WSRC-TR-93-577

Key Words:
Wind
Dose
Risk
Common Cause
Tornado

ESTIMATION OF INTEGRATED PUBLIC RISKS FOR NONSEISMIC EXTERNAL EVENTS AFFECTING THE SAVANNAH RIVER SITE (U)

W. S. Durant
R. J. Robinette
J. R. Kirchner

March 1994

Westinghouse Savannah River Company
Savannah River Technology Center
Aiken, SC 29808

SAFETY • RESPONSIBILITY • SECURITY
SRS
SAVANNAH RIVER SITE

PREPARED FOR THE U.S. DEPARTMENT OF ENERGY UNDER CONTRACT NO. DE-AC09-89SR18035

UNCLASSIFIED
W. S. Durant - ADC

WSRC-TR-93-577

Estimation of Integrated Public Risks for Nonseismic External Events Affecting the Savannah River Site

by
W. S. Durant
Westinghouse Savannah River Company
Savannah River Site
Aiken, South Carolina 29808
R. J. Robinette
J. R. Kirchner

DOE Contract No. DE-AC09-89SR18035

DISCLAIMER

DISCLAIMER

Available to DOE and DOE contractors from the Office of Scientific and Technical Information, P. O. Box 62, Oak Ridge, TN 37831; prices available from (615) 576-8401.

Available to the public from the National Technical Information Service, U. S. Department of Commerce, 5285 Port Royal Rd., Springfield, VA 22161

WSRC-TR-93-577

Project: Nonseismic External Events

Document: WSRC-TR-93-577

Title: Estimation of Integrated Public Risks for Nonseismic External Events Affecting the Savannah River Site (U)

Approvals:

M.L. Cowen, Manager Process Safety Tech Sect — Date: 3/23/94

O.M. Ebra-Lima, Manager NMPD Reg Compliance — Date

J.R. Schornhorst, Technical Reviewer, PST Staff — Date: 3/22/94

WSRC-TR-93-577

Key Words:
Wind
Dose
Risk
Common Cause
Tornado

ESTIMATION OF INTEGRATED PUBLIC RISKS FOR NONSEISMIC EXTERNAL EVENTS AFFECTING THE SAVANNAH RIVER SITE

W. S. Durant
R. J. Robinette
J. R. Kirchner

March 1994

Westinghouse Savannah River Company
Savannah River Technology Center
Aiken, SC 29808

SAFETY • RESPONSIBILITY • SECURITY
SRS
SAVANNAH RIVER SITE

PREPARED FOR THE U.S. DEPARTMENT OF ENERGY UNDER CONTRACT NO. DE-AC09-89SR18035

TABLE OF CONTENTS

TABLE OF CONTENTS (continued)

TABLE OF CONTENTS (continued)

Page

TABLE OF CONTENTS (continued)

Page

TABLE OF CONTENTS (continued)

LIST OF FIGURES

LIST OF TABLES

LIST OF TABLES (continued)

Page

LIST OF TABLES (continued)

Page

Page

LIST OF TABLES (continued)

Page

SUMMARY

Estimated radiation doses and risks from nonseismic external events for individual nuclear facilities at the SRS have been combined to obtain site-wide dose and risk estimates for these events. The external events considered are extreme straight-line winds, tornadoes, floods, other extreme weather events (lightning, hail, and extremes in temperature or precipitation), vehicle impact, accidents at adjacent facilities, aircraft impact, and meteorite impact. Only extreme straight-line wind events and tornadoes can credibly cause radionuclide releases from multiple facilities simultaneously. Thus, attention was focused on these events in this study.

Integrated (site-wide) doses and risks were estimated for the maximally exposed off-site individual and for the off-site population within 50 miles of the center of the SRS. Doses were calculated both for airborne radionuclide releases and for liquid radionuclide releases to surface water. However, these doses were not combined because of differences in receptor locations. Dose calculations for the individual facilities were updated to incorporate 1993 off-site population estimates and ICRP-30 dose conversion factors.

For extreme straight-line winds, the integrated risks to the maximally exposed off-site individual are 1.8×10^{-5} rem/year (airborne releases) and 1.5×10^{-5} rem/year (liquid releases). Integrated risks to the off-site population located within 50 miles of the center of the SRS are 1.1 person-rem/year (airborne releases) and 0.055 person-rem/year (liquid releases). The risks from airborne releases are mostly due to postulated releases from the New Production Control Facility and the SRTC Technical Area. The risks from liquid releases are almost entirely attributable to the H-Area Outside Facilities.

Integrated risks from tornado events are slightly lower. The integrated risks to the maximally exposed off-site individual are 1.4×10^{-6} rem/year (airborne releases) and 7.3×10^{-7} rem/year (liquid releases). Population risks are 0.013 person-rem/year (airborne releases) and 0.0027 person-rem/year (liquid releases). The risks from airborne releases are dominated by the risk contribution from the Fuel Fabrication Facility (321-M). Again, the risks from liquid releases are almost entirely attributable to the H-Area Outside Facilities.

The risks just presented can be summed to obtain integrated risks for all nonseismic external events as a class. For airborne releases, the integrated risk to the maximally exposed off-site individual is 1.9×10^{-5} rem/year, and the population risk is 1.1 person-rem/year. For liquid releases to surface water, the maximally exposed individual integrated risk is 1.6×10^{-5} rem/year,

and the population risk is 0.058 person-rem/year. These risks are negligible compared to the risks associated with background radiation* (on the order of 0.38 rem/year for individuals and 2.5 x 10^5 person-rem/year for the 50-mile population), and they are well within the guidelines established by DOE SEN-35-91.

*C.L. Cummins et al., 1990 *Savannah River Site Environmental Report (U)*, WSRC-IM-91-28, Vol 1., Westinghouse Savannah River Company, Aiken, South Carolina, 1991.

1.0 INTRODUCTION

The objectives of this study were to review the existing safety analysis documentation for nuclear facilities at the Savannah River Site (SRS), determine if any nonseismic events could impact more than one of these facilities at a time, identify which facilities could be impacted simultaneously, and estimate the expected radiation doses and risks to members of the public that would result from such an impact.

1.1 BACKGROUND

The available existing safety analysis documentation for nuclear facilities at the SRS was reviewed. This existing documentation included approved or approval review cycle versions of safety analysis reports (SARs) and justifications for continued operations (JCOs). These documents, listed in Section 6 as References 1-40, record the analyses of the following nuclear facilities at the SRS:

300 M Area / 700 A Area

Bldg. 321-M, Fuel Fabrication Facility
Bldg. 773-A et al., SRTC Technical Area

200 E Area

Bldg. 643-G et al., Solid Waste Disposal Areas

200 F Area

Bldg. 241-F et al., F-Area Outside Facility Operations
Bldg. 772-F, Production Control Facility
Bldg. 772-1F, New Production Control Facility
Bldg. 221-F et al., F Canyon Operations
Bldg. 221-F, B-Line Plutonium Storage

Bldg. 221-F, A-Line Operations

Bldg. 221-F, FB-Line Operations

Bldg. 247-F, Plutonium Storage Facility

Bldg. 235-F, Plutonium Fuel Form Facility

Bldg. 235-F, Metallography Laboratory

Bldg. 235-F

Bldg. 235-F, Vaults

200 H Area

Bldg. 211-H et al., H-Area Outside Facility Operations

Bldg. 242-H et al., Liquid Radioactive Waste Handling Facilities

Bldg. 241-84H, F/H Effluent Treatment Facility

Bldg. 244-H, Receiving Basin for Off-Site Fuel

Bldg. 221-H et al., H Canyon Operations

Bldg. 221-H, Uranium Solidification Facility

Bldg. 221-H, B-Line Scrap Recovery

Bldg. 232-H, et al., Tritium Processing Facilities

Bldg. 233-H, Replacement Tritium Facility

100 K Area

Bldg. 105-K, K-Reactor

200 S Area

Bldg. 221-S et al., Defense Waste Processing Facility

200 Z Area

Bldg. 210-Z et al., Saltstone Facility

All Areas

Truck and Rail Transport of Hazardous Materials

From the review of the existing documentation, the nonseismic external events considered in these safety analyses were extreme straight-line winds, tornadoes, floods, other extreme weather events (lightning, hail, and extremes in temperature or precipitation), vehicle impact, accidents involving adjacent facilities, aircraft impact, and meteorite impact.

1.2 SCOPE

In essence, this study was envisioned as the "combination" of existing accident dose and risk calculations from safety analyses of individual facilities. However, because of the extended time period over which the safety analyses were prepared, calculational assumptions and methodologies differed between the analyses. The scope of this study therefore included the standardization of assumptions and calculations as necessary to insure that the analytical logic was consistent for all the facilities. The most important of these standardizations were (1) the general use of the dose conversion model from ICRP-30 for all facilities, (2) the general use of 1993 off-site population estimates, and (3) the general use of a standard set of values for the return frequencies of extreme wind and tornado events. Where other standardizations have been made for individual analyses, it is so noted in the text.

Dose and risk calculations were made for the off-site individual and off-site population group (usually limited to the population in a single 22.5° radial sector emanating from the release location) that could potentially receive the largest dose. Radioactive materials were the only hazard considered in the study. The calculated radiological dose reported is the committed effective dose equivalent (EDE), i.e., the expected 50-year dose to a person resulting from both transient exposure and radionuclide uptake in the body, taking into account the differing effects of various radiation sources on the body as well as the differing effects of radiation on various body organs.

1.3 FORMAT

Each of the nonseismic external events considered in the analyses are addressed in individual sections in this report. In Section 2, extreme straight-line winds are examined. Section 3 addresses tornadoes, and Section 4 addresses other external events [floods, other extreme weather events (lightning, hail, and extremes in temperature or precipitation), vehicle impact, accidents involving adjacent facilities, aircraft impact, and meteorite impact]. Section 5 provides a summary of the general conclusions of the report.

2.0 EXTREME STRAIGHT-LINE WIND EVENTS

For this study, interest is centered on extreme straight-line wind events of sufficient magnitude to cause destruction simultaneously at several nuclear facilities located in one or more operating areas of the SRS.

2.1 CHARACTERIZATION, TERMINOLOGY, AND MODELING

An extreme straight-line wind event is a body of air moving in an approximately straight path for a sustained time (of the order of minutes). Such an event is caused by a severe imbalance in atmospheric pressure. Usually such pressure anomalies are associated with large cyclonic storms. Typically, but not always, such storms form over the ocean and move inland over a continent. The term "extreme" is given to the event to indicate that it is not normally experienced by the general population and to indicate that extreme value distribution theory is used to estimate the likelihood of a site experiencing high wind speeds for which no recorded data exist.

From a probabilistic viewpoint, the DOE considers a straight-line wind event as being in this category if its expected frequency of occurrence is less than 1×10^{-1}/year.[41] This is equivalent to a wind event with a fastest-mile wind speed greater than about 60 mph at most DOE sites, a gale with a Beaufort scale rating of 10 or higher. From actual wind measurements above this lower threshold, a hazard curve can be extrapolated in which wind speeds increase as the expected frequency of such an event decreases. From a probabilistic viewpoint, the upper threshold of this category should be 1×10^{-6}/year, the value generally adopted in safety analysis for an event that is "not credible." However, experts in the study of this phenomena indicate that terrain at most DOE sites tends to prevent winds from physically achieving the extrapolated wind speeds that would correspond to this 1×10^{-6}/year value. Therefore, the upper threshold for an extreme straight-line wind event at a DOE site usually has a higher expected frequency.

2.1.1 Extreme Straight-Line Wind Event at the SRS

Historically, extreme straight-line winds have occurred at the SRS as events associated with thunderstorms or hurricanes. Between 1955 and 1993, the National Severe Storms Center has logged the equivalent of 18 extreme straight-line wind events in Barnwell County and 59 in Aiken County.[42] The highest wind speed in the SRS area, including gusts, has been in the 75-85 mph range. The DOE has adopted an extreme straight-line wind probability model for the SRS that is shown in Figure 2.1. Extreme straight-line winds are projected to occur within a range from 60 mph to 156 mph with expected frequencies of 1×10^{-1}/year to 2×10^{-5}/year, respectively. The straight-line wind curve in Figure 2.1 represents the mid-range of the expected 95% confidence level projection. (NOTE: This model was adopted in 1990. The SRS safety analyses that were documented prior to 1990 may show maximum wind speeds and associated return frequencies that differ from this model.) For standardization, risk calculations in this document use the return frequency value associated with a specific wind speed as given by this DOE model.

2.1.2 Fastest-Mile Wind Speed

The fastest-mile wind speed is an American National Standards Institute (ANSI) wind measurement concept that is used to distinguish steady air mass movement from gusts. The fastest-mile wind speed is the average speed of a body of air, measured at a height of 10 m, averaged over a distance of one mile. Theoretically a steady mass of air with a speed of 100 mph pushing against a flat vertical structure can exert a dynamic pressure of about 26 pounds per cubic foot, assuming all the kinetic energy of the air mass is transmitted to the structure with no losses. Likewise a steady mass of air with a speed of 150 mph pushing against a flat vertical structure can exert a dynamic pressure of about 58 pounds per cubic foot.

2.1.3 Radionuclide Release Models

Modeling a radionuclide release from several concurrently damaged facilities requires consideration of several facility-specific characteristics. These characteristics are discussed in the following paragraphs.

First, each of the facilities must have a similar failure threshold. That is, for each facility to incur damage from the same high-wind initiator, the force level at which each facility fails (with a resultant radionuclide release) must be below the force level of the extreme wind event. For extreme straight-line wind events at the SRS, it is convenient to use a failure threshold range of

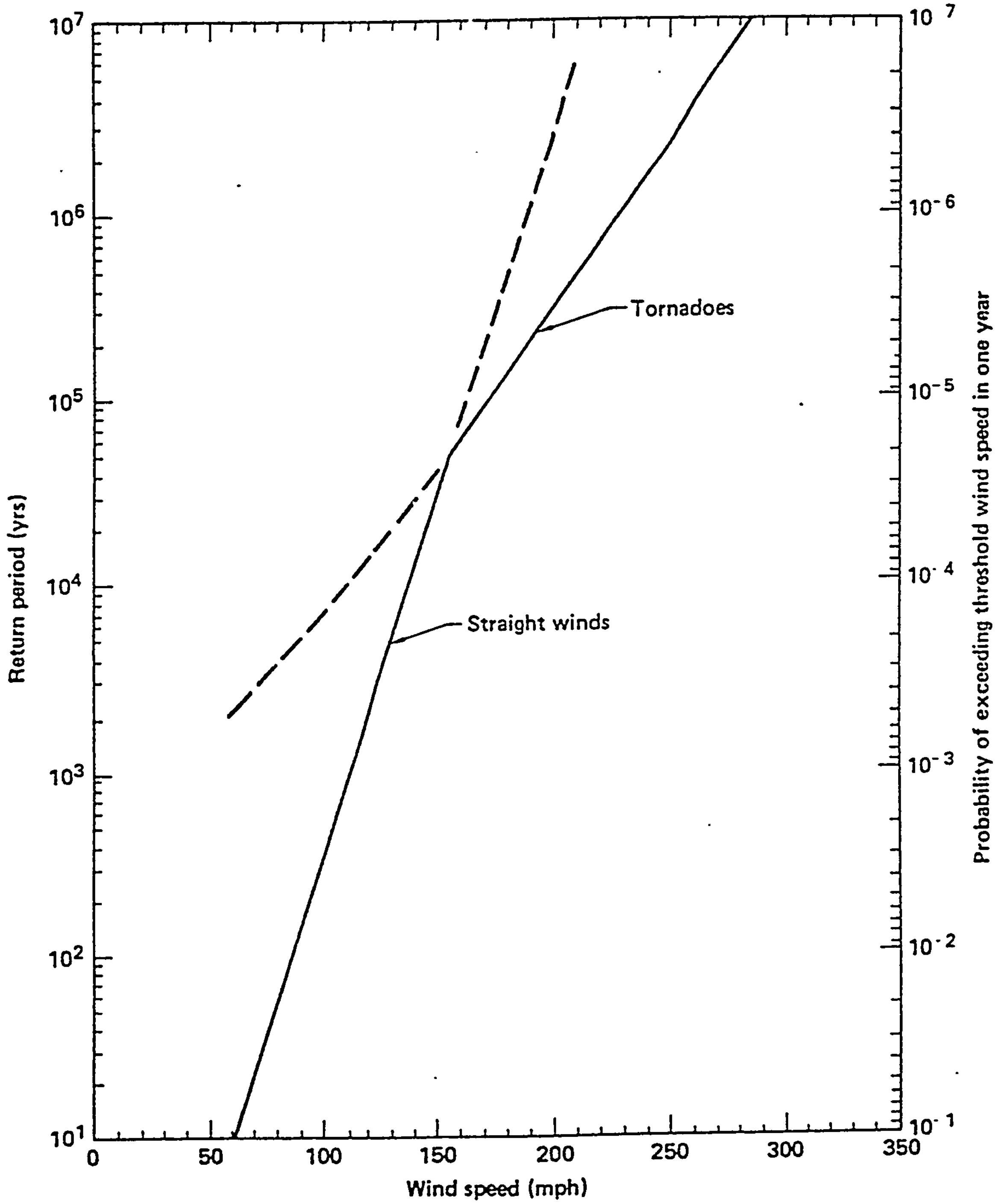

Figure 2.1. Wind hazard at the Savannah River Site, South Carolina.

(Source, Reference 41, p. 68)

fastest-mile wind speeds because (1) the rarity of these events and the difficulty of their measurement precludes the development of detailed force vector models, (2) the rarity of these events and the difficulty of their measurement precludes precise recurrence interval or frequency prediction (i.e., frequency prediction is more meaningful for a range of wind speeds rather than for a specific speed), and (3) the failure thresholds for the facilities under extreme straight-line wind loading were generally determined judgmentally rather than systematically.

The second consideration is that of delay time. That is, the time between structural failure of the facility and the beginning of a radionuclide release must be considered. This consideration may impact the type of dispersion model used and will impact how releases from different facilities will be combined.

The third consideration is the radioactivity spectrum and quantity of the material at risk in a specific facility. The radionuclide content of a facility may vary with time. This may result in modeling the release as a "worst-case" activity level, a more typical average activity level, or both.

The fourth consideration is the amount of material released. In one facility, the probability may be high that all the material at risk is released when the threshold force level is exceeded. A different facility may only release a potion of the material at that threshold force level, requiring a higher force level to release all of it.

Finally, the physical form of the material may impact how the radionuclides are dispersed. In one facility the radionuclide release may be entirely airborne. In another, liquid may be released to a local watershed. Thus, a concurrent release from several facilities may impact different geographic areas.

2.1.4 Radionuclide Dispersion Models

The radiological consequences of radionuclide releases resulting from an extreme straight-line wind event are evaluated for the off-site individual receiving the maximum dose and the off-site population within 50 miles (80 km) of the center of the SRS.

For each release resulting from facility damage, the associated radiological consequences resulting from airborne releases are analyzed by using either the AXAOTHER or the AXAIR89Q computer codes. The AXAOTHER code is used to calculate the consequences associated with incidents that occur during or immediately after the extreme straight-line wind event. The AXAIR89Q code is used to calculate the consequences resulting from the release of radioactive materials under "normal" atmospheric conditions following the high-wind event. Both codes estimate the dose resulting from the inhalation of radioactive materials as well as the dose from immersion in the dispersed airborne radioactive materials. Neither code considers doses delivered via food pathways.

It is important to note that the release points for facilities in F, E, H, S, Z, and M/A Areas are set at the center of the corresponding area, as shown in Figure 2.2. Although these are not the exact release points from the damaged facilities, the impact of assuming a single, central release point for each area on the dose calculations is insignificant for most cases because of the large distances to the site boundary.

The consequences of releasing radionuclide-bearing liquids to surface streams are estimated by using the LADTAP XL code. LADTAP XL models public exposures via ingestion of contaminated aquatic foods, ingestion of contaminated water, and contact with contaminated water through recreational activity.

The three computer codes are described in a bit more detail in the following sections.

2.1.4.1 AXAOTHER

The concentration of radionuclides in air downwind of the release location is calculated by AXAOTHER using a Gaussian plume model. The release of radioactivity is treated mathematically as a plume because the dispersion in the traveling direction is insignificant relative to transport time. The AXAOTHER code estimates doses utilizing X/Q values input by the user. The X/Q values are taken from the curves for straight-line winds of various speeds in Figure 16 of the *Environmental Dose Assessment Manual.*[43] The curves were developed from standard deviations of azimuth and elevation angles of the winds typical of those occurring during severe thunderstorms in the area. The initial "cloud" is assumed to be 10 meters above ground level after 0.5 minutes. A mixing height of 500 m is used because it represents an approximate climatological average.

Radiation doses from inhalation of airborne radionuclides depend on the quantity of radionuclides released; the dispersion factor (X/Q); the physical, chemical, and radiological nature of the radionuclides; and various biological parameters such as breathing rate. Standard breathing rates and ICRP-30 50-year inhalation dose conversion factors for adults are used in the AXAOTHER code for calculating the maximum dose to an off-site individual. Standard

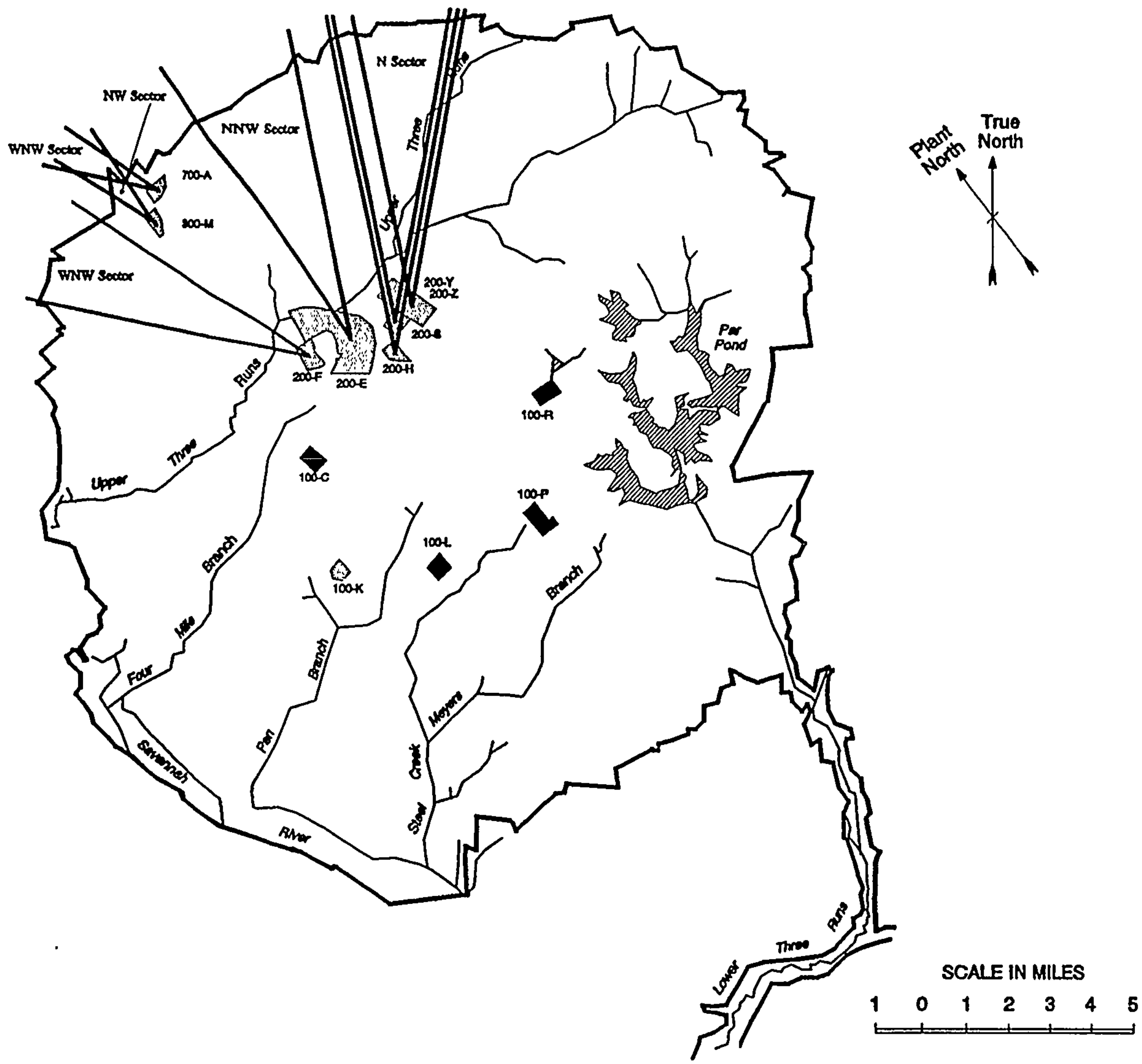

Figure 2.2. Representative release locations and maximally exposed individual sectors for SRS operating areas.

breathing rates for the mix of several age groups in the projected 1993 off-site population in a specific 22.5° sector are used for calculating the dose to the population within 50 miles of the release point. However, ICRP-30 50-year inhalation dose conversion factors for adults are used for all age groups in the off-site population.

Radiation doses from immersion result from radiation emanating from the dispersed airborne radioactive materials and are affected by the spatial distribution of the radionuclides, the energy of the radiation, and the extent of shielding. In the AXAOTHER code, no shielding was assumed for the off-site individual receiving the maximum dose, and 50% shielding was assumed for the off-site population. The immersion doses were calculated by using a uniform plume model because only ground-level dispersion factors associated with extreme straight-line winds are known.

2.1.4.2 AXAIR89Q

The AXAIR89Q code employs the atmospheric transport modeling methodology set forth in U.S. Nuclear Regulatory Commission (NRC) Regulatory Guide 1.145. A Gaussian plume model is used in conjunction with site-specific, direction-specific meteorological data to compute values of the dispersion factor (X/Q) for 16 compass directions at various downwind distances. Either worst-case (99.5%) or average (50%) meteorological conditions can be used in the calculations. (Worst-case conditions were used in the calculations performed for this study.) In addition, both ground-level releases and elevated (stack) releases can be modeled with AXAIR89Q. In the case of stack releases, plume rise is neglected, yielding conservative estimates of downwind concentrations.

Radiation doses from inhalation of radionuclides in air depend on the quantity of radionuclides released; the dispersion factor (X/Q); the physical, chemical, and radiological nature of the radionuclides; and various biological parameters such as breathing rate. Standard breathing rates and ICRP-30 50-year inhalation dose conversion factors for adults are used in the AXAIR89Q code for calculating the maximum dose to an off-site individual. Standard breathing rates for the mix of several age groups in the projected 1993 off-site population in a specific 22.5° sector are used for calculating the dose to the largest population group residing within 50 miles of the release point. However, ICRP-30 50-year inhalation dose conversion factors for adults are used for all age groups in the projected off-site population.

Radiation doses from immersion result from radiation emanating from the traveling plume and are affected by spatial distribution of the radionuclides, the energy of the radiation, and the extent of shielding. In the AXAIR89Q code, no shielding was assumed for the off-site individual receiving the maximum dose, and 50% shielding was assumed for the off-site population. The immersion doses are calculated by using a nonuniform Gaussian model because the nonuniform model employs more realistic assumptions than the conventional uniform semi-infinite plume model.

2.1.4.3 LADTAP XL

The environmental effects of radioactive materials released in liquid effluents are evaluated for the pathways of drinking water, aquatic foods consumption, and recreational uses of bodies of water. For a liquid release to the Savannah River, exposure through consumption of drinking water and aquatic foods is deemed the most significant. There are no available models that will characterize the uptake and retention of radionuclides by aquatic foods (fish, invertebrates, etc.) under transient conditions or over short-term periods as experienced during accidental releases. However, rather than omit the aquatic foods pathway, doses from consumption of aquatic foods are calculated for steady-state conditions, recognizing that such doses are conservative.

The method of calculating doses from liquid effluent pathways is that recommended in U.S. NRC Regulatory Guide 1.109. The LADTAP XL code, developed by the NRC and Oak Ridge National Laboratory (ORNL), performs dose calculations by using the dose models specified in Regulatory Guide 1.109. Although LADTAP XL was specifically developed for routine releases, its use for postulated accidental releases may be appropriate because it provides conservative estimates. The 50-year age-specific dose commitment factors specified in Regulatory Guide 1.109, with minor corrections by the original author, were used.

2.1.5 Information from Existing Safety Analyses

In general, a wind speed of 75 mph (fastest mile) was considered to be the lower threshold of extreme wind consideration in the existing safety analysis documentation, with a wind speed of 175 mph being considered the upper level of credibility for the geographic region of the

SRS. The extreme straight-line wind events considered are separated into three wind-speed ranges for purposes of this study. The ranges considered are 75 mph - 100 mph, 100 mph - 150 mph, and 150 mph - 175 mph.

2.1.5.1 Wind Events with a Fastest-Mile Speed Between 75 mph and 100 mph

For straight-line wind events with wind speeds between 75 mph and 100 mph, the analysis documentation identified only one facility which may have an extreme-wind-initiated release of radioactive materials (75 mph): the 200 H Area Consolidated Tritium Facility (Building 234-H only). Because only one facility was expected to have a release of radionuclides for events in this wind speed range, multiple facilities are not impacted, and further analysis for extreme straight-line wind events in this wind speed range is not necessary.

2.1.5.2 Wind Events with a Fastest-Mile Speed Between 100 mph and 150 mph

For straight-line wind events with wind speeds between 100 mph and 150 mph, the analysis documentation identified an additional eight facilities which may have an extreme-wind-initiated release of radioactive materials:

200 F Area

Bldg. 241-F et al., F-Area Outside Facility Operations (100 mph)
Bldg. 772-F, Production Control Facility (108 mph)
Bldg. 772-1F, New Production Control Facility (108 mph)

200 E Area

Bldg. 643-G et al., Solid Waste Disposal Areas (100 mph)

200 H Area

Bldg. 211-H et al., H-Area Outside Facility Operations (100 mph)

Bldg. 241-84H, F/H Effluent Treatment Facility (110 mph)

200 Z Area

Bldg. 210-Z et al., Saltstone Facility (110 mph)

300 M Area

Bldg. 321-M, Fuel Fabrication Facility (100 mph)

In addition, the analysis performed for the Consolidated Tritium Facility considers a larger source term for winds exceeding 100 mph.

2.1.5.3 Wind Events with a Fastest-Mile Speed Between 150 mph and 175 mph

For straight-line wind events with wind speeds between 150 mph and 175 mph, the analysis documentation identified an additional two facilities which may have an extreme-wind-initiated release of radioactive materials:

200 F Area

Bldg. 247-F, Plutonium Storage Facility (150 mph)

700 A Area

Bldg. 773-A et al., SRTC Technical Area (150 mph)

In addition, analyses performed for the Solid Waste Disposal Areas (except for the E-Area Vaults), the New Production Control Facility, the Consolidated Tritium Facility, and the Fuel Fabrication Facility consider larger source terms for winds exceeding 150 mph.

Consequently, integrated source terms from six site areas were evaluated for straight-line wind event initiators for this study. It should be noted that the safety documentation for transportation of hazardous materials by truck and rail at the SRS excluded consideration of extreme wind events because transport operations are not conducted during the weather conditions in which such events occur.

2.2 DOSES AND RISKS RESULTING FROM AN EXTREME STRAIGHT-LINE WIND EVENT WITH FASTEST-MILE WIND SPEEDS BETWEEN 100 MPH AND 150 MPH

The basic accident scenario to be analyzed in this study postulates that an extreme straight-line wind event with a fastest-mile speed between 100 and 150 mph occurs at the SRS. The existing safety analysis documentation predicts that nine SRS nuclear facilities will incur sufficient damage from this accident initiator to result in a release of radioactive material.

2.2.1 200 F Area

The site boundary location for the hypothetical off-site individual receiving the greatest airborne dose is 5.46 miles from the assumed release point (center of F-Area) in the west-northwest direction. The sector with the largest population subject to airborne exposure is the sector located to the west-northwest.

2.2.1.1 F-Area Outside Facility Operations

The nuclear facility denoted as F-Area Outside Facility Operations consists primarily of storage points for very low level radioactive process liquids. Solvent washing, evaporation, and acid recovery systems also exist in the outside facilities. For this scenario, it was assumed by the SRS safety analysis[1] that 25% of the liquid contents of the largest vessel in each of seven process loops would be released as the vessel wall was damaged by winds ranging from 100 to 150 mph. The analysis assumed that the liquid would be confined in diked areas in all but one of these liquid releases. Radionuclide dispersion was modeled in the analysis as an evaporation of 30% of the confined material into 50-mph winds. In the one process loop that has insufficient diked area capacity to contain the liquid release, about 16% of the total liquid release was assumed to eventually migrate to Upper Three Runs Creek. Consequently, for this study off-site doses are calculated by using the AXAOTHER code for airborne dispersion at 50 mph and the LADTAP XL code for the liquid dispersion via the creek. Table 2.1 displays the source term and the resulting calculated doses for an airborne release from this facility. The calculated maximally exposed off-site individual dose resulting from the airborne release is 0.002 mrem. The calculated maximum off-site population dose from the airborne release is 0.093 person-rem. Table 2.2 displays the source term and the resulting calculated doses for a liquid release from this facility. The calculated maximally exposed off-site individual dose resulting from the liquid release is 0.0028 mrem. The calculated maximum off-site population dose from the liquid release is 0.192 person rem.

2.2.1.2 Production Control Facility

It was concluded by the SRS safety analysis[3] that there would be no high-wind-initiated release of radioactive materials from the Production Control Facility per se because of its construction. However, the analysis assumed that the ventilation system stack external to the facility would collapse under this type of wind load, destroying the collocated ventilation system filter house. To create a conservative estimated source term, the analysis postulated that a laboratory accident had occurred within the facility just prior to the extreme straight-line wind event. The loss of the filter house to the wind event would allow 0.5% of the accident source term to migrate outside the facility to be dispersed by winds ranging from 100 to 150 mph. Consequently, for this study off-site doses are calculated by using the AXAOTHER code for plume dispersion at 150 mph. Table 2.3 displays the source term and the resulting calculated doses for an airborne release from this facility. The calculated maximally exposed off-site individual dose resulting from the airborne release is essentially zero. The calculated maximum off-site population dose from the airborne release is 0.0026 person-rem.

Table 2.1. Airborne radionuclide source terms and calculated off-site doses for the F-Area Outside Facilities resulting from an extreme straight-line wind event with wind speeds in the range 100 mph - 150 mph

Radionuclide	Airborne Source Term[a] (Ci)	50-Year EDE to Maximally Exposed Individual Off-Site from 1 Ci Release (mrem)	50-Year EDE to Maximally Exposed Individual Off-Site (mrem)	50-Year EDE to Off-Site Population from 1 Ci Release (person-rem)	50-Year EDE to Off-Site Population (person-rem)
Zr-95	4.32E-04	2.35E-04	1.02E-07	1.39E-02	6.00E-06
Nb-95	2.44E-04	5.88E-05	1.43E-08	3.43E-03	8.37E-07
Ru-103	2.03E-03	9.74E-05	1.98E-07	5.76E-03	1.17E-05
Ru-106	6.03E-03	5.36E-03	3.23E-05	3.20E-01	1.93E-03
Cs-134	3.60E-09	5.80E-04	2.09E-12	3.45E-02	1.24E-10
Cs-137	3.14E-08	3.90E-04	1.22E-11	2.32E-02	7.28E-10
Ce-141	2.71E-09	1.04E-04	2.82E-13	6.19E-03	1.68E-11
Ce-144	1.95E-07	4.26E-03	8.31E-10	2.54E-01	4.95E-08
U-234	3.27E-04	1.58E+00	5.17E-04	9.44E+01	3.09E-02
U-235	1.82E-04	1.46E+00	2.66E-04	8.71E+01	1.59E-02
U-236	1.82E-04	1.46E+00	2.66E-04	8.71E+01	1.59E-02
U-238	1.82E-04	1.46E+00	2.66E-04	8.71E+01	1.59E-02
Pu-238	1.96E-05	5.60E+00	1.10E-04	3.34E+02	6.55E-03
Pu-239	9.11E-06	6.21E+00	5.66E-05	3.70E+02	3.37E-03
Pu-240	6.24E-06	6.21E+00	3.88E-05	3.70E+02	2.31E-03
Pu-241	5.56E-05	1.22E-01	6.78E-06	7.26E+00	4.04E-04
TOTAL			1.56E-03		9.30E-02

[a]Source: Reference 1, p. B-2

Table 2.2. Liquid radionuclide source terms and calculated off-site doses for the F-Area Outside Facilities resulting from an extreme straight-line wind event with wind speeds in the range 100 mph - 150 mph

Radionuclide	Liquid Source Term[a] (Ci)	50-Year EDE to Maximally Exposed Individual Off-Site from 1 Ci Release (mrem)	50-Year EDE to Maximally Exposed Individual Off-Site (mrem)	50-Year EDE to Off-Site Population from 1 Ci Release (person-rem)	50-Year EDE to Off-Site Population (person-rem)
Zr-95	3.43E-02	3.4E-04	1.17E-05	1.2E-02	4.12E-04
Nb-95	1.17E-02	1.3E-01	1.52E-03	2.2E-01	2.57E-03
Ru-103	3.86E-01	2.7E-04	1.04E-04	3.3E-02	1.27E-02
Ru-106	5.68E-01	2.1E-03	1.19E-03	3.1E-01	1.76E-01
U-234	3.91E-12	2.1E-02	8.21E-14	5.8E-01	2.27E-12
U-235	5.62E-11	2.1E-02	1.18E-12	5.9E-01	3.32E-11
U-236	5.60E-11	2.0E-02	1.12E-12	5.5E-01	3.08E-11
U-238	5.60E-09	1.9E-02	1.06E-10	5.1E-01	2.86E-09
TOTAL			2.83E-03		1.92E-01

[a]Source: Reference 1, p. B-2

Table 2.3. Airborne radionuclide source terms and calculated off-site doses for the Production Control Facility (772-F) resulting from an extreme straight-line wind event with wind speeds in the range 100 mph - 150 mph

Radionuclide	Airborne Source Term[a] (Ci)	50-Year EDE to Maximally Exposed Individual Off-Site from 1 Ci Release (mrem)	50-Year EDE to Maximally Exposed Individual Off-Site (mrem)	50-Year EDE to Off-Site Population from 1 Ci Release (person-rem)	50-Year EDE to Off-Site Population (person-rem)
Sr-89	2.34E-08	1.69E-04	3.95E-12	8.57E-03	2.01E-11
Sr-90	2.23E-09	5.94E-03	1.32E-11	3.01E-01	6.71E-10
Y-90	2.23E-09	3.74E-05	8.34E-14	1.90E-03	4.24E-12
Y-91	3.58E-08	2.01E-04	7.20E-12	1.02E-02	3.65E-11
Zr-95	3.58E-07	8.82E-05	3.16E-11	4.45E-03	1.59E-09
Nb-95	2.38E-08	2.21E-05	5.26E-13	1.09E-03	2.59E-11
Ru-103	1.94E-08	3.65E-05	7.08E-13	1.84E-03	3.57E-11
Ru-106	1.97E-08	2.01E-03	3.96E-11	1.02E-01	2.01E-09
Ag-110m	2.27E-09	2.47E-04	5.61E-13	1.25E-02	2.84E-11
Sn-123	3.06E-10	1.37E-04	4.19E-14	6.95E-03	2.13E-12
Sb-125	3.86E-10	4.56E-05	1.76E-14	2.30E-03	8.88E-13
Te-127	5.83E-10	1.33E-06	7.75E-16	6.66E-05	3.88E-14
Te-129	3.65E-10	4.45E-07	1.62E-16	1.91E-05	6.97E-15
Cs-134	3.90E-10	2.18E-04	8.50E-14	1.10E-02	4.29E-12
Cs-137	2.99E-09	1.46E-04	4.37E-13	7.41E-03	2.22E-11
Ce-141	1.15E-08	3.90E-05	4.49E-13	1.97E-03	2.27E-11

Table 2.3. (continued)

Radionuclide	Airborne Source Term[a] (Ci)	50-Year EDE to Maximally Exposed Individual Off-Site from 1 Ci Release (mrem)	50-Year EDE to Maximally Exposed Individual Off-Site (mrem)	50-Year EDE to Off-Site Population from 1 Ci Release (person-rem)	50-Year EDE to Off-Site Population (person-rem)
Ce-144	5.38E-08	1.60E-03	8.61E-11	8.11E-02	4.06E-11
Pr-144	5.38E-08	2.38E-07	1.28E-14	7.82E-06	4.21E-13
Pm-147	9.64E-09	1.55E-04	1.49E-12	7.87E-03	7.59E-11
Pm-148m	1.23E-10	4.84E-05	5.95E-15	2.41E-03	2.96E-13
Eu-155	1.70E-10	1.78E-04	3.03E-14	9.04E-03	1.54E-12
U-234	4.45E-17	5.94E-01	2.64E-17	3.01E+01	1.34E-15
U-235	7.12E-16	5.48E-01	3.90E-16	2.78E+01	1.98E-14
U-236	7.12E-16	5.48E-01	3.90E-16	2.78E+01	1.98E-14
U-238	6.58E-14	5.48E-01	3.61E-14	2.78E+01	1.83E-12
Np-237	9.46E-16	2.24E+00	2.12E-15	1.13E+02	1.07E-13
Pu-239	2.20E-05	2.33E+00	5.13E-05	1.18E+02	2.60E-03
TOTAL			5.13E-05		2.60E-03

[a]Source: Reference 3, p. 5-44

2.2.1.3 New Production Control Facility

The SRS safety analysis[5] concluded that there could be a high-wind-initiated release of radioactive materials from the New Production Control Facility secondary confinement. To create a conservative estimated source term, the analysis postulated that all of the facility radionuclide inventory was located in the facility secondary confinement just prior to the extreme straight-line wind event. The damage to the secondary confinement by the wind event would allow 50% of the inventory to migrate outside the facility to be dispersed by winds ranging from 100 to 150 mph. Thus, off-site doses are calculated by using the AXAOTHER code for plume dispersion at 150 mph. Table 2.4 displays the source term and the resulting calculated doses for an airborne release from this facility. The calculated maximally exposed off-site individual dose resulting from the airborne release is 5.84 mrem. The calculated maximum off-site population dose from the airborne release is 296 person-rem.

2.2.2 200 E Area

The site boundary location for the hypothetical off-site individual receiving the greatest airborne dose is 6.46 miles from the release point in the north-northwest direction. The sector with the largest population subject to airborne exposure is the sector located to the west-northwest.

2.2.2.1 Solid Waste Disposal Operations

From the viewpoint of vulnerability to wind damage, the nuclear facility denoted as Solid Waste Disposal Operations consists primarily of storage points for radioactively contaminated solid materials. For this scenario, it was assumed by the SRS safety analysis[16,17] that fractions of the contaminated materials stored in the TRU pad drum storage area as well as those stored in the E-Area vaults [Intermediate-Level Tritium Vault (ILTV), Intermediate-Level Nontritium Vault (ILNTV), and Low-Activity Waste Vault (LAWV)] would be released following facility damage by winds ranging from 100 to 150 mph. Consequently, for this study off-site doses are

Table 2.4. Airborne radionuclide source terms and calculated off-site doses for the New Production Control Facility (772-1F) resulting from an extreme straight-line wind event with wind speeds in the range 100 mph - 150 mph

Radionuclide	Airborne Source Term[a] (Ci)	50-Year EDE to Maximally Exposed Individual Off-Site from 1 Ci Release (mrem)	50-Year EDE to Maximally Exposed Individual Off-Site (mrem)	50-Year EDE to Off-Site Population from 1 Ci Release (person-rem)	50-Year EDE to Off-Site Population (person-rem)
Sr-89	8.40E-01	1.69E-04	1.42E-04	8.57E-03	7.20E-04
Sr-90	8.00E-02	5.94E-03	4.75E-04	3.01E-01	2.41E-02
Y-90	8.00E-02	3.74E-05	2.99E-06	1.90E-03	1.52E-04
Y-91	1.26E+00	2.01E-04	2.53E-04	1.02E-02	1.29E-03
Zr-95	1.26E+00	8.82E-05	1.11E-04	4.45E-03	5.61E-03
Nb-95	3.40E-01	2.21E-05	7.51E-06	1.09E-03	3.71E-04
Ru-103	6.30E-01	3.65E-05	2.30E-05	1.84E-03	1.16E-03
Ru-106	6.30E-01	2.01E-03	1.27E-03	1.02E-01	6.43E-02
Rh-106	6.30E-01	1.91E-08	1.20E-08	2.84E-09	1.79E-09
Ag-110m	8.00E-03	2.47E-04	1.98E-06	1.25E-02	1.00E-04
Sn-123	1.05E-02	1.37E-04	1.44E-06	6.95E-03	7.30E-05
Sb-125	1.40E-02	4.56E-05	6.38E-07	2.30E-03	3.22E-05
Te-127	2.00E-02	1.33E-06	2.66E-08	6.66E-05	1.33E-06
Te-129	1.25E-02	4.45E-07	5.56E-09	1.91E-05	2.39E-07
Cs-134	1.40E-02	2.18E-04	3.05E-06	1.10E-02	1.54E-04
Cs-137	1.05E-01	1.46E-04	1.53E-05	7.41E-03	7.78E-04
Ce-141	3.99E-01	3.90E-05	1.56E-05	1.97E-03	7.86E-04

Table 2.4. (continued)

Radionuclide	Airborne Source Term[a] (Ci)	50-Year EDE to Maximally Exposed Individual Off-Site from 1 Ci Release (mrem)	50-Year EDE to Maximally Exposed Individual Off-Site (mrem)	50-Year EDE to Off-Site Population from 1 Ci Release (person-rem)	50-Year EDE to Off-Site Population (person-rem)
Ce-144	1.89E+00	1.60E-03	3.02E-03	8.11E-02	1.43E-03
Pr-144	1.89E+00	2.38E-07	4.50E-07	7.82E-06	1.48E-05
Pm-147	3.41E-01	1.55E-04	5.29E-05	7.87E-03	2.68E-03
Pm-148	3.94E-03	4.68E-05	1.84E-07	2.35E-03	9.26E-06
Eu-154	5.80E-03	1.19E-03	6.90E-06	6.03E-02	3.50E-04
Pu-238	8.60E-01	2.10E+00	1.81E+00	1.07E+02	9.20E+01
Pu-239	1.24E+00	2.33E+00	2.89E+00	1.18E+02	1.46E+02
Pu-241	2.50E+01	4.57E-02	1.14E+00	2.32E+00	5.80E+01
TOTAL			5.84E+00		2.96E+02

[a]Source: Reference 5, p. B-4

calculated by using the AXAOTHER code for plume dispersion at 150 mph. Tables 2.5 through 2.8 display the source terms and the resulting calculated doses for airborne releases from this facility. The calculated maximally exposed off-site individual dose resulting from the airborne release (combined releases from TRU pad and E-Area Vaults) is 0.28 mrem. The calculated maximum off-site population dose from the airborne release is 19.8 person-rem.

2.2.3 200 H Area

The site boundary location for the hypothetical off-site individual receiving the greatest airborne dose is 7.25 miles from the release point in the north direction. The sector with the largest population subject to airborne exposure is the sector located to the west-northwest.

2.2.3.1 H-Area Outside Facility Operations

The nuclear facility denoted as H-Area Outside Facility Operations consists primarily of storage points for very low level radioactive process liquids. Solvent washing, evaporation, and acid recovery systems also exist in the outside facilities. For this extreme straight-line wind scenario, it was assumed by the SRS safety analysis[22] that 100% of the liquid contents of the largest vessel in each of eight process loops would be released as the vessel wall was damaged by winds ranging from 100 to 150 mph. The analysis assumed that the liquid would be confined in diked areas in all but five of these liquid releases. The airborne radionuclide release was modeled in the analysis as an evaporation of 30% of the confined material into 50-mph winds. In the five process loops with insufficient dike capacity to contain the liquid releases, about 13 to 35% of the liquid release was assumed to eventually migrate to Upper Three Runs Creek. Consequently, off-site doses are calculated by using the AXAOTHER code for airborne dispersion at 50 mph and the LADTAP XL code for the liquid dispersion via the creek. Table 2.9 displays the source term and the resulting calculated doses for an evaporative release from this facility. The calculated maximally exposed off-site individual dose resulting from the airborne release is 0.006 mrem. The calculated maximum off-site population dose from the airborne release is 0.525 person-rem. Table 2.10 displays the source term and the resulting calculated doses for a liquid release from this facility. The calculated maximally exposed off-site individual dose resulting from the liquid release is 18.6 mrem. The calculated maximum off-site population dose from the liquid release is 67.9 person-rem.

Table 2.5. Airborne radionuclide source terms and calculated off-site doses for the TRU pad drum storage area resulting from an extreme straight-line wind event with wind speeds in the range 100 mph - 150 mph

Radionuclide	Airborne Source Term[a] (Ci)	50-Year EDE to Maximally Exposed Individual Off-Site from 1 Ci Release (mrem)	50-Year EDE to Maximally Exposed Individual Off-Site (mrem)	50-Year EDE to Off-Site Population from 1 Ci Release (person-rem)	50-Year EDE to Off-Site Population (person-rem)
Pu-238	2.10E-02	1.65E+00	3.47E-02	1.17E+02	2.46E+00
TOTAL			3.47E-02		2.46E+00

[a]Source: Reference 16, p. 5-47

Table 2.6. Airborne radionuclide source terms and calculated off-site doses for the ILTV resulting from an extreme straight-line wind event with wind speeds in the range 100 mph - 150 mph

Radionuclide	Airborne Source Term[a] (Ci)	50-Year EDE to Maximally Exposed Individual Off-Site from 1 Ci Release (mrem)	50-Year EDE to Maximally Exposed Individual Off-Site (mrem)	50-Year EDE to Off-Site Population from 1 Ci Release (person-rem)	50-Year EDE to Off-Site Population (person-rem)
H-3	2.72E+03	3.40E-07	9.25E-04	2.42E-05	6.58E-02
C-14	2.72E+01	8.58E-08	2.33E-06	6.12E-06	1.66E-04
Mn-54	2.72E-02	2.42E-05	2.27E-07	1.69E-03	4.60E-05
Fe-55	2.72E-01	9.30E-06	2.53E-06	6.63E-04	1.80E-04
Ni-59	2.72E-01	4.65E-06	1.26E-06	3.32E-04	9.03E-05
Co-60	2.16E+00	5.40E-04	1.17E-03	3.84E-02	8.29E-02
Ni-63	2.72E+00	1.07E-05	2.91E-05	7.65E-04	2.08E-03
Zn-65	2.72E-01	6.53E-05	1.78E-05	4.63E-03	1.26E-03
Se-75	2.72E-02	2.99E-05	8.13E-07	2.12E-03	5.77E-04
Se-79	2.72E-06	3.18E-05	8.65E-11	2.27E-03	6.17E-09
Rb-87	2.72E-06	1.18E-05	3.21E-11	8.41E-04	2.29E-09
Sr-90	2.99E+00	4.65E-03	1.39E-02	3.31E-01	9.90E-01
Y-90	2.72E+00	2.93E-05	7.97E-05	2.09E-03	5.68E-03
Nb-94	2.72E-02	1.48E-03	4.03E-05	1.06E-01	2.88E-03

Table 2.6. (continued)

Radionuclide	Airborne Source Term[a] (Ci)	50-Year EDE to Maximally Exposed Individual Off-Site from 1 Ci Release (mrem)	50-Year EDE to Maximally Exposed Individual Off-Site (mrem)	50-Year EDE to Off-Site Population from 1 Ci Release (person-rem)	50-Year EDE to Off-Site Population (person-rem)
Zr-95	2.72E-01	6.91E-05	1.88E-05	4.90E-03	1.33E-03
Tc-99	2.72E-02	2.68E-05	7.29E-07	1.91E-03	5.20E-05
Ru-106	2.72E-01	1.57E-03	4.27E-04	1.12E-01	3.05E-02
Rh-106	2.72E-01	8.58E-09	2.33E-09	3.17E-09	8.62E-10
Ag-110m	2.72E-02	1.94E-04	5.28E-06	1.37E-02	3.73E-04
Cd-115m	2.72E-02	2.33E-04	6.34E-06	1.66E-02	4.52E-04
Sb-125	2.72E-02	3.57E-05	9.71E-07	2.53E-03	6.88E-05
Te-125m	6.78E-03	2.40E-05	1.63E-07	1.71E-03	1.16E-05
Sb-126m	2.72E-06	1.00E-07	2.72E-13	7.14E-06	1.94E-11
Sn-126	2.72E-06	3.07E-04	8.35E-10	2.19E-02	5.96E-08
I-129	2.72E-04	6.44E-04	1.75E-07	4.59E-02	1.25E-05
Cs-134	2.72E-02	1.70E-04	4.62E-06	1.21E-02	3.29E-04
Cs-135	5.82E-06	1.61E-05	9.37E-11	1.15E-03	6.69E-09
Cs-137	2.72E-01	1.14E-04	3.10E-05	8.16E-03	2.22E-03
Ba-137m	2.72E-01	4.52E-07	1.23E-07	2.77E-06	7.53E-07

Table 2.6. (continued)

Radionuclide	Airborne Source Term[a] (Ci)	50-Year EDE to Maximally Exposed Individual Off-Site from 1 Ci Release (mrem)	50-Year EDE to Maximally Exposed Individual Off-Site (mrem)	50-Year EDE to Off-Site Population from 1 Ci Release (person-rem)	50-Year EDE to Off-Site Population (person-rem)
Ce-144	2.72E-01	1.25E-03	3.40E-04	8.92E-02	2.43E-02
Pr-144	2.72E-01	1.83E-07	4.98E-08	8.58E-06	2.33E-06
Pm-147	2.72E-01	1.22E-04	3.32E-05	8.67E-03	2.36E-03
Sm-151	2.72E-02	1.04E-04	2.83E-06	7.39E-03	2.01E-04
Eu-154	2.72E-02	9.32E-04	2.54E-05	6.64E-02	1.81E-03
Eu-155	2.72E-02	1.40E-04	3.81E-06	9.94E-03	2.70E-04
Th-231	2.72E-06	2.90E-06	7.89E-12	2.07E-04	5.63E-10
Th-232	2.72E-06	5.72E+00	1.56E-05	4.08E+02	1.11E-03
Pa-233	2.53E-06	3.07E-05	7.77E-11	2.19E-03	5.54E-09
U-233	8.40E-08	4.65E-01	3.91E-08	3.31E+01	2.78E-06
U-234	2.72E-03	4.65E-01	1.26E-03	3.31E+01	9.00E-02
U-235	3.96E-07	4.29E-01	1.70E-07	3.06E+01	1.21E-05
U-236	2.72E-03	4.29E-01	1.17E-03	3.06E+01	8.32E-02
Np-237	2.53E-06	1.75E+00	4.43E-06	1.25E+02	3.16E-04
U-238	2.72E-03	4.29E-01	1.17E-03	3.06E+01	8.32E-02

Table 2.6. (continued)

Radionuclide	Airborne Source Term[a] (Ci)	50-Year EDE to Maximally Exposed Individual Off-Site from 1 Ci Release (mrem)	50-Year EDE to Maximally Exposed Individual Off-Site (mrem)	50-Year EDE to Off-Site Population from 1 Ci Release (person-rem)	50-Year EDE to Off-Site Population (person-rem)
Pu-238	2.45E-04	1.65E+00	4.04E-04	1.17E+02	2.87E-02
Pu-239	5.81E-04	1.82E+00	1.06E-03	1.30E+02	7.55E-02
Pu-240	2.45E-04	1.82E+00	4.46E-04	1.30E+02	3.19E-02
Pu-241	2.45E-04	3.58E-02	8.77E-06	2.55E+00	6.25E-04
Am-241	2.45E-04	1.86E+00	4.56E-04	1.33E+02	3.26E-02
Pu-242	2.45E-04	1.72E+00	4.21E-04	1.22E+02	2.99E-02
Am-243	7.20E-05	1.86E+00	1.34E-04	1.33E+02	9.58E-03
Cm-244	2.45E-04	9.66E-01	2.37E-04	6.88E+01	1.69E-02
Cm-248	2.45E-04	6.79E+00	1.66E-03	4.85E+02	1.19E-01
Cf-252	2.45E-04	4.65E-01	1.14E-04	3.31E+01	8.11E-03
TOTAL			2.56E-02		1.82E+00

[a]Source: Reference 17, p. 88

Table 2.7. Airborne radionuclide source terms and calculated off-site doses for the ILNTV resulting from an extreme straight-line wind event with wind speeds in the range 100 mph - 150 mph

Radionuclide	Airborne Source Term[a] (Ci)	50-Year EDE to Maximally Exposed Individual Off-Site from 1 Ci Release (mrem)	50-Year EDE to Maximally Exposed Individual Off-Site (mrem)	50-Year EDE to Off-Site Population from 1 Ci Release (person-rem)	50-Year EDE to Off-Site Population (person-rem)
H-3	1.20E+01	3.40E-07	4.08E-06	2.42E-05	2.90E-04
C-14	2.18E+02	8.58E-08	1.87E-05	6.12E-06	1.33E-03
Mn-54	2.18E-01	2.42E-05	5.28E-06	1.69E-03	3.68E-04
Fe-55	2.18E+00	9.30E-06	2.03E-05	6.63E-04	1.45E-03
Ni-59	2.18E+00	4.65E-06	1.01E-05	3.32E-04	7.24E-04
Co-60	2.18E+00	5.40E-04	1.18E-03	3.84E-02	8.37E-02
Ni-63	2.18E+01	1.07E-05	2.33E-04	7.65E-04	1.67E-02
Zn-65	2.18E+00	6.53E-05	1.42E-04	4.63E-03	1.01E-02
Se-75	2.18E-01	2.99E-05	6.52E-06	2.12E-03	4.62E-04
Se-79	2.18E-05	3.18E-05	6.93E-10	2.27E-03	4.95E-08
Rb-87	2.18E-05	1.18E-05	2.57E-10	8.41E-04	1.83E-08
Sr-90	2.40E+01	4.65E-03	1.12E-01	3.31E-01	7.94E+00
Y-90	2.18E+01	2.93E-05	6.39E-04	2.09E-03	4.56E-02
Nb-94	2.18E-01	1.48E-03	3.23E-04	1.06E-01	2.31E-02

Table 2.7. (continued)

Radionuclide	Airborne Source Term[a] (Ci)	50-Year EDE to Maximally Exposed Individual Off-Site from 1 Ci Release (mrem)	50-Year EDE to Maximally Exposed Individual Off-Site (mrem)	50-Year EDE to Off-Site Population from 1 Ci Release (person-rem)	50-Year EDE to Off-Site Population (person-rem)
Zr-95	2.18E+00	6.91E-05	1.51E-04	4.90E-03	1.07E-02
Tc-99	2.18E-01	2.68E-05	5.84E-06	1.91E-03	4.16E-04
Ru-106	2.18E+00	1.57E-03	3.42E-03	1.12E-01	2.44E-01
Rh-106	2.18E+00	8.58E-09	1.87E-08	3.17E-09	6.91E-09
Ag-110m	2.18E-01	1.94E-04	4.23E-05	1.37E-02	2.99E-03
Cd-115m	2.18E-01	2.33E-04	5.08E-05	1.66E-02	3.62E-03
Sb-125	2.18E-01	3.57E-05	7.78E-06	2.53E-03	5.52E-04
Te-125m	5.44E-02	2.40E-05	1.31E-06	1.71E-03	9.30E-05
Sb-126m	2.18E-05	1.00E-07	2.18E-12	7.14E-06	1.56E-10
Sn-126	2.18E-05	3.07E-04	6.69E-09	2.19E-02	4.77E-07
I-129	2.18E-02	6.44E-04	1.40E-05	4.59E-02	1.00E-03
Cs-134	2.18E-01	1.70E-04	3.71E-05	1.21E-02	2.64E-03
Cs-135	4.08E-05	1.61E-05	6.57E-10	1.15E-03	4.69E-08
Cs-137	2.18E+01	1.14E-04	2.49E-03	8.16E-03	1.78E-01
Ba-137m	2.18E+01	4.52E-07	9.85E-06	2.77E-06	6.04E-05

Table 2.7. (continued)

Radionuclide	Airborne Source Term[a] (Ci)	50-Year EDE to Maximally Exposed Individual Off-Site from 1 Ci Release (mrem)	50-Year EDE to Maximally Exposed Individual Off-Site (mrem)	50-Year EDE to Off-Site Population from 1 Ci Release (person-rem)	50-Year EDE to Off-Site Population (person-rem)
Ce-144	2.18E+00	1.25E-03	2.73E-03	8.92E-02	1.94E-01
Pr-144	2.18E+00	1.83E-07	3.99E-07	8.58E-06	1.87E-05
Pm-147	2.18E+00	1.22E-04	2.66E-04	8.67E-03	1.89E-02
Sm-151	2.18E-01	1.04E-04	2.27E-05	7.39E-03	1.61E-03
Eu-154	2.18E-01	9.32E-04	2.03E-04	6.64E-02	1.45E-02
Eu-155	2.18E-01	1.40E-04	3.05E-05	9.94E-03	2.17E-03
Th-231	2.18E-05	2.90E-06	6.32E-11	2.07E-04	4.51E-09
Th-232	2.18E-05	5.72E+00	1.25E-04	4.08E+02	8.89E-03
Pa-233	1.01E-05	3.07E-05	3.10E-10	2.19E-03	2.21E-08
U-233	5.76E-07	4.65E-01	2.68E-07	3.31E+01	1.91E-05
U-234	2.18E-02	4.65E-01	1.01E-02	3.31E+01	7.22E-01
U-235	3.96E-07	4.29E-01	1.70E-07	3.06E+01	1.21E-05
U-236	2.18E-02	4.29E-01	9.35E-03	3.06E+01	6.67E-01
Np-237	1.01E-05	1.75E+00	1.77E-05	1.25E+02	1.26E-03
U-238	2.18E-02	4.29E-01	9.35E-03	3.06E+01	6.67E-01

Table 2.7. (continued)

Radionuclide	Airborne Source Term[a] (Ci)	50-Year EDE to Maximally Exposed Individual Off-Site from 1 Ci Release (mrem)	50-Year EDE to Maximally Exposed Individual Off-Site (mrem)	50-Year EDE to Off-Site Population from 1 Ci Release (person-rem)	50-Year EDE to Off-Site Population (person-rem)
Pu-238	1.97E-03	1.65E+00	3.25E-03	1.17E+02	2.30E-01
Pu-239	3.76E-03	1.82E+00	6.84E-03	1.30E+02	4.89E-01
Pu-240	1.97E-03	1.82E+00	3.59E-03	1.30E+02	2.56E-01
Pu-241	1.96E-03	3.58E-02	7.02E-05	2.55E+00	5.00E-03
Am-241	1.97E-03	1.86E+00	3.66E-03	1.33E+02	2.62E-01
Pu-242	1.97E-03	1.72E+00	3.39E-03	1.22E+02	2.40E-01
Am-243	2.88E-04	1.86E+00	5.36E-04	1.33E+02	3.83E-02
Cm-244	1.96E-03	9.66E-01	1.89E-03	6.88E+01	1.35E-01
Cm-248	1.97E-03	6.79E+00	1.34E-02	4.85E+02	9.55E-01
Cf-252	1.96E-03	4.65E-01	9.11E-04	3.31E+01	6.49E-02
TOTAL			1.90E-01		1.35E+01

[a]Source: Reference 17, p. 85

Table 2.8. Airborne radionuclide source terms and calculated off-site doses for the LAWV resulting from an extreme straight-line wind event with wind speeds in the range 100 mph - 150 mph

Radionuclide	Airborne Source Term[a] (Ci)	50-Year EDE to Maximally Exposed Individual Off-Site from 1 Ci Release (mrem)	50-Year EDE to Maximally Exposed Individual Off-Site (mrem)	50-Year EDE to Off-Site Population from 1 Ci Release (person-rem)	50-Year EDE to Off-Site Population (person-rem)
H-3	1.20E+01	3.40E-07	4.08E-06	2.42E-05	2.90E-04
C-14	2.72E+01	8.58E-08	2.33E-06	6.12E-06	1.66E-04
Mn-54	2.72E-03	2.42E-05	6.58E-08	1.69E-03	4.60E-06
Fe-55	2.72E-02	9.30E-06	2.53E-07	6.63E-04	1.80E-05
Ni-59	2.72E-02	4.65E-06	1.26E-07	3.32E-04	9.03E-06
Co-60	2.72E-02	5.40E-04	1.47E-05	3.84E-02	1.04E-03
Ni-63	2.72E-01	1.07E-05	2.91E-06	7.65E-04	2.08E-04
Zn-65	2.72E-02	6.53E-05	1.78E-06	4.63E-03	1.26E-04
Se-75	2.72E-03	2.99E-05	8.13E-08	2.12E-03	5.77E-06
Se-79	2.72E-06	3.18E-05	8.65E-11	2.27E-03	6.17E-09
Rb-87	2.72E-06	1.18E-05	3.21E-11	8.41E-04	2.29E-09
Sr-90	4.66E+00	4.65E-03	2.17E-02	3.31E-01	1.54E+00
Y-90	4.63E+00	2.93E-05	1.36E-04	2.09E-03	9.68E-03

Table 2.8. (continued)

Radionuclide	Airborne Source Term[a] (Ci)	50-Year EDE to Maximally Exposed Individual Off-Site from 1 Ci Release (mrem)	50-Year EDE to Maximally Exposed Individual Off-Site (mrem)	50-Year EDE to Off-Site Population from 1 Ci Release (person-rem)	50-Year EDE to Off-Site Population (person-rem)
Nb-94	2.72E-03	1.48E-03	4.03E-06	1.06E-01	2.88E-04
Zr-95	2.72E-02	6.91E-05	1.88E-06	4.90E-03	1.33E-04
Tc-99	2.72E-02	2.68E-05	7.29E-07	1.91E-03	5.20E-05
Ru-106	2.72E-02	1.57E-03	4.27E-05	1.12E-01	3.05E-03
Rh-106	2.72E-02	8.58E-09	2.33E-10	3.17E-09	8.62E-11
Ag-110m	2.72E-03	1.94E-04	5.28E-07	1.37E-02	3.73E-05
Cd-115m	2.72E-03	2.33E-04	6.34E-07	1.66E-02	4.52E-05
Sb-125	2.72E-03	3.57E-05	9.71E-08	2.53E-03	6.88E-06
Te-125m	6.80E-04	2.40E-05	1.63E-08	1.71E-03	1.16E-06
Sb-126m	2.72E-06	1.00E-07	2.72E-13	7.14E-06	1.94E-11
Sn-126	2.72E-06	3.07E-04	8.35E-10	2.19E-02	5.96E-08
I-129	2.72E-03	6.44E-04	1.75E-06	4.59E-02	1.25E-04
Cs-134	2.72E-03	1.70E-04	4.62E-07	1.21E-02	3.29E-05
Cs-135	5.71E-06	1.61E-05	9.19E-11	1.15E-03	6.57E-09
Cs-137	2.72E-01	1.14E-04	3.10E-05	8.16E-03	2.22E-03

Table 2.8. (continued)

Radionuclide	Airborne Source Term[a] (Ci)	50-Year EDE to Maximally Exposed Individual Off-Site from 1 Ci Release (mrem)	50-Year EDE to Maximally Exposed Individual Off-Site (mrem)	50-Year EDE to Off-Site Population from 1 Ci Release (person-rem)	50-Year EDE to Off-Site Population (person-rem)
Ba-137m	2.72E-01	4.52E-07	1.23E-07	2.77E-06	7.53E-07
Ce-144	2.72E-02	1.25E-03	3.40E-05	8.92E-02	2.43E-03
Pr-144	2.72E-02	1.83E-07	4.98E-09	8.58E-06	2.33E-07
Pm-147	2.72E-02	1.22E-04	3.32E-06	8.67E-03	2.36E-04
Sm-151	2.72E-03	1.04E-04	2.83E-07	7.39E-03	2.01E-05
Eu-154	2.72E-03	9.32E-04	2.54E-06	6.64E-02	1.81E-04
Eu-155	2.72E-03	1.40E-04	3.81E-07	9.94E-03	2.70E-05
Th-231	2.72E-06	2.90E-06	7.89E-12	2.07E-04	5.63E-10
Th-232	2.72E-06	5.72E+00	1.56E-05	4.08E+02	1.11E-03
Pa-233	5.07E-07	3.07E-05	1.56E-11	2.19E-03	1.11E-09
U-233	2.62E-08	4.65E-01	1.22E-08	3.31E+01	8.67E-07
U-234	2.72E-04	4.65E-01	1.26E-04	3.31E+01	9.00E-03
U-235	3.96E-07	4.29E-01	1.70E-07	3.06E+01	1.21E-05
U-236	2.72E-03	4.29E-01	1.17E-03	3.06E+01	8.32E-02
Np-237	5.08E-07	1.75E+00	8.89E-07	1.25E+02	6.35E-05

Table 2.8. (continued)

Radionuclide	Airborne Source Term[a] (Ci)	50-Year EDE to Maximally Exposed Individual Off-Site from 1 Ci Release (mrem)	50-Year EDE to Maximally Exposed Individual Off-Site (mrem)	50-Year EDE to Off-Site Population from 1 Ci Release (person-rem)	50-Year EDE to Off-Site Population (person-rem)
U-238	2.72E-03	4.29E-01	1.17E-03	3.06E+01	8.32E-02
Pu-238	2.54E-04	1.65E+00	4.19E-04	1.17E+02	2.97E-02
Pu-239	4.04E-04	1.82E+00	7.35E-04	1.30E+02	5.25E-02
Pu-240	2.45E-04	1.82E+00	4.46E-04	1.30E+02	3.19E-02
Pu-241	2.45E-04	3.58E-02	8.77E-06	2.55E+00	6.25E-04
Am-241	2.45E-04	1.86E+00	4.56E-04	1.33E+02	3.26E-02
Pu-242	2.45E-04	1.72E+00	4.21E-04	1.22E+02	2.99E-02
Am-243	1.44E-05	1.86E+00	2.68E-05	1.33E+02	1.92E-03
Cm-244	2.45E-06	9.66E-01	2.37E-06	6.88E+01	1.69E-04
Cm-248	2.45E-04	6.79E+00	1.66E-03	4.85E+02	1.19E-01
Cf-252	2.72E-06	4.65E-01	1.26E-06	3.31E+01	9.00E-05
TOTAL			2.86E-02		2.04E+00

[a]Source: Reference 17, p. 83

Table 2.9. Airborne radionuclide source terms and calculated off-site doses for the H-Area Outside Facilities resulting from an extreme straight-line wind event with wind speeds in the range 100 mph - 150 mph

Radionuclide	Airborne Source Term[a] (Ci)	50-Year EDE to Maximally Exposed Individual Off-Site from 1 Ci Release (mrem)	50-Year EDE to Maximally Exposed Individual Off-Site (mrem)	50-Year EDE to Off-Site Population from 1 Ci Release (person-rem)	50-Year EDE to Off-Site Population (person-rem)
Nb-95	2.82E-02	5.15E-05	1.45E-06	4.14E-03	1.17E-04
Zr-95	9.99E-02	2.06E-04	2.06E-05	1.69E-02	1.69E-03
Ru-103	1.30E-01	8.52E-05	1.11E-05	6.96E-03	9.05E-04
Ru-106	7.97E-01	4.69E-03	3.74E-03	3.86E-01	3.08E-01
Cs-137	2.90E-06	3.41E-04	9.89E-10	2.81E-02	8.15E-08
Pa-233	2.68E-03	1.02E-04	2.73E-07	1.11E-02	2.97E-05
U-233	1.52E-05	1.44E+00	2.19E-05	1.57E+02	2.39E-03
U-234	1.52E-03	1.39E+00	2.11E-03	1.14E+02	1.73E-01
U-235	1.52E-05	1.28E+00	1.95E-05	1.05E+02	1.60E-03
U-236	3.51E-04	1.28E+00	4.49E-04	1.05E+02	3.69E-02
U-238	9.75E-07	1.28E+00	1.25E-06	1.05E+02	1.02E-04
TOTAL			6.38E-03		5.25E-01

[a]Source: Reference 22, p. B-3

Table 2.10. Liquid radionuclide source terms and calculated off-site doses for the H-Area Outside Facilities resulting from an extreme straight-line wind event with wind speeds in the range 100 mph - 150 mph

Radionuclide	Liquid Source Term[a] (Ci)	50-Year EDE to Maximally Exposed Individual Off-Site from 1 Ci Release (mrem)	50-Year EDE to Maximally Exposed Individual Off-Site (mrem)	50-Year EDE to Off-Site Population from 1 Ci Release (person-rem)	50-Year EDE to Off-Site Population (person-rem)
Nb-95	1.36E+02	1.3E-01	1.77E+01	2.22E-01	3.02E+01
Zr-95	4.98E+02	3.4E-04	1.69E-01	1.24E-02	6.18E+00
Ru-103	6.62E+00	2.7E-04	1.79E-03	3.32E-02	2.20E-01
Ru-106	3.88E+01	2.1E-03	8.15E-02	3.07E-01	1.19E+01
Cs-137	7.00E-03	3.1E-01	2.17E-03	8.08E-01	5.66E-03
U-234	2.73E+01	2.1E-02	5.73E-01	5.75E-01	1.57E+01
U-235	2.73E-01	2.1E-02	5.73E-03	5.94E-01	1.62E-01
U-236	6.30E+00	2.0E-02	1.26E-01	5.54E-01	3.49E+00
U-238	1.75E-02	1.9E-02	3.33E-04	5.11E-01	8.94E-03
TOTAL			1.86E+01		6.79E+01

[a]Source: Reference 22, p. B-3

2.2.3.2 F/H Effluent Treatment Facility

From the viewpoint of vulnerability to wind damage, the nuclear facility denoted as the F/H Effluent Treatment Facility consists primarily of storage points for radioactive process liquids. For this scenario, it was assumed by the SRS safety analysis[23] that 50% of the liquid contents of the facility would be released as the equipment and piping were damaged by winds ranging from 100 to 150 mph. The analysis assumed that none of the liquid would be confined in diked areas. The radionuclide release was modeled in the analysis as an evaporation of 50% of the spilled liquid into 50-mph winds. In addition, 50% of the liquid release was assumed to eventually migrate to Upper Three Runs Creek. Therefore, off-site doses are calculated by using the AXAOTHER code for airborne dispersion at 50 mph and the LADTAP XL code for the dispersion via the creek. Table 2.11 displays the source term and the resulting calculated doses for an evaporative release from this facility. The calculated maximally exposed off-site individual dose resulting from the airborne release is essentially zero. The calculated maximum off-site population dose from the airborne release is 0.012 person-rem. Table 2.12 displays the source term and the resulting calculated doses for a liquid release form this facility to surface water. The calculated maximally exposed off-site individual dose resulting from the liquid release is 0.042 mrem. The calculated maximum off-site population dose from the liquid release is 0.301 person-rem.

2.2.3.3 Consolidated Tritium Facility

From the viewpoint of vulnerability to wind damage, the Consolidated Tritium Facility (Building 234-H only in this case) consists primarily of storage points for tritium gas. For this scenario, it was assumed by the SRS safety analysis[25] that 5% of the tritium inventory stored in the equipment and piping would be released in the event of facility damage by winds with fastest-mile speeds in the range 100 mph - 150 mph. In the safety analysis, 1% of the released tritium was assumed to be in oxide form. Therefore, off-site doses are calculated with the AXAOTHER code for plume dispersion at 150 mph. Table 2.13 shows the source term and resulting calculated doses for an airborne release from this facility. The calculated maximally exposed individual dose resulting from the airborne release is 0.012 mrem. The calculated maximum off-site population dose from the airborne release is about 1.0 person-rem.

Table 2.11. Airborne radionuclide source terms and calculated off-site doses for the F/H Effluent Treatment Facility resulting from an extreme straight-line wind event with wind speeds in the range 100 mph - 150 mph

Radionuclide	Airborne Source Term[a] (Ci)	50-Year EDE to Maximally Exposed Individual Off-Site from 1 Ci Release (mrem)	50-Year EDE to Maximally Exposed Individual Off-Site (mrem)	50-Year EDE to Off-Site Population from 1 Ci Release (person-rem)	50-Year EDE to Off-Site Population (person-rem)
H-3	1.30E+02	1.01E-06	1.31E-04	8.33E-05	1.08E-02
Sr-90	1.10E-06	1.39E-02	1.53E-08	1.14E+00	1.25E-06
Ru-106	2.13E-03	4.69E-03	9.99E-06	3.86E-01	8.22E-04
Cs-134	1.44E-06	5.08E-04	7.32E-10	4.16E-02	5.99E-08
Cs-137	1.03E-05	3.41E-04	3.51E-09	2.81E-02	2.89E-07
Ce-144	2.82E-06	3.73E-03	1.05E-08	3.07E-01	8.66E-07
Pu-239	5.56E-07	5.43E+00	3.02E-06	4.47E+02	2.49E-04
TOTAL			1.44E-04		1.19E-02

[a]Source: Reference 23, p. A-2

Table 2.12. Liquid radionuclide source terms and calculated off-site doses for the F/H Effluent Treatment Facility resulting from an extreme straight-line wind event with wind speeds in the range 100 mph - 150 mph

Radionuclide	Liquid Source Term[a] (Ci)	50-Year EDE to Maximally Exposed Individual Off-Site from 1 Ci Release (mrem)	50-Year EDE to Maximally Exposed Individual Off-Site (mrem)	50-Year EDE to Off-Site Population from 1 Ci Release (person-rem)	50-Year EDE to Off-Site Population (person-rem)
H-3	1.30E+02	5.0E-06	6.50E-04	1.31E-04	1.70E-02
Sr-90	1.10E-02	1.8E-02	1.98E-04	3.19E-01	3.51E-03
Ru-106	2.13E-01	2.1E-03	4.47E-04	3.07E-01	6.54E-02
Cs-134	1.44E-02	4.6E-01	6.62E-03	1.08E+00	1.56E-02
Cs-137	1.03E-01	3.1E-01	3.19E-02	8.08E-01	8.32E-02
Ce-144	2.82E-02	1.6E-03	4.51E-05	1.91E-01	5.39E-03
Pu-239	5.56E-03	3.7E-01	2.06E-03	2.00E+01	1.11E-01
TOTAL			4.20E-02		3.01E-01

[a]Source: Reference 23, p. A-2

Table 2.13. **Airborne radionuclide source terms and calculated off-site doses for the Consolidated Tritium Facility (234-H) resulting from an extreme straight-line wind event with wind speeds in the range 100 mph - 150 mph**

Radionuclide	Airborne Source Term[a] (Ci)	50-Year EDE to Maximally Exposed Individual Off-Site from 1 Ci Release (mrem)	50-Year EDE to Maximally Exposed Individual Off-Site (mrem)	50-Year EDE to Off-Site Population from 1 Ci Release (person-rem)	50-Year EDE to Off-Site Population (person-rem)
H-3	3.90E+06	3.08E-09[b]	1.20E-02	2.67E-07[b]	1.04E+00
TOTAL			1.20E-02		1.04E+00

[a]Source: Reference 25, p. 3-24

[b]This value was derived by correcting the AXAOTHER result to account for the assumed oxide fraction (1%).

2.2.4 200 Z Area

The site boundary location for the hypothetical off-site individual receiving the greatest airborne dose is 5.79 miles from the release point in the north direction. The sector with the largest population subject to airborne exposure is the sector located to the west-northwest.

2.2.4.1 Saltstone Facility

From the viewpoint of vulnerability to wind damage, the nuclear facility denoted as the Saltstone Facility consists primarily of storage for radioactive salt solution. For this scenario, it was assumed by the SRS safety analysis[26] that 100% of the liquid contents of the process equipment would be released as the equipment was damaged by winds ranging from 100 to 150 mph. The radionuclide release was modeled in the analysis as an evaporation of 100% the spilled liquid into 50-mph winds. Off-site doses are calculated for this study with the AXAOTHER code for dispersion at 50 mph. Table 2.14 displays the source term and the resulting calculated doses for an evaporative release from this facility. The calculated maximally exposed off-site individual dose resulting from the airborne release is essentially zero. The calculated maximum off-site population dose from the airborne release is also essentially zero.

2.2.5 300 M Area

The site boundary location for M-Area for the hypothetical off-site individual receiving the greatest airborne dose is 0.75 miles from the release point in the northwest direction. The population sector with the largest population subject to airborne exposure is the sector located to the west-northwest.

2.2.5.1 Fuel Fabrication Facility

For this scenario, it was concluded by the SRS safety analysis[28] that there would be no release of particulate radioactive materials from the Fuel Fabrication Facility per se because of its construction. However, the analysis assumed that the ventilation system filter house external to

Table 2.14. Airborne radionuclide source terms and calculated off-site doses for the Saltstone Facility resulting from an extreme straight-line wind event with wind speeds in the range 100 mph - 150 mph

Radionuclide	Airborne Source Term[a] (Ci)	50-Year EDE to Maximally Exposed Individual Off-Site from 1 Ci Release (mrem)	50-Year EDE to Maximally Exposed Individual Off-Site (mrem)	50-Year EDE to Off-Site Population from 1 Ci Release (person-rem)	50-Year EDE to Off-Site Population (person-rem)
H-3	1.48E-03	1.08E-06	1.60E-09	9.08E-05	1.34E-07
Ru-106	5.51E-05	5.02E-03	2.77E-07	4.21E-01	2.32E-05
I-129	2.90E-05	2.05E-03	5.95E-08	1.72E-01	4.99E-06
Cs-137	2.90E-07	3.65E-04	1.06E-10	3.06E-02	8.87E-09
Pu-238	7.54E-10	5.25E+00	3.96E-09	4.40E+02	3.32E-07
TOTAL			3.42E-07		2.87E-05

[a]Source: Reference 26, pp. 3-13 - 3-14

the facility would be damaged, releasing some of the radionuclides accumulated in the ventilation system filters. In addition, a nuclear criticality event involving 5 x 10^{17} fissions was assumed to occur with a conditional probability of 0.01. Off-site doses are calculated with the AXAOTHER code for dispersion of 613 g of uranium at 150 mph. Radionuclide dispersion following a nuclear criticality is modeled as a release under assumed worst-case (99.5%) meteorological conditions. Therefore, the AXAIR89Q code is used to calculate the associated off-site doses. Table 2.15 displays the source terms and the resulting calculated doses for releases from this facility. The calculated maximally exposed off-site individual dose resulting from the direct release is 0.14 mrem. The dose to the off-site individual from a nuclear criticality is 17.4 mrem. The corresponding maximum off-site population doses are 3.9 person-rem and 10.8 person-rem, respectively.

2.2.6 Integrated Site Effects

Additional clarification and description is required to give meaning to the calculated integrated off-site dose values for an extreme straight-line wind event that damages nine separate facilities in four separate operations areas. In such a scenario, after a warning period of at least a day,[44] a violent windstorm many miles in diameter would appear over the SRS, cause severe damage, including damage to the nine nuclear facilities that can release radioactive materials at these force levels, and then dissipate. Obviously, many of the nonnuclear structures both at the site and in the surrounding off-site areas would be damaged. As shown in the previous sections, the SRS safety analyses predict that five of the nuclear facilities at SRS would immediately release radioactive material into the wind field and that four others would spill liquid radioactive materials that would evaporate during the next day. Table 2.16 tabulates the expected dose and risk by facility for airborne radionuclide releases resulting from an extreme straight-line wind event with wind speeds in the range 100 mph - 150 mph. Results are presented both for the maximally exposed off-site individual and for the off-site population (worst-sector results). Similarly, Table 2.17 tabulates the expected dose and risk by facility for liquid releases resulting from this magnitude of high-wind event.

Table 2.15. Airborne radionuclide source terms and calculated off-site doses for the Fuel Fabrication Facility (321-M) resulting from an extreme straight-line wind event with wind speeds in the range 100 mph - 150 mph

Radionuclide	Airborne Source Term[a] (Ci)	50-Year EDE to Maximally Exposed Individual Off-Site from 1 Ci Release (mrem)	50-Year EDE to Maximally Exposed Individual Off-Site (mrem)	50-Year EDE to Off-Site Population from 1 Ci Release (person-rem)	50-Year EDE to Off-Site Population (person-rem)
Direct Release					
U-232	5.39E-04	7.39E+00	3.98E-03	2.10E+02	1.13E-01
U-233	5.90E-05	1.43E+00	8.44E-05	4.08E+01	2.41E-03
U-234	7.60E-02	1.43E+00	1.09E-01	4.08E+01	3.10E+00
U-235	5.30E-04	1.32E+00	7.00E-04	3.77E+01	2.00E-02
U-236	1.67E-02	1.32E+00	2.20E-02	3.77E+01	6.30E-01
U-238	3.30E-05	1.32E+00	4.36E-05	3.77E+01	1.24E-03
TOTAL			1.36E-01		3.87E+00
Nuclear Criticality					
Kr-83m	8.00E+00	1.99E-07	1.59E-06	8.63E-09	6.90E-08
Kr-85	8.00E-05	2.02E-05	1.62E-09	1.62E-05	1.30E-09
Kr-85m	7.50E+00	1.48E-03	1.11E-02	3.86E-04	2.90E-03
Kr-87	4.95E+01	5.50E-03	2.72E-01	2.27E-04	1.12E-02
Kr-88	3.25E+01	1.45E-02	4.71E-01	2.40E-03	7.80E-02

Table 2.15. (continued)

Radionuclide	Airborne Source Term[a] (Ci)	50-Year EDE to Maximally Exposed Individual Off-Site from 1 Ci Release (mrem)	50-Year EDE to Maximally Exposed Individual Off-Site (mrem)	50-Year EDE to Off-Site Population from 1 Ci Release (person-rem)	50-Year EDE to Off-Site Population (person-rem)
Kr-89	2.10E+03	8.82E-04	1.85E+00	1.33E-07	2.79E-04
I-131	1.09E-01	6.58E-01	7.17E-02	7.00E-01	7.63E-02
I-132	1.38E+01	2.45E-02	3.38E-01	3.15E-03	4.35E-02
I-133	2.00E+00	1.63E-02	3.26E-02	1.26E-02	2.52E-02
I-134	5.62E+01	2.03E-02	1.14E+00	3.67E-04	2.06E-02
I-135	5.88E+00	3.45E-02	2.03E-01	1.59E-02	9.35E-02
Xe-131m	4.10E-03	2.33E-04	9.55E-07	1.09E-04	4.47E-07
Xe-133	1.35E+00	5.20E-04	7.02E-04	3.24E-04	4.37E-04
Xe-133m	9.00E-02	4.36E-04	3.92E-05	2.44E-04	2.20E-05
Xe-135	1.80E+01	2.34E-03	4.21E-02	1.53E-03	2.75E-02
Xe-135m	1.13E+02	2.34E-03	2.64E-01	2.41E-04	2.72E-02
Xe-137	2.45E+03	1.54E-04	3.77E-01	2.96E-08	7.25E-05
Xe-138	6.50E+02	4.49E-03	2.92E+00	5.80E-06	3.77E-03
U-232	2.02E-05	1.37E+04	2.77E-01	1.50E+04	3.03E-01
U-233	2.21E-06	2.66E+03	5.88E-03	2.92E+03	6.45E-03

Table 2.15. (continued)

Radionuclide	Airborne Source Term[a] (Ci)	50-Year EDE to Maximally Exposed Individual Off-Site from 1 Ci Release (mrem)	50-Year EDE to Maximally Exposed Individual Off-Site (mrem)	50-Year EDE to Off-Site Population from 1 Ci Release (person-rem)	50-Year EDE to Off-Site Population (person-rem)
U-234	2.85E-03	2.66E+03	7.58E+00	2.92E+03	8.32E+00
U-235	1.99E-05	2.46E+03	4.90E-02	2.69E+03	5.35E-02
U-236	6.25E-04	2.46E+03	1.54E+00	2.69E+03	1.68E+00
U-238	1.24E-06	2.46E+03	3.05E-03	2.69E+03	3.34E-03
TOTAL			1.74E+01		1.08E+01

[a]Source: Reference 28, pp. A-8 and A-12

Table 2.16. Doses and risks by facility for airborne radionuclide releases resulting from an extreme straight-line wind event with wind speeds in the range 100 mph - 150 mph

Facility	Accident Frequency ($year^{-1}$)	Maximally Exposed Individual		Off-Site Population	
		Dose[a] (mrem)	Risk (rem/year)	Dose[a] (person-rem)	Risk (person-rem/year)
F-Area Outside Facilities	3.0E-03	1.6E-03	4.8E-09	9.3E-02	2.8E-04
Production Control Facilities (772-F)	3.0E-03	5.1E-05	1.5E-10	2.6E-03	7.8E-06
New Production Control Facilities (772-1F)	3.0E-03	5.8E+00	1.7E-05	3.0E+02	9.0E-01
Solid Waste Disposal Facilities	3.0E-03	2.8E-01	8.4E-07	2.0E+01	5.9E-02
H-Area Outside Facilities	7.5E-04[b]	6.4E-03	4.8E-09	5.3E-01	4.0E-04
F/H Effluent Treatment Facility	3.0E-03	1.4E-04	4.2E-10	1.2E-02	3.6E-05
Consolidated Tritium Facility	3.0E-03	1.2E-02	3.6E-08	1.0E+00	3.0E-03
Saltstone Facility	3.0E-03	3.4E-07	1.0E-12	2.9E-05	8.7E-08
Fuel Fabrication Facility					
• Direct release	3.0E-03	1.4E-01	4.2E-07	3.9E+00	1.2E-02
• Nuclear criticality	3.0E-05	1.7E+01	5.2E-07	1.1E+01	3.2E-04

[a]50-year effective dose equivalent (EDE) estimated by using ICRP-30 dose conversion factors

[b]Return frequency for a 100-mph straight-line wind event (3.0E-03/year) multiplied by the conditional probability of release (2.5E-01)

Table 2.17. Doses and risks by facility for liquid releases resulting from an extreme straight-line wind event with wind speeds in the range 100 mph - 150 mph

Facility	Accident Frequency ($year^{-1}$)	Maximally Exposed Individual		Off-Site Population	
		Dose[a] (mrem)	Risk (rem/year)	Dose[a] (person-rem)	Risk (person-rem/year)
F-Area Outside Facilities	3.0E-03	2.8E-03	8.4E-09	1.9E-01	5.7E-04
H-Area Outside Facilities	7.5E-04[b]	1.9E+01	1.4E-05	6.8E+01	5.1E-02
F/H Effluent Treatment Facility	3.0E-03	4.2E-02	1.3E-07	3.0E-01	9.0E-04

[a]50-year effective dose equivalent (EDE) estimated by using ICRP-30 dose conversion factors

[b]Return frequency for a 100-mph straight-line wind event (3.0E-03/year) multiplied by the conditional probability of release (2.5E-01)

2.2.6.1 Maximally Exposed Off-Site Individual Dose and Risk (from airborne releases)

Inspecting the dose values for the maximally exposed off-site individual resulting from airborne radionuclide releases (Table 2.16), one could simply sum the doses resulting from each facility release to derive an integrated maximally exposed off-site individual dose for the site for this event. However, such a summation is illogical because there is no single location at the site boundary that corresponds to the maximum exposure location for E, F, H, Z and M/A Areas. This summation also implies that the wind can blow toward several different directions at once.

A more rational approach is to adjust the maximally exposed off-site individual dose values from each operating area to derive the integrated maximally exposed individual dose at the location of the maximally exposed off-site individual for the dominant facility. For this event category, the dominant off-site individual dose is realized at the site boundary northwest of M-Area. To include the contributions from F-Area facilities at this boundary site, the X/Q values for F-Area must be scaled. First, the distance from the center of F-Area to the boundary site is determined from a site map. Then, the X/Q for this distance at the wind speed of interest is obtained from Figure 16 of the *Environmental Dose Assessment Manual*.[43] The maximally exposed off-site individual dose for each F-Area facility is then multiplied by the ratio of the "new" X/Q value to the "original" X/Q value corresponding to the F-Area maximally exposed off-site individual location. The scaled doses can then be added to the off-site individual doses for the M-Area facility. This procedure is then repeated for facilities in other operating areas. A maximum dose of 23.6 mrem is calculated by using this approach.

Finally, the most rational approach for the derivation of an integrated maximally exposed off-site individual dose for the site resulting from this event is to (1) consider only the maximally exposed off-site individual location for the dominant facility and (2) sum the calculated doses for facilities that share this maximally exposed individual location. The maximally exposed off-site individual doses calculated for other facilities are then omitted from the integrated dose calculation. For this category of events, the nuclear criticality at the Fuel Fabrication Facility (Section 2.2.5.1) results in the dominant maximally exposed off-site individual dose, and the boundary location closest to M-Area is the location for the off-site individual. A maximum dose of 23.3 mrem is calculated by using this approach.

Table 2.18 presents the integrated doses and risks to the maximally exposed off-site individual (from airborne releases only) that result from applying these three approaches.

Table 2.18. Integrated doses and risks to the maximally exposed off-site individual for airborne releases resulting from an extreme straight-line wind event with wind speeds in the range 100 mph - 150 mph

	Calculation Option	Dose[a] (mrem)	Risk (rem/year)
1.	Sum worst-case, worst-sector doses/risks for all affected facilities, not accounting for the different receptor locations	2.4E+01	1.9E-05
2.	Sum worst-case doses/risks for a single boundary location (location of the maximally exposed off-site individual for the dominant facility)	2.4E+01	1.9E-05
3.	Sum worst-case, worst-sector doses/risks for facilities whose maximally exposed off-site individual is located in the same sector as the maximally exposed off-site individual of the dominant facility; ignore doses/risks for other facilities	2.3E+01	1.8E-05

[a]50-year effective dose equivalent (EDE) estimated by using ICRP-30 dose conversion factors

2.2.6.2 Maximally Exposed Off-Site Individual Dose and Risk (from liquid releases to surface water)

The maximally exposed off-site individual with regard to any radionuclide release to surface water bodies is assumed to live alongside the Savannah River south of the SRS. Therefore, doses resulting from liquid spills at the facilities affected by the extreme straight-line wind event can be summed to obtain the integrated dose. Maximum doses from airborne releases are realized at locations along the northern and western site boundaries. Therefore, it is inappropriate to combine these doses with those resulting from releases to surface water bodies. The integrated dose to the maximally exposed off-site individual from liquid releases to surface water is then 19 mrem, and the integrated risk is 1.4 x 10^{-5} rem/year.

2.2.6.3 Maximum Off-Site Population Dose and Risk (from airborne releases)

One can simply sum the maximum off-site population doses resulting from airborne releases from each facility to derive an integrated maximum off-site population dose for the site for this event. This approach is valid because the worst-sector with regard to population dose is the same for all facilities considered (west-northwest sector). The downwind sectors in the west-northwest direction from E, F, H, Z and M/A Areas do not overlay exactly. However, at the off-site location corresponding to the bulk of the population (Augusta, Georgia), the differences in sector locations are insignificant. The release from the New Production Control Facility results in the dominant maximum off-site population dose. The integrated off-site population dose is 332 person-rem, and the integrated risk is 0.97 person-rem/year.

2.2.6.4 Maximum Off-Site Population Dose and Risk (from liquid releases to surface water)

The integrated maximum off-site population dose and risk resulting from liquid releases to surface water are 68.5 person-rem and 0.0525 person-rem/year, respectively. The individual facility contributions given in Table 2.17 are simply summed to obtain the integrated dose and risk because these contributions reflect doses to the entire population within a 50-mile radius of the center of the SRS, not just the population in a single sector.

2.2.6.5 Risk

Tables 2.16 and 2.17 present the expected frequencies and risks associated with individual facilities damaged by an extreme straight-line wind event with wind speeds between 100 mph and 150 mph. With regard to airborne releases, the dominant risk contributor is the New Production Control Facility. For liquid releases to surface water bodies, the dominant risk contributor is the H-Area Outside Facilities. Figure 2.3 displays the risk of the individual facility releases in a graphic format.

2.3 DOSES AND RISKS RESULTING FROM AN EXTREME STRAIGHT-LINE WIND EVENT WITH FASTEST-MILE WIND SPEEDS BETWEEN 150 MPH AND 175 MPH

The basic accident scenario to be analyzed postulates that an extreme straight-line wind event with a fastest-mile wind speed between 150 and 175 mph occurs at the SRS . The existing safety analysis documentation predicts that eleven SRS nuclear facilities will incur sufficient damage from this accident initiator to result in a release of radioactive material.

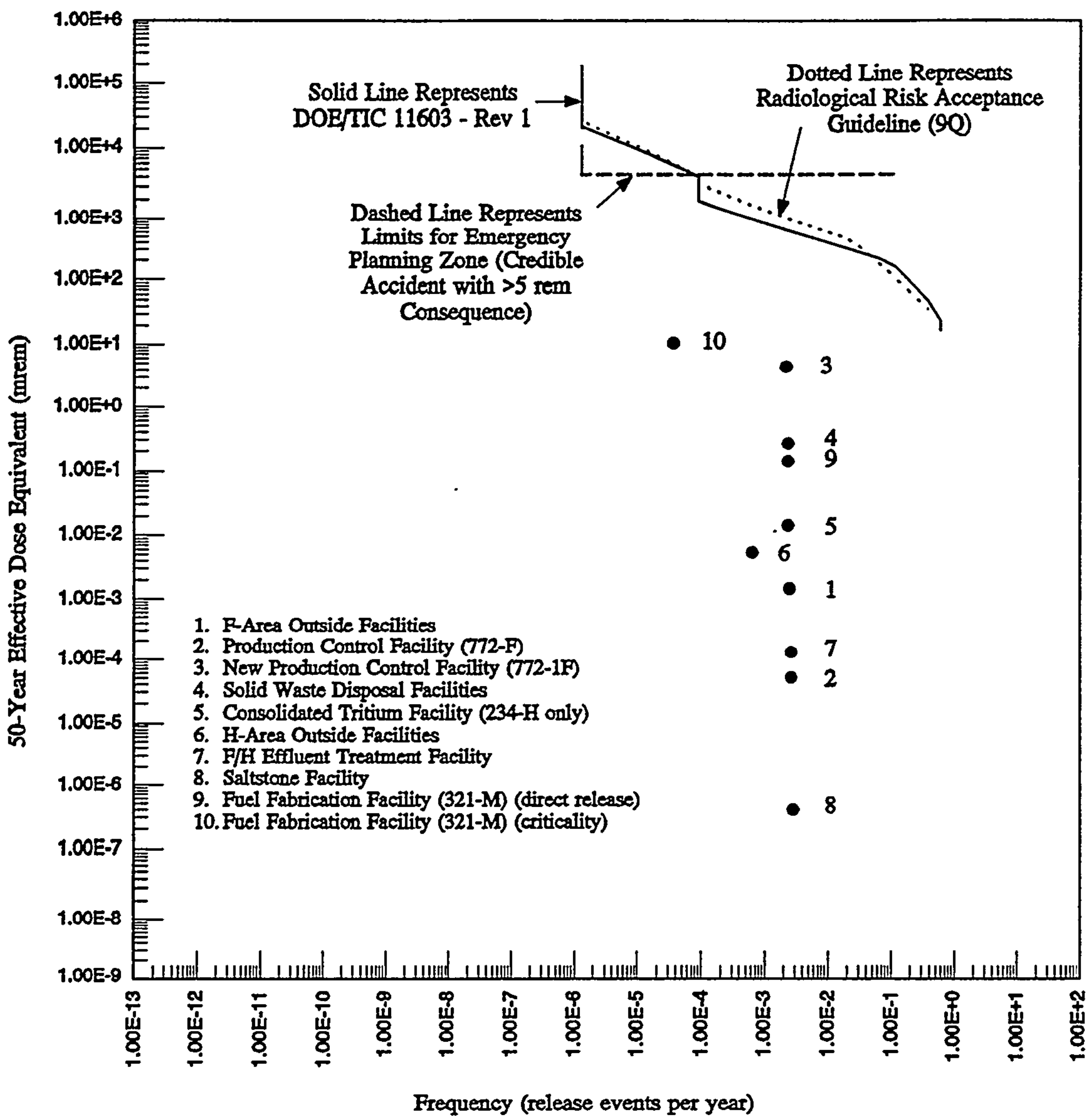

Figure 2.3. Public risks associated with an extreme straight-line wind event with wind speeds in the range 100 mph - 150 mph.

2.3.1 200 F Area

The site boundary location for the hypothetical off-site individual receiving the greatest airborne dose is 5.46 miles from the release point in the west-northwest direction. The population sector with the largest population subject to airborne exposure is the sector located to the west-northwest.

2.3.1.1 F-Area Outside Facility Operations

The SRS safety analysis for F-Area Outside Facility Operations[1] did not specifically address an extreme straight-line wind event in the wind speed range 150-175 mph. However, after a review of the accident scenario for an extreme straight-line wind event at the lower wind speed range (Section 2.2.1.1), it is concluded that there is no reason to assume that a larger source term will be generated for a similar event occurring at the higher wind speed range. Because this scenario was assumed to be a liquid release from several process vessels, radionuclide dispersion was modeled in the analysis as partly an evaporation of the diked material into 50-mph winds and partly a liquid release to the creek. Consequently, the off-site doses for this event are taken to be the same as those that were previously calculated for the extreme straight-line wind event at the lower wind speed range. Table 2.1 cited previously displays the source term and the resulting calculated doses for an evaporative release from this facility. The calculated maximally exposed off-site individual dose resulting from the airborne release is 0.002 mrem. The calculated maximum off-site population dose from the airborne release is 0.093 person-rem. Table 2.2 cited previously displays the source term and the resulting calculated doses for a liquid release from this facility. The calculated maximally exposed off-site individual dose resulting from the liquid release is 0.0028 mrem. The calculated maximum off-site population dose from the liquid release is 0.192 person-rem.

2.3.1.2 Production Control Facility

The SRS safety analysis for the Production Control Facility[3] did not specifically address an extreme straight-line wind event in the wind speed range 150-175 mph. However, after a review of the accident scenario for an extreme straight-line wind event at the lower wind speed range

(Section 2.2.1.2), it is concluded that there is no reason to assume that a larger source term will be generated for a similar event occurring at the higher wind speed range. For this scenario, it was concluded by the SRS safety analysis that there would be no release of radioactive materials from the facility per se because of its construction. However, the analysis assumed that the ventilation system stack external to the facility would collapse under this type of wind load, destroying the collocated ventilation system filter house. The loss of the filter house to the wind event would allow 0.5% of the accident source term to migrate outside the facility to be dispersed by the high winds during the event. Thus, off-site doses resulting from the similar event occurring at the higher speed range are calculated by using the AXAOTHER code for plume dispersion at 175 mph. Table 2.19 displays the source term and the resulting calculated doses for an airborne release from this facility. The calculated maximally exposed off-site individual dose resulting from the airborne release is essentially zero. The calculated maximum off-site population dose from the airborne release is 0.002 person-rem.

2.3.1.3 New Production Control Facility

The SRS safety analysis for the New Production Control Facility[5] addressed an extreme straight-line wind event in the wind speed range 150-175 mph. It was concluded that the source term for this event would be larger than the source term specified for the lower-wind-speed event. The analysis postulated that all of the facility radionuclide inventory was located in the facility secondary confinement just prior to the extreme straight-line wind event. The damage to the secondary confinement by the wind event would allow 100% of the inventory to migrate outside the facility to be dispersed by the high winds. Consequently, off-site doses are calculated by using the AXAOTHER code for plume dispersion at 175 mph. Table 2.20 displays the source term and the resulting calculated doses for an airborne release from this facility. The calculated maximally exposed off-site individual dose resulting from the airborne release is 87.8 mrem. The calculated maximum off-site population dose from the airborne release is 5,050 person-rem.

Table 2.19. Airborne radionuclide source terms and calculated off-site doses for the Production Control Facility (772-F) resulting from an extreme straight-line wind event with wind speeds exceeding 150 mph

Radionuclide	Airborne Source Term[a] (Ci)	50-Year EDE to Maximally Exposed Individual Off-Site from 1 Ci Release (mrem)	50-Year EDE to Maximally Exposed Individual Off-Site (mrem)	50-Year EDE to Off-Site Population from 1 Ci Release (person-rem)	50-Year EDE to Off-Site Population (person-rem)
Sr-89	2.34E-08	1.27E-04	2.97E-12	7.30E-03	1.71E-10
Sr-90	2.23E-09	4.45E-03	9.92E-12	2.56E-01	5.71E-10
Y-90	2.23E-09	2.81E-05	6.27E-14	1.61E-03	3.59E-12
Y-91	3.58E-08	1.51E-04	5.41E-12	8.68E-03	3.11E-10
Zr-95	3.58E-07	6.62E-05	2.37E-11	3.79E-03	1.36E-09
Nb-95	2.38E-08	1.65E-05	3.93E-13	9.31E-04	2.22E-11
Ru-103	1.94E-08	2.74E-05	5.32E-13	1.56E-03	3.03E-11
Ru-106	1.97E-08	1.51E-03	2.97E-11	8.68E-02	1.71E-09
Ag-110m	2.27E-09	1.86E-04	4.22E-13	1.06E-02	2.41E-11
Sn-123	3.06E-10	1.03E-04	3.15E-14	5.92E-03	1.81E-12
Sb-125	3.86E-10	3.42E-05	1.32E-14	1.96E-03	7.57E-13
Te-127	5.83E-10	9.98E-07	5.82E-16	5.68E-05	3.31E-14
Te-129	3.65E-10	3.35E-07	1.22E-16	1.65E-05	6.02E-15
Cs-134	3.90E-10	1.63E-04	6.36E-14	9.36E-03	3.65E-12
Cs-137	2.99E-09	1.10E-04	3.29E-13	6.31E-03	1.89E-11

Table 2.19. (continued)

Radionuclide	Airborne Source Term[a] (Ci)	50-Year EDE to Maximally Exposed Individual Off-Site from 1 Ci Release (mrem)	50-Year EDE to Maximally Exposed Individual Off-Site (mrem)	50-Year EDE to Off-Site Population from 1 Ci Release (person-rem)	50-Year EDE to Off-Site Population (person-rem)
Ce-141	1.15E-08	2.92E-05	3.36E-13	1.68E-03	1.93E-11
Ce-144	5.38E-08	1.20E-03	6.46E-11	6.90E-02	3.71E-09
Pr-144	5.38E-08	1.81E-07	9.74E-15	7.06E-06	3.80E-13
Pm-147	9.64E-09	1.16E-04	1.12E-12	6.71E-03	6.47E-11
Pm-148m	1.23E-10	3.63E-05	4.46E-15	2.05E-03	2.52E-13
Eu-155	1.70E-10	1.34E-04	2.28E-14	7.69E-03	1.31E-12
U-234	4.45E-17	4.45E-01	1.98E-17	2.56E+01	1.14E-15
U-235	7.12E-16	4.11E-01	2.93E-16	2.37E+01	1.69E-14
U-236	7.12E-16	4.11E-01	2.93E-16	2.37E+01	1.69E-14
U-238	6.58E-14	4.11E-01	2.70E-14	2.37E+01	1.56E-12
Np-237	9.46E-16	1.68E+00	1.59E-15	9.66E+01	9.14E-14
Pu-239	2.20E-05	1.75E+00	3.85E-05	1.01E+02	2.22E-03
TOTAL			3.85E-05		2.22E-03

[a]Source: Reference 3, p. 5-44

Table 2.20. **Airborne radionuclide source terms and calculated off-site doses for the New Production Control Facility (772-1F) resulting from an extreme straight-line wind event with wind speeds exceeding 150 mph**

Radionuclide	Airborne Source Term[a] (Ci)	50-Year EDE to Maximally Exposed Individual Off-Site from 1 Ci Release (mrem)	50-Year EDE to Maximally Exposed Individual Off-Site (mrem)	50-Year EDE to Off-Site Population from 1 Ci Release (person-rem)	50-Year EDE to Off-Site Population (person-rem)
Sr-89	1.68E+01	1.27E-04	2.13E-03	7.30E-03	1.23E-01
Sr-90	1.60E+00	4.45E-03	7.12E-03	2.56E-01	4.10E-01
Y-90	1.60E+00	2.81E-05	4.50E-05	1.61E-03	2.58E-03
Y-91	2.52E+01	1.51E-04	3.81E-03	8.68E-03	2.19E-01
Zr-95	2.52E+01	6.62E-05	1.67E-03	3.79E-03	9.55E-02
Nb-95	6.80E+00	1.65E-05	1.12E-04	9.31E-04	6.33E-03
Ru-103	1.26E+01	2.74E-05	3.45E-04	1.56E-03	1.97E-02
Ru-106	1.26E+01	1.51E-03	1.90E-02	8.68E-02	1.09E+00
Rh-106	1.26E+01	2.21E-08	2.78E-07	4.93E-09	6.21E-08
Ag-110m	1.60E-01	1.86E-04	2.98E-05	1.06E-02	1.70E-03
Sn-123	2.10E-01	1.03E-04	2.16E-05	5.92E-03	1.24E-03
Sb-125	2.80E-01	3.42E-05	9.58E-06	1.96E-03	5.49E-04
Te-127	4.00E-01	9.98E-07	3.99E-07	5.68E-05	2.27E-05
Te-129	2.50E-01	3.35E-07	8.38E-08	1.65E-05	4.13E-06
Cs-134	2.80E-01	1.63E-04	4.56E-05	9.36E-03	2.62E-03

Table 2.20. (continued)

Radionuclide	Airborne Source Term[a] (Ci)	50-Year EDE to Maximally Exposed Individual Off-Site from 1 Ci Release (mrem)	50-Year EDE to Maximally Exposed Individual Off-Site (mrem)	50-Year EDE to Off-Site Population from 1 Ci Release (person-rem)	50-Year EDE to Off-Site Population (person-rem)
Cs-137	2.10E+00	1.10E-04	2.31E-04	6.31E-03	1.33E-02
Ce-141	7.98E+00	2.92E-05	2.33E-04	1.68E-03	1.34E-02
Ce-144	3.78E+01	1.20E-03	4.54E-02	6.90E-02	2.61E+00
Pr-144	3.78E+01	1.81E-07	6.84E-06	7.06E-06	2.67E-04
Pm-147	6.83E+00	1.16E-04	7.92E-04	6.71E-03	4.58E-02
Pm-148	7.88E-02	3.51E-05	2.77E-06	2.00E-03	1.58E-04
Eu-154	1.16E-01	8.92E-04	1.03E-04	5.13E-02	5.95E-03
Pu-238	1.72E+01	1.58E+00	2.72E+01	9.07E+01	1.56E+03
Pu-239	2.48E+01	1.75E+00	4.34E+01	1.01E+02	2.50E+03
Pu-241	5.00E+02	3.42E-02	1.71E+01	1.97E+00	9.85E+02
TOTAL			8.78E+01		5.05E+03

[a]Source: Reference 5, p. B-7

2.3.1.4 Building 247-F Plutonium Storage Facility

From the viewpoint of vulnerability to wind damage, the nuclear facility denoted as the Building 247-F Plutonium Storage Facility consists primarily of storage points for solid materials. For this scenario, it was assumed by the SRS safety analysis[11] that fractions of the plutonium materials stored in the drum storage area would be released following facility damage by winds exceeding 150 mph. Consequently, off-site doses are calculated by using the AXAOTHER code for plume dispersion at 175 mph. Table 2.21 displays the source term and the resulting calculated doses for an airborne release from this facility. The calculated maximally exposed off-site individual dose resulting from the airborne release is essentially zero. The calculated maximum off-site population dose from the airborne release is also essentially zero.

2.3.2 200 E Area

The site boundary location for the hypothetical off-site individual receiving the greatest airborne dose is 6.46 miles from the release point in the north-northwest direction. The population sector with the largest population subject to airborne exposure is the sector located to the west-northwest.

2.3.2.1 Solid Waste Disposal Operations

The SRS safety analysis for the TRU pad drum storage area[16] addressed an extreme straight-line wind event in the wind speed range 150-175 mph. It was concluded that the source term generated by such an event would be higher than the source term estimated for the lower wind-speed event (Section 2.2.2.1). The safety analysis for the E-Area Vaults[17] did not specifically address an event in this wind speed range. However, for this analysis the source terms from the E-Area Vaults are assumed to be the same as those specified for the lower-wind-speed event. Consequently, off-site doses are calculated by using the AXAOTHER code for plume dispersion at 175 mph. Tables 2.22 through 2.25 display the source term and the resulting calculated doses for airborne releases from this facility. The calculated maximally exposed off-site individual dose

Table 2.21. Airborne radionuclide source terms and calculated off-site doses for the Building 247-F Plutonium Storage Facility resulting from an extreme straight-line wind event with wind speeds exceeding 150 mph

Radionuclide	Airborne Source Term[a] (Ci)	50-Year EDE to Maximally Exposed Individual Off-Site from 1 Ci Release (mrem)	50-Year EDE to Maximally Exposed Individual Off-Site (mrem)	50-Year EDE to Off-Site Population from 1 Ci Release (person-rem)	50-Year EDE to Off-Site Population (person-rem)
Pu-239	8.66E-08	1.75E+00	1.52E-07	1.01E+02	8.75E-06
Pu-240	2.44E-08	1.75E+00	4.27E-08	1.01E+02	2.46E-06
TOTAL			1.94E-07		1.12E-05

[a]Source: Reference 11, p. 1 (reference to weapons-grade plutonium parts) and p. 44 (total curie release); isotopic mix assumed to be 93% by weight ^{239}Pu and 7% by weight ^{240}Pu; specific activities of ^{239}Pu and ^{240}Pu are 0.0613 Ci/g and 0.23 Ci/g, respectively

Table 2.22. Airborne radionuclide source terms and calculated off-site doses for the TRU pad drum storage area resulting from an extreme straight-line wind event with wind speeds exceeding 150 mph

Radionuclide	Airborne Source Term[a] (Ci)	50-Year EDE to Maximally Exposed Individual Off-Site from 1 Ci Release (mrem)	50-Year EDE to Maximally Exposed Individual Off-Site (mrem)	50-Year EDE to Off-Site Population from 1 Ci Release (person-rem)	50-Year EDE to Off-Site Population (person-rem)
Pu-238	4.20E-02	1.49E+00	6.26E-02	9.99E+01	4.20E+00
TOTAL			6.26E-02		4.20E+00

[a]Source: Reference 16, p. 5-47

Table 2.23. Airborne radionuclide source terms and calculated off-site doses for the ILTV resulting from an extreme straight-line wind event with wind speeds exceeding 150 mph

Radionuclide	Airborne Source Term[a] (Ci)	50-Year EDE to Maximally Exposed Individual Off-Site from 1 Ci Release (mrem)	50-Year EDE to Maximally Exposed Individual Off-Site (mrem)	50-Year EDE to Off-Site Population from 1 Ci Release (person-rem)	50-Year EDE to Off-Site Population (person-rem)
H-3	2.72E+03	3.07E-07	8.36E-04	2.06E-05	5.60E-02
C-14	2.72E+01	7.76E-08	2.11E-06	5.21E-06	1.42E-04
Mn-54	2.72E-02	2.19E-05	5.95E-07	1.44E-03	3.92E-05
Fe-55	2.72E-01	8.41E-06	2.29E-06	5.66E-04	1.54E-04
Ni-59	2.72E-01	4.20E-06	1.14E-06	2.83E-04	7.70E-05
Co-60	2.16E+00	4.89E-04	1.06E-03	3.27E-02	7.06E-02
Ni-63	2.72E+00	9.70E-06	2.64E-05	6.51E-04	1.77E-03
Zn-65	2.72E-01	5.90E-05	1.61E-05	3.94E-03	1.07E-03
Se-75	2.72E-02	2.71E-05	7.37E-07	1.80E-03	4.90E-05
Se-79	2.72E-06	2.88E-05	7.82E-11	1.93E-03	5.25E-09
Rb-87	2.72E-06	1.07E-05	2.90E-11	7.16E-04	1.95E-09
Sr-90	2.99E+00	4.20E-03	1.26E-02	2.82E-01	8.43E-01
Y-90	2.72E+00	2.65E-05	7.21E-05	1.78E-03	4.84E-03
Nb-94	2.72E-02	1.34E-03	3.64E-05	9.04E-02	2.46E-03

Table 2.23. (continued)

Radionuclide	Airborne Source Term[a] (Ci)	50-Year EDE to Maximally Exposed Individual Off-Site from 1 Ci Release (mrem)	50-Year EDE to Maximally Exposed Individual Off-Site (mrem)	50-Year EDE to Off-Site Population from 1 Ci Release (person-rem)	50-Year EDE to Off-Site Population (person-rem)
Zr-95	2.72E-01	6.25E-05	1.70E-05	4.17E-03	1.13E-03
Tc-99	2.72E-02	2.43E-05	6.61E-07	1.63E-03	4.43E-05
Ru-106	2.72E-01	1.42E-03	3.86E-04	9.55E-02	2.60E-02
Rh-106	2.72E-01	1.30E-08	3.54E-09	5.44E-09	1.48E-09
Ag-110m	2.72E-02	1.75E-04	4.77E-06	1.17E-02	3.18E-04
Cd-115m	2.72E-02	2.10E-04	5.71E-06	1.41E-02	3.84E-04
Sb-125	2.72E-02	3.23E-05	8.78E-07	2.15E-03	5.85E-05
Te-125m	6.78E-03	2.17E-05	1.47E-07	1.45E-03	9.83E-06
Sb-126m	2.72E-06	9.04E-08	2.46E-13	6.09E-06	1.66E-11
Sn-126	2.72E-06	2.78E-04	7.55E-10	1.87E-02	5.08E-08
I-129	2.72E-04	5.82E-04	1.58E-07	3.91E-02	1.06E-05
Cs-134	2.72E-02	1.54E-04	4.18E-06	1.03E-02	2.80E-04
Cs-135	5.82E-06	1.46E-05	8.47E-11	9.81E-04	5.71E-09
Cs-137	2.72E-01	1.03E-04	2.80E-05	6.95E-03	1.89E-03
Ba-137m	2.72E-01	4.52E-07	1.23E-07	3.37E-06	9.17E-07

Table 2.23. (continued)

Radionuclide	Airborne Source Term[a] (Ci)	50-Year EDE to Maximally Exposed Individual Off-Site from 1 Ci Release (mrem)	50-Year EDE to Maximally Exposed Individual Off-Site (mrem)	50-Year EDE to Off-Site Population from 1 Ci Release (person-rem)	50-Year EDE to Off-Site Population (person-rem)
Ce-144	2.72E-01	1.13E-03	3.07E-04	7.60E-02	2.07E-02
Pr-144	2.72E-01	1.68E-07	4.57E-08	7.75E-06	2.11E-06
Pm-147	2.72E-01	1.10E-04	3.00E-05	7.38E-03	2.01E-03
Sm-151	2.72E-02	9.38E-05	2.55E-06	6.29E-03	1.71E-04
Eu-154	2.72E-02	8.43E-04	2.29E-05	5.65E-02	1.54E-03
Eu-155	2.72E-02	1.26E-04	3.43E-06	8.47E-03	2.30E-04
Th-231	2.72E-06	2.62E-06	7.13E-12	1.77E-04	4.80E-10
Th-232	2.72E-06	5.17E+00	1.41E-05	3.47E+02	9.44E-04
Pa-233	2.53E-06	2.78E-05	7.02E-11	1.87E-03	4.73E-09
U-233	8.40E-08	4.20E-01	3.53E-08	2.82E+01	2.37E-06
U-234	2.72E-03	4.20E-01	1.14E-03	2.82E+01	7.67E-02
U-235	3.96E-07	3.88E-01	1.54E-07	2.60E+01	1.03E-05
U-236	2.72E-03	3.88E-01	1.06E-03	2.60E+01	7.07E-02
Np-237	2.53E-06	1.58E+00	4.00E-06	1.06E+02	2.68E-04
U-238	2.72E-03	3.88E-01	1.06E-03	2.60E+01	7.07E-02

Table 2.23. (continued)

Radionuclide	Airborne Source Term[a] (Ci)	50-Year EDE to Maximally Exposed Individual Off-Site from 1 Ci Release (mrem)	50-Year EDE to Maximally Exposed Individual Off-Site (mrem)	50-Year EDE to Off-Site Population from 1 Ci Release (person-rem)	50-Year EDE to Off-Site Population (person-rem)
Pu-238	2.45E-04	1.49E+00	3.66E-04	9.99E+01	2.45E-02
Pu-239	5.81E-04	1.65E+00	9.56E-04	1.11E+02	6.45E-02
Pu-240	2.45E-04	1.65E+00	4.03E-04	1.11E+02	2.72E-02
Pu-241	2.45E-04	3.23E-02	7.91E-06	2.17E+02	5.32E-02
Am-241	2.45E-04	1.68E+00	4.12E-04	1.13E+02	2.77E-02
Pu-242	2.45E-04	1.56E+00	3.81E-04	1.04E+02	2.55E-02
Am-243	7.20E-05	1.68E+00	1.21E-04	1.13E+02	8.17E-03
Cm-244	2.45E-04	8.73E-01	2.14E-04	5.86E+01	1.44E-02
Cm-248	2.45E-04	6.14E+00	1.50E-03	4.14E+02	1.01E-01
Cf-252	2.45E-04	4.20E-01	1.03E-04	2.82E+01	6.91E-03
TOTAL			2.32E-02		1.61E+00

[a]Source: Reference 17, p. 88

Table 2.24. Airborne radionuclide source terms and calculated off-site doses for the ILNTV resulting from an extreme straight-line wind event with wind speeds exceeding 150 mph

Radionuclide	Airborne Source Term[a] (Ci)	50-Year EDE to Maximally Exposed Individual Off-Site from 1 Ci Release (mrem)	50-Year EDE to Maximally Exposed Individual Off-Site (mrem)	50-Year EDE to Off-Site Population from 1 Ci Release (person-rem)	50-Year EDE to Off-Site Population (person-rem)
H-3	1.20E+01	3.07E-07	3.69E-06	2.06E-05	2.47E-04
C-14	2.18E+02	7.76E-08	1.69E-05	5.21E-06	1.14E-03
Mn-54	2.18E-01	2.19E-05	4.77E-06	1.44E-03	3.14E-04
Fe-55	2.18E+00	8.41E-06	1.83E-05	5.66E-04	1.23E-03
Ni-59	2.18E+00	4.20E-06	9.17E-06	2.83E-04	6.17E-04
Co-60	2.18E+00	4.89E-04	1.07E-03	3.27E-02	7.13E-02
Ni-63	2.18E+01	9.70E-06	2.11E-04	6.51E-04	1.42E-02
Zn-65	2.18E+00	5.90E-05	1.29E-04	3.94E-03	8.59E-03
Se-75	2.18E-01	2.71E-05	5.91E-06	1.80E-03	3.92E-04
Se-79	2.18E-05	2.88E-05	6.27E-10	1.93E-03	4.21E-08
Rb-87	2.18E-05	1.07E-05	2.33E-10	7.16E-04	1.56E-08
Sr-90	2.40E+01	4.20E-03	1.01E-01	2.82E-01	6.77E+00
Y-90	2.18E+01	2.65E-05	5.78E-04	1.78E-03	3.88E-02
Nb-94	2.18E-01	1.34E-03	2.92E-04	9.04E-02	1.97E-02

Table 2.24. (continued)

Radionuclide	Airborne Source Term[a] (Ci)	50-Year EDE to Maximally Exposed Individual Off-Site from 1 Ci Release (mrem)	50-Year EDE to Maximally Exposed Individual Off-Site (mrem)	50-Year EDE to Off-Site Population from 1 Ci Release (person-rem)	50-Year EDE to Off-Site Population (person-rem)
Zr-95	2.18E+00	6.25E-05	1.36E-04	4.17E-03	9.09E-03
Tc-99	2.18E-01	2.43E-05	5.30E-06	1.63E-03	3.55E-04
Ru-106	2.18E+00	1.42E-03	3.09E-03	9.55E-02	2.08E-01
Rh-106	2.18E+00	1.30E-08	2.83E-08	5.44E-09	1.19E-08
Ag-110m	2.18E-01	1.75E-04	3.82E-05	1.17E-02	2.55E-03
Cd-115m	2.18E-01	2.10E-04	4.58E-05	1.41E-02	3.07E-03
Sb-125	2.18E-01	3.23E-05	7.04E-06	2.15E-03	4.69E-04
Te-125m	5.44E-02	2.17E-05	1.18E-06	1.45E-03	7.89E-05
Sb-126m	2.18E-05	9.04E-08	1.97E-12	6.09E-06	1.33E-10
Sn-126	2.18E-05	2.78E-04	6.05E-09	1.87E-02	4.07E-07
I-129	2.18E-02	5.82E-04	1.27E-05	3.91E-02	8.52E-04
Cs-134	2.18E-01	1.54E-04	3.35E-05	1.03E-02	2.25E-03
Cs-135	4.08E-05	1.46E-05	5.94E-10	9.81E-04	4.00E-08
Cs-137	2.18E+01	1.03E-04	2.25E-03	6.95E-03	1.52E-01
Ba-137m	2.18E+01	4.52E-07	9.85E-06	3.37E-06	7.35E-05

Table 2.24. (continued)

Radionuclide	Airborne Source Term[a] (Ci)	50-Year EDE to Maximally Exposed Individual Off-Site from 1 Ci Release (mrem)	50-Year EDE to Maximally Exposed Individual Off-Site (mrem)	50-Year EDE to Off-Site Population from 1 Ci Release (person-rem)	50-Year EDE to Off-Site Population (person-rem)
Ce-144	2.18E+00	1.13E-03	2.46E-03	7.60E-02	1.66E-01
Pr-144	2.18E+00	1.68E-07	3.66E-07	7.75E-06	1.69E-05
Pm-147	2.18E+00	1.10E-04	2.40E-04	7.38E-03	1.61E-02
Sm-151	2.18E-01	9.38E-05	2.04E-05	6.29E-03	1.37E-03
Eu-154	2.18E-01	8.43E-04	1.84E-04	5.65E-02	1.23E-02
Eu-155	2.18E-01	1.26E-04	2.75E-05	8.47E-03	1.85E-03
Th-231	2.18E-05	2.62E-06	5.72E-11	1.77E-04	3.85E-09
Th-232	2.18E-05	5.17E+00	1.13E-04	3.47E+02	7.56E-03
Pa-233	1.01E-05	2.78E-05	2.80E-10	1.87E-03	1.89E-08
U-233	5.76E-07	4.20E-01	2.42E-07	2.82E+01	1.63E-05
U-234	2.18E-02	4.20E-01	9.17E-03	2.82E+01	6.15E-01
U-235	3.96E-07	3.88E-01	1.54E-07	2.60E+01	1.03E-05
U-236	2.18E-02	3.88E-01	8.46E-03	2.60E+01	5.67E-01
Np-237	1.01E-05	1.58E+00	1.60E-05	1.06E+02	1.07E-03
U-238	2.18E-02	3.88E-01	8.46E-03	2.60E+01	5.67E-01

Table 2.24. (continued)

Radionuclide	Airborne Source Term[a] (Ci)	50-Year EDE to Maximally Exposed Individual Off-Site from 1 Ci Release (mrem)	50-Year EDE to Maximally Exposed Individual Off-Site (mrem)	50-Year EDE to Off-Site Population from 1 Ci Release (person-rem)	50-Year EDE to Off-Site Population (person-rem)
Pu-238	1.97E-03	1.49E+00	2.94E-03	9.99E+01	1.97E-01
Pu-239	3.76E-03	1.65E+00	6.19E-03	1.11E+02	4.17E-01
Pu-240	1.97E-03	1.65E+00	3.24E-03	1.11E+02	2.19E-01
Pu-241	1.96E-03	3.23E-02	6.33E-05	2.17E+02	4.25E-01
Am-241	1.97E-03	1.68E+00	3.31E-03	1.13E+02	2.23E-01
Pu-242	1.97E-03	1.56E+00	3.06E-03	1.04E+02	2.05E-01
Am-243	2.88E-04	1.68E+00	4.84E-04	1.13E+02	3.27E-02
Cm-244	1.96E-03	8.73E-01	1.71E-03	5.86E+01	1.15E-01
Cm-248	1.97E-03	6.14E+00	1.21E-02	4.14E+02	8.15E-01
Cf-252	1.96E-03	4.20E-01	8.24E-04	2.82E+01	5.53E-02
TOTAL			1.72E-01		1.20E+01

[a]Source: Reference 17, p. 85

Table 2.25. Airborne radionuclide source terms and calculated off-site doses for the LAWV resulting from an extreme straight-line wind event with wind speeds exceeding 150 mph

Radionuclide	Airborne Source Term[a] (Ci)	50-Year EDE to Maximally Exposed Individual Off-Site from 1 Ci Release (mrem)	50-Year EDE to Maximally Exposed Individual Off-Site (mrem)	50-Year EDE to Off-Site Population from 1 Ci Release (person-rem)	50-Year EDE to Off-Site Population (person-rem)
H-3	1.20E+01	3.07E-07	3.69E-06	2.06E-05	2.47E-04
C-14	2.72E+01	7.76E-08	2.11E-06	5.21E-06	1.42E-04
Mn-54	2.72E-03	2.19E-05	5.95E-08	1.44E-03	3.92E-06
Fe-55	2.72E-02	8.41E-06	2.29E-07	5.66E-04	1.54E-05
Ni-59	2.72E-02	4.20E-06	1.14E-07	2.83E-04	7.70E-06
Co-60	2.72E-02	4.89E-04	1.33E-05	3.27E-02	8.89E-04
Ni-63	2.72E-01	9.70E-06	2.64E-06	6.51E-04	1.77E-04
Zn-65	2.72E-02	5.90E-05	1.61E-06	3.94E-03	1.07E-04
Se-75	2.72E-03	2.71E-05	7.37E-08	1.80E-03	4.90E-06
Se-79	2.72E-06	2.88E-05	7.82E-11	1.93E-03	5.25E-09
Rb-87	2.72E-06	1.07E-05	2.90E-11	7.16E-04	1.95E-09
Sr-90	4.66E+00	4.20E-03	1.96E-02	2.82E-01	1.31E+00
Y-90	4.63E+00	2.65E-05	1.23E-04	1.78E-03	8.24E-03
Nb-94	2.72E-03	1.34E-03	3.64E-06	9.04E-02	2.46E-04

Table 2.25. (continued)

Radionuclide	Airborne Source Term[a] (Ci)	50-Year EDE to Maximally Exposed Individual Off-Site from 1 Ci Release (mrem)	50-Year EDE to Maximally Exposed Individual Off-Site (mrem)	50-Year EDE to Off-Site Population from 1 Ci Release (person-rem)	50-Year EDE to Off-Site Population (person-rem)
Zr-95	2.72E-02	6.25E-05	1.70E-06	4.17E-03	1.13E-04
Tc-99	2.72E-02	2.43E-05	6.61E-07	1.63E-03	4.43E-05
Ru-106	2.72E-02	1.42E-03	3.86E-05	9.55E-02	2.60E-03
Rh-106	2.72E-02	1.30E-08	3.54E-10	5.44E-09	1.48E-10
Ag-110m	2.72E-03	1.75E-04	4.77E-07	1.17E-02	3.18E-05
Cd-115m	2.72E-03	2.10E-04	5.71E-07	1.41E-02	3.84E-05
Sb-125	2.72E-03	3.23E-05	8.78E-08	2.15E-03	5.85E-06
Te-125m	6.80E-04	2.17E-05	1.48E-08	1.45E-03	9.86E-07
Sb-126m	2.72E-06	9.04E-08	2.46E-13	6.09E-06	1.66E-11
Sn-126	2.72E-06	2.78E-04	7.55E-10	1.87E-02	5.08E-08
I-129	2.72E-03	5.82E-04	1.58E-06	3.91E-02	1.06E-04
Cs-134	2.72E-03	1.54E-04	4.18E-07	1.03E-02	2.80E-05
Cs-135	5.71E-06	1.46E-05	8.31E-11	9.81E-04	5.60E-09
Cs-137	2.72E-01	1.03E-04	2.80E-05	6.95E-03	1.89E-03
Ba-137m	2.72E-01	4.52E-07	1.23E-07	3.37E-06	9.17E-07

Table 2.25. (continued)

Radionuclide	Airborne Source Term[a] (Ci)	50-Year EDE to Maximally Exposed Individual Off-Site from 1 Ci Release (mrem)	50-Year EDE to Maximally Exposed Individual Off-Site (mrem)	50-Year EDE to Off-Site Population from 1 Ci Release (person-rem)	50-Year EDE to Off-Site Population (person-rem)
Ce-144	2.72E-02	1.13E-03	3.07E-05	7.60E-02	2.07E-03
Pr-144	2.72E-02	1.68E-07	4.57E-09	7.75E-06	2.11E-07
Pm-147	2.72E-02	1.10E-04	3.00E-06	7.38E-03	2.01E-04
Sm-151	2.72E-03	9.38E-05	2.55E-07	6.29E-03	1.71E-05
Eu-154	2.72E-03	8.43E-04	2.29E-06	5.65E-02	1.54E-04
Eu-155	2.72E-03	1.26E-04	3.43E-07	8.47E-03	2.30E-05
Th-231	2.72E-06	2.62E-06	7.13E-12	1.77E-04	4.80E-10
Th-232	2.72E-06	5.17E+00	1.41E-05	3.47E+02	9.44E-04
Pa-233	5.07E-07	2.78E-05	1.41E-11	1.87E-03	9.47E-10
U-233	2.62E-08	4.20E-01	1.10E-08	2.82E+01	7.40E-07
U-234	2.72E-04	4.20E-01	1.14E-04	2.82E+01	7.67E-03
U-235	3.96E-07	3.88E-01	1.54E-07	2.60E+01	1.03E-05
U-236	2.72E-03	3.88E-01	1.06E-03	2.60E+01	7.07E-02
Np-237	5.08E-07	1.58E+00	8.04E-07	1.06E+02	5.38E-05
U-238	2.72E-03	3.88E-01	1.06E-03	2.60E+01	7.07E-02

Table 2.25. (continued)

Radionuclide	Airborne Source Term[a] (Ci)	50-Year EDE to Maximally Exposed Individual Off-Site from 1 Ci Release (mrem)	50-Year EDE to Maximally Exposed Individual Off-Site (mrem)	50-Year EDE to Off-Site Population from 1 Ci Release (person-rem)	50-Year EDE to Off-Site Population (person-rem)
Pu-238	2.54E-04	1.49E+00	3.79E-04	9.99E+01	2.54E-02
Pu-239	4.04E-04	1.65E+00	6.65E-04	1.11E+02	4.48E-02
Pu-240	2.45E-04	1.65E+00	4.03E-04	1.11E+02	2.72E-02
Pu-241	2.45E-04	3.23E-02	7.91E-06	2.17E+02	5.32E-02
Am-241	2.45E-04	1.68E+00	4.12E-04	1.13E+02	2.77E-02
Pu-242	2.45E-04	1.56E+00	3.81E-04	1.04E+02	2.55E-02
Am-243	1.44E-05	1.68E+00	2.42E-05	1.13E+02	1.63E-03
Cm-244	2.45E-06	8.73E-01	2.14E-06	5.86E+01	1.44E-04
Cm-248	2.45E-04	6.14E+00	1.50E-03	4.14E+02	1.01E-01
Cf-252	2.72E-06	4.20E-01	1.14E-06	2.82E+01	7.67E-05
TOTAL			2.59E-02		1.79E+00

[a]Source: Reference 17, p. 83

resulting from the airborne release (combined releases from the TRU pad and E-Area Vaults) is 0.28 mrem. The calculated maximum off-site population dose from the airborne release is 19.6 person-rem.

2.3.3 200 H Area

The site boundary location for the hypothetical off-site individual receiving the greatest airborne dose is 7.25 miles from the release point in the north direction. The population sector with the largest population subject to airborne exposure is the sector located to the west-northwest.

2.3.3.1 H-Area Outside Facility Operations

The SRS safety analysis for the H-Area Outside Facility Operations[22] did not specifically address an extreme straight-line wind event in the wind speed range 150-175 mph. However, it is concluded that this event would not generate a larger source term than the extreme wind event with wind speeds between 100 mph and 150 mph. Because that scenario involves a liquid release from several process vessels, radionuclide dispersion was modeled in the analysis as partly an evaporation of the confined material into 50-mph winds and partly a liquid release to the creek. Consequently, the off-site doses that were previously calculated with the AXAOTHER code for airborne dispersion at 50 mph and the LADTAP XL code for the liquid dispersion via the creek are applied to this scenario as well. Table 2.9 cited previously displays the source term and the resulting calculated doses for an evaporative release from this facility. The calculated maximally exposed off-site individual dose resulting from the airborne release is 0.006 mrem. The calculated maximum off-site population dose from the airborne release is 0.525 person-rem. Table 2.10 cited previously displays the source term and the resulting calculated doses for a liquid release from this facility. The calculated maximally exposed off-site individual dose resulting from the liquid release is 18.6 mrem. The calculated maximum off-site population dose from the liquid release is 67.9 person-rem.

2.3.3.2 F/H Effluent Treatment Facility

The SRS safety analysis for the F/H Effluent Treatment Facility[23] addressed an extreme straight-line wind event in the wind-speed range 150-175 mph. However, it was concluded that the source term for this event would be the same as that for the lower-wind-speed event described previously (Section 2.2.3.2). Because this scenario was assumed to be a liquid release from equipment and piping, radionuclide dispersion was modeled in the analysis as partly an evaporation of the released material into 50-mph winds and partly a liquid release to the creek. Consequently, the off-site doses that were previously calculated by using the AXAOTHER code for evaporative dispersion at 50 mph and the LADTAP XL code for liquid dispersion via the creek are applied to this event as well. Table 2.11 cited previously displays the source term and the resulting calculated doses for an evaporative release from this facility. The calculated maximally exposed off-site individual dose resulting from the airborne release is essentially zero. The calculated maximum off-site population dose from the airborne release is 0.012 person-rem. Table 2.12 cited previously displays the source term and the resulting calculated doses for a liquid release from this facility. The calculated maximally exposed off-site individual dose resulting from the liquid release is 0.042 mrem. The calculated maximum off-site population dose from the liquid release is 0.3 person-rem.

2.3.3.3 Consolidated Tritium Facility

From the viewpoint of vulnerability to wind damage, the nuclear facility denoted as the Consolidated Tritium Facility (Building 234-H only in this case) consists primarily of storage points for tritium gas. For this scenario, it was assumed by the SRS safety analysis[25] that 50% of the tritium inventory stored in the equipment and piping would be released in the event of facility damage by winds greater than 170 mph, with 1% of the release in oxide form. Therefore, off-site doses are calculated with the AXAOTHER code for plume dispersion at 175 mph. Table 2.26 shows the source term and the resulting calculated doses for an airborne release from this facility. The calculated maximally exposed off-site individual dose resulting from the airborne release is 0.11 mrem. The calculated maximum off-site population dose from the airborne release is 8.84 person-rem.

Table 2.26. **Airborne radionuclide source terms and calculated off-site doses for the Consolidated Tritium Facility (234-H) resulting from an extreme straight-line wind event with wind speeds exceeding 150 mph**

Radionuclide	Airborne Source Term[a] (Ci)	50-Year EDE to Maximally Exposed Individual Off-Site from 1 Ci Release (mrem)	50-Year EDE to Maximally Exposed Individual Off-Site (mrem)	50-Year EDE to Off-Site Population from 1 Ci Release (person-rem)	50-Year EDE to Off-Site Population (person-rem)
H-3	3.90E+07	2.87E-09[b]	1.12E-01	2.27E-07[b]	8.84E+00
TOTAL			1.12E-01		8.84E+00

[a]Source: Reference 25, p. 3-24

[b]This value was derived by correcting the AXAOTHER result to account for the assumed oxide fraction (1%).

2.3.4 200 Z Area

The site boundary location for the hypothetical off-site individual receiving the greatest airborne dose is 5.79 miles from the release point in the north direction. The population sector with the largest population subject to airborne exposure is the sector located to the west-northwest.

2.3.4.1 Saltstone Facility

The SRS safety analysis for the Saltstone Facility[26] did not specifically address an extreme straight-line wind event in the wind speed range 150-175 mph. However, it is concluded that there is no reason to assume that this event would generate a larger source term than the 100 mph - 150 mph extreme straight-line wind event. Because this scenario was assumed to be a liquid release from process equipment, radionuclide dispersion was modeled in the analysis as an evaporation of the released material into 50-mph winds. Consequently, the off-site doses that were previously calculated by using the AXAOTHER code for evaporative dispersion at 50 mph for the extreme straight-line wind event at the lower wind-speed range are applied to this event as well. Table 2.14 cited previously displays the source term and the resulting calculated doses for an evaporative release from this facility. The calculated maximally exposed off-site individual dose resulting from the airborne release is essentially zero. The calculated maximum off-site population dose from the airborne release is also essentially zero.

2.3.5 300 M / 700 A Area

The site boundary location for M-Area for the hypothetical off-site individual receiving the greatest airborne dose is 0.75 miles from the release point in the northwest direction. The population sector with the largest population subject to airborne exposure is the sector located to the west-northwest.

The site boundary location for A-Area for the hypothetical off-site individual receiving the greatest airborne dose is 0.27 miles from the release point in the west-northwest direction. The population sector with the largest population subject to airborne exposure is the sector located to the west-northwest.

2.3.5.1 Fuel Fabrication Facility

For this scenario, it was concluded by the SRS safety analysis[28] that there would be no release of radioactive materials from the Fuel Fabrication Facility per se because of its construction. However, the analysis assumed that the ventilation system filter house external to the facility would be damaged under this type of wind load, releasing some of the radionuclides accumulated in the ventilation system filters. The damage to the filter house by the wind event would allow the filter material accumulation to be dispersed. In addition, the safety analysis assumed that a nuclear criticality would occur in 1% of these high-wind events. Off-site doses from the filter house release are calculated with the AXAOTHER code for plume dispersion of 1.3 kg of uranium at 175 mph. Radionuclide dispersion following a nuclear criticality is modeled as a release under assumed worst-case (99.5%) meteorological conditions. Therefore, the AXAIR89Q code is used to calculate the associated off-site doses. Table 2.27 displays the source terms and the resulting calculated doses for airborne releases from this facility. The calculated maximally exposed off-site individual dose resulting from the direct release is 0.24 mrem. The calculated maximally exposed off-site individual dose resulting from a nuclear criticality event is 17.4 mrem. The corresponding maximum off-site population doses are 6.5 person-rem and 10.8 person-rem, respectively.

2.3.5.2 SRTC Technical Area

The SRS safety analysis[29] concluded that there could be a release of radioactive materials from the primary confinement of portions of the SRTC Technical Area . To create a conservative estimated source term, the analysis postulated that fractions of the facility glovebox and laboratory hood radionuclide inventory would be dispersed by winds greater than 150 mph. Additional inventory may be released over the ensuing 24-h period if a fire occurs following the wind damage. Thus, off-site doses associated with the direct release are calculated with the AXAOTHER code for plume dispersion at 175 mph. Doses resulting from a fire are calculated with the AXAIR89Q code for assumed worst-case (99.5%) meteorological conditions. Table 2.28 displays the source term and the resulting calculated doses for airborne releases from this facility.

Table 2.27. Airborne radionuclide source terms and calculated off-site doses for the Fuel Fabrication Facility (321-M) resulting from an extreme straight-line wind event with wind speeds exceeding 150 mph

Radionuclide	Airborne Source Term[a] (Ci)	50-Year EDE to Maximally Exposed Individual Off-Site from 1 Ci Release (mrem)	50-Year EDE to Maximally Exposed Individual Off-Site (mrem)	50-Year EDE to Off-Site Population from 1 Ci Release (person-rem)	50-Year EDE to Off-Site Population (person-rem)
Direct Release					
U-232	1.08E-03	6.63E+00	7.16E-03	1.76E+02	1.90E-01
U-233	1.18E-04	1.29E+00	1.52E-04	3.42E+01	4.04E-03
U-234	1.52E-01	1.29E+00	1.96E-01	3.42E+01	5.20E+00
U-235	1.06E-03	1.19E+00	1.26E-03	3.15E+01	3.34E-02
U-236	3.33E-02	1.19E+00	3.96E-02	3.15E+01	1.05E+00
U-238	6.59E-05	1.19E+00	7.84E-05	3.15E+01	2.08E-03
TOTAL			2.44E-01		6.48E+00
Nuclear Criticality					
Kr-83m	8.00E+00	1.99E-07	1.59E-06	8.63E-09	6.90E-08
Kr-85	8.00E-05	2.02E-05	1.62E-09	1.62E-05	1.30E-09
Kr-85m	7.50E+00	1.48E-03	1.11E-02	3.86E-04	2.90E-03
Kr-87	4.95E+01	5.50E-03	2.72E-01	2.27E-04	1.12E-02
Kr-88	3.25E+01	1.45E-02	4.71E-01	2.40E-03	7.80E-02

Table 2.27. (continued)

Radionuclide	Airborne Source Term[a] (Ci)	50-Year EDE to Maximally Exposed Individual Off-Site from 1 Ci Release (mrem)	50-Year EDE to Maximally Exposed Individual Off-Site (mrem)	50-Year EDE to Off-Site Population from 1 Ci Release (person-rem)	50-Year EDE to Off-Site Population (person-rem)
Kr-89	2.10E+03	8.82E-04	1.85E+00	1.33E-07	2.79E-04
I-131	1.09E-01	6.58E-01	7.17E-02	7.00E-01	7.63E-02
I-132	1.38E+01	2.45E-02	3.38E-01	3.15E-03	4.35E-02
I-133	2.00E+00	1.63E-02	3.26E-02	1.26E-02	2.52E-02
I-134	5.62E+01	2.03E-02	1.14E+00	3.67E-04	2.06E-02
I-135	5.88E+00	3.45E-02	2.03E-01	1.59E-02	9.35E-02
Xe-131m	4.10E-03	2.33E-04	9.55E-07	1.09E-04	4.47E-07
Xe-133	1.35E+00	5.20E-04	7.02E-04	3.24E-04	4.37E-04
Xe-133m	9.00E-02	4.36E-04	3.92E-05	2.44E-04	2.20E-05
Xe-135	1.80E+01	2.34E-03	4.21E-02	1.53E-03	2.75E-02
Xe-135m	1.13E+02	2.34E-03	2.64E-01	2.41E-04	2.72E-02
Xe-137	2.45E+03	1.54E-04	3.77E-01	2.96E-08	7.25E-05
Xe-138	6.50E+02	4.49E-03	2.92E+00	5.80E-06	3.77E-03
U-232	2.02E-05	1.37E+04	2.77E-01	1.50E+04	3.03E-01
U-233	2.21E-06	2.66E+03	5.88E-03	2.92E+03	6.45E-03

Table 2.27. (continued)

Radionuclide	Airborne Source Term[a] (Ci)	50-Year EDE to Maximally Exposed Individual Off-Site from 1 Ci Release (mrem)	50-Year EDE to Maximally Exposed Individual Off-Site (mrem)	50-Year EDE to Off-Site Population from 1 Ci Release (person-rem)	50-Year EDE to Off-Site Population (person-rem)
U-234	2.85E-03	2.66E+03	7.58E+00	2.92E+03	8.32E+00
U-235	1.99E-05	2.46E+03	4.90E-02	2.69E+03	5.35E-02
U-236	6.25E-04	2.46E+03	1.54E+00	2.69E+03	1.68E+00
U-238	1.24E-06	2.46E+03	3.05E-03	2.69E+03	3.34E-03
TOTAL			1.74E+01		1.08E+01

[a]Source: Reference 28, pp. A-8 and A-12

Table 2.28. Airborne radionuclide source terms and calculated off-site doses for the SRTC Technical Area resulting from an extreme straight-line wind event with wind speeds exceeding 150 mph

Radionuclide	Airborne Source Term[a] (Ci)	50-Year EDE to Maximally Exposed Individual Off-Site from 1 Ci Release (mrem)	50-Year EDE to Maximally Exposed Individual Off-Site (mrem)	50-Year EDE to Off-Site Population from 1 Ci Release (person-rem)	50-Year EDE to Off-Site Population (person-rem)
Direct Release					
Am-241	6.34E-05	5.94E+00	3.77E-04	1.38E+02	8.75E-03
Ba-133	3.84E-07	8.05E-05	3.09E-11	1.86E-03	7.14E-10
C-14	5.98E-06	2.74E-07	1.64E-12	6.38E-06	3.82E-11
Ca-45	3.03E-04	6.96E-05	2.11E-08	1.62E-03	4.91E-07
Ce-144	5.87E-02	4.00E-03	2.35E-04	9.31E-02	5.46E-03
Cm-244	2.91E-07	3.08E+00	8.96E-07	7.18E+01	2.09E-05
Co-60	3.91E-04	1.72E-03	6.73E-07	4.01E-02	1.57E-05
Cs-134	1.16E-04	5.44E-04	6.31E-08	1.26E-02	1.46E-06
Cs-137	4.44E-02	3.65E-04	1.62E-05	8.51E-03	3.78E-04
Eu-154	2.30E-07	2.97E-03	6.83E-10	6.92E-02	1.59E-08
Eu-155	4.68E-08	4.45E-04	2.08E-11	1.04E-02	4.87E-10
H-3	4.26E-02	1.08E-06	4.60E-08	2.53E-05	1.08E-06
Hg-203	1.20E-04	5.25E-05	6.30E-09	1.21E-03	1.45E-07
I-129	2.91E-07	2.05E-03	5.97E-10	4.79E-02	1.39E-08
Na-22	6.00E-05	1.06E-04	6.36E-09	2.33E-03	1.40E-07
Np-237	1.19E-05	5.59E+00	6.65E-05	1.30E+02	1.55E-03

Table 2.28. (continued)

Radionuclide	Airborne Source Term[a] (Ci)	50-Year EDE to Maximally Exposed Individual Off-Site from 1 Ci Release (mrem)	50-Year EDE to Maximally Exposed Individual Off-Site (mrem)	50-Year EDE to Off-Site Population from 1 Ci Release (person-rem)	50-Year EDE to Off-Site Population (person-rem)
Np-239	1.50E-07	2.59E-05	3.89E-12	5.96E-04	8.94E-11
Pu-238	1.04E-04	5.25E+00	5.46E-04	1.22E+02	1.27E-02
Pu-239	1.15E-02	5.82E+00	6.69E-02	1.36E+02	1.56E+00
Pu-240	1.16E-03	5.82E+00	6.75E-03	1.36E+02	1.58E-01
Pu-241	4.20E-02	1.14E-01	4.79E-03	2.66E+00	1.12E-01
Pu-242	1.01E-07	5.48E+00	5.53E-07	1.28E+02	1.29E-05
Ru-103	7.17E-06	9.13E-05	6.55E-10	2.11E-03	1.51E-08
Ru-106	1.84E-03	5.02E-03	9.24E-06	1.17E-01	2.15E-04
Sb-125	1.26E-04	1.14E-04	1.44E-08	2.64E-03	3.33E-07
Sr-90	2.14E-04	1.48E-02	3.17E-06	3.46E-01	7.40E-05
Tc-99	1.27E-03	8.56E-05	1.09E-07	1.99E-03	2.53E-06
U-235	1.90E-07	1.37E+00	2.60E-07	3.19E+01	6.06E-06
U-238	1.17E-06	1.37E+00	1.60E-06	3.19E+01	3.73E-05
Zr-95	3.62E-06	2.21E-04	8.00E-10	5.10E-03	1.85E-08
TOTAL			7.97E-02		1.86E+00

Table 2.28. (continued)

Radionuclide	Airborne Source Term[a] (Ci)	50-Year EDE to Maximally Exposed Individual Off-Site from 1 Ci Release (mrem)	50-Year EDE to Maximally Exposed Individual Off-Site (mrem)	50-Year EDE to Off-Site Population from 1 Ci Release (person-rem)	50-Year EDE to Off-Site Population (person-rem)
Fire-Initiated Release					
Am-241	2.11E-06	1.88E+04	3.97E-02	3.98E+03	8.40E-03
Ba-133	1.28E-08	2.54E-01	3.25E-09	5.38E-02	6.89E-10
C-14	1.99E-07	8.69E-04	1.73E-10	1.84E-04	3.66E-11
Ca-45	1.01E-05	2.21E-01	2.23E-06	4.66E-02	4.71E-07
Ce-144	2.15E-03	1.27E+01	2.73E-02	2.68E+00	5.76E-03
Cm-244	9.71E-09	9.78E+03	9.50E-05	2.07E+03	2.01E-05
Co-60	1.30E-05	5.45E+00	7.09E-05	1.15E+00	1.49E-05
Cs-134	3.88E-06	1.72E+00	6.67E-06	3.63E-01	1.41E-06
Cs-137	1.48E-03	1.16E+00	1.72E-03	2.45E-01	3.63E-04
Eu-154	7.67E-09	9.43E+00	7.23E-08	1.99E+00	1.53E-08
Eu-155	1.56E-09	1.41E+00	2.20E-09	2.99E-01	4.66E-10
H-3	1.42E-03	3.44E-03	4.88E-06	7.27E-04	1.03E-06
Hg-203	4.00E-06	1.65E-01	6.60E-07	3.49E-02	1.40E-07
I-129	9.69E-09	6.52E+00	6.32E-08	1.38E+00	1.34E-08
Na-22	2.00E-06	3.08E-01	6.16E-07	6.63E-02	1.33E-07
Np-237	7.03E-06	1.78E+04	1.25E-01	3.75E+03	2.64E-02

Table 2.28. (continued)

Radionuclide	Airborne Source Term[a] (Ci)	50-Year EDE to Maximally Exposed Individual Off-Site from 1 Ci Release (mrem)	50-Year EDE to Maximally Exposed Individual Off-Site (mrem)	50-Year EDE to Off-Site Population from 1 Ci Release (person-rem)	50-Year EDE to Off-Site Population (person-rem)
Np-239	5.01E-09	8.12E-02	4.07E-10	1.59E-02	7.97E-11
Pu-238	3.12E-04	1.67E+04	5.21E+00	3.52E+03	1.10E+00
Pu-239	2.21E-02	1.85E+04	4.09E+02	3.90E+03	8.62E+01
Pu-240	3.44E-03	1.85E+04	6.36E+01	3.90E+03	1.34E+01
Pu-241	4.75E-02	3.62E+02	1.72E+01	7.65E+01	3.63E+00
Pu-242	3.01E-07	1.74E+04	5.24E-03	3.67E+03	1.10E-03
Ru-103	2.39E-07	2.87E-01	6.86E-08	6.06E-02	1.45E-08
Ru-106	1.26E-04	1.59E+01	2.00E-03	3.37E+00	4.25E-04
Sb-125	4.20E-06	3.59E-01	1.51E-06	7.60E-02	3.19E-07
Sr-90	1.52E-05	4.71E+01	7.16E-04	9.95E+00	1.51E-04
Tc-99	4.43E-05	2.72E-01	1.20E-05	5.74E-02	2.54E-06
U-235	7.18E-07	4.35E+03	3.12E-03	9.18E+02	6.59E-04
U-238	1.13E-05	4.35E+03	4.92E-02	9.18E+02	1.04E-02
Zr-95	1.21E-07	6.94E-01	8.40E-08	1.47E-01	1.78E-08
TOTAL			4.95E+02		1.04E+02

[a]Source: Reference 29, p. C-71

The calculated maximally exposed off-site individual dose resulting from the direct release is 0.08 mrem. The calculated maximally exposed off-site individual dose from a fire is 495 mrem. The corresponding maximum off-site population doses are 1.86 person-rem and 104 person-rem, respectively. The maximally exposed individual dose for the fire is significantly higher than that presented in the SRS safety analysis because the release was assumed to occur at the center of A-Area for this study. However, this dose was not recalculated because of the low frequency of the event.

2.3.6 Integrated Site Effects

After a warning period of at least a day,[44] a violent windstorm many miles in diameter would appear over the SRS, cause severe damage (including damage to the eleven nuclear facilities that can release radioactive materials at these force levels), and then dissipate. As shown in the previous sections, the existing safety analyses predict that seven of the nuclear facilities at the SRS would release radioactive material immediately into the wind field and four others would spill liquid radioactive materials that would evaporate during the next day. Table 2.29 tabulates the expected dose and risk by facility for airborne radionuclide releases resulting from an extreme straight-line wind event with wind speeds exceeding 150 mph. Results are presented both for the maximally exposed off-site individual and for the off-site population (worst-sector results). Similarly, Table 2.30 tabulates the expected dose and risk by facility for liquid releases resulting from an event of this magnitude.

2.3.6.1 Maximally Exposed Off-Site Individual Dose and Risk (from airborne releases)

One could simply sum the maximally exposed off-site individual doses and risks for all affected facilities to obtain integrated site values for this event. However, as discussed in Section 2.2.6.1, this approach is rather illogical and generates overly conservative results.

Two more realistic approaches for estimating integrated doses and risks are described in Section 2.2.6.1. Briefly, the first of these approaches involves adjusting the dose values from each affected facility to obtain an integrated dose for the maximally exposed off-site individual location for the dominant facility. The fire-initiated release from the SRTC Technical Area (Section 2.3.5.2) results in the dominant maximally exposed off-site individual dose. The boundary location

Table 2.29. Doses and risks by facility for airborne releases resulting from an extreme straight-line wind event with wind speeds exceeding 150 mph

Facility	Accident Frequency ($year^{-1}$)	Maximally Exposed Individual		Off-Site Population	
		Dose[a] (mrem)	Risk (rem/year)	Dose[a] (person-rem)	Risk (person-rem/year)
F-Area Outside Facilities	3.3E-05	1.6E-03	5.3E-11	9.3E-02	3.1E-06
Production Control Facilities (772-F)	3.3E-05	3.9E-05	1.3E-12	2.2E-03	7.3E-08
New Production Control Facilities (772-1F)	3.3E-05	8.8E+01	2.9E-06	5.1E+03	1.7E-01
Building 247-F Plutonium Storage Facility	7.3E-07	1.9E-07	1.4E-16	1.1E-05	8.0E-12
Solid Waste Disposal Facilities	3.3E-05	2.8E-01	9.4E-09	2.0E+01	6.5E-04
H-Area Outside Facilities	3.3E-05	6.4E-03	2.1E-10	5.3E-01	1.7E-05
F/H Effluent Treatment Facility	3.3E-05	1.4E-04	4.6E-12	1.2E-02	4.0E-07
Consolidated Tritium Facility (234-H)	3.3E-05	1.1E-01	3.6E-09	8.8E+00	2.9E-04
Saltstone Facility	3.3E-05	3.4E-07	1.1E-14	2.9E-05	9.6E-10
SRTC Technical Area					
• Direct release	3.3E-05	8.0E-02	2.6E-09	1.9E+00	6.3E-05
• Fire-initiated release	3.3E-07[b]	5.0E+02	1.6E-07	1.0E+02	3.4E-05
Fuel Fabrication Facility (321-M)					
• Direct release	3.3E-05	2.4E-01	7.9E-09	6.5E+00	2.2E-04
• Nuclear criticality	3.3E-07[c]	1.7E+01	5.7E-09	1.1E+01	3.6E-06

[a]50-year effective dose equivalent (EDE) estimated by using ICRP-30 dose conversion factors

[b]Return frequency for a 150 mph - 175 mph wind event (3.3E-05/year) multiplied by the conditional probability of fire (1E-02)

[c]Return frequency for a 150 mph - 175 mph wind event (3.3E-05/year) multiplied by the conditional probability of nuclear criticality (1E-02)

Table 2.30. Doses and risks by facility for liquid releases resulting from an extreme straight-line wind event with wind speeds exceeding 150 mph

Facility	Accident Frequency ($year^{-1}$)	Maximally Exposed Individual		Off-Site Population	
		Dose[a] (mrem)	Risk (rem/year)	Dose[a] (person-rem)	Risk (person-rem/year)
F-Area Outside Facilities	3.3E-05	2.8E-03	9.2E-11	1.9E-01	6.3E-06
H-Area Outside Facilities	3.3E-05	1.9E+01	6.3E-07	6.8E+01	2.2E-03
F/H Effluent Treatment Facility	3.3E-05	4.2E-02	1.4E-09	3.0E-01	9.9E-06

[a]50-year effective dose equivalent (EDE) estimated by using ICRP-30 dose conversion factors

closest to A-Area is the location for the off-site individual. A maximum dose of 592 mrem is calculated by following this approach.

The second of the two more realistic approaches for estimating integrated doses and risks considers only those facility releases that result in maximum off-site individual exposure at the same location as the dominant facility. Again, the fire-initiated release from the SRTC Technical Area (Section 2.3.5.2) results in the dominant maximally exposed off-site individual dose. A maximum dose of 495 mrem is calculated by following this approach.

Table 2.31 presents the integrated doses and risks to the maximally exposed off-site individual (from airborne releases only) that result from applying these three approaches.

2.3.6.2 Maximally Exposed Off-Site Individual Dose and Risk (from liquid releases to surface water)

As mentioned in Section 2.2.6.2, the maximally exposed off-site individual with regard to any radionuclide release to surface water bodies is assumed to live alongside the Savannah River south of the SRS. Therefore, doses resulting from liquid spills at the facilities affected by the extreme straight-line wind event can be summed to obtain the integrated dose. Maximum doses from airborne releases are realized at locations along the northern and western site boundaries. Therefore, it is inappropriate to combine these doses with those resulting from releases to surface water bodies. The integrated dose to the maximally exposed off-site individual from liquid releases to surface water is then 19 mrem, and the integrated risk is 6.3×10^{-7} rem/year.

2.3.6.3 Maximum Off-Site Population Dose and Risk (from airborne releases)

One can simply sum the maximum off-site population doses resulting from airborne releases from each facility to derive an integrated maximum off-site population dose for the site for this event. This approach is valid because the worst sector with regard to population dose is the same for all affected facilities (west-northwest sector). The dominant sectors in this direction from E, F, H, Z, and M/A Areas do not overlay exactly. However, at the off-site location corresponding to the bulk of the population (Augusta, Georgia), the sector difference is insignificant. The integrated dose is 5,205 person-rem, and the integrated risk is 0.17 person-rem/year.

Table 2.31. Integrated doses and risks to the maximally exposed off-site individual for airborne releases resulting from an extreme straight-line wind event with wind speeds exceeding 150 mph

Calculation Option		Dose[a] (mrem)	Risk (rem/year)
1.	Sum worst-case, worst-sector doses/risks for all affected facilities, not accounting for the different receptor locations	6.0E+02	3.2E-06
2.	Sum worst-case doses/risks for a single boundary location (location of the maximally exposed off-site individual for the dominant facility)	5.9E+02	3.1E-06
3.	Sum worst-case, worst-sector doses/risks for facilities whose maximally exposed off-site individual is located in the same sector as the maximally exposed off-site individual of the dominant facility; ignore doses/risks for other facilities	5.0E+02	1.6E-07

[a]50-year effective dose equivalent (EDE) estimated by using ICRP-30 dose conversion factors

2.3.6.4 Maximum Off-Site Population Dose and Risk (from liquid releases to surface water)

The integrated maximum off-site population dose and risk resulting from releases to surface water are 68.5 person-rem and 0.0023 person-rem/year, respectively. The individual facility contributions shown in Table 2.30 are simply summed to obtain these results.

2.3.6.5 Risk

Tables 2.29 and 2.30 show the expected frequencies and risks associated with the facilities damaged by an extreme straight-line wind event with wind speeds exceeding 150 mph. With regard to airborne releases, the dominant risk contributor is the New Production Control Facility. For liquid releases to surface water bodies, the dominant risk contributor is the H-Area Outside Facilities. Figure 2.4 displays the risk of the individual facility releases in a graphic format.

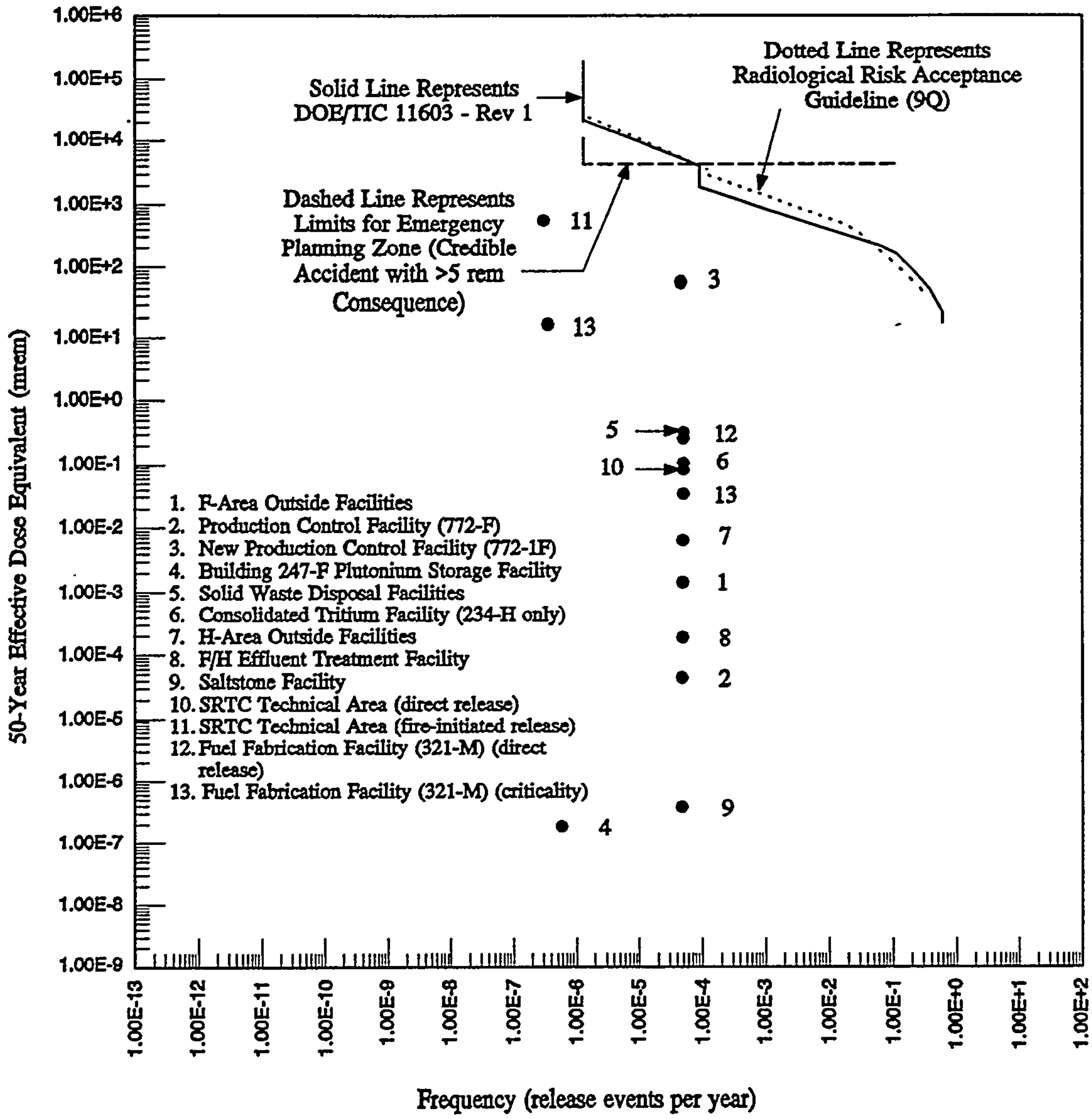

Figure 2.4. Public risks associated with an extreme straight-line wind event with wind speeds exceeding 150 mph.

2.4 SUMMARY

To summarize, it is possible to model a scenario in which a violent windstorm damages multiple facilities at the SRS with extreme straight-line winds. Based on the facility safety analysis reports, only the more vulnerable facilities would release radionuclides as a result of such damage. The results of analyzing these scenarios with conservative release assumptions and conservative dispersion models indicate that 50-year effective dose equivalents to the hypothetical maximally exposed off-site individual and the off-site population would be negligible.

For extreme straight-line wind events in the more likely 100 mph - 150 mph wind-speed range, the maximally exposed off-site individual would receive about 23 mrem, and the ~200,000 persons in the worst-case off-site population sector would receive a total of 332 person-rem from airborne releases. The maximum dose that an off-site individual could receive from liquid releases in this scenario is 19 mrem; the maximum dose that the entire off-site population within a 50-mile radius of the site could receive from liquid releases in this scenario is 68.5 person-rem.

For extreme straight-line wind events in the less likely 150 mph-and-greater wind-speed range, the resulting maximum off-site doses are higher than those for the more likely wind-speed range. The maximally exposed off-site individual would receive about 495 mrem, and the ~200,000 persons in the worst-case off-site population sector would receive a total of 5,205 person-rem from airborne releases. The maximum dose that an off-site individual could receive from liquid releases in this scenario is 19 mrem; the maximum dose that the entire off-site population within a 50-mile radius of the site could receive from liquid releases in this scenario is 68.5 person-rem.

Two conclusions can be made about the threat that these high-wind scenarios present to the SRS. First, because these worst-case dose values are 50-year totals, the average yearly expected dose from these scenarios would be in the range of 10-20 mrem, a dose that would be extremely difficult to measure and that is an order of magnitude below the average annual background dose experienced by persons living off-site. Second, worst case assumptions have been utilized in analyzing these scenarios; the actual off-site dose, given that one of these events occurs, is likely to be one-to-two orders of magnitude lower. Thus, without discussing probabilistic aspects of the scenarios, the threat from exposure to radioactivity that the scenarios present to persons located off-site is negligible. This is especially true when the threat from exposure to radioactivity is placed in the context of the direct threat to life and health from the extreme wind event itself.

3.0 TORNADO EVENTS

For this study, interest is centered on a tornado event (a ground strike by a tornado or group of tornadoes) of sufficient magnitude to cause destruction simultaneously at several nuclear facilities located in one or more operating areas of the SRS.

3.1 CHARACTERIZATION, TERMINOLOGY, AND MODELING

A tornado is a violently whirling air vortex sufficiently compact to enable it to be distinctly visible in relation to the surrounding air. Such a vortex is usually observed to form during the collapsing phase of a violent, long-lived, thunderstorm that is organized around a single powerful updraft. While a tornado is a transient storm phenomenon, it can extend to contact (strike) the ground, moving in an approximately straight path for a sustained time (of the order of minutes). Typically, but not always, thunderstorms which include tornados form over flat terrain regions and, at the SRS, move in a generally southwest-to-northeast direction.

The DOE uses the Fujita-Pearson classification scheme for characterization of tornado events.[41] This classification scheme is based on damage assessments following a tornado strike, and it ranks the tornado event by damage severity, path length and path width. Each classification on the Fujita scale has a range of associated wind speeds; for example, the median peak gust wind speed values that are associated with F-4 through F-0 classifications are: F-4, 234 mph; F-3, 182 mph; F-2, 135 mph; F-1, 93 mph; and F-0, 56 mph. Similarly, each classification has a range of associated path lengths and widths; these Pearson path length and width values are distances in which damage caused by winds exceeding 75 mph can be found. It is important to note that the damage found to be caused by peak gust winds will have path width values that will be much lower. That is, given a tornado strike area defined by the Pearson values, the actual area in which the peak gusts impact will be relatively small. For example, Pearson value ranges (damage caused by wind speeds exceeding 75 mph) for an F-4 tornado classification are 31.6 to 99 miles for path length and 557 to 1759 yards for path width, yet the path width wherein damage is caused by wind speeds of 234 mph will actually be about 200 yards.

Because tornado events are very terrain and locality dependent, the frequencies of occurrence for various tornado wind speeds will vary significantly between different DOE sites.

At some sites, tornadoes are not considered to be a concern. At others, specific design criteria are defined.

3.1.1 Tornado Events at the SRS

Historically, tornado events have occurred at the SRS. Between 1950 and 1992, the National Severe Storms Center logged about 680 tornado events within a 125-mile radius of the center of the SRS.[45] Eleven of these have been classified as F-4 tornado events; 22 as F-3; 163 as F-2; 363 as F-1; and the remainder as F-0. As noted previously, these Fujita-scale classifications are based on damage assessment.

The DOE has adopted a tornado event probability model for the SRS that was shown previously in Figure 2.1. The tornado curve in Figure 2.1 represents the mid-range of the expected 95% confidence level projection. Credible tornado events are projected to occur at any point on the site within a range of fastest-mile wind speeds from 46 mph to 207 mph (a range of peak gust wind speeds of 60 mph to 228 mph) with expected frequencies of 5 x 10^{-4}/year to 1 x 10^{-6}/year, respectively. (See the note on fastest-mile wind speeds in the next section.) (NOTE: This model was adopted in 1990. SRS safety analyses that were documented prior to this date may show maximum wind speeds and associated return frequencies that differ from this model.) For standardization, risk calculations in this document use the return frequency value associated with a specific wind speed taken from this DOE model.

Note that in the figure, a frequency of occurrence of 1 x 10^{-6}/year corresponds to a peak gust wind speed of 228 mph, a gust speed value roughly matching values found in the lower end of the F-4 tornado wind speed range. The 1 x 10^{-6}/year frequency of occurrence value is generally adopted in safety analysis for an event that is "not credible." For this reason, Fujita-scale F-4 and F-5 tornado events are not considered "credible" at the SRS and are not analyzed in this study, although they have been considered as accident initiators in some safety analysis documentation.

3.1.2 Fastest-Mile Wind Speed

As noted in Section 2.1.2, the fastest-mile wind speed is an American National Standards Institute (ANSI) wind measurement concept that is used to distinguish steady air mass movement from gusts. The fastest-mile wind speed is the average speed of a body of air, measured at a height of 10 m, averaged over a distance of one mile. Care must be taken when reading the wind-speed scale in Figure 2.1. The curve for extreme straight-line winds in the figure corresponds to fastest-mile wind speed values on the wind-speed scale. The curve for tornado events, however, does not correspond to fastest-mile wind speed values. It represents peak gust wind speeds at 10-m height.

3.1.3 Radionuclide Release Models

In a manner similar to that described in Section 2.1.3, modeling a radionuclide release from several concurrently damaged facilities requires consideration of several facility-specific characteristics. Again, each of the facilities must have a similar failure threshold. That is, for each facility to incur damage from the same natural phenomena initiator, the force level at which each facility fails (with a resultant radionuclide release) must be below the force level of the initiating event.

For tornado events at the SRS, it is convenient to use Fujita-scale classifications as failure threshold ranges of peak gust wind speeds because (1) the rarity of these events and the difficulty of their measurement precludes development of detailed force vector models, (2) the rarity of these events and the difficulty of their measurement precludes precise recurrence interval or frequency prediction (i.e., frequency prediction is more meaningful for a range of wind speeds than for a specific speed), and (3) the failure thresholds for the facilities under tornado wind loading were generally determined judgmentally rather than systematically.

Again, the second consideration is that of delay time. That is, the time between structural failure of the facility and the beginning of a radionuclide release must be considered. This consideration may impact the type of dispersion model used and will impact how releases from different facilities are combined.

The third consideration is the radioactivity spectrum and quantity of the material at risk in a specific facility. The radionuclide content of a facility may vary with time. This may result in modeling the release as a "worst-case" activity level, a more typical average activity level, or both.

The fourth consideration is the amount of material released. In one facility, the probability may be high that all the material at risk is released when the threshold force level is exceeded. A different facility may only release a portion of the material at that threshold force level, requiring a higher force level to release all of it.

The physical form of the material may impact how the radionuclides are dispersed. In one facility the radionuclide release may be entirely airborne; in another, liquid may be released to a local watershed. Thus, concurrent releases from several facilities may impact different geographic areas.

Three force impact aspects must also be considered when a radionuclide release caused by a tornado event is modeled. First, unlike an extreme straight-line wind event, a tornado event has a relatively narrow impact path width. As explained previously, impact paths for tornado wind damage, even for tornadoes with 250-mph peak gust speeds, are about 200 yards wide or less. This means that in reality it is probably not possible for a tornado event to cause radionuclide releases from multiple facilities at more than one SRS operating area, unless multiple tornado funnels impact the site. Because the possibility of multiple tornado funnels cannot be ruled out, it is assumed for this analysis that all vulnerable facilities at the SRS could be impacted by a tornado event.

The second aspect of tornado impact to be considered is that of damage caused by facility pressurization. As pointed out above, the path width for wind damage caused by peak gust winds is relatively narrow, so that if wind damage to a facility occurs, it is virtually certain that the damage was caused by actual funnel cloud contact, not a "near miss." This contact will cause a transient pressurization of the facility envelope as the vortex passes over it. Most of the SRS safety analyses considered this phenomenon generically and made conservative assumptions about it, particularly in regard to those facilities with gloveboxes or vulnerable ventilation systems. Typically, an analysis simply assumes that a glovebox radionuclide inventory would be blown from the glovebox for dispersion through open ducts, doors, etc.

The third aspect of tornado impact to be considered is that of damage caused by tornado missiles. Unlike the damage caused by wind or pressurization, the path width for missile damage can be relatively wide, up to the Pearson path width and perhaps beyond. Nuclear facilities which may not be vulnerable to 75-mph wind force may be vulnerable to an object propelled at 75 mph. Exterior piping, utilities, and ductwork can be vulnerable to missile damage. In most cases, the SRS safety documentation did not specifically address tornado missile damage to the nuclear facilities because the facilities feature blast-resistant construction that would withstand credible missile impacts.

3.1.4 Radionuclide Dispersion Models

The radiological consequences of radionuclides released as a result of a tornado event are evaluated for two population groups: the off-site individual receiving the maximum dose and the off-site population within 50 miles (80 km).

For each event involving facility damage, the associated radiological consequences resulting from airborne releases are analyzed by using either the AXAOTHER or the AXAIR89Q computer codes. The AXAOTHER code is used to calculate the consequences associated with incidents that occur during the tornado event. The AXAIR89Q code is used to calculate the consequences resulting from the release of radioactive materials after the tornado event in relatively still atmospheric conditions. Both codes estimate the dose from the inhalation of radioactive materials as well as the dose from immersion in the dispersed airborne radioactive materials. Neither code considers a dose received from food pathways.

Again, the release points for facilities in the various operating areas are set at the center of each area, as shown in Figure 2.2. Although these are not the exact release points from the damaged facilities, the impact on dose calculations of assuming a single, central release point for each area is insignificant in most cases because of the relatively large downwind distances involved.

The consequences of releasing radionuclide-bearing liquids to surface streams are estimated by using the LADTAP XL code. LADTAP XL models public exposures via ingestion of contaminated aquatic foods, ingestion of contaminated water, and contact with contaminated water through recreational activity.

The three computer codes are described further in the following sections.

3.1.4.1 AXAOTHER

Dispersion associated with tornadoes is modeled within AXAOTHER by using a simplified methodology with the following assumptions: (1) small respirable particles (up to 10 microns) that are released are initially lifted as a small puff to heights of 75 m or 400 m above the ground inside the tornado vortex and are then assumed to diffuse out of the vortex; (2) after diffusing from the tornado vortex, the puff of radioactive material is carried along behind the tornado, and (3) heavy rains accompany the thunderstorm during the first 10 min, decreasing to light rains for the next 20 min. Finally, the puff is allowed to continue to disperse in unstable atmospheric conditions in the wake of the thunderstorm. The AXAOTHER code estimates doses utilizing X/Q values input by the user. The X/Q values are taken from the curves for two release heights in Figure 17 of the *Environmental Dose Assessment Manual*.[43] The curve for each release height is a composite of the concentration at the lowest and highest translational velocities. The concentration is greatest at short distances for low velocities and lowest at large distances for high velocities. Hence, each curve is a profile of worst-case conditions at that release height.

Radiation doses from inhalation of radionuclides in air depend on the quantity of radionuclides released; the dispersion factor (X/Q); the physical, chemical, and radiological nature of the radionuclides; and various biological parameters such as breathing rate. Standard breathing rates and ICRP-30 50-year inhalation dose conversion factors for adults are used in the AXAOTHER code for calculating the maximum dose to an off-site individual. Standard breathing rates for the mix of several age groups in the projected 1993 off-site population in a specific sector are combined for calculating the dose to the largest population group residing within 50 miles of the release point. However, ICRP-30 50-year inhalation dose conversion factors for adults are used for all age groups in the projected off-site population.

Radiation doses from immersion result from radiation emanating from the dispersed airborne radioactive materials and are affected by the spatial distribution of the radionuclides, the energy of the radiation, and the extent of shielding. In the AXAOTHER code no shielding was assumed for the off-site individual receiving the maximum dose, and 50% shielding was assumed for the off-site population. The immersion doses were calculated by using a uniform plume model because only ground-level dispersion factors associated with such events are known.

3.1.4.2 AXAIR89Q

The AXAIR89Q code is used to calculate the consequences resulting from the release of radioactive materials after the tornado event has passed. The modeling of consequences resulting from tornado events is the same as that described in Section 2.1.4.2 for extreme straight-line wind events.

3.1.4.3 LADTAP XL

The LADTAP XL code is used to model the environmental effects of radioactive materials released in liquid effluents. The modeling of consequences resulting from tornado events is the same as that described in Section 2.1.4.3 for extreme straight-line wind events.

3.1.5 Information from Existing Safety Analyses

In general, a peak gust wind speed of 73 mph is considered to be the lower threshold of tornado events considered in the safety documentation, with a peak gust wind speed of 206 mph being considered the upper level of tornado event credibility for the geographic region of the SRS.

3.1.5.1 Tornado Events with a Peak Gust Speed Between 73 mph and 112 mph (F-1 Fujita Scale)

For tornado events with wind speeds between 73 and 112 mph, the analysis documentation identifies only one facility which may have a tornado-initiated release of radioactive materials:

200 F Area

Bldg. 772-F, Production Control Facility (108 mph)

Safety analysis documentation for certain other SRS nuclear facilities does not consider tornado events as accident initiators. However, these same documents demonstrate that the subject facilities are vulnerable to extreme straight-line winds exceeding a particular wind speed. To be consistent in this study, it is assumed that if a facility is determined to fail from extreme straight-line winds at a specific fastest-mile wind speed, the facility would also fail in a tornado event at a peak gust wind speed that corresponds to that fastest-mile wind speed, unless there is evidence in the safety analysis documentation that failure from a tornado event cannot occur. Because of this assumption, one additional facility is included in the analysis of this class of tornadoes:

200 H Area

Bldg. 234-H, Consolidated Tritium Facility (75 mph fastest-mile wind speed)

3.1.5.2 Tornado Events with a Peak Gust Speed Between 113 mph and 157 mph (F-2 Fujita Scale)

For tornado events with wind speeds between 113 mph and 157 mph, the analysis documentation identifies an additional six facilities which may have a tornado-initiated release of radioactive materials:

200 F Area

Bldg. 241-F et al., F-Area Outside Facility Operations (113 mph)

200 E Area

Bldg. 643-G et al., Solid Waste Disposal Areas (113 mph)

200 H Area

Bldg. 211-H et al., H-Area Outside Facility Operations (113 mph)
Bldg. 241-84H, F/H Effluent Treatment Facility (113 mph)

200 Z Area

Bldg. 210-Z et al., Saltstone Facility (113 mph)

300 M Area

Bldg. 321-M, Fuel Fabrication Facility (113 mph)

In addition, the safety analysis for the Consolidated Tritium Facility identifies a larger source term for tornadoes with an F-2 classification.

3.1.5.3 Tornado Events with a Peak Gust Speed Between 158 mph and 206 mph (F-3 Fujita Scale)

For tornado events with wind speeds between 158 mph and 206 mph, the analysis documentation identifies an additional three facilities which may have a tornado-initiated release of radioactive materials:

200 F Area

Bldg. 772-1F, New Production Control Facility (180 mph)
Bldg. 221-F, A-Line Operations (158 mph)
Bldg. 235-F (158 mph)

In addition, the safety documentation for the F-Area Outside Facilities, Solid Waste Disposal Areas (except for the E-Area Vaults), Consolidated Tritium Facility, and Fuel Fabrication Facility assumes larger source terms for tornadoes of this magnitude. Furthermore, although the documentation for two other SRS nuclear facilities did not specifically analyze the facilities for damage by a tornado event, it shows that the facilities are vulnerable to extreme straight-line winds in this wind speed range. These facilities are included in the analysis of this class of tornadoes for consistency:

700 A Area

Bldg. 773-A et al., SRTC Technical Area (150 mph fastest-mile wind speed)

200 F Area

Bldg. 247-F, Plutonium Storage Facility (150 mph fastest-mile wind speed)

Consequently, integrated source terms from six site areas will be evaluated for tornado event initiators. It should be noted that the safety documentation for transportation of hazardous materials by truck and rail at the SRS excludes consideration of tornado events because transport operations are not conducted during the weather conditions in which such events occur.

3.2 DOSES AND RISKS RESULTING FROM A TORNADO EVENT WITH PEAK GUST SPEED BETWEEN 73 MPH AND 112 MPH (F-1 FUJITA SCALE)

The basic accident scenario to be analyzed postulates that a tornado event occurs at the SRS with a peak gust speed between 73 and 112 mph. The existing safety analysis documentation predicts that two SRS nuclear facilities will incur damage from this accident initiator sufficient to result in a release of radioactive material.

3.2.1 200 F Area

The site boundary location for the hypothetical off-site individual receiving the greatest airborne dose is 5.46 miles from the release point in the west-northwest direction. The population sector with the largest population subject to airborne exposure is the sector located to the west-northwest.

3.2.1.1 Production Control Facility

For this scenario, it was concluded by the SRS safety analysis[3] that there would be no release of radioactive materials from the Production Control Facility per se because of its construction. However, the analysis assumed that the ventilation system stack external to the facility would collapse under this type of tornado wind load, destroying the collocated ventilation system filter house. To create a conservative estimated source term, the analysis postulated that a laboratory accident had occurred within the facility just prior to the tornado event. The loss of the filter house to the tornado event would allow 0.5% of the accident source term to migrate outside the facility to be dispersed by winds ranging from 13 to 50 mph. For this study, off-site doses are calculated by using the AXAOTHER code for tornado dispersion at 75 m height.

Table 3.1 displays the source term and the resulting calculated doses for an airborne release from this facility. The calculated maximally exposed off-site individual dose resulting from the airborne release is 0.001 mrem. The calculated maximum off-site population dose from the airborne release is 0.012 person-rem.

3.2.2 200 H Area

The site boundary location for the hypothetical off-site individual receiving the greatest airborne dose is 7.25 miles from the release point in the north direction. The population sector with the largest population subject to airborne exposure is the sector located to the west-northwest.

3.2.2.1 Consolidated Tritium Facility

For the extreme straight-line wind scenario, the SRS safety analysis[25] assumed that 0.01% of the tritium inventory stored in the equipment and piping would be released in the event of facility damage by winds with fastest-mile speeds in the range 73 mph - 100 mph. Logically, the same damage can be caused by a tornado with a peak gust speed equivalent to the extreme straight-line wind speed. In the safety analysis, 1% of the released tritium was assumed to be in oxide form. Therefore, off-site doses are calculated with the AXAOTHER code for tornado dispersion at 75 m height. Table 3.2 shows the source term and resulting calculated doses for an airborne release from this facility. The calculated maximally exposed individual dose resulting from the airborne release is negligible. The calculated maximum off-site population dose from the airborne release is 0.009 person-rem.

3.2.3 Integrated Site Effects

Additional clarification and description is required to give meaning to the calculated integrated off-site dose values for a tornado event that damages two separate facilities in two separate operations areas. In such a scenario, after a warning period of at least a day,[44] a violent thunderstorm many miles in diameter would appear over the SRS. Without much warning, however, a tornado or group of tornadoes associated with the storm cause severe damage, including damage to the two nuclear facilities that can release radioactive materials. Obviously,

Table 3.1. Airborne radionuclide source terms and calculated off-site doses for the Production Control Facility (772-F) resulting from a tornado event with peak gust speeds in the range 73 mph - 112 mph (F-1 Fujita Scale)

Radionuclide	Airborne Source Term[a] (Ci)	50-Year EDE to Maximally Exposed Individual Off-Site from 1 Ci Release (mrem)	50-Year EDE to Maximally Exposed Individual Off-Site (mrem)	50-Year EDE to Off-Site Population from 1 Ci Release (person-rem)	50-Year EDE to Off-Site Population (person-rem)
Sr-89	2.34E-08	4.79E-03	1.12E-10	3.87E-02	9.06E-10
Sr-90	2.23E-09	1.68E-01	3.75E-10	1.36E+00	3.03E-09
Y-90	2.23E-09	1.06E-03	2.36E-12	8.43E-03	1.88E-11
Y-91	3.58E-08	5.69E-03	2.04E-10	4.60E-02	1.65E-09
Zr-95	3.58E-07	2.46E-03	8.81E-10	2.01E-02	7.20E-09
Nb-95	2.38E-08	5.82E-04	1.39E-11	4.93E-03	1.17E-10
Ru-103	1.94E-08	1.01E-03	1.96E-11	8.29E-03	1.61E-10
Ru-106	1.97E-08	5.69E-02	1.12E-09	4.60E-01	9.06E-09
Ag-110m	2.27E-09	6.86E-03	1.56E-11	5.62E-02	1.28E-10
Sn-123	3.06E-10	3.88E-03	1.19E-12	3.14E-02	9.61E-12
Sb-125	3.86E-10	1.27E-03	4.90E-13	1.04E-02	4.01E-12
Te-127	5.83E-10	3.66E-05	2.13E-14	2.72E-04	1.59E-13
Te-129	3.65E-10	8.20E-06	2.99E-15	3.95E-05	1.44E-14
Cs-134	3.90E-10	6.08E-03	2.37E-12	4.96E-02	1.93E-11
Cs-137	2.99E-09	4.14E-03	1.24E-11	3.35E-02	1.00E-10
Ce-141	1.15E-08	1.10E-03	1.27E-11	8.90E-03	1.02E-10

Table 3.1. (continued)

Radionuclide	Airborne Source Term[a] (Ci)	50-Year EDE to Maximally Exposed Individual Off-Site from 1 Ci Release (mrem)	50-Year EDE to Maximally Exposed Individual Off-Site (mrem)	50-Year EDE to Off-Site Population from 1 Ci Release (person-rem)	50-Year EDE to Off-Site Population (person-rem)
Ce-144	5.38E-08	4.53E-02	2.44E-09	3.66E-01	1.97E-08
Pr-144	5.38E-08	2.48E-06	1.33E-13	2.53E-06	1.36E-13
Pm-147	9.64E-09	4.40E-03	4.24E-11	3.56E-02	3.43E-10
Pm-148m	1.23E-10	1.29E-03	1.59E-13	1.09E-02	1.34E-12
Eu-155	1.70E-10	5.05E-03	8.59E-13	4.08E-02	6.94E-12
U-234	4.45E-17	1.68E+01	7.48E-16	1.36E+02	6.05E-15
U-235	7.12E-16	1.55E+01	1.10E-14	1.25E+02	8.90E-14
U-236	7.12E-16	1.55E+01	1.10E-14	1.25E+02	8.90E-14
U-238	6.58E-14	1.55E+01	1.02E-12	1.25E+02	8.23E-12
Np-237	9.46E-16	6.34E+01	6.00E-14	5.12E+02	4.84E-13
Pu-239	2.20E-05	6.60E+01	1.45E-03	5.33E+02	1.17E-02
TOTAL			1.45E-03		1.17E-02

[a]Source: Reference 3, p. 5-44

Table 3.2. Airborne radionuclide source terms and calculated off-site doses for the Consolidated Tritium Facility (234-H) resulting from a tornado event with peak gust speeds in the range 73 mph - 112 mph (F-1 Fujita Scale)

Radionuclide	Airborne Source Term[a] (Ci)	50-Year EDE to Maximally Exposed Individual Off-Site from 1 Ci Release (mrem)	50-Year EDE to Maximally Exposed Individual Off-Site (mrem)	50-Year EDE to Off-Site Population from 1 Ci Release (person-rem)	50-Year EDE to Off-Site Population (person-rem)
H-3	7.80E+03	7.25E-08[b]	5.65E-04	1.19E-06[b]	9.31E-03
TOTAL			5.65E-04		9.31E-03

[a]Source: Reference 25, p. 3-24

[b]This value was derived by correcting the AXAOTHER result to account for the assumed oxide fraction (1%).

many of the nonnuclear structures both at the site and in the surrounding off-site areas would be damaged. As shown in the previous sections, the SRS safety analyses predict that two nuclear facilities at the SRS would immediately release radioactive material into the wind field. Table 3.3 tabulates the expected dose and risk by facility for airborne releases resulting from an F-1 tornado. Results are presented both for the maximally exposed off-site individual and for the off-site population (worst-sector results).

3.2.3.1 Maximally Exposed Off-Site Individual Dose and Risk (from airborne releases)

Inspecting the dose values for the maximally exposed off-site individual resulting from airborne radionuclide releases (Table 3.3), one could simply sum the maximally exposed off-site individual doses resulting from each facility release to derive an integrated maximally exposed off-site individual dose for the site for this event. However, such a dose value has no physical meaning.

As stated previously in Section 2.2.6.1, a more rational approach is to adjust the maximally exposed off-site individual dose values from each operating area to derive the integrated maximally exposed individual dose at the location of the maximally exposed off-site individual for the dominant facility. The dominant off-site individual dose is realized at the site boundary west-northwest of F-Area. To include the contribution from H-Area at this boundary site, the X/Q value for the Consolidated Tritium Facility must be scaled. First, the distance from the center of H-Area to the boundary site is determined from a site map. Then, the X/Q for this distance is obtained from Figure 17 of the *Environmental Dose Assessment Manual*.[43] The maximally exposed off-site individual dose is then multiplied by the ratio of the "new" X/Q value to the "original" X/Q value corresponding to the H-Area maximally exposed off-site individual location. The scaled Consolidated Tritium Facility dose can then be added to the dominant off-site individual dose from the Production Control Facility. A maximum dose of 0.002 mrem is calculated by using this approach.

The most rational approach for the derivation of an integrated maximally exposed off-site individual dose for the site resulting from this event is to (1) consider only the maximally exposed off-site individual location for the dominant facility and (2) sum the calculated doses for facilities that share this maximally exposed individual location. The maximally exposed off-site individual doses calculated for other facilities are then omitted from the integrated dose calculation. In this

Table 3.3. Doses and risks by facility for airborne radionuclide releases resulting from a tornado event with peak gust speeds in the range 73 mph - 112 mph (F-1 Fujita Scale)

Facility	Accident Frequency ($year^{-1}$)	Maximally Exposed Individual		Off-Site Population	
		Dose[a] (mrem)	Risk (rem/year)	Dose[a] (person-rem)	Risk (person-rem/year)
Production Control Facilities (772-F)	1.4E-04	1.5E-03	2.1E-10	1.2E-02	1.7E-06
Consolidated Tritium Facility (234-H)	1.4E-04	5.65E-04	7.9E-11	9.3E-03	1.3E-06

[a]50-year effective dose equivalent (EDE) estimated by using ICRP-30 dose conversion factors

case, the release from the Production Control Facility (Section 3.2.1.1) results in the dominant maximally exposed off-site individual dose, and the boundary location closest to F-Area is the location for the off-site individual. A maximum dose of 0.0015 mrem is calculated for this case.

Arguments can be made about the credibility of directional phenomena (such as a tornado or group of tornadoes) striking both F and H Areas then dispersing radionuclides to the northwest; insufficient knowledge about particle dispersion in tornadoes is available to permit formulating a validated conclusion. It is clear, however, that the approaches presented here will conservatively bound the potential accident consequences.

Table 3.4 presents the integrated doses and risks to the maximally exposed off-site individual (from airborne releases only) that result from applying these three approaches.

Table 3.4. Integrated doses and risks to the maximally exposed off-site individual for airborne releases resulting from a tornado event with peak gust speeds in the range 73 mph - 112 mph (F-1 Fujita Scale)

	Calculation Option	Dose[a] (mrem)	Risk (rem/year)
1.	Sum worst-case, worst-sector doses/risks for all affected facilities, not accounting for the different receptor locations	2.1E-03	2.9E-10
2.	Sum worst-case doses/risks for a single boundary location (location of the maximally exposed off-site individual for the dominant facility)	2.0E-03	2.8E-10
3.	Sum worst-case, worst-sector doses/risks for facilities whose maximally exposed off-site individual is located in the same sector as the maximally exposed off-site individual of the dominant facility; ignore doses/risks for other facilities	1.5E-03	2.1E-10

[a]50-year effective dose equivalent (EDE) estimated by using ICRP-30 dose conversion factors

3.2.3.2 Maximum Off-Site Population Dose and Risk (from airborne releases)

Inspecting the dose values for the maximum off-site population exposure resulting from airborne radionuclide dispersion (Table 3.3), one can simply sum the maximum off-site population doses resulting from each facility release to derive an integrated maximum off-site population dose for the site for this event. This approach is valid because the worst sector with regard to population dose is the same for all facilities considered (west-northwest sector). The downwind sectors in this direction from F and H Areas do not overlay exactly. However, at the off-site location corresponding to the bulk of the population (Augusta, Georgia), the differences in sector locations are insignificant. A maximum dose of 0.021 person-rem is calculated for this event. The integrated risk is 3×10^{-6} person-rem/year.

3.2.3.3 Risk

Table 3.3 displays the expected frequencies and risks associated with individual facilities damaged by a tornado event with peak gust speeds between 73 mph and 112 mph. The dominant risk contributor is the Production Control Facility. Figure 3.1 displays the risk of the individual facility releases in a graphic format.

3.3 DOSES AND RISKS RESULTING FROM A TORNADO EVENT WITH PEAK GUST SPEED BETWEEN 113 MPH AND 157 MPH (F-2 FUJITA SCALE)

The basic accident scenario to be analyzed postulates that a tornado event with a peak gust speed between 113 and 157 mph occurs at the SRS. The existing safety analysis documentation predicts that eight SRS nuclear facilities will incur damage from this accident initiator sufficient to result in a release of radioactive material.

3.3.1 200 F Area

The site boundary location for the hypothetical off-site individual receiving the greatest airborne dose is 5.46 miles from the release point in the west-northwest direction. The population sector with the largest population subject to airborne exposure is the sector located to the west-northwest.

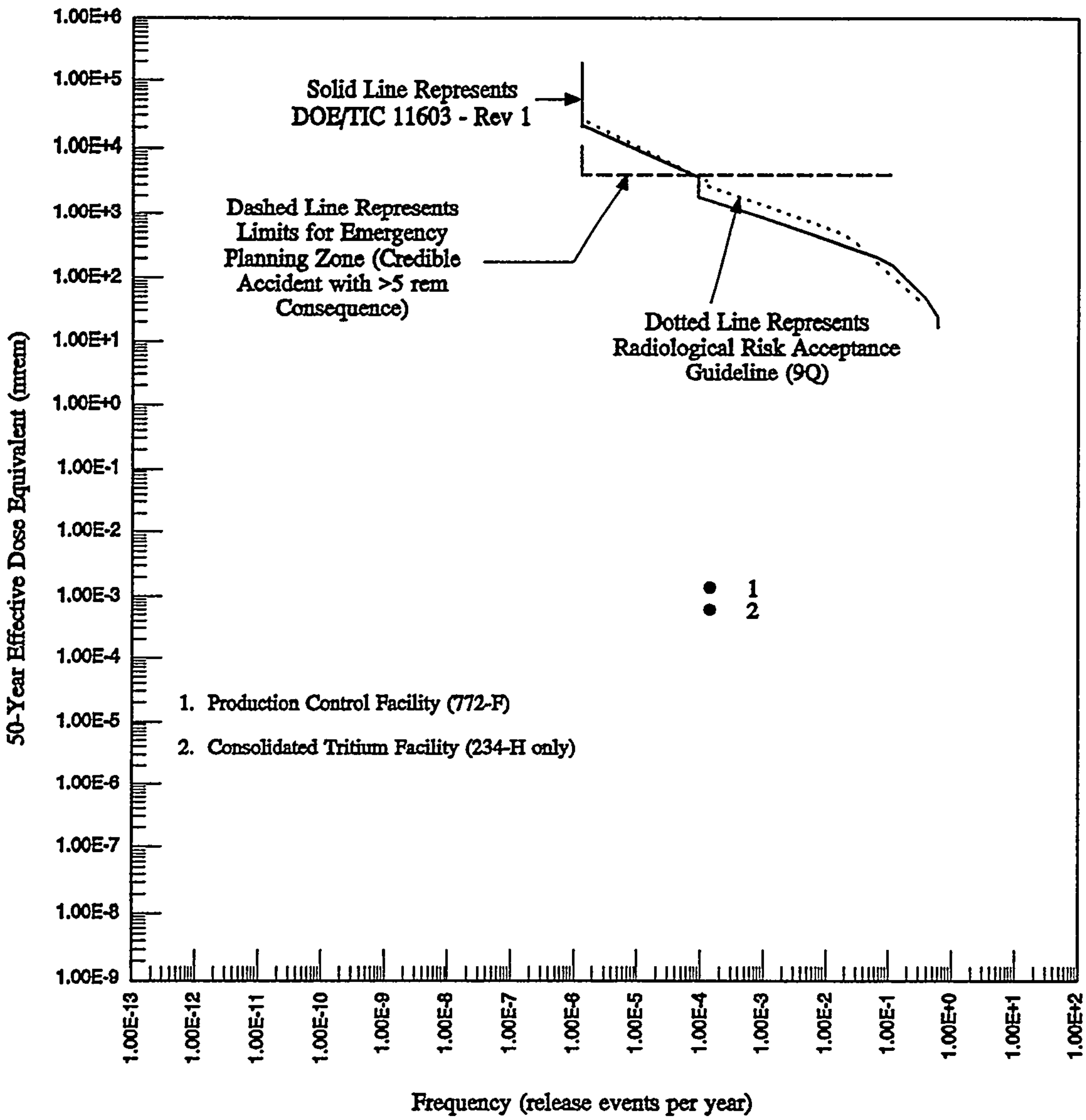

Figure 3.1. Public risks associated with an F-1 tornado event.

3.3.1.1 F-Area Outside Facility Operations

The SRS safety analysis for the F-Area Outside Facility Operations[1] assumed that in this scenario 25% of the liquid contents of the largest vessel in each of seven process loops would be released as the vessel wall was damaged by a tornado with an F-2 classification. The analysis assumed that the liquid would be confined in diked areas in all but one of these liquid releases. Radionuclide dispersion was modeled in the analysis as an evaporation of 30% of the diked material. In the one process loop where there would be insufficient diked area capacity to contain the liquid release, about 16% of the total liquid release was assumed to eventually migrate to Upper Three Runs Creek. In the SRS safety analysis, off-site doses were calculated by using the AXAOTHER code for the evaporative release into 50-mph winds and the LADTAP XL code for the liquid release to the creek. In later safety analyses for other SRS facilities, the AXAIR89Q code was used in place of AXAOTHER to model evaporative releases that may occur following passage of a tornado. To be consistent with this change, off-site doses are calculated for this study by using (1) the AXAIR89Q code for airborne evaporative dispersion in assumed worst-case (99.5%) meteorological conditions and (2) the LADTAP XL code for the liquid release to the creek. Table 3.5 displays the source term and the resulting calculated doses for an airborne release from this facility. The calculated maximally exposed off-site individual dose resulting from the airborne release is 0.339 mrem. The calculated maximum off-site population dose from the airborne release is 1.710 person-rem. Table 3.6 displays the source term and the resulting calculated doses for a liquid release from this facility. The calculated maximally exposed off-site individual dose resulting from the liquid release is 0.003 mrem. The calculated maximum off-site population dose from the liquid release is 0.192 person-rem.

3.3.1.2 Production Control Facility

The SRS safety analysis for the Production Control Facility[3] did not specifically address a tornado event with the F-2 classification. However, after a review of the accident scenario for a tornado event with the lower F-1 classification (Section 3.2.1.1), it is concluded that there is no reason to assume that a larger source term would be generated by the F-2 tornado. For this scenario, the SRS safety analysis concluded that there would be no release of radioactive materials from the facility per se because of its construction. However, the analysis assumed that the ventilation system stack external to the facility would collapse under this type of wind load,

Table 3.5. Airborne radionuclide source terms and calculated off-site doses for the F-Area Outside Facilities resulting from a tornado event with peak gust speeds in the range 113 mph - 157 mph (F-2 Fujita Scale)

Radionuclide	Airborne Source Term[a] (Ci)	50-Year EDE to Maximally Exposed Individual Off-Site from 1 Ci Release (mrem)	50-Year EDE to Maximally Exposed Individual Off-Site (mrem)	50-Year EDE to Off-Site Population from 1 Ci Release (person-rem)	50-Year EDE to Off-Site Population (person-rem)
Zr-95	4.32E-04	5.09E-02	2.20E-05	2.56E-01	1.11E-04
Nb-95	2.44E-04	1.26E-02	3.07E-06	6.28E-02	1.53E-05
Ru-103	2.03E-03	2.11E-02	4.28E-05	1.05E-01	2.13E-04
Ru-106	6.03E-03	1.16E+00	6.99E-03	5.87E+00	3.54E-02
Cs-134	3.60E-09	1.26E-01	4.54E-10	6.34E-01	2.28E-09
Cs-137	3.14E-08	8.47E-02	2.66E-09	4.27E-01	1.34E-08
Ce-141	2.71E-09	2.26E-02	6.12E-11	1.13E-01	3.06E-10
Ce-144	1.95E-07	9.26E-01	1.81E-07	4.67E+00	9.11E-07
U-234	3.27E-04	3.44E+02	1.12E-01	1.74E+03	5.69E-01
U-235	1.82E-04	3.18E+02	5.79E-02	1.60E+03	2.91E-01
U-236	1.82E-04	3.18E+02	5.79E-02	1.60E+03	2.91E-01
U-238	1.82E-04	3.18E+02	5.79E-02	1.60E+03	2.91E-01
Pu-238	1.96E-05	1.22E+03	2.39E-02	6.14E+03	1.20E-01
Pu-239	9.11E-06	1.35E+03	1.23E-02	6.81E+03	6.20E-02
Pu-240	6.24E-06	1.35E+03	8.42E-03	6.81E+03	4.25E-02
Pu-241	5.56E-05	2.65E+01	1.47E-03	1.34E+02	7.45E-03
TOTAL			3.39E-01		1.71E+00

[a]Source: Reference 1, p. B-3

Table 3.6. Liquid radionuclide source terms and calculated off-site doses for the F-Area Outside Facilities resulting from a tornado event with peak gust speeds in the range 113 mph - 157 mph (F-2 Fujita Scale)

Radionuclide	Liquid Source Term[a] (Ci)	50-Year EDE to Maximally Exposed Individual Off-Site from 1 Ci Release (mrem)	50-Year EDE to Maximally Exposed Individual Off-Site (mrem)	50-Year EDE to Off-Site Population from 1 Ci Release (person-rem)	50-Year EDE to Off-Site Population (person-rem)
Zr-95	3.43E-02	3.4E-04	1.17E-05	1.2E-02	4.12E-04
Nb-95	1.17E-02	1.3E-01	1.52E-03	2.2E-01	2.57E-03
Ru-103	3.86E-01	2.7E-04	1.04E-04	3.3E-02	1.27E-02
Ru-106	5.68E-01	2.1E-03	1.19E-03	3.1E-01	1.76E-01
U-234	3.91E-12	2.1E-02	8.21E-14	5.8E-01	2.27E-12
U-235	5.62E-11	2.1E-02	1.18E-12	5.9E-01	3.32E-11
U-236	5.60E-11	2.0E-02	1.12E-12	5.5E-01	3.08E-11
U-238	5.60E-09	1.9E-02	1.06E-10	5.1E-01	2.86E-09
TOTAL			2.83E-03		1.92E-01

[a]Source: Reference 1, p. B-3

destroying the collocated ventilation system filter house. The loss of the filter house to the wind event would allow 0.5% of the accident source term to migrate outside the facility to be dispersed by the high winds during the event. Consequently for this study, off-site doses resulting from the similar event occurring at the higher peak-gust-speed range are calculated by using the AXAOTHER code for tornado dispersion at 75 m height. Because the source term does not change and the AXAOTHER tornado code is a composite model that combines the translational speeds of tornadoes of all peak gust speed ranges, the resulting dose will be the same as that calculated previously for F-1 tornado damage at this facility (Section 3.2.1.1). Table 3.1 cited previously displays the calculated values for source term and the resulting calculated dose for an airborne release from this facility. The calculated maximally exposed off-site individual dose resulting from the airborne release is 0.001 mrem. The calculated maximum off-site population dose from the airborne release is 0.012 person-rem.

3.3.2 200 E Area

The site boundary location for the hypothetical off-site individual receiving the greatest airborne dose is 6.46 miles from the release point in the north-northwest direction. The population sector with the largest population subject to airborne exposure is the sector located to the west-northwest.

3.3.2.1 Solid Waste Disposal Operations

For this scenario, it was assumed by the SRS safety analysis[16,17] that fractions of the contaminated materials stored in the TRU pad drum storage area and the E-Area Vaults (ILTV, ILNTV, and LAWV only) would be released following facility damage by a tornado event with the F-2 classification. Off-site doses are calculated by using the AXAOTHER code for tornado dispersion at 75 m height. Tables 3.7 - 3.10 display the source terms and the resulting calculated doses for airborne releases from these areas. The calculated maximally exposed off-site individual dose resulting from the airborne release (combined releases from TRU pad and E-Area Vaults) is 13 mrem. The calculated maximum off-site population dose from the airborne release is 170.1 person-rem.

Table 3.7. Airborne radionuclide source terms and calculated off-site doses for the TRU pad drum storage area resulting from a tornado event with peak gust speeds in the range 113 mph - 157 mph (F-2 Fujita Scale)

Radionuclide	Airborne Source Term[a] (Ci)	50-Year EDE to Maximally Exposed Individual Off-Site from 1 Ci Release (mrem)	50-Year EDE to Maximally Exposed Individual Off-Site (mrem)	50-Year EDE to Off-Site Population from 1 Ci Release (person-rem)	50-Year EDE to Off-Site Population (person-rem)
Pu-238	2.50E-02	4.03E+01	1.01E+00	5.28E+02	1.32E+01
TOTAL			1.01E+00		1.32E+01

[a]Source: Reference 16, p. 5-47

Table 3.8. Airborne radionuclide source terms and calculated off-site doses for the ILTV resulting from a tornado event with peak gust speeds in the range 113 mph - 157 mph (F-2 Fujita Scale)

Radionuclide	Airborne Source Term[a] (Ci)	50-Year EDE to Maximally Exposed Individual Off-Site from 1 Ci Release (mrem)	50-Year EDE to Maximally Exposed Individual Off-Site (mrem)	50-Year EDE to Off-Site Population from 1 Ci Release (person-rem)	50-Year EDE to Off-Site Population (person-rem)
H-3	5.45E+03	8.31E-06	4.53E-02	1.09E-04	5.94E-01
C-14	5.45E+01	2.10E-06	1.14E-04	2.76E-05	1.50E-03
Mn-54	5.45E-02	5.92E-04	3.23E-05	7.63E-03	4.16E-04
Fe-55	5.45E-01	2.28E-04	1.24E-04	2.99E-03	1.63E-03
Ni-59	5.45E-01	1.14E-04	6.20E-05	1.50E-03	8.16E-04
Co-60	4.32E+00	1.32E-02	5.70E-02	1.73E-01	7.47E-01
Ni-63	5.45E+00	2.63E-04	1.43E-03	3.45E-03	1.88E-02
Zn-65	5.45E-01	1.60E-03	8.72E-04	2.09E-02	1.14E-02
Se-75	5.45E-02	7.32E-04	3.99E-05	9.54E-03	5.20E-04
Se-79	5.45E-06	7.79E-04	4.25E-09	1.02E-02	5.56E-08
Rb-87	5.44E-06	2.89E-04	1.57E-09	3.79E-03	2.06E-08
Sr-90	5.98E+00	1.14E-01	6.82E-01	1.49E+00	8.91E+00
Y-90	5.45E+00	7.17E-04	3.91E-03	9.37E-03	5.11E-02
Nb-94	5.45E-02	3.62E-02	1.97E-03	4.78E-01	2.61E-02
Zr-95	5.45E-01	1.69E-03	9.21E-04	2.21E-02	1.20E-02
Tc-99	5.45E-02	6.56E-04	3.58E-05	8.62E-03	4.70E-04
Ru-106	5.45E-01	3.85E-02	2.10E-02	5.05E-01	2.75E-01

Table 3.8. (continued)

Radionuclide	Airborne Source Term[a] (Ci)	50-Year EDE to Maximally Exposed Individual Off-Site from 1 Ci Release (mrem)	50-Year EDE to Maximally Exposed Individual Off-Site (mrem)	50-Year EDE to Off-Site Population from 1 Ci Release (person-rem)	50-Year EDE to Off-Site Population (person-rem)
Rh-106	5.45E-01	1.71E-10	9.32E-11	1.68E-11	9.16E-12
Ag-110m	5.45E-02	4.74E-03	2.58E-04	6.18E-02	3.37E-03
Cd-115m	5.45E-02	5.69E-03	3.10E-04	7.46E-02	4.07E-03
Sb-125	5.45E-02	8.73E-04	4.76E-05	1.14E-02	6.21E-04
Te-125m	1.36E-02	5.87E-04	7.96E-06	7.70E-03	1.04E-04
Sb-126m	5.45E-06	2.45E-06	1.33E-11	3.22E-05	1.75E-10
Sn-126	5.45E-06	7.51E-03	4.09E-08	9.88E-02	5.38E-07
I-129	5.45E-04	1.58E-02	8.61E-06	2.07E-01	1.13E-04
Cs-134	5.45E-02	4.17E-03	2.27E-04	5.45E-02	2.97E-03
Cs-135	1.16E-05	3.94E-04	4.59E-09	5.19E-03	6.04E-08
Cs-137	5.45E-01	2.80E-03	1.53E-03	3.68E-02	2.01E-02
Ba-137m	5.45E-01	2.75E-06	1.50E-06	1.17E-06	6.38E-07
Ce-144	5.45E-01	3.06E-02	1.67E-02	4.02E-01	2.19E-01
Pr-144	5.45E-01	3.66E-06	1.99E-06	1.81E-05	9.86E-06
Pm-147	5.45E-01	2.98E-03	1.62E-03	3.91E-02	2.13E-02
Sm-151	5.45E-02	2.54E-03	1.38E-04	3.33E-02	1.81E-03
Eu-154	5.45E-02	2.28E-02	1.24E-03	2.99E-01	1.63E-02
Eu-155	5.45E-02	3.42E-03	1.86E-04	4.48E-02	2.44E-03

Table 3.8. (continued)

Radionuclide	Airborne Source Term[a] (Ci)	50-Year EDE to Maximally Exposed Individual Off-Site from 1 Ci Release (mrem)	50-Year EDE to Maximally Exposed Individual Off-Site (mrem)	50-Year EDE to Off-Site Population from 1 Ci Release (person-rem)	50-Year EDE to Off-Site Population (person-rem)
Th-231	5.45E-06	7.10E-05	3.87E-10	9.34E-04	5.09E-09
Th-232	5.45E-06	1.40E+02	7.63E-04	1.84E+03	1.00E-02
Pa-233	5.06E-06	7.51E-04	3.80E-09	9.88E-03	5.00E-08
U-233	1.68E-07	1.14E+01	1.91E-06	1.49E+02	2.51E-05
U-234	5.45E-03	1.14E+01	6.21E-02	1.49E+02	8.12E-01
U-235	7.92E-07	1.05E+01	8.32E-06	1.38E+02	1.09E-04
U-236	5.45E-03	1.05E+01	5.72E-02	1.38E+02	7.52E-01
Np-237	5.06E-06	4.29E+01	2.17E-04	5.63E+02	2.85E-03
U-238	5.45E-03	1.05E+01	5.72E-02	1.38E+02	7.52E-01
Pu-238	4.90E-04	4.03E+01	1.97E-02	5.28E+02	2.59E-01
Pu-239	1.16E-03	4.46E+01	5.18E-02	5.86E+02	6.81E-01
Pu-240	4.90E-04	4.46E+01	2.19E-02	5.86E+02	2.87E-01
Pu-241	4.90E-04	8.75E-01	4.29E-04	1.15E+01	5.64E-03
Am-241	4.90E-04	4.55E+01	2.23E-02	5.97E+02	2.93E-01
Pu-242	4.90E-04	4.21E+01	2.06E-02	5.50E+02	2.70E-01
Am-243	1.44E-04	4.55E+01	6.55E-03	6.00E+02	8.64E-02
Cm-244	4.90E-04	2.36E+01	1.16E-02	3.10E+02	1.52E-01
Cm-248	4.90E-04	1.66E+02	8.14E-02	2.19E+03	1.07E+00

Table 3.8. (continued)

Radionuclide	Airborne Source Term[a] (Ci)	50-Year EDE to Maximally Exposed Individual Off-Site from 1 Ci Release (mrem)	50-Year EDE to Maximally Exposed Individual Off-Site (mrem)	50-Year EDE to Off-Site Population from 1 Ci Release (person-rem)	50-Year EDE to Off-Site Population (person-rem)
Cf-252	4.90E-04	1.14E+01	5.59E-03	1.49E+02	7.30E-02
TOTAL			1.26E+00		1.65E+01

[a]Source: Reference 17, p. 89

Table 3.9. Airborne radionuclide source terms and calculated off-site doses for the ILNTV resulting from a tornado event with peak gust speeds in the range 113 mph - 157 mph (F-2 Fujita Scale)

Radionuclide	Airborne Source Term[a] (Ci)	50-Year EDE to Maximally Exposed Individual Off-Site from 1 Ci Release (mrem)	50-Year EDE to Maximally Exposed Individual Off-Site (mrem)	50-Year EDE to Off-Site Population from 1 Ci Release (person-rem)	50-Year EDE to Off-Site Population (person-rem)
H-3	2.40E+01	8.31E-06	1.99E-04	1.09E-04	2.62E-03
C-14	4.36E+02	2.10E-06	9.16E-04	2.76E-05	1.20E-02
Mn-54	4.36E-01	5.92E-04	2.58E-04	7.63E-03	3.33E-03
Fe-55	4.36E+00	2.28E-04	9.92E-04	2.99E-03	1.30E-02
Ni-59	4.36E+00	1.14E-04	4.96E-04	1.50E-03	6.53E-03
Co-60	4.36E+00	1.32E-02	5.76E-02	1.73E-01	7.54E-01
Ni-63	4.36E+01	2.63E-04	1.15E-02	3.45E-03	1.50E-01
Zn-65	4.36E+00	1.60E-03	6.98E-03	2.09E-02	9.11E-02
Se-75	4.36E-01	7.32E-04	3.19E-04	9.54E-03	4.16E-03
Se-79	4.36E-05	7.79E-04	3.40E-08	1.02E-02	4.45E-07
Rb-87	4.36E-05	2.89E-04	1.26E-08	3.79E-03	1.65E-07
Sr-90	4.80E+01	1.14E-01	5.47E+00	1.49E+00	7.15E+01
Y-90	4.37E+01	7.17E-04	3.13E-02	9.37E-03	4.09E-01
Nb-94	4.36E-01	3.62E-02	1.58E-02	4.78E-01	2.08E-01

Table 3.9. (continued)

Radionuclide	Airborne Source Term[a] (Ci)	50-Year EDE to Maximally Exposed Individual Off-Site from 1 Ci Release (mrem)	50-Year EDE to Maximally Exposed Individual Off-Site (mrem)	50-Year EDE to Off-Site Population from 1 Ci Release (person-rem)	50-Year EDE to Off-Site Population (person-rem)
Zr-95	4.36E+00	1.69E-03	7.37E-03	2.21E-02	9.64E-02
Tc-99	4.36E-01	6.56E-04	2.86E-04	8.62E-03	3.76E-03
Ru-106	4.37E+00	3.85E-02	1.68E-01	5.05E-01	2.21E+00
Rh-106	4.36E+00	1.71E-10	7.46E-10	1.68E-11	7.32E-11
Ag-110m	4.36E-01	4.74E-03	2.07E-03	6.18E-02	2.69E-02
Cd-115m	4.36E-01	5.69E-03	2.48E-03	7.46E-02	3.25E-02
Sb-125	4.36E-01	8.73E-04	3.81E-04	1.14E-02	4.97E-03
Te-125m	1.09E-01	5.87E-04	6.39E-05	7.70E-03	8.38E-04
Sb-126m	4.36E-05	2.45E-06	1.07E-10	3.22E-05	1.40E-09
Sn-126	4.36E-05	7.51E-03	3.28E-07	9.88E-02	4.31E-06
I-129	4.36E-02	1.58E-02	6.89E-04	2.07E-01	9.03E-03
Cs-134	4.36E-01	4.17E-03	1.82E-03	5.45E-02	2.38E-02
Cs-135	8.16E-05	3.94E-04	3.21E-08	5.19E-03	4.23E-07
Cs-137	4.36E+01	2.80E-03	1.22E-01	3.68E-02	1.60E+00
Ba-137m	4.36E+01	2.75E-06	1.20E-04	1.17E-06	5.10E-05

Table 3.9. (continued)

Radionuclide	Airborne Source Term[a] (Ci)	50-Year EDE to Maximally Exposed Individual Off-Site from 1 Ci Release (mrem)	50-Year EDE to Maximally Exposed Individual Off-Site (mrem)	50-Year EDE to Off-Site Population from 1 Ci Release (person-rem)	50-Year EDE to Off-Site Population (person-rem)
Ce-144	4.36E+00	3.06E-02	1.33E-01	4.02E-01	1.75E+00
Pr-144	4.36E+00	3.66E-06	1.60E-05	1.81E-05	7.89E-05
Pm-147	4.36E+00	2.98E-03	1.30E-02	3.91E-02	1.70E-01
Sm-151	4.36E-01	2.54E-03	1.11E-03	3.33E-02	1.45E-02
Eu-154	4.36E-01	2.28E-02	9.94E-03	2.99E-01	1.30E-01
Eu-155	4.36E-01	3.42E-03	1.49E-03	4.48E-02	1.95E-02
Th-231	4.36E-05	7.10E-05	3.09E-09	9.34E-04	4.07E-08
Th-232	4.36E-05	1.40E+02	6.10E-03	1.84E+03	8.02E-02
Pa-233	2.02E-05	7.51E-04	1.52E-08	9.88E-03	2.00E-07
U-233	1.15E-06	1.14E+01	1.31E-05	1.49E+02	1.72E-04
U-234	4.37E-02	1.14E+01	4.98E-01	1.49E+02	6.51E+00
U-235	7.92E-07	1.05E+01	8.32E-06	1.38E+02	1.09E-04
U-236	4.37E-02	1.05E+01	4.59E-01	1.38E+02	6.03E+00
Np-237	2.02E-05	4.29E+01	8.67E-04	5.63E+02	1.14E-02
U-238	4.37E-02	1.05E+01	4.59E-01	1.38E+02	6.03E+00

Table 3.9. (continued)

Radionuclide	Airborne Source Term[a] (Ci)	50-Year EDE to Maximally Exposed Individual Off-Site from 1 Ci Release (mrem)	50-Year EDE to Maximally Exposed Individual Off-Site (mrem)	50-Year EDE to Off-Site Population from 1 Ci Release (person-rem)	50-Year EDE to Off-Site Population (person-rem)
Pu-238	3.94E-03	4.03E+01	1.59E-01	5.28E+02	2.08E+00
Pu-239	7.52E-03	4.46E+01	3.35E-01	5.86E+02	4.41E+00
Pu-240	3.94E-03	4.46E+01	1.76E-01	5.86E+02	2.31E+00
Pu-241	3.92E-03	8.75E-01	3.43E-03	1.15E+01	4.51E-02
Am-241	3.94E-03	4.55E+01	1.79E-01	5.97E+02	2.35E+00
Pu-242	3.94E-03	4.21E+01	1.66E-01	5.50E+02	2.17E+00
Am-243	5.76E-04	4.55E+01	2.62E-02	6.00E+02	3.46E-01
Cm-244	3.92E-03	2.36E+01	9.25E-02	3.10E+02	1.22E+00
Cm-248	3.94E-03	1.66E+02	6.55E-01	2.19E+03	8.62E+00
Cf-252	3.92E-03	1.14E+01	4.47E-02	1.49E+02	5.84E-01
TOTAL			9.32E+00		1.22E+02

[a]Source: Reference 17, p. 86

Table 3.10. Airborne radionuclide source terms and calculated off-site doses for the LAWV resulting from a tornado event with peak gust speeds in the range 113 mph - 157 mph (F-2 Fujita Scale)

Radionuclide	Airborne Source Term[a] (Ci)	50-Year EDE to Maximally Exposed Individual Off-Site from 1 Ci Release (mrem)	50-Year EDE to Maximally Exposed Individual Off-Site (mrem)	50-Year EDE to Off-Site Population from 1 Ci Release (person-rem)	50-Year EDE to Off-Site Population (person-rem)
H-3	2.40E+01	8.31E-06	1.99E-04	1.09E-04	2.62E-03
C-14	5.44E+01	2.10E-06	1.14E-04	2.76E-05	1.50E-03
Mn-54	5.44E-03	5.92E-04	3.22E-06	7.63E-03	4.15E-05
Fe-55	5.44E-02	2.28E-04	1.24E-05	2.99E-03	1.63E-04
Ni-59	5.44E-02	1.14E-04	6.19E-06	1.50E-03	8.15E-05
Co-60	5.45E-02	1.32E-02	7.19E-04	1.73E-01	9.43E-03
Ni-63	5.44E-01	2.63E-04	1.43E-04	3.45E-03	1.88E-03
Zn-65	5.44E-02	1.60E-03	8.70E-05	2.09E-02	1.14E-03
Se-75	5.44E-03	7.32E-04	3.98E-06	9.54E-03	5.19E-05
Se-79	5.44E-06	7.79E-04	4.24E-09	1.02E-02	5.55E-08
Rb-87	5.44E-06	2.89E-04	1.57E-09	3.79E-03	2.06E-08
Sr-90	9.32E+00	1.14E-01	1.06E+00	1.49E+00	1.39E+01
Y-90	9.26E+00	7.17E-04	6.64E-03	9.37E-03	8.68E-02
Nb-94	5.44E-03	3.62E-02	1.97E-04	4.78E-01	2.60E-03

Table 3.10. (continued)

Radionuclide	Airborne Source Term[a] (Ci)	50-Year EDE to Maximally Exposed Individual Off-Site from 1 Ci Release (mrem)	50-Year EDE to Maximally Exposed Individual Off-Site (mrem)	50-Year EDE to Off-Site Population from 1 Ci Release (person-rem)	50-Year EDE to Off-Site Population (person-rem)
Zr-95	5.44E-02	1.69E-03	9.19E-05	2.21E-02	1.20E-03
Tc-99	5.44E-02	6.56E-04	3.57E-05	8.62E-03	4.69E-04
Ru-106	5.45E-02	3.85E-02	2.10E-03	5.05E-01	2.75E-02
Rh-106	5.45E-02	1.71E-10	9.32E-12	1.68E-11	9.16E-13
Ag-110m	5.44E-03	4.74E-03	2.58E-05	6.18E-02	3.36E-04
Cd-115m	5.44E-03	5.69E-03	3.10E-05	7.46E-02	4.06E-04
Sb-125	5.44E-03	8.73E-04	4.75E-06	1.14E-02	6.20E-05
Te-125m	1.36E-03	5.87E-04	7.98E-07	7.70E-03	1.05E-05
Sb-126m	5.44E-06	2.45E-06	1.33E-11	3.22E-05	1.75E-10
Sn-126	5.44E-06	7.51E-03	4.09E-08	9.88E-02	5.37E-07
I-129	5.44E-03	1.58E-02	8.60E-05	2.07E-01	1.13E-03
Cs-134	5.44E-03	4.17E-03	2.27E-05	5.45E-02	2.96E-04
Cs-135	1.14E-05	3.94E-04	4.50E-09	5.19E-03	5.92E-08
Cs-137	5.45E-01	2.80E-03	1.53E-03	3.68E-02	2.01E-02
Ba-137m	5.44E-01	2.75E-06	1.50E-06	1.17E-06	6.36E-07

Table 3.10. (continued)

Radionuclide	Airborne Source Term[a] (Ci)	50-Year EDE to Maximally Exposed Individual Off-Site from 1 Ci Release (mrem)	50-Year EDE to Maximally Exposed Individual Off-Site (mrem)	50-Year EDE to Off-Site Population from 1 Ci Release (person-rem)	50-Year EDE to Off-Site Population (person-rem)
Ce-144	5.45E-02	3.06E-02	1.67E-03	4.02E-01	2.19E-02
Pr-144	5.44E-02	3.66E-06	1.99E-07	1.81E-05	9.85E-07
Pm-147	5.44E-02	2.98E-03	1.62E-04	3.91E-02	2.13E-03
Sm-151	5.44E-03	2.54E-03	1.38E-05	3.33E-02	1.81E-04
Eu-154	5.44E-03	2.28E-02	1.24E-04	2.99E-01	1.63E-03
Eu-155	5.44E-03	3.42E-03	1.86E-05	4.48E-02	2.44E-04
Th-231	5.44E-06	7.10E-05	3.86E-10	9.34E-04	5.08E-09
Th-232	5.45E-06	1.40E+02	7.63E-04	1.84E+03	1.00E-02
Pa-233	1.01E-06	7.51E-04	7.62E-10	9.88E-03	1.00E-08
U-233	5.24E-08	1.14E+01	5.96E-07	1.49E+02	7.82E-06
U-234	5.45E-04	1.14E+01	6.21E-03	1.49E+02	8.12E-02
U-235	7.92E-07	1.05E+01	8.32E-06	1.38E+02	1.09E-04
U-236	5.45E-03	1.05E+01	5.72E-02	1.38E+02	7.52E-01
Np-237	1.02E-06	4.29E+01	4.36E-05	5.63E+02	5.72E-04
U-238	5.45E-03	1.05E+01	5.72E-02	1.38E+02	7.52E-01

Table 3.10. (continued)

Radionuclide	Airborne Source Term[a] (Ci)	50-Year EDE to Maximally Exposed Individual Off-Site from 1 Ci Release (mrem)	50-Year EDE to Maximally Exposed Individual Off-Site (mrem)	50-Year EDE to Off-Site Population from 1 Ci Release (person-rem)	50-Year EDE to Off-Site Population (person-rem)
Pu-238	5.09E-04	4.03E+01	2.05E-02	5.28E+02	2.69E-01
Pu-239	8.08E-04	4.46E+01	3.60E-02	5.86E+02	4.73E-01
Pu-240	4.90E-04	4.46E+01	2.19E-02	5.86E+02	2.87E-01
Pu-241	4.90E-04	8.75E-01	4.29E-04	1.15E+01	5.64E-03
Am-241	4.90E-04	4.55E+01	2.23E-02	5.97E+02	2.93E-01
Pu-242	4.90E-04	4.21E+01	2.06E-02	5.50E+02	2.70E-01
Am-243	2.88E-05	4.55E+01	1.31E-03	6.00E+02	1.73E-02
Cm-244	4.90E-06	2.36E+01	1.16E-04	3.10E+02	1.52E-03
Cm-248	4.90E-04	1.66E+02	8.14E-02	2.19E+03	1.07E+00
Cf-252	5.44E-06	1.14E+01	6.20E-05	1.49E+02	8.11E-04
TOTAL			1.40E+00		1.84E+01

[a]Source: Reference 17, p. 84

3.3.3 200 H Area

The site boundary location for the hypothetical off-site individual receiving the greatest airborne dose is 7.25 miles from the release point in the north direction. The population sector with the largest population subject to airborne exposure is the sector located to the west-northwest.

3.3.3.1 H-Area Outside Facility Operations

For this scenario, it was assumed by the SRS safety analysis[22] that 100% of the liquid contents of the largest vessel in each of eight process loops would be released as the vessel wall was damaged by a tornado with an F-2 classification. The analysis assumed that the liquid would be confined in diked areas in all but five of these liquid releases. Radionuclide dispersion was modeled in the analysis as an evaporation of 30% of the confined material. In the five process loops where there would be insufficient dike capacity to contain the liquid releases, about 13 to 35% of the liquid release was assumed to eventually migrate to Upper Three Runs Creek. In the SRS analysis, off-site doses were calculated by using (1) the AXAOTHER code for evaporative release into 50-mph winds and (2) the LADTAP XL code for the liquid release to the creek. In later safety analyses for other SRS facilities, the AXAIR89Q code was used instead of AXAOTHER to model evaporative releases that may occur following a tornado. To be consistent with this change, off-site doses are calculated for this study by using (1) the AXAIR89Q code for evaporative release under assumed worst-case (99.5%) meteorological conditions and (2) the LADTAP XL code for the liquid release to the creek. Table 3.11 displays the source term and the resulting calculated doses for an evaporative release from this facility. The calculated maximally exposed off-site individual dose resulting from the airborne release is 1.3 mrem. The calculated maximum off-site population dose from the airborne release is 10.1 person-rem. Table 3.12 displays the source term and the resulting calculated doses for a liquid release from this facility. The calculated maximally exposed off-site individual dose resulting from the liquid release is 18.6 mrem. The calculated maximum off-site population dose from the liquid release is 67.9 person-rem.

Table 3.11. Airborne radionuclide source terms and calculated off-site doses for the H-Area Outside Facilities resulting from a tornado event with peak gust speeds in the range 113 mph - 157 mph (F-2 Fujita Scale)

Radionuclide	Airborne Source Term[a] (Ci)	50-Year EDE to Maximally Exposed Individual Off-Site from 1 Ci Release (mrem)	50-Year EDE to Maximally Exposed Individual Off-Site (mrem)	50-Year EDE to Off-Site Population from 1 Ci Release (person-rem)	50-Year EDE to Off-Site Population (person-rem)
Nb-95	2.82E-02	1.01E-02	2.85E-04	7.87E-02	2.22E-03
Zr-95	9.99E-02	4.08E-02	4.08E-03	3.22E-01	3.22E-02
Ru-103	1.30E-01	1.69E-02	2.20E-03	1.33E-01	1.73E-02
Ru-106	7.97E-01	9.34E-01	7.44E-01	7.44E+00	5.93E+00
Cs-137	2.90E-06	6.79E-02	1.97E-07	5.39E-01	1.56E-06
Pa-233	2.68E-03	2.03E-02	5.44E-05	2.12E-01	5.68E-04
U-233	1.52E-05	2.87E+02	4.36E-03	3.00E+03	4.56E-02
U-234	1.52E-03	2.76E+02	4.20E-01	2.19E+03	3.33E+00
U-235	1.52E-05	2.55E+02	3.88E-03	2.02E+03	3.07E-02
U-236	3.51E-04	2.55E+02	8.95E-02	2.02E+03	7.09E-01
U-238	9.75E-07	2.55E+02	2.49E-04	2.02E+03	1.97E-03
TOTAL			1.27E+00		1.01E+01

[a]Source: Reference 22, p. B-4

Table 3.12. Liquid radionuclide source terms and calculated off-site doses for the H-Area Outside Facilities resulting from a tornado event with peak gust speeds in the range 113 mph - 157 mph (F-2 Fujita Scale)

Radionuclide	Liquid Source Term[a] (Ci)	50-Year EDE to Maximally Exposed Individual Off-Site from 1 Ci Release (mrem)	50-Year EDE to Maximally Exposed Individual Off-Site (mrem)	50-Year EDE to Off-Site Population from 1 Ci Release (person-rem)	50-Year EDE to Off-Site Population (person-rem)
Nb-95	1.36E+02	1.3E-01	1.77E+01	2.22E-01	3.02E+01
Zr-95	4.98E+02	3.4E-04	1.69E-01	1.24E-02	6.18E+00
Ru-103	6.62E+00	2.7E-04	1.79E-03	3.32E-02	2.20E-01
Ru-106	3.88E+01	2.1E-03	8.15E-02	3.07E-01	1.19E+01
Cs-137	7.00E-03	3.1E-01	2.17E-03	8.08E-01	5.66E-03
U-234	2.73E+01	2.1E-02	5.73E-01	5.75E-01	1.57E+01
U-235	2.73E-01	2.1E-02	5.73E-03	5.94E-01	1.62E-01
U-236	6.30E+00	2.0E-02	1.26E-01	5.54E-01	3.49E+00
U-238	1.75E-02	1.9E-02	3.33E-04	5.11E-01	8.94E-03
TOTAL			1.86E+01		6.79E+01

[a]Source: Reference 22, p. B-4

3.3.3.2 F/H Effluent Treatment Facility

For this scenario, the SRS safety analysis[23] assumed that 50% of the liquid contents of the facility would be released as the equipment and piping were damaged by a tornado with an F-2 classification. The analysis assumed that none of the liquid would be confined in diked areas. Radionuclide dispersion was modeled in the analysis as an evaporation of 50% of the liquid release. In addition, 50% of the liquid release was assumed to eventually migrate to Upper Three Runs Creek. For this study, off-site doses are calculated by using the AXAIR89Q code for evaporative releases under assumed worst-case (99.5%) meteorological conditions, and doses resulting from the liquid release to the creek are calculated by using the LADTAP XL code. Table 3.13 displays the source term and the resulting calculated doses for an evaporative release from this facility. The calculated maximally exposed off-site individual dose resulting from the airborne release is 0.029 mrem. The calculated maximum off-site population dose from the airborne release is 0.229 person-rem. Table 3.14 displays the source term and the resulting calculated doses for a liquid release from this facility. The calculated maximally exposed off-site individual dose resulting from the liquid release is 0.042 mrem. The calculated maximum off-site population dose from the liquid release is 0.301 person-rem.

3.3.3.3 Consolidated Tritium Facility

The SRS safety analysis for this facility[25] assumed that 5% of the tritium inventory stored in the equipment and piping would be released in the event of facility damage by a tornado with an F-2 classification. In the safety analysis, 1% of the released tritium was assumed to be in oxide form. Therefore, off-site doses are calculated with the AXAOTHER code for tornado dispersion at 75 m height. Table 3.15 shows the source term and resulting calculated doses for an airborne release from this facility. The calculated maximally exposed individual dose resulting from the airborne release is 0.28 mrem. The calculated maximum off-site population dose from the airborne release is 4.6 person-rem.

Table 3.13. Airborne radionuclide source terms and calculated off-site doses for the F/H Effluent Treatment Facility resulting from a tornado event with peak gust speeds in the range 113 mph - 157 mph (F-2 Fujita Scale)

Radionuclide	Airborne Source Term[a] (Ci)	50-Year EDE to Maximally Exposed Individual Off-Site from 1 Ci Release (mrem)	50-Year EDE to Maximally Exposed Individual Off-Site (mrem)	50-Year EDE to Off-Site Population from 1 Ci Release (person-rem)	50-Year EDE to Off-Site Population (person-rem)
H-3	1.30E+02	2.02E-04	2.63E-02	1.60E-03	2.08E-01
Sr-90	1.10E-06	2.76E+00	3.04E-06	2.19E+01	2.41E-05
Ru-106	2.13E-03	9.34E-01	2.00E-03	7.40E+00	1.58E-02
Cs-134	1.44E-06	1.01E-01	1.45E-07	7.98E-01	1.15E-06
Cs-137	1.03E-05	6.79E-02	6.99E-07	5.39E-01	5.55E-06
Ce-144	2.82E-06	7.43E-01	2.10E-06	5.89E+00	1.66E-05
Pu-239	5.56E-07	1.08E+03	6.00E-04	8.58E+03	4.77E-03
TOTAL			2.89E-02		2.29E-01

[a]Source: Reference 23, p. A-2

Table 3.14. Liquid radionuclide source terms and calculated off-site doses for the F/H Effluent Treatment Facility resulting from a tornado event with peak gust speeds in the range 113 mph - 157 mph (F-2 Fujita Scale)

Radionuclide	Liquid Source Term[a] (Ci)	50-Year EDE to Maximally Exposed Individual Off-Site from 1 Ci Release (mrem)	50-Year EDE to Maximally Exposed Individual Off-Site (mrem)	50-Year EDE to Off-Site Population from 1 Ci Release (person-rem)	50-Year EDE to Off-Site Population (person-rem)
H-3	1.30E+02	5.0E-06	6.50E-04	1.31E-04	1.70E-02
Sr-90	1.10E-02	1.8E-02	1.98E-04	3.19E-01	3.51E-03
Ru-106	2.13E-01	2.1E-03	4.47E-04	3.07E-01	6.54E-02
Cs-134	1.44E-02	4.6E-01	6.62E-03	1.08E+00	1.56E-02
Cs-137	1.03E-01	3.1E-01	3.19E-02	8.08E-01	8.32E-02
Ce-144	2.82E-02	1.6E-03	4.51E-05	1.91E-01	5.39E-03
Pu-239	5.56E-03	3.7E-01	2.06E-03	2.00E+01	1.11E-01
TOTAL			4.20E-02		3.01E-01

[a]Source: Reference 23, p. A-2

Table 3.15. Airborne radionuclide source terms and calculated off-site doses for the Consolidated Tritium Facility (234-H) resulting from a tornado event with peak gust speeds in the range 113 mph - 157 mph (F-2 Fujita Scale)

Radionuclide	Airborne Source Term[a] (Ci)	50-Year EDE to Maximally Exposed Individual Off-Site from 1 Ci Release (mrem)	50-Year EDE to Maximally Exposed Individual Off-Site (mrem)	50-Year EDE to Off-Site Population from 1 Ci Release (person-rem)	50-Year EDE to Off-Site Population (person-rem)
H-3	3.90E+06	7.25E-08[b]	2.83E-01	1.19E-06[b]	4.64E+00
TOTAL			2.83E-01		4.64E+00

[a]Source: Reference 26, p. 3-24

[b]This value was derived by correcting the AXAOTHER result to account for the assumed oxide fraction (1%).

3.3.4 200 Z Area

The site boundary location for the hypothetical off-site individual receiving the greatest airborne dose is 5.79 miles from the release point in the north direction. The population sector with the largest population subject to airborne exposure is the sector located to the west-northwest.

3.3.4.1 Saltstone Facility

For this scenario, it was assumed by the SRS safety analysis[26] that 100% of the liquid contents of the process equipment would be released as the equipment was damaged by a tornado with an F-2 classification. Radionuclide dispersion was modeled in the analysis as an evaporation of 100% the released liquid. In the SRS analysis, off-site doses were calculated by using the AXAOTHER code for evaporative release into 50-mph winds. In later safety analyses for other SRS facilities, the AXAIR89Q code was used instead of AXAOTHER to model evaporative releases that may occur following a tornado. To be consistent with this change, off-site doses are calculated for this study by using the AXAIR89Q code for evaporative releases under assumed worst-case (99.5%) meteorological conditions. Table 3.16 displays the source term and the resulting calculated doses for an evaporative release from this facility. The calculated maximally exposed off-site individual dose resulting from the airborne release is essentially zero. The calculated maximum off-site population dose from the airborne release is also essentially zero.

3.3.5 300 M Area

The location for M-Area for the hypothetical off-site individual receiving the greatest airborne dose is 0.75 miles from the release point in the northwest direction. The population sector with the largest population subject to airborne exposure is the sector located to the west-northwest.

Table 3.16. Airborne radionuclide source terms and calculated off-site doses for the Saltstone Facility resulting from a tornado event with peak gust speeds in the range 113 mph - 157 mph (F-2 Fujita Scale)

Radionuclide	Airborne Source Term[a] (Ci)	50-Year EDE to Maximally Exposed Individual Off-Site from 1 Ci Release (mrem)	50-Year EDE to Maximally Exposed Individual Off-Site (mrem)	50-Year EDE to Off-Site Population from 1 Ci Release (person-rem)	50-Year EDE to Off-Site Population (person-rem)
H-3	1.48E-03	2.61E-04	3.86E-07	1.74E-03	2.58E-06
Ru-106	5.51E-05	1.21E+00	6.67E-05	8.05E+00	4.44E-04
I-129	2.90E-05	4.95E-01	1.44E-05	3.30E+00	9.57E-05
Cs-137	2.90E-07	8.80E-02	2.55E-08	5.86E-01	1.70E-07
Pu-238	7.54E-10	1.26E+03	9.50E-07	8.43E+03	6.36E-06
TOTAL			8.25E-05		5.49E-04

[a]Source: Reference 26, pp. 3-13 - 3-14

3.3.5.1 Fuel Fabrication Facility

For this scenario, it was concluded by the SRS safety analysis[28] that there would be no release of particulate radioactive materials from the Fuel Fabrication Facility per se because of its construction. However, the analysis assumed that the ventilation system filter house external to the facility would be damaged, releasing some of the radionuclides accumulated in the ventilation system filters. In addition, a nuclear criticality event involving 5×10^{17} fissions was assumed to occur. Off-site doses are calculated with the AXAOTHER code for tornado dispersion of 736 g of uranium at 75 m height. Radionuclide dispersion following a nuclear criticality is modeled as a release under assumed worst-case (99.5%) meteorological conditions. Therefore, the AXAIR89Q code is used to calculate the associated off-site doses. Table 3.17 displays the source terms and the resulting calculated doses for airborne releases from this facility. The calculated maximally exposed off-site individual dose resulting from the event is 35.4 mrem. The maximum off-site population dose is 33.6 person-rem.

3.3.6 Integrated Site Effects

In this scenario, after a warning period of at least a day,[44] a violent thunderstorm many miles in diameter would appear over the SRS. Without much warning, however, a tornado or group of tornadoes associated with the storm cause severe damage, including damage to the eight nuclear facilities that can release radioactive materials. As shown in the previous sections, the SRS safety analyses predict that four of the nuclear facilities at the SRS would release radioactive material immediately into the wind field and that four others would spill liquid radioactive materials that would subsequently evaporate. Table 3.18 tabulates the expected dose and risk by facility for airborne releases resulting from an F-2 tornado. Results are presented both for the maximally exposed off-site individual and for the off-site population (worst-sector results). Similarly, Table 3.19 tabulates the expected dose and risk by facility for liquid releases to surface streams resulting from this event.

Table 3.17. **Airborne radionuclide source terms and calculated off-site doses for the Fuel Fabrication Facility (321-M) resulting from a tornado event with peak gust speeds in the range 113 mph - 157 mph (F-2 Fujita Scale)**

Radionuclide	Airborne Source Term[a] (Ci)	50-Year EDE to Maximally Exposed Individual Off-Site from 1 Ci Release (mrem)	50-Year EDE to Maximally Exposed Individual Off-Site (mrem)	50-Year EDE to Off-Site Population from 1 Ci Release (person-rem)	50-Year EDE to Off-Site Population (person-rem)
Direct Release					
U-232	6.47E-04	8.16E+02	5.28E-01	1.04E+03	6.73E-01
U-233	7.08E-05	1.58E+02	1.12E-02	2.01E+02	1.42E-02
U-234	9.12E-02	1.58E+02	1.44E+01	2.01E+02	1.83E+01
U-235	6.36E-04	1.46E+02	9.29E-02	1.85E+02	1.18E-01
U-236	2.00E-02	1.46E+02	2.92E+00	1.85E+02	3.70E+00
U-238	3.95E-05	1.46E+02	5.77E-03	1.85E+02	7.31E-03
TOTAL			1.80E+01		2.28E+01
Nuclear Criticality					
Kr-83m	8.00E+00	1.99E-07	1.59E-06	8.63E-09	6.90E-08
Kr-85	8.00E-05	2.02E-05	1.62E-09	1.62E-05	1.30E-09
Kr-85m	7.50E+00	1.48E-03	1.11E-02	3.86E-04	2.90E-03
Kr-87	4.95E+01	5.50E-03	2.72E-01	2.27E-04	1.12E-02
Kr-88	3.25E+01	1.45E-02	4.71E-01	2.40E-03	7.80E-02

Table 3.17. (continued)

Radionuclide	Airborne Source Term[a] (Ci)	50-Year EDE to Maximally Exposed Individual Off-Site from 1 Ci Release (mrem)	50-Year EDE to Maximally Exposed Individual Off-Site (mrem)	50-Year EDE to Off-Site Population from 1 Ci Release (person-rem)	50-Year EDE to Off-Site Population (person-rem)
Kr-89	2.10E+03	8.82E-04	1.85E+00	1.33E-07	2.79E-04
I-131	1.09E-01	6.58E-01	7.17E-02	7.00E-01	7.63E-02
I-132	1.38E+01	2.45E-02	3.38E-01	3.15E-03	4.35E-02
I-133	2.00E+00	1.63E-02	3.26E-02	1.26E-02	2.52E-02
I-134	5.62E+01	2.03E-02	1.14E+00	3.67E-04	2.06E-02
I-135	5.88E+00	3.45E-02	2.03E-01	1.59E-02	9.35E-02
Xe-131m	4.10E-03	2.33E-04	9.55E-07	1.09E-04	4.47E-07
Xe-133	1.35E+00	5.20E-04	7.02E-04	3.24E-04	4.37E-04
Xe-133m	9.00E-02	4.36E-04	3.92E-05	2.44E-04	2.20E-05
Xe-135	1.80E+01	2.34E-03	4.21E-02	1.53E-03	2.75E-02
Xe-135m	1.13E+02	2.34E-03	2.64E-01	2.41E-04	2.72E-02
Xe-137	2.45E+03	1.54E-04	3.77E-01	2.96E-08	7.25E-05
Xe-138	6.50E+02	4.49E-03	2.92E+00	5.80E-06	3.77E-03
U-232	2.02E-05	1.37E+04	2.77E-01	1.50E+04	3.03E-01
U-233	2.21E-06	2.66E+03	5.88E-03	2.92E+03	6.45E-03

Table 3.17. (continued)

Radionuclide	Airborne Source Term[a] (Ci)	50-Year EDE to Maximally Exposed Individual Off-Site from 1 Ci Release (mrem)	50-Year EDE to Maximally Exposed Individual Off-Site (mrem)	50-Year EDE to Off-Site Population from 1 Ci Release (person-rem)	50-Year EDE to Off-Site Population (person-rem)
U-234	2.85E-03	2.66E+03	7.58E+00	2.92E+03	8.32E+00
U-235	1.99E-05	2.46E+03	4.90E-02	2.69E+03	5.35E-02
U-236	6.25E-04	2.46E+03	1.54E+00	2.69E+03	1.68E+00
U-238	1.24E-06	2.46E+03	3.05E-03	2.69E+03	3.34E-03
TOTAL			1.74E+01		1.08E+01

[a]Source: Reference 28, pp. A-8 and A-12

Table 3.18. Doses and risks by facility for airborne radionuclide releases resulting from a tornado event with peak gust speeds in the range 113 mph - 157 mph (F-2 Fujita Scale)

Facility	Accident Frequency ($year^{-1}$)	Maximally Exposed Individual		Off-Site Population	
		Dose[a] (mrem)	Risk (rem/year)	Dose[a] (person-rem)	Risk (person-rem/year)
F-Area Outside Facilities	1.0E-04[b]	3.4E-01	3.4E-08	1.7E+00	1.7E-04
Production Control Facilities (772-F)	3.7E-05	1.5E-03	5.6E-11	1.2E-02	4.4E-07
Solid Waste Disposal Facilities	3.7E-05	1.3E+01	4.8E-07	1.7E+02	6.3E-03
H-Area Outside Facilities	2.5E-05[c]	1.3E+00	3.3E-08	1.0E+01	2.5E-04
F/H Effluent Treatment Facility	3.7E-05	2.9E-02	1.1E-09	2.3E-01	8.5E-06
Consolidated Tritium Facility (234-H)	3.7E-05	2.8E-01	1.0E-08	4.6E+00	1.7E-04
Saltstone Facility	3.7E-05	8.3E-05	3.1E-12	5.5E-04	2.0E-08
Fuel Fabrication Facility (321-M)	3.7E-05	3.5E+01	1.3E-06	3.4E+01	1.2E-03

[a]50-year effective dose equivalent (EDE) estimated by using ICRP-30 dose conversion factors

[b]Corrected strike frequency for an F-2 tornado (Reference 1, p. 5-34)

[c]Corrected strike frequency for F-2 tornado (9.9E-05/year) multiplied by the conditional probability of release (2.5E-01)-

Table 3.19. Doses and risks by facility for liquid radionuclide releases resulting from a tornado event with peak gust speeds in the range 113 mph - 157 mph (F-2 Fujita Scale)

Facility	Accident Frequency ($year^{-1}$)	Maximally Exposed Individual		Off-Site Population	
		Dose[a] (mrem)	Risk (rem/year)	Dose[a] (person-rem)	Risk (person-rem/year)
F-Area Outside Facilities	1.0E-04[b]	2.8E-03	2.8E-10	1.9E-01	1.9E-05
H-Area Outside Facilities	2.5E-05[c]	1.9E+01	4.7E-07	6.8E+01	1.7E-03
F/H Effluent Treatment Facility	3.7E-05	4.2E-02	1.6E-09	3.0E-01	1.1E-05

[a]50-year effective dose equivalent (EDE) estimated by using ICRP-30 dose conversion factors

[b]Corrected strike frequency for an F-2 tornado (Reference 1, p. 5-34)

[c]Corrected strike frequency for F-2 tornado (9.9E-05/year) multiplied by the conditional probability of release (2.5E-01)

3.3.6.1 Maximally Exposed Off-Site Individual Dose and Risk (from airborne releases)

Inspecting the dose values for the maximally exposed off-site individual exposure resulting from airborne radionuclide releases (Table 3.18), one could simply sum the maximally exposed off-site individual doses resulting from each facility release to derive an integrated maximally exposed off-site individual dose for the site for this event. Again, such a dose value has no physical meaning because the locations of the maximally exposed individuals for many of the affected facilities are different.

Two more realistic approaches for estimating integrated doses and risks are described in Section 3.2.3.1. Briefly, the first of these approaches involves adjusting the dose values from each affected facility to obtain an integrated dose for the maximally exposed off-site individual location for the dominant facility. The release from the Fuel Fabrication Facility (Section 3.3.6.1) results in the dominant maximally exposed off-site individual dose. The maximally exposed off-site individual location for M-Area is the location selected for the dose calculation. A maximum dose of 49.2 mrem is calculated by using this approach.

The second of the two more realistic approaches for estimating integrated doses and risks considers only those facility releases that result in maximum off-site individual exposure at the same boundary location as the dominant facility. Again, the release from the Fuel Fabrication Facility (Section 3.3.6.1) results in the dominant maximally exposed off-site individual dose. A maximum dose of 35.7 mrem is calculated with this approach.

Table 3.20 presents the integrated doses and risks to the maximally exposed off-site individual (from airborne releases only) that result from applying these three approaches.

3.3.6.2 Maximally Exposed Off-Site Individual Dose and Risk (from liquid releases to surface water)

The maximally exposed off-site individual with regard to any radionuclide release to surface water bodies is assumed to live alongside the Savannah River south of the SRS. Therefore, doses resulting from liquid spills at the facilities affected by the F-2 tornado event can be summed to obtain the integrated dose. Maximum doses from airborne releases are realized at locations along the northern and western site boundaries. Therefore, it is inappropriate to

Table 3.20. Integrated doses and risks to the maximally exposed off-site individual for airborne releases resulting from a tornado event with peak gust speeds in the range 113 mph - 157 mph (F-2 Fujita Scale)

	Calculation Option	Dose[a] (mrem)	Risk (rem/year)
1.	Sum worst-case, worst-sector doses/risks for all affected facilities, not accounting for the different receptor locations	5.0E+01	1.8E-06
2.	Sum worst-case doses/risks for a single boundary location (location of the maximally exposed off-site individual for the dominant facility)	4.9E+01	1.8E-06
3.	Sum worst-case, worst-sector doses/risks for facilities whose maximally exposed off-site individual is located in the same sector as the maximally exposed off-site individual of the dominant facility; ignore doses/risks for other facilities	3.6E+01	1.3E-06

[a]50-year effective dose equivalent (EDE) estimated by using ICRP-30 dose conversion factors

combine these doses with those resulting from releases to surface water bodies. The integrated dose to the maximally exposed off-site individual from liquid releases to surface water is then 18.6 mrem, and the integrated risk is 4.7×10^{-7} rem/year.

3.3.6.3 Maximum Off-Site Population Dose and Risk (from airborne releases)

One can simply sum the maximum off-site population doses resulting from each facility release to derive an integrated maximum off-site population dose for the site for this event. This approach is valid because the worst sector with regard to population dose is the same for all affected facilities (west-northwest sector). The dominant sectors in this direction from E, F, H, Z, and M Areas do not overlay exactly. However, at the off-site location corresponding to the bulk of the population (Augusta, Georgia), the sector difference is insignificant. A maximum dose of 221 person-rem is calculated. The integrated risk is 0.008 person-rem/year.

3.3.6.4 Maximum Off-Site Population Dose and Risk (from liquid releases to surface water)

The integrated maximum off-site population dose and risk resulting from releases to surface water are 68.4 person-rem and 0.0017 person-rem/year, respectively. The individual facility contributions shown in Table 3.19 are simply summed to obtain these results.

3.3.6.5 Risk

Tables 3.18 and 3.19 show the expected frequencies and risks associated with the facilities damaged by an F-2 tornado event. Note that the safety analysis for the F-Area Outside Facilities increased the expected frequency of the tornado strike to account for the large area of the facility. The safety analysis for the H-Area Outside Facilities also increased the expected frequency of the tornado strike to account for the large area of the facility and included a conditional damage probability in the frequency expression. With regard to airborne releases, the dominant risk contributor is the Solid Waste Disposal Facilities. For liquid releases to surface water bodies, the dominant risk contributor is the H-Area Outside Facilities. Figure 3.2 displays the risk of the individual facility releases in a graphic format.

3.4 DOSES AND RISKS RESULTING FROM A TORNADO EVENT WITH PEAK GUST SPEED BETWEEN 158 MPH AND 206 MPH (F-3 FUJITA SCALE)

The basic accident scenario to be analyzed postulates that a tornado event occurs at the SRS with a peak gust speed between 158 and 206 mph. The existing safety analysis documentation predicts that thirteen SRS nuclear facilities will incur damage from this accident initiator sufficient to result in a release of radioactive material.

3.4.1 200 F Area

The site boundary location for the hypothetical off-site individual receiving the greatest airborne dose is 5.46 miles from the release point in the west-northwest direction. The population sector with the largest population subject to airborne exposure is the sector located to the west-northwest.

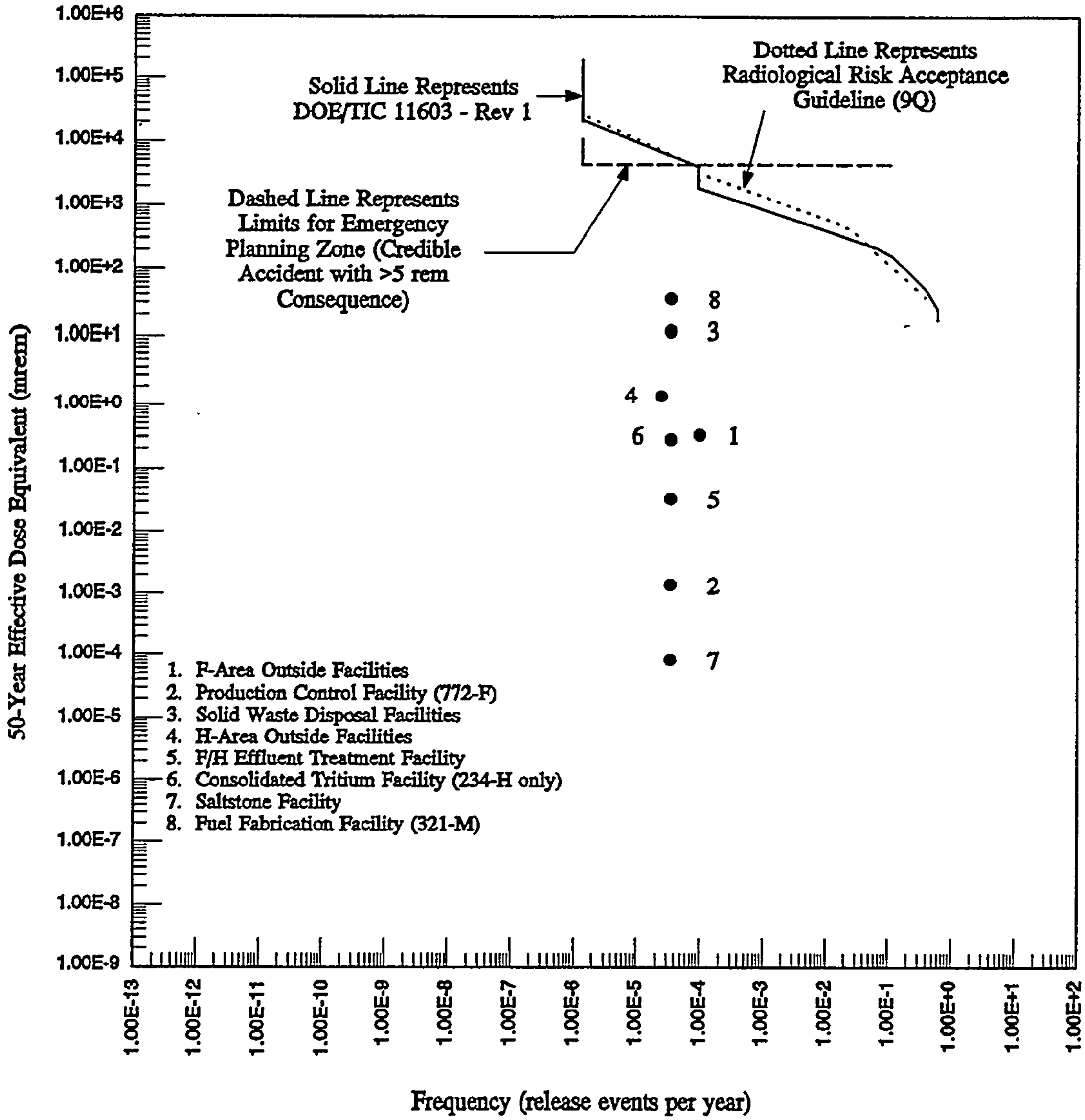

Figure 3.2. Public risks associated with an F-2 tornado event.

3.4.1.1 F-Area Outside Facility Operations

For this scenario, it was assumed by the SRS safety analysis for the F-Area Outside Facility Operations[1] that 50% of the liquid contents of the largest vessel in each of seven process loops would be released as the vessel wall was damaged by a tornado with an F-3 classification. The analysis assumed that the liquid would be confined in diked areas in all but one of these liquid releases. Radionuclide dispersion was modeled in the analysis as an evaporation of 30% of the diked material. In the one process loop where there would be insufficient diked area capacity to contain the liquid release, about 16% of the total liquid release was assumed to eventually migrate to Upper Three Runs Creek. Again, for this study off-site doses are calculated by using the AXAIR89Q code for evaporative releases under assumed worst-case (99.5%) meteorological conditions and the LADTAP XL code for the liquid release to the creek. Table 3.21 displays the source term and the resulting calculated doses for an airborne release from this facility. The calculated maximally exposed off-site individual dose resulting from the airborne release is 0.679 mrem. The calculated maximum off-site population dose from the airborne release is 3.42 person-rem. Table 3.22 displays the source term and the resulting calculated doses for a liquid release from this facility. The calculated maximally exposed off-site individual dose resulting from the liquid release is 0.011 mrem. The calculated maximum off-site population dose from the liquid release is 0.767 person-rem.

3.4.1.2 Production Control Facility

The SRS safety analysis for the Production Control Facility[3] did not specifically address a tornado event with the F-3 classification. However, after a review of the accident scenario for a tornado event with the lower F-1 classification (Section 3.2.1.1), it is concluded that there is no reason to assume that an F-3 tornado event would generate a larger source term. For this scenario, it was concluded by the SRS safety analysis that there would be no release of radioactive materials from the facility per se because of its construction. However, the analysis assumed that the ventilation system stack external to the facility would collapse under this type of wind load, destroying the collocated ventilation system filter house. The loss of the filter house in the wind event would allow 0.5% of the accident source term to migrate outside the facility to be dispersed by the high winds during the event. Consequently, for this study off-site doses are calculated by

Table 3.21. Airborne radionuclide source terms and calculated off-site doses for the F-Area Outside Facilities resulting from a tornado event with peak gust speeds in the range 158 mph - 206 mph (F-3 Fujita Scale)

Radionuclide	Airborne Source Term[a] (Ci)	50-Year EDE to Maximally Exposed Individual Off-Site from 1 Ci Release (mrem)	50-Year EDE to Maximally Exposed Individual Off-Site (mrem)	50-Year EDE to Off-Site Population from 1 Ci Release (person-rem)	50-Year EDE to Off-Site Population (person-rem)
Zr-95	8.64E-04	5.09E-02	4.40E-05	2.56E-01	2.21E-04
Nb-95	4.88E-04	1.26E-02	6.15E-06	6.28E-02	3.06E-05
Ru-103	4.06E-03	2.11E-02	8.57E-05	1.05E-01	4.26E-04
Ru-106	1.21E-02	1.16E+00	1.40E-02	5.87E+00	7.10E-02
Cs-134	7.20E-09	1.26E-01	9.07E-10	6.34E-01	4.56E-09
Cs-137	6.28E-08	8.47E-02	5.32E-09	4.27E-01	2.68E-08
Ce-141	5.42E-09	2.26E-02	1.22E-10	1.13E-01	6.12E-10
Ce-144	3.90E-07	9.26E-01	3.61E-07	4.67E+00	1.82E-06
U-234	6.54E-04	3.44E+02	2.25E-01	1.74E+03	1.14E+00
U-235	3.64E-04	3.18E+02	1.16E-01	1.60E+03	5.82E-01
U-236	3.64E-04	3.18E+02	1.16E-01	1.60E+03	5.82E-01
U-238	3.64E-04	3.18E+02	1.16E-01	1.60E+03	5.82E-01
Pu-238	3.92E-05	1.22E+03	4.78E-02	6.14E+03	2.41E-01
Pu-239	1.82E-05	1.35E+03	2.46E-02	6.81E+03	1.24E-01
Pu-240	1.25E-05	1.35E+03	1.69E-02	6.81E+03	8.51E-02
Pu-241	1.11E-04	2.65E+01	2.94E-03	1.34E+02	1.49E-02
TOTAL			6.79E-01		3.42E+00

[a]Source: Reference 1, p. B-4

Table 3.22. **Liquid radionuclide source terms and calculated off-site doses for the F-Area Outside Facilities resulting from a tornado event with peak gust speeds in the range 158 mph - 206 mph (F-3 Fujita Scale)**

Radionuclide	Liquid Source Term[a] (Ci)	50-Year EDE to Maximally Exposed Individual Off-Site from 1 Ci Release (mrem)	50-Year EDE to Maximally Exposed Individual Off-Site (mrem)	50-Year EDE to Off-Site Population from 1 Ci Release (person-rem)	50-Year EDE to Off-Site Population (person-rem)
Zr-95	1.37E-01	3.4E-04	4.66E-05	1.2E-02	1.64E-03
Nb-95	4.68E-02	1.3E-01	6.08E-03	2.2E-01	1.03E-02
Ru-103	1.54E+00	2.7E-04	4.16E-04	3.3E-02	5.08E-02
Ru-106	2.27E+00	2.1E-03	4.77E-03	3.1E-01	7.04E-01
U-234	1.56E-11	2.1E-02	3.28E-13	5.8E-01	9.05E-12
U-235	2.25E-10	2.1E-02	4.73E-12	5.9E-01	1.33E-10
U-236	2.24E-10	2.0E-02	4.48E-12	5.5E-01	1.23E-10
U-238	2.24E-08	1.9E-02	4.26E-10	5.1E-01	1.14E-08
TOTAL			1.13E-02		7.67E-01

[a]Source: Reference 1, p. B-4

using the AXAOTHER code for tornado dispersion at 75 m height. Because the source term does not change and the AXAOTHER tornado code is a composite model that combines the translational speeds of tornadoes of all peak gust ranges, the resulting dose will be the same as that calculated previously for tornado damage at this facility (Section 3.2.1.1). Table 3.1 cited previously displays the source term and the resulting calculated dose for an airborne release from this facility. The calculated maximally exposed off-site individual dose resulting from the airborne release is 0.001 mrem. The calculated maximum off-site population dose from the airborne release is 0.012 person-rem.

3.4.1.3 New Production Control Facility

The SRS safety analysis for the New Production Control Facility[5] addressed a tornado event with the F-3 classification. It was concluded that damage to the building resulting in radionuclide release would begin to occur at a peak gust speed of 180 mph. The analysis postulated that all of the facility radionuclide inventory was located in the facility secondary confinement just prior to the tornado event. The damage to the secondary confinement by the tornado event would allow 100% of the inventory to migrate outside the facility to be dispersed by the tornado. Consequently, off-site doses resulting from the tornado are calculated by using the AXAOTHER code for tornado dispersion at 75 m height. Table 3.23 displays the source term and the resulting calculated doses for an airborne release from this facility. The calculated maximally exposed off-site individual dose resulting from the airborne release is 33.1 mrem. The calculated maximum off-site population dose from the airborne release is 268 person-rem.

3.4.1.4 Building 247-F Plutonium Storage Facility

For this scenario, it was assumed by the SRS safety analysis[11] that fractions of the plutonium materials stored in the drum storage area would be released following facility damage by winds exceeding 150 mph (fastest-mile speed). Logically, the same damage can be caused by a tornado with a peak gust speed equivalent to the extreme straight-line wind speed. Consequently, off-site doses resulting from the tornado are calculated by using the AXAOTHER code for tornado dispersion at 75 m height. Table 3.24 displays the source term and the resulting calculated doses for an airborne release from this facility. The calculated maximally exposed off-

Table 3.23. Airborne radionuclide source terms and calculated off-site doses for the New Production Control Facility (772-1F) resulting from a tornado event with peak gust speeds in the range 158 mph - 206 mph (F-3 Fujita Scale)

Radionuclide	Airborne Source Term[a] (Ci)	50-Year EDE to Maximally Exposed Individual Off-Site from 1 Ci Release (mrem)	50-Year EDE to Maximally Exposed Individual Off-Site (mrem)	50-Year EDE to Off-Site Population from 1 Ci Release (person-rem)	50-Year EDE to Off-Site Population (person-rem)
Sr-89	1.68E-01	4.79E-03	8.05E-04	3.87E-02	6.50E-03
Sr-90	1.60E-02	1.68E-01	2.69E-03	1.36E+00	2.18E-02
Y-90	1.60E-02	1.06E-03	1.70E-05	8.43E-03	1.35E-04
Y-91	2.52E-01	5.69E-03	1.43E-03	4.60E-02	1.16E-02
Zr-95	2.52E-01	2.50E-03	6.30E-04	2.01E-02	5.07E-03
Nb-95	6.80E-02	6.25E-04	4.25E-05	4.93E-03	3.35E-04
Ru-103	1.26E-01	1.03E-03	1.30E-04	8.29E-03	1.04E-03
Ru-106	1.26E-01	5.69E-02	7.17E-03	4.60E-01	5.80E-02
Rh-106	1.26E-01	1.88E-17	2.37E-18	2.37E-22	2.99E-23
Ag-110m	1.60E-03	7.01E-03	1.12E-05	5.62E-02	8.99E-05
Sn-123	2.10E-03	3.88E-03	8.15E-06	3.14E-02	6.59E-05
Sb-125	2.80E-03	1.29E-03	3.61E-06	1.04E-02	2.91E-05
Te-127	4.00E-03	3.69E-05	1.48E-07	2.72E-04	1.09E-06
Te-129	2.50E-03	1.06E-05	2.65E-08	3.95E-05	9.88E-08
Cs-134	2.80E-03	6.17E-03	1.73E-05	4.96E-02	1.39E-04

Table 3.23. (continued)

Radionuclide	Airborne Source Term[a] (Ci)	50-Year EDE to Maximally Exposed Individual Off-Site from 1 Ci Release (mrem)	50-Year EDE to Maximally Exposed Individual Off-Site (mrem)	50-Year EDE to Off-Site Population from 1 Ci Release (person-rem)	50-Year EDE to Off-Site Population (person-rem)
Cs-137	2.10E-02	4.14E-03	8.69E-05	3.35E-02	7.04E-04
Ce-141	7.98E-02	1.10E-03	8.78E-05	8.90E-03	7.10E-04
Ce-144	3.78E-01	4.53E-02	1.71E-02	3.66E-01	1.38E-01
Pr-144	3.78E-01	3.37E-06	1.27E-06	2.53E-06	9.56E-07
Pm-147	6.83E-02	4.40E-03	3.01E-04	3.56E-02	2.43E-03
Pm-148	7.88E-04	1.32E-03	1.04E-06	1.05E-02	8.27E-06
Eu-154	1.16E-03	3.37E-02	3.91E-05	2.72E-01	3.16E-04
Pu-238	1.72E-01	5.95E+01	1.02E+01	4.81E+02	8.27E+01
Pu-239	2.48E-01	6.60E+01	1.64E+01	5.33E+02	1.32E+02
Pu-241	5.00E+00	1.29E+00	6.45E+00	1.05E+01	5.25E+01
TOTAL			3.31E+01		2.68E+02

[a]Source: Reference 5, p. B-10

Table 3.24. Airborne radionuclide source terms and calculated off-site doses for the Building 247-F Plutonium Storage Facility resulting from a tornado event with peak gust speeds in the range 158 mph - 206 mph (F-3 Fujita Scale)

Radionuclide	Airborne Source Term[a] (Ci)	50-Year EDE to Maximally Exposed Individual Off-Site from 1 Ci Release (mrem)	50-Year EDE to Maximally Exposed Individual Off-Site (mrem)	50-Year EDE to Off-Site Population from 1 Ci Release (person-rem)	50-Year EDE to Off-Site Population (person-rem)
Pu-239	8.66E-08	6.60E+01	5.72E-06	5.33E+02	4.62E-05
Pu-240	2.44E-08	6.60E+01	1.61E-06	5.33E+02	1.30E-05
TOTAL			7.33E-06		5.92E-05

[a]Source: Reference 11, p. 1 (reference to weapons-grade plutonium parts) and p. 44 (total curie release); isotopic mix assumed to be 93% by weight ^{239}Pu and 7% by weight ^{240}Pu; specific activities of ^{239}Pu and ^{240}Pu are 0.0613 Ci/g and 0.23 Ci/g, respectively

site individual dose resulting from the airborne release is essentially zero. The calculated maximum off-site population dose from the airborne release is likewise essentially zero.

3.4.1.5 A-Line Operations

For this scenario, the SRS safety analysis[8] concluded that there would be a release of radioactive materials from this facility resulting from damage caused by an F-3 tornado event. The analysis assumed that 1% of the maximum in-process inventory of the product dust collector, crude oxide storage bin, and outside equipment would be dispersed by the tornado event. Consequently, off-site doses resulting from the tornado are calculated by using the AXAOTHER code for tornado dispersion at 75 m height. Table 3.25 displays the source term and the resulting calculated doses for an airborne release from this facility. The calculated maximally exposed off-site individual dose resulting from the airborne release is 2.86 mrem. The calculated maximum off-site population dose from the airborne release is 23.1 person-rem.

3.4.1.6 Building 235-F

For this scenario, it was concluded by the SRS safety analysis[14] that there could be a tornado-initiated release of radioactive materials from this nuclear facility. Although the analysis indicated that the facility structure was likely to resist tornado wind and missile damage, it assumed that the internal confinement systems would be vulnerable to pressurization caused by the tornado event, resulting in a release of radionuclides both at ground level and through the ventilation system stack following passage of the funnel cloud. An apparent logic error was made in the analysis when considering the tornado effects. The analysis used an evaluation of whether or not damage would be caused by a 185-mph design basis tornado as the basis for the safety analysis without first determining the threshold failure level of confinement systems. As a consequence, the expected frequency of damage given in the document may or may not be correct. If, as implied by the safety analysis documentation, the threshold failure level of the confinement systems is close to the design basis tornado force level, the expected frequency of the damage given in the documentation is incorrect. The peak gust speed range corresponding to the design basis tornado speed is that associated with the F-3 classification, not the range associated with the F-2 classification. Consequently, for this study off-site doses resulting from the tornado

Table 3.25. Airborne radionuclide source terms and calculated off-site doses for A-Line operations resulting from a tornado event with peak gust speeds in the range 158 mph - 206 mph (F-3 Fujita Scale)

Radionuclide	Airborne Source Term[a] (Ci)	50-Year EDE to Maximally Exposed Individual Off-Site from 1 Ci Release (mrem)	50-Year EDE to Maximally Exposed Individual Off-Site (mrem)	50-Year EDE to Off-Site Population from 1 Ci Release (person-rem)	50-Year EDE to Off-Site Population (person-rem)
Sr-89	2.54E-04	4.79E-03	1.22E-06	3.87E-02	9.83E-06
Sr-90	2.40E-05	1.68E-01	4.03E-06	1.36E+00	3.26E-05
Y-90	2.40E-05	1.06E-03	2.54E-08	8.43E-03	2.02E-07
Y-91	3.90E-04	5.69E-03	2.22E-06	4.60E-02	1.79E-05
Zr-95	5.56E-03	2.50E-03	1.39E-05	2.01E-02	1.12E-04
Nb-95	3.50E-04	6.25E-04	2.19E-07	4.93E-03	1.73E-06
Ru-103	8.60E-04	1.03E-03	8.86E-07	8.29E-03	7.13E-06
Ru-106	8.80E-04	5.69E-02	5.01E-05	4.60E-01	4.05E-04
Rh-106	1.96E-04	1.88E-17	3.68E-21	2.37E-22	4.65E-26
Ag-110m	2.50E-06	7.01E-03	1.75E-08	5.62E-02	1.41E-07
Sn-123	3.30E-06	3.88E-03	1.28E-08	3.14E-02	1.04E-07
Sb-125	4.20E-06	1.29E-03	5.42E-09	1.04E-02	4.37E-08
Te-127	6.30E-06	3.69E-05	2.32E-10	2.72E-04	1.71E-09
Te-129	4.00E-06	1.06E-05	4.24E-11	3.95E-05	1.58E-10
Cs-134	4.20E-06	6.17E-03	2.59E-08	4.96E-02	2.08E-07

Table 3.25. (continued)

Radionuclide	Airborne Source Term[a] (Ci)	50-Year EDE to Maximally Exposed Individual Off-Site from 1 Ci Release (mrem)	50-Year EDE to Maximally Exposed Individual Off-Site (mrem)	50-Year EDE to Off-Site Population from 1 Ci Release (person-rem)	50-Year EDE to Off-Site Population (person-rem)
Cs-137	3.25E-06	4.14E-03	1.35E-08	3.35E-02	1.09E-07
Ce-141	1.26E-04	1.10E-03	1.39E-07	8.90E-03	1.12E-06
Ce-144	5.84E-04	4.53E-02	2.65E-05	3.66E-01	2.14E-04
Pr-144	5.84E-04	3.37E-06	1.97E-09	2.53E-06	1.48E-09
Pm-147	9.40E-05	4.40E-03	4.14E-07	3.56E-02	3.35E-06
Pm-148	1.20E-06	1.32E-03	1.58E-09	1.05E-02	1.26E-08
Eu-155	8.00E-06	5.05E-03	4.04E-08	4.08E-02	3.26E-07
U-234	1.22E-04	1.68E+01	2.05E-03	1.36E+02	1.66E-02
U-235	1.85E-03	1.55E+01	2.87E-02	1.25E+02	2.31E-01
U-236	1.85E-03	1.55E+01	2.87E-02	1.25E+02	2.31E-01
U-238	1.81E-01	1.55E+01	2.81E+00	1.25E+02	2.26E+01
TOTAL			2.86E+00		2.31E+01

[a]Source: Reference 8, p. A-6

event are calculated by using the AXAIR89Q code for ground-level and stack releases occurring under assumed worst-case (99.5%) meteorological conditions, and the risk calculation is based on the expected return frequency of an F-3 tornado event. Table 3.26 displays the source terms and the resulting calculated doses for the postulated airborne releases from this facility. The calculated maximally exposed off-site individual dose resulting from the airborne release is 0.051 mrem. This dose is from the stack release only. The dose resulting from the ground-level release is much lower, and the location of the maximally exposed individual is different for the two releases because of the differences in plume elevations. The calculated maximum off-site population dose from the airborne release is 0.277 person-rem.

3.4.2 200 E Area

The site boundary location for the hypothetical off-site individual receiving the greatest airborne dose is 6.46 miles from the release point in the north-northwest direction. The population sector with the largest population subject to airborne exposure is the sector located to the west-northwest.

3.4.2.1 Solid Waste Disposal Operations

The SRS safety analysis for the Solid Waste Disposal Operations[16,17] concluded that fractions of the contaminated materials stored in the TRU pad drum storage area and the E-Area Vaults would be released following facility damage by a tornado event with the F-3 classification. The analysis assumed that damage to the area from an F-3 tornado event would result in a greater radionuclide release from the TRU pad than that caused by an F-2 tornado event. The safety analysis for the E-Area Vaults[17] did not specifically analyze a tornado event with this classification, but for this study the source terms and resulting doses are assumed to be the same as those specified for the F-2 tornado event and presented in Tables 3.8 - 3.10. Off-site doses for the TRU pad are calculated by using the AXAOTHER code for tornado dispersion at 75 m height. Table 3.27 displays the source term and the resulting calculated doses for an airborne release from the TRU pad. The calculated maximally exposed off-site individual dose resulting from the airborne release (combined releases from the TRU pad and E-Area Vaults) is 14.1 mrem. The calculated maximum off-site population dose from the airborne release is 185 person-rem.

Table 3.26. Airborne radionuclide source terms and calculated off-site doses for Building 235-F resulting from a tornado event with peak gust speeds in the range 158 mph - 206 mph (F-3 Fujita Scale)

Radionuclide	Airborne Source Term[a] (Ci)	50-Year EDE to Maximally Exposed Individual Off-Site from 1 Ci Release (mrem)	50-Year EDE to Maximally Exposed Individual Off-Site (mrem)	50-Year EDE to Off-Site Population from 1 Ci Release (person-rem)	50-Year EDE to Off-Site Population (person-rem)
Ground-Level Release					
Pu-238	5.80E-07	1.22E+03	7.08E-04	6.14E+03	3.56E-03
Pu-239	3.54E-10	1.35E+03	4.78E-07	6.81E+03	2.41E-06
Pu-240	1.90E-10	1.35E+03	2.57E-07	6.81E+03	1.29E-06
Pu-241	1.92E-08	2.65E+01	5.09E-07	1.34E+02	2.57E-06
Np-237	2.20E-09	1.30E+03	2.86E-06	6.54E+03	1.44E-05
TOTAL			7.12E-04		3.58E-03
Stack Release					
Pu-238	5.80E-05	8.72E+02	5.06E-02	4.71E+03	2.73E-01
Pu-239	3.54E-08	9.67E+02	3.42E-05	5.22E+03	1.85E-04
Pu-240	1.90E-08	9.67E+02	1.84E-05	5.22E+03	9.92E-05
Pu-241	1.92E-06	1.90E+01	3.65E-05	1.02E+02	1.96E-04
Np-237	3.30E-10	9.29E+02	3.07E-07	5.02E+03	1.66E-06
TOTAL			5.07E-02		2.73E-01

[a]Source: Reference 14, p. 9.4-74 and Reference 13, p. 5-20

Table 3.27. Airborne radionuclide source terms and calculated off-site doses for the TRU pad drum storage area resulting from a tornado event with peak gust speeds in the range 158 mph - 206 mph (F-3 Fujita Scale)

Radionuclide	Airborne Source Term[a] (Ci)	50-Year EDE to Maximally Exposed Individual Off-Site from 1 Ci Release (mrem)	50-Year EDE to Maximally Exposed Individual Off-Site (mrem)	50-Year EDE to Off-Site Population from 1 Ci Release (person-rem)	50-Year EDE to Off-Site Population (person-rem)
Pu-238	5.30E-02	4.03E+01	2.14E+00	5.28E+02	2.80E+01
TOTAL			2.14E+00		2.80E+01

[a]Source: Reference 16, p. 5-47

3.4.3 200 H Area

The site boundary location for the hypothetical off-site individual receiving the greatest airborne dose is 7.25 miles from the release point in the north direction. The population sector with the largest population subject to airborne exposure is the sector located to the west-northwest.

3.4.3.1 H-Area Outside Facility Operations

For this scenario, it was assumed by the SRS safety analysis[22] that 100% of the liquid contents of the largest vessel in each of eight process loops would be released as the vessel wall was damaged by a tornado with an F-3 classification. The analysis assumed that the liquid would be confined in diked areas in all but five of these liquid releases. Radionuclide dispersion was modeled in the analysis as an evaporation of 30% of the confined material. In the five process loops where there would be insufficient dike capacity to contain the liquid releases, about 13 to 35% of the liquid release was assumed to eventually migrate to Upper Three Runs Creek. Again, to ensure consistency in this study, off-site doses are calculated by using the AXAIR89Q code for evaporative release under assumed worst-case (99.5%) meteorological conditions and the LADTAP XL code for the liquid release to the creek. Because the source term is the same as for the F-2 tornado event, Table 3.11 cited previously displays the source term and the resulting calculated doses for an evaporative release from this facility. The calculated maximally exposed off-site individual dose resulting from the airborne release is 1.27 mrem. The calculated maximum off-site population dose from the airborne release is 10.1 person-rem. Table 3.12 cited previously displays the source term and the resulting calculated doses for a liquid release from this facility. The calculated maximally exposed off-site individual dose resulting from the liquid release is 18.6 mrem. The calculated maximum off-site population dose from the liquid release is 67.9 person-rem.

3.4.3.2 F/H Effluent Treatment Facility

For this scenario, it was assumed by the SRS safety analysis[23] that 50% of the liquid contents of the facility would be released as the equipment and piping were damaged by a tornado with an F-3 classification. The analysis assumed that none of the liquid would be confined in diked areas. Radionuclide dispersion was modeled in the analysis as an evaporation of 50% of the liquid release. In addition, 50% of the liquid release was assumed to eventually migrate to Upper Three Runs Creek. For this study off-site doses are calculated by using the AXAIR89Q code for evaporative release under assumed worst-case (99.5%) meteorological conditions and the LADTAP XL code for the liquid release to the creek. Because the source term is the same as for the F-2 tornado event, Table 3.13 cited previously displays the source term and the resulting calculated doses for an evaporative release from this facility. The calculated maximally exposed off-site individual dose resulting from the airborne release is 0.029 mrem. The calculated maximum off-site population dose from the airborne release is 0.229 person-rem. Table 3.14 cited previously displays the source term and the resulting calculated doses for a liquid release from this facility. The calculated maximally exposed off-site individual dose resulting from the liquid release is 0.042 mrem. The calculated maximum off-site population dose from the liquid release is 0.301 person-rem.

3.4.3.3 Consolidated Tritium Facility

For this scenario, it was assumed by the SRS safety analysis[25] that 50% of the tritium inventory stored in the equipment and piping would be released in the event of facility damage by a tornado with an F-2 classification. The safety analysis also assumed that 1% of the released tritium would be in oxide form. Consequently, off-site doses resulting from the tornado are calculated by using the AXAOTHER code for tornado dispersion at 75 m height. Table 3.28 displays the source term and the resulting calculated doses for an airborne release from this facility. The calculated maximally exposed off-site individual dose resulting from the airborne release is 2.8 mrem. The calculated maximum off-site population dose from the airborne release is 46.4 person-rem.

3.4.4 200 Z Area

The site boundary location for the hypothetical off-site individual receiving the greatest airborne dose is 5.79 miles from the release point in the north direction. The population sector with the largest population subject to airborne exposure is the sector located to the west-northwest.

Table 3.28. Airborne radionuclide source terms and calculated off-site doses for the Consolidated Tritium Facility (234-H) resulting from a tornado event with peak gust speeds in the range 158 mph - 206 mph (F-3 Fujita Scale)

Radionuclide	Airborne Source Term[a] (Ci)	50-Year EDE to Maximally Exposed Individual Off-Site from 1 Ci Release (mrem)	50-Year EDE to Maximally Exposed Individual Off-Site (mrem)	50-Year EDE to Off-Site Population from 1 Ci Release (person-rem)	50-Year EDE to Off-Site Population (person-rem)
H-3	3.90E+07	7.25E-08[b]	2.83E+00	1.19E-06[b]	4.64E+01
TOTAL			2.83E+00		4.64E+01

[a]Source: Reference 25, p. 3-24

[b]This value was derived by correcting the AXAOTHER result to account for the assumed oxide fraction (1%)

3.4.4.1 Saltstone Facility

For this scenario, it was assumed by the SRS safety analysis[26] that 100% of the liquid contents of the process equipment would be released as the equipment was damaged by a tornado with an F-3 classification. Radionuclide dispersion was modeled in the analysis as an evaporation of 100% of the released liquid. The off-site doses are calculated by using the AXAIR89Q code for evaporative release under assumed worst-case (99.5%) meteorological conditions. Because the source term is the same as for the F-2 tornado event, Table 3.16 cited previously displays the source term and the resulting calculated doses for an evaporative release from this facility. The calculated maximally exposed off-site individual dose resulting from the airborne release is essentially zero. The calculated maximum off-site population dose from the airborne release is also essentially zero.

3.4.5 300 M / 700 A Area

The location for M-Area for the hypothetical off-site individual receiving the greatest airborne dose is 0.75 miles from the release point in the northwest direction. The population sector with the largest population subject to airborne exposure is the sector located to the west-northwest.

The location for A-Area for the hypothetical off-site individual receiving the greatest airborne dose is 0.27 miles from the release point in the west-northwest direction. The population sector with the largest population subject to airborne exposure is the sector located to the west-northwest.

3.4.5.1 Fuel Fabrication Facility

For this scenario it was concluded by the SRS safety analysis[28] that there could be a release of radioactive materials from the rooftop filter enclosures at the Fuel Fabrication Facility caused by a tornado event with an F-3 classification. A nuclear criticality involving 5×10^{17} fissions was also assumed to occur. Off-site doses resulting from the filter release are calculated by using the AXAOTHER code for tornado dispersion at 75 m height. Dispersion following the nuclear criticality event is modeled as a release under assumed worst-case (99.5%) meteorological conditions. Therefore, the AXAIR89Q code is used to calculate off-site doses resulting from the nuclear criticality. Table 3.29 displays the source terms and the resulting calculated doses for airborne releases from this facility. The calculated maximally exposed off-site individual dose resulting from the airborne release is 62.3 mrem. The calculated maximum off-site population dose from the airborne release is 67.9 person-rem.

3.4.5.2 SRTC Technical Area

The SRS safety analysis[29] did not address a tornado-initiated release of radioactive materials from the primary confinement of the SRTC Technical Area. However, the analysis postulated that fractions of the facility glovebox and laboratory hood radionuclide inventory would be dispersed by winds exceeding 150 mph (fastest-mile speed). The safety analysis assumed that in 1% of the instances where this damage occurs, an additional radionuclide release will be caused by an associated fire. Logically, the same damage can be caused by a tornado with a peak gust speed equivalent to the extreme straight-line wind speed. Off-site doses resulting from the direct release are calculated by using the AXAOTHER code for tornado dispersion at 75 m height. Doses resulting from a fire are calculated with the AXAIR89Q code for assumed worst-case (99.5%) meteorological conditions. Table 3.30 displays the source term and the resulting calculated doses for an airborne release from this facility, both for the direct airborne release and for the additional release caused by fire. The calculated maximally exposed off-site individual dose resulting from the airborne release is 503 mrem (sum of doses from direct release and fire-initiated release). The calculated maximum off-site population dose from the airborne release is 115 person-rem. The maximally exposed individual dose from the fire is significantly higher than that presented in the SRS safety analysis because the release was assumed to occur at the center of A-Area for this study. However, this dose was not recalculated because of the low frequency of the fire event.

3.4.6 Integrated Site Effects

In this scenario, after a warning period of at least a day,[44] a violent thunderstorm many miles in diameter would appear over the SRS. Without much warning, however, a tornado or group of tornadoes associated with the storm causes severe damage, including damage to the thirteen nuclear facilities that can release radioactive materials. As shown in the previous sections, the SRS safety analyses predict that eight of the nuclear facilities at the SRS would

Table 3.29. Airborne radionuclide source terms and calculated off-site doses for the Fuel Fabrication Facility (321-M) resulting from a tornado event with peak gust speeds in the range 158 mph - 206 mph (F-3 Fujita Scale)

Radionuclide	Airborne Source Term[a] (Ci)	50-Year EDE to Maximally Exposed Individual Off-Site from 1 Ci Release (mrem)	50-Year EDE to Maximally Exposed Individual Off-Site (mrem)	50-Year EDE to Off-Site Population from 1 Ci Release (person-rem)	50-Year EDE to Off-Site Population (person-rem)
Direct Release					
U-232	1.62E-03	8.16E+02	1.32E+00	1.04E+03	1.68E+00
U-233	1.77E-04	1.58E+02	2.80E-02	2.01E+02	3.56E-02
U-234	2.28E-01	1.58E+02	3.60E+01	2.01E+02	4.58E+01
U-235	1.59E-03	1.46E+02	2.32E-01	1.85E+02	2.94E-01
U-236	5.00E-02	1.46E+02	7.30E+00	1.85E+02	9.25E+00
U-238	9.89E-05	1.46E+02	1.44E-02	1.85E+02	1.83E-02
TOTAL			4.49E+01		5.71E+01
Nuclear Criticality					
Kr-83m	8.00E+00	1.99E-07	1.59E-06	8.63E-09	6.90E-08
Kr-85	8.00E-05	2.02E-05	1.62E-09	1.62E-05	1.30E-09
Kr-85m	7.50E+00	1.48E-03	1.11E-02	3.86E-04	2.90E-03
Kr-87	4.95E+01	5.50E-03	2.72E-01	2.27E-04	1.12E-02
Kr-88	3.25E+01	1.45E-02	4.71E-01	2.40E-03	7.80E-02
Kr-89	2.10E+03	8.82E-04	1.85E+00	1.33E-07	2.79E-04

Table 3.29. (continued)

Radionuclide	Airborne Source Term[a] (Ci)	50-Year EDE to Maximally Exposed Individual Off-Site from 1 Ci Release (mrem)	50-Year EDE to Maximally Exposed Individual Off-Site (mrem)	50-Year EDE to Off-Site Population from 1 Ci Release (person-rem)	50-Year EDE to Off-Site Population (person-rem)
I-131	1.09E-01	6.58E-01	7.17E-02	7.00E-01	7.63E-02
I-132	1.38E+01	2.45E-02	3.38E-01	3.15E-03	4.35E-02
I-133	2.00E+00	1.63E-02	3.26E-02	1.26E-02	2.52E-02
I-134	5.62E+01	2.03E-02	1.14E+00	3.67E-04	2.06E-02
I-135	5.88E+00	3.45E-02	2.03E-01	1.59E-02	9.35E-02
Xe-131m	4.10E-03	2.33E-04	9.55E-07	1.09E-04	4.47E-07
Xe-133	1.35E+00	5.20E-04	7.02E-04	3.24E-04	4.37E-04
Xe-133m	9.00E-02	4.36E-04	3.92E-05	2.44E-04	2.20E-05
Xe-135	1.80E+01	2.34E-03	4.21E-02	1.53E-03	2.75E-02
Xe-135m	1.13E+02	2.34E-03	2.64E-01	2.41E-04	2.72E-02
Xe-137	2.45E+03	1.54E-04	3.77E-01	2.96E-08	7.25E-05
Xe-138	6.50E+02	4.49E-03	2.92E+00	5.80E-06	3.77E-03
U-232	2.02E-05	1.37E+04	2.77E-01	1.50E+04	3.03E-01
U-233	2.21E-06	2.66E+03	5.88E-03	2.92E+03	6.45E-03
U-234	2.85E-03	2.66E+03	7.58E+00	2.92E+03	8.32E+00
U-235	1.99E-05	2.46E+03	4.90E-02	2.69E+03	5.35E-02

Table 3.29. (continued)

Radionuclide	Airborne Source Term[a] (Ci)	50-Year EDE to Maximally Exposed Individual Off-Site from 1 Ci Release (mrem)	50-Year EDE to Maximally Exposed Individual Off-Site (mrem)	50-Year EDE to Off-Site Population from 1 Ci Release (person-rem)	50-Year EDE to Off-Site Population (person-rem)
U-236	6.25E-04	2.46E+03	1.54E+00	2.69E+03	1.68E+00
U-238	1.24E-06	2.46E+03	3.05E-03	2.69E+03	3.34E-03
TOTAL			1.74E+01		1.08E+01

[a]Source: Reference 28, pp. A-9 and A-12

Table 3.30. Airborne radionuclide source terms and calculated off-site doses for the SRTC Technical Area resulting from a tornado event with peak gust speeds in the range 158 mph - 206 mph (F-3 Fujita Scale)

Radionuclide	Airborne Source Term[a] (Ci)	50-Year EDE to Maximally Exposed Individual Off-Site from 1 Ci Release (mrem)	50-Year EDE to Maximally Exposed Individual Off-Site (mrem)	50-Year EDE to Off-Site Population from 1 Ci Release (person-rem)	50-Year EDE to Off-Site Population (person-rem)
Direct Release					
Am-241	6.34E-05	6.33E+02	4.01E-02	8.35E+02	5.29E-02
Ba-133	3.84E-07	8.59E-03	3.30E-09	1.12E-02	4.30E-09
C-14	5.98E-06	2.92E-05	1.75E-10	3.85E-05	2.30E-10
Ca-45	3.03E-04	7.43E-03	2.25E-06	9.79E-03	2.97E-06
Ce-144	5.87E-02	4.26E-01	2.50E-02	5.62E-01	3.30E-02
Cm-244	2.91E-07	3.29E+02	9.57E-05	4.34E+02	1.26E-04
Co-60	3.91E-04	1.84E-01	7.19E-05	2.42E-01	9.46E-05
Cs-134	1.16E-04	5.80E-02	6.73E-06	7.62E-02	8.84E-06
Cs-137	4.44E-02	3.90E-02	1.73E-03	5.14E-02	2.28E-03
Eu-154	2.30E-07	3.17E-01	7.29E-08	4.18E-01	9.61E-08
Eu-155	4.68E-08	4.75E-02	2.22E-09	6.27E-02	2.93E-09
H-3	4.26E-02	1.16E-04	4.94E-06	1.53E-04	6.52E-06
Hg-203	1.20E-04	5.60E-03	6.72E-07	7.33E-03	8.80E-07
I-129	2.91E-07	2.19E-01	6.37E-08	2.89E-01	8.41E-08
Na-22	6.00E-05	1.13E-02	6.78E-07	1.42E-02	8.52E-07
Np-237	1.19E-05	5.97E+02	7.10E-03	7.87E+02	9.37E-03
Np-239	1.50E-07	2.76E-03	4.14E-10	3.59E-03	5.39E-10

Table 3.30. (continued)

Radionuclide	Airborne Source Term[a] (Ci)	50-Year EDE to Maximally Exposed Individual Off-Site from 1 Ci Release (mrem)	50-Year EDE to Maximally Exposed Individual Off-Site (mrem)	50-Year EDE to Off-Site Population from 1 Ci Release (person-rem)	50-Year EDE to Off-Site Population (person-rem)
Pu-238	1.04E-04	5.60E+02	5.82E-02	7.39E+02	7.69E-02
Pu-239	1.15E-02	6.21E+02	7.14E+00	8.19E+02	9.42E+00
Pu-240	1.16E-03	6.21E+02	7.20E-01	8.19E+02	9.50E-01
Pu-241	4.20E-02	1.22E+01	5.12E-01	1.61E+01	6.76E-01
Pu-242	1.01E-07	5.85E+02	5.91E-05	7.71E+02	7.79E-05
Ru-103	7.17E-06	9.74E-03	6.98E-08	1.27E-02	9.11E-08
Ru-106	1.84E-03	5.36E-01	9.86E-04	7.07E-01	1.30E-03
Sb-125	1.26E-04	1.21E-02	1.52E-06	1.59E-02	2.00E-06
Sr-90	2.14E-04	1.58E+00	3.38E-04	2.09E+00	4.47E-04
Tc-99	1.27E-03	9.13E-03	1.16E-05	1.20E-02	1.52E-05
U-235	1.90E-07	1.46E+02	2.77E-05	1.93E+02	3.67E-05
U-238	1.17E-06	1.46E+02	1.71E-04	1.93E+02	2.26E-04
Zr-95	3.62E-06	2.35E-02	8.51E-08	3.08E-02	1.11E-07
TOTAL			8.53E+00		1.12E+01

Table 3.30. (continued)

Radionuclide	Airborne Source Term[a] (Ci)	50-Year EDE to Maximally Exposed Individual Off-Site from 1 Ci Release (mrem)	50-Year EDE to Maximally Exposed Individual Off-Site (mrem)	50-Year EDE to Off-Site Population from 1 Ci Release (person-rem)	50-Year EDE to Off-Site Population (person-rem)
Fire-Initiated Release					
Am-241	2.11E-06	1.88E+04	3.97E-02	3.98E+03	8.40E-03
Ba-133	1.28E-08	2.54E-01	3.25E-09	5.38E-02	6.89E-10
C-14	1.99E-07	8.69E-04	1.73E-10	1.84E-04	3.66E-11
Ca-45	1.01E-05	2.21E-01	2.23E-06	4.66E-02	4.71E-07
Ce-144	2.15E-03	1.27E+01	2.73E-02	2.68E+00	5.76E-03
Cm-244	9.71E-09	9.78E+03	9.50E-05	2.07E+03	2.01E-05
Co-60	1.30E-05	5.45E+00	7.09E-05	1.15E+00	1.49E-05
Cs-134	3.88E-06	1.72E+00	6.67E-06	3.63E-01	1.41E-06
Cs-137	1.48E-03	1.16E+00	1.72E-03	2.45E-01	3.63E-04
Eu-154	7.67E-09	9.43E+00	7.23E-08	1.99E+00	1.53E-08
Eu-155	1.56E-09	1.41E+00	2.20E-09	2.99E-01	4.66E-10
H-3	1.42E-03	3.44E-03	4.88E-06	7.27E-04	1.03E-06
Hg-203	4.00E-06	1.65E-01	6.60E-07	3.49E-02	1.40E-07
I-129	9.69E-09	6.52E+00	6.32E-08	1.38E+00	1.34E-08
Na-22	2.00E-06	3.08E-01	6.16E-07	6.63E-02	1.33E-07
Np-237	7.03E-06	1.78E+04	1.25E-01	3.75E+03	2.64E-02
Np-239	5.01E-09	8.12E-02	4.07E-10	1.59E-02	7.97E-11

Table 3.30. (continued)

Radionuclide	Airborne Source Term[a] (Ci)	50-Year EDE to Maximally Exposed Individual Off-Site from 1 Ci Release (mrem)	50-Year EDE to Maximally Exposed Individual Off-Site (mrem)	50-Year EDE to Off-Site Population from 1 Ci Release (person-rem)	50-Year EDE to Off-Site Population (person-rem)
Pu-238	3.12E-04	1.67E+04	5.21E+00	3.52E+03	1.10E+00
Pu-239	2.21E-02	1.85E+04	4.09E+02	3.90E+03	8.62E+01
Pu-240	3.44E-03	1.85E+04	6.36E+01	3.90E+03	1.34E+01
Pu-241	4.75E-02	3.62E+02	1.72E+01	7.65E+01	3.63E+00
Pu-242	3.01E-07	1.74E+04	5.24E-03	3.67E+03	1.10E-03
Ru-103	2.39E-07	2.87E-01	6.86E-08	6.06E+03	1.45E-08
Ru-106	1.26E-04	1.59E+01	2.00E-03	3.37E+00	4.25E-04
Sb-125	4.20E-06	3.59E-01	1.51E-06	7.60E-02	3.19E-07
Sr-90	1.52E-05	4.71E+01	7.16E-04	9.95E+00	1.51E-04
Tc-99	4.43E-05	2.72E-01	1.20E-05	5.74E-02	2.54E-06
U-235	7.18E-07	4.35E+03	3.12E-03	9.18E+02	6.59E-04
U-238	1.13E-05	4.35E+03	4.92E-02	9.18E+02	1.04E-02
Zr-95	1.21E-07	6.94E-01	8.40E-08	1.47E-01	1.78E-08
TOTAL			4.95E+02		1.04E+02

[a]Source: Reference 29, p. C-71

release particulate radioactive material immediately into the wind field, four others would spill liquid radioactive materials that would subsequently evaporate, and one would release particulate radioactive material soon after passage of the tornado. Table 3.31 tabulates the expected dose risk by facility for airborne releases resulting from an F-3 tornado. Results are presented both for the maximally exposed off-site individual and for the off-site population (worst-sector results). Similarly, Table 3.32 tabulates the expected dose and risk by facility for liquid releases to surface streams resulting from this event.

3.4.6.1 Maximally Exposed Off-Site Individual Dose and Risk (from airborne releases)

Inspecting the dose values for the maximally exposed off-site individual exposure resulting from airborne radionuclide releases (Table 3.31), one could simply sum the maximally exposed off-site individual doses resulting from each facility release to derive an integrated maximally exposed off-site individual dose for the site for this event. Again, such a dose value has no physical meaning because the locations of the maximally exposed individuals for many of the affected facilities are different.

Two more realistic approaches for estimating integrated doses and risks are described in Section 3.2.3.1. Briefly, the first of these approaches involves adjusting the dose values from each affected facility to obtain an integrated dose for the maximally exposed off-site individual location for the dominant facility. The fire-initiated release from the SRTC Technical Area (Section 3.4.5.2) results in the dominant maximally exposed off-site individual dose. The boundary location closest to A-Area is the location for the off-site individual. A maximum dose of 594 mrem is calculated with this approach.

The second of the two more realistic approaches for estimating integrated doses and risks considers only those facility releases that result in maximum off-site individual exposure at the same boundary location as the dominant facility. Again, the fire-initiated release from the SRTC Technical Area (Section 3.4.5.2) results in the dominant maximally exposed off-site individual dose. A maximum dose of 504 mrem is calculated by using this approach.

Table 3.33 presents the integrated doses and risks to the maximally exposed off-site individual (from airborne releases only) that result from applying these three approaches.

Table 3.31. Doses and risks by facility for airborne radionuclide releases resulting from a tornado event with peak gust speeds in the range 158 mph - 206 mph (F-3 Fujita Scale)

Facility	Accident Frequency ($year^{-1}$)	Maximally Exposed Individual		Off-Site Population	
		Dose[a] (mrem)	Risk (rem/year)	Dose[a] (person-rem)	Risk (person-rem/year)
F-Area Outside Facilities	2.7E-05[b]	6.8E-01	1.8E-08	3.4E+00	9.2E-05
Production Control Facilities (772-F)	8.0E-06	1.5E-03	1.2E-11	1.2E-02	9.6E-08
New Production Control Facilities (772-1F)	8.0E-06	3.3E+01	2.6E-07	2.7E+02	2.1E-03
Building 247-F Plutonium Storage Facility	1.8E-07[c]	7.4E-06	1.3E-15	5.9E-05	1.1E-11
A-Line Operations	8.0E-06	2.9E+00	2.3E-08	2.3E+01	1.9E-04
Building 235-F	8.0E-06	5.1E-02	4.2E-10	2.7E-01	2.2E-06
Solid Waste Disposal Facilities	8.0E-06	1.4E+01	1.1E-07	1.9E+02	1.5E-03
H-Area Outside Facilities	1.4E-05[d]	1.3E+00	1.8E-08	1.0E+01	1.4E-04
F/H Effluent Treatment Facility	8.0E-06	2.9E-02	2.3E-10	2.3E-01	1.8E-06
Consolidated Tritium Facility (234-H)	8.0E-06	2.8E+00	2.2E-08	4.6E+01	3.7E-04
Saltstone Facility	8.0E-06	8.3E-05	6.6E-13	5.5E-04	4.4E-09
Fuel Fabrication Facility (321-M)	8.0E-06	6.2E+01	5.0E-07	6.8E+01	5.4E-04
SRTC Technical Area					
• Direct release	8.0E-06	8.5E+00	6.8E-08	1.1E+01	9.0E-05
• Fire-initiated release	8.0E-08[e]	5.0E+02	4.0E-08	1.0E+02	8.3E-06

[a]50-year effective dose equivalent (EDE) estimated by using ICRP-30 dose conversion factors

[b]Corrected strike frequency for an F-3 tornado (Reference 1, p. 5-34)

[c]Point strike frequency for F-3 tornado multiplied by conditional probability of release (2.2E-02)

[d]Corrected strike frequency for F-3 tornado (2.7E-05/year) multiplied by the conditional probability of release (5.0E-01)

[e]Point strike frequency for F-3 tornado multiplied by conditional probability of fire (1.0E-02)

Table 3.32. Doses and risks by facility for liquid radionuclide releases resulting from a tornado event with peak gust speeds in the range 158 mph - 206 mph (F-3 Fujita Scale)

Facility	Accident Frequency ($year^{-1}$)	Maximally Exposed Individual		Off-Site Population	
		Dose[a] (mrem)	Risk (rem/year)	Dose[a] (person-rem)	Risk (person-rem/year)
F-Area Outside Facilities	2.7E-05[b]	1.1E-02	3.0E-10	7.7E-01	2.1E-05
H-Area Outside Facilities	1.4E-05[c]	1.9E+01	2.6E-07	6.8E+01	9.5E-04
F/H Effluent Treatment Facility	8.0E-06	4.2E-02	3.4E-10	3.0E-01	2.4E-06

[a]50-year effective dose equivalent (EDE) estimated by using ICRP-30 dose conversion factors

[b]Corrected strike frequency for an F-3 tornado (Reference 1, p. 5-34)

[c]Corrected strike frequency for F-3 tornado (2.7E-05/year) multiplied by the conditional probability of release (5.0E-01)

Table 3.33. Integrated doses and risks to the maximally exposed off-site individual for airborne releases resulting from a tornado event with peak gust speeds in the range 158 mph - 206 mph (F-3 Fujita Scale)

Calculation Option	Dose[a] (mrem)	Risk (rem/year)
1. Sum worst-case, worst-sector doses/risks for all affected facilities, not accounting for the different receptor locations	6.2E+02	1.1E-06
2. Sum worst-case doses/risks for a single boundary location (location of the maximally exposed off-site individual for the dominant facility)	5.9E+02	7.7E-07
3. Sum worst-case, worst-sector doses/risks for facilities whose maximally exposed off-site individual is located in the same sector as the maximally exposed off-site individual of the dominant facility; ignore doses/risks for other facilities	5.0E+02	1.1E-07

[a]50-year effective dose equivalent (EDE) estimated by using ICRP-30 dose conversion factors

3.4.6.2 Maximally Exposed Off-Site Individual Dose and Risk (from liquid releases to surface water)

The maximally exposed off-site individual with regard to any radionuclide release to surface water bodies is assumed to live alongside the Savannah River south of the SRS. Therefore, doses resulting from liquid spills at the facilities affected by the F-3 tornado event can be summed to obtain the integrated dose. Maximum doses from airborne releases are realized at locations along the northern and western site boundaries. Therefore, it is inappropriate to combine these doses with those resulting from releases to surface water bodies. The integrated dose to the maximally exposed off-site individual from liquid releases to surface water is then 18.6 mrem, and the integrated risk is 2.6 x 10^{-7} rem/year.

3.4.6.3 Maximum Off-Site Population Dose and Risk (from airborne releases)

One can simply sum the maximum off-site population doses resulting from each facility release to derive an integrated maximum off-site population dose for the site for this event. This approach is valid because the worst sector with regard to population dose is the same for all affected facilities (west-northwest sector). The dominant sectors in this direction from M/A, E, F, H, and Z Areas do not overlay exactly. However, at the off-site location corresponding to the bulk of the population (Augusta, Georgia), the sector difference is insignificant. A maximum dose of 720 person-rem is calculated. The integrated risk to the off-site population is 0.0051 person-rem/year.

3.4.6.4 Maximum Off-Site Population Dose and Risk (from liquid releases to surface water)

The integrated maximum off-site population dose and risk resulting from releases to surface water are 69.0 person-rem and 9.7×10^{-4} person-rem/year, respectively. The individual facility contributions shown in Table 3.32 are simply summed to obtain these results.

3.4.6.5 Risk

Tables 3.31 and 3.32 show the expected frequencies and risks associated with the facilities damaged by an F-3 tornado event. Note that the safety analysis for the F-Area Outside Facilities increased the expected frequency of the tornado strike to account for the large area of the facility. The safety analysis for the H-Area Outside Facilities also increased the expected frequency of the tornado strike to account for the large area of the facility and included a conditional damage probability in the frequency expression. With regard to airborne releases, the dominant risk contributor is the Fuel Fabrication Facility. For liquid releases to surface water bodies, the dominant risk contributor is the H-Area Outside Facilities. Figure 3.3 displays the risk of the individual facility releases in a graphic format.

3.5 SUMMARY

To summarize, it is possible to model a scenario in which a tornado event damages multiple facilities at the SRS. Based on the facility safety analysis reports, only the more vulnerable facilities would release radionuclides as a result of such damage. The results of analyzing these scenarios with conservative release assumptions and conservative dispersion models indicate that 50-year effective dose equivalents to the hypothetical maximally exposed off-site individual and the off-site population would be negligible.

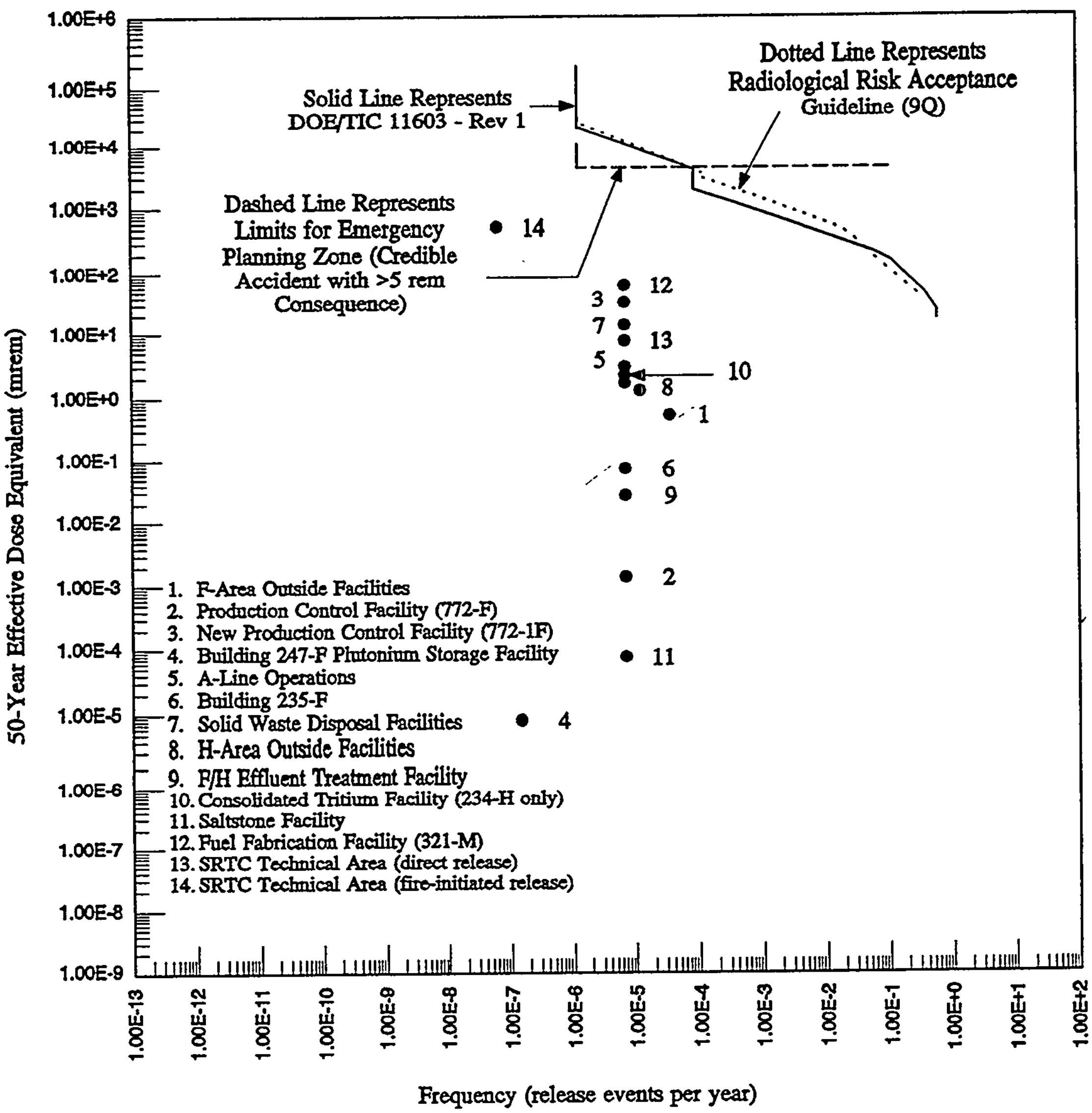

Figure 3.3. Public risks associated with an F-3 tornado event.

For tornado events with the most likely F-1 classification, the maximally exposed off-site individual would receive about 0.002 mrem, and the ~200,000 persons in the worst-case off-site population sector would receive a total of 0.02 person-rem from airborne releases.

For tornado events with the less likely F-2 classification, the resulting maximum off-site doses are higher than those for the more likely F-1 tornado classification. The maximally exposed off-site individual would receive about 36 mrem, and the ~200,000 persons in the worst-case off-site population sector would receive a total of 221 person-rem from airborne releases. The maximum dose that an off-site individual could receive from liquid releases in this scenario is 19 mrem; the maximum dose that the entire off-site population within a 50-mile radius of the site could receive from liquid releases in this scenario is 68.4 person-rem.

For tornado events with the least likely F-3 classification, the resulting maximum off-site doses are greater than those for the more likely F-2 tornado classification. The maximally exposed off-site individual would receive about 504 mrem, and the ~200,000 persons in the worst-case off-site population sector would receive a total of 720 person-rem from airborne releases. The maximum dose that an off-site individual could receive from liquid releases in this scenario is 19 mrem; the maximum dose that the entire off-site population within a 50-mile radius of the site could receive from liquid releases in this scenario is 69 person-rem.

Two conclusions can be drawn about the threat that these tornado scenarios present to the SRS. First, because these worst-case dose values are 50-year totals, the average yearly expected dose from these scenarios would be in the range of 10-20 mrem, a dose that would be extremely difficult to measure and that is an order of magnitude below the average annual background dose experienced by persons living off-site. Second, worst case assumptions have been utilized in analyzing these scenarios; the actual off-site dose, given that one of these events occurs, is likely to be one-to-two orders of magnitude lower. Thus, without discussing probabilistic aspects of the scenarios, the threat from exposure to radioactivity that the scenarios present to persons located off-site is negligible. This is especially true when the threat from exposure to radioactivity is placed in the context of the direct threat to life and health from the tornado event itself.

4.0 OTHER EXTERNAL EVENTS

4.1 FLOOD EVENTS

The safety analysis documentation does not consider riverine flooding as a credible accident scenario at the SRS because of the high elevation of the facilities relative to that of the river. Heavy rainfall flooding is not considered as a credible radionuclide release initiator for any facility except the 200 E Area Solid Waste Disposal Facilities. Consequently, integrated doses and risks will not be evaluated for flood event initiators.

4.2 OTHER EXTREME WEATHER EVENTS

In general, the safety analysis documentation does not consider other extreme weather events (rainfall, snow, hail, extreme temperatures, or lightning) as credible radionuclide release initiators at the SRS. Instead, they are considered as sources of aggravation to prevention or mitigation systems. Consequently, integrated doses and risks will not be evaluated for other extreme weather event initiators.

4.3 EXTERNAL VEHICLE IMPACT EVENTS

Five nuclear facilities at the SRS have physical exposures that make external vehicle impact events credible radionuclide release accident initiators. In general, however, these facilities are too far apart for a single external vehicle impact to cause a release from more than one facility. Consequently, integrated doses and risks will not be evaluated for external vehicle impact event initiators.

4.4 ADJACENT FACILITY FIRE OR EXPLOSION EVENTS

In general, the safety analysis documentation does not consider adjacent facility fire or explosion events as credible radionuclide release initiators at the SRS. Consequently, integrated doses and risks will not be evaluated for adjacent facility fire or explosion event initiators.

4.5 AIRCRAFT IMPACT EVENTS

The safety analysis documentation does not consider aircraft impact events as credible at the SRS. However, the safety documentation for five facilities (Plutonium Fuel Form Facility, Saltstone Facility, Liquid Radioactive Waste Handling Facilities, Building 321-M Fuel Fabrication Facility, and F-Canyon) does include very low risk estimates (all $\leq 3 \times 10^{-7}$ rem/year) for this initiator. In order for an aircraft crash to impact multiple facilities, the facilities must be in close proximity to one another. The five facilities for which risk estimates have been made are located in different areas of the SRS, except for the Plutonium Fuel Form Facility and F-Canyon, both of which are located in the 200 F Area. However, these facilities are located about 0.25 miles apart within the 200 F Area. Consequently, integrated doses and risks will not be evaluated for aircraft impacts.

4.6 METEORITE IMPACT EVENTS

The safety analysis documentation does not consider meteorite impact events as credible at the SRS, although the safety documentation for one facility (Plutonium Fuel Form Facility) does include a very low risk estimate (frequency of 1×10^{-12}/year; 65 rem EDE to the maximally exposed off-site individual). Consequently, integrated doses and risks will not be evaluated for meteorite impact initiators.

5.0 CONCLUSIONS

Estimated radiation doses and risks from nonseismic external events for individual nuclear facilities at the SRS have been combined to obtain site-wide dose and risk estimates for these events. Among nonseismic external events, only extreme straight-line wind events and tornadoes can credibly cause radionuclide releases from multiple facilities simultaneously. Thus, attention was focused on these events in this study.

Integrated (site-wide) doses and risks were estimated for the maximally exposed off-site individual and for the off-site population within 50 miles of the center of the SRS. Exposure pathways considered were inhalation, immersion, ingestion of contaminated water and aquatic foods, and dermal contact with contaminated water. The first two pathways were only evaluated for airborne radionuclide releases, whereas the other pathways were only evaluated for liquid releases to surface water bodies. Doses and risks resulting from airborne releases and liquid releases are reported separately because the receptors would not be the same.

In the case of extreme straight-line wind events, two wind-speed ranges were evaluated (fastest-mile wind speed in the range 100 mph - 150 mph and fastest-mile wind speed greater than 150 mph).

For the lower wind-speed range, the estimated dose to the maximally exposed off-site individual from airborne releases is 23 mrem, with the corresponding risk estimate being 1.8×10^{-5} rem/year. The dose to the maximally exposed off-site individual from liquid releases is 19 mrem, with a corresponding risk estimate of 1.4×10^{-5} rem/year. The expected dose and risk to the off-site population for airborne releases are 332 person-rem and 0.97 person-rem/year. The population dose and risk from liquid releases are 68.5 person-rem and 0.0525 person-rem/year, respectively. Doses and risks from airborne releases are dominated by the Fuel Fabrication Facility and the New Production Control Facility, whereas the doses and risks from liquid releases are dominated by the H-Area Outside Facilities contribution.

For the higher wind-speed range, the estimated dose to the maximally exposed off-site individual from airborne releases is 495 mrem, with the corresponding risk estimate being 1.6×10^{-7} rem/year. The dose to the maximally exposed off-site individual from liquid releases is again 19 mrem, with a corresponding risk estimate of 6.3×10^{-7} rem/year. The expected dose and risk to the off-site population for airborne releases are 5,205 person-rem and 0.17 person-rem/year. The population dose and risk from liquid releases are 68.5 person-rem and 0.0023 person-rem/year, respectively. The doses and risks from airborne releases at this wind-speed range are dominated by the SRTC Technical Area and the New Production Control Facility. The doses and risks from liquid releases are again dominated by releases from the H-Area Outside Facilities.

Table 5.1 shows the integrated risks for extreme straight-line wind events (all wind speeds combined). These values are summations of the values presented above for the two wind-speed ranges.

For tornado events, three wind-speed ranges were evaluated [peak gust speed in the range 73 mph - 112 mph (F-1 Fujita Scale), peak gust speed in the range 113 mph - 157 mph (F-2 Fujita Scale), and peak gust speed in the range 158 mph - 206 mph (F-3 Fujita Scale)].

For F-1 tornadoes, the estimated dose to the maximally exposed off-site individual from airborne releases is 0.002 mrem, with the corresponding risk estimate being 2.1×10^{-10} rem/year. The expected dose and risk to the off-site population for airborne releases are 0.02 person-rem and 3×10^{-6} person-rem/year. Doses and risks from airborne releases are dominated by the Production Control Facility. No liquid releases to surface water were postulated for a tornado event of this magnitude.

For tornadoes having an F-2 classification, the estimated dose to the maximally exposed off-site individual from airborne releases is 36 mrem, with the corresponding risk estimate being 1.3×10^{-6} rem/year. The dose to the maximally exposed off-site individual from liquid releases is 18.6 mrem, with a corresponding risk estimate of 4.7×10^{-7} rem/year. The expected dose and risk to the off-site population for airborne releases are 221 person-rem and 0.008 person-rem/year. The population dose and risk from liquid releases are 68.4 person-rem and 0.0017 person-rem/year, respectively. The doses and risks from airborne releases for this tornado classification are dominated by the Fuel Fabrication Facility and the Solid Waste Disposal Facilities. The doses and risks from liquid releases are dominated by releases from the H-Area Outside Facilities.

For tornadoes having an F-3 classification, the estimated dose to the maximally exposed off-site individual from airborne releases is 504 mrem, with the corresponding risk estimate being 1.1×10^{-7} rem/year. The dose to the maximally exposed off-site individual from liquid releases is 18.7 mrem, with a corresponding risk estimate of 2.6×10^{-7} rem/year. The expected dose and risk to the off-site population for airborne releases are 720 person-rem and 0.0051 person-rem/year. The population dose and risk from liquid releases are 69 person-rem and 9.7×10^{-4} person-rem/year, respectively. The doses and risks from airborne releases for this tornado classification

Table 5.1. Integrated risks for extreme straight-line wind events

Type of Release	Risk to Maximally Exposed Off-Site Individual (rem/year)	Risk to Off-Site Population (person-rem/year)
Airborne	1.8E-05	1.1E+00
Liquid (to surface water)	1.5E-05	5.5E-02

are dominated by the Fuel Fabrication Facility and the SRTC Technical Area. The doses and risks from liquid releases are dominated by releases from the H-Area Outside Facilities.

Table 5.2 shows the integrated risks for tornado events (all classifications combined). These values are summations of the values presented above for the three classifications.

Integrated risks for all nonseismic external events are simply summations of the combined extreme straight-line wind and tornado values given previously. For airborne releases, the integrated risk to the maximally exposed off-site individual is 1.9×10^{-5} rem/year, and the population risk is 1.1 person-rem/year. For liquid releases to surface water, the maximally exposed individual integrated risk is 1.6×10^{-5} rem/year, and the population risk is 0.058 person-rem/year. These risks are negligible compared to the risks associated with background radiation (on the order of 0.38 rem/year for individuals and 2.5×10^{5} person-rem/year for the 50-mile population),[46] and they are well within the guidelines established by DOE SEN-35-91.

Table 5.2. Integrated risks for tornado events

Type of Release	Risk to Maximally Exposed Off-Site Individual (rem/year)	Risk to Off-Site Population (person-rem/year)
Airborne	1.4E-06	1.3E-02
Liquid (to surface water)	7.3E-07	2.7E-03

6.0 REFERENCES

1. *Safety Analysis -- 200 Area Savannah River Plant: F-Area Outside Facility Operations*, DPSTSA-200-10, Supplement 10, E. I. du Pont de Nemours & Company, Aiken, South Carolina, August 1986.

2. P. B. Gerrard, *Safety Analysis -- 200 Area Savannah River Site: Production Control Facilities, Building 772-F*, DPSTSA-200-10, Supplement 12, WSRC Review Draft, Westinghouse Savannah River Company, Aiken, South Carolina, July 1990.

3. P. B. Gerrard, *Safety Analysis -- 200 Area Savannah River Site: Production Control Facilities, Building 772-F (with Addendum of October 9, 1992)*, DPSTSA-200-10, Supplement 12, Westinghouse Savannah River Company, Aiken, South Carolina, March 1992.

4. P. R. Pritchard, *Safety Analysis -- 200 Area Savannah River Plant: New Production Control Facilities, Building 772-1F*, DPSTSA-200-10, Supplement 14, E. I. du Pont de Nemours & Company, Aiken, South Carolina, April 1987.

5. P. B. Gerrard, *Safety Analysis -- 200 Area Savannah River Site: Addendum to the SAR for the New Production Control Facilities, Building 772-1F (U)*, DOE Review Draft, DPSTSA-200-10, Supplement 14, Westinghouse Savannah River Company, Aiken, South Carolina, November 1992.

6. *Safety Analysis -- 200 F-Area Savannah River Site: F-Canyon Operations*, WSRC-RP-89-60, SRS Comment Draft, Westinghouse Savannah River Company, Aiken, South Carolina, April 1992.

7. *Safety Analysis -- 200 Area Savannah River Site Separations Area Operations: Building 221-F B-Line Plutonium Storage Facility*, DPSTSA-200-10, Supplement 19, Westinghouse Savannah River Company, Aiken, South Carolina, July 1989.

8. D. H. Stoddard, *Safety Analysis -- 200 Area Savannah River Plant: A-Line Operations*, DPSTSA-200-10, Supplement 7, E. I. du Pont de Nemours & Company, Aiken, South Carolina, December 1986.

9. W. S. Durant, *Safety Analysis -- 200 Area Savannah River Plant: FB-Line Operations*, DPSTSA-200-10, Supplement 9, E. I. du Pont de Nemours & Company, Aiken, South Carolina, April 1988.

10. *Nuclear Processes Safety Research -- FB-Line Justification for Continued Operation, Addendum to DPSTSA-200-10, Supplement 9*, WSRC-RP-91-1020, Rev. 3, WSRC Review Draft, Westinghouse Savannah River Company, Aiken, South Carolina, April 1993.

11. *Safety Analysis -- 200 F-Area Savannah River Plant: Naval Fuel Material Facility, Storage of Plutonium in the 247-F Facility (U)*, DPSTSA-200-16, Addendum, Westinghouse Savannah River Company, Aiken, South Carolina, August 1992.

12. H. R. Haynes, *Safety Analysis -- 200 Area Savannah River Plant Separations Area Operations: $^{238}PuO_2$ Fuel Form Facility*, DPSTSA-200-10-1, Supplement 1, E. I. du Pont de Nemours & Company, Aiken, South Carolina, June 1983.

13. J. M. Low, *Safety Analysis -- 200 Area Savannah River Site: Plutonium Experimental Facility, Metallography Laboratory, Fuel Form Encapsulation Cells*, WSRC-RP-89-272, Westinghouse Savannah River Company, Aiken, South Carolina, August 1989.

14. *Safety Analysis -- 200 F-Area Savannah River Site: Building 235-F Final Safety Analysis Report (U)*, WSRC-RP-89-575, Rev. 0, DOE Preappoval Copy, Westinghouse Savannah River Company, Aiken, South Carolina, November 1992.

15. C. R. Lux, *Safety Analysis -- 200 Area Savannah River Plant: Building 235-F Vaults*, DPSTSA-200-10, Supplement 15, E. I. du Pont de Nemours & Company, Aiken, South Carolina, August 1986.

16. R. H. Emslie, *Safety Analysis -- 200 Area Savannah River Plant: Burial Ground Operations*, DPSTSA-200-10, Supplement 8, E. I. du Pont de Nemours & Company, Aiken, South Carolina, October 1988.

17. *Burial Ground Operations Safety Analysis Report Addendum, E-Area Vaults (U)*, WSRC-SA-5, Addendum 1, DOE Approval Copy, Westinghouse Savannah River Company, Aiken, South Carolina, February 1994.

18. *Savannah River Site Solid Waste Disposal Facility, Justification for Continued Operation (U)*, WSRC-RP-92-1015, WSRC Review Draft, Westinghouse Savannah River Company, Aiken, South Carolina, August 1992.

19. B. M. Legler et al., *Safety Analysis -- 200 Area Savannah River Plant Separations Area Operations: Liquid Radioactive Waste Handling Facilities*, DPSTSA-200-10, Supplement 18, E. I. du Pont de Nemours & Company, Aiken, South Carolina, February 1988.

20. *Safety Analysis -- 200 Area Savannah River Site: Liquid Radioactive Waste Handling Facilities, Addendum 1, Additional Analysis for DWPF Feed Preparation by In-Tank Processing*, WSRC-SA-15, DOE Approval Draft, Westinghouse Savannah River Company, Aiken, South Carolina, August 1993.

21. *Savannah River Site Liquid Radioactive Waste Handling Facilities, Justification for Continued Operation (U)*, WSRC-RP-92-964, DOE Approval Draft, Westinghouse Savannah River Company, Aiken, South Carolina, April 1993.

22. *Safety Analysis -- 200 Area Savannah River Site Separations Area Operations: Building 211-H Outside Facilities*, DPSTSA-200-10, Supplement 11, Rev. 1, Westinghouse Savannah River Company, Aiken, South Carolina, January 1993.

23. J. P. Ryan, *Safety Assessment -- 200 Area Savannah River Plant: F/H Effluent Treatment Facility*, DPSTSAD-200-5, E. I. du Pont de Nemours & Company, Aiken, South Carolina, December 1986.

24. *Safety Analysis -- 200 Area Savannah River Plant: Tritium Processing Facilities*, DPSTSAWD-200-21, E. I. du Pont de Nemours & Company, Aiken, South Carolina, September 1987.

25. *Savannah River Site Consolidated Tritium Facility, Justification for Continued Operation (U)*, WSRC-RP-92-850, DOE Approval Draft, Westinghouse Savannah River Company, Aiken, South Carolina, May 1993.

26. *Safety Assessment -- 200 Area Savannah River Plant: Saltstone Facility*, DPSTSAD-200-4, E. I. du Pont de Nemours & Company, Aiken, South Carolina, December 1986.

27. *Safety Analysis Report -- Z-Area Savannah River Site: Saltstone Facility*, WSRC-SA-3, DOE Review Draft, Westinghouse Savannah River Company, Aiken, South Carolina, September 1992.

28. *Savannah River Site M Area, Justification for Continued Operation (U)*, DPSTSA-300-3A, Addendum 1, DOE Approval Draft, Westinghouse Savannah River Company, Aiken, South Carolina, November 1993.

29. *Safety Analysis -- Savannah River Laboratory: Technical Area (U)*, WSRC-SA-2, DOE Approval Draft, Westinghouse Savannah River Company, Aiken, South Carolina, September 1992.

30. *Safety Analysis -- 200 S-Area Savannah River Site: Defense Waste Processing Facility Operations (U)*, DPSTSA-200-10, Supplement 20, Rev. 2, Westinghouse Savannah River Company, Aiken, South Carolina, February 1991.

31. P. M. Allen, *Safety Analysis -- 200 Area Savannah River Plant Separations Area Operations: Receiving Basin for Offsite Fuel*, DPSTSA-200-10, Supplement 3, E. I. du Pont de Nemours & Company, Aiken, South Carolina, September 1983.

32. W. S. Durant, *Safety Analysis -- 200 Area Savannah River Plant: H-Canyon Operations*, DPSTSA-200-10, Supplement 5, E. I. du Pont de Nemours & Company, Aiken, South Carolina, February 1986.

33. *Safety Analysis -- 200 Area Savannah River Plant: H-Canyon Operations, H-Canyon SAR Addenda*, DPSTSA-200-10, Supplement 5, Appendix F, Westinghouse Savannah River Company, Aiken, South Carolina, February 1993.

34. *Safety Analysis -- 200 H-Area Savannah River Site: Uranium Solidification Facility*, DOE Review Draft, Westinghouse Savannah River Company, Aiken, South Carolina, November 1990.

35. *Safety Analysis -- 200 Area Savannah River Plant Separations Area Operations: Building 221-H B-Line Scrap Recovery*, DPSTSA-200-10, Supplement 2, E. I. du Pont de Nemours & Company, Aiken, South Carolina, August 1983.

36. *Safety Analysis -- 200 Area Savannah River Plant Separations Area Operations: Building 221-H B-Line Scrap Recovery*, DPSTSA-200-10, Supplement 2A, Westinghouse Savannah River Company, Aiken, South Carolina, July 1991.

37. *Safety Analysis -- 200 Area Savannah River Site: Replacement Tritium Facility Final Safety Analysis Report*, WSRC-SA-1-1, Rev. 1, Westinghouse Savannah River Company, Aiken, South Carolina, August 1992.

38. *Savannah River Site Production Reactor Safety Analysis Report (U), K Production Reactor*, WSRC-SA-10003, Amendment 1, Westinghouse Savannah River Company, Aiken, South Carolina, July 1991.

39. *Savannah River Site Production Reactor Safety Analysis Report (U), K Production Reactor*, WSRC-SA-10003, Amendment 2, Westinghouse Savannah River Company, Aiken, South Carolina, November 1991.

40. *Evaluation of Accident Risks in the Transportation of Hazardous Materials by Truck and Rail at the Savannah River Site (U)*, WSRC-RP-89-715, Rev. 1, Westinghouse Savannah River Company, Aiken, South Carolina, September 1992.

41. D. W. Coats and R. C. Murray, *Natural Phenomena Hazards Modeling Project: Extreme Wind/Tornado Hazard Models for Department of Energy Sites*, UCRL-53526, Rev. 1, Lawrence Livermore National Laboratory, Livermore, California, August 1985.

42. Data for hail and wind events occurring in Aiken and Barnwell Counties, South Carolina, National Severe Storms Forecast Center, Kansas City, Missouri, June 1993.

43. J. C. Huang and D. M. Hamby, *Environmental Dose Assessment Manual*, WSRC-IM-91-1, Westinghouse Savannah River Company, Aiken, South Carolina, December 1991.

44. R. W. Anthony, *Verification of Severe Local Storms Forecasts Issued by the National Severe Storms Forecast Center: 1992*, NOAA Technical Memorandum NWS NSSFC-35, National Severe Storms Forecast Center, Kansas City, Missouri, June 1993.

45. Data for tornadoes occurring within 125 nautical miles of latitude 33°20' and longitude 81°40', National Severe Storms Forecast Center, Kansas City, Missouri, June 1993.

46. C. L. Cummins et al., *1990 Savannah River Site Environmental Report* (U), WSRC-1M-91-28, Vol. 1, Westinghouse Savannah River Company, Aiken, South Carolina, 1991.