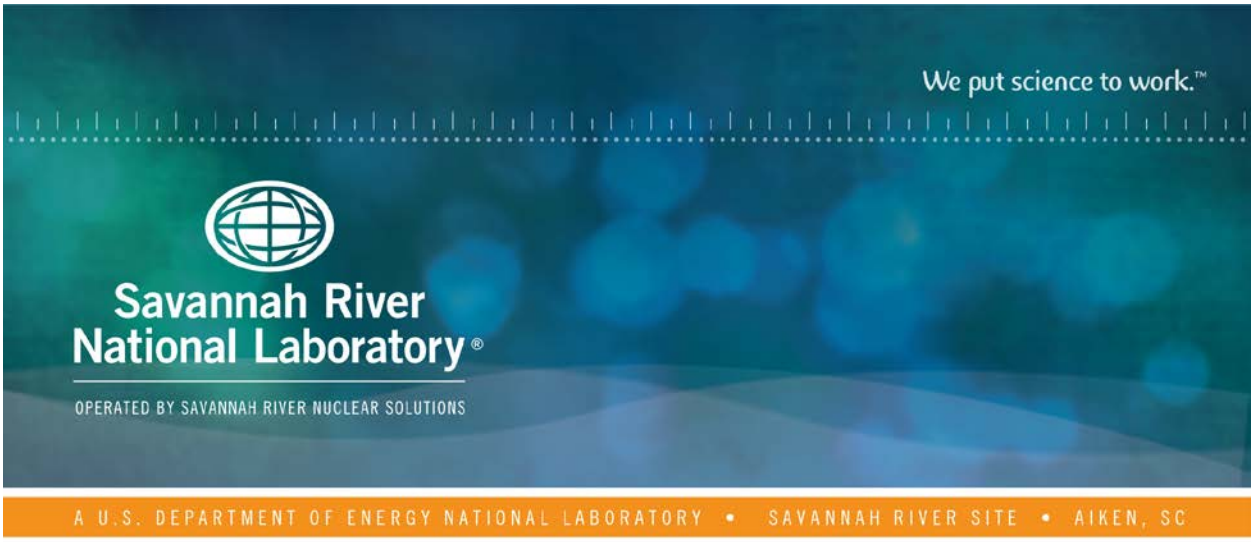


# Radiological Impact of 2019 Operations at the Savannah River Site

B. H. Stagich
G. T. Jannik
K. L. Dixon

June 2020
SRNL-STI-2020-00241, Revision 0

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Prepared for the U.S. Department of Energy under contract number DE-AC09-08SR22470.

Savannah River National Laboratory®
OPERATED BY SAVANNAH RIVER NUCLEAR SOLUTIONS

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# EXECUTIVE SUMMARY

This report presents the environmental dose assessment methods and the estimated potential doses to the offsite public from 2019 Savannah River Site (SRS) air and liquid radioactive releases. Also documented are potential doses from special-case exposure scenarios, such as the consumption of wildlife or goat milk.

## Dose to the Offsite Representative Person

The 2019 dose to the offsite representative person from SRS liquid releases was 0.16 mrem and from SRS air releases it was 0.018 mrem. To show compliance with the U. S. Department of Energy (DOE) all-pathway dose standard of 100 mrem/yr, SRS conservatively adds these two doses for a total representative person dose of 0.18 mrem which is 0.18% of the DOE standard.

## Sportsman Doses

**Onsite Hunter:** SRS conducts annual hunts to control onsite deer and feral hog populations. The estimated dose from consuming harvested deer or hog meat is determined for every onsite hunter. During 2019, the maximum potential dose an onsite hunter received was 17.4 mrem, or 17.4% of DOE's 100 mrem/yr all-pathway dose standard.

**Creek Mouth Fisherman:** SRS estimated the maximum potential dose from fish consumption at 0.227 mrem from bass collected at the mouth of Lower Three Runs Branch. This dose is 0.227% of the DOE standard. SRS bases this hypothetical dose on the low probability scenario that, during 2019, a fisherman consumed 24 kg (53 lbs) of bass caught exclusively from the mouth of Lower Three Runs.

## Release of Material Containing Residual Radioactivity

SRS did not release any real property (land or buildings) in 2019. SRS unconditionally released a total of 10,325 items of personal property (such as tools) from radiological areas in 2019. Most of these items did not leave the Site. However, all of these items required no additional radiological controls post-survey as they met DOE Order 458.1 release criteria.

## Radiation Dose to Aquatic and Terrestrial Biota

SRS conducts screening evaluations of plant and animal doses for aquatic and terrestrial ecosystems. For 2019, all SRS aquatic system locations passed the initial (Level 1) screening and no further assessments were required at those locations.

For the land-based systems evaluation, SRS performed initial screenings using concentration data from the five onsite radiological soil sampling locations. Typically, SRS collects and analyzes only one soil sample per year from each location. For 2019, all land-based locations passed their initial (Level 1) pathway screenings.

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| | |
|---|---|
| ALARA | As Low as Reasonably Achievable |
| BCG | Biota Concentration Guide |
| BJWSA | Beaufort-Jasper Water and Sewer Authority |
| BLLDF | Barnwell Low-Level Disposal Facility |
| DOE | U. S. Department of Energy |
| EPA | U. S. Environmental Protection Agency |
| GDNR | Georgia Department of Natural Resources |
| ICRP | International Commission on Radiological Protection |
| MCL | Maximum Contaminant Levels |
| MEI | Maximally Exposed Individual |
| NESHAP | National Emissions Standards for Hazardous Air Pollutants |
| NRC | Nuclear Regulatory Commission |
| RM | River Mile |
| SCDHEC | South Carolina Department of Health and Environmental Control |
| SRNL | Savannah River National Laboratory |
| SRS | Savannah River Site |
| TRL | Three Rivers Landfill |
| USGS | U. S. Geological Survey |
| VEGP | Georgia Power Company's Vogtle Electric Generating Plant |

## Introduction

This report presents environmental dose assessment methods and the estimated potential doses to the offsite public from 2019 Savannah River Site (SRS) atmospheric and liquid radioactive releases. It also documents potential doses from special-case exposure scenarios, such as the consumption of wildlife and/or goat milk. Unless noted, the generic term "dose," as used in this report, includes both the committed effective dose (50-year committed dose) from internal deposition of radionuclides and the effective dose attributable to sources external to the body. Using the effective dose allows doses from different types of radiation and to different parts of the body to be expressed on the same basis.

Humans, plants, and animals potentially receive radiation doses from natural and man-made occurrences. The average annual "background" dose for all people living in the United States is 625 mrem. This includes an average background dose of 311 mrem from naturally occurring radionuclides (found in our bodies and in the earth) and from cosmic radiation. Man-made sources include medical procedures (300 mrem), consumer products (13 mrem), and industrial and occupational exposures (less than 1 mrem) (NCRP 160).

The U.S. Department of Energy (DOE) has established dose limits to the public, so that DOE operations will not contribute significantly to this average annual exposure. DOE Order 458.1 (DOE 2013) establishes 100 mrem/yr (1mSv/yr) as the annual dose limit to a member of the public. As shown in Figure 1-1, radiation exposure primarily occurs through the following pathways:

- Inhalation,
- Ingestion,
- Skin absorption, and
- Direct (external) exposure to radionuclides in soil, air, and water.

## 1.0 Dose Assessment Methods

DOE Order 458.1 (2013) 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 which is based on adult dose coefficients and adult male usage parameters. Beginning in 2012, SRS now uses the representative person concept for dose compliance.

### 1.1 Representative Person

DOE Order 458.1 (2013) 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 *International Commission on Radiological Protection* (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 representative person who is at the 95th percentile of national usage data is now used as a replacement for the MEI. SRS believes the representative person concept is superior to the MEI concept for dose calculations because it includes all members of the population receiving dose as opposed to only adult males (as is the case for the MEI concept).

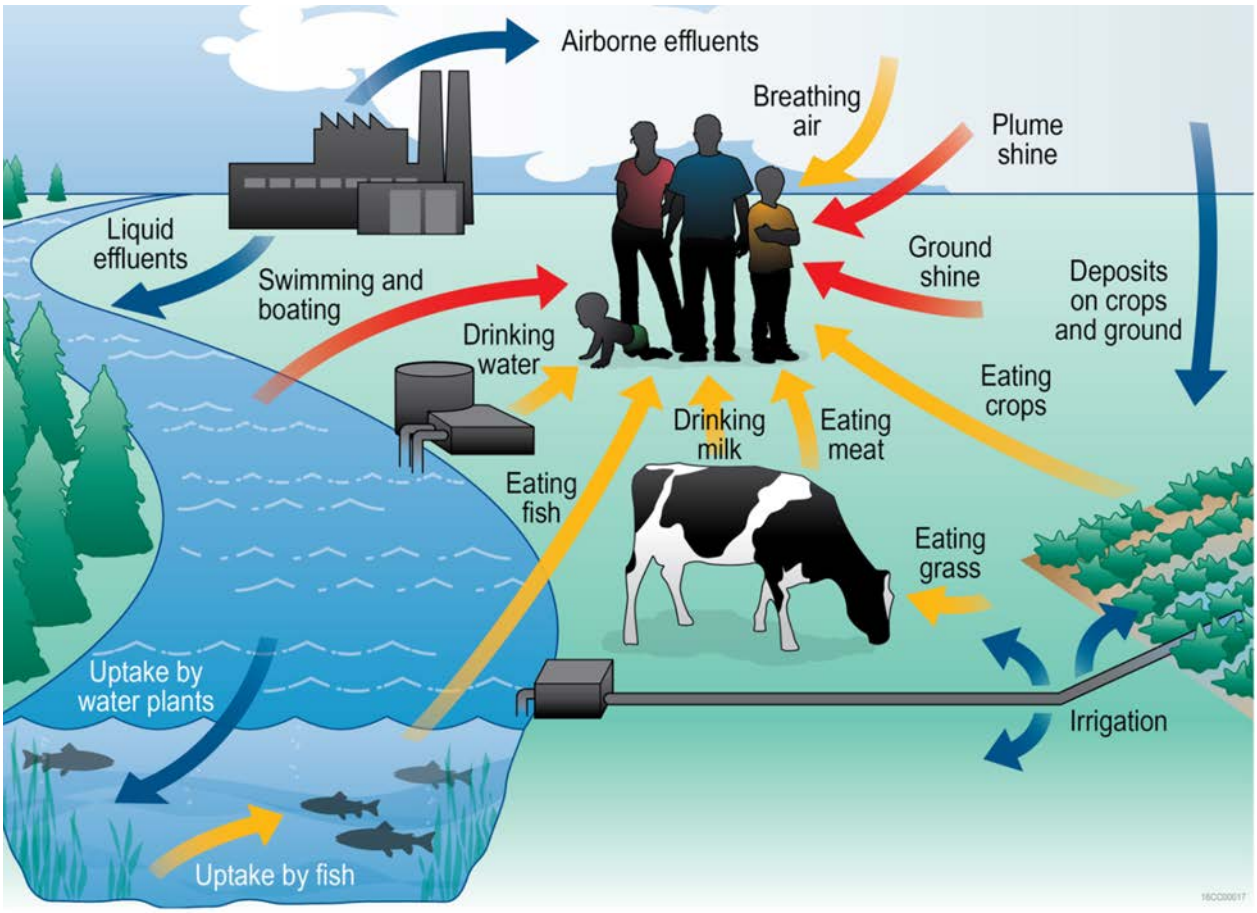



**Figure 1-1. Exposure Pathways to Humans from Atmospheric and Liquid Effluents**

The representative person dose is based on a reference person using exposure parameters (at the 95th percentile of national and regional data) developed specifically for SRS. The reference person is a hypothetical person with average physical and physiological characteristics— including factors such as age and gender—used internationally to standardize radiation dose calculations. 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) 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) and are provided in Table 1-1. The applicable national and regional data used are from the Environmental Protection Agency (EPA) *Exposure Factors Handbook (Final Report)* (EPA 2011). SRS also developed reference usage parameters at the 50th percentile to calculate dose to a "typical" person for determining collective (population) doses.

The Land and Water Use Characteristics and Human Health Input Parameters for use in Environmental Dosimetry and Risk Assessments at the Savannah River Site (Jannik and Stagich 2017) 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 land and water report. Data Table A-1 and Data Table A-2 provide a summary of the site-specific input parameters that are the most important to the dose calculations for the liquid and airborne pathways, respectively.

**Table 1-1. SRS Representative and Typical Person Usage Parameters**

| | Unit | Representative Person | Typical Person |
|---|---|---|---|
| **Air** | $m^3/y$ | 6,400 | 5,000[a] |
| **Water** | L/y | 800 | 300[b] |
| **Meat** | kg/y | 81 | 32[c] |
| **Leafy Vegetables** | kg/y | 31 | 11 |
| **Other Produce** | kg/y | 289 | 89 |
| **Milk/Dairy** | L/y | 260 | 69 |
| **Freshwater Fish** | kg/y | 24 | 3.7 |
| **Saltwater Invertebrate** | kg/y | N/A | 1.5 |

***a. 1 cubic meter = 1.3 cubic yards***
***b. 1 liter = 1.06 quarts***
**c.** ***1 kilogram = 2.2 pounds***

In 2017, SRS made two major changes in the locations of the representative person:

1) For the liquid pathway, the representative person was moved from river mile (RM) 118.8 (near US Hwy 301 bridge) to RM 141.5, which is slightly downriver from the Steel Creek mouth. The historical location at RM 118.8 is downriver of all SRS streams. However, SRS radiological releases into Lower Three Runs are 1) from legacy contamination and not current operations and 2) have remained small for many years. Moving the representative person to near Steel Creek is more conservative because it accounts for less dilution and gives a better indication of the potential dose from fish.
2) For the air pathway, in addition to the offsite representative person living near the Site boundary, SRS also calculated potential dose for an adult worker at the Three Rivers Landfill (TRL) located near B Area. Three Rivers Landfill is located on SRS, but it is accessed directly from public South Carolina Hwy 125 outside of the Site's security perimeter in Aiken County. The workers at Three Rivers Landfill are not Site employees and are now considered members of the public to comply with DOE Order 458.1 and with National Emissions Standards for Hazardous Pollutants Compliance (NESHAP) regulations (EPA 2006). Figure 1-2 shows these new locations.

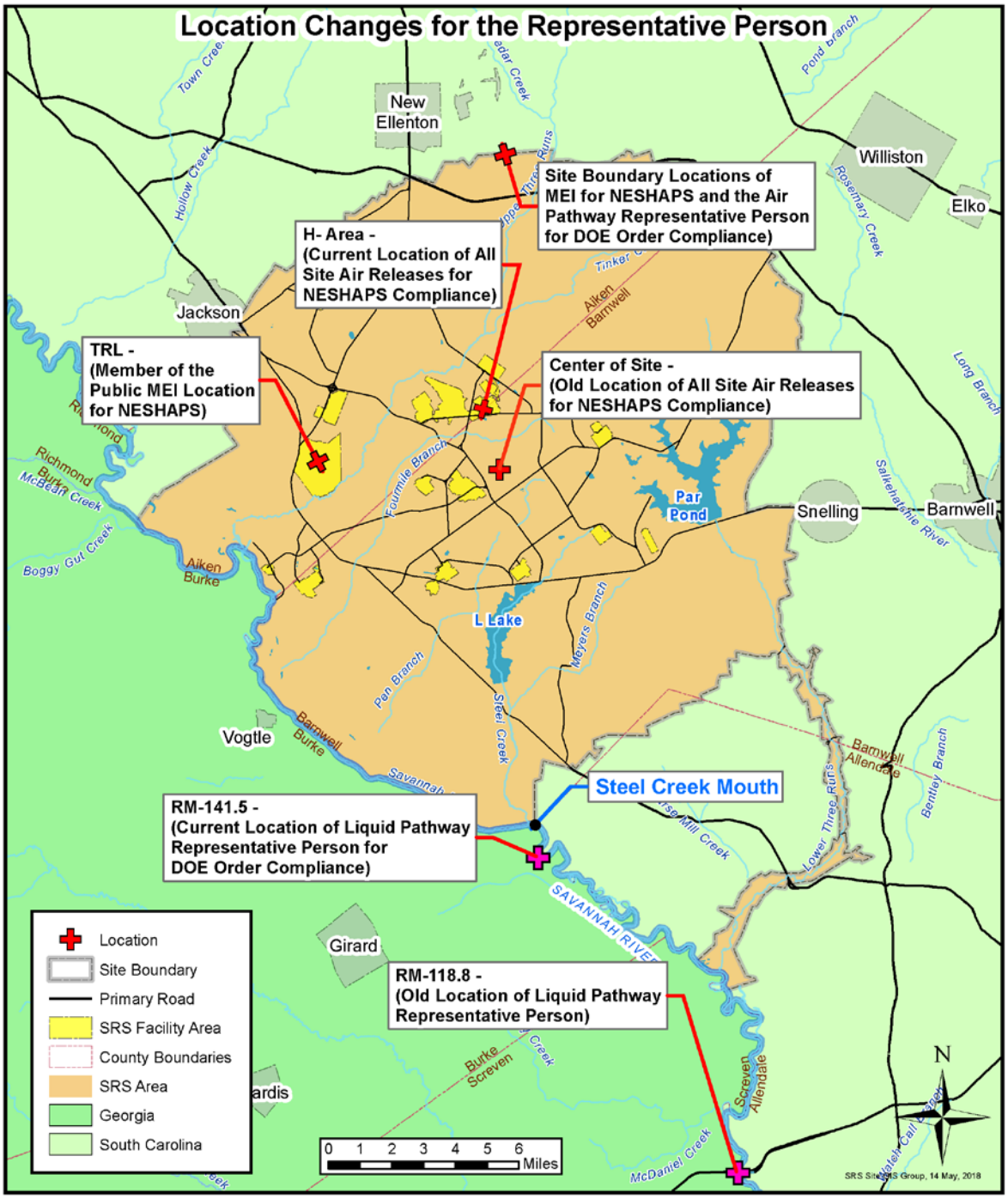



**Figure 1-2. 2017 Location Changes for Representative Persons for Air and Liquid Releases**

1.2 Dose Models

SRS calculates the potential offsite doses from SRS effluent releases of radioactive materials (air and liquid) for the following scenarios for DOE public dose compliance:

- Representative person living at the SRS boundary
- Industrial worker at the Three Rivers Landfill located on SRS (near B Area)

- Population living within a 50-mile (80-kilometer [km]) radius of SRS's H-Area

To demonstrate compliance with the DOE Order 458.1 all-pathway dose standard of 100 mrem per year, SRS conservatively combines the air pathway and liquid pathway dose estimates, even though the two doses are calculated for hypothetical individuals residing at different geographic locations (Figure 1-2).

For SRS dose calculations, unspecified alpha releases were treated as plutonium-239, and unspecified beta releases as strontium-90. These radionuclides have the highest dose factors of the alpha- and beta-emitters, respectively, commonly measured in SRS waste streams.

SRS has assessed the potential effects of routine radioactive releases annually since operations began and, since 1972, has published annual offsite dose estimates in Site environmental reports made available to the public. For all routine environmental dose calculations performed since 1978, SRS has used environmental transport models based on the Nuclear Regulatory Commission (NRC) developed codes (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.

For showing compliance with DOE Order 458.1 at SRS, the MAXDOSE-SR and POPDOSE-SR codes are used for air releases (representative person and population, respectively) and LADTAP XL© is used for liquid releases. The *SRS Environmental Dose Assessment Manual* (SRNL 2017) describes these models.

To demonstrate compliance with EPA National Emission Standards for Hazardous Air Pollutants (NESHAP) regulations (EPA 2006), SRS calculated the MEI and collective doses using 1) the CAP88 PC version 4.1.0.2 computer code, 2) the 2019 airborne-release source term (Data Table A-23), and 3) site-specific input parameters (Data Table A-24). The EPA requires the use of the MEI concept and does not allow use of the representative person concept at this time. The EPA hard-codes most of the input parameters in the CAP88 PC program, and they cannot be changed without EPA approval. For 2019, SRS changed to using the new version of CAP88-PC (v.4.1.0.2) that became available from EPA in January 2020 (Stagich 2020). CAP88-PC v.4.1.0.2 includes improvements to the user interface and system capabilities. Additionally, EPA updated the radionuclide physical data, dose factors, risk factors and decay chain information from the DCFPAK Version 2.2. to the DCFPAK 3.02, both provided by Oak Ridge National Laboratory (Eckerman and Leggett, 2013).

CAP88-PC allows up to six different stack heights per release. For the stack height inputs at SRS, the reference heights related to operational stack heights in the tritium production facilities located in H Area were used; 0m, 15m, 21m, 31m, 56m, 59m. If there were emissions from other areas on site at a stack height not in the six previously listed, the stack height was defaulted to the shorter stack height, as shorter stack heights produce a higher estimated dose (Minter et al. 2018).

### 1.3 Dose Coefficients

From 1988 through 2009, SRS used the internal and external dose conversion factors provided in DOE (1988). In 2010, the internal dose conversion factors were updated to use the dose factors from ICRP Publication 72 (ICRP 1996) and the external dose conversion factors were updated to the dose factors provided in *Federal Guidance Report 12* (FGR) (EPA 1993). In 2012, SRS changed to the reference person concept and started using the (gender- and age-averaged) ingestion and inhalation dose coefficients documented in *DOE Derived Concentration Technical Standard*, DOE-STD-1196-2011 (DOE 2011). In 2019, SRS started using the external dose factors from FGR 15 (EPA 2019). FGR 15 is a revision to FGR 12 that incorporated age-specific external dose coefficients. SRS used the age-specific values to develop "reference person" external dose coefficients in a method similar to that documented in DOE (2011). The

SRS report *Updated External Exposure Dose Coefficients,* SRNL-L3200-2020-00014 (Laird and Jannik 2020) documents the external dose coefficients used.

For 2019, 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-1196-2011 (DOE 2011), and 3) the external dose coefficients derived from *Federal Guidance Report 15* (EPA 2019).

### 1.4 Meteorological Database

SRS calculated the potential offsite doses from radiological releases to the air with 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) for DOE compliance. To show compliance with NESHAP regulations (EPA 2006), only the H-Area meteorological database was used in the calculations, because the EPA-required dosimetry code (CAP88 PC version 4.1.0.2) is limited to a single release location.

The current five-year meteorological datasets used in dose calculations cover the period 2007 through 2011 (Viner 2013). These datasets differ from previous five-year datasets in that they now 1) estimate atmospheric stability using the standard deviation of the vertical wind velocity and 2) use an updated surface roughness factor for SRS. Data Table A-3 shows the 2007-2011 meteorological database for H-Area. Figure 1-3 is the H-Area wind rose for 2007-2011, with the directions shown being those toward which the wind blows. As shown, the wind blows towards the East-Northeast the highest percentage of time (about 9%).

### 1.5 Population Database and Distribution

SRS calculates the collective (population) doses from air releases for the population within a 50-mile radius of H-Area, which is the location of most of the Site's radiological releases. Based on the U.S. Census Bureau's 2010 data, the population within a 50-mile radius of H-Area is 803,370. This translates to an average population density of about 107 people per square mile outside the SRS boundary, with the largest concentration in the Augusta metropolitan area. Data Table A-4a and Data Table A-4b show the population distribution around the SRS Center of Site (COS) and H-Area, respectively.

SRS also calculates the collective doses resulting from SRS liquid releases for the populations served by the City of Savannah Industrial and Domestic Water Supply Plant (City of Savannah I&D), near Port Wentworth, Georgia, and for the Beaufort-Jasper Water and Sewer Authority's (BJWSA) Chelsea and Purrysburg Water Treatment Plants, both near Beaufort, South Carolina. According to the treatment plant operators, the population served by the City of Savannah I&D facility during 2019 was 35,000 people while the BJWSA Chelsea facility served 100,622 people and the BJWSA Purrysburg facility served 76,538 people. The total population dose resulting from routine SRS liquid releases is the sum of five contributing categories: 1) BJWSA water consumers, 2) City of Savannah I&D water consumers, 3) consumption of fish and invertebrates of Savannah River origin, 4) recreational activities on the Savannah River, and 5) irrigation of foodstuffs using river water near River Mile (RM) 141.5 (Down river near the Steel Creek mouth).

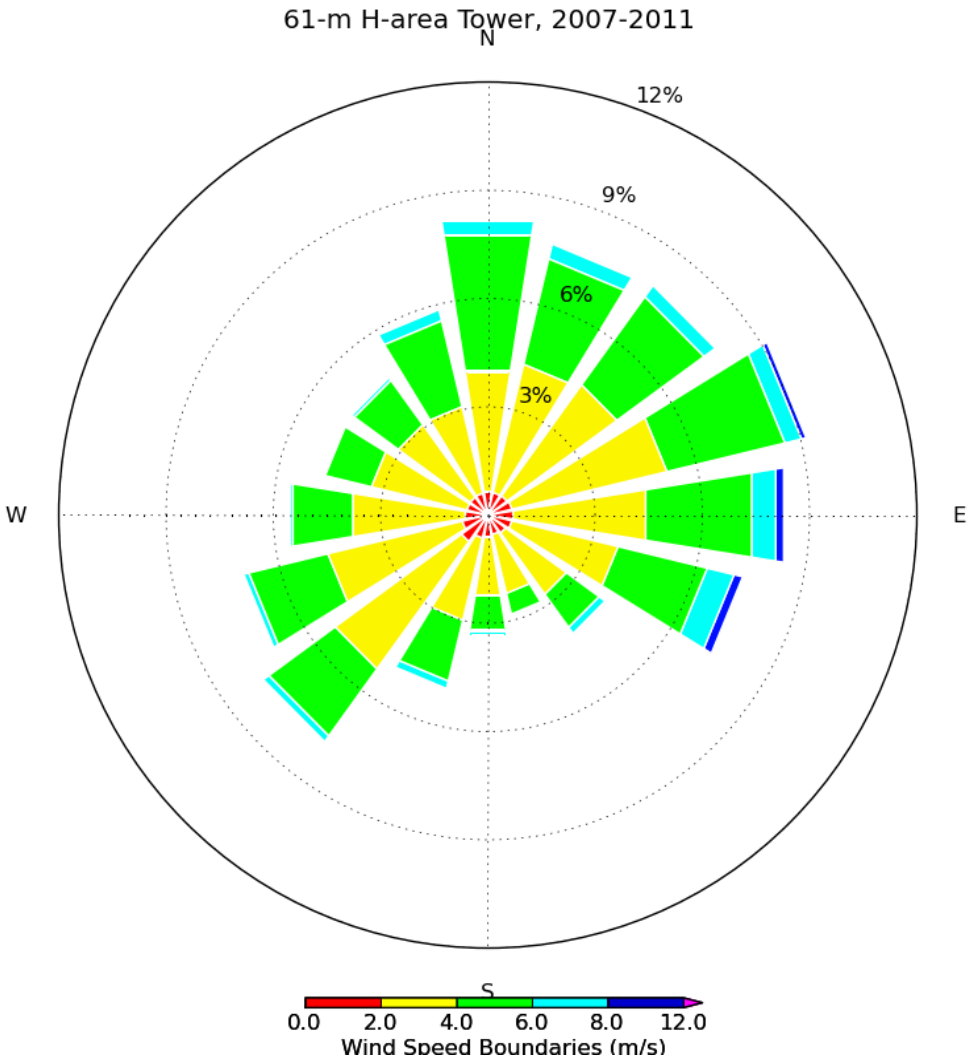



**Figure 1-3. 2007-2011 Wind Rose for H-Area (Direction is toward which the wind blows)**

1.6 Savannah River Flow Rate Data

SRS determines the Savannah River annual average flow rates using the recorded water elevation at a U.S. Geological Survey (USGS) gauging station #02197500, near RM 118.8. Data Table A-5 provides river flow rates measured at this location from 1954 through 2019. Figure 1-4 shows that the average river flow rate for these years is about 9,900 cubic feet per second (cfs). However, recently, there has been a downward trend in these data, with an average measured flow rate of 8,353 cfs during the past 10 years.

The SRS liquid dose calculations typically do not use these data. Instead, SRS uses an "effective" flow rate based on 1) the measured annual release of tritium and 2) the annual average tritium concentrations measured from RM 141.5 and from the downriver water treatment plants. Data Table A-6 provides the effective river flow rate calculations.

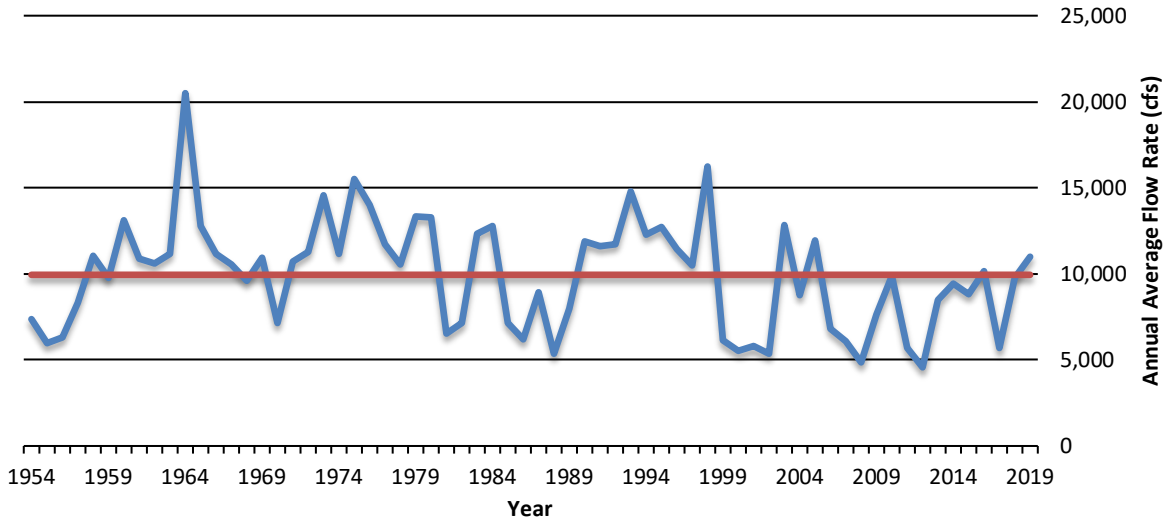



**Figure 1-4. Savannah River Annual Average Flow Rates at River Mile 118.8**

The effective flow rates used in the dose calculations are usually more conservative (that is, lead to higher dose estimates) than the measured flow rates because it accounts for less dilution. However, if SRS calculates an effective flow that is more than the measured value at RM 118.8, then the measured value is used.

For 2019, SRS used an effective Savannah River flow rate of 8,481 cfs in the dose calculations. The 2019 effective flow rate is 50% more than the 2018 effective flow rate of 5,667 cfs. This estimated flow rate (based on actual measured tritium concentrations in the river) is more conservative than the 2019 USGS measured flow rate (at RM 118.8) of 10,968 cfs.

## 2.0 Dose Calculation Results

### 2.1 Liquid Pathway Doses

No known large-scale uses of Savannah River water downstream of SRS exist for agricultural irrigation purposes. However, the potential for agricultural irrigation does exist, especially for individual garden use. Therefore, the totals for the SRS representative person and collective dose include doses from the irrigation pathway.

#### *2.1.1 Liquid Release Source Terms*

Table 2-1 shows, by radionuclide, the 2019 radioactive liquid release quantities used as the source term in SRS dose calculations and Data Table A-7 shows these liquid releases by Site stream. Data Table A-8 provides a five-year history of SRS liquid radioactive releases.

Tritium accounts for more than 99% of the total amount of radioactivity the Site released to the Savannah River. In 2019, SRS released a total of 452 curies of tritium to the river, a 32% decrease from the 2018 amount of 666 curies.

In 2019, the Georgia Power Company's Vogtle Electric Generating Plant (VEGP) released 1,303 curies of tritium to the Savannah River and 39.5 curies migrated from the Barnwell Low-Level Disposal Facility (BLLDF) for an overall total of 1,795 curies of tritium (SRS plus VEGP plus BLLDF). This is a 28% decrease from the combined total of 2,505 curies in 2018.

*2.1.2 Radionuclide Concentrations in Savannah River Water, Drinking Water, and Fish*

At several locations along the Savannah River, SRS measures the tritium concentrations in the river water and cesium-137 in fish. SRS uses these measurements to make dose determinations. The amounts of all other radionuclides released from SRS are so small that their concentration in the Savannah River usually cannot be detected using conventional analytical techniques. SRS calculates concentrations in the river based on the annual release amounts and river flow rates using the LADTAP XL code, version 2020 (Dixon 2020).

*2.1.2.1 Radionuclide Concentrations in River Water and Treated Drinking Water*

Table 2-1 shows the measured tritium concentrations in the Savannah River near RM 141.5 and at the BJWSA Purrysburg Water Treatment Facility, which is representative of the BJWSA Chelsea and the City of Savannah I&D water treatment plants. These downriver tritium concentrations include tritium releases from SRS, VEGP, and BLLDF. Table 2-1 also provides the calculated concentrations for the other released radionuclides and a comparison of these concentrations to the Safe Drinking Water Act, 40 CFR 141 (EPA 2000) maximum contaminant level (MCL) for each radionuclide.

In 2019, the 12-month average tritium concentration measured in Savannah River water near RM 141.5 was 237 picocuries per liter (pCi/L). This reflects a 52% decrease from the 495 pCi/L measured in 2018. SRS attributes this decrease to the 28% decrease in the combined (SRS plus VEGP plus BLLDF) total of tritium released to the Savannah River in 2019 and to the 50% increase in the effective river flow rate from 2018 to 2019, which caused more dilution.

Table 2-1 indicates that all individual radionuclide concentrations at the three downriver community drinking water systems, as well as at RM 141.5, were below the EPA MCLs. Because SRS releases more than one radionuclide, the sum-of-the-fractions of the reported concentration of each radionuclide divided by its corresponding MCL must not exceed 1.0. As Data Table A-9 shows, the sum-of-the-fractions for the water treatment plants (determined at the BJWSA Chelsea plant) was 0.0143, which is below the 1.0 sum-of-the-fractions requirement.

*2.1.2.2 Radionuclide Concentrations in Fish*

At SRS, an important dose pathway for the representative person is from the consumption of fish. Fish exhibit a high degree of bioaccumulation for certain elements. For cesium (including radioactive isotopes of cesium, such as cesium-137), the bioaccumulation factor for Savannah River fish is 3,000, meaning that the concentration of cesium in fish flesh is about 3,000 times the concentration of cesium found in the water in which the fish live (Carlton et al. 1994).

Because of this high bioaccumulation factor, SRS can detect cesium-137 more easily in fish flesh than in river water. Therefore, when conservative to do so, SRS will base the fish pathway dose from cesium-137 directly on the analysis of the fish collected near RM 141.5, the assumed location of the hypothetical representative person. As shown in Data Table A-10, the 2019 cesium-137 release value of 0.210 Ci is based on analysis of fish in the river.

**Table 2-1. 2019 Radioactive Liquid Releases and 12-Month Average Downriver Radionuclide Concentrations Compared to the EPA's Drinking Water Maximum Contaminant Levels (MCL)**

| Nuclide | Curies Released | 12-Month Average Concentration (pCi/L) | | |
|---|---|---|---|---|
| | | Below SRS[a] | at BJWSA Purrysburg Plant[b] | EPA MCL[c] |
| H-3[d] | 1.80E+03 | 2.37E+02 | 2.29E+02 | 2.00E+04 |
| C-14 | 1.53E-02 | 2.02E-03 | 1.95E-03 | 2.00E+03 |
| Sr-90 | 1.31E-02 | 1.73E-03 | 1.67E-03 | 8.00E+00 |
| Tc-99 | 1.66E-02 | 2.19E-03 | 2.12E-03 | 9.00E+02 |
| I-129 | 8.92E-03 | 1.18E-03 | 1.14E-03 | 1.00E+00 |
| Cs-137 | 2.10E-01 | 2.77E-02 | 2.68E-02 | 2.00E+02 |
| Ra-226 | 2.32E-03 | 3.06E-04 | 2.96E-04 | 5.00E+00 |
| U-234 | 1.93E-02 | 2.55E-03 | 2.46E-03 | 1.03E+01 |
| U-235 | 3.62E-04 | 4.78E-05 | 4.61E-05 | 4.67E-01 |
| U-238 | 2.20E-02 | 2.90E-03 | 2.80E-03 | 1.00E+01 |
| Np-237 | 8.61E-05 | 1.14E-05 | 1.10E-05 | 1.50E+01 |
| Pu-238 | 1.21E-04 | 1.60E-05 | 1.54E-05 | 1.50E+01 |
| Pu-239 | 9.38E-06 | 1.24E-06 | 1.20E-06 | 1.50E+01 |
| Am-241 | 1.16E-05 | 1.53E-06 | 1.48E-06 | 1.50E+01 |
| Cm-244 | 2.17E-06 | 2.86E-07 | 2.77E-07 | 1.50E+01 |
| Alpha | 4.91E-03 | 6.48E-04 | 6.26E-04 | 1.50E+01 |
| Beta | 4.18E-02 | 5.51E-03 | 5.33E-03 | 8.00E+00 |

**a.** **Near Savannah River Mile 141.5, downriver of SRS**

**b.** **Beaufort-Jasper Water and Sewer Authority, drinking water at the Purrysburg Plant**

**c.** **MCLs for uranium based on radioisotope specific activity X 30 µg/L X isotopic abundance**

**d.** **The tritium concentrations and source term are based on actual measurements of the Savannah River water at the various locations. They include contributions from VEGP and Barnwell Low-Level Disposal Facility. All other radionuclide concentrations are calculated based on the effective or measured river flow rate.**

*2.1.2.3 Dose to the Representative Person*

Data Table A-11 shows the 2019 dose to the representative person from all liquid pathways, including irrigation, was estimated at 0.16 mrem (0.0016 mSv), which is a 17% decrease from the 0.19 mrem dose in 2018. Table 2-2 shows that this total dose is 0.16% of the all-pathway public dose standard of 100 mrem/yr (1 mSv/yr).

**Table 2-2. Potential Dose to the Representative Person from SRS Liquid Releases in 2019**

| | Committed Dose (mrem) | Applicable Standard (mrem) | Percent of Standard (%) |
|---|---|---|---|
| **Near Site Boundary (All Liquid Pathways)** | | | |
| **All Liquid Pathways Except Irrigation** | 0.11 | | |
| **Irrigation Pathways** | 0.050 | | |
| **Total Liquid Pathways** | 0.16 | 100[a] | 0.16 |

**a.** **All-pathway dose standard: 100 mrem/yr (DOE Order 458.1)**

About 31% of the 2019 all liquid pathways total dose to the representative person resulted from the irrigation pathway (Data Table A-11). This pathway is based on the ingestion of meat, milk, and vegetables that have been exposed to irrigation water from the Savannah River. The fish consumption pathway, based on concentrations in fish from Steel Creek, accounted for 63% and the drinking water pathway accounted for 5%. Figure 2-1 shows, cesium-137 (68%) and technetium-99 (11%) were the major contributors to the total dose. Data Table A-12 provides a five-year history of SRS liquid pathway doses.

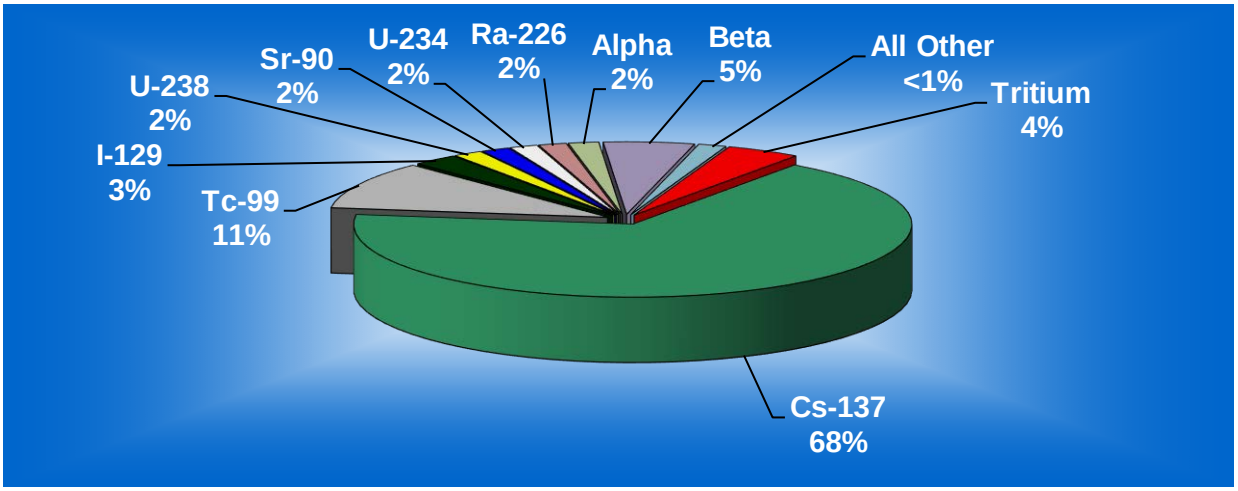



**Figure 2-1. Radionuclide Contributions to the 2019 SRS Representative Person Total Liquid Pathway Dose of 0.16 mrem (0.0016 mSv)**

*2.1.2.4 Drinking Water Pathway Dose*

People living downriver of SRS may receive some dose by consuming drinking water that contains radioactive releases from the Site. Tritium in downriver drinking water represented the highest percentage of the dose (about 78%) to customers of the three downriver water treatment plants.

Data Table A-13 shows the 2019 SRS-only releases were responsible for a maximum potential drinking water dose of 0.0076 mrem (0.000076 mSv). This dose is 37% less than the 2018 dose of 0.012 mrem (0.00012 mSv). SRS attributes this decrease to the 50% increase in the estimated Savannah River effective flow rate during 2019 (Section 1.6). DOE and EPA do not have a specific regulatory drinking water dose standard, but the EPA MCLs, defined in 40 CFR 141 (EPA 2000), assume a potential dose of 4 mrem/yr for beta and gamma emitters. The 2019 maximum drinking water dose of 0.0076 mrem is well below this value.

*2.1.2.5 Collective (Population) Dose*

SRS calculates the collective drinking water consumption dose for the separate population groups that the BJWSA and City of Savannah I&D water treatment plants serve (Data Table A-14).

Calculations of collective doses from agricultural irrigation assume that 1,000 acres of land are used for each of the major food types grown in the SRS area (vegetables, milk, and meat) with the population within 50 miles of SRS consuming all the food produced on these 1,000-acre parcels. Historically, SRS limited the food consumption pathway dose to the smaller of 1) the total foodstuffs actually produced in the SRS 50-mile radius or 2) the total foodstuffs produced on the 1,000-acre parcels (based on regional productivity rates (Jannik and Stagich 2017). The total amount of foodstuff produced in the SRS area (which is difficult to determine because of under reporting by small farms and individual gardens) has typically been less than the amount produced on 1,000-acre parcels. Beginning in 2016, SRS now conservatively uses only the amount produced on the 1,000-acre irrigated parcels for collective dose estimates.

In 2019, the collective dose from all liquid pathways was 2.1 person-rem (0.021 person-Sv) (Data Table A-15). Person-rem is calculated as the dose to a "typical" person multiplied by the number of people exposed. This is a 38% decrease from the comparable 2018 collective dose of 3.4 person-rem (0.034 person-Sv). DOE Order 458.1 requires that a collective dose be calculated and reported, but there is not a separate collective dose standard for comparison.

## 2.2 Air Pathway Doses

### *2.2.1 Atmospheric Source Terms*

Data Table A-16 documents the 2019 SRS radiological air releases by Site area. Data Table A-17 provides a five-year history of SRS atmospheric releases, and it shows that tritium oxide releases, which account for a majority of the offsite doses, decreased about 79% from 2018 to 2019. Estimates of unmonitored diffuse and fugitive sources were included in the atmospheric source term, as required for demonstrating compliance with EPA regulations.

### *2.2.2 Atmospheric Concentrations*

For dose determinations, SRS uses calculated radionuclide concentrations from standard modeling of measured effluent releases instead of measured concentrations in the air surveillance samples. This is because most radionuclides SRS released in 2019 were not detected (using conventional analytical methods) in the air samples collected at the Site perimeter and offsite locations. The exception to this is tritium oxide, which can be measured at the site perimeter locations. Therefore, to confirm the dose models, SRS compares the measured concentrations of tritium oxide with the calculated concentrations from CAP88 PC and MAXDOSE. In Data Table A-18, this comparison showed that in 2019 the dose models used at SRS were about 1.5 to 2.5 times more conservative than the measured tritium oxide concentrations.

### *2.2.3 Dose to the Representative Person*

As shown in Data Table A-19a, the 2019 estimated dose from air releases to the representative person was 0.018 mrem (0.00018 mSv), 0.18% of the DOE Order 458.1 air pathway standard of 10 mrem per year. Table 2-3 compares the representative person dose with the DOE standard. The 2019 dose was about 78% less than the 2018 dose of 0.082 mrem (0.00082 mSv). SRS attributes most of this decrease to the decrease in tritium oxide releases during 2019.

In 2017, SRS began to calculate the potential dose for an adult worker at the Three Rivers Landfill near B Area. As shown in Figure 1-2, Three Rivers Landfill is located on SRS, but it is accessed directly from public Hwy 125 outside of the Site's security perimeter. The workers at Three Rivers Landfill are not Site employees and are now considered members of the public to comply with DOE Order 458.1.

For this assessment, SRS assumed that an adult person worked at Three Rivers Landfill for 2000 hours during the year (8 hours/day, 5 days/week, 50 weeks/year). SRS also assumed that this worker was only exposed from the inhalation and external-exposure pathways. No locally grown food consumption was considered at this industrial location.

For 2019, SRS calculated a potential dose to a Three Rivers Landfill worker of 0.00977 mrem (0.0000977 mSv). This dose is less than the representative person dose of 0.018 mrem that was reported for DOE Order 458.1 compliance. Data Table A-19b shows the results of these calculations.

**Table 2-3. Potential Doses to the Representative Person and to the NESHAP MEI from SRS Atmospheric Releases in 2019 and Comparison to the Applicable Dose Standard**

| | MAXDOSE-SR Site Boundary DOE 458.1 | CAP88-PC (EPA NESHAP) Site Boundary | CAP88-PC (EPA NESHAP) TRL Worker |
|---|---|---|---|
| **Calculated dose (mrem)** | 0.018 | 0.018 | 0.018 |
| **Applicable Standard (mrem)** | 10[(a)] | 10[(b)] | 10[(a)] |
| **Percent of Standard (%)** | 0.18 | 0.18 | 0.18 |

**a. DOE: DOE Order 458.1**
**b. EPA: (NESHAP) 40 CFR 61, Subpart H**

As shown in Figure 2-2, tritium oxide releases accounted for nearly 68% of the dose to the representative person. Iodine-129 and Krypton-85 contributed 23% and 3% to the dose, respectively. Cesium-137, Plutonium-239, and Strontium-90 each contributed about 2% to the dose. No other individual radionuclide accounted for more than 1% of the representative person dose. Data Table A-19a shows that the major pathways through which a representative person received radioactivity from atmospheric releases were vegetable consumption (39%), inhalation (30%), and cow milk consumption (22%). As shown in Data Table A-20 and in Figure 2-3, the due north sector (0.0180 mrem) of the Site was slightly higher than the north northwest sector (0.0176 mrem) making it the location of the highest dose to the representative person.

Because of the potential in the SRS vicinity for the consumption of goat milk, additional calculations of the dose to the representative person were performed substituting goat milk for the customary cow milk pathway. As shown in Data Table A-21, SRS estimated that the potential dose to the representative person using the goat milk pathway is 0.020 mrem (0.00020 mSv). SRS provides this dose for reference only.

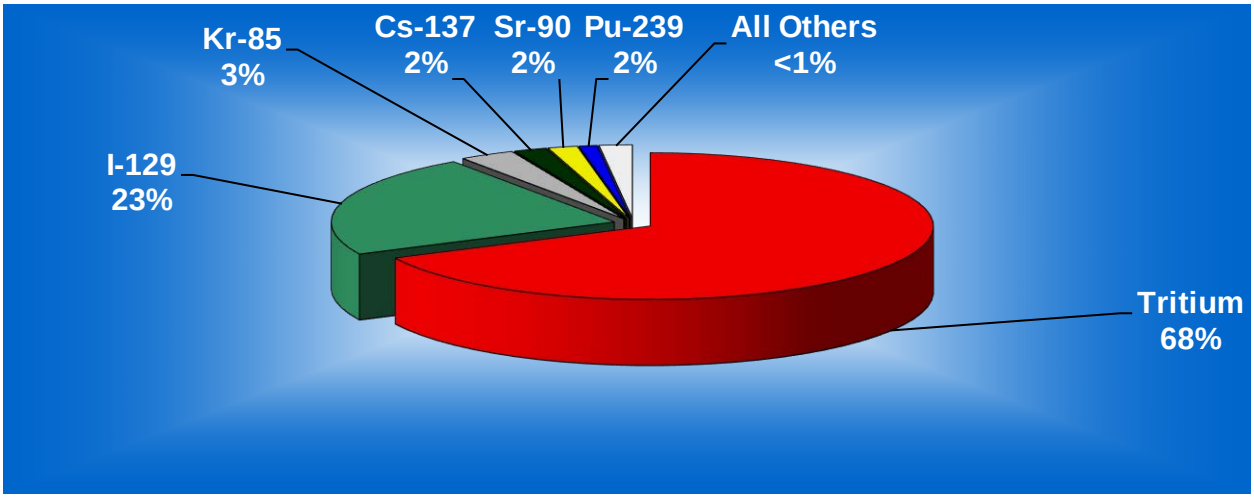
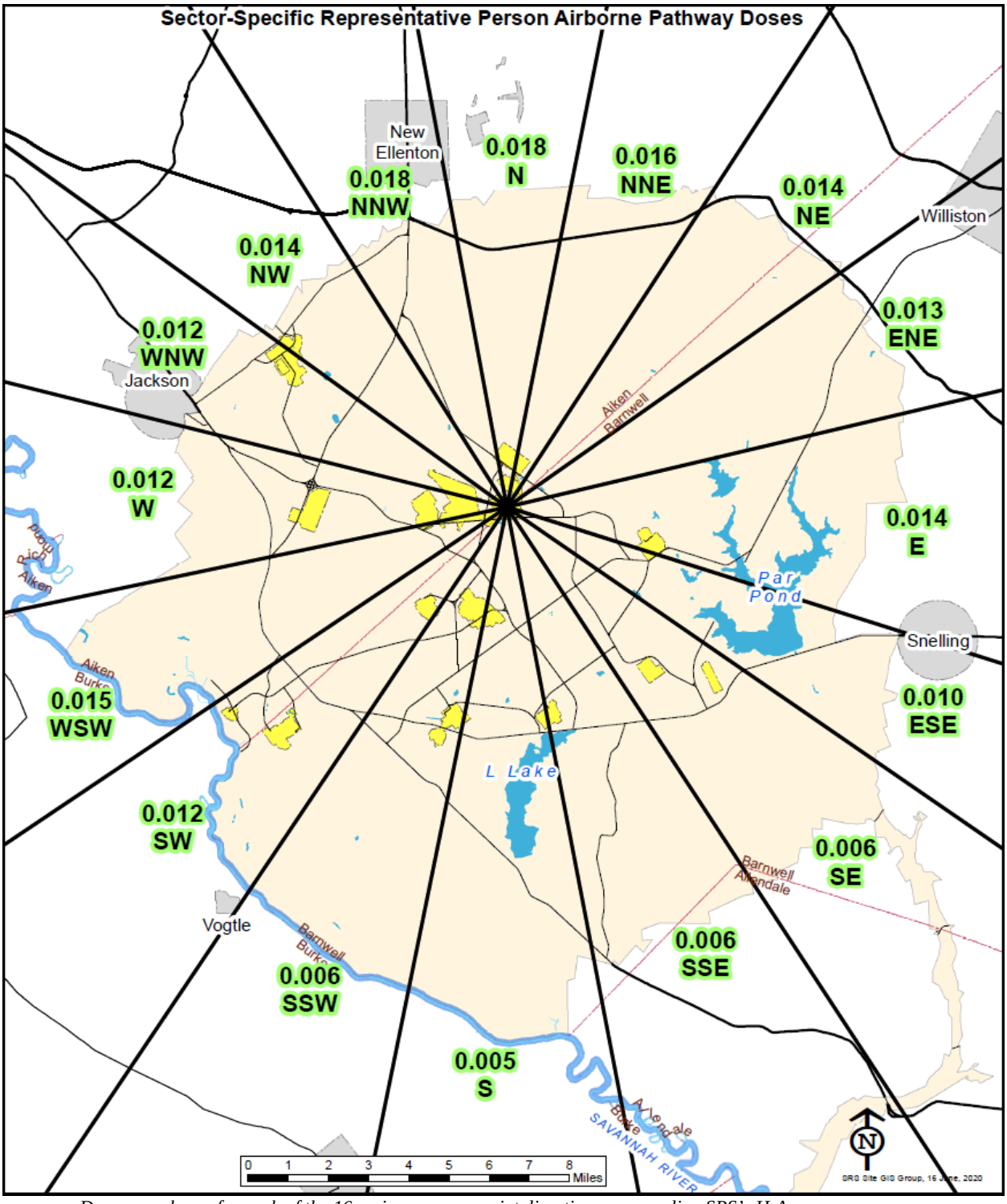



**Figure 2-2. Radionuclide Contributions to the 2019 SRS Air Pathway Dose of 0.018 mrem (0.00018 mSv)**




*Doses are shown for each of the 16 major compass point directions surrounding SRS's H-Area. In 2019, the N sector was slightly higher (0.0180 mrem) than the NNW sector (0.0176 mrem)*

**Figure 2-3. Sector-specific Representative Person Site Boundary Doses**

*2.2.4 Collective (Population) Dose*

SRS calculates the air-pathway collective dose for the entire 803,370 population living within 50 miles of SRS's H-Area. Data Table A-4a and Data Table A-4b shows the population distribution around the SRS COS and H-Area, respectively.

In 2019, SRS estimated the air-pathway collective dose at 0.70 person-rem (0.0070 person-Sv), which is less than 0.01% of the annual collective dose from natural sources of radiation (about 234,000 person-rem). Data Table A-22 shows the 2019 air-pathway collective doses by radionuclide and pathway. Tritium oxide releases accounted for 78% of the collective dose.

*2.2.5 National Emission Standards for Hazardous Air Pollutants (NESHAP) Compliance*

*2.2.5.1 Maximally Exposed Individual Dose*

To demonstrate compliance with NESHAP regulations (EPA 2006), SRS calculated MEI and collective doses using 1) CAP88 PC version 4.1.0.2 computer code, 2) the 2019 air-release source term shown in Data Table A-23, and 3) Site-specific input parameters shown in Data Table A-24. The EPA requires the use of the MEI concept and does not allow use of the representative person concept. The EPA specifies most of the input parameters in the CAP88 PC program; they cannot be changed without specific EPA approval.

For 2019, SRS used CAP88 PC (version 4.1.0.2, dated January 2020) to demonstrate compliance with the EPA's 10 mrem/yr (0.1 mSv/yr) public dose standard for airborne emissions from DOE sites. For 2019, the MEI dose (Data Table A-25a) was estimated at 0.0178 mrem (0.000178 mSv), or 0.18% of the 10-mrem/yr EPA standard, as shown in Table 2-3.

SRS estimated the MEI dose for the Three Rivers Landfill worker (Data Table A-25b) to be 0.0176 mrem (0.000176 mSv). For 2019, SRS reported the slightly higher Site boundary dose of 0.0178 mrem for NESHAP compliance. This dose is 0.18% of the 10-mrem/yr EPA standard, as Table 2-3 shows.

Data Table A-25a shows tritium oxide releases accounted for about 79% of the MEI dose and elemental tritium accounted for 12.5%. The CAP88 PC model very conservatively treats elemental tritium the same as tritium oxide. The 2019 NESHAP compliance dose (MEI dose) was about 79% less than the 2018 dose of 0.088 mrem (0.00088 mSv). NESHAP regulations require separate dose reporting from diffuse and fugitive releases. Data Table A-26a shows the MEI dose at the Site boundary from diffuse and fugitive releases was about 0.0018 mrem (0.0000018 mSv). The diffuse and fugitive releases account for about 10% of the total 2019 MEI dose. Data Table A-26b provides the MEI dose at the TRL Worker location from diffuse and fugitive releases.

Comparisons (by pathway and major radionuclides) of the CAP88 PC-determined MEI and collective doses with the MAXDOSE-SR and POPDOSE-SR representative person doses are provided in Data Table A-27 and Data Table A-28. As shown in Data Table A-27, the CAP88 PC code estimates about a 50% higher dose for tritium than does the MAXDOSE code because CAP88 PC assumes a one to one ratio between tritium oxide in air and tritium oxide in plant leaves, whereas MAXDOSE-SR assumes a 50% ratio. For iodine-129, CAP88 PC estimates a much lower dose because it does not consider deposition for the vapor form of iodine, which MAXDOSE-SR does.

*2.2.5.2 Collective Dose*

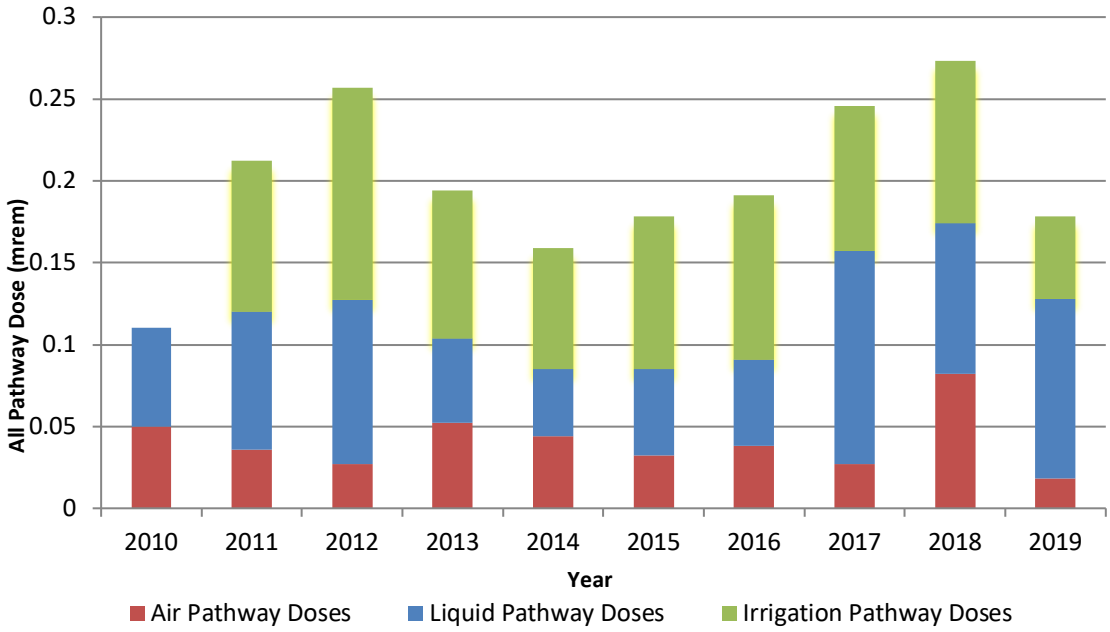
The CAP88 PC-determined collective (population) dose for 2019 was estimated at 1.7 person-rem (0.017 person-Sv), which is 80% less than the 2018 collective dose of 8.6 person-rem (0.086 person-Sv). Tritium releases accounted for 91% of the NESHAP collective dose.

For the population dose (Data Table A-28), the CAP88 PC version 4.1.0.2 estimates a higher dose compared to POPDOSE-SR, mainly because 1) it assumes the general population has the same inhalation and consumption rates as the maximally exposed individual, and 2) it assumes a one-to-one ratio between tritium oxide in air and tritium oxide in plant leaves (whereas POPDOSE-SR assumes a 50% ratio).

## 2.3 All-Pathway Dose

As stated in DOE Order 458.1, the all-pathway dose standard is 100 mrem/yr. SRS ensures a conservative estimate by combining the representative person airborne pathway and liquid pathway dose estimates, even though the two estimated doses are for hypothetical individuals residing at different geographic locations (Figure 1-2).

For 2019, the potential representative person all-pathway dose was 0.18 mrem (0.0018 mSv), calculated as 0.018 mrem from air pathways plus 0.16 mrem from liquid pathways. The all-pathway dose is 0.18% of the 100 mrem/yr (1 mSv/yr) DOE dose standard. The 2019 all-pathway dose is about 33% less than the 2018 total dose of 0.27 mrem (0.0027 mSv). Data Table A-12 provides a five-year history of the SRS all-pathway doses. Figure 2-4 shows a 10-year history of SRS's all-pathway (airborne, liquid, and irrigation pathways) doses to the MEI/representative person.




*1. Beginning in 2011, the irrigation pathway dose is included in the liquid pathway dose. Previous years do not include the irrigation pathway dose.*

*2. Beginning in 2012, SRS began using the representative person dose instead of the MEI dose.*

**Figure 2-4. Ten-Year History of SRS Maximum Potential All-Pathway Dose**

## 2.4 Sportsman Dose

DOE Order 458.1 specifies radiation dose standards for individual members of the public. The dose standard of 100 mrem/yr includes the dose a person receives from routine DOE operations through all exposure pathways. Additionally, SRS considers and quantifies unique exposure pathways that are not included in the standard calculations of the doses to the representative person. This is because they apply to unlikely scenarios, such as eating fish caught only from the mouths of SRS streams ("creek-mouth fish"), or to special scenarios, such as onsite volunteer hunters.

In addition to deer, hog, fish, and turkey consumption, SRS considered the following exposure pathways for an offsite hunter and an offsite fisherman on Creek Plantation, a privately-owned portion of the Savannah River Swamp.

- External exposure to contaminated soil,
- Incidental ingestion of contaminated soil, and
- Incidental inhalation of renewed suspension of contaminated soil.

### *2.4.1 Onsite Hunter Dose*

#### *2.4.1.1 Deer and Hog Consumption Pathway*

SRS holds annual hunts for the public to control the Site's deer and wild pig populations and to reduce animal-vehicle accidents. The estimated dose from consuming harvested deer or hog meat is determined for every onsite hunter. During 2019, the maximum potential dose an onsite hunter received was 17.4 mrem (0.174 mSv), or 17.4% of DOE's 100 mrem/yr dose standard (Table 2-4). This dose is for an actual hunter who harvested four animals (three hogs and one deer) during the 2019 hunts (Data Table A-29). For the hunter-dose calculation, SRS conservatively assumes that this hunter individually consumed the entire edible portion of these animals, about 91 kilograms (kg) (200 lbs).

#### *2.4.1.2 Turkey Consumption Pathway*

SRS hosts a special turkey hunt during April for hunters with mobility impairments. Hunters harvested 19 turkeys in 2019. SRS measured all the turkeys for cesium-137. Since none of them measured above background, SRS did not assign a dose to these hunters.

### *2.4.2 Hypothetical Offsite Hunter Doses*

#### *2.4.2.1 Deer and Hog Consumption Pathway*

The deer and hog consumption pathways considered were for hypothetical offsite individuals whose entire intake of meat (81 kg) during the year was either deer or hog meat. SRS assumes these individuals harvested deer or hogs that had resided on SRS during the year and then moved offsite prior to hunting season.

Based on these unlikely assumptions and on the measured average concentration of cesium-137 in all deer (1.02 pCi/g) and hogs (2.40 pCi/g) harvested from SRS during 2019, the potential maximum doses from this pathway were estimated at 2.12 mrem (0.0212 mSv) for the offsite deer hunter and 7.74 mrem (0.0774 mSv) for the offsite hog hunter. Data Table A-29 documents these dose calculations.

Beginning in 2013, a background cesium-137 concentration of 0.5 pCi/g is subtracted from the onsite average concentrations, before calculating the offsite hunter doses. The 0.5 pCi/g background concentration is based on the median value determined by South Carolina Department of Health and Environmental Control (SCDHEC) for South Carolina deer, from 2008 through 2012 (SCDHEC 2013).

#### *2.4.2.2 Savannah River Swamp Hunter Soil Exposure Pathway*

SRS estimated the potential dose to a recreational hunter exposed to SRS legacy contamination on the privately-owned Creek Plantation. SRS assumes that this recreational sportsman hunted for 120 hours during the year (8 hours per day for 15 days) at the location of maximum radionuclide contamination. Table 2-4 shows the offsite hog consumption pathway 7.74 mrem, and the Savannah River swamp hunter soil exposure pathway 1.86 mrem were conservatively added together to obtain a total offsite hunter dose of 9.60 mrem (0.0960 mSv). This potential dose is 9.6% of the DOE 100 mrem/yr all-pathway dose standard.

### *2.4.3 Hypothetical Offsite Fisherman Dose and Risk*

#### *2.4.3.1 Creek-Mouth Fish Consumption Pathway*

For 2019, SRS analyzed three species of fish (panfish, catfish, and bass) taken from the mouths of four SRS streams. Using these concentrations, SRS estimated the maximum potential dose from fish consumption at 0.227 mrem (0.00227 mSv) from bass collected at the mouth of Lower Three Runs Branch. SRS bases this hypothetical dose on the low-probability scenario that, during 2019, a fisherman consumed 24 kg (53 lbs) of bass caught exclusively from the mouth of Lower Three Runs Branch. All this potential dose was from cesium-137. Data Table A-30a and Data Table A-30b, respectively, show the measured concentrations and resulting doses for each location and species combination.

#### *2.4.3.2 Savannah River Swamp Fisherman Soil Exposure Pathway*

Using the RESRAD code (Yu et al. 2001), SRS calculated the potential dose to a recreational fisherman exposed to SRS legacy contamination in Savannah River Swamp soil on the privately-owned Creek Plantation. SRS assumes that this recreational sportsman fished on the South Carolina bank of the Savannah River, near the mouth of Steel Creek, for 250 hours during the year.

Using the radionuclide concentrations measured in soil at this location, SRS estimated the potential dose to a fisherman from a combination of 1) external exposure to the contaminated soil, 2) incidental ingestion of the soil, and 3) incidental inhalation of renewed suspension soil to be 2.08 mrem (0.00208 mSv).

Table 2-4 shows how SRS conservatively combined the maximum Steel Creek fish consumption dose (0.118 mrem) and the Savannah River Swamp fisherman soil exposure pathway (2.08 mrem) to obtain a total offsite fisherman dose of 2.20 mrem (0.0220 mSv). This potential dose is 2.20% of the DOE 100 mrem/yr all-pathway dose standard.

#### *2.4.3.3 Potential Risk from Consumption of SRS Creek-Mouth Fish*

During 1991 and 1992, in response to a U.S. House of Representatives Appropriations Committee request for a plan to evaluate risk to the public from fish collected from the Savannah River, SRS developed a fish monitoring plan in conjunction with the EPA, the Georgia Department of Natural Resources (GDNR), and SCDHEC. This plan ensures SRS assesses the radiological risk from the consumption of Savannah River fish and requires that SRS present a summary of the results in the SRS Annual Site Environmental Report.

**Table 2-4. 2019 Representative Person All-Pathways and Sportsman Doses Compared to the DOE All-Pathways Dose Standard**

| | Committed Dose (mrem) | Applicable Standard (mrem)[a] | Percent of Standard (%) |
|---|---|---|---|
| **Representative Person Dose** | | | |
| All-Pathways (Liquid Plus Airborne Pathways) | 0.18 | 100 | 0.18 |
| **Sportsman Dose** | | | |
| Onsite Hunter | 17.4 | 100 | 17.4 |
| Creek-Mouth Fisherman[b] | 0.227 | 100 | 0.227 |
| **Savannah River Swamp Hunter** | | | |
| Offsite Hog Consumption | 7.74 | | |
| Offsite Deer Consumption | 2.12 | | |
| Soil Exposure[c] | 1.86 | | |
| Total Offsite Hunter Dose (Hog + Soil Exposure) | 9.60 | 100 | 9.60 |
| **Savannah River Swamp Fisherman** | | | |
| Steel Creek Fish Consumption | 0.118 | | |
| Soil Exposure[d] | 2.08 | | |
| Total Offsite Fisherman Dose (Fish + Soil Exposure) | 2.20 | 100 | 2.20 |

**a. All-pathway dose standard; 100 mrem/yr (DOE Order 458.1)**
**b. In 2019, the maximum dose to a hypothetical fisherman resulted from the consumption of bass from the mouth of Lower Three Runs Branch**
**c. Includes the dose from a combination of external exposure to and incidental ingestion and inhalation of the worst-case Savannah River swamp soil**
**d. Includes the dose from a combination of external exposure and incidental ingestion and inhalation of Savannah River swamp soil near the mouth of Steel Creek**

*2.4.3.4 Risk Comparisons*

For 2019, SRS compared the maximum potential radiation doses and lifetime fatal and nonfatal cancer risks (from the consumption of SRS creek-mouth fish for 1-year, 30-year, and 50-year exposure durations) to the radiation risks associated with the DOE Order 458.1 all-pathway dose standard of 100 mrem/yr (1.0 mSv/yr) in Table 2-5. SRS estimated the potential risks using the cancer morbidity risk coefficients from Federal Guidance Report No. 13 (EPA, 1999). The assumed maximum fish consumption rate is 24 kg per year (Table 1-1).

In 2019, the maximum dose and risk to a hypothetical fisherman resulted from the consumption of bass from the mouth of Lower Three Runs Branch (Data Table A-30b and Data Table A-30c). Figure 2-5 shows the history (1993-2019) of the annual potential radiation doses from consumption of Savannah River fish. Over the past ten years, there are no apparent trends in these data. This is because of the relatively large variability in the radionuclide concentrations measured in fish from the same location, due to differences in the following:

- Size of the fish collected each year,
- Mobility and location within the stream mouth from which they are collected,
- Time of year they are collected,
- Amount of radionuclides in the stream water and sediments in which they live that are chemically and physically available to the fish,

- Water quality at each SRS stream mouth, caused by annual changes in stream flow rates (turbulence) and water chemistry.

**Table 2-5. Potential Lifetime Risks from the Consumption of Savannah River Fish Compared to Dose Standards**

| | Committed Dose (mrem) | Potential Risk[(a)] |
|---|---|---|
| **2019 Savannah River Fish** | | |
| 1-Year Exposure | 0.23 | 1.7E-07 |
| 30-Year Exposure | 6.80 | 5.2E-06 |
| 50-Year Exposure | 11.3 | 8.6E-06 |
| **Dose Standard** | | |
| 100 mrem/yr All Pathway | | |
| 1-Year Exposure | 100 | 7.3E-05 |
| 30-Year Exposure | 3,000 | 2.2E-03 |
| 50-Year Exposure | 5,000 | 3.7E-03 |

**a. All radiological risk factors are based on observed and documented health effects to actual people who have received high doses (more than 10,000 mrem) of radiation, such as the Japanese atomic bomb survivors. Radiological risks at low doses (less than 10,000 mrem) are theoretical and are estimated by extrapolating the observed health effects at high doses to the low-dose region by using a linear, no-threshold model. However, cancer and other health effects have not been observed consistently at low radiation doses because the health risks either do not exist or are so low that they are undetectable by current scientific methods.**

As indicated in Table 2-5, the 50-year maximum potential lifetime risk from consumption of SRS creek-mouth fish was 8.6E-06, well below the 50-year risk (3.7E-03) associated with the 100 mrem/yr dose standard.

If a potential lifetime risk is less than 1.0E-06 (i.e., one additional case of cancer over that expected in a group of 1,000,000 people), the risk is considered minimal and the corresponding contaminant concentrations are considered negligible. If a calculated risk is more than 1.0E-04 (one additional case of cancer in a population of 10,000), some form of corrective action or remediation may be required. However, if a calculated risk falls between 1.0E-04 and 1.0E-06 (the case with the maximum potential lifetime risks from the consumption of Savannah River fish), then the risk may be deemed acceptable, if it is kept ‘as low as reasonably achievable’ (ALARA). At SRS, an environmental ALARA program (3Q 18.5) is in place, to ensure that the potential doses and risks from Site radioactive liquid effluents (and, therefore, from consumption of Savannah River fish) are kept ALARA (SRS 2015).

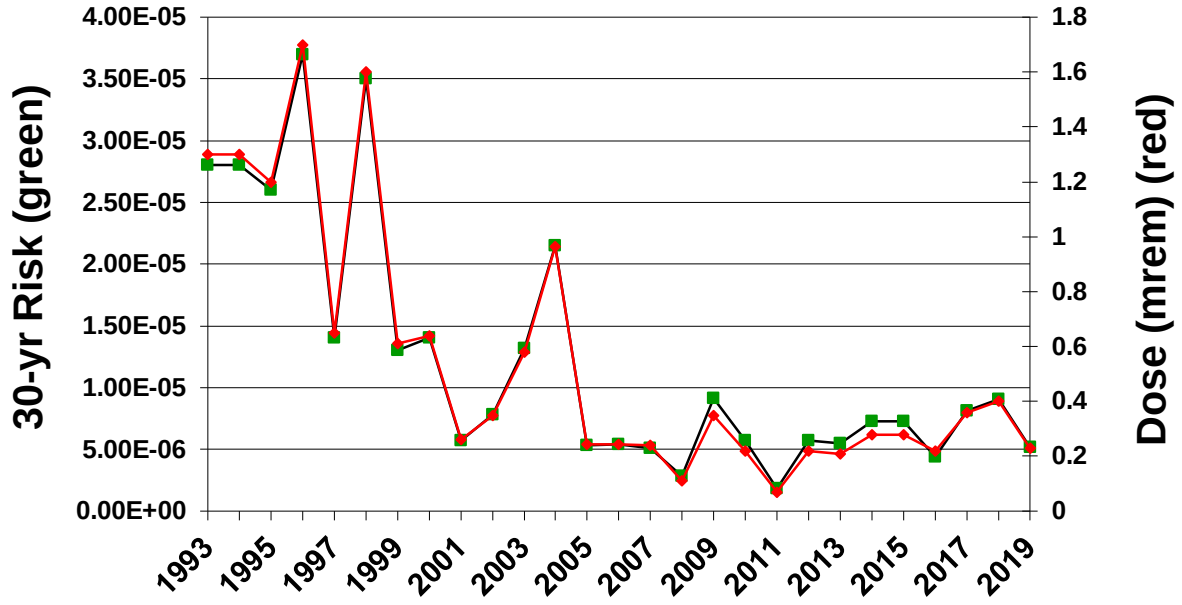



**Figure 2-5. History of SRS Maximum Potential Fisherman Doses and 30-y Projected Risks**

## 3.0 Release of Material Containing Residual Radioactivity

DOE Order 458.1 establishes authorized surface contamination limits, which, in turn, allow SRS to release personal and real property unconditionally. This order defines personal property as, "*property of any kind, except for real property" and defines real property as "land and anything permanently affixed to the land such as buildings, fences and those things attached to the buildings, such as light fixtures, plumbing and heating fixtures, or other such items, that would be personal property if not attached*." SRS handles unconditional release of real property on a case-by-case basis, which requires specific approval from DOE. SRS did not release any real property in 2019, so the following discussion is associated with release of personal property from SRS. DOE Order 458.1 specifies that SRS must prepare and submit an annual summary of cleared property to the Field Element Manager (i.e. DOE-SR Manager).

### 3.1 Property Release Methodology

Through the use of procedures, SRS governs the unconditional release of equipment and material. Following a radiological survey, SRS can unconditionally release an item if it meets specific documented limits. For items meeting unconditional release criteria, SRS generates a form and electronically attaches it to the applicable radiological survey, via the Site's Visual Survey Data System. To determine the amount of material and equipment released from SRS facilities in 2019, SRS subsequently compiled these electronic forms and coordinated a site-wide review. These measures ensure that radiological releases of material from SRS are consistent with the requirements of DOE Order 458.1.

In 2019, SRS unconditionally released a total of 10,325 items of personal property from radiological areas. Most of these items did not leave the Site. Therefore, all of these items required no additional radiological controls, post-survey, as they met DOE Order 458.1 release criteria. The recently implemented DOE Order 458.1 allows using DOE Order 5400.5 derived supplemental limits for unconditional release of equipment and materials.

In 2003, DOE approved an SRS request to use supplemental limits for releasing material from the Site, with no further DOE controls. These supplemental release limits, provided in Data Table A-31, are dose-based.

These limits are such, that if any member of the public received any exposure, it would be less than 1 mrem/yr. The supplemental limits include both surface and volume concentration criteria. The surface criteria are very similar to those used in previous years. The volume criteria allow SRS the option to dispose of potentially volume-contaminated material in Three Rivers Landfill, an onsite sanitary waste facility. In 2019, SRS did not release any material from the Site using the supplemental release limits volume concentration criteria.

## 4.0 Radiation Dose to Aquatic and Terrestrial Biota

DOE Order 458.1 requires that SRS conduct Site operations in a manner that protects the local biota from adverse effects due to radiation and radioactive material releases. To demonstrate compliance with this requirement, SRS uses the approved DOE Standard, DOE-STD-1153-2019, *A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota* (DOE 2019).

The biota dose rate limits specified in this standard are:

- Aquatic animals 1.0 rad/day (0.01 gray/day),
- Riparian animals 0.1 rad/day (0.001 gray/day),
- Terrestrial plants 1.0 rad/day (0.01 gray/day), and
- Terrestrial animals 0.1 rad/day (0.001 gray/day).

### 4.1 DOE Biota Concentration Guides

SRS evaluates biota doses for aquatic and terrestrial systems using the RESRAD Biota model (version 1.8) (DOE 2004), which directly implements the DOE (2019) guidance.

For aquatic systems (aquatic and riparian animals), the RESRAD Biota model performs a combined water-plus-sediment evaluation. SRS performed initial screenings in 2019 using maximum (for Level 1) radionuclide concentration data from the 14 SRS environmental monitoring stream and sediment sampling locations that are co-located. These screenings determine the biota concentration guide (BCG) sum-of-the-fractions for each of the 14 assessed aquatic systems. A sum-of-the-fractions less than 1.0 indicates the sampling site has passed its initial pathway screening. This means that the biota dose rate limits were not exceeded, and that no further assessments are needed.

Data Table A-32 presents the results of the 2019 biota dose assessment. For 2019, all SRS aquatic system locations passed the initial screening and no further assessments were required.

To evaluate the terrestrial systems (terrestrial plants and animals), SRS performed initial screenings using concentration data from the five onsite radiological soil sampling locations. Typically, SRS collects and analyzes only one soil sample per year from each location. For 2019, all terrestrial locations passed their initial (Level 1) pathway screenings (Data Table A-32).

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# Appendix A

## Data Table A-1. Parameters Used for Liquid Pathway Dose Calculations

### Table A-1, Parameters Used for Liquid Pathway Dose Calculations



**Reference and Typical Person Consumption and Usage Rates**

(Note: Values developed by Savannah River National Laboratory for SRS in Stone and Jannik, 2013)

| Pathway | Reference Person 95th percentile | Typical Person 50th percentile | Units |
|---|---|---|---|
| Fish consumption | 24 | 3.7 | kg/y |
| Marine invertebrates | Not applicable | 1.5 | kg/y |
| Boating | 44 | 3,110,000 | h/y (person-h/y) |
| Swimming | 14 | 295,000 | h/y (person-h/y) |
| Shoreline recreation | 20 | 822,000 | h/y (person-h/y) |
| Water consumption | 800 | 300 | L/y |
| **Population Served by Downriver Water Treatment Plants** | | | |
| Beaufort-Jasper Purrysburg Plant | | 76,538 | persons |
| Beaufort-Jasper Chelsea Plant | | 100,622 | persons |
| City of Savannah Industrial & Domestic Water Supply | | 35,000 | persons |
| **50-mile Population** | | | |
| Center of Site - 2010 US Census | | 781,060 | persons |
| H-Area - 2010 US Census | | 803,370 | persons |

| Site-Specific Parameters Used in Liquid Dose Calculations | Value | Units |
|---|---|---|
| Savannah River *effective* flow rate at RM 141.5 for 2019 [(a)] | 8,481 | $ft^3/s$ |
| River dilution in estuary | 3 | |
| Transport Time | | |
| Recreation | 1 | d |
| Drinking Water | 1.5 | d |
| Fish | 2 | d |
| Treatment Plant Drinking Water | 4 | d |
| Sport Fish | 10 | d |
| Commercial Fish | 13 | d |
| Salt Water Invertebrate | 13 | d |
| Edible aquatic food harvest | | |
| Fish - sport | 8,220 | person-kg/y |
| Fish - commercial | 57,000 | person-kg/y |
| Invertebrates - salt water | 380,000 | person-kg/y |
| Shoreline width factor | 0.2 | |
| Fish bioaccumulation factor for cesium | 3,000 | |

a) The effective river flow rate was based on tritium concentration measurements.
The 2019 measured river flow rate was 10,968 cfs. See Data Table 6-6 for details.

**Parameters Used for Liquid Pathway Dose Calculations** 

**Irrigation Parameter Values:**

| Parameter | Value | Units | Comments |
|---|---|---|---|
| 50Mile Total Vegetable Production: | 7122412 | kg/yr | **5.30E+06*** |
| 50Mile Total Leafy Veg Production: | 1780603 | kg/yr | **1.40E+06*** |
| Irrigated land area: | 1000 | acres | |
| Pop dose determined by: | area | | POP or AREA |
| River transit time: | 2 | d | |
| Irrigation rate: | 3.6 | L/sq.m/d | 102 L/sq.m/mo |
| Weathering removal constant: | 0.0495 | 1/d | 14 d half-life |
| Crop exposure time: | 70 | d | |
| Grass exposure time: | 30 | d | |
| Vegetable crop yield: | 2.2 | kg/sq.m | |
| Pasture grass yield: | 0.7 | kg/sq.m | |
| Milk production yield: | 0.34 | L/sq.m | |
| Meat production yield: | 0.01 | kd/sq.m | |
| Surface density of soil: | 240 | kg/sq.m | |
| Pasture grass hold-up time: | 0 | d | |
| Veg transport time (individual): | 1 | d | d |
| Veg transport time (population): | 6 | d | d |
| Milk transport time: | 3 | d | d |
| Meat transport time: | 6 | d | d |
| Fraction of fodder from irrigated field: | 1.00 | | |
| Cattle consumption rate of fodder: | 36 | kg/d | beef |
| | 52 | kg/d | milk |
| Fraction of water from Savannah River: | 1.00 | | |
| Cattle consumption rate of water: | 28 | L/d | beef |
| | 50 | L/d | milk |
| Individual consumption rates: | 289 | kg/yr | veg |
| | 31 | kg/yr | leafy |
| | 81 | kg/yr | meat |
| | 260 | L/yr | milk |
| Population consumption rates: | 89 | kg/yr | veg |
| | 11 | kg/yr | leafy |
| | 32 | kg/yr | meat |
| | 69 | L/yr | milk |
| Fractional retention on leaves: | 0.25 | | all nuclides |

**Data Table A-2. Site-Specific Parameters Used for Airborne Pathway Doses**

**Data Table A-2, Site-Specific Parameters Used for Airborne Pathway Doses using MAXDOSE and POPDOSE**

| Pathway | Reference Person 95th Percentile (Individual) | SRS MEI Pre-2012 Adult Individual | Percent Difference | Typical Person 50th Percentile (Population) | SRS Population Pre-2012 Average Adult | Percent Difference |
|---|---|---|---|---|---|---|
| Fruits, vegetables, and grains (kg/yr) | 289 | 276 | ↑4.7% | 89 | 163 | ↓45.4% |
| Leafy vegetables (kg/yr) | 31 | 43 | ↓27.9% | 11 | 21 | ↓47.6% |
| Milk (L/yr) | 260 | 230 | ↑13% | 69 | 120 | ↓42.3% |
| Meat (beef) (kg/yr) | 81 | 81 | 0.00% | 32 | 43 | ↓25.6% |
| Inhalation ($m^3$/yr) | 6,400 | 8,000 | ↓20.0% | 5,000 | 5,548 | ↓9.9% |

| **50-mile Population** | |
|---|---|
| Center of Site - 2010 US Census (persons) | 781,060 |
| H-Area - 2010 US Census (persons) | 803,370 |

**Release Locations for Representative Person Dose**

| | **Reactors** | **F & H** | **SRNL** | **Diffuse and Fugitive** |
|---|---|---|---|---|
| **Release height, m** | 40 | 61 | 31 | 0 |
| **Release location (site coordinates)** | | | | |
| **East** | 40740 | 63380 | 51860 | 58000 |
| **North** | 54130 | 71900 | 106670 | 62000 |
| **Grade Elevation** | 269 | 308 | 368 | 338 |

## Data Table A-3. Meteorological Data (2007 – 2011)

**Data Table A-3, Meteorological Data (2007-2011)** **1 of 7**

Direction is from which the wind blows

43824 WIND STATS H_AREA 60MIN 62M 07-11 STABILITY FROM SIGMA E

Joint Frequency Distribution of Wind Speed and Direction: Atmospheric Stability Class A
Extremely Unstable Conditions

| UMAX(M/S) | N | NNE | NE | ENE | E | ESE | SE | SSE |
|---|---|---|---|---|---|---|---|---|
| 2.00 | 0.170 | 0.160 | 0.140 | 0.144 | 0.147 | 0.140 | 0.151 | 0.138 |
| 4.00 | 0.199 | 0.252 | 0.296 | 0.403 | 0.447 | 0.342 | 0.261 | 0.241 |
| 6.00 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 8.00 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 12.00 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 14.10 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| TOTAL | 0.370 | 0.410 | 0.440 | 0.550 | 0.590 | 0.480 | 0.410 | 0.380 |

Joint Frequency Distribution of Wind Speed and Direction: Atmospheric Stability Class A
Extremely Unstable Conditions

| UMAX(M/S) | S | SSW | SW | WSW | W | WNW | NW | NNW | TOTAL |
|---|---|---|---|---|---|---|---|---|---|
| 2.00 | 0.131 | 0.135 | 0.158 | 0.202 | 0.202 | 0.220 | 0.147 | 0.158 | 2.542 |
| 4.00 | 0.335 | 0.337 | 0.433 | 0.660 | 0.729 | 0.392 | 0.252 | 0.227 | 5.806 |
| 6.00 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 8.00 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 12.00 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 14.10 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| TOTAL | 0.470 | 0.470 | 0.590 | 0.860 | 0.930 | 0.610 | 0.400 | 0.390 | 8.350 |

**Data Table A-3. Meteorological Data (2007-2011) (continued)** **2 of 7**

Direction is from which the wind blows

43824 WIND STATS H_AREA 60MIN 62M 07-11 STABILITY FROM SIGMA E

Joint Frequency Distribution of Wind Speed and Direction: Atmospheric Stability Class B
Moderately Unstable Conditions

| UMAX(M/S) | N | NNE | NE | ENE | E | ESE | SE | SSE |
|---|---|---|---|---|---|---|---|---|
| 2.00 | 0.025 | 0.034 | 0.041 | 0.025 | 0.046 | 0.037 | 0.032 | 0.032 |
| 4.00 | 0.151 | 0.163 | 0.282 | 0.488 | 0.424 | 0.316 | 0.218 | 0.105 |
| 6.00 | 0.011 | 0.011 | 0.062 | 0.080 | 0.066 | 0.046 | 0.011 | 0.002 |
| 8.00 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 12.00 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 14.10 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| TOTAL | 0.190 | 0.210 | 0.390 | 0.590 | 0.540 | 0.400 | 0.260 | 0.140 |

Joint Frequency Distribution of Wind Speed and Direction: Atmospheric Stability Class B
Moderately Unstable Conditions

| UMAX(M/S) | S | SSW | SW | WSW | W | WNW | NW | NNW | TOTAL |
|---|---|---|---|---|---|---|---|---|---|
| 2.00 | 0.005 | 0.028 | 0.034 | 0.046 | 0.032 | 0.062 | 0.037 | 0.032 | 0.548 |
| 4.00 | 0.197 | 0.261 | 0.376 | 0.695 | 0.582 | 0.397 | 0.135 | 0.138 | 4.928 |
| 6.00 | 0.030 | 0.037 | 0.053 | 0.105 | 0.133 | 0.064 | 0.028 | 0.009 | 0.750 |
| 8.00 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 12.00 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 14.10 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| TOTAL | 0.230 | 0.330 | 0.460 | 0.850 | 0.750 | 0.520 | 0.200 | 0.180 | 6.230 |

**Data Table A-3. Meteorological Data (2007-2011) (continued)** 

Direction is from which the wind blows

43824 WIND STATS H_AREA 60MIN 62M 07-11 STABILITY FROM SIGMA E

Joint Frequency Distribution of Wind Speed and Direction: Atmospheric Stability Class C
Slightly Unstable Conditions

| UMAX(M/S) | N | NNE | NE | ENE | E | ESE | SE | SSE |
|---|---|---|---|---|---|---|---|---|
| 2.00 | 0.064 | 0.064 | 0.108 | 0.087 | 0.089 | 0.064 | 0.055 | 0.048 |
| 4.00 | 0.202 | 0.323 | 0.722 | 0.745 | 0.566 | 0.406 | 0.300 | 0.179 |
| 6.00 | 0.138 | 0.229 | 0.791 | 0.697 | 0.369 | 0.183 | 0.172 | 0.117 |
| 8.00 | 0.048 | 0.057 | 0.117 | 0.073 | 0.011 | 0.005 | 0.018 | 0.048 |
| 12.00 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 14.10 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| TOTAL | 0.450 | 0.670 | 1.740 | 1.600 | 1.040 | 0.660 | 0.550 | 0.390 |

Joint Frequency Distribution of Wind Speed and Direction: Atmospheric Stability Class C
Slightly Unstable Conditions

| UMAX(M/S) | S | SSW | SW | WSW | W | WNW | NW | NNW | TOTAL |
|---|---|---|---|---|---|---|---|---|---|
| 2.00 | 0.062 | 0.034 | 0.060 | 0.096 | 0.078 | 0.062 | 0.062 | 0.055 | 1.089 |
| 4.00 | 0.403 | 0.463 | 0.575 | 0.882 | 0.555 | 0.509 | 0.238 | 0.181 | 7.250 |
| 6.00 | 0.328 | 0.436 | 0.623 | 1.029 | 0.933 | 0.752 | 0.266 | 0.110 | 7.172 |
| 8.00 | 0.050 | 0.057 | 0.115 | 0.206 | 0.277 | 0.238 | 0.048 | 0.014 | 1.384 |
| 12.00 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 14.10 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| TOTAL | 0.840 | 0.990 | 1.370 | 2.210 | 1.840 | 1.560 | 0.610 | 0.360 | 16.900 |

**Data Table A-3. Meteorological Data (2007-2011) (continued)** **4 of 7**

Direction is from which the wind blows

43824 WIND STATS H_AREA 60MIN 62M 07-11 STABILITY FROM SIGMA E

Joint Frequency Distribution of Wind Speed and Direction: Atmospheric Stability Class D
Neutral Conditions

| UMAX(M/S) | N | NNE | NE | ENE | E | ESE | SE | SSE |
|---|---|---|---|---|---|---|---|---|
| 2.00 | 0.108 | 0.142 | 0.215 | 0.204 | 0.121 | 0.119 | 0.131 | 0.131 |
| 4.00 | 0.431 | 0.731 | 1.563 | 1.295 | 0.995 | 0.798 | 0.653 | 0.665 |
| 6.00 | 0.367 | 0.591 | 1.057 | 0.614 | 0.532 | 0.419 | 0.656 | 1.364 |
| 8.00 | 0.101 | 0.115 | 0.048 | 0.028 | 0.018 | 0.025 | 0.025 | 0.215 |
| 12.00 | 0.018 | 0.016 | 0.000 | 0.002 | 0.000 | 0.000 | 0.005 | 0.023 |
| 14.10 | 0.000 | 0.000 | 0.000 | 0.000 | 0.002 | 0.000 | 0.000 | 0.000 |
| TOTAL | 1.020 | 1.600 | 2.880 | 2.140 | 1.670 | 1.360 | 1.470 | 2.400 |

Joint Frequency Distribution of Wind Speed and Direction: Atmospheric Stability Class D
Neutral Conditions

| UMAX(M/S) | S | SSW | SW | WSW | W | WNW | NW | NNW | TOTAL |
|---|---|---|---|---|---|---|---|---|---|
| 2.00 | 0.160 | 0.167 | 0.144 | 0.117 | 0.165 | 0.131 | 0.133 | 0.138 | 2.774 |
| 4.00 | 1.300 | 1.169 | 1.389 | 1.389 | 1.213 | 1.015 | 0.692 | 0.488 | 17.725 |
| 6.00 | 1.937 | 1.116 | 1.187 | 1.249 | 1.217 | 1.238 | 0.486 | 0.273 | 15.445 |
| 8.00 | 0.293 | 0.355 | 0.257 | 0.289 | 0.433 | 0.546 | 0.121 | 0.037 | 3.044 |
| 12.00 | 0.053 | 0.032 | 0.032 | 0.121 | 0.183 | 0.241 | 0.032 | 0.005 | 0.791 |
| 14.10 | 0.000 | 0.000 | 0.000 | 0.000 | 0.002 | 0.000 | 0.000 | 0.000 | 0.005 |
| TOTAL | 3.740 | 2.840 | 3.010 | 3.170 | 3.210 | 3.170 | 1.460 | 0.940 | 39.780 |

**Data Table A-3. Meteorological Data (2007-2011) (continued)** **5 of 7**

Direction is from which the wind blows

43824 WIND STATS H_AREA 60MIN 62M 07-11 STABILITY FROM SIGMA E

Joint Frequency Distribution of Wind Speed and Direction: Atmospheric Stability Class E
Slightly Stable Conditions

| UMAX(M/S) | N | NNE | NE | ENE | E | ESE | SE | SSE |
|---|---|---|---|---|---|---|---|---|
| 2.00 | 0.048 | 0.041 | 0.066 | 0.055 | 0.085 | 0.057 | 0.080 | 0.050 |
| 4.00 | 0.193 | 0.270 | 0.706 | 0.653 | 0.546 | 0.626 | 0.635 | 0.672 |
| 6.00 | 0.248 | 0.342 | 0.257 | 0.442 | 0.523 | 0.415 | 0.470 | 0.740 |
| 8.00 | 0.002 | 0.000 | 0.000 | 0.000 | 0.000 | 0.002 | 0.000 | 0.005 |
| 12.00 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 14.10 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| TOTAL | 0.490 | 0.650 | 1.030 | 1.150 | 1.150 | 1.100 | 1.190 | 1.470 |

Joint Frequency Distribution of Wind Speed and Direction: Atmospheric Stability Class E
Slightly Stable Conditions

| UMAX(M/S) | S | SSW | SW | WSW | W | WNW | NW | NNW | TOTAL |
|---|---|---|---|---|---|---|---|---|---|
| 2.00 | 0.066 | 0.055 | 0.057 | 0.073 | 0.062 | 0.066 | 0.053 | 0.048 | 0.965 |
| 4.00 | 0.795 | 0.853 | 0.678 | 0.587 | 0.630 | 0.486 | 0.403 | 0.332 | 9.065 |
| 6.00 | 1.277 | 0.983 | 0.972 | 0.814 | 0.628 | 0.436 | 0.215 | 0.083 | 8.843 |
| 8.00 | 0.011 | 0.011 | 0.007 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.039 |
| 12.00 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 14.10 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| TOTAL | 2.150 | 1.900 | 1.710 | 1.470 | 1.320 | 0.990 | 0.670 | 0.460 | 18.910 |

**Data Table A-3. Meteorological Data (2007-2011) (continued)** **6 of 7**

Direction is from which the wind blows

43824 WIND STATS H_AREA 60MIN 62M 07-11 STABILITY FROM SIGMA E

Joint Frequency Distribution of Wind Speed and Direction: Atmospheric Stability Class F
Moderately Stable Conditions

| UMAX(M/S) | N | NNE | NE | ENE | E | ESE | SE | SSE |
|---|---|---|---|---|---|---|---|---|
| 2.00 | 0.064 | 0.048 | 0.092 | 0.066 | 0.046 | 0.066 | 0.055 | 0.089 |
| 4.00 | 0.309 | 0.346 | 0.465 | 0.213 | 0.176 | 0.254 | 0.332 | 0.497 |
| 6.00 | 0.163 | 0.319 | 0.094 | 0.030 | 0.025 | 0.080 | 0.135 | 0.167 |
| 8.00 | 0.000 | 0.005 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 12.00 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 14.10 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| TOTAL | 0.540 | 0.720 | 0.650 | 0.310 | 0.250 | 0.400 | 0.520 | 0.750 |

Joint Frequency Distribution of Wind Speed and Direction: Atmospheric Stability Class F
Moderately Stable Conditions

| UMAX(M/S) | S | SSW | SW | WSW | W | WNW | NW | NNW | TOTAL |
|---|---|---|---|---|---|---|---|---|---|
| 2.00 | 0.105 | 0.103 | 0.092 | 0.069 | 0.071 | 0.083 | 0.069 | 0.092 | 1.210 |
| 4.00 | 0.536 | 0.607 | 0.474 | 0.433 | 0.328 | 0.303 | 0.339 | 0.328 | 5.944 |
| 6.00 | 0.309 | 0.438 | 0.232 | 0.257 | 0.140 | 0.138 | 0.066 | 0.083 | 2.675 |
| 8.00 | 0.000 | 0.002 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.007 |
| 12.00 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 14.10 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| TOTAL | 0.950 | 1.150 | 0.800 | 0.760 | 0.540 | 0.520 | 0.470 | 0.500 | 9.840 |

**Data Table A-3. Meteorological Data (2007-2011) (continued)** **7 of 7**

Direction is from which the wind blows

43824 WIND STATS H_AREA 60MIN 62M 07-11 STABILITY FROM SIGMA E

Joint Frequency Distribution of Wind Speed and Direction: Atmospheric Stability Class G
Extremely Stable Conditions

| UMAX(M/S) | N | NNE | NE | ENE | E | ESE | SE | SSE |
|---|---|---|---|---|---|---|---|---|
| 2.00 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 4.00 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 6.00 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 8.00 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 12.00 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 14.10 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| TOTAL | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |

Joint Frequency Distribution of Wind Speed and Direction: Atmospheric Stability Class G
Extremely Stable Conditions

| UMAX(M/S) | S | SSW | SW | WSW | W | WNW | NW | NNW | TOTAL |
|---|---|---|---|---|---|---|---|---|---|
| 2.00 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 4.00 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 6.00 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 8.00 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 12.00 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 14.10 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| TOTAL | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |

## Data Table A-4a. Population Distribution Around SRS Center of Site (2010 Census)

**Data Table A-4a, Population Distribution Around the SRS Center of Site (2010 Census)**

| Dir(Miles) | 5-10 | 10-20 | 20-30 | 30-40 | 40-50 | TOTAL |
|---|---|---|---|---|---|---|
| **N** | 29 | 9561 | 13784 | 4919 | 12842 | 41135 |
| **NNE** | 0 | 3572 | 2756 | 7035 | 32199 | 45562 |
| **NE** | 0 | 4791 | 2835 | 6128 | 18663 | 32417 |
| **ENE** | 16 | 1919 | 4524 | 5598 | 47214 | 59271 |
| **E** | 57 | 8029 | 7260 | 7301 | 4361 | 27008 |
| **ESE** | 26 | 2366 | 1371 | 1723 | 3048 | 8534 |
| **SE** | 10 | 536 | 6513 | 6300 | 9595 | 22954 |
| **SSE** | 5 | 122 | 242 | 431 | 5251 | 6051 |
| **S** | 0 | 306 | 1206 | 7932 | 3871 | 13315 |
| **SSW** | 0 | 1119 | 2149 | 5416 | 3472 | 12156 |
| **SW** | 4 | 1052 | 1634 | 1026 | 1871 | 5587 |
| **WSW** | 53 | 1310 | 10111 | 1226 | 5732 | 18432 |
| **W** | 1 | 3245 | 9710 | 4818 | 7206 | 24980 |
| **WNW** | 360 | 2598 | 115475 | 87020 | 17035 | 222488 |
| **NW** | 222 | 8478 | 93847 | 56513 | 3194 | 162254 |
| **NNW** | 449 | 28925 | 30971 | 10834 | 7737 | 78916 |
| **Total** | 1232 | 77929 | 304388 | 214220 | 183291 | 781060 |

**For a 50-mile (80-km) radius around SRS Center of Site**

## Data Table A-4b. Population Distribution Around SRS's H-Area (2010 Census)

**Data Table A-4b, Population Distribution Around SRS's H-Area (2010 Census)**

| Dir(Miles) | 5-10 | 10-20 | 20-30 | 30-40 | 40-50 | TOTAL |
|---|---|---|---|---|---|---|
| **N** | 339 | 12400 | 8770 | 6240 | 14500 | 42249 |
| **NNE** | 133 | 3560 | 3610 | 7090 | 42800 | 57193 |
| **NE** | 80 | 3200 | 3110 | 7070 | 24300 | 37760 |
| **ENE** | 25 | 3400 | 3700 | 6880 | 47500 | 61505 |
| **E** | 88 | 5000 | 7750 | 7860 | 4810 | 25508 |
| **ESE** | 10 | 5590 | 1870 | 1880 | 2930 | 12280 |
| **SE** | 0 | 620 | 5630 | 5950 | 10200 | 22400 |
| **SSE** | 0 | 147 | 275 | 451 | 5760 | 6633 |
| **S** | 0 | 368 | 840 | 7620 | 3970 | 12798 |
| **SSW** | 0 | 770 | 2320 | 5580 | 2980 | 11650 |
| **SW** | 19 | 1290 | 3450 | 838 | 1670 | 7267 |
| **WSW** | 6 | 1120 | 8800 | 1290 | 5930 | 17146 |
| **W** | 146 | 4130 | 21400 | 4640 | 9170 | 39486 |
| **WNW** | 1840 | 3350 | 151000 | 97300 | 14900 | 268390 |
| **NW** | 775 | 12100 | 68900 | 21900 | 1910 | 105585 |
| **NNW** | 2510 | 36400 | 20800 | 12800 | 3010 | 75520 |
| **Total** | 5971 | 93445 | 312225 | 195389 | 196340 | 803370 |

**For a 50-mile (80-km) radius around SRS's H-Area**

## Data Table A-5. Savannah River Mile 118.8 Flow Rates, 1954 – 2019

## Data Table A-5, Savannah River Mile 118.8 Flow Rates, 1954-2019

| Year | Mean Annual Flow (cfs) |
|---|---|
| 1954 | 7,382 |
| 1955 | 5,974 |
| 1956 | 6,309 |
| 1957 | 8,312 |
| 1958 | 11,038 |
| 1959 | 9,748 |
| 1960 | 13,112 |
| 1961 | 10,909 |
| 1962 | 10,580 |
| 1963 | 11,138 |
| 1964 | 20,497 |
| 1965 | 12,785 |
| 1966 | 11,175 |
| 1967 | 10,573 |
| 1968 | 9,624 |
| 1969 | 10,945 |
| 1970 | 7,169 |
| 1971 | 10,715 |
| 1972 | 11,275 |
| 1973 | 14,536 |
| 1974 | 11,138 |
| 1975 | 15,533 |
| 1976 | 14,008 |
| 1977 | 11,695 |
| 1978 | 10,547 |
| 1979 | 13,333 |
| 1980 | 13,282 |
| 1981 | 6,544 |
| 1982 | 7,169 |
| 1983 | 12,348 |
| 1984 | 12,759 |
| 1985 | 7,167 |
| 1986 | 6,175 |
| 1987 | 8,955 |
| 1988 | 5,364 |
| 1989 | 7,966 |
| 1990 | 11,858 |
| 1991 | 11,598 |
| 1992 | 11,697 |
| 1993 | 14,788 |
| 1994 | 12,271 |
| 1995 | 12,750 |
| 1996 | 11,467 |
| 1997 | 10,464 |
| 1998 | 16,239 |
| 1999 | 6,160 |
| 2000 | 5,550 |
| 2001 | 5,804 |
| 2002 | 5,386 |
| 2003 | 12,842 |
| 2004 | 8,778 |
| 2005 | 11,935 |
| 2006 | 6,818 |
| 2007 | 6,088 |
| 2008 | 4,833 |
| 2009 | 7,666 |
| 2010 | 9,893 |
| 2011 | 5,714 |
| 2012 | 4,570 |
| 2013 | 8,479 |
| 2014 | 9,440 |
| 2015 | 8,833 |
| 2016 | 10,150 |
| 2017 | 5,698 |
| 2018 | 9,787 |
| 2019 | 10,968 |
| **Mean =** | **9,944** |
| Harmonic Mean = | 8909 |
| Geometric Mean = | 9430 |
| 10 year mean | 8,353 |
| 15 year mean | 7,781 |

(USGS #02197500)
Near River Mile 118.8 (Hwy 301 Bridge)

USGS #021973269
RM 160 Near Wayneboro, GA

## Data Table A-6. Calculated Effective River Flow Rates

**Data Table A-6, Calculated Effective River Flow Rates**

**Savannah River Monthly Flow Rate**
**Based on USGS Daily Flow Rate**
**Average is Monthly Average**

| | Flow, cfs |
|---|---|
| Month | River Mile 118.8 (Hwy 301) |
| January | 27,200 |
| February | 16,137 |
| March | 19,526 |
| April | 15,307 |
| May | 9,897 |
| June | 6,340 |
| July | 6,365 |
| August | 6,978 |
| September | 5,129 |
| October | 5,030 |
| November | 5,258 |
| December | 8,566 |
| **Average** | **10,978** |

**Savannah River Annual Flow Rate**
**Annual Average Based on**
**USGS Daily Flow Rate**

| Year | River Mile 118.8 |
|---|---|
| | cfs |
| 2010 | 9,893 |
| 2011 | 5,714 |
| 2012 | 4,570 |
| 2013 | 8,479 |
| 2014 | 9,440 |
| 2015 | 8,833 |
| 2016 | 10,150 |
| 2017 | 5,698 |
| 2018 | 9,787 |
| **2019** | **10,968** |
| **10-y Average** | **8,353** |

**NOTE:**
**The annual measured river flow rate shown in the tables above is not used in the dose calculations unless the calculated "effective" river flow rate is higher.**

## River Flow Rate Adjustment Based on Tritium Measurements

Total Tritium Released to the Savannah River: **1,795** Curies

(For 2019, this release total is from the River Transport measurements, which were the highest)

(2019 Reported: 452.3 Ci from SRS, 39.5 Ci from the Barnwell Low-Level Disposal Facility, and 1,303.5 Ci from Plant Vogtle)

| **Location** | **Finished Water Meas. Conc. pCi/ml** | **Calculated Total Flow ml** | **Effective Flow Rate cfs** |
|---|---|---|---|
| River Mile 141.5 - calc [a,b] | 0.237 | 7.57E+15 | **8,481** |
| Beaufort-Jasper/Purrysburg - calc [a,b] | 0.229 | 7.84E+15 | **8,778** |
| Beaufort-Jasper/Chelsea - calc [a,b] | N/A | N/A | 8,778 |
| Savannah I&D - calc [a,b] | N/A | N/A | 8,778 |
| Estuary (1.1 x River Mile 118.8 Effective Flow Rate)[c] | | | 9,329 |

a) Total flow calculated on basis of releases of tritium and measured tritium concentrations in the river using the following equation: Total flow, ml=(Q,Ci)(1.0E+12 pCi/Ci)/(Conc,pCi/ml).

b) Effective Flow rate, in cfs, is calculated using the following equation:

Flow Rate, cfs = (Total Flow, ml/yr)/(8.93E+11 ml-sec/$ft^3$-yr)

c) Estuary effective flow rate is used for the collective dose calculation

## Data Table A-7. Radioactive Liquid Releases by Source (Curies)

### Data Table 6-7, Radioactive Liquid Releases by Site Stream - (Curies)

**(Used as the Source Term for the 2019 Liquid Pathway Dose Calculations)**

| Nuclide | Upper Three Runs (A,M,F,H) | Fourmile Branch (F,H,Tritium) | Steel Creek + Pen Branch (K,L) | Lower Three Runs (P,R) | Totals |
|---|---|---|---|---|---|
| H-3[a] | 8.11E+01 | 2.14E+02 | 1.29E+02 | 2.99E-01 | **4.52E+02** |
| C-14 | 3.43E-04 | 1.50E-02 | | | **1.53E-02** |
| Sr-90 | 1.51E-06 | 1.31E-02 | 0.00E+00 | | **1.31E-02** |
| Tc-99 | 0.00E+00 | 1.66E-02 | | | **1.66E-02** |
| I-129 | 0.00E+00 | 8.92E-03 | | | **8.92E-03** |
| Cs-137[b] | 1.17E-04 | 8.12E-03 | 0.00E+00 | 0.00E+00 | **2.10E-01** |
| Ra-226 | 1.82E-02 | 1.11E-03 | | | **1.93E-02** |
| U-234 | 3.62E-04 | 2.50E-07 | | | **3.62E-04** |
| U-235 | 2.07E-02 | 1.37E-03 | | | **2.20E-02** |
| U-238 | 0.00E+00 | 8.61E-05 | | | **8.61E-05** |
| Np-237 | 1.70E-05 | 1.04E-04 | | | **1.21E-04** |
| Pu-238 | 3.93E-06 | 5.45E-06 | | | **9.38E-06** |
| Pu-239 | 0.00E+00 | 1.16E-05 | | | **1.16E-05** |
| Am-241 | 0.00E+00 | 2.17E-06 | | | **2.17E-06** |
| Cm-244 | | 2.32E-03 | | | **2.32E-03** |
| Alpha[c] | 6.79E-04 | 3.72E-04 | 0.00E+00 | 3.86E-03 | **4.91E-03** |
| Beta-Gamma[d] | 1.97E-03 | 1.67E-03 | 2.06E-02 | 1.75E-02 | **4.18E-02** |

a) Depending which one is higher, the tritium release total includes direct + migration releases or tritium transport in streams totals.

The higher one is used in the dose calclulations for determining SRS-only impacts.

It does not include releases to the Savannah River from the Vogtle Electric Generating Plant or migration releases into

Lower Three Runs from the Barnwell Low-Level Radioactive Waste Disposal Facility.

b) Depending on which value is higher, the Cs-137 release is based on concentrations measured in Steel Creek (mouth) fish or on the actual measured effluent + migration release total from the site. Refer to data table 6-10 for more information.

c,d) For dose calculations, unspecified alpha and beta releases are assumed to be Pu-239 and Sr-90, respectively.

## Data Table A-8. Radioactive Liquid Releases, 2015 – 2019 (Curies)

**Data Table A-8, Radioactive Liquid Releases, 2015-2019 (curies)**

| Radionuclide | 2015 | 2016 | 2017 | 2018 | 2019 | 2018 to 2019 Percent Change |
|---|---|---|---|---|---|---|
| | | | | | | |
| H-3 | 7.86E+02 | 6.68E+02 | 4.94E+02 | 5.31E+02 | **4.24E+02** | -20% |
| C-14 | 5.33E-03 | 5.82E-04 | 1.09E-02 | 6.22E-04 | **1.53E-02** | 2369% |
| Sr-89,90 | 2.43E-02 | 1.95E-02 | 2.13E-02 | 3.18E-02 | **1.31E-02** | -59% |
| Tc-99 | 1.30E-02 | 1.88E-02 | 1.51E-02 | 2.84E-02 | **1.66E-02** | -41% |
| I-129 | 1.44E-02 | 1.82E-02 | 2.18E-02 | 1.66E-02 | **8.92E-03** | -46% |
| Cs-137 | 1.08E-02 | 1.78E-02 | 5.78E-03 | 8.06E-03 | **8.24E-03** | 2% |
| Ra-226 | | | 7.27E-04 | 1.03E-03 | **2.32E-03** | 125% |
| U-234 | 6.77E-02 | 3.30E-02 | 3.48E-02 | 2.95E-02 | **1.93E-02** | -35% |
| U-235 | 2.50E-03 | 1.04E-03 | 1.23E-03 | 5.74E-04 | **3.62E-04** | -37% |
| U-238 | 7.55E-02 | 3.68E-02 | 3.61E-02 | 3.22E-02 | **2.20E-02** | -32% |
| Np-237 | 3.21E-07 | 2.78E-06 | 5.57E-05 | 1.82E-06 | **8.61E-05** | 4629% |
| Pu-238 | 5.13E-04 | 2.60E-04 | 2.33E-04 | 5.35E-05 | **1.21E-04** | 127% |
| Pu-239 | 1.10E-04 | 1.37E-05 | 2.00E-05 | 5.45E-06 | **9.38E-06** | 72% |
| Am-241 | 1.79E-04 | 1.80E-03 | 5.62E-03 | 1.36E-04 | **1.16E-05** | -92% |
| Cm-244 | 1.21E-04 | 1.54E-04 | 1.49E-04 | 6.81E-05 | **2.17E-06** | -97% |
| Alpha | 8.60E-03 | 1.98E-02 | 2.45E-03 | 3.21E-03 | **4.91E-03** | 53% |
| Beta-Gamma | 9.53E-02 | 1.36E-01 | 5.50E-02 | 4.51E-02 | **4.18E-02** | -7% |

Measured liquid releases only, no tritium transport or cesium-137 adjustment from fish

## Data Table A-9. Radionuclide Concentrations at Downriver Drinking Water Plants Compared to EPA MCLs

## Data Table A-9, Radionuclide Concentrations at the Downriver Drinking Water Plants Compared to EPA MCLs

| | | 12-Month Average Concentrations | | | |
|---|---|---|---|---|---|
| Nuclide | EPA MCL (pCi/L) | Below SRS [a] (pCi/L) | Fraction of EPA MCL (unitless) | BJWSA Purrysburg [b] (pCi/L) | Fraction of EPA MCL (unitless) |
| H-3[c] | 2.00E+04 | 2.37E+02 | 1.18E-02 | 2.29E+02 | 1.14E-02 |
| C-14 | 2.00E+03 | 2.02E-03 | 1.01E-06 | 1.95E-03 | 9.75E-07 |
| Sr-90 | 8.00E+00 | 1.73E-03 | 2.16E-04 | 1.67E-03 | 2.09E-04 |
| Tc-99 | 9.00E+02 | 2.19E-03 | 2.43E-06 | 2.12E-03 | 2.35E-06 |
| I-129 | 1.00E+00 | 1.18E-03 | 1.18E-03 | 1.14E-03 | 1.14E-03 |
| Cs-137 | 2.00E+02 | 2.77E-02 | 1.39E-04 | 2.68E-02 | 1.34E-04 |
| Ra-226 | 5.00E+00 | 3.06E-04 | 6.12E-05 | 2.96E-04 | 5.91E-05 |
| U-234[d] | 1.03E+01 | 2.55E-03 | 2.47E-04 | 2.46E-03 | 2.39E-04 |
| U-235[d] | 4.67E-01 | 4.78E-05 | 1.02E-04 | 4.61E-05 | 9.89E-05 |
| U-238[d] | 1.00E+01 | 2.90E-03 | 2.90E-04 | 2.80E-03 | 2.80E-04 |
| Np-237 | 1.50E+01 | 1.14E-05 | 7.57E-07 | 1.10E-05 | 7.32E-07 |
| Pu-238 | 1.50E+01 | 1.60E-05 | 1.06E-06 | 1.54E-05 | 1.03E-06 |
| Pu-239 | 1.50E+01 | 1.24E-06 | 8.25E-08 | 1.20E-06 | 7.97E-08 |
| Am-241 | 1.50E+01 | 1.53E-06 | 1.02E-07 | 1.48E-06 | 9.86E-08 |
| Cm-244 | 1.50E+01 | 2.86E-07 | 1.91E-08 | 2.77E-07 | 1.84E-08 |
| Alpha | 1.50E+01 | 6.48E-04 | 4.32E-05 | 6.26E-04 | 4.17E-05 |
| Nonvolatile Beta | 8.00E+00 | 5.51E-03 | 6.89E-04 | 5.33E-03 | 6.66E-04 |
| **Sum of the Fractions =** | | | **1.48E-02** | | **1.43E-02** |

a. Near Savannah River Mile 141.5, below Steel Creek mouth

b. Beaufort-Jasper Water and Sewer Authority, finished drinking water at the Purrysburg Plant

c. The tritium concentrations and source term are based on actual measurements of the Savannah River water at the various locations
They include contributions from VEGP (1,303.5 Ci in 2019) and the Barnwell Low-Level Disposal Facility (39.5 Ci in 2019)
All other radionuclide concentrations are calculated based on the effective or measured river flow rate

d. MCLs for Uranium based on radioisotope specific activity X 30 µg/L X isotopic abundance

## Data Table A-9 – *Support*. 2019 Radioactive Liquid Release Source Term and 12-Month Average Downriver Radionuclide Concentrations Compared to the US EPA's Drinking Water Maximum Contaminant Levels (MCL)

**2019 Radioactive Liquid Release Source Term and 12-Month Average Downriver Radionuclide Concentrations Compared to the US EPA's Drinking Water Maximum Contaminant Levels (MCL)**

| | | 12-Month Average Concentration (pCi/L) | | | Output from LADTAP XL (uCi/mL) | |
|---|---|---|---|---|---|---|
| Nuclide | Curies Released | Below SRS [a] | at BJWSA Purrysburg [b] | EPA MCL [d] | Below SRS [a] | at BJWSA Purrysburg [b] |
| H-3[c] | 1.80E+03 | 2.37E+02 | 2.29E+02 | 2.00E+04 | 2.37E-07 | 2.29E-07 |
| C-14 | 1.53E-02 | 2.02E-03 | 1.95E-03 | 2.00E+03 | 2.02E-12 | 1.95E-12 |
| Sr-90 | 1.31E-02 | 1.73E-03 | 1.67E-03 | 8.00E+00 | 1.73E-12 | 1.67E-12 |
| Tc-99 | 1.66E-02 | 2.19E-03 | 2.12E-03 | 9.00E+02 | 2.19E-12 | 2.12E-12 |
| I-129 | 8.92E-03 | 1.18E-03 | 1.14E-03 | 1.00E+00 | 1.18E-12 | 1.14E-12 |
| Cs-137 | 2.10E-01 | 2.77E-02 | 2.68E-02 | 2.00E+02 | 2.77E-11 | 2.68E-11 |
| Ra-226 | 2.32E-03 | 3.06E-04 | 2.96E-04 | 5.00E+00 | 3.06E-13 | 2.96E-13 |
| U-234 | 1.93E-02 | 2.55E-03 | 2.46E-03 | 1.03E+01 | 2.55E-12 | 2.46E-12 |
| U-235 | 3.62E-04 | 4.78E-05 | 4.61E-05 | 4.67E-01 | 4.78E-14 | 4.61E-14 |
| U-238 | 2.20E-02 | 2.90E-03 | 2.80E-03 | 1.00E+01 | 2.90E-12 | 2.80E-12 |
| Np-237 | 8.61E-05 | 1.14E-05 | 1.10E-05 | 1.50E+01 | 1.14E-14 | 1.10E-14 |
| Pu-238 | 1.21E-04 | 1.60E-05 | 1.54E-05 | 1.50E+01 | 1.60E-14 | 1.54E-14 |
| Pu-239 | 9.38E-06 | 1.24E-06 | 1.20E-06 | 1.50E+01 | 1.24E-15 | 1.20E-15 |
| Am-241 | 1.16E-05 | 1.53E-06 | 1.48E-06 | 1.50E+01 | 1.53E-15 | 1.48E-15 |
| Cm-244 | 2.17E-06 | 2.86E-07 | 2.77E-07 | 1.50E+01 | 2.86E-16 | 2.77E-16 |
| Alpha | 4.91E-03 | 6.48E-04 | 6.26E-04 | 1.50E+01 | 6.48E-13 | 6.26E-13 |
| Beta | 4.18E-02 | 5.51E-03 | 5.33E-03 | 8.00E+00 | 5.51E-12 | 5.33E-12 |

a. Near Savannah River Mile 141.5, downriver of SRS.

b. Beaufort-Jasper Water and Sewer Authority, finished drinking water at the Purrysburg Plant

c. The tritium concentrations and source term are based on actual measurements of the Savannah River water at the various locations
They include contributions from VEGP (1,303.5 Ci in 2019) and the Barnwell Low-Level Disposal Facility (39.5 Ci in 2019)
All other radionuclide concentrations are calculated based on the effective or measured river flow rate

d. MCLs for Uranium based on radioisotope specific activity X 30 µg/L X isotopic abundance

**Data Table A-10. Adjustment of Cs-137 Release Based on Fish Concentrations**

**Data Table A-10, Adjustment of Cs-137 Release Based on Fish Concentrations**

| **Activity in Fish** | **Cs-137 Conc,pCi/g** |
|---|---|
| River Mile 141.5 wtd avg conc | 8.30E-02 |

| Cs-137 | Measured Ci Released | LADTAP BAF | RM 118.8 Flow, cfs | Calc Fish Conc,pCi/g | Meas Fish Conc,pCi/g | Ratio meas/calc |
|---|---|---|---|---|---|---|
| RM141.5-Max Ind | 8.24E-03 | 3000 | 8,481 | 3.26E-03 | 8.30E-02 | 25.45 |

Ratios (right column) are multipliers for measured releases in order for LADTAP to calculate the appropriate dose using the built in BAF factors. Calculated release values used in LADTAP calculations are shown below:

| Cs-137 | Multiplier (ratio) | Measured Ci Release | Calc Ci Release | |
|---|---|---|---|---|
| RM141.5-Max Ind | 25.45 | 8.24E-03 | 2.10E-01 | (see note below) |

| | | |
|---|---|---|
| Cs-137 direct+migration releases: | 8.24E-03 | Ci |
| 2019 total effective flow RM 141.5: | 7.57E+15 | ml |
| Calc Cs-137 conc = | 1.09E-06 | pCi/ml |

Ratios of Measured/Calculated Conc. of Cs-137 in fish

| Year | Ratio | Year | Ratio |
|---|---|---|---|
| 1985 | 5.2 | 2006 | 0.39 |
| 1986 | 8.4 | 2007 | 0.6 |
| 1987 | 3.0 | 2008 | 0.56 |
| 1988 | 1.4 | 2009 | 0.45 |
| 1989 | 1.2 | 2010 | 1.3 |
| 1990 | 6.8 | 2011 | 0.34 |
| 1991 | 25.3 | 2012 | 0.5 |
| 1992 | 1.2 | 2013 | 2.36 |
| 1993 | 1.1 | 2014 | 0.77 |
| 1994 | 1.4 | 2015 | 4.33 |
| 1995 | 3.1 | 2016 | 2.69 |
| 1996 | 1.3 | 2017 | 24.9 |
| 1997 | 2.6 | 2018 | 13.26 |
| 1998 | 1.2 | 2019 | 25.45 |
| 1999 | 2.3 | | |
| 2000 | 1.1 | | |
| 2001 | 0.8 | | |
| 2002 | 2.1 | | |
| 2003 | 0.54 | | |
| 2004 | 0.27 | | |
| 2005 | 0.42 | | |

NOTE: FOR 2019, THE CALCULATED CS-137 EFFLUENT RELEASE VALUE OF 0.210 CURIE WAS USED IN THE DOSE CALCULATIONS INSTEAD OF THE MEASURED EFFLUENT RELEASE VALUE OF 0.00824 CURIE.

**Data Table A-10 – *Support*. Adjustment of Cs-137 Liquid Releases Based on Fish Concentrations**

**Adjustment of Cs-137 Liquid Release Based on Fish Concentrations**

Cesium-137 Measured Mean Concentrations in Steel Creek Fish

| Location | Species | Number of Composites | Cs-137, pCi/g Average | # comp X avg. conc. pCi/g |
|---|---|---|---|---|
| Near River Mile 141.5 | bass | 3 | 8.59E-02 | 2.58E-01 |
| | catfish | 3 | 9.98E-02 | 2.99E-01 |
| | panfish | 3 | 6.34E-02 | 1.90E-01 |
| | Total Composites | 9 | Sum = | 7.47E-01 |
| | | | Overall weighted average-----> | 8.30E-02 |

## Data Table A-11. Representative Person Dose – All Liquid Pathways Including Irrigation

**Data Table A-11, Representative Person Dose - All Liquid Pathways Including Irrigation**

**By Pathway**

| Pathway | Representative Person Dose, mrem [a] | Percent of Total Dose |
|---|---|---|
| Vegetable | 3.9E-02 | 25.0% |
| Milk | 6.8E-03 | 4.3% |
| Meat | 3.7E-03 | 2.4% |
| Fish Consumption | 9.9E-02 | 63.0% |
| Water Consumption | 7.9E-03 | 5.0% |
| Shoreline | 5.8E-04 | 0.4% |
| Swimming and Boating | 3.0E-06 | 0.0% |
| **Total** | **1.6E-01** | |

**By Radionuclide**

| Radionuclide | Representative Person Dose, mrem [a] | Percent of Total Dose |
|---|---|---|
| H-3 (oxide) | 6.9E-03 | 4.4% |
| C-14 | 1.7E-04 | 0.1% |
| Sr-90 | 2.6E-03 | 1.7% |
| Tc-99 | 1.7E-02 | 10.7% |
| I-129 | 4.2E-03 | 2.7% |
| Cs-137 | 1.1E-01 | 68.2% |
| Ra-226 | 2.6E-03 | 1.6% |
| U-234 | 2.6E-03 | 1.6% |
| U-235 | 4.6E-05 | 0.0% |
| U-238 | 2.7E-03 | 1.7% |
| Np-237 | 2.3E-05 | 0.0% |
| Pu-238 | 6.3E-05 | 0.0% |
| Pu-239 | 5.4E-06 | 0.0% |
| Am-241 | 1.2E-05 | 0.0% |
| Cm-244 | 6.5E-07 | 0.0% |
| Alpha | 2.8E-03 | 1.8% |
| Nonvolatile Beta | 8.4E-03 | 5.3% |
| **Total** | **1.6E-01** | |

a) Committed effective dose

## Data Table A-11 – *Support*. Representative Person Dose – All Liquid Pathways

**Representative Person Dose - Liquid Pathways Except Irrigation**

**Irrigation Pathway Doses from IRRIDOSE**

**By Pathway**

| | LADTAPXL | IRRIDOSE (Irrigation Pathway) | |
|---|---|---|---|
| **Pathway** | **Representative Person Dose, mrem [(a)]** | **Food Type** | **Representative Person, mrem** |
| Fish Consumption | 9.9E-02 | Vegetable | 3.9E-02 |
| Water Consumption | 7.9E-03 | Milk | 6.8E-03 |
| Shoreline | 5.8E-04 | Meat | 3.7E-03 |
| Swimming and Boating | 3.0E-06 | | |
| **Total** | **1.1E-01** | **Total** | **5.0E-02** |

**By Radionuclide**

| | LADTAPXL | IRRIDOSE (Irrigation Pathway) | |
|---|---|---|---|
| **Radionuclide** | **Representative Person Dose, mrem [(a)]** | **Radionuclide** | **Representative Person Dose, mrem** |
| H-3 (oxide) | 3.8E-03 | H-3 (oxide) | 3.1E-03 |
| C-14 | 4.2E-06 | C-14 | 1.7E-04 |
| Sr-90 | 2.1E-04 | Sr-90 | 2.4E-03 |
| Tc-99 | 9.7E-06 | Tc-99 | 1.7E-02 |
| I-129 | 8.0E-04 | I-129 | 3.4E-03 |
| Cs-137 | 1.0E-01 | Cs-137 | 7.9E-03 |
| Ra-226 | 4.6E-04 | Ra-226 | 2.1E-03 |
| U-234 | 4.5E-04 | U-234 | 2.1E-03 |
| U-235 | 8.4E-06 | U-235 | 3.8E-05 |
| U-238 | 5.0E-04 | U-238 | 2.2E-03 |
| Np-237 | 7.0E-06 | Np-237 | 1.6E-05 |
| Pu-238 | 2.4E-05 | Pu-238 | 4.0E-05 |
| Pu-239 | 2.0E-06 | Pu-239 | 3.4E-06 |
| Am-241 | 8.8E-06 | Am-241 | 3.5E-06 |
| Cm-244 | 2.4E-07 | Cm-244 | 4.1E-07 |
| Alpha | 1.0E-03 | Alpha | 1.8E-03 |
| Nonvolatile Beta | 6.8E-04 | Nonvolatile Beta | 7.8E-03 |
| **Total** | **1.1E-01** | **Total** | **5.0E-02** |

a) Committed effective dose

## Data Table A-12. Comparisons of 2015 – 2019 Offsite Doses

### Data Table A-12, Comparison of 2015-2019 Offsite Doses

| | 2015 | 2016 | 2017 | 2018 | 2019 | 2019 vs 2018 % |
|---|---|---|---|---|---|---|
| **Atmospheric Releases** | | | | | | |
| Representative Person, mrem [a] | | | | | | |
| All Pathways | 3.2E-02 | 3.8E-02 | 2.7E-02 | 8.2E-02 | 1.8E-02 | **-78.0%** |
| Population, person-rem | | | | | | |
| 50-mile (80-km) Population | 1.1E+00 | 1.4E+00 | 9.7E-01 | 2.6E+00 | 7.0E-01 | **-72.9%** |
| **Liquid Releases** | | | | | | |
| Representative Person, mrem [a] | | | | | | |
| All Pathways Except Irrigation | 5.3E-02 | 5.3E-02 | 1.3E-01 | 9.2E-02 | 1.1E-01 | **17.1%** |
| Irrigation Pathway | 9.3E-02 | 1.0E-01 | 8.9E-02 | 9.9E-02 | 5.0E-02 | **-49.5%** |
| | 1.5E-01 | 1.5E-01 | 2.2E-01 | 1.9E-01 | 1.6E-01 | **-17.4%** |
| Population, person-rem | | | | | | |
| Down River Population | 1.3E+00 | 1.1E+00 | 1.4E+00 | 1.1E+00 | 9.5E-01 | **-13.7%** |
| Irrigation Pathway at RM 141.5 | 1.3E+00 | 2.4E+00 | 2.0E+00 | 2.3E+00 | 1.1E+00 | **-50.6%** |
| | 2.6E+00 | 3.5E+00 | 3.4E+00 | 3.4E+00 | 2.1E+00 | **-38.7%** |
| **Total Representative Person** (Air + Liquid + Irrigation) (mrem) | **0.18** | **0.19** | **0.25** | **0.27** | **0.18** | **-35.6%** |
| **Total Population** (Air + Liquid + Irrigation) (person-rem) | **3.7** | **4.9** | **4.4** | **6.0** | **2.8** | **-53.4%** |

a. In 2012, SRS changed from the MEI to the Representative Person concept for dose compliance.

## Data Table A-13. Representative Person Drink Water Dose

**Data Table A-13, Representative Person Drinking Water Dose**

| Radionuclide | Representative Person Dose, mrem [a] | Percent of Total Dose | Representative Person Dose, mrem [b] | Percent of Total Dose |
|---|---|---|---|---|
| H-3 (oxide) | 1.4E-02 | 78% | 3.6E-03 | 47% |
| C-14 | 3.7E-06 | 0% | 3.7E-06 | 0% |
| Sr-90 | 1.8E-04 | 1% | 1.8E-04 | 2% |
| Tc-99 | 5.6E-06 | 0% | 5.6E-06 | 0% |
| I-129 | 4.1E-04 | 2% | 4.1E-04 | 5% |
| Cs-137 | 1.1E-03 | 6% | 1.1E-03 | 14% |
| Ra-226 | 4.0E-04 | 2% | 4.0E-04 | 5% |
| U-234 | 4.2E-04 | 2% | 4.2E-04 | 6% |
| U-235 | 7.5E-06 | 0% | 7.5E-06 | 0% |
| U-238 | 4.3E-04 | 2% | 4.3E-04 | 6% |
| Np-237 | 4.1E-06 | 0% | 4.1E-06 | 0% |
| Pu-238 | 1.2E-05 | 0% | 1.2E-05 | 0% |
| Pu-239 | 1.0E-06 | 0% | 1.0E-06 | 0% |
| Am-241 | 1.0E-06 | 0% | 1.0E-06 | 0% |
| Cm-244 | 1.2E-07 | 0% | 1.2E-07 | 0% |
| Alpha | 5.3E-04 | 3% | 5.3E-04 | 7% |
| Nonvolatile Beta | 5.7E-04 | 3% | 5.7E-04 | 7% |
| **Total** | **1.8E-02** | | **7.6E-03** | |

a) Based on Tritium Measurements from the BJSWA Purrysburg Treatment Plant. This includes Plant Vogtle and BLLWF releases

b) Based on SRS-Only releases of tritium

## Data Table A-14. Collective Drinking Water Doses (person-rem) from SRS Only

**Data Table A-14, Collective Drinking Water Doses (person-rem) from SRS Only**

**For the Beaufort Jasper Water and Sewer Authority Chelsea and Purrysburg Water Treatment Plants and the Savannah Industrial and Domestic Water Treatment Plant**

| Radionuclide | BJWSA Chelsea[a] | BJWSA Purrysburg[b] | Savannah I&D[c] |
|---|---|---|---|
| **Total** | **2.9E-01** | **2.2E-01** | **1.0E-01** |

a) 100,622 people served (4/27/20 email from Tricia Kilgore to Tim Jannik)

b) 76,538 people served (4/27/20 email from Tricia Kilgore to Tim Jannik)

c) 35,000 people served (4/3/17 email from Tony Tucker to Tim Jannik)

## Data Table A-15. Collective Dose – All Liquid Pathways Including Irrigation

**Data Table A-15, Collective Dose - All Liquid Pathways Including Irrigation**

**By Pathway**

| Pathway | Collective Dose (person-rem)[a] | Percent of Total Dose |
|---|---|---|
| Sport fish | 3.4E-02 | 2% |
| Commercial fish | 2.4E-01 | 11% |
| Saltwater invertebrates | 5.1E-02 | 2% |
| Shoreline Exposure | 2.4E-02 | 1% |
| Swimming | 5.4E-05 | 0% |
| Boating | 3.1E-05 | 0% |
| Beaufort-Jasper (Chelsea) | 2.9E-01 | 14% |
| Beaufort-Jasper (Purrysburg) | 2.2E-01 | 10% |
| Savannah I&D | 1.0E-01 | 5% |
| Vegetable consumption | 1.1E+00 | 53% |
| Milk consumption | 3.6E-02 | 2% |
| Meat consumption | 1.9E-03 | 0% |
| **Total** | **2.1E+00** | |

**By Radionuclide**

| Radionuclide | Collective Dose (person-rem)[a] | Percent of Total Dose |
|---|---|---|
| H-3 | 3.3E-01 | 16% |
| C-14 | 1.4E-02 | 1% |
| Sr-90 | 7.7E-02 | 4% |
| Tc-99 | 4.2E-01 | 20% |
| I-129 | 1.0E-01 | 5% |
| Cs-137 | 5.0E-01 | 24% |
| Ra-226 | 9.4E-02 | 4% |
| U-234 | 8.7E-02 | 4% |
| U-235 | 1.6E-03 | 0% |
| U-238 | 9.1E-02 | 4% |
| Np-237 | 7.8E-04 | 0% |
| Pu-238 | 2.6E-03 | 0% |
| Pu-239 | 2.2E-04 | 0% |
| Am-241 | 2.6E-04 | 0% |
| Cm-244 | 3.0E-05 | 0% |
| Alpha | 1.2E-01 | 6% |
| Nonvolatile Beta | 2.5E-01 | 12% |
| **Total** | **2.1E+00** | |

a) Committed effective dose

## Data Table A-15 – *Support.* Collective Dose – All Liquid Pathways

**Irrigation Pathway Doses from Irridose output**

| Radionuclide | Population (person-rem) |
|---|---|
| H-3 (oxide) | 4.8E-02 |
| C-14 | 2.7E-03 |
| Sr-90 | 6.3E-02 |
| Tc-99 | 4.2E-01 |
| I-129 | 6.5E-02 |
| Cs-137 | 1.2E-01 |
| Ra-226 | 5.6E-02 |
| U-234 | 5.2E-02 |
| U-235 | 9.3E-04 |
| U-238 | 5.4E-02 |
| Np-237 | 4.4E-04 |
| Pu-238 | 1.1E-03 |
| Pu-239 | 9.4E-05 |
| Am-241 | 9.6E-05 |
| Cm-244 | 1.1E-05 |
| Alpha | 4.9E-02 |
| Nonvolatile Beta | 2.0E-01 |
| **Total** | **1.1E+00** |

**Other Liquid Pathway Doses from Ladtap output**

| Radionuclide | Collective Dose (person-rem)[(a)] |
|---|---|
| H-3 | 2.9E-01 |
| C-14 | 1.1E-02 |
| Sr-90 | 1.5E-02 |
| Tc-99 | 4.8E-04 |
| I-129 | 3.6E-02 |
| Cs-137 | 3.8E-01 |
| Ra-226 | 3.8E-02 |
| U-234 | 3.4E-02 |
| U-235 | 6.3E-04 |
| U-238 | 3.7E-02 |
| Np-237 | 3.4E-04 |
| Pu-238 | 1.5E-03 |
| Pu-239 | 1.3E-04 |
| Am-241 | 1.6E-04 |
| Cm-244 | 1.9E-05 |
| Alpha | 6.8E-02 |
| Nonvolatile Beta | 4.7E-02 |
| **Total** | **9.5E-01** |

## Data Table A-16. 2019 Radioactive Atmospheric Releases by Source (Curies)

**Data Table A-16, Radioactive Atmospheric Releases by Source (Curies)[a]** **2 Pages**

| Radionuclide | Half-Life[b] | | Calculated[c] | Reactors | Separations[d] | SRNL | Total |
|---|---|---|---|---|---|---|---|
| **Gases and Vapors** | | | | | | | |
| H-3 (oxide) | 12.3 | y | 2.46E+02 | 9.85E+02 | 6.71E+03 | | **7.94E+03** |
| H-3 (elemental) | 12.3 | y | | | 1.31E+03 | | **1.31E+03** |
| H-3 Total | 12.3 | y | 2.46E+02 | 9.85E+02 | 8.02E+03 | | **9.25E+03** |
| C-14 | 5700 | y | 9.48E-08 | | 5.00E-02 | | **5.00E-02** |
| Hg-203 | 46.6 | d | 6.51E-10 | | | | **6.51E-10** |
| Kr-85 | 10.8 | y | | | 1.07E+04 | | **1.07E+04** |
| I-129 | 1.57E+07 | y | 4.31E-05 | | 9.95E-03 | 8.67E-07 | **9.99E-03** |
| I-131 | 8.02 | d | 7.01E-10 | | | | **7.01E-10** |
| **Particles** | | | | | | | |
| Ag-110m | 250 | d | 1.48E-11 | | | | **1.48E-11** |
| Am-241 | 432 | y | 1.13E-05 | 0.00E+00 | 6.07E-06 | | **1.73E-05** |
| Am-243 | 7370 | y | 3.97E-09 | | | | **3.97E-09** |
| Ba-133 | 10.5 | y | 7.74E-07 | | | | **7.74E-07** |
| Cd-109 | 461 | d | 1.68E-08 | | | | **1.68E-08** |
| Ce-139 | 138 | d | 6.71E-10 | | | | **6.71E-10** |
| Ce-141 | 32.5 | d | 4.94E-11 | | | | **4.94E-11** |
| Ce-144 | 285 | d | 2.00E-08 | | | | **2.00E-08** |
| Cf-249 | 351 | y | 7.89E-12 | | | | **7.89E-12** |
| Cf-251 | 900 | y | 1.78E-11 | | | | **1.78E-11** |
| Cm-243 | 29.1 | y | 2.90E-09 | | | | **2.90E-09** |
| Cm-244 | 18.1 | y | 2.75E-07 | 0.00E+00 | 2.39E-08 | | **2.99E-07** |
| Co-57 | 272 | d | 6.41E-10 | | | | **6.41E-10** |
| Co-58 | 70.9 | d | | | 1.04E-06 | | **1.04E-06** |
| Co-60 | 5.27 | y | 6.30E-07 | 0.00E+00 | 0.00E+00 | 0.00E+00 | **6.30E-07** |
| Cs-134 | 2.06 | y | 4.32E-07 | | | | **4.32E-07** |
| Cs-137 | 30.2 | y | 3.84E-03 | 0.00E+00 | 3.42E-05 | 0.00E+00 | **3.88E-03** |
| Eu-152 | 13.5 | y | 1.90E-09 | | | | **1.90E-09** |
| Eu-154 | 8.59 | y | 3.56E-07 | | | | **3.56E-07** |
| Eu-155 | 4.76 | y | 1.18E-07 | | | | **1.18E-07** |
| F-18 | 110 | m | 4.00E-02 | | | | **4.00E-02** |
| Fe-55 | 2.74 | y | 8.04E-09 | | | | **8.04E-09** |
| Mn-54 | 312 | d | 6.01E-10 | | | | **6.01E-10** |
| Nb-94 | 2.03E+04 | y | 2.42E-07 | | | | **2.42E-07** |
| Nb-95 | 35.0 | d | 3.63E-07 | | | | **3.63E-07** |
| Ni-59 | 1.01E+05 | y | 5.76E-11 | | | | **5.76E-11** |
| Ni-63 | 100 | y | 7.41E-09 | | | | **7.41E-09** |
| Np-237 | 2.14E+06 | y | 1.55E-06 | 0.00E+00 | 6.80E-08 | | **1.61E-06** |
| Pa-233 | 27.0 | d | 1.42E-06 | | | | **1.42E-06** |
| Pb-212 | 10.6 | h | 8.43E-07 | | | | **8.43E-07** |
| Pm-147 | 2.62 | y | 2.89E-06 | | | | **2.89E-06** |
| Pm-148m | 41.3 | d | 1.90E-12 | | | | **1.90E-12** |
| Pr-144 | 17.3 | m | 2.00E-08 | | | | **2.00E-08** |
| Pu-236 | 2.86 | y | 5.52E-10 | | | | **5.52E-10** |
| Pu-238 | 87.7 | y | 3.13E-05 | 4.42E-10 | 4.39E-06 | | **3.57E-05** |
| Pu-239 | 2.41E+04 | y | 6.84E-05 | 0.00E+00 | 7.01E-05 | | **1.38E-04** |
| Pu-240 | 6560 | y | 7.68E-06 | | | | **7.68E-06** |
| Pu-241 | 14.4 | y | 2.07E-04 | | | | **2.07E-04** |
| Pu-242 | 3.75E+05 | y | 3.28E-06 | | | | **3.28E-06** |
| Ra-226 | 1600 | y | 5.97E-07 | | | | **5.97E-07** |

**Data Table A-16, Radioactive Atmospheric Releases by Source (Curies)[a]** **2 Pages**

| Radionuclide | Half-Life[b] | | Calculated[c] | Reactors | Separations[d] | SRNL | Total |
|---|---|---|---|---|---|---|---|
| Ra-228 | 5.75 | y | 5.93E-07 | | | | **5.93E-07** |
| Rh-106(e) | 29.8 | s | 3.05E-06 | | | | **3.05E-06** |
| Ru-103 | 39.3 | d | 5.11E-10 | | | | **5.11E-10** |
| Ru-106 | 374 | d | 3.05E-06 | | | | **3.05E-06** |
| Sb-125 | 2.76 | y | 1.18E-06 | | | | **1.18E-06** |
| Sb-126(e) | 12.4 | d | 1.70E-07 | | | | **1.70E-07** |
| Se-79 | 2.95E+05 | y | 4.90E-09 | | | | **4.90E-09** |
| Sm-151 | 90 | y | 2.89E-06 | | | | **2.89E-06** |
| Sn-113 | 115 | d | 8.31E-10 | | | | **8.31E-10** |
| Sn-123 | 129 | d | 6.66E-12 | | | | **6.66E-12** |
| Sn-126 | 2.30E+05 | y | 1.70E-07 | | | | **1.70E-07** |
| Sr-85 | 64.8 | d | 7.61E-10 | | | | **7.61E-10** |
| Sr-89 | 50.5 | d | 5.99E-10 | | | | **5.99E-10** |
| Sr-90 | 28.8 | y | 3.32E-03 | 0.00E+00 | 3.21E-05 | | **3.35E-03** |
| Tc-99 | 2.11E+05 | y | 5.08E-05 | | | | **5.08E-05** |
| Te-127 | 9.35 | h | 1.04E-11 | | | | **1.04E-11** |
| Te-129 | 69.6 | m | 1.05E-12 | | | | **1.05E-12** |
| Th-228 | 1.91 | y | 1.34E-08 | 2.69E-09 | | | **1.61E-08** |
| Th-229 | 7340 | y | 1.34E-09 | | | | **1.34E-09** |
| Th-230 | 7.54E+04 | y | 9.73E-11 | 6.51E-09 | | | **6.61E-09** |
| Th-231 | 25.5 | h | 2.12E-04 | | | | **2.12E-04** |
| Th-232 | 1.41E+10 | y | 9.86E-12 | 3.13E-09 | | | **3.14E-09** |
| Tl-208 | 3.05 | m | 1.41E-06 | | | | **1.41E-06** |
| U-232 | 68.9 | y | 5.50E-09 | | | | **5.50E-09** |
| U-233 | 1.59E+05 | y | 3.42E-09 | | | | **3.42E-09** |
| U-234 | 2.46E+05 | y | 4.12E-07 | 2.92E-09 | 2.68E-05 | | **2.72E-05** |
| U-235 | 7.04E+08 | y | 1.25E-08 | 0.00E+00 | 1.36E-06 | | **1.37E-06** |
| U-236 | 2.34E+07 | y | 3.01E-08 | | | | **3.01E-08** |
| U-238 | 4.47E+09 | y | 2.72E-07 | 2.84E-09 | 3.52E-05 | | **3.55E-05** |
| Y-88 | 107 | d | 5.81E-10 | | | | **5.81E-10** |
| Y-90(e) | 64.1 | h | 3.32E-03 | 0.00E+00 | 3.21E-05 | | **3.35E-03** |
| Y-91 | 58.5 | d | 2.14E-09 | | | | **2.14E-09** |
| Zn-65 | 244 | d | 5.82E-10 | | | | **5.82E-10** |
| Zr-95 | 64.0 | d | 1.22E-07 | | | | **1.22E-07** |
| Unidentified alpha | N/A | | 4.14E-05 | 1.58E-07 | 3.88E-07 | 0.00E+00 | **4.19E-05** |
| Unidentified beta | N/A | | 1.03E-03 | 5.59E-05 | 9.92E-05 | 1.24E-06 | **1.19E-03** |
| **TOTAL** | N/A | | 2.46E+02 | 9.85E+02 | 1.87E+04 | 2.11E-06 | **2.00E+04** |

a. One curie equals 3.7E+10 Becquerels
b. ICRP 107, *Nuclear Decay Data for Dosimetric Calculations (2008)*

c. Estimated releases from unmonitored sources. Beginning in 2016, individual isotope annual releases below 1E-12 Ci (1 pCi) are no longer reported in this table and, therefore, not used in the dose calculations.
d. Includes separations, waste management, and tritium facilities
e. Daughter products (Sb-126, Rh-106 & Y-90) in secular equilibrium with source terms (Sn-126, Ru-106 & Sr-90, respectively). In MAXDOSE/POPDOSE, they are included in the source term and their ingrowth is included in their parents' source term.

## Data Table A-17. 2015 - 2019 Atmospheric Releases (Curies)

**Data Table A-17, 2015-2019 Atmospheric Releases (Curies)** **2 Pages**

| Radionuclide | 2015 | 2016[a] | 2017 | 2018 | 2019 | 2018-2019 %Change |
|---|---|---|---|---|---|---|
| **Gases and Vapors** | | | | | | |
| H-3 (oxide) | 1.66E+04 | 1.99E+04 | 1.38E+04 | 3.78E+04 | 7.94E+03 | -79% |
| H-3 (elemental) | 2.47E+03 | 1.88E+03 | 1.38E+03 | 1.49E+03 | 1.31E+03 | -12% |
| H-3 Total | 1.91E+04 | 2.17E+04 | 1.52E+04 | 3.93E+04 | 9.25E+03 | -76% |
| C-14 | 1.37E-02 | 1.64E-02 | 3.00E-02 | 5.00E-02 | 5.00E-02 | 0% |
| Hg-203 | | 5.22E-10 | 5.07E-10 | 5.48E-10 | 6.51E-10 | 19% |
| Kr-85 | 2.78E+03 | 3.96E+03 | 5.45E+03 | 1.03E+04 | 1.07E+04 | 3% |
| I-129 | 1.93E-03 | 2.09E-03 | 3.06E-03 | 3.76E-03 | 9.99E-03 | 166% |
| I-131 | | 6.75E-10 | 5.64E-10 | 1.13E-09 | 7.01E-10 | -38% |
| **Particles** | | | | | | |
| Ag-110m | 1.48E-11 | 1.48E-11 | 1.48E-11 | 1.48E-11 | 1.48E-11 | 0% |
| Am-241 | 1.33E-05 | 3.73E-05 | 3.28E-05 | 2.00E-05 | 1.73E-05 | -13% |
| Am-243 | 5.26E-09 | 4.50E-09 | 3.76E-09 | 4.11E-09 | 3.97E-09 | -3% |
| Ba-133 | | 7.01E-10 | 1.40E-06 | 8.03E-07 | 7.74E-07 | -4% |
| Cd-109 | | 1.34E-08 | 1.20E-08 | 1.18E-08 | 1.68E-08 | 42% |
| Ce-139 | | 5.20E-10 | 5.15E-10 | 5.20E-10 | 6.71E-10 | 29% |
| Ce-141 | 4.94E-11 | 4.94E-11 | 4.94E-11 | 4.94E-11 | 4.94E-11 | 0% |
| Ce-144 | 2.00E-08 | 2.00E-08 | 2.00E-08 | 2.00E-08 | 2.00E-08 | 0% |
| Cf-249 | | | | | 7.89E-12 | |
| Cf-251 | | | | | 1.78E-11 | |
| Cm-242 | 1.89E-16 | | | | | |
| Cm-243 | | | 1.56E-09 | 2.77E-09 | 2.90E-09 | 5% |
| Cm-244 | 2.97E-07 | 1.14E-06 | 6.02E-07 | 4.38E-07 | 2.99E-07 | -32% |
| Co-57 | | 4.96E-10 | 4.81E-10 | 4.76E-10 | 6.41E-10 | 35% |
| Co-58 | | | | | 1.04E-06 | |
| Co-60 | 4.37E-07 | 4.96E-07 | 5.37E-07 | 8.71E-07 | 6.30E-07 | -28% |
| Cs-134 | 4.31E-07 | 4.31E-07 | 4.31E-07 | 4.31E-07 | 4.32E-07 | 0% |
| Cs-137 | 1.18E-03 | 9.05E-03 | 1.13E-03 | 1.31E-02 | 3.88E-03 | -70% |
| Eu-152 | 5.01E-08 | 1.47E-09 | 1.43E-09 | 1.39E-09 | 1.90E-09 | 37% |
| Eu-154 | 3.55E-07 | 3.56E-07 | 3.56E-07 | 3.56E-07 | 3.56E-07 | 0% |
| Eu-155 | 1.18E-07 | 1.18E-07 | 1.18E-07 | 1.18E-07 | 1.18E-07 | 0% |
| F-18 | 4.00E-02 | 4.00E-02 | 4.00E-02 | 2.00E-02 | 4.00E-02 | 100% |
| Fe-55 | | 1.17E-08 | 6.54E-09 | 5.69E-09 | 8.04E-09 | 41% |
| Mn-54 | | 3.78E-10 | 4.82E-10 | 4.46E-10 | 6.01E-10 | 35% |
| Nb-94 | 2.42E-07 | 2.42E-07 | 2.42E-07 | 2.42E-07 | 2.42E-07 | 0% |
| Nb-95 | 3.63E-07 | 3.63E-07 | 3.63E-07 | 3.63E-07 | 3.63E-07 | 0% |
| Ni-59 | 5.76E-11 | 5.76E-11 | 5.76E-11 | 5.76E-11 | 5.76E-11 | 0% |
| Ni-63 | 5.62E-09 | 5.46E-09 | 4.73E-09 | 5.05E-09 | 7.41E-09 | 47% |
| Np-237 | 1.61E-06 | 1.71E-06 | 2.11E-06 | 1.72E-06 | 1.61E-06 | -6% |
| Pa-233 | 1.42E-06 | 1.42E-06 | 1.42E-06 | 1.42E-06 | 1.42E-06 | 0% |
| Pb-212 | 8.43E-07 | 8.43E-07 | 8.43E-07 | 8.43E-07 | 8.43E-07 | 0% |
| Pm-147 | 2.89E-06 | 2.89E-06 | 2.89E-06 | 2.89E-06 | 2.89E-06 | 0% |
| Pm-148m | 1.90E-12 | 1.90E-12 | 1.90E-12 | 1.90E-12 | 1.90E-12 | 0% |
| Pr-144 | 2.00E-08 | 2.00E-08 | 2.00E-08 | 2.00E-08 | 2.00E-08 | 0% |
| Pu-236 | 5.75E-10 | 5.55E-10 | 4.21E-10 | 5.28E-10 | 5.52E-10 | 5% |
| Pu-238 | 3.55E-05 | 3.94E-05 | 3.86E-05 | 4.05E-05 | 3.57E-05 | -12% |
| Pu-239 | 4.72E-05 | 1.04E-04 | 2.58E-04 | 1.85E-04 | 1.38E-04 | -25% |
| Pu-240 | 7.73E-06 | 7.73E-06 | 7.68E-06 | 7.68E-06 | 7.68E-06 | 0% |
| Pu-241 | 2.07E-04 | 2.07E-04 | 2.07E-04 | 2.07E-04 | 2.07E-04 | 0% |

**Data Table A-17, 2015-2019 Atmospheric Releases (Curies)** **2 Pages**

| Radionuclide | 2015 | 2016[a] | 2017 | 2018 | 2019 | 2018-2019 %Change |
|---|---|---|---|---|---|---|
| Pu-242 | 1.78E-08 | 2.16E-06 | 2.88E-06 | 3.11E-06 | 3.28E-06 | 5% |
| Ra-226 | 2.76E-07 | 2.48E-07 | 5.03E-07 | 1.21E-06 | 5.97E-07 | -51% |
| Ra-228 | 2.62E-07 | 2.29E-07 | 4.92E-07 | 1.19E-06 | 5.93E-07 | -50% |
| Rh-106 | 1.19E-08 | 1.19E-08 | 1.19E-08 | 3.04E-06 | 3.05E-06 | 0% |
| Ru-103 | 5.11E-10 | 5.11E-10 | 9.23E-09 | 5.11E-10 | 5.11E-10 | 0% |
| Ru-106 | 3.04E-06 | 3.04E-06 | 3.04E-06 | 3.04E-06 | 3.05E-06 | 0% |
| Sb-125 | 1.18E-06 | 1.18E-06 | 1.18E-06 | 1.18E-06 | 1.18E-06 | 0% |
| Sb-126 | 1.70E-07 | 1.70E-07 | 1.70E-07 | 1.70E-07 | 1.70E-07 | 0% |
| Se-75 | | 1.94E-07 | | 0.00E+00 | | |
| Se-79 | 4.90E-09 | 4.90E-09 | 4.90E-09 | 4.90E-09 | 4.90E-09 | 0% |
| Sm-151 | 2.89E-06 | 2.89E-06 | 2.89E-06 | 2.89E-06 | 2.89E-06 | 0% |
| Sn-113 | | 6.27E-10 | 6.43E-10 | 6.47E-10 | 8.31E-10 | 28% |
| Sn-123 | 6.66E-12 | 6.66E-12 | 6.66E-12 | 6.66E-12 | 6.66E-12 | 0% |
| Sn-126 | 1.70E-07 | 1.70E-07 | 1.70E-07 | 1.70E-07 | 1.70E-07 | 0% |
| Sr-85 | | 6.00E-10 | 5.80E-10 | 6.24E-10 | 7.61E-10 | 22% |
| Sr-89 | 6.02E-10 | 5.99E-10 | 6.66E-10 | 5.10E-10 | 5.99E-10 | 18% |
| Sr-89,90 | 4.44E-05 | 1.87E-04 | 8.53E-05 | 3.35E-03 | 3.35E-03 | 0% |
| Tc-99 | 3.87E-07 | 1.06E-06 | 2.08E-05 | 5.08E-05 | 5.08E-05 | 0% |
| Te-127 | 1.04E-11 | 1.04E-11 | 1.04E-11 | 1.04E-11 | 1.04E-11 | 0% |
| Te-129 | 1.05E-12 | 1.05E-12 | 1.05E-12 | 1.05E-12 | 1.05E-12 | 0% |
| Th-228 | 8.64E-10 | 9.55E-10 | 1.49E-08 | 1.53E-08 | 1.61E-08 | 5% |
| Th-229 | 1.56E-09 | 1.60E-09 | 1.38E-09 | 1.31E-09 | 1.34E-09 | 2% |
| Th-230 | 9.36E-09 | 7.82E-09 | 3.68E-09 | 5.24E-09 | 6.61E-09 | 26% |
| Th-231 | 2.12E-04 | 2.12E-04 | 2.12E-04 | 2.12E-04 | 2.12E-04 | 0% |
| Th-232 | 2.43E-09 | 2.18E-09 | 1.92E-09 | 2.38E-09 | 3.14E-09 | 32% |
| Tl-208 | 1.41E-06 | 1.41E-06 | 1.41E-06 | 1.41E-06 | 1.41E-06 | 0% |
| U-232 | 6.56E-09 | 6.04E-09 | 5.25E-09 | 5.65E-09 | 5.50E-09 | -3% |
| U-233 | 5.78E-09 | 4.21E-10 | 3.90E-09 | 3.36E-09 | 3.42E-09 | 2% |
| U-234 | 7.02E-06 | 1.03E-04 | 1.19E-04 | 4.06E-05 | 2.72E-05 | -33% |
| U-235 | 8.26E-07 | 6.34E-06 | 1.01E-05 | 2.54E-06 | 1.37E-06 | -46% |
| U-236 | 3.01E-08 | 3.01E-08 | 3.39E-08 | 3.01E-08 | 3.01E-08 | 0% |
| U-238 | 8.69E-06 | 1.48E-04 | 1.66E-04 | 6.20E-05 | 3.55E-05 | -43% |
| Y-88 | | 4.58E-10 | 4.67E-10 | 4.34E-10 | 5.81E-10 | 34% |
| Y-90 | 4.44E-05 | 1.87E-04 | 8.53E-05 | 3.35E-03 | 3.35E-03 | 0% |
| Y-91 | 7.98E-10 | 7.98E-10 | 7.98E-10 | 7.98E-10 | 2.14E-09 | 168% |
| Zn-65 | | 9.56E-10 | 9.42E-10 | 9.02E-10 | 5.82E-10 | -35% |
| Zr-95 | 1.22E-07 | 1.22E-07 | 1.22E-07 | 1.22E-07 | 1.22E-07 | 0% |
| Unidentified Alpha | 3.08E-05 | 5.15E-05 | 5.44E-04 | 1.46E-04 | 4.19E-05 | -71% |
| Unidentified Beta | 2.09E-03 | 3.13E-03 | 1.16E-03 | 1.83E-03 | 1.19E-03 | -35% |

a. Beginning in 2016, individual isotope annual releases below 1E-12 Ci (1 pCi) will no longer be reported in this table.

# Data Table A-18. Comparison of Measured vs. Calculated Tritium in Air Concentrations

Data Table 6-18, Comparison of Measured vs. Calculated Tritium in Air Concentrations

| | pCi/m³ | |
|---|---|---|
| Source of Data | Average Concentration at Site Boundary | Concentration in the North Sector[a] |
| Measured: | 3.2 | 2.8 |
| Calculated: | | |
| MAXDOSE-SR | 4.0 | 7.4 |
| CAP88-PC | 4.2 | 7.5 |

| CAP88 HTO Concentration Calculated from Chi/Q based on Total (HTO & Elemental Tritium) Curies Released (Ci/y): | |
|---|---|
| 2.47E+02 | at 0 m |
| 1.48E+03 | at 15 m |
| 3.10E+02 | at 21 m |
| 1.47E+03 | at 31 m |
| 2.57E+03 | at 56 m |
| 3.17E+03 | at 59 m |
| 9.25E+03 | Total |

| | | 2007-2011 Chi/Q | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Toward Sector | Distance m | 0-m sec/m³ | Concentration pCi/m³ | 15m sec/m3 | Concentration pCi/m³ | 21-m sec/m³ | Concentration pCi/m³ | 31-m sec/m3 | Concentration pCi/m³ | 56-m sec/m³ | Concentration pCi/m³ | 59-m sec/m³ | Concentration pCi/m³ | HTO Conc. pCi/m³ |
| N | 12378 | 3.258E-08 | 2.554E-01 | 3.161E-08 | 1.482E+00 | 3.072E-08 | 3.02E-01 | 2.878E-08 | 1.34E+00 | 2.275E-08 | 1.85E+00 | 2.203E-08 | 2.216E+00 | 7.4 |
| NNW | 12280 | 2.521E-08 | 1.977E-01 | 2.441E-08 | 1.145E+00 | 2.368E-08 | 2.33E-01 | 2.208E-08 | 1.03E+00 | 1.716E-08 | 1.40E+00 | 1.658E-08 | 1.668E+00 | 5.7 |
| NW | 11871 | 2.039E-08 | 1.599E-01 | 1.979E-08 | 9.281E-01 | 1.925E-08 | 1.89E-01 | 1.806E-08 | 8.41E-01 | 1.435E-08 | 1.17E+00 | 1.390E-08 | 1.398E+00 | 4.7 |
| WNW | 13009 | 1.697E-08 | 1.330E-01 | 1.651E-08 | 7.743E-01 | 1.610E-08 | 1.58E-01 | 1.519E-08 | 7.07E-01 | 1.231E-08 | 1.00E+00 | 1.196E-08 | 1.203E+00 | 4.0 |
| W | 13179 | 1.712E-08 | 1.342E-01 | 1.676E-08 | 7.860E-01 | 1.644E-08 | 1.62E-01 | 1.571E-08 | 7.31E-01 | 1.336E-08 | 1.09E+00 | 1.307E-08 | 1.315E+00 | 4.2 |
| WSW | 17817 | 1.381E-08 | 1.083E-01 | 1.354E-08 | 6.350E-01 | 1.330E-08 | 1.31E-01 | 1.274E-08 | 5.93E-01 | 1.094E-08 | 8.92E-01 | 1.072E-08 | 1.078E+00 | 3.4 |
| SW | 17089 | 1.861E-08 | 1.459E-01 | 1.814E-08 | 8.507E-01 | 1.770E-08 | 1.74E-01 | 1.675E-08 | 7.80E-01 | 1.375E-08 | 1.12E+00 | 1.339E-08 | 1.347E+00 | 4.4 |
| SSW | 19649 | 1.042E-08 | 8.170E-02 | 1.009E-08 | 4.732E-01 | 9.802E-09 | 9.64E-02 | 9.155E-09 | 4.26E-01 | 7.166E-09 | 5.84E-01 | 6.931E-09 | 6.972E-01 | 2.4 |
| S | 19763 | 7.947E-09 | 6.231E-02 | 7.684E-09 | 3.604E-01 | 7.444E-09 | 7.32E-02 | 6.916E-09 | 3.22E-01 | 5.298E-09 | 4.32E-01 | 5.108E-09 | 5.138E-01 | 1.8 |
| SSE | 18726 | 8.325E-09 | 6.527E-02 | 8.029E-09 | 3.766E-01 | 7.760E-09 | 7.63E-02 | 7.168E-09 | 3.34E-01 | 5.361E-09 | 4.37E-01 | 5.151E-09 | 5.182E-01 | 1.8 |
| SE | 18125 | 9.624E-09 | 7.545E-02 | 9.326E-09 | 4.374E-01 | 9.055E-09 | 8.90E-02 | 8.457E-09 | 3.94E-01 | 6.605E-09 | 5.38E-01 | 6.385E-09 | 6.423E-01 | 2.2 |
| ESE | 13728 | 1.851E-08 | 1.451E-01 | 1.803E-08 | 8.456E-01 | 1.758E-08 | 1.73E-01 | 1.660E-08 | 7.73E-01 | 1.355E-08 | 1.10E+00 | 1.319E-08 | 1.327E+00 | 4.4 |
| E | 16220 | 1.691E-08 | 1.326E-01 | 1.650E-08 | 7.738E-01 | 1.613E-08 | 1.59E-01 | 1.529E-08 | 7.12E-01 | 1.266E-08 | 1.03E+00 | 1.234E-08 | 1.241E+00 | 4.0 |
| ENE | 15788 | 2.021E-08 | 1.585E-01 | 1.966E-08 | 9.220E-01 | 1.917E-08 | 1.88E-01 | 1.807E-08 | 8.41E-01 | 1.466E-08 | 1.19E+00 | 1.425E-08 | 1.433E+00 | 4.7 |
| NE | 14701 | 2.276E-08 | 1.784E-01 | 2.211E-08 | 1.037E+00 | 2.151E-08 | 2.11E-01 | 2.020E-08 | 9.40E-01 | 1.612E-08 | 1.31E+00 | 1.563E-08 | 1.572E+00 | 5.3 |
| NNE | 13482 | 2.833E-08 | 2.221E-01 | 2.739E-08 | 1.285E+00 | 2.654E-08 | 2.61E-01 | 2.467E-08 | 1.15E+00 | 1.893E-08 | 1.54E+00 | 1.826E-08 | 1.837E+00 | 6.3 |
| Maximum | | 3.258E-08 | 2.554E-01 | 3.161E-08 | 1.482E+00 | 3.072E-08 | 3.020E-01 | 2.878E-08 | 1.340E+00 | 2.275E-08 | 1.854E+00 | 2.203E-08 | 2.216E+00 | 7.450E+00 |
| Minimum | | 7.947E-09 | 6.231E-02 | 7.684E-09 | 3.604E-01 | 7.444E-09 | 7.317E-02 | 6.916E-09 | 3.219E-01 | 5.298E-09 | 4.318E-01 | 5.108E-09 | 5.138E-01 | 1.763E+00 |
| Mean | | 1.798E-08 | 1.410E-01 | 1.747E-08 | 8.195E-01 | 1.701E-08 | 1.672E-01 | 1.599E-08 | 7.443E-01 | 1.281E-08 | 1.044E+00 | 1.243E-08 | 1.250E+00 | 4.166E+00 |

Measured Averages of HTO Concentration in Air at Site Perimeter

| Location | pCi/m³ of Air |
|---|---|
| Allendale Gate | 1.4 |
| Barnwell Gate | 2.6 |
| D Area | 4.8 |
| Darkhorse | 3.7 |
| East Talatha[a] | 2.8 |
| Greenpond | 4.3 |
| Highways 21 & 167 | 2.8 |
| Jackson | 4.1 |
| Patterson Mill Road | 1.9 |
| Talatha Gate | 3.8 |
| **Maximum** | **4.8** |
| **Minimum** | **1.4** |
| **Mean** | **3.2** |

(a) Since the Site MEI and Reference Person are located in the North sector for air dose calculations, the East Talatha (located in the North sector) measured concentration and CAP88 North sector calculated concentration are used for comparison.

**Data Table A-19a. MAXDOSE-SR Representative Person Dose Using Cow Milk Pathway**

**Data Table A-19a, MAXDOSE-SR Representative Person Dose Using Cow Milk Pathway**

**2019 MAXDOSE-SR Representative Person Dose Using Cow Milk Pathway**

| Pathway | Representative Person Dose (mrem)[a] | Percent of Total Dose |
|---|---|---|
| Plume | 5.7E-04 | 3.14% |
| Ground | 4.4E-04 | 2.42% |
| Inhalation | 5.4E-03 | 30.08% |
| Vegetation | 7.0E-03 | 39.14% |
| Cow Milk | 4.0E-03 | 22.35% |
| Meat | 5.2E-04 | 2.86% |
| **Total** | **1.8E-02** | **100.0%** |

| Radionuclide | Maximally Exposed Individual Dose (mrem)[a] | Percent of Total Dose [b] |
|---|---|---|
| **Gases and Vapors** | | |
| H-3 | 1.2E-02 | 67.79% |
| C-14 | 3.8E-05 | 0.21% |
| K-85 | 5.7E-04 | 3.14% |
| I-129 | 4.1E-03 | 22.56% |
| **Particulates** | | |
| Am-241 | 2.1E-05 | 0.12% |
| Cs-137 | 3.4E-04 | 1.88% |
| Pu-238 | 5.0E-05 | 0.28% |
| Pu-239 | 1.9E-04 | 1.04% |
| Pu-240 | 1.2E-05 | 0.07% |
| Pu-241 | 5.7E-06 | 0.03% |
| Pu-242 | 4.8E-06 | 0.03% |
| Sr-90 | 3.0E-04 | 1.68% |
| Tc-99 | 1.3E-05 | 0.07% |
| U-234 | 3.0E-06 | 0.02% |
| U-238 | 4.4E-06 | 0.02% |
| Unidentified Alpha | 6.5E-05 | 0.36% |
| Unidentified Beta | 1.2E-04 | 0.68% |
| **Total** | **1.8E-02** | **100.0%** |

NOTE: (a) Committed effective dose

NOTE: (b) Radionuclides contributing 0.01% or more of the total dose

**Data Table A-19b. MAXDOSE-SR Potential Dose to TRL Industrial Worker**

## Data Table A-19b, Potential Dose to an Adult Worker at Three Rivers Landfill

2000 h/y exposure via inhalation and shine.

| Pathway | Industrial Worker Dose at TRL (mrem)[a] | Percent of Total Dose |
|---|---|---|
| Shine Dose[b] | 3.92E-03 | 40.13% |
| Inhalation | 5.85E-03 | 59.87% |
| **Total** | **9.77E-03** | **100.0%** |

NOTE: (a) Committed effective dose

NOTE: (b ) Shine dose is the total of both plume shine and ground shine output from MAXINE

## Data Table A-20. Sector- Specific Representative Person Airborne Pathway Doses (Using Cow Milk Pathway)

### Data Table A-20, Sector-Specific Representative Person Airborne Pathway Doses (Using Cow Milk Pathway)

**2019 Representative Person Airborne Pathway Doses**

| | |
|---|---|
| N[(a)] | 0.018 |
| NNE | 0.016 |
| NE | 0.014 |
| ENE | 0.013 |
| E | 0.014 |
| ESE | 0.010 |
| SE | 0.006 |
| SSE | 0.006 |
| S | 0.005 |
| SSW | 0.006 |
| SW | 0.012 |
| WSW | 0.015 |
| W | 0.012 |
| WNW | 0.012 |
| NW | 0.014 |
| NNW | 0.018 |

NOTE: (a) Maximum Location

## Data Table A-21. MAXDOSE-SR Representative Person Dose Using Goat Milk Pathway

## Data Table A-21, MAXDOSE-SR Representative Person Dose Using Goat Milk Pathway

**2019 Representative Person Dose Using Goat Milk Pathway**

| Pathway | Maximally Exposed Individual Dose (mrem)[a] | Percent of Total Dose |
|---|---|---|
| Plume | 5.7E-04 | 2.78% |
| Ground | 4.4E-04 | 2.14% |
| Inhalation | 7.0E-03 | 34.59% |
| Vegetation | 5.2E-04 | 2.53% |
| Goat Milk | 6.4E-03 | 31.39% |
| Meat | 5.4E-03 | 26.58% |
| Total | **2.0E-02** | **100.0%** |

| Radionuclide | Maximally Exposed Individual Dose (mrem)[a] | Percent of Total Dose [b] |
|---|---|---|
| ***Gases and Vapors*** | | |
| H-3 | 1.4E-02 | 67.66% |
| C-14 | 4.0E-05 | 0.19% |
| Kr-85 | 5.7E-04 | 2.77% |
| I-129 | 4.8E-03 | 23.39% |
| **Particulates** | | |
| Am-241 | 2.1E-05 | 0.10% |
| Cs-137 | 4.3E-04 | 2.08% |
| Pu-238 | 5.0E-05 | 0.24% |
| Pu-239 | 1.9E-04 | 0.92% |
| Pu-240 | 1.2E-05 | 0.06% |
| Pu-241 | 5.7E-06 | 0.03% |
| Pu-242 | 4.8E-06 | 0.02% |
| Sr-90 | 3.1E-04 | 1.52% |
| Tc-99 | 1.2E-05 | 0.06% |
| U-234 | 3.0E-06 | 0.01% |
| U-238 | 4.3E-06 | 0.02% |
| Unidentified Alpha | 6.5E-05 | 0.32% |
| Unidentified Beta | 1.2E-04 | 0.58% |
| **Total** | **2.0E-02** | **100.0%** |

NOTE: (a) Committed effective dose

NOTE: (b) Radionuclides contributing 0.01% or more of the total dose

## Data Table A-22. POPDOSE-SR Population Doses from Airborne Releases

### Data Table A-22, POPDOSE-SR Population Dose from Airborne Releases
**2019 Population Dose from Airborne Releases**

| Pathway | Population Dose (person-rem)[a] | Percent of Total Dose |
|---|---|---|
| Plume | 4.5E-02 | 6.45% |
| Ground | 3.7E-02 | 5.37% |
| Inhalation | 4.7E-01 | 67.1% |
| Vegetation | 2.5E-02 | 3.60% |
| Cow Milk | 1.2E-01 | 16.51% |
| Meat | 7.0E-03 | 1.01% |
| **Total** | **7.0E-01** | **100.0%** |

| Radionuclide | Population Dose (person-rem)[a] | Percent of Total Dose[b] |
|---|---|---|
| **Gases and Vapors** | | |
| H-3 | 5.4E-01 | 77.9% |
| C-14 | 4.2E-04 | 0.1% |
| Kr-85 | 4.5E-02 | 6.44% |
| I-129 | 5.0E-02 | 7.22% |
| **Particulates** | | |
| Am-241 | 1.2E-03 | 0.17% |
| Cs-137 | 2.5E-02 | 3.57% |
| Pu-238 | 2.6E-03 | 0.37% |
| Pu-239 | 1.1E-02 | 1.56% |
| Pu-240 | 6.1E-04 | 0.09% |
| Pu-241 | 2.9E-04 | 0.04% |
| Pu-242 | 2.5E-04 | 0.04% |
| Sr-90 | 9.5E-03 | 1.36% |
| U-234 | 1.7E-04 | 0.02% |
| U-238 | 3.0E-04 | 0.04% |
| Unidentified Alpha | 3.3E-03 | 0.47% |
| Unidentified Beta | 4.0E-03 | 0.57% |
| **Total** | **7.0E-01** | **100.0%** |

NOTE: (a) Committed effective dose

NOTE: (b) Radionuclides contributing 0.01% or more of the total dose

## Data Table A-23. Airborne Releases by Stack Height for NESHAP

**Data Table A-23, Airborne Releases by Stack Height for NESHAP (Curies)**

**3 Pages**

| Radionuclide | Total 0 m Stack | Total 15 m Stack | Total 21 m Stack | Total 31 m Stack | Total 56 m Stack | Total 59 m Stack | Total All Stacks |
|---|---|---|---|---|---|---|---|
| **GASES AND VAPORS** | | | | | | | |
| H-3 (oxide) | 2.47E+02 | 5.98E+02 | 3.10E+02 | 1.45E+03 | 2.57E+03 | 2.76E+03 | 7.94E+03 |
| H-3 (elemental) | | 8.81E+02 | | 1.50E+01 | | 4.11E+02 | 1.31E+03 |
| H-3 Total | 2.47E+02 | 1.48E+03 | 3.10E+02 | 1.47E+03 | 2.57E+03 | 3.17E+03 | 9.25E+03 |
| C-14 | 9.48E-08 | | | | | 5.00E-02 | 5.00E-02 |
| Hg-203 | 6.51E-10 | | | | | | 6.51E-10 |
| Kr-85 | | | | | | 1.07E+04 | 1.07E+04 |
| I-129 | 4.31E-05 | | 8.67E-07 | | | 9.95E-03 | 9.99E-03 |
| I-131 | 7.01E-10 | | | | | | 7.01E-10 |
| **PARTICLES** | | | | | | | |
| Ag-110m | 1.48E-11 | | | | | | 1.48E-11 |
| Am-241 | 1.20E-05 | 7.77E-08 | | 8.53E-07 | | 4.38E-06 | 1.73E-05 |
| Am-243 | 3.97E-09 | | | | | | 3.97E-09 |
| Ba-133 | 7.74E-07 | | | | | | 7.74E-07 |
| Cd-109 | 1.68E-08 | | | | | | 1.68E-08 |
| Ce-139 | 6.71E-10 | | | | | | 6.71E-10 |
| Ce-141 | 4.94E-11 | | | | | | 4.94E-11 |
| Ce-144 | 2.00E-08 | | | | | | 2.00E-08 |
| Cf-249 | 7.89E-12 | | | | | | 7.89E-12 |
| Cf-251 | 1.78E-11 | | | | | | 1.78E-11 |
| Cm-243 | 2.90E-09 | | | | | | 2.90E-09 |
| Cm-244 | 2.75E-07 | | | | | 2.39E-08 | 2.99E-07 |
| Co-57 | 6.41E-10 | | | | | | 6.41E-10 |
| Co-58 | | | | | | 1.04E-06 | 1.04E-06 |
| Co-60 | 6.30E-07 | | | | | | 6.30E-07 |
| Cs-134 | 4.32E-07 | | | | | | 4.32E-07 |
| Cs-137 | 3.84E-03 | | | | | 3.36E-05 | 3.88E-03 |
| Eu-152 | 1.90E-09 | | | | | | 1.90E-09 |
| Eu-154 | 3.56E-07 | | | | | | 3.56E-07 |
| Eu-155 | 1.18E-07 | | | | | | 1.18E-07 |
| F-18 | 4.00E-02 | | | | | | 4.00E-02 |
| Fe-55 | 8.04E-09 | | | | | | 8.04E-09 |
| Mn-54 | 6.01E-10 | | | | | | 6.01E-10 |
| Nb-94 | 2.42E-07 | | | | | | 2.42E-07 |
| Nb-95 | 3.63E-07 | | | | | | 3.63E-07 |
| Ni-59 | 5.76E-11 | | | | | | 5.76E-11 |

**Data Table A-23, Airborne Releases by Stack Height for NESHAP (Curies)**

**3 Pages**

| Radionuclide | Total 0 m Stack | Total 15 m Stack | Total 21 m Stack | Total 31 m Stack | Total 56 m Stack | Total 59 m Stack | Total All Stacks |
|---|---|---|---|---|---|---|---|
| Ni-63 | 7.41E-09 | | | | | | 7.41E-09 |
| Np-237 | 1.55E-06 | | | | | 6.80E-08 | 1.61E-06 |
| Pa-233 | 1.42E-06 | | | | | | 1.42E-06 |
| Pb-212 | 8.43E-07 | | | | | | 8.43E-07 |
| Pm-147 | 2.89E-06 | | | | | | 2.89E-06 |
| Pm-148m | 1.90E-12 | | | | | | 1.90E-12 |
| Pr-144 | 2.00E-08 | | | | | | 2.00E-08 |
| Pu-236 | 5.52E-10 | | | | | | 5.52E-10 |
| Pu-238 | 3.14E-05 | 6.09E-08 | | 5.26E-09 | | 4.26E-06 | 3.57E-05 |
| Pu-239 | 6.84E-05 | | | 1.31E-08 | | 7.00E-05 | 1.38E-04 |
| Pu-240 | 7.68E-06 | | | | | | 7.68E-06 |
| Pu-241 | 2.07E-04 | | | | | | 2.07E-04 |
| Pu-242 | 3.28E-06 | | | | | | 3.28E-06 |
| Ra-226 | 5.97E-07 | | | | | | 5.97E-07 |
| Ra-228 | 5.93E-07 | | | | | | 5.93E-07 |
| Rh-106(b) | 3.05E-06 | | | | | | 3.05E-06 |
| Ru-103 | 5.11E-10 | | | | | | 5.11E-10 |
| Ru-106 | 3.05E-06 | | | | | | 3.05E-06 |
| Sb-125 | 1.18E-06 | | | | | | 1.18E-06 |
| Sb-126(b) | 1.70E-07 | | | | | | 1.70E-07 |
| Se-79 | 4.90E-09 | | | | | | 4.90E-09 |
| Sm-151 | 2.89E-06 | | | | | | 2.89E-06 |
| Sn-113 | 8.31E-10 | | | | | | 8.31E-10 |
| Sn-123 | 6.66E-12 | | | | | | 6.66E-12 |
| Sn-126 | 1.70E-07 | | | | | | 1.70E-07 |
| Sr-85 | 7.61E-10 | | | | | | 7.61E-10 |
| Sr-89 | 5.99E-10 | | | | | | 5.99E-10 |
| Sr-90 | 3.32E-03 | | | 9.62E-08 | | 3.20E-05 | 3.35E-03 |
| Tc-99 | 5.08E-05 | | | | | | 5.08E-05 |
| Te-127 | 1.04E-11 | | | | | | 1.04E-11 |
| Te-129 | 1.05E-12 | | | | | | 1.05E-12 |
| Th-228 | 1.34E-08 | 2.69E-09 | | | | | 1.61E-08 |
| Th-229 | 1.34E-09 | | | | | | 1.34E-09 |
| Th-230 | 9.73E-11 | 6.51E-09 | | | | | 6.61E-09 |
| Th-231 | 2.12E-04 | | | | | | 2.12E-04 |
| Th-232 | 9.86E-12 | 3.13E-09 | | | | | 3.14E-09 |
| Tl-208 | 1.41E-06 | | | | | | 1.41E-06 |

**Data Table A-23, Airborne Releases by Stack Height for NESHAP (Curies)**

**3 Pages**

| Radionuclide | Total 0 m Stack | Total 15 m Stack | Total 21 m Stack | Total 31 m Stack | Total 56 m Stack | Total 59 m Stack | Total All Stacks |
|---|---|---|---|---|---|---|---|
| U-232 | 5.50E-09 | | | | | | 5.50E-09 |
| U-233 | 3.42E-09 | | | | | | 3.42E-09 |
| U-234 | 2.86E-06 | 3.13E-07 | | 2.72E-06 | | 2.13E-05 | 2.72E-05 |
| U-235 | 1.25E-08 | | | | | 1.36E-06 | 1.37E-06 |
| U-236 | 3.01E-08 | | | | | | 3.01E-08 |
| U-238 | 2.63E-06 | 2.59E-07 | | 2.24E-06 | | 3.04E-05 | 3.55E-05 |
| Y-88 | 5.81E-10 | | | | | | 5.81E-10 |
| Y-90(b) | 3.32E-03 | | | 9.62E-08 | | 3.20E-05 | 3.35E-03 |
| Y-91 | 2.14E-09 | | | | | | 2.14E-09 |
| Zn-65 | 5.82E-10 | | | | | | 5.82E-10 |
| Zr-95 | 1.22E-07 | | | | | | 1.22E-07 |
| Unidentified alpha | 4.15E-05 | | | 3.88E-07 | | | 4.19E-05 |
| Unidentified beta | 1.05E-03 | | 8.63E-07 | 2.43E-05 | | 1.07E-04 | 1.19E-03 |

a. Beginning in 2016, calculated individual isotope annual releases below 1E-12 Ci (1 pCi) are no longer reported in this table and, therefore, not used in the dose calculations.

b. Daughter products (Sb-126, Rh-106 & Y-90) are assumed to be in secular equilibrium with their parent source terms (Sn-126, Ru-106 & Sr-90, respectively).

**Data Table A-24. Site-Specific Parameters Used with CAP88 PC for NESHAP**

**Data Table A-24, Site-Specific Parameters Used with CAP88 PC for NESHAP**

**2019 Parameters Used with CAP88 PC for NESHAP**

| Parameter | Value | |
|---|---|---|
| Particle size, AMAD[a] | | |
| Gases and Vapors | 0 | |
| Particles | 1 | |
| Meteorological data | 2007-2011; H Area | |
| Plume rise | None | |
| Number of stacks | 6 | |
| Stack heights, m | 0, 15, 21, 31, 56, and 59 | |
| Height of lid, m | 1328 | |
| Rainfall rate, cm/yr | 123.2 | |
| Average air temperature, C | 18.1 | |
| Absolute humidity, g/m$^3$ | 12.9 | |
| State | South Carolina | |
| **MEI Specific Parameters** | | |
| Distance to MEI | 12378 m in North Direction | |
| Food supply fractions: | Home Produced | From Assessment Area |
| Vegetable | 1.00 | 0.00 |
| Meat | 1.00 | 0.00 |
| Milk | 1.00 | 0.00 |
| EPA Food Source Scenario | Local | |
| **TRL Worker MEI Specific Parameters** | | |
| Distance to MEI | 9379 m in West Southwest Direction | |
| Food supply fractions: | Home Produced | From Assessment Area |
| Vegetable | 0.00 | 1.00 |
| Meat | 0.00 | 1.00 |
| Milk | 0.00 | 1.00 |
| EPA Food Source Scenario | Regional | |
| **Population Specific Parameters** | | |
| Population size (around H-Area) | 803,370 | |
| Food supply fractions:[b] | Home Produced | From Assessment Area |
| Vegetable | 0.70 | 0.30 |
| Meat | 0.44 | 0.56 |
| Milk | 0.40 | 0.60 |
| EPA Food Source Scenario | Rural | |

[a]Activity Medium Aerodynamic Diameter, micrometers

[b]CAP88-PC may recalculate the input food source fractions should the productivity of the local or assessment area be insufficient to produce enough food to meet the population times the consumption rates.

**Data Table A-25a. Radioactive Atmospheric Releases and MEI Doses for Site Boundary MEI**

**Data Table A-25a, Radioactive Atmospheric Releases and MEI Doses for Site Boundary MEI**
**2019 CAP88 PC Dose Calculations for NESHAP Report to EPA** **4 Pages**

| Radionuclide | Releases (Curies) | | | | | | Maximally Exposed Individual Dose (mrem) | Fraction of Dose |
|---|---|---|---|---|---|---|---|---|
| | 0 m | 15m | 21m | 31m | 56m | 59m | | |
| H-3 (oxide) | 2.47E+02 | 5.98E+02 | 3.10E+02 | 1.45E+03 | 2.57E+03 | 2.76E+03 | 1.40E-02 | 0.79 |
| H-3 (elemental) | 0.00E+00 | 8.81E+02 | 0.00E+00 | 1.50E+01 | 0.00E+00 | 4.11E+02 | 2.22E-03 | 0.12 |
| Sr-90 | 3.32E-03 | 0.00E+00 | 0.00E+00 | 9.62E-08 | 0.00E+00 | 3.20E-05 | 3.44E-04 | 0.02 |
| Cs-137 | 3.84E-03 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 3.36E-05 | 2.92E-04 | 0.02 |
| Ba-137m | | | | | | | 2.76E-04 | 0.02 |
| Kr-85 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.07E+04 | 2.10E-04 | 0.01 |
| Unidentified Beta | 1.05E-03 | 0.00E+00 | 8.63E-07 | 2.43E-05 | 0.00E+00 | 1.07E-04 | 1.38E-04 | 0.01 |
| Pu-239 | 6.84E-05 | 0.00E+00 | 0.00E+00 | 1.31E-08 | 0.00E+00 | 7.00E-05 | 1.05E-04 | 0.01 |
| Y-90 | | | | | | | 4.71E-05 | 0.003 |
| Unidentified Alpha | 4.15E-05 | 0.00E+00 | 0.00E+00 | 3.88E-07 | 0.00E+00 | 0.00E+00 | 3.61E-05 | 0.002 |
| Pu-238 | 3.14E-05 | 6.09E-08 | 0.00E+00 | 5.26E-09 | 0.00E+00 | 4.26E-06 | 2.74E-05 | 0.002 |
| I-129 | 4.31E-05 | 0.00E+00 | 8.67E-07 | 0.00E+00 | 0.00E+00 | 9.95E-03 | 1.34E-05 | 0.001 |
| C-14 | 9.48E-08 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 5.00E-02 | 1.27E-05 | 0.001 |
| Am-241 | 1.20E-05 | 7.77E-08 | 0.00E+00 | 8.53E-07 | 0.00E+00 | 4.38E-06 | 1.17E-05 | 0.001 |
| Bi-214 | | | | | | | 9.02E-06 | 0.001 |
| Pu-240 | 7.68E-06 | | | | | | 6.62E-06 | 0.0004 |
| Th-230 | 9.73E-11 | 6.51E-09 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 5.81E-06 | 0.0003 |
| Ra-226 | 5.97E-07 | | | | | | 4.97E-06 | 0.0003 |
| Pu-241 | 2.07E-04 | | | | | | 3.25E-06 | 0.0002 |
| Pu-242 | 3.28E-06 | | | | | | 2.68E-06 | 0.0002 |
| Pb-214 | | | | | | | 1.55E-06 | 0.0001 |
| U-238 | 2.63E-06 | 2.59E-07 | 0.00E+00 | 2.24E-06 | 0.00E+00 | 3.04E-05 | 1.38E-06 | 0.0001 |
| U-234 | 2.86E-06 | 3.13E-07 | 0.00E+00 | 2.72E-06 | 0.00E+00 | 2.13E-05 | 1.28E-06 | 0.0001 |
| Tc-99 | 5.08E-05 | | | | | | 1.10E-06 | 0.0001 |
| Pa-234m | | | | | | | 9.02E-07 | 0.0001 |
| Np-237 | 1.55E-06 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 6.80E-08 | 6.50E-07 | 0.00004 |
| F-18 | 4.00E-02 | | | | | | 1.93E-07 | 0.00001 |
| Ra-228 | 5.93E-07 | | | | | | 1.48E-07 | 0.00001 |
| Cm-244 | 2.75E-07 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 2.39E-08 | 1.31E-07 | 0.00001 |
| Bi-210 | | | | | | | 1.23E-07 | 0.00001 |
| U-235 | 1.25E-08 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.36E-06 | 1.01E-07 | 0.00001 |
| Nb-94 | 2.42E-07 | | | | | | 8.83E-08 | 0.000005 |
| Pa-233 | 1.42E-06 | | | | | | 8.07E-08 | 0.000005 |
| Th-234 | | | | | | | 7.79E-08 | 0.000004 |
| Sb-126m | | | | | | | 6.49E-08 | 0.000004 |
| Co-60 | 6.30E-07 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 5.92E-08 | 0.000003 |
| Cs-134 | 4.32E-07 | | | | | | 2.91E-08 | 0.000002 |

**Data Table A-25a, Radioactive Atmospheric Releases and MEI Doses for Site Boundary MEI**

**2019 CAP88 PC Dose Calculations for NESHAP Report to EPA** **4 Pages**

| Radionuclide | Releases (Curies) | | | | | | Maximally Exposed Individual Dose (mrem) | Fraction of Dose |
|---|---|---|---|---|---|---|---|---|
| | 0 m | 15m | 21m | 31m | 56m | 59m | | |
| Tl-208 | 1.41E-06 | | | | | | 2.64E-08 | 0.000001 |
| Eu-154 | 3.56E-07 | | | | | | 2.43E-08 | 0.000001 |
| Ac-228 | | | | | | | 2.10E-08 | 0.000001 |
| Ba-133 | 7.74E-07 | | | | | | 1.94E-08 | 0.000001 |
| Pa-234 | | | | | | | 1.78E-08 | 0.000001 |
| Sb-126 | | | | | | | 1.57E-08 | 0.000001 |
| Th-228 | 1.34E-08 | 2.69E-09 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.25E-08 | 0.000001 |
| Sb-125 | 1.18E-06 | | | | | | 1.06E-08 | 0.000001 |
| Rh-106 | | | | | | | 8.62E-09 | 0.0000005 |
| Pb-210 | | | | | | | 7.60E-09 | 0.0000004 |
| Ru-106 | 3.05E-06 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 6.09E-09 | 0.0000003 |
| Th-229 | 1.34E-09 | | | | | | 5.98E-09 | 0.0000003 |
| Th-231 | 2.12E-04 | | | | | | 5.60E-09 | 0.0000003 |
| Pb-212 | 8.43E-07 | | | | | | 4.90E-09 | 0.0000003 |
| Sn-126 | 1.70E-07 | | | | | | 4.84E-09 | 0.0000003 |
| Bi-212 | | | | | | | 4.13E-09 | 0.0000002 |
| Tl-210 | | | | | | | 3.52E-09 | 0.0000002 |
| Am-243 | 3.97E-09 | | | | | | 2.84E-09 | 0.0000002 |
| Rn-222 | | | | | | | 2.36E-09 | 0.0000001 |
| Co-58 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.04E-06 | 1.79E-09 | 0.0000001 |
| Cm-243 | 2.90E-09 | | | | | | 1.59E-09 | 0.0000001 |
| U-236 | 3.01E-08 | | | | | | 1.57E-09 | 0.0000001 |
| Th-232 | 9.86E-12 | 3.13E-09 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.46E-09 | 0.0000001 |
| Ra-224 | | | | | | | 1.03E-09 | 0.0000001 |
| U-232 | 5.50E-09 | | | | | | 1.02E-09 | 0.0000001 |
| Po-214 | | | | | | | 5.00E-10 | 0.00000003 |
| Sm-151 | 2.89E-06 | | | | | | 4.76E-10 | 0.00000003 |
| Pm-147 | 2.89E-06 | | | | | | 4.74E-10 | 0.00000003 |
| Ac-225 | | | | | | | 4.54E-10 | 0.00000003 |
| Te-125m | | | | | | | 4.52E-10 | 0.00000003 |
| Nb-95 | 3.63E-07 | | | | | | 4.50E-10 | 0.00000003 |
| Ra-225 | | | | | | | 4.15E-10 | 0.00000002 |
| Eu-155 | 1.18E-07 | | | | | | 2.50E-10 | 0.00000001 |
| U-233 | 3.42E-09 | | | | | | 1.99E-10 | 0.00000001 |
| Bi-213 | | | | | | | 1.93E-10 | 0.00000001 |
| Pu-236 | 5.52E-10 | | | | | | 1.81E-10 | 0.00000001 |
| Eu-152 | 1.90E-09 | | | | | | 1.69E-10 | 0.00000001 |
| Np-239 | | | | | | | 1.58E-10 | 0.00000001 |
| Zr-95 | 1.22E-07 | | | | | | 1.45E-10 | 0.00000001 |

**Data Table A-25a, Radioactive Atmospheric Releases and MEI Doses for Site Boundary MEI**

**2019 CAP88 PC Dose Calculations for NESHAP Report to EPA** **4 Pages**

| Radionuclide | Releases (Curies) | | | | | | Maximally Exposed Individual Dose (mrem) | Fraction of Dose |
|---|---|---|---|---|---|---|---|---|
| | 0 m | 15m | 21m | 31m | 56m | 59m | | |
| Se-79 | 4.90E-09 | | | | | | 1.26E-10 | 0.00000001 |
| U-237 | | | | | | | 5.20E-11 | 0.000000003 |
| Tl-209 | | | | | | | 4.95E-11 | 0.000000003 |
| Po-210 | | | | | | | 3.18E-11 | 0.000000002 |
| Fr-221 | | | | | | | 3.16E-11 | 0.000000002 |
| Ce-144 | 2.00E-08 | | | | | | 3.01E-11 | 0.000000002 |
| Cf-251 | 1.78E-11 | | | | | | 2.23E-11 | 0.000000001 |
| Pr-144 | 2.00E-08 | | | | | | 2.02E-11 | 0.000000001 |
| Cd-109 | 1.68E-08 | | | | | | 1.67E-11 | 0.000000001 |
| Rn-220 | | | | | | | 1.49E-11 | 0.000000001 |
| Ra-223 | | | | | | | 1.41E-11 | 0.000000001 |
| Th-227 | | | | | | | 1.27E-11 | 0.000000001 |
| Pb-211 | | | | | | | 1.21E-11 | 0.000000001 |
| Cf-249 | 7.89E-12 | | | | | | 1.00E-11 | 0.000000001 |
| Pa-231 | | | | | | | 8.65E-12 | 0.0000000005 |
| Zn-65 | 5.82E-10 | | | | | | 8.60E-12 | 0.0000000005 |
| Tl-207 | | | | | | | 6.23E-12 | 0.0000000004 |
| Rn-219 | | | | | | | 6.13E-12 | 0.0000000003 |
| Bi-211 | | | | | | | 4.96E-12 | 0.0000000003 |
| Pb-209 | | | | | | | 3.74E-12 | 0.0000000002 |
| Y-88 | 5.81E-10 | | | | | | 3.53E-12 | 0.0000000002 |
| Mn-54 | 6.01E-10 | | | | | | 3.40E-12 | 0.0000000002 |
| Fe-55 | 8.04E-09 | | | | | | 3.03E-12 | 0.0000000002 |
| Ni-63 | 7.41E-09 | | | | | | 2.73E-12 | 0.0000000002 |
| Nb-95m | | | | | | | 2.27E-12 | 0.0000000001 |
| Y-91 | 2.14E-09 | | | | | | 1.03E-12 | 0.0000000001 |
| Sr-85 | 7.61E-10 | | | | | | 6.48E-13 | 0.00000000004 |
| Co-57 | 6.41E-10 | | | | | | 5.70E-13 | 0.00000000003 |
| In-113m | | | | | | | 5.26E-13 | 0.00000000003 |
| Sr-89 | 5.99E-10 | | | | | | 4.62E-13 | 0.00000000003 |
| Po-216 | | | | | | | 3.60E-13 | 0.00000000002 |
| Ce-139 | 6.71E-10 | | | | | | 3.37E-13 | 0.00000000002 |
| Tl-206 | | | | | | | 2.87E-13 | 0.00000000002 |
| I-131 | 7.01E-10 | | | | | | 2.79E-13 | 0.00000000002 |
| Ru-103 | 5.11E-10 | | | | | | 2.73E-13 | 0.00000000002 |
| Sn-113 | 8.31E-10 | | | | | | 2.66E-13 | 0.00000000001 |
| At-217 | | | | | | | 2.66E-13 | 0.00000000001 |
| Ag-110m | 1.48E-11 | | | | | | 2.27E-13 | 0.00000000001 |
| At-218 | | | | | | | 1.59E-13 | 0.00000000001 |

**Data Table A-25a, Radioactive Atmospheric Releases and MEI Doses for Site Boundary MEI**

**2019 CAP88 PC Dose Calculations for NESHAP Report to EPA** **4 Pages**

| Radionuclide | Releases (Curies) | | | | | | Maximally Exposed Individual Dose (mrem) | Fraction of Dose |
|---|---|---|---|---|---|---|---|---|
| | 0 m | 15m | 21m | 31m | 56m | 59m | | |
| Fr-223 | | | | | | | 1.20E-13 | 0.00000000001 |
| Hg-203 | 6.51E-10 | | | | | | 9.28E-14 | 0.00000000001 |
| Po-218 | | | | | | | 4.23E-14 | <0.00000000001 |
| Po-213 | | | | | | | 4.09E-14 | <0.00000000001 |
| Ac-227 | | | | | | | 2.65E-14 | <0.00000000001 |
| Po-215 | | | | | | | 1.87E-14 | <0.00000000001 |
| Pr-144m | | | | | | | 1.34E-14 | <0.00000000001 |
| Ni-59 | 5.76E-11 | | | | | | 1.02E-14 | <0.00000000001 |
| Hg-206 | | | | | | | 9.91E-15 | <0.00000000001 |
| Ce-141 | 4.94E-11 | | | | | | 7.96E-15 | <0.00000000001 |
| Sn-123 | 6.66E-12 | | | | | | 7.92E-15 | <0.00000000001 |
| Pm-148m | 1.90E-12 | | | | | | 3.90E-15 | <0.00000000001 |
| Po-211 | | | | | | | 2.39E-15 | <0.00000000001 |
| U-235m | | | | | | | 1.19E-15 | <0.00000000001 |
| Rn-218 | | | | | | | 9.20E-16 | <0.00000000001 |
| Cm-245 | | | | | | | 4.79E-16 | <0.00000000001 |
| Rh-103m | | | | | | | 3.83E-16 | <0.00000000001 |
| Pm-148 | | | | | | | 2.96E-16 | <0.00000000001 |
| Ag-110 | | | | | | | 1.81E-16 | <0.00000000001 |
| Bi-215 | | | | | | | 2.76E-17 | <0.00000000001 |
| Te-127 | 1.04E-11 | | | | | | 1.70E-17 | <0.00000000001 |
| Cm-247 | | | | | | | 1.96E-18 | <0.00000000001 |
| Te-129 | 1.05E-12 | | | | | | 5.45E-19 | <0.00000000001 |
| Pu-243 | | | | | | | 1.49E-19 | <0.00000000001 |
| Xe-131m | | | | | | | 7.91E-22 | <0.00000000001 |
| Sm-147 | | | | | | | 3.37E-22 | <0.00000000001 |
| Nd-144 | | | | | | | 1.17E-28 | <0.00000000001 |
| Gd-152 | | | | | | | 4.74E-29 | <0.00000000001 |
| At-219 | | | | | | | 0.00E+00 | <0.00000000001 |
| Po-212 | | | | | | | 0.00E+00 | <0.00000000001 |
| Sm-148 | | | | | | | 0.00E+00 | <0.00000000001 |
| **Grand Total** | **2.47E+02** | **1.48E+03** | **3.10E+02** | **1.47E+03** | **2.57E+03** | **1.38E+04** | **1.78E-02** | |

a. Daughter products are calculated to have the same release rate as their parent source terms

## Data Table A-25b. Radioactive Atmospheric Releases and MEI Doses at TRL Worker MEI Location

### Data Table A-25b, Radioactive Atmospheric Releases and MEI Doses at TRL Worker MEI Location

**2019 CAP88 PC Dose Calculations for NESHAP Report to EPA** **4 Pages**

| Radionuclide | Releases (Curies) | | | | | | Maximally Exposed Individual Dose (mrem) | Fraction of Dose |
|---|---|---|---|---|---|---|---|---|
| | 0 m | 15m | 21m | 31m | 56m | 59m | | |
| H-3 (oxide) | 2.47E+02 | 5.98E+02 | 3.10E+02 | 1.45E+03 | 2.57E+03 | 2.76E+03 | 1.38E-02 | 0.78 |
| H-3 (elemental) | 0.00E+00 | 8.81E+02 | 0.00E+00 | 1.50E+01 | 0.00E+00 | 4.11E+02 | 2.17E-03 | 0.12 |
| Sr-90 | 3.32E-03 | 0.00E+00 | 0.00E+00 | 9.62E-08 | 0.00E+00 | 3.20E-05 | 3.58E-04 | 0.02 |
| Ba-137m | | | | | | | 3.18E-04 | 0.02 |
| Cs-137 | 3.84E-03 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 3.36E-05 | 3.04E-04 | 0.02 |
| Kr-85 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.07E+04 | 2.29E-04 | 0.01 |
| Unidentified Beta | 1.05E-03 | 0.00E+00 | 8.63E-07 | 2.43E-05 | 0.00E+00 | 1.07E-04 | 1.44E-04 | 0.01 |
| Pu-239 | 6.84E-05 | 0.00E+00 | 0.00E+00 | 1.31E-08 | 0.00E+00 | 7.00E-05 | 1.10E-04 | 0.01 |
| Y-90 | | | | | | | 5.44E-05 | 0.003 |
| Unidentified Alpha | 4.15E-05 | 0.00E+00 | 0.00E+00 | 3.88E-07 | 0.00E+00 | 0.00E+00 | 3.63E-05 | 0.002 |
| Pu-238 | 3.14E-05 | 6.09E-08 | 0.00E+00 | 5.26E-09 | 0.00E+00 | 4.26E-06 | 2.78E-05 | 0.002 |
| I-129 | 4.31E-05 | 0.00E+00 | 8.67E-07 | 0.00E+00 | 0.00E+00 | 9.95E-03 | 1.46E-05 | 0.001 |
| C-14 | 9.48E-08 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 5.00E-02 | 1.23E-05 | 0.001 |
| Am-241 | 1.20E-05 | 7.77E-08 | 0.00E+00 | 8.53E-07 | 0.00E+00 | 4.38E-06 | 1.20E-05 | 0.001 |
| Bi-214 | | | | | | | 1.08E-05 | 0.001 |
| Pu-240 | 7.68E-06 | | | | | | 6.66E-06 | 0.0004 |
| Th-230 | 9.73E-11 | 6.51E-09 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 6.22E-06 | 0.0004 |
| Ra-226 | 5.97E-07 | | | | | | 5.21E-06 | 0.0003 |
| Pu-241 | 2.07E-04 | | | | | | 3.27E-06 | 0.0002 |
| Pu-242 | 3.28E-06 | | | | | | 2.70E-06 | 0.0002 |
| Pb-214 | | | | | | | 1.85E-06 | 0.0001 |
| U-238 | 2.63E-06 | 2.59E-07 | 0.00E+00 | 2.24E-06 | 0.00E+00 | 3.04E-05 | 1.48E-06 | 0.0001 |
| U-234 | 2.86E-06 | 3.13E-07 | 0.00E+00 | 2.72E-06 | 0.00E+00 | 2.13E-05 | 1.36E-06 | 0.0001 |
| Tc-99 | 5.08E-05 | | | | | | 1.14E-06 | 0.0001 |
| Pa-234m | | | | | | | 1.08E-06 | 0.0001 |
| Np-237 | 1.55E-06 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 6.80E-08 | 6.58E-07 | 0.00004 |
| F-18 | 4.00E-02 | | | | | | 2.10E-07 | 0.00001 |
| Ra-228 | 5.93E-07 | | | | | | 1.53E-07 | 0.00001 |
| Bi-210 | | | | | | | 1.47E-07 | 0.00001 |
| Cm-244 | 2.75E-07 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 2.39E-08 | 1.32E-07 | 0.00001 |
| U-235 | 1.25E-08 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.36E-06 | 1.15E-07 | 0.00001 |
| Nb-94 | 2.42E-07 | | | | | | 1.02E-07 | 0.00001 |
| Pa-233 | 1.42E-06 | | | | | | 9.32E-08 | 0.00001 |
| Th-234 | | | | | | | 9.19E-08 | 0.00001 |
| Sb-126m | | | | | | | 7.49E-08 | 0.000004 |
| Co-60 | 6.30E-07 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 6.77E-08 | 0.000004 |

**Data Table A-25b, Radioactive Atmospheric Releases and MEI Doses at TRL Worker MEI Location**

**2019 CAP88 PC Dose Calculations for NESHAP Report to EPA** **4 Pages**

| Radionuclide | Releases (Curies) | | | | | | Maximally Exposed Individual Dose (mrem) | Fraction of Dose |
|---|---|---|---|---|---|---|---|---|
| | 0 m | 15m | 21m | 31m | 56m | 59m | | |
| Cs-134 | 4.32E-07 | | | | | | 3.15E-08 | 0.000002 |
| Tl-208 | 1.41E-06 | | | | | | 3.05E-08 | 0.000002 |
| Eu-154 | 3.56E-07 | | | | | | 2.79E-08 | 0.000002 |
| Ac-228 | | | | | | | 2.42E-08 | 0.000001 |
| Ba-133 | 7.74E-07 | | | | | | 2.24E-08 | 0.000001 |
| Pa-234 | | | | | | | 2.14E-08 | 0.000001 |
| Sb-126 | | | | | | | 1.81E-08 | 0.000001 |
| Th-228 | 1.34E-08 | 2.69E-09 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.26E-08 | 0.000001 |
| Sb-125 | 1.18E-06 | | | | | | 1.22E-08 | 0.000001 |
| Rh-106 | | | | | | | 9.95E-09 | 0.000001 |
| Pb-210 | | | | | | | 9.09E-09 | 0.000001 |
| Th-231 | 2.12E-04 | | | | | | 6.59E-09 | 0.0000004 |
| Ru-106 | 3.05E-06 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 6.29E-09 | 0.0000004 |
| Th-229 | 1.34E-09 | | | | | | 6.03E-09 | 0.0000003 |
| Pb-212 | 8.43E-07 | | | | | | 5.43E-09 | 0.0000003 |
| Sn-126 | 1.70E-07 | | | | | | 5.27E-09 | 0.0000003 |
| Bi-212 | | | | | | | 4.71E-09 | 0.0000003 |
| Tl-210 | | | | | | | 4.21E-09 | 0.0000002 |
| Am-243 | 3.97E-09 | | | | | | 2.86E-09 | 0.0000002 |
| Rn-222 | | | | | | | 2.83E-09 | 0.0000002 |
| Co-58 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.04E-06 | 2.10E-09 | 0.0000001 |
| Cm-243 | 2.90E-09 | | | | | | 1.61E-09 | 0.0000001 |
| U-236 | 3.01E-08 | | | | | | 1.59E-09 | 0.0000001 |
| Th-232 | 9.86E-12 | 3.13E-09 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.47E-09 | 0.0000001 |
| Ra-224 | | | | | | | 1.07E-09 | 0.0000001 |
| U-232 | 5.50E-09 | | | | | | 1.04E-09 | 0.0000001 |
| Po-214 | | | | | | | 5.98E-10 | 0.00000003 |
| Nb-95 | 3.63E-07 | | | | | | 5.13E-10 | 0.00000003 |
| Te-125m | | | | | | | 4.90E-10 | 0.00000003 |
| Pm-147 | 2.89E-06 | | | | | | 4.82E-10 | 0.00000003 |
| Sm-151 | 2.89E-06 | | | | | | 4.81E-10 | 0.00000003 |
| Ac-225 | | | | | | | 4.58E-10 | 0.00000003 |
| Ra-225 | | | | | | | 4.19E-10 | 0.00000002 |
| Eu-155 | 1.18E-07 | | | | | | 2.84E-10 | 0.00000002 |
| Bi-213 | | | | | | | 2.23E-10 | 0.00000001 |
| U-233 | 3.42E-09 | | | | | | 2.01E-10 | 0.00000001 |
| Eu-152 | 1.90E-09 | | | | | | 1.94E-10 | 0.00000001 |
| Np-239 | | | | | | | 1.82E-10 | 0.00000001 |
| Pu-236 | 5.52E-10 | | | | | | 1.82E-10 | 0.00000001 |

**Data Table A-25b, Radioactive Atmospheric Releases and MEI Doses at TRL Worker MEI Location**

**2019 CAP88 PC Dose Calculations for NESHAP Report to EPA** **4 Pages**

| Radionuclide | Releases (Curies) | | | | | | Maximally Exposed Individual Dose (mrem) | Fraction of Dose |
|---|---|---|---|---|---|---|---|---|
| | 0 m | 15m | 21m | 31m | 56m | 59m | | |
| Zr-95 | 1.22E-07 | | | | | | 1.64E-10 | 0.00000001 |
| Se-79 | 4.90E-09 | | | | | | 1.31E-10 | 0.00000001 |
| U-237 | | | | | | | 5.99E-11 | 0.000000003 |
| Tl-209 | | | | | | | 5.70E-11 | 0.000000003 |
| Po-210 | | | | | | | 3.80E-11 | 0.000000002 |
| Fr-221 | | | | | | | 3.63E-11 | 0.000000002 |
| Ce-144 | 2.00E-08 | | | | | | 3.11E-11 | 0.000000002 |
| Pr-144 | 2.00E-08 | | | | | | 2.33E-11 | 0.000000001 |
| Cf-251 | 1.78E-11 | | | | | | 2.25E-11 | 0.000000001 |
| Cd-109 | 1.68E-08 | | | | | | 1.76E-11 | 0.000000001 |
| Rn-220 | | | | | | | 1.72E-11 | 0.000000001 |
| Ra-223 | | | | | | | 1.71E-11 | 0.000000001 |
| Th-227 | | | | | | | 1.53E-11 | 0.000000001 |
| Pb-211 | | | | | | | 1.45E-11 | 0.000000001 |
| Pa-231 | | | | | | | 1.02E-11 | 0.000000001 |
| Cf-249 | 7.89E-12 | | | | | | 1.02E-11 | 0.000000001 |
| Zn-65 | 5.82E-10 | | | | | | 9.15E-12 | 0.000000001 |
| Tl-207 | | | | | | | 7.54E-12 | 0.0000000004 |
| Rn-219 | | | | | | | 7.41E-12 | 0.0000000004 |
| Bi-211 | | | | | | | 5.99E-12 | 0.0000000003 |
| Pb-209 | | | | | | | 4.31E-12 | 0.0000000002 |
| Y-88 | 5.81E-10 | | | | | | 4.04E-12 | 0.0000000002 |
| Mn-54 | 6.01E-10 | | | | | | 3.91E-12 | 0.0000000002 |
| Fe-55 | 8.04E-09 | | | | | | 3.16E-12 | 0.0000000002 |
| Ni-63 | 7.41E-09 | | | | | | 2.84E-12 | 0.0000000002 |
| Nb-95m | | | | | | | 2.40E-12 | 0.0000000001 |
| Y-91 | 2.14E-09 | | | | | | 1.09E-12 | 0.0000000001 |
| Sr-85 | 7.61E-10 | | | | | | 7.33E-13 | 0.00000000004 |
| Co-57 | 6.41E-10 | | | | | | 6.41E-13 | 0.00000000004 |
| In-113m | | | | | | | 6.07E-13 | 0.00000000003 |
| Sr-89 | 5.99E-10 | | | | | | 4.85E-13 | 0.00000000003 |
| Po-216 | | | | | | | 4.15E-13 | 0.00000000002 |
| Ce-139 | 6.71E-10 | | | | | | 3.83E-13 | 0.00000000002 |
| Tl-206 | | | | | | | 3.44E-13 | 0.00000000002 |
| Ru-103 | 5.11E-10 | | | | | | 3.08E-13 | 0.00000000002 |
| At-217 | | | | | | | 3.07E-13 | 0.00000000002 |
| Sn-113 | 8.31E-10 | | | | | | 2.80E-13 | 0.00000000002 |
| I-131 | 7.01E-10 | | | | | | 2.75E-13 | 0.00000000002 |
| Ag-110m | 1.48E-11 | | | | | | 2.60E-13 | 0.00000000001 |

**Data Table A-25b, Radioactive Atmospheric Releases and MEI Doses at TRL Worker MEI Location**

**2019 CAP88 PC Dose Calculations for NESHAP Report to EPA** **4 Pages**

| Radionuclide | Releases (Curies) | | | | | | Maximally Exposed Individual Dose (mrem) | Fraction of Dose |
|---|---|---|---|---|---|---|---|---|
| | 0 m | 15m | 21m | 31m | 56m | 59m | | |
| At-218 | | | | | | | 1.90E-13 | 0.00000000001 |
| Fr-223 | | | | | | | 1.44E-13 | 0.00000000001 |
| Hg-203 | 6.51E-10 | | | | | | 9.12E-14 | 0.00000000001 |
| Po-218 | | | | | | | 5.06E-14 | <0.00000000001 |
| Po-213 | | | | | | | 4.73E-14 | <0.00000000001 |
| Ac-227 | | | | | | | 3.21E-14 | <0.00000000001 |
| Po-215 | | | | | | | 2.26E-14 | <0.00000000001 |
| Pr-144m | | | | | | | 1.54E-14 | <0.00000000001 |
| Hg-206 | | | | | | | 1.19E-14 | <0.00000000001 |
| Ni-59 | 5.76E-11 | | | | | | 1.06E-14 | <0.00000000001 |
| Ce-141 | 4.94E-11 | | | | | | 8.50E-15 | <0.00000000001 |
| Sn-123 | 6.66E-12 | | | | | | 8.34E-15 | <0.00000000001 |
| Pm-148m | 1.90E-12 | | | | | | 4.43E-15 | <0.00000000001 |
| Po-211 | | | | | | | 2.88E-15 | <0.00000000001 |
| U-235m | | | | | | | 1.24E-15 | <0.00000000001 |
| Rn-218 | | | | | | | 1.10E-15 | <0.00000000001 |
| Cm-245 | | | | | | | 5.52E-16 | <0.00000000001 |
| Rh-103m | | | | | | | 4.39E-16 | <0.00000000001 |
| Pm-148 | | | | | | | 3.26E-16 | <0.00000000001 |
| Ag-110 | | | | | | | 2.09E-16 | <0.00000000001 |
| Bi-215 | | | | | | | 3.33E-17 | <0.00000000001 |
| Te-127 | 1.04E-11 | | | | | | 1.73E-17 | <0.00000000001 |
| Cm-247 | | | | | | | 2.26E-18 | <0.00000000001 |
| Te-129 | 1.05E-12 | | | | | | 5.99E-19 | <0.00000000001 |
| Pu-243 | | | | | | | 1.72E-19 | <0.00000000001 |
| Xe-131m | | | | | | | 6.82E-22 | <0.00000000001 |
| Sm-147 | | | | | | | 2.96E-22 | <0.00000000001 |
| Nd-144 | | | | | | | 1.06E-28 | <0.00000000001 |
| Gd-152 | | | | | | | 4.20E-29 | <0.00000000001 |
| At-219 | | | | | | | | <0.00000000001 |
| Po-212 | | | | | | | | <0.00000000001 |
| Sm-148 | | | | | | | | <0.00000000001 |
| **Grand Total** | **2.47E+02** | **1.48E+03** | **3.10E+02** | **1.47E+03** | **2.57E+03** | **1.38E+04** | **1.76E-02** | |

a. Daughter products are calculated to have the same release rate as their parent source terms

## Data Table A-26a. Diffuse and Fugitive Releases and MEI Doses for NESHAP at Site Boundary MEI

**Data Table A-26a, Diffuse and Fugitive Releases and MEI Doses for NESHAP** **4 Pages**

**2019 Diffuse and Fugitive Releases[a] and MEI Doses at Site Boundary MEI**

| Radionuclide | Releases (curies) | Maximally Exposed Individual Dose (mrem) | Fraction of Dose |
|---|---|---|---|
| H-3 (oxide) | 2.47E+02 | 5.69E-04 | 0.32 |
| Cs-137 | 3.84E-03 | 5.63E-04 | 0.31 |
| Sr-90 | 3.32E-03 | 3.41E-04 | 0.19 |
| Gross Beta | 1.05E-03 | 1.23E-04 | 0.07 |
| Pu-239 | 6.84E-05 | 5.90E-05 | 0.03 |
| Y-90 | 0.00E+00 | 4.67E-05 | 0.03 |
| Gross Alpha | 4.15E-05 | 3.58E-05 | 0.02 |
| Pu-238 | 3.14E-05 | 2.48E-05 | 0.01 |
| Am-241 | 1.20E-05 | 8.62E-06 | 0.00 |
| Pu-240 | 7.68E-06 | 6.62E-06 | 0.004 |
| Pu-241 | 2.07E-04 | 3.25E-06 | 0.002 |
| Pu-242 | 3.28E-06 | 2.68E-06 | 0.001 |
| Bi-214 | 0.00E+00 | 1.21E-06 | 0.001 |
| Tc-99 | 5.08E-05 | 1.10E-06 | 0.001 |
| Th-230 | 9.73E-11 | 7.46E-07 | 0.000 |
| Ra-226 | 5.97E-07 | 6.86E-07 | 0.0004 |
| Np-237 | 1.55E-06 | 6.29E-07 | 0.0004 |
| Pb-214 | 0.00E+00 | 2.06E-07 | 0.0001 |
| F-18 | 4.00E-02 | 1.93E-07 | 0.0001 |
| U-234 | 2.86E-06 | 1.63E-07 | 0.0001 |
| Ra-228 | 5.93E-07 | 1.47E-07 | 0.0001 |
| U-238 | 2.63E-06 | 1.25E-07 | 0.0001 |
| Cm-244 | 2.75E-07 | 1.22E-07 | 0.0001 |
| Nb-94 | 2.42E-07 | 8.83E-08 | 0.0000 |
| I-129 | 4.31E-05 | 8.51E-08 | 0.00005 |
| Pa-233 | 1.42E-06 | 7.76E-08 | 0.00004 |
| Pa-234m | 0.00E+00 | 7.25E-08 | 0.00004 |
| Sb-126m | 0.00E+00 | 6.49E-08 | 0.00004 |
| Co-60 | 6.30E-07 | 5.92E-08 | 0.00003 |
| Cs-134 | 4.32E-07 | 2.91E-08 | 0.00002 |
| Tl-208 | 1.41E-06 | 2.56E-08 | 0.00001 |
| Eu-154 | 3.56E-07 | 2.43E-08 | 0.00001 |
| Ac-228 | 0.00E+00 | 2.03E-08 | 0.00001 |
| Ba-133 | 7.74E-07 | 1.94E-08 | 0.00001 |
| Bi-210 | 0.00E+00 | 1.64E-08 | 0.00001 |
| Sb-126 | 0.00E+00 | 1.57E-08 | 0.00001 |

**Data Table A-26a, Diffuse and Fugitive Releases and MEI Doses for NESHAP** **4 Pages**

**2019 Diffuse and Fugitive Releases[a] and MEI Doses at Site Boundary MEI**

| Radionuclide | Releases (curies) | Maximally Exposed Individual Dose (mrem) | Fraction of Dose |
|---|---|---|---|
| Th-228 | 1.34E-08 | 1.09E-08 | 0.00001 |
| Sb-125 | 1.18E-06 | 1.06E-08 | 0.00001 |
| Rh-106 | 0.00E+00 | 8.62E-09 | 0.00000 |
| Th-234 | 0.00E+00 | 6.31E-09 | 0.000004 |
| Ru-106 | 3.05E-06 | 6.09E-09 | 0.000003 |
| Th-229 | 1.34E-09 | 5.98E-09 | 0.000003 |
| Sn-126 | 1.70E-07 | 4.84E-09 | 0.000003 |
| Pb-212 | 8.43E-07 | 4.80E-09 | 0.000003 |
| Bi-212 | 0.00E+00 | 4.01E-09 | 0.000002 |
| Am-243 | 3.97E-09 | 2.84E-09 | 0.000002 |
| Cm-243 | 2.90E-09 | 1.59E-09 | 0.000001 |
| U-236 | 3.01E-08 | 1.57E-09 | 0.000001 |
| Pa-234 | 0.00E+00 | 1.43E-09 | 0.0000008 |
| U-235 | 1.25E-08 | 1.10E-09 | 0.0000006 |
| U-232 | 5.50E-09 | 1.02E-09 | 0.0000006 |
| Pb-210 | 0.00E+00 | 1.02E-09 | 0.0000006 |
| Th-231 | 2.12E-04 | 9.79E-10 | 0.0000005 |
| Ra-224 | 0.00E+00 | 9.18E-10 | 0.0000005 |
| Sm-151 | 2.89E-06 | 4.76E-10 | 0.0000003 |
| Pm-147 | 2.89E-06 | 4.74E-10 | 0.0000003 |
| Tl-210 | 0.00E+00 | 4.70E-10 | 0.0000003 |
| Ac-225 | 0.00E+00 | 4.54E-10 | 0.0000003 |
| Te-125m | 0.00E+00 | 4.52E-10 | 0.0000003 |
| Nb-95 | 3.63E-07 | 4.50E-10 | 0.0000003 |
| Ra-225 | 0.00E+00 | 4.15E-10 | 0.0000002 |
| Rn-222 | 0.00E+00 | 3.16E-10 | 0.0000002 |
| Eu-155 | 1.18E-07 | 2.50E-10 | 0.0000001 |
| U-233 | 3.42E-09 | 1.99E-10 | 0.0000001 |
| Bi-213 | 0.00E+00 | 1.93E-10 | 0.0000001 |
| Pu-236 | 5.52E-10 | 1.81E-10 | 0.0000001 |
| Eu-152 | 1.90E-09 | 1.69E-10 | 0.0000001 |
| Np-239 | 0.00E+00 | 1.6E-10 | 0.0000001 |
| Zr-95 | 1.22E-07 | 1.5E-10 | 0.0000001 |
| Se-79 | 4.90E-09 | 1.3E-10 | 0.0000001 |
| Po-214 | 0.00E+00 | 6.7E-11 | 0.0000000 |
| U-237 | 0.00E+00 | 5.2E-11 | 0.00000003 |
| Tl-209 | 0.00E+00 | 5.0E-11 | 0.00000003 |
| C-14 | 9.48E-08 | 3.6E-11 | 0.00000002 |

**Data Table A-26a, Diffuse and Fugitive Releases and MEI Doses for NESHAP** **4 Pages**

**2019 Diffuse and Fugitive Releases[a] and MEI Doses at Site Boundary MEI**

| Radionuclide | Releases (curies) | Maximally Exposed Individual Dose (mrem) | Fraction of Dose |
|---|---|---|---|
| Fr-221 | 0.00E+00 | 3.2E-11 | 0.00000002 |
| Ce-144 | 2.00E-08 | 3.0E-11 | 0.00000002 |
| Cf-251 | 1.78E-11 | 2.23E-11 | 0.00000001 |
| Pr-144 | 2.00E-08 | 2.02E-11 | 0.00000001 |
| Cd-109 | 1.68E-08 | 1.67E-11 | 0.00000001 |
| Rn-220 | 0.00E+00 | 1.44E-11 | 0.00000001 |
| Cf-249 | 7.89E-12 | 1.00E-11 | 0.00000001 |
| Zn-65 | 5.82E-10 | 8.6E-12 | 0.00000000 |
| Th-232 | 9.86E-12 | 4.5E-12 | 0.000000003 |
| Po-210 | 0.00E+00 | 4.3E-12 | 0.000000002 |
| Pb-209 | 0.00E+00 | 3.74E-12 | 0.000000002 |
| Y-88 | 5.81E-10 | 3.53E-12 | 0.000000002 |
| Mn-54 | 6.01E-10 | 3.40E-12 | 0.000000002 |
| Fe-55 | 8.04E-09 | 3.03E-12 | 0.000000002 |
| Ni-63 | 7.41E-09 | 2.73E-12 | 0.000000002 |
| Nb-95m | 0.00E+00 | 2.3E-12 | 0.000000001 |
| Y-91 | 2.14E-09 | 1.0E-12 | 0.000000001 |
| Pa-231 | 0.00E+00 | 1.0E-12 | 0.000000001 |
| Sr-85 | 7.61E-10 | 6.48E-13 | 0.000000000 |
| Co-57 | 6.41E-10 | 5.70E-13 | 0.0000000003 |
| In-113m | 0.00E+00 | 5.26E-13 | 0.0000000003 |
| Ra-223 | 0.00E+00 | 4.65E-13 | 0.0000000003 |
| Sr-89 | 5.99E-10 | 4.62E-13 | 0.0000000003 |
| Th-227 | 0.00E+00 | 4.16E-13 | 0.0000000002 |
| Pb-211 | 0.00E+00 | 3.95E-13 | 0.0000000002 |
| Po-216 | 0.00E+00 | 3.48E-13 | 0.0000000002 |
| Ce-139 | 6.71E-10 | 3.37E-13 | 0.0000000002 |
| I-131 | 7.01E-10 | 2.79E-13 | 0.0000000002 |
| Ru-103 | 5.11E-10 | 2.73E-13 | 0.0000000002 |
| Sn-113 | 8.31E-10 | 2.66E-13 | 0.0000000001 |
| At-217 | 0.00E+00 | 2.66E-13 | 0.0000000001 |
| Ag-110m | 1.48E-11 | 2.27E-13 | 0.0000000001 |
| Tl-207 | 0.00E+00 | 2.05E-13 | 0.0000000001 |
| Rn-219 | 0.00E+00 | 2.01E-13 | 0.0000000001 |
| Bi-211 | 0.00E+00 | 1.63E-13 | 0.0000000001 |
| Hg-203 | 6.51E-10 | 9.28E-14 | 0.0000000001 |
| Po-213 | 0.00E+00 | 4.09E-14 | 0.0000000000 |
| Tl-206 | 0.00E+00 | 3.84E-14 | 0.00000000002 |

**Data Table A-26a, Diffuse and Fugitive Releases and MEI Doses for NESHAP** **4 Pages**

**2019 Diffuse and Fugitive Releases[a] and MEI Doses at Site Boundary MEI**

| Radionuclide | Releases (curies) | Maximally Exposed Individual Dose (mrem) | Fraction of Dose |
|---|---|---|---|
| At-218 | 0.00E+00 | 2.12E-14 | 0.00000000001 |
| Pr-144m | 0.00E+00 | 1.34E-14 | 0.00000000001 |
| Ni-59 | 5.76E-11 | 1.02E-14 | 0.00000000001 |
| Ce-141 | 4.94E-11 | 7.96E-15 | <0.00000000001 |
| Sn-123 | 6.66E-12 | 7.92E-15 | <0.00000000001 |
| Po-218 | 0.00E+00 | 5.64E-15 | <0.00000000001 |
| Fr-223 | 0.00E+00 | 3.92E-15 | <0.00000000001 |
| Pm-148m | 1.90E-12 | 3.90E-15 | <0.00000000001 |
| Hg-206 | 0.00E+00 | 1.33E-15 | <0.00000000001 |
| Ac-227 | 0.00E+00 | 8.72E-16 | <0.00000000001 |
| U-235m | 0.00E+00 | 6.72E-16 | <0.00000000001 |
| Po-215 | 0.00E+00 | 6.16E-16 | <0.00000000001 |
| Cm-245 | 0.00E+00 | 4.79E-16 | <0.00000000001 |
| Rh-103m | 0.00E+00 | 3.83E-16 | <0.00000000001 |
| Pm-148 | 0.00E+00 | 2.96E-16 | <0.00000000001 |
| Ag-110 | 0.00E+00 | 1.81E-16 | <0.00000000001 |
| Rn-218 | 0.00E+00 | 1.23E-16 | <0.00000000001 |
| Po-211 | 0.00E+00 | 7.84E-17 | <0.00000000001 |
| Te-127 | 1.04E-11 | 1.70E-17 | <0.00000000001 |
| Cm-247 | 0.00E+00 | 1.96E-18 | <0.00000000001 |
| Bi-215 | 0.00E+00 | 9.06E-19 | <0.00000000001 |
| Te-129 | 1.05E-12 | 5.45E-19 | <0.00000000001 |
| Pu-243 | 0.00E+00 | 1.49E-19 | <0.00000000001 |
| Xe-131m | 0.00E+00 | 7.91E-22 | <0.00000000001 |
| Sm-147 | 0.00E+00 | 3.37E-22 | <0.00000000001 |
| Nd-144 | 0.00E+00 | 1.17E-28 | <0.00000000001 |
| Gd-152 | 0.00E+00 | 4.74E-29 | <0.00000000001 |
| At-219 | 0.00E+00 | 0.00E+00 | <0.00000000001 |
| Po-212 | 0.00E+00 | 0.00E+00 | <0.00000000001 |
| Sm-148 | 0.00E+00 | 0.00E+00 | <0.00000000001 |
| **Grand Total** | **2.47E+02** | **1.79E-03** | **100.00%** |

a. Beginning in 2016, calculated individual isotope annual releases below 1E-12 Ci (1 pCi) are no longer reported in this table and, therefore, not used in the dose calculations.
b. Daughter products (Sb-126 & Y-90) in secular equilibrium with source terms (Sn-126 & Sr-90, respectively). In CAP88, they are included in their parents' source term and are not run separately.
c. Radionuclides with no release values are daughter products with no original source term of their own.

## Data Table A-26b. Diffuse and Fugitive Releases and MEI Doses for NESHAP at TRL Worker Location

**Data Table A-26b, Diffuse and Fugitive Releases and MEI Doses for NESHAP** **4 Pages**

**2019 Diffuse and Fugitive Releases[a] and MEI Doses TRL Worker Location**

| Radionuclide | Releases (curies) | Maximally Exposed Individual Dose (mrem) | Fraction of Dose |
|---|---|---|---|
| Cs-137 | 3.84E-03 | 6.17E-04 | 0.33 |
| H-3 (oxide) | 2.47E+02 | 5.57E-04 | 0.30 |
| Sr-90 | 3.32E-03 | 3.55E-04 | 0.19 |
| Gross Beta | 1.05E-03 | 1.29E-04 | 0.07 |
| Pu-239 | 6.84E-05 | 5.93E-05 | 0.03 |
| Y-90 | 0.00E+00 | 5.39E-05 | 0.03 |
| Gross Alpha | 4.15E-05 | 3.60E-05 | 0.02 |
| Pu-238 | 3.14E-05 | 2.50E-05 | 0.01 |
| Am-241 | 1.20E-05 | 8.68E-06 | 0.00 |
| Pu-240 | 7.68E-06 | 6.66E-06 | 0.004 |
| Pu-241 | 2.07E-04 | 3.27E-06 | 0.002 |
| Pu-242 | 3.28E-06 | 2.70E-06 | 0.001 |
| Bi-214 | 0.00E+00 | 1.39E-06 | 0.001 |
| Tc-99 | 5.08E-05 | 1.14E-06 | 0.001 |
| Th-230 | 9.73E-11 | 7.52E-07 | 0.000 |
| Ra-226 | 5.97E-07 | 7.09E-07 | 0.0004 |
| Np-237 | 1.55E-06 | 6.35E-07 | 0.0003 |
| Pb-214 | 0.00E+00 | 2.39E-07 | 0.0001 |
| F-18 | 4.00E-02 | 2.10E-07 | 0.0001 |
| U-234 | 2.86E-06 | 1.64E-07 | 0.0001 |
| Ra-228 | 5.93E-07 | 1.52E-07 | 0.0001 |
| U-238 | 2.63E-06 | 1.27E-07 | 0.0001 |
| Cm-244 | 2.75E-07 | 1.23E-07 | 0.0001 |
| Nb-94 | 2.42E-07 | 1.02E-07 | 0.0001 |
| Pa-233 | 1.42E-06 | 8.95E-08 | 0.0000 |
| Pa-234m | 0.00E+00 | 8.37E-08 | 0.00005 |
| I-129 | 4.31E-05 | 8.36E-08 | 0.00004 |
| Sb-126m | 0.00E+00 | 7.49E-08 | 0.00004 |
| Co-60 | 6.30E-07 | 6.77E-08 | 0.00004 |
| Cs-134 | 4.32E-07 | 3.15E-08 | 0.00002 |
| Tl-208 | 1.41E-06 | 2.95E-08 | 0.00002 |
| Eu-154 | 3.56E-07 | 2.79E-08 | 0.00002 |
| Ac-228 | 0.00E+00 | 2.34E-08 | 0.00001 |
| Ba-133 | 7.74E-07 | 2.24E-08 | 0.00001 |
| Bi-210 | 0.00E+00 | 1.89E-08 | 0.00001 |
| Sb-126 | 0.00E+00 | 1.81E-08 | 0.00001 |

**Data Table A-26b, Diffuse and Fugitive Releases and MEI Doses for NESHAP** **4 Pages**

**2019 Diffuse and Fugitive Releases[a] and MEI Doses TRL Worker Location**

| Radionuclide | Releases (curies) | Maximally Exposed Individual Dose (mrem) | Fraction of Dose |
|---|---|---|---|
| Sb-125 | 1.18E-06 | 1.22E-08 | 0.00001 |
| Th-228 | 1.34E-08 | 1.10E-08 | 0.00001 |
| Rh-106 | 0.00E+00 | 9.95E-09 | 0.00001 |
| Th-234 | 0.00E+00 | 7.16E-09 | 0.00000 |
| Ru-106 | 3.05E-06 | 6.29E-09 | 0.000003 |
| Th-229 | 1.34E-09 | 6.03E-09 | 0.000003 |
| Pb-212 | 8.43E-07 | 5.30E-09 | 0.000003 |
| Sn-126 | 1.70E-07 | 5.27E-09 | 0.000003 |
| Bi-212 | 0.00E+00 | 4.57E-09 | 0.000002 |
| Am-243 | 3.97E-09 | 2.86E-09 | 0.000002 |
| Pa-234 | 0.00E+00 | 1.65E-09 | 0.000001 |
| Cm-243 | 2.90E-09 | 1.61E-09 | 0.000001 |
| U-236 | 3.01E-08 | 1.59E-09 | 0.000001 |
| Pb-210 | 0.00E+00 | 1.17E-09 | 0.000001 |
| U-235 | 1.25E-08 | 1.17E-09 | 0.000001 |
| U-232 | 5.50E-09 | 1.04E-09 | 0.000001 |
| Th-231 | 2.12E-04 | 1.00E-09 | 0.000001 |
| Ra-224 | 0.00E+00 | 9.56E-10 | 0.000001 |
| Tl-210 | 0.00E+00 | 5.43E-10 | 0.000000 |
| Nb-95 | 3.63E-07 | 5.13E-10 | 0.0000003 |
| Te-125m | 0.00E+00 | 4.90E-10 | 0.0000003 |
| Pm-147 | 2.89E-06 | 4.82E-10 | 0.0000003 |
| Sm-151 | 2.89E-06 | 4.81E-10 | 0.0000003 |
| Ac-225 | 0.00E+00 | 4.58E-10 | 0.0000002 |
| Ra-225 | 0.00E+00 | 4.19E-10 | 0.0000002 |
| Rn-222 | 0.00E+00 | 3.64E-10 | 0.0000002 |
| Eu-155 | 1.18E-07 | 2.84E-10 | 0.0000002 |
| Bi-213 | 0.00E+00 | 2.23E-10 | 0.0000001 |
| U-233 | 3.42E-09 | 2.01E-10 | 0.0000001 |
| Eu-152 | 1.90E-09 | 1.94E-10 | 0.0000001 |
| Np-239 | 0.00E+00 | 1.82E-10 | 0.0000001 |
| Pu-236 | 5.52E-10 | 1.8E-10 | 0.0000001 |
| Zr-95 | 1.22E-07 | 1.6E-10 | 0.0000001 |
| Se-79 | 4.90E-09 | 1.3E-10 | 0.0000001 |
| Po-214 | 0.00E+00 | 7.7E-11 | 0.0000000 |
| U-237 | 0.00E+00 | 6.0E-11 | 0.00000003 |
| Tl-209 | 0.00E+00 | 5.7E-11 | 0.00000003 |
| Fr-221 | 0.00E+00 | 3.6E-11 | 0.00000002 |

**Data Table A-26b, Diffuse and Fugitive Releases and MEI Doses for NESHAP** **4 Pages**

**2019 Diffuse and Fugitive Releases[a] and MEI Doses TRL Worker Location**

| Radionuclide | Releases (curies) | Maximally Exposed Individual Dose (mrem) | Fraction of Dose |
|---|---|---|---|
| C-14 | 9.48E-08 | 3.5E-11 | 0.00000002 |
| Ce-144 | 2.00E-08 | 3.1E-11 | 0.00000002 |
| Pr-144 | 2.00E-08 | 2.33E-11 | 0.00000001 |
| Cf-251 | 1.78E-11 | 2.25E-11 | 0.00000001 |
| Cd-109 | 1.68E-08 | 1.76E-11 | 0.00000001 |
| Rn-220 | 0.00E+00 | 1.66E-11 | 0.00000001 |
| Cf-249 | 7.89E-12 | 1.02E-11 | 0.00000001 |
| Zn-65 | 5.82E-10 | 9.2E-12 | 0.00000000 |
| Po-210 | 0.00E+00 | 4.9E-12 | 0.000000003 |
| Th-232 | 9.86E-12 | 4.5E-12 | 0.000000002 |
| Pb-209 | 0.00E+00 | 4.31E-12 | 0.000000002 |
| Y-88 | 5.81E-10 | 4.04E-12 | 0.000000002 |
| Mn-54 | 6.01E-10 | 3.91E-12 | 0.000000002 |
| Fe-55 | 8.04E-09 | 3.16E-12 | 0.000000002 |
| Ni-63 | 7.41E-09 | 2.84E-12 | 0.000000002 |
| Nb-95m | 0.00E+00 | 2.4E-12 | 0.000000001 |
| Y-91 | 2.14E-09 | 1.1E-12 | 0.000000001 |
| Pa-231 | 0.00E+00 | 9.4E-13 | 0.000000001 |
| Sr-85 | 7.61E-10 | 7.33E-13 | 0.000000000 |
| Co-57 | 6.41E-10 | 6.41E-13 | 0.0000000003 |
| In-113m | 0.00E+00 | 6.07E-13 | 0.0000000003 |
| Ra-223 | 0.00E+00 | 5.36E-13 | 0.0000000003 |
| Sr-89 | 5.99E-10 | 4.85E-13 | 0.0000000003 |
| Th-227 | 0.00E+00 | 4.79E-13 | 0.0000000003 |
| Pb-211 | 0.00E+00 | 4.56E-13 | 0.0000000002 |
| Po-216 | 0.00E+00 | 4.02E-13 | 0.0000000002 |
| Ce-139 | 6.71E-10 | 3.83E-13 | 0.0000000002 |
| Ru-103 | 5.11E-10 | 3.08E-13 | 0.0000000002 |
| At-217 | 0.00E+00 | 3.07E-13 | 0.0000000002 |
| Sn-113 | 8.31E-10 | 2.80E-13 | 0.0000000002 |
| I-131 | 7.01E-10 | 2.75E-13 | 0.0000000001 |
| Ag-110m | 1.48E-11 | 2.60E-13 | 0.0000000001 |
| Tl-207 | 0.00E+00 | 2.37E-13 | 0.0000000001 |
| Rn-219 | 0.00E+00 | 2.32E-13 | 0.0000000001 |
| Bi-211 | 0.00E+00 | 1.88E-13 | 0.0000000001 |
| Hg-203 | 6.51E-10 | 9.12E-14 | 0.0000000000 |
| Po-213 | 0.00E+00 | 4.73E-14 | 0.00000000003 |
| Tl-206 | 0.00E+00 | 4.43E-14 | 0.00000000002 |

**Data Table A-26b, Diffuse and Fugitive Releases and MEI Doses for NESHAP** **4 Pages**

**2019 Diffuse and Fugitive Releases[a] and MEI Doses TRL Worker Location**

| Radionuclide | Releases (curies) | Maximally Exposed Individual Dose (mrem) | Fraction of Dose |
|---|---|---|---|
| At-218 | 0.00E+00 | 2.45E-14 | 0.00000000001 |
| Pr-144m | 0.00E+00 | 1.54E-14 | 0.00000000001 |
| Ni-59 | 5.76E-11 | 1.06E-14 | 0.00000000001 |
| Ce-141 | 4.94E-11 | 8.50E-15 | <0.00000000001 |
| Sn-123 | 6.66E-12 | 8.34E-15 | <0.00000000001 |
| Po-218 | 0.00E+00 | 6.51E-15 | <0.00000000001 |
| Fr-223 | 0.00E+00 | 4.52E-15 | <0.00000000001 |
| Pm-148m | 1.90E-12 | 4.43E-15 | <0.00000000001 |
| Hg-206 | 0.00E+00 | 1.53E-15 | <0.00000000001 |
| Ac-227 | 0.00E+00 | 1.01E-15 | <0.00000000001 |
| Po-215 | 0.00E+00 | 7.10E-16 | <0.00000000001 |
| U-235m | 0.00E+00 | 6.75E-16 | <0.00000000001 |
| Cm-245 | 0.00E+00 | 5.52E-16 | <0.00000000001 |
| Rh-103m | 0.00E+00 | 4.39E-16 | <0.00000000001 |
| Pm-148 | 0.00E+00 | 3.26E-16 | <0.00000000001 |
| Ag-110 | 0.00E+00 | 2.09E-16 | <0.00000000001 |
| Rn-218 | 0.00E+00 | 1.42E-16 | <0.00000000001 |
| Po-211 | 0.00E+00 | 9.05E-17 | <0.00000000001 |
| Te-127 | 1.04E-11 | 1.73E-17 | <0.00000000001 |
| Cm-247 | 0.00E+00 | 2.26E-18 | <0.00000000001 |
| Bi-215 | 0.00E+00 | 1.05E-18 | <0.00000000001 |
| Te-129 | 1.05E-12 | 5.99E-19 | <0.00000000001 |
| Pu-243 | 0.00E+00 | 1.72E-19 | <0.00000000001 |
| Xe-131m | 0.00E+00 | 6.82E-22 | <0.00000000001 |
| Sm-147 | 0.00E+00 | 2.96E-22 | <0.00000000001 |
| Nd-144 | 0.00E+00 | 1.06E-28 | <0.00000000001 |
| Gd-152 | 0.00E+00 | 4.20E-29 | <0.00000000001 |
| At-219 | 0.00E+00 | 0.00E+00 | <0.00000000001 |
| Po-212 | 0.00E+00 | 0.00E+00 | <0.00000000001 |
| Sm-148 | 0.00E+00 | 0.00E+00 | <0.00000000001 |
| **Grand Total** | **2.47E+02** | **1.86E-03** | **100.00%** |

a. Beginning in 2016, calculated individual isotope annual releases below 1E-12 Ci (1 pCi) are no longer reported in this table and, therefore, not used in the dose calculations.
b. Daughter products (Sb-126 & Y-90) in secular equilibrium with source terms (Sn-126 & Sr-90, respectively). In CAP88, they are included in their parents' source term and are not run separately.
c. Radionuclides with no release values are daughter products with no original source term of their own.

## Data Table A-27. CAP88 Offsite MEI Dose Compared to MAXDOSE-SR

### Data Table A-27, CAP88 Offsite MEI Dose Compared to MAXDOSE-SR

**2019 Maximally Exposed Individual Dose Commitment at Site Boundary from Atmospheric Releases**

| Pathway | CAP88 PC Maximally Exposed Individual | | MAXDOSE-SR Representative Person | |
|---|---|---|---|---|
| | (Millirem)[a] | (Percent of Dose) | (Millirem)[a] | (Percent of Dose)[d] |
| Plume | 2.10E-04 | 1.19% | 5.65E-04 | 3.14% |
| Ground | 3.54E-04 | 2.00% | 4.35E-04 | 2.42% |
| Inhalation | 2.44E-03 | 13.77% | 5.41E-03 | 30.08% |
| Food[b] | 1.47E-02 | 83.05% | 1.16E-02 | 64.36% |
| **Total** | **1.78E-02** | **100.00%** | **1.80E-02** | **100.00%** |

| Radionuclide | CAP88 PC Maximally Exposed Individual | | MAXDOSE-SR Representative Person | |
|---|---|---|---|---|
| | (Millirem)[a] | (Percent of Dose) | (Millirem)[a] | (Percent of Dose)[d] |
| **Gases and Vapors** | | | | |
| H-3[c] | 1.62E-02 | 91.26% | 1.22E-02 | 67.79% |
| C-14 | 1.27E-05 | 0.07% | 3.82E-05 | 0.21% |
| Kr-85 | 2.10E-04 | 1.18% | 5.65E-04 | 3.14% |
| I-129 | 1.34E-05 | 0.08% | 4.06E-03 | 22.56% |
| **Particulates** | | | | |
| Am-241 | 1.17E-05 | 0.07% | 2.07E-05 | 0.12% |
| Cs-137 | 5.68E-04 | 3.20% | 3.39E-04 | 1.88% |
| Pu-238 | 2.74E-05 | 0.15% | 4.95E-05 | 0.28% |
| Pu-239 | 1.05E-04 | 0.59% | 1.88E-04 | 1.04% |
| Pu-240 | 6.62E-06 | 0.04% | 1.19E-05 | 0.07% |
| Pu-241 | 3.25E-06 | 0.02% | 5.72E-06 | 0.03% |
| Pu-242 | 2.68E-06 | 0.02% | 4.84E-06 | 0.03% |
| Sr-90 | 3.44E-04 | 1.94% | 3.03E-04 | 1.68% |
| Tc-99 | 1.10E-06 | 0.01% | 1.25E-05 | 0.07% |
| U-234 | 1.28E-06 | 0.01% | 3.04E-06 | 0.02% |
| U-238 | 1.38E-06 | 0.01% | 4.44E-06 | 0.02% |
| Unidentified Alpha | 3.61E-05 | 0.20% | 6.48E-05 | 0.36% |
| Unidentified Beta | 1.38E-04 | 0.77% | 1.23E-04 | 0.68% |
| Others | 7.13E-05 | 0.40% | 3.12E-06 | 0.02% |
| **Total** | **1.78E-02** | **100.00%** | **1.80E-02** | **100.00%** |

NOTE: (a) Committed effective dose.

NOTE: (b) Meat, milk, and vegetables.

NOTE: (c) Dose from tritium in foods calculated with absolute humidity of 12.9 g water/cubic meter of air.

NOTE: (d) Radionuclides contributing 0.01% or more from MAXDOSE-SR output.

## Data Table A-28. CAP88 PC Population Dose Compared to POPDOSE-SR

## Data Table A-28, CAP88 PC Population Dose Compared to POPDOSE-SR

**2019 Collective Committed Dose from Atmospheric Releases**

| Pathway | CAP88 Code | | POPDOSE-SR Code | |
|---|---|---|---|---|
| | Person-rem[a] | Percent of Dose | Person-rem[a] | Percent of Dose[d] |
| Plume | 2.64E-02 | 1.52% | 4.49E-02 | 6.45% |
| Ground | 4.22E-02 | 2.44% | 3.74E-02 | 5.37% |
| Inhalation | 2.96E-01 | 17.11% | 4.67E-01 | 67.06% |
| Food[b] | 1.37E+00 | 78.93% | 1.47E-01 | 21.12% |
| **Total** | **1.73E+00** | **100.00%** | **6.96E-01** | **100.00%** |

| Radionuclide | CAP88 Code | | POPDOSE-SR Code | |
|---|---|---|---|---|
| | Person-rem(a) | Percent of Dose | Person-rem(a) | Percent of Dose(d) |
| ***Gases and Vapors*** | | | | |
| H-3[c] | 1.57E+00 | 90.69% | 5.43E-01 | 77.94% |
| C-14 | 1.20E-03 | 0.07% | 4.18E-04 | 0.06% |
| Kr-85 | 2.64E-02 | 1.53% | 4.49E-02 | 6.44% |
| I-129 | 1.68E-03 | 0.10% | 5.03E-02 | 7.22% |
| ***Particulates*** | | | | |
| Am-241 | 1.08E-03 | 0.06% | 1.15E-03 | 0.17% |
| Cs-137 | 6.13E-02 | 3.55% | 2.49E-02 | 3.57% |
| Pu-238 | 2.50E-03 | 0.14% | 2.60E-03 | 0.37% |
| Pu-239 | 9.94E-03 | 0.58% | 1.09E-02 | 1.56% |
| Pu-240 | 5.97E-04 | 0.03% | 6.06E-04 | 0.09% |
| Pu-241 | 2.93E-04 | 0.02% | 2.91E-04 | 0.04% |
| Pu-242 | 2.42E-04 | 0.01% | 2.46E-04 | 0.04% |
| Sr-90 | 3.09E-02 | 1.79% | 9.46E-03 | 1.36% |
| U-234 | 1.20E-04 | 0.01% | 1.70E-04 | 0.02% |
| U-238 | 1.29E-04 | 0.01% | 2.99E-04 | 0.04% |
| Unidentified Alpha | 3.25E-03 | 0.19% | 3.30E-03 | 0.47% |
| Unidentified Beta | 1.28E-02 | 0.74% | 3.95E-03 | 0.57% |
| Others | 8.22E-03 | 0.48% | 2.06E-04 | 0.03% |
| **Total** | **1.73E+00** | **100.00%** | **6.97E-01** | **100.00%** |

NOTE: (a) Committed effective dose equivalent

NOTE: (b) Meat, milk, and vegetables

NOTE: (c) Dose from tritium in foods calculated with absolute humidity of 12.9 g water/cubic meter of air

NOTE: (d) Radionuclides contributing 0.01% or more from POPDOSE-SR or CAP88 output.

## Data Table A-29. Deer and Hog Hunter Doses

### Data Table A-29, Deer and Hog Hunter Doses

**2019 Deer and Hog Hunter Doses**

| | | | | |
|---|---|---|---|---|
| **Onsite Deer Hunter (Actual Hunter)** | | | | |
| Maximum Individual Dose determined by field measurements = | | | **17.38** | **mrem** |
| 4 animals harvested (3-Hog, 1-Deer) | | | | |
| Total gross (live) weight = | 445 | lbs | *202* | *kg* |
| Total edible weight = | 200 | lbs | *91* | *kg* |
| **Offsite Deer Hunter Dose (Hypothetical Hunter)** | | | | |
| Mean of the gross cesium-137 concentration in onsite deer = | | | 1.02 | pCi/g |
| CSRA background concentration = | | | 0.5 | pCi/g |
| MEI meat consumption rate = | | | 81 | kg/y |
| Cesium-137 adult dose coefficient (from DOE-STD-1196-2011) = | | | 5.03E-05 | mrem/pCi |
| **Dose =** | | | **2.12** | **mrem** |
| **Offsite Hog Hunter Dose (Hypothetical Hunter)** | | | | |
| Mean of the gross cesium-137 concentration in onsite hogs = | | | 2.40 | pCi/g |
| CSRA background concentration = | | | 0.5 | pCi/g |
| MEI meat consumption rate = | | | 81 | kg/y |
| Cesium-137 adult dose coefficient (from DOE-STD-1196-2011) = | | | 5.03E-05 | mrem/pCi |
| **Dose =** | | | **7.74** | **mrem** |

Data in red are from the Environmental Monitoring Program Subject Matter Expert

Email from Brian Price to Tim Jannik (4/29/2020)

**Data Table A-30a. Average Concentration in Composites used in the Dose Calculations (pCi/g)**

**Data Table A-30a, Average Concentration in Composites used in the Dose Calculations (pCi/g)**



| Location | Species | Sr-89,90 | Cs-137 | I-129 | Tc-99 |
|---|---|---|---|---|---|
| Augusta | Bass | 3.14E-03 | 1.15E-02 | | |
| Lock + Dam | Catfish | | 2.68E-02 | | 5.65E-02 |
| | Panfish | | 1.40E-02 | | |
| U3R | Bass | | 2.36E-02 | | |
| Mouth | Catfish | | 2.05E-02 | | |
| | Panfish | | 2.11E-02 | | |
| Fourmile | Bass | 2.74E-03 | 9.48E-02 | | |
| Branch Mouth | Catfish | | 5.63E-02 | | |
| | Panfish | 3.18E-03 | 4.24E-02 | | |
| Steel Creek | Bass | 2.46E-03 | 8.59E-02 | | 5.86E-02 |
| Mouth | Catfish | | 9.98E-02 | | |
| | Panfish | | 6.34E-02 | | |
| L3R | Bass | | 1.92E-01 | | |
| Mouth | Catfish | | 7.57E-02 | | |
| | Panfish | 5.46E-03 | 3.58E-02 | | |
| Hwy-301 | Bass | | 2.34E-02 | | 9.48E-02 |
| Bridge Area | Catfish | 1.85E-03 | 1.96E-02 | | 8.02E-02 |
| | Panfish | 4.83E-03 | 1.79E-02 | | 9.99E-02 |

Note: Averages are based on three composites of up to five fish of each species from each location.
At least one of the three composite samples had to have a significant result for an average concentration to be reported.
Refer to Data Table 5-16 for the radioanalytical results.

**Data Table A-30b. Total Dose from Consumption of 24 kg/y from Savannah River Fish (mrem)**

**Data Table A-30b, Total Dose from Consumption of 24 kg/y from Savannah River Fish (mrem)** 

| Location | Species | Sr-90 | Cs-137 | I-129 | Tc-99 | Total |
|---|---|---|---|---|---|---|
| Augusta | Bass | 1.00E-02 | 1.36E-02 | | | 2.36E-02 |
| Lock + Dam | Catfish | | 3.17E-02 | | 4.52E-03 | 3.62E-02 |
| | Panfish | | 1.65E-02 | | | 1.65E-02 |
| U3R | Bass | | 2.79E-02 | | | 2.79E-02 |
| Mouth | Catfish | | 2.42E-02 | | | 2.42E-02 |
| | Panfish | | 2.49E-02 | | | 2.49E-02 |
| Fourmile | Bass | 8.76E-03 | 1.12E-01 | | | 1.21E-01 |
| Branch Mouth | Catfish | | 6.65E-02 | | | 6.65E-02 |
| | Panfish | 1.02E-02 | 5.01E-02 | | | 6.02E-02 |
| Steel Creek | Bass | 7.86E-03 | 1.01E-01 | | 4.68E-03 | 1.14E-01 |
| Mouth | Catfish | | 1.18E-01 | | | 1.18E-01 |
| | Panfish | | 7.49E-02 | | | 7.49E-02 |
| L3R | Bass | | 2.27E-01 | | | **2.27E-01** |
| Mouth | Catfish | | 8.94E-02 | | | 8.94E-02 |
| | Panfish | 1.75E-02 | 4.23E-02 | | | 5.97E-02 |
| Hwy-301 | Bass | | 2.76E-02 | | 7.58E-03 | 3.52E-02 |
| Bridge Area | Catfish | 5.91E-03 | 2.31E-02 | | 6.41E-03 | 3.55E-02 |
| | Panfish | 1.54E-02 | 2.11E-02 | | 7.98E-03 | 4.46E-02 |

Note: Ingestion dose coefficients are from the DOE Derived Concentration Technical Standard (DOE-STD-1196-2011)

**Data Table A-30c. Total Risk from Consumption of 24 kg/y from Savannah River Fish (risk/year)**

**Data Table A-30c, Total Risk from Consumption of 24 kg/y from Savannah River Fish (risk/year)** 

| Location | Species | Sr-90 | Cs-137 | I-129 | Tc-99 | Total |
|---|---|---|---|---|---|---|
| Augusta | Bass | 7.18E-09 | 1.03E-08 | | | 1.75E-08 |
| Lock + Dam | Catfish | | 2.41E-08 | | 5.42E-09 | 2.95E-08 |
| | Panfish | | 1.26E-08 | | | 1.26E-08 |
| U3R | Bass | | 2.12E-08 | | | 2.12E-08 |
| Mouth | Catfish | | 1.84E-08 | | | 1.84E-08 |
| | Panfish | | 1.89E-08 | | | 1.89E-08 |
| Fourmile | Bass | 6.27E-09 | 8.51E-08 | | | 9.14E-08 |
| Branch Mouth | Catfish | | 5.05E-08 | | | 5.05E-08 |
| | Panfish | 7.27E-09 | 3.81E-08 | | | 4.53E-08 |
| Steel Creek | Bass | 5.63E-09 | 7.71E-08 | | 5.63E-09 | 8.84E-08 |
| Mouth | Catfish | | 8.96E-08 | | | 8.96E-08 |
| | Panfish | | 5.69E-08 | | | 5.69E-08 |
| L3R | Bass | | 1.72E-07 | | | **1.72E-07** |
| Mouth | Catfish | | 6.79E-08 | | | 6.79E-08 |
| | Panfish | 1.25E-08 | 3.21E-08 | | | 4.46E-08 |
| Hwy-301 | Bass | | 2.10E-08 | | 9.10E-09 | 3.01E-08 |
| Bridge Area | Catfish | 4.23E-09 | 1.76E-08 | | 7.70E-09 | 2.95E-08 |
| | Panfish | 1.10E-08 | 1.61E-08 | | 9.59E-09 | 3.67E-08 |

Note: SRS estimated the potential risks using the cancer morbidity risk coefficients from Federal Guidance Report No. 13.

## Data Table A-31. SRS Supplemental Release Criteria

**Data Table A-31, SRS Supplemental Release Criteria**

| Radionuclide Groups (a) | Removable (b) dpm/100 cm2 | Total (Fixed+Removable)(c) dpm/100 cm2 | Volumetric (d) pCi/g |
|---|---|---|---|
| Group 1 Radium, Thorium, and Transuranics: 210Po, 210Pb, 226Ra, 228Ra, 228Th, 230Th, 232Th, 237Np, 239Pu, 240Pu, 241Am, 244Cm, and associated decay chains(e), and others(a) | 20 | 500 | 3 |
| Group 2 U-nat, 234U, 235U, 238U, and associated decay products(f): 14C, 22Na, 24Na, 32P, 35S, 36Cl, 45Ca, 51Cr, 54Mn, 55Fe, 59Fe, 58Co, 60Co, 63Ni, 65Zn, 89Sr, 90Sr, 94Nb, 99Tc, 106Ru, 110mAg, 109Cd, 111In, 124Sb, 125I, 129I, 131I, 134Cs, 137Cs, 144Ce, 147Pm, 152Eu, 154Eu, 192Ir, 198Au, 241Pu, and others(a) | 1000 | 5000 | 30 |
| Tritium and tritiated compounds(g) | 10,000/100,000(h) | N/A | 2000 |

(a) To determine the specific group for radionuclides not shown, a comparison of the effective dose factors, by exposure pathway, listed in Table A.1 of NCRP Report No. 123 for the radionuclides in question and the radionuclides in the general groups above shall be performed and a determination of the proper group made, based on similarity of the factors.

(b) The amount of removable radioactive material per 100 cm2 of surface area should be determined by swiping the area with dry filter or soft absorbent paper, applying moderate pressure, and then assessing the amount of radioactive material on the swipe with an appropriate instrument of known efficiency. (Note - The use of dry material may not be appropriate for tritium). When removable contamination on objects of surface area less than 100 cm2 is determined, the activity per unit area shall be based on the actual area and the entire surface shall be wiped. It is not necessary to use swiping techniques to measure removable contamination levels if direct scan surveys indicate that the total residual surface contamination levels are within the limits for removable contamination.

(c) The levels may be averaged over one square meter provided the maximum surface activity in any area of 100 cm2 is less than three times the value specified. For purpose of averaging, any square meter of surface shall be considered to be above the surface contamination value if: (1) from measurements of a representative number of sections it is determined that the average contamination exceeds the applicable value; or (2) it is determined that the sum of the activity of all isolated spots or particles in any 100 cm2 area exceeds three times the applicable value.

(d) Volume criteria will only be applied for the purpose of release of materials for disposal in a state, DOE, permitted or approved on-site landfill.

(e) For decay chains, the screening levels represent the total activity (i.e., the activity of the parent plus the activity of all progeny) present.

(f) Alpha component of activity

(g) Tritium contamination may diffuse into the volume or matrix of materials. Evaluation of surface contamination shall consider the extent to which such contamination may migrate to the surface in order to ensure the surface contamination value is not exceeded. Once this contamination migrates to the surface, it may be removable, not fixed; therefore, a "Total" value does not apply.

(h) The criterion of 10,000 dpm/100 cm2 will be used for release of material for unrestricted use (reuse or recycle). The criterion of 100,000 dpm/100 cm2 will be used for the controlled on-site landfill disposal of material. (Note - DOE Suspension (July 2000) for recycle of metals will apply until rescinded). However, WSRC will only implement this more relaxed tritium surface criterion if a future exemption to 10CFR835 is granted.

## Data Table A-32. Biota Dose Assessment

**Data Table A-32, Biota Dose Assessment**

**Initial Level 1 Aquatic Systems Screen using Maximum Radionuclide Concentrations in Water and Sediment[a,b]**

| Location | Sum-of-the-Fractions of BCGs |
|---|---|
| FM-2 | 0.1030 |
| FM-2B | 0.3290 |
| FM-3A | 0.1280 |
| FM-6 | 0.1270 |
| FM-A7 | 0.1980 |
| L3R-1A | 0.0955 |
| L3R-3 | 0.3730 |
| PB-3 | 0.0579 |
| SC-2A | 0.3030 |
| SC-4 | 0.0728 |
| TB-5 | 0.0703 |
| U3R-3 | 0.0898 |
| U3R-4 | 0.0859 |
| Z-Area Basin | 0.7640 |

Note: Values are provided in SRNL-L3200-2020-00049

**Initial Level 1 Terrestrial Systems Screen using Maximum Radionuclide Concentrations in Soil[a,b]**

| Location | Sum-of-the-Fractions of BCGs |
|---|---|
| F-Area | 0.0071 |
| H-Area | 0.0141 |
| Z-Area | 0.0102 |
| 643-26E | 0.0018 |
| Burial Ground-North | 0.0032 |

Note: Values are provided in SRNL-3200-2020-00050

a. Soils and sediment are sampled on an annual basis. Stream water is generally sampled monthly.
b. Negative concentrations were assumed to be 0.

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