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Idaho National Laboratory CY 2022 National Emission Standards for Hazardous Air Pollutants Analysis, Methodology, and Results for Radionuclides

May 2023

Kira B. Overin and A. Jeffrey Sondrup
Idaho National Laboratory

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Idaho National Laboratory
Idaho Falls, Idaho 83415

http://www.inl.gov

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EXECUTIVE SUMMARY

This report details calculations of potential dose—at public receptor locations surrounding the Idaho National Laboratory (INL) Site boundary and INL in-town facilities—from radionuclides reported to be in use and potentially emitted from INL facilities during calendar year (CY) 2022. All calculations were performed in accordance with the requirements of Code of Federal Regulations (CFR), Title 40, "Protection of the Environment," Part 61, "National Emission Standards for Hazardous Air Pollutants (NESHAPs)," Subpart H, "National Emission Standards for Emissions of Radionuclides Other than Radon from Department of Energy Facilities" (40 CFR 61, Subpart H). Modeling methodology, model-input parameters, and contribution to dose by facility, source, and radionuclide at the maximally exposed individual (MEI) location are also discussed. The information in this report supports the "National Emission Standards for Hazardous Air Pollutants—Calendar Year 2022 INL Report for Radionuclides" (DOE-ID 2023).

During CY 2022, the estimated annual potential dose at the INL Site MEI location was 1.78E-02 mrem/yr, down from the previous year, and far less than the regulatory standard of 10 mrem/yr (CFR 40 Part 61, Subpart H). Approximately 87% of the total dose to the INL Site MEI originated from Materials and Fuels Complex sources. Emissions from INL in-town facilities resulted in an estimated annual potential dose of 4.03E-03 mrem/yr to the MEI, down 35% from the CY 2021 estimated dose. Year-to-year variations in estimated annual dose can be attributed to adjustments in laboratory operations, changes to facility infrastructure, and variation in meteorological conditions.

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ACRONYMS

ARP	Accelerated Retrieval Project
ATR	Advanced Test Reactor
BEA	Battelle Energy Alliance, LLC
CAP88-PC	Clean Air Act Assessment Package 1988–Personal Computer
CFA	Central Facilities Area
CFR	Code of Federal Regulations
CITRC	Critical Infrastructure Test Range Complex
CY	calendar year
DOE	U.S. Department of Energy
DOS	disk operating system
ED	effective dose
EDE	effective dose equivalent
EPA	Environmental Protection Agency
FY	fiscal year
GUI	graphical user interface
INL	Idaho National Laboratory
INTEC	Idaho Nuclear Technology and Engineering Center
IRC	INL Research Complex
MEI	maximally exposed individual
MFC	Materials and Fuels Complex
MS	main stack
MTR	Materials Test Reactor
NESHAP	National Emissions Standards for Hazardous Air Pollutants
NOAA	National Oceanic and Atmospheric Administration
NRF	Naval Reactors Facility
NSL	National Security Laboratory
RESL	Radiological and Environmental Sciences Laboratory
RRTR	Radiological Response Training Range
NTR	Northern Test Range
NETP	New Explosive Test Pad
RTP	Radiological Training Pad
RSWF	Radioactive Scrap and Waste Facility
RTC	Reactor Technology Complex

RWMC	Radioactive Waste Management Complex
SMC	Specific Manufacturing Capability
SQL	Structured Query Language
STAR	Safety and Tritium Applied Research Facility
TAN-TSF	Test Area North – Test Support Facility
TRA	Test Reactor Area
TREAT	Transient Reactor Test Facility
UDF	unit-dose factor

Idaho National Laboratory CY 2022 National Emission Standards for Hazardous Air Pollutants Analysis, Methodology, and Results for Radionuclides

1. INTRODUCTION

This report documents the methodology and results for calculating the effective dose equivalent (EDE) to the maximally exposed individual (MEI) from atmospheric radionuclide emissions from Idaho National Laboratory (INL) sources in Calendar Year (CY) 2022. The calculations were performed in accordance with requirements in Code of Federal Regulations (CFR), Title 40, "Protection of the Environment," Part 61, "National Emission Standards for Hazardous Air Pollutants (NESHAPs)," Subpart H, "National Emission Standards for Emissions of Radionuclides Other than Radon from Department of Energy Facilities" (40 CFR 61, Subpart H). UDF were calculated using the computer model CAP88-PC for unit (1 Ci/yr) emission rates at INL Site facilities and INL in-town (Idaho Falls) facilities and stored in Microsoft Access databases. The UDFs—in this case, mrem/Ci—were then combined with radionuclide-specific release (emission) rates for each facility-specific source to compute doses at predetermined public receptor locations, including the MEI locations. This report contains the dose results and a description of the methodology and tools used to compute the doses.

1.1 Updates to INL NESHAP Assessments

Beginning in CY 22, two primary updates were made to INL NESHAP assessments. These are:

- Receptor locations for INL Site facilities were updated. This decreased the number of receptors from 62 to 31 and is described in *Update of Receptor Locations for INL National Emissions Standard for Hazardous Air Pollutants Assessments* (INL 2023a).
- The methodology used to model in-town emissions and doses was updated to make it consistent with the methodology used for the INL Site. In previous years, emissions from in-town facilities were modeled as releases from a single location. Beginning in CY 22, the methodology was changed to allow emissions to be modeled as separate emission sources. This necessitated updating receptor locations for in-town facilities, which is also described in INL (2023).

2. ATMOSPHERIC DISPERSION AND DOSE MODELING

Atmospheric dispersion and dose modeling of potential radioactive emissions from INL facilities was performed with the Clean Air Act Assessment Package 1988-Personal Computer (CAP88-PC). The CAP88-PC computer model is a set of computer programs, databases, and associated utility programs for estimation of dose and risk from radionuclide emissions to air. CAP88-PC is a mature model required by the U.S. Environmental Protection Agency (EPA) for demonstration of compliance with 40 CFR 61, Subpart H. While any officially approved version of CAP88 may be used to demonstrate compliance, CAP88-PC, Version 4.1 (approved for use March 2020), was used for this assessment. Testing and validation of CAP88-PC is performed by EPA and documented in EPA (2020, 2021). Verification of proper installation and operation of CAP88-PC is performed by Battelle Energy Alliance (BEA) staff annually by simulating the example problem (Modtest) provided in the downloaded zip file. The verification files can be found in Appendix F with additional verification test results.

All modeling and calculations were performed on a Dell OptiPlex 7090 computer (Intel Core i7-10700 central processing unit (CPU) @ 2.90 GHz) running Microsoft Windows 10, Enterprise. Microsoft Excel and Microsoft Access for Office 365 (MSO) Version 2304 Build 16.0.16327.20200, 64-bit, Part of Microsoft Office 365 ProPlus, were used for pre- and post-processing calculations. The modeling was conducted according to guidance for performing environmental compliance-driven air modeling of

emissions from INL facilities (Staley et al. 2004). The modeling entailed calculating annual doses for unit emission rates for 339 radionuclides released from INL Site facilities and 31 radionuclides for INL in-town facilities in Idaho Falls. UDFs were calculated for each INL Site facility at 31 updated INL Site NESHAP receptor locations that encircle the INL Site boundary (see Figure 1). The selection of these 31 updated locations is documented in INL (2023). For releases at INL in-town facilities, radionuclides were assumed to be released from two ground-level point sources, located at the IF-683 and IF-603 facilities, and doses were calculated at the nearest public buildings (business, residence, apartment, church, etc., not including INL Research Complex [IRC] buildings) at 30 receptor locations surrounding the IRC facilities. The selection of these 30 updated locations is documented in INL (2023). The update of in-town receptors was necessary because the methodology used to model in-town emissions was updated to make it consistent with the methodology used for the INL Site.

Meteorological data files provided by the Idaho Falls Office of the National Oceanic and Atmospheric Administration (NOAA) were used for the calculations. Meteorological monitoring station locations for the INL Site are shown in Figure 1. Data from the Idaho Falls Greenbelt meteorological station, located approximately 1.1 miles southwest of the IRC, was used for the in-town modeling. In general, data from the station nearest to each INL facility was used. Table 1 lists the meteorological stations and wind files used for each facility. Stability array (*.str) files for each meteorological station were converted to wind (*.wnd) files using the computer program STARGET. The 2022 wind files are presented in Appendix A. Stack emissions were modeled for the Idaho Nuclear Technology and Engineering Center (INTEC) main stack (MS) (INTEC-MS, CPP-708), the Advanced Test Reactor (ATR) stack (RTC-ATR, TRA-770) at the ATR Complex, the main stack at the Materials and Fuels Complex (MFC) (MFC-MS, MFC-764), and the Transient Reactor Test (TREAT) exhaust stack (MFC-TREAT, MFC-720-007) using the nearest wind file from an upper (46 to 76 m) measurement height. All other sources were modeled as ground-level releases and used the wind file from the lower (10 to 15 m) measurement height. Parameters for the modeled stacks are provided in Table 2.

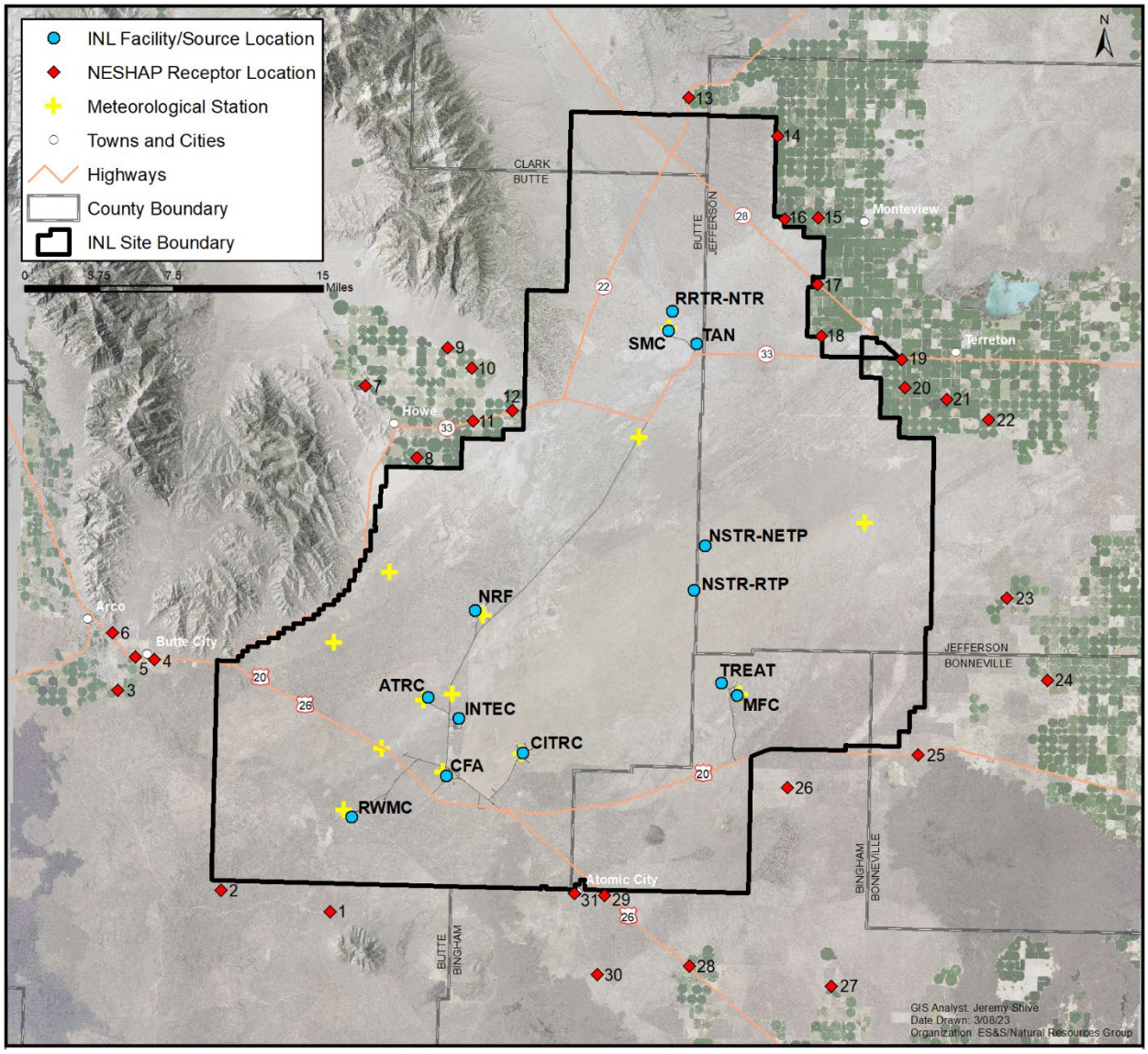

Figure 1. INL Site, including major facility areas and the 31 INL Site NESHAP receptor locations including the CY 2022 MEI location (Receptor 26). Meteorological station locations are shown but not labeled.

Table 1. Facilities and wind files used in CAP88-PC simulations.

Facility	FacilityID	Met StationID	2022 Wind File Name	Measurement Height (m)[c]
Central Facilities Area	CFA	690	690L22.WND	15
Critical Infrastructure Test Range Complex	CITRC	PBF	PBFL22.WND	15
Idaho Nuclear Technology and Engineering Center, Idaho CERCLA Disposal Facility	INTEC	GRI	GRIL22.WND	10
Idaho Nuclear Technology and Engineering Center, INTEC-MS	INTEC-MS	GRI	GRIU22.WND[b]	61
Materials and Fuels Complex	MFC	EBR	EBRL22.WND	10
Materials and Fuels Complex-MS	MFC-MS	EBR	EBRU22.WND	76
Materials and Fuels Complex-TREAT Stack	MFC-TREAT	EBR	EBRU22.WND	76

Naval Reactor Facility	NRF	NRF	NRFL22.WND	15
Advanced Test Reactor Complex[a]	RTC	TRA	TRAL22.WND	15
Advanced Test Reactor Complex[a], ATR MS	RTC-ATR	GRI	GRIU22.WND[b]	61
Radioactive Waste Management Complex	RWMC	RWMC	RWML22.WND	15
Specific Manufacturing Capability	SMC	LOF	LOFL22.WND	10
Test Area North, Technical Support Facility	TAN-TSF	LOF	LOFL22.WND	10
INL Research Center	IRC	IDA	IDAL22.WND	15

a. The ATR Complex was formerly known as the Test Reactor Area (TRA) and Reactor Technology Complex (RTC). Acronyms based on former names may still be used to describe facility buildings, meteorological stations, etc.
b. The nearest tower with an upper (>30 m) measurement height was used for modeling stack emissions at INTEC and the ATR Complex. The GRID III (GRI) tower is approximately 1.6 km north of INTEC and 1.7 km east of the ATR Complex.
c. Height above ground where meteorological measurements are taken.

Note: *Advanced Test Reactor Complex, Materials Test Reactor MSMain Stack reported no releases during calendar year 2022; therefore, it has been omitted from this table*

Table 2. Stack parameters used in CAP88-PC simulations.

FacilityID	Stack SourceID	Stack Height (m)	Stack Diameter (m)	Exit Velocity (m/s)
INTEC-MS[b]	CPP-708-001	76.2	1.83	8.47[a]
RTC-ATR	TRA-770-001	76.2	1.524	9.68[a]
MFC-MS[b]	MFC-764-001	61	1.524	8.72[a]
MFC-TREAT	MFC-720-007	42.7	0.61	6.78

a. Exit velocity a change from previous year.
b. MS = main stack

For dose calculations, the "local" food source option in CAP88-PC was selected to simulate a rural subsistence-farming scenario for the public receptors, including INL in-town receptors. This assumes all food products are grown at the receptor location. This is very conservative for in-town receptors because there are likely very few food products grown at the receptor location or in the assessment area. The CAP88-PC, Version 4.1, default parameters for this exposure scenario are shown in Table 3.

Table 3. CAP88-PC, Version 4.1, radionuclide-independent parameters for the local receptor scenario.

Parameter Description	Value	Units
Inhalation rate	5.26E+03	m^3/yr
Effective surface density of soil, dry weight (assumes 15 cm plow depth)	215	kg/m^2
Build-up time for radionuclides in soil	100	year
Build-up time for radionuclides deposited on ground/water	3.65E+04	day
Delay time, ingestion of pasture grass by animals	0	hr
Delay time, ingestion of stored feed by animals	2160	hr
Delay time, ingestion of leafy vegetables by man	336	hr
Delay time, ingestion of produce by man	336	hr
Delay time, transport time from animal feed to milk to man	2	day
Delay time, time from animal slaughter to consumption	20	day
Removal rate constant for physical loss by weathering	2.90E-03	1/hr
Crop exposure duration, pasture grass	720	hr
Crop exposure duration, crops, or leafy vegetables	1440	hr
Agricultural productivity, grass to cow to milk to man pathway	0.28	kg/m^2
Agricultural productivity, produce/leafy vegetables for human consumption	0.716	kg/m^2
Fallout interception fraction, vegetables	0.2	---
Fallout interception fraction, pasture	0.57	---
Fraction of year animals graze on pasture	0.4	---

Parameter Description	Value	Units
Fraction of daily feed that is pasture grass (when animal on pasture)	0.43	---
Animal consumption rate of contaminated feed/forage (dry weight)	15.6	kg/day
Milk production of cow	11	L/day
Muscle mass of animal at slaughter	200	kg
Fraction of animal herd slaughtered per day	3.81E-03	---
Fraction of radioactivity retained after washing (leafy veg & produce)	0.5	---
Fraction of produce ingested grown in garden of interest	1	---
Fraction of leafy vegetables ingested grown in garden of interest	1	---
Human produce ingestion rate	76.2	kg/yr
Human milk ingestion rate	53	L/yr
Human meat ingestion rate	84	kg/yr
Human leafy vegetable ingestion rate	7.79	kg/yr
Fraction of time spent swimming	0	---
Depth of water for dilution for water immersion doses	1	cm
Fraction vegetables home produced	1.0[a]	---
Fraction milk home produced	1.0[a]	---
Fraction meat home produced	1.0[a]	---
Fraction vegetables from assessment area	0.0[a]	---
Fraction meat from assessment area	0.0[a]	---
Fraction meat from assessment area	0.0[a]	---
Minimum ingestion fractions from outside area, vegetables	0	---
Minimum ingestion fractions from outside area, meat	0	---
Minimum ingestion fractions from outside area, milk	0	---
Default beef cattle density	7.19E-02[b]	#/ha
Milk cattle density	8.56E-03[b]	#/ha
Land fraction cultivated for vegetables	7.15E-02[b]	---

a. Value for a Local food source option. Options are Urban, Rural, Local, Regional, or Imported.
b. Values specific to the state of Idaho.

2.1 Unit-Dose Factors

The UDF is the annual dose at a receptor location for a given radionuclide from a given source location for a unit (1 Ci/yr) release, expressed as:

$$UDF_{i,j,k} = \frac{D_{i,j,k}}{Q_{i,k}} \quad (1)$$

where:

$UDF_{i,j,k}$ = UDF for radionuclide i (including progeny), at receptor j, from source k (mrem/Ci),
$D_{i,j,k}$ = CAP88-PC total pathway parent/progeny annual EDE for radionuclide i, at receptor j, from source k (mrem/yr),
$Q_{i,k}$ = unit release rate for radionuclide i, from source k (1 Ci/yr).

UDFs were calculated by running the CAP88-PC, Version 4.1, computer code for each radionuclide source-receptor combination even though not all radionuclides were emitted from each source. Because CAP88-PC, Version 4.1, only allows 20 receptors at a time, two separate CAP88-PC runs were made for each radionuclide source-receptor combination for the 14 INL Site facilities (see Table 1). Files were identified by an "A" suffix for receptors 1–20 and "B" for receptors 21–31. Therefore, the total number of CAP88-PC simulations for INL Site facilities was:

339 radionuclides × 14 facilities × 2 files/facility = 9,492 simulations.

The distance and direction to each receptor for each INL Site facility is listed in Appendix B. UDFs for each radionuclide source-receptor combination are combined with radionuclide and facility-specific release (emission) information to calculate the total dose at each receptor locations (see Sections 2.3 and 2.4). The MEI for all INL Site sources is determined after all dose calculations are made by comparing the total dose at each receptor location and selecting the maximum.

Development of input files and execution of CAP88-PC were automated by use of three Perl scripts, which are contained in Appendix C. Perl is a family of general-purpose script programming languages useful for file and data manipulation. The first script (*mkFiles.pl*) creates the CAP88-PC input files from (1) facility-specific template files, and (2) radionuclide-specific templates files. The facility-specific template files contain the filename and location of the wind file, receptor distances from the source, model options, release parameters, and other meteorological data (see Table 4) specific to a facility. Unless the source was from an identified stack, releases were assumed to be at ground level (i.e., 1 m) with no momentum or buoyant plume rise. All sources were located at the approximate geographic center of each facility. Radionuclide-specific template files were created with the graphical user interface of CAP88-PC one at a time using generic facility data. After creating each file, the generic facility-specific information was removed so the file could be combined with the facility-specific template files using the *mkFiles.pl* script. Each radionuclide template file contains radionuclide-specific data, including half-life and decay-chain information, deposition velocity and scavenging coefficient, food-transfer factors, radionuclide solubility class, and particle size. CAP88-PC default parameter values were used for all radionuclide template files. An exception is the chemical form of the radionuclide. Chemical forms were modified for radionuclides when provided by the generator.

The second script (*RunFiles.pl*) runs or executes each CAP88-PC simulation for all radionuclide files listed in the input file *NucFiles.inp*. *RunFiles.pl* creates and executes a batch file called *run.bat* that copies an input file (*.DAT) and the appropriate wind file (*.WND) to the directory containing the CAP88-PC Fortran executable file (*Cap88v41fortran.exe*). The files are renamed *input.dat* and *input.wnd*, respectively, before the Fortran executable file is run. After each simulation, *RunFiles.pl* copies the summary output file (*.SUM) for each radionuclide from the output directory to the appropriate facility directory for post-processing. This process is repeated for each radionuclide at each facility. The third script (*getCAP88dose2.pl*) post-processes all the *.SUM output files listed in the file *OutputFiles.inp*. The script extracts the dose from the 31 facility-specific receptor locations in each *.SUM output file and writes the UDFs to a text file (*tempdoses.txt*) containing facility name, radionuclide, receptor distance and direction, and UDF. This file is imported into a database to calculate doses for actual releases. Similar scripts with "IRC" in the script file name (*mkFilesIRC.pl, RunFilesIRC.pl,* and *getCAP88dose2IRC.pl*) are used for the INL in-town simulations and dose calculations.

Table 4. Other meteorological parameters used in the CAP88-PC modeling.

Variable	INL Site Value	In-Town Value	Units
Lid height	800[a]	800[a]	meters
Mean temperature	5.78[b]	7.06[d]	Celsius
Annual Precipitation	21.3[b]	23.9[d]	cm/yr
Absolute humidity	4.31[c]	4.90[d]	g/m^3

a. Memo from J. Sagendorf, NOAA, to M. Abbott, INL, February 11, 1991.
b. Annual average value at CFA based on data from 1950 to 2015 (Clawson et al. 2018).
c. Calculated from annual average mean temperature at CFA (1950–2015), pressure and relative humidity at CFA (1994–2015) (Clawson et al. 2018).
d. 2022 average value from NOAA Mesonet tower located in Idaho Falls.

2.2 Source Term

Source terms (annual emissions data) were provided in spreadsheets. These data were checked for accuracy and proper formatting before being imported into the *Releases* table in the database that calculates dose. There is one database file for the INL Site facilities, and one for INL in-town facilities. INL facilities report annual emission rates or radionuclide inventories. To estimate the potential annual emissions from radionuclide inventories, the inventories were multiplied by appropriate release factors based on the methodology in 40 CFR 61, Appendix D, and additional guidance/approval by EPA Region 10 for radioactive solid materials that undergo heating (see letter from Donald Dossett [EPA Region 10] to Tim Safford [DOE-ID], October 19, 2017 [CCN 241475]). These calculations were performed before the data were imported into the *Releases* table. The *Releases* tables for the INL Site and INL in-town facilities can be found in Appendix D. For each INL Site facility and source, the facility supplied the radionuclide and total annual release (Ci) for CY 2022. In addition, each source was designated as either fugitive or non-fugitive. Point sources such as stacks, vents, and ducts are considered non-fugitive. Fugitive releases are non-point sources (e.g., volatilization from a pond or wind suspension of surface material) released directly to the atmosphere. Fugitive emissions inside enclosures that are released out stacks, vents, or ducts are considered non-fugitive.

For the INL Site, 1,118 radionuclide emissions from 67 different sources were reported to be in use and potentially emitted for CY 2022. For comparison, there were 1,047 emissions from 66 sources reported the previous year. The total number of unique radionuclides for which a release rate was provided was 339 from all INL Site sources. This is an increase of 21 from the 318 reported the previous year. Eleven radionuclides were not simulated with CAP88 because they are not included in the CAP88 database. They are not included because they are either considered stable, or they have short half-lives (less than 1 minute). Of these eleven, seven radionuclides with short half-lives were modeled as the first progeny included in CAP88-PC, converting the parent activity into the equivalent activity of the daughter. One radionuclide was omitted from modeling because it has a very short half-life (scale of milliseconds), and the subsequent daughter product is stable. Previously, radionuclides included in the progeny chain of Te-129m could not be modeled using CAP-88, Version 4.1, due to errors in isotope information, so these radionuclides were modeled using Version 4.0. An updated version of CAP-88 was released in 2021, Version 4.1.1, which fixed the issues with the progeny chain (EPA 2021). Version 4.1.1 was used for creating input files for three radionuclides, all of which are either Te-129m or its progeny. Version 4.1 was used to create the remaining 1,249 input files. The full list of radionuclide releases is presented in Appendix E.

For INL in-town sources, 68 radionuclide emissions or potential emissions were reported from two buildings. The total number of unique radionuclides for which an inventory and release rate were provided was 63. This is up from 62 reported the previous year because four radionuclides from 2021 were dropped (i.e., no release was reported), and five new radionuclides were added in 2022. The full list of releases is presented in Appendix E.

2.3 Database Implementation for INL Site Facilities

Calculations for INL Site facilities are performed in the Microsoft Access database (*NESHAPv41-INL_CAP88DoseCalculator2022.mdb*) using three primary data tables (Table 5). The *UnitDoses* table contains the unit doses calculated with CAP88-PC for each radionuclide-receptor-facility combination. These values come from the file *tempdoses.txt*. The *Releases* table contains the generator-provided radionuclide-release rates from each source. The *MkMEIsBySecName* table contains the distance and direction from each facility to each of the 31 receptor locations. Note that the same data field name is used in multiple tables. This allows relationships between tables to be established.

Doses are calculated for each source-radionuclide-receptor combination in the *CalculatedDoses* query. The SQL language for this query is shown below.

```
SELECT Releases.SourceID, Releases.FacilityID, UnitDoses.Nuclide, UnitDoses.Direction,
UnitDoses.Distance, UnitDoses.uDose, Releases.Q, Releases.Fugitive, [uDose]*[Q] AS
[Dose (mrem/yr)], MkMEIsBySecName.ReceptorNum

FROM (Releases LEFT JOIN UnitDoses ON (Releases.Radionuclide = UnitDoses.Nuclide) AND
(Releases.FacilityID = UnitDoses.FacilityID)) LEFT JOIN MkMEIsBySecName ON
(UnitDoses.Distance = MkMEIsBySecName.Distance) AND (UnitDoses.Direction =
MkMEIsBySecName.SectorName) AND (UnitDoses.FacilityID = MkMEIsBySecName.FacilityID)
```

Table 5. Description of data tables in NESHAP CAP88-PC database for INL Site facilities.

Table Name	Field Name	Type	Description
UnitDoses	FacilityID	Text	Facility Identification (see Table 1)
	Nuclide	Text	Radionuclide name
	Direction	Text	Direction to MEI
	Distance	Double	Distance to MEI
	uDose	Double	Unit dose (mrem/Ci)
Releases	SourceID	Text	Source identification
	FacilityID	Text	Facility Identification (see Table 1)
	Fugitive	Text	Fugitive or Non-Fugitive release flag
	Radionuclide	Text	Radionuclide name
	Q	Double	Radionuclide-release rate (Ci/yr)
MkMEIsBySecName	FacilityID	Text	Facility Identification (see Table 1)
	SectorName	Text	Text name of the 16, 22.5-degree sectors
	Distance	Text	Distance from the facility to the receptor
	ReceptorNum[a]	Long	Receptor number index

a. The receptor number is the identification assigned to the 62 receptors surrounding INL. The distance and direction to each receptor varies by facility (see Appendix B).

The *CalculatedDoses* query multiplies the UDFs in the *UnitDoses* table for a facility-radionuclide-receptor combination by the corresponding radionuclide-release rate in the *Releases* table. The *MkMEIsBySecName* table provides the receptor number for the dose.

Subsequent queries use the *CalculatedDoses* query to extract total dose by radionuclide, source, or facility. Of prime importance are the total maximum dose and the location of the total maximum dose. Several queries are used to obtain this value. First, the make-table query *TotalDoseByRecNumber* is run that sums the dose across all radionuclides and sources at each receptor location, sorts the doses in decreasing order, and writes these data to the table *MkTotalDoseByRecNum*. The first record in this table identifies the receptor location. The query *LocationOfMaxTotalDose* extracts this record that is used in subsequent queries to extract dose by radionuclide and dose by source at the receptor. Verification of proper execution of INL Site database calculations is provided in Appendix G.

2.4 Database Implementation for INL In-Town Facilities at the IRC

Calculations for INL in-town facilities at the IRC are performed in the Microsoft Access database (*NESHAPv41-IRC_CAP88DoseCalculator2022.mdb*) using two primary data tables: *Releases* and *UnitDoses*. The *UnitDoses* table contains the doses from a unit (1 Ci/yr) release calculated with CAP88-PC for each radionuclide, receptor, and source-facility combination. These values come from the file *tempdoses.txt*. The receptors are defined for the 30 locations surrounding the in-town facilities. Previously, the distance to each receptor was the distance from the facility with the highest dose contribution. This was iterative, and in the past, the highest dose contributions were from the Radiological and Environmental Sciences Laboratory (RESL, IF-683). However, reported emissions have been separated into distinct sources (buildings) at IRC to reflect expanded use of radioactive materials in IRC

facilities. The *Releases* table contains the generator-provided radionuclide-release rate from each source. The doses are calculated in the query *CalculatedDoses*. Verification of proper execution of INL in-town database calculations is provided in Appendix G.

3. RESULTS

3.1 Dose Results for INL Site Facilities

The maximum annual dose to a public receptor around the INL Site is 1.78E-02 mrem/yr and occurs at Receptor 26, a farmhouse and cattle operation located 3.1 km south of Highway 20, 3 km from INL's east entrance. This is the same as the MEI location in 2019 through 2021, but different from the MEI location for several years prior to 2019 which was Receptor 1 (a.k.a., Frenchman's Cabin), located 2.3 km south of the INL boundary, south of RWMC (see Figure 1).

Annual doses at the MEI location from each of the INL Site facilities are provided in Table 6. The MEI dose contribution from all MFC facilities (including TREAT) is 1.56E-02 mrem/yr and accounts for 87.3% of the total MEI dose.

Table 6. Annual doses at the MEI location (Receptor 26) by facility for INL Site facilities.

Facility	Point source dose (mrem/yr)	Fugitive source dose (mrem/yr)	Total dose (mrem/yr)	Notes
CFA Total	**5.43E-07**	**2.59E-06**	**3.13E-06**	Total from 3 CFA sources
CITRC Total	**2.56E-11**	**7.92E-15**	**2.56E-11**	Total from 3 CITRC sources
INTEC	1.21E-06	2.75E-04	2.76E-04	10 INTEC sources including ICDF
INTEC-MS	2.18E-07		2.18E-07	INTEC Main Stack (CPP-708)
INTEC Total	**1.43E-06**	**2.75E-04**	**2.77E-04**	Total from all INTEC sources
MFC	1.56E-02		1.56E-02	20 MFC sources
MFC-MS	4.92E-08		4.92E-08	MFC Main Stack (MFC-764)
MFC-TREAT	4.96E-04		4.96E-04	TREAT Exhaust Stack
MFC Total	**1.61E-02**		**1.61E-02**	Total from all MFC sources
NRF Total	**4.57E-05**	**1.20E-07**	**4.58E-05**	Total from all NRF sources
ATRC	3.37E-06	6.02E-04	6.05E-04	8 ATR COMPLEX sources
ATRC-ATR	2.91E-06		2.91E-06	ATR Stack (TRA-770)
ATRC-MTR	0.00E+00		0.00E+00	No emissions from MTR stack in CY 2022[a]
ATRC Total	**6.27E-06**	**6.02E-04**	**6.08E-04**	Total from all ATRC sources
RRTR Total		**2.14E-04**	**2.14E-04**	Total from all RRTR sources
RWMC Total	**7.73E-05**	**5.34E-04**	**6.12E-04**	14 RWMC sources including ARP sites
SMC Total	**4.08E-09**		**4.08E-09**	Total from all SMC sources
TAN-TSF Total	**1.23E-06**		**1.23E-06**	OU 1-07B emissions

Facility	Point source dose (mrem/yr)	Fugitive source dose (mrem/yr)	Total dose (mrem/yr)	Notes
INL Site Total	**1.62E-02**	**1.63E-03**	**1.78E-02**	**Total MEI dose from all INL Site sources**

a. Emissions from the Safety and Tritium Applied Research (STAR) facility (TRA-666) at the ATR Complex are typically routed to and out the MTR stack. During CY 2021, TRA-666 began a building ventilation system modification project and emissions were routed to a much shorter temporary stack. Therefore, all TRA-666 emissions for CY 2022 were conservatively reported as a ground-level release, and no emissions were reported for the MTR stack.

b. RRTR is a test area located approximately 1.8 km north-northeast of SMC.

The INL Site 2022 total MEI dose (1.78E-02 mrem/yr) is down 73.3% from 2021. This decrease is due primarily to lower emissions at MFC. ATR had significantly reduced emissions in 2022 due to shutdown of the reactor for changeout of core internal structural components, but emissions at ATR have little impact on the dose at the CY 2022 MEI location which is closer to MFC. In 2021, dose contributions from MFC were dominated by Cs-137 emissions, accounting for only 0.14% of total emissions from MFC, but contributing 56.2% of total dose from this source. In 2022, the sample that contributed the majority of Cs-137 was disposed of, resulting in greatly reduced overall dose to the MEI (INL 2023b). In contrast, while emission from ATR dropped 98.8% in 2022, overall dose to the MEI was reduced by only 37.3%.

Doses by INL Site facility and radionuclide at the MEI location for radionuclides that represent greater than 0.1% of the total dose are presented in Table 7. Doses by source at the MEI location for sources that represent more than 0.1% of the total dose are presented in Table 8. Doses by radionuclide at the MEI location for radionuclides that represent more than 0.1% of the total dose for INL Site facilities are shown in Table 9.

Table 7. Dose by INL Site facility and radionuclide at the MEI location (Receptor 26) for contributions greater than 0.1% of the total MEI dose for INL Site facilities.

Facility ID	Nuclide	Annual MEI Dose (mrem/yr)	Percent of Total MEI Dose	Cumulative Percent of Total MEI Dose
MFC	U-238	5.38E-03	30.19%	30.19%
MFC	Cl-36	3.65E-03	20.50%	50.69%
MFC	U-234	3.33E-03	18.66%	69.36%
MFC	Am-241	2.11E-03	11.84%	81.19%
RWMC	H-3	5.29E-04	2.97%	84.16%
MFC	Cs-137	4.62E-04	2.59%	86.75%
RTC	Sr-90	4.12E-04	2.31%	89.06%
MFC-TREAT	Ar-41	3.28E-04	1.84%	90.90%
MFC	U-235	2.44E-04	1.37%	92.27%
MFC	Sr-90	1.97E-04	1.11%	93.37%
RRTR	Br-82	1.81E-04	1.01%	94.39%
INTEC	Am-241	1.10E-04	0.62%	95.00%
MFC	I-131	1.07E-04	0.60%	95.60%
MFC-TREAT	Kr-88	1.06E-04	0.59%	96.20%
RTC	Cs-137	1.02E-04	0.57%	96.77%
RTC	Co-60	7.57E-05	0.42%	97.19%
INTEC	Sr-90	5.69E-05	0.32%	97.51%
RWMC	Am-241	4.97E-05	0.28%	97.79%
INTEC	Pu-239	4.92E-05	0.28%	98.07%

Facility ID	Nuclide	Annual MEI Dose (mrem/yr)	Percent of Total MEI Dose	Cumulative Percent of Total MEI Dose
INTEC	Pu-240	4.92E-05	0.28%	98.34%
NRF	C-14	4.48E-05	0.25%	98.59%
RRTR	Cu-64	3.24E-05	0.18%	98.78%
MFC-TREAT	Xe-138	2.62E-05	0.15%	98.92%
MFC	Cf-252	2.35E-05	0.13%	99.05%
MFC	Te-129m	2.28E-05	0.13%	99.18%
RWMC	Pu-239	2.18E-05	0.12%	99.30%
MFC-TREAT	Kr-87	2.12E-05	0.12%	99.42%

Table 8. Dose by INL Site source at the MEI location (Receptor 26) for sources that represent greater than 0.1% of the total MEI dose for INL Site facilities.

SourceID	Facility ID	Annual MEI Dose (mrem/yr)	Percent of Total MEI Dose	Cumulative Percent of Total MEI Dose
MFC-784-001	MFC	8.95E-03	50.22%	50.22%
MFC-794-002	MFC	2.46E-03	13.79%	64.02%
MFC-774-029	MFC	9.49E-04	5.33%	69.34%
MFC-774-026	MFC	9.49E-04	5.33%	74.67%
MFC-774-028	MFC	9.49E-04	5.33%	79.99%
MFC-774-027	MFC	9.49E-04	5.33%	85.32%
TRA-715-001	RTC	6.02E-04	3.37%	88.69%
Beryllium Blocks	RWMC	5.34E-04	3.00%	91.69%
MFC-720-007	MFC-TREAT	4.96E-04	2.78%	94.47%
MFC-1702-001	MFC	3.61E-04	2.02%	96.50%
ICDF-Landfill	INTEC	2.74E-04	1.54%	98.03%
RRTR	RRTR	1.81E-04	1.02%	99.05%
ARP-VII	RWMC	6.00E-05	0.34%	99.38%
NRF	NRF	4.58E-05	0.23%	99.64%
RRTR_CuPellets	RRTR	3.24E-05	0.18%	99.82%

Table 9. Dose by radionuclide at the MEI location (Receptor 26) for radionuclides that represent greater than 0.1% of the total MEI dose for INL Site facilities.

Radionuclide	Annual MEI Dose (mrem/yr)	Percent of Total MEI Dose	Cumulative Percent of Total MEI Dose
U-238	5.38E-03	30.19%	30.19%
Cl-36	3.65E-03	20.50%	50.69%
U-234	3.33E-03	18.66%	69.36%
Am-241	2.27E-03	12.75%	82.11%
Sr-90	6.68E-04	3.74%	85.85%
Cs-137	5.71E-04	3.20%	89.06%
H-3	5.50E-04	3.09%	92.14%
Ar-41	3.28E-04	1.84%	93.98%
U-235	2.44E-04	1.37%	95.35%

Radionuclide	Annual MEI Dose (mrem/yr)	Percent of Total MEI Dose	Cumulative Percent of Total MEI Dose
Br-82	1.81E-04	1.01%	96.36%
I-131	1.07E-04	0.60%	96.96%
Kr-88	1.06E-04	0.59%	97.56%
Co-60	7.57E-05	0.42%	97.98%
Pu-239	7.32E-05	0.41%	98.39%
Pu-240	5.42E-05	0.30%	98.70%
C-14	4.99E-05	0.28%	98.98%
Cu-64	3.24E-05	0.18%	99.16%
Xe-138	2.62E-05	0.15%	99.31%
Cf-252	2.35E-05	0.13%	99.44%
Te-129m	2.28E-05	0.13%	99.57%
Kr-87	2.12E-05	0.12%	99.69%

3.2 Dose Results for INL In-Town Facilities at the IRC

Annual doses for INL in-town facilities at the IRC are shown in Figure 2 and in Table 10 to Table 12. Figure 2 shows the dose at the location of the nearest public receptor surrounding the in-town facilities. Table 10 contains the annual dose for each of the sources and the total overall dose. The maximum total dose for 2022 was 4.03E-03 mrem/yr at Receptor 1 (see Figure 2). This is down 35% from 2021.

Releases from RESL (IF-683) accounted for 94% of the total dose while releases from surrounding facilities (IF-611, IF-603, and IF-638) contributed 6%. While the majority of emission still originate from RESL, this result still supports the transition from collocating and modeling all emission sources at IF-683, in favor of a more realistic set up, where IF-683 emissions are modeled separately from other facility emissions.

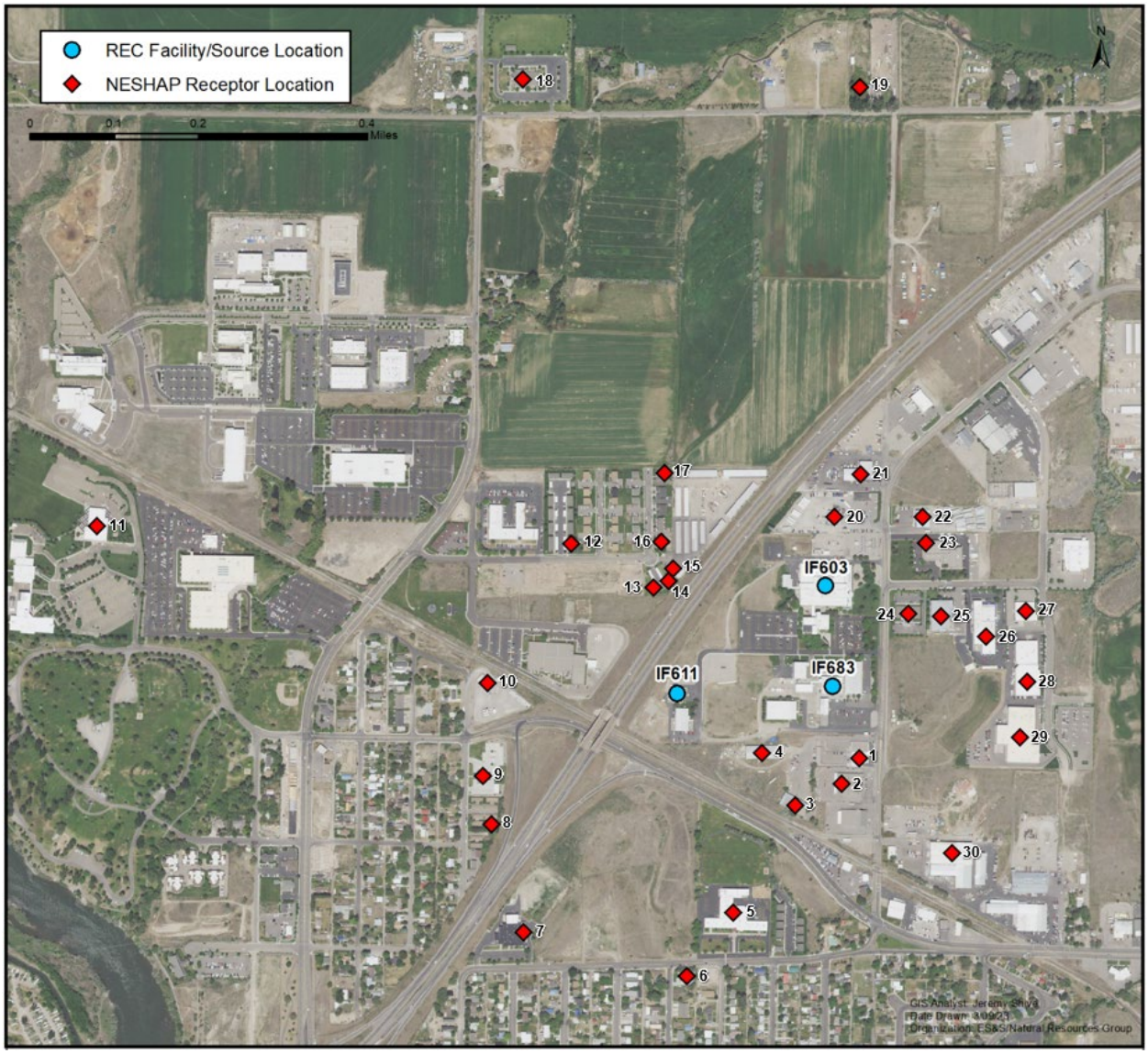

Figure 2. In-town facilities with 30 surrounding receptor locations shown. MEI is located at Receptor 1.

Table 10. Annual doses at the MEI location by source for INL in-town facilities.

SourceID	Non-Fugitive MEI Dose[a] (mrem/yr)	Percent of Total MEI Dose	Cumulative Percent of Total MEI Dose
IF-683	3.79E-03	93.89%	93.89%
IF-603	2.46E-04	6.11%	100.00%
INL in-town Total	**4.03E-03**	**100%**	**100%**

a. All INL in-town releases are non-fugitive. There are no fugitive releases from INL in-town facilities.

Doses for INL in-town facilities at the MEI by source and radionuclide that represent more than 0.1% of the total dose are presented in Table 11. Doses by radionuclide at the MEI that represent greater than 0.1% of the total dose are presented in Table 12.

Table 11. Doses at the MEI location, by source, by radionuclide that represents more than 0.1% of the total MEI dose for INL in-town facilities.

SourceID	Radionuclide	Annual MEI Dose (mrem/yr)	Percent of Total MEI Dose	Cumulative % of Total MEI Dose
IF683	Pu-239	1.28E-03	31.76%	IF683
IF683	Am-241	8.32E-04	20.63%	IF683
IF683	Pu-238	6.92E-04	17.15%	IF683
IF683	Ra-226	2.86E-04	7.09%	IF683
IF603	Xe-133	2.43E-04	6.03%	IF603
IF683	U-233	1.00E-04	2.48%	IF683
IF683	U-232	9.77E-05	2.42%	IF683
IF683	Ac-227	7.32E-05	1.82%	IF683
IF683	Eu-154	6.92E-05	1.72%	IF683
IF683	Cs-137	6.48E-05	1.61%	IF683
IF683	Ba-133	5.04E-05	1.25%	IF683
IF683	Sr-90	4.74E-05	1.18%	IF683
IF683	Np-237	3.05E-05	0.76%	IF683
IF683	Na-22	2.83E-05	0.70%	IF683
IF683	Pb-210	2.46E-05	0.61%	IF683
IF683	Eu-152	2.22E-05	0.55%	IF683
IF683	Pa-231	2.19E-05	0.54%	IF683
IF683	Co-60	2.16E-05	0.53%	IF683
IF683	Am-243	1.71E-05	0.43%	IF683
IF683	Cs-134	7.04E-06	0.17%	IF683
IF683	I-131	4.03E-06	0.10%	IF683

Table 12. Doses at the MEI location, by radionuclide that represents more than 0.1% of the total MEI dose for INL in-town facilities.

Radionuclide	Annual MEI Dose (mrem/yr)	Percent of Total MEI Dose	Cumulative % of Total MEI Dose
Pu-239	1.28E-03	31.76%	31.76%
Am-241	8.32E-04	20.63%	52.39%
Pu-238	6.92E-04	17.15%	69.54%
Ra-226	2.86E-04	7.09%	76.63%
Xe-133	2.43E-04	6.03%	82.66%
U-233	1.00E-04	2.48%	85.14%
U-232	9.77E-05	2.42%	87.56%
Ac-227	7.32E-05	1.82%	89.38%
Eu-154	6.92E-05	1.72%	91.10%
Cs-137	6.48E-05	1.61%	92.70%
Ba-133	5.04E-05	1.25%	93.95%
Sr-90	4.74E-05	1.18%	95.13%
Np-237	3.05E-05	0.76%	95.88%
Na-22	2.83E-05	0.70%	96.59%

Radionuclide	Annual MEI Dose (mrem/yr)	Percent of Total MEI Dose	Cumulative % of Total MEI Dose
Pb-210	2.46E-05	0.61%	97.20%
Eu-152	2.22E-05	0.55%	97.75%
Pa-231	2.19E-05	0.54%	98.29%
Co-60	2.16E-05	0.53%	98.82%
Am-243	1.71E-05	0.43%	99.25%
Cs-134	7.04E-06	0.17%	99.42%
I-131	4.03E-06	0.10%	99.52%

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Appendix A

Wind Files

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Appendix A

Wind Files

690L22.WND

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EBRL22.WND

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 3.24 3.36 2.98 2.34 1.57 2.92 2.01 1.93 1.45 1.49 2.10 2.23 2.63 2.42 2.57 3.60
 4.05 3.41 3.79 2.36 2.55 2.12 2.55 2.07 2.26 2.70 3.27 2.89 2.95 3.02 3.70 3.81
 6.69 5.53 4.58 4.90 3.28 3.14 3.69 3.64 2.92 3.27 3.87 3.48 3.97 7.12 8.43 7.46
 2.73 2.61 1.86 1.35 1.69 1.84 2.28 2.11 1.79 1.69 1.64 1.33 1.65 2.03 2.57 2.46
 1.28 1.05 1.02 1.52 0.95 1.10 1.20 1.50 1.56 1.45 1.00 1.49 1.45 1.52 1.42 1.19
 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
 1.94 1.83 1.72 2.08 1.87 1.97 2.09 1.94 1.66 1.69 2.00 1.69 1.97 1.99 2.09 2.07
 3.47 3.60 3.17 3.34 2.57 3.47 2.95 2.87 2.18 2.33 2.98 3.09 3.15 3.34 3.31 3.82
 4.73 4.31 3.98 4.17 3.97 3.43 3.60 3.05 3.04 4.23 4.70 4.16 4.06 4.32 4.77 4.88
 8.16 7.73 6.55 5.86 5.19 5.41 5.92 5.23 5.18 5.49 5.94 5.46 5.82 8.65 9.50 8.71
 3.65 3.52 2.70 2.41 2.84 2.88 3.02 2.93 2.60 2.29 2.46 2.00 2.39 2.75 3.36 3.17
 1.80 1.45 1.40 2.04 1.26 1.54 1.70 2.02 2.07 1.97 1.36 2.01 1.97 2.04 1.95 1.67
 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
    0.0399    0.0399    0.0758    0.7564    0.0599    0.0281    0.0000
    0.0528    0.0620    0.0878    0.6432    0.0835    0.0707    0.0000
    0.1304    0.0408    0.0618    0.4932    0.0958    0.1780    0.0000
    0.1185    0.0749    0.1078    0.4733    0.1176    0.1078    0.0000
    0.1798    0.0931    0.0543    0.4301    0.1565    0.0860    0.0000
    0.1025    0.0751    0.0852    0.4948    0.0991    0.1434    0.0000
    0.0464    0.0502    0.0758    0.6647    0.0871    0.0758    0.0000
    0.0494    0.0396    0.0881    0.5868    0.1317    0.1045    0.0000
    0.1112    0.0415    0.0593    0.4853    0.1098    0.1929    0.0000
    0.1338    0.0629    0.0685    0.4425    0.1038    0.1886    0.0000
    0.1591    0.0574    0.0796    0.4365    0.1019    0.1654    0.0000
    0.1799    0.0617    0.0787    0.4690    0.0834    0.1273    0.0000
    0.1608    0.1012    0.0744    0.4585    0.0891    0.1160    0.0000
    0.0870    0.0560    0.0744    0.6872    0.0435    0.0519    0.0000
    0.0429    0.0297    0.0578    0.8190    0.0279    0.0227    0.0000
    0.0381    0.0428    0.1047    0.7405    0.0500    0.0238    0.0000
```

GRIL22.WND

```
   3.88067
0.04320.02760.01860.01420.02040.04440.10870.10400.07080.03460.02430.02870.04370.13900.19800.0798
 1.73 1.76 1.62 1.43 1.48 1.33 1.31 1.38 1.05 1.39 1.16 1.37 1.45 1.48 1.48 1.64
 2.74 2.13 1.86 1.55 1.86 1.72 2.26 2.13 1.19 0.96 1.49 1.22 2.24 2.19 2.85 2.24
 3.77 3.88 3.36 1.57 1.71 1.80 2.30 2.44 2.47 3.58 1.64 2.33 3.38 2.74 3.86 3.07
 3.43 4.28 2.65 1.74 1.97 2.87 3.23 2.70 2.21 2.18 1.69 2.76 2.77 4.60 4.87 3.02
 1.87 1.83 2.26 1.41 1.75 1.59 2.04 2.06 1.35 1.17 1.33 1.24 1.60 1.86 2.09 2.08
 1.11 0.95 1.05 0.98 1.00 0.93 1.04 1.13 1.11 0.95 0.97 0.95 1.02 1.08 1.17 1.09
 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
 2.19 2.22 2.12 1.96 2.00 1.85 1.83 1.91 1.45 1.92 1.64 1.89 1.97 2.00 2.01 2.13
 3.15 2.81 2.57 2.06 2.57 2.68 3.02 2.75 2.09 1.28 2.57 1.93 3.05 3.04 3.51 3.05
 4.39 4.45 3.59 2.57 2.97 2.70 3.21 3.24 3.93 4.48 3.07 4.16 4.34 4.27 4.92 4.26
 4.68 5.37 4.19 2.69 3.15 4.08 4.37 3.92 3.23 4.16 3.47 4.77 4.38 7.04 7.07 4.53
 2.73 2.75 3.02 2.13 2.38 2.36 2.78 2.78 1.94 1.71 1.97 1.95 2.44 2.82 2.88 2.80
 1.55 1.26 1.45 1.32 1.36 1.21 1.44 1.58 1.56 1.25 1.31 1.25 1.39 1.51 1.65 1.52
 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
    0.1520    0.0748    0.0855    0.3465    0.1253    0.2159    0.0000
    0.2332    0.0918    0.0669    0.3001    0.1251    0.1829    0.0000
    0.3227    0.0938    0.0436    0.2112    0.0991    0.2295    0.0000
    0.3329    0.0571    0.0487    0.2278    0.0656    0.2680    0.0000
    0.4458    0.0564    0.0402    0.1638    0.0510    0.2428    0.0000
    0.2459    0.0857    0.1089    0.3652    0.0880    0.1062    0.0000
    0.1174    0.0846    0.1344    0.4667    0.1260    0.0709    0.0000
    0.0597    0.0343    0.1140    0.5132    0.1925    0.0863    0.0000
    0.0391    0.0179    0.0603    0.5819    0.1447    0.1560    0.0000
    0.0730    0.0234    0.0669    0.3687    0.1659    0.3021    0.0000
    0.1278    0.0382    0.0432    0.1899    0.1706    0.4303    0.0000
    0.1485    0.0565    0.0206    0.2691    0.1164    0.3890    0.0000
    0.0947    0.0396    0.0554    0.3973    0.1395    0.2736    0.0000
    0.0447    0.0224    0.0405    0.6559    0.1439    0.0926    0.0000
    0.0406    0.0291    0.0668    0.6625    0.1249    0.0761    0.0000
    0.0822    0.0649    0.0865    0.4293    0.1743    0.1628    0.0000
```

GRIU22.WND

```
   5.13665
0.03620.02900.02270.01570.01940.04480.14540.17350.06380.02230.01730.01760.03780.13080.16170.0622
 1.71 1.72 1.52 1.72 1.36 1.46 1.35 1.14 1.07 1.24 1.11 1.40 1.45 1.61 1.70 1.57
 3.01 2.23 2.80 1.22 2.77 2.26 2.42 2.00 1.22 1.19 1.19 1.81 1.70 2.94 2.90 3.05
 4.56 3.77 4.41 1.71 1.61 2.51 2.81 2.86 2.00 3.70 1.85 1.93 2.86 2.79 4.15 4.04
 3.83 3.11 3.57 1.80 2.03 3.45 3.95 3.97 2.70 3.41 2.59 2.70 4.32 6.53 6.66 4.43
 1.49 1.24 1.37 1.04 1.17 1.58 1.87 1.86 1.39 1.33 1.20 1.30 1.25 1.94 1.95 1.49
 1.16 1.09 1.02 0.98 0.90 1.10 1.36 1.38 1.15 1.01 1.00 1.19 1.25 1.20 1.29 1.15
 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
 2.18 2.19 2.04 2.19 1.89 1.99 1.87 1.60 1.49 1.75 1.55 1.93 1.97 2.11 2.18 2.08
 3.50 2.84 3.34 1.91 2.88 3.04 3.19 2.69 1.89 1.67 1.67 2.80 2.71 3.44 3.45 3.56
 4.85 4.68 5.04 2.97 3.14 3.63 3.62 3.64 3.61 4.91 3.56 3.73 4.17 4.26 4.94 4.81
 6.14 5.75 5.59 3.28 3.41 5.37 5.51 5.34 4.65 5.72 4.78 5.80 6.41 8.55 8.61 6.36
 2.07 1.88 2.09 1.51 1.72 2.44 2.78 2.67 2.11 1.91 1.97 2.25 2.01 2.82 2.90 2.39
 1.63 1.53 1.39 1.33 1.15 1.55 1.89 1.90 1.62 1.37 1.35 1.67 1.76 1.69 1.81 1.62
 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
    0.1635    0.0931    0.0959    0.4997    0.0804    0.0674    0.0000
    0.1680    0.1080    0.0842    0.4796    0.0839    0.0763    0.0000
    0.2760    0.1074    0.0506    0.3570    0.0766    0.1325    0.0000
    0.3106    0.0593    0.0523    0.2226    0.1626    0.1926    0.0000
    0.3769    0.0361    0.0542    0.2633    0.1260    0.1435    0.0000
    0.1841    0.0802    0.0675    0.4092    0.1088    0.1503    0.0000
    0.0837    0.0606    0.0973    0.5773    0.0973    0.0838    0.0000
    0.0394    0.0407    0.0955    0.6507    0.0982    0.0755    0.0000
    0.0728    0.0292    0.0690    0.5110    0.1491    0.1690    0.0000
    0.1252    0.0206    0.1041    0.4372    0.1409    0.1719    0.0000
    0.1543    0.0405    0.0676    0.3890    0.1410    0.2075    0.0000
    0.1844    0.0528    0.0460    0.4733    0.1118    0.1317    0.0000
    0.1014    0.0429    0.0611    0.5768    0.0889    0.1289    0.0000
    0.0310    0.0239    0.0363    0.8281    0.0443    0.0363    0.0000
    0.0294    0.0309    0.0530    0.8294    0.0387    0.0187    0.0000
    0.0951    0.0542    0.1213    0.5970    0.0727    0.0597    0.0000
```

LOFL22.WND

```
   3.56723
0.03580.02370.02460.02150.02910.04010.09110.10820.15700.12860.03710.02580.02520.05440.13160.0661
 1.35 1.24 1.30 1.19 1.28 1.35 1.37 1.23 1.07 0.90 1.27 1.22 1.30 1.08 1.27 1.51
 2.87 1.95 1.74 1.87 1.83 2.03 2.23 1.94 1.52 1.02 1.79 1.74 2.07 2.17 2.50 2.45
 3.31 2.83 2.35 2.06 1.71 2.35 2.24 2.12 3.72 2.67 3.57 3.36 3.72 2.68 3.80 3.51
 4.30 3.68 2.26 2.69 3.56 2.49 2.90 2.84 3.11 4.03 2.83 3.33 3.53 4.24 5.63 4.24
 1.96 1.35 1.74 1.45 1.19 1.33 1.90 2.09 2.01 2.42 1.31 1.20 1.04 1.22 1.62 1.76
 0.97 0.93 0.98 0.99 1.13 0.99 1.09 1.09 1.10 1.08 0.95 0.93 0.92 0.89 0.94 0.94
 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
 1.87 1.74 1.82 1.68 1.79 1.87 1.90 1.73 1.49 1.14 1.78 1.71 1.81 1.50 1.78 2.03
 3.39 2.57 2.57 3.02 2.67 2.61 2.76 2.71 2.33 1.65 2.79 2.57 3.18 3.20 3.17 3.21
 4.49 3.48 3.59 3.40 3.14 3.06 3.00 2.87 4.78 4.00 5.17 4.41 4.77 4.47 4.67 4.26
 5.07 4.29 3.37 3.85 4.40 3.27 3.72 3.50 4.05 6.53 4.43 4.81 5.40 6.95 7.65 5.25
 2.33 1.97 2.57 1.97 1.67 1.93 2.60 2.77 2.57 3.02 1.91 1.97 1.43 1.84 2.36 2.21
 1.29 1.22 1.32 1.33 1.58 1.34 1.53 1.53 1.55 1.50 1.26 1.21 1.18 1.12 1.23 1.22
 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
    0.3463    0.1476    0.0961    0.1632    0.0481    0.1987    0.0000
    0.4930    0.0868    0.0771    0.0965    0.0725    0.1740    0.0000
    0.5678    0.0929    0.0601    0.0881    0.0373    0.1538    0.0000
    0.5483    0.0854    0.0738    0.1063    0.0320    0.1541    0.0000
    0.4100    0.1419    0.1141    0.1375    0.0392    0.1574    0.0000
    0.3314    0.1400    0.1059    0.2200    0.0483    0.1542    0.0000
    0.1373    0.0870    0.1800    0.3906    0.0882    0.1171    0.0000
    0.0636    0.0286    0.0805    0.4794    0.1920    0.1559    0.0000
    0.0293    0.0109    0.0219    0.6711    0.1396    0.1272    0.0000
    0.0259    0.0053    0.0222    0.5657    0.2310    0.1499    0.0000
    0.0773    0.0245    0.0398    0.2808    0.1174    0.4602    0.0000
    0.1023    0.0356    0.0709    0.1375    0.0934    0.5602    0.0000
    0.0864    0.0682    0.0860    0.2272    0.0864    0.4457    0.0000
    0.1139    0.0611    0.0970    0.4348    0.0780    0.2153    0.0000
    0.0750    0.0496    0.1046    0.6347    0.0436    0.0924    0.0000
    0.2118    0.1876    0.1823    0.2429    0.0433    0.1320    0.0000
```

LOFU22.WND

```
   4.61695
0.02900.01950.02310.01710.02740.03840.09640.15800.14570.12010.04080.02110.02280.04620.11370.0806
 1.46 1.37 1.44 1.45 1.29 1.40 1.36 1.16 1.05 1.00 1.17 0.98 1.10 1.13 1.40 1.54
 2.41 2.77 1.98 2.10 2.16 2.41 2.32 2.25 1.55 1.16 2.58 1.69 1.97 3.50 2.85 2.43
 3.13 2.33 4.08 3.46 2.61 2.43 2.51 2.74 2.57 2.66 2.64 4.53 3.28 2.72 4.69 3.78
 4.97 4.57 4.05 4.56 4.15 3.16 3.45 3.74 4.16 5.58 3.75 3.45 3.31 5.79 7.21 6.27
 1.65 1.92 1.19 1.54 2.05 2.07 1.91 2.73 2.34 1.98 1.12 1.32 1.50 1.49 1.89 1.51
 1.09 0.95 0.98 1.08 1.16 1.17 1.29 1.46 1.36 1.20 1.01 0.94 0.92 1.06 1.11 1.06
 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
 1.99 1.89 1.97 1.97 1.81 1.92 1.89 1.63 1.45 1.36 1.65 1.32 1.53 1.59 1.93 2.05
 3.10 3.25 2.73 2.70 2.97 2.99 2.88 2.82 2.06 2.06 3.56 2.57 2.93 3.73 3.60 3.16
 4.28 3.66 4.54 4.53 3.83 3.49 3.31 3.29 4.10 4.05 4.47 4.91 4.81 4.47 4.98 4.69
 6.46 5.20 5.22 5.09 5.16 4.29 4.62 4.48 5.28 8.03 5.70 5.20 6.03 8.18 9.22 7.89
 2.88 2.76 1.67 2.79 3.12 2.71 2.75 3.23 3.00 2.90 1.57 2.10 2.02 2.30 2.57 2.13
 1.52 1.26 1.31 1.51 1.63 1.65 1.81 1.99 1.88 1.69 1.38 1.22 1.18 1.47 1.56 1.46
 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
    0.3065    0.1632    0.1436    0.2469    0.0241    0.1157    0.0000
    0.4379    0.1422    0.0767    0.1540    0.0593    0.1299    0.0000
    0.5499    0.1146    0.0705    0.1453    0.0199    0.0999    0.0000
    0.4656    0.1015    0.1214    0.1424    0.0543    0.1149    0.0000
    0.3586    0.1726    0.1011    0.2284    0.0423    0.0970    0.0000
    0.3345    0.1414    0.1175    0.2350    0.0422    0.1295    0.0000
    0.1414    0.0899    0.1751    0.4401    0.0599    0.0935    0.0000
    0.0520    0.0213    0.0651    0.6676    0.1061    0.0879    0.0000
    0.0445    0.0111    0.0183    0.6317    0.1477    0.1468    0.0000
    0.0356    0.0067    0.0231    0.7081    0.0992    0.1272    0.0000
    0.0992    0.0255    0.0367    0.4279    0.1019    0.3088    0.0000
    0.1262    0.0607    0.0607    0.2748    0.1262    0.3512    0.0000
    0.1318    0.0760    0.1168    0.3404    0.0659    0.2692    0.0000
    0.0825    0.0351    0.0854    0.5964    0.0652    0.1354    0.0000
    0.0569    0.0428    0.0682    0.7366    0.0325    0.0631    0.0000
    0.1248    0.1278    0.1936    0.4562    0.0231    0.0745    0.0000
```

NRFL22.WND

```
   3.80850
0.06480.03610.03100.03140.04600.06530.11370.08240.05920.04070.02160.01690.02680.08130.18120.1015
 1.68 1.41 1.35 1.19 1.38 1.47 1.40 1.24 1.32 1.22 1.48 1.45 1.19 1.47 1.41 1.39
 2.26 1.72 1.51 1.35 1.40 2.35 2.38 1.79 2.30 2.40 3.37 2.64 2.52 2.33 3.26 2.57
 2.18 1.65 1.28 1.41 1.40 2.16 2.69 2.39 2.21 2.95 3.52 4.50 4.40 4.44 3.39 3.85
 2.60 3.14 1.93 1.92 2.58 3.02 3.25 2.88 2.41 4.41 3.78 3.47 3.29 5.18 5.29 2.85
 1.67 1.35 1.49 1.48 1.35 1.50 1.77 1.51 1.37 1.22 1.34 2.07 1.42 1.89 2.04 1.71
 1.04 0.92 0.88 0.96 0.93 1.00 1.04 1.08 1.00 0.96 0.90 1.02 1.01 1.08 1.05 0.98
 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
 2.16 1.94 1.88 1.68 1.91 1.99 1.93 1.75 1.84 1.72 2.00 1.97 1.67 1.99 1.93 1.91
 3.02 2.64 2.32 1.93 2.09 2.82 2.88 2.57 3.17 3.26 3.61 3.49 3.30 2.94 3.49 3.29
 3.62 2.84 2.09 2.12 2.08 3.00 3.35 3.23 3.62 4.08 4.52 4.56 4.66 4.88 4.65 4.52
 4.47 5.07 2.94 2.82 3.20 4.19 4.05 3.68 3.49 6.24 4.83 4.47 4.87 7.41 7.47 4.68
 2.50 2.25 2.20 2.17 1.91 2.43 2.40 2.13 2.01 1.72 1.96 2.47 1.95 2.61 3.02 2.65
 1.43 1.18 1.10 1.27 1.20 1.36 1.43 1.50 1.35 1.28 1.13 1.39 1.37 1.51 1.46 1.32
 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
    0.1549    0.0703    0.0879    0.3471    0.1620    0.1778    0.0000
    0.2596    0.0948    0.0824    0.2024    0.1234    0.2374    0.0000
    0.3898    0.0773    0.0551    0.1289    0.0880    0.2610    0.0000
    0.3454    0.1019    0.1165    0.1528    0.0325    0.2509    0.0000
    0.3101    0.0919    0.1067    0.2010    0.1017    0.1886    0.0000
    0.1678    0.0892    0.1102    0.3775    0.0892    0.1661    0.0000
    0.0844    0.0774    0.1134    0.5110    0.0924    0.1214    0.0000
    0.0637    0.0484    0.0983    0.5153    0.1234    0.1509    0.0000
    0.0617    0.0291    0.0734    0.4845    0.1293    0.2220    0.0000
    0.0590    0.0224    0.0647    0.5730    0.0534    0.2275    0.0000
    0.1164    0.0371    0.0895    0.3015    0.0793    0.3762    0.0000
    0.1422    0.0675    0.0877    0.1481    0.1214    0.4331    0.0000
    0.0679    0.0425    0.0511    0.3322    0.0977    0.4087    0.0000
    0.0394    0.0140    0.0534    0.6895    0.0731    0.1306    0.0000
    0.0284    0.0271    0.0624    0.7341    0.0706    0.0775    0.0000
    0.0675    0.0652    0.1001    0.4894    0.1789    0.0990    0.0000
```

PBFL22.WND

```
    4.19188
0.06310.04070.01960.01080.01870.06070.13640.11830.06130.03810.02710.02870.03860.10880.15430.0750
 1.68 1.19 1.35 1.85 1.41 1.56 1.45 1.33 1.30 1.21 1.19 1.27 1.28 1.26 1.60 1.59
 3.10 2.78 2.91 1.95 2.14 1.45 2.36 1.82 1.43 1.51 1.16 1.78 2.58 2.46 2.81 2.68
 4.31 3.73 3.55 2.22 5.37 2.44 2.95 2.59 1.94 1.92 1.61 1.80 2.59 3.61 4.15 3.45
 3.74 4.38 5.28 3.50 3.39 3.64 3.40 3.14 2.45 2.44 1.98 2.41 3.82 6.30 6.47 3.44
 1.73 2.68 2.41 1.48 2.33 2.35 2.34 1.97 1.44 0.92 1.12 1.09 1.34 1.68 1.69 1.65
 1.03 1.03 1.04 0.99 1.06 1.10 1.29 1.03 0.93 0.92 0.93 1.00 0.89 0.89 0.93 1.02
 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
 2.16 1.67 1.87 2.27 1.94 2.07 1.97 1.85 1.82 1.70 1.67 1.78 1.79 1.77 2.11 2.10
 3.63 3.41 3.08 2.91 2.79 2.47 2.86 2.57 2.21 2.42 1.75 2.85 3.04 3.25 3.38 3.37
 4.66 4.10 3.77 3.63 5.66 2.93 3.74 3.39 3.02 3.27 2.87 3.37 3.83 4.74 4.66 4.46
 5.20 5.41 6.07 4.02 3.81 4.49 4.66 4.24 3.93 5.33 3.81 4.83 5.48 8.21 8.38 5.55
 2.65 3.49 3.26 2.13 3.02 3.02 3.08 2.85 2.13 1.30 1.57 1.62 2.12 2.62 2.64 2.48
 1.41 1.41 1.44 1.34 1.48 1.54 1.80 1.42 1.21 1.18 1.21 1.36 1.12 1.12 1.21 1.39
 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
    0.0639    0.0495    0.0731    0.4815    0.1314    0.2007    0.0000
    0.0625    0.0484    0.0285    0.5240    0.1613    0.1753    0.0000
    0.1061    0.0413    0.0352    0.3939    0.1531    0.2704    0.0000
    0.1274    0.0536    0.0536    0.2336    0.1283    0.4035    0.0000
    0.2281    0.0498    0.0128    0.2222    0.1729    0.3142    0.0000
    0.0815    0.0342    0.0285    0.5225    0.2215    0.1118    0.0000
    0.0607    0.0421    0.0953    0.5515    0.1442    0.1062    0.0000
    0.0827    0.0497    0.0953    0.5321    0.1265    0.1138    0.0000
    0.1350    0.0657    0.0732    0.4260    0.0844    0.2157    0.0000
    0.1751    0.0696    0.0908    0.2780    0.0816    0.3050    0.0000
    0.2038    0.0558    0.0643    0.2555    0.1064    0.3143    0.0000
    0.2004    0.0763    0.0408    0.2450    0.1286    0.3088    0.0000
    0.1851    0.0568    0.0449    0.3194    0.1195    0.2743    0.0000
    0.0570    0.0307    0.0561    0.6796    0.0412    0.1353    0.0000
    0.0433    0.0284    0.0583    0.6964    0.0582    0.1155    0.0000
    0.0582    0.0415    0.0768    0.4846    0.1212    0.2178    0.0000
```

RWML22.WND

```
   4.15934
0.02820.02240.01620.01520.02000.05590.11760.04910.02330.01900.03210.06230.10000.14290.20470.0910
 1.38 1.48 1.26 1.34 1.70 2.01 1.38 1.12 0.89 0.81 0.92 1.19 1.14 1.12 1.52 1.66
 2.99 2.18 3.24 3.24 2.68 3.01 2.48 1.92 1.22 1.26 1.82 1.54 1.41 2.24 2.63 3.05
 3.06 4.25 4.08 4.14 4.01 3.43 2.53 2.16 2.86 2.95 2.27 1.79 2.16 2.21 3.62 4.01
 4.62 4.68 3.96 3.21 3.20 3.80 3.12 2.35 1.97 2.17 3.54 2.06 2.26 4.99 5.33 4.77
 1.71 1.44 1.61 1.57 2.06 1.99 2.45 1.88 1.64 1.91 1.16 1.17 1.20 1.53 2.09 2.95
 1.10 1.09 1.10 0.91 0.95 1.19 1.02 0.97 0.98 0.92 0.93 0.98 0.92 0.94 1.09 1.02
 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
 1.90 2.00 1.77 1.86 2.18 2.36 1.90 1.57 1.12 0.91 1.18 1.67 1.61 1.57 2.04 2.15
 3.47 2.76 3.47 3.47 3.14 3.36 3.08 2.68 1.91 2.22 2.87 2.43 2.33 3.17 3.44 3.55
 3.68 4.44 4.19 4.51 4.29 4.02 3.28 2.82 4.18 4.26 3.98 3.03 3.21 4.05 4.70 4.53
 6.14 5.39 4.60 4.15 3.93 4.89 4.54 3.46 2.96 3.03 5.33 3.53 3.79 7.67 6.98 5.70
 2.30 1.97 2.11 2.08 2.87 2.82 3.13 2.85 2.33 2.47 1.74 1.70 1.83 2.36 2.94 3.34
 1.54 1.53 1.54 1.15 1.25 1.67 1.39 1.30 1.33 1.20 1.21 1.32 1.19 1.24 1.53 1.40
 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
    0.2869    0.1229    0.0861    0.3358    0.0535    0.1148    0.0000
    0.3763    0.0464    0.0624    0.3090    0.0464    0.1596    0.0000
    0.3996    0.1137    0.0716    0.1859    0.0290    0.2001    0.0000
    0.3659    0.0461    0.0461    0.2063    0.0837    0.2518    0.0000
    0.3182    0.1271    0.0635    0.3122    0.0690    0.1101    0.0000
    0.1219    0.1180    0.1528    0.4050    0.0908    0.1115    0.0000
    0.0689    0.0491    0.1564    0.5004    0.1485    0.0767    0.0000
    0.0635    0.0376    0.1129    0.4282    0.1978    0.1600    0.0000
    0.1289    0.0398    0.0647    0.2968    0.1482    0.3216    0.0000
    0.0854    0.0611    0.0738    0.2313    0.1096    0.4389    0.0000
    0.0793    0.0432    0.0361    0.3092    0.1474    0.3848    0.0000
    0.0408    0.0223    0.0353    0.2616    0.2264    0.4137    0.0000
    0.0323    0.0173    0.0393    0.3757    0.2313    0.3040    0.0000
    0.0291    0.0218    0.0428    0.6781    0.1100    0.1181    0.0000
    0.0344    0.0187    0.0627    0.7899    0.0553    0.0389    0.0000
    0.1079    0.0724    0.1030    0.6009    0.0534    0.0623    0.0000
```

TRAL22.WND

```
   4.05125
0.04250.03100.01880.01270.02240.05170.11230.09860.06780.03200.02400.02840.04730.13010.19860.0819
 1.34 1.38 1.61 1.23 1.28 1.26 1.19 1.14 0.89 1.51 1.05 1.06 1.04 1.11 1.36 1.43
 2.86 2.31 2.35 1.64 1.59 2.21 2.04 1.41 1.67 1.32 0.98 2.79 2.52 1.91 2.66 2.51
 2.89 3.24 2.13 1.52 2.20 2.19 2.56 2.15 1.81 2.94 2.58 1.20 1.90 2.47 2.98 3.22
 3.00 3.45 2.77 2.00 2.35 3.14 3.44 2.85 2.74 2.16 2.04 2.87 2.84 4.70 5.37 3.73
 1.39 1.72 1.53 1.38 1.48 1.46 1.72 1.61 1.51 1.50 1.42 1.26 1.71 1.85 2.30 1.87
 0.97 1.02 0.99 1.11 1.06 0.96 1.09 1.05 0.94 0.97 0.95 0.96 1.00 0.94 1.01 1.06
 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
 1.86 1.90 2.11 1.74 1.79 1.77 1.68 1.60 1.12 2.03 1.45 1.48 1.43 1.56 1.89 1.95
 3.36 3.26 2.70 2.13 2.36 2.94 2.77 2.19 2.33 2.05 1.52 2.92 3.30 2.89 3.32 3.24
 3.74 3.96 3.31 2.88 3.13 2.98 3.22 3.13 3.41 4.10 4.27 2.55 3.63 4.10 4.41 4.51
 4.97 5.39 4.17 3.10 3.27 4.31 4.31 3.66 4.16 3.75 3.85 4.98 4.72 7.08 7.54 5.26
 2.23 2.82 2.40 2.19 2.17 2.05 2.22 2.26 2.20 2.07 1.99 1.80 2.66 2.85 3.30 2.76
 1.29 1.40 1.33 1.55 1.48 1.29 1.52 1.46 1.24 1.29 1.25 1.29 1.36 1.22 1.38 1.48
 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
    0.1564    0.0619    0.0782    0.3804    0.1265    0.1967    0.0000
    0.2287    0.0774    0.0735    0.3248    0.1035    0.1919    0.0000
    0.3113    0.0912    0.0299    0.2447    0.1279    0.1951    0.0000
    0.5055    0.0355    0.0718    0.1349    0.0450    0.2074    0.0000
    0.3521    0.0866    0.0665    0.2142    0.0455    0.2352    0.0000
    0.2146    0.1195    0.1305    0.3650    0.0464    0.1239    0.0000
    0.1070    0.0826    0.2079    0.4495    0.0622    0.0907    0.0000
    0.0406    0.0487    0.0941    0.5832    0.1265    0.1069    0.0000
    0.0608    0.0134    0.0474    0.5642    0.1640    0.1502    0.0000
    0.0715    0.0247    0.0353    0.3397    0.2179    0.3110    0.0000
    0.0762    0.0329    0.0616    0.3099    0.1616    0.3578    0.0000
    0.0927    0.0201    0.0363    0.3994    0.1692    0.2823    0.0000
    0.0726    0.0241    0.0605    0.4455    0.1963    0.2010    0.0000
    0.0344    0.0202    0.0326    0.6654    0.1487    0.0987    0.0000
    0.0438    0.0236    0.0502    0.7217    0.1060    0.0547    0.0000
    0.0937    0.0601    0.1203    0.4545    0.1609    0.1104    0.0000
```

IDAL22.WND

```
   2.72274
0.06420.02760.02180.01410.01210.01600.02380.06920.15740.12720.04610.01650.01420.03740.15480.1975
 1.29 1.37 1.23 1.01 0.89 0.93 0.97 0.98 1.06 1.10 1.18 1.19 1.05 1.39 1.63 1.68
 2.54 2.28 1.87 1.48 1.05 1.45 1.40 1.34 1.27 1.43 1.52 1.57 1.57 2.93 3.34 3.43
 4.56 3.85 3.74 2.83 2.13 1.59 2.43 2.28 2.08 1.94 2.07 3.47 4.61 4.85 4.81 4.79
 3.12 1.32 1.54 1.08 1.27 1.86 2.60 2.61 2.00 1.30 1.26 2.93 4.05 5.67 5.62 4.83
 1.62 1.10 1.19 1.00 1.48 1.14 1.16 1.18 1.20 1.14 1.08 1.29 1.45 1.97 2.31 2.44
 0.93 0.90 0.84 0.86 0.89 0.79 0.84 0.83 0.88 0.89 0.88 0.85 0.98 1.02 1.27 1.31
 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
 1.80 1.90 1.73 1.37 1.12 1.21 1.29 1.32 1.47 1.54 1.66 1.67 1.46 1.91 2.13 2.16
 3.02 2.74 2.57 2.17 1.94 1.97 2.05 1.96 1.94 2.08 2.10 2.57 2.57 3.28 3.58 3.66
 4.95 4.03 4.28 2.97 3.31 2.30 3.13 3.44 2.84 2.38 3.11 3.91 4.73 5.06 5.01 4.99
 4.04 2.43 2.89 1.66 1.98 2.77 3.39 3.77 3.00 2.07 2.00 4.91 4.56 6.36 6.22 5.41
 2.12 1.55 1.67 1.44 2.00 1.61 1.63 1.66 1.69 1.61 1.52 1.81 1.97 2.44 2.67 2.73
 1.20 1.15 0.99 1.03 1.10 0.85 0.99 0.96 1.09 1.12 1.08 1.02 1.32 1.39 1.78 1.83
 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
    0.1373    0.1212    0.1088    0.3138    0.1479    0.1711    0.0000
    0.1661    0.0457    0.0207    0.1994    0.2694    0.2988    0.0000
    0.1571    0.0256    0.0733    0.2358    0.1676    0.3407    0.0000
    0.1955    0.0725    0.0732    0.0810    0.1301    0.4478    0.0000
    0.2450    0.0281    0.0462    0.1419    0.1799    0.3589    0.0000
    0.3211    0.0430    0.0499    0.1291    0.1072    0.3498    0.0000
    0.2164    0.1155    0.0479    0.1059    0.1105    0.4038    0.0000
    0.1471    0.0776    0.1323    0.2017    0.1784    0.2629    0.0000
    0.1199    0.0996    0.1177    0.2217    0.2536    0.1875    0.0000
    0.1241    0.0989    0.0495    0.1358    0.3327    0.2590    0.0000
    0.1861    0.0570    0.0573    0.1787    0.2134    0.3075    0.0000
    0.3339    0.0200    0.1111    0.1803    0.0486    0.3060    0.0000
    0.4436    0.0487    0.0564    0.0317    0.0487    0.3709    0.0000
    0.3334    0.1404    0.0920    0.1070    0.0428    0.2845    0.0000
    0.1464    0.1338    0.2040    0.2963    0.0525    0.1671    0.0000
    0.1222    0.1188    0.1773    0.3760    0.0736    0.1321    0.0000
```

Appendix B

Distance and Direction to INL Site and In-Town Receptor Locations

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Appendix B

Distance and Direction to INL Site and In-Town Receptor Locations

Table B-1. Location (direction and distance[a]) from INL facilities to the 31 INL Site receptor locations.

	CFA		CITRC		INTEC, INTEC-MS		MFC, MFC-MS		MFC-TREAT		NRF		ATR, ATR-ATR, ATR-MTR		RWMC		SMC		RRTR		TAN-TSF	
Receptor Number	Sector	Dist (m)	Sector	Dist (m)	Sector	Dist (m)	Sector	Dist (m)	Sector	Dist (m)	Sector	Dist (m)	Sector	Dist (m)	Sector	Dist (m)	Sector	Dist (m)	Sector	Dist (m)	Sector	Dist (m)
1	SW	14474	SW	20227	SSW	18808	WSW	37321	WSW	36706	SSW	27056	SSW	19068	SSW	7859	SSW	54463	SSW	56006	SSW	54729
2	WSW	20480	WSW	26866	SW	23761	WSW	44676	WSW	43874	SW	30596	SW	22905	WSW	12138	SW	58032	SW	59481	SW	58655
3	WNW	27561	W	33238	W	27746	W	50188	W	48941	WSW	29707	W	25179	WNW	21581	WSW	53320	SW	54469	WSW	54663
4	WNW	25483	WNW	30791	W	25108	W	47275	W	45978	W	26299	W	22385	NW	20446	WSW	49450	SW	50590	WSW	50815
5	WNW	26989	WNW	32331	W	26655	W	48820	W	47521	W	27789	W	23934	NW	21791	WSW	50641	WSW	51758	WSW	52046
6	WNW	29463	WNW	34651	WNW	28902	W	50845	W	49513	W	29458	WNW	26111	NW	24472	WSW	51275	WSW	52328	WSW	52782
7	NNW	32276	NNW	32337	NNW	27954	NW	39148	NW	37564	NNW	20265	NNW	25740	N	34930	W	24953	WSW	25593	W	27016
8	N	25900	NNW	25407	N	21375	NW	32300	NW	30716	NNW	13277	N	19444	N	29568	WSW	22862	WSW	23897	WSW	24470
9	N	34677	N	33357	N	30006	NW	36611	NW	35064	N	21404	N	28357	NNE	38774	W	17953	W	18457	W	20153
10	N	33138	N	31472	N	28411	NW	34148	NW	32606	N	19688	N	26942	NNE	37658	W	16248	WSW	16920	W	18323
11	N	28839	N	27179	N	24102	NW	30823	NW	29255	N	15369	N	22689	NNE	33542	WSW	17449	WSW	18452	WSW	19140
12	N	30089	N	27742	N	25305	NW	29361	NW	27824	N	16498	NNE	24233	NNE	35406	WSW	14198	WSW	15260	WSW	15838
13	NNE	58352	NNE	54751	NNE	53613	N	48572	N	47513	NNE	45016	NNE	52980	NNE	64344	N	18946	N	17325	N	19956
14	NNE	58353	NNE	54041	NNE	53757	N	45398	N	44535	NNE	45575	NNE	53560	NNE	65042	NNE	18052	NNE	16512	NNE	18054
15	NNE	54308	NNE	49491	NE	49895	N	39227	NNE	38499	NE	42226	NE	50067	NE	61490	NE	15156	ENE	13984	NE	14177
16	NNE	52756	NNE	48136	NNE	48268	N	38749	N	37926	NE	40406	NE	48311	NE	59770	NE	13017	NE	11720	NE	12356
17	NE	49860	NNE	44800	NE	45574	N	33897	NNE	33209	NE	38272	NE	45957	NE	57280	ENE	12598	E	11912	ENE	10895
18	NE	46815	NE	41521	NE	42675	NNE	29874	NNE	29247	NE	35791	NE	43268	NE	54446	E	12405	E	12259	E	10162
19	NE	49975	NE	44233	NE	46174	NNE	30285	NNE	30000	ENE	40093	NE	47134	NE	57945	E	19050	ESE	19008	E	16700
20	NE	48691	NE	42838	NE	45010	NNE	28415	NNE	28201	ENE	39239	ENE	46091	NE	56747	ESE	19715	ESE	19853	ESE	17283
21	NE	50717	NE	44707	ENE	47218	NE	29391	NE	29359	ENE	41841	ENE	48454	NE	58879	ESE	23186	ESE	23323	ESE	20750
22	ENE	52525	NE	46365	ENE	49247	NE	30213	NE	30376	ENE	44346	ENE	50656	ENE	60782	ESE	26899	ESE	27077	ESE	24446
23	ENE	47620	ENE	41162	ENE	45457	ENE	23244	ENE	24125	E	43068	E	47570	ENE	55952	SE	34929	SE	35706	SE	32504
24	E	49286	E	42898	E	47788	E	25186	E	26406	E	46685	E	50190	E	57432	SE	41762	SE	42641	SE	39389
25	E	38227	E	32012	E	37327	ESE	15454	ESE	16954	ESE	37719	E	39962	E	46146	SSE	39881	SSE	41117	SSE	37844
26	E	27634	E	21624	ESE	27223	SSE	8534	SSE	10010	ESE	29067	ESE	30019	E	35382	SSE	38254	SSE	39731	SSE	36702
27	ESE	35495	SE	31312	SE	37159	SSE	24750	SSE	26079	SE	41889	SE	40154	ESE	41186	SSE	54689	SSE	56171	SSE	53143
28	SE	24982	SE	21917	SE	27430	S	22252	S	23041	SSE	33600	SE	30358	ESE	29915	S	51487	S	53078	S	50392
29	SE	16024	SSE	13292	SE	18572	SSW	19421	SSW	19609	SSE	25305	SE	21463	ESE	21436	S	46025	S	47651	S	45278
30	SE	20176	SSE	18934	SSE	23592	SSW	25290	SSW	25651	SSE	31071	SSE	26286	ESE	23624	S	52475	S	54100	S	51714
31	SE	14060	SSE	12141	SSE	17015	SW	20776	SW	20800	SSE	24276	SE	19816	ESE	19069	S	46241	S	47872	SSW	45621

a. Distances are measured from the approximate geographic center of each facility to each receptor location.

Table B-2. Location (direction and distance[a]) from INL facilities to the 30 INL in-town receptor locations.

	IF-603		IF-683	
Receptor Number	**Sector**	**Dist (m)**	**Sector**	**Dist (m)**
1	S	336	SSE	147
2	S	379	S	187
3	S	422	SSW	238
4	SSW	341	SW	186
5	SSW	648	SSW	472
6	SSW	790	SSW	619
7	SW	875	SW	753
8	SW	783	WSW	702
9	WSW	747	WSW	689
10	WSW	670	W	658
11	W	1394	WNW	1436
12	W	491	WNW	568
13	W	327	WNW	390
14	W	299	WNW	371
15	W	291	NW	377
16	WNW	323	NW	427
17	NW	374	NW	517
18	NNW	1124	NNW	1299
19	N	952	N	1142
20	N	132	N	323
21	NNE	223	N	407
22	NE	228	NNE	365
23	ENE	209	NNE	326
24	ESE	167	NE	200
25	ESE	229	ENE	246
26	ESE	322	ENE	308
27	E	386	ENE	396
28	ESE	427	E	372
29	SE	471	ESE	370
30	SSE	564	SE	391

a. Distances are measured from the approximate geographic center of each facility to each receptor location.

Appendix C

Perl Scripts for Pre- and Post-Processing

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Appendix C

Perl Scripts for Pre- and Post-Processing

mkFiles.pl (for INL Site)

```
# mkFiles.pl
# This script inserts the current wind file in the template file and then concatentate the template file
# with the nuclide file to create all the CAP88 input files. It also replaces the second line of the template
# file with the filename sans the "dat" (e.g. Ac227A.). A second file is created that is used by subsequent
# scripts. This file contains a list of nuclide file names and the name of the nuclide


# ================================================================================================
# REQUIRED USER INPUT

# --- Update with new met files? (Y/N)
      $update="Y";

# --- Working Directory (each facility directory is below this directory)
      $templatef="C:\\Projects\\FY2023\\NESHAP\\CAP88\\";

# --- Path to the wind files
      $windpath="C:\\Projects\\FY2023\\NESHAP\\Windfiles\\";

# --- Path to the nuclide template files
      $nuctemplate="C:\\Users\\OVERKB\\Documents\\cap88NucTempv411\\";

# --- Names of the template files - same name for each facility
      @tempfnames = ("v41TempA.dat","v41TempB.dat");

# --- Input File containing list of nuclides to be processed
      $NuclideList = "NucList.inp";      # nuclide names

# --- Output File containing the CAP88 nuclide input files names and name of nuclide
      $NuclideFile = "NucFiles.inp";

# --- Output File containing the CAP88 nuclide output file names and name of nuclide
      $OutputFile = "OutputFiles.inp";

# --- Input File containing all the facility names and wind file names
      $FacAndWnd = "Facility.inp";        # facility and wind file names

# --- Facility name and wind file format
#         Facility         WindFile  header (discarded)
#         CFA              690L08.WND
#         CITRC            PBFL08.WND
#         INTEC            GRIL08.WND
#         .
#         .
#         .
# ================================================================================================

# Get list of facilities and wind files

      open (INFILE, "<$FacAndWnd");
      $line=<INFILE>;                     # read and discard header
      $nfac=0;
      while ($line=<INFILE>)
      {
        $line =~ s/^[ ]+//;               # delete initial spaces
        chop ($line);                     # remove carrige return
        @field = split /[ \t]+/, $line;   # split field
        $facID[$nfac]=$field[0];
        $wndfile[$nfac]=$field[1];
        $nfac=$nfac+1;
      }
      close (INFILE);

# get list of nuclides
      open(INFILE,"<$NuclideList");
      $nnuc=0;
      while ($line=<INFILE>)
      {
```

```
        $line =~ s/^[ ]+//;                # delete initial spaces

        chop ($line);                      # remove carrige return
        @field = split /[ \t]+/, $line;    # split field
        $nucnames[$nnuc]=$field[0];
        $nnuc=$nnuc+1;
      }
      close (INFILE);



# Loop through the files and insert current met file
    if($update eq "Y")
    {
      for $i (0..$nfac-1)
      {
        print "$facID[$i] \n";

# update template files with new met dat

        for $k (0..1)
        {

          $fname=$templatef.$facID[$i]."\\".$tempfnames[$k];
          open (TFILE,"<$fname");
          $n=0;
          while ($line=<TFILE>)
          {
            $tline[$n]=$line;
            $n=$n+1;
          }
          close(TFILE);
          system ("del $fname");

          open (TFILE,">$fname");
          for $j (0..$n)
          {
        if ($j==22)
            {
              $wfile=$windpath.$wndfile[$i];
              print TFILE "$wfile \n";
            }
            else
            {
              print TFILE "$tline[$j]";
            }

          }
          close (TFILE);
        }

      }
    }


# Now append nuclide files to each template file and write template files and nuclide name to $NuclideFile
      open(NLIST,">$NuclideFile");
      open(OLIST,">$OutputFile");

      for $i (0..$nfac-1)
      {
        print "$facID[$i]\n";

        for $j (0..$nnuc-1)
        {
          $fname=$nucnames[$j];
          $fname =~ s/-//;


          $ffname=$fname."A.dat";
          $outfile=$fname."A.SUM";
          if($i==0)
          {
            print OLIST "$outfile $nucnames[$j] \n";
            print NLIST "$ffname $nucnames[$j] \n";
          }
          $ofile=$templatef.$facID[$i]."\\".$ffname." \n";
          $cmd="del ".$ofile;
#         print "$cmd \n";
          system $cmd;
```

```
          $cmd="copy ".$templatef.$facID[$i]."\\".$tempfnames[0]." + ".$nuctemplate.$fname.".dat ".$ofile;
#         print "$cmd \n";
          system $cmd;

# AJS added following lines to replace 2nd line of cap88 input file with nucname (reqd by v4)
# Not terribly efficient, but it works. It reads every line of the file, then writes it back replacing line 2.
          open (OFILE,"<$ofile");
          $n=0;
          while ($line=<OFILE>)
          {
            $zline[$n]=$line;
            $n=$n+1;
          }
          close(OFILE);
          system ("del $ofile");
          open (OFILE,">$ofile");
          for $l (0..$n)
          {
        if ($l==1)
            {
           $capname=$fname."A.";
              print OFILE "$capname \n";
            }
        else
            {
              print OFILE "$zline[$l]";
            }
          }
# AJS End of AJS changes

          $ffname=$fname."B.dat";
          $outfile=$fname."B.SUM";
          if($i==0)
          {
            print OLIST "$outfile $nucnames[$j] \n";
            print NLIST "$ffname $nucnames[$j] \n";
          }
          $ofile=$templatef.$facID[$i]."\\".$ffname." \n";
          $cmd="del ".$ofile;
#         print "$cmd \n";
          system $cmd;
          $cmd="copy ".$templatef.$facID[$i]."\\".$tempfnames[1]." + ".$nuctemplate.$fname.".dat ".$ofile;
#         print "$cmd \n";
          system $cmd;

# AJS added following lines to replace 2nd line of cap88 input file with nucname (reqd by v4)
# Not terribly efficient, but it works. It reads every line of the file, then writes it back replacing line 2.
          open (OFILE,"<$ofile");
          $n=0;
          while ($line=<OFILE>)
          {
            $zline[$n]=$line;
            $n=$n+1;
          }
          close(OFILE);
          system ("del $ofile");

          open (OFILE,">$ofile");
          for $l (0..$n)
          {
        if ($l==1)
            {
           $capname=$fname."B.";
              print OFILE "$capname \n";
            }
        else
            {
              print OFILE "$zline[$l]";
            }
          }
# AJS End of AJS changes


        }
      }

      close (NLIST);
      close (OLIST);
```

RunFiles.pl (for INL Site)

```
# RunFiles.pl
# This script runs all the CAP88 files in a given directory


# ================================================================================================
# REQUIRED USER INPUT

# --- Path to the input files (excluding specific facility name)
      $templatef="C:\\Projects\\FY2023\\NESHAP\\CAP88\\";
      $wrkdir="C:\\Projects\\FY2023\\NESHAP\\CAP88\\Scripts";

# --- File containing all the facility names - These names correspond to directories for each calcilites
      $FacAndWnd = "Facility.inp";        # facility and wind file names

# --- Path to the wind files
      $windpath="C:\\Projects\\FY2023\\NESHAP\\Windfiles\\";

# --- Facility name and wind file format
#         Facility         WindFile  header (discarded)
#         CFA              690L08.WND
#         CITRC            PBFL08.WND
#         INTEC-ICDF       GRIL08.WND
#         .
#         .
#         .

# --- File containing all the nuclide file names
      $NuclideFile = "NucFiles.inp";
# ================================================================================================
# END OF USER INPUT



# Get list of facilities

      open (INFILE, "<$FacAndWnd");
      $line=<INFILE>;                       # read and discard header
      $nfac=0;
      while ($line=<INFILE>)
      {
        $line =~ s/^[ ]+//;                 # delete initial spaces
        chop ($line);                       # remove carrige return
        @field = split /[ \t]+/, $line;     # split field
        $facID[$nfac]=$field[0];
        $wndfile[$nfac]=$field[1];
        $nfac=$nfac+1;
      }
      close (INFILE);

# get list of nuclides
      open(INFILE,"<$NuclideFile");
      $nnuc=0;
      while ($line=<INFILE>)
      {
        $line =~ s/^[ ]+//;                 # delete initial spaces

        chop ($line);                       # remove carrige return
        @field = split /[ \t]+/, $line;     # split field
        $nucfiles[$nnuc]=$field[0];
        $nnuc=$nnuc+1;
      }
      close (INFILE);



# Loop through each facility, write a batch file to run CAP88, and run batch file


      $batfile="run.bat";
      for $i (0..$nfac-1)
      {
        print "$facID[$i] \n";
        $wfile=$windpath.$wndfile[$i];
    print "$wfile \n";
        for $j (0..$nnuc-1)
        {

# --- open batch file
          open (BATFILE,">$batfile");
```

```
          $nucf=$templatef.$facID[$i]."\\".$nucfiles[$j];
          $nucname=substr($nucfiles[$j],0,-4);
#         print $nucname;
          $sumfile=$templatef.$facID[$i]."\\".substr($nucfiles[$j],0,-4).".SUM";
          print BATFILE "cd C:\\Users\\OVERKB\\Documents\\CAP88\\Fortran\n";
          print BATFILE "copy $nucf INPUT.DAT\n";
      print BATFILE "copy $wfile INPUT.WND\n";
          print BATFILE "Cap88v41Fortran.exe\n";
          print BATFILE "cd output\n";
          print BATFILE "copy $nucname.SUM $sumfile\n";
          print BATFILE "DEL $nucname.*\n";
          print BATFILE "cd $wrkdir\n";

          close (BATFILE);
          system "run.bat";

        }

      }
```

getCAP88dose2.pl (for INL Site)

```
# getCAP88dose.pl
# This script extracts doses from the CAP88 *.SUM file and writes it to a text file
# The file contaning list of output files ($filein) is generated in the script mkfiles.pl

# ================================================================================
# REQUIRED USER INPUT
#     Working Directory
      $wrkdir="C:\\Projects\\FY2023\\NESHAP\\CAP88\\";
#     File contaning list of output files
      $filein="OutputFiles.inp";
# --- File containing all the facility names - These names correspond to directories for each facilites
      $FacAndWnd = "Facility.inp";        # facility and wind file names
# --- Output File
      $fileout="tempdoses.txt";
# --- Number of MEI locations
      $nmei=31;
# --- MEI File
      $meifile="MEI.dat";
# ================================================================================
#   if($ARGV[0] eq "?")
#   {
#      print "usage getCAP88dose.pl [file name containing files to process] [output file] [facility name] \n";
#      die;
#   }
#   $filein=$ARGV[0];
#   $fileout=$ARGV[1];
#   $facility_name=$ARGV[2];
#   print "$filein \n";

# Open and store file containing list of output files and make nuclide names

      open (INFILE, "<$filein");
      $nf=0;

      while ($line=<INFILE>)
      {
        $line =~ s/^[ ]+//; # delete initial spaces
        chop ($line); # remove carrige return
        @field = split /[ \t]+/, $line;     #split field
        $files[$nf]=$field[0];
        $nname[$nf]=$field[1];
#        $nname[$nf]=substr($files[$nf],0,-5);
        $nf=$nf+1;
      }
      close (INFILE);
      $nf=$nf-1;

# Open and store file containing list of facilities

      open (INFILE, "<$FacAndWnd");
      $line=<INFILE>;                     # read and discard header
      $nfac=0;
      while ($line=<INFILE>)
      {
        $line =~ s/^[ ]+//;               # delete initial spaces
        chop ($line);                     # remove carrige return
```

```
        @field = split /[ \t]+/, $line;     # split field
        $facID[$nfac]=$field[0];
        $nfac=$nfac+1;
      }
      close (INFILE);
      $nfac=$nfac-1;


# load MEI locations
      open (INFILE, "<$meifile");
      $line=<INFILE>;                      # read and discard header
# --- There are 62 MEI locations per facility - so for each faility, store each location

      $i=1;
      while ($line=<INFILE>)
      {
        $line =~ s/^[ ]+//; # delete initial spaces
        chop ($line); # remove carrige return
        @field = split /[ \t]+/, $line;     #split field

        $mei_dir{$field[0]}{$i}=$field[1];
        $mei_dist{$field[0]}{$i}=$field[2];
        $i=$i+1;
        if($i>$nmei) {$i=1;}

      }

      close (INFILE);


# Open output file
      open (OUTFILE, ">$fileout");

      print " Number of Files:         $nf \n";
      print " Number of Facilities:    $nfac \n";
      print " Number of MEI Locations: $nmei \n";

      $n1=0;
      $n2=1;

      for $j (0..$nfac)
      {
        print "[$j] \n";
        print "Facility: $facID[$j] \n";
        $cnt=0;
        for $i (0..$nf)
        {
          if ($i % 5 == 0) { print STDERR "$i"; }
          else { print STDERR ".";}

          $filein=$wrkdir.$facID[$j]."\\".$files[$i];
          open (INFILE, "<$filein");
          while ($line=<INFILE>)
          {

            if($line=~ /INDIVIDUAL LIFETIME RISK/)
            {last;}


            if($line=~ /Distance/)
            {

              @field=(-1,-1,-1,-1,-1,-1,-1,-1);
              $line=<INFILE>;   # skip 2 lines
              $line=<INFILE>;
# get distances
              $line=<INFILE>;

              $line =~ s/^[ ]+//; # delete initial spaces
              chop ($line); # remove carrige return
              @field = split /[ \t]+/, $line;     #split field

# find number of values
              $nvals=0;
              for $k (1..7)
              {
                if($field[$k] >0 )
                {
                  $nvals=$nvals+1;
                  $dist[$nvals]=$field[$k];
                }
```

```
              }

              $line=<INFILE>;   # skip 2 lines
              $line=<INFILE>;
# get dose values
              for $k (1..16)
              {
                $line=<INFILE>;
                $line =~ s/^[ ]+//; # delete initial spaces
                chop ($line); # remove carrige return
                @field = split /[ \t]+/, $line;     #split field
                $direct=$field[$0];

                for $m (1..$nvals)
                {

# --- Loop through all MEIs to the facility. if the location is an MEI and print it.
                  for $kk (1..$nmei)
                  {
                    if($dist[$m]==$mei_dist{$facID[$j]}{$kk} && $direct eq $mei_dir{$facID[$j]}{$kk})
                    {
                      print OUTFILE
"$facID[$j],$nname[$i],$mei_dir{$facID[$j]}{$kk},$mei_dist{$facID[$j]}{$kk},$field[$m] \n";
                    }

                  }
                }     # end of distance loop

              }       # end of direction loop

            }         # end of if statement

          }           # end of line search loop
          close (INFILE);

        }              # end of file loop

      }                # end of facility loop


# Close output file and terminate

   close OUTFILE;
```

mkFilesIRC.pl (for In-Town IRC Site)

```
# mkFiles.pl
# This script inserts the current wind file in the template file and then concatentate the template file
# with the nuclide file to create all the CAP88 input files. It also replaces the second line of the template
# file with the filename sans the "dat" (e.g. Ac227A.). A second file is created that is used by subsequent
# scripts. This file contains a list of nuclide file names and the name of the nuclide

# ================================================================================================================
# REQUIRED USER INPUT

# --- Update with new met files? (Y/N)
      $update="Y";

# --- Working Directory (each facility directory is below this directory)
      $templatef="C:\\Projects\\FY2023\\NESHAP\\CAP88IRC\\CAP88\\";

# --- Path to the wind files
      $windpath="C:\\Projects\\FY2023\\NESHAP\\Windfiles\\";

# --- Path to the nuclide template files
      $nuctemplate="C:\\Users\\OVERKB\\Documents\\cap88NucTempv411\\";

# --- Names of the template files - same name for each facility
      @tempfnames = ("v41TempA.dat","v41TempB.dat");

# --- Input File containing list of nuclides to be processed
      $NuclideList = "NucListIRC.inp";      # nuclide names

# --- Output File containing the CAP88 nuclide input files names and name of nuclide
      $NuclideFile = "NucFilesIRC.inp";

# --- Output File containing the CAP88 nuclide output file names and name of nuclide
      $OutputFile = "OutputFilesIRC.inp";
```

```
# --- Input File containing all the facility names and wind file names
      $FacAndWnd = "FacilityIRC.inp";        # facility and wind file names

# --- Facility name and wind file format
#         Facility         WindFile  header (discarded)
#         CFA              690L08.WND
#         CITRC            PBFL08.WND
#         INTEC            GRIL08.WND
#         .
#         .
#         .
# ============================================================================================================

# Get list of facilities and wind files

      open (INFILE, "<$FacAndWnd");
      $line=<INFILE>;                       # read and discard header
      $nfac=0;
      while ($line=<INFILE>)
      {
        $line =~ s/^[ ]+//;                 # delete initial spaces
        chop ($line);                       # remove carrige return
        @field = split /[ \t]+/, $line;     # split field
        $facID[$nfac]=$field[0];
        $wndfile[$nfac]=$field[1];
        $nfac=$nfac+1;
      }
      close (INFILE);

# get list of nuclides
      open(INFILE,"<$NuclideList");
      $nnuc=0;
      while ($line=<INFILE>)
      {
        $line =~ s/^[ ]+//;                 # delete initial spaces

        chop ($line);                       # remove carrige return
        @field = split /[ \t]+/, $line;     # split field
        $nucnames[$nnuc]=$field[0];
        $nnuc=$nnuc+1;
      }
      close (INFILE);



# Loop through the files and insert current met file
    if($update eq "Y")
    {
      for $i (0..$nfac-1)
      {
        print "$facID[$i] \n";

# update template files with new met data

        for $k (0..1)
        {

          $fname=$templatef.$facID[$i]."\\".$tempfnames[$k];
          open (TFILE,"<$fname");
          $n=0;
          while ($line=<TFILE>)
          {
            $tline[$n]=$line;
            $n=$n+1;
          }
          close(TFILE);
          system ("del $fname");

          open (TFILE,">$fname");
          for $j (0..$n)
          {
            if ($j==22)
            {
              $wfile=$windpath.$wndfile[$i];
              print TFILE "$wfile \n";
            }
            else
            {
              print TFILE "$tline[$j]";
            }
```

```
          }
          close (TFILE);
        }

      }
    }


# Now append nuclide files to each template file and write template files and nuclide name to $NuclideFile
      open(NLIST,">$NuclideFile");
      open(OLIST,">$OutputFile");

      for $i (0..$nfac-1)
      {
        print "$facID[$i]\n";

        for $j (0..$nnuc-1)
        {
          $fname=$nucnames[$j];
          $fname =~ s/-//;


          $ffname=$fname."A.dat";
          $outfile=$fname."A.SUM";
          if($i==0)
          {
            print OLIST "$outfile $nucnames[$j] \n";
            print NLIST "$ffname $nucnames[$j] \n";
          }
          $ofile=$templatef.$facID[$i]."\\".$ffname." \n";
          $cmd="del ".$ofile;
          print "$cmd \n";
          system $cmd;

          $cmd="copy ".$templatef.$facID[$i]."\\".$tempfnames[0]." + ".$nuctemplate.$fname.".dat ".$ofile;
          print "$cmd \n";
          system $cmd;

# AJS added following lines to replace 2nd line of cap88 input file with nucname (reqd by v4)
# Not terribly efficient, but it works. It reads every line of the file, then writes it back replacing line 2.
          open (OFILE,"<$ofile");
          $n=0;
          while ($line=<OFILE>)
          {
            $zline[$n]=$line;
            $n=$n+1;
          }
          close(OFILE);
          system ("del $ofile");
          open (OFILE,">$ofile");
          for $l (0..$n)
          {
        if ($l==1)
            {
          $capname=$fname."A.";
              print OFILE "$capname \n";
            }
        else
            {
              print OFILE "$zline[$l]";
            }
          }
# AJS End of AJS changes

          $ffname=$fname."B.dat";
          $outfile=$fname."B.SUM";
          if($i==0)
          {
            print OLIST "$outfile $nucnames[$j] \n";
            print NLIST "$ffname $nucnames[$j] \n";
          }
          $ofile=$templatef.$facID[$i]."\\".$ffname." \n";
          $cmd="del ".$ofile;
          print "$cmd \n";
          system $cmd;

          $cmd="copy ".$templatef.$facID[$i]."\\".$tempfnames[1]." + ".$nuctemplate.$fname.".dat ".$ofile;
          print "$cmd \n";
          system $cmd;
```

```
# AJS added following lines to replace 2nd line of cap88 input file with nucname (reqd by v4)
# Not terribly efficient, but it works. It reads every line of the file, then writes it back replacing line 2.
          open (OFILE,"<$ofile");
          $n=0;
          while ($line=<OFILE>)
          {
            $zline[$n]=$line;
            $n=$n+1;
          }
          close(OFILE);
          system ("del $ofile");
          open (OFILE,">$ofile");
          for $l (0..$n)
          {
         if ($l==1)
            {
          $capname=$fname."B.";
              print OFILE "$capname \n";
            }
         else
            {
              print OFILE "$zline[$l]";
            }
          }
# AJS End of AJS changes
        }
      }

      close (NLIST);
      close (OLIST);
```

RunFilesIRC.pl (for In-Town IRC Site)

```
# RunFiles.pl
# This script runs all the CAP88 files in a given directory


#
================================================================================================
=====
# REQUIRED USER INPUT

# --- Path to the input files (excluding specific facility name)
      $templatef="C:\\Projects\\FY2023\\NESHAP\\CAP88IRC\\CAP88\\";
      $wrkdir="C:\\Projects\\FY2023\\NESHAP\\CAP88IRC\\CAP88\\Scripts";

# --- File containing all the facility names - These names correspond to directories for each
calcilites
      $FacAndWnd = "FacilityIRC.inp";        # facility and wind file names

# --- Path to the wind files
      $windpath="C:\\Projects\\FY2023\\NESHAP\\Windfiles\\";

# --- Facility name and wind file format
#         Facility         WindFile  header (discarded)
#         CFA              690L08.WND
#         CITRC            PBFL08.WND
#         INTEC-ICDF       GRIL08.WND
#         .
#         .
#         .

# --- File containing all the nuclide file names
      $NuclideFile = "NucFilesIRC.inp";
#
================================================================================================
=====
# END OF USER INPUT



# Get list of facilities

      open (INFILE, "<$FacAndWnd");
      $line=<INFILE>;                      # read and discard header
```

```
      $nfac=0;
      while ($line=<INFILE>)
      {
        $line =~ s/^[ ]+//;                 # delete initial spaces
        chop ($line);                       # remove carrige return
        @field = split /[ \t]+/, $line;     # split field
        $facID[$nfac]=$field[0];
        $wndfile[$nfac]=$field[1];
        $nfac=$nfac+1;
      }
      close (INFILE);

# get list of nuclides
      open(INFILE,"<$NuclideFile");
      $nnuc=0;
      while ($line=<INFILE>)
      {
        $line =~ s/^[ ]+//;                 # delete initial spaces

        chop ($line);                       # remove carrige return
        @field = split /[ \t]+/, $line;     # split field
        $nucfiles[$nnuc]=$field[0];
        $nnuc=$nnuc+1;
      }
      close (INFILE);



# Loop through each facility, write a batch file to run CAP88, and run batch file


      $batfile="run.bat";
      for $i (0..$nfac-1)
      {
        print "$facID[$i] \n";
        $wfile=$windpath.$wndfile[$i];

        for $j (0..$nnuc-1)
        {

# --- open batch file
          open (BATFILE,">$batfile");

          $nucf=$templatef.$facID[$i]."\\".$nucfiles[$j];
      $nucname=substr($nucfiles[$j],0,-4);
          $sumfile=$templatef.$facID[$i]."\\".substr($nucfiles[$j],0,-4).".SUM";
          print BATFILE "cd C:\\Users\\OVERKB\\Documents\\CAP88\\Fortran\n";
          print BATFILE "DEL INPUT.DAT\n";
          print BATFILE "DEL INPUT.WND\n";
          print BATFILE "copy $nucf INPUT.DAT\n";
      print BATFILE "copy $wfile INPUT.WND\n";
          print BATFILE "Cap88v41Fortran.exe\n";
          print BATFILE "cd output\n";
#         print BATFILE "copy RunIRC.Sum $sumfile\n";
          print BATFILE "copy $nucname.SUM $sumfile\n";
          print BATFILE "DEL $nucname.*\n";
          print BATFILE "cd $wrkdir\n";

          close (BATFILE);
          system "run.bat";

        }

      }
```

getCAP88Dose2IRC.pl (for In-Town IRC Site)

```
# getCAP88dose.pl
```

```
# This script extracts doses from the CAP88 *.SUM file and writes it to a text file
# The file contaning list of output files ($filein) is generated in the script mkfiles.pl

# ================================================================================
# REQUIRED USER INPUT
#     Working Directory
      $wrkdir="C:\\Projects\\FY2023\\NESHAP\\CAP88IRC\\CAP88\\";
#     File contaning list of output files
      $filein="OutputFilesIRC.inp";
# --- File containing all the facility names - These names correspond to directories for each facilites
      $FacAndWnd = "FacilityIRC.inp";        # facility and wind file names
# --- Output File
      $fileout="tempdoses.txt";
# --- Number of MEI locations
      $nmei=30;
# --- MEI File
      $meifile="MEI.dat";
# ================================================================================
#   if($ARGV[0] eq "?")
#   {
#      print "usage getCAP88dose.pl [file name containing files to process] [output file] [facility name] \n";
#      die;
#   }
#   $filein=$ARGV[0];
#   $fileout=$ARGV[1];
#   $facility_name=$ARGV[2];
#   print "$filein \n";

# Open and store file containing list of output files and make nuclide names

      open (INFILE, "<$filein");
      $nf=0;

      while ($line=<INFILE>)
      {
        $line =~ s/^[ ]+//; # delete initial spaces
        chop ($line); # remove carrige return
        @field = split /[ \t]+/, $line;     #split field
        $files[$nf]=$field[0];
        $nname[$nf]=$field[1];
#        $nname[$nf]=substr($files[$nf],0,-5);
        $nf=$nf+1;
      }
      close (INFILE);
      $nf=$nf-1;

# Open and store file containing list of facilities

      open (INFILE, "<$FacAndWnd");
      $line=<INFILE>;                       # read and discard header
      $nfac=0;
      while ($line=<INFILE>)
      {
        $line =~ s/^[ ]+//;                 # delete initial spaces
        chop ($line);                       # remove carrige return
        @field = split /[ \t]+/, $line;     # split field
        $facID[$nfac]=$field[0];
        $nfac=$nfac+1;
      }
      close (INFILE);
      $nfac=$nfac-1;


# load MEI locations
      open (INFILE, "<$meifile");
      $line=<INFILE>;                      # read and discard header
# --- There are 62 MEI locations per facility - so for each faility, store each location

      $i=1;
      while ($line=<INFILE>)
      {
        $line =~ s/^[ ]+//; # delete initial spaces
        chop ($line); # remove carrige return
        @field = split /[ \t]+/, $line;     #split field

        $mei_dir{$field[0]}{$i}=$field[1];
        $mei_dist{$field[0]}{$i}=$field[2];
        $i=$i+1;
        if($i>$nmei) {$i=1;}

      }
```

```
      close (INFILE);


# Open output file
      open (OUTFILE, ">$fileout");

      print " Number of Files:         $nf \n";
      print " Number of Facilities:    $nfac \n";
      print " Number of MEI Locations: $nmei \n";

      $n1=0;
      $n2=1;

      for $j (0..$nfac)
      {
        print "[$j] \n";
        print "Facility: $facID[$j] \n";
        $cnt=0;
        for $i (0..$nf)
        {
          if ($i % 5 == 0) { print STDERR "$i"; }
          else { print STDERR ".";}

          $filein=$wrkdir.$facID[$j]."\\".$files[$i];
          open (INFILE, "<$filein");
          while ($line=<INFILE>)
          {

            if($line=~ /INDIVIDUAL LIFETIME RISK/)
            {last;}


            if($line=~ /Distance/)
            {

              @field=(-1,-1,-1,-1,-1,-1,-1,-1);
              $line=<INFILE>;   # skip 2 lines
              $line=<INFILE>;
# get distances
              $line=<INFILE>;

              $line =~ s/^[ ]+//; # delete initial spaces
              chop ($line); # remove carrige return
              @field = split /[ \t]+/, $line;     #split field

# find number of values
              $nvals=0;
              for $k (1..7)
              {
                if($field[$k] >0 )
                {
                  $nvals=$nvals+1;
                  $dist[$nvals]=$field[$k];
                }
              }

              $line=<INFILE>;   # skip 2 lines
              $line=<INFILE>;
# get dose values
              for $k (1..16)
              {
                $line=<INFILE>;
                $line =~ s/^[ ]+//; # delete initial spaces
                chop ($line); # remove carrige return
                @field = split /[ \t]+/, $line;     #split field
                $direct=$field[$0];

                for $m (1..$nvals)
                {

# --- Loop through all MEIs to the facility. if the location is an MEI and print it.
                  for $kk (1..$nmei)
                  {
                    if($dist[$m]==$mei_dist{$facID[$j]}{$kk} && $direct eq $mei_dir{$facID[$j]}{$kk})
                    {
                      print OUTFILE
"$facID[$j],$nname[$i],$mei_dir{$facID[$j]}{$kk},$mei_dist{$facID[$j]}{$kk},$field[$m] \n";
                    }

                  }
```

```
                }     # end of distance loop

              }       # end of direction loop

            }         # end of if statement

          }           # end of line search loop
          close (INFILE);

        }              # end of file loop

      }                # end of facility loop


# Close output file and terminate

   close OUTFILE;
```

Appendix D

Releases Tables

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Appendix D

Releases Tables

Table D-1. Radionuclide releases reported for INL Site Facilities. (Sorted by FacilityID, SourceID, Fugitive/Non-Fugitive, and Radionuclide).

SourceID	FacilityID	Fugitive/Non-Fugitive	Radionuclide	Q (Ci/yr)
CFA-1618	CFA	Non-Fugitive	Ar-41	2.00E-05
CFA-1618	CFA	Non-Fugitive	C-14	2.00E-09
CFA-625	CFA	Non-Fugitive	Ac-227	6.67E-13
CFA-625	CFA	Non-Fugitive	Ag-109m	1.21E-13
CFA-625	CFA	Non-Fugitive	Ag-110	2.01E-20
CFA-625	CFA	Non-Fugitive	Ag-110m	1.37E-14
CFA-625	CFA	Non-Fugitive	Ag-111	1.34E-12
CFA-625	CFA	Non-Fugitive	Ag-112	6.30E-12
CFA-625	CFA	Non-Fugitive	Am-241	8.33E-12
CFA-625	CFA	Non-Fugitive	Am-243	1.20E-12
CFA-625	CFA	Non-Fugitive	Ar-41	2.70E-05
CFA-625	CFA	Non-Fugitive	As-73	1.28E-21
CFA-625	CFA	Non-Fugitive	As-76	8.53E-18
CFA-625	CFA	Non-Fugitive	As-77	1.06E-13
CFA-625	CFA	Non-Fugitive	As-78	3.23E-14
CFA-625	CFA	Non-Fugitive	Au-196	1.67E-19
CFA-625	CFA	Non-Fugitive	Au-198	2.48E-17
CFA-625	CFA	Non-Fugitive	Au-198m	2.55E-17
CFA-625	CFA	Non-Fugitive	Ba-133	2.01E-15
CFA-625	CFA	Non-Fugitive	Ba-137m	7.90E-13
CFA-625	CFA	Non-Fugitive	Ba-139	2.65E-13
CFA-625	CFA	Non-Fugitive	Ba-140	3.87E-12
CFA-625	CFA	Non-Fugitive	Bi-207	8.33E-15
CFA-625	CFA	Non-Fugitive	Bi-211	9.30E-17
CFA-625	CFA	Non-Fugitive	Bi-212	5.52E-17
CFA-625	CFA	Non-Fugitive	Bi-214	1.91E-16
CFA-625	CFA	Non-Fugitive	Br-80	6.43E-09
CFA-625	CFA	Non-Fugitive	Br-82	8.93E-07
CFA-625	CFA	Non-Fugitive	Br-83	1.90E-03
CFA-625	CFA	Non-Fugitive	Br-84	7.11E-10
CFA-625	CFA	Non-Fugitive	C-14	3.13E-14
CFA-625	CFA	Non-Fugitive	Cd-109	6.60E-16
CFA-625	CFA	Non-Fugitive	Cd-113m	1.70E-16
CFA-625	CFA	Non-Fugitive	Cd-115	2.49E-12
CFA-625	CFA	Non-Fugitive	Cd-115m	8.87E-15
CFA-625	CFA	Non-Fugitive	Cd-117	4.70E-13
CFA-625	CFA	Non-Fugitive	Ce-139	8.63E-14
CFA-625	CFA	Non-Fugitive	Ce-141	1.85E-12
CFA-625	CFA	Non-Fugitive	Ce-143	1.82E-11
CFA-625	CFA	Non-Fugitive	Ce-144	8.01E-13
CFA-625	CFA	Non-Fugitive	Cm-244	1.62E-11
CFA-625	CFA	Non-Fugitive	Co-57	7.91E-15

SourceID	FacilityID	Fugitive/Non-Fugitive	Radionuclide	Q (Ci/yr)
CFA-625	CFA	Non-Fugitive	Co-58	1.83E-10
CFA-625	CFA	Non-Fugitive	Co-58m	3.17E-20
CFA-625	CFA	Non-Fugitive	Co-60	2.34E-11
CFA-625	CFA	Non-Fugitive	Cr-51	1.07E-12
CFA-625	CFA	Non-Fugitive	Cs-134	2.32E-11
CFA-625	CFA	Non-Fugitive	Cs-135	2.22E-13
CFA-625	CFA	Non-Fugitive	Cs-136	4.18E-12
CFA-625	CFA	Non-Fugitive	Cs-137	4.14E-08
CFA-625	CFA	Non-Fugitive	Cs-138	3.30E-11
CFA-625	CFA	Non-Fugitive	Cu-64	5.47E-18
CFA-625	CFA	Non-Fugitive	Cu-67	2.28E-15
CFA-625	CFA	Non-Fugitive	Dy-159	3.53E-21
CFA-625	CFA	Non-Fugitive	Dy-165	3.47E-16
CFA-625	CFA	Non-Fugitive	Dy-166	5.66E-16
CFA-625	CFA	Non-Fugitive	Er-169	1.97E-19
CFA-625	CFA	Non-Fugitive	Eu-152	1.20E-13
CFA-625	CFA	Non-Fugitive	Eu-154	2.97E-13
CFA-625	CFA	Non-Fugitive	Eu-155	8.75E-14
CFA-625	CFA	Non-Fugitive	Eu-156	7.29E-14
CFA-625	CFA	Non-Fugitive	Eu-157	5.03E-13
CFA-625	CFA	Non-Fugitive	Eu-158	2.67E-18
CFA-625	CFA	Non-Fugitive	Fe-55	1.17E-12
CFA-625	CFA	Non-Fugitive	Fe-59	5.67E-13
CFA-625	CFA	Non-Fugitive	Ga-70	3.57E-17
CFA-625	CFA	Non-Fugitive	Ga-72	2.36E-12
CFA-625	CFA	Non-Fugitive	Ga-73	9.26E-12
CFA-625	CFA	Non-Fugitive	Gd-153	1.52E-12
CFA-625	CFA	Non-Fugitive	Gd-159	1.58E-13
CFA-625	CFA	Non-Fugitive	Ge-75	2.79E-16
CFA-625	CFA	Non-Fugitive	Ge-77	2.01E-13
CFA-625	CFA	Non-Fugitive	Ge-78	1.68E-15
CFA-625	CFA	Non-Fugitive	H-3	6.90E-02
CFA-625	CFA	Non-Fugitive	Hf-175	1.93E-14
CFA-625	CFA	Non-Fugitive	Hf-180m	1.45E-21
CFA-625	CFA	Non-Fugitive	Hf-181	6.67E-13
CFA-625	CFA	Non-Fugitive	Hg-203	6.67E-17
CFA-625	CFA	Non-Fugitive	Ho-166	3.57E-22
CFA-625	CFA	Non-Fugitive	Ho-166m	1.53E-20
CFA-625	CFA	Non-Fugitive	I-125	2.57E-20
CFA-625	CFA	Non-Fugitive	I-126	4.07E-21
CFA-625	CFA	Non-Fugitive	I-128	3.67E-13
CFA-625	CFA	Non-Fugitive	I-129	1.44E-18
CFA-625	CFA	Non-Fugitive	I-130	2.58E-15
CFA-625	CFA	Non-Fugitive	I-131	4.88E-12
CFA-625	CFA	Non-Fugitive	I-132	1.32E-11
CFA-625	CFA	Non-Fugitive	I-133	3.59E-11
CFA-625	CFA	Non-Fugitive	I-134	4.04E-14
CFA-625	CFA	Non-Fugitive	I-135	3.03E-11
CFA-625	CFA	Non-Fugitive	In-114	1.09E-20
CFA-625	CFA	Non-Fugitive	In-114m	1.13E-20

SourceID	FacilityID	Fugitive/Non-Fugitive	Radionuclide	Q (Ci/yr)
CFA-625	CFA	Non-Fugitive	In-115m	5.07E-13
CFA-625	CFA	Non-Fugitive	In-117	1.20E-12
CFA-625	CFA	Non-Fugitive	Ir-190	2.06E-19
CFA-625	CFA	Non-Fugitive	Ir-192	1.94E-18
CFA-625	CFA	Non-Fugitive	Ir-194	1.38E-17
CFA-625	CFA	Non-Fugitive	K-40	2.13E-14
CFA-625	CFA	Non-Fugitive	Kr-83m	1.79E-11
CFA-625	CFA	Non-Fugitive	Kr-85	6.68E-06
CFA-625	CFA	Non-Fugitive	Kr-85m	4.80E-06
CFA-625	CFA	Non-Fugitive	Kr-87	1.46E-04
CFA-625	CFA	Non-Fugitive	Kr-88	8.95E-03
CFA-625	CFA	Non-Fugitive	La-140	1.58E-12
CFA-625	CFA	Non-Fugitive	La-141	1.40E-11
CFA-625	CFA	Non-Fugitive	La-142	3.96E-13
CFA-625	CFA	Non-Fugitive	Lu-177	1.59E-19
CFA-625	CFA	Non-Fugitive	Lu-177m	8.90E-21
CFA-625	CFA	Non-Fugitive	Mn-52	1.28E-15
CFA-625	CFA	Non-Fugitive	Mn-54	3.79E-13
CFA-625	CFA	Non-Fugitive	Mn-56	6.33E-15
CFA-625	CFA	Non-Fugitive	Mo-93	1.85E-16
CFA-625	CFA	Non-Fugitive	Mo-99	1.75E-11
CFA-625	CFA	Non-Fugitive	Na-22	6.88E-10
CFA-625	CFA	Non-Fugitive	Na-24	2.34E-09
CFA-625	CFA	Non-Fugitive	Nb-93m	2.64E-16
CFA-625	CFA	Non-Fugitive	Nb-94	4.33E-20
CFA-625	CFA	Non-Fugitive	Nb-95	2.10E-12
CFA-625	CFA	Non-Fugitive	Nb-95m	1.22E-14
CFA-625	CFA	Non-Fugitive	Nb-96	2.43E-16
CFA-625	CFA	Non-Fugitive	Nb-97	3.56E-11
CFA-625	CFA	Non-Fugitive	Nd-147	2.03E-12
CFA-625	CFA	Non-Fugitive	Nd-149	2.75E-13
CFA-625	CFA	Non-Fugitive	Ni-57	9.91E-14
CFA-625	CFA	Non-Fugitive	Ni-59	1.60E-13
CFA-625	CFA	Non-Fugitive	Ni-63	1.57E-11
CFA-625	CFA	Non-Fugitive	Ni-66	9.80E-17
CFA-625	CFA	Non-Fugitive	Np-237	3.98E-12
CFA-625	CFA	Non-Fugitive	Np-239	1.71E-16
CFA-625	CFA	Non-Fugitive	Os-189m	1.11E-21
CFA-625	CFA	Non-Fugitive	Os-191	1.64E-19
CFA-625	CFA	Non-Fugitive	Os-191m	1.17E-19
CFA-625	CFA	Non-Fugitive	Os-193	4.40E-19
CFA-625	CFA	Non-Fugitive	P-32	3.33E-10
CFA-625	CFA	Non-Fugitive	Pa-231	1.68E-20
CFA-625	CFA	Non-Fugitive	Pa-233	2.55E-15
CFA-625	CFA	Non-Fugitive	Pa-234	3.58E-17
CFA-625	CFA	Non-Fugitive	Pa-234m	2.24E-14
CFA-625	CFA	Non-Fugitive	Pb-210	7.33E-16
CFA-625	CFA	Non-Fugitive	Pb-211	9.30E-17
CFA-625	CFA	Non-Fugitive	Pb-212	5.52E-17
CFA-625	CFA	Non-Fugitive	Pb-214	2.60E-16

SourceID	FacilityID	Fugitive/Non-Fugitive	Radionuclide	Q (Ci/yr)
CFA-625	CFA	Non-Fugitive	Pd-107	6.70E-20
CFA-625	CFA	Non-Fugitive	Pd-109	6.58E-12
CFA-625	CFA	Non-Fugitive	Pm-146	1.10E-21
CFA-625	CFA	Non-Fugitive	Pm-147	1.92E-11
CFA-625	CFA	Non-Fugitive	Pm-148	9.93E-20
CFA-625	CFA	Non-Fugitive	Pm-148m	2.06E-18
CFA-625	CFA	Non-Fugitive	Pm-149	5.34E-12
CFA-625	CFA	Non-Fugitive	Pm-150	1.26E-17
CFA-625	CFA	Non-Fugitive	Pm-151	4.11E-12
CFA-625	CFA	Non-Fugitive	Po-210	3.33E-17
CFA-625	CFA	Non-Fugitive	Po-212	3.54E-17
CFA-625	CFA	Non-Fugitive	Po-215	9.30E-17
CFA-625	CFA	Non-Fugitive	Po-216	5.52E-17
CFA-625	CFA	Non-Fugitive	Pr-143	1.34E-12
CFA-625	CFA	Non-Fugitive	Pr-144	6.64E-13
CFA-625	CFA	Non-Fugitive	Pr-144m	4.91E-15
CFA-625	CFA	Non-Fugitive	Pr-145	1.55E-11
CFA-625	CFA	Non-Fugitive	Pt-189	3.24E-20
CFA-625	CFA	Non-Fugitive	Pt-191	2.48E-17
CFA-625	CFA	Non-Fugitive	Pt-193	8.00E-21
CFA-625	CFA	Non-Fugitive	Pt-193m	2.09E-17
CFA-625	CFA	Non-Fugitive	Pt-195m	2.17E-17
CFA-625	CFA	Non-Fugitive	Pt-197	1.45E-17
CFA-625	CFA	Non-Fugitive	Pu-238	7.04E-15
CFA-625	CFA	Non-Fugitive	Pu-239	8.12E-12
CFA-625	CFA	Non-Fugitive	Pu-240	7.66E-13
CFA-625	CFA	Non-Fugitive	Pu-241	9.65E-14
CFA-625	CFA	Non-Fugitive	Pu-242	1.08E-13
CFA-625	CFA	Non-Fugitive	Pu-244	2.83E-23
CFA-625	CFA	Non-Fugitive	Ra-223	9.30E-17
CFA-625	CFA	Non-Fugitive	Ra-224	5.52E-17
CFA-625	CFA	Non-Fugitive	Ra-226	3.33E-15
CFA-625	CFA	Non-Fugitive	Rb-83	8.00E-18
CFA-625	CFA	Non-Fugitive	Rb-84	9.20E-17
CFA-625	CFA	Non-Fugitive	Rb-86	7.27E-15
CFA-625	CFA	Non-Fugitive	Rb-88	3.34E-09
CFA-625	CFA	Non-Fugitive	Rb-89	3.67E-11
CFA-625	CFA	Non-Fugitive	Re-188	6.00E-15
CFA-625	CFA	Non-Fugitive	Rh-102	1.95E-21
CFA-625	CFA	Non-Fugitive	Rh-102m	4.70E-22
CFA-625	CFA	Non-Fugitive	Rh-103m	8.24E-13
CFA-625	CFA	Non-Fugitive	Rh-105	1.52E-11
CFA-625	CFA	Non-Fugitive	Rh-106	5.02E-13
CFA-625	CFA	Non-Fugitive	Rn-219	2.79E-07
CFA-625	CFA	Non-Fugitive	Rn-220	1.62E-06
CFA-625	CFA	Non-Fugitive	Ru-103	1.79E-12
CFA-625	CFA	Non-Fugitive	Ru-105	1.21E-11
CFA-625	CFA	Non-Fugitive	Ru-106	5.06E-13
CFA-625	CFA	Non-Fugitive	Sb-122	2.20E-17
CFA-625	CFA	Non-Fugitive	Sb-124	2.97E-14

SourceID	FacilityID	Fugitive/Non-Fugitive	Radionuclide	Q (Ci/yr)
CFA-625	CFA	Non-Fugitive	Sb-125	1.75E-13
CFA-625	CFA	Non-Fugitive	Sb-126	2.00E-15
CFA-625	CFA	Non-Fugitive	Sb-126m	1.28E-18
CFA-625	CFA	Non-Fugitive	Sb-127	3.55E-12
CFA-625	CFA	Non-Fugitive	Sb-128	1.30E-12
CFA-625	CFA	Non-Fugitive	Sb-128m	2.43E-14
CFA-625	CFA	Non-Fugitive	Sb-129	7.35E-12
CFA-625	CFA	Non-Fugitive	Sb-130	9.36E-18
CFA-625	CFA	Non-Fugitive	Sc-46	5.44E-15
CFA-625	CFA	Non-Fugitive	Sc-47	1.96E-12
CFA-625	CFA	Non-Fugitive	Sc-48	7.73E-15
CFA-625	CFA	Non-Fugitive	Se-79	9.51E-20
CFA-625	CFA	Non-Fugitive	Se-81	2.12E-17
CFA-625	CFA	Non-Fugitive	Sm-151	1.20E-15
CFA-625	CFA	Non-Fugitive	Sm-153	1.51E-12
CFA-625	CFA	Non-Fugitive	Sm-156	7.30E-13
CFA-625	CFA	Non-Fugitive	Sn-113	3.56E-15
CFA-625	CFA	Non-Fugitive	Sn-117m	3.30E-18
CFA-625	CFA	Non-Fugitive	Sn-119m	6.51E-15
CFA-625	CFA	Non-Fugitive	Sn-121	3.78E-12
CFA-625	CFA	Non-Fugitive	Sn-121m	3.70E-16
CFA-625	CFA	Non-Fugitive	Sn-123	2.52E-14
CFA-625	CFA	Non-Fugitive	Sn-125	2.11E-13
CFA-625	CFA	Non-Fugitive	Sn-126	1.28E-18
CFA-625	CFA	Non-Fugitive	Sn-127	2.93E-13
CFA-625	CFA	Non-Fugitive	Sn-128	1.86E-15
CFA-625	CFA	Non-Fugitive	Sr-85	3.93E-16
CFA-625	CFA	Non-Fugitive	Sr-89	1.02E-12
CFA-625	CFA	Non-Fugitive	Sr-90	2.34E-12
CFA-625	CFA	Non-Fugitive	Sr-91	2.52E-11
CFA-625	CFA	Non-Fugitive	Sr-92	4.71E-12
CFA-625	CFA	Non-Fugitive	Ta-179	2.17E-21
CFA-625	CFA	Non-Fugitive	Ta-180	1.87E-20
CFA-625	CFA	Non-Fugitive	Ta-182	1.70E-14
CFA-625	CFA	Non-Fugitive	Ta-183	3.30E-13
CFA-625	CFA	Non-Fugitive	Ta-184	1.29E-20
CFA-625	CFA	Non-Fugitive	Tb-157	3.43E-22
CFA-625	CFA	Non-Fugitive	Tb-158	2.29E-21
CFA-625	CFA	Non-Fugitive	Tb-160	3.28E-17
CFA-625	CFA	Non-Fugitive	Tb-161	4.02E-15
CFA-625	CFA	Non-Fugitive	Tc-97m	1.42E-21
CFA-625	CFA	Non-Fugitive	Tc-99	2.22E-14
CFA-625	CFA	Non-Fugitive	Tc-99m	3.15E-12
CFA-625	CFA	Non-Fugitive	Te-123m	2.89E-17
CFA-625	CFA	Non-Fugitive	Te-125m	1.96E-14
CFA-625	CFA	Non-Fugitive	Te-127	4.17E-12
CFA-625	CFA	Non-Fugitive	Te-127m	1.89E-12
CFA-625	CFA	Non-Fugitive	Te-129	8.56E-12
CFA-625	CFA	Non-Fugitive	Te-129m	7.98E-14
CFA-625	CFA	Non-Fugitive	Te-131	4.87E-13

SourceID	FacilityID	Fugitive/Non-Fugitive	Radionuclide	Q (Ci/yr)
CFA-625	CFA	Non-Fugitive	Te-131m	1.95E-13
CFA-625	CFA	Non-Fugitive	Te-132	1.27E-11
CFA-625	CFA	Non-Fugitive	Te-133	3.51E-16
CFA-625	CFA	Non-Fugitive	Te-134	7.16E-17
CFA-625	CFA	Non-Fugitive	Th-227	9.17E-17
CFA-625	CFA	Non-Fugitive	Th-228	5.59E-17
CFA-625	CFA	Non-Fugitive	Th-230	9.82E-18
CFA-625	CFA	Non-Fugitive	Th-231	3.65E-14
CFA-625	CFA	Non-Fugitive	Th-234	2.24E-14
CFA-625	CFA	Non-Fugitive	Tl-207	9.27E-17
CFA-625	CFA	Non-Fugitive	Tl-208	1.98E-17
CFA-625	CFA	Non-Fugitive	Tm-168	1.03E-20
CFA-625	CFA	Non-Fugitive	Tm-170	8.57E-19
CFA-625	CFA	Non-Fugitive	Tm-171	1.80E-16
CFA-625	CFA	Non-Fugitive	U-232	1.09E-14
CFA-625	CFA	Non-Fugitive	U-233	2.25E-15
CFA-625	CFA	Non-Fugitive	U-234	6.77E-12
CFA-625	CFA	Non-Fugitive	U-235	2.47E-13
CFA-625	CFA	Non-Fugitive	U-236	2.03E-13
CFA-625	CFA	Non-Fugitive	U-237	2.39E-10
CFA-625	CFA	Non-Fugitive	U-238	3.90E-13
CFA-625	CFA	Non-Fugitive	V-48	4.13E-15
CFA-625	CFA	Non-Fugitive	W-181	1.18E-18
CFA-625	CFA	Non-Fugitive	W-185	1.89E-18
CFA-625	CFA	Non-Fugitive	W-187	4.02E-15
CFA-625	CFA	Non-Fugitive	Xe-127	2.33E-12
CFA-625	CFA	Non-Fugitive	Xe-131m	1.90E-07
CFA-625	CFA	Non-Fugitive	Xe-133	1.86E-02
CFA-625	CFA	Non-Fugitive	Xe-133m	4.14E-04
CFA-625	CFA	Non-Fugitive	Xe-135	1.49E-01
CFA-625	CFA	Non-Fugitive	Xe-135m	7.33E-06
CFA-625	CFA	Non-Fugitive	Xe-138	5.90E-05
CFA-625	CFA	Non-Fugitive	Y-88	1.90E-16
CFA-625	CFA	Non-Fugitive	Y-89m	2.68E-17
CFA-625	CFA	Non-Fugitive	Y-90	9.91E-13
CFA-625	CFA	Non-Fugitive	Y-91	1.06E-12
CFA-625	CFA	Non-Fugitive	Y-91m	8.13E-14
CFA-625	CFA	Non-Fugitive	Y-92	2.48E-11
CFA-625	CFA	Non-Fugitive	Y-93	2.97E-11
CFA-625	CFA	Non-Fugitive	Zn-65	1.05E-13
CFA-625	CFA	Non-Fugitive	Zn-69	2.84E-18
CFA-625	CFA	Non-Fugitive	Zn-69m	1.01E-17
CFA-625	CFA	Non-Fugitive	Zn-71m	2.98E-21
CFA-625	CFA	Non-Fugitive	Zn-72	3.85E-15
CFA-625	CFA	Non-Fugitive	Zr-93	5.65E-19
CFA-625	CFA	Non-Fugitive	Zr-95	2.05E-12
CFA-625	CFA	Non-Fugitive	Zr-97	3.31E-11
CFA-Tritium	CFA	Fugitive	H-3	4.70E-01
PBF-612	CITRC	Fugitive	Ga-68	2.601E-08
PBF-622	CITRC	Non-Fugitive	U-235	1.149E-11

SourceID	FacilityID	Fugitive/Non-Fugitive	Radionuclide	Q (Ci/yr)
PBF-622	CITRC	Non-Fugitive	U-238	8.71E-10
PBF-623	CITRC	Fugitive	Ga-68	1.799E-08
CPP-1608-001	INTEC	Non-Fugitive	Am-241	4.44E-12
CPP-1608-001	INTEC	Non-Fugitive	Cm-242	1.48E-13
CPP-1608-001	INTEC	Non-Fugitive	Cm-244	9.10E-14
CPP-1608-001	INTEC	Non-Fugitive	Co-60	8.45E-14
CPP-1608-001	INTEC	Non-Fugitive	Cs-137	2.14E-11
CPP-1608-001	INTEC	Non-Fugitive	Eu-154	3.43E-14
CPP-1608-001	INTEC	Non-Fugitive	Np-237	9.18E-17
CPP-1608-001	INTEC	Non-Fugitive	Pu-238	8.43E-13
CPP-1608-001	INTEC	Non-Fugitive	Pu-239	8.65E-12
CPP-1608-001	INTEC	Non-Fugitive	Pu-240	6.00E-13
CPP-1608-001	INTEC	Non-Fugitive	Pu-241	4.41E-13
CPP-1608-001	INTEC	Non-Fugitive	Pu-242	3.07E-16
CPP-1608-001	INTEC	Non-Fugitive	Sr-90	2.24E-11
CPP-1608-001	INTEC	Non-Fugitive	U-233	4.52E-14
CPP-1608-001	INTEC	Non-Fugitive	U-234	1.81E-14
CPP-1608-001	INTEC	Non-Fugitive	U-235	2.14E-16
CPP-1608-001	INTEC	Non-Fugitive	U-238	1.38E-16
CPP-1774	INTEC	Non-Fugitive	H-3	1.51E-01
CPP-1774	INTEC	Non-Fugitive	I-129	3.60E-05
CPP-1774	INTEC	Non-Fugitive	Kr-85	1.08E+00
CPP-2707	INTEC	Non-Fugitive	Kr-85	4.04E-04
CPP-603-001	INTEC	Non-Fugitive	Ag-108m	1.21E-16
CPP-603-001	INTEC	Non-Fugitive	Am-241	3.07E-17
CPP-603-001	INTEC	Non-Fugitive	Cm-244	2.63E-17
CPP-603-001	INTEC	Non-Fugitive	Co-57	3.93E-17
CPP-603-001	INTEC	Non-Fugitive	Co-60	1.42E-16
CPP-603-001	INTEC	Non-Fugitive	Cs-137	1.28E-14
CPP-603-001	INTEC	Non-Fugitive	Eu-152	1.24E-16
CPP-603-001	INTEC	Non-Fugitive	Ni-63	4.19E-16
CPP-603-001	INTEC	Non-Fugitive	Pu-238	7.29E-17
CPP-603-001	INTEC	Non-Fugitive	Pu-239	1.33E-17
CPP-603-001	INTEC	Non-Fugitive	Ru-106	9.43E-17
CPP-603-001	INTEC	Non-Fugitive	Sb-125	1.05E-16
CPP-603-001	INTEC	Non-Fugitive	Sr-90	8.93E-14
CPP-603-001	INTEC	Non-Fugitive	U-234	6.25E-17
CPP-603-001	INTEC	Non-Fugitive	Zn-65	6.06E-17
CPP-659-033	INTEC	Non-Fugitive	U-238	2.17E-09
CPP-684-001	INTEC	Non-Fugitive	Am-241	6.61E-13
CPP-684-001	INTEC	Non-Fugitive	Cd-113m	2.62E-14
CPP-684-001	INTEC	Non-Fugitive	Cm-243	2.38E-14
CPP-684-001	INTEC	Non-Fugitive	Co-60	1.85E-14
CPP-684-001	INTEC	Non-Fugitive	Cs-135	9.18E-15
CPP-684-001	INTEC	Non-Fugitive	Cs-137	5.45E-10
CPP-684-001	INTEC	Non-Fugitive	Eu-152	1.84E-14
CPP-684-001	INTEC	Non-Fugitive	Eu-154	1.63E-12
CPP-684-001	INTEC	Non-Fugitive	Eu-155	1.67E-13
CPP-684-001	INTEC	Non-Fugitive	Nb-93m	2.30E-14
CPP-684-001	INTEC	Non-Fugitive	Ni-59	5.95E-13

SourceID	FacilityID	Fugitive/Non-Fugitive	Radionuclide	Q (Ci/yr)
CPP-684-001	INTEC	Non-Fugitive	Pm-147	1.33E-13
CPP-684-001	INTEC	Non-Fugitive	Pu-238	1.09E-11
CPP-684-001	INTEC	Non-Fugitive	Pu-239	6.82E-14
CPP-684-001	INTEC	Non-Fugitive	Pu-240	4.43E-14
CPP-684-001	INTEC	Non-Fugitive	Pu-241	1.60E-12
CPP-684-001	INTEC	Non-Fugitive	Sm-151	2.79E-12
CPP-684-001	INTEC	Non-Fugitive	Sr-90	4.96E-10
CPP-684-001	INTEC	Non-Fugitive	Tc-99	1.71E-13
CPP-684-001	INTEC	Non-Fugitive	Zr-93	2.75E-14
CPP-749-001	INTEC	Non-Fugitive	Kr-85	8.04E-03
ICDF-Landfill	INTEC	Fugitive	Am-241	5.79E-04
ICDF-Landfill	INTEC	Fugitive	Cs-137	3.14E-04
ICDF-Landfill	INTEC	Fugitive	Pu-238	6.32E-06
ICDF-Landfill	INTEC	Fugitive	Pu-239	2.14E-04
ICDF-Landfill	INTEC	Fugitive	Pu-240	2.14E-04
ICDF-Landfill	INTEC	Fugitive	Sr-90	2.99E-03
ICDF-Ponds	INTEC	Fugitive	C-14	1.11E-04
ICDF-Ponds	INTEC	Fugitive	Cl-36	1.70E-07
ICDF-Ponds	INTEC	Fugitive	Cs-137	2.45E-05
ICDF-Ponds	INTEC	Fugitive	H-3	1.72E-02
ICDF-Ponds	INTEC	Fugitive	I-129	3.94E-05
ICDF-Ponds	INTEC	Fugitive	Sr-90	3.33E-06
ICDF-Ponds	INTEC	Fugitive	Tc-99	4.29E-08
ICDF-Ponds	INTEC	Fugitive	U-234	1.89E-07
ICDF-Ponds	INTEC	Fugitive	U-235	1.43E-07
ICDF-Ponds	INTEC	Fugitive	U-238	1.43E-07
OU-3-14-EvapPond	INTEC	Fugitive	Cs-137	2.10E-08
OU-3-14-EvapPond	INTEC	Fugitive	Sr-90	2.10E-08
OU-3-14-EvapPond	INTEC	Fugitive	Tc-99	2.10E-08
CPP-708-001	INTEC-MS	Non-Fugitive	Am-241	2.66E-13
CPP-708-001	INTEC-MS	Non-Fugitive	Cs-137	5.99E-10
CPP-708-001	INTEC-MS	Non-Fugitive	H-3	6.42E-02
CPP-708-001	INTEC-MS	Non-Fugitive	I-129	3.92E-06
CPP-708-001	INTEC-MS	Non-Fugitive	Pu-238	5.74E-12
CPP-708-001	INTEC-MS	Non-Fugitive	Pu-239	9.80E-14
CPP-708-001	INTEC-MS	Non-Fugitive	Pu-240	8.83E-14
CPP-708-001	INTEC-MS	Non-Fugitive	Sr-90	5.49E-10
CPP-653-001	MFC	Non-Fugitive	U-234	1.19E-12
CPP-653-001	MFC	Non-Fugitive	U-235	3.69E-14
CPP-653-001	MFC	Non-Fugitive	U-238	4.03E-14
MFC-1702-001	MFC	Non-Fugitive	Am-241	2.08E-11
MFC-1702-001	MFC	Non-Fugitive	Am-243	2.53E-11
MFC-1702-001	MFC	Non-Fugitive	Cd-109	1.06E-05
MFC-1702-001	MFC	Non-Fugitive	Cd-115M	1.32E-12
MFC-1702-001	MFC	Non-Fugitive	Ce-141	2.11E-12
MFC-1702-001	MFC	Non-Fugitive	Cf-252	5.00E-05
MFC-1702-001	MFC	Non-Fugitive	Cl-36	2.54E-05
MFC-1702-001	MFC	Non-Fugitive	Co-60	1.59E-12
MFC-1702-001	MFC	Non-Fugitive	Cs-134	8.61E-06
MFC-1702-001	MFC	Non-Fugitive	Cs-135	5.83E-06

SourceID	FacilityID	Fugitive/Non-Fugitive	Radionuclide	Q (Ci/yr)
MFC-1702-001	MFC	Non-Fugitive	Cs-137	2.41E-03
MFC-1702-001	MFC	Non-Fugitive	Fe-55	2.04E-10
MFC-1702-001	MFC	Non-Fugitive	H-3	4.83E-07
MFC-1702-001	MFC	Non-Fugitive	I-129	4.54E-05
MFC-1702-001	MFC	Non-Fugitive	I-131	8.29E-09
MFC-1702-001	MFC	Non-Fugitive	Na-22	1.50E-12
MFC-1702-001	MFC	Non-Fugitive	Na-24	4.23E-08
MFC-1702-001	MFC	Non-Fugitive	Np-237	4.28E-09
MFC-1702-001	MFC	Non-Fugitive	Pm-147	1.05E-11
MFC-1702-001	MFC	Non-Fugitive	Pu-238	5.51E-10
MFC-1702-001	MFC	Non-Fugitive	Pu-239	1.73E-09
MFC-1702-001	MFC	Non-Fugitive	Pu-240	3.58E-11
MFC-1702-001	MFC	Non-Fugitive	Pu-241	1.32E-10
MFC-1702-001	MFC	Non-Fugitive	Pu-242	3.79E-10
MFC-1702-001	MFC	Non-Fugitive	Sm-151	2.78E-12
MFC-1702-001	MFC	Non-Fugitive	Sn-113	3.17E-12
MFC-1702-001	MFC	Non-Fugitive	Sr-90	5.31E-11
MFC-1702-001	MFC	Non-Fugitive	Tc-99	2.90E-12
MFC-1702-001	MFC	Non-Fugitive	U-233	2.05E-12
MFC-1702-001	MFC	Non-Fugitive	U-234	2.95E-12
MFC-1702-001	MFC	Non-Fugitive	Y-90	6.51E-11
MFC-1729-001	MFC	Non-Fugitive	Pu-239	2.16E-08
MFC-1729-001	MFC	Non-Fugitive	Sr-90	2.22E-07
MFC-704-008	MFC	Non-Fugitive	Pu-239	1.84E-08
MFC-704-008	MFC	Non-Fugitive	Sr-90	5.07E-08
MFC-752-004	MFC	Non-Fugitive	I-131	2.24E-06
MFC-752-004	MFC	Non-Fugitive	Pu-239	2.92E-08
MFC-752-004	MFC	Non-Fugitive	Sb-125	6.96E-07
MFC-752-004	MFC	Non-Fugitive	Sr-90	2.56E-07
MFC-752-005	MFC	Non-Fugitive	Pu-239	5.41E-08
MFC-752-005	MFC	Non-Fugitive	Sr-90	1.64E-07
MFC-768-105	MFC	Non-Fugitive	H-3	1.80E-04
MFC-768-108	MFC	Non-Fugitive	H-3	1.35E-03
MFC-774-026	MFC	Non-Fugitive	Ar-39	3.05E-07
MFC-774-026	MFC	Non-Fugitive	Ca-45	8.53E-08
MFC-774-026	MFC	Non-Fugitive	Cd-109	1.32E-03
MFC-774-026	MFC	Non-Fugitive	Cd-113m	1.14E-05
MFC-774-026	MFC	Non-Fugitive	Cd-115	1.58E-03
MFC-774-026	MFC	Non-Fugitive	Cd-115m	7.95E-05
MFC-774-026	MFC	Non-Fugitive	Ce-141	4.80E-11
MFC-774-026	MFC	Non-Fugitive	Ce-144	6.58E-11
MFC-774-026	MFC	Non-Fugitive	Cl-36	1.79E-03
MFC-774-026	MFC	Non-Fugitive	Cs-134	3.85E-12
MFC-774-026	MFC	Non-Fugitive	Cs-137	9.50E-11
MFC-774-026	MFC	Non-Fugitive	Eu-154	6.03E-13
MFC-774-026	MFC	Non-Fugitive	Eu-155	3.90E-13
MFC-774-026	MFC	Non-Fugitive	Fe-55	5.85E-13
MFC-774-026	MFC	Non-Fugitive	H-3	8.98E-02
MFC-774-026	MFC	Non-Fugitive	I-129	9.98E-07
MFC-774-026	MFC	Non-Fugitive	I-131	2.23E-02

SourceID	FacilityID	Fugitive/Non-Fugitive	Radionuclide	Q (Ci/yr)
MFC-774-026	MFC	Non-Fugitive	Kr-85	1.99E-02
MFC-774-026	MFC	Non-Fugitive	Na-22	8.55E-06
MFC-774-026	MFC	Non-Fugitive	Na-24	1.38E-04
MFC-774-026	MFC	Non-Fugitive	P-32	2.14E-04
MFC-774-026	MFC	Non-Fugitive	P-33	1.72E-07
MFC-774-026	MFC	Non-Fugitive	Po-210	7.83E-12
MFC-774-026	MFC	Non-Fugitive	Pu-238	6.48E-13
MFC-774-026	MFC	Non-Fugitive	Pu-239	1.27E-12
MFC-774-026	MFC	Non-Fugitive	Pu-240	4.40E-13
MFC-774-026	MFC	Non-Fugitive	Pu-241	6.20E-12
MFC-774-026	MFC	Non-Fugitive	Rb-87	1.16E-11
MFC-774-026	MFC	Non-Fugitive	Rn-220	1.71E-09
MFC-774-026	MFC	Non-Fugitive	S-35	5.25E-04
MFC-774-026	MFC	Non-Fugitive	Sb-125	9.68E-12
MFC-774-026	MFC	Non-Fugitive	Se-79	2.40E-07
MFC-774-026	MFC	Non-Fugitive	Sn-113	8.35E-13
MFC-774-026	MFC	Non-Fugitive	Sr-89	4.25E-11
MFC-774-026	MFC	Non-Fugitive	Sr-90	7.90E-11
MFC-774-026	MFC	Non-Fugitive	Te-125m	1.06E-05
MFC-774-026	MFC	Non-Fugitive	Te-129	6.78E+00
MFC-774-026	MFC	Non-Fugitive	Te-129m	9.83E-03
MFC-774-026	MFC	Non-Fugitive	Zn-65	6.30E-09
MFC-774-027	MFC	Non-Fugitive	Ar-39	3.05E-07
MFC-774-027	MFC	Non-Fugitive	Ca-45	8.53E-08
MFC-774-027	MFC	Non-Fugitive	Cd-109	1.32E-03
MFC-774-027	MFC	Non-Fugitive	Cd-113m	1.14E-05
MFC-774-027	MFC	Non-Fugitive	Cd-115	1.58E-03
MFC-774-027	MFC	Non-Fugitive	Cd-115m	7.95E-05
MFC-774-027	MFC	Non-Fugitive	Ce-141	4.80E-11
MFC-774-027	MFC	Non-Fugitive	Ce-144	6.58E-11
MFC-774-027	MFC	Non-Fugitive	Cl-36	1.79E-03
MFC-774-027	MFC	Non-Fugitive	Cs-134	3.85E-12
MFC-774-027	MFC	Non-Fugitive	Cs-137	9.50E-11
MFC-774-027	MFC	Non-Fugitive	Eu-154	6.03E-13
MFC-774-027	MFC	Non-Fugitive	Eu-155	3.90E-13
MFC-774-027	MFC	Non-Fugitive	Fe-55	5.85E-13
MFC-774-027	MFC	Non-Fugitive	H-3	8.98E-02
MFC-774-027	MFC	Non-Fugitive	I-129	9.98E-07
MFC-774-027	MFC	Non-Fugitive	I-131	2.23E-02
MFC-774-027	MFC	Non-Fugitive	Kr-85	1.99E-02
MFC-774-027	MFC	Non-Fugitive	Na-22	8.55E-06
MFC-774-027	MFC	Non-Fugitive	Na-24	1.38E-04
MFC-774-027	MFC	Non-Fugitive	P-32	2.14E-04
MFC-774-027	MFC	Non-Fugitive	P-33	1.72E-07
MFC-774-027	MFC	Non-Fugitive	Po-210	7.83E-12
MFC-774-027	MFC	Non-Fugitive	Pu-238	6.48E-13
MFC-774-027	MFC	Non-Fugitive	Pu-239	1.27E-12
MFC-774-027	MFC	Non-Fugitive	Pu-240	4.40E-13
MFC-774-027	MFC	Non-Fugitive	Pu-241	6.20E-12
MFC-774-027	MFC	Non-Fugitive	Rb-87	1.16E-11

SourceID	FacilityID	Fugitive/Non-Fugitive	Radionuclide	Q (Ci/yr)
MFC-774-027	MFC	Non-Fugitive	Rn-220	1.71E-09
MFC-774-027	MFC	Non-Fugitive	S-35	5.25E-04
MFC-774-027	MFC	Non-Fugitive	Sb-125	9.68E-12
MFC-774-027	MFC	Non-Fugitive	Se-79	2.40E-07
MFC-774-027	MFC	Non-Fugitive	Sn-113	8.35E-13
MFC-774-027	MFC	Non-Fugitive	Sr-89	4.25E-11
MFC-774-027	MFC	Non-Fugitive	Sr-90	7.90E-11
MFC-774-027	MFC	Non-Fugitive	Te-125m	1.06E-05
MFC-774-027	MFC	Non-Fugitive	Te-129	6.78E+00
MFC-774-027	MFC	Non-Fugitive	Te-129m	9.83E-03
MFC-774-027	MFC	Non-Fugitive	Zn-65	6.30E-09
MFC-774-028	MFC	Non-Fugitive	Ar-39	3.05E-07
MFC-774-028	MFC	Non-Fugitive	Ca-45	8.53E-08
MFC-774-028	MFC	Non-Fugitive	Cd-109	1.32E-03
MFC-774-028	MFC	Non-Fugitive	Cd-113m	1.14E-05
MFC-774-028	MFC	Non-Fugitive	Cd-115	1.58E-03
MFC-774-028	MFC	Non-Fugitive	Cd-115m	7.95E-05
MFC-774-028	MFC	Non-Fugitive	Ce-141	4.80E-11
MFC-774-028	MFC	Non-Fugitive	Ce-144	6.58E-11
MFC-774-028	MFC	Non-Fugitive	Cl-36	1.79E-03
MFC-774-028	MFC	Non-Fugitive	Cs-134	3.85E-12
MFC-774-028	MFC	Non-Fugitive	Cs-137	9.50E-11
MFC-774-028	MFC	Non-Fugitive	Eu-154	6.03E-13
MFC-774-028	MFC	Non-Fugitive	Eu-155	3.90E-13
MFC-774-028	MFC	Non-Fugitive	Fe-55	5.85E-13
MFC-774-028	MFC	Non-Fugitive	H-3	8.98E-02
MFC-774-028	MFC	Non-Fugitive	I-129	9.98E-07
MFC-774-028	MFC	Non-Fugitive	I-131	2.23E-02
MFC-774-028	MFC	Non-Fugitive	Kr-85	1.99E-02
MFC-774-028	MFC	Non-Fugitive	Na-22	8.55E-06
MFC-774-028	MFC	Non-Fugitive	Na-24	1.38E-04
MFC-774-028	MFC	Non-Fugitive	P-32	2.14E-04
MFC-774-028	MFC	Non-Fugitive	P-33	1.72E-07
MFC-774-028	MFC	Non-Fugitive	Po-210	7.83E-12
MFC-774-028	MFC	Non-Fugitive	Pu-238	6.48E-13
MFC-774-028	MFC	Non-Fugitive	Pu-239	1.27E-12
MFC-774-028	MFC	Non-Fugitive	Pu-240	4.40E-13
MFC-774-028	MFC	Non-Fugitive	Pu-241	6.20E-12
MFC-774-028	MFC	Non-Fugitive	Rb-87	1.16E-11
MFC-774-028	MFC	Non-Fugitive	Rn-220	1.71E-09
MFC-774-028	MFC	Non-Fugitive	S-35	5.25E-04
MFC-774-028	MFC	Non-Fugitive	Sb-125	9.68E-12
MFC-774-028	MFC	Non-Fugitive	Se-79	2.40E-07
MFC-774-028	MFC	Non-Fugitive	Sn-113	8.35E-13
MFC-774-028	MFC	Non-Fugitive	Sr-89	4.25E-11
MFC-774-028	MFC	Non-Fugitive	Sr-90	7.90E-11
MFC-774-028	MFC	Non-Fugitive	Te-125m	1.06E-05
MFC-774-028	MFC	Non-Fugitive	Te-129	6.78E+00
MFC-774-028	MFC	Non-Fugitive	Te-129m	9.83E-03
MFC-774-028	MFC	Non-Fugitive	Zn-65	6.30E-09

SourceID	FacilityID	Fugitive/Non-Fugitive	Radionuclide	Q (Ci/yr)
MFC-774-029	MFC	Non-Fugitive	Ar-39	3.05E-07
MFC-774-029	MFC	Non-Fugitive	Ca-45	8.53E-08
MFC-774-029	MFC	Non-Fugitive	Cd-109	1.32E-03
MFC-774-029	MFC	Non-Fugitive	Cd-113m	1.14E-05
MFC-774-029	MFC	Non-Fugitive	Cd-115	1.58E-03
MFC-774-029	MFC	Non-Fugitive	Cd-115m	7.95E-05
MFC-774-029	MFC	Non-Fugitive	Ce-141	4.80E-11
MFC-774-029	MFC	Non-Fugitive	Ce-144	6.58E-11
MFC-774-029	MFC	Non-Fugitive	Cl-36	1.79E-03
MFC-774-029	MFC	Non-Fugitive	Cs-134	3.85E-12
MFC-774-029	MFC	Non-Fugitive	Cs-137	9.50E-11
MFC-774-029	MFC	Non-Fugitive	Eu-154	6.03E-13
MFC-774-029	MFC	Non-Fugitive	Eu-155	3.90E-13
MFC-774-029	MFC	Non-Fugitive	Fe-55	5.85E-13
MFC-774-029	MFC	Non-Fugitive	H-3	8.98E-02
MFC-774-029	MFC	Non-Fugitive	I-129	9.98E-07
MFC-774-029	MFC	Non-Fugitive	I-131	2.23E-02
MFC-774-029	MFC	Non-Fugitive	Kr-85	1.99E-02
MFC-774-029	MFC	Non-Fugitive	Na-22	8.55E-06
MFC-774-029	MFC	Non-Fugitive	Na-24	1.38E-04
MFC-774-029	MFC	Non-Fugitive	P-32	2.14E-04
MFC-774-029	MFC	Non-Fugitive	P-33	1.72E-07
MFC-774-029	MFC	Non-Fugitive	Po-210	7.83E-12
MFC-774-029	MFC	Non-Fugitive	Pu-238	6.48E-13
MFC-774-029	MFC	Non-Fugitive	Pu-239	1.27E-12
MFC-774-029	MFC	Non-Fugitive	Pu-240	4.40E-13
MFC-774-029	MFC	Non-Fugitive	Pu-241	6.20E-12
MFC-774-029	MFC	Non-Fugitive	Rb-87	1.16E-11
MFC-774-029	MFC	Non-Fugitive	Rn-220	1.71E-09
MFC-774-029	MFC	Non-Fugitive	S-35	5.25E-04
MFC-774-029	MFC	Non-Fugitive	Sb-125	9.68E-12
MFC-774-029	MFC	Non-Fugitive	Se-79	2.40E-07
MFC-774-029	MFC	Non-Fugitive	Sn-113	8.35E-13
MFC-774-029	MFC	Non-Fugitive	Sr-89	4.25E-11
MFC-774-029	MFC	Non-Fugitive	Sr-90	7.90E-11
MFC-774-029	MFC	Non-Fugitive	Te-125m	1.06E-05
MFC-774-029	MFC	Non-Fugitive	Te-129	6.78E+00
MFC-774-029	MFC	Non-Fugitive	Te-129m	9.83E-03
MFC-774-029	MFC	Non-Fugitive	Zn-65	6.30E-09
MFC-777-002	MFC	Non-Fugitive	Pu-239	1.56E-08
MFC-777-002	MFC	Non-Fugitive	Sr-90	4.04E-08
MFC-784-001	MFC	Non-Fugitive	U-234	4.32E-02
MFC-784-001	MFC	Non-Fugitive	U-235	2.44E-03
MFC-784-001	MFC	Non-Fugitive	U-238	5.98E-02
MFC-785-018	MFC	Non-Fugitive	Pu-239	8.88E-08
MFC-785-018	MFC	Non-Fugitive	Sr-90	4.54E-07
MFC-787-001	MFC	Non-Fugitive	Pu-239	2.72E-08
MFC-787-001	MFC	Non-Fugitive	Sr-90	1.54E-07
MFC-792-001	MFC	Non-Fugitive	Pu-238	1.41E-17
MFC-792-001	MFC	Non-Fugitive	Pu-239	2.76E-18

SourceID	FacilityID	Fugitive/Non-Fugitive	Radionuclide	Q (Ci/yr)
MFC-792-001	MFC	Non-Fugitive	Pu-240	3.45E-19
MFC-793-001	MFC	Non-Fugitive	H-3	2.15E-02
MFC-793-001	MFC	Non-Fugitive	Na-22	7.56E-16
MFC-794-002	MFC	Non-Fugitive	Am-241	2.11E-03
MFC-794-002	MFC	Non-Fugitive	Cd-115	7.35E-07
MFC-794-002	MFC	Non-Fugitive	Cd-115m	3.67E-08
MFC-794-002	MFC	Non-Fugitive	Ce-144	2.60E-11
MFC-794-002	MFC	Non-Fugitive	Cl-36	8.22E-09
MFC-794-002	MFC	Non-Fugitive	Cs-134	5.45E-05
MFC-794-002	MFC	Non-Fugitive	Cs-137	1.14E-03
MFC-794-002	MFC	Non-Fugitive	Eu-154	1.87E-06
MFC-794-002	MFC	Non-Fugitive	Eu-155	2.04E-05
MFC-794-002	MFC	Non-Fugitive	Ni-63	1.53E-12
MFC-794-002	MFC	Non-Fugitive	Pu-238	1.44E-10
MFC-794-002	MFC	Non-Fugitive	Pu-239	5.64E-10
MFC-794-002	MFC	Non-Fugitive	Pu-240	3.11E-10
MFC-794-002	MFC	Non-Fugitive	Pu-241	1.20E-08
MFC-794-002	MFC	Non-Fugitive	Pu-242	1.27E-14
MFC-794-002	MFC	Non-Fugitive	Ru-106	1.22E-12
MFC-794-002	MFC	Non-Fugitive	Sb-124	1.58E-06
MFC-794-002	MFC	Non-Fugitive	Sb-125	1.43E-06
MFC-794-002	MFC	Non-Fugitive	Sr-90	1.97E-03
MFC-794-002	MFC	Non-Fugitive	U-234	1.38E-08
MFC-794-002	MFC	Non-Fugitive	U-235	4.67E-10
MFC-794-002	MFC	Non-Fugitive	U-238	2.75E-08
MFC-794-002	MFC	Non-Fugitive	Y-90	3.68E-10
MFC-794-006	MFC	Non-Fugitive	Pu-239	2.83E-09
MFC-794-006	MFC	Non-Fugitive	Sr-90	1.28E-08
MFC-764-001	MFC-MS	Non-Fugitive	Pu-239	2.31E-08
MFC-764-001	MFC-MS	Non-Fugitive	Sr-90	4.83E-07
MFC-720-007	MFC-TREAT	Non-Fugitive	Ar-41	8.19E+01
MFC-720-007	MFC-TREAT	Non-Fugitive	Cs-138	1.35E-01
MFC-720-007	MFC-TREAT	Non-Fugitive	Cs-139	1.01E+00
MFC-720-007	MFC-TREAT	Non-Fugitive	Cs-140	2.00E+00
MFC-720-007	MFC-TREAT	Non-Fugitive	Kr-85m	1.01E+01
MFC-720-007	MFC-TREAT	Non-Fugitive	Kr-87	1.06E+01
MFC-720-007	MFC-TREAT	Non-Fugitive	Kr-88	9.63E+00
MFC-720-007	MFC-TREAT	Non-Fugitive	Kr-89	3.47E+01
MFC-720-007	MFC-TREAT	Non-Fugitive	Pu-239	8.03E-09
MFC-720-007	MFC-TREAT	Non-Fugitive	Rb-88	1.40E-01
MFC-720-007	MFC-TREAT	Non-Fugitive	Rb-89	6.26E-01
MFC-720-007	MFC-TREAT	Non-Fugitive	Rb-90	8.69E+00
MFC-720-007	MFC-TREAT	Non-Fugitive	Sr-90	4.08E-07
MFC-720-007	MFC-TREAT	Non-Fugitive	Sr-91	6.19E-03
MFC-720-007	MFC-TREAT	Non-Fugitive	Sr-92	1.50E-04
MFC-720-007	MFC-TREAT	Non-Fugitive	Xe-133	2.12E-01
MFC-720-007	MFC-TREAT	Non-Fugitive	Xe-135	2.65E+00
MFC-720-007	MFC-TREAT	Non-Fugitive	Xe-135m	2.75E-01
MFC-720-007	MFC-TREAT	Non-Fugitive	Xe-137	1.54E+01
MFC-720-007	MFC-TREAT	Non-Fugitive	Xe-138	1.64E+01

SourceID	FacilityID	Fugitive/Non-Fugitive	Radionuclide	Q (Ci/yr)
NRF	NRF	Fugitive	Cs-137	1.00E-05
NRF	NRF	Non-Fugitive	C-14	3.20E-01
NRF	NRF	Non-Fugitive	H-3	1.10E-02
NRF	NRF	Non-Fugitive	I-129	9.60E-06
NRF	NRF	Non-Fugitive	I-131	4.80E-06
NRF	NRF	Non-Fugitive	Kr-85	4.20E-03
NRF	NRF	Non-Fugitive	Pu-239	2.70E-06
NRF	NRF	Non-Fugitive	Sr-90	5.50E-05
RRTR	RRTR	Fugitive	Ag-106	3.77E-12
RRTR	RRTR	Fugitive	Ag-109m	2.32E-13
RRTR	RRTR	Fugitive	Ag-110	4.62E-11
RRTR	RRTR	Fugitive	Ag-110m	3.47E-09
RRTR	RRTR	Fugitive	Ag-111	6.03E-14
RRTR	RRTR	Fugitive	Ar-39	3.35E-06
RRTR	RRTR	Fugitive	Ar-41	5.10E-11
RRTR	RRTR	Fugitive	Ar-42	5.03E-17
RRTR	RRTR	Fugitive	As-76	2.51E-11
RRTR	RRTR	Fugitive	Br-82	6.02E+00
RRTR	RRTR	Fugitive	Cd-109	7.56E-17
RRTR	RRTR	Fugitive	Cl-36	1.59E-09
RRTR	RRTR	Fugitive	Cu-64	8.17E-09
RRTR	RRTR	Fugitive	Cu-67	3.24E-11
RRTR	RRTR	Fugitive	Ga-72	2.22E-21
RRTR	RRTR	Fugitive	Ir-192	1.91E-12
RRTR	RRTR	Fugitive	Ir-194	7.52E-12
RRTR	RRTR	Fugitive	K-40	8.04E-08
RRTR	RRTR	Fugitive	K-42	1.64E-01
RRTR	RRTR	Fugitive	Kr-79	3.43E-11
RRTR	RRTR	Fugitive	Kr-81	1.02E-13
RRTR	RRTR	Fugitive	Kr-83m	5.53E-15
RRTR	RRTR	Fugitive	Kr-85	5.11E-12
RRTR	RRTR	Fugitive	Kr-87	1.02E-20
RRTR	RRTR	Fugitive	Ni-63	4.24E-14
RRTR	RRTR	Fugitive	Ni-65	8.57E-16
RRTR	RRTR	Fugitive	Pd-107	6.71E-21
RRTR	RRTR	Fugitive	Pd-109	2.27E-13
RRTR	RRTR	Fugitive	Rb-86	6.87E-06
RRTR	RRTR	Fugitive	Rb-87	1.09E-10
RRTR	RRTR	Fugitive	Rh-105	5.06E-23
RRTR	RRTR	Fugitive	Se-79	2.99E-10
RRTR	RRTR	Fugitive	Se-81m	3.01E-23
RRTR	RRTR	Fugitive	Zn-65	2.51E-08
RRTR	RRTR	Fugitive	Zn-69	2.85E-20
RRTR_CuPellets	RRTR	Fugitive	Cu-64	2.70E+01
670-074	RTC	Non-Fugitive	Ba-141	2.39E-12
670-074	RTC	Non-Fugitive	Co-60	3.37E-11
670-074	RTC	Non-Fugitive	Cr-51	9.38E-13
670-074	RTC	Non-Fugitive	H-3	9.65E-04
670-074	RTC	Non-Fugitive	I-128	2.26E-07
670-074	RTC	Non-Fugitive	I-131	3.10E-10

SourceID	FacilityID	Fugitive/Non-Fugitive	Radionuclide	Q (Ci/yr)
670-074	RTC	Non-Fugitive	I-133	4.68E-10
670-074	RTC	Non-Fugitive	I-135	3.65E-09
670-074	RTC	Non-Fugitive	Na-24	5.21E-11
670-074	RTC	Non-Fugitive	Re-188	7.68E-13
670-074	RTC	Non-Fugitive	Sr-91	9.00E-13
670-074	RTC	Non-Fugitive	Sr-92	5.87E-13
670-074	RTC	Non-Fugitive	Tc-99m	1.31E-13
670-074	RTC	Non-Fugitive	Zn-65	1.14E-11
670-086	RTC	Non-Fugitive	Ba-141	2.40E-12
670-086	RTC	Non-Fugitive	Co-60	3.38E-11
670-086	RTC	Non-Fugitive	Cr-51	9.40E-13
670-086	RTC	Non-Fugitive	H-3	9.67E-04
670-086	RTC	Non-Fugitive	I-128	2.27E-07
670-086	RTC	Non-Fugitive	I-131	3.11E-10
670-086	RTC	Non-Fugitive	I-133	4.69E-10
670-086	RTC	Non-Fugitive	I-135	3.65E-09
670-086	RTC	Non-Fugitive	Na-24	5.22E-11
670-086	RTC	Non-Fugitive	Re-188	7.70E-13
670-086	RTC	Non-Fugitive	Sr-91	9.02E-13
670-086	RTC	Non-Fugitive	Sr-92	5.89E-13
670-086	RTC	Non-Fugitive	Tc-99m	1.31E-13
670-086	RTC	Non-Fugitive	Zn-65	1.14E-11
670-098	RTC	Non-Fugitive	Ba-141	1.31E-13
670-098	RTC	Non-Fugitive	Co-60	1.85E-12
670-098	RTC	Non-Fugitive	Cr-51	5.16E-14
670-098	RTC	Non-Fugitive	H-3	5.30E-05
670-098	RTC	Non-Fugitive	I-128	1.24E-08
670-098	RTC	Non-Fugitive	I-131	1.70E-11
670-098	RTC	Non-Fugitive	I-133	2.57E-11
670-098	RTC	Non-Fugitive	I-135	2.00E-10
670-098	RTC	Non-Fugitive	Na-24	2.86E-12
670-098	RTC	Non-Fugitive	Re-188	4.22E-14
670-098	RTC	Non-Fugitive	Sr-91	4.94E-14
670-098	RTC	Non-Fugitive	Sr-92	3.23E-14
670-098	RTC	Non-Fugitive	Tc-99m	7.18E-15
670-098	RTC	Non-Fugitive	Zn-65	6.27E-13
670-ATR-Canal	RTC	Non-Fugitive	Co-60	6.77E-05
670-ATR-Canal	RTC	Non-Fugitive	H-3	5.82E-01
670-ATR-Canal	RTC	Non-Fugitive	Re-188	1.54E-06
670-ATR-Canal	RTC	Non-Fugitive	Zn-65	2.29E-05
TRA-1627	RTC	Non-Fugitive	Ag-110	1.68E-14
TRA-1627	RTC	Non-Fugitive	Ag-110m	1.23E-11
TRA-1627	RTC	Non-Fugitive	Am-241	9.44E-13
TRA-1627	RTC	Non-Fugitive	Am-243	3.96E-13
TRA-1627	RTC	Non-Fugitive	Ar-41	2.70E-05
TRA-1627	RTC	Non-Fugitive	Ba-133	1.13E-11
TRA-1627	RTC	Non-Fugitive	Ba-140	5.70E-14
TRA-1627	RTC	Non-Fugitive	Be-10	3.63E-17
TRA-1627	RTC	Non-Fugitive	Br-83	5.20E-06
TRA-1627	RTC	Non-Fugitive	C-14	3.99E-10

SourceID	FacilityID	Fugitive/Non-Fugitive	Radionuclide	Q (Ci/yr)
TRA-1627	RTC	Non-Fugitive	Ce-139	3.03E-16
TRA-1627	RTC	Non-Fugitive	Ce-141	5.10E-11
TRA-1627	RTC	Non-Fugitive	Ce-144	1.56E-14
TRA-1627	RTC	Non-Fugitive	Cm-242	3.30E-15
TRA-1627	RTC	Non-Fugitive	Cm-243	4.35E-15
TRA-1627	RTC	Non-Fugitive	Cm-244	5.07E-14
TRA-1627	RTC	Non-Fugitive	Co-57	5.11E-12
TRA-1627	RTC	Non-Fugitive	Co-58	1.65E-07
TRA-1627	RTC	Non-Fugitive	Co-60	2.10E-08
TRA-1627	RTC	Non-Fugitive	Cr-51	9.60E-10
TRA-1627	RTC	Non-Fugitive	Cs-134	3.19E-12
TRA-1627	RTC	Non-Fugitive	Cs-137	1.93E-09
TRA-1627	RTC	Non-Fugitive	Cs-138	2.97E-11
TRA-1627	RTC	Non-Fugitive	Eu-152	1.08E-10
TRA-1627	RTC	Non-Fugitive	Eu-154	8.40E-11
TRA-1627	RTC	Non-Fugitive	Eu-155	1.41E-11
TRA-1627	RTC	Non-Fugitive	Eu-156	1.74E-11
TRA-1627	RTC	Non-Fugitive	Fe-55	1.05E-09
TRA-1627	RTC	Non-Fugitive	Fe-59	5.10E-10
TRA-1627	RTC	Non-Fugitive	H-3	6.93E-02
TRA-1627	RTC	Non-Fugitive	Hf-175	1.74E-11
TRA-1627	RTC	Non-Fugitive	Hf-181	6.00E-10
TRA-1627	RTC	Non-Fugitive	Hg-203	6.00E-17
TRA-1627	RTC	Non-Fugitive	I-125	1.00E-06
TRA-1627	RTC	Non-Fugitive	I-128	1.10E-06
TRA-1627	RTC	Non-Fugitive	I-129	6.53E-11
TRA-1627	RTC	Non-Fugitive	I-131	1.60E-09
TRA-1627	RTC	Non-Fugitive	I-132	2.30E-08
TRA-1627	RTC	Non-Fugitive	I-133	9.80E-09
TRA-1627	RTC	Non-Fugitive	I-134	9.90E-08
TRA-1627	RTC	Non-Fugitive	I-135	2.70E-08
TRA-1627	RTC	Non-Fugitive	K-40	2.92E-14
TRA-1627	RTC	Non-Fugitive	Kr-85m	4.80E-06
TRA-1627	RTC	Non-Fugitive	Kr-87	1.70E-05
TRA-1627	RTC	Non-Fugitive	Kr-88	1.50E-05
TRA-1627	RTC	Non-Fugitive	La-140	2.97E-11
TRA-1627	RTC	Non-Fugitive	La-142	6.00E-13
TRA-1627	RTC	Non-Fugitive	Mn-54	3.00E-10
TRA-1627	RTC	Non-Fugitive	Mn-56	5.70E-12
TRA-1627	RTC	Non-Fugitive	Mo-99	2.04E-11
TRA-1627	RTC	Non-Fugitive	Na-24	6.00E-10
TRA-1627	RTC	Non-Fugitive	Nb-94	3.90E-17
TRA-1627	RTC	Non-Fugitive	Nb-95	2.55E-10
TRA-1627	RTC	Non-Fugitive	Ni-59	1.44E-10
TRA-1627	RTC	Non-Fugitive	Ni-63	1.41E-08
TRA-1627	RTC	Non-Fugitive	Np-237	4.80E-12
TRA-1627	RTC	Non-Fugitive	Np-239	3.90E-13
TRA-1627	RTC	Non-Fugitive	P-32	1.31E-17
TRA-1627	RTC	Non-Fugitive	Po-210	1.20E-13
TRA-1627	RTC	Non-Fugitive	Pu-236	1.60E-14

SourceID	FacilityID	Fugitive/Non-Fugitive	Radionuclide	Q (Ci/yr)
TRA-1627	RTC	Non-Fugitive	Pu-238	2.29E-14
TRA-1627	RTC	Non-Fugitive	Pu-239	9.01E-10
TRA-1627	RTC	Non-Fugitive	Pu-240	6.55E-15
TRA-1627	RTC	Non-Fugitive	Pu-241	1.94E-14
TRA-1627	RTC	Non-Fugitive	Pu-242	1.23E-13
TRA-1627	RTC	Non-Fugitive	Ra-226	2.81E-14
TRA-1627	RTC	Non-Fugitive	Rb-88	1.44E-11
TRA-1627	RTC	Non-Fugitive	Rb-89	3.30E-11
TRA-1627	RTC	Non-Fugitive	Re-188	5.40E-12
TRA-1627	RTC	Non-Fugitive	Rh-106m	3.00E-13
TRA-1627	RTC	Non-Fugitive	Ru-103	2.46E-11
TRA-1627	RTC	Non-Fugitive	Ru-106	1.62E-12
TRA-1627	RTC	Non-Fugitive	Sb-122	1.98E-14
TRA-1627	RTC	Non-Fugitive	Sb-124	2.55E-11
TRA-1627	RTC	Non-Fugitive	Sb-125	1.19E-11
TRA-1627	RTC	Non-Fugitive	Sc-46	5.92E-15
TRA-1627	RTC	Non-Fugitive	Si-32	1.46E-18
TRA-1627	RTC	Non-Fugitive	Sn-113	2.88E-12
TRA-1627	RTC	Non-Fugitive	Sr-80	1.08E-13
TRA-1627	RTC	Non-Fugitive	Sr-85	9.00E-10
TRA-1627	RTC	Non-Fugitive	Sr-89	4.80E-11
TRA-1627	RTC	Non-Fugitive	Sr-90	2.24E-10
TRA-1627	RTC	Non-Fugitive	Sr-91	3.60E-12
TRA-1627	RTC	Non-Fugitive	Sr-92	1.65E-12
TRA-1627	RTC	Non-Fugitive	Ta-182	1.53E-11
TRA-1627	RTC	Non-Fugitive	Ta-183	2.97E-10
TRA-1627	RTC	Non-Fugitive	Tc-99	2.78E-12
TRA-1627	RTC	Non-Fugitive	Tc-99m	1.65E-10
TRA-1627	RTC	Non-Fugitive	Th-229	3.60E-16
TRA-1627	RTC	Non-Fugitive	Th-230	2.51E-14
TRA-1627	RTC	Non-Fugitive	Th-232	3.33E-17
TRA-1627	RTC	Non-Fugitive	U-232	6.85E-15
TRA-1627	RTC	Non-Fugitive	U-233	1.41E-11
TRA-1627	RTC	Non-Fugitive	U-234	1.32E-13
TRA-1627	RTC	Non-Fugitive	U-235	3.13E-14
TRA-1627	RTC	Non-Fugitive	U-236	3.60E-16
TRA-1627	RTC	Non-Fugitive	U-238	1.09E-12
TRA-1627	RTC	Non-Fugitive	W-187	3.60E-12
TRA-1627	RTC	Non-Fugitive	Xe-133	2.10E-08
TRA-1627	RTC	Non-Fugitive	Xe-135	1.60E-05
TRA-1627	RTC	Non-Fugitive	Xe-135m	7.30E-06
TRA-1627	RTC	Non-Fugitive	Xe-138	5.90E-05
TRA-1627	RTC	Non-Fugitive	Y-88	2.85E-16
TRA-1627	RTC	Non-Fugitive	Y-92	7.80E-13
TRA-1627	RTC	Non-Fugitive	Zn-65	1.11E-10
TRA-1627	RTC	Non-Fugitive	Zr-95	9.90E-11
TRA-1627	RTC	Non-Fugitive	Zr-97	5.70E-12
TRA-678	RTC	Non-Fugitive	Ag-110m	1.23E-11
TRA-678	RTC	Non-Fugitive	Am-241	2.37E-13
TRA-678	RTC	Non-Fugitive	Am-243	6.60E-16

SourceID	FacilityID	Fugitive/Non-Fugitive	Radionuclide	Q (Ci/yr)
TRA-678	RTC	Non-Fugitive	Ar-41	2.70E-05
TRA-678	RTC	Non-Fugitive	Ba-133	1.13E-11
TRA-678	RTC	Non-Fugitive	Ba-140	5.70E-14
TRA-678	RTC	Non-Fugitive	Br-83	5.20E-06
TRA-678	RTC	Non-Fugitive	C-14	2.82E-11
TRA-678	RTC	Non-Fugitive	Cd-109	1.93E-12
TRA-678	RTC	Non-Fugitive	Ce-139	7.87E-14
TRA-678	RTC	Non-Fugitive	Ce-141	5.10E-11
TRA-678	RTC	Non-Fugitive	Ce-144	1.56E-14
TRA-678	RTC	Non-Fugitive	Cm-242	3.30E-15
TRA-678	RTC	Non-Fugitive	Cm-243	5.40E-16
TRA-678	RTC	Non-Fugitive	Cm-244	4.80E-14
TRA-678	RTC	Non-Fugitive	Co-57	5.16E-12
TRA-678	RTC	Non-Fugitive	Co-58	1.65E-07
TRA-678	RTC	Non-Fugitive	Co-60	2.10E-08
TRA-678	RTC	Non-Fugitive	Cr-51	9.60E-10
TRA-678	RTC	Non-Fugitive	Cs-134	3.07E-12
TRA-678	RTC	Non-Fugitive	Cs-137	1.92E-09
TRA-678	RTC	Non-Fugitive	Cs-138	2.97E-11
TRA-678	RTC	Non-Fugitive	Eu-152	4.91E-10
TRA-678	RTC	Non-Fugitive	Eu-154	8.40E-11
TRA-678	RTC	Non-Fugitive	Eu-155	1.41E-11
TRA-678	RTC	Non-Fugitive	Eu-156	1.74E-11
TRA-678	RTC	Non-Fugitive	Fe-55	1.05E-09
TRA-678	RTC	Non-Fugitive	Fe-59	5.10E-10
TRA-678	RTC	Non-Fugitive	H-3	6.90E-02
TRA-678	RTC	Non-Fugitive	Hf-175	1.74E-11
TRA-678	RTC	Non-Fugitive	Hf-181	6.00E-10
TRA-678	RTC	Non-Fugitive	Hg-203	2.06E-13
TRA-678	RTC	Non-Fugitive	I-128	1.10E-06
TRA-678	RTC	Non-Fugitive	I-129	1.50E-11
TRA-678	RTC	Non-Fugitive	I-131	1.60E-09
TRA-678	RTC	Non-Fugitive	I-132	2.30E-08
TRA-678	RTC	Non-Fugitive	I-133	9.80E-09
TRA-678	RTC	Non-Fugitive	I-134	9.90E-08
TRA-678	RTC	Non-Fugitive	I-135	2.70E-08
TRA-678	RTC	Non-Fugitive	K-40	1.92E-14
TRA-678	RTC	Non-Fugitive	Kr-85m	4.80E-06
TRA-678	RTC	Non-Fugitive	Kr-87	1.70E-05
TRA-678	RTC	Non-Fugitive	Kr-88	1.50E-05
TRA-678	RTC	Non-Fugitive	La-140	2.97E-11
TRA-678	RTC	Non-Fugitive	La-142	6.00E-13
TRA-678	RTC	Non-Fugitive	Mn-54	3.00E-10
TRA-678	RTC	Non-Fugitive	Mn-56	5.70E-12
TRA-678	RTC	Non-Fugitive	Mo-99	2.04E-11
TRA-678	RTC	Non-Fugitive	Na-24	6.00E-10
TRA-678	RTC	Non-Fugitive	Nb-92m	3.96E-10
TRA-678	RTC	Non-Fugitive	Nb-93m	6.65E-13
TRA-678	RTC	Non-Fugitive	Nb-94	3.36E-14
TRA-678	RTC	Non-Fugitive	Nb-95	2.55E-10

SourceID	FacilityID	Fugitive/Non-Fugitive	Radionuclide	Q (Ci/yr)
TRA-678	RTC	Non-Fugitive	Ni-59	1.44E-10
TRA-678	RTC	Non-Fugitive	Ni-63	1.41E-08
TRA-678	RTC	Non-Fugitive	Np-237	2.29E-10
TRA-678	RTC	Non-Fugitive	Np-239	3.90E-13
TRA-678	RTC	Non-Fugitive	Pb-210	1.65E-12
TRA-678	RTC	Non-Fugitive	Pu-238	1.77E-14
TRA-678	RTC	Non-Fugitive	Pu-239	1.49E-08
TRA-678	RTC	Non-Fugitive	Pu-240	6.30E-15
TRA-678	RTC	Non-Fugitive	Pu-241	5.10E-15
TRA-678	RTC	Non-Fugitive	Pu-242	1.95E-16
TRA-678	RTC	Non-Fugitive	Ra-226	3.06E-10
TRA-678	RTC	Non-Fugitive	Rb-88	1.44E-11
TRA-678	RTC	Non-Fugitive	Rb-89	3.30E-11
TRA-678	RTC	Non-Fugitive	Re-188	5.40E-12
TRA-678	RTC	Non-Fugitive	Ru-103	2.46E-11
TRA-678	RTC	Non-Fugitive	Sb-122	1.98E-14
TRA-678	RTC	Non-Fugitive	Sb-124	2.55E-11
TRA-678	RTC	Non-Fugitive	Sb-125	1.14E-11
TRA-678	RTC	Non-Fugitive	Sc-46	4.50E-15
TRA-678	RTC	Non-Fugitive	Sn-113	3.09E-12
TRA-678	RTC	Non-Fugitive	Sr-85	2.68E-13
TRA-678	RTC	Non-Fugitive	Sr-89	4.80E-11
TRA-678	RTC	Non-Fugitive	Sr-90	1.60E-10
TRA-678	RTC	Non-Fugitive	Sr-91	3.60E-12
TRA-678	RTC	Non-Fugitive	Sr-92	1.65E-12
TRA-678	RTC	Non-Fugitive	Ta-182	1.59E-11
TRA-678	RTC	Non-Fugitive	Ta-183	2.97E-10
TRA-678	RTC	Non-Fugitive	Tc-99	6.90E-15
TRA-678	RTC	Non-Fugitive	Tc-99m	1.65E-10
TRA-678	RTC	Non-Fugitive	Th-230	2.62E-15
TRA-678	RTC	Non-Fugitive	Th-232	3.09E-11
TRA-678	RTC	Non-Fugitive	U-232	2.23E-11
TRA-678	RTC	Non-Fugitive	U-233	5.40E-12
TRA-678	RTC	Non-Fugitive	U-234	1.32E-13
TRA-678	RTC	Non-Fugitive	U-235	2.99E-10
TRA-678	RTC	Non-Fugitive	U-236	3.60E-16
TRA-678	RTC	Non-Fugitive	U-238	8.00E-10
TRA-678	RTC	Non-Fugitive	W-187	3.60E-12
TRA-678	RTC	Non-Fugitive	Xe-133	2.10E-08
TRA-678	RTC	Non-Fugitive	Xe-135	1.60E-05
TRA-678	RTC	Non-Fugitive	Xe-135m	7.30E-06
TRA-678	RTC	Non-Fugitive	Xe-138	5.90E-05
TRA-678	RTC	Non-Fugitive	Y-88	4.32E-13
TRA-678	RTC	Non-Fugitive	Y-90	1.80E-13
TRA-678	RTC	Non-Fugitive	Y-92	7.80E-13
TRA-678	RTC	Non-Fugitive	Zn-65	9.01E-11
TRA-678	RTC	Non-Fugitive	Zr-95	9.90E-11
TRA-678	RTC	Non-Fugitive	Zr-97	5.70E-12
TRA-710-001	RTC	Non-Fugitive	Ar-39	1.48E-19
TRA-710-001	RTC	Non-Fugitive	Ba-133	7.65E-16

SourceID	FacilityID	Fugitive/Non-Fugitive	Radionuclide	Q (Ci/yr)
TRA-710-001	RTC	Non-Fugitive	Be-10	5.43E-20
TRA-710-001	RTC	Non-Fugitive	Bi-210	7.68E-22
TRA-710-001	RTC	Non-Fugitive	Bi-210m	5.73E-28
TRA-710-001	RTC	Non-Fugitive	C-14	1.35E-14
TRA-710-001	RTC	Non-Fugitive	Ca-45	3.27E-14
TRA-710-001	RTC	Non-Fugitive	Co-57	1.16E-13
TRA-710-001	RTC	Non-Fugitive	Co-58	9.13E-10
TRA-710-001	RTC	Non-Fugitive	Co-60	1.19E-09
TRA-710-001	RTC	Non-Fugitive	Co-60m	1.03E-19
TRA-710-001	RTC	Non-Fugitive	Cr-51	2.77E-11
TRA-710-001	RTC	Non-Fugitive	Cs-134	4.96E-13
TRA-710-001	RTC	Non-Fugitive	Cs-137	8.70E-11
TRA-710-001	RTC	Non-Fugitive	Eu-152	1.61E-12
TRA-710-001	RTC	Non-Fugitive	Eu-154	4.14E-13
TRA-710-001	RTC	Non-Fugitive	Eu-155	8.52E-13
TRA-710-001	RTC	Non-Fugitive	Fe-55	1.69E-09
TRA-710-001	RTC	Non-Fugitive	Fe-59	7.72E-12
TRA-710-001	RTC	Non-Fugitive	Fe-60	1.03E-19
TRA-710-001	RTC	Non-Fugitive	Ge-68	6.00E-12
TRA-710-001	RTC	Non-Fugitive	Ge-71	3.21E-19
TRA-710-001	RTC	Non-Fugitive	H-3	8.60E-02
TRA-710-001	RTC	Non-Fugitive	Hf-178m	2.35E-20
TRA-710-001	RTC	Non-Fugitive	Hf-179m	5.34E-20
TRA-710-001	RTC	Non-Fugitive	Hf-181	2.88E-15
TRA-710-001	RTC	Non-Fugitive	Hf-182	2.55E-23
TRA-710-001	RTC	Non-Fugitive	Hg-203	4.77E-21
TRA-710-001	RTC	Non-Fugitive	Ir-192	2.80E-13
TRA-710-001	RTC	Non-Fugitive	Mn-53	7.20E-23
TRA-710-001	RTC	Non-Fugitive	Mn-54	1.41E-11
TRA-710-001	RTC	Non-Fugitive	Mo-93	1.01E-09
TRA-710-001	RTC	Non-Fugitive	Na-22	6.03E-10
TRA-710-001	RTC	Non-Fugitive	Ni-59	1.67E-11
TRA-710-001	RTC	Non-Fugitive	Ni-63	2.02E-08
TRA-710-001	RTC	Non-Fugitive	Os-185	2.63E-12
TRA-710-001	RTC	Non-Fugitive	Os-191	7.38E-21
TRA-710-001	RTC	Non-Fugitive	P-32	5.88E-18
TRA-710-001	RTC	Non-Fugitive	P-33	3.15E-21
TRA-710-001	RTC	Non-Fugitive	Pb-205	1.72E-21
TRA-710-001	RTC	Non-Fugitive	Pb-210	7.68E-22
TRA-710-001	RTC	Non-Fugitive	Po-210	3.03E-21
TRA-710-001	RTC	Non-Fugitive	Re-184	5.96E-14
TRA-710-001	RTC	Non-Fugitive	Re-184m	1.85E-11
TRA-710-001	RTC	Non-Fugitive	Re-186	8.28E-20
TRA-710-001	RTC	Non-Fugitive	Re-186m	7.44E-14
TRA-710-001	RTC	Non-Fugitive	Re-187	3.45E-17
TRA-710-001	RTC	Non-Fugitive	Re-188	1.74E-08
TRA-710-001	RTC	Non-Fugitive	Sc-46	2.75E-13
TRA-710-001	RTC	Non-Fugitive	Si-32	5.34E-18
TRA-710-001	RTC	Non-Fugitive	Ta-179	1.34E-14
TRA-710-001	RTC	Non-Fugitive	Ta-182	1.32E-10

SourceID	FacilityID	Fugitive/Non-Fugitive	Radionuclide	Q (Ci/yr)
TRA-710-001	RTC	Non-Fugitive	Tl-204	3.81E-21
TRA-710-001	RTC	Non-Fugitive	U-234	1.40E-10
TRA-710-001	RTC	Non-Fugitive	U-235	1.02E-11
TRA-710-001	RTC	Non-Fugitive	U-238	7.73E-10
TRA-710-001	RTC	Non-Fugitive	V-49	3.21E-19
TRA-710-001	RTC	Non-Fugitive	W-181	2.15E-08
TRA-710-001	RTC	Non-Fugitive	W-185	1.38E-06
TRA-710-001	RTC	Non-Fugitive	W-188	5.00E-08
TRA-710-001	RTC	Non-Fugitive	Zn-65	9.45E-10
TRA-715-001	RTC	Fugitive	Ag-110m	1.51E-06
TRA-715-001	RTC	Fugitive	Am-241	2.19E-05
TRA-715-001	RTC	Fugitive	Ba-140	5.00E-08
TRA-715-001	RTC	Fugitive	Ce-144	1.73E-06
TRA-715-001	RTC	Fugitive	Co-58	9.30E-07
TRA-715-001	RTC	Fugitive	Co-60	6.24E-03
TRA-715-001	RTC	Fugitive	Cr-51	7.70E-07
TRA-715-001	RTC	Fugitive	Cs-134	1.75E-06
TRA-715-001	RTC	Fugitive	Cs-137	5.35E-03
TRA-715-001	RTC	Fugitive	Eu-152	6.78E-05
TRA-715-001	RTC	Fugitive	Eu-154	5.60E-05
TRA-715-001	RTC	Fugitive	Eu-155	5.82E-06
TRA-715-001	RTC	Fugitive	H-3	2.33E+00
TRA-715-001	RTC	Fugitive	Hf-181	6.90E-07
TRA-715-001	RTC	Fugitive	I-131	3.30E-07
TRA-715-001	RTC	Fugitive	La-140	3.00E-08
TRA-715-001	RTC	Fugitive	Mn-54	2.84E-06
TRA-715-001	RTC	Fugitive	Na-24	1.90E-07
TRA-715-001	RTC	Fugitive	Nb-95	1.87E-06
TRA-715-001	RTC	Fugitive	Np-239	2.00E-08
TRA-715-001	RTC	Fugitive	Pu-239	8.44E-06
TRA-715-001	RTC	Fugitive	Sb-122	8.00E-08
TRA-715-001	RTC	Fugitive	Sb-124	1.60E-07
TRA-715-001	RTC	Fugitive	Sr-89	1.00E-13
TRA-715-001	RTC	Fugitive	Sr-90	2.75E-02
TRA-715-001	RTC	Fugitive	Ta-182	1.70E-06
TRA-715-001	RTC	Fugitive	Y-90	5.90E-04
TRA-715-001	RTC	Fugitive	Zn-65	5.56E-06
TRA-715-001	RTC	Fugitive	Zr-95	1.40E-07
TRA-770-001	RTC-ATR	Non-Fugitive	Am-241	1.90E-07
TRA-770-001	RTC-ATR	Non-Fugitive	Ba-140	2.69E-06
TRA-770-001	RTC-ATR	Non-Fugitive	Cs-137	8.74E-06
TRA-770-001	RTC-ATR	Non-Fugitive	H-3	6.74E+00
TRA-770-001	RTC-ATR	Non-Fugitive	Hg-203	2.07E-07
TRA-770-001	RTC-ATR	Non-Fugitive	Re-188	1.06E-05
ARP-II	RWMC	Non-Fugitive	Am-241	2.84E-09
ARP-II	RWMC	Non-Fugitive	Pu-239	1.79E-10
ARP-II	RWMC	Non-Fugitive	Pu-240	4.01E-11
ARP-III	RWMC	Non-Fugitive	Am-241	1.65E-13
ARP-III	RWMC	Non-Fugitive	Pu-238	1.65E-15
ARP-III	RWMC	Non-Fugitive	Pu-239	5.46E-14

SourceID	FacilityID	Fugitive/Non-Fugitive	Radionuclide	Q (Ci/yr)
ARP-III	RWMC	Non-Fugitive	Pu-240	1.23E-14
ARP-III	RWMC	Non-Fugitive	Sr-90	7.12E-20
ARP-III	RWMC	Non-Fugitive	U-235	1.35E-18
ARP-III	RWMC	Non-Fugitive	U-238	7.31E-17
ARP-IV	RWMC	Non-Fugitive	Am-241	4.39E-09
ARP-IV	RWMC	Non-Fugitive	Pu-238	1.84E-11
ARP-IV	RWMC	Non-Fugitive	Pu-239	6.11E-10
ARP-IV	RWMC	Non-Fugitive	Pu-240	1.38E-10
ARP-IV	RWMC	Non-Fugitive	Sr-90	1.89E-11
ARP-IV	RWMC	Non-Fugitive	U-235	4.61E-14
ARP-IV	RWMC	Non-Fugitive	U-238	3.45E-12
ARP-IV Demo	RWMC	Non-Fugitive	Am-241	4.16E-09
ARP-IV Demo	RWMC	Non-Fugitive	Pu-238	1.81E-11
ARP-IV Demo	RWMC	Non-Fugitive	Pu-239	5.89E-10
ARP-IV Demo	RWMC	Non-Fugitive	Pu-240	1.33E-10
ARP-IV Demo	RWMC	Non-Fugitive	Pu-241	4.86E-11
ARP-IV Demo	RWMC	Non-Fugitive	Sr-90	1.74E-11
ARP-IV Demo	RWMC	Non-Fugitive	U-235	4.24E-14
ARP-IV Demo	RWMC	Non-Fugitive	U-238	3.18E-12
ARP-IX	RWMC	Non-Fugitive	Am-241	2.49E-05
ARP-IX	RWMC	Non-Fugitive	Pu-238	2.03E-07
ARP-IX	RWMC	Non-Fugitive	Pu-239	7.27E-06
ARP-IX	RWMC	Non-Fugitive	Pu-240	1.63E-06
ARP-IX	RWMC	Non-Fugitive	Sr-90	2.08E-08
ARP-IX	RWMC	Non-Fugitive	U-235	8.14E-11
ARP-IX	RWMC	Non-Fugitive	U-238	6.17E-09
ARP-V	RWMC	Non-Fugitive	Am-241	4.23E-10
ARP-V	RWMC	Non-Fugitive	Pu-238	2.92E-12
ARP-V	RWMC	Non-Fugitive	Pu-239	5.07E-11
ARP-V	RWMC	Non-Fugitive	Pu-240	1.21E-11
ARP-V	RWMC	Non-Fugitive	Sr-90	1.92E-17
ARP-V	RWMC	Non-Fugitive	U-235	8.34E-16
ARP-V	RWMC	Non-Fugitive	U-238	4.44E-14
ARP-VII	RWMC	Non-Fugitive	Am-241	7.85E-05
ARP-VII	RWMC	Non-Fugitive	Pu-238	1.43E-06
ARP-VII	RWMC	Non-Fugitive	Pu-239	3.02E-05
ARP-VII	RWMC	Non-Fugitive	Pu-240	6.95E-06
ARP-VII	RWMC	Non-Fugitive	Sr-90	2.22E-08
ARP-VII	RWMC	Non-Fugitive	U-235	1.58E-10
ARP-VII	RWMC	Non-Fugitive	U-238	1.03E-08
ARP-VIII	RWMC	Non-Fugitive	Am-241	7.69E-09
ARP-VIII	RWMC	Non-Fugitive	Pu-238	5.55E-12
ARP-VIII	RWMC	Non-Fugitive	Pu-239	1.80E-09
ARP-VIII	RWMC	Non-Fugitive	Pu-240	4.03E-10
ARP-VIII	RWMC	Non-Fugitive	Sr-90	1.30E-11
ARP-VIII	RWMC	Non-Fugitive	U-235	7.24E-14
ARP-VIII	RWMC	Non-Fugitive	U-238	1.55E-12
Beryllium Blocks	RWMC	Fugitive	C-14	2.22E-02
Beryllium Blocks	RWMC	Fugitive	H-3	4.81E+01
WMF-601	RWMC	Non-Fugitive	Pu-239	2.89E-11

SourceID	FacilityID	Fugitive/Non-Fugitive	Radionuclide	Q (Ci/yr)
WMF-601	RWMC	Non-Fugitive	Sr-90	2.65E-12
WMF-615	RWMC	Non-Fugitive	Am-241	1.07E-15
WMF-615	RWMC	Non-Fugitive	Co-60	4.43E-17
WMF-615	RWMC	Non-Fugitive	Cs-137	4.43E-18
WMF-615	RWMC	Non-Fugitive	K-40	2.72E-15
WMF-615	RWMC	Non-Fugitive	Pb-210	6.15E-16
WMF-615	RWMC	Non-Fugitive	Pu-239	8.37E-15
WMF-615	RWMC	Non-Fugitive	Sr-90	1.07E-14
WMF-634-001	RWMC	Non-Fugitive	Am-241	4.03E-19
WMF-634-001	RWMC	Non-Fugitive	Co-60	1.66E-20
WMF-634-001	RWMC	Non-Fugitive	Cs-137	1.66E-21
WMF-634-001	RWMC	Non-Fugitive	K-40	1.02E-18
WMF-634-001	RWMC	Non-Fugitive	Pb-210	2.31E-19
WMF-634-001	RWMC	Non-Fugitive	Pu-239	3.14E-18
WMF-634-001	RWMC	Non-Fugitive	Sr-90	4.00E-18
WMF-636-001	RWMC	Non-Fugitive	Am-241	9.67E-09
WMF-636-001	RWMC	Non-Fugitive	Pu-238	3.03E-08
WMF-636-001	RWMC	Non-Fugitive	Pu-239	2.69E-08
WMF-636-001	RWMC	Non-Fugitive	Pu-240	2.69E-08
WMF-636-002	RWMC	Non-Fugitive	Pu-239	5.63E-09
WMF-636-002	RWMC	Non-Fugitive	Pu-240	5.63E-09
SMC	SMC	Non-Fugitive	U-234	2.03E-08
SMC	SMC	Non-Fugitive	U-235	1.42E-09
SMC	SMC	Non-Fugitive	U-238	1.13E-07
OU-1-07B	TAN-TSF	Non-Fugitive	H-3	1.45E-02
OU-1-07B	TAN-TSF	Non-Fugitive	Sr-90	3.01E-05

Table D-2. Radionuclide releases reported for INL in-town IRC Site Facilities. (Sorted by FacilityID, SourceID, Fugitive/Non-Fugitive, and Radionuclide).

Source ID	Facility ID	Fugitive/Non-Fugitive	Radionuclide	Q (Ci/yr)
IF603	IF603	Non-Fugitive	Co-60	3.90E-13
IF603	IF603	Non-Fugitive	Kr-85	1.15E-02
IF603	IF603	Non-Fugitive	Th-232	7.63E-14
IF603	IF603	Non-Fugitive	U-234	4.43E-12
IF603	IF603	Non-Fugitive	U-235	2.26E-13
IF603	IF603	Non-Fugitive	U-238	2.63E-12
IF603	IF603	Non-Fugitive	Xe-131m	7.40E-04
IF603	IF603	Non-Fugitive	Xe-133	6.57E-01
IF603	IF603	Non-Fugitive	Xe-135	8.00E-04
IF683	IF683	Non-Fugitive	Ac-227	5.23E-09
IF683	IF683	Non-Fugitive	Am-241	1.04E-07
IF683	IF683	Non-Fugitive	Am-243	2.09E-09
IF683	IF683	Non-Fugitive	Ba-133	3.36E-07
IF683	IF683	Non-Fugitive	Ba-140	7.10E-60
IF683	IF683	Non-Fugitive	C-14	1.05E-07
IF683	IF683	Non-Fugitive	Cd-109	3.42E-08
IF683	IF683	Non-Fugitive	Ce-139	1.59E-09
IF683	IF683	Non-Fugitive	Cf-252	9.18E-15
IF683	IF683	Non-Fugitive	Cm-244	3.56E-10
IF683	IF683	Non-Fugitive	Co-57	1.56E-08
IF683	IF683	Non-Fugitive	Co-60	3.92E-08
IF683	IF683	Non-Fugitive	Cs-134	1.76E-08
IF683	IF683	Non-Fugitive	Cs-137	7.54E-08
IF683	IF683	Non-Fugitive	Eu-152	4.26E-08
IF683	IF683	Non-Fugitive	Eu-154	1.73E-07
IF683	IF683	Non-Fugitive	Eu-155	5.85E-08
IF683	IF683	Non-Fugitive	Fe-55	3.44E-08
IF683	IF683	Non-Fugitive	Gd-148	8.89E-10
IF683	IF683	Non-Fugitive	H-3	1.43E-07
IF683	IF683	Non-Fugitive	Hg-203	4.60E-09
IF683	IF683	Non-Fugitive	I-125	6.29E-09
IF683	IF683	Non-Fugitive	I-129	1.10E-10
IF683	IF683	Non-Fugitive	I-131	1.06E-07
IF683	IF683	Non-Fugitive	Ir-192	4.06E-19
IF683	IF683	Non-Fugitive	Mn-54	1.83E-08
IF683	IF683	Non-Fugitive	Na-22	9.14E-08
IF683	IF683	Non-Fugitive	Ni-63	9.31E-09
IF683	IF683	Non-Fugitive	Np-237	6.48E-09
IF683	IF683	Non-Fugitive	Pa-231	1.15E-09
IF683	IF683	Non-Fugitive	Pb-210	2.24E-08

Source ID	Facility ID	Fugitive/Non-Fugitive	Radionuclide	Q (Ci/yr)
IF683	IF683	Non-Fugitive	Pu-236	2.39E-12
IF683	IF683	Non-Fugitive	Pu-238	7.77E-08
IF683	IF683	Non-Fugitive	Pu-239	1.32E-07
IF683	IF683	Non-Fugitive	Ra-226	7.52E-08
IF683	IF683	Non-Fugitive	Ru-103	1.20E-25
IF683	IF683	Non-Fugitive	Ru-106	3.15E-09
IF683	IF683	Non-Fugitive	Sb-125	1.31E-08
IF683	IF683	Non-Fugitive	Se-75	2.75E-14
IF683	IF683	Non-Fugitive	Sm-151	1.01E-07
IF683	IF683	Non-Fugitive	Sn-113	5.71E-09
IF683	IF683	Non-Fugitive	Sr-85	5.00E-08
IF683	IF683	Non-Fugitive	Sr-89	3.67E-14
IF683	IF683	Non-Fugitive	Sr-90	6.87E-08
IF683	IF683	Non-Fugitive	Tc-99	5.00E-09
IF683	IF683	Non-Fugitive	Tc-99m	4.08E-07
IF683	IF683	Non-Fugitive	Th-228	9.54E-11
IF683	IF683	Non-Fugitive	Th-229	9.98E-11
IF683	IF683	Non-Fugitive	Th-230	9.10E-11
IF683	IF683	Non-Fugitive	Th-232	9.60E-11
IF683	IF683	Non-Fugitive	U-232	3.15E-08
IF683	IF683	Non-Fugitive	U-233	1.64E-07
IF683	IF683	Non-Fugitive	U-234	6.20E-10
IF683	IF683	Non-Fugitive	U-235	3.61E-10
IF683	IF683	Non-Fugitive	U-238	6.32E-10
IF683	IF683	Non-Fugitive	Y-88	4.16E-12
IF683	IF683	Non-Fugitive	Zn-65	1.07E-08
IF683	IF683	Non-Fugitive	Zr-95	4.88E-08

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Appendix E

Radionuclides Reported During CY 2022

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Appendix E

Radionuclides Reported During CY 2022

Table E-1. Radionuclides reported in use and potentially emitted to the atmosphere from the INL Site facilities in CY 2022.

Ac-227	Ge-71	Pb-212	Sn-125
Ag-106	Ge-75	Pb-214	Sn-126
Ag-108m	Ge-77	Pd-107	Sn-127
Ag-109m	Ge-78	Pd-109	Sn-128
Ag-110	H-3	Pm-146	Sr-80
Ag-110m	He-3[a]	Pm-147	Sr-85
Ag-111	Hf-175	Pm-148	Sr-89
Ag-112	Hf-178m	Pm-148m	Sr-90
Am-241	Hf-179m	Pm-149	Sr-91
Am-243	Hf-180m	Pm-150	Sr-92
Ar-39	Hf-181	Pm-151	Ta-179
Ar-41	Hf-182	Po-210	Ta-180
Ar-42	Hg-203	Po-212	Ta-180m[a]
As-73	Ho-166	Po-215	Ta-182
As-76	Ho-166m	Po-216	Ta-183
As-77	I-125	Pr-143	Ta-184
As-78	I-126	Pr-144	Tb-157
Au-196	I-128	Pr-144m	Tb-158
Au-198	I-129	Pr-145	Tb-160
Au-198m	I-130	Pt-189	Tb-161
Ba-133	I-131	Pt-191	Tc-97m
Ba-137m	I-132	Pt-193	Tc-99
Ba-139	I-133	Pt-193m	Tc-99m
Ba-140	I-134	Pt-195m	Te-123m
Ba-141	I-135	Pt-197	Te-125m
Be-10	In-114	Pu-236	Te-127
Bi-207	In-114m	Pu-238	Te-127m
Bi-210	In-115m	Pu-239	Te-129
Bi-210m	In-117	Pu-240	Te-129m
Bi-211	Ir-190	Pu-241	Te-131
Bi-212	Ir-192	Pu-242	Te-131m
Bi-214	Ir-194	Pu-244	Te-132
Br-80	K-40	Ra-223	Te-133
Br-82	K-42	Ra-224	Te-134
Br-83	Kr-79	Ra-226	Th-227
Br-84	Kr-81	Rb-83	Th-228
C-14	Kr-83m	Rb-84	Th-229
Ca-45	Kr-85	Rb-86	Th-230
Cd-109	Kr-85m	Rb-87	Th-231
Cd-113m	Kr-87	Rb-88	Th-232

Cd-115	Kr-88	Rb-89	Th-234
Cd-115m	Kr-89	Rb-90	Tl-204
Cd-117	Kr-90[b] (Rb-90)	Rb-91[b] (Sr-91)	Tl-207
Ce-139	Kr-91[b] (Sr-91)	Rb-92[b] (Sr-92)	Tl-208
Ce-141	Kr-92[b] (Sr-92)	Re-184	Tm-168
Ce-143	La-140	Re-184m	Tm-170
Ce-144	La-141	Re-186	Tm-171
Cf-252	La-142	Re-186m	U-232
Cl-36	Lu-177	Re-187	U-233
Cm-242	Lu-177m	Re-188	U-234
Cm-243	Mn-52	Rh-102	U-235
Cm-244	Mn-53	Rh-102m	U-236
Co-57	Mn-54	Rh-103m	U-237
Co-58	Mn-56	Rh-105	U-238
Co-58m	Mo-93	Rh-106	V-48
Co-59[a]	Mo-99	Rh-106m	V-49
Co-60	Na-22	Rn-219	W-181
Co-60m	Na-24	Rn-220	W-185
Cr-51	Nb-92m	Ru-103	W-187
Cs-134	Nb-93m	Ru-105	W-188
Cs-135	Nb-94	Ru-106	Xe-127
Cs-136	Nb-95	S-35	Xe-131m
Cs-137	Nb-95m	Sb-122	Xe-133
Cs-138	Nb-96	Sb-124	Xe-133m
Cs-139	Nb-97	Sb-125	Xe-135
Cs-140	Nd-147	Sb-126	Xe-135m
Cu-64	Nd-149	Sb-126m	Xe-137
Cu-67	Ni-57	Sb-127	Xe-138
Dy-159	Ni-59	Sb-128	Xe-139[b] (Cs-139)
Dy-165	Ni-63	Sb-128m	Xe-140[b] (Cs-140)
Dy-166	Ni-65	Sb-129	Y-88
Er-169	Ni-66	Sb-130	Y-89m
Eu-152	Np-237	Sc-46	Y-90
Eu-154	Np-239	Sc-47	Y-91
Eu-155	Os-185	Sc-48	Y-91m
Eu-156	Os-189m	Se-79	Y-92
Eu-157	Os-191	Se-81	Y-93
Eu-158	Os-191m	Se-81m	Zn-65
Fe-55	Os-193	Si-32	Zn-69
Fe-59	P-32	Sm-151	Zn-69m
Fe-60	P-33	Sm-153	Zn-71m
Ga-68	Pa-231	Sm-156	Zn-72
Ga-70	Pa-233	Sn-113	Zr-93
Ga-72	Pa-234	Sn-117m	Zr-95
Ga-73	Pa-234m	Sn-119m	Zr-97
Gd-153	Pb-205	Sn-121	
Gd-159	Pb-210	Sn-121m	

Ge-68	Pb-211	Sn-123

[a] Radionuclide not included in CAP88 database as it is stable.

[b] Radionuclide not included in CAP88 database due to short half-life. Parent converted into first progeny (shown in parentheses) included in CAP88 database.

NOTE: *Ba-136m was reported as a release during CY 2021, but is not shown above due to its very short half-life (scale of milliseconds). Other nuclides with similar half-lives were modeled as the first progeny included in the CAP88 Version 4.1 database; however, the first progeny of Ba-136m is stable isotope Ba-136. Therefore, this particular nuclide could not be modeled and was omitted from this list.*

Table E-2. Radionuclides reported in use and potentially emitted to the atmosphere from the INL in-town facilities in CY 2022.

Ac-227	Hg-203	Sn-113
Am-241	I-125	Sr-85
Am-243	I-129	Sr-89
Ba-133	I-131	Sr-90
Ba-140	Ir-192	Tc-99
C-14	Kr-85	Tc-99m
Cd-109	Mn-54	Th-228
Ce-139	Na-22	Th-229
Cf-252	Ni-63	Th-230
Cm-244	Np-237	Th-232
Co-57	Pa-231	U-232
Co-58	Pb-210	U-233
Co-60	Pu-236	U-234
Cs-134	Pu-238	U-235
Cs-137	Pu-239	U-238
Eu-152	Ra-226	Xe-131m
Eu-154	Ru-103	Xe-133
Eu-155	Ru-106	Xe-135
Fe-55	Sb-125	Y-88
Gd-148	Se-75	Zn-65
H-3	Sm-151	Zr-95

NOTE: *All radionuclides reported from INL in-town facilities were available in the CAP88, Version 4.1, database and did not require any supplemental processing.*

Appendix F

CAP88-PC Verification

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Appendix F

CAP88-PC Verification

Three checks were performed to ensure the CAP88-PC Version 4.1 computer code was installed and operating properly. All checks and CAP88-PC simulations were performed on a Dell OptiPlex 7090 computer (Intel Core i7-10700 CPU @ 2.90 GHz) running Microsoft Windows 10 Enterprise.

Check 1: After CAP88-PC, Version 4.1, was downloaded and installed, it was used to simulate the example problem (Modtest) provided in the download zip file. The Modtest.dat input file was opened with the CAP88-PC graphical user interface (GUI) and run. The Modtest.SYN output file generated by running CAP88-PC on the local computer matched the output file in the CAP88-PC, Version 4.1, Sample Datasets and Reports, exactly indicating the code was loaded properly and is operating as expected. All other output files (Modtest.CHI, Modtest.CON, Modtest.FAC, Modtest.GEN, Modtest.SUM, Modtest.WEA) also matched exactly. Shown below is the input file Modtest.DAT after it was opened and saved on the local INL computer. It matches the input file Modtest.dat supplied with the CAP88-PC download files except the paths to the population and wind files were modified for the local INL computer. Also shown below is the output file Modtest.SYN, which was generated running Modtest.dat input file on the local INL computer using the GUI. As stated previously, it matched the file supplied with the CAP88-PC Modtest.SYN download output file as well as the output file in the CAP88-PC, Version 4.1, Sample Datasets and Reports.

Check 2: This test was performed to ensure CAP88-PC, Version 4.1, could be run from the DOS command line and produce similar results to the GUI version. To test this the Modtest.dat input file generated using the GUI was run from a DOS command line. This was done using the following batch file:

```
cd C:\Users\OVERKB\Documents\CAP88\Fortran
del input.dat
copy C:\Projects\FY2023\NESHAP\QAchk_Modtest\Modtest_check\Cmd_line_output_5-15-
23\Modtest.dat INPUT.DAT
del input.pop
del input.wnd
copy C:\Projects\FY2023\NESHAP\QAchk_Modtest\Modtest_check\Cmd_line_output_5-15-
23\PORTS.POP input.pop
copy C:\Projects\FY2023\NESHAP\QAchk_Modtest\Modtest_check\Cmd_line_output_5-15-
23\PORTS30.WND input.wnd
Cap88v41Fortran.exe
```

The output files (Modtest.CHI, Modtest.CON, Modtest.FAC, Modtest.GEN, Modtest.SUM, Modtest.WEA) from the simulation were compared to the output files generated using the GUI and to the versions supplied with the CAP88-PC download files. The output files generated by running from the DOS command line matched the output files generated using the GUI and the files supplied with the CAP88-PC download files.

Check 3: One input file from each of the 14 INL facility directories was run with the GUI and the *.SUM output file compared to the *.SUM output file from running from the DOS command line. In all 14 cases, the output files matched exactly. The input files checked and the *.SUM files generated using the GUI are found in the local directory C:\Projects\FY2023\NESHAP\QAchk_Modtest\FacilityTest.

Modtest.dat (run with GUI for Check 1)

```
4.1
Modtest.
May 15, 2023 11:13 AM
May 15, 2023 11:14 AM
CAP88-PC Version 4
1111 Simulation Dr

Portsmouth
45111
Single Stack
2006
Modtest problem
for Version 4 User Manual
1
C:\Users\OVERKB\Documents\CAP88\Population Files\PORTS.POP
Adult
100
10
0
0
800       2400      4000      5600      7250      12100     24150     40250     56350     72200     0         0
0         0         0         0         0         0         0
T         T         T         T
C:\Users\OVERKB\Documents\CAP88\Wind Files\PORTS30.WND
100.00
10.01
1000.00
8.00
0
1
1.000e+01
1.000e+00
0
1.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00
1
0.7000    0.3000    0.0000
0.4000    0.6000    0.0000
0.4400    0.5600    0.0000
OH
2.030e-01
4.560e-02
1.700e-02
86400
5
F
3
0         U-238     Particulate                               M         1.0000    1.000e+01
0         U-235     Particulate                               M         1.0000    1.000e+01
0         U-234     Particulate                               M         1.0000    8.000e+00
84        93        53        84        493       5263
Adrenals  UB_Wall   Bone_Sur  Brain     Breasts   St_Wall   SI_Wall   ULI_Wall  LLI_Wall  Kidneys   Liver
Muscle    Ovaries   Pancreas  R_Marrow  Skin      Spleen    Testes    Thymus    Thyroid   GB_Wall   Ht_Wall
Uterus    ET_Reg    Lung      E_50
esophagus stomach   colon     liver     lung      bone      skin      breast    ovary     bladder   kidney
thyroid   leukemia  residual  Total
5
U-238     Particulate                               M         1.0000    1.410e+17 1.800e-03 1.000e-07 5.480e-05
2.000e-02 2.000e-02 8.000e-04 4.000e-04 2.000e-03 1.000e-01
0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00
0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00
0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00
2.455e-08 2.463e-08 7.114e-07 2.455e-08 2.454e-08 2.552e-08 2.696e-08 3.938e-08 6.929e-08 2.541e-07 9.556e-08
2.455e-08 2.456e-08 2.455e-08 7.458e-08 2.454e-08 2.455e-08 2.454e-08 2.454e-08 2.455e-08 2.455e-08 2.455e-08
2.455e-08 2.455e-08 2.455e-08 4.454e-08
1.184e-07 1.187e-07 3.445e-06 1.183e-07 1.183e-07 1.185e-07 1.188e-07 1.216e-07 1.283e-07 1.233e-06 4.633e-07
1.183e-07 1.186e-07 1.183e-07 3.635e-07 1.183e-07 1.183e-07 1.185e-07 1.183e-07 1.183e-07 1.183e-07 1.184e-07
1.183e-07 4.150e-06 1.709e-05 2.236e-06
1.330e-18 1.550e-18 9.160e-18 1.750e-18 8.690e-18 1.630e-18 1.220e-18 1.320e-18 1.230e-18 1.860e-18 1.630e-18
4.240e-18 1.150e-18 1.160e-18 2.030e-18 2.790e-17 1.580e-18 4.900e-18 2.020e-18 3.450e-18 1.290e-18 1.550e-18
1.170e-18 1.160e-18 1.910e-18 3.200e-18
5.180e-20 7.030e-20 7.570e-19 4.020e-20 1.140e-18 6.580e-20 3.900e-20 4.270e-20 4.280e-20 1.000e-19 6.140e-20
7.060e-19 7.850e-20 3.490e-20 1.320e-19 6.630e-18 5.230e-20 8.620e-19 9.120e-20 1.990e-19 4.340e-20 5.890e-20
3.850e-20 3.100e-20 6.980e-20 3.910e-19
1.910e-11 5.440e-11 6.160e-10 1.330e-10 1.350e-10 8.390e-11 1.380e-12 2.690e-11 2.190e-11 4.680e-11 1.520e-10
3.880e-12 4.050e-11 1.730e-10 1.510e-09
8.430e-11 1.970e-10 5.270e-10 5.720e-10 2.340e-07 3.680e-10 5.650e-12 1.120e-10 1.010e-10 1.990e-10 6.560e-10
1.580e-11 1.980e-10 6.830e-10 2.380e-07
1.330e-21 6.580e-21 1.320e-20 2.470e-21 1.870e-20 8.700e-22 2.780e-21 4.200e-20 1.640e-21 3.750e-21 9.680e-22
1.100e-21 1.140e-20 3.340e-20 1.400e-19
```

```
3.570e-23 2.660e-22 4.410e-22 9.310e-23 6.820e-22 7.190e-23 6.620e-22 5.510e-21 1.120e-22 1.700e-22 5.200e-23
6.340e-23 7.410e-22 3.930e-21 1.280e-20
Th-234    Particulate                              S         1.0000    2.082e+06 1.800e-03 1.000e-07 5.480e-05
5.000e-04 5.000e-04 1.000e-04 5.000e-06 1.000e-03 1.000e-01
1.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00
0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00
0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00
2.290e-12 1.066e-11 4.827e-11 6.516e-13 9.167e-13 9.988e-10 2.551e-09 1.512e-08 4.307e-08 1.926e-11 8.169e-12
4.165e-12 3.546e-11 4.177e-12 2.943e-11 1.782e-12 3.356e-12 4.818e-12 8.432e-13 6.864e-13 9.676e-12 1.322e-12
1.476e-11 6.864e-13 1.095e-12 3.398e-09
1.608e-11 3.103e-12 7.134e-11 1.962e-12 1.671e-11 1.949e-10 4.675e-10 2.760e-09 7.858e-09 2.640e-11 2.144e-11
8.471e-12 9.479e-12 1.248e-11 4.131e-11 4.169e-12 1.232e-11 3.445e-12 2.012e-11 6.942e-12 7.363e-12 2.975e-11
3.909e-12 2.504e-09 5.130e-08 6.787e-09
2.380e-16 2.620e-16 1.230e-15 3.170e-16 4.420e-16 2.780e-16 2.230e-16 2.410e-16 2.250e-16 2.910e-16 2.830e-16
3.310e-16 2.080e-16 2.160e-16 2.720e-16 8.230e-16 2.830e-16 3.700e-16 3.140e-16 3.560e-16 2.340e-16 2.670e-16
2.150e-16 2.140e-16 3.300e-16 3.220e-16
6.280e-18 7.240e-18 2.910e-17 6.590e-18 9.860e-18 7.200e-18 6.410e-18 6.760e-18 6.670e-18 7.320e-18 7.260e-18
9.020e-18 6.410e-18 6.160e-18 7.010e-18 1.810e-17 7.320e-18 9.630e-18 7.390e-18 8.050e-18 6.550e-18 6.930e-18
6.410e-18 5.610e-18 7.850e-18 8.190e-18
1.260e-15 5.910e-12 5.000e-10 1.620e-14 1.770e-14 6.450e-15 2.550e-16 7.160e-15 5.880e-14 3.400e-14 1.210e-14
3.520e-16 3.020e-13 8.100e-14 5.070e-10
2.530e-14 1.340e-12 1.070e-10 3.740e-14 6.040e-10 8.590e-15 4.900e-16 9.290e-14 1.890e-14 1.080e-14 1.550e-14
2.800e-15 3.440e-13 2.280e-13 7.130e-10
2.460e-19 1.120e-18 2.420e-18 4.290e-19 3.230e-18 1.170e-19 8.210e-20 2.140e-18 2.960e-19 6.340e-19 1.510e-19
1.130e-19 1.530e-18 3.890e-18 1.640e-17
6.450e-21 2.910e-20 6.940e-20 1.100e-20 7.680e-20 2.760e-21 1.810e-21 4.760e-20 9.120e-21 1.750e-20 3.810e-21
2.560e-21 3.930e-20 1.060e-19 4.240e-19
Pa-234m   B                                        B         0.0000    7.020e+01 1.800e-03 1.000e-07 5.480e-05
5.000e-04 5.000e-04 5.000e-06 5.000e-06 1.000e-02 1.000e-01
0.000e+00 1.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00
0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00
0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00
0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00
0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00
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0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00
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7.570e-16 7.570e-16 1.570e-15 9.760e-16 1.060e-15 8.150e-16 7.380e-16 7.630e-16 7.520e-16 8.230e-16 8.280e-16
8.980e-16 7.530e-16 7.260e-16 8.900e-16 5.470e-14 8.300e-16 9.280e-16 8.600e-16 9.470e-16 7.530e-16 8.100e-16
7.170e-16 7.670e-16 9.170e-16 1.420e-15
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1.700e-17 1.560e-17 1.850e-17 1.120e-16
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0.000e+00 0.000e+00 0.000e+00 0.000e+00
8.820e-19 3.290e-18 7.830e-18 1.250e-18 8.970e-18 1.490e-19 5.460e-18 5.120e-18 1.070e-18 1.830e-18 4.280e-19
3.020e-19 5.000e-18 1.180e-17 5.340e-17
1.790e-20 7.110e-20 1.810e-19 2.680e-20 1.810e-19 2.950e-21 9.320e-19 9.660e-20 2.380e-20 4.280e-20 9.310e-21
6.050e-21 1.050e-19 2.630e-19 1.960e-18
Pa-234    Particulate                              M         1.0000    2.412e+04 1.800e-03 1.000e-07 5.480e-05
5.000e-04 5.000e-04 5.000e-06 5.000e-06 1.000e-02 1.000e-01
0.000e+00 0.000e+00 1.600e-03 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00
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3.131e-11 7.024e-11 2.600e-11 2.089e-13 6.592e-12 6.243e-10 1.080e-09 2.515e-09 1.977e-09 6.105e-11 4.321e-11
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1.640e-11 1.262e-11 3.287e-11 6.927e-12 1.376e-11 9.691e-11 1.586e-10 3.662e-10 2.876e-10 1.699e-11 1.688e-11
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2.401e-11 2.335e-09 1.011e-09 2.461e-10
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1.250e-15 1.160e-15 1.340e-15 1.380e-15
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3.170e-14 6.640e-13 7.170e-12 3.610e-14 1.440e-11 4.230e-15 9.970e-16 9.200e-14 8.730e-14 4.780e-14 1.240e-14
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4.390e-19 7.690e-18 1.920e-17 7.500e-17
U-234     Particulate                              M         1.0000    7.747e+12 1.800e-03 1.000e-07 5.480e-05
2.000e-02 2.000e-02 8.000e-04 4.000e-04 2.000e-03 1.000e-01
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7.620e-18 2.660e-18 2.720e-18 4.220e-18 4.230e-17 3.700e-18 8.780e-18 4.490e-18 6.700e-18 3.000e-18 3.560e-18
2.730e-18 2.700e-18 4.430e-18 6.140e-18
1.070e-19 1.380e-19 1.210e-18 9.310e-20 1.620e-18 1.320e-19 8.990e-20 9.710e-20 9.670e-20 1.790e-19 1.260e-19
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8.950e-20 7.460e-20 1.410e-19 5.800e-19
2.150e-11 6.130e-11 6.780e-10 1.500e-10 1.520e-10 9.340e-11 1.550e-12 2.990e-11 2.450e-11 5.270e-11 1.720e-10
4.370e-12 2.410e-11 1.950e-10 1.660e-09
9.470e-11 2.220e-10 5.770e-10 6.430e-10 2.870e-07 4.090e-10 6.350e-12 1.250e-10 1.130e-10 2.240e-10 7.400e-10
1.780e-11 1.050e-10 7.660e-10 2.910e-07
3.110e-21 1.510e-20 3.090e-20 5.730e-21 4.330e-20 1.900e-21 4.220e-21 6.960e-20 3.780e-21 8.560e-21 2.150e-21
2.130e-21 2.370e-20 6.670e-20 2.810e-19
8.580e-23 5.330e-22 1.000e-21 1.910e-22 1.380e-21 1.150e-22 9.040e-22 7.830e-21 2.030e-22 3.340e-22 9.310e-23
1.010e-22 1.230e-21 6.000e-21 2.000e-20
5
U-235 Particulate M 1.0000 2.222e+16 1.800e-03 1.000e-07 5.480e-05
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4.060e-12 2.790e-11 1.820e-10 1.630e-09
8.850e-11 2.070e-10 5.560e-10 5.960e-10 2.530e-07 3.830e-10 5.900e-12 1.180e-10 1.060e-10 2.080e-10 6.850e-10
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1.370e-19 5.610e-19 1.390e-18 2.110e-19 1.440e-18 3.150e-20 2.060e-20 7.730e-19 1.860e-19 3.340e-19 7.180e-20
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Th-231 Particulate S 1.0000 9.187e+04 1.800e-03 1.000e-07 5.480e-05
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8.410e-21 4.160e-20 9.310e-20 1.560e-20 1.100e-19 4.460e-21 7.960e-21 1.250e-19 1.270e-20 2.540e-20 5.930e-21
4.430e-21 6.010e-20 1.800e-19 6.940e-19
Pa-231 Particulate M 1.0000 1.034e+12 1.800e-03 1.000e-07 5.480e-05
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6.880e-12 2.200e-10 2.790e-10 4.290e-09
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1.350e-18 5.290e-18 1.220e-17 2.020e-18 1.460e-17 3.270e-19 2.400e-19 8.890e-18 1.550e-18 3.000e-18 6.920e-19
5.000e-19 7.860e-18 1.910e-17 7.750e-17
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Ac-227 Particulate M 1.0000 6.871e+08 1.800e-03 1.000e-07 5.480e-05
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2.270e-18 2.510e-18 1.160e-17 2.970e-18 7.020e-18 2.640e-18 2.100e-18 2.260e-18 2.120e-18 2.860e-18 2.680e-18
4.230e-18 1.960e-18 2.030e-18 2.860e-18 1.590e-17 2.650e-18 4.810e-18 3.070e-18 4.060e-18 2.180e-18 2.540e-18
2.030e-18 2.040e-18 3.110e-18 3.650e-18
6.870e-20 8.510e-20 5.300e-19 6.340e-20 5.900e-19 8.230e-20 6.130e-20 6.640e-20 6.430e-20 1.030e-19 8.040e-20
3.860e-19 7.770e-20 5.640e-20 1.100e-19 3.190e-18 7.640e-20 4.590e-19 9.670e-20 1.550e-19 6.430e-20 7.530e-20
6.070e-20 5.110e-20 8.940e-20 2.370e-19
4.070e-11 1.110e-10 3.770e-10 2.880e-09 2.930e-10 6.890e-10 3.050e-12 6.120e-11 1.910e-10 9.700e-11 3.740e-11
8.650e-12 1.540e-10 3.990e-10 5.340e-09
6.470e-09 1.540e-08 3.900e-08 4.660e-07 1.140e-06 1.140e-07 4.390e-10 8.640e-09 3.300e-08 1.500e-08 5.860e-09
1.210e-09 2.370e-08 5.380e-08 1.920e-06
2.350e-21 1.070e-20 2.270e-20 4.060e-21 3.040e-20 1.100e-21 1.590e-21 3.390e-20 2.790e-21 6.070e-21 1.490e-21
1.290e-21 1.610e-20 4.230e-20 1.770e-19
5.880e-23 3.320e-22 6.760e-22 1.220e-22 8.740e-22 5.030e-23 3.180e-22 2.850e-21 1.110e-22 2.060e-22 5.360e-23
4.940e-23 6.170e-22 2.540e-21 8.860e-21
Th-227 Particulate S 1.0000 1.614e+06 1.800e-03 1.000e-07 5.480e-05
5.000e-04 5.000e-04 1.000e-04 5.000e-06 1.000e-03 1.000e-01
0.000e+00 0.000e+00 0.000e+00 9.862e-01 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00
0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00
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3.219e-10 3.736e-10 8.795e-08 3.129e-10 3.139e-10 1.817e-09 4.215e-09 2.659e-08 9.149e-08 2.594e-09 4.947e-09
3.320e-10 7.097e-10 3.315e-10 7.865e-09 3.186e-10 3.291e-10 5.533e-10 3.137e-10 3.129e-10 3.619e-10 3.162e-10
3.914e-10 3.129e-10 3.150e-10 9.115e-09
4.005e-10 2.276e-10 6.816e-08 2.217e-10 4.000e-10 6.823e-10 1.183e-09 6.573e-09 2.107e-08 3.018e-09 4.227e-09
2.945e-10 5.205e-10 3.501e-10 5.937e-09 2.483e-10 3.455e-10 4.870e-10 4.424e-10 2.832e-10 2.819e-10 5.591e-10
2.333e-10 4.921e-06 6.373e-05 7.651e-06
4.360e-15 4.480e-15 1.320e-14 5.600e-15 6.510e-15 4.740e-15 4.120e-15 4.340e-15 4.180e-15 4.810e-15 4.830e-15
5.330e-15 3.970e-15 4.100e-15 5.030e-15 7.850e-15 4.830e-15 5.650e-15 5.110e-15 5.660e-15 4.240e-15 4.670e-15
4.030e-15 4.210e-15 5.420e-15 5.220e-15
9.910e-17 1.060e-16 2.380e-16 1.030e-16 1.270e-16 1.060e-16 1.000e-16 1.030e-16 1.040e-16 1.060e-16 1.060e-16
1.250e-16 1.040e-16 9.610e-17 1.110e-16 1.870e-16 1.070e-16 1.280e-16 1.050e-16 1.150e-16 9.750e-17 1.030e-16
1.010e-16 9.160e-17 1.130e-16 1.150e-16
5.030e-13 1.090e-11 1.000e-09 9.730e-12 5.280e-12 1.740e-11 5.300e-14 1.290e-12 1.220e-12 1.280e-12 1.650e-12
1.780e-13 4.860e-12 8.420e-12 1.060e-09
5.730e-13 3.950e-12 2.570e-10 7.320e-12 8.980e-07 9.380e-12 3.010e-14 1.650e-12 8.810e-13 6.810e-13 1.760e-12
1.130e-13 3.290e-12 6.290e-12 8.980e-07
4.840e-18 1.910e-17 4.410e-17 7.320e-18 5.300e-17 1.250e-18 7.830e-19 3.150e-17 5.650e-18 1.080e-17 2.500e-18
1.800e-18 2.820e-17 6.840e-17 2.790e-16
1.050e-19 4.280e-19 1.070e-18 1.610e-19 1.100e-18 2.260e-20 1.870e-20 6.140e-19 1.480e-19 2.560e-19 5.510e-20
3.660e-20 6.230e-19 1.590e-18 6.230e-18
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U-234 Particulate M 1.0000 7.747e+12 1.800e-03 1.000e-07 5.480e-05
2.000e-02 2.000e-02 8.000e-04 4.000e-04 2.000e-03 1.000e-01
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2.762e-08 2.771e-08 7.857e-07 2.762e-08 2.762e-08 2.873e-08 3.035e-08 4.417e-08 7.618e-08 2.869e-07 1.076e-07
2.762e-08 2.762e-08 2.762e-08 8.118e-08 2.762e-08 2.762e-08 2.762e-08 2.762e-08 2.762e-08 2.762e-08 2.762e-08
2.762e-08 2.762e-08 2.762e-08 4.954e-08

1.330e-07 1.335e-07 3.801e-06 1.330e-07 1.330e-07 1.332e-07 1.336e-07 1.363e-07 1.426e-07 1.391e-06 5.205e-07
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1.330e-07 4.811e-06 2.086e-05 2.708e-06
3.100e-18 3.540e-18 2.000e-17 4.120e-18 1.440e-17 3.740e-18 2.840e-18 3.090e-18 2.870e-18 4.130e-18 3.780e-18
7.620e-18 2.660e-18 2.720e-18 4.220e-18 4.230e-17 3.700e-18 8.780e-18 4.490e-18 6.700e-18 3.000e-18 3.560e-18
2.730e-18 2.700e-18 4.430e-18 6.140e-18
1.070e-19 1.380e-19 1.210e-18 9.310e-20 1.620e-18 1.320e-19 8.990e-20 9.710e-20 9.670e-20 1.790e-19 1.260e-19
1.020e-18 1.430e-19 8.300e-20 2.200e-19 9.060e-18 1.140e-19 1.230e-18 1.660e-19 3.180e-19 9.750e-20 1.210e-19
8.950e-20 7.460e-20 1.410e-19 5.800e-19
2.150e-11 6.130e-11 6.780e-10 1.500e-10 1.520e-10 9.340e-11 1.550e-12 2.990e-11 2.450e-11 5.270e-11 1.720e-10
4.370e-12 2.410e-11 1.950e-10 1.660e-09
9.470e-11 2.220e-10 5.770e-10 6.430e-10 2.870e-07 4.090e-10 6.350e-12 1.250e-10 1.130e-10 2.240e-10 7.400e-10
1.780e-11 1.050e-10 7.660e-10 2.910e-07
3.110e-21 1.510e-20 3.090e-20 5.730e-21 4.330e-20 1.900e-21 4.220e-21 6.960e-20 3.780e-21 8.560e-21 2.150e-21
2.130e-21 2.370e-20 6.670e-20 2.810e-19
8.580e-23 5.330e-22 1.000e-21 1.910e-22 1.380e-21 1.150e-22 9.040e-22 7.830e-21 2.030e-22 3.340e-22 9.310e-23
1.010e-22 1.230e-21 6.000e-21 2.000e-20
Th-230 Particulate S 1.0000 2.379e+12 1.800e-03 1.000e-07 5.480e-05
5.000e-04 5.000e-04 1.000e-04 5.000e-06 1.000e-03 1.000e-01
1.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00
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1.360e-08 1.360e-08 1.227e-05 1.360e-08 1.360e-08 1.470e-08 1.634e-08 3.019e-08 6.226e-08 1.852e-07 1.592e-07
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3.075e-07 3.073e-07 2.830e-04 3.075e-07 3.075e-07 3.076e-07 3.082e-07 3.119e-07 3.207e-07 4.421e-06 3.735e-06
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2.920e-19 3.330e-19 1.660e-18 2.950e-19 1.320e-18 3.320e-19 2.870e-19 3.020e-19 2.990e-19 3.550e-19 3.320e-19
9.410e-19 3.290e-19 2.750e-19 3.800e-19 7.230e-18 3.290e-19 1.050e-18 3.580e-19 4.510e-19 2.830e-19 3.170e-19
2.860e-19 2.480e-19 3.600e-19 6.410e-19
1.170e-11 3.780e-11 6.310e-10 1.980e-10 8.560e-11 7.420e-10 8.650e-13 1.760e-11 1.020e-10 2.800e-11 8.230e-11
2.520e-12 1.130e-10 1.120e-10 2.170e-09
1.910e-10 3.990e-10 9.020e-10 3.260e-09 6.970e-07 1.400e-08 1.190e-11 2.200e-10 1.810e-09 4.590e-10 1.370e-09
3.240e-11 1.940e-09 1.340e-09 7.230e-07
1.110e-20 5.010e-20 1.080e-19 1.910e-20 1.430e-19 5.130e-21 4.570e-21 1.160e-19 1.330e-20 2.830e-20 6.760e-21
5.320e-21 7.070e-20 1.830e-19 7.640e-19
2.850e-22 1.340e-21 3.100e-21 5.030e-22 3.520e-21 1.580e-22 7.210e-22 6.380e-21 4.680e-22 8.050e-22 1.850e-22
1.440e-22 2.130e-21 7.480e-21 2.720e-20
Ra-226 Particulate M 1.0000 5.049e+10 1.800e-03 1.000e-07 5.480e-05
1.000e-01 2.000e-01 2.000e-03 1.000e-03 4.000e-02 2.000e-01
0.000e+00 1.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00
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4.094e-08 4.003e-08 1.247e-05 4.067e-08 3.982e-08 4.105e-08 4.304e-08 6.671e-08 1.518e-07 5.959e-08 1.790e-07
4.028e-08 4.069e-08 4.026e-08 8.765e-07 3.999e-08 5.385e-08 3.982e-08 3.999e-08 4.022e-08 4.001e-08 4.009e-08
4.018e-08 4.022e-08 4.020e-08 2.796e-07
2.306e-08 2.249e-08 7.011e-06 2.290e-08 2.244e-08 2.269e-08 2.327e-08 3.009e-08 5.446e-08 3.347e-08 1.008e-07
2.267e-08 2.280e-08 2.268e-08 4.934e-07 2.251e-08 3.033e-08 2.240e-08 2.253e-08 2.265e-08 2.251e-08 2.261e-08
2.257e-08 4.942e-06 2.103e-05 2.677e-06
2.550e-16 2.650e-16 8.690e-16 3.290e-16 3.870e-16 2.800e-16 2.430e-16 2.560e-16 2.450e-16 2.850e-16 2.870e-16
3.160e-16 2.370e-16 2.420e-16 2.950e-16 5.230e-16 2.860e-16 3.370e-16 3.060e-16 3.370e-16 2.490e-16 2.770e-16
2.380e-16 2.470e-16 3.230e-16 3.110e-16
5.860e-18 6.210e-18 1.480e-17 6.060e-18 7.120e-18 6.280e-18 5.880e-18 6.080e-18 6.080e-18 6.240e-18 6.270e-18
7.120e-18 5.920e-18 5.690e-18 6.510e-18 8.880e-18 6.330e-18 7.260e-18 6.010e-18 6.630e-18 5.740e-18 6.040e-18
5.930e-18 5.380e-18 6.620e-18 6.680e-18
5.770e-11 2.290e-10 1.750e-09 4.470e-10 5.280e-10 2.410e-09 5.400e-12 1.280e-10 6.810e-11 1.280e-10 4.940e-11
1.730e-11 4.920e-10 3.260e-09 9.560e-09
2.570e-11 8.380e-11 5.230e-10 1.880e-10 2.900e-07 9.490e-10 2.080e-12 4.770e-11 3.130e-11 5.640e-11 1.960e-11
6.290e-12 2.090e-10 1.250e-09 2.930e-07
2.840e-19 1.130e-18 2.590e-18 4.350e-19 3.160e-18 8.250e-20 5.220e-20 1.870e-18 3.370e-19 6.410e-19 1.480e-19
1.070e-19 1.660e-18 4.030e-18 1.650e-17
6.190e-21 2.540e-20 6.280e-20 9.500e-21 6.470e-20 1.410e-21 8.860e-22 3.440e-20 8.420e-21 1.500e-20 3.250e-21
2.110e-21 3.650e-20 9.260e-20 3.630e-19
Rn-222 B B 0.0000 3.304e+05 0.000e+00 0.000e+00 5.480e-05
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1.510e-17 1.510e-17 3.220e-17 1.930e-17 2.080e-17 1.610e-17 1.430e-17 1.490e-17 1.460e-17 1.620e-17 1.630e-17
1.770e-17 1.350e-17 1.420e-17 1.740e-17 2.220e-17 1.640e-17 1.820e-17 1.680e-17 1.850e-17 1.470e-17 1.590e-17
1.390e-17 1.480e-17 1.810e-17 1.730e-17

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3.240e-19 3.540e-19 5.640e-19 3.450e-19 3.880e-19 3.450e-19 3.360e-19 3.430e-19 3.480e-19 3.480e-19 3.470e-19
3.980e-19 3.670e-19 3.180e-19 3.710e-19 5.070e-19 3.470e-19 4.040e-19 3.540e-19 3.840e-19 3.300e-19 3.420e-19
3.360e-19 3.120e-19 3.680e-19 3.720e-19
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1.700e-20 6.500e-20 1.530e-19 2.470e-20 1.770e-19 3.060e-21 2.220e-21 1.000e-19 1.920e-20 3.650e-20 8.430e-21
5.890e-21 9.770e-20 2.330e-19 9.430e-19
3.590e-22 1.390e-21 3.560e-21 5.260e-22 3.600e-21 5.360e-23 5.060e-23 1.870e-21 5.220e-22 8.560e-22 1.810e-22
1.220e-22 2.080e-21 5.160e-21 2.030e-20
Po-218    B                                       B         0.0000    1.860e+02 1.800e-03 1.000e-07 5.480e-05
1.000e-01 1.000e-01 5.000e-03 4.000e-04 1.000e-03 1.000e-01
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7.690e-23 8.910e-23 4.820e-22 1.040e-22 2.130e-22 9.480e-23 6.810e-23 7.610e-23 6.880e-23 1.070e-22 9.610e-23
1.370e-22 6.120e-23 6.330e-23 9.250e-23 2.500e-19 9.450e-23 1.650e-22 1.150e-22 1.460e-22 7.350e-23 8.710e-23
6.430e-23 6.220e-23 1.150e-22 2.620e-21
3.590e-24 4.610e-24 2.460e-23 3.550e-24 1.150e-23 4.580e-24 3.330e-24 3.710e-24 3.460e-24 5.370e-24 4.550e-24
8.590e-24 3.200e-24 2.970e-24 4.340e-24 2.890e-23 4.490e-24 1.050e-23 5.210e-24 6.650e-24 3.420e-24 4.070e-24
3.200e-24 2.530e-24 5.170e-24 6.650e-24
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0.000e+00 0.000e+00 0.000e+00 0.000e+00
7.160e-26 3.830e-25 7.530e-25 1.460e-25 1.120e-24 4.580e-26 2.490e-23 1.030e-24 8.710e-26 2.150e-25 5.570e-26
4.650e-26 5.190e-25 1.380e-24 3.080e-23
2.900e-27 1.850e-26 3.720e-26 6.900e-27 5.060e-26 2.300e-27 2.900e-27 5.560e-26 4.600e-27 1.110e-26 2.800e-27
2.100e-27 2.440e-26 7.520e-26 2.970e-25
```

Modtest.SYN (Generated by running Modtest.dat with GUI for Check 1)

```
                              C A P 8 8 - P C

                               Version 4.1


                    Clean Air Act Assessment Package - 1988


                         S Y N O P S I S   R E P O R T

                        Non-Radon Population Assessment
                             Mon May 15 11:14:01 2023


            Facility:  CAP88-PC Version 4
             Address:  1111 Simulation Dr
                City:  Portsmouth
               State:  OH          Zip:  45111


            Source Category:  Single Stack
                Source Type:  Stack
              Emission Year:  2006
             DOSE Age Group:  Adult

            Comments:  Modtest problem
                       for Version 4 User Manual


                      Effective Dose Equivalent
                                (mrem)
                    ____________________________________
```

3.59E+02

At This Location: 800 Meters East Northeast

Dataset Name: Modtest.
Dataset Date: May 15, 2023 11:13 AM
Wind File: C:\Users\OVERKB\Documents\CAP88\Wind Files\PORTS30.WND
p File: C:\Users\OVERKB\Documents\CAP88\Population Files\PORTS.POP

MAXIMALLY EXPOSED INDIVIDUAL

Location Of The Individual: 800 Meters East Northeast
Lifetime Fatal Cancer Risk: 3.07E-04

ORGAN DOSE EQUIVALENT SUMMARY
(RN-222 Working Level Calculations Excluded)

Organ	Selected Individual (mrem)	Collective Population (person-rem)
Adrenals	7.65E+01	1.50E+02
UB_Wall	8.04E+01	1.57E+02
Bone_Sur	8.79E+02	1.85E+03
Brain	7.81E+01	1.53E+02
Breasts	9.42E+01	1.83E+02
St_Wall	8.10E+01	1.59E+02
SI_Wall	7.81E+01	1.55E+02
ULI_Wall	8.72E+01	1.79E+02
LLI_Wall	1.04E+02	2.29E+02
Kidneys	3.22E+02	6.78E+02
Liver	1.55E+02	3.18E+02
Muscle	9.15E+01	1.78E+02
Ovaries	7.71E+01	1.51E+02
Pancreas	7.49E+01	1.47E+02
R_Marrow	1.34E+02	2.71E+02
Skin	3.02E+03	5.65E+03
Spleen	8.09E+01	1.58E+02
Testes	9.39E+01	1.83E+02
Thymus	7.88E+01	1.55E+02
Thyroid	8.49E+01	1.66E+02
GB_Wall	7.60E+01	1.49E+02
Ht_Wall	7.86E+01	1.54E+02
Uterus	7.70E+01	1.51E+02
ET_Reg	5.09E+02	7.13E+02
Lung	1.96E+03	2.62E+03
Effectiv	3.59E+02	5.59E+02

FREQUENCY DISTRIBUTION OF LIFETIME FATAL CANCER RISKS

Risk Range	# of People	# of People in This Risk Range or Higher	Deaths in This Risk Range	Deaths in This Risk Range or Higher
1.0E+00 TO 1.0E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1.0E-01 TO 1.0E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1.0E-02 TO 1.0E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1.0E-03 TO 1.0E-04	1.94E+02	1.94E+02	2.45E+00	2.45E+00
1.0E-04 TO 1.0E-05	4.08E+03	4.27E+03	5.93E+00	8.38E+00
1.0E-05 TO 1.0E-06	5.25E+04	5.68E+04	1.40E+01	2.23E+01
LESS THAN 1.0E-06	6.05E+05	6.62E+05	3.58E+01	5.81E+01

RADIONUCLIDE EMISSIONS DURING THE YEAR 2006

Nuclide	Type	Size	Source #1 Ci/y	TOTAL Ci/y
U-238	M	1.000	1.0E+01	1.0E+01
U-235	M	1.000	1.0E+01	1.0E+01
U-234	M	1.000	8.0E+00	8.0E+00

SITE INFORMATION

Temperature:	10.010	degrees C
Precipitation:	100.000	cm/y
Humidity:	8.000	g/cu m
Mixing Height:	1000.0	m

SOURCE INFORMATION

Source Number: 1

Stack Height (m): 10.00
Diameter (m): 1.00

Plume Rise
Buoyant (cal/s): 1.00
(Heat Release Rate)

ADJUSTED AGRICULTURAL DATA

	Vegetable	Milk	Meat
Fraction Home Produced:	0.7000	0.4000	0.4400
Fraction From Assessment Area:	0.3000	0.6000	0.5600
Fraction Imported:	0.0000	0.0000	0.0000

Beef Cattle Density:	2.03E-01
Milk Cattle Density:	4.56E-02
Land Fraction Cultivated for Vegetable Crops:	1.70E-02

POPULATION DATA

	Distance (m)						
Direction	800	2400	4000	5600	7250	12100	24150
N	0	0	19	443	803	3785	0
NNW	0	9	14	10	34	1069	3248
NW	0	121	0	371	141	1106	2284
WNW	0	0	0	0	33	922	1600
W	30	0	40	57	46	876	1348
WSW	57	6	9	16	20	569	1674
SW	46	7	57	224	20	707	1375
SSW	38	0	173	40	71	1631	3183
S	7	18	207	144	36	3518	30593
SSE	0	104	18	35	170	1656	13613
SE	7	39	10	3	75	986	4587
ESE	2	12	5	57	63	878	1980
E	6	54	40	2	96	1102	5808
ENE	1	65	37	93	95	1023	2435
NE	0	12	20	63	225	359	2329
NNE	0	10	82	79	567	2780	2266

	Distance (m)		
Direction	40250	56350	72200
N	42304	7518	26978
NNW	4628	4028	21176
NW	4111	12150	7605
WNW	6021	13838	9880
W	5591	7376	18285
WSW	2464	11058	17205
SW	1923	2702	5657
SSW	3732	6222	4633
S	4489	3037	14068
SSE	14145	43111	76266
SE	4108	4698	14064
ESE	6106	5645	25178
E	7400	4997	8015
ENE	11823	5583	9245
NE	2653	3232	16780
NNE	3879	7594	12216

Appendix G

Verification of Database Dose Calculations

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Appendix G

Verification of Database Dose Calculations

To ensure the dose calculations performed by the Microsoft Access database were performed correctly, doses were calculated by hand and using Microsoft Excel for selected sources and radionuclides. The results were compared to doses calculated by the Microsoft Access database. The tables below show how dose results from calculations [Dose (mrem/yr) = Release (Ci/yr) × UDF (mrem/Ci)] performed by hand and, also using Microsoft Excel match the dose results calculated by the Microsoft Access databases. The dose results in **bold font** are a match. Small differences between hand calculated values and database values may occur and are due to rounding of the UDFs taken from the CAP88-PC *.SUM files.

Table G-1. Verification data for INL Site NESHAP CY 2022 dose calculations.

FacilityID	SourceID	Nuclide	Input filename	Output filename	MEI direction[a] (sector)	MEI distance[a] (m)	Release[b] (Ci/yr)	UDF[c] (mrem/Ci)	Dose calculated by hand and MS Excel (Release × UDF) (mrem/yr)	Dose from MS Access Database (mrem/yr)
CFA	CFA-625	H-3	H3A.DAT	H3A.SUM	E	27634	6.90E-02	5.50E-06	**3.80E-07**	**3.80E-07**
MFC	MFC-720-007	Cs-140	Cs140A.DAT	Cs140A.SUM	SSE	10010	2.00E+00	3.40E-08	**6.79E-08**	**6.79E-08**
RTC	TRA-710-001	Co-60	Co60A.DAT	Co60A.SUM	ESE	30019	1.19E-09	1.20E-02	**1.42E-11**	**1.42E-11**
INTEC-MS	CPP-708-001	I-129	I129A.DAT	I129A.SUM	ESE	27223	3.92E-06	4.80E-02	**1.88E-07**	**1.88E-07**

a. The INL Site MEI for 2021 is a farmhouse and cattle operation located 3.1 km south of Highway 20, 3 km from INL's east entrance (Receptor 26).
b. Releases are taken from the *Releases* table in the database and checked against the release data from the Source Term spreadsheet that was imported into the database to make the Releases table. The *Releases* table is also reproduced as Appendix D.
c. UDFs are taken from the tempdoses.txt file and checked against the output contained in the *.SUM files according to the direction and distance.

Table G-2. Verification data for INL in-town NESHAP CY 2022 dose calculations.

FacilityID	SourceID	Nuclide	Input filename	Output filename	MEI direction[a] (sector)	MEI distance[a] (m)	Release[b] (Ci/yr)	UDF[c] (mrem/Ci)	Dose calculated by hand and MS Excel (Release × UDF) (mrem/yr)	Dose from MS Access Database (mrem/yr)
IF683	IF683	H-3	H3A.DAT	H3A.SUM	SSE	147	1.43E-07	5.70E-02	**8.15E-09**	**8.15E-09**
IF603	IF603	Kr-85	Kr85A.DAT	Kr85A.SUM	S	336	1.15E-02	6.50E-05	**7.46E-07**	**7.46E-07**
IF683	IF683	Ac-227	Ac227A.DAT	Ac227A.SUM	SSE	147	5.23E-09	1.40E+04	**7.32E-05**	**7.32E-05**
IF603	IF603	U-238	U238A.DAT	U238A.SUM	S	336	2.63E-12	1.40E+02	**3.68E-10**	**3.68E-10**

a. The INL in-town MEI is located at Receptor 1, located south-southeast and south of the IF683 and IF603 sources, respectively.
b. Releases are taken from the *Releases* table in the database and checked against the release data from the Source Term spreadsheet that was imported into the database to make the Releases table. The *Releases* table is also reproduced as Appendix D.
c. UDFs are taken from the tempdoses.txt file and checked against the output contained in the *.SUM files according to the direction and distance.