APPENDIX C. ANALYSIS OF ENVIRONMENTAL JUSTICE

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C.1 INTRODUCTION

Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, directs federal agencies to identify and address, as appropriate, disproportionately high and adverse health or environmental effects of their programs, policies, and activities on minority and low-income populations.

The Council on Environmental Quality (CEQ) released guidance on environmental justice in December 1997. As an independent agency, the Council's guidance is not binding on the NRC; however, the NRC considered the CEQ's guidance when establishing its policies and procedures. The analysis of environmental justice in this ER is based on the guidance document *Environmental Justice in NEPA Documents*, developed as part of the NMSS Policy and Procedures Letter 1-50 (NRC 1999a) and provided by the NRC as guidance.

C.2 APPROACH

The NMSS document provides guidelines for identifying the geographical area for assessment of environmental justice as follows:

> If the facility is located within the city limits, a 0.56 mile radius (1 square mile) from the center of the site is probably sufficient for evaluation purposes; however, if the facility itself covers this much area, use a radius that would be equivalent to 0.5 miles from the site. If the facility is located outside the city limits or in a rural area, a 4-mile radius (50 square miles) should be used.

The MFFF site is located in a rural part of South Carolina, within the SRS property. The nearest SRS property boundary is over 4 mi (6.4 km) from the site, and there is no population except for a daily transient population associated with SRS activities within the 4-mi (6.4-km) distance suggested in the NMSS guidance.

Looking further beyond the suggested 4-mi (6.4-km) radius, the nearest residential population is located over 5 mi (8 km) northwest of the MFFF site. To be conservative, the distribution of the population below the federal poverty level and the minority population was reviewed within a 10-mi (16-km) radius using maps developed from 1990 census data at the block group level (Figures 4-15 and 4-16). Detailed population characteristics of the counties and towns that comprise the 10-mi (16-km) area were also reviewed.

C.3 POPULATION PROJECTIONS

Projections of population growth for the 50-mi (80-km) area surrounding the MFFF site were compiled by SRS as part of their regular GSAR update (Tables 4-12 through 4-16). The population is not projected to grow any closer to the MFFF.

C.4 GEOGRAPHICAL DISPERSION OF MINORITY AND LOW-INCOME POPULATIONS

Figures 4-16 and 4-17 show the geographical distribution of minority and low-income populations in the vicinity (within 10 mi [16 km]) of the MFFF site. Distributions shown on these figures are based on baseline U.S. Census 1990 block group data. Figure 4-16 shows the geographical distribution of minority populations in areas within a distance of 10 mi (16 km) of the MFFF site. Block groups are shaded to indicate the percentage of minorities within the total population (calculated by subtracting the white, not of Hispanic origin, count from the total persons count). The highest concentration of minorities is located in the town of New Ellenton, over 7 mi (11.3 km) north of the MFFF site.

The incorporated boundaries of the towns of New Ellenton and Jackson are situated entirely within a 10-mi (16-km) radius of the MFFF site. The combined populations of New Ellenton and Jackson represent about 66% of the population within a 10-mi (16-km) radius of the MFFF site. Growth rates obtained by race for South Carolina were applied to the populations of the towns to determine future potential shifts in the racial balance of the area (DOC 2000b). Within the town of New Ellenton, the population is expected to shift slightly from about 34% black and 66% non-Hispanic white in 1990 to about 41% black and 58% non-Hispanic white in 2025. The town of Jackson shows even less change. In 1990, Jackson's population was about 4% black and about 94% non-Hispanic white. The population is projected to change only slightly to about 5% black and 92% non-Hispanic white by 2025. Population projections by race for places entirely or partially within a 10-mi (16-km) radius of the MFFF site are listed in Table C-1.

Figure 4-17 shows the geographical distribution of low-income populations within the local, 10-mi (16-km) radial area. According to the decennial census of 1990, about 16.8% and 16.6% of the respective populations of Georgia and South Carolina were living below the federal poverty limit. Within the three-county local area, Aiken County was below the state average with only about 14% of its population living below the poverty threshold, while Barnwell County and Burke County were above their state averages with 21.9% and 29.2% below the poverty thresholds, respectively. As shown on Figure 4-17, the population within about a 7-mi (11.3-km) radius of the MFFF site is above the state average with only 0% to 12% living on less than the poverty limit. In total, a minimal portion, less than 25%, of the 10-mi (16-km) area contains high numbers of people living below the poverty threshold.

C.5 ENVIRONMENTAL EFFECTS ON MINORITY AND LOW-INCOME POPULATIONS

The analysis of environmental effects on populations residing within 10 mi (16 km) of proposed facilities is presented in Chapter 5. This analysis shows that no radiological fatalities are likely to result from implementation of the proposed action. Radiological risks to the public are small regardless of the racial and ethnic composition or the economic status of individuals comprising the population. Nonradiological risks to the general population are also small regardless of the racial and ethnic composition or economic status of the population. Thus, disproportionately high and adverse impacts on minority and low-income populations residing near the various facilities are not likely to result from implementation of the proposed action or alternatives.

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Tables

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Table C-1. Population Projections by Race and Ethnicity

	1990	1995	2000	2005	2015	2025
New Ellenton Division*	***4,603***	***4,095***	***4,515***	***4,866***	***5,421***	***5,922***
Black	1,849	2,031	2,293	2,529	2,946	3,341
Am. Indian, Eskimo, Aleut	31	34	36	38	40	44
Asian or Pacific Islander	18	20	25	29	35	42
Hispanic	50	55	69	82	101	125
Non-Hispanic White	2,655	1,955	2,092	2,188	2,299	2,370
New Ellenton Town	***2,630***	***2,890***	***3,151***	***3,360***	***3,673***	***3,936***
Black	898	987	1,114	1,229	1,432	1,624
Am. Indian, Eskimo, Aleut	0	0	0	0	0	0
Asian or Pacific Islander	0	0	0	0	0	0
Hispanic	5	5	6	7	9	11
Non-Hispanic White	1,727	1,898	2,031	2,124	2,232	2,301
Jackson Division*	***1,126***	***1,237***	***1,345***	***1,396***	***1,512***	***1,605***
Black	295	324	366	371	432	489
Am. Indian, Eskimo, Aleut	0	0	0	0	0	0
Asian or Pacific Islander	9	10	13	15	18	22
Hispanic	0	0	0	0	0	0
Non-Hispanic White	822	903	966	1,010	1,062	1,094
Jackson Town	***1,681***	***1,847***	***1,981***	***2,078***	***2,197***	***2,281***
Black	66	73	82	90	105	119
Am. Indian, Eskimo, Aleut	25	27	29	31	33	36
Asian or Pacific Islander	2	2	2	2	2	2
Hispanic	8	9	11	13	16	20
Non-Hispanic White	1,580	1,736	1,857	1,942	2,041	2,104
Barnwell Division	***8,371***	***9,200***	***10,015***	***10,354***	***11,246***	***11,983***
Black	2,460	2,704	3,053	3,061	3,566	4,044
Am. Indian, Eskimo, Aleut	0	0	0	0	0	0
Asian or Pacific Islander	41	45	57	67	82	99
Hispanic	14	15	19	23	28	35
Non-Hispanic White	5,856	6,436	6,886	7,203	7,570	7,805
Burke County	***20,534***	***21,649***	***22,693***	***23,664***	***25,585***	***27,217***
Black	10,741	11,325	11,867	12,365	13,391	14,368
Am. Indian, Eskimo, Aleut	26	27	27	27	34	34
Asian or Pacific Islander	5	5	6	7	9	11
Hispanic	58	61	71	82	107	133
Non-Hispanic White	9,702	10,229	10,720	11,181	12,042	12,668

* The populations of New Ellenton and Jackson towns are not included in their respective division's population to give a more reliable estimate of the divisions' racial mix in areas outside the incorporated boundaries of the towns.

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APPENDIX D. RISK FROM IONIZING RADIATION

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This appendix presents the assessment of potential radiation to offsite individuals, the offsite general population, site workers, and MFFF facility workers due to normal operations of the MFFF. Site workers are defined as those who work within the SRS boundaries but are not involved with process activities at the MFFF. Facility workers are defined as those individuals who are engaged in MFFF activities within the MFFF fence. The term "dose" is used here to reflect the committed effective dose equivalent (i.e., 50-year committed dose) due to internal exposure to radionuclides and the effective dose equivalent due to external exposure to radionuclides. The dose assessment considers chronic atmospheric releases from both an elevated release point and a release point at ground level. Exposure pathways for the offsite public are inhalation uptake, external exposure to the airborne plume, ingestion of terrestrial foods and animal products, and inadvertent soil ingestion. Exposure pathways for the site workers are inhalation uptake, external exposure to the airborne plume, and inadvertent soil ingestion. The MFFF does not have a liquid release to the environment as a result of normal operations and, therefore, the liquid/aquatic pathway was not considered in the dose calculations.

Potential offsite doses to the public were determined for the MEI and the general population residing within an assessment area defined by a 50-mi (80-km) radius around the facility. The entire population within the 50-mi (80-km) assessment area was assumed to consist of adults (DOE 1988). The MEI was assumed to reside 5 mi (8 km) from the facility (i.e., at the SRS boundary) in the southwest direction.

Potential doses to site workers (SRS workers not assigned to the MFFF) were determined for the MEI and the worker population within the SRS boundary but outside the boundary of the MFFF. All workers were assumed to be adults. The MEI was assumed to be located 328 ft (100 m) from the release point, which is the standard distance used at SRS. R2

Potential doses to facility workers (MFFF workers) were determined from preliminary dose analyses for the MFFF. The historical measurements from similar facilities were adjusted to reflect the expected source term in the MFFF.

Fifty-year committed doses were calculated for both the offsite public and site workers based on one year of release and one year of intake. All dose calculations assumed no previous contamination of the ground surface, no previous irrigation with contaminated water, and a finite plume model, which assumes that the center of the plume is located at ground level.

Determination of the potential annual doses utilized the GENII system (the Hanford Environmental Radiation Dosimetry Software System) (Pacific Northwest Laboratory 1988a). GENII is a system of codes and associated data libraries designed to calculate radiation doses to populations and individuals resulting from environmental contamination. The GENII system calculates the transport of radionuclides in the environment due to contamination of air, water, and soil. Calculated radionuclide concentrations are combined with external exposure rates and intake to determine external and internal radiation doses. A complete discussion of the theory and implementation of the GENII system is provided in *GENII – The Hanford Environmental Radiation Dosimetry Software System Volume 1: Conceptual Representation* (Pacific Northwest

Laboratory 1988a). The GENII user's manual is given in *GENII – The Hanford Environmental Radiation Dosimetry Software System Volume 2: Users' Manual* (Pacific Northwest Laboratory 1988b).

D.1 GENII INPUT

The following sections summarize the GENII input parameters and values used for the assessment of potential doses to the offsite public and to site workers due to normal operations of the MFFF.

D.1.1 Meteorological Data

GENII requires meteorological data in the form of a joint frequency distribution for the calculations of dose to the offsite public and to site workers due to airborne releases. This distribution contains wind data specifying the time (in percentage) that the wind blows in each of 16 sectors for user-specified wind speeds and atmospheric stability classes. The joint frequency distribution used in the dose calculations is presented in Table D-1. This distribution was developed using meteorological data collected from the 197-ft (60-m) tower level in H Area from 1992 to 1996. Data from the H-Area meteorological tower were used because the tower is located near F Area and the geographical center of SRS.

The GENII calculations of dose also use the absolute humidity when considering airborne releases. During the period from January 1995 to December 1996, the average monthly absolute humidity ranged from 6.0 to 18.4 g/m^3 (WSRC 1999a). The overall average absolute humidity for this same time period was 11.1 g/m^3, which is the value used in the GENII analyses.

D.1.2 Population Data for the Offsite Public

The population data used in the population dose calculations were taken from the GSAR (WSRC 1999a) and are presented in Table D-2. The 1990 Census of Population and Housing Data (DOC 1992a) were used to project the population distribution within a 50-mi (80-km) radius of the SRS F Area at 10-year intervals through 2030 (WSRC 1993). Population growth was determined using growth ratios relative to the 1990 population of 1.140 for the year 2000, 1.299 for the year 2010, 1.481 for the year 2020, and 1.688 for the year 2030. These ratios were determined assuming that the growth rate for the total population in the west-northwest sector can be applied to all other sectors (Huang 1993). The population growth projected by the GSAR was compared to actual population growth as determined by the 2000 census. The GSAR predicted a 14% increase in population within 50 mi (80 km) of the MFFF for the year 2000. Checking against actual increases from the 2000 census DCS determined that the county populations within 50 mi (80 km) actually increased by 16%. Therefore the GSAR underestimated population increase by 2%. The population was distributed into 16 radial sectors and six radial distances of 0 to 5, 5 to 10, 10 to 20, 20 to 30, 30 to 40, and 40 to 50 mi (0 to 8, 8 to 16, 16 to 32, 32 to 64, and 64 to 80 km). All property within 5 mi (8 km) of F Area is owned by DOE and has zero permanent population. R1

Calculation of the population dose for the offsite public used the projected population for 2030. Operation of the MFFF is expected to end in 2027 based on a 20-year license and startup in 2007. Use of a population distribution projected for a time later than the end of operational life ensures conservative dose calculations and provides a buffer for underestimates of population growth or if the start of the project is delayed. R2 R1

Dose calculations for the MEI assumed that the individual resides 5 mi (8 km) from the MFFF in the southwest direction. The nearest SRS boundary is actually located 5.1 mi (8.2 km) from the facility in the northwest direction. This distance was reduced to 5 mi (8 km) for the analysis. Examination of the joint frequency distribution data indicates that the wind blows in the southwest direction the majority of the time (see Table D-1). Therefore, an individual located southwest of the facility should receive the highest dose due to airborne releases. This assumption was confirmed by conducting GENII simulations with the MEI located in each of the 16 wind directions. Results from those simulations yielded the highest dose due to airborne releases when the MEI was assumed to be located in the southwest direction.

D.1.3 Population Data for Site Workers

Approximately 13,616 site workers were employed at SRS in 2000. The current spatial distribution of those workers is not readily available. Therefore, a population dose for the site workers could not be directly determined. The methodology used to estimate the population dose for the site workers is discussed in Section D.2.

The MEI dose calculations for the maximally exposed site worker assumed that the worker was located at the edge of the MFFF boundary, which is 328 ft (100 m) from the release point. The maximally exposed site worker was assumed to be located in the direction from the release point that gives the maximum dose based on dose calculations for the 16 wind directions considered by GENII. These directions are east-northeast for the elevated release and southwest for the groundlevel release.

D.1.4 Food Production Data

The dose due to ingestion of terrestrial food and animal products, calculated for the offsite population only, requires information regarding food production. Production data for the 50-mi (80-km) assessment area surrounding SRS were taken from the 1987 Census of Agriculture (Halliburton NUS Corp. 1996). The food production data were organized into a food grid, or wheel, consistent with the grid developed for the population distribution. The fraction of each county located within the grid sectors was combined with the food production in each sector to generate the food grid. Food production in each county was assumed to occur uniformly across the entire county. The grid consists of data for the eight food categories included in the analysis (i.e., leafy vegetables, root vegetables, fruits, grains, beef, poultry, milk, and eggs) at 10 radial distances from the facility for 16 wind directions. The food grid used in the GENII analysis was taken from the data for an F-Area release location given in Table 3.6-5 of *Storage and Disposition of Weapons-Usable Fissile Materials Final Programmatic Environmental Impact*

Statement Volume 2: Health Risk Data Reading Room Material (Halliburton NUS Corp. 1996). These data are reproduced in Table D-3.

The radiation dose from ingestion of food products was not included in the calculation of dose to the site workers because no food is produced within the SRS boundary and, therefore, consumption of food grown within the SRS boundary is impossible.

D.1.5 Food Ingestion Data (applicable for calculations of dose to the offsite public only)

This section summarizes the input parameters required for the calculation of dose to the offsite public due to food ingestion. The two types of food considered in the analysis were terrestrial food and animal products.

D.1.5.1 Terrestrial Food

Determination of dose due to the ingestion of terrestrial food requires input of (1) consumption rate, (2) the length of the growing season (used only for analyses with acute releases), (3) data related to irrigation with contaminated water, (4) crop yield, (5) the food production rate, and (6) holdup time between harvest and storage. Although the growing season lengths are input, they are not used by GENII for this analysis, which considers a chronic release rather than an acute release. Irrigation of the terrestrial food with contaminated water was not incorporated into the dose calculations. The dose calculations assumed that the MEI and the general population consume only food grown within the assessment area. The input parameters related to the ingestion of terrestrial foods are summarized in Table D-4. The source for the consumption rates is *Savannah River Site Environmental Data for 1999* (Arnett and Mamatey 2000b). For the remaining parameters, the GENII default values were used.

D.1.5.2 Animal Products

Calculation of dose due to the ingestion of animal products requires input of (1) consumption rates, (2) holdup times, (3) production rates, (4) the fraction of drinking water consumed by the animals that comes from a contaminated source, and (5) parameters related to the diet and food sources for the animals. GENII considers two food sources for beef (stored feed and fresh forage), and a single food source for poultry (stored feed). The dose calculations assume that (1) all water consumed by the animals comes from an uncontaminated source, (2) animal food sources are not irrigated, and (3) all animal products consumed by the MEI and general population are produced within the assessment area. The input parameters related to the ingestion of animal products are summarized in Table D-5 along with their sources.

D.1.6 External Exposure Data

The calculation of dose to the offsite public and to site workers due to external and inhalation exposure to contaminated air requires input of (1) external exposure time to chronic atmospheric plumes, (2) external exposure time to soil contamination, (3) inhalation exposure time to contaminated air from either chronic plumes or from resuspension, (4) the resuspension model to be used, and (5) stack height for elevated releases. Values for these parameters are needed for calculation of the dose for the MEI in the offsite public, the general public population, and the maximally exposed site worker. The parameter values used are given in Table D-6.

NRC Regulatory Guide 1.109 (NRC 1977a) states the following:

- The annual external exposure time to the plume and to soil contamination should be 0.7 year for the MEI.
- The annual external exposure time to the plume and to soil contamination should be 0.5 year for the population.
- The annual inhalation exposure time to the plume should be 1 year for the MEI and the population.

These guidelines were used for the GENII analyses.

All dose calculations assumed no resuspension of soil particles into the air. Based on the design heights for the MFFF building and the vent stack, airborne emissions will exit the facility at a height of 120 ft (37 m) above grade (see Section 3.1.1). Calculations of dose to the offsite public and to site workers considered a groundlevel release in order to bound the dose calculations and to provide a buffer in the event that the designed building and/or vent stack heights are modified in the future. For both releases, plume rise was conservatively ignored since calculated dose decreases as release height increases. R2

D.1.7 Release Data

Airborne releases due to normal operations of the MFFF were taken from the SPD EIS (DOE 1999c) and are given in Table D-7. These releases are about an order of magnitude higher than the releases expected during normal MFFF operations. Therefore, these source terms are conservative and bounding based on the latest design information.

D.2 CALCULATED DOSES

Recall that the spatial distribution of site workers within the SRS boundary is not readily available and, therefore, a population dose for site workers could not be directly determined. In order to estimate a site worker population dose, the MEI dose was multiplied by the estimated number of site workers for the year 2000 (13,616 workers). Calculation of the dose in this manner overestimated the site worker population dose because it used the dose for the maximally exposed site worker rather than the dose for an average exposed worker. As previously stated, the MEI dose for the maximally exposed site worker assumed that the worker is located at the MFFF boundary 328 ft (100 m) from the release point. Not all site workers will work this close to the MFFF. In order to take into account the fact that site workers are distributed between the MFFF boundary and the SRS boundary located 5 mi (8 km) from the release point, a range in the population dose for the site workers was determined. The maximum value for the range was estimated using an MEI dose calculated for a worker located at the MFFF boundary, and the minimum value for the range was estimated using an MEI dose calculated for a worker located at the SRS boundary. For both locations GENII simulations were performed to determine the direction from the release point to the maximally exposed worker that yielded the highest dose. Those maximum doses were then used to calculate the worker population dose. The direction giving the highest dose was southwest for both groundlevel releases. R2 R2

Table D-8 gives the doses calculated for the offsite public and for site workers due to airborne releases resulting from normal operations of the MFFF. This table also shows a comparison of the calculated potential doses due to normal operations to the all-pathway standard given in 10 CFR Part 20, Subpart D for the offsite public and in 10 CFR Part 20, Subpart C for site workers, and the doses from natural background radiation. Annual LCFs were calculated based on a cancer risk factor of 0.0005 per rem (500 cancers per 10^6 person-rem) for the offsite public and 0.0004 per rem (400 cancers per 10^6 person-rem) for site workers (see Table D-8). The annual dose to an average member of the offsite population within the 50-mi (80-km) assessment area is also presented in Table D-8. This dose was calculated as the annual offsite population dose divided by the total population projected to live in the assessment area in the year 2030.

As can be seen from Table D-8, the MEI doses for both the offsite public and site workers fall below the 10 CFR Part 20 standards and the natural background radiation. In addition, the population doses for both the offsite public and site workers, as well as the dose for an average individual in the offsite public, also fall below natural background radiation levels. These results indicate that normal operation of the MFFF should have no adverse health effect on the offsite public or site workers.

Tables

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Table D-1. Joint Frequency Distribution Used for Calculation of Dose to the Offsite Public and to Site Workers Due to Airborne Releases Resulting from Normal Operations of the MFFF

Wind Speed (m/s)	Stability Class	Wind Direction															
		S	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE
2.0	A	0.25	0.20	0.24	0.24	0.21	0.18	0.15	0.18	0.17	0.17	0.21	0.22	0.18	0.18	0.16	0.21
	B	0.02	0.03	0.03	0.03	0.01	0	0	0.01	0.01	0.01	0.03	0.03	0	0.03	0.03	0.02
	C	0.02	0.01	0.01	0.02	0.01	0.01	0.02	0.03	0.03	0.01	0.01	0.01	0.01	0.02	0.01	0.01
	D	0.01	0.02	0	0.02	0.02	0.01	0.01	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.03
	E	0	0	0	0	0	0	0	0	0.01	0.01	0	0	0	0	0	0
	F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5.5	A	0.88	0.73	0.92	1.04	1.06	0.79	0.70	0.55	0.74	0.78	1.12	1.37	1.19	0.82	0.56	0.57
	B	0.24	0.36	0.43	0.44	0.35	0.25	0.19	0.21	0.26	0.24	0.34	0.38	0.29	0.25	0.16	0.16
	C	0.15	0.39	0.73	0.50	0.39	0.24	0.24	0.29	0.33	0.36	0.43	0.49	0.34	0.28	0.23	0.18
	D	0.09	0.25	0.59	0.34	0.31	0.27	0.34	0.37	0.42	0.39	0.38	0.33	0.30	0.22	0.26	0.21
	E	0.01	0.09	0.28	0.11	0.08	0.16	0.17	0.18	0.26	0.22	0.19	0.20	0.13	0.13	0.11	0.13
	F	0.01	0.02	0.02	0.01	0	0.03	0.02	0.03	0.03	0.03	0.02	0.05	0	0.01	0.02	0.04
	G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10.0	A	1.03	0.66	0.53	0.50	0.44	0.30	0.26	0.20	0.37	0.43	0.60	0.70	0.71	0.48	0.24	0.36
	B	0.21	0.57	0.65	0.67	0.32	0.23	0.16	0.19	0.31	0.33	0.55	0.75	0.55	0.36	0.16	0.18
	C	0.16	0.69	1.49	0.86	0.67	0.44	0.42	0.42	0.52	0.58	0.74	0.78	0.78	0.57	0.27	0.14
	D	0.12	0.52	1.64	0.95	0.81	0.70	0.84	1.12	1.48	1.05	1.26	1.27	1.01	0.88	0.50	0.20
	E	0.06	0.64	1.08	0.81	0.62	0.62	0.82	0.98	1.20	1.10	1.06	1.12	0.63	0.47	0.42	0.24
	F	0.02	0.22	0.19	0.07	0.10	0.16	0.18	0.17	0.22	0.16	0.21	0.27	0.07	0.06	0.05	0.06
	G	0	0.02	0.01	0	0	0.01	0.01	0.01	0.02	0.01	0.01	0.02	0	0	0	0
15.5	A	0.21	0.18	0.03	0.03	0.01	0.02	0.02	0.01	0.02	0.04	0.05	0.10	0.09	0.11	0.03	0.09
	B	0.02	0.17	0.12	0.04	0.04	0.03	0.05	0.04	0.04	0.09	0.18	0.31	0.46	0.34	0.09	0.03
	C	0	0.18	0.46	0.21	0.08	0.09	0.16	0.22	0.20	0.29	0.41	0.46	0.73	0.62	0.13	0.01
	D	0	0.09	0.19	0.08	0.05	0.06	0.13	0.46	0.43	0.24	0.24	0.12	0.13	0.11	0.07	0
	E	0	0.09	0.06	0.09	0.07	0.05	0.05	0.09	0.13	0.10	0.19	0.07	0.02	0.02	0.01	0
	F	0	0.04	0.02	0.03	0.01	0.03	0.02	0.01	0.01	0.01	0.03	0.02	0.01	0	0	0
	G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table D-1. Joint Frequency Distribution Used for Calculation of Dose to the Offsite Public and to Site Workers Due to Airborne Releases Resulting from Normal Operations of the MFFF (continued)

Wind Speed (m/s)	Stability Class	Wind Direction															
		S	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE
21.5	A	0.01	0	0	0	0	0	0	0	0	0	0	0.01	0.02	0.02	0	0.01
	B	0	0.01	0	0	0	0	0	0	0	0	0.02	0.03	0.08	0.06	0.01	0
	C	0	0.01	0	0	0.01	0	0.01	0.04	0.04	0.05	0.05	0.08	0.18	0.10	0.02	0
	D	0	0	0	0	0	0	0	0.03	0.02	0.02	0.01	0	0.02	0	0	0
	E	0	0	0	0	0	0	0	0	0	0	0	0	0.01	0	0	0
	F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25.0	A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	D	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table D-2. Projected Population Distribution for the Offsite Public Within 50 miles (80 km) of SRS F Area for the Year 2030[a]

	Distance (miles)						
Direction	**0 to 5**	**5 to 10**	**10 to 20**	**20 to 30**	**30 to 40**	**40 to 50**	**Total**
S	0	0	920	2,696	11,367	6,013	**20,996**
SSW	0	15	1,317	3,692	8,115	4,376	**17,515**
SW	0	186	1,978	7,732	3,535	4,579	**18,010**
WSW	0	171	2,572	7,553	4,368	10,385	**25,049**
W	0	407	10,186	17,766	15,109	11,753	**55,221**
WNW	0	2,331	8,556	219,212	54,849	24,980	**309,928**
NW	0	1,861	25,692	137,243	15,851	5,567	**186,214**
NNW	0	1,978	33,320	18,925	11,627	5,648	**71,498**
N	0	3,500	36,210	15,530	11,294	17,670	**84,204**
NNE	0	397	3,010	3,515	6,925	28,857	**42,704**
NE	0	14	2,609	4,611	8,850	19,325	**35,409**
ENE	0	0	5,535	7,865	8,764	53,785	**75,949**
E	0	2	8,061	8,590	18,423	9,310	**44,386**
ESE	0	14	3,658	4,352	5,466	488	**13,978**
SE	0	0	951	7,673	7,409	17,619	**33,652**
SSE	0	0	615	1,154	1,767	4,234	**7,770**
Total	**0**	**10,876**	**145,190**	**468,109**	**193,719**	**224,589**	**1,042,483**

[a] Source: Figure 1.3-39 of the GSAR (WSRC 1999a).

Table D-3. Agricultural Food Production Within 50 miles (80 km) Surrounding SRS Used for Determination of Population Dose to the Offsite Public

Leafy Vegetables (kg/yr)

Direction	Distance (miles)					
	0 to 5	**5 to 10**	**10 to 20**	**20 to 30**	**30 to 40**	**40 to 50**
S	0	0	0	0	0	1.0E+05
SSW	0	0	0	0	0	1.0E+05
SW	0	3.4E+05	0	0	0	1.1E+03
WSW	0	3.7E+02	33	0	1.6E+03	8.8E+03
W	0	1.3E+03	1.3E+02	0	2.8E+03	4.1E+03
WNW	0	1.4E+03	3.4E+03	0	0	0
NW	0	1.4E+03	6.3E+03	4.7E+03	0	0
NNW	0	1.3E+03	6.9E+03	8.7E+03	8.6	2.4E+03
N	0	1.1E+03	6.9E+03	1.2E+04	1.1E+04	4.8E+04
NNE	0	3.9E+02	3.9E+03	1.2E+04	5.1E+03	5.3E+03
NE	0	46	6.0E+03	3.1E+04	2.5E+05	7.7E+05
ENE	0	0	7.6	3.2E+04	1.6E+05	2.1E+05
E	0	0	0	0	2.3E+04	1.3E+05
ESE	0	0	0	0	0	1.0E+05
SE	0	0	0	0	0	1.0E+05
SSE	0	0	0	0	0	1.0E+05

Table D-3. Agricultural Food Production Within 50 miles (80 km) Surrounding SRS Used for Determination of Population Dose to the Offsite Public (continued)

Root Vegetables (kg/yr)

Direction	Distance (miles)					
	0 to 5	**5 to 10**	**10 to 20**	**20 to 30**	**30 to 40**	**40 to 50**
S	0	0	1.8E+06	3.1E+06	4.1E+06	6.3E+06
SSW	0	3.1E+03	2.1E+06	3.4E+06	4.3E+06	6.7E+06
SW	0	9.7E+07	2.2E+06	3.6E+06	4.8E+06	5.8E+06
WSW	0	1.1E+05	2.1E+06	3.6E+06	5.3E+06	8.0E+06
W	0	1.8E+05	2.3E+05	1.3E+06	3.4E+06	4.4E+06
WNW	0	1.9E+05	5.0E+05	1.1E+05	5.4E+04	3.2E+05
NW	0	2.0E+05	8.8E+05	8.2E+05	4.0E+05	1.4E+05
NNW	0	1.9E+05	9.6E+05	1.3E+06	7.3E+05	1.2E+06
N	0	1.5E+05	9.6E+05	1.6E+06	1.7E+06	2.4E+06
NNE	0	8.1E+04	9.6E+05	1.6E+06	2.5E+06	3.8E+06
NE	0	6.3E+03	1.2E+06	2.6E+06	4.2E+06	5.1E+06
ENE	0	0	3.4E+06	6.3E+06	7.8E+06	9.9E+06
E	0	0	3.6E+06	6.3E+06	7.9E+06	1.0E+07
ESE	0	0	3.3E+06	6.6E+06	8.4E+06	5.3E+06
SE	0	0	6.4E+07	6.8E+06	8.8E+06	9.2E+06
SSE	0	0	3.8E+07	3.0E+07	6.7E+06	7.8E+06

Table D-3. Agricultural Food Production Within 50 miles (80 km) Surrounding SRS Used for Determination of Population Dose to the Offsite Public (continued)

Fruit (kg/yr)

Direction	Distance (miles)					
	0 to 5	5 to 10	10 to 20	20 to 30	30 to 40	40 to 50
S	0	0	3.9E+05	1.1E+06	1.7E+06	2.5E+06
SSW	0	6.9E+02	4.5E+05	8.7E+05	1.4E+06	2.3E+06
SW	0	3.3E+07	4.8E+05	7.9E+05	1.2E+06	1.2E+06
WSW	0	4.4E+04	4.7E+05	7.9E+05	1.0E+06	8.8E+05
W	0	1.1E+05	4.5E+04	2.7E+05	4.4E+05	3.9E+05
WNW	0	1.2E+05	2.8E+05	1.1E+03	2.3E+02	1.3E+03
NW	0	1.2E+05	5.3E+05	2.8E+06	6.6E+06	2.2E+06
NNW	0	1.1E+05	5.8E+05	2.8E+06	1.2E+07	1.4E+07
N	0	9.0E+04	5.8E+05	9.7E+05	5.1E+06	4.8E+06
NNE	0	4.9E+04	5.8E+05	9.7E+05	1.0E+06	7.4E+05
NE	0	3.9E+03	5.3E+05	8.9E+05	1.0E+06	7.5E+05
ENE	0	0	2.5E+05	4.9E+05	8.5E+05	1.1E+06
E	0	0	2.6E+05	3.4E+05	1.6E+05	7.0E+05
ESE	0	0	2.4E+05	4.0E+05	1.8E+05	5.6E+04
SE	0	0	4.3E+06	3.1E+05	3.7E+05	3.1E+05
SSE	0	0	2.6E+06	2.0E+06	1.1E+06	1.0E+06

Table D-3. Agricultural Food Production Within 50 miles (80 km) Surrounding SRS Used for Determination of Population Dose to the Offsite Public (continued)

Grains (kg/yr)

Direction	Distance (miles)					
	0 to 5	**5 to 10**	**10 to 20**	**20 to 30**	**30 to 40**	**40 to 50**
S	0	0	2.6E+06	7.4E+06	1.1E+07	1.5E+07
SSW	0	4.5E+03	2.9E+06	6.0E+06	1.1E+07	1.4E+07
SW	0	1.1E+08	3.1E+06	5.1E+06	8.2E+06	1.0E+07
WSW	0	1.4E+05	3.0E+06	5.1E+06	8.1E+06	1.5E+07
W	0	2.1E+05	6.4E+05	2.2E+06	6.1E+06	7.9E+06
WNW	0	2.2E+05	7.6E+05	7.2E+05	2.6E+05	6.5E+05
NW	0	2.2E+05	1.0E+06	1.2E+06	7.5E+05	3.3E+05
NNW	0	2.1E+05	1.1E+06	1.6E+06	1.3E+06	2.0E+06
N	0	1.7E+05	1.1E+06	1.8E+06	2.3E+06	4.1E+06
NNE	0	9.3E+04	1.1E+06	1.8E+06	2.7E+06	3.6E+06
NE	0	7.3E+03	1.3E+06	3.6E+06	6.1E+06	6.9E+06
ENE	0	0	4.0E+06	8.7E+06	1.4E+07	1.8E+07
E	0	0	4.2E+06	9.0E+06	1.6E+07	1.9E+07
ESE	0	0	3.9E+06	8.9E+06	1.6E+07	1.2E+07
SE	0	0	8.2E+07	1.1E+07	1.5E+07	1.7E+07
SSE	0	0	5.2E+07	5.2E+07	1.3E+07	1.6E+07

Table D-3. Agricultural Food Production Within 50 miles (80 km) Surrounding SRS Used for Determination of Population Dose to the Offsite Public (continued)

Beef (kg/yr)

Direction	Distance (miles)					
	0 to 5	**5 to 10**	**10 to 20**	**20 to 30**	**30 to 40**	**40 to 50**
S	0	0	1.2E+05	4.6E+05	7.3E+05	9.9E+05
SSW	0	2.2E+02	1.5E+05	3.4E+05	6.9E+05	9.3E+05
SW	0	6.0E+04	1.5E+05	2.5E+05	4.6E+05	6.1E+05
WSW	0	1.0E+04	1.5E+05	2.5E+05	4.1E+05	7.9E+05
W	0	2.1E+04	4.0E+04	1.2E+05	3.4E+05	5.1E+05
WNW	0	2.2E+04	7.0E+04	5.0E+04	9.5E+04	1.8E+05
NW	0	2.3E+04	1.1E+05	1.4E+05	1.6E+05	2.1E+05
NNW	0	2.2E+04	1.1E+05	1.8E+05	2.3E+05	3.5E+05
N	0	1.7E+04	1.1E+05	1.9E+05	3.1E+05	6.5E+05
NNE	0	9.6E+03	1.1E+05	1.9E+05	2.5E+05	2.9E+05
NE	0	7.5E+02	1.0E+05	2.6E+05	4.3E+05	5.0E+05
ENE	0	0	2.4E+04	2.2E+05	8.2E+05	1.1E+06
E	0	0	2.6E+04	1.4E+05	5.2E+05	8.8E+05
ESE	0	0	2.4E+04	8.2E+04	3.4E+05	4.5E+05
SE	0	0	4.8E+05	6.4E+04	2.0E+05	5.2E+05
SSE	0	0	3.6E+05	5.8E+05	4.3E+05	6.7E+05

Table D-3. Agricultural Food Production Within 50 miles (80 km) Surrounding SRS Used for Determination of Population Dose to the Offsite Public (continued)

Poultry (kg/yr)

Direction	Distance (miles)					
	0 to 5	5 to 10	10 to 20	20 to 30	30 to 40	40 to 50
S	0	0	0	0	0	5.4E+04
SSW	0	0	0	0	0	6.7E+04
SW	0	4.7E+07	0	0	0	45
WSW	0	5.1E+04	4.5E+03	0	61	3.5E+02
W	0	1.7E+05	1.8E+04	0	1.1E+02	1.6E+02
WNW	0	1.9E+05	4.6E+05	0	0	5.1E+03
NW	0	1.9E+05	8.6E+05	6.4E+05	0	3.0E+05
NNW	0	1.8E+05	9.4E+05	1.2E+06	1.2E+03	5.4E+05
N	0	1.5E+05	9.4E+05	1.6E+06	1.7E+06	3.6E+06
NNE	0	8.0E+04	9.4E+05	1.6E+06	1.3E+06	5.4E+03
NE	0	6.3E+03	8.2E+05	1.2E+06	9.7E+05	0
ENE	0	0	1.1E+03	0	0	0
E	0	0	0	0	0	1.0E+05
ESE	0	0	0	0	0	1.0E+05
SE	0	0	0	0	0	1.0E+05
SSE	0	0	0	0	0	1.0E+05

Table D-3. Agricultural Food Production Within 50 miles (80 km) Surrounding SRS Used for Determination of Population Dose to the Offsite Public (continued)

Milk (kg/yr)

Direction	Distance (miles)					
	0 to 5	**5 to 10**	**10 to 20**	**20 to 30**	**30 to 40**	**40 to 50**
S	0	0	5.5E+05	6.2E+05	6.5E+05	7.6E+05
SSW	0	9.7E+02	6.4E+05	2.9E+06	7.9E+06	8.1E+06
SW	0	3.2E+06	6.7E+05	1.1E+06	3.8E+06	2.9E+06
WSW	0	2.2E+04	6.6E+05	1.1E+06	2.0E+06	4.4E+06
W	0	1.2E+04	4.9E+04	3.8E+05	1.8E+06	3.5E+06
WNW	0	1.3E+04	3.1E+04	0	4.7E+04	1.2E+06
NW	0	1.3E+04	5.8E+04	4.4E+05	1.1E+06	7.9E+05
NNW	0	1.2E+04	6.4E+04	4.3E+05	2.0E+06	3.3E+06
N	0	9.9E+03	6.4E+04	1.1E+05	1.9E+06	7.4E+06
NNE	0	5.4E+03	6.4E+04	1.1E+05	3.9E+05	9.7E+06
NE	0	4.2E+02	5.5E+04	6.9E+05	1.7E+06	1.8E+06
ENE	0	0	70	1.1E+06	4.6E+06	5.6E+06
E	0	0	0	9.6E+05	4.2E+06	5.7E+06
ESE	0	0	0	3.2E+05	2.6E+06	1.6E+06
SE	0	0	2.4E+04	1.2E+04	4.2E+04	1.2E+05
SSE	0	0	2.0E+05	3.2E+05	3.5E+05	3.9E+05

Table D-3. Agricultural Food Production Within 50 miles (80 km) Surrounding SRS Used for Determination of Population Dose to the Offsite Public (continued)

Eggs (kg/yr)

Direction	Distance (miles)					
	0 to 5	5 to 10	10 to 20	20 to 30	30 to 40	40 to 50
S	0	0	6.3E+02	0	0	8.3E+04
SSW	0	0	0	0	0	1.0E+05
SW	0	6.2E+05	0	0	0	91
WSW	0	0	0	0	1.2E+02	7.0E+02
W	0	0	0	0	2.2E+02	3.3E+02
WNW	0	0	0	0	0	1.0E+05
NW	0	0	0	1.2E+05	3.2E+05	1.1E+05
NNW	0	0	0	1.0E+05	5.9E+05	6.4E+05
N	0	0	0	0	1.7E+05	29
NNE	0	0	0	0	0	1.0E+05
NE	0	0	4.1E+03	4.0E+03	1.6E+02	1.2E+02
ENE	0	0	4.3E+04	5.5E+04	5.0E+02	6.3E+02
E	0	0	4.5E+04	5.6E+04	71	4.0E+02
ESE	0	0	4.2E+04	5.8E+04	1.2E+02	0
SE	0	0	6.3E+05	1.2E+03	0	0
SSE	0	0	3.1E+05	0	0	0

Source: *Storage and Disposition of Weapons-Usable Fissile Materials Final Programmatic Environmental Impact Statement Volume 2: Health Risk Data Reading Room Material* (Halliburton NUS Corp. 1996)

Table D-4. Input Parameters and Values for Calculation of Dose to the Offsite Public Due to Ingestion of Terrestrial Food

Parameter	Value	
	Maximally Exposed Individual	Population
Consumption rate (kg/yr)[a]		
leafy vegetables	43	21
root vegetables	276	163
fruit	276	163
grain	276	163
Length of growing season[b]	N/A	N/A
Crop yield (kg/m^2)[c]		
leafy vegetables	1.5	1.5
root vegetables	4.0	4.0
fruit	2.0	2.0
grain	0.8	0.8
Production rates (kg/yr)	N/A	[d]
Hold time between harvest and storage (days)[c]		
leafy vegetables	1	14
root vegetables	5	14
fruit	5	14
grain	180	180

[a] Source: *Savannah River Site Environmental Data for 1999* (Arnett and Mamatey 2000b).

[b] Growing season length, which is used only for acute releases, is not applicable for this analysis, which considers chronic releases.

[c] GENII default values.

[d] See Section D.1.4 and Table D-3.

N/A = Not applicable

Table D-5. Input Parameters and Values for Calculation of Dose to the Offsite Public Due to Ingestion of Animal Products

Parameter	Value	
	Maximally Exposed Individual	Population
Consumption rate (kg/yr)		
beef[a]	81	43
milk[a]	230	120
poultry[b]	18	8.5
eggs[b]	30	20
Holdup time (days)[b]		
beef	15	34
milk	1	3
poultry	1	34
eggs	1	18
Production rate (kg/yr)	N/A	[c]
Diet fraction for animal food sources[b]		
stored feed		
beef	0.25	0.25
milk	0.25	0.25
poultry	1.00	1.00
eggs	1.00	1.00
fresh forage		
beef	0.75	0.75
milk	0.75	0.75
Growing time for animal food sources (days)[b]		
stored feed		
beef	90	90
milk	45	45
poultry	90	90
eggs	90	90
fresh forage		
beef	45	45
milk	30	30
Yield of animal food sources (kg/m^3)[b]		
stored feed		
beef	0.8	0.8
milk	2.0	2.0
poultry	0.8	0.8
eggs	0.8	0.8
fresh forage		
beef	2.0	2.0
milk	1.5	1.5

Table D-5. Input Parameters and Values for Calculation of Dose to the Offsite Public Due to Ingestion of Animal Products (continued)

Parameter	Value	
	Maximally Exposed Individual	Population
Storage time for animal food sources (days)[b]		
stored feed		
beef	180	180
milk	100	100
poultry	180	180
eggs	180	180
fresh forage		
beef	100	100
milk	0	0

[a] Source: *Savannah River Site Environmental Data for 1999* (Arnett and Mamatey 2000b).

[b] GENII default values.

[c] See Section D.1.4 and Table D-3.

N/A = Not applicable

Table D-6. Input Parameters and Values for Calculation of Dose to the Offsite Public and Site Workers Due to External Exposure and Inhalation

Parameter	Value	
	Maximally Exposed Individual[a]	Population[b]
External exposure time to chronic atmospheric plume (hr/yr)[c]	6,136.2	4,383
External exposure time to soil contamination (hr/yr)[c]	6,136.2	4,383
Inhalation exposure time to chronic plume (hr/yr)[c]	8,766	8,766
Stack height (m)	28 and 0.3[d]	28 and 0.3[d]

[a] Applicable for calculation of radiological impact on both the offsite public and site workers.

[b] Applicable for calculation of radiological impact to the offsite public only.

[c] Source: *Calculation of Annual Doses to Man From Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR 50, Appendix I* (NRC 1977a).

[d] Doses were calculated for both an elevated release (93 ft [28 m] above grade; see Section 3.1.1) and an essentially groundlevel release (1 ft [0.3 m] above grade) to bound the dose calculations.

Table D-7. Estimated Radiological Releases from the MFFF during Normal Operations[a] and Radionuclide Half-lives[b]

Isotope	Airborne Radiological Releases (μCi/yr)	Half-Life (days)
Plutonium-236	1.3E-08	1,041.33
Plutonium-238	8.5	32,050.7
Plutonium-239	91	8.814E+06
Plutonium-240	23	2.388E+06
Plutonium-241	101	5,259.6
Plutonium-242	6.1E-03	1.373E+08
Americium-241	48	157,861
Uranium-234	5.1E-03	8.93E+07
Uranium-235	2.1E-04	257.1E+09
Uranium-238	0.012	1.63E+12

[a] Source terms taken from the SPD EIS (DOE 1999c); these source terms are about an order of magnitude higher than the source terms expected for normal MFFF operations.

[b] Values for radionuclide half-lives used by GENII.

Table D-8. Potential Radiological Impacts on the General Public and Site Workers Due to Normal Operations of the MFFF

RADIATION DOSE TO THE GENERAL PUBLIC	Groundlevel Release[b]
Maximally Exposed Individual	
Annual Dose (mrem/yr)[c]	1.5E-03
Percentage of 10 CFR Part 20, Subpart D Standard[d]	1.5E-03
Percentage of Natural Background Radiation[e]	5.1E-04
Annual LCF Risk[f]	7.5E-10
General Population Within 50 mi (80 km)	
Annual Dose (person-rem/yr)[c]	0.12
Percentage of Natural Background Radiation[g]	3.9E-05
Annual LCF Risk[f]	6.0E-05
Average Exposed Individual Within 50 mi (80 km)	
Annual Dose (mrem/yr)[h]	1.2E-04
Percentage of 10 CFR Part 20, Subpart D Standard[d]	1.2E-04
Percentage of Natural Background Radiation[e]	4.1E-05
Annual LCF Risk[f]	6.0E-11

RADIATION DOSE TO SITE WORKERS	Groundlevel Release[b]	
Maximally Exposed Site Worker		
Annual Dose (mrem/yr)[i]	3.0	
Percentage of 10 CFR Part 20, Subpart C Standard[j]	6.0E-02	
Percentage of Natural Background Radiation[e]	1.0	
Annual LCF Risk[k]	1.2E-06	
General Site Worker Population	**Minimum[l]**	**Maximum[m]**
Maximum Annual Dose (person-rem/yr)[g]	0.019	40.8
Percentage of Natural Background Radiation[e]	4.7E-04	1.0
Annual LCF Risk[k]	7.6E-06	1.6E-02

R2

Table D-8. Potential Radiological Impacts on the General Public and Site Workers Due to Normal Operations of the MFFF R2

[a] [Text Deleted]
[b] Height of groundlevel release is 1 ft (0.3 m) above grade.
[c] Source is GENII model results for the offsite public.
[d] 10 CFR Part 20, Subpart D standard is an annual dose of 100 mrem.
[e] Natural background radiation is 295 mrem/yr (see Table 4-23).
[f] Calculated using a cancer risk factor of 0.0005 per rem (500 cancers/10^6 person-rem).
[g] Natural background radiation for the offsite public was calculated as the individual background radiation (295 mrem/yr) times the number of people projected to live in the 50-mi (80-km) assessment area in the year 2030 (1,042,483 people). The calculated value is 307,532 person-rem/yr.
[h] Calculated as the population dose divided by the number of people projected to live in the 50-mi (80-km) assessment area in the year 2030 (1,042,483 people).
[i] Source is GENII model results for site workers.
[j] 10 CFR Part 20, Subpart C standard is an annual dose of 5,000 mrem.
[k] Calculated using a cancer risk factor of 0.0004 per rem (400 cancers/10^6 person-rem).
[l] Minimum values based on a distance of 5 mi (8 km) from the release point (i.e., at the SRS boundary).
[m] Maximum values based on a distance of 328 ft (100 m) from the release point (i.e., at the MFFF boundary).
[n] Dose for the site worker population was determined by multiplying the MEI dose at the respective distance from the release point by the total number of site workers (13,616 workers). The MEI doses are as follows:

MEI dose at the MFFF boundary for an elevated release =	2.2E-02 mrem/yr
MEI dose at the SRS boundary for an elevated release =	3.9E-04 mrem/yr
MEI dose at the MFFF boundary for a groundlevel release =	3.0 mrem/yr
MEI dose at the SRS boundary for a groundlevel release =	1.4E-03 mrem/yr

[o] Natural background radiation for the site workers was calculated as the individual background radiation (295 mrem/yr) times the estimated number of site workers in 2000 (13,616 workers). The calculated value is 4,017 person-rem/yr.

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APPENDIX F. FACILITY ACCIDENTS

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This appendix summarizes the assessment methods and important analysis assumptions used to support the accident analysis presented in Section 5.5. This information is based on the MFFF safety assessment in the Construction Authorization Request. R1

F.1 GENERAL CONSEQUENCE ANALYSIS METHODS AND ASSUMPTIONS

F.1.1 Total Effective Dose Equivalent

The Total Effective Dose Equivalent (TEDE) to the receptors of interest is equal to the Inhalation Dose. Air submersion, ingestion, water immersion, and contaminated soil dose pathways are assumed negligible contributors to the TEDE. The Inhalation Dose is calculated as follows:

$$[\text{Inhalation Dose}]_{\text{effective}} = [\text{ST}] \cdot [\chi/\text{Q}] \cdot [\text{BR}] \cdot [\text{C}] \cdot \sum_{X=1}^{N} ST_X \cdot f_X \cdot [\text{DCF}]_{effective,X} \quad \text{(F-1)}$$

where:

ST_x	=	source term expressed as mass of radionuclide, x, released
χ/Q	=	atmospheric dispersion factor
BR	=	breathing rate
C	=	unit's conversion constant
f	=	specific activity of nuclide x
DCF	=	dose conversion factor of nuclide x
N	=	total number of dose-contributing radionuclides

R1

F.1.2 Source Term

The source term (ST) is the amount of respirable radioactive material released to the air. The initial source term is the amount of radioactive material driven airborne at the accident source. The initial respirable source term, a subset of the initial source term, is the amount of radioactive material driven airborne at the accident source that is effectively inhalable. Lesser source terms are determined by applying filtration or deposition factors to the initial source term. The MFFF Safety Assessment uses the following equation to determine the quantity of respirable material released by an event to the environs:

$$[ST_X] = [MAR] \times [DR] \times [ARF] \times [RF] \times [LPF] \quad \text{(NRC 1998d)} \qquad \text{(F-2)}$$

R1

The material at risk (MAR) is the amount of radioactive material (in grams) available to be acted on by a given physical stress associated with the accident. For facilities, processes, and activities, the MAR is a value representing some maximum quantity of radionuclide present or reasonably anticipated for the process or structure being analyzed. Different MARs may be assigned for different accidents since it is only necessary to define the material in those discrete physical locations that are exposed to a given stress. R1

The damage ratio (DR) is the fraction of the MAR actually impacted by the accident-generated conditions. The DR is estimated based upon engineering analysis of the response of structural materials for containment to the type and level of stress or force generated by the event. Conservative engineering approximations are typically used. These approximations often include a degree of conservatism due to simplification of phenomena to obtain a usable model, but the purpose of the approximation is to obtain, to the degree possible, a realistic understanding of potential effects.

The airborne release fraction (ARF) is the coefficient used to estimate the amount of a radioactive material suspended in air as an aerosol and thus available for transport due to physical stresses from a specific accident. For discrete events, the ARF is a fraction of the material affected. An entrainment event is treated in the same manner, with the exception that its release mechanism is a function of time. Thus, to use the five-factor formula, the airborne release rate (ARR) of an entrainment event must be multiplied by the duration of the entrainment and then equated to the ARF (i.e., ARF = ARR x duration). Entrainment is not considered for materials in the form of a pellet or for materials contained in rods or filters.

The respirable fraction (RF) is the fraction of airborne radionuclides as particles that can be transported through air and inhaled into the human respiratory system.

Values for the RF and ARF are based on bounding values from the NRC (NRC 1998d).

The leak path factor (LPF) is the fraction of the radionuclides in the aerosol transported through some confinement deposition or filtration mechanism. There can be many LPFs for some hazard events, and their cumulative effect is often expressed as one value that is the product of all leak-path multiples. Inclusion of these multiples in a single LPF is done to clearly differentiate between calculations of doses without controls (where the LPF is assumed equal to 1) and calculations of doses with controls (where the LPF reflects the dose credit provided to the controls). In this manner, the LPF represents the credit taken for the control features at the MFFF.

Specific values for these parameters used in the bounding analysis are provided in Section F.6.

F.1.3 Potential Receptors

For each potential accident, information is provided on accident consequences and frequencies to three types of receptors: (1) a site worker, (2) the maximally exposed member of the public, and (3) the offsite population. The first receptor, a site worker or SRS worker, is a hypothetical individual working on the site but not involved in the proposed activity. The worker is conservatively evaluated downwind at a point 328 ft (100 m) from the accident. The second receptor, a maximally exposed member of the public, is a hypothetical individual assumed to be downwind at the site boundary. The MFFF site boundary is conservatively evaluated at a distance of 5 mi (8 km). Exposures received by this individual are intended to represent the highest doses to a member of the public. The third receptor, the offsite population, is all members of the public within 50 mi (80 km) of the accident location.

F.1.4 Dispersion Modeling

The MACCS2 (MELCOR Accident Consequence Code System for the Calculation of the Health and Economic Consequences of Accidental Atmospheric Radiological Releases) computer code was used to compute the downwind relative air concentrations (χ/Q) for a groundlevel release from the MFFF (NRC 1998a). The relative concentration (atmospheric dispersion factors) (χ/Q) is the dilution provided relative to site meteorology and distance to the receptor(s). MACCS2 simulates the impact of accidental atmospheric releases of radiological materials on the surrounding environment. MACCS2 was developed as a general-purpose application to diverse reactor and nonreactor facilities licensed by the NRC or operated by DOE or the Department of Defense.

The receptor of interest includes the maximally exposed individual (MEI) member of the public at the SRS boundary [5 mi (8 km)]. This input is conservative with respect to the nearest site boundary and the nearest public road barricade (5.4 and 5.2 miles, respectively). The input into the MACCS2 code included a meteorological data file, which contains one year of hourly meteorological conditions for SRS. No credit is taken for building wake effects. The SRS meteorological data files are composed of hourly data for each calendar year from 1987 through 1996. Test runs demonstrated that 1987 and 1988 yield the most conservative site boundary χ/Q values; therefore, calculations were performed using the 1987 and 1988 meteorological data files. The dose incurred by the MEI is reported at the 95th percentile level, without regard to sector, from a ground release. The associated atmospheric dispersion factor (χ/Q) is 3.69E-06 sec/m^3. New meteorological data was used in the calculation of χ/Q with no effect on the resultant value. R1 R1 R1

The ARCON96 computer code was used to compute the downwind relative air concentrations (χ/Q) for the onsite receptor located within 328 ft (100 m) of a groundlevel release from the MFFF to account for low wind meander and building wake effects (NRC 1997). ARCON96 implements a straight-line Gaussian dispersion model with dispersion coefficients that are modified to account for low wind meander and building wake effects. A constant release rate is assumed for the entire period of release. Building wake effects are considered in the evaluation of relative concentration from groundlevel releases. ARCON96 calculates relative concentration using hourly meteorological data. The SRS meteorological data files are composed of hourly data taken at a height of 61m for each calendar year from 1987 through 1996. It then combines the hourly averages to estimate concentrations for periods ranging in duration from 2 hours to 30 days. Wind direction is considered as the averages are formed. As a result, the averages account for persistence in both diffusion conditions and wind direction. Cumulative frequency R1 distributions are prepared from the average relative concentrations. Relative concentrations that are exceeded no more than 5% of the time (95th percentile relative concentrations) are determined from the cumulative frequency distributions for each averaging period. The associated χ/Q for the site worker is 6.09E-04sec/m^3. R1

The breathing rate is conservatively assumed to be 3.47E-04 m^3/sec. This value is from Regulatory Guide 1.25 (NRC 1972) and is equivalent to the uptake volume (353 ft^3 [10 m^3]) of a worker in an eight-hour workday.

The inhalation dose conversion factors are taken from Federal Guidance Report 11 (EPA 1988). While some events involve radionuclides such as americium, the bounding releases from potential events at the MFFF involve plutonium particulate in the form of an oxide. The dose conversion factors corresponding to the yearly lung clearance class are applied to the released radionuclides accounting for this chemical form.

F.1.5 Source Term Composition

Source term composition for the plutonium involved in the bounding events is provided in Table F-1. Plutonium is designated as unpolished prior to being processed through the aqueous polishing process. Plutonium is designated as polished after it has been processed through the aqueous polishing process.

F.1.6 Likelihood Of Fatal Cancer

The probability coefficients for determining the likelihood of fatal cancer, given a dose, is taken from the *1990 Recommendations of the International Commission on Radiological Protection* (ICRP 1991). For low doses or low dose rates, respective probability coefficients of 4.0E-04 and 5.0E-04 fatal cancers per rem are applied for workers and the general public. For high doses received at a high rate, respective probability coefficients of 8.0E-04 and 1.0E-03 fatal cancers per rem are applied for noninvolved workers and the public. These higher probability coefficients apply where doses are above 20 rem and dose rates are above 10 rem/hr.

F.2 FREQUENCY CATEGORIES

Frequency categories in the MFFF Safety Assessment are based on qualitative estimates. The frequency categories are defined as follows:

- Not Unlikely – Event may occur during the facility's lifetime.
- Unlikely – Event is not expected to occur during the facility's lifetime.
- Highly Unlikely – The use of sufficient principal SSCs (or IROFS) applied to unmitigated events classified as Not Unlikely or Unlikely to further reduce their frequency to an acceptable level.

- Credible – Events that are not "Not Credible."
- Not Credible – Natural phenomena or external man-made events with an extremely low initiating frequency, or process events that are not possible.

Note that the Highly Unlikely category is not used in the unmitigated analysis. Only through the application of MFFF engineered features are events placed into this category. Also note that events deemed Not Credible are not considered in the MFFF design.

F.3 CONSEQUENCE CATEGORIES

Consequences are categorized according to three severity levels: High, Intermediate, and Low. The consequence severity levels are based on 10 CFR §70.61 and are shown in Table F-2.

F.4 RISK CATEGORIES

Risk is represented by the frequency and the consequence. Based on 10 CFR §70.61, the risk categories are shown in Table F-3. This matrix is applicable to all receptors.

In accordance with 10 CFR §70.61, the risk posed by those events falling in risk categories 6 and 9 must be addressed with engineered controls, administrative controls, or both to reduce the risk to an acceptable level.

Note that 10 CFR §70.61 places no consequence criteria for events considered Highly Unlikely. Thus, the environmental assessment does not report consequences for events deemed Highly Unlikely.

F.5 UNCERTAINTIES AND CONSERVATISM

The determination of risk is based on calculations associated with hypothetical sequences of events and models of their effects. The models provide estimates of the frequencies, source terms, pathways for dispersion, exposures, and the effects on human health and the environment that are as realistic as possible within the scope of the analysis. The uncertainty in the calculation of consequences and event frequency requires the use of models or input values that yield conservative consequence and frequency estimates. All events have been evaluated using uniform methods and data, allowing a fair comparison of all events.

The bounding consequence calculations are based on extremely conservative assumptions. The actual source term involved in the event would be far lower than the source term considered in the calculation due to the actual MFFF design. Specific conservative assumptions include 95% meteorology; an LPF of 1E-04 for more than two sets of HEPA filters; and bounding source terms, release fractions, and respirable fractions as described in Section F.6. When relied upon to mitigate the effects of an accident, the filters are assumed to have a 99% removal efficiency (i.e. 1% leak path factor) per stage. Each HEPA system relied upon for safety includes two banks or stages of HEPA filters in series. The effective leak path factor for a system of staged HEPA R1 filters is the product of the individual leak path factors for successive filter stages. Thus, a leak path factor of 1E-04 was applied for the HEPA system. The combination of efficiencies is more conservative than the value of 2E-06 presented in NRC 1998d (Section F.2.1.3) for filters protected by pre-filters, sprinklers and demisters. R1

The estimation of event frequency is especially subject to considerable uncertainty. The uncertainty in estimates of the frequency of Highly Unlikely events can be several orders of magnitude. For this reason, event frequency is reported qualitatively, in terms of broad frequency bins, as opposed to numerically.

The analysis uses an extremely conservative approach with respect to frequency. All natural phenomena hazards and external man-made hazards are considered unless their probability of impacting the MFFF is extremely low, and all internal hazards generated by the MFFF design and operations are considered. For these hazards, unmitigated events are evaluated without regard to the frequency of the initiating event. In most cases, the failure of many features is required for the bounding event to occur.

F.6 ADDITIONAL INTERNAL EVENT DESCRIPTIONS

This section provides supporting details for the bounding events described in Section 5.5. Two types of events are presented; bounding events and bounding low consequence events. Bounding events are defined as events that have a frequency greater than or equal to unlikely and that have the potential to produce the largest unmitigated consequences. Bounding low consequence events are defined as events that have the potential to produce the largest unmitigated consequences that are below the intermediate consequence criteria of 10CFR70.61. These events do not require mitigation or prevention, however mitigation may be available from features required for other events. All events identified in the PHA (Preliminary Hazards Analysis) are evaluated to determine the bounding and bounding low consequence events.

F.6.1 Loss of Confinement

R1

The bounding loss of confinement event is an event caused by a load handling accident of the Jar Storage and Handling Unit. (See Section F.6.3 for a description of this event.) The bounding radiological consequences associated with this event are provided in Table 5-13a. The frequency associated with this event is estimated to be unlikely or lower since multiple failures are required for this event to occur.

The bounding low consequence event is a spill of the silver recovery tank. This unit contains americium and other metals that have been removed during the plutonium purification process. The evaluation conservatively assumes the tank is full to its service capacity resulting in a total MAR for this event of 2.2 lb (1.0 kg) of americium in solution. The ARF is 2E-5, the RF is 1.0, and the DR is conservatively assumed to be 1.0. Consequences are presented in Table 5-13b. R1
Although not required in order to satisfy the requirements of 10CFR70.61, an LPF of 1E-4 is applied to this event because the event takes place in a process cell and the release of the radiological material would pass though multiple banks of credited HEPA filters.

The MFFF utilizes many features to reduce the likelihood and consequences of these events as well as other loss-of-confinement events. Key features include reliable and redundant confinement systems; process temperature, pressure, and flow controls; radiation monitoring systems; redundant control systems; emergency procedures; and worker training.

F.6.2 Internal Fire

The bounding internal fire event is a fire in the fire area containing the Final Dosing Unit. This unit contains polished plutonium powder for the purpose of down blending the mixed oxide R2
powder to the desired blend for fuel rod fabrication. This fire area is postulated to contain the largest source term for this event, thus producing the largest consequences. Fire areas with a larger material at risk have a lower damage ratio for this event resulting in a lower overall source term.

The evaluation conservatively assumes that a fire occurs in this fire area and impacts the powder R2
stored in this area, resulting in a release of radioactive material. The maximum amount of plutonium in this fire area does not exceed 90 lb (41 kg) of polished powder. Due to the low combustible loading in this fire area, just a small fraction of this material would be expected to be involved in the fire. However, the evaluation conservatively uses the entire fire area inventory in the consequence analysis. The damage ratio is assumed to be 1.0, the bounding respirable release fraction is 6E-04, and the bounding leak path factor is 1E-04. The bounding radiological consequences associated with this event are provided in Table 5-13a. R2

The MFFF utilizes many features to reduce the likelihood and consequences of this event as well as other fire-related events. Key features include fire barriers, minimization of combustibles and ignition sources, ventilation systems with fire dampers and HEPA filters, qualified canisters and containers, fire suppression and detection systems, emergency procedures, worker training, and local fire brigades.

The frequency associated with this event is estimated to be Unlikely or lower because multiple failures are required for this event to occur.

The bounding low consequence fire event is due to a fire in a waste drum located in the truck bay. Although most waste drums contain only small amounts of plutonium, the evaluation R1
conservatively assumes that 50 grams of unpolished plutonium is involved in the fire. The ARF is 6E-3, the RF is 0.1, the LPF is 1.0, and the DR is 1.0. The results are presented in Table 5-13b.

F.6.3 Load Handling

The bounding load-handling event is a drop event involving the glovebox in the Jar Storage and Handling Unit. This glovebox contains jars of plutonium powder. This glovebox is postulated to contain the largest source term for this event, thus producing the largest consequences. Gloveboxes that contain a larger material at risk have a lower damage ratio for this event resulting in a lower overall source term. R1

The glovebox is postulated to be impacted during maintenance operations by either a lifting device or a lifted load outside of the glovebox, damaging a portion of the glovebox causing some of its contents to drop to the floor, resulting in a release of radioactive material. The maximum amount of plutonium in this glovebox is approximately 743 lb (337 kg) of polished powder. Due to the large glovebox size, it is expected that just a small fraction of this amount would be involved in the event. However, the evaluation conservatively uses the entire glovebox inventory in the consequence calculations. The damage ratio is assumed to be one, the bounding respirable release fraction is 6E-04, and the bounding leak path factor is 1E-04. The bounding radiological consequences associated with this event are provided in Table 5-13a. R2

The MFFF utilizes many features to reduce the likelihood and consequences of this event as well as other load-handling events. Key features include loadpath restrictions, crane-operating procedures, maintenance procedures, operator training, qualified canisters, reliable load-handling equipment, and ventilation systems with multiple banks of HEPA filters. R

The frequency associated with this event is estimated to be Unlikely or lower because multiple failures are required for this event to occur.

The bounding low consequence load handling event is a spill of the silver recovery tank. This event differs from the previous loss of confinement bounding low consequence event in the respect that this event is postulated to occur during maintenance operations in the process cell. During maintenance operations, the tank contains a minimal amount of MAR to minimize the potential exposure to operators. However, for conservative evaluation of the event, the tank is assumed to be full resulting in a total MAR of 2.2 lb (1.0 kg) of americium in solution form. The ARF is 2E-5, the RF is 1.0, and the DR is conservatively assumed to be 1.0. Although not required in order to satisfy the requirements of 10CFR70.61, an LPF 1E-4 is applied to this event because the event takes place in a process cell and the release of the radiological material would pass though multiple banks of credited HEPA filters. Consequences are presented in Table 5-13b. R1

F.6.4 Hypothetical Criticality Event

The MFFF processes are designed to preclude a criticality event through the use of reliable engineered features and administrative controls. Adherence to the double contingency principle, as specified in ANSI/ANS-8.1 (ANSI/ANS 1983b), is employed. Simultaneous failure of the criticality controls is Highly Unlikely.

Although criticality events at the MFFF are prevented, a generic hypothetical criticality event is evaluated. A bounding source term of 10^{19} fissions in solution is evaluated consistent with guidance provided in Regulatory Guide 3.71 (NRC 1998c). Airborne releases and direct radiation result from the criticality. The direct radiation contribution is negligible due to the shielding provided by the building and the distance to the site worker and the offsite public. Airborne releases are calculated consistent with the guidance of Regulatory Guide 3.35 (NRC 1979). The leak path factor for gases and particulates is 1.0 and 1E-04, respectively. The evaluation is based on 88 lb (40 kg) of unpolished plutonium, the maximum tank inventory of plutonium in solution. The radiological consequences associated with this event are shown in Table 5-13a. R2

F.6.5 Hypothetical Explosion Event

The MFFF processes are designed to preclude explosions through the use of reliable engineered features and administrative controls, the simultaneous failure of which is Highly Unlikely.

Although explosion events at the MFFF are Highly Unlikely, a generic hypothetical explosion event is evaluated. The evaluation conservatively assumes that an explosion occurs and involves the entire material at risk within a process cell. The maximum amount of plutonium in any process cell is approximately 132 lb (60 kg) of unpolished plutonium. Because the material at risk is in three separate tanks within this cell, only a fraction of this amount would be involved in the event. However, the evaluation conservatively uses the entire process cell inventory in the consequence calculation. The damage ratio is assumed to be one, the bounding respirable release fraction is 0.01, and the bounding leak path factor is 1E-04. The radiological consequences of this hypothetical event are presented in Table 5-13a. R1

F.6.6 Chemical Releases

Consequences of chemical releases were determined for a potential release of each chemical. For evaporative releases, the chemical consequence analysis modeling for public consequences used the ALOHA code (EPA 1999), the ARCON96 code (NRC 1997), and the MACCS2 code (NRC 1998a) to calculate the maximum airborne chemical concentration at the SRS boundary (5.0 miles from the MFFF). R1

An evaporation model extracted from the ALOHA code was used to calculate a release from a spilled or leaked chemical, which is assumed to form a puddle one-centimeter deep. A spill or leak from the largest tank or container holding the chemical was modeled. Consideration for spill size, location, container integrity, and chemical concentration was included in the evaluation. R2

Calculated concentrations were compared to Emergency Response Planning Guidelines (ERPGs) or to Temporary Emergency Exposure Limits (TEELs). TEELs describe temporary or equivalent exposure limits for chemicals for which official Emergency Response Planning Guidelines have not yet been developed. This method was adopted by DOE's Subcommittee on Consequence Assessment and Protective Action (SCAPA). The SCAPA-approved methodology published in the American Industrial Hygiene Association Journal was used to obtain hierarchy-derived TEELs (WSRC 1998). TEELs are provided for nearly 1,200 additional chemicals. TEELs are equal to the Acute Exposure Guideline Level and Emergency Response Planning Guidelines, where these values are available.

The definitions of TEEL levels consistent with 10 CFR §70.61 are as follows:

- TEEL-1 – The maximum concentration in air below which it is believed nearly all individuals could be exposed without experiencing other than mild transient adverse health effects or perceiving a clearly defined objectionable odor.
- TEEL-2 – The maximum concentration in air below which it is believed nearly all individuals could be exposed without experiencing or developing irreversible or other serious health effects or symptoms that could impair their abilities to take protective action.
- TEEL-3 – The maximum concentration in air below which it is believed nearly all individuals could be exposed without experiencing or developing life-threatening health effects.

Three severity consequence levels identified are Low, Intermediate, and High. The consequence severity level defined in Table F-4 is based on 10 CFR §70.61.

Based on the results of the chemical evaluation, DCS concludes that the chemical consequences at the site boundary and to the site worker are low. R1

Tables

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Table F-1. Isotopic Composition for Bounding Accidents

Isotope	Unpolished Pu Isotopic Fraction	Polished Pu Isotopic Fraction
Pu-236	0.00%	0.00%
Pu-238	0.04%	0.04%
Pu-239	92.02%	92.67%
Pu-240	6.14%	6.18%
Pu-241	1.00%	1.01%
Pu-242	0.10%	0.10%
Am-241	0.70%	0.00%

Table F-2. Consequence Severity Categories Based on 10 CFR §70.61

Consequence Category	Worker TEDE	Offsite Public TEDE/Uranium Intake	Environmental Release
3: High	> 1 Sv (> 100 rem)	> 0.25 Sv (> 25 rem) >30 mg soluble uranium intake	Not applicable
2: Intermediate	0.25 Sv to ≤ 1 Sv (25 rem to ≤ 100 rem)	0.05 Sv to ≤ 0.25 Sv (5 rem to ≤ 25 rem)	> 5,000 times the concentrations in Table 2, Attachment B of 10 CFR Part 20
1: Low	Events of lesser radiological exposures to workers than those above in this column	Events of lesser radiological exposures to the public than those above in this column	Radioactive releases producing effects less than those specified above in this column

TEDE – Total Effective Dose Equivalent

Table F-3. Event Risk Matrix

CONSEQUENCE	Highly Unlikely	Unlikely	Not Unlikely
High	3 acceptable risk	6 unacceptable risk	9 unacceptable risk
Intermediate	2 acceptable risk	4 acceptable risk	6 unacceptable risk
Low	1 acceptable risk	2 acceptable risk	3 acceptable risk

LIKELIHOOD

Table F-4. Consequence Severity Categories Based on TEEL

Consequence Category	Workers	Offsite Public
High	> TEEL-3	> TEEL-2
Intermediate	TEEL-2 < x < TEEL-3	TEEL-1< x < TEEL-2
Low	< TEEL-2	< TEEL-1

APPENDIX G.

ENVIRONMENTAL IMPACTS OF CONSTRUCTION AND OPERATION OF THE WASTE SOLIDIFICATION BUILDING

[NEW APPENDIX]

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The DOE has decided to construct the Waste Solidification Building (WSB) as part of the PDCF. This building will remove radioisotopes from the MFFF and PDCF liquid wastes and convert them into solid waste that will be disposed as transuranic waste or low-level radioactive waste. Because the environmental impacts of constructing and operating the WSB were not explicitly evaluated as part of the SPD EIS, and the WSB is a connected action, the impacts are included in those evaluated for the MFFF in this ER. The environmental impacts of constructing and operating the WSB are less than the projected impacts from the construction and operation of the Plutonium Immobilization Plant evaluated in the SPD EIS but subsequently cancelled.

The WSB design is at the conceptual design stage. Information and impact projections presented in this appendix are bounding projections.

G.1 DESCRIPTION OF THE WASTE SOLIDIFICATION BUILDING

G.1.1 Building Description

The 75,000 ft^2 WSB, which is not part of the NRC licensed MFFF, will be constructed by the DOE on the PDCF site south of the PDCF to process the following liquid waste streams from the PDCF and the MFFF:

MFFF High Alpha Stream

MFFF Stripped Uranium Stream

PDCF Laboratory Liquid Stream

PDCF Laboratory Concentrated Liquid Stream

The building will be a combination of concrete and soft structure. Concrete will be utilized to provide confinement of the high alpha exposure field caused by the MFFF high alpha stream. A concrete-cell configuration will be utilized as this stream is processed through the building. Process enclosures adjacent to the cells will provide worker protection to accommodate operations and maintenance activities. The shielding and confinement will also serve as fire isolation barriers. The soft-shell construction composed of a steel siding on structural steel members will house the low activity process, cold chemical feeds, storage, shipping areas and balance of plant services. Secondary confinement features such as dikes, sumps and leak detection will be provided for those areas with liquid waste spill potential. The major pieces of process equipment are tanks, evaporators, and cementation equipment.

The building will contain no more than 11,000 gallons of high alpha waste stream (including transfer pipeline flush water) and 21,000 gallons (including transfer pipeline flush water) of low activity waste. Materials in drum storage will be in cement form and are not considered to be at risk because the cement matrix immobilizes the radionuclides. Cold chemical processing rooms, drum storage, and truck loading/unloading will be performed in non-hardened structures. The drum storage area will be at grade.

The waste receipt area has tanks to separately receive high alpha waste, stripped uranium waste, and the PDCF laboratory liquid stream waste. The tank volumes are sufficient to receive and store waste from six weeks of processing by the MFFF and eight weeks by PDCF.

The PDCF and MFFF will each transfer a transuranic (TRU) waste and a low-level radioactive waste (LLW) stream to the WSB. Within the WSB, these TRU and LLW streams will be treated separately. The WSB will produce a TRU and a LLW solid waste form acceptable for shipment and disposal at their respective locations. The TRU waste form will be sent to WIPP. The LLW form will be sent to E-Area (SRS) or to another permitted disposal site.

Within the WSB, the waste streams are collected into receipt tanks, chemically adjusted, evaporated, neutralized, combined with cement into drums, stored and shipped. The MFFF high alpha stream receipt tanks and process rooms will be located inside a hardened (reinforced concrete) structure. The other streams will be included in a standard metal constructed building. The process areas will be exhausted through a HEPA filtration confinement system prior to release through a stack. The building will be divided into individual fire zones to reduce potential doses to the on-site receptor.

G.1.2 Waste Processing

The WSB will receive waste from the MFFF and PDCF. Table G-1 provides a characterization of these waste streams. As noted in Chapter 3, Table 3-3, three of the MFFF liquid waste streams (liquid americium, excess acid, and solvent regeneration alkaline wash) are combined into the high alpha waste. The stripped uranium waste stream is transferred as a separate waste to the WSB. The two wastes are batch transferred through separate double-walled stainless steel pipes to the WSB. PDCF Laboratory Liquid Stream (Table G-1) is also transferred through double-walled stainless steel pipes to the WSB. Following each transfer, provisions exist to rinse the pipeline, if necessary. The pipes are maintained in a drained state between waste transfers. PDCF Laboratory Concentrated Liquid Stream is transported in containers to the WSB.

Evaporation with cementation will be used to process PDCF Laboratory Liquid Stream, MFFF High Alpha Stream, and MFFF Stripped Uranium Stream. Evaporation will be used to reduce the "water" content of the streams to that needed for efficient cement mixing. Excess water will be recycled where practical or transferred to the existing SRS Effluent Treatment Facility (ETF) and processed to allow release to the environment.

The PDCF Lab Concentrated Waste is processed separately through neutralization and absorption in a solidification additive for eventual disposal to WIPP.

Chemicals used in the treatment process are listed in Table G-2.

G.1.2.1 PDCF Laboratory Liquid Stream Receipts

The PDCF Laboratory Liquids Stream is 0.5 Molar (average) acidic with large quantities of nitrates salts but very little radionuclides. This stream will be pumped approximately 800 ft (243.8 m) to the WSB from PDCF in a welded-jacketed stainless steel pipe, which will be direct buried. The volume of this waste stream is anticipated to be a nominal 11,000 gallons per year, and will be received in approximately 12 transfers (900 gallons each) at a frequency of about one transfer every month. Each transfer may be accompanied by a two line volume flush which is estimated to be 300 gallons total of water provided by PDCF.

The line flush technique for PDCF waste will be to pump one line volume of flush water (estimated to be 150 gallons) to the WSB tanks. The residual line volume will then be drained back to a PDCF flush water collection tank for use in the next flush.

The WSB receipt tanks will be sized to hold two transfers (eight weeks of PDCF Laboratory Liquid Stream capacity) in two 1,500 gallons tanks. The PDCF tanks are similarly sized, providing a total system storage of eight to 16 weeks of PDCF processing capacity in the event of a shutdown of WSB operations for maintenance or processing anomalies. The WSB tanks will be agitated to mix the waste and flush water.

G.1.2.2 MFFF Stripped Uranium Stream Receipts

The MFFF Stripped Uranium Stream will be nominally 0.1 Molar acidic with large quantities of Uranium (<1% ^{235}U). This stream will be pumped approximately 2,000 ft (609.6 m) from the MFFF to the WSB in a double-walled stainless steel pipe. The nominal waste volume of this stream will be 42,530 gallons per year, received in approximately 42 transfers at a frequency of about one every week. Each transfer will be accompanied by a two line volume flush, which is estimated to be 700 gallons total of distillate wash liquid provided by MFFF. The first flush volume will go into the WSB stripped uranium stream receipt tanks. The second flush volume will drain back into the MFFF stripped uranium stream collection tank.

The WSB receipt tanks will be sized to hold six transfers (six weeks of MFFF capacity). The MFFF tanks are sized to hold three months of MFFF waste. The WSB tanks will be agitated to mix the waste and flush.

G.1.2.3 Processing Of PDCF Lab Liquids and MFFF Stripped Uranium

Both streams are anticipated to be LLW and to be RCRA corrosive wastes (pH will be less than 2). Due to extremely low fissile material content, criticality is not a credible event. In addition, these streams are compatible for mixing. The WSB will be able to process these streams in any combination necessary. Sampling will be done to support downstream processing.

G.1.2.3.1 Evaporator

The low activity waste (LAW) evaporator will be designed to operate at approximately 100°C and may be electrically or steam heated. External coils may be used to provide isolation from the waste and to lengthen the evaporator life. The bottoms size of the evaporator will be approximately 500 gallons with a continuous feed from the head tank during steady state operation. Bottoms will be pumped to the LAW bottoms collection tank, cooled and sampled before being pumped to the neutralization tank. If the sample results are unacceptable, the bottoms may be pumped back to the LAW head tank for reprocessing. Overheads will be condensed and collected in the effluent head tank and pumped to the effluent polishing evaporator for a second evaporator cleanup if needed or, in the case of a batch of high activity overheads, a third evaporator pass.

G.1.2.3.2 Neutralization

The acidic bottoms from evaporation must be pH adjusted in order to be compatible with the cementation process. Sodium hydroxide (50%) was selected to mix in the neutralization tank to achieve a free hydroxide normality of approximately 1.2, with pH 12-14. Chemical reaction heat will require dissipation via cooling coils and a cooling tower. Any overflows will be contained. Rinse water will be provided.

G.1.2.3.3 Cement Process

Neutralized waste will be pumped to a cement mixer. A metering pump will inject controlled amounts of the waste stream from the neutralization tank to a twin-screw cement mixer to be continuously mixed with supplied dry cement powder. Forty gallons of the mix is caught in a 55-gallon steel drum. A splash collar will be utilized to minimize the spread of contamination. This sequence will be repeated until the LAW neutralization tank is emptied. The conveyor supplying drums will be loaded and will accommodate approximately one week's production of drums.

In-drum automated mixing is considered a viable alternative to the twin screw mixer. A metering pump would be used to provide a precise amount of neutralized waste deposited directly into the 55-gallon (40-gallon final volume cement waste form) container. A lid with paddle blade agitator would be lowered into place, dry cement powder would be added and the cement would be thoroughly mixed in the lined drum. The motor head would be de-coupled from the paddle blade shaft and withdrawn. The paddle blade assembly would remain in the drum. The drum would be conveyed down the line, the next drum moved to the fill position, and the process repeated until the LAW Neutralization Tank is emptied.

Dust control measures and collection will be provided for the dry cement powder. The output air stream will be pre-filtered before being introduced to the main exhaust ventilation system, preventing cement blinding of the building HEPA system. In addition, this air is pulled from around the mixer and at the dry cement addition zone, and is anticipated to contain radionuclides.

G.1.2.3.4 Overheads Processing to ETF

Overheads from the high activity waste (HAW) Condensate Hold Tank will be batch fed into the LAW head tank (separately from MFFF / PDCF LAW waste streams) for feed to the LAW Evaporator. Overheads from the LAW evaporator will be processed through the Effluent Polishing Evaporator to meet the SRS ETF Waste Acceptance Criteria (WAC) limits. This stream will be condensed, collected, sampled, and neutralized in the Effluent Holding Tank before being pumped to an existing F-Area process sewer connected to the ETF facility. This condensate can also be pumped to either the HAW Head Tank or LAW Head Tank and used for dilution purposes. Bottoms from this evaporation step will be transferred to the LAW Bottoms Collection Tank where it will mix with the bottoms evolved from LAW evaporator operations.

The Effluent Polishing Evaporator is similar to the other evaporators used in the WSB. Overheads are condensed to the Effluent Holding Tank. They are sampled and are either acceptable and pumped to ETF, rejected and adjusted to be sent to ETF, or used as dilution water in the HAW Head Tank. Adjustment would consist of the addition and mixing of small amounts of caustic to meet the pH requirements of ETF.

G.1.2.4 PDCF Lab Concentrates Processing

PDCF is anticipated to transport less than 200 one-liter containers of Laboratory Concentrated Waste to the WSB for processing each year. Each container will hold between 10 and 37 gram equivalent Pu. The average expected receipt rate is approximately 96 containers per year at 13 grams Pu equivalent in a 1.9-molar nitric acid solution. Processing only one liter-container of waste at a time, which reflects similar processes currently in use at SRS for materials of this type, precludes criticality events.

The WSB will accept/store up to 10 containers maximum in a rack storage. This rack and the solidification process will be housed in a glovebox. One container at a time will be processed by pouring its contents into a 5-liter bottle containing approximately two liters of dry soda ash for neutralization, and set aside to offgas. Up to three liters of a solidification additive will be added to absorb the neutralized material, ensuring no free liquids. The 5-liter container will be closed, bagged out of the glovebox, packaged into a "paint" can (with a second 5-liter bagged bottle), the "paint" can inserted into a WIPP "Pipe-N-Go" and over-packed into a 55-gallon drum for shipment in a TRUPACT II. As an alternative, solidification could also be accomplished by directly placing neutralized material in a 55-gallon drum with concrete.

G.1.2.5 MFFF High Alpha Stream

G.1.2.5.1 Receipts

The MFFF high alpha stream will be pumped approximately 2,000 ft (609.6 m) from MFFF to the WSB in a double-walled stainless steel pipe. The waste stream can vary within given ranges. The nominal volume received is anticipated to be approximately 22,000 gallons per year of this combined stream, which will be received in approximately 25 transfers, at a frequency of about once every two weeks. Each transfer will be accompanied by a two line volume flush, estimated to be approximately 700 gallons of distillate wash liquid provided by MFFF.

The line flush technique for MFFF high alpha waste will pump a line volume of flush (estimated to be 350 gallons in the 2,000-ft (609.6-m) run to WSB) to the WSB tanks. The second line volume will then be drained back to MFFF waste tanks.

The WSB receipt tanks will be sized to hold three transfers (six weeks capacity in two 3,000-gallon tanks). The MFFF high alpha stream collection tanks are sized for three months capacity. This arrangement will provide continued MFFF processing capacity in the event of a shutdown of WSB operations due to maintenance or other disruptions. The tanks are agitated to mix the waste and flush.

These receipt tanks will generate a radiation field and will be contained in concrete walled cells. Sampling capability, pumps, and valves will be located in gloveboxes in order to minimize the potential for contamination, to provide shielding during operations and maintenance, and to facilitate disposal. The waste stream is anticipated to include a silver constituent and to exceed the RCRA threshold for corrosivity (pH < 2), necessitating leak detection and confinement. Sump liquids will be directed to overflow tanks.

Hydrogen gas generated by the radiolysis of water in this waste stream will be vented and purged by a vessel vent system in order to prevent hydrogen from reaching the lower flammability limit.

G.1.2.5.2 Evaporator

The HAW evaporator will be designed to operate at approximately 100°C and may be electrically or steam heated. External coils may be used to provide isolation from the waste and to lengthen the evaporator life. Bottoms will be pumped to the bottoms collection tank (approximately 50 gallon bottoms), where it will be cooled and sampled before being pumped to the HAW neutralization tank. If the sample results are unacceptable, the bottoms will be pumped back to the HAW head tank for reprocessing. Overheads will be condensed and collected in the HAW condensate hold tank, sampled, and if the results are acceptable, pumped to the LAW head tank for a second evaporator cleanup. If the sample results are not acceptable, the overheads will be pumped back to the HAW head tank for reprocessing.

The HAW evaporator will be able to be bypassed, and the HAW head tank directed to the HAW bottoms collection tank. While not as efficient, this arrangement will allow continued processing if necessary during an evaporator outage, with alternate processing directly to the cement process. In this case, the amount of dilution water used in the process would be adjusted, in order to reduce the total amount of cement produced while keeping the americium loading at an acceptable level for shipment to WIPP. In using the bypass mode approximately 120 additional drums of TRU waste may be added to the annual waste values discussed in Section G.3.6.

G.1.2.5.3 Neutralization

The acidic bottoms from evaporation must be pH adjusted in order to be compatible with the cementation process. Sodium hydroxide (50%) was selected to mix in the neutralization tank to achieve a free hydroxide Normality of approximately 1.2, with pH 12-14. Chemical reaction heat will require dissipation via cooling coils and a cooling tower. Caustic solution will be batch fed into a Cold Chemical addition tank before being gravity fed to the HAW Neutralization Tank. This approach will prevent over-addition of caustic and will aid in controlling the rate of reaction. Any overflows will be directed to an overflow tank in order to contain the americium. Rinse water is connected to the HAW Neutralization Tank in order to provide the capability to remove buildup in the tank bottom. This tank is sampled to ensure that the input to the cement process is within anticipated parameters.

G.1.2.5.4 Cement Process

Neutralized high alpha waste will be pumped to two 30-gallon cement head tanks. One tank will receive material while the other tank is being pumped to the cement mixer. A metering pump will inject controlled amounts of the waste stream from the 30-gallon head tank to a twin-screw cement mixer to be continuously mixed with supplied dry cement powder. The mix is caught in a twenty-gallon cement waste container, which will then be deposited into a 55-gallon steel drum. A splash collar will be utilized to minimize the spread of contamination. This sequence will be repeated until the high activity waste Neutralization Tank is emptied. The conveyor supplying drums will be loaded and will accommodate approximately one week's production of drums.

In-drum automated mixing is considered a viable alternative to the twin screw mixer. A metering pump would be used to provide a precise amount of neutralized waste from the 30-gallon tanks. In this case, the waste would be deposited directly into the 20-gallon cement waste-form container. A lid with paddle blade agitator would be lowered automatically in place, dry cement powder would be added, and the cement would be thoroughly mixed in the drum. The motor head would be de-coupled from the paddle blade shaft and withdrawn. The paddle blade assembly would remain in the drum. The drum would be conveyed down the line, the next drum moved to the fill position, and the process repeated until the high activity Neutralization Tank is emptied.

The high activity waste cementation process area is anticipated to have a high background radiation level. Equipment requiring regular operator access will be shielded. Remotely operated drum handling (conveyor), instrumentation, pumps, and valves will also be required to limit exposure. Some components will be located in gloveboxes to prevent the spread of contamination, to provide shielding for operations and maintenance, and to facilitate maintenance and disposal. Dikes or other methods of leak detection and confinement prevent this silver containing waste from entering building drains and the NPDES permitted treatment system.

G.2 EFFECTS OF FACILITY CONSTRUCTION

The WSB will be located on the south end of the PDCF site (Figure G-1). The ecological description of this land is provided in the SPD EIS and is similar to the terrestrial ecology of the MFFF site described in Chapter 4.

G.2.1 Impacts to Air Quality

Potential impacts to local air quality during construction of the WSB are anticipated to be bounded by the impacts presented in Section G.4.2.3.1 of the SPD EIS (DOE 1999c) for the immobilization plant. These impacts are summarized in Table G-3 of this ER.

G.2.2 Impacts to Water Quality

G.2.2.1 Water Use

All water (25 million gallons per year) for construction activities will be provided from existing SRS utilities. Local surface water would not be used in the construction of proposed facilities at SRS. Thus, there would be no impact on the local surface water availability to downstream users.

G.2.2.2 Surface Water Quality

Sanitary waste will be collected using portable toilets or processed through the SRS Central Sanitary Wastewater Treatment Facility. Because this sanitary wastewater is a small fraction of the SRS Central Sanitary Wastewater Treatment Facility capacity, no impacts on surface water quality would be expected from the discharge of these flows to the treatment system and, subsequently, to the receiving stream.

Proven construction techniques will be used to mitigate the impact of soil erosion on receiving streams. The WSB construction stormwater pollution prevention plan will be consistent with the existing SRS stormwater and erosion management practices. Because of the effectiveness of these techniques, no long-term impacts from soil erosion due to construction activities would be expected.

To comply with *South Carolina State Standards for Stormwater Management and Sediment Reduction* (SCDHEC 2000b), detention ponds designed to control the release of the stormwater runoff at a rate equal to or less than that of the pre-development stage will be built at strategic locations as part of SRS infrastructure development.

G.2.2.3 Groundwater Quality

The estimated water usage for constructing the WSB site is estimated to be 25 million gal/yr (95 million L/yr). Current water usage in F Area is 98.8 million gal/yr (374 million L/yr) (DOE 1999c). The total construction requirement represents approximately 1.6% of the A-Area loop groundwater capacity, which includes F Area, of about 1.58 billion gal/yr (6.0 billion L/yr) (Tansky 2002). WSB groundwater withdrawals are not anticipated to have any impact on SRS or local groundwater supplies.

G.2.3 Impacts to Terrestrial Ecology

G.2.3.1 Land Use

The WSB will be constructed on the PDCF site. Construction of the WSB will require approximately 5 acres (2 ha) of land. Construction on the site is consistent with other SRS uses and with the industrial land use activity in the surrounding area. It is also consistent with the

SRS Land Use Technical Committee's *Draft SRS Long Range Comprehensive Plan* (DOE 2000a) for land use in the area.

Part of the land within F Area has been previously disturbed and is partially developed. The area where the WSB will be located is mostly grass and pine plantation. This area was already designated to be cleared for the PDCF construction. Some changes in topography have already taken place.

G.2.3.2 Non-Sensitive Habitat

There should be no direct impacts on non-sensitive aquatic habitats because best-management practices for soil erosion and sediment control will be used to prevent construction runoff to these habitats, and direct construction disturbance would be avoided. Any scrub vegetation located on the site will be removed. The associated animal populations would be affected. Some of the less-mobile or established animals within the construction zone could perish during land-clearing activities and from increased vehicular traffic. Furthermore, activities and noise associated with construction could cause larger mammals and birds to relocate to similar habitat in the area. Also, animal species inhabiting areas surrounding F Area could be disturbed by the increased noise associated with construction activities, and the additional vehicular traffic could result in higher mortality for individual members of local animal populations. The recent survey of the site (DOA 2000) did not reveal any migratory bird nests. There would be no impacts on aquatic habitat from surface water consumption because water required for construction will be drawn from groundwater by the SRS utilities.

G.2.3.3 Sensitive Habitat

Wetlands associated with floodplains, streams, and impoundments will not be directly impacted by construction activities. No runoff or sediments are expected to be deposited in these areas because appropriate erosion and sedimentation controls will be used during construction.

No critical habitat for any threatened or endangered species exists on SRS. However, as discussed in Section 4.6.2.1, the bald eagle, red-cockaded woodpecker, wood stork, American alligator, smooth purple coneflower, and Oconee azalea might occur near F Area. Surveys conducted in 1998 and 2000 for the proposed WSB did not find any federally listed threatened, endangered, proposed, or sensitive plant or animal species (DOA 2000). Consultations were initiated by DOE with the U.S. Fish and Wildlife Service (USFWS) and the South Carolina Department of Natural Resources (SCDNR) to request comments on potential impacts on animal and plant species and to request any additional sensitive species information. The USFWS field office in Charleston, South Carolina, provided a written response indicating that the proposed facilities at SRS do not appear to present a substantial risk to federally listed species or other species of concern.

G.2.3.4 Noise

Construction impacts on local noise levels were evaluated in Section 4.4.1.1 of the SPD EIS (DOE 1999c).

The location of the WSB relative to the site boundary and sensitive receptors was examined to evaluate the potential for onsite and offsite noise impacts. Noise sources during construction would include heavy construction equipment, employee vehicles, and truck traffic. Traffic noise associated with the construction of the WSB would occur on the site and along offsite local and regional transportation routes used to bring construction materials and workers to the site.

Given the distance to the SRS site boundary (about 5 mi [8 km]), noise emissions from construction equipment would not be expected to annoy the public. These noise sources would be far enough away from offsite areas that the contribution to offsite noise levels would be small. Some noise sources could have onsite impacts, such as the disturbance of wildlife. However, noise would be unlikely to affect federally-listed threatened or endangered species or their critical habitats because none are known to occur in F Area (see ER Section 4.6.2.2). Noise from traffic associated with the construction of the WSB would likely produce less than a 1-dB increase in traffic noise levels along roads used to access the site, and thus would not result in any increased annoyance of the public.

Construction workers could be exposed to noise levels higher than the acceptable limits specified by the Occupational Safety and Health Administration (OSHA) in its noise regulations (29 CFR §1926.52). However, DOE has implemented appropriate hearing protection programs to minimize noise impacts on workers. These programs include the use of standard silencing packages on construction equipment, administrative controls, engineering controls, and personal hearing protection equipment.

G.2.4 Impacts to SRS Infrastructure

The WSB will use the same roads and utility headers as the MFFF and PDCF. Less than one acre of land will be used for new roads within the WSB boundary, beyond those described for the MFFF in ER Section 5.1.11. Construction would require only a fraction of the available resources and thus would not jeopardize the resources required to operate the site. Total construction requirements for diesel fuel might be higher than currently available storage, but the majority of fuel usage would be connected to construction vehicle usage. Therefore, storage would not be limiting. Table G-4 reflects estimates of the additional infrastructure requirements for construction of the proposed facilities. Site resource availability is also presented.

G.2.5 Impacts from Construction Waste

Construction wastes for the WSB are expected to be bounded by the values projected in the SPD EIS for the immobilization plant. Table G-5 compares these waste values to the existing treatment, storage, and disposal capacity for the various waste types. It is anticipated that no

TRU waste, LLW, or mixed LLW would be generated during the construction period. In addition, no soil contaminated with hazardous or radioactive constituents should be generated during construction. However, if any were generated, the waste would be managed in accordance with site practice and applicable federal and state regulations.

Hazardous wastes generated during construction would be typical of those generated during the construction of an industrial facility. Any hazardous wastes generated during construction would be packaged in DOT-approved containers and shipped offsite to permitted commercial recycling, treatment, and disposal facilities.

G.2.6 Impacts to Historic, Scenic, and Cultural Resources

The area that will be used for the WSB is part of the area designated for the PDCF. Historic, scenic and cultural resource investigations were performed in this area for the SPD EIS. WSB construction will not affect pre-historic or historic resources, including those associated with the Cold War Era, nor will construction affect resources of value to Native Americans. Preliminary consultations with appropriate American Indian Tribal Governments and the State Historic Preservation Office have been performed by DOE. Consultations with Native American groups indicate that it is unlikely that significant Native American resources will be impacted.

Inadvertent discoveries of cultural resources will be handled in accordance with 36 CFR §800.11 (historic properties) or 43 CFR §10.4 (Native American human remains, funerary objects, objects of cultural patrimony, and sacred objects) as well as with the terms of the SRS Programmatic Memorandum of Agreement.

The WSB will have a minimal effect on the scenic character of the surrounding area and is consistent with the VRM Class IV designation for the area. The buildings are low-rise structures of varying heights less than 100 ft (30 m). This height is consistent with, and does not exceed, the other building heights in the area, which range from 10 to 100 ft (3 to 30 m). The distance from sensitive receptors and screening by trees will minimize its impact as a visual intrusion to the scenic character of the area.

G.2.7 Socioeconomic Impacts

Construction of the WSB at SRS would have some beneficial socioeconomic impacts on the region. Construction will employ 1,000 workers. The impacts on the local economy are anticipated to be similar to those for the MFFF discussed in Section 5.1.8.

G.2.8 Environmental Justice Impacts

The WSB is located within SRS and is over 5 mi (8 km) from the nearest minority or low-income community. Impacts from construction activities that could affect public health, such as the generation of noise and dust, will be limited to the construction site area. As presented in Section 4.4.1.6 of the SPD EIS (DOE 1999c), there are no anticipated environmental justice issues associated with construction of the WSB at SRS. Construction would pose no significant health risks to the public regardless of racial or ethnic composition, or economic status.

G.3 EFFECTS OF FACILITY OPERATION

G.3.1 Impacts to Air Quality

There are four sources of non-radioactive air emissions from the WSB operations:

- NO_X emissions from the WSB stack derived from acidic waste evaporation
- Criteria pollutant emissions from routine testing of the diesel generator
- Fugitive emissions from chemical and fuel storage tanks
- Emissions from employee and site vehicles.

Maximum air pollutant concentrations resulting from operation of the WSB are anticipated to be bounded by the concentrations projected for the immobilization plant in the SPD EIS, with the exception of NO_X. Depending upon the final design, the new WSB could generate a maximum of 14,000 lbs[1] of NO_X annually. While this is more NO_X than considered for the PIP, the WSB offgas system design will include NO_X emission control equipment as needed to cost effectively control the WSB emissions so that SRS site boundary NO_X concentrations due to the WSB are less than 10% of the most stringent standard or guideline for total SRS site emissions. Projected impacts to ambient air quality concentrations are summarized in Table G-6.

The potential airborne chemical emissions from waste processing are comprised of aluminum nitrate, nitric acid, and sodium hydroxide. A chemical consequences analysis was performed and determined that the airborne releases from the WSB at both 328 ft (100 m) from the WSB and at the SRS site boundary are well below the Temporary Emergency Exposure Limits (TEELs) for each chemical. Therefore, the impact on air quality from process chemicals is low.

G.3.2 Impacts to Water Quality

G.3.2.1 Water Use

The annual domestic and process water uses for the WSB are bounded by the water use of 29 million gallons (110 million liters) projected for the immobilization facility in the SPD EIS.

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[1] Assumes complete evaporation of all waste streams and no offgas treatment to reduce NOx.

G.3.2.2 Surface Water Quality

The WSB does not discharge any process liquid directly to the environment. The WSB design will include discharges of water (HVAC condensate, storm water, etc.) to an NPDES outfall. All liquid discharges to NPDES outfalls will meet state and federal regulations. All liquid wastes are transferred to SRS waste management facilities for treatment and ultimate disposal. Liquid LLW generated by the treatment of MFFF and PDCF wastes in the WSB will be transferred to the SRS ETF for treatment and disposal. The WSB will generate a maximum of 235,000 gallons (890 m^3) of liquid LLW annually from the processing of the MFFF and PDCF waste streams. The ETF discharges treated wastewater to Upper Three Run. The LLW volume represents less than 0.001% of the 7-day, 10-year low flow of Upper Three Run.

G.3.2.3 Groundwater Quality

The WSB does not employ settling or holding basins as part of the waste treatment system. There will be no direct discharge of wastewater to the groundwater. Therefore, no impacts on groundwater quality are expected.

G.3.3 Impacts to Terrestrial Ecology

G.3.3.1 Land Use

Operation of the WSB is not projected to have any impact on land use other than the continued removal of the 5-acre (2-ha) site from other uses. The operation of the WSB should not impact site geology.

G.3.3.2 Non-Sensitive Habitat

Noise disturbance will probably be the most significant impact of routine operation of the WSB on local wildlife populations. Disturbed individual members of local populations could migrate to adjacent areas of similar habitat. However, impacts associated with airborne releases of criteria pollutants, hazardous and toxic air pollutants, and radionuclides would be unlikely because scrubbers and filters will be used. Impacts on aquatic habitats should be limited because all liquid will be transferred to SRS for disposal in accordance with approved permits and procedures.

G.3.3.3 Sensitive Habitat

Operational impacts on wetlands or other sensitive habitats would be unlikely because airborne and aqueous effluents would be controlled through state permits.

It is also unlikely that any federally listed threatened or endangered species would be affected, although South Carolina state-classified special-status species (American alligator) could be affected by noise or human activity during operations.

G.3.3.4 Noise

The location of the WSB relative to the SRS site boundary and sensitive receptors was examined to evaluate the potential for onsite and offsite noise impacts. Noise sources during operations would include new or existing sources (e.g., cooling systems, vents, motors, material-handling equipment, emergency and standby diesel generators), employee vehicles, and truck traffic. Given the distance to the site boundary (about 5.4 mi [8.7 km]), noise emissions from equipment would not be expected to annoy the public.

G.3.4 Impacts from Ionizing Radiation

All potential sources of radioactivity associated with the WSB were evaluated for potential releases during normal operations. This includes both the vapors from the waste receipt tanks exhausted through the stack (after HEPA filtration) and the liquid effluent pumped to the SRS ETF for further site processing.

G.3.4.1 Radiation Doses to the Public

The total radioactivity in the waste streams processed by the WSB on an annual basis is estimated to be approximately 85,000 Curies, of which 99.7% is a result of the Am-241 in the High Alpha Waste Stream from the MFFF. Radioactive releases from the WSB are dominated by Am-241 entrained in vapors which may escape from the High Alpha Waste Receipt Tanks. The plutonium isotopes do not significantly contribute to the dose. The emission is projected to result in a dose to the general public at the SRS site boundary of less than 5E-08 Rem/yr which is below the 10 CFR 835 regulated limit.

A series of evaporation steps will be used to reduce the waste volume for the LLW and TRU waste that will be mixed with cement to form an acceptable solid waste form. Each evaporator reduces the radionuclide concentration in the output liquid waste stream by a conservative factor of at least 1000 (NUREG-0017, *Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Pressurized Water Reactors*, US NRC, April 1976). Consequently, the maximum amount of activity in the effluent waste stream to be sent to the SRS ETF for further processing prior to release to the environment is 8.42 E-05 Curies. This source of radioactivity would have negligible impact on receptor doses. In addition, the waste streams are further treated by the onsite ETF prior to release to the environment.

The dose to the public from operations of the WSB (5E-05 mrem/yr) is bounded by the conservative estimate of public dose for the MFFF (1.5E-03 mrem/yr).

G.3.4.2 Radiation Doses to Site Workers

The dose to the site workers from operations of the WSB are bounded by the conservative estimates and ranges calculated for the MFFF (see Section 5.2.10.2).

G.3.4.3 Radiation Doses to Facility Workers

The annual dose to facility workers in the WSB is estimated to be below 200 person-rem/yr. The maximum dose to the worker from normal operations will below the DOE Administrative Control Level of 2,000 mrem/year. The average annual dose will be below the current SRS guideline of 500 mrem/year.

G.3.5 Impacts to SRS Infrastructure

The WSB is anticipated to use less than 30,000 MWh /yr.

As noted in Section G.3.2.1, the annual domestic and process water uses for the WSB are bounded by the water use of 29 million gallons (110 million liters) projected for the immobilization facility in the SPD EIS. This represents a groundwater withdrawal rate of 55 gal/min (208 L/min). The domestic water capacity from deep wells supplying the A area loop, which includes F Area, is 3,000 gpm and that the average domestic water consumption from the A area domestic water loop in 2000 was 754 gpm (about 1,200 gpm peak). F area process water system capacity is 2,100 gpm with an average demand of 350 gpm (800 gpm peak). WSB groundwater withdrawals are not anticipated to have any impact on SRS or local groundwater supplies.

G.3.6 Impacts to SRS Waste Management

As discussed in Section G.1.2.5.4, after evaporation, the high alpha waste bottoms will contain essentially all of the salts, silver, etc. in the MFFF high alpha waste stream. This will be metered into the cement process. The 20-gallon final package sent to WIPP will have approximately 20 grams Am-241 per drum, and the remaining waste constituents as received from the MFFF. The WSB will produce 405 yd^3 (310 m^3)[2] of TRU waste annually. The forecast in DOE (1995b) for SRS TRU waste generation over the next 30 years ranges from a minimum estimate of 7,578 yd^3 (5,794 m^3) to 710,648 yd^3 (543,361 m^3), with an expected forecast of 16,433 yd^3 (12,564 m^3) (DOE 1995b, Table A-1). The estimated lifetime WSB contribution (4,050 yd^3 or 3,100 m^3) to SRS TRU solid waste quantity is a 25% increase over the expected volume but only a small fraction (< 1%) of the maximum SRS estimate. The environmental impacts of adding this waste to the SRS inventory are bounded by the environmental impacts projected in the *Savannah River Site Waste Management Final Environmental Impact Statement* (DOE 1995b).

The environmental impacts resulting from the disposal of TRU waste at the Waste Isolation Pilot Plant (WIPP) are discussed in *Waste Isolation Pilot Plant Disposal Phase Final Supplemental Environmental Impact Statement* (DOE 1997e). The impacts projected in DOE 1997e (Table 2-2 in DOE 1997e) were based on disposal of 170,000 m^3 TRU waste. The additional 3,100 m^3 TRU waste from the WSB represents an increase of < 2% in the projected waste disposed. Any

[2] These volumes are based on no reduction from evaporation. Use of evaporation would reduce these volumes to 125 yd^3 (100 m^3)

increase in impacts resulting from disposing WSB solid TRU waste at WIPP should be within the error associated with any projected impacts of WIPP operation. Furthermore, the *Waste Isolation Pilot Plant Disposal Phase Final Supplemental Environmental Impact Statement* projected that, "No LCFs would be expected in the population around WIPP from radiation exposure (3 E-4 LCFs). ... no cancer incidence (2 x 10^{-5} cancers) would be expected in the population from hazardous chemical exposure." (DOE 1997e, pg 5-29) The addition of 3,100 m^3 TRU waste from the WSB would not be expected to change this conclusion.

The WSB will generate a maximum of 235,000 gallons (890 m^3) of liquid LLW annually from the processing of the MFFF and PDCF high radioactivity waste streams. This waste will be transferred to the ETF. This volume will be less than 0.1% of the 1,930,000 m^3/yr capacity of the ETF.

Assuming that solidification of stripped uranium waste does not result in any volume reduction, the WSB will produce a maximum of 228 yd^3 (175 m^3) of solid LLW per year. The forecast for SRS LLW generation over the next 30 years ranges from a minimum estimate of 480,310 yd^3 (367,000 m^3) to 1,837,068 yd^3 (1,400,000 m^3), with an expected forecast of 620,533 yd^3 (475,000 m^3) (DOE 1995b, Table A-1).). The estimated lifetime WSB contribution to SRS solid LLW waste quantity is only a small fraction (<1%) of the expected SRS estimate. The environmental impacts of adding this waste to the SRS inventory are bounded by the environmental impacts projected in the *Savannah River Site Waste Management Final Environmental Impact Statement* (DOE 1995b).

The building job control waste will be in compliance with WSRC Manual 1S, *SRS Waste Acceptance Criteria Manual* (2002). All streams will be managed in accordance with applicable laws and regulations (e.g., RCRA).

G.3.7 Impacts to Historic, Scenic, and Cultural Resources

Operation of the WSB will not impact any historic, scenic or cultural resources.

G.3.8 Socioeconomic Impacts

Less than 100 new permanent jobs will be created in 2006 for WSB operation. To fill these jobs, some employees may be hired from other regions of the state or country. Over 400,000 people resided within the five-county region of influence (ROI) in 1990. Assuming that any WSB employees and their families that may move into the area as a direct result of WSB employment choose to live in one of the five ROI counties, their numbers would represent less than 1% of the total 1990 ROI population. Given the size of the population of the region, and the rate of growth it is already experiencing, no significant socioeconomic impacts are anticipated.

G.3.9 Environmental Justice Impacts

Nuclear Materials Safety and Safeguards policy and procedures[3] specify that a 4-mi (6.4-km) radius should be used as the area of consideration in rural areas or areas that are outside of city limits. The WSB is located on SRS. There is no resident population within a 5-mi (8-km) radius of the WSB site, and the nearest minority or low-income community is over 5 mi (8 km) away. As noted in Section 4.9 and shown on Figures 4-15 and 4-16, a disproportionate minority or low-income population does not exist even within a 10-mi (16-km) radius of the WSB site. As a result, WSB operation will pose no significant health risks to the public regardless of the racial or ethnic composition or economic status.

G.3.10 DECOMMISSIONING

G.3.10.1 Introduction

After all of the MFFF and PDCF waste is processed, NNSA will determine the future use of the WSB, including any decision to decommission or reutilize the facility. If NNSA should decide to decommission the WSB, the ultimate goal of decommissioning is unrestricted release or restricted use of the site.[4] In decommissioning, the facility is taken to its ultimate end state through decontamination and/or dismantlement to demolition or entombment. Four guidance documents have been developed to support the disposition of contaminated, excess facilities:

- DOE G 430.1-2, Implementation Guide For Surveillance and Maintenance During Facility Transition And Disposition
- DOE G 430.1-3, Deactivation Implementation Guide
- DOE G 430.1-4, Decommissioning Implementation Guide
- DOE G 430.1-5, Transition Implementation Guide.

Upon completion of WSB activities, a preliminary characterization will be performed to establish a baseline of information concerning the physical, chemical, and radiological condition of the facility. These results will serve as the technical basis for decommissioning.

G.3.10.2 Design Features to Facilitate Decommissioning

Design features are incorporated into the WSB design that will facilitate both deactivation and the eventual decommissioning or reutilization of the facility; these features minimize the spread

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[3] *Environmental Justice in NEPA Documents* (NRC 1999) specifies the guidelines for determining the area for assessment, "If the facility is located outside the city limits or in a rural area, a 4 mile radius (50 square miles) should be used."

[4] DOE O 430.1A, Life Cycle Asset Management.

of radioactive contamination and maintain occupational and public doses at as low as reasonably achievable (ALARA) levels during WSB operations. Design features that will minimize the spread of radioactive contamination and maintain occupational and public doses ALARA:

1. **Plant layout**: All areas of the WSB will be sectioned off into clean areas and potentially contaminated areas with appropriate radiation zone designations to meet 10 CFR Part 835 criteria. Process equipment and supporting systems will be situated according to radiation zone designations and have adequate space to facilitate access for required maintenance to permit easy installation of shielding. The plant layout provides for ready removal of equipment and appropriate space for equipment decontamination.

2. **Access control**: In accordance with ALARA design considerations in 10 CFR Part 835, an appropriate entry control program for WSB radiological areas will be established with associated ingress and egress monitoring to minimize the spread of contamination.

3. **Radiation shielding**: The radiation shielding design will be based on conservative estimates of quantity and isotopic materials anticipated during operations. The analyses address both gamma and neutron radiation and include exposures due to scatter and streaming radiation. Therefore, the shielding design will minimize the occupational doses during deactivation.

4. **Ventilation**: The WSB ventilation system will be designed with the capability of capturing and filtering airborne particulate activity and is continuously maintained under a slight negative pressure.

5. **Structural, mechanical, instrumentation, and electrical components**: Numerous design features of the WSB (e.g., use of washable epoxy coatings, segregation of waste streams, remote readout for instrumentation, and location of breaker boxes and electrical cabinets in low-dose-rate areas) facilitate decontamination, minimize the spread of contamination, and maintain doses to facility personnel ALARA.

6. **Radiation monitoring**: The WSB is designed with radiation monitoring systems to monitor working spaces and potential releases to the environment for the purpose of protecting the health and safety of the workforce, the public, and the environment.

G.3.10.3 Administrative Programs to Facilitate Decommissioning

The WSB design utilizes lessons learned from the operation of similar waste processing facilities to minimize contamination during operations, thereby reducing the effects of contamination on deactivation/decommissioning. Good housekeeping practices are essential to minimize the buildup of contamination and the generation of contaminated waste.

G.3.10.4 Projected Environmental Impacts of Potential Decommissioning

If NNSA should decide to decommission the WSB, a conservative approach to decommissioning is to assume that the facility will be decontaminated, dismantled, and the environment restored as presently being implemented at the Rocky Flats Environmental Technology Site (RFETS) near Denver, Colorado. The values for decommissioning waste volumes for the WSB were estimated using waste volumes from the decommissioned RFETS facilities. The following assumptions apply to this analysis:

1. The WSB waste estimate was based on the decommissioning waste estimating method used for RFETS plutonium handling facilities. This method used the physical characteristics and waste generated from the decommissioning of the first DOE site plutonium facility that was completed in 2000. Relevant metrics (e.g., process area square feet, cubic meters of process equipment) were compared against the TRU, low-level, low-level mixed, and construction demolition waste generated during the decontamination, strip-out, and decommissioning of the building.

2. The summary estimate methodology identified the RFETS buildings that were most representative of the MFFF since the majority of the waste is from the MFFF. The methodology assumed that the secondary systems (i.e., ventilation, instrumentation and control, power, etc.) were similar. It also assumed that the decommissioning methods used for these facilities would be similar to those that were used for RFETS facilities.

The results of the comparison projected 78 yd^3 (60 m^3) of TRU waste, 13,830 yd^3 (10,570 m^3) of LLW and 22,400 tons of nonradioactive demolition waste.

G.3.10.5 Accessibility of Land After Decommissioning

Accessibility to the land surrounding the WSB will be controlled by NNSA or DOE and subject to its applicable security requirements. A final radiological survey will verify that accessibility will not be limited as a result of radioactive contamination.

G.4 FACILITY ACCIDENTS

This section summarizes the evaluation of potential facility accidents applicable to the WSB. The volumes of the various tanks, vessels, evaporators, etc.. upon which this accident analysis is based are specified in Table G-7. The assumed concentrations of the waste streams processed are provided in Tables G-8 through G-11. The assumed concentrations of the high activity evaporation process feed, bottoms and overhead are provided in Table G-12. The accident evaluation includes internal process-related events, external man-made events, and events associated with natural phenomena. The evaluations of these events show that the risk from a facility accident is low.

G.4.1 Environmental Risk Assessment Method

Accidents that could occur as a result of WSB operations are identified and evaluated in a systematic, comprehensive manner. The general approach includes the following evaluations:

- Internal Hazard Identification – A systematic and comprehensive identification of radioactive, hazardous material, and energy sources in the WSB
- External Hazard Identification – A systematic and comprehensive identification of applicable natural phenomena and events originating from nearby facilities
- Hazard Evaluation – A systematic and comprehensive evaluation to postulate event scenarios involving the information developed in the Hazard Identification
- Accident Analysis – A Preliminary Hazards Analysis is performed for the WSB to identify possible accident events and to estimate consequences and frequencies and to identify preliminary prevention and mitigation features. The accident analysis evaluates all credible events. Thus, all internally initiated accidents are evaluated without regard to their initiating frequency, and all natural phenomena hazard and external man-made hazard generated events are evaluated unless their probability of impacting the WSB is extremely low. The results of the evaluation include events with no or low consequences, design basis events, and severe accidents.

G.4.2 Environmental Risk Assessment Summary

From the Hazard Evaluation, those WSB accidents that represent the highest risk to the worker or public were identified. These potential accidents were then grouped into one of the following event types based on similar initiators:

- Natural phenomena
- Loss of confinement (Spill)
- Fire
- Explosion
- Direct Radiation Exposure
- Nuclear Criticality
- Chemical Releases.

The environmental risk assessment addresses the consequences associated with accidents in each event type up to and including design basis accidents. The environmental impacts of beyond design basis events are remote and speculative and do not warrant consideration under NEPA. While beyond design basis events are theoretically possible, their likelihood of occurrence is so low as to not result in any significant, additional risk from WSB operations.

For each potential accident, accident consequences and frequencies are evaluated for two types of receptors: (1) a site worker, and (2) the maximally exposed member of the public. The first receptor, a site worker or SRS worker, is a hypothetical individual working on the SRS site but not involved in the proposed activity. The worker is conservatively evaluated downwind at a point 328 ft (100 m) from the accident. The second receptor, a maximally exposed member of the public, is a hypothetical individual assumed to be downwind at the SRS boundary. The SRS boundary is conservatively evaluated at a distance of 5.8 mi (9.4 km). Exposures received by this individual are intended to represent the highest doses to a member of the public.

The unmitigated consequences of the events identified in the hazard evaluation have been estimated based on the quantities and types of hazardous material, the release mechanisms associated with the accident, and the release pathway of the hazardous material to the environment.

The Total Effective Dose Equivalent (TEDE) to the receptors of interest is equal to the Inhalation Dose. Air submersion, ingestion, water immersion, and contaminated soil dose pathways are assumed negligible contributors to the TEDE. The Inhalation Dose is calculated as follows:

$$[\text{Inhalation Dose}]_{\text{effective}} = [\text{ST}]\cdot[\chi/\text{Q}]\cdot[\text{BR}]\cdot[\text{C}]\cdot\sum_{X=1}^{N} f_X \cdot[\text{DCF}]_{\textit{effective},X}$$

where:

ST = source term

χ/Q = atmospheric dispersion factor

BR = breathing rate

C = unit's conversion constant

f = specific activity of nuclide x

DCF = dose conversion factor of nuclide x

N = total number of dose-contributing radionuclides

Based on local SRS meteorological data, the atmospheric dispersion factor (χ/Q) for the MEI member of the public at the SRS boundary (5.8 mi [9.4 km]) from a ground release is 2.8E-06 sec/m^3. The associated χ/Q for the site worker located within 328 ft (100 m) of a groundlevel release of 3-minutes duration from the WSB based on the local SRS meteorological conditions is 7.5E-04 sec/m^3.

The radiological doses are based on the amount of respirable radioactive material released to the air, the source term (ST). The initial source term is the amount of radioactive material driven airborne at the accident source. The initial respirable source term, a subset of the initial source term, is the amount of radioactive material driven airborne at the accident source that is effectively inhalable. The following equation is used to determine the respirable airborne source term (ST) for each event:

$$[\text{ST}] = [\text{MAR}]\times[\text{DR}]\times[\text{ARF}]\times[\text{RF}]\times[\text{LPF}] \quad (\text{NRC 1998d})$$

The material at risk (MAR) is the amount of radioactive material (in grams or curies of activity) available to be acted on by a given physical stress. For facilities, processes, and activities, the MAR is a value representing some maximum quantity of radionuclide present or reasonably anticipated for the process or structure being analyzed. Different MARs may be assigned for different accidents since it is only necessary to define the material in those discrete physical locations that are exposed to a given stress.

The damage ratio (DR) is the fraction of the MAR actually impacted by the accident-generated conditions. The DR is estimated based upon engineering analysis of the response of structural materials for containment to the type and level of stress or force generated by the event. For conservatism, the DR is conservatively assumed to be 1.0 for all accident analyses for the WSB.

The airborne release fraction (ARF) is the coefficient used to estimate the amount of a radioactive material suspended in air as an aerosol and thus available for transport due to physical stresses from a specific accident. For discrete events, the ARF is a fraction of the material affected.

The respirable fraction (RF) is the fraction of airborne radionuclides as particles that can be transported through air and inhaled into the human respiratory system.

Values for RF and ARF were selected for these dose consequence analyses based on bounding values obtained from *Airborne Release Fractions/Rates and Respirable Fractions for Nonreactor Nuclear Facilities* (DOE 1994c) based on the release mechanism for solutions.

The leak path factor (LPF) is the fraction of the radionuclides in the aerosol transported through some confinement deposition or filtration mechanism. There can be many LPFs for some hazard events, and their cumulative effect is often expressed as one value that is the product of all leak-path multiples. Inclusion of these multiples in a single LPF is done to clearly differentiate between calculations of unmitigated doses (where the LPF is assumed equal to 1.0) and calculations of mitigated doses (where the LPF reflects the dose credit provided to the controls). For all unmitigated dose consequence calculations for the WSB, a value of 1.0 is used. For most of the identified hazard events, a value of 1.0 for the LPF is also used for the mitigated dose consequences. Any deviations from a LPF of 1.0 are identified in the summary of the accident events that follow.

Design basis events for each event type are discussed in the following sections.

G.4.2.1 Natural Phenomena

A screening process is performed on a comprehensive list of natural phenomena to identify those credible natural phenomena that have the potential to affect the WSB during the period of facility operation. Credible natural phenomena that could have an impact on WSB operations include the following:

- Extreme winds
- External flooding
- Earthquakes
- Tornadoes
- Rain, snow, and ice.

Natural phenomena could result in the dispersion of radioactive material and hazardous chemicals. Performance goals for annual probability of exceedance were determined to be 5E-04 for all process areas and equipment except for the high activity waste processing and receipt cells. For those cells in which the high activity waste is stored or processed, the hardened reinforced concrete structure will be designed for a performance goal for annual probability of exceedance of 1E-04. Natural phenomena events are discussed in the following sections.

G.4.2.1.1 Extreme Winds

Extreme winds are straight-line winds associated with thunderstorms or hurricanes. Extreme wind loads include loads from wind pressure and wind-driven missiles.

For all portions of the WSB except those hardened reinforced concrete cells housing the MFFF High Alpha Waste, the equipment will be housed inside a standard metal-constructed building designed to withstand a 3-second wind speed of 107 mph. Because of the lower quantity of radioactive material in the areas processing the low activity waste streams, there is no design criteria for the wind-driven missiles. However, no significant radioactive or hazardous material release at the WSB is postulated to occur as a result of damage from wind-driven missiles caused by extreme wind events.

The process cells housing the High Alpha Waste stream will be designed to withstand the effects of the design basis extreme wind of 133 mph and the associated missiles. The missile criteria include the ability to withstand the force of a 2x4 timber plank weighing 15 pounds being driven at the structure at a horizontal velocity of 50 mph at a maximum height of 30 ft (9.1 m).

G.4.2.1.2 External Flooding

External flooding includes floods associated with rising rivers or lakes. For all process areas and equipment except for the high activity waste processing and receipt cells, the structures are designed for the flooding consequences associated with flooding events with an annual exceedance probability of 5E-04 (return period of 2,000 years). For the high activity cells, the hardened reinforced concrete structure will be designed to withstand the flooding consequences associated with a flooding event with an annual hazard exceedance probability of 1E-04.

G.4.2.1.3 Earthquakes

Earthquakes may result from movement of the earth's tectonic plates or volcanic activity. For all process areas and equipment except for the high activity waste processing and receipt cells, the structures are designed for the seismic consequences associated with an earthquake with a minimum annual exceedance probability of 1E-03 (return period of 1,000 years). For the high activity cells, the hardened reinforced concrete structure will be designed to withstand the consequences associated with an earthquake event with a minimum annual hazard exceedance probability of 5E-04 (return period of 2,000 years). Earthquake load design for the WSB is performed in accordance with the SRS-specific structural design criteria given in Section 5.2.9 of *SRS Engineering Standards Manual: Structural Design Criteria* (WSRC 2001b).

Although the MFFF High Alpha waste stream receipt tanks may fail as a result of the design basis earthquake, the concrete cells surrounding the tanks are designed to enhanced seismic criteria. The other waste streams will be included in a standard metal-constructed building and may be subject to full release as a result of structural damage caused by this natural phenomenon event. The loss of confinement caused by earthquakes is evaluated in the loss of confinement (spill) event.

G.4.2.1.4 Tornadoes

Tornadoes may occur in extreme weather such as thunderstorms or hurricanes. All process areas and equipment are designed in accordance with the SRS-specific tornado wind load criteria given in Section 5.2.8 of *SRS Engineering Standards Manual: Structural Design Criteria* (WSRC 2001b). For the high activity cells, the hardened reinforced concrete structure will be designed to withstand the consequences associated with a design basis tornado having an annual exceedance probability of 2E-05. Tornado loads include loads due to tornado wind pressure, loads created by the tornado-created differential pressure, and loads resulting from tornado-generated missiles.

The associated wind load criteria and differential pressure load criteria for the WSB's hardened concrete structures are based on the following criteria used for the MFFF site:

- Maximum tornado wind speed: 180 mph
- Pressure drop across tornado: 70 psf
- Rate of pressure drop: 31 psf/sec.

The associated tornado-generated missile load criteria are based on the following:

Missile Description	Mass (lb)	Size (in)	Horizontal Impact Speed (mph)	Maximum Height (ft)	Vertical Impact Speed (mph)
Penetrating missile – 3-in (7.6-cm) diameter steel pipe	75	3 ½ (outside diameter)	50	75	35
Small missile – 2- by 4-in (5.1- by 10.2-cm) timber plank	15	1 ½ by 3 ½	100	150	70

Missile Description	Mass (lb)	Size (in)	Horizontal Impact Speed (mph)	Maximum Height (ft)	Vertical Impact Speed (mph)
Automobile	3,000	not applicable	19	rolls and tumbles	not applicable

The MFFF High Alpha waste stream receipt tanks and process rooms are enclosed with hardened reinforced concrete and will be designed to withstand the effects of the design basis tornado. The other waste streams will be included in a standard metal-constructed building and may be subject to damage and release following this natural phenomenon event. No significant radioactive or hazardous material release at the WSB is postulated to occur for tornadoes (see bounding loss of confinement (spill) event).

G.4.2.1.5 Rain, Snow, and Ice

Rain, snow, and ice are postulated to occur at the WSB several times during operation of the facility. These loads are defined according to the methodology in Sections 5.2.5, 5.2.6, and 5.2.7 of *SRS Engineering Standards Manual: Structural Design Criteria* (WSRC 2001b). The minimum drainage system design corresponds to a 25-year, 6-hour rainfall event (4.5 inches total accumulation). Snow loads are based on an annual exceedance probability of 4E-04, or a return period of about 2,500 years.

The WSB will be designed to withstand the effects of rain, snow, and ice. Thus, no radioactive or hazardous material release at the WSB is postulated to occur during or following these conditions.

G.4.2.2 Loss of Confinement

Within the WSB, radioactive material is confined within one or more confinement barriers. Primary confinement barriers include welded vessels, tanks, and piping; and their associated ventilated systems. Secondary confinement barriers include the WSB building structure itself and the associated ventilation system which maintains a negative differential pressure relative to the outside atmospheric pressure. Confinement capabilities will ensure that a controlled, continuous airflow pattern from the environment to the WSB, and from the non-contaminated areas of the building to potentially contaminated areas, to the normally contaminated areas, and through HEPA filters and the stack prior to release to the environment.

The loss or damage of the primary confinement barrier may result in the dispersion of radioactive materials and hazardous chemicals. The effects of hazardous chemicals are discussed in Section G.4.2.7. The loss at each level of confinement is necessary for a non-negligible release from the WSB to occur.

Damage to or failure of the confinement barriers can be caused by human error or equipment failure resulting in the following:

- Breaches of container boundaries due to crushing, shearing, grinding, cutting, and handling errors
- Corrosion-induced confinement failures
- Pipe or vessel breaks or leaks
- Clogging or failure of HEPA filters.

Loss-of-confinement events caused by fires, explosions, load-handling events, natural phenomena, and external events are covered in their respective event discussions.

The bounding credible loss-of-confinement event involves a facility-wide spill of all material in the building due to a natural phenomena or external event. Only the high activity waste and overheads were analyzed as the low activity waste would add only a slight increase to the dose. The total quantity of high activity waste includes 6,500 gallons in the storage tanks and evaporator, 500 gallons of high activity bottoms each in the High Level Evaporator, High Activity Bottoms Collection Tank, and High Activity Neutralization Tank, and 4,000 gallons of high activity overhead. The release factors applied for the release of waste from failed components was that based on a free fall spill, with an ARF of 2E-05 and a RF of 1.0. The radiological consequences associated with this event are mitigated by the robust cell structure design for the high activity waste processing area and implementation of an Emergency Response Plan. The release from the MFFF High Alpha Waste Stream tanks is estimated to be reduced by a factor of 10 (LPF = 0.1) by the structural confinement capability of the cell. In addition, as part of the Emergency Response Plan, personnel would be directed to proceed to assembly points away from the facility in order to limit potential radiological exposures. With these controls in place, the radiological consequences associated with a spill are less than the limits, as shown in Table G-13.

As shown in Table G-13, the radiological consequences at the SRS boundary are negligible. Such impacts would not be sufficient to warrant evacuation of the public or interdiction or decontamination of land or food supplies. Table G-13 also shows that the radiological consequences to the nearest site worker are low.

The WSB utilizes many features to reduce the likelihood and consequences of this event as well as other loss-of-confinement events. Key features include: piping design to take into consideration thermal and pressure stresses, erosion, corrosion, etc.; material selection for chemical compatibility; a concrete bunker to protect waste transfer pipelines; and facility emergency response procedures; and worker training. The waste transfer lines from the PDCF and the MFFF to the WSB are composed of welded, jacketed two-inch stainless steel piping, enclosed in an underground seismically-qualified pipe trench.

Given the low consequences and/or small likelihood of this type of accident, the radiological risk from the loss-of-confinement events is low.

G.4.2.3 Fire

A fire hazard arises from the simultaneous presence of combustible materials, an oxygen source, and a sufficient ignition source. A fire can spread from one point to another by conduction, convection, or radiation. The immediate consequence of a fire is the destruction, by combustion or by thermal damage, of elements in contact with the fire. A fire can lead to the dispersion of radioactive materials and hazardous chemicals.

Fires can be caused by human error, electrical equipment failures, equipment that operates at high temperatures, uncontrolled chemical reactions, or static electricity.

A number of fire events were postulated in the individual process cells. For each event, the value of ARF used is 2E-03 with an RF value of 1.0. It is assumed that the fire is severe enough to cause boiling of the material. Though limited combustibles are expected to be present in the process cells, the fire events assumed the fire spreads and impacts the entire cell inventory. In addition, both area fires and a full facility fire were postulated having potentially high consequences to facility and site workers. Postulated fire events include the following:

- Cell fires involving the low activity and effluent processing sections of the WSB (process feed tanks, evaporators, and/or piping containing waste solutions)
- Cell fires involving the high alpha storage and processing tanks (receipt tank, head tank, evaporator, bottoms collection tank, neutralization tank, cementation cell)
- Full facility fire that affects the entire facility inventory
- An area fire affecting just the low activity and effluent processing sections of the facility
- An area fire affecting the area used to store and process the PDCF Lab Concentrate waste.

The control strategies used to reduce the risk of the postulated fire events include a combination of administrative controls and design features. A Fire Protection Program provides controls to reduce the probability of a fire and the means to ensure protection of personnel and equipment if a fire should occur. Key elements of the administrative control program include: a fire pre-plan, a transient combustible control program, a control on the use of flammable liquids and gases, fire department response, and worker training. These administrative controls are supplemented with the following design features: fire barriers between the High Alpha receipt tanks and within the high activity waste stream processing area, fires sprinkler systems, fire resistant construction materials, and the building confinement system. Robust construction of the cells used for storing and processing high activity waste prevents fires in these areas and the potential release of its large source term.

The bounding credible fire event postulated to produce the largest radiological consequences is a fire in the low activity and effluent processing sections of the WSB, causing structural damage to the facility and causing the release of radionuclides in these areas. An area fire involving the low activity and effluent processing sections of the WSB could potentially release up to 18,600 gallons of the unprocessed low activity waste, 1,500 gallons of low activity bottoms, 6,000 gallons of low activity overheads, 1,000 gallons of effluent bottoms, and 6,000 gallons of effluent overheads. The radiological consequences associated with this event are provided in Table G-13.

The MFFF utilizes many features to reduce the likelihood and consequences of this event as well as other fire-related events. Key features include minimization of combustibles and ignition sources through mitigative programs, fire suppression and detection systems (designed to NFPA standards), and emergency procedures. As part of the emergency response program, facility and onsite workers would be directed to proceed to assembly locations away from the WSB to limit potential exposures.

Given the low consequences and/or small likelihood of this type of accident, the radiological risk from fire events is low.

G.4.2.4 Explosion

Internal explosion events within the WSB could result from the presence of potentially explosive mixtures and potential overpressurization events. These events may result in the dispersion of radioactive materials and hazardous chemicals. Explosions may be caused by human error or equipment failure and include the following:

- Hydrogen accumulation in the any of the tanks or evaporators used to process radiological material (caused by radiolysis)
- Inadvertent caustic addition to the acidic waste streams causing an energetic acid/base chemical reaction
- Red Oil Explosion in the High Activity Evaporator
- Overpressurization of the High Activity Evaporator.

The control strategy for explosion events associated with the WSB tanks and vessels other than the high activity evaporator is to prevent the explosions through the use of a passive vent on the tanks. Hydrogen gas generated by the radiolysis of water in the MFFF High Alpha Waste stream will be vented and connected to a vessel vent system in order to prevent hydrogen from reaching the lower flammability limit. In addition, inert atmospheres will be present in the storage tanks and vessels to preclude the formation of an explosive atmosphere in those areas containing the high activity waste streams. Radiolysis is not a concern for the other waste streams due to their low activities.

A configuration control program and a chemical control program will be implemented to ensure no caustic is introduced to the tank and to prevent possible energetic chemical reactions. Organics in the waste streams will be eliminated or at least minimized through waste acceptance criteria and sampling and/or the use of inert oils or lubricants. Design features of temperature and pressure interlocks will also be utilized to shut down the High Activity Evaporator upon detection of high temperature or pressure conditions. For overpressurization events in the High Activity Evaporator, controls selected to mitigate the event include the robust cell structure to confine potential releases, and an access control program to minimize the potential for a worker to be near the evaporator during its operation.

The bounding credible explosion event at the WSB is a hydrogen deflagration in the High Activity Evaporator due to hydrogen accumulation if waste material remains in the evaporator vessel during shutdown. The volume of the high activity evaporator is 528 gallons with the normal operating volume of high activity waste expected to be approximately 250 gallons. To determine the source term for this explosion, the tank volume is conservatively assumed to contain hydrogen at a stoichiometric concentration of 30%. The volume of hydrogen in the vapor space of the evaporator is converted to moles of hydrogen based on one mole of hydrogen occupying 22.4 liters. The bounding respirable release for an explosion is the mass of inert material equal to the TNT equivalent for the exploding vapor (DOE 1994c). One mole of hydrogen is equivalent to 68,317 calories and one gram of TNT is equal to 1,100 calories per gram, Assuming the density of the waste material is approximately 1.2 g/ml, the respirable source term for the explosion is calculated using the following equation:

$$\text{SourceTerm (gal)} = \left\{\frac{1\,\text{mole}\,H_2}{22.4\,\text{L}}\right\} \times \left\{\frac{68{,}317\,\text{cal}}{\text{mole}\,H_2}\right\} \times \left\{\frac{\text{gram TNT}}{1{,}100\,\text{cal}}\right\} \times \left\{\frac{\text{L of material}}{1.2\,\text{g/ml}}\right\} \times \left\{\frac{1\,\text{gal}}{3{,}785\,\text{ml}}\right\}$$

The likelihood and consequences of such an event will be limited through the use of reliable engineering features and administrative controls. Key features include a vent device on the evaporator with a vent position indicator, dedicated instrument air purge with air bottle (or other source) backup purge capability, alarm on loss of purge flow to the evaporator, robust design of the high activity waste processing cells, and access control program to minimize the potential for workers to be present in the cell with the evaporator. Given these features, the consequences to the site worker and facility worker as a result of this hydrogen deflagration event would be low with negligible consequences to the offsite public (see Table G-13).

G.4.2.5 Direct Radiation Exposure

A direct radiation hazard arises from the presence of radioactive material within the WSB. Direct radiation exposure events include those events that result in a radiation dose from radiation sources external to the body. Due to the nature of the radioactive material present in the WSB (within tanks, process vessels and containers), there are no accidents at the WSB that produce a direct radiation exposure hazard to the public or site workers from routine operations. A number of events were postulated that result in high radiation to the facility worker as a result of either entering a high activity cell during process operations or performing maintenance on process equipment. The probability and consequences of these events is controlled through adequate shielding provided by the tank walls, and administrative controls to control access to these radiation areas and a radiation protection program.

G.4.2.6 Nuclear Criticality

Because the waste streams processed in the WSB have low concentrations of fissile material, criticality is not a concern.

G.4.2.7 Chemical Releases

A chemical hazard arises mainly from the use of chemicals in the waste processing operations - aluminum nitrate, dry cement, nitric acid, and sodium hydroxide. Chemicals evaluated include those used during all modes of operation. Accidental chemical releases are postulated to occur from human error and equipment failures.

Consequences of chemical releases were determined for a potential release of each chemical. For evaporative releases, the chemical consequence analysis modeling for public consequences used the ALOHA code (ALOHA 2000), the ARCON96 code (ARCON96 1997), and the MACCS2 code (MACCS2 1998) to calculate the maximum airborne chemical concentration at the SRS boundary (approximately 5 miles from the WSB). Calculated concentrations were compared to TEELs. TEELs describe temporary or equivalent exposure limits for chemicals for which official Emergency Response Planning Guidelines have not yet been developed.

An evaporation model extracted from the ALOHA code was used to calculate a release from a spilled or leaked chemical, which is assumed to form a puddle one-cm deep. The entire anticipated onsite inventory of individual chemicals in the WSB was assumed to be in a single tank and a spill or leak was modeled. No credit was taken for an enclosure (such as a building) or a dike or containment/impoundment basin. For leaks or spills of nitric acid, credit was taken for the partial pressure of the nitric acid in a 13.6 N solution. For leaks or spills of aluminum nitrate, dry cement, and sodium hydroxide, which have negligible partial pressures in a solution, an airborne release fraction was applied in a direct release calculation.

The results indicate that the concentration of all chemicals at the SRS boundary following a release from the WSB is low. The results also indicate that the maximum chemical concentration for an site worker is low. The release due to a leak or spill of the entire anticipated onsite inventory of chemicals in the Waste Solidification Building is calculated to not exceed the applicable TEEL-2 concentration at 328 ft (100 m).

WSB features to reduce the frequency and magnitude of a chemical release include at least the following: vessel level indications, leak detection, sumps, drains, operating procedures, emergency procedures, operator training, hazardous material control, and ventilation systems.

Given the low consequences and/or small likelihood of this type of accident, the risk from chemical releases is low.

G.4.3 Evaluation of Facility Workers

The risk to workers is qualitatively evaluated for all WSB events. Sufficient engineering design features and administrative controls have been incorporated into the WSB design to ensure that any unacceptable consequence is highly unlikely.

Key design features include confinement systems, the robust construction of the high activity waste tanks and processing cells, explosion mitigation structures, systems, and components (SSCs), radiation monitoring systems, and fire protection systems. Key administrative controls include operator training, radiation protection, fire safety, and industrial hygiene programs. In addition, workers are trained and qualified and perform their work in accordance with approved procedures.

Given the low consequences and/or low likelihood of events, the overall radiological risk to the WSB worker is low.

G.4.4 Conclusions

The impacts that have been considered include potential radiation and chemical exposures to individuals and to the population as a whole, and the risk of near- and long-term adverse health effects that such exposures could entail. The evaluation demonstrates that the environmental risk associated with potential accidents at the WSB is low.

G.5 TRANSPORTATION

The PDCF Laboratory Concentrates and the MFFF High Alpha Waste will be treated separately for processing at the WSB. However, both wastes will be neutralized and mixed with a solidification additive and placed in 55-gallon steel waste drums and sampled to assure that the WIPP waste acceptance criteria are met for the TRU waste. The wastes will be loaded in a TRUPACT II shipping container for transport via truck to WIPP. Approximately 35 shipments of this TRU waste will be sent to WIPP annually.

The environmental impacts of transportation of waste from the SRS waste management facilities to ultimate disposal sites are documented in the Waste Management PEIS (DOE 1997a) and the SRS Waste Management Final EIS (DOE 1995b). This included the transportation of TRU waste from the SRS site to WIPP for disposal. Although the waste volumes cited in the Waste Management PEIS are different than that being analyzed for the WSB (up to 35 shipments), a dose per shipment value can be calculated from the Waste Management PEIS and applied to the WSB shipments to WIPP. The Waste Management PEIS calculated the cumulative dose and lifetime risk to a Maximally Exposed Individual (MEI) living along the SRS site entrance who is assumed to be present for all the shipments. The dose per shipment[5] to this MEI is 1.5E-04 mrem (based on DOE 1997a). For 35 shipments of TRU waste, the total additional dose to the MEI is 5.3 E-03 mrem which equates to an increase in lifetime cancer risk of 2.6E-09. The consequences from the most severe transportation accidents involving the transport of the TRU waste were also evaluated by DOE in the Waste Management PEIS. The transportation accidents involving TRU waste shipments from the WSB at SRS to WIPP are bounded by those analyzed in the Waste Management PEIS. The consequences from the most severe transportation accidents are summarized in Table G-14. For the accident analysis, the MEI is assumed to be located at the point of maximum exposure. The locations of maximum exposure were 160 m (525 ft) from the accident site under neutral atmospheric conditions, and 400 m (1,312 ft) for stable atmospheric conditions.

G.6 IMPACTS SUMMARY

The WSB will convert the radioactive liquid wastes from the MFFF and PDCF into solid waste that will be disposed as transuranic waste or low-level radioactive waste. The environmental impacts of constructing and operating the WSB are less than the projected impacts from the construction and operation of the Plutonium Immobilization Plant evaluated in the SPD EIS but subsequently cancelled.

The WSB will be constructed on five acres of the existing PDCF site. Potential impacts to local air quality and water quality during construction of the WSB are anticipated to be bounded by the impacts presented in the SPD EIS (DOE 1999c) for the immobilization plant. Any scrub vegetation located on the site will be removed. There should be no direct impacts on non-sensitive aquatic habitats because best-management practices for soil erosion and sediment control will be used to prevent construction runoff to these habitats, and direct construction disturbance would be avoided. There are no sensitive habitats located on the WSB site. The WSB will use the same roads and utility headers as the MFFF. Less than one acre of land will be used for new roads within the WSB boundary, beyond those described for the MFFF.

Construction wastes for the WSB are expected to be bounded by the values projected in the SPD EIS for the immobilization plant. It is anticipated that no TRU waste, LLW, or mixed LLW would be generated during the construction period. Hazardous wastes generated during construction would be typical of those generated during the construction of an industrial facility. Any hazardous wastes generated during construction would be packaged in DOT-approved containers and shipped offsite to permitted commercial recycling, treatment, and disposal facilities.

Maximum air pollutant concentrations resulting from operation of the WSB are anticipated to be bounded by the concentrations projected for the immobilization plant in the SPD EIS, with the

[5] DOE 1997a, Table E-27 projects a dose of 3.6E-04 Rem for 2,370 shipments passing the MEI located at the site entrance for SRS in the decentralized option. This yields an average dose of 1.5E-07 Rem (1.5E-04 mrem) per shipment.

exception of NO_X. The WSB offgas system design will include NO_X emission control equipment as needed to cost effectively control the WSB emissions so that SRS site boundary NO_X concentrations due to the WSB are less than 10% of the most stringent standard or guideline for total SRS site emissions. The potential airborne chemical emissions from waste processing are comprised of aluminum nitrate, nitric acid, sodium hydroxide and dry cement. A chemical consequences analysis was performed and determined that the airborne releases from the WSB at both 100 m and the SRS boundary are well below the TEEL limits for each chemical.

The WSB does not discharge any process liquid directly to the environment. The WSB design will include discharges of water (HVAC condensate, storm water, etc.) to an NPDES outfall. All liquid discharges to NPDES outfalls will meet state and federal regulations. All liquid wastes are transferred to SRS waste management facilities for treatment and ultimate disposal. The WSB will generate a maximum of 235,000 gallons (890 m^3) of liquid LLW annually from the processing of the MFFF and PDCF high radioactivity waste streams. This waste will be transferred to the ETF. This volume would be less than 0.1% of the 1,930,000 m^3/yr capacity of the ETF.

The dose to the public and site workers from WSB operations are bounded by the conservative estimate of dose for the MFFF (1.5E-03 mrem/yr). The annual dose to facility workers in the WSB is estimated to be below 200 person-rem/yr). The average annual dose will be below the current SRS guideline of 500 mrem/year.

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Figures

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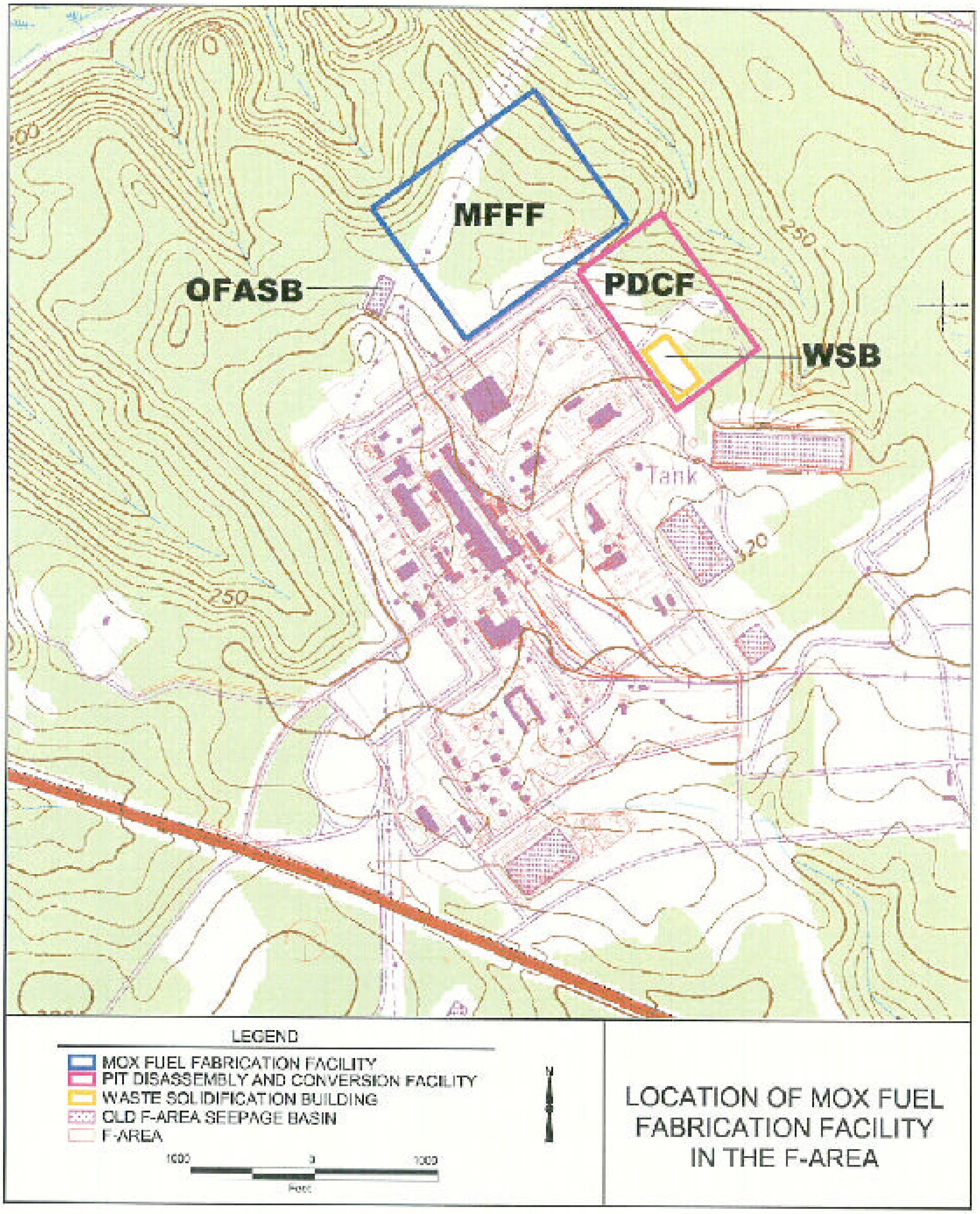

Figure G-1. Location of Waste Solidification Building in the F Area

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Tables

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Table G-1. Liquid Waste Streams Processed by the Waste Solidification Building

Waste Stream	Source	Nominal Characteristics	Annual Volume w/o flush (gallons)
High Alpha	MFFF	Am-241: < 24.5 kg/yr (0.7% maximum Pu content) (84,000 Ci/yr) Pu: < 221 g/yr U: < 13 g/yr [H+] = 3 N Nitrate salts = 1500 kg/yr Silver: 300 kg/yr Na: 147 kg/yr	14,301 21,841 (max)
Stripped Uranium	MFFF	Pu: < 0.1 mg/L U: < 5000 kg/yr [~1% U-235] [H+] = 0.1 N	42,530 46,000 (max)
Lab Liquids	PDCF	3% HNO_3, 5 g Pu, 4 g U, 1.2 kg Fl, 1 kg Cl, 1,200 kg nitrates, 0.5 kg sulfates	11,000 17,000 (max)
Lab Concentrated Liquid	PDCF	10% HNO_3, 600 g U, 800 g Pu, 11 kg nitrates	25 60 (max)

Table G-2. Waste Treatment Chemicals

Chemical	Annual Consumption	Anticipated Onsite Inventory
Aluminum Nitrate (34%)	50 gal	<1,000 gal
Dry Cement	<500,000 lb	<100,000 lb
Nitric acid (64%)	2,000 gal	2,000 gal
Sodium hydroxide (50%)	<7,000 gal	<1,500 gal

Table G-3. Emissions (kg/yr) from Construction of the Waste Solidification Building

Pollutant	Diesel Equipment	Construction Fugitive Emissions	Concrete Batch Plant	Vehicles
Carbon Monoxide	20,300	0	0	48,700
Nitrogen dioxide	52,700	0	0	14,100
Sulfur dioxide	24,400	0	0	0
Volatile organic compounds	3,900	<1	0	6,520
Total suspended particulates	3,930	21,600	2,610	49,900

Source: DOE 1999c, Table G-61

Table G-4. Maximum Additional Site Infrastructure Requirements for WSB Construction in F Area at SRS

Resource	WSB	Availability[a]
Transportation[b]		
Roads (mi)	1	142
Electricity (MWh)	32,000	482,700
Diesel Fuel (gal/yr)	30,000	NA[c]
Water (gal/yr)	25,000,000	321,000,000

Source: DOE 1999c, Table E-12

[a] Capacity minus current usage

[b] WSB will use roads constructed for MFFF

[c] Not applicable due to the ability to procure additional resources.

Table G-5. Wastes Generated During Construction

Waste Type	Estimated Additional Waste Generation (m^3/yr)	Disposal Capacity (m^3/yr)
Hazardous	35	74
Nonhazardous		
Liquid	21,000	1,033,000 [a]
Solid	2,200	6,670

Source: DOE 1999c, Table H-29.

[a] Capacity of CSWTF.

Table G-6. Increments to Ambient Concentrations (μg/m³) from MFFF Operation

Pollutant	Averaging Period	Most Stringent Standard or Guideline [a]	SRS Maximum Concentration [b]	WSB Contribution	Total
Carbon monoxide	8 hours	10,000	66	0.152	66
	1 hour	40,000	254	0.657	254
Nitrogen dioxide	Annual	100	17.2	10	27.2
PM_{10}	Annual	50	7	0.00181	7
	24 hours	150	97	0.032	97
Sulfur dioxide	Annual	80	24	0.042	24
	24 hours	365	337	0.61	337
	3 hours	1,300	1,171	1.63	1,172
Total suspended particulates	Annual	75	46	0.00181	46

[a] The more stringent of the federal and state standards is presented if both exists for the averaging period.

[b] Hunter (2001), Includes background plus SRS emissions

Table G-7. Volume of WSB Tanks and Vessels

Tank/Vessel	Number of Tanks/Vessels	Contents	Volume (gal)
PDCF Lab Liquids Storage Tank	2	Unprocessed Waste	2500
MFFF Stripped Uranium Storage Tank	2	Unprocessed Waste	4000
MFFF High Alpha Storage Tank	2	Unprocessed Waste	2500
PDCF Lab Concentrate	TBD	Unprocessed Waste	16
High Activity Head Tank (Evaporator Feed)	1	Unprocessed Waste	4500
High Level Evaporator	1	HA Bottoms	528
High Activity Bottoms Collection Tank	1	HA Bottoms	528
High Activity Neutralization Tank	1	HA Bottoms	1000
High Activity Condensate Hold Tank (Overheads)	1	HA Overheads	4000
Low Activity Head Tank (Evaporator Feed)	1	Unprocessed Waste	5600
Low Level Evaporator	1	LA Bottoms	1000
Low Activity Bottoms Collection Tank	1	LA Bottoms	150
Low Activity Neutralization Tank	1	LA Bottoms	200
Effluent Head Tank	1	LA Overheads	6000
Effluent Polishing Evaporator	1	Effluent Bottoms	1000
Effluent Holding Tank	1	Effluent Overheads	6000

Table G-8. PDCF Lab Liquids Waste Radionuclide Concentration

Radionuclide	Concentration (g/l)
Pu-238	1.48E-07
Pu-239	2.74E-04
Pu-240	1.93E-05
Pu-242	2.96E-07
Am-241	2.96E-06
U-234	2.50E-06
U-235	2.33E-04
U-236	1.25E-06
U-238	1.35E-05

Table G-9. PDCF Lab Concentrated Liquid Waste Radionuclide Concentration

Radionuclide	Concentration (g/l)
Pu-238	1.27E-02
Pu-239	2.34E+01
Pu-240	1.64E+00
Pu-242	2.53E-02
Am-241	2.53E-01
U-234	1.91E-01
U-235	1.78E+01
U-236	9.55E-02
U-238	1.03E+00

Table G-10. MFFF Stripped Uranium Waste Stream Radionuclide Concentration

Radionuclide	Concentration (g/l)
Pu-238	5.00E-08
Pu-239	9.00E-05
Pu-240	9.00E-06
Pu-241	1.00E-06
Pu-242	1.00E-07
U-232	1.34E-06
U-233	1.34E-02
U-234	2.68E-01
U-235	7.77E+00
U-236	5.36E+00

Table G-11. MFFF High Alpha Waste Stream Radionuclide Concentration

Radionuclide	Concentration (g/l)
Pu-238	8.00E-07
Pu-239	1.44E-03
Pu-240	1.44E-04
Pu-241	1.60E-05
Pu-242	1.60E-06
Am-241	1.80E-01
U-232	9.54E-12
U-233	9.54E-08
U-234	1.91E-06
U-235	5.53E-05
U-236	3.82E-06

Table G-12. High Activity Evaporation Process Concentrations

Radionuclide	Feed Concentration (with 3X dilution) (g/L)	Bottoms Concentration (g/L)	Overhead Concentration (g/L)
Pu-238	1.74E-06	1.48E-05	1.99E-10
Pu-239	3.12E-03	2.66E-02	3.57E-07
Pu-240	3.12E-04	2.66E-03	3.57E-08
Pu-241	3.47E-05	2.96E-04	3.97E-09
Pu-242	3.47E-06	2.96E-05	3.97E-10
Am-241	5.75E-02	4.90E-01	6.57E-06
U-232	3.00E-10	2.56E-09	3.43E-14
U-233	3.00E-06	2.56E-05	3.43E-10
U-234	6.00E-05	5.12E-04	6.86E-09
U-235	1.74E-03	1.48E-02	1.99E-07
U-236	1.20E-03	1.02E-02	1.37E-07

Table G-13. Summary of Consequences for WSB Bounding Credible Events

Accident Event	Maximum Impact to Site Worker (rem)	Maximum Impact to Site Worker (probability of cancer deaths)	Maximum Impact to Public at SRS Boundary (rem)	Maximum Impact Public at SRS Boundary (probability of cancer deaths)
Loss of Confinement (Spill)	9.0	3.6E-03	0.03	1.5E-05
Fire	2.4	9.6E-04	0.01	5.0E-06
Hydrogen Explosion in High Activity Waste Evaporator	5.1	2.0E-03	0.02	1.0E-05

Table G-14. Estimated Consequences for the Most Severe Accidents Involving Truck Shipments of TRU Waste

Accident Location	Neutral Conditions				Stable Conditions			
	Population		MEI		Population		MEI	
	Dose (person-rem)	Risk (cancer fatalities)	Dose (rem)	Risk (cancer fatalities)	Dose (person-rem)	Risk (cancer fatalities)	Dose (rem)	Risk (cancer fatalities)
Urban	4.0E+03	2.0E+00	3.5E+00	1.8E-03	3.2E+04	1.6E+01	1.2E+01	6.0E-03
Suburban	7.4E+02	3.7E-01	3.5E+00	1.8E-03	5.9E+03	3.0E+00	1.2E+01	6.0E-03
Rural	6.5E+00	3.0E-03	3.5E+00	1.8E-03	5.2E+01	3.0E-02	1.2E+01	6.0E-03

Source: DOE 1997a, Table E-26