Organic liquids	3000 gal. truck	1	2,238	4,523	6,495	197	398	572	197	398	572	197	398	572
	CIF ashcrete ^d	55 gal. drum	48	(e)	(e)	(e)	72	132	198	72	132	198	55	66	73
	Bulk	Bulk box	1	3,389	6,642	9,474	62	122	174	62	122	174	62	122	174
	Inorganic sludge	55 gal. drum	30	2,327	4,545	6,867	388	758	1,145	388	758	1,145	388	758	1,145
	Metal debris	90 cu. ft. box	4	7,800	14,220	20,974	765	1,394	2,056	765	1,394	2,056	765	1,394	2,056
	Sand/rock/gravel	45 cu. ft. box	6	19,698	38,060	62,091	2,565	4,956	8,085	2,565	4,956	8,085	2,565	4,956	8,085
	Paint waste	55 gal. drum	4	2,294	4,062	6,122	2,868	5,078	7,653	2,868	5,078	7,653	2,868	5,078	7,653
	Glass debris	55 gal. drum	60	4,297	7,999	12,245	358	667	1,020	358	667	1,020	358	667	1,020
	PCBs	55 gal. drum	1	2,437	2,437	2,280	12,185	12,185	11,400	12,185	12,185	11,400	12,185	12,185	11,400
	OFFSITE SHIPMENTS ^f														
	Various types ^g	40 foot van	25 m ³	(h)	(h)	(h)	8,093	14,745	24,843	7,713	14,725	23,780	6,558	7,944	9,233
TC TE	Average daily shipments ⁱ			(No-Action)											
	Hazardous waste			14			8	14	20	8	14	20	8	13	18

Source: Rollins (1995).

a. Cubic meters.

b. Expected waste volume is assumed to be the same as for the no-action alternative.

c. Onsite shipments average 8 kilometers (5 miles) each.

d. CIF = Consolidated Incineration Facility. Volumes from the Consolidated Incineration Facility vary depending on alternative. Source: Hess (1994a, b, c, and d).

e. Ashcrete volume varies depending on alternative (Ashcrete is not a hazardous waste).

f. Offsite shipments average 1,609 kilometers (1,000 miles) each.

g. Offsite shipments of hazardous waste types vary depending on alternative.

h. Hazardous waste volume varies depending on alternatives.

i. Daily shipments are estimated by totaling all shipments for each alternative/forecast and dividing this sum by 30 years and 250 working days per year.

Table E.3-2. Low-level and transuranic (TRU) waste shipments during the 30-year period of interest.

		Containers per truck	Waste forecast			Alternative A			Alternative B			Alternative C			
			Min. volume (m ³) ^a	Exp. ^b volume (m ³)	Max. volume (m ³)	Min. shipments	Exp. shipments	Max. shipments	Min. shipments	Exp. shipments	Max. shipments	Min. shipments	Exp. shipments	Max. shipments	
Waste	Shipping container														
ONSITE SHIPMENTS ^c															TE
Tritiated equipment	90 cu. ft. box	10	461	1,184	1,622	18	46	64	18	46	64	18	46	64	
Spent deionizers	Liner	1	30	30	30	11	11	11	11	11	11	11	11	11	
LLW job-control ^d	90 cu. ft. box	6	309,115	366,285	413,812	21,375	25,112	28,218	20,204	23,940	27,047	20,204	23,940	27,047	TE
Offsite job-control	90 cu. ft. box	10	12,600	12,600	25,200	494	494	988	494	494	988	494	494	988	
LLW equipment	90 cu. ft. box	6	(e)	(e)	(e)	2,220	4,543	15,386	1,707	3,319	10,525	1,177	2,089	5,471	TE
ILW job-control ^f	90 cu. ft. box	2	12,477	22,335	28,111	2,446	4,449	5,512	2,446	4,449	5,512	2,446	4,449	5,512	
Long-lived waste	55 gal. drum	1	1,003	3,302	4,643	5,015	16,510	23,215	5,015	16,510	23,215	5,015	16,510	23,215	
Tritiated job-control	90 cu. ft. box	10	1,558	3,860	133,994	61	151	5,255	61	151	5,255	61	151	5,255	
Low-level soils	45 cu. ft. box	10	8,068	19,791	311,923	630	1,548	24,371	630	1,548	24,371	630	1,548	24,371	
Suspect soils	45 cu. ft. box	10	12,102	29,669	467,884	946	2,318	36,556	946	2,318	36,556	946	2,318	36,556	
Tritiated soils	45 cu. ft. box	10	575	1,532	2,492	45	119	195	45	119	195	45	119	195	
CIF ashcrete ^g	55 gal. drum	48	(h)	(h)	(h)	0	0	0	1,922	1,527	3,471	737	947	1,033	TE
TRU waste ⁱ	55 gal. drum	15	3,164	4,400	252,919	1,055	1,467	84,298	1,055	1,467	84,298	1,055	1,467	84,298	
10-100 nCi ^j															
TRU waste ^{i,j,k} >100 nCi, <0.5 Ci ^k	55 gal. drum	15	2,165	3,112	51,295	722	1,036	17,097	722	1,036	17,097	722	1,036	17,097	
TRU waste ^{i,j} >0.5 Ci ^l	55 gal. drum	15	2,228	3,202	52,780	742	1,066	17,591	742	1,066	17,591	742	1,066	17,591	
TRU waste ⁱ bulk	Bulk box	1	8,146	11,707	192,989	150	215	3,547	150	215	3,547	150	215	3,547	
TRU waste ⁱ remote	Bulk box	1	146	209	3,449	3	4	63	3	4	63	3	4	63	TE
OFFSITE SHIPMENTS ^m															
Offsite smelter	Railroad Car	NA	(n)	(n)	(n)	0	0	0	54	762	332	37	479	173	
LLW offsite ^o	40 ft van	25m ³	(p)	(p)	(p)	0	0	0	18,540	30,525	77,815	0	0	0	
Average daily shipments ^q			(No-Action)												
Transuranic waste				1		<1	1	16	<1	1	16	<1	1	16	
Low-level waste				7		4	7	19	6	9	20	4	7	17	TC

Source: Rollins (1995).

- Cubic meters.
- Expected waste volume is assumed to be the same as for the no-action alternative.
- Onsite shipments average 8 kilometers (5 miles) each.
- LLW = low-level waste.
- Volumes of low-level equipment vary with alternative.
- ILW = intermediate-level waste.
- CIF = Consolidated Incineration Facility.
- Volumes from the Consolidated Incineration Facility vary depending on alternative. Source: Hess (1994a, b, c, and d).
- TRU = transuranic.
- Includes mixed and nonmixed transuranic waste at 10-100 nanocuries per drum.
- Includes mixed and nonmixed transuranic waste between 100 nanocuries and 0.5 curies per drum.
- Includes mixed and nonmixed transuranic waste greater than 0.5 curies per drum.
- Offsite shipments average 541 kilometers (336 miles) each.
- Volumes to Offsite Smelter Facility vary with alternative.
- Includes return shipments of processed waste.
- Offsite low-level waste shipments vary by alternative.
- Daily shipments are estimated by totaling all shipments for each alternative/forecast and dividing this sum by 30 years and 250 working days per year.

Table E.3-3. Mixed waste shipments during the 30-year period of interest.

	Waste	Shipping container	Containers per truck	Waste forecast			Alternative A			Alternative B			Alternative C		
				Min. volume (m ³) ^a	Exp. ^b volume (m ³)	Max. volume (m ³)	Min. shipments	Exp. shipments	Max. shipments	Min. shipments	Exp. shipments	Max. shipments	Min. shipments	Exp. shipments	Max. shipments
TE	ONSITE SHIPMENTS ^c														
	Inorganic debris	90 cu. ft. box	6	6,240	15,170	23,516	408	992	1,537	408	992	1,537	408	992	1,537
	Waste filters	45 cu. ft. box	1	1,256	2,851	3,858	981	2,227	3,014	981	2,236	3,014	981	2,227	3,014
	Aqueous liquids	3000 gal. truck	1	8,957	32,862	51,026	788	2,893	4,492	788	2,893	4,492	788	2,893	4,492
	Organic debris	90 cu. ft. box	1	242	241	27,769	95	95	10,890	95	95	10,890	95	95	10,890
	Organic sludge	55 gal. drum	1	1,335	3,672	5,113	6,675	18,360	25,565	6,675	18,360	25,565	6,675	18,360	25,565
	Heterogenous debris	90 cu. ft. box	2	10,594	25,699	126,967	2,077	5,039	24,896	2,077	5,039	24,896	2,077	5,039	24,896
	Gold traps	55 gal. drum	1	3	3	3	14	14	14	14	14	14	14	14	14
	M-Area glass	71 gal. drum	3	2,058	2,058	2,058	2,618	2,618	2,618	2,618	2,618	2,618	2,618	2,618	2,618
	Lead	22.5 cu. ft. box	1	1,280	5,956	7,677	2,009	4,675	12,052	2,009	4,675	12,052	2,009	4,675	12,052
	PUREX solvents	3000 gal. truck	1	345	345	345	30	30	30	30	30	30	30	30	30
	Organic liquids	3000 gal. truck	1	1,149	2,879	7,873	101	253	693	101	253	693	101	253	693
	TE	CIF ashcrete ^d	55 gal. drum	48	(e)	(e)	(e)	4,941	13,301	82,407	4,897	445	1,331	62	109
Bulk		Bulk box	1	4,202	10,358	32,295	77	190	594	77	190	594	77	190	594
Inorganic sludge		55 gal. drum	30	1,299	3,636	5,046	217	606	841	217	606	841	217	606	841
Metal debris		90 cu. ft. box	4	6,768	12,897	53,719	664	1,264	5,267	664	1,264	5,267	664	1,264	5,267
Soils/sand/rock/gravel		45 cu. ft. box	6	22,186	88,329	440,062	2,889	11,501	57,300	2,889	11,501	57,300	2,889	11,501	57,300
Paint waste		55 gal. drum	4	1,468	2,133	2,598	1,835	2,666	3,248	1,835	2,666	3,248	1,835	2,666	3,248
Glass debris		55 gal. drum	60	1,652	2,997	7,558	138	250	630	138	250	630	138	250	630
OFFSITE SHIPMENTS ^f															
Lead	22.5 cu. ft. box	1	(g)	(g)	(g)	2,115	4,802	12,237	2,115	4,802	12,237	2,112	4,799	12,234	
TC	Average daily shipments ^h			(No-Action)											
	Mixed waste			8			4	10	33	4	8	22	3	8	22

Source: Rollins (1995).

a. Cubic meters.

b. Expected waste volume is assumed to be the same as for the no-action alternative.

c. Onsite shipments average 8 kilometers (5 miles) each.

d. CIF = Consolidated Incineration Facility.

e. Volumes from the Consolidated Incineration Facility vary depending on alternative. Source: Hess (1994a, b, c, and d).

f. Offsite shipments average 541 kilometers (336 miles) each.

g. Volumes to offsite treatment facilities vary with alternative.

h. Daily shipments are estimated by totaling all shipments for each alternative and forecast and dividing this sum by 30 years and 250 working days per year.

- a. Cubic meters.
- b. Expected waste volume is assumed to be the same as for the no-action alternative.
- c. Onsite shipments average 8 kilometers (5 miles) each.
- d. CIF = Consolidated Incineration Facility.
- e. Volumes from the Consolidated Incineration Facility vary depending on alternative. Source: Hess (1994a, b, c, and d).
- f. Offsite shipments average 541 kilometers (336 miles) each.
- g. Volumes to offsite treatment facilities vary with alternative.
- h. Daily shipments are estimated by totaling all shipments for each alternative and forecast and dividing this sum by 30 years and 250 working days per year.

Table E.3-4. Annual radiological doses from incident-free transportation during onsite transport of low-level, mixed, and transuranic waste under the no-action alternative.

Waste stream	Dose from incident-free transportation		
	Uninvolved workers ^a	Involved workers	Uninvolved workers
1. Tritiated equipment	2.37E-11	2.10E-06	4.56E-08
2. Spent deionizers	2.89E-06	9.59E-02	4.42E-04
3. Low-level job-control	9.27E-05	7.28E+00	1.80E-01
4. Offsite job-control	2.03E-06	2.47E-01	3.94E-03
5. Low-activity equip.	2.39E-06	3.24E+01	4.64E-03
6. Inter.-level job-control	9.23E-03	7.52E+01	1.04E+00
7. Long-lived	1.83E-03	3.10E+01	7.43E-01
8. Tritiated job-control	3.08E-08	2.30E-03	5.95E-05
9. Low-level waste soils	1.26E-07	1.33E-02	2.43E-04
10. Suspect soils	1.90E-07	1.96E-02	3.68E-04
11. Tritiated soils	9.72E-08	1.03E-02	1.88E-04
12. MW inorganic debris	9.06E-06	6.82E-01	1.76E-02
13. Mixed waste soil	1.08E-05	1.14E+00	2.09E-02

14. MW comp. filters	1.51E-06	1.36E-01	2.92E-03
15a. 0.01 Ci/m ³ TRU wastec,d	1.07E-10	3.92E-06	2.07E-07
15b. 1.5 Ci/m ³ TRU waste	1.18E-08	4.14E-04	2.29E-05
15c. 208 Ci/m ³ TRU waste	1.61E-06	5.91E-02	3.11E-03
15d. Bulk eq. TRU waste	9.23E-09	2.46E-04	1.79E-05
15e. Bulk eq. Rmt. TRU ^e	1.28E-04	8.58E-02	6.32E-03
16. MW aqueous liquids	8.37E-06	4.24E-03	1.37E-02
17. MW organic debris	1.28E-07	1.11E-02	3.33E-04
18. Organic sludge	1.19E-06	1.20E-01	3.07E-03
19. Heterogeneous debris	9.07E-06	1.37E+00	2.35E-02
19a. Lead	6.33E-08	1.02E-02	1.64E-04
20. PUREX solvents ^f	2.60E-08	1.77E-05	4.27E-05
21. Organic liquids	2.29E-06	1.15E-03	3.75E-03
22. Ashcreteg	0.00E+00	0.00E+00	0.00E+00
23. Bulk waste	2.80E-06	8.00E-02	7.28E-03
24. Inorganic sludge	2.24E-06	1.08E-01	5.82E-03
25. Metal debris	2.58E-06	2.73E-01	6.70E-03
26. Sand/rock/gravel	1.80E-06	1.94E-01	4.66E-03
27. Paint waste	2.87E-07	6.13E-02	7.44E-04
28. Glass debris	3.18E-06	1.18E-01	8.25E-03
Totals: ^h			
Low-level	1.1E-02	1.5E+02	2.0E+00
Mixed	5.5E-05	4.3E+00	1.2E-01
Transuranic	1.3E-04	1.5E-01	9.5E-03

Source: Washburn (1995).

a. Dose in rem; all other doses in person-rem.

b. MW = Mixed waste.

c. Ci/m³ = Curie per cubic meter.

d. TRU = Transuranic.

e. Rmt = Remotely-handled.

f. PUREX = Plutonium-uranium extraction.

g. Consolidated Incineration Facility does not operate under the no-action alternative so there would be no ashcrete.

h. For incident-free dose, the sum of waste streams 1 through 11 are used to calculate the corresponding dose of low level waste in Chapter 4 transportation sections; 12 through 14 and 16 through 28 constitute the mixed waste dose; and 15a through 15e constitute the transuranic dose. For each waste type, assumes the same individual has maximum exposure to each waste stream in a single year.

Table E.3-5. Annual radiological doses from incident-free transportation during onsite transport of low-level, mixed, and transuranic waste for alternative A - expected waste forecast.

Waste stream	Dose from incident-free transportation		
	Uninvolved workers ^a	Involved workers	Uninvolved workers
1. Tritiated equipment	2.37E-11	2.10E-06	4.56E-08
2. Spent deionizers	2.89E-06	9.59E-02	4.42E-04
3. Low-level job-control	9.27E-05	7.28E+00	1.80E-01
4. Offsite job-control	2.03E-06	2.47E-01	3.94E-03
5. Low-activity equip.	1.25E-05	1.69E+02	2.42E-02
6. Inter.-level job-control	9.23E-03	7.52E+01	1.04E+00
7. Long-lived	1.83E-03	3.10E+01	7.43E-01
8. Tritiated job-control	3.08E-08	2.30E-03	5.95E-05
9. Low-level waste soils	1.26E-07	1.33E-02	2.43E-04
10. Suspect soils	1.90E-07	1.96E-02	3.68E-04
11. Tritiated soils	9.72E-08	1.03E-02	1.88E-04
12. MW inorganic debris ^b	9.06E-06	6.82E-01	1.76E-02
13. Mixed waste soil	1.08E-05	1.14E+00	2.09E-02
14. MW comp. filters	1.51E-06	1.36E-01	2.92E-03
15a. 0.01 Ci/m ³ TRU waste ^{c,d}	1.07E-10	3.92E-06	2.07E-07
15b. 1.5 Ci/m ³ TRU waste	1.18E-08	4.14E-04	2.29E-05
15c. 208 Ci/m ³ TRU waste	1.61E-06	5.91E-02	3.11E-03
15d. Bulk eq. TRU waste	9.23E-09	2.46E-04	1.79E-05
15e. Bulk eq. Rmt. TRU ^e	1.28E-04	8.58E-02	6.32E-03
16. MW aqueous liquids	8.37E-06	4.24E-03	1.37E-02
17. MW organic debris	1.28E-07	1.11E-02	3.33E-04
18. Organic sludge	1.19E-06	1.20E-01	3.07E-03
19. Heterogeneous debris	9.07E-06	1.37E+00	2.35E-02
19a. Lead	3.16E-08	5.11E-03	8.20E-05
20. PUREX solvents ^f	2.60E-08	1.77E-05	4.27E-05
21. Organic liquids	2.29E-06	1.15E-03	3.75E-03
22. Ashcrete	4.1E-05	1.4E+00	7.9E-02
23. Bulk waste	2.80E-06	8.00E-02	7.28E-03
24. Inorganic sludge	2.24E-06	1.08E-01	5.82E-03
25. Metal debris	2.58E-06	2.73E-01	6.70E-03
26. Sand/rock/gravel	1.80E-06	1.94E-01	4.67E-03
27. Paint waste	2.87E-07	6.13E-02	7.44E-04
28. Glass debris	3.18E-06	1.18E-01	8.25E-03
Totals: ^g			
Low-level	1.1E-02	2.8E+02	2.0E+00
Mixed	8.4E-05	5.3E+00	1.7E-01
Transuranic	1.3E-04	1.5E-01	9.5E-03

Source: Washburn (1995).

a. Dose in rem; all other doses in person-rem.

b. MW = Mixed waste.

c. Ci/m³ = Curie per cubic meter.

d. TRU = Transuranic.

e. Rmt = Remotely-handled.

f. PUREX = Plutonium-uranium extraction..

g. For incident-free dose, the sum of waste streams 1 through 12 are used to calculate the corresponding dose of low-level waste in Chapter 4 transportation sections; 12 through 14 and 16 through 28 constitute the mixed waste dose; and 15a through 15e constitutes the transuranic dose. For each waste type, assumes the same individual has maximum exposure to each waste stream in a single year.

Table E.3-6. Annual radiological doses from incident-free transportation during onsite transport of low-level, mixed, and transuranic waste for alternative A - minimum waste forecast.

Waste	Dose from incident-free transportation		
	Uninvolved worker ^a	Involved workers	Uninvolved workers
1. Tritiated equipment	9.21E-12	8.19E-07	1.78E-08
2. Spent deionizers	2.89E-06	9.59E-02	4.42E-04
3. Low-level job-control	7.82E-05	6.14E+00	1.52E-01
4. Offsite job-control	2.03E-06	2.47E-01	3.94E-03
5. Low-activity equip.	6.10E-06	8.28E+01	1.18E-02
6. Inter.-level job-control	5.07E-03	4.14E+01	5.72E-01
7. Long-lived	5.56E-04	9.41E+00	2.26E-01
8. Tritiated job-control	1.25E-08	9.29E-04	2.40E-05
9. Low-level waste soils	5.11E-08	5.43E-03	9.91E-05
10. Suspect soils	7.75E-08	7.98E-03	1.50E-04
11. Tritiated soils	3.66E-08	3.89E-03	7.09E-05
12. MW inorganic debris ^b	3.73E-06	2.81E-01	7.22E-03
13. Mixed waste soil	2.71E-06	2.87E-01	5.25E-03

14. MW comp. filters	6.64E-07	6.01E-02	1.29E-03
15a. 0.01 Ci/m ³ TRU waste ^{c,d}	7.70E-11	2.81E-06	1.49E-07
15b. 1.5 Ci/m ³ TRU waste	8.25E-09	2.88E-04	1.60E-05
15c. 208 Ci/m ³ TRU waste	1.12E-06	4.12E-02	2.17E-03
15d. Bulk eq. TRU waste	6.43E-09	1.71E-04	1.24E-05
15e. Bulk eq. Rmt. TRU ^e	8.91E-05	5.97E-02	4.40E-03
16. MW aqueous liquids	2.25E-06	1.14E-03	3.69E-03
17. MW organic debris	1.28E-07	1.11E-02	3.33E-04
18. Organic sludge	4.32E-07	4.37E-02	1.12E-03
19. Heterogeneous debris	3.74E-06	5.65E-01	9.69E-03
19a. Lead	1.36E-08	2.20E-03	3.52E-05
20. PUREX solvents ^f	2.60E-08	1.77E-05	4.27E-05
21. Organic liquids	1.82E-06	9.18E-04	2.98E-03
22. Ashcrete	1.5E-05	5.9E-01	3.0E-02
23. Bulk waste	1.14E-06	3.25E-02	2.95E-03
24. Inorganic sludge	8.01E-07	3.86E-02	2.08E-03
25. Metal debris	1.35E-06	1.44E-01	3.52E-03
26. Sand/rock/gravel	4.53E-07	4.87E-02	1.17E-03
27. Paint waste	1.98E-07	4.22E-02	5.12E-04
28. Glass debris	1.75E-06	6.51E-02	4.55E-03
Totals: g			
Low-level	5.7E-03	1.4E+02	9.8E-01
Mixed	3.2E-05	2.0E+00	6.7E-02
Transuranic	9.0E-05	1.0E-01	6.6E-03

Source: Washburn (1995).

a. Dose in rem; all other doses in person-rem.

b. MW = Mixed waste.

c. Ci/m³ = Curie per cubic meter.

d. TRU = Transuranic.

e. Rmt = Remotely-handled.

f. PUREX = Plutonium-uranium extraction..

g. For incident-free dose, the sum of waste streams 1 through 12 are used to calculate the corresponding dose of low-level waste in Chapter 4 transportation sections; 12 through 14 and 16 through 28 constitute the mixed waste dose; and 15a through 15e constitutes the transuranic dose. For each waste type, assumes the same individual has maximum exposure to each waste stream in a single year.

Table E.3-7. Annual radiological doses from incident-free transportation during onsite transport of low-level, mixed, and transuranic waste for alternative A - maximum waste forecast.

Waste stream	Dose from incident-free transportation		
	Uninvolved workers	Involved workers	Uninvolved workers
1. Tritiated equipment	3.24E-11	2.88E-06	6.25E-08
2. Spent deionizers	2.89E-06	9.59E-02	4.42E-04
3. Low-level job-control	1.05E-04	8.22E+00	2.03E-01
4. Offsite job-control	4.06E-06	4.95E-01	7.88E-03
5. Low-activity equip.	4.23E-05	5.74E+02	8.21E-02
6. Inter.-level job-control	1.14E-02	9.32E+01	1.29E+00
7. Long-lived	2.58E-03	4.36E+01	1.04E+00
8. Tritiated job-control	1.07E-06	7.99E-02	2.07E-03
9. Low-level waste soils	1.98E-06	2.10E-01	3.83E-03
10. Suspect soils	3.00E-06	3.09E-01	5.81E-03
11. Tritiated soils	1.59E-07	1.68E-02	3.07E-04
12. MW inorganic debris	1.40E-05	1.06E+00	2.72E-02
13. Mixed waste soil	5.37E-05	5.70E+00	1.04E-01
14. MW comp. filters	2.04E-06	1.85E-01	3.95E-03
15a. 0.01 Ci/m ³ TRU waste, d	6.15E-09	2.25E-04	1.19E-05
15b. 1.5 Ci/m ³ TRU waste	1.95E-07	6.83E-03	3.78E-04
15c. 208 Ci/m ³ TRU waste	2.66E-05	9.75E-01	5.13E-02
15d. Bulk eq. TRU waste	1.52E-07	4.06E-03	2.95E-04
15e. Bulk eq. Rmt. TRUe	2.11E-03	1.42E+00	1.04E-01
16. MW aqueous liquids	1.30E-05	6.60E-03	2.13E-02
17. MW organic debris	1.47E-05	1.27E+00	3.82E-02
18. Organic sludge	1.65E-06	1.68E-01	4.28E-03
19. Heterogeneous debris	4.48E-05	6.77E+00	1.16E-01
19a. Lead	8.16E-08	1.32E-02	2.11E-04
20. PUREX solvents f	2.60E-08	1.77E-05	4.27E-05
21. Organic liquids	3.64E-06	1.84E-03	5.96E-03
22. Ashcrete	2.0E-04	7.8E+00	3.9E-01
23. Bulk waste	8.73E-06	2.50E-01	2.27E-02
24. Inorganic sludge	3.11E-06	1.50E-01	8.07E-03
25. Metal debris	1.07E-05	1.14E+00	2.79E-02
26. Sand/rock/gravel	8.98E-06	9.65E-01	2.32E-02
27. Paint waste	3.50E-07	7.47E-02	9.06E-04
28. Glass debris	8.03E-06	2.98E-01	2.08E-02
Totals: g			
Low-level	1.4E-02	7.2E+02	2.8E+00
Mixed	3.3E-04	2.4E+01	7.0E-01
Transuranic	2.1E-03	2.4E+00	1.6E-01

Source: Washburn (1995).

a. Dose in rem; all other doses in person-rem.

b. MW = Mixed waste.

c. Ci/m^3 = Curie per cubic meter.

d. TRU = Transuranic.

e. Rmt = Remotely-handled.

f. PUREX = Plutonium-uranium extraction.

g. For incident-free dose, the sum of waste streams 1 through 12 are used to calculate the corresponding dose of low-level waste in Chapter 4 transportation sections; 12 through 14 and 16 through 28 constitute the mixed waste dose; and 15a through 15e constitutes the transuranic dose. For each waste type, assumes the same individual has maximum exposure to each waste stream in a single year.

Table E.3-8. Annual radiological doses from incident-free transportation during onsite transport of low-level, mixed, and transuranic waste for alternative B - expected waste forecast.

Waste stream	Dose from incident-free transportation		
	Uninvolved workers ^a	Involved workers	Uninvolved workers
1. Tritiated equipment	2.37E-11	2.10E-06	4.56E-08
2. Spent deionizers	2.89E-06	9.59E-02	4.42E-04
3. Low-level job-control	9.27E-05	7.28E+00	1.80E-01
4. Offsite job-control	2.03E-06	2.47E-01	3.94E-03
5. Low-activity equip.	9.12E-06	1.24E+02	1.77E-02
6. Inter.-level job-control	9.23E-03	7.52E+01	1.04E+00
7. Long-lived	1.83E-03	3.10E+01	7.43E-01
8. Tritiated job-control	3.08E-08	2.30E-03	5.95E-05
9. Low-level waste soils	1.26E-07	1.33E-02	2.43E-04
10. Suspect soils	1.90E-07	1.96E-02	3.68E-04
11. Tritiated soils	9.72E-08	1.03E-02	1.88E-04
12. MW inorganic debris ^b	9.06E-06	6.82E-01	1.76E-02

13. Mixed waste soil	1.08E-05	1.14E+00	2.09E-02
14. MW comp. filters	1.51E-06	1.36E-01	2.92E-03
15a. 0.01 Ci/m ³ TRU waste ^{c,d}	1.07E-10	3.92E-06	2.07E-07
15b. 1.5 Ci/m ³ TRU waste	1.18E-08	4.14E-04	2.29E-05
15c. 208 Ci/m ³ TRU waste	1.61E-06	5.91E-02	3.11E-03
15d. Bulk eq. TRU waste	9.23E-09	2.46E-04	1.79E-05
15e. Bulk eq. Rmt. TRU ^e	1.28E-04	8.58E-02	6.32E-03
16. MW aqueous liquids	8.37E-06	4.24E-03	1.37E-02
17. MW organic debris	1.28E-07	1.11E-02	3.33E-04
18. Organic sludge	1.19E-06	1.20E-01	3.07E-03
19. Heterogeneous debris	9.07E-06	1.37E+00	2.35E-02
19a. Lead	3.16E-08	5.11E-03	8.20E-05
20. PUREX solvents ^f	2.60E-08	1.77E-05	4.27E-05
21. Organic liquids	2.29E-06	1.15E-03	3.75E-03
22. Ashcrete	5.5E-05	2.1E+00	1.1E-01
23. Bulk waste	2.80E-06	8.00E-02	7.28E-03
24. Inorganic sludge	2.24E-06	1.08E-01	5.82E-03
25. Metal debris	2.58E-06	2.73E-01	6.70E-03
26. Sand/rock/gravel	1.80E-06	1.94E-01	4.67E-03
27. Paint waste	2.87E-07	6.13E-02	7.44E-04
28. Glass debris	3.18E-06	1.18E-01	8.25E-03
Totals: g			
Low-level	1.1E-02	2.4E+02	2.1E+00
Mixed	6.7E-05	4.8E+00	1.4E-01
Transuranic	1.3E-04	1.5E-01	9.5E-03

Source: Washburn (1995).

a. Dose in rem; all other doses in person-rem.

b. MW = Mixed waste.

c. Ci/m³ = Curie per cubic meter.

d. TRU = Transuranic.

e. Rmt = Remotely-handled.

f. PUREX = Plutonium-uranium extraction.

g. For incident-free dose, the sum of waste streams 1 through 12 are used to calculate the corresponding dose of low-level waste in Chapter 4 transportation sections; 12 through 14 and 16 through 28 constitute the mixed waste dose; and 15a through 15e constitutes the transuranic dose. For each waste type, assumes the same individual has maximum exposure to each waste stream in a single year.

Table E.3-9. Annual radiological doses from incident-free transportation during onsite transport of low-level, mixed, and transuranic waste for alternative B - minimum waste forecast.

Waste stream	Dose from incident-free transportation		
	Uninvolved workers	Involved workers	Uninvolved workers
1. Tritiated equipment	9.21E-12	8.19E-07	1.78E-08
2. Spent deionizers	2.89E-06	9.59E-02	4.42E-04
3. Low-level job-control	7.82E-05	6.14E+00	1.52E-01
4. Offsite job-control	2.03E-06	2.47E-01	3.94E-03
5. Low-activity equip.	4.69E-06	6.37E+01	9.10E-03
6. Inter.-level job-control	5.07E-03	4.14E+01	5.72E-01
7. Long-lived	5.56E-04	9.41E+00	2.26E-01
8. Tritiated job-control	1.25E-08	9.29E-04	2.40E-05
9. Low-level waste soils	5.11E-08	5.43E-03	9.91E-05
10. Suspect soils	7.75E-08	7.98E-03	1.50E-04
11. Tritiated soils	3.66E-08	3.89E-03	7.09E-05
12. MW inorganic debris ^b	3.73E-06	2.81E-01	7.22E-03
13. Mixed waste soil	2.71E-06	2.87E-01	5.25E-03
14. MW comp. filters	6.64E-07	6.01E-02	1.29E-03
15a. 0.01 Ci/m ³ TRU waste ^{c,d}	7.70E-11	2.81E-06	1.49E-07
15b. 1.5 Ci/m ³ TRU waste	8.25E-09	2.88E-04	1.60E-05
15c. 208 Ci/m ³ TRU waste	1.12E-06	4.12E-02	2.17E-03
15d. Bulk eq. TRU waste	6.43E-09	1.71E-04	1.24E-05
15e. Bulk eq. Rmt. TRU ^e	8.91E-05	5.97E-02	4.40E-03
16. MW aqueous liquids	2.25E-06	1.14E-03	3.69E-03
17. MW organic debris	1.28E-07	1.11E-02	3.33E-04
18. Organic sludge	4.32E-07	4.37E-02	1.12E-03
19. Heterogeneous debris	3.74E-06	5.65E-01	9.69E-03

19a. Lead	1.36E-08	2.20E-03	3.52E-05
20. PUREX solvents ^f	2.60E-08	1.77E-05	4.27E-05
21. Organic liquids	1.82E-06	9.18E-04	2.98E-03
22. Ashcrete	4.4E-05	1.7E+00	8.6E-02
23. Bulk waste	1.14E-06	3.25E-02	2.95E-03
24. Inorganic sludge	8.01E-07	3.86E-02	2.08E-03
25. Metal debris	1.35E-06	1.44E-01	3.52E-03
26. Sand/rock/gravel	4.53E-07	4.87E-02	1.17E-03
27. Paint waste	1.98E-07	4.22E-02	5.12E-04
28. Glass debris	1.75E-06	6.51E-02	4.55E-03
Totals: ^g			
Low-level	5.7E-03	1.2E+02	1.0E+00
Mixed	4.4E-05	2.5E+00	9.1E-02
Transuranic	9.0E-05	1.0E-01	6.6E-03

Source: Washburn (1995).

a. Dose in rem; all other doses in person-rem.

b. MW = Mixed waste.

c. Ci/m³ = Curie per cubic meter.

d. TRU = Transuranic.

e. Rmt = Remotely-handled.

f. PUREX = Plutonium-uranium extraction.

g. For incident-free dose, the sum of waste streams 1 through 12 are used to calculate the corresponding dose of low-level waste in Chapter 4 transportation sections; 12 through 14 and 16 through 28 constitute the mixed waste dose; and 15a through 15e constitutes the transuranic dose. For each waste type, assumes the same individual has maximum exposure to each waste stream in a single year.

Table E.3-10. Annual radiological doses from incident-free transportation during onsite transport of low-level, mixed, and transuranic waste for alternative B - maximum waste forecast.

Waste stream	Dose from incident-free transportation		
	Uninvolved workers ^a	Involved workers	Uninvolved workers

1. Tritiated equipment	3.24E-11	2.88E-06	6.25E-08
2. Spent deionizers	2.89E-06	9.59E-02	4.42E-04
3. Low-level job-control	1.05E-04	8.22E+00	2.03E-01
4. Offsite job-control	4.06E-06	4.95E-01	7.88E-03
5. Low-activity equip.	2.89E-05	3.93E+02	5.61E-02
6. Inter.-level job-control	1.14E-02	9.32E+01	1.29E+00
7. Long-lived	2.58E-03	4.36E+01	1.04E+00
8. Tritiated job-control	1.07E-06	7.99E-02	2.07E-03
9. Low-level waste soils	1.98E-06	2.10E-01	3.83E-03
10. Suspect soils	3.00E-06	3.09E-01	5.81E-03
11. Tritiated soils	1.59E-07	1.68E-02	3.07E-04
12. MW inorganic debris ^b	1.40E-05	1.06E+00	2.72E-02
13. Mixed waste soil	5.37E-05	5.70E+00	1.04E-01
14. MW comp. filters	2.04E-06	1.85E-01	3.95E-03
15a. 0.01 Ci/m ³ TRU waste ^{c,d}	6.15E-09	2.25E-04	1.19E-05
15b. 1.5 Ci/m ³ TRU waste	1.95E-07	6.83E-03	3.78E-04
15c. 208 Ci/m ³ TRU waste	2.66E-05	9.75E-01	5.13E-02
15d. Bulk eq. TRU waste	1.52E-07	4.06E-03	2.95E-04
15e. Bulk eq. Rmt. TRU ^e	2.11E-03	1.42E+00	1.04E-01
16. MW aqueous liquids	1.30E-05	6.60E-03	2.13E-02
17. MW organic debris	1.47E-05	1.27E+00	3.82E-02
18. Organic sludge	1.65E-06	1.68E-01	4.28E-03
19. Heterogeneous debris	4.48E-05	6.77E+00	1.16E-01
19a. Lead	8.16E-08	1.32E-02	2.11E-04
20. PUREX solvents ^f	2.60E-08	1.77E-05	4.27E-05
21. Organic liquids	3.64E-06	1.84E-03	5.96E-03
22. Ashcrete	7.6E-05	3.0E+00	1.5E-01
23. Bulk waste	8.73E-06	2.50E-01	2.27E-02
24. Inorganic sludge	3.11E-06	1.50E-01	8.07E-03
25. Metal debris	1.07E-05	1.14E+00	2.79E-02
26. Sand/rock/gravel	8.98E-06	9.65E-01	2.32E-02
27. Paint waste	3.50E-07	7.47E-02	9.06E-04
28. Glass debris	8.03E-06	2.98E-01	2.08E-02
Totals: ^g			
Low-level	1.4E-02	5.4E+02	2.7E+00
Mixed	2.1E-04	1.9E+01	4.7E-01
Transuranic	2.1E-03	2.4E+00	1.6E-01

Source: Washburn (1995).

a. Dose in rem; all other doses in person-rem.

b. MW = Mixed waste.

c. Ci/m³ = Curie per cubic meter.

d. TRU = Transuranic.

e. Rmt = Remotely-handled.

f. PUREX = Plutonium-uranium extraction..

g. For incident-free dose, the sum of waste streams 1 through 12 are used to calculate the corresponding dose of low-level waste in Chapter 4 transportation sections; 12 through 14 and 16 through 28 constitute the mixed waste dose; and 15a through 15e constitutes the transuranic dose. For each waste type, assumes the same individual has maximum exposure to each waste stream in a single year.

Table E.3-11. Annual radiological doses from incident-free transportation during onsite transport of low-level, mixed, and transuranic waste for alternative C - expected waste forecast.

Waste stream	Dose from incident-free transportation		
	Uninvolved workers	Involved workers	Uninvolved workers
1. Tritiated equipment	2.37E-11	2.10E-06	4.56E-08
2. Spent deionizers	2.89E-06	9.59E-02	4.42E-04
3. Low-level job-control	9.27E-05	7.28E+00	1.80E-01
4. Offsite job-control	2.03E-06	2.47E-01	3.94E-03
5. Low-activity equip.	5.74E-06	7.80E+01	1.11E-02
6. Inter.-level job-control	9.23E-03	7.52E+01	1.04E+00
7. Long-lived	1.83E-03	3.10E+01	7.43E-01
8. Tritiated job-control	3.08E-08	2.30E-03	5.95E-05
9. Low-level waste soils	1.26E-07	1.33E-02	2.43E-04
10. Suspect soils	1.90E-07	1.96E-02	3.68E-04
11. Tritiated soils	9.72E-08	1.03E-02	1.88E-04
12. MW inorganic debris ^b	9.06E-06	6.82E-01	1.76E-02

13. Mixed waste soil	1.08E-05	1.14E+00	2.09E-02
14. MW comp. filters	1.51E-06	1.36E-01	2.92E-03
15a. 0.01 Ci/m ³ TRU waste ^{c,d}	1.07E-10	3.92E-06	2.07E-07
15b. 1.5 Ci/m ³ TRU waste	1.18E-08	4.14E-04	2.29E-05
15c. 208 Ci/m ³ TRU waste	1.61E-06	5.91E-02	3.11E-03
15d. Bulk eq. TRU waste	9.23E-09	2.46E-04	1.79E-05
15e. Bulk eq. Rmt. TRU ^e	1.28E-04	8.58E-02	6.32E-03
16. MW aqueous liquids	8.37E-06	4.24E-03	1.37E-02
17. MW organic debris	1.28E-07	1.11E-02	3.33E-04
18. Organic sludge	1.19E-06	1.20E-01	3.07E-03
19. Heterogeneous debris	9.07E-06	1.37E+00	2.35E-02
19a. Lead	3.16E-08	5.11E-03	8.20E-05
20. PUREX solvents ^f	2.60E-08	1.77E-05	4.27E-05
21. Organic liquids	2.29E-06	1.15E-03	3.75E-03
22. Ashcrete	1.6E-05	6.1E-01	3.1E-02
23. Bulk waste	2.80E-06	8.00E-02	7.28E-03
24. Inorganic sludge	2.24E-06	1.08E-01	5.82E-03
25. Metal debris	2.58E-06	2.73E-01	6.70E-03
26. Sand/rock/gravel	1.80E-06	1.94E-01	4.67E-03
27. Paint waste	2.87E-07	6.13E-02	7.44E-04
28. Glass debris	3.18E-06	1.18E-01	8.25E-03
Totals: ^g			
Low-level	1.1E-02	1.9E+02	2.0E+00
Mixed	5.8E-05	4.4E+00	1.2E-01
Transuranic	1.3E-04	1.5E-01	9.5E-03

Source: Washburn (1995).

a. Dose in rem; all other doses in person-rem.

b. MW = Mixed waste.

c. Ci/m³ = Curie per cubic meter.

d. TRU = Transuranic.

e. Rmt = Remotely-handled.

f. PUREX = Plutonium-uranium extraction.

g. For incident-free dose, the sum of waste streams 1 through 12 are used to calculate the corresponding dose of low-level waste in Chapter 4 transportation sections; 12 through 14 and 16 through 28 constitute the mixed waste dose; and 15a through 15e constitutes the transuranic dose. For each waste type, assumes the same individual has maximum exposure to each waste stream in a single year.

Table E.3-12. Annual radiological doses from incident-free transportation during onsite transport of low-level, mixed, and transuranic waste for alternative C - minimum waste forecast.

Waste stream	Dose from incident-free transportation		
	Uninvolved workers	Involved workers	Uninvolved workers
1. Tritiated equipment	9.21E-12	8.19E-07	1.78E-08
2. Spent deionizers	2.89E-06	9.59E-02	4.42E-04
3. Low-level job-control	7.82E-05	6.14E+00	1.52E-01
4. Offsite job-control	2.03E-06	2.47E-01	3.94E-03
5. Low-activity equip.	3.24E-06	4.39E+01	6.28E-03
6. Inter.-level job-control	5.07E-03	4.14E+01	5.72E-01
7. Long-lived	5.56E-04	9.41E+00	2.26E-01
8. Tritiated job-control	1.25E-08	9.29E-04	2.40E-05
9. Low-level waste soils	5.11E-08	5.43E-03	9.91E-05
10. Suspect soils	7.75E-08	7.98E-03	1.50E-04
11. Tritiated soils	3.66E-08	3.89E-03	7.09E-05
12. MW inorganic debris	3.73E-06	2.81E-01	7.22E-03
13. Mixed waste soil	2.71E-06	2.87E-01	5.25E-03
14. MW comp. filters	6.64E-07	6.01E-02	1.29E-03
15a. 0.01 Ci/m ³ TRU waste, d	7.70E-11	2.81E-06	1.49E-07
15b. 1.5 Ci/m ³ TRU waste	8.25E-09	2.88E-04	1.60E-05
15c. 208 Ci/m ³ TRU waste	1.12E-06	4.12E-02	2.17E-03
15d. Bulk eq. TRU waste	6.43E-09	1.71E-04	1.24E-05
15e. Bulk eq. Rmt. TRUe	8.91E-05	5.97E-02	4.40E-03
16. MW aqueous liquids	2.25E-06	1.14E-03	3.69E-03
17. MW organic debris	1.28E-07	1.11E-02	3.33E-04
18. Organic sludge	4.32E-07	4.37E-02	1.12E-03
19. Heterogeneous debris	3.74E-06	5.65E-01	9.69E-03

19a. Lead	1.36E-08	2.20E-03	3.52E-05
20. PUREX solvents ^f	2.60E-08	1.77E-05	4.27E-05
21. Organic liquids	1.82E-06	9.18E-04	2.98E-03
22. Ashcrete	1.1E-05	4.5E-01	2.2E-02
23. Bulk waste	1.14E-06	3.25E-02	2.95E-03
24. Inorganic sludge	8.01E-07	3.86E-02	2.08E-03
25. Metal debris	1.35E-06	1.44E-01	3.52E-03
26. Sand/rock/gravel	4.53E-07	4.87E-02	1.17E-03
27. Paint waste	1.98E-07	4.22E-02	5.12E-04
28. Glass debris	1.75E-06	6.51E-02	4.55E-03
Totals: g			
Low-level	5.7E-03	1.0E+02	9.8E-01
Mixed	2.3E-05	1.7E+00	5.0E-02
Transuranic	9.0E-05	1.0E-01	6.6E-03

Source: Washburn (1995).

a. Dose in rem; all other doses in person-rem.

b. MW = Mixed waste.

c. Ci/m³ = Curie per cubic meter.

d. TRU = Transuranic.

e. Rmt = Remotely-handled.

f. PUREX = Plutonium-uranium extraction..

g. For incident-free dose, the sum of waste streams 1 through 12 are used to calculate the corresponding dose of low-level waste in Chapter 4 transportation sections; 12 through 14 and 16 through 28 constitute the mixed waste dose; and 15a through 15e constitutes the transuranic dose. For each waste type, assumes the same individual has maximum exposure to each waste stream in a single year.

Table E.3-13. Annual radiological doses from incident-free transportation during onsite transport of low-level, mixed, and transuranic waste for alternative C - maximum waste forecast.

Waste stream	Dose from incident-free transportation		
	Uninvolved workers	Involved workers	Uninvolved workers

1. Tritiated equipment	3.24E-11	2.88E-06	6.25E-08
2. Spent deionizers	2.89E-06	9.59E-02	4.42E-04
3. Low-level job-control	1.05E-04	8.22E+00	2.03E-01
4. Offsite job-control	4.06E-06	4.95E-01	7.88E-03
5. Low-activity equip.	1.50E-05	2.04E+02	2.92E-02
6. Inter.-level job-control	1.14E-02	9.32E+01	1.29E+00
7. Long-lived	2.58E-03	4.36E+01	1.04E+00
8. Tritiated job-control	1.07E-06	7.99E-02	2.07E-03
9. Low-level waste soils	1.98E-06	2.10E-01	3.83E-03
10. Suspect soils	3.00E-06	3.09E-01	5.81E-03
11. Tritiated soils	1.59E-07	1.68E-02	3.07E-04
12. MW inorganic debris	1.40E-05	1.06E+00	2.72E-02
13. Mixed waste soil	5.37E-05	5.70E+00	1.04E-01
14. MW comp. filters	2.04E-06	1.85E-01	3.95E-03
15a. 0.01 Ci/m ³ TRU wastec,d	6.15E-09	2.25E-04	1.19E-05
15b. 1.5 Ci/m ³ TRU waste	1.95E-07	6.83E-03	3.78E-04
15c. 208 Ci/m ³ TRU waste	2.66E-05	9.75E-01	5.13E-02
15d. Bulk eq. TRU waste	1.52E-07	4.06E-03	2.95E-04
15e. Bulk eq. Rmt. TRUe	2.11E-03	1.42E+00	1.04E-01
16. MW aqueous liquids	1.30E-05	6.60E-03	2.13E-02
17. MW organic debris	1.47E-05	1.27E+00	3.82E-02
18. Organic sludge	1.65E-06	1.68E-01	4.28E-03
19. Heterogeneous debris	4.48E-05	6.77E+00	1.16E-01
19a. Lead	8.16E-08	1.32E-02	2.11E-04
20. PUREX solvents ^f	2.60E-08	1.77E-05	4.27E-05
21. Organic liquids	3.64E-06	1.84E-03	5.96E-03
22. Ashcrete	3.6E-05	1.4E+00	6.9E-02
23. Bulk waste	8.73E-06	2.50E-01	2.27E-02
24. Inorganic sludge	3.11E-06	1.50E-01	8.07E-03
25. Metal debris	1.07E-05	1.14E+00	2.79E-02
26. Sand/rock/gravel	8.98E-06	9.65E-01	2.32E-02
27. Paint waste	3.50E-07	7.47E-02	9.06E-04
28. Glass debris	8.03E-06	2.98E-01	2.08E-02
Totals: g			
Low-level	1.4E-02	3.5E+02	2.6E+00
Mixed	2.0E-04	1.9E+01	4.5E-01
Transuranic	2.1E-03	2.4E+00	1.6E-01

Source: Washburn (1995).

a. Dose in rem; all other doses in person-rem.

b. MW = Mixed waste.

c. Ci/m³ = Curie per cubic meter.

d. TRU = Transuranic.

e. Rmt = Remotely-handled.

f. PUREX = Plutonium-uranium extraction..

g. For incident-free dose, the sum of waste streams 1 through 12 are used to calculate the corresponding dose of low-level waste in Chapter 4 transportation sections; 12 through 14 and 16 through 28 constitute the mixed waste dose; and 15a through 15e constitutes the transuranic dose. For each waste type, assumes the same individual has maximum exposure to each waste stream in a single year.

Table E.3-14. Accident probabilities for onsite shipments of low-level, mixed, and transuranic waste by alternative and waste forecast.

Waste	Alternative A			Alternative B			Alternative C		
	Expected	Minimum	Maximum	Expected	Minimum	Maximum	Expected	Minimum	Maximum
1. Tritiated equipment	5.62E-07	2.19E-07	7.70E-07	5.62E-07	2.19E-07	7.70E-07	5.62E-07	2.19E-07	7.70E-07
2. Spent deionizers	6.56E-08	6.56E-08	6.56E-08	6.56E-08	6.56E-08	6.56E-08	6.56E-08	6.56E-08	6.56E-08
3. Low-level job-control	2.87E-04	2.42E-04	3.24E-04	2.87E-04	2.42E-04	3.24E-04	2.87E-04	2.42E-04	3.24E-04
4. Offsite job-control	5.92E-06	5.92E-06	1.18E-05	5.92E-06	5.92E-06	1.18E-05	5.92E-06	5.92E-06	1.18E-05
5. Low-activity equip.	5.45E-05	2.66E-05	1.85E-04	3.98E-05	2.05E-05	1.26E-04	2.51E-05	1.41E-05	6.57E-05
6. Inter.-level job-control	5.28E-05	2.90E-05	6.54E-05	5.28E-05	2.90E-05	6.54E-05	5.28E-05	2.90E-05	6.54E-05
7. Long-lived	1.97E-04	6.00E-05	2.78E-04	1.97E-04	6.00E-05	2.78E-04	1.97E-04	6.00E-05	2.78E-04
8. Tritiated job-control	1.82E-06	7.34E-07	6.31E-05	1.82E-06	7.34E-07	6.31E-05	1.82E-06	7.34E-07	6.31E-05
9. Low-level waste soils	1.85E-06	7.55E-07	2.92E-05	1.85E-06	7.55E-07	2.92E-05	1.85E-06	7.55E-07	2.92E-05
10. Suspect soils	2.77E-05	1.13E-05	4.37E-04	2.77E-05	1.13E-05	4.37E-04	2.77E-05	1.13E-05	4.37E-04
11. Tritiated soils	1.44E-06	5.41E-07	2.34E-06	1.44E-06	5.41E-07	2.34E-06	1.44E-06	5.41E-07	2.34E-06
12. MW inorganic debris ^a	1.19E-05	4.88E-06	1.84E-05	1.19E-05	4.88E-06	1.84E-05	1.19E-05	4.88E-06	1.84E-05

13. Mixed waste soil	7.08E-05	1.78E-05	3.53E-04	7.08E-05	1.78E-05	3.53E-04	7.08E-05	1.78E-05	3.53E-04
14. MW comp. filters	2.66E-05	1.17E-05	3.61E-05	2.66E-05	1.17E-05	3.61E-05	2.66E-05	1.17E-05	3.61E-05
15a. 0.01 Ci/m ³ TRU waste _{b,c}	1.76E-05	1.26E-05	1.01E-03	1.76E-05	1.26E-05	1.01E-03	1.76E-05	1.26E-05	1.01E-03
15b. 1.5 Ci/m ³ TRU waste	1.24E-05	8.63E-06	2.05E-04	1.24E-05	8.63E-06	2.05E-04	1.24E-05	8.63E-06	2.05E-04
15c. 208 Ci/m ³ TRU waste	1.28E-05	8.88E-06	2.10E-04	1.28E-05	8.88E-06	2.10E-04	1.28E-05	8.88E-06	2.10E-04
15d. Bulk eq. TRU waste	2.57E-06	1.79E-06	4.24E-05	2.57E-06	1.79E-06	4.24E-05	2.57E-06	1.79E-06	4.24E-05
15e. Bulk eq. Rmt. TRU _d	4.79E-08	3.33E-08	7.90E-07	4.79E-08	3.33E-08	7.90E-07	4.79E-08	3.33E-08	7.90E-07
16. MW aqueous liquids	3.46E-05	9.32E-06	5.38E-05	3.46E-05	9.32E-06	5.38E-05	3.46E-05	9.32E-06	5.38E-05
17. MW organic debris	1.51E-06	1.51E-06	1.74E-04	1.51E-06	1.51E-06	1.74E-04	1.51E-06	1.51E-06	1.74E-04
18. Organic sludge	2.93E-04	1.06E-04	4.07E-04	2.93E-04	1.06E-04	4.07E-04	2.93E-04	1.06E-04	4.07E-04
19. Heterogeneous debris	8.03E-05	3.31E-05	3.97E-04	8.03E-05	3.31E-05	3.97E-04	8.03E-05	3.31E-05	3.97E-04
19a. Lead	7.45E-05	3.20E-05	1.92E-04	7.45E-05	3.20E-05	1.92E-04	7.45E-05	3.20E-05	1.92E-04
20. PUREX solvent _e	3.71E-07	3.71E-07	3.71E-07	3.71E-07	3.71E-07	3.71E-07	3.71E-07	3.71E-07	3.71E-07

Table E.3-14. (continued).

Waste	Alternative A			Alternative B			Alternative C		
	Expected	Minimum	Maximum	Expected	Minimum	Maximum	Expected	Minimum	Maximum
21. Organic liquids	8.89E-06	7.07E-06	1.41E-05	8.89E-06	7.07E-06	1.41E-05	8.89E-06	7.07E-06	1.41E-05
22. Ashcreter									
23. Bulk Waste	3.03E-06	1.23E-06	9.44E-06	3.03E-06	1.23E-06	9.44E-06	3.03E-06	1.23E-06	9.44E-06
24. Inorganic Sludge	9.66E-06	3.45E-06	1.34E-05	9.66E-06	3.45E-06	1.34E-05	9.66E-06	3.45E-06	1.34E-05
25. Metal Debris	2.01E-05	1.06E-05	8.39E-05	2.01E-05	1.06E-05	8.39E-05	2.01E-05	1.06E-05	8.39E-05
26. Sand/Rock/Gravel	2.63E-05	6.61E-06	1.31E-04	2.63E-05	6.61E-06	1.31E-04	2.63E-05	6.61E-06	1.31E-04
27. Paint Chips/Solids	4.25E-05	2.92E-05	5.17E-05	4.25E-05	2.92E-05	5.17E-05	4.25E-05	2.92E-05	5.17E-05
28. Glass Debris	3.98E-06	2.20E-06	1.00E-05	3.98E-06	2.20E-06	1.00E-05	3.98E-06	2.20E-06	1.00E-05

Source: Washburn (1995).

a. MW = Mixed waste.

b. Ci/m³ = Curie per cubic meter.

c. TRU = Transuranic.

d. Rmt = Remotely-handled.

e. PUREX = Plutonium-uranium extraction

f. See Table E.3-16.

Table E.3-15. Radiological doses from a single accident during onsite transport of low-level, mixed, and transuranic waste under any alternative.

Waste	Uninvolved workers	Involved workers	Uninvolved workers ^a	Probability
1. Tritiated equipment	7.15E+02	6.50E+01	9.24E-03	5.62E-07
2. Spent deionizers	5.76E-02	3.28E-03	4.69E-07	6.56E-08
3. Low-level job-control	3.83E-02	3.80E-03	5.42E-07	2.87E-04
4. Offsite job-control	6.40E-02	6.34E-03	9.04E-07	5.92E-06
5. Low-activity equip.	3.83E-02	3.80E-03	5.42E-07	1.04E-05
6. Inter.-level job-control	6.18E-01	1.08E-02	1.54E-06	5.28E-05
7. Long-lived low-level waste	6.96E-01	8.44E-03	1.21E-06	1.97E-04
8. Tritiated job-control	2.03E-03	2.59E-04	3.69E-08	1.82E-06
9. Low-level waste soils	6.39E+01	6.35E+00	9.06E-04	1.85E-06
10. Suspect soils	6.39E+00	6.35E-01	9.06E-05	2.77E-05
11. Tritiated soils	6.45E+01	6.80E+00	9.70E-04	1.44E-06
12. MW inorganic debris	1.37E-02	1.36E-03	1.94E-07	1.19E-05
13. Mixed waste soil	1.44E+02	1.43E+01	2.04E-03	7.07E-05
14. MW comp. filters	7.18E-03	7.14E-04	1.02E-07	2.66E-05
15a. 0.01 Ci/m ³ TRU waste ^{c,d}	2.22E+00	1.95E-01	2.78E-05	1.76E-05
15b. 1.5 Ci/m ³ TRU waste	3.33E+02	2.92E+01	4.17E-03	1.24E-05
15c. 208 Ci/m ³ TRU waste	4.61E+04	4.05E+03	5.78E-01	1.28E-05
15d. Bulk eq. TRU waste	3.09E+05	2.72E+04	3.88E+00	2.6E-06
15e. Bulk eq. Rmt. TRU ^e	3.09E+05	2.72E+04	3.88E+00	4.79E-08
16. MW aqueous liquids	3.57E-03	3.54E-04	5.05E-08	3.46E-05
17. MW organic debris	2.96E+01	2.84E+00	4.05E-04	1.51E-06

18. Organic sludge	2.32E+00	2.22E-01	3.17E-05	2.93E-04
19. Heterogeneous debris	5.92E+01	5.68E+00	8.10E-04	8.03E-05
19a. Lead	3.71E-01	3.56E-02	5.08E-06	1.49E-04
20. PUREX solvents ^f	2.50E-01	2.19E-02	3.13E-06	3.71E-07
21. Organic liquids	3.57E-03	3.54E-04	5.05E-08	8.89E-06
22. Ashcrete ^g				
23. Bulk waste	6.32E-01	6.05E-02	8.64E-06	3.03E-06
24. Inorganic sludge	6.95E+01	6.67E+00	9.51E-04	9.66E-06
25. Metal debris	5.90E+00	5.68E-01	8.10E-05	2.01E-05
26. Sand/rock/gravel	8.90E+01	8.56E+00	1.22E-03	2.63E-05
27. Paint chips/solids	9.25E+00	8.89E-01	1.27E-04	4.25E-05
28. Glass debris	1.39E+02	1.33E+01	1.90E-03	3.98E-06

Source: Washburn (1995).

a. Dose in rem; all other doses in person-rem.

b. MW = Mixed waste.

c. Ci/m³ = Curie per cubic meter.

d. TRU = Transuranic.

e. Rmt = Remotely-handled.

f. PUREX = Plutonium-uranium extraction.

g. The dose from an accident involving ashcrete varies among alternatives. See Table E.316.

Table E.3-16. Probability of and radiological dose from a single accident during onsite transport of low-level and mixed waste ashcrete from the Consolidated Incineration Facility under each alternative.

Waste forecast	Onsite population	Offsite population	Offsite MEI ^b	Probability
Alternative A				
<u>Expected</u>				
Low-level waste	4.3E-02	4.2E-03	6.0E-07	6.1E-05
Mixed waste	4.3E-02	4.2E-03	6.0E-07	1.4E-04

Minimum				
Low-level waste	7.9E-02	7.5E-03	1.1E-06	1.7E-05
Mixed waste	7.9E-02	7.5E-03	1.1E-06	3.9E-05
Maximum				
Low-level waste	2.2E-02	2.1E-03	3.0E-07	3.0E-04
Mixed waste	2.2E-02	2.1E-03	3.0E-07	6.9E-04
Alternative B				
Expected				
Low-level waste	3.5E-01	3.4E-02	4.9E-06	2.8E-05
Mixed waste	3.5E-01	3.4E-02	4.9E-06	7.5E-06
Minimum				
Low-level waste	1.3E-01	1.3E-02	1.8E-06	3.8E-05
Mixed waste	1.3E-01	1.3E-02	1.8E-06	4.1E-05
Maximum				
Low-level waste	2.9E-01	2.8E-02	4.0E-06	4.2E-05
Mixed waste	2.9E-01	2.8E-02	4.0E-06	1.6E-05
Alternative C				
Expected				
Low-level waste	6.0E-01	5.6E-02	8.0E-06	9.1E-06
Mixed waste	6.0E-01	5.6E-02	8.0E-06	1.9E-06
Minimum				
Low-level waste	5.2E-01	4.9E-02	7.0E-06	6.9E-06
Mixed waste	5.2E-01	4.9E-02	7.0E-06	1.2E-06
Maximum				
Low-level waste	6.4E-01	6.0E-02	8.6E-06	1.2E-05
Mixed waste	6.4E-01	6.0E-02	8.6E-06	8.1E-06

Source: HNUS (1995).

a. The Consolidated Incineration Facility would not operate under the no-action alternative, so no ashcrete would be generated.

b. MEI = Maximally exposed individual.

Table E.3-17. Radiological doses from incident-free transportation and accidents during offsite transport of low-level (low-activity equipment), mixed waste (lead), and low-level waste volume reduction.

		Annual dose from incident-free transportation		Dose from a single potential accident
		Remote	Involved	Remote
		MEI ^a	workers	Population
Description				Population
Alternative A - Expected Waste Forecast				
Low-activity equipment ^b	NA ^c	NA	NA	NA
Lead	3.2E-08	3.6E-01	7.5E-02	4.7E-03
Alternative A - Minimum Waste Forecast				
Low-activity equipment ^b	NA	NA	NA	NA
Lead	1.4E-08	1.6E-01	3.2E-02	4.7E-03
Alternative A - Maximum Waste Forecast				
Low-activity equipment ^b	NA	NA	NA	NA
Lead	8.2E-08	9.3E-01	1.9E-01	4.7E-03
Alternative B - Expected Waste Forecast				
Low-activity equipment	5.2E-05	1.7E+01	2.6E+01	4.8E-04
Lead	3.2E-08	3.6E-01	7.5E-02	4.7E-03
Low-level volume reduction	8.1E-05	1.6E+01	6.4E+00	3.7E+02
Alternative B - Minimum Waste Forecast				
Low-activity equipment	2.7E-05	8.8E+00	1.3E+01	4.8E-04
Lead	1.4E-08	1.6E-01	3.2E-02	4.7E-03
Low-level volume reduction	6.6E-05	2.0E+01	5.2E+00	3.7E+02
Alternative B - Maximum Waste Forecast				
Low-activity equipment	1.6E-04	5.4E+01	8.2E+01	4.8E-04
Lead	8.2E-08	9.3E-01	1.9E-01	4.7E-03
Low-level volume reduction	9.6E-05	8.0E+01	7.5E+00	3.7E+02

Alternative C - Expected Waste Forecast				
Low-activity equipment	3.3E-05	1.1E+01	1.6E+01	4.8E-04
Lead	3.2E-08	3.6E-01	7.5E-02	4.7E-03
Alternative C - Minimum Waste Forecast				
Low-activity equipment	1.8E-05	6.0E+00	9.2E+00	4.8E-04
Lead	1.4E-08	1.6E-01	3.2E-02	4.7E-03
Alternative C - Maximum Waste Forecast				
Low-activity equipment	8.6E-05	2.8E+01	4.3E+01	4.8E-04
Lead	8.2E-08	9.3E-01	1.9E-01	4.7E-03

Source: Washburn (1995).

a. Remote maximally exposed individual along transportation route. Dose is rem; all others in person-rem.

b. No low-activity equipment would be shipped offsite under alternative A.

c. NA = not applicable.

Table E.3-18. Waste volumes (in cubic meters) shipped in each alternative.

Waste	No-Action	Alternative A			Alternative B			Alternative C		
		Expected	Minimum	Maximum	Expected	Minimum	Maximum	Expected	Minimum	Maximum
1. Tritiated equipment	1.18E+03	1.18E+03	4.61E+02	1.62E+03	1.18E+03	4.61E+02	1.62E+03	1.18E+03	4.61E+02	1.62E+03
2. Spent deionizers	3.00E+01	3.00E+01	3.00E+01	3.00E+01	3.00E+01	3.00E+01	3.00E+01	3.00E+01	3.00E+01	3.00E+01
3. Low-level job-control	3.66E+05	3.66E+05	3.09E+05	4.14E+05	3.66E+05	3.09E+05	4.14E+05	3.66E+05	3.09E+05	4.14E+05
4. Offsite job job-control	1.26E+04	1.26E+04	1.26E+04	2.52E+04	1.26E+04	1.26E+04	2.52E+04	1.26E+04	1.26E+04	2.52E+04
5. Low-activity equip.	1.33E+04	6.95E+04	3.40E+04	2.35E+05	5.08E+04	2.61E+04	1.61E+05	3.20E+04	1.80E+04	8.37E+04
6. Inter.-level job-control	2.27E+04	2.27E+04	1.25E+04	2.81E+04	2.27E+04	1.25E+04	2.81E+04	2.27E+04	1.25E+04	2.81E+04
7. Long-lived	3.30E+03	3.30E+03	1.00E+03	4.64E+03	3.30E+03	1.00E+03	4.64E+03	3.30E+03	1.00E+03	4.64E+03
8. Tritiated job-control	3.86E+03	3.86E+03	1.56E+03	1.34E+05	3.86E+03	1.56E+03	1.34E+05	3.86E+03	1.56E+03	1.34E+05
9. Low-level waste soils	1.98E+04	1.98E+04	8.07E+03	3.12E+05	1.98E+04	8.07E+03	3.12E+05	1.98E+04	8.07E+03	3.12E+05
10. Suspect soils	2.97E+04	2.97E+04	1.21E+04	4.68E+05	2.97E+04	1.21E+04	4.68E+05	2.97E+04	1.21E+04	4.68E+05
11. Tritiated soils	1.53E+03	1.53E+03	5.75E+02	2.49E+03	1.53E+03	5.75E+02	2.49E+03	1.53E+03	5.75E+02	2.49E+03
12. MW inorganic debris	1.52E+04	1.52E+04	6.24E+03	2.35E+04	1.52E+04	6.24E+03	2.35E+04	1.52E+04	6.24E+03	2.35E+04

13. Mixed waste soil	7.56E+04	7.56E+04	1.90E+04	3.77E+05	7.56E+04	1.90E+04	3.77E+05	7.56E+04	1.90E+04	3.77E+05
14. MW comp. filters	2.85E+03	2.85E+03	1.26E+03	3.86E+03	2.85E+03	1.26E+03	3.86E+03	2.85E+03	1.26E+03	3.86E+03
15a. 0.01 ci/m3 TRU waste b,c	4.40E+03	4.40E+03	3.16E+03	2.53E+05	4.40E+03	3.16E+03	2.53E+05	4.40E+03	3.16E+03	2.53E+05
15b. 1.5 ci/m3 TRU waste	3.11E+03	3.11E+03	2.16E+03	5.13E+04	3.11E+03	2.16E+03	5.13E+04	3.11E+03	2.16E+03	5.13E+04
15c. 208 ci/m3 TRU waste	3.20E+03	3.20E+03	2.23E+03	5.28E+04	3.20E+03	2.23E+03	5.28E+04	3.20E+03	2.23E+03	5.28E+04
15d. Bulk eq. TRU waste	1.17E+04	1.17E+04	8.14E+03	1.93E+05	1.17E+04	8.14E+03	1.93E+05	1.17E+04	8.14E+03	1.93E+05
15e. Bulk eq. rmt. TRUd	2.09E+02	2.09E+02	1.46E+02	3.45E+03	2.09E+02	1.46E+02	3.45E+03	2.09E+02	1.46E+02	3.45E+03
16. MW aqueous liquids	3.27E+04	3.27E+04	8.81E+03	5.09E+04	3.27E+04	8.81E+03	5.09E+04	3.27E+04	8.81E+03	5.09E+04
17. MW organic debris	2.42E+02	2.42E+02	2.42E+02	2.78E+04	2.42E+02	2.42E+02	2.78E+04	2.42E+02	2.42E+02	2.78E+04
18. Organic sludge	3.67E+03	3.67E+03	1.34E+03	5.11E+03	3.67E+03	1.34E+03	5.11E+03	3.67E+03	1.34E+03	5.11E+03
19. Heterogeneous debris	2.57E+04	2.57E+04	1.06E+04	1.27E+05	2.57E+04	1.06E+04	1.27E+05	2.57E+04	1.06E+04	1.27E+05
19a. Lead	5.96E+03	2.98E+03	1.28E+03	7.68E+03	2.98E+03	1.28E+03	7.68E+03	2.98E+03	1.28E+03	7.68E+03
20. PUREX solventse	3.45E+02	3.45E+02	3.45E+02	3.45E+02	3.45E+02	3.45E+02	3.45E+02	3.45E+02	3.45E+02	3.45E+02
21. Organic liquids	8.45E+03	8.45E+03	6.72E+03	1.34E+04	8.45E+03	6.72E+03	1.34E+04	8.45E+03	6.72E+03	1.34E+04
22. Ashcretef	0.00E+00	1.63E+05	4.49E+04	7.96E+05	2.81E+04	6.38E+04	4.62E+04	8.79E+03	6.55E+03	1.65E+04

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Table E.3-18. (continued).

Waste	No-Action	Alternative A			Alternative B			Alternative C		
		Expected	Minimum	Maximum	Expected	Minimum	Maximum	Expected	Minimum	Maximum
23. Bulk waste	1.04E+04	1.04E+04	4.20E+03	3.23E+04	1.04E+04	4.20E+03	3.23E+04	1.04E+04	4.20E+03	3.23E+04
24. Inorganic sludge	3.64E+03	3.64E+03	1.30E+3	5.05E+03	3.64E+03	1.30E+3	5.05E+03	3.64E+03	1.30E+3	5.05E+03
25. Metal debris	1.29E+04	1.29E+04	6.77E+03	5.37E+04	1.29E+04	6.77E+03	5.37E+04	1.29E+04	6.77E+03	5.37E+04
26. Sand/rock/gravel	1.27E+04	1.27E+04	3.19E+03	6.32E+04	1.27E+04	3.19E+03	6.32E+04	1.27E+04	3.19E+03	6.32E+04
27. Paint waste	2.13E+03	2.13E+03	1.47E+03	2.60E+03	2.13E+03	1.47E+03	2.60E+03	2.13E+03	1.47E+03	2.60E+03
28. Glass debris	3.00E+03	3.00E+03	1.65E+03	7.56E+03	3.00E+03	1.65E+03	7.56E+03	3.00E+03	1.65E+03	7.56E+03
29. Low-activity equipmentg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.68E+04	8.68E+03	5.31E+04	1.05E+04	5.94E+03	2.76E+04
30. Leadg	0.00E+00	2.98E+03	1.28E+03	7.68E+03	2.98E+03	1.28E+03	7.68E+03	2.98E+03	1.28E+03	7.68E+03
31. Low Level Job Controlh	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.87E+05	1.58E+05	2.10E+05	0.00E+00	0.00E+00	0.00E+00

32. Low Activity Equip	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.44E+05	9.85E+04	1.61E+05	0.00E+00	0.00E+00	0.00E+00
33. LLW from Deconh	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.54E+05	2.29E+05	1.63E+06	0.00E+00	0.00E+00	0.00E+00
34. Supercompacted ^{h,i}	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.02E+05	7.57E+04	1.01E+05	0.00E+00	0.00E+00	0.00E+00
35. Incinerate/S'compacted ^{h,i}	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.19E+03	1.63E+03	2.19E+03	0.00E+00	0.00E+00	0.00E+00
36. Reduce/ Repkg (CIF) ^{h,i}	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.26E+04	3.17E+04	4.21E+04	0.00E+00	0.00E+00	0.00E+00
37. Reduce/Repkg (vaults) ^{h,i}	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.64E+04	1.39E+04	1.84E+04	0.00E+00	0.00E+00	0.00E+00
38. Metal / Supercompact ^{h,i}	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.03E+04	8.72E+03	1.16E+04	0.00E+00	0.00E+00	0.00E+00
39. Supercompacted Equip. ^{h,i}	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.44E+05	9.85E+04	1.61E+05	0.00E+00	0.00E+00	0.00E+00
40. Supercompacted Decon ^{h,i}	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.54E+05	2.29E+05	1.63E+06	0.00E+00	0.00E+00	0.00E+00
Onsite totals: Low-level waste	4.74E+05	5.30E+05	3.92E+05	1.63E+06	5.26E+05	4.03E+05	1.58E+06	5.02E+05	3.83E+05	1.48E+06
Mixed waste	2.15E+05	3.40E+05	1.22E+05	1.59E+06	2.17E+05	1.21E+05	8.14E+05	2.14E+05	7.50E+04	8.09E+05
Transuranic waste	2.24E+04	2.24E+04	1.57E+04	5.50E+05	2.24E+04	1.57E+04	5.50E+05	2.24E+04	1.57E+04	5.50E+05
Offsite totals: Low-level waste	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.57E+06	9.54E+05	4.02E+06	1.05E+04	5.94E+03	2.76E+04
Mixed waste	0.00E+00	2.98E+03	1.28E+03	7.68E+03	2.98E+03	1.28E+03	7.68E+03	2.98E+03	1.28E+03	7.68E+03

Source: Washburn (1995), Sinkowski (1995).

a. MW = mixed waste.

b. Ci/m³ = Curies per cubic meter.

c. TRU = transuranic.

d. Rmt. = Remote-handled.

e. PUREX = Plutonium-uranium solution.

f. Ashcrete values are the result of processing of low-level and mixed waste only.

g. Offsite shipments.

h. Low-level volume reduction offsite shipments.

i. Low-level volume reduction return shipments to SRS.

SECTION 4

OCCUPATIONAL AND PUBLIC Health

Table E.4-1. Average number of workers assigned to onsite facilities.

Facility	No-Action	Alternative A			Alternative B			Alternative C		
		Min.	Exp.	Max.	Min.	Exp.	Max.	Min.	Exp.	Max.
E-Area Vaults	7	7	7	14	7	7	14	3	3	5
Containment building	0	10	10	25	10	10	19	10	10	13
RCRA-Permitted Disposal Vaults	1	5	6	11	5	5	11	5	5	11
Long-Lived Waste Storage Building	1	1	1	1	1	1	1	1	1	1
MW Storage Buildings ^b	39	10	16	67	9	14	65	10	13	65
Non-alpha vitrification facility	0	0	0	0	0	13	25	51	63	79
Shallow land disposal	8	8	8	16	8	8	16	8	8	16
TRU waste characterization/certification facility ^c	5	26	38	122	20	20	107	20	20	107
TRU waste retrieval operations	4	4	4	4	4	4	4	4	4	4
TRU Waste Storage Pads	14	10	10	96	10	10	97	11	11	99
Alpha vitrification facility	0	0	0	0	40	40	119	40	40	119
Soil sort facility	0	3	3	3	3	3	3	3	3	3
Aqueous and Organic Waste Storage Tanks	15	0	0	0	0	0	0	0	0	0
Consolidated Incineration Facility	0	26	26	26	26	26	26	10	10	10
F/H-Area Effluent Treatment Facility	40	40	40	40	40	40	40	40	40	40
H-Area Tank Farm	1,562	1,562	1,562	1,562	1,562	1,562	1,562	1,562	1,562	1,562
Replacement High-Level Waste Evaporator	15	15	15	15	15	15	15	15	15	15
Waste removal operations	10	10	10	10	10	10	10	10	10	10
M-Area Compaction Facility	4	4	4	4	4	4	4	4	4	4
M-Area Liquid Effluent Treatment Facility	31	31	31	31	31	31	31	31	31	31
M-Area Vendor Treatment Facility	10	10	10	10	10	10	10	10	10	10
SRTC MW Tanks/Ion Exchanged	4	4	4	4	4	4	4	4	4	4

D-Area Ion Exchange Process	1	1	1	1	1	1	1	1	1	1	1
F-Area Tank Farm	308	308	308	308	308	308	308	308	308	308	308
253-H Compaction Facility	3	3	3	3	3	3	3	3	3	3	3
Waste management workers (average yearly)	2,082	2,098	2,117	2,373	2,131	2,148	2,495	2,163	2,178	2,520	

a. Source: Hess (1994e).

b. MW = mixed waste.

c. TRU = transuranic.

d. SRTC = Savannah River Technology Center.

Table E.4-2. Onsite facility workers annual dose during the 30-year period of interest (in person-millirem).

Facility worker dose	Averageb annual dose	No- Action	Alternative A			Alternative B			Alternative C		
			Min.	Exp.	Max.	Min.	Exp.	Max.	Min.	Exp.	Max.
E-Area Vaults	16	112	112	112	224	112	112	224	41	41	82
Containment building	250	0	2,375	2,375	6,333	2,375	2,375	4,750	2,375	2,375	3,167
RCRA-Permitted Disposal Vaults	16	12	86	97	172	86	86	172	86	86	172
Long-Lived Waste Storage Building	16	16	16	16	16	16	16	16	16	16	16
MW Storage Buildingsc	16	624	160	256	1,072	144	224	1,040	160	208	1,040
Non-alpha vitrification facility	250	0	0	0	0	0	3167	6,333	12,667	15,833	19,792
Shallow Land Disposal	16	128	128	128	256	128	128	256	128	128	256
TRU waste characterization/certification facilityd	220	1,100	5,720	8,360	26,840	4,400	4,400	23,540	4,400	4,400	23,540
TRU waste retrieval operations	220	880	880	880	880	880	880	880	880	880	880
TRU Waste Storage Pads	220	3,080	2,200	2,200	21,120	2,200	2,200	21,340	2,420	2,420	21,780
Alpha vitrification facility	250	0	0	0	0	9,917	9,917	29,750	9,917	9,917	29,750
Soil sort facility	220	0	697	697	697	697	697	697	697	697	697
Aqueous and Organic Waste Storage Tanks	16	240	0	0	0	0	0	0	0	0	0
Consolidated Incineration Facility	350	0	9,135	9,135	9,135	9,135	9,135	9,135	3,465	3,465	3,465
F/H-Area Effluent Treatment Facility	1	40	40	40	40	40	40	40	40	40	40
H-Area Tank Farm	21	32,804	32,804	32,804	32,804	32,804	32,804	32,804	32,804	32,804	32,804
Replacement High-Level Waste Evaporator	149	2,235	2,235	2,235	2,235	2,235	2,235	2,235	2,235	2,235	2,235
Waste removal operations	21	210	210	210	210	210	210	210	210	210	210
M-Area Compaction Facility	1	4	4	4	4	4	4	4	4	4	4

M-Area Liquid Effluent Treatment Facility	1	31	31	31	31	31	31	31	31	31	31
M-Area Vendor Treatment Facility	250	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500
SRTC MW Tanks/Ion Exchange	8	32	32	32	32	32	32	32	32	32	32
D-Area Ion Exchange Process	2	2	2	2	2	2	2	2	2	2	2
F-Area Tank Farm	26	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000
253-H Compaction Facility	1	3	3	3	3	3	3	3	3	3	3
Total annual dose, person-millirem		52,000	67,000	70,000	113,000	76,000	79,000	144,000	83,000	86,000	150,000
Average worker dose, millirem per year		25	32	33	47	36	37	58	38	40	60

a. Source: Hess (1994e).

b. Average annual dose for a facility worker.

c. MW = mixed waste.

d. TRU = transuranic.

e. SRTC = Savannah River Technology Center.

f. Average annual worker dose from all facilities.

Table E.4-3. Summary of facility-specific doses to the offsite maximally exposed individual from atmospheric releases (in millirem).

	No-Action	Alternative A			Alternative B			Alternative C		
Onsite facilities		Minimum	Expected	Maximum	Minimum	Expected	Maximum	Minimum	Expected	Maximum
Consolidated Incineration Facility	(b)	0.09	0.212	0.568	0.255	0.318	0.689	0.0667	0.0916	0.215
Compaction facilities	1.55E-06	1.55E-06	1.55E-06	1.55E-06	5.18E-08	5.18E-08	5.18E-08	1.99E-07	2.40E-07	2.48E-07
Onsite vitrification facilities	(b)	(b)	(b)	(b)	0.315	0.561	8.08	2.56	5.20	118
M-Area Vendor Treatment Facility ^c	0.00371	0.00371	0.00371	0.00371	0.00371	0.00371	0.00371	0.00371	0.00371	0.00371
Soil sort facilities	(b)	6.96E-07	2.58E-06	1.28E-05	8.17E-07	2.87E-06	1.75E-05	5.52E-07	2.03E-06	1.18E-05
Transuranic waste characterization/certification facility	(b)	0.0775	0.111	1.83	0.0775	0.111	1.83	0.0775	0.110	1.83

F/H-Area Effluent Treatment Facility	(d)	(d)	(d)	(d)	(d)	(d)	(d)	(d)	(d)	(d)
Containment building	(d)	1.22E-06	2.41E-06	8.26E-06	7.99E-07	1.59E-06	5.55E-06	3.24E-07	6.82E-07	2.51E-06
30-year total	0.0037	0.171	0.327	2.41	0.651	0.994	10.6	2.71	5.40	120
Average annual dose	1.24E-04	0.00571	0.0109	0.802	0.217	0.331	0.354	0.0902	0.18	4.02
Offsite facilities										
Supercompaction, sorting	(b)	6.66E-06	1.52E-05	3.88E-05	3.83E-04	4.85E-04	6.86E-04	6.66E-06	1.52E-05	3.88E-05
Smelt, incinerate, metal melt	(b)	(b)	(b)	(b)	0.0377	0.0514	0.0927	0.00607	0.0108	0.0284
30-year total		6.66E-06	1.52E-05	3.88E-05	0.0381	0.0519	0.0934	0.00608	0.0108	0.0284
Average annual dose		2.22E-07	5.08E-07	1.29E-06	0.00127	0.00173	0.00311	2.03E-04	3.61E-04	9.47E-04

Source: Chesney (1995).

a. Except where noted, the doses reported are for the 30-year period of interest.

b. Facility not operated in this alternative.

c. Doses are calculated from the center of SRS due to unavailability of other population data.

d. Routine operations are not expected to provide atmospheric releases.

e. Offsite-maximally-exposed individual average annual dose is determined by dividing the 30-year dose by 30. For onsite facilities the offsite maximally exposed individual is within 80 kilometers (50 miles) of SRS. For offsite facilities the offsite maximally exposed individual is considered to be within 80 kilometers (50 miles) of Oak Ridge, Tennessee.

Table E.4-4. Summary of facility-specific doses to offsite population from atmospheric releases (person-rem).

	No-Action	Alternative A			Alternative B			Alternative C		
Onsite facilities		Minimum	Expected	Maximum	Minimum	Expected	Maximum	Minimum	Expected	Maximum
Consolidated Incineration Facility	(b)	5.31	12.6	33.9	15.1	18.8	36.2	3.95	5.42	12.6
Compaction facilities	6.15E-05	6.15E-05	6.15E-05	6.15E-05	2.05E-06	2.05E-06	2.05E-06	7.86E-06	9.49E-06	9.82E-06
Onsite vitrification facilities	(b)	(b)	(b)	(b)	12.5	24.4	330	141	293	6,790
M-Area Vendor Treatment Facility	0.00851	0.00851	0.00851	0.00851	0.00851	0.00851	0.00851	0.00851	0.00851	0.00851
Soil sort facilities	(b)	2.75E-05	1.02E-04	5.08E-04	3.23E-05	1.14E-04	6.93E-04	2.56E-05	9.38E-05	5.47E-04
Transuranic waste characterization/certification facility	(b)	2.92	4.19	69.1	2.92	4.19	69.1	2.92	4.19	69.1

F/H-Area Effluent Treatment Facility	(d)	(d)	(d)	(d)	(d)	(d)	(d)	(d)	(d)	(d)
Containment building	(b)	4.83E-05	9.56E-05	3.27E-04	3.16E-05	6.31E-05	2.20E-04	1.28E-05	2.70E-05	9.93E-05
30-year total	0.0857	8.24	16.8	103	30.5	47.4	436	148	302	6,880
Average annual dose ^e	2.86E-04	0.275	0.560	3.43	1.02	1.58	14.5	4.92	10.1	220
Offsite facilities										
Supercompaction, sorting	(b)	3.03E-06	6.93E-06	1.77E-05	1.74E-04	2.21E-04	3.13E-04	3.03E-06	6.93E-06	1.77E-05
Smelt, incinerate, metal melt	(b)	(b)	(b)	(b)	0.251	0.346	0.624	0.0409	0.0728	0.191
30-year total		3.03E-06	6.93E-06	1.77E-05	0.254	0.346	0.625	0.0409	0.0728	0.191
Average annual dose ^e		1.01E-07	2.31E-07	5.89E-07	0.00847	0.0115	0.0208	0.00136	0.00243	0.00637

Source: Chesney (1995).

a. Except where noted, the doses reported are for the 30-year period of interest.

b. Facility not operated in this alternative.

c. Doses are calculated from the center of SRS due to unavailability of other population data.

d. Routine operations are not expected to provide atmospheric releases.

e. Average annual dose is determined by dividing the 30-year dose by 30. For onsite facilities the offsite maximally exposed individual is within 80 kilometers (50 miles) of SRS. For offsite facilities the offsite maximally exposed individual is considered to be within 80 kilometers (50 miles) of Oak Ridge, Tennessee.

Table E.4-5. Summary of facility-specific doses to the 640-meter (2,100 feet) uninvolved worker from atmospheric releases (in millirem).

	No-Action	Alternative A			Alternative B			Alternative C		
Onsite facilities		Minimum	Expected	Maximum	Minimum	Expected	Maximum	Minimum	Expected	Maximum
Consolidated Incineration Facility	(b)	1.77	4.25	11.5	5.07 ^c	6.28	9.76	1.32	1.81	4.12
Compaction facilities	6.01E-05	6.01E-05	6.01E-05	6.01E-05	2.00E-06	2.00E-06	2.00E-06	7.67E-06	9.27E-06	9.59E-06
Onsite vitrification facilities	(b)	(b)	(b)	(b)	1.60	4.52	48.8	42.7	92	219
M-Area Vendor Treatment Facility	0.00856	0.00856	0.00856	0.00856	0.00856	0.00856	0.00856	0.00856	0.00856	0.00856
Soil sort facilities	(b)	2.69E-05	9.95E-05	4.96E-04	3.16E-05	1.11E-04	6.76E-04	6.76E-06	2.48E-05	1.45E-04
Transuranic waste characterization/certification facility	(b)	3.26	4.68	77.1	3.26	4.68	77.1	3.26	4.68	77.1

F/H-Area Effluent Treatment Facility	(d)	(d)	(d)	(d)	(d)	(d)	(d)	(d)	(d)	(d)
Containment building	(b)	4.72E-05	9.33E-05	3.19E-04	3.09E-05	6.16E-05	2.14E-04	1.25E-05	2.64E-05	9.69E-05
Average annual dose ^a	2.85E-04	0.0109	0.156	2.57	0.169	0.209	2.57	1.42	3.07	73
Offsite facilities										
Supercompaction, sorting	(f)	(f)	(f)	(f)	(f)	(f)	(f)	(f)	(f)	(f)
Smelt, incinerate, metal melt	(f)	(f)	(f)	(f)	(f)	(f)	(f)	(f)	(f)	(f)

Source: Chesney (1995).

a. Except where noted, the doses reported are for a 30-year period of interest.

b. Facility not operated in this alternative.

c. Italics indicate the facility that would produce the highest dose to any individual under each alternative/forecast. This maximum dose was used to calculate the average annual dose.

d. Routine operations are not expected to provide atmospheric releases.

e. Maximally exposed individual doses are not added; average annual dose is determined by dividing the 30-year dose from the highest impact facility (shown in italics) by 30.

f. The 640 meter worker is a receptor unique to DOE and is not evaluated by the Nuclear Regulatory Commission or agreement state licensees.

Table E.4-6. Summary of facility-specific doses^a to the 100-meter (328 foot) uninvolved worker (in millirem) from atmospheric releases.

	No-Action	Alternative A			Alternative B			Alternative C		
Onsite facilities		Minimum	Expected	Maximum	Minimum	Expected	Maximum	Minimum	Expected	Maximum
Consolidated Incineration Facility	(b)	5.14	12.2	32.8	14.6	18.1	32.4	3.80	5.23	12
Compaction facilities	0.00169	0.00169	0.00169	0.00169	5.64E-05	5.64E-05	5.64E-05	2.16E-04	2.61E-04	2.70E-04
Onsite vitrification facilities	(b)	(b)	(b)	(b)	12.2	23.8	323	<i>136c</i>	<i>283</i>	<i>6,580</i>
M-Area Vendor Treatment Facility	<i>0.304</i>	0.304	0.304	0.304	0.304	0.304	0.304	0.304	0.304	0.304
Soil sort facilities	(b)	7.57E-04	0.0028	0.014	8.88E-04	0.00312	0.019	2.56E-05	9.40E-05	5.47E-04
Transuranic waste characterization/certification facility	(b)	<i>112</i>	<i>161</i>	<i>2,650</i>	<i>112</i>	<i>161</i>	<i>2,650</i>	111	161	2,650
F/H-Area Effluent Treatment Facility	(d)	(d)	(d)	(d)	(d)	(d)	(d)	(d)	(d)	(d)
Containment building	(b)	0.00133	0.00263	0.00899	8.69E-04	0.00173	0.00604	3.53E-04	7.42E-04	0.00273
Average annual dose ^a	0.0102	3.73	5.37	88.3	3.73	5.37	88.3	4.53	9.43	219
Offsite facilities										
Supercompaction, sorting	(f)	(f)	(f)	(f)	(f)	(f)	(f)	(f)	(f)	(f)
Smelt, incinerate, metal melt	(f)	(f)	(f)	(f)	(f)	(f)	(f)	(f)	(f)	(f)

Source: Chesney (1995).

a. Except where noted, the doses reported are for a 30-year period of interest.

b. Facility not operated in this alternative.

c. Italics indicate the facility that would produce the highest dose to any individual under each alternative/forecast. This maximum dose was used to calculate the average annual dose.

d. Routine operations are not expected to provide atmospheric releases.

e. Maximally exposed individual doses are not added; average annual dose is determined by dividing the 30-year dose from the highest impact facility (shown in italics) by 30.

f. The 100 meter worker is a receptor unique to DOE and is not evaluated by the Nuclear Regulatory Commission or agreement state licensees.

Table E.4-7. Summary of facility-specific doses to the offsite maximally exposed individual from aqueous releases

	No-Action	Alternative A			Alternative B			
Onsite facilities		Minimum	Expected	Maximum	Minimum	Expected	Maximum	
Consolidated Incineration Facility	(b)	(c)	(c)	(c)	(c)	(c)	(c)	
Compaction facilities	(c)	(c)	(c)	(c)	(c)	(c)	(c)	
Onsite vitrification facilities	(b)	(b)	(b)	(b)	(c)	(c)	(c)	
M-Area Vendor Treatment Facility	(c)	(c)	(c)	(c)	(c)	(c)	(c)	
Soil sort facilities	(b)	(c)	(c)	(c)	(c)	(c)	(c)	
Transuranic waste characterization/certification facility	(b)	(c)	(c)	(c)	(c)	(c)	(c)	
F/H-Area Effluent Treatment Facility	0.0208	0.0208	0.0208	0.0208	0.0208	0.0208	0.0208	0
Containment building	(b)	(c)	(c)	2.07E-05	(c)	(c)	1.41E-05	
30-year total	0.0208	0.0208	0.0208	0.0208	0.0208	0.0208	0.0208	0
Average annual dose	6.93E-04	6.93E-04	6.93E-04	6.94E-04	6.93E-04	6.93E-04	6.94E-04	6
Offsite facilities								
Supercompaction, sorting	(b)	(c)	(c)	(c)	(c)	(c)	(c)	
Smelt, incinerate, metal melt	(b)	(b)	(b)	(b)	(c)	(c)	(c)	

Source: Chesney (1995).

a. Except where noted, the doses reported are for a 30-year period of interest.

b. Facility not operated in this alternative.

c. Routine operations are not expected to provide liquid releases.

Table E.4-8. Summary of facility-specific doses to the offsite population (in person-rem) from aqueous releases.

	No-Action	Alternative A				Alternative B		
Onsite facilities		Minimum	Expected	Maximum	Minimum	Expected	Maximum	Minimum
Consolidated Incineration Facility	(b)	(c)	(c)	(c)	(c)	(c)	(c)	(c)
Compaction facilities	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)
Onsite vitrification facilities	(b)	(b)	(b)	(b)	(c)	(c)	(c)	(c)
M-Area Vendor Treatment Facility	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)
Soil sort facilities	(b)	(c)	(c)	(c)	(c)	(c)	(c)	(c)
Transuranic waste characterization/certification facility	(b)	(c)	(c)	(c)	(c)	(c)	(c)	(c)
F/H-Area Effluent Treatment Facility	0.0203	0.0203	0.0203	0.0203	0.0203	0.0203	0.0203	0.0203
Containment building	(b)	(c)	(c)	1.82E-04	(c)	(c)	1.24E-04	(c)
30-year total	0.203	0.203	0.203	0.204	0.203	0.203	0.204	0.203
Average annual dose	0.00678	0.00678	0.00678	0.00679	0.00678	0.00678	0.00679	0.00678
Offsite facilities								
Supercompaction, sorting	(b)	(c)	(c)	(c)	(c)	(c)	(c)	(c)

Smelter, incinerator, metal metal	(b)	(c)	(c)	(c)	(c)	(c)	(c)	(c)
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Source: Chesney (1995).

a. Except where noted, the doses reported are for the 30-year period of interest.

b. Facility not operated in this alternative.

c. Routine operations are not expected to provide liquid releases.

Table E.4-9. Compactor facility dose distribution by isotope for the no-action alternative.

Radionuclides	Atmospheric releases (percent of total dose)			
	MEI ^b	Population ^c	640-meter uninvolved worker ^d (2,100 feet)	100-meter uninvolved worker ^d (328 feet)
Cobalt-60	7.08	6.13	11.21	8.56
Cesium-134	6.13	3.94	5.15	3.90
Cesium-137	19.81	28.86	25.85	19.39
Europium-154	≤1.0 ^e	≤1.0 ^e	1.51	≤1.0 ^e
Tritium	18.44	18.31	11.37	12.11
Plutonium-238	31.18	29.68	33.96	41.53
Plutonium-239	≤1.0 ^e	≤1.0 ^e	≤1.0 ^e	1.35
Ruthenium-106	1.13	≤1.0 ^e	≤1.0 ^e	≤1.0 ^e
Strontium-90	8.36	4.44	1.75	2.16
Uranium-234	3.99	4.37	5.57	6.87
Other ^f	3.88	4.28	3.62	4.13
	Millirem	Person-rem	Millirem	Millirem
Total dose ^{g,h}	1.55E-06	6.15E-05	6.01E-05	1.69E-03

Source: Blankenhorn (1994); Hess (1994f, g); Simpkins (1994a); and Chesney (1995).

a. Routine operations are not expected to produce aqueous releases.

b. MEI = maximally exposed individual.

c. For atmospheric releases, the dose to the population within 80 kilometers (50 miles) of SRS.

d. Dose to 640-meter and 100-meter uninvolved workers are based on an 80-hour work week.

e. The contribution from this radionuclide to the given receptor is less than or equal to 1.0 percent and is accounted for in the "Other" category.

f. Refer to Table E.4-34 for a listing of the radionuclides included in "Other."

g. Dose refers to committed effective dose equivalent (see glossary).

h. Total doses are for the 30-year period of interest.

Table E.4-10. Consolidated Incineration Facility dose distribution by isotope for alternative A.

Radionuclides	Atmospheric releases (percent of total dose)			
	MEI ^b	Population ^c	640-meter uninvolved worker (2,100 feet)	100-meter uninvolved worker (328 feet)
Cobalt-60	2.29	≤1.0 ^d	3.33	3.38
Cesium-134	20.25	11.00	16.03	15.89
Cesium-137	66.44	81.97	78.79	77.00
Strontium-90	7.62	2.83	≤1.0 ^d	≤1.0 ^d
Other ^e	3.40	4.20	1.75	3.74
Total dose ^{f,g}	Millirem	Person-rem	Millirem	Millirem
Expected	0.21	12.60	4.25	12.20
Maximum	0.57	34.00	11.50	32.80
Minimum	0.090	5.31	1.77	5.14

Source: Blankenhorn (1994); Hertel et al. (1994); Hess (1994g); Simpkins (1994a); and Chesney (1995).

a. Routine operations are not expected to produce aqueous releases.

b. MEI = maximally exposed individual.

c. For atmospheric releases, the dose is to the population within 80 kilometers (50 miles) of SRS.

d. The contribution from this radionuclide to the given receptor is less than or equal to 1.0 percent and is accounted for in the "Other" total.

e. Refer to Table E.4-34 for a listing of the radionuclides included in "Other."

f. Dose refers to committed effective dose equivalent (see glossary).

g. Total doses are for the 30-year period of interest.

Table E.4-11. Compactor facilities dose distribution by isotope for alternative A.

Radionuclides	Atmospheric releases (percent of total dose)			
	MEI ^b	Population ^c	640-meter uninvolved worker (2,100 feet)	100-meter uninvolved worker (328 feet)
Cobalt-60	7.08	6.13	11.21	8.56
Cesium-134	6.13	3.94	5.15	3.90
Cesium-137	19.81	28.86	25.85	19.39
Europium-154	≤1.0 ^d	≤1.0 ^d	1.51	≤1.0 ^d
Tritium	18.44	18.31	11.37	12.11
Plutonium-238	31.18	29.68	33.96	41.53
Plutonium-239	≤1.0 ^d	≤1.0 ^d	≤1.0 ^d	1.35
Ruthenium-106	1.13	≤1.0 ^d	≤1.0 ^d	≤1.0 ^d
Strontium-90	8.36	4.44	1.75	2.16
Uranium-234	3.99	4.37	5.57	6.87
Other ^e	3.88	4.28	3.62	4.13
Total dose ^{f,g}	Millirem	Person-rem	Millirem	Millirem
Expected	1.55E-06	6.15E-05	6.01E-05	1.69E-03
Maximum	1.55E-06	6.15E-05	6.01E-05	1.69E-03
Minimum	1.55E-06	6.15E-05	6.01E-05	1.69E-03

Source: Blankenhorn (1994); Hess (1994f, g); Simpkins (1994a); and Chesney (1995).

a. Routine operations are not expected to produce aqueous releases.

b. MEI = maximally exposed individual.

c. For atmospheric releases, the dose to the population within 80 kilometers (50 miles) of SRS.

d. The contribution from this radionuclide to the given receptor is less than or equal to 1.0 percent and is accounted for in the "Other" total.

e. Refer to Table E.4-34 for a listing of the radionuclides included in "Other."

f. Dose refers to committed effective dose equivalent (see glossary).

g. Total doses are for the 30-year period of interest.

Table E.4-12. Soil sort facility dose distribution by isotope for alternative A.

Radionuclides	Atmospheric releases (percent of total dose)			
	MEI ^b	Population ^c	640-meter uninvolved worker (2,100 feet)	100-meter uninvolved worker (328 feet)
Cobalt-60	7.08	6.13	11.21	8.56
Cesium-134	6.13	3.94	5.15	3.90
Cesium-137	19.81	28.86	25.85	19.39
Europium-154	≤1.0 ^d	≤1.0 ^d	1.51	≤1.0 ^d
Tritium	18.44	18.31	11.37	12.11
Plutonium-238	31.18	29.68	33.96	41.53
Plutonium-239	≤1.0 ^d	≤1.0 ^d	≤1.0 ^d	1.35
Ruthenium-106	1.13	≤1.0 ^d	≤1.0 ^d	≤1.0 ^d
Strontium-90	8.36	4.44	1.75	2.16
Uranium-234	3.99	4.37	5.57	6.87
Other ^e	3.88	4.28	3.62	4.13
Total dose ^f ,g	Millirem	Person-rem	Millirem	Millirem
Expected	2.58E-06	1.02E-04	9.95E-05	2.80E-03
Maximum	1.28E-05	5.08E-04	4.96E-04	1.40E-02
Minimum	6.96E-07	2.75E-05	2.69E-05	7.57E-04

Source: Blankenhorn (1994); Hess (1994g); Simpkins (1994a); and Chesney (1995).

a. Routine operations are not expected to produce aqueous releases.

b. MEI = maximally exposed individual.

c. For atmospheric releases, the dose to the population within 80 kilometers (50 miles) of SRS.

d. The contribution from this radionuclide to the given receptor is less than or equal to 1.0 percent and is accounted for in the "Other" total.

e. Refer to Table E.4-34 for a listing of the radionuclides included in "Other."

f. Dose refers to committed effective dose equivalent (see glossary).

g. Total doses are for the 30-year period of interest.

Table E.4-13. Transuranic waste characterization/certification facility dose distribution by isotope for alternative A.

Radionuclides	Atmospheric releases (percent of total dose)			
	MEI ^b	Population ^c	640-meter uninvolved worker (2,100 feet)	100-meter uninvolved worker (328 feet)
Plutonium-238	83.65	83.66	83.85	83.89
Plutonium-239	15.38	15.37	15.17	15.13
Other ^d	0.97	0.97	0.98	0.98
Total dose ^{e,f}	Millirem	Person-rem	Millirem	Millirem
Expected	0.111	4.19	4.68	161
Maximum	1.83	69.1	77	2.650
Minimum	0.0775	2.92	3.26	112

Source: Blankenhorn (1994); Hess (1994g); Simpkins (1994a); and Chesney (1995).

a. Routine operations are not expected to produce aqueous releases.

b. MEI = maximally exposed individual.

c. For atmospheric releases, the dose to the population within 80 kilometers (50 miles) of SRS.

d. Refer to Table E.4-34 for a listing of the radionuclides included in "Other."

e. Dose refers to committed effective dose equivalent (see glossary).

f. Total doses are for the 30-year period of interest.

Table E.4-14. Containment building dose distribution by isotope for alternative A.

Radionuclides	Atmospheric releases (percent of total dose)				Aqueous releases (percent of total dose)	
	MEI ^a	Population ^b	640-meter uninvolved worker (2,100 feet)	100-meter uninvolved worker (328 feet)	MEI ^a	Population ^b

Cobalt-60	7.08	6.13	11.21	8.56	<1.0 ^c	5.97
Cesium-134	6.13	3.94	5.15	3.90	81.85	21.81
Cesium-137	19.81	28.86	25.85	19.39	<1.0 ^c	<1.0 ^c
Europium-154	<1.0 ^c	<1.0 ^c	1.51	<1.0 ^c	<1.0 ^c	<1.0 ^c
Tritium	18.44	18.31	11.37	12.11	10.51	32.22
Plutonium-238	31.18	29.68	33.96	41.53	4.62	28.48
Plutonium-239	<1.0 ^c	<1.0 ^c	<1.0 ^c	1.35	<1.0 ^c	<1.0 ^c
Ruthenium-106	1.13	<1.0 ^c	<1.0 ^c	<1.0 ^c	<1.0 ^c	2.37
Strontium-90	8.36	4.44	1.75	2.16	<1.0 ^c	<1.0 ^c
Uranium-234	3.99	4.37	5.57	6.87	<1.0 ^c	<1.0 ^c
Other ^d	3.88	4.28	3.62	4.13	3.02	9.17
Total dose ^{e,f}	Millirem	Person-rem	Millirem	Millirem	Millirem	Person-rem
Expected	2.41E-06	9.56E-05	9.33E-05	0.00263	(g)	(g)
Maximum	8.26E-06	3.27E-04	3.19E-04	0.00899	2.07E-05	1.82E-04
Minimum	1.22E-06	4.83E-05	4.72E-05	0.00133	(g)	(g)

Source: Blankenhorn (1994); Hess (1994g, h); Simpkins (1994a); and Chesney (1995).

a. MEI = maximally exposed individual.

b. For atmospheric releases, the dose to the population within 80 kilometers (50 miles) of SRS. For aqueous releases, the dose is to the people using the Savannah River from SRS to the Atlantic Ocean.

c. The contribution from this radionuclide to the given receptor is less than or equal to 1.0 percent and is accounted for in the "Other" total.

d. Refer to Table E.4-34 for a listing of the radionuclides included in "Other."

e. Dose refers to committed effective dose equivalent (see glossary).

f. Total doses are for the 30-year period of interest.

g. Routine operations are not expected to produce aqueous releases.

Table E.4-15. Mixed waste offsite vendor dose distribution by isotope for alternative A.

Radionuclides	Atmospheric releases (percent of total dose)	
	MEI ^b	Population ^c
Cesium-134	<1.0 ^d	1.62
Cesium-137	1.68	1.92
Tritium	75.92	32.52
Plutonium-238	13.54	44.04

Plutonium-239	<1.0d	1.39
Strontium-90	1.49	<1.0d
Uranium-234	3.68	12.12
Uranium-236	<1.0d	2.13
Other	3.69	4.26
Total dose ^{f,g}	Millirem	Person-rem
Expected	1.52E-05	6.93E-06
Maximum	3.88E-05	1.77E-05
Minimum	6.66E-06	3.03E-06

Source: Blankenhorn (1994); Hess (1994g); Simpkins (1994a); and Chesney (1995).

- a. Routine operations are not expected to produce aqueous releases.
- b. MEI = maximally exposed individual.
- c. For atmospheric releases, the dose to the population within 80 kilometers (50 miles) of SRS.
- d. The contribution from this radionuclide to the given receptor is less than or equal to 1.0 percent and is accounted for in the "Other" total.
- e. Refer to Table E.4-34 for a listing of the radionuclides included in "Other."
- f. Dose refers to committed effective dose equivalent (see glossary).
- g. Total doses are for the 30-year period of interest.

Table E.4-16. Consolidated Incineration Facility dose distribution by isotope for alternative B.

Radionuclides	Atmospheric releases (percent of total dose)			
	MEI ^b	Population ^c	640-meter uninvolved worker (2,100 feet)	100-meter uninvolved worker (328 feet)
Cobalt-60	2.26	1.72	3.32	3.33
Cesium-134	19.92	10.88	15.99	15.78
Cesium-137	65.28	80.97	78.62	76.38
Strontium-90	7.50	2.80	<1.0 ^d	<1.0 ^d
Tritium	2.30	<1.0 ^d	<1.0 ^d	<1.0 ^d
Other	2.74	3.63	2.06	4.48
Total dose ^{f,g}	Millirem	Person-rem	Millirem	Millirem
Expected	0.318	18.8	6.28	18.1

Maximum	0.689	32.6	9.76	32.4
Minimum	0.255	15.1	5.07	14.6

Source: Blankenhorn (1994); Hertel et al. (1994); Hess (1994g); Simpkins (1994a); and Chesney (1995).

a. Routine operations are not expected to produce aqueous releases.

b. MEI = maximally exposed individual.

c. For atmospheric releases, the dose is to the population within 80 kilometers (50 miles) of SRS.

d. The contribution from this radionuclide to the given receptor is less than or equal to 1.0 percent and is accounted for in the "Other" total.

e. Refer to Table E.4-34 for a listing of the radionuclides included in "Other."

f. Dose refers to committed effective dose equivalent (see glossary).

g. Total doses are for the 30-year period of interest.

Table E.4-17. Onsite compactor facility dose distribution by isotope for alternative B.

Radionuclides	Atmospheric releases (percent of total dose)			
	MEI ^b	Population ^c	640-meter uninvolved worker (2,100 feet)	100-meter uninvolved worker (328 feet)
Cobalt-60	7.08	6.13	11.21	8.56
Cesium-134	6.13	3.94	5.15	3.90
Cesium-137	19.81	28.86	25.85	19.39
Europium-154	≤1.0 ^d	≤1.0 ^d	1.51	≤1.0 ^d
Tritium	18.44	18.31	11.37	12.11
Plutonium-238	31.18	29.68	33.96	41.53
Plutonium-239	≤1.0 ^d	≤1.0 ^d	≤1.0 ^d	1.35
Ruthenium-106	1.13	≤1.0 ^d	≤1.0 ^d	≤1.0 ^d
Strontium-90	8.36	4.44	1.75	2.16
Uranium-234	3.99	4.37	5.57	6.87
Other ^e	3.88	4.28	3.62	4.13
Total dose ^{f,g}	Millirem	Person-rem	Millirem	Millirem
Expected	5.18E-08	2.05E-06	2.00E-06	5.64E-05
Maximum	5.18E-08	2.06E-06	2.00E-06	5.64E-05
Minimum	5.18E-08	2.05E-06	2.00E-06	5.64E-05

Source: Blankenhorn (1994); Hess (1994f, g); Simpkins (1994a); and Chesney (1995).

- a. Routine operations are not expected to produce aqueous releases.
- b. MEI = maximally exposed individual.
- c. For atmospheric releases, the dose to the population within 80 kilometers (50 miles) of SRS.
- d. The contribution from this radionuclide to the given receptor is less than or equal to 1.0 percent and is accounted for in the "Other" category.
- e. Refer to Table E.4-34 for a listing of the radionuclides included in "Other."
- f. Dose refers to committed effective dose equivalent (see glossary).
- g. Total doses are for the 30-year period of interest.

Table E.4-18. Onsite vitrification facilities dose distribution by isotope for alternative B.

Radionuclides	Atmospheric releases (percent of total dose)			
	MEI ^b	Population ^c	640-meter uninvolved worker (2,100 feet)	100-meter uninvolved worker (328 feet)
Cesium-134	4.04	3.00	7.97	4.30
Cesium-137	13.21	22.25	39.07	20.75
Plutonium-238	67.42	61.29	42.37	61.47
Plutonium-239	12.26	11.16	7.80	11.16
Other ^d	3.07	2.30	2.79	2.31
Total dose ^{e,f}	Millirem	Person-rem	Millirem	Millirem
Expected	0.561	24.4	4.52	23.8
Maximum	8.08	330	48.8	323
Minimum	0.315	12.5	1.60	12.2

Source: Blankenhorn (1994); Hess (1994g); Simpkins (1994a); and Chesney (1995).

- a. Routine operations are not expected to produce aqueous releases.
- b. MEI = maximally exposed individual.
- c. For atmospheric releases, the dose to the population within 80 kilometers (50 miles) of SRS.
- d. Refer to Table E.4-34 for a listing of the radionuclides included in "Other."

e. Dose refers to committed effective dose equivalent (see glossary).

f. Total doses are for the 30-year period of interest.

Table E.4-19. Soil sort facility dose distribution by isotope for alternative B.

Radionuclides	Atmospheric releases (percent of total dose)			
	MEI ^b	Population ^c	640-meter uninvolved worker (2,100 feet)	100-meter uninvolved worker (328 feet)
Cobalt-60	7.08	6.13	11.21	8.56
Cesium-134	6.13	3.94	5.15	3.90
Cesium-137	19.81	28.86	25.85	19.39
Europium-154	<1.0 ^d	<1.0 ^d	1.51	<1.0 ^d
Tritium	18.44	18.31	11.37	12.11
Plutonium-238	31.18	29.68	33.96	41.53
Plutonium-239	<1.0 ^d	<1.0 ^d	<1.0 ^d	1.35
Ruthenium-106	1.13	<1.0 ^d	<1.0 ^d	<1.0 ^d
Strontium-90	8.36	4.44	1.75	2.16
Uranium-234	3.99	4.37	5.57	6.87
Other ^e	3.88	4.28	3.62	4.13
Total dose ^f ,g	Millirem	Person-rem	Millirem	Millirem
Expected	2.87E-06	1.14E-04	1.11E-04	0.00312
Maximum	1.75E-05	6.93E-04	6.76E-04	0.0190
Minimum	8.17E-07	3.23E-05	3.16E-05	8.88E-04

Source: Blankenhorn (1994); Hess (1994g); Simpkins (1994a); and Chesney (1995).

a. Routine operations are not expected to produce aqueous releases.

b. MEI = maximally exposed individual.

c. For atmospheric releases, the dose to the population within 80 kilometers (50 miles) of SRS.

d. The contribution from this radionuclide to the given receptor is less than or equal to 1.0 percent and is accounted for in the "Other" total.

e. Refer to Table E.4-34 for a listing of the radionuclides included in "Other."

f. Dose refers to committed effective dose equivalent (see glossary).

g. Total doses are for the 30-year period of interest.

Table E.4-20. Transuranic waste characterization/certification facility dose distribution by isotope for alternative B.

Radionuclides	Atmospheric releases (percent of total dose)			
	MEI ^b	Population ^c	640-meter uninvolved worker (2,100 feet)	100-meter uninvolved worker (328 feet)
Plutonium-238	83.65	83.66	83.85	83.89
Plutonium-239	15.38	15.37	15.17	15.13
Other ^d	0.97	0.97	0.98	0.98
Total dose ^{e,f}	Millirem	Person-rem	Millirem	Millirem
Expected	0.111	4.19	4.68	161
Maximum	1.83	69.1	77.1	2,650
Minimum	0.0775	2.92	3.26	112

Source: Blankenhorn (1994); Hess (1994g); Simpkins (1994a); and Chesney (1995).

a. Routine operations are not expected to produce aqueous releases.

b. MEI = maximally exposed individual.

c. For atmospheric releases, the dose to the population within 80 kilometers (50 miles) of SRS.

d. Refer to Table E.4-34 for a listing of the radionuclides included in "Other."

e. Dose refers to committed effective dose equivalent (see glossary).

f. Total doses are for the 30-year period of interest.

Table E.4-21. Containment building dose distribution by isotope for alternative B.

	Atmospheric releases (percent of total dose)	Aqueous releases (percent of total dose)
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Radionuclides	MEI ^a	Population ^b	640-meter uninvolved worker (2,100 feet)	100 meter uninvolved worker (328 feet)	MEI ^a	Population ^b
Cobalt-60	7.08	6.13	11.21	8.56	<1.0 ^c	5.97
Cesium-134	6.13	3.94	5.15	3.90	81.85	21.81
Cesium-137	19.81	28.86	25.85	19.39	<1.0 ^c	<1.0 ^c
Europium-154	<1.0 ^c	<1.0 ^c	1.51	<1.0 ^c	<1.0 ^c	<1.0 ^c
Tritium	18.44	18.31	11.37	12.11	10.51	32.22
Plutonium-238	31.18	29.68	33.96	41.53	4.62	28.48
Plutonium-239	<1.0 ^c	<1.0 ^c	<1.0 ^c	1.35	<1.0 ^c	<1.0 ^c
Ruthenium-106	1.13	<1.0 ^c	<1.0 ^c	<1.0 ^c	<1.0 ^c	2.37
Strontium-90	8.36	4.44	1.75	2.16	<1.0 ^c	<1.0 ^c
Uranium-234	3.99	4.37	5.57	6.87	<1.0 ^c	<1.0 ^c
Other ^d	3.88	4.28	3.62	4.13	3.02	9.17
Total dose ^{e,f}	Millirem	Person-rem	Millirem	Millirem	Millirem	Person-rem
Expected	1.59E-06	6.31E-05	6.16E-05	1.78E-03	(g)	(g)
Maximum	5.55E-06	2.20E-04	2.14E-04	6.04E-03	1.41E-05	1.24E-04
Minimum	7.99E-07	3.16E-05	3.09E-05	8.69E-04	(g)	(g)

Source: Blankenhorn (1994); Hess (1994g, h); Simpkins (1994a); and Chesney (1995).

a. MEI = maximally exposed individual.

b. For atmospheric releases, the dose to the population within 80 kilometers (50 miles) of SRS. For aqueous releases, the dose is to the people using the Savannah River from SRS to the Atlantic.

c. The contribution from this radionuclide to the given receptor is less than or equal to 1.0 percent and is accounted for in the "Other" total.

d. Refer to Table E.4-34 for a listing of the radionuclides included in "Other."

e. Dose refers to committed effective dose equivalent (see glossary).

f. Total doses are for the 30-year period of interest.

g. Routine operations are not expected to produce aqueous releases.

Table E.4-22. Offsite supercompaction, sorting, repackaging dose distribution by isotope for alternative B.

Radionuclides	Atmospheric releases (percent of total dose)	
	MEI ^b	Population ^c
Cesium-134	≤1.0 ^d	1.62
Cesium-137	1.68	1.92
Tritium	75.92	32.52
Plutonium-238	13.54	44.04
Plutonium-239	≤1.0 ^d	1.39
Strontium-90	1.49	≤1.0 ^d
Uranium-234	3.68	12.12
Uranium-236	≤1.0 ^d	2.13
Other ^e	3.69	4.26
Total dose ^{f,g}	Millirem	Person-rem
Expected	4.85E-04	2.21E-04
Maximum	6.86E-04	3.13E-04
Minimum	3.83E-04	1.74E-04

Source: Blankenhorn (1994); Hess (1994g); Simpkins (1994a); and Chesney (1995).

a. Routine operations are not expected to produce aqueous releases.

b. MEI = maximally exposed individual.

c. For atmospheric releases, the dose to the population within 80 kilometers (50 miles) of SRS.

d. The contribution from this radionuclide to the given receptor is less than or equal to 1.0 percent and is accounted for in the "Other" total.

e. Refer to Table E.4-34 for a listing of the radionuclides included in "Other."

f. Dose refers to committed effective dose equivalent (see glossary).

g. Total doses are for the 30-year period of interest.

Table E.4-23. Offsite smelting, incineration, and metal melt dose distribution by isotope for alternative B.

Radionuclides	Atmospheric releases (percent of total dose)	
	MEI ^b	Population ^c
Cesium-134	31.68	31.37
Cesium-137	44.16	36.07
Strontium-90	11.09	3.18
Uranium-234	9.24	21.21

Uranium-236	≤1.0d	3.71
Other ^e	3.83	4.46
Total dose ^{f,g}	Millirem	Person-rem
Expected	0.0514	0.346
Maximum	0.0927	0.624
Minimum	0.0377	0.254

Source: Blankenhorn (1994); Hess (1994g); Simpkins (1994a); and Chesney (1995).

a. Routine operations are not expected to produce aqueous releases.

b. MEI = maximally exposed individual.

c. For atmospheric releases, the dose to the population within 80 kilometers (50 miles) of SRS.

d. The contribution from this radionuclide to the given receptor is less than or equal to 1.0 percent and is accounted for in the "Other" total.

e. Refer to Table E.4-34 for a listing of the radionuclides included in "Other."

f. Dose refers to committed effective dose equivalent (see glossary).

g. Total doses are for the 30-year period of interest.

Table E.4-24. Consolidated Incineration Facility dose distribution by isotope for alternative C.

Radionuclides	Atmospheric releases (percent of total dose)			
	MEI ^b	Population ^c	640-meter uninvolved worker (2,100 feet)	100-meter uninvolved worker (328 feet)
Cobalt-60	2.26	1.72	3.32	3.35
Cesium-134	19.93	10.88	15.97	15.77
Cesium-137	65.45	81.11	78.67	76.46
Strontium-90	7.50	2.80	≤1.0 ^d	≤1.0 ^d
Other ^e	4.86	3.49	2.04	4.42
Total dose ^{f,g}	Millirem	Person-rem	Millirem	Millirem
Expected	0.091	5.42	1.81	5.23
Maximum	0.215	12.60	4.12	12.00
Minimum	0.0667	3.95	1.32	3.81

Source: Blankenhorn (1994); Hertel et al. (1994); Hess (1994g); Simpkins (1994a); and Chesney (1995).

- a. Routine operations are not expected to produce aqueous releases.
- b. MEI = maximally exposed individual.
- c. For atmospheric releases, the dose is to the population within 80 kilometers (50 miles) of SRS.
- d. The contribution from this radionuclide to the given receptor is less than or equal to 1.0 percent and is accounted for in the "Other" total.
- e. Refer to Table E.4-34 for a listing of the radionuclides included in "Other."
- f. Dose refers to committed effective dose equivalent (see glossary).
- g. Total doses are for the 30-year period of interest.

Table E.4-25. Compactor facilities dose distribution by isotope for alternative C.

Radionuclides	Atmospheric releases (percent of total dose)			
	MEI ^b	Population ^c	640-meter uninvolved worker (2,100 feet)	100-meter uninvolved worker (328 feet)
Cobalt-60	7.08	6.13	11.21	8.56
Cesium-134	6.13	3.94	5.15	3.90
Cesium-137	19.81	28.86	25.85	19.39
Europium-154	<1.0 ^d	<1.0 ^d	1.51	<1.0 ^d
Tritium	18.44	18.31	11.37	12.11
Plutonium-238	31.18	29.68	33.96	41.53
Plutonium-239	<1.0 ^d	<1.0 ^d	<1.0 ^d	1.35
Ruthenium-106	1.13	<1.0 ^d	<1.0 ^d	<1.0 ^d
Strontium-90	8.36	4.44	1.75	2.16
Uranium-234	3.99	4.37	5.57	6.87
Other ^e	3.88	4.28	3.62	4.13
Total dose ^{f,g}	Millirem	Person-rem	Millirem	Millirem
Expected	2.40E-07	9.49E-06	9.27E-06	2.61E-04
Maximum	2.48E-07	9.82E-06	9.59E-06	2.70E-04
Minimum	1.99E-07	7.86E-06	7.67E-06	2.16E-04

Source: Blankenhorn (1994); Hess (1994f, g); Simpkins (1994a); and Chesney (1995).

- a. Routine operations are not expected to produce aqueous releases.

b. MEI = maximally exposed individual.

c. For atmospheric releases, the dose to the population within 80 kilometers (50 miles) of SRS.

d. The contribution from this radionuclide to the given receptor is less than or equal to 1.0 percent and is accounted for in the "Other" total.

e. Refer to Table E.4-34 for a listing of the radionuclides included in "Other."

f. Dose refers to committed effective dose equivalent (see glossary).

g. Total doses are for the 30-year period of interest.

Table E.4-26. Onsite vitrification facilities dose distribution by isotope for alternative C.

Radionuclides	Atmospheric releases (percent of total dose)			
	MEI ^b	Population ^c	640-meter uninvolved worker (2,100 feet)	100-meter uninvolved worker (328 feet)
Cobalt-60	≤1.0 ^d	≤1.0 ^d	3.11	2.94
Strontium-90	6.41	2.51	≤1.0 ^d	≤1.0 ^d
Cesium-134	17.13	9.82	15.37	14.21
Cesium-137	56.08	22.99	75.48	68.69
Plutonium-238	13.96	9.81	3.99	9.93
Plutonium-239	2.54	≤1.0 ^d	≤1.0 ^d	≤1.0 ^d
Other ^e	3.88	4.86	2.05	4.24
Total dose ^{f,g}	Millirem	Person-rem	Millirem	Millirem
Expected	5.20	293	92	283
Maximum	118	6,790	2,190	6,580
Minimum	2.56	141	42.70	136

Source: Blankenhorn (1994); Hess (1994g); Simpkins (1994a); and Chesney (1995).

a. Routine operations are not expected to produce aqueous releases.

b. MEI = maximally exposed individual.

c. For atmospheric releases, the dose to the population within 80 kilometers (50 miles) of SRS.

d. The contribution from this radionuclide to the given receptor is less than or equal to 1.0 percent and is accounted for in the "Other" total.

e. Refer to Table E.4-34 for a listing of the radionuclides included in "Other."

f. Dose refers to committed effective dose equivalent (see glossary).

g. Total doses are for the 30-year period of interest.

Table E.4-27. Soil sort facility dose distribution by isotope for alternative C.

Radionuclides	Atmospheric releases (percent of total dose)			
	MEI ^b	Population ^c	640-meter uninvolved worker (2,100 feet)	100-meter uninvolved worker (328 feet)
Cobalt-60	8.37	8.14	19.89	15.29
Cesium-134	7.38	5.15	9.57	7.19
Cesium-137	24.12	38.23	46.91	34.70
Europium-154	≤1.0 ^d	≤1.0 ^d	2.78	2.15
Tritium	11.81	10.41	3.89	7.38
Plutonium-238	29.92	25.60	12.37	24.98
Plutonium-239	≤1.0 ^d	≤1.0 ^d	≤1.0 ^d	≤1.0 ^d
Ruthenium-106	1.32	≤1.0 ^d	≤1.0 ^d	≤1.0 ^d
Strontium-90	9.92	4.74	≤1.0 ^d	≤1.0 ^d
Uranium-234	3.34	3.49	≤1.0 ^d	4.15
Other ^e	3.82	4.24	4.58	4.16
Total dose ^{f,g}	Millirem	Person-rem	Millirem	Millirem
Expected	2.03E-06	9.38E-05	2.48E-05	9.40E-05
Maximum	1.18E-05	5.47E-04	1.45E-04	5.47E-04
Minimum	5.52E-07	2.56E-05	6.76E-06	2.56E-05

Source: Blankenhorn (1994); Hess (1994g); Simpkins (1994a); and Chesney (1995).

a. Routine operations are not expected to produce aqueous releases.

b. MEI = maximally exposed individual.

c. For atmospheric releases, the dose to the population within 80 kilometers (50 miles) of SRS.

d. The contribution from this radionuclide to the given receptor is less than or equal to 1.0 percent and is accounted for in the "Other" total.

e. Refer to Table E.4-34 for a listing of the radionuclides included in "Other."

f. Dose refers to committed effective dose equivalent (see glossary).

g. Total doses are for the 30-year period of interest.

Table E.4-28. Transuranic waste characterization/certification facility dose distribution by isotope for alternative C.

Radionuclides	Atmospheric releases (percent of total dose)			
	MEI ^b	Population ^c	640-meter uninvolved worker (2,100 feet)	100-meter uninvolved worker (328 feet)
Plutonium-238	83.65	83.66	83.85	83.89
Plutonium-239	15.38	15.37	15.17	15.13
Other ^d	0.97	0.97	0.98	0.98
Total dose ^{e,f}	Millirem	Person-rem	Millirem	Millirem
Expected	0.111	4.19	4.68	161
Maximum	1.83	69.1	77	2,650
Minimum	0.0775	2.92	3.26	112

Source: Blankenhorn (1995); Hess (1994g); Simpkins (1994a); and Chesney (1995).

a. Routine operations are not expected to produce aqueous releases.

b. MEI = maximally exposed individual.

c. For atmospheric releases, the dose to the population within 80 kilometers (50 miles) of SRS.

d. Refer to Table E.4-34 for a listing of the radionuclides included in "Other."

e. Dose refers to committed effective dose equivalent (see glossary).

f. Total doses are for the 30-year period of interest.

Table E.4-29. Containment building dose distribution by isotope for alternative C.

Radionuclides	Atmospheric releases (percent of total dose)			
	MEI ^b	Population ^c	640-meter uninvolved worker (2,100 feet)	100-meter uninvolved worker (328 feet)
Cobalt-60	≤1.0 ^d	≤1.0 ^d	≤1.0 ^d	≤1.0 ^d
Cesium-134	≤1.0 ^d	≤1.0 ^d	≤1.0 ^d	≤1.0 ^d
Cesium-137	≤1.0 ^d	≤1.0 ^d	≤1.0 ^d	≤1.0 ^d
Europium-154	≤1.0 ^d	≤1.0 ^d	≤1.0 ^d	≤1.0 ^d
Tritium ^e	99	99	99	99
Plutonium-238	≤1.0 ^d	≤1.0 ^d	≤1.0 ^d	≤1.0 ^d
Plutonium-239	≤1.0 ^d	≤1.0 ^d	≤1.0 ^d	≤1.0 ^d
Ruthenium-106	≤1.0 ^d	≤1.0 ^d	≤1.0 ^d	≤1.0 ^d
Strontium-90	≤1.0 ^d	≤1.0 ^d	≤1.0 ^d	≤1.0 ^d
Uranium-234	≤1.0 ^d	≤1.0 ^d	≤1.0 ^d	≤1.0 ^d
Other ^f	≤1.0 ^d	≤1.0 ^d	≤1.0 ^d	≤1.0 ^d
Total dose ^{g,h}	Millirem	Person-rem	Millirem	Millirem
Expected	2.17E-02	8.52E-01	5.16E-01	1.55E+01
Maximum	2.17E-02	8.52E-01	5.16E-01	1.55E+01
Minimum	2.17E-02	8.52E-01	5.16E-01	1.55E+01

Source: Blankenhorn (1994); Hess (1994g); Simpkins (1994a); and Chesney (1995).

a. Routine operations are not expected to produce aqueous releases.

b. MEI = maximally exposed individual.

c. For atmospheric releases, the dose to the population within 80 kilometers (50 miles) of SRS.

d. The contribution from this radionuclide to the given receptor is less than or equal to 1.0 percent and is accounted for in the "Other" total.

e. Tritium releases due to processing of tritium contaminated mercury pumps.

f. Refer to Table E.4-34 for a listing of the radionuclides included in "Other."

g. Dose refers to committed effective dose equivalent (see glossary).

h. Total doses are for the 30-year period of interest.

Table E.4-30. Mixed waste offsite vendor dose distribution by isotope for alternative C.

Radionuclides	Atmospheric releases (percent of total dose)	
	MEI ^b	Population ^c
Cesium-134	<1.0 ^d	1.62
Cesium-137	1.68	1.92
Tritium	75.92	32.52
Plutonium-238	13.54	44.04
Plutonium-239	<1.0 ^d	1.39
Strontium-90	1.49	<1.0 ^d
Uranium-234	3.68	12.12
Uranium-236	<1.0 ^d	2.13
Other ^e	3.69	4.26
Total dose ^{f,g}	Millirem	Person-rem
Expected	1.52E-05	6.93E-06
Maximum	3.88E-05	1.77E-05
Minimum	6.66E-06	3.03E-06

Source: Blankenhorn (1994); Hess (1994g); Simpkins (1994a); and Chesney (1995).

- a. Routine operations are not expected to produce aqueous releases.
- b. MEI = maximally exposed individual.
- c. For atmospheric releases, the dose to the population within 80 kilometers (50 miles) of SRS.
- d. The contribution from this radionuclide to the given receptor is less than or equal to 1.0 percent and is accounted for in the "Other" total.
- e. Refer to Table E.4-34 for a listing of the radionuclides included in "Other."
- f. Dose refers to committed effective dose equivalent (see glossary).
- g. Total doses are for the 30-year period of interest.

Table E.4-31. Offsite smelter dose distribution by isotope for alternative C.

Radionuclides	Atmospheric releases (percent of total dose)	
	MEI ^b	Population ^c
Cesium-134	31.68	31.37
Cesium-137	44.16	36.07
Strontium-90	11.09	3.18

Uranium-234	9.24	21.21
Uranium-236	$\leq 1.0^d$	3.71
Other ^e	3.83	4.46
Total dose ^{f,g}	Millirem	Person-rem
Expected	0.0108	0.0728
Maximum	0.0284	0.191
Minimum	0.00607	0.0409

Source: Blankenhorn (1994); Hess (1994g); Simpkins (1994a); and Chesney (1995).

a. Routine operations are not expected to produce aqueous releases.

b. MEI = maximally exposed individual.

c. For atmospheric releases, the dose to the population within 80 kilometers (50 miles) of SRS.

d. The contribution from this radionuclide to the given receptor is less than or equal to 1.0 percent and is accounted for in the "Other" total.

e. Refer to Table E.4-34 for a listing of the radionuclides included in "Other."

f. Dose refers to committed effective dose equivalent (see glossary).

g. Total doses are for the 30-year period of interest.

Table E.4-32. F/H-Area Effluent Treatment Facility dose distribution by isotope for all alternatives.

Radionuclides	Aqueous releases (percent of total dose)	
	MEI ^b	Population ^c
Cesium-137	70.52	18.79
Tritium	28.95	79.91
Other ^d	.053	1.30
	Millirem	Person-rem
Total dose ^{e,f,g}	0.0208	0.203

Source: Blankenhorn (1994); Hess (1994g, i); Poirier and Wiggins (1994), Simpkins (1994a); and Chesney (1995).

a. Routine operations are not expected to produce atmospheric releases.

b. MEI = maximally exposed individual.

c. For aqueous releases, the dose is to the people using the Savannah River from SRS to Atlantic Ocean.

d. Refer to Table E.4-34 for a listing of the radionuclides included in "Other."

e. Dose refers to committed effective dose equivalent (see glossary).

f. Total doses are for the 30-year period of interest.

g. Includes releases from processing of Defense Waste Processing Facility recycle. Remains essentially constant for all alternatives.

Table E.4-33. M-Area Vendor Treatment Facility dose distribution by isotope for all alternatives.

Radionuclides	Atmospheric releases (percent of total dose)			
	MEI ^b	Population ^c	640-meter uninvolved worker (2,100 feet)	100-meter uninvolved worker (328 feet)
Uranium-234	32.67	31.49	32.10	32.31
Uranium-238	64.93	65.98	65.48	65.31
Other ^d	2.40	2.53	2.43	2.38
Total dose ^{e,f}	Millirem	Person-rem	Millirem	Millirem
All alternatives	0.00371	0.00851	0.00856	0.304

Source: Blankenhorn (1994); Hamby (1994); Hess (1994g, j); Simpkins (1994a); and Chesney (1995).

a. Routine operations are not expected to produce aqueous releases.

b. MEI = maximally exposed individual.

c. For atmospheric releases, the dose to the population within 80 kilometers (50 miles) of SRS.

d. Refer to Table E.4-34 for a listing of the radionuclides included in "Other."

e. Dose refers to committed effective dose equivalent (see glossary).

f. Total doses are for the 30-year period of interest.

Table E.4-34. Radionuclides listed under "Other" in Tables E.4-9 through E.4-33.

Silver-110	Curium-246	Promethium-147	Strontium-89
Silver-110m	Curium-248	Promethium-148	Strontium-90
Aluminum-26	Chromium-51	Promethium-148m	Tantalum-182
Americium-241	Europium-154	Praseodymium-143	Terbium-160
Americium-243	Europium-155	Praseodymium-144	Technetium-99
Barium-137m	Europium-156	Plutonium-238	Tellurium-125m
Barium-140	Iron-55	Plutonium-239	Tellurium-127

Carbon-14	Iron-59	Plutonium-240	Tellurium-127m
Cadmium-113	Tritium	Plutonium-241	Tellurium-129
Cerium-141	Hafnium-181	Plutonium-242	Tellurium-129m
Cerium-144	Iodine-129	Rhodium-106	Uranium-233
Cobalt-58	Indium-113m	Ruthenium-103	Uranium-234
Cobalt-60	Indium-114	Ruthenium-103m	Uranium-235
Cesium-134	Krypton-85	Ruthenium-106	Uranium-236
Cesium-135	Lanthanum-140	Antimony-125	Uranium-238
Cesium-137	Manganese-54	Scandium-46	Yttrium-90
Californium-249	Nickel-59	Selenium-79	Yttrium 91
Californium-251	Nickel-63	Samarium-151	Zinc-65
Californium-252	Niobium-94	Tin-113	Zirconium-93
Californium-242	Niobium-95	Tin-119m	Zirconium-95
Californium-243	Niobium-95m	Tin-121m	Other Alpha
Californium-244	Neptunium-237	Tin-123	Other B/Gb
Californium-245	Palladium-107	Tin-126	

Source: Blankenhorn (1994), Hunt (1994), and Chesney (1995).

a. Each of the listed radionuclides contribute less than or equal to 1.0 percent of the total dose unless identified as a major contributor to total dose.

b. B/G = Unidentifiable beta/gamma emitting radionuclides.

SECTION 5

ENVIRONMENTAL JUSTICE

LOCAL AREA DOSES

Figure 4-6 is a map of the area around SRS out to a distance of 80 kilometers (50 miles). This map identifies annular sectors around SRS by a letter-number combination. Table E.5-1 uses these annular sector identifiers to show:

- The fraction of total population dose in each annular sector.
- The fraction of total population dose that the average person in each annular sector will receive (the per capita dose in each sector).

The total population dose for any of the alternatives and forecasts can be multiplied by the appropriate fraction associated with any annular sector to obtain the total population dose to the annular sector, or the per capita dose in that sector for any of the forecasts.

Tables E.5-2 through E.5-11 show the estimated per capita 30-year dose for identified types of communities within the 80 kilometer region for each of the alternatives and forecasts.

Table E.5-1. Annular sector factors for local dose evaluations.

Annular number and distance from center of SRS	Fraction of total population dose in annular sector					Fraction of total population dose that is dose to average person in annular sector				
	1 (5-10 mi) ^b	2 (10-20 mi)	3 (20-30 mi)	4 (30-40 mi)	5 (40-50 mi)	1 (5-10 mi)	2 (10-20 mi)	3 (20-30 mi)	4 (30-40 mi)	5 (40-50 mi)
Sector:										
A (N)	3.09E-04	2.79E-02	2.70E-02	8.63E-03	1.49E-02	1.19E-05	5.25E-06	2.69E-06	1.70E-06	1.22E-06
B (NNE)	5.86E-05	5.75E-03	4.71E-03	6.5E-03	1.51E-02	9.77E-06	4.35E-06	2.28E-06	1.46E-06	1.05E-06
C (NE)	1.02E-05	1.35E-02	7.03E-03	8.33E-03	1.17E-02	1.02E-05	4.57E-06	2.40E-06	1.58E-06	1.15E-06
D (ENE)	2.76E-04	1.29E-02	9.56E-03	7.43E-03	4.15E-02	1.02E-05	4.12E-06	2.13E-06	1.39E-06	1.02E-06
E (E)	1.28E-03	2.21E-02	8.91E-03	9.67E-03	3.48E-03	8.27E-06	3.27E-06	1.68E-06	1.10E-06	8.02E-07
F (ESE)	2.55E-04	4.37E-03	2.79E-03	2.56E-03	2.24E-03	7.07E-06	2.81E-06	1.45E-06	9.44E-07	6.90E-07
G (SE)	1.29E-04	1.11E-03	6.78E-03	4.54E-03	4.25E-03	4.96E-06	2.02E-06	1.04E-06	6.79E-07	4.95E-07
H (SSE)	1.61E-04	6.63E-04	6.92E-04	8.10E-04	1.12E-03	4.04E-06	1.70E-06	9.00E-07	5.97E-07	4.40E-07
I (S)	2.25E-06	5.48E-04	7.24E-04	2.69E-03	9.34E-04	2.25E-06	9.83E-07	5.44E-07	3.71E-07	2.80E-07
J (SSW)	1.29E-05	2.42E-03	2.90E-03	4.11E-03	2.12E-03	6.46E-06	2.70E-06	1.45E-06	9.82E-07	7.22E-07
K (SW)	1.87E-04	4.17E-03	5.22E-03	4.06E-03	3.02E-03	1.10E-06	4.41E-06	2.33E-06	1.56E-06	1.14E-06
L (WSW)	5.18E-04	3.87E-03	1.32E-02	2.84E-03	5.31E-03	8.64E-06	3.50E-06	1.86E-06	1.24E-06	9.13E-07
M (W)	3.43E-04	8.52E-03	1.11E-02	7.51E-03	4.62E-03	6.24E-06	2.57E-06	1.40E-06	9.40E-07	6.82E-07
N (WNW)	2.89E-03	9.16E-03	1.57E-01	4.99E-02	8.33E-03	6.43E-06	2.74E-06	1.47E-06	9.92E-07	7.22E-07
O (NW)	2.23E-03	2.08E-02	1.57E-01	3.04E-02	2.48E-03	8.22E-06	3.52E-06	1.79E-06	1.14E-06	8.21E-07
P (NNW)	3.97E-03	8.47E-02	6.28E-02	9.74E-03	6.34E-03	1.09E-05	4.70E-06	2.31E-06	1.46E-06	1.04E-06

a. Source: Simpkins (1994b).

b. No population resides within 8 kilometers (5 miles) of the center of SRS.

c. Sector letter is letter shown on Figure 4-6. Letters in parentheses after the sector letter indicate the compass direction of the sector.

Table E.5-2. Estimated per capita 30-year dose for identified communities in 80-kilometer (50-mile) region for the no-action alternative.

Distance	All	Persons of color more than 50% of Population	Persons of color 35% to 50% of Population	Persons of color less than 35% of Population	Low incomes more than 25% of population population	Low incomes less than 25% of Population
0-16 km (0-10 miles)	9.37E-08	8.49E-08	9.97E-08	8.67E-08	9.02E-08	9.55E-08
0-32 km (0-20 miles)	4.50E-08	3.54E-08	6.20E-08	4.10E-08	4.27E-08	4.57E-08
0-48 km (0-30 miles)	2.42E-08	1.89E-08	2.95E-08	2.49E-08	2.57E-08	2.37E-08
0-64 km (0-40 miles)	1.97E-08	1.73E-08	2.28E-08	1.94E-08	2.11E-08	1.93E-08
0-80 km (0-50 miles)	1.84E-08	1.59E-08	2.03E-08	1.88E-08	1.93E-08	1.82E-08
Total population populationdose = 0.0086 person-rem.						

Table E.5-3. Estimated per capita 30-year dose for identified communities in 80-kilometer (50-mile) region for alternative A - expected waste forecast.

Distance	All	Persons of color more than 50% of Population	Persons of color 35% to 50% of Population	Persons of color less than 35% of Population	Low incomes more than 25% of population population	Low incomes less than 25% of Population
0-16 km (0-10 miles)	1.85E-04	1.68E-04	1.97E-04	1.71E-04	1.78E-04	1.89E-04
0-32 km (0-20 miles)	8.89E-05	7.00E-05	1.22E-04	8.11E-05	8.45E-05	9.04E-05
0-48 km (0-30 miles)	4.78E-05	3.74E-05	5.84E-05	4.92E-05	5.09E-05	4.69E-05
0-64 km (0-40 miles)	3.89E-05	3.43E-05	4.51E-05	3.83E-05	4.17E-05	3.82E-05
0-80 km (0-50 miles)	3.64E-05	3.15E-05	4.01E-05	3.71E-05	3.81E-05	3.60E-05

Total population populationdose = 17 person-rem.
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Table E.5-4. Estimated per capita 30-year dose for identified communities in 80-kilometer (50-mile) region for alternative A - minimum waste forecast.

Distance	All	Persons of color more than 50% of Population	Persons of color 35% to 50% of Population	Persons of color less than 35% of Population	Low incomes more than 25% of population population	Low incomes less than 25% of Population
0-16 km (0-10 miles)	8.93E-05	8.10E-05	9.51E-05	8.26E-05	8.60E-05	9.10E-05
0-32 km (0-20 miles)	4.29E-05	3.37E-05	5.91E-05	3.91E-05	4.07E-05	4.36E-05
0-48 km (0-30 miles)	2.30E-05	1.81E-05	2.82E-05	2.37E-05	2.45E-05	2.26E-05
0-64 km (0-40 miles)	1.88E-05	1.65E-05	2.17E-05	1.85E-05	2.01E-05	1.84E-05
0-80 km (0-50 miles)	1.76E-05	1.52E-05	1.94E-05	1.79E-05	1.84E-05	1.73E-05
Total population populationdose = 8.2 person-rem.						

Table E.5-5. Estimated per capita 30-year dose for identified communities in 80-kilometer (50-mile) region for alternative A - maximum waste forecast.

Distance	All	Persons of color more than 50% of Population	Persons of color 35% to 50% of Population	Persons of color less than 35% of Population	Low incomes more than 25% of population population	Low incomes less than 25% of Population
0-16 km (0-10 miles)	1.12E-03	1.02E-03	1.19E-03	1.04E-03	1.08E-03	1.14E-03
0-32 km (0-20 miles)	5.39E-04	4.24E-04	7.42E-04	4.91E-04	5.12E-04	5.48E-04
0-48 km (0-30 miles)	2.89E-04	2.27E-04	3.54E-04	2.98E-04	3.08E-04	2.84E-04
0-64 km (0-40 miles)	2.36E-04	2.08E-04	2.73E-04	2.32E-04	2.53E-04	2.32E-04
0-80 km (0-50 miles)	2.21E-04	1.91E-04	2.43E-04	2.25E-04	2.31E-04	2.18E-04
Total population populationdose = 103 person-rem.						

Table E.5-6. Estimated per capita 30-year dose for identified communities in 80-kilometer (50-mile) region for alternative C - expected waste forecast.

Distance	All	Persons of color more than 50% of Population	Persons of color 35% to 50% of Population	Persons of color less than 35% of Population	Low incomes more than 25% of population population	Low incomes less than 25% of Population
0-16 km (0-10 miles)	3.29E-03	2.98E-03	3.50E-03	3.04E-03	3.17E-03	3.35E-03
0-32 km (0-20 miles)	1.58E-03	1.24E-03	2.18E-03	1.44E-03	1.50E-03	1.61E-03
0-48 km (0-30 miles)	8.49E-04	6.65E-04	1.04E-03	8.73E-04	9.04E-04	8.33E-04
0-64 km (0-40 miles)	6.92E-04	6.09E-04	8.01E-04	6.81E-04	7.41E-04	6.79E-04
0-80 km (0-50 miles)	6.47E-04	5.59E-04	7.13E-04	6.59E-04	6.76E-04	6.39E-04
Total population populationdose = 302 person-rem.						

Table E.5-7. Estimated per capita 30-year dose for identified communities in 80-kilometer (50-mile) region for alternative C - minimum waste forecast.

Distance	All	Persons of color more than 50% of Population	Persons of color 35% to 50% of Population	Persons of color less than 35% of Population	Low incomes more than 25% of population population	Low incomes less than 25% of Population
0-16 km (0-10 miles)	1.61E-03	1.46E-03	1.72E-03	1.49E-03	1.55E-03	1.64E-03
0-32 km (0-20 miles)	7.74E-04	6.09E-04	1.07E-03	7.06E-04	7.35E-04	7.87E-04
0-48 km (0-30 miles)	4.16E-04	3.26E-04	5.08E-04	4.28E-04	4.43E-04	4.08E-04
0-64 km (0-40 miles)	3.39E-04	2.99E-04	3.92E-04	3.34E-04	3.63E-04	3.33E-04
0-80 km (0-50 miles)	3.17E-04	2.74E-04	3.50E-04	3.23E-04	3.31E-04	3.13E-04
Total population populationdose = 148 person-rem.						

Table E.5-8. Estimated per capita 30-year dose for identified communities in 80-kilometer (50-mile) region for alternative C - maximum waste forecast.

Distance	All	Persons of color more than 50% of Population	Persons of color 35% to 50% of Population	Persons of color less than 35% of Population	Low incomes more than 25% of population population	Low incomes less than 25% of Population
0-16 km (0-10 miles)	7.49E-02	6.79E-02	7.98E-02	6.93E-02	7.22E-02	7.64E-02
0-32 km (0-20 miles)	3.60E-02	2.83E-02	4.96E-02	3.28E-02	3.42E-02	3.66E-02
0-48 km (0-30 miles)	1.93E-02	1.52E-02	2.36E-02	1.99E-02	2.06E-02	1.90E-02
0-64 km (0-40 miles)	1.58E-02	1.39E-02	1.82E-02	1.55E-02	1.69E-02	1.55E-02
0-80 km (0-50 miles)	1.47E-02	1.27E-02	1.62E-02	1.50E-02	1.54E-02	1.46E-02
Total population populationdose = 6,880 person-rem.						

Table E.5-9. Estimated per capita 30-year dose for identified communities in 80-kilometer (50-mile) region for alternative B - expected waste forecast.

Distance	All	Persons of color more than 50% of Population	Persons of color 35% to 50% of Population	Persons of color less than 35% of Population	Low incomes more than 25% of population population	Low incomes less than 25% of Population
0-16 km (0-10 miles)	5.01E-04	4.54E-04	5.33E-04	4.64E-04	4.83E-04	5.11E-04
0-32 km (0-20 miles)	2.41E-04	1.89E-04	3.31E-04	2.19E-04	2.29E-04	2.45E-04
0-48 km (0-30 miles)	1.29E-04	1.01E-04	1.58E-04	1.33E-04	1.38E-04	1.27E-04
0-64 km (0-40 miles)	1.05E-04	9.28E-05	1.22E-04	1.04E-04	1.13E-04	1.03E-04
0-80 km (0-50 miles)	9.85E-05	8.52E-05	1.09E-04	1.00E-04	1.03E-04	9.73E-05
Total population populationdose = 46 person-rem.						

Table E.5-10. Estimated per capita 30-year dose for identified communities in 80-kilometer (50-mile) region for alternative B - minimum waste forecast.

Distance	All	Persons of color more than 50% of Population	Persons of color 35% to 50% of Population	Persons of color less than 35% of Population	Low incomes more than 25% of population population	Low incomes less than 25% of Population
0-16 km (0-10 miles)	3.27E-04	2.96E-04	3.48E-04	3.02E-04	3.15E-04	3.33E-04
0-32 km (0-20 miles)	1.57E-04	1.23E-04	2.16E-04	1.43E-04	1.49E-04	1.60E-04
0-48 km (0-30 miles)	8.43E-05	6.61E-05	1.03E-04	8.68E-05	8.98E-05	8.28E-05
0-64 km (0-40 miles)	6.87E-05	6.05E-05	7.95E-05	6.77E-05	7.36E-05	6.74E-05
0-80 km (0-50 miles)	6.43E-05	5.56E-05	7.09E-05	6.55E-05	6.72E-05	6.35E-05
Total population populationdose = 30 person-rem.						

Table E.5-11. Estimated per capita 30-year dose for identified communities in 80-kilometer (50-mile) region for alternative B - maximum waste forecast.

Distance	All	Persons of color more than 50% of Population	Persons of color 35% to 50% of Population	Persons of color less than 35% of Population	Low incomes more than 25% of population population	Low incomes less than 25% of Population
0-16 km (0-10 miles)	4.43E-03	4.02E-03	4.72E-03	4.10E-03	4.27E-03	4.52E-03
0-32 km (0-20 miles)	2.13E-03	1.67E-03	2.93E-03	1.94E-03	2.02E-03	2.16E-03
0-48 km (0-30 miles)	1.14E-03	8.97E-04	1.40E-03	1.18E-03	1.22E-03	1.12E-03
0-64 km (0-40 miles)	9.32E-04	8.21E-04	1.08E-03	9.18E-04	9.99E-04	9.15E-04
0-80 km (0-50 miles)	8.72E-04	7.54E-04	9.61E-04	8.89E-04	9.12E-04	8.61E-04
Total population populationdose = 407 person-rem.						

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