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Environmental Dose Assessment Manual

B. H. Stagich

April 2023

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LIST OF ABBREVIATIONS

ANL	Argonne National Laboratory
DOE	Department of Energy
EDAM	Environmental Dose Assessment Manual
EISs	Environmental Impact Statements
EPA	Environmental Protection Agency
ES&D	Environmental Sciences & Dosimetry
HADs	Hazard Assessment Documents
ICRP	International Commission on Radiological Protection
JCL	job control language
JFD	joint frequency distribution
MCL	maximum contaminant level
MEI	maximally exposed individual
NESHAP	National Emission Standards for Hazardous Air Pollutants
NRC	Nuclear Regulatory Commission
ORNL	Oak Ridge National Laboratory
RSIC	Radiation Shielding Information Center
SARs	Safety Analysis Reports
SRNL	Savannah River National Laboratory
SRS	Savannah River Site
TED	total effective dose

1.0 Introduction

1.1 Background

The Environmental Sciences and Dosimetry Group (ES&D) of the Savannah River National Laboratory (SRNL) has been tasked with standardizing Savannah River Site (SRS) environmental dose assessment methods. The set of environmental transport and dosimetry models that have been chosen to employ technically valid methodologies comparable to those accepted by the U.S. Department of Energy (DOE) and other regulating agencies. They are used to estimate potential radiation doses to a representative person or to a maximally exposed individual (MEI) and to the collective population living within 50 miles (80 km) of SRS as well as the downriver populations who use the Savannah River as a drinking water source. The representative person or MEI is a hypothetical off site individual constructed to receive the most dose. This dose is not likely to underestimate or substantially overestimate the potential dose. The estimated collective doses are as realistic as practicable and include all members of the actual exposed population.

This Environmental Dose Assessment Manual (EDAM) presents a discussion of the environmental transport and dosimetry models, and their associated computer codes, selected for standardization at SRS. This manual summarizes the procedures and practices in place at SRS to determine individual and collective public doses and it should serve as a reference document for DOE personnel and their consultants, who will review documents prepared by SRNL. The highlights and conclusions of standardizing the environmental transport and dosimetry methods are shown in Figure 1-1.

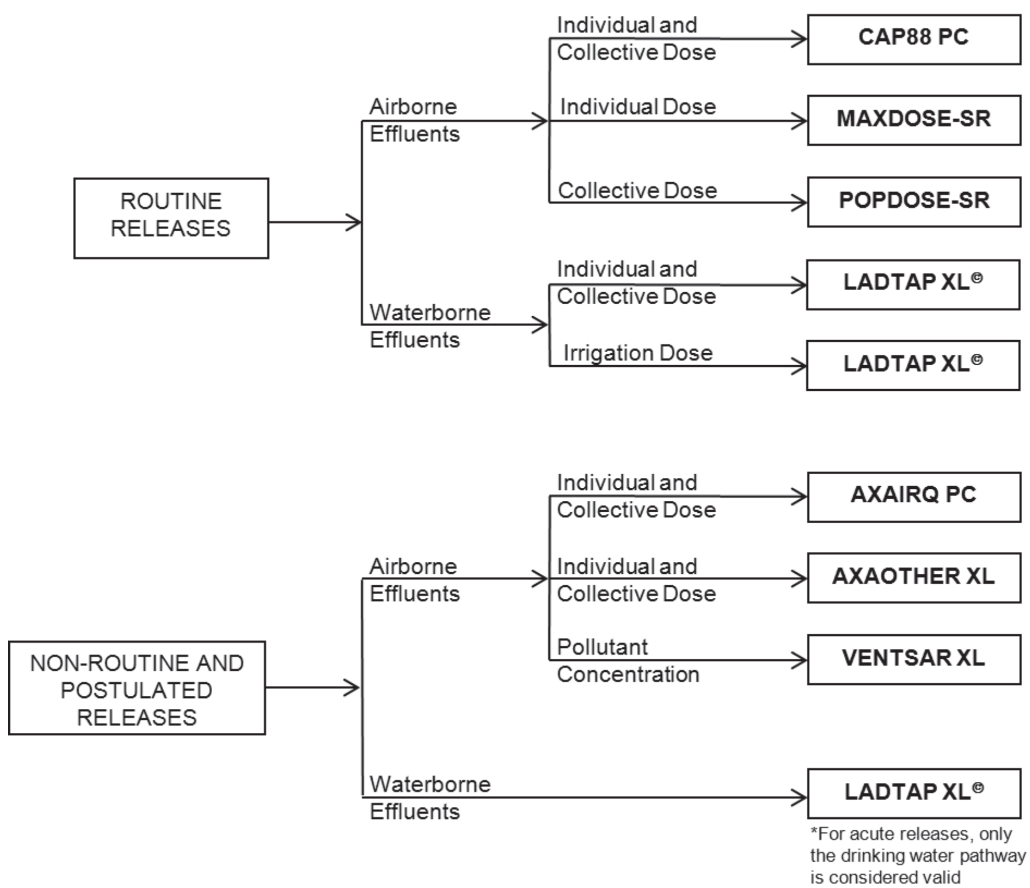

Figure 1-1. Diagram of Consequences Analysis Codes

1.2 Demonstrating Compliance with Public Dose Limits

DOE Order 458.1 (DOE 2020) specifies a public total effective dose (TED) limit of 100 mrem per year. The applicable environmental dosimetry codes used at SRS for demonstrating compliance with this public dose limit are identified and described in Section 2.0. The TED to members of the public from airborne effluents also are evaluated using the U.S. Environmental Protection Agency (EPA) CAP88 PC model to demonstrate compliance with 40 CFR Part 61, subpart H (EPA 2002) air pathway public dose limit of 10 mrem per year. Compliance with the radionuclide drinking water maximum contaminant levels (MCL) specified in 40 CFR Part 141 (EPA 2000) is demonstrated using the LADTAP XL© code for all radionuclides except tritium. Tritium is the only DOE radionuclide measurable in the three downriver drinking water plants.

1.2.1 Other Compliance Assessments

DOE O 458.1 requires that if the DOE-related individual dose is greater than 25 mrem in a year, the TED to members of the public must include both major non-DOE sources of exposure and the dose from DOE-related sources. Compliance with this requirement would be demonstrated by ES&D personnel performing a special, site-specific assessment of all potential non-DOE sources.

DOE O 458.1 also requires that if the DOE-related individual dose is greater than 25 mrem in a year, then the equivalent dose to the lens of the eye (1,500 mrem per year limit) and the equivalent doses to the skin or extremities (5,000 mrem per year limit) must be evaluated. Compliance with this requirement would be demonstrated by ES&D personnel performing a special, site-specific, equivalent dose assessment following the organ dose methods recommended in Publication 103 of the International Commission on Radiological Protection (ICRP) (ICRP 2007).

2.0 Dose Model Descriptions

2.1 Routine Liquid Releases

To demonstrate compliance with DOE (2020) and EPA (2000) regulations governing annual public dose limits and MCLs from routine liquid releases, the computer code LADTAP XL© (Jannik and Minter 2017) has been written for SRS use by ES&D personnel. LADTAP XL© calculates the offsite MEI and population doses resulting from the exposure pathways including drinking water, aquatic foods, and recreation exposure pathways. LADTAP XL© is a Microsoft Excel™ spreadsheet version of LADTAP II [U.S. Nuclear Regulatory Agency (NRC) code of the same name] with improvements in the shoreline exposure and aquatic foods pathway models. LADTAP XL© includes the IRRIDOSE model for determining irrigation pathway doses.

2.2 Accidental Liquid Releases

To demonstrate compliance with DOE annual public dose limits from non-routine and accidental liquid releases, the computer code LADTAP XL© (Jannik and Minter 2017) is used. For acute releases, only the drinking water dose is considered to be valid when using LADTAP XL©.

2.3 Routine Atmospheric Releases

To show compliance with DOE (2020) regulations governing annual public dose limits from routine atmospheric releases and for other routine atmospheric releases, the computer codes MAXDOSE-SR and POPDOSE-SR (SRNL-modified versions of NRC's XOQDOQ and GASPAR codes) are selected for SRS use (Jannik and Trimor 2017). The MAXDOSE-SR code calculates the representative person dose to offsite people and the POPDOSE-SR code estimates the offsite (80 km radius) collective (population) dose. Plume and ground gamma-shine, inhalation, and foodstuff ingestion pathways are considered in these codes.

MAXINE is an EXCEL© spreadsheet, used to estimate dose to individuals for routine atmospheric releases of radioactive materials (Jannik, Bell, and Dixon 2017). MAXINE does not contain an atmospheric dispersion model. Doses are estimated using previously determined air and ground concentrations as input (typically from MAXDOSE-SR). Minimal input is required to run the program and site-specific parameters are used when possible.

2.3.1 Routine Atmospheric Releases for NESHAP

To show compliance with EPA's National Emission Standards for Hazardous Air Pollutants (NESHAP) radionuclide regulations (EPA 2002) governing annual dose limits from routine atmospheric releases, the computer code CAP88 PC (Moore et al. 2016) is required to be used at SRS. The CAP88 PC code calculates the MEI dose to offsite people and the offsite population dose. Plume and ground gamma-shine, inhalation, and foodstuff ingestion pathways are considered in this code. CAP88 PC is not used for other routine dose calculations because the code does not address site-specific factors such as multiple release locations, irregular site boundaries, and uneven terrain.

2.4 Accidental Atmospheric Releases

For accidental atmospheric releases, the computer code AXAIRQ PC (Dixon and Abbott 2016) is used to calculate the plume-exposure doses from potential process-accident or earthquake-induced releases to the atmosphere. The plume-exposure doses include maximum doses to offsite individuals, and population doses to the 80-km population. Exposure pathways include plume and ground gamma-shine and inhalation.

2.5 Near-In Dispersion for Atmospheric Releases

For MEI and population dose calculations for near-in dispersion, the SRNL-developed computer code VENTSAR XL© (Simpkins 1997; Dixon 2018) is chosen for SRS use. VENTSAR XL© uses near-in dispersion characteristics to estimate concentrations by taking into account the interaction of plume and air-flow patterns around buildings and plume rise due to buoyancy or momentum.

2.6 Non-Routine Weather Conditions for Atmospheric Releases

For MEI and population dose calculations for specific dispersion characteristics, AXAOTHER XL (Simpkins 1996) is used. AXAOTHER XL is a spreadsheet based on AXAOTHER (Haynes and Taylor 1983) which estimates doses for high-velocity straight winds and tornado conditions.

2.6.1 High Velocity Straight Winds

Based on a Gaussian plume model, the dispersion factors associated with high-velocity straight winds have been determined and are available in a graphical form (Garrett and Murphy 1981; Hoel 1985). The chi/Q values are input for the dose calculation code, AXAOTHER XL, for MEI and population dose calculations.

2.6.2 Tornadoes

Based on a realistic but simplified methodology, the dispersion factors associated with tornadoes have been determined and plotted in a graphical form (Weber and Hunter 1995). The chi/Q values are input for the dose calculation code, AXAOTHER XL, for MEI and population dose calculations.

2.7 Residual Radioactivity in Soil and Concrete Slabs

RESRAD-ONSITE is used to estimate the dose due to residual radioactive contamination at SRS. RESRAD is a PC based computer code designed to calculate radiation doses to the MEI or representative person. The model considers direct exposure, inhalation of dust and radon, and ingestion of plant foods, meat, milk, aquatic foods, soil, and water pathways. Default exposure scenarios include the resident farmer, suburban resident, and industrial worker. However, other exposure scenarios can be accomplished by adjusting the applicable input parameters. Coding of the software is performed and controlled by the Argonne National

Laboratory (ANL) and the executable file is provided free to users through the RESRAD website: (http://resrad.evs.anl.gov/).

2.8 Residual Radioactivity in Buildings

RESRAD-Build is used to estimate the dose due to residual radioactive contamination remaining in decommissioned buildings at SRS. RESRAD-Build is a PC based computer code designed to calculate radiation doses to the MEI. The model considers direct exposure, inhalation of dust and radon, and incidental ingestion of dust. Coding of the software is performed and controlled by the ANL and the executable file is provided free to users through the RESRAD website: (http://resrad.evs.anl.gov/)

2.9 Doses to Aquatic and Terrestrial Biota

RESRAD-Biota (also called the RAD-BCG Calculator) estimates doses for aquatic or riparian, and terrestrial plants and animals. The doses are determined using measured radioactivity in soil, sediment, and SRS stream water. Coding of the software is performed and controlled by ANL and the executable file is provided free to users through the RESRAD website: (http://resrad.evs.anl.gov/).

The RESRAD-Biota model directly implements the screening and analysis methods contained in DOE-STD-1153-2019, which is referred to as the Biota Dose Manual (DOE 2019). No other alternative approaches to this model or ecological risk assessments are planned at SRS to demonstrate compliance with the DOE biota dose rate limits.

The biota concentration guides used in RESRAD-Biota are based on the dose rate limits specified in DOE-STD-1153-2019, which are shown in Table 2-1.

Table 2-1. Biota Dose Rate Limits from DOE-STD-1153-2019

Biota	Dose Rate Limit
Aquatic Animals	1 rad/d
Riparian Animals	0.1 rad/d
Terrestrial Animals	0.1 rad/d
Terrestrial Plants	1 rad/d

3.0 Dose Assessment Methods

The general dose assessment methods used in the various dosimetry codes are summarized in the following sections for routine and accidental releases.

3.1 Dose Assessment for Routine Releases

During routine operations at a nuclear facility, limited amounts of radioactive materials are released to the environment through atmospheric and/or liquid pathways. These releases potentially result in a radiation dose commitment to offsite people. The principal pathways by which people are exposed to releases of radioactivity are:

- Inhalation
- Ingestion
- Skin absorption
- External exposure

Figure 3-1 is a simplified representation of the principal exposure pathways.

At SRS, the potential effects of routine radioactive releases have been assessed annually since operations began. Since 1972, annual offsite dose estimates have been published in site environmental reports, which are made available to the public. For all routine environmental dose calculations performed since 1978, SRS has used environmental transport models based on codes developed by the NRC (NRC 1977). The NRC based transport models use DOE accepted methods, consider all significant exposure pathways, and permit detailed analysis of the effects of routine operations.

DOE Order 458.1 (2020) states that compliance with the DOE annual dose limit of 100 mrem (1 mSv), for a member of the public, may be demonstrated by calculating dose to the maximally exposed individual (MEI) or to a representative person. Prior to 2012, SRS used the MEI concept for dose compliance using adult dose coefficients and adult male usage parameters. Beginning in 2012, SRS now uses the representative person concept for dose compliance.

DOE Order 458.1 defines the representative person as an individual receiving a dose that is representative of the more highly exposed individuals in the population. This term is equivalent of and replaces the "average member of the critical group." However, in the ICRP Report 101 (ICRP 2006), the definition is extended to include the average value for the more highly exposed group or the 95th percentile of appropriate national or regional data. At SRS, the reference person who is at the 95th percentile of national usage data is now used as a replacement for the MEI.

The representative person dose is based on reference person usage parameters (at the 95th percentile of national and regional data) developed specifically for SRS. The applicable national and regional data used are from the *EPA Exposure Factors Handbook* (EPA 2011) and the subsequent updated chapters (EPA 2017, 2018a-c). SRS also developed reference usage parameters at the 50th percentile to calculate dose to a "typical" person for determining collective (population) doses.

The reference person is weighted, based on sex and age, and this weighting is based on the six age groups documented in Report 89 (ICRP 2002): infant (0 years), 1 year, 5 years, 10 years, 15 years, and adult. The EPA (2011, 2017, 2018a-c) proportioned the various age- and gender-specific intake rates to correspond with these respective age groupings. The SRS-specific reference person usage parameters were developed by Stone and Jannik (2013).

The *Land and Water Use Characteristics and Human Health Input Parameters for use in Environmental Dosimetry and Risk Assessments at the Savannah River Site* (Stagich 2021) documents all other applicable land- and water- use parameters used in the dose calculations. These parameters include local characteristics of food production, river recreational activities, and other human usage parameters required in the SRS dosimetry models. In addition, SRS documents the preferred elemental bioaccumulation and transfer factors to be used in human health exposure calculations in this report.

SRS conservatively combines the airborne pathway and liquid pathway MEI dose estimates, even though the two doses are calculated for hypothetical individuals residing at different geographic locations. This is done to demonstrate compliance, which is documented annually in the SRS Annual Environmental Report, with the DOE O 458.1 (DOE 2020) all-pathway TED standard of 100 mrem per year.

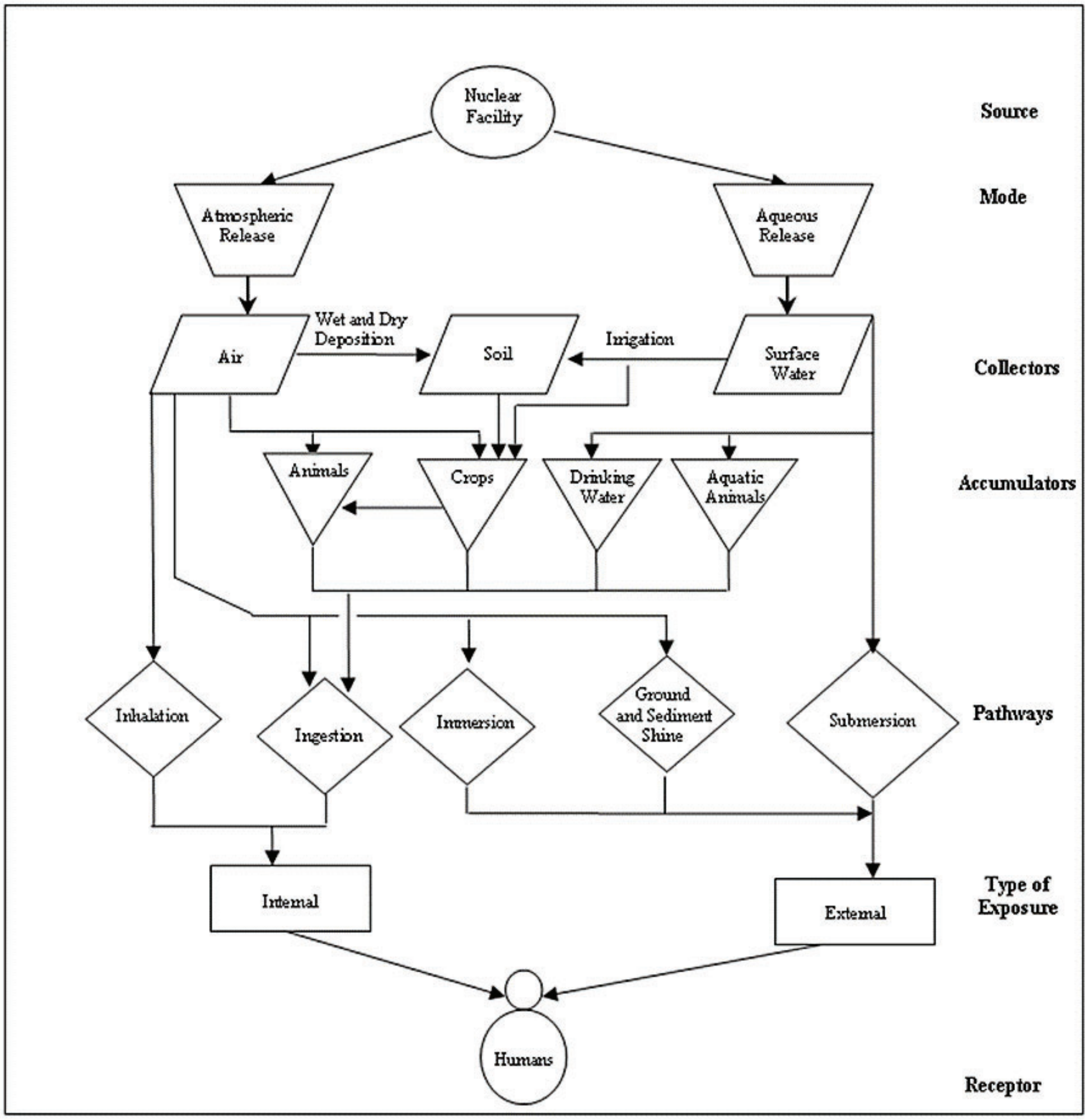

Figure 3-1. Exposure Pathways to Humans from Atmospheric and Aqueous Releases

3.2 Dose Assessment for Accidental Releases

Accidents in one of the SRS facilities can result in an airborne release, a liquid release, or a combination of both. Accidents causing an environmental release may result from natural phenomena (such as high-velocity straight winds, tornadoes, earthquakes, etc.), man-made external events (such as vehicle/building collision, aircraft crash, etc.), or process incidents (such as process upsets, equipment malfunction, operator error, etc.).

Radiological consequences following postulated accidental radioactive releases from SRS facilities can be estimated using one or more of SRNLs dose assessment computer codes. Computer code packages different from those used for routine releases are used to assess environmental consequences resulting from accidental airborne releases because of the differences in characterizing atmospheric dispersion under different meteorological conditions.

3.2.1 Airborne Accidental Releases

Three different computer codes are used to analyze short duration accidental airborne releases at SRS depending on the conditions associated with the release. AXAIRQ PC is used to analyze postulated accidents involving both ground level and elevated releases. The mainframe version of AXAIRQ was retired in 2012. Results from AXAIRQ PC are typically used for reviewing Safety Analysis Reports (SARs), Hazard Assessment Documents (HADs), and Environmental Impact Statements (EISs). VENTSAR XL© is used to predict downwind pollutant concentrations resulting from releases affected by building wake effects and plume rise. AXAOTHER XL is used to model releases with high velocity straight winds or tornado conditions.

3.2.2 Surface Water Accidental Releases

Postulated accidents resulting from SRS operations may involve liquid releases to onsite streams that eventually reach the Savannah River. The reference person and population dose commitments resulting from postulated aqueous releases of radioactive materials are predicted using the LADTAP XL© spreadsheet.

Models characterizing acute uptake and retention of radionuclides by aquatic foods (fish, invertebrates, etc.) are not utilized in LADTAP XL©. However, doses from the consumption of aquatic foods can be estimated assuming steady-state conditions, recognizing that such doses are conservative and overestimated. Development of a model to estimate radionuclide concentrations in fish and invertebrates under acute exposure conditions has not been completed at SRS. Until these studies are complete, dose resulting from acute releases will be estimated using only the drinking water pathway.

The offsite individual who will receive the maximum dose from an accidental liquid release is a hypothetical person who lives on the shore of the Savannah River just downriver of SRS, where complete mixing is assumed to have occurred. It is conservatively assumed that this individual drinks untreated river water.

3.3 Dosimetry Code Descriptions

At SRNL, the consequence analysis computer codes were originally selected after a thorough review of existing methods and associated software. The evaluation criteria for computer codes included the following:

- Acceptability to the regulatory agencies
- Adaptability
- Versatility
- Availability

The selected computer codes are stored in write-protected datasets with access limited to authorized personnel (i.e., ES&D personnel). For a complete description of the software quality assurance requirements governing environmental dose assessments, refer to Jannik (2017).

3.3.1 ES&D Originated Codes

Since 2001, ES&D has been systematically creating detailed code-specific user's manuals that include

1) The code's background information and methods
2) User information including program features, input, job control language (JCL), and output
3) Verification of calculations performed.

In lieu of repeating these details in this manual, the following references are provided to the codes originated and "owned" by ES&D:

- LADTAP XL© — Jannik and Minter (2017)
- MAXDOSE-SR — Jannik and Trimor (2017)
- POPDOSE-SR — Jannik and Trimor (2017)
- AXAIRQ PC — Dixon and Abbott (2016)
- AXAOTHER XL — Simpkins (1996)
- VENTSAR XL© — Simpkins (1997)
- MAXINE — Jannik, Bell, and Dixon (2017)

3.3.2 Non-ES&D Originated Codes

To show compliance with NESHAP (EPA 2002) regulations, the use of the EPA supplied CAP88 PC dosimetry code is required. The latest version of CAP88 PC is found at (https://www.epa.gov/radiation/cap88-pc).

For residual radioactivity in soil and buildings and for estimating doses to biota, the RESRAD family of dosimetry codes, which were developed by ANL (http://web.ead.anl.gov/resrad) are used at SRS. Currently, three RESRAD codes have been incorporated into the Environmental Dosimetry Software QA Plan (Jannik 2017). They are the original RESRAD-ONSITE, RESRAD-BUILD, and RESRAD-BIOTA.

In lieu of repeating the details of these codes in this manual, the following references are provided to the non-ES&D originated codes "owned" and used by ES&D:

- CAP88 PC — Moore et al. (2016)
- RESRAD-ONSITE — Kamboj et al. (2018)
- RESRAD-BUILD — Yu, et al. (2003)
- RESRAD-BIOTA — DOE (2004)

3.4 Dosimetry Code Input Parameters

Most of the physical and behavior input parameters required for use in environmental dosimetry calculations performed at SRS are documented in Stagich (2021). The other datasets required for environmental dosimetry calculations are described in the following sections.

3.4.1 Dose Coefficients

Since 1989, the dose coefficients used with the SRS consequence analysis codes were based on ICRP dosimetry method recommendations provided in ICRP-26 (ICRP 1977) and ICRP-30 (ICRP 1979) and obtained from DOE/EH-0070 (DOE 1988a) and DOE/EH-0071 (DOE 1988b). In 2010 and 2011, ES&D transitioned all dosimetry codes to the dose factors based on ICRP-60 (ICRP 1991) dosimetry method recommendations as obtained from 1) Federal Guidance Report 12 (EPA 1993) for external exposures and 2) ICRP-72 (ICRP 1996) for internal exposures. From 2012 to the present, the dose to a representative person is based on: 1) the SRS-specific reference person usage parameters at the 95th percentile of appropriate national or regional data documented in Stone and Jannik (2013), 2) the reference person (gender- and age-averaged) ingestion and inhalation dose coefficients documented in DOE Derived Concentration Technical Standard, DOE-STD-1196-2021 (DOE 2021), and 3) the external dose coefficients provided in the Federal Guidance Report 15 (EPA 2019). Currently, there are no age-specific external dose factors available.

3.4.2 Internal Dose Coefficients

Internal doses estimated using the ICRP recommended dose coefficients are 50-year dose-commitments from a one-year intake. More specifically, these dose estimates are based on continuous intake over a one-year exposure period, and an associated dose commitment extending over a 50-year period from initial intake. Internal dose coefficients account for progeny ingrowth once the nuclide has been inhaled or ingested.

Atmospheric tritium also enters the body through skin absorption (ICRP 1979; Pinson and Langham 1957). The rate at which uptake occurs via skin absorption is approximately equal to one-half the inhalation uptake rate (ICRP 1979). To account for this pathway, the inhalation dose coefficient for tritium oxide has been increased by 50% over the value given in ICRP (1996). The predicted inhalation dose for all dose assessments involving tritium oxide, therefore, includes tritium uptake via skin absorption (this includes the EPA required code, CAP88 PC).

3.4.3 External Dose Commitment Factors

External dose coefficients for gamma and beta exposures exist for ground, water, and air immersion geometries. Except for AXAIRQ PC, the external doses are calculated in all dose assessment packages using a semi-infinite plume model. AXAIRQ PC gives the user the option to choose between three external exposure models.

The external dose coefficients recommended in EPA (2019) do not include contributions from radioactive progeny. However, when needed, progeny radiation may be considered using methods described in Hamby (1991). The AXAIRQ PC program includes progeny ingrowth.

For calculating external doses resulting from plume gamma shine in the AXAIRQ PC code, the total-body dose coefficients for 23 photon energy groups were developed (Pillinger and Huang 1986). Photon energies and relative intensities were obtained from the DRALIST Radioactive Decay Data (RSIC 1981). Reference data and computational means to evaluate the photon energy absorption coefficients for air and tissue were taken from the DOSFACTOR II computer code (RSIC 1981).

3.4.4 Inhalation Rates and Absorption Types

The inhalation exposure pathway includes any intake that enters the body through the respiratory system via the bloodstream. There are three absorption types used in human dosimetry: F, M, S. The F type absorption has a quick biological lifetime, M type absorption has an intermediate biological lifetime, and S type absorption has a very slow biological lifetime. The class of the radionuclide depends on its chemical compound. Generally, class F materials are absorbed in greater fractions in the body than class S. The absorption types used at SRS are taken from Table 5 of DOE-STD-1196-2021. For the elements with no ICRP recommended absorption type listed in that table, the absorption type that has the highest dose coefficient is used.

The reference person inhalation rates used in the ES&D dosimetry codes for inhalation dose calculations for the representative person and population are shown in Table 3-1. Age-specific breathing rates are provided for comparison and should be used as needed.

Table 3-1. Breathing Rates Used for Inhalation Dose Calculations at SRS

Age Group	Age x, (y)	Inhalation (m^3/d)			
		95%		50%	
		Male	Female	Male	Female
newborn	x<1	5.04	4.75	3.8	3.61
1 year	1.x<3	6.56	6.36	5.12	4.78
5 year	3.x<7	10.185	9.675	8.12	7.64
10 year	7.x<12	13.87	12.61	10.59	9.84
15 year	12.<17	23.26	17.56	17.23	13.28
Adult	17 and older	20.808	16.128	16.158	12.548
Reference Person (Age and Gender Combined)		17.4		13.5	

The daily 95% reference person and 50% typical person intake rates for inhalation of air convert to about 6400 m^3/y and 5000 m^3/y, respectively.

For accidental release dose assessments, it is recommended that these inhalation rate values be increased by 50 percent.

3.4.5 Agricultural Data Base

An agricultural database including the annual production of milk, meat, and produce is required when population doses resulting from routine releases are to be calculated. Statistical sources include state crop and livestock reporting services, and the US Department of Agriculture. The agricultural databases for the SRS-area were updated in 2021 (Stagich 2021).

3.4.6 Topographic Data

The topography of SRS and its vicinity is representative of the Coastal Plain with gently rolling hills and elevations ranging from 100 to 500 feet above mean sea level. Terrain elevations directly affect the effective stack height and effective height of the inversion layer in the transport calculations. Maximum elevations within 22.5-degree sectors between SRS facilities and each incremental distance to 50 miles are determined during execution of the dose assessment codes. The height of the plume as it travels from the release point may be adjusted to account for changes in terrain. The terrain file is a binary file called ‘TPGY100.bin.’ This terrain database is a product of Oak Ridge National Laboratory (ORNL) and contains elevations above mean sea level referenced by coordinates of latitude and longitude. These data are used to develop an array of maximum changes in elevation, relative to the release point’s elevations. This array is then called to determine the reduction in plume height required for a specific compass sector and downwind location. The plume height is reduced to account for the fact that if the plume is traveling in a straight line and a receptor is standing on elevated ground, they are closer to the plume.

3.4.7 Offsite Population Distribution

The population data for a given calendar year for geographical divisions, formed by subdividing the 50-mile-radius circle centered on the release point into 22.5-degree compass sectors and circles at radii of 10, 20, 30, 40, and 50 miles, are the required input for offsite population dose calculations for airborne releases.

Due to rapidly changing work assignments, onsite population distributions will be determined on an as needed basis.

Within the 50-mile radius of SRS, the total population determined by the 2020 U.S. Census was 838,833. For establishing the offsite population distribution, a population database was prepared for SRS by SRNL following the method described in Minter (2018). The data were supplied for the population residing in a 20 by 20 study area converted to 1 minute grid cells. This database is transformed by the POPDOSE-SR and AXAIRQ PC codes into polar coordinates of 16 compass sectors and varying radial distances out to the 50-mile radius. The POPDOSE-SR and AXAIRQ PC codes can prepare a polar coordinate database for any release point input into the code. The POPDOSE-SR and AXAIRQ PC codes also have the capability of generating offsite population distributions relative to the user-specified release location. A separate, fixed-polar-coordinate database was prepared for use with the CAP88 PC code, which does not have the capability of transforming the grid into polar coordinates.

3.4.8 Population Served by Downriver Drinking Water Plants

For 2022, the operators of the three public drinking water plants that are located downriver of SRS confirmed that the following estimated populations were served:

- Beaufort-Jasper Water and Sewer Authority (Chelsea Plant) 107,000 people
- Beaufort-Jasper Water and Sewer Authority (Purrysburg Plant) 83,000 people
- City of Savannah Industrial and Domestic Water Supply Plant 37,637 people

These totals will be updated annually for use in the SRS Annual Environmental Report.

3.4.9 Meteorological Data

Meteorological data at SRS have been collected regularly since 1965. The system has been modified, upgraded, and expanded over the years. The measurement facilities consist of eight 61-meter meteorological towers located onsite and an instrumented 335-meter television tower (WJBF) located in Beech Island, SC. Local wind characteristics are represented by the meteorological data collected at these facilities.

To show compliance with DOE environmental orders, potential offsite doses from releases of radioactivity to the atmosphere are calculated with the quality-assured meteorological data for A-Area, K-Area (for combined releases from C-Area, K-Area, and L-Area), and H-Area (for combined releases from all other areas and for the Center of Site). The meteorological databases for the years 2014–2018, are the most recent 5-year compilation period (Bell 2020).

To show compliance with EPA regulations, only the H-Area database was used in the calculations because the EPA-required dosimetry code (CAP88 PC, Version 4.1) is limited to a single release location

Meteorological data are input to the dose assessment codes as a joint frequency distribution (JFD) of wind speed and atmospheric stability. The meteorological data consist of the following:

- Wind direction frequency of occurrence determined for 22.5-degree sectors centered on 16 compass directions
- Atmospheric stability category (one of seven defined by σ_a)
- Categorization of wind speed into one of six speeds: 0-2, 2-4, 4-6, 6-8, 8-12, >12 m/sec

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