Risk-Dominant Scenarios from Several SRS Facilities

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November 1998

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EXECUTIVE SUMMARY

At the request of the DOE Rocky Flats Field Office, an examination of several postulated accidents for Savannah River Site's (SRS's) Hazard Category 2 nuclear facilities was performed. The request for this study was made following a Rocky Flats Environment Technology Site (RFETS) evaluation indicating that many postulated accidents exceed evaluation guidelines.

For this evaluation, selected events were drawn from four SRS authorization basis documents and supporting Engineering Calculations. A detailed review was conducted to extract details from the SRS accident analyses and recast information in terms of scenario spreadsheets for comparison purposes to the RFETS analyses. The accident analysis details included specific information with respect to source term evaluation, chemical form, material-at-risk, damage ratio, airborne release fractions, respirable fractions, leak path factors and event timings. Aspects of the consequence analysis review included distance to receptors, dose quantile, treatment of plume meander and surface roughness, inhalation dose factors, and plume deposition parameters.

The four SRS facilities chosen for examination were HB-Line, the proposed Actinide Packaging and Storage Facility, Building 235-F, and the Solid Waste Management Facility. For each facility, the bounding accident for each frequency bin was evaluated as discussed above. Additional events, particularly those resulting in high consequences or representing additional accident types, were evaluated if deemed necessary. Postulated accidents determined to be risk-dominant were evaluated with respect to Evaluation Guidelines and compared with RFETS facility safety analyses to determine possible differences in consequence analysis methodology between the two sets of facilities.

The analysis comparison concludes that the chief sources of difference in dose consequences may be traced to: (1) site boundary distances; (2) different meteorological basis for the onsite receptor; (3) application of lofted and non-lofted plume conditions for fire scenarios in the RFETS analyses; (4) differences in the assumed breathing rate for onsite and offsite receptors; and (5) in general, higher amounts of material-at-risk in the RFETS scenarios.

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1.0 INTRODUCTION

The Department of Energy Rocky Flats Field Office (RFFO) recently summarized risk-dominant scenarios for Category 2 facilities at the Rocky Flats Environmental Technology Site (RFETS). The summary is based on DOE-STD-3011-94 methodology and a spreadsheet format that follows RADIDOSE methodology (Peterson 1998). Since a number of the risk-dominant scenarios exceed RFETS guidelines, the Rocky Flats Field Office sought to compare the analyses to other similar nuclear facilities within the DOE Complex for relative risk perspectives, risk criteria, and consistency of assumptions. The DOE Savannah River Operations Office was requested to provide a set of Savannah River Site (SRS) facility-based scenarios to compare with the RFETS results.

This report and associated spreadsheets describe the SRS safety analysis provided for four selected transuranic storage and stabilization facilities. For each of the four sets of analysis, the bounding events in each frequency category are identified, key inputs and assumptions are stated, and final doses tabulated.

2.0 DISCUSSION

2.1 ISSUE PROMPTING REVIEW OF SCENARIOS AT SRS

An examination of risk-dominant accident scenarios for Hazard Category 2 nuclear facilities at RFETS was recently conducted. This study indicated that a number of RFETS postulated accident scenarios exceeded evaluation guidelines. As a result of this study, RFFO requested SRS to review their risk-dominant scenarios for Category 2 facilities. This request was to include a comparison of relative risk perspectives, risk acceptance, and consistency of assumptions when appropriate. The TRU/TRUM waste storage facilities were of particular concern for RFFO.

2.2 METHODOLOGY, FACILITIES AND SCENARIOS FROM RFETS

To provide a reference for the requested comparison, SRS was provided the EXCEL spreadsheet used by RFETS to calculate consequences and risk-categories for accidents evaluated at Rocky Flats (RF). This spreadsheet includes information on the following parameters for each accident event examined:

- Material of concern and its form
- Assumed breathing rate
- Material-at-risk (MAR)
- Damage ratio (DR)
- Leakpath factor (LPF)
- Airborne release fraction (ARF)
- Inhalation Dose conversion factor (IDCF)
- Release duration (min)
- Solubility class (Y or W)
- Expansion factor
- Relative downwind air concentration (χ/Q)
- Dose (rem) – occupationally exposed persons (OEP) and maximum offsite individual (MOI)
- Consequence class for OEP and MOI
- Frequency class
- Risk class and if risk-dominant
- Respirable BST
- Respirable Factor (RF)

Within this spreadsheet, consequence (dose) is calculated as the product of the DR, MAR, LPF, RF, ARF, χ/Q , breathing rate, and the IDCF, divided by the expansion factor.

Following calculation of dose, the postulated radiological consequences and the frequencies for each event are assigned to a bin category based on respective values. The combination of the consequence and frequency bins determines the risk category to which the event is assigned (Table 1). Accident events assigned a risk category of I or II for either the onsite or offsite individual are determined to be risk-dominant (DOE 1994b).

Table 1. Risk-category determination based on consequence and frequency bin

Consequence	Frequency of Occurrence		
	Extremely Unlikely	Unlikely	Anticipated
High MOI: >5rem; OEP: >25 rem	II	I	I
Moderate	III	II	I
Low MOI: <0.1 rem; OEP: >0.5 rem	IV	III	III

In addition to the methodology used at RFETS, SRS was also provided with the completed EXCEL spreadsheets for two RF facilities, Buildings 664 and 440. The accident scenarios for each facility included in the spreadsheet are listed below:

Building 664

- SAND box puncture*
- Multi-container drop*
- Earthquake*
- Drum fire*
- Mixed drums / crates fires*
- Truck fire
- Plane crash – worst-case* and realistic*

Building 440

- Repack spill
- Multi-fire*
- Truck fire
- Aircraft crash*
- Earthquake spill*
- Drum spill
- Median crate fire

Accidents followed by an asterisk were determined to be risk-dominant following the guidelines in Table 1.

2.3 BASIS FOR CHOSEN SRS FACILITIES AND ACCIDENT EVENTS

The SRS facilities examined in this report were chosen based on processes occurring (or proposed to occur) at the facility and the nature of the request from Rocky Flats which requested an examination of processes similar to those at RF. Specifically, Rocky Flats requested an examination of the risk-dominant scenarios for the TRU/TRUM waste storage facility.

For each facility, the bounding events in each frequency category were examined. Additional events were included in the examination based on type of accident or consequence values as needed. Risk-dominant events are characterized by mitigated

doses that bound others for the frequency category in question. These events may approach the Evaluation Guidelines.

2.4 FACILITIES CHOSEN FROM SRS

Four SRS facilities were chosen for this comparison. The four SRS facilities examined and the authorization basis documents reviewed are:

1. Actinide Packaging and Storage Facility

WSRC (1998a). *Actinide Packaging and Storage Facility Preliminary Safety Analysis Report*. Westinghouse Savannah River Company, Aiken, SC, WSRC-SA-35, Rev. 0.

2. HB-Line

WSRC (1998b). *H-B Line Basis for Interim Operation*. Westinghouse Savannah River Company, Aiken, SC, WSRC-RP-96-553, Rev. 3, Addendum 1.

3. Bldg. 235-F

WSRC (1998c). *Safety Analysis-200 F-Area Savannah River Site Building 235-F Final Safety Analysis Report (U)*. Westinghouse Savannah River Company, Aiken, SC, WSRC-RP-89-575, Rev.0.

4. Solid Waste Management Facility

WSRC (1996). *Solid Waste Management Facility Safety Analysis Report*. Westinghouse Savannah River Company, Aiken, SC, WSRC-SA-22, Rev. 0.

A description of the accident events chosen for each facility is given in Section 2.6.

2.5 OVERALL ASSUMPTIONS AND INPUTS USED IN SRS SCENARIOS

Radiological consequences for postulated accidents occurring in HB-Line, APSF, and Building 235-F were performed using the MACCS Version 1.5.11.1 consequence code [Chanin 1990; Jow 1990; Rollstin 1990; and Chanin 1993]. The MACCS input file used in each set of facility analysis is based on SRS-specific inputs and assumptions:

- 1) For the individual analysis, the radial ring endpoints examined are determined based on the distance from the release to the receptor(s) of concern and will, at a minimum, bound either side of the desired distance.
- 2) Building wake effects are not included.
- 3) MACCS uses the Gifford model to adjust the sigma y for plume meander due to varying averaging times. This model is only valid from the averaging time of the experimental basis for the sigma y, assumed to be 3 minutes, to an averaging time of 100 hours [Gifford, 1975].
- 4) No wet deposition is assumed.

- 5) Surface roughness is assumed 100 cm, which combines the urban attributes of the operational area with the forested features of the site. [Jow, 1990] MACCS [Jow, 1990] incorporates the change in the surface roughness using the model proposed in [AMS, 1977]. In this model, the sigma z parameter is adjusted by applying the one-fifth law to the quotient of the new surface roughness divided by the Prairie Grass surface roughness (3 cm) [Haugen, 1959].
- 6) The site meteorological data files are composed of hourly H-Area data for the calendar years 1987 through 1991, at a measured windspeed height of 10 meters. [East, 1997].
- 7) The assumed breathing rate is 3.33×10^{-4} cubic meters per second [DOE, 1989]. The same breathing rate is used for onsite and offsite receptors.
- 8) No shielding is assumed.
- 9) No evacuation and/or sheltering is assumed.
- 10) Dose Conversion Factors are based on Federal Guidance Reports 11 and 12. [Eckerman, 1988 and Eckerman, 1993].
- 11) Facility-specific distances are used to the general public receptor (MOI).

For the remaining facility, SWMF, dose calculations were performed using an estimator technique in which the MAR is determined by summing the total curies of primary TRU alpha emitters. Radiological consequences are calculated as the product of the MAR, ARF, RF, LPF, DR, and the IDCF. The IDCF used assumes that for SWMF HC-2 facilities the TRU alpha emitters are the primary contributors to total dose and the rem/Ci values for the primary alpha emitters are all similar to each other.

After determination of the potential dose for each accident event, the calculated radiological consequence and frequency for each event are assigned to a bin category as discussed in Section 2.2. As shown in Table 1 above, the combination of the consequence and frequency bins determines the risk category to which the accident event is assigned. Accident events assigned a risk category of I or II are determined to be risk-dominant. For each frequency bin, the maximum radiological consequences allowed for the onsite and offsite individual are defined as the Evaluation Guidelines (Table 2).

Table 2. Onsite and offsite Evaluation Guidelines for each frequency class

Frequency Class	Maximum Consequence (rem)	
	Onsite	Offsite
Anticipated	25	0.5
Unlikely	25	5
Extremely Unlikely	100	25

2.6 ACCIDENT SCENARIOS BY FACILITY

The following is a description of the accidents examined for each of the SRS facilities included in this report. Although many accident scenarios were examined in the documentation for each facility, only a limited number were included in this study. Inclusion of a scenario was based on several factors. These factor include using

bounding events for each accident category and a representative event for the most severe accident categories.

2.6.1 Actinide Packaging and Storage Facility

The Actinide Packaging and Storage Facility (APSF) is a proposed facility for SRS. Information regarding accident scenarios for this facility was taken from the APSF Preliminary Safety Analysis Report (WSRC-SA-35, Rev. 0) Chapter 3: Hazard and Accident Analysis.

Three scenarios were examined for APSF. Each accident scenario represents the bounding consequence for the respective frequency category bin. The accidents examined were a fire starting in the Accountability Measurement room, a seismic induced full-facility fire, and an explosion in the repackaging area. These accidents were assigned to the Extremely Unlikely, Unlikely, and Anticipated frequency bins, respectively. The first release was assumed to occur over 3 min, while the second release, aerodynamic entrainment or resuspension, was assumed to occur over 10 hours. Releases were assumed to occur from a 24.7 m stack.

2.6.2 HB-Line

Accident events for HB-Line and their resulting consequences were taken from the Safety Analysis Addendum 1 for HB-Line BIO (WSRC-RP-96-553, Rev. 3). Six events were examined for HB-Line. These events are a full-facility fire, full-facility fire with secondary events (bounding fire event), intermediate room fire, intermediate room fire with secondary events, process spills (bounding anticipated frequency bin event) and an earthquake with secondary events (bounding non-fire event). Resuspension was examined for all events, but was not a significant contributor in all cases.

The full-facility fire involves all of the processing areas in the facility and any residual material from previous operations. A smaller fire in a single room of the facility is termed an intermediate fire. Because of uncertainty about the exact configuration of the facility inventory when a room fire may occur, conservative assumptions maximize the material at risk to the point that it contains an appreciable fraction of the entire facility inventory. The entire facility inventory is available for release in the evaluation basis earthquake. Secondary events following the seismic event contribute significantly to a release and may include resin explosion, hydrogen deflagration, or fire which may be initiated by the seismic event. In the same manner, secondary events are also postulated to occur in fire scenarios with some frequency that warrants their being assessed in the safety documentation program.

Event timing scenarios are projected in which portions of the material are released over specified time intervals based on analysis of the accident progression. While a specific accident may occur over the duration of several hours, the majority of the facility inventory may be released during a short interval during that overall time. Chemical

forms and storage methods take a role in selection of release fractions, while in general the scope of the event is used to determine the damage ratio and the leak path factor.

2.6.3 Building 235-F

The facilities included in the Building 235-F analysis which contain radiological hazards include the Actinide Billet Line (NpO_2 contamination); and the Plutonium Fuel Form and Plutonium Experimental Facilities (PuO_2 contamination).

Two accident types were examined for Building 235-F: design basis earthquake with fire-filtered release and facility fire. The SAR examines two types of fires for Building 235-F, a worst case fire and a best estimate fire.

2.6.4 Solid Waste Management Facilities (SWMF)

For the Solid Waste Management Facility, six accident scenarios were examined. The first five events involve the TRU pads, and are representative of the different accident categories that may occur (fire & explosion, tornado, external impact, transfer & handling event). The culvert drum internal fire event represents a fire within a single waste drum. The sixth accident event occurs in the 643-7E Buried Waste facility. Both of these subfacilities have been categorized as Hazard Category 2. The events are assumed to be ground-level releases from E area. The material of interest was combined into the total Ci of alpha emitters present rather than individual radionuclides.

A synopsis of the accident events examined for the four SRS facilities is presented in Table 3. This summary table lists the facility and event type, the MAR and release duration, and the event frequency category.

Table 3. SRS Scenarios

Facility / Event	MAR (g)	Release Time (min)	Frequency Category
APSF			
AM Room Fire	4.8E+4	3 initial; 600 resus..	Unlikely
Seismic induced full facility fire*	6.22, 7.92E-5, 1.58E-4 initial; 0.67 entrainment	3 initial; 600 resuspension	Unlikely
Explosion in Repackaging Area	40000 oxide (35200 metal-equiv)	3 initial; 600 resuspension	Anticipated
HB-Line**			
Full Facility Fire & Secondary Events	Pu-238 3.3E+3 Pu-240 5.9E+2	Initial: 160 total Resuspension: 600 total	Extremely Unlikely
Full Facility Fire	Pu-238 3.3E+3 Pu-240 5.9E+2	Initial: 160 total Resuspension: 600 total	Extremely Unlikely
Intermediate Fire & Secondary Events	Pu-238 3.1E+3 Pu-240 5.4E+2	Initial: 145 total Resuspension: 600 total	Unlikely
Intermediate Fire	Pu-238 3.1E+3 Pu-240 5.4E+2	Initial: 145 total Resuspension: 600 total	Unlikely
Spill	Pu-238 1.2E+3 Pu-240 2.1E+2 init. & resus.	Initial: 3 total Resuspension: 600 total	Anticipated
Earthquake with Secondary Events	Nitrate form Am-241 8.0E+2 WPu-238 2.7E+2 WPu-239 1.7E+4 WPu-240 7.5E+3 WPu-241 8.0E+2 Oxide form Am-241 1.2E+3 Pu-239 6.49E+2 Pu-239 2.5E+4 Pu-240 1.1E+4 Pu-241 1.2E+3	Onsite: 45 total Offsite: 600 total Resuspension: 10080 total	Extremely Unlikely
Bldg. 235-F (source terms, Ci)			
DBE	PuO ₂ 5.0E-2		Extremely Unlikely
Fire - Best Case	PuO ₂ 9.00E-4		Unlikely
Fire - Worst Case	PuO ₂ 2.0E-1		Unlikely
SWMF (Ci alpha emitters)			
TRU Pads - Fire & Exp.	3.2E+3	60	Unlikely
TRU Pads - Tornado	3.4E+3	60	Extremely Unlikely
TRU Pads - High-Energy Vehicle Impact	8.0E+3	60	Extremely Unlikely
TRU Pads - Trans. & Handling	3.4E+3	60	Anticipated
TRU Pads - Internal Culvert Drum Fire	6.3E+2	60	Unlikely
634-7E - Buried Waste; Helicopter Crash	2.6E+3	60	Extremely Unlikely

* APSF seismic induced FF fire: MAR column values are for source term; multiple values for the following forms of Pu-239, respectively: power grade; fuel grade; weapons grade; entrainment is power grade form

** HB-Line: release durations are given as intervals; times listed are for total time.

3.0 SAVANNAH RIVER SITE RESULTS

For ease of comparison between the two DOE sites, the accident analysis spreadsheet provided was completed for each of the SRS facilities examined. Due to differences in calculation methodology, not all categories contain information. For many of the accident scenarios examined, the source term rather than the MAR is provided. In cases where the source term is listed, additional parameters such as ARF, RF, LPF, DR, and respirable building source term (BST) may not be provided. The completed EXCEL spreadsheets for the four SRS facilities are located in the Appendix.

Events determined to be risk-dominant for each of the four SRS facilities were examined relative to the SRS Evaluation Guidelines (EGs). The Farmer Plots in Figures 1 and 2 graphically depict the MOI and OEP dose, respectively, in relation to the EGs for all SRS events examined. Accidents for which only frequency bins were provided were assigned a frequency value within the range of the given bin. Calculated consequences for the onsite receptor are shown for APSF, HB-Line, and Building 235-F. The SWMF SAR Hazard and Accident Analysis Chapter does not include onsite dose calculations.

Of the three events examined for APSF, the seismic induced full facility fire and the Accountability Measurement (AM) room fire approach the MOI and OEP EGs, respectively. The calculated consequence for the seismic induced fire is 1.7 rem for the MOI. The AM room fire resulted in OEP consequences of 22 rem. The onsite receptor dose evaluation for the seismic induced full facility fire currently exceeds the guideline for the Unlikely frequency category. The facility design, material-at-risk controls, and aspects of the accident analysis are in the process of being revised.

For the Solid Waste Management Facility, two of the six events approach but do not exceed the MOI evaluation guidelines. These two events, Culvert Explosion and the TRU Pad Dropped Steel Box, resulted in calculated MOI consequences of 4.5 and 0.45 rem, respectively. The EGs for these events are 5 rem for the explosion and 0.5 rem for the dropped steel box. The calculated consequences are below the SRS EGs.

Of the six events examined for HB-Line, two Unlikely events approach both the OEP and MOI EGs. The calculated OEP and MOI consequences for the fire without secondary events are 2.6 and 0.36 rem, respectively. Consequences for the fire with secondary events were calculated to be 12 rem for the OEP and 0.58 rem for the MOI. These fall below the EGs for an Unlikely event of 25 rem OEP and 5 rem MOI.

For the three events examined for Building 235-F, the worst case fire initially exceeded the OEP EGs. However, physical modifications in the facility were performed and the Fire Hazard Analysis was revised. The new dose analysis reports this consequence to be well below the guideline value.

Figure 1. Farmer Plot indicating frequency of occurrence versus calculated consequences for the MOI. Events include those examined for SWMF, HB Line, Building 235-F and APSF. The solid line represents the MOI EGs for each occurrence frequency.

Figure 2. Farmer Plot indicating frequency of occurrence versus calculated consequences for events examined for HB Line, Building 235-F and APSF. The consequences calculated are for the OEP, or the onsite receptor. The solid line represents the OEP EGs for each occurrence frequency.

4.0 COMPARISON WITH RFETS RESULTS

A comparison of the scenario spreadsheets was performed to determine the major sources of the differences in the accident and consequence analyses between the RFETS and SRS results, and the associated dose results. The key areas are with respect to distance to the site boundary, meteorological basis for the onsite receptor, lofted plume model use, breathing rates, and source terms variations.

4.1 DISTANCE TO THE SITE BOUNDARY

The SRS safety analysis reflects the larger distance to offsite receptors from most SRS facilities. For the SRS analyses noted in this report, all distances to the MOI receptor are considerably greater than the corresponding used in the two RFETS facility analyses. Specifically, the distance to the MOI for the SRS facility analyses are: APSF - 8.9 km; HB-Line - 11.85 km; 235-F 9.4 km; and SWMF - 10.5 km. For the two Rocky Flats facilities, the closest MOI location is 1.24 km for a non-lofted fire or 4.0 km for a lofted fire. The large differences in MOI distance for SRS as compared to RF facilities and the site-specific meteorology employed result in lower relative air concentration factors applied for postulated accident. The

Table 3. Comparison of χ/Q values for SRS and RFETS

Rocky Flats Environmental Technology Site			
Building 440 BFO			
Facility			
Receptor	χ/Q (s/m ³)	Percentile Meteorology	Distance (m)
Onsite - non-lofted	1.05E-02	95 th	100
Onsite - lofted	3.59E-04	95 th	100
Offsite - non-lofted	1.98E-04	95 th	1243
Offsite - lofted	1.03E-05	95 th	4020
Building 664 FSAR			
Receptor	χ/Q (s/m ³)	Percentile Meteorology	Distance (m)
Onsite - non-lofted	1.05E-02	95 th	100
Onsite - lofted	3.59E-04	95 th	100
Offsite - non-lofted	1.54E-04	95 th	1453
Offsite - lofted	1.03E-05	95 th	4020
Savannah River Site			
	χ/Q (s/m ³)	Percentile Meteorology	Distance (m)
All Facilities			
Onsite	6.59E-04	50 th	100
Onsite	1.97E-05	50 th	640
Offsite - APSF	2.86E-06	95 th	8900
Offsite - 235-F	2.61E-6	95 th	9400
Offsite - SWMF	2.25E-06	95 th	10500
Offsite - HB-Line	4.09E-07	95 th	11850

relative air concentrations, the meteorology basis, and the distance to the various receptors are listed in Table 3 for the two RFETS and the four SRS facilities.

4.2 ONSITE DISTANCE

The SRS and RFETS analyses appear to be consistent for the onsite receptor, using a distance of 100m. However, in reviewing the RFETS facility spreadsheets, it was not clear if the "lofted plume" distance remains at 100 m or moves to a point of plume "touchdown". Touchdown is that distance at which the plume has grown axially such that inhalation by a ground-based receptor would be possible. It was not obvious from the spreadsheet if under lofted plume conditions,¹ the onsite receptor would remain within the RFETS security fence, would move to a location within the buffer zone, or be positioned outside of the boundary perimeter fence. In other words, the 95th quantile meteorology condition and lofted plume combination is not described sufficiently to compare to the typical assumptions made in the corresponding case for lofted plume conditions in SRS analysis.

4.3 ONSITE METEOROLOGY BASIS

The SRS analysis for onsite receptors evaluates postulated accident conditions using median (50th quantile) meteorology. This assumption has been applied to revised safety documentation at SRS since preparation of the Safety Analysis Report for the Replacement Tritium Facility in the 1993 – 1994 timeframe. At this time, WSRC Safety Engineering was directed by DOE Office of Defense Programs (DOE/DP) to use "average meteorological conditions" rather than adverse for onsite receptor evaluation (Robertson 1993). Implementation of the "average" meteorology at SRS in practice has been to use the 50th quantile condition.

4.4 LOFTED PLUME CASES

The fire scenarios listed as part of the SRS analyses did not apply the sensible heat model in MACCS, and instead assume a ground release of radionuclides. This assumption contrasts to the lofted plume assumption available within the RADIDOSE spreadsheets. The issue of the fraction of heat released as sensible heat and therefore available to "loft" the plume versus that released as radiative heat has not been resolved nor standardized in accident analysis at SRS. Moreover, the distance to the site boundary for most SRS facilities including those compared here is such that sensible heat-impacted plumes and no sensible heat plumes result in similar air concentrations (χ/Q) to the offsite receptor. Furthermore, WSMS has some concern regarding the appropriateness of the current MACCS model for modeling areal release of sensible heat.

¹ Usually the onsite evaluation point is the maximally exposed onsite receptor.

4.5 BREATHING RATE

The Rocky Flats analysis uses a heavy breathing rate for both the onsite and offsite receptors of $3.47 \times 10^{-4} \text{ m}^3/\text{s}$. This breathing rate corresponds to constant running. SRS analyses use an occupational breathing rate of $3.33 \times 10^{-4} \text{ m}^3/\text{s}$ for both onsite and offsite receptors.

4.6 RELEASE FRACTIONS

Review of the airborne release fractions (ARF) and respirable fractions (RF) from the RADIDOSE spreadsheets does not identify any systematic difference in methodology or assumptions between RFETS and SRS radiological assessments. While in some cases specific release fractions assigned to a scenario may differ, the analyses are generally consistent.

4.7 DOSE CONVERSION FACTORS

Differences in the use of dose conversion factors used at the two facilities may also contribute to differences in calculated consequences. For the Rocky Flats calculations, IDCFS are for a category of material, such as weapons grade (WG) Pu, aged WG Pu, or High-Am Residues. For SRS consequence calculations, the IDCFS for each isotope is used. Additionally, for the two RFETS facilities for which information was provided, all Pu was listed to be in the oxide form (class Y). For SRS facilities, a distinction is made between the nitrate (class W) and oxide forms.

4.8 AMERICIUM CONCENTRATIONS

Due to the nature of the material-at-risk at RFETS, especially processes and storage of concentrations of americium in waste residues, the accident analysis for MAR containing aged weapons grade plutonium may include a disproportionate amount of americium. In contrast, SRS analysis does not generally see similar amounts of americium.

4.9 MATERIAL-AT-RISK

Compared to accident scenarios evaluated for SRS facilities, the maximum Rocky Flats MAR appears to be about two orders-of-magnitude higher than typically assumed for SRS analysis.

5.0 CONCLUSIONS

A comparison of postulated accident scenarios has been performed for safety analyses for two Rocky Flats Environmental Technology Site facilities (Building 440 and Building 664) and four Savannah River Site facilities (APSF, HB-Line, 235-F, and SWMF). This work was in response to a request from the Rocky Flats Field Office of the Department of Energy to identify the sources of differences in the two sets of safety analyses.

This review concludes that the major points of difference include:

- Distance to the Site Boundaries, and therefore differences in the relative air concentrations for the offsite receptor evaluation
- Different meteorological basis for the onsite receptor
- Use of the lofted and non-lofted plume conditions in some of the RFETS scenarios
- Slight difference in the assumed breathing rate for onsite and offsite receptors
- In general, higher amounts of material-at-risk in the RFETS scenarios, and
- Weapons Grade components to the MAR for RFETS analysis, and often higher americium levels.

To a large extent, the analyses differences are driven by the shorter MOI distances at RFETS compared to SRS. To a lesser level, variation in the MAR and constituents to the source terms also contribute.

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7.0 APPENDIX

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	A	B	C	D	E	F	G	H	I	J	K	L
1	HB-Line											
2	HB-Line - WSRC-RP-96-553 and supporting calc notes S-CLC-H-00664 and S-CLC-H-00667											
3	Data entered by: D. Marx											
4	12/3/98											
5		Calculation constants:					Dose Conversion Factor (rem/g)		Class Y	Class W		
6								WGPu	2.77E+7	4.28E+7		
7		MOI Distance (m)	11,850	(95%ile)				Aged WGPu	3.03E+7	4.35E+7		
8		Max. Offsite Indiv. X/Q (s/m^3)	X.XXE-4	(95%ile)				Hghi-Am Residues	1.92E+8	2.06E+8		
9		Collocated Worker X/Q (s/m^3)	X.XXE-2	(50%ile)								
10		Breathing Rate (m^3/s)	3.3E-4	(occupational)								
11												
12			Meteorology*		Breathing**	Form of	Solubility	Damage	MAR	BESTCF	Source Term (g)	
13	Scenario Description	Material	Onsite	Offsite	Rate (m3/s)	Material	Class	Ratio	(g)	ARF, RF, LPF for onsite	Onsite	Offsite
14	SAR Farmer Event #5 - Full Facility Fire & Secondary Events	PU-238	5.0E-1	9.5E-1	3.3E-4	Oxide	Y		3.3E+3	8.9E-3	2.1E-2	2.3E+0
15		PU-240	5.0E-1	9.5E-1	3.3E-4	Oxide	Y		5.9E+2	8.9E-3	3.7E-3	4.1E-1
16												
17	SAR Farmer Event #4 - Full Facility Fire	PU-238	5.0E-1	9.5E-1	3.3E-4	Oxide	Y		3.3E+3	2.4E-3	3.9E-3	1.6E+0
18		PU-240	5.0E-1	9.5E-1	3.3E-4	Oxide	Y		5.9E+2	2.4E-3	6.8E-4	2.8E-1
19												
20	SAR Farmer Event #3 - Intermediate Fire & Secondary Events	PU-238	5.0E-1	9.5E-1	3.3E-4	Nitrate	Y		3.1E+3	2.7E-2	1.9E-3	2.7E-1
21		PU-240	5.0E-1	9.5E-1	3.3E-4	Nitrate	Y		5.4E+2	2.7E-2	3.5E-4	4.8E-2
22												
23	SAR Farmer Event #2 - Intermediate Fire	PU-238	5.0E-1	9.5E-1	3.3E-4	Nitrate	Y		3.1E+3	7.2E-3	1.4E-3	1.9E-1
24		PU-240	5.0E-1	9.5E-1	3.3E-4	Nitrate	Y		5.4E+2	7.2E-3	2.3E-4	3.3E-2
25												
26	SAR Farmer Event #1 - Spill	Initial PU-238	5.0E-1	9.5E-1	3.3E-4	Oxide	Y		1.2E+3	6.7E-2	2.4E-4	3.5E-3
27		Initial PU-240	5.0E-1	9.5E-1	3.3E-4	Oxide	Y		2.1E+2	6.7E-2	4.2E-5	6.2E-4
28		resuspension PU-238	5.0E-1	9.5E-1	3.3E-4	Oxide	Y		1.2E+3	6.7E-2	2.6E-3	3.9E-2
29		resuspension PU-240	5.0E-1	9.5E-1	3.3E-4	Oxide	Y		2.1E+2	6.7E-2	4.6E-4	7.0E-3
30												
31	SAR Farmer Event #9 - Earthquake with Secondary Events	Nitrate release AM-241	5.0E-1	9.5E-1	3.3E-4	N/A			8.0E+2	4.9E-3	2.4E-3	4.9E-1
32		PU-238	5.0E-1	9.5E-1	3.3E-4	Nitrate	W		2.7E+2	4.9E-3	7.8E-4	1.6E-1
33		PU-239	5.0E-1	9.5E-1	3.3E-4	Nitrate	W		1.7E+4	4.9E-3	5.3E-2	1.1E+1
34		PU-240	5.0E-1	9.5E-1	3.3E-4	Nitrate	W		7.5E+3	4.9E-3	2.2E-2	4.6E+0
35		PU-241	5.0E-1	9.5E-1	3.3E-4	Nitrate	W		8.0E+2	4.9E-3	2.4E-3	4.9E-1
36		Np-237	5.0E-1	9.5E-1	3.3E-4	N/A			2.1E+4	4.9E-3	7.3E-4	1.5E-1
37		Oxide Release										
38		Am-241	5.0E-1	9.5E-1	3.3E-4	N/A			1.2E+3	4.9E-3	5.8E-5	1.2E-2
39		Pu-238	5.0E-1	9.5E-1	3.3E-4	Oxide	Y		6.5E+2	4.9E-3	3.7E-7	4.4E-3
40		Pu-239	5.0E-1	9.5E-1	3.3E-4	Oxide	Y		2.5E+4	4.9E-3	1.3E-3	2.7E-1
41		Pu-240	5.0E-1	9.5E-1	3.3E-4	Oxide	Y		1.1E+4	4.9E-3	5.3E-4	1.1E-1
42		Pu-241	5.0E-1	9.5E-1	3.3E-4	Oxide	Y		1.2E+3	4.9E-3	5.8E-5	1.2E-2
43												
44	* meteorology is sector-independent				Consequence class from DOE-STD-3011-94							
45	** breathing rate is the DOE occupational breathing rate				K.F. Eckerman, (1988) A.B. Wolbarst, A.C.B. Richardson. <i>Limiting Values of Radionuclid Dose Conversion Factors for Inhalation, Submersion, and Ingestion</i> . Federal Guidance R Protection Agency, Washington, DC, DE89-011065. K.F. Eckerman (1993) and J.C. Ryman. <i>External Exposure to Radionuclides in Air, Water</i> 12, U.S. Environmental Protection Agency, Washington, DC, PB94-114451.							
46	release times are modeled as intervals, times presented are the sum of the intervals											
47	* dose calculated using MACCS											
48	*MOI is plume centerline EDE at 11.85 km											
49	*Consequence classes taken from PHA											

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	Y	Z
1		
2	Occurrence	
3		
4	Anticipated	
5	I	
6	I	
7	III	
8		
9		
10		
11		
12		
13	Scenario Description	
14	SAR Farmer Event #5 - Full Facility Fire & Secondary Events	
15		
16		
17	SAR Farmer Event #4 - Full Facility Fire	
18		
19		
20	SAR Farmer Event #3 - Intermediate Fire & Secondary Events	
21		
22		
23	SAR Farmer Event #2 - Intermediate Fire	
24		
25		
26	SAR Farmer Event #1 - Spill	
27		
28		
29		
30		
31	SAR Farmer Event #9 - Earthquake with Secondary Events	
32		
33		
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	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Solid Waste Management Facility												
2	Solid Waste Management Facility - WSRC-SA-95-22												
3	Review by: Author's Name												
4	12/3/98												
5		Calculation constants:			Dose Conversion Factor (rem/g)			Class Y	Class W				
6			non-lofted	lofted			WGPu	2.77E+7	4.28E+7				
7		MOI Distance (m)	10,500		(95%ile)		Aged WGPu	3.03E+7	4.35E+7				
8		Max. Offsite Indiv. X/Q (s/m^3)			(95%ile)		Hghi-Am Residues	1.92E+8	2.06E+8				
9		Collocated Worker X/Q (s/m^3)			(50%ile)								
10		Breathing Rate (m^3/s)	3.3E-4		(occupational)								
11													
12					Breathing	Form of	Solubility	Damage	Material-at-Risk (MAR)			Release	
13	Scenario Description	Scenario	Material	Meteorology	Rate	Material	Class	Ratio	# items	(Ci)	LPF	Duration (min)	Expansion Factor
14	TRU Pads - Fire & Explosion	Culvert Drum Internal Fire	Ci of alpha emitters	95%				1.00		6.3E+2		60	
15	TRU Pads - Fire & Explosion	Culvert Explosion	Ci of alpha emitters	95%				1.00		3.2E+3	1.0	60	
16	TRU Pads - Tornado	Low-Activity Drums	Ci of alpha emitters	95%				0.44		3.4E+3	1.0	60	
17	TRU Pads - High-Energy Automobile Vehicle Impact	Container Rupture + Fire	Ci of alpha emitters	95%				1.00		8.0E+3	1.0	60	
18	TRU Pads - Transfer & Handling	Dropped Steel Box	Ci of alpha emitters	95%				0.10		3.4E+3	1.0	60	
19	634-7E - Buried Waste; Helicopter Crash	Buried Waste	Ci of alpha emitters	95%				1.00		2.6E+3	1.0	60	
20													
21													
22	Dose calculations performed by multiplying the total Ci of alpha emitters by ARF, RF, LPF and DCF to determine dose												
23	Ground level release from E Area												
24	DCF determined using all alpha emitters and a X/Q calculated using Reg Guide 1.145												

	N	O	P	Q	R	S	T	U	V	W	X	Y
1												
2							Risk class:		Frequency of Occurrence			
3									Extremely			
4							Consequence		Unlikely	Unlikely	Anticipated	
5								High	II	I	I	
6								Moderate	III	II	I	
7								Low	IV	III	III	
8												
9												
10												
11												
12			DCF	Respirable	Collocated Worker		Max. Offsite Indiv.		Frequency	Risk Class		
13	ARF*RF		(rem/CI)	BST (g)	Dose (rem)	Conseq. Class	Dose (rem)	Conseq. Class	Class	CW	MOI	Scenario Description
14	5.0E-4		1.18				3.7E-1	Moderate	Unlikely		II	TRU Pads - Fire & Explosion
15	1.0E-3		1.18				4.52	Moderate	Unlikely		II	TRU Pads - Fire & Explosion
16	2.0E-4		1.18				0.04	Low	Extremely Unlikely		IV	TRU Pads - Tornado
17	5.0E-4		1.18				4.81	Moderate	Extremely Unlikely		III	TRU Pads - High-Energy Automobile Vehicle Impact
18	1.1E-3		1.18				0.45	Moderate	Anticipated		I	TRU Pads - Transfer & Handling
19	1.0E-3		1.18				2.44	Moderate	Extremely Unlikely		III	634-7E - Buried Waste; Helicopter Crash
20												
21												
22												
23												
24												

	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI
1	Solid Waste Management Facility									
2	Solid Waste Management Facility - WSRC-SA-95-22									
3	Review by: Author's Name									
4	12/3/98									
5										
6										
7										
8										
9										
10										
11	SUMMARY OF RISK DOMINANT SCENARIOS FOR COMPARISON TO OTHER BUILDINGS									
12				Collocated Worker		Max. Offsite Indiv.		Frequency	Risk Class	
13	Scenario Description	Risk Dominant?	Effective MAR (g)	Dose (rem)	Conseq. Class	Dose (rem)	Conseq. Class	Class	CW	MOI
14	TRU Pads - Fire & Explosion	yes	6.3E+2			3.7E-1	Moderate	Unlikely		II
15	TRU Pads - Fire & Explosion	yes	3.2E+3			4.5E+0	Moderate	Unlikely		II
16	TRU Pads - Tornado	no								
17	TRU Pads - High-Energy Automobile Vehicle Impact	no								
18	TRU Pads - Transfer & Handling	yes	3.4E+2			4.5E-1	Moderate	Anticipated		I
19	634-7E - Buried Waste; Helicopter Crash	no								
20										
21										
22										
23										
24										

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