INL/RPT-22-67457

# Idaho National Laboratory CY 2021 National Emission Standards for Hazardous Air Pollutants Analysis, Methodology and Results for Radionuclides

June 2022

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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) 2021. All calculations were performed in accordance with the 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). 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 2021 INL Report for Radionuclides" (INL 2022).

In CY 2021, the estimated annual potential dose at the INL Site MEI location was 6.67E-02 mrem/yr, up slightly from the previous year, but far less than the regulatory standard of 10 mrem/yr (CFR 40 Part 61, Subpart H). Approximately 97% 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 6.21E-03 mrem/yr to the MEI, down 40% from the CY 2020 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 |
| ATRC | Advanced Test Reactor Complex |
| 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 |
| 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 2021 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) 2021. The calculations were performed in accordance with the 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). Unit dose factors 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 unit dose factors (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.

## 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). 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 download 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 CPU @ 2.90 GHz) running Microsoft® Windows® 10 Enterprise. Microsoft® Excel® and Microsoft® Access® for Office 365 MSO (Version 2205 Build 16.0.15225.20278) 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 315 radionuclides released from INL Site facilities and 62 radionuclides for INL in-town facilities in Idaho Falls. Unit dose factors were calculated for each INL Site facility at the 62 INL Site NESHAP receptor locations that encircle the INL Site boundary (see Figure 1). For releases at INL in-town facilities, radionuclides were assumed to be released from a single ground-level point source and doses were calculated at the nearest public building (business, residence, apartment, church, etc., not including INL Research Complex [IRC] buildings) in each of the 16, 22.5-degree sectors. The in-town facility or building with the highest dose contribution is used as the source location for modeling in-town releases.

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 2021 wind files are presented in Appendix A. Stack emissions were modeled for the Idaho Nuclear Technology and Engineering Center (INTEC) Main Stack (INTEC-MS, CPP-708), the Advanced Test Reactor (ATR) stack (RTC-ATR, TRA-770) at the Advanced Test Reactor Complex (ATRC), the main stack at MFC (MFC-MS, MFC-764), and the 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.

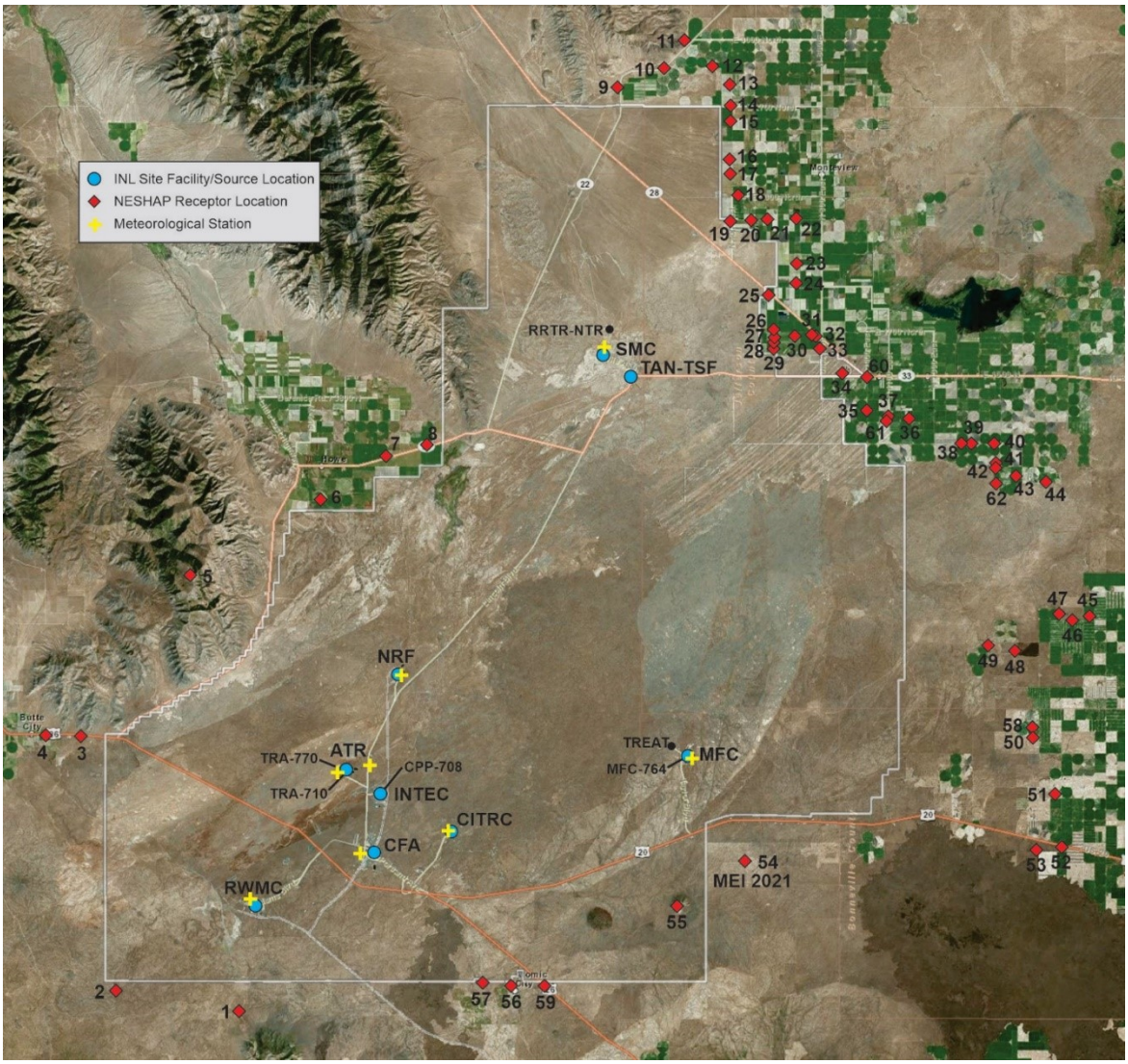


Figure 1. INL Site, including major facility areas and the 62 INL Site NESHAP receptor locations including the CY 2021 MEI location (Receptor 54). Meteorological station locations are shown but not labeled.

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

| Facility | FacilityID | Met StationID | 2021 Wind File Name | Measurement Height (m)[c] |
|---|---|---|---|---|
| Central Facilities Area | CFA | 690 | 690L21.WND | 15 |
| Critical Infrastructure Test Range Complex | CITRC | PBF | PBFL21.WND | 15 |
| Idaho Nuclear Technology and Engineering Center, Idaho CERCLA Disposal Facility | INTEC | GRI | GRIL21.WND | 10 |
| Idaho Nuclear Technology and Engineering Center – Main Stack | INTEC-MS | GRI | GRIU21.WND[b] | 61 |
| Materials and Fuels Complex | MFC | EBR | EBRL21.WND | 10 |
| Materials and Fuels Complex – Main Stack | MFC-MS | EBR | EBRU21.WND | 76 |
| Materials and Fuels Complex – TREAT Stack | MFC-TREAT | EBR | EBRU21.WND | 76 |
| Naval Reactor Facility | NRF | NRF | NRFL21.WND | 15 |
| Advanced Test Reactor Complex[a] | RTC | TRA | TRAL21.WND | 15 |
| Advanced Test Reactor Complex[a], Advanced Test Reactor Main Stack | RTC-ATR | GRI | GRIU21.WND[b] | 61 |
| Radioactive Waste Management Complex | RWMC | RWMC | RWMCL21.WND | 15 |
| Specific Manufacturing Capability | SMC | LOF | LOFL21.WND | 10 |
| Test Area North, Technical Support Facility | TAN-TSF | LOF | LOFL21.WND | 10 |
| INL Research Center | IRC | IDA | IDAL21.WND | 15 |

a. The Advanced Test Reactor Complex (ATRC) 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 Main Stack reported no releases during calendar year 2021; 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 | 6.32[a] |
| RTC-ATR | TRA-770-001 | 76.2 | 1.524 | 8.77[a] |
| MFC-MS[b] | MFC-764-001 | 61 | 1.524 | 9.08[a] |
| MFC-TREAT | MFC-720-007 | 42.7 | 0.61 | 6.78[a] |

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-milk-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-cow-milk-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 | --- |
| 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 unit dose factor (*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:

$UDF_{i,j,k}$ = unit dose factor 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, four separate CAP88-PC runs were made for each radionuclide-source-receptor combination for the 13 INL Site facilities (see Table 1). Files were identified by an "A" suffix for receptors 1–20, "B" for receptors 21–39, "C" for Receptors 40–59, and "D" for Receptors 60–62. Therefore, the total number of CAP88-PC simulations for INL Site facilities was:

315 radionuclides × 13 facilities × 4 files/facility = 16,380 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 was 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 (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 62 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 unit dose factor. 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] | 8.72[d] | Celsius |
| Annual Precipitation | 21.3[b] | 20.75[d] | cm/yr |
| Absolute humidity | 4.31[c] | 5.10[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. 2021 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 2021. In addition, each source was designated as either fugitive or non-fugitive. Point sources such as stacks, vents, ducts, etc., 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, 1,047 radionuclide emissions from 66 different sources were reported to be in use and potentially emitted for CY 2021. For comparison, there were 1,006 emissions from 64 sources reported the previous year. The total number of unique radionuclides for which a release rate was provided was 318 from all INL Site sources. This is an increase of 42 from the 276 reported the previous year. Nine of the 318 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 nine, five radionuclides with short half-lives were modeled as the first progeny included in CAP88, with a factor applied to represent equivalent activity in the daughter product.

One radionuclide was omitted from modeling because it has a very short half-life (scale of milliseconds), and the subsequent daughter product is stable. Finally, two radionuclides that could not be modeled with CAP88 Version 4.1, due to inconsistencies in isotope information that caused errors during program execution, were modeled using CAP88 Version 4.0. CAP88 developers are aware of this issue and are working to correct it. The full list of radionuclide releases is presented in Appendix E.

For INL in-town sources, 70 radionuclide emissions or potential emissions were reported from three buildings. The total number of unique radionuclides for which an inventory/release rate was provided was 62. This is down from 65 reported the previous year as there were five radionuclides from 2020 that were dropped (no release reported) and two new radionuclides added in 2021. 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_CAP88DoseCalculator2021.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 62 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_CAP88DoseCalculator2021.mdb*) using two primary data tables: *Releases* and *UnitDoses*. The calculations are simplified because there is only one facility. The *UnitDoses* table contains the doses from a unit (1 Ci/yr) release calculated with CAP88-PC for each radionuclide-receptor combination. These values come from the file *tempdoses.txt*. The receptors are defined for the 16, 22.5-degree sectors. The distance to each receptor is the distance from the facility with the highest dose contribution. This is iterative, but in the past the highest dose contributions have been from the Radiological and Environmental Sciences Laboratory (RESL, IF-683). 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 6.67E-02 mrem/yr and occurs at Receptor 54, 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 and 2020, 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). Although the dose was slightly higher at Receptor 55 (East Butte) than Receptor 54, Receptor 55 does not currently qualify as a NESHAP receptor location. Privately owned communication (TV, radio, cell) towers are located on top of East Butte, but currently there are no dwellings or places of business, and the site is visited only occasionally by maintenance workers. Nevertheless, doses are calculated at this point should the occupancy situation change in the future.

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 6.48E-02 mrem/yr and accounts for 97.2% of the total MEI dose.

Table 6. Annual doses at the MEI location (Receptor 54) by facility for INL Site facilities.

| Facility | Point source dose (mrem/yr) | Fugitive source dose (mrem/yr) | Total dose (mrem/yr) | Notes |
|---|---|---|---|---|
| **CFA Total** | **3.27E-07** | **1.80E-06** | **2.13E-06** | Total from 3 CFA sources |
| **CITRC Total** | | **3.96E-15** | **3.96E-15** | Total from 2 CITRC sources |
| INTEC | 1.00E-06 | 1.06E-04 | 1.07E-04 | 13 INTEC sources including ICDF |
| INTEC-MS | 2.00E-07 | | 2.00E-07 | INTEC Main Stack (CPP-708) |
| **INTEC Total** | **1.20E-06** | **1.06E-04** | **1.07E-04** | Total from all INTEC sources |
| MFC | 6.42E-02 | | 6.42E-02 | 19 MFC sources |
| MFC-MS | 1.85E-08 | | 1.85E-08 | MFC Main Stack (MFC-764) |
| MFC-TREAT | 6.16E-04 | | 6.16E-04 | TREAT Exhaust Stack |
| **MFC Total** | **6.48E-02** | | **6.48E-02** | Total from all MFC sources |
| **NRF Total** | **7.26E-05** | **6.93E-07** | **7.33E-05** | Total from all NRF sources |
| ATRC | 7.20E-05 | 7.39E-04 | 8.11E-04 | 8 ATRC sources |
| ATRC-ATR | 1.58E-04 | | 1.58E-04 | ATR Stack (TRA-770) |
| ATRC-MTR | 0.00E+00 | | 0.00E+00 | No emissions from MTR stack in CY-2021[a] |
| **ATRC Total** | **2.30E-04** | **7.39E-04** | **9.69E-04** | Total from all ATRC sources |
| **RWMC Total** | **5.81E-05** | **3.69E-04** | **4.27E-04** | 14 RWMC sources including ARP sites |
| **SMC Total** | **3.42E-09** | **3.51E-04** | **3.51E-04** | SMC emissions plus RRTR North[b] |
| **TAN-TSF Total** | **2.35E-07** | | **2.35E-07** | OU 1-07B emissions |
| **INL Site Total** | **6.51E-02** | **1.57E-03** | **6.67E-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 for most of the year. Therefore, all TRA-666 emissions for CY-2021 were conservatively reported as a ground-level release and no emissions were reported for the MTR stack.

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

The INL Site 2021 total MEI dose (6.67E-02 mrem/yr) is up 7.48% from 2020. This small increase is due to differences in emissions and meteorological conditions. 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 greater than 0.1% of the total dose are presented in Table 8. Doses by radionuclide at the MEI location for radionuclides that represent greater 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 54) for contributions greater than 0.1% of the total MEI dose for INL Site facilities.

| FacilityID | Nuclide | Annual MEI Dose (mrem/yr) | Percent of Total MEI Dose | Cumulative Percent of Total MEI Dose |
|---|---|---|---|---|
| MFC | Cs-137 | 3.64E-02 | 54.6% | 54.6% |
| MFC | U-238 | 1.09E-02 | 16.3% | 70.9% |
| MFC | U-234 | 5.54E-03 | 8.31% | 79.2% |
| MFC | Zn-65 | 4.65E-03 | 6.98% | 86.2% |
| MFC | Cl-36 | 4.02E-03 | 6.03% | 92.2% |
| MFC | U-235 | 2.41E-03 | 3.61% | 95.8% |
| MFC-TREAT | Ar-41 | 4.05E-04 | 0.61% | 96.5% |
| RTC | Sr-90 | 3.97E-04 | 0.60% | 97.1% |
| RWMC | H-3 | 3.66E-04 | 0.55% | 97.6% |
| SMC | Br-82 | 3.50E-04 | 0.53% | 98.1% |
| RTC | H-3 | 2.24E-04 | 0.34% | 98.5% |
| MFC | I-131 | 1.88E-04 | 0.23% | 98.7% |
| RTC-ATR | H-3 | 1.25E-04 | 0.12% | 98.9% |
| MFC-TREAT | Kr-88 | 1.24E-04 | 0.19% | 99.1% |
| RTC | Cs-137 | 9.86E-05 | 0.15% | 99.3% |
| RTC | Co-60 | 8.49E-05 | 0.13% | 99.4% |
| NRF | C-14 | 7.15E-05 | 0.11% | 99.5% |

Table 8. Dose by INL Site source at the MEI location (Receptor 54) for sources that represent greater than 0.1% of the total MEI dose for INL Site facilities.

| SourceID | FacilityID | Annual MEI Dose (mrem/yr) | Percent of Total MEI Dose | Cumulative Percent of Total MEI Dose |
|---|---|---|---|---|
| MFC-1702-001 | MFC | 3.64E-02 | 54.6% | 54.6% |
| MFC-784-001 | MFC | 1.88E-02 | 28.3% | 82.9% |
| MFC-774-027 | MFC | 2.22E-03 | 3.3% | 86.2% |
| MFC-774-028 | MFC | 2.22E-03 | 3.3% | 89.5% |
| MFC-774-026 | MFC | 2.22E-03 | 3.3% | 92.9% |
| MFC-774-029 | MFC | 2.22E-03 | 3.3% | 96.2% |
| TRA-715-001 | RTC | 7.39E-04 | 1.11% | 97.3% |
| MFC-720-007 | MFC-TREAT | 6.16E-04 | 0.92% | 98.2% |
| Beryllium Blocks | RWMC | 3.69E-04 | 0.55% | 98.8% |
| RRTR-North | SMC | 3.51E-04 | 0.53% | 99.3% |
| TRA-770-001 | RTC-ATR | 1.58E-04 | 0.24% | 99.5% |
| ICDF-Landfill | INTEC | 1.05E-04 | 0.16% | 99.7% |
| NRF | NRF | 7.33E-05 | 0.11% | 99.8% |
| 670-ATR-Canal | RTC | 6.94E-05 | 0.10% | 99.9% |

Table 9. Dose by radionuclide at the MEI location (Receptor 54) 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 |
|---|---|---|---|
| Cs-137 | 3.65E-02 | 54.7% | 54.7% |
| U-238 | 1.09E-02 | 16.3% | 71.0% |
| U-234 | 5.54E-03 | 8.3% | 79.3% |
| Zn-65 | 4.65E-03 | 7.0% | 86.3% |
| Cl-36 | 4.02E-03 | 6.0% | 92.4% |
| U-235 | 2.41E-03 | 3.6% | 96.0% |
| H-3 | 7.23E-04 | 1.08% | 97.1% |
| Ar-41 | 4.36E-04 | 0.65% | 97.7% |
| Sr-90 | 3.99E-04 | 0.60% | 98.3% |
| Br-82 | 3.50E-04 | 0.52% | 98.8% |
| I-131 | 1.88E-04 | 0.28% | 99.1% |
| Kr-88 | 1.24E-04 | 0.19% | 99.3% |
| Am-241 | 8.92E-05 | 0.13% | 99.4% |
| Co-60 | 8.51E-05 | 0.13% | 99.6% |
| C-14 | 7.78E-05 | 0.12% | 99.7% |

## 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 in each of the 16, 22.5-degree sectors. Table 10 contains the annual dose for each of the sources and the total overall dose. The maximum total dose for 2021 was 6.21E-03 mrem/yr and occurred at a commercial building location approximately 115 m south-southeast of RESL (IF-683) in Sector 10 (see Figure 2). This is down 46% from 2020 and occurs at the same MEI location.

Releases from RESL (IF-683) account for 74.2% of the total dose, while releases from National Security Laboratory (NSL) (IF-611) and IRC Laboratory (IF-603) account for 16.5% and 9.3% respectively. This confirms the selection of RESL (IF-683) as the most conservative source location for all INL in-town facilities.


Figure 2. Dose (mrem/yr) at the nearest public receptor locations in each of the 16 sectors for INL in-town releases. All releases are assumed to occur at RESL (IF-683). Sectors are shown with yellow dashed lines, and nearest receptor locations are shown with orange circles. Sectors and receptors are numbered counterclockwise from north.

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 |
|---|---|---|---|
| RESL_IF-683 | 4.61E-03 | 74.19% | 74.19% |
| IF-611 | 1.03E-03 | 16.51% | 90.71% |
| IF-603 | 5.77E-04 | 9.29% | 100.00% |
| **INL in-town Total** | **6.21E-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 greater 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 and radionuclide that represent greater 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 |
|---|---|---|---|---|
| RESL IF-683 | Pu-239 | 1.58E-03 | 25.5% | 25.5% |
| RESL IF-683 | Am-241 | 1.02E-03 | 16.4% | 41.9% |
| IF-611 | Xe-133 | 1.02E-03 | 16.4% | 58.3% |
| RESL IF-683 | Pu-238 | 8.61E-04 | 13.9% | 72.2% |
| IF-603 | Cs-134 | 4.68E-04 | 7.5% | 79.8% |
| RESL IF-683 | Ra-226 | 3.69E-04 | 5.9% | 85.7% |
| RESL IF-683 | U-233 | 1.28E-04 | 2.1% | 87.8% |
| RESL IF-683 | U-232 | 1.24E-04 | 2.0% | 89.8% |
| IF-603 | Cs-137 | 1.03E-04 | 1.7% | 91.4% |
| RESL IF-683 | Ac-227 | 9.70E-05 | 1.6% | 93.0% |
| RESL IF-683 | Cs-137 | 7.90E-05 | 1.3% | 94.3% |
| RESL IF-683 | Ba-133 | 6.82E-05 | 1.1% | 95.4% |
| RESL IF-683 | Sr-90 | 6.20E-05 | 1.0% | 96.4% |
| RESL IF-683 | Eu-154 | 3.92E-05 | 0.63% | 97.0% |
| RESL IF-683 | Np-237 | 3.89E-05 | 0.63% | 97.6% |
| RESL IF-683 | Eu-152 | 2.96E-05 | 0.48% | 98.1% |
| RESL IF-683 | Pa-231 | 2.76E-05 | 0.44% | 98.5% |
| RESL IF-683 | I-125 | 2.24E-05 | 0.36% | 98.9% |
| RESL IF-683 | Cs-134 | 1.29E-05 | 0.21% | 99.1% |
| RESL IF-683 | Am-243 | 1.04E-05 | 0.17% | 99.3% |
| RESL IF-683 | Zn-65 | 9.25E-06 | 0.15% | 99.4% |
| RESL IF-683 | Co-60 | 8.12E-06 | 0.13% | 99.6% |

Table 12. Doses at the MEI location by radionuclide that represent greater 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 | 1.58E-03 | 25.5% | 25.5% |
| Am-241 | 1.02E-03 | 16.4% | 41.9% |
| Xe-133 | 1.02E-03 | 16.41% | 58.3% |
| Pu-238 | 8.61E-04 | 13.87% | 72.2% |
| Cs-134 | 4.81E-04 | 7.75% | 80.0% |
| Ra-226 | 3.69E-04 | 5.94% | 85.9% |
| Cs-137 | 1.82E-04 | 2.94% | 88.8% |
| U-233 | 1.28E-04 | 2.06% | 90.9% |
| U-232 | 1.24E-04 | 1.997% | 92.9% |
| Ac-227 | 9.70E-05 | 1.563% | 94.5% |
| Ba-133 | 6.82E-05 | 1.099% | 95.6% |
| Sr-90 | 6.20E-05 | 0.998% | 96.6% |
| Eu-154 | 3.92E-05 | 0.632% | 97.2% |

| Radionuclide | Annual MEI Dose (mrem/yr) | Percent of Total MEI Dose | Cumulative % of Total MEI Dose |
|---|---|---|---|
| Np-237 | 3.89E-05 | 0.626% | 97.8% |
| Eu-152 | 2.96E-05 | 0.477% | 98.3% |
| Pa-231 | 2.76E-05 | 0.445% | 98.7% |
| I-125 | 2.24E-05 | 0.362% | 99.1% |
| Zn-65 | 1.44E-05 | 0.232% | 99.3% |
| Am-243 | 1.04E-05 | 0.168% | 99.5% |
| Co-60 | 8.12E-06 | 0.131% | 99.6% |

# 4. REFERENCES


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# Appendix A

# Wind Files

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# Appendix A

# Wind Files

**690L21.WND**

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 2.21 2.81 2.02 3.08 2.30 1.99 2.24 2.11 1.66 3.08 3.24 2.47 2.20 2.67 3.46 3.20
 3.67 3.64 3.03 4.05 2.98 3.20 3.03 2.48 2.49 1.83 3.99 4.20 3.39 3.68 4.62 4.14
 4.45 3.43 4.01 2.61 3.49 3.66 4.25 3.11 2.66 2.03 2.35 2.68 3.33 6.24 6.42 4.38
 2.13 2.52 2.72 2.57 2.13 1.99 2.15 2.27 1.22 1.71 1.46 1.67 2.35 2.46 2.75 2.33
 1.32 1.36 1.08 1.09 1.19 0.96 1.24 1.06 1.04 1.12 1.05 1.13 1.13 1.08 1.36 1.33
 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 2.06 1.93 1.86 1.97 1.92 2.05 1.81 1.59 1.75 1.89 1.56 1.83 2.17 1.73 2.36
 3.10 3.31 2.77 3.30 2.73 2.78 2.82 2.71 2.27 3.30 3.47 2.97 3.14 3.42 3.84 3.62
 4.41 4.11 4.15 4.56 3.99 3.73 3.62 3.14 3.52 2.87 4.59 4.47 4.48 4.63 5.02 4.45
 5.45 4.07 4.66 3.14 4.30 4.74 5.39 3.96 3.89 3.16 3.89 4.07 4.70 7.56 7.58 5.33
 2.97 2.78 2.81 2.57 2.41 2.84 2.90 2.91 1.76 2.22 2.07 2.36 2.88 3.38 3.40 3.02
 1.84 1.89 1.50 1.52 1.67 1.27 1.74 1.47 1.44 1.57 1.45 1.59 1.58 1.51 1.88 1.85
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    0.1777    0.0797    0.0689    0.3983    0.0943    0.1812    0.0000
    0.2666    0.1063    0.0830    0.2661    0.0887    0.1893    0.0000
    0.3921    0.0515    0.0407    0.1653    0.0307    0.3198    0.0000
    0.4291    0.0686    0.0681    0.1773    0.0626    0.1943    0.0000
    0.2403    0.0952    0.1228    0.3658    0.0754    0.1006    0.0000
    0.0800    0.0614    0.1450    0.5724    0.0929    0.0483    0.0000
    0.0514    0.0416    0.0778    0.5619    0.1797    0.0876    0.0000
    0.0590    0.0226    0.0874    0.5076    0.1427    0.1807    0.0000
    0.0890    0.0202    0.0486    0.2994    0.1660    0.3767    0.0000
    0.0677    0.0193    0.0227    0.3787    0.1845    0.3271    0.0000
    0.0446    0.0390    0.0446    0.4428    0.1642    0.2647    0.0000
    0.0510    0.0335    0.0686    0.4947    0.2078    0.1444    0.0000
    0.0201    0.0266    0.0497    0.7413    0.1046    0.0578    0.0000
    0.0321    0.0389    0.1030    0.6996    0.0642    0.0622    0.0000
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```

**EBRL21.WND**

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 3.45 2.45 3.55 3.73 2.09 1.57 2.02 2.30 2.26 1.51 1.69 2.25 1.60 2.33 2.76 3.17
 4.35 4.69 4.26 3.96 3.96 4.40 3.30 3.25 2.71 1.88 2.58 2.19 3.45 3.14 4.00 4.54
 4.87 3.94 3.70 3.01 1.84 2.03 3.23 3.49 3.53 3.11 3.02 4.01 3.95 4.75 6.30 5.97
 2.35 2.67 2.50 2.35 1.77 2.33 2.43 2.05 1.62 1.75 1.21 1.63 1.39 2.13 1.81 2.30
 0.96 1.00 0.95 0.92 0.91 0.89 1.04 1.01 0.95 0.96 0.97 0.92 1.11 1.10 1.00 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
 1.97 2.19 2.13 1.81 1.98 2.21 2.09 2.15 1.80 1.94 1.63 1.83 1.97 2.06 2.20 2.18
 3.91 3.03 3.77 3.93 2.57 2.57 2.77 2.82 2.84 2.16 2.39 2.83 2.63 3.00 3.27 3.57
 4.79 4.95 4.71 4.26 4.36 4.64 3.80 3.87 3.46 2.61 3.57 3.57 4.02 3.67 4.54 4.81
 6.36 5.47 4.77 3.95 2.79 3.11 4.24 5.02 5.61 4.86 4.26 5.21 5.00 5.68 7.50 7.15
 3.25 3.59 3.59 3.32 2.57 3.10 3.21 2.81 2.26 2.73 1.85 2.37 2.21 2.57 2.53 3.33
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    0.0505    0.0204    0.0437    0.2770    0.2906    0.3178    0.0000
    0.0475    0.0284    0.0490    0.4194    0.2959    0.1599    0.0000
    0.0506    0.0518    0.1284    0.5054    0.1685    0.0954    0.0000
    0.0930    0.0655    0.1803    0.4728    0.0710    0.1175    0.0000
    0.1622    0.1005    0.1300    0.3767    0.0777    0.1530    0.0000
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    0.3449    0.1208    0.0691    0.1981    0.0774    0.1898    0.0000
    0.2877    0.1033    0.1437    0.2325    0.0371    0.1957    0.0000
    0.2006    0.1139    0.0956    0.3863    0.0267    0.1768    0.0000
    0.0518    0.0401    0.0742    0.7246    0.0410    0.0683    0.0000
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**EBRU21.WND**

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 3.13 2.76 3.73 3.85 2.86 2.98 2.07 2.38 2.59 1.92 1.83 2.27 2.00 2.47 3.10 3.48
 4.74 4.89 3.72 4.82 4.21 3.15 3.04 3.19 2.35 2.47 3.17 3.56 3.64 4.10 4.63 4.90
 7.06 6.33 4.68 3.82 3.43 3.82 5.03 4.76 4.61 4.10 4.84 3.74 4.29 6.28 7.88 7.79
 2.69 1.99 3.29 1.88 2.52 2.01 2.54 2.31 1.89 1.62 2.08 1.57 1.53 1.94 2.40 2.73
 1.33 1.44 1.04 1.13 1.25 1.48 1.39 1.51 1.52 1.31 1.36 1.11 1.11 1.61 1.67 1.65
 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
 2.26 2.04 1.59 1.90 2.04 1.26 2.08 2.21 2.24 1.75 1.67 2.02 1.95 2.19 2.04 2.36
 3.35 3.41 3.93 4.03 3.01 3.17 2.85 2.94 3.03 2.64 2.78 2.81 2.84 3.06 3.52 3.71
 5.02 5.11 3.92 5.02 4.71 4.35 3.93 3.76 3.12 3.60 3.99 4.32 4.27 4.82 4.99 5.22
 8.18 7.60 6.57 4.81 5.10 5.94 6.61 6.33 6.55 5.90 6.21 5.55 5.70 7.90 9.17 8.81
 3.28 2.82 3.53 3.03 3.30 2.92 3.33 2.84 2.67 2.28 2.70 2.26 2.05 2.70 3.00 3.41
 1.85 1.97 1.43 1.59 1.75 2.00 1.91 2.03 2.04 1.83 1.89 1.56 1.56 2.11 2.16 2.14
 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
    0.0237    0.0321    0.1158    0.7684    0.0460    0.0140    0.0000
    0.0505    0.0445    0.0417    0.7620    0.0656    0.0357    0.0000
    0.0882    0.0315    0.0644    0.6081    0.1197    0.0882    0.0000
    0.1047    0.0656    0.1059    0.4212    0.1577    0.1450    0.0000
    0.0926    0.0366    0.1389    0.4354    0.0926    0.2039    0.0000
    0.0534    0.0440    0.0734    0.6581    0.0781    0.0930    0.0000
    0.0471    0.0407    0.0877    0.6609    0.0995    0.0642    0.0000
    0.0463    0.0488    0.1255    0.6119    0.0842    0.0834    0.0000
    0.0903    0.0596    0.1010    0.5213    0.0841    0.1438    0.0000
    0.1354    0.0620    0.0596    0.5137    0.0849    0.1444    0.0000
    0.1813    0.0572    0.0736    0.4497    0.0974    0.1408    0.0000
    0.2070    0.0986    0.0956    0.3982    0.0541    0.1466    0.0000
    0.2524    0.1113    0.1043    0.3434    0.0807    0.1078    0.0000
    0.0876    0.0579    0.0530    0.6857    0.0672    0.0485    0.0000
    0.0282    0.0305    0.0595    0.8268    0.0351    0.0199    0.0000
    0.0226    0.0271    0.1128    0.7762    0.0388    0.0226    0.0000
```

**GRIL21.WND**

```
   3.99242
0.04610.02450.01740.01800.02170.05500.12960.09030.07190.02830.02200.02550.04750.15490.17040.0767
 1.67 1.56 1.64 1.78 1.45 1.64 1.50 1.36 1.21 1.56 1.12 1.24 1.37 1.62 1.51 1.62
 2.44 1.96 2.48 3.17 2.82 1.93 2.23 1.91 1.66 2.15 2.28 3.12 1.78 3.56 2.78 3.03
 3.56 2.89 2.47 3.87 2.04 3.12 2.96 2.60 2.78 3.34 2.92 4.68 3.91 4.12 4.11 3.29
 3.86 3.43 3.49 2.07 2.33 3.22 3.82 2.85 2.35 1.90 2.27 2.84 2.90 4.99 4.53 3.51
 2.35 2.63 1.79 1.44 1.54 2.44 2.40 2.16 1.38 1.24 1.39 1.65 2.15 2.11 2.12 2.05
 1.25 0.97 1.17 0.93 0.99 1.01 1.12 1.01 1.02 1.00 1.02 1.05 1.09 1.16 1.06 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
 2.15 2.07 2.13 2.23 1.97 2.13 2.02 1.89 1.70 2.07 1.57 1.74 1.89 2.12 2.03 2.12
 3.15 2.68 3.28 3.40 2.95 2.60 2.91 2.63 2.48 3.23 2.97 3.34 2.57 3.79 3.50 3.57
 4.34 3.78 3.24 4.41 2.72 3.77 3.49 3.41 4.14 4.71 4.17 5.29 4.74 4.72 4.83 4.27
 4.69 4.19 4.50 3.00 3.46 4.14 5.24 4.24 3.61 3.44 4.00 5.13 4.88 6.92 6.64 4.88
 3.04 3.06 2.67 2.23 2.29 3.09 3.08 2.73 1.98 1.78 2.06 2.34 2.77 3.11 3.02 2.79
 1.75 1.30 1.65 1.22 1.33 1.37 1.57 1.38 1.40 1.35 1.39 1.45 1.52 1.64 1.47 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
    0.1518    0.0786    0.0836    0.4179    0.0962    0.1719    0.0000
    0.2901    0.0812    0.0669    0.2619    0.1049    0.1950    0.0000
    0.3013    0.0673    0.0811    0.2151    0.1139    0.2214    0.0000
    0.4413    0.0846    0.0846    0.1107    0.0712    0.2076    0.0000
    0.3061    0.1024    0.0696    0.1936    0.1024    0.2259    0.0000
    0.1906    0.1208    0.1525    0.3095    0.1187    0.1079    0.0000
    0.0585    0.0756    0.1411    0.4928    0.1574    0.0746    0.0000
    0.0644    0.0413    0.0607    0.4672    0.2439    0.1226    0.0000
    0.0470    0.0292    0.0777    0.4911    0.1282    0.2269    0.0000
    0.0741    0.0452    0.0494    0.2923    0.1687    0.3703    0.0000
    0.0954    0.0477    0.0581    0.2593    0.1108    0.4287    0.0000
    0.1187    0.0321    0.0592    0.2966    0.1050    0.3883    0.0000
    0.0906    0.0320    0.0612    0.4095    0.1544    0.2524    0.0000
    0.0392    0.0278    0.0467    0.7005    0.1106    0.0753    0.0000
    0.0451    0.0383    0.1060    0.6239    0.1162    0.0704    0.0000
    0.0974    0.0744    0.0821    0.4649    0.1262    0.1550    0.0000
```

**GRIU21.WND**

```
   5.55352
0.04120.02380.01720.01890.02410.06790.19000.10270.04340.02000.01580.01750.03960.15650.16230.0591
 1.73 1.60 1.69 1.83 1.57 1.43 1.70 1.39 1.29 1.19 1.51 1.19 1.39 1.49 1.88 1.81
 2.89 3.11 2.43 3.03 2.54 2.33 2.47 2.18 2.33 2.36 2.33 3.24 3.35 3.35 3.09 3.33
 4.29 3.73 3.16 2.87 2.47 2.70 3.38 3.03 2.72 4.38 4.04 4.59 4.01 4.44 4.33 3.88
 4.51 4.14 2.83 2.09 2.50 3.87 5.03 4.32 4.07 3.32 3.47 4.41 5.24 7.66 6.76 4.83
 2.09 1.48 1.43 1.40 1.48 2.03 2.44 2.30 1.48 1.34 1.66 1.83 2.66 2.20 2.73 2.13
 1.42 1.28 1.54 1.29 1.32 1.25 1.44 1.53 1.02 1.13 1.27 1.37 1.45 1.52 1.34 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
 2.20 2.10 2.17 2.26 2.08 1.95 2.18 1.91 1.81 1.67 2.03 1.67 1.91 2.01 2.29 2.25
 3.49 3.32 2.98 3.23 3.30 2.97 2.90 2.84 2.89 3.24 3.33 3.47 3.59 3.58 3.74 3.56
 4.66 4.14 3.39 3.70 3.37 3.68 3.95 3.54 3.79 4.60 4.57 5.39 5.22 5.11 5.05 4.42
 6.29 5.62 4.55 3.43 4.17 5.57 6.25 5.41 5.92 5.37 6.28 6.39 6.96 8.97 8.41 6.37
 2.85 2.15 2.06 2.01 2.13 2.82 3.11 3.14 2.21 2.10 2.57 2.71 3.29 2.92 3.33 2.91
 1.95 1.80 2.05 1.80 1.84 1.76 1.97 2.05 1.39 1.59 1.78 1.90 1.97 2.04 1.87 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
    0.1373    0.1115    0.0828    0.5112    0.0743    0.0828    0.0000
    0.2075    0.1191    0.0795    0.4205    0.1040    0.0694    0.0000
    0.2462    0.0891    0.0757    0.3492    0.0960    0.1438    0.0000
    0.2856    0.1177    0.0935    0.2550    0.1177    0.1304    0.0000
    0.2830    0.1075    0.0929    0.3021    0.0585    0.1560    0.0000
    0.1055    0.1176    0.1126    0.4914    0.0623    0.1107    0.0000
    0.0420    0.0402    0.0965    0.6691    0.0804    0.0717    0.0000
    0.0469    0.0457    0.0687    0.6247    0.1236    0.0903    0.0000
    0.0703    0.0297    0.0867    0.5368    0.1192    0.1573    0.0000
    0.1179    0.0945    0.0885    0.3938    0.1114    0.1939    0.0000
    0.1496    0.0526    0.0602    0.3802    0.1046    0.2529    0.0000
    0.1345    0.0536    0.0610    0.4493    0.0872    0.2144    0.0000
    0.0889    0.0475    0.0593    0.6531    0.0444    0.1068    0.0000
    0.0241    0.0188    0.0421    0.8661    0.0233    0.0256    0.0000
    0.0318    0.0290    0.1014    0.7813    0.0362    0.0203    0.0000
    0.1212    0.0796    0.1153    0.5206    0.1074    0.0558    0.0000
```

**LOFL21.WND**

```
   3.65762
0.03900.02440.02420.02470.03340.04800.08930.11440.15060.14430.04160.01820.02180.03370.11490.0775
 1.53 1.57 1.32 1.17 1.51 1.47 1.46 1.11 1.17 1.10 1.06 1.40 1.34 1.21 1.40 1.71
 2.78 1.82 1.71 1.50 1.87 1.84 2.13 1.93 1.92 2.85 1.95 1.45 3.24 2.11 2.55 3.28
 4.39 2.95 1.96 3.13 2.68 2.40 2.72 2.48 2.48 2.83 2.56 6.95 1.98 2.37 3.89 4.61
 4.32 3.20 3.78 2.38 2.96 2.42 2.91 3.17 3.00 4.28 3.20 4.12 3.34 3.53 5.70 4.99
 1.93 1.54 1.54 1.48 1.79 1.66 1.97 2.01 1.99 2.49 1.33 1.13 1.24 1.46 1.51 1.93
 0.96 1.06 1.05 1.02 1.01 1.04 1.11 1.19 1.17 1.13 1.00 1.02 0.93 1.02 1.00 1.01
 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
 2.04 2.08 1.84 1.65 2.03 1.99 1.99 1.56 1.64 1.54 1.47 1.93 1.86 1.71 1.93 2.18
 3.20 2.71 2.46 2.49 2.61 2.55 2.77 2.47 3.00 3.54 2.95 2.57 3.47 3.02 3.12 3.76
 4.62 3.89 2.96 3.92 3.50 3.12 3.46 3.26 3.46 4.34 3.97 6.95 3.61 3.96 4.80 4.87
 4.98 3.93 4.21 3.41 4.27 3.32 4.14 4.13 3.90 6.46 4.61 4.82 5.65 5.57 7.50 5.83
 2.43 2.05 2.05 2.17 2.33 2.14 2.60 2.66 2.51 3.03 1.93 1.58 1.74 2.18 2.28 2.37
 1.28 1.46 1.45 1.41 1.37 1.43 1.55 1.68 1.64 1.59 1.37 1.41 1.21 1.39 1.37 1.38
 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
    0.3403    0.1671    0.1203    0.1878    0.0380    0.1465    0.0000
    0.4439    0.1215    0.0700    0.1498    0.0327    0.1821    0.0000
    0.4383    0.1511    0.0945    0.0945    0.0330    0.1886    0.0000
    0.5140    0.1017    0.0928    0.0786    0.0413    0.1715    0.0000
    0.3872    0.1540    0.1130    0.1301    0.0512    0.1645    0.0000
    0.3024    0.1620    0.1664    0.1381    0.0500    0.1810    0.0000
    0.1381    0.1254    0.2008    0.3529    0.0703    0.1125    0.0000
    0.0499    0.0499    0.0949    0.5025    0.1679    0.1349    0.0000
    0.0266    0.0099    0.0410    0.6418    0.1305    0.1502    0.0000
    0.0261    0.0118    0.0135    0.6096    0.2011    0.1378    0.0000
    0.0495    0.0522    0.0575    0.3601    0.1072    0.3736    0.0000
    0.0881    0.0314    0.0253    0.1761    0.1260    0.5531    0.0000
    0.1468    0.0211    0.0628    0.1564    0.1362    0.4766    0.0000
    0.0848    0.0406    0.0780    0.3729    0.0777    0.3459    0.0000
    0.0528    0.0427    0.1036    0.6655    0.0359    0.0995    0.0000
    0.1297    0.1549    0.1978    0.3510    0.0398    0.1268    0.0000
```

**LOFU21.WND**

```
   4.83849
0.03560.02230.02060.02020.03250.04300.10730.16130.14560.11010.04170.01840.01700.03260.10260.0894
 1.58 1.43 1.35 1.33 1.61 1.68 1.47 1.29 1.34 1.14 1.31 1.19 1.41 1.14 1.57 1.62
 2.51 2.44 2.60 1.71 2.32 2.40 2.04 2.04 1.63 2.54 1.98 2.97 2.71 2.37 2.87 2.94
 3.67 2.76 2.78 3.28 2.93 2.82 3.08 2.92 3.17 2.20 2.96 2.52 2.88 2.12 4.07 4.64
 5.72 3.84 4.79 3.64 3.80 2.95 4.01 4.17 4.44 6.33 4.81 2.44 3.34 4.73 7.63 7.34
 1.87 1.86 1.66 1.61 1.86 1.98 2.27 3.00 2.58 1.91 1.47 1.56 1.24 2.06 2.24 1.99
 1.14 1.07 0.97 0.99 1.13 1.19 1.20 1.42 1.45 1.22 1.07 1.02 1.04 1.07 1.17 1.14
 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
 2.08 1.95 1.87 1.85 2.11 2.16 1.99 1.80 1.87 1.60 1.83 1.67 1.94 1.61 2.08 2.12
 3.24 3.00 2.97 2.57 2.92 2.90 2.64 2.66 2.37 3.06 2.94 3.15 2.79 3.36 3.53 3.40
 4.78 4.01 3.47 3.98 3.88 3.48 3.92 3.71 3.99 3.79 4.27 3.38 4.68 3.61 4.87 4.80
 6.54 5.07 5.44 5.11 5.25 3.93 5.23 4.92 5.60 8.33 6.19 4.82 5.79 7.33 9.18 8.38
 2.71 2.57 2.57 2.24 2.57 2.57 2.82 3.47 3.16 2.78 2.33 2.20 1.83 2.88 2.93 2.35
 1.61 1.49 1.29 1.35 1.59 1.67 1.69 1.95 1.98 1.72 1.49 1.39 1.44 1.48 1.64 1.60
 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
    0.2595    0.1731    0.1122    0.2789    0.0449    0.1313    0.0000
    0.3440    0.1949    0.0974    0.1841    0.0516    0.1280    0.0000
    0.4723    0.1279    0.0939    0.1503    0.0389    0.1167    0.0000
    0.4352    0.1306    0.1182    0.1301    0.0618    0.1241    0.0000
    0.3418    0.1794    0.1445    0.1655    0.0527    0.1162    0.0000
    0.2900    0.1755    0.2048    0.2155    0.0505    0.0638    0.0000
    0.1192    0.1107    0.1747    0.4516    0.0543    0.0895    0.0000
    0.0383    0.0291    0.0666    0.6364    0.1340    0.0957    0.0000
    0.0361    0.0141    0.0416    0.6727    0.1138    0.1217    0.0000
    0.0250    0.0155    0.0197    0.7746    0.0706    0.0945    0.0000
    0.0465    0.0412    0.0575    0.4521    0.1206    0.2821    0.0000
    0.1120    0.0185    0.0554    0.3049    0.1489    0.3603    0.0000
    0.1148    0.0536    0.0530    0.3561    0.1136    0.3090    0.0000
    0.0983    0.0246    0.0630    0.5825    0.0633    0.1684    0.0000
    0.0490    0.0379    0.0769    0.7417    0.0278    0.0668    0.0000
    0.0971    0.0780    0.1739    0.5691    0.0205    0.0613    0.0000
```

**NRFL21.WND**

```
   4.05675
0.05790.03660.02780.03640.04600.08360.12010.07370.05880.03860.01820.01520.02730.08660.17740.0959
 1.80 1.77 1.39 1.30 1.40 1.28 1.40 1.19 1.19 1.62 1.35 1.24 1.45 1.16 1.30 1.98
 2.45 1.84 1.54 1.45 1.91 2.24 2.28 2.06 2.53 3.36 2.65 3.03 2.98 3.24 3.36 3.06
 2.82 2.00 2.03 2.05 2.14 2.69 2.86 2.48 3.42 4.45 5.19 4.42 3.84 4.20 4.48 4.13
 3.41 3.69 2.52 2.26 2.71 3.25 3.43 3.02 3.20 5.25 3.62 4.07 3.87 5.27 5.53 3.88
 2.57 1.84 1.27 1.32 2.16 1.71 1.66 1.89 1.56 1.55 2.22 2.13 1.85 1.96 2.66 2.39
 1.09 1.05 1.07 1.00 0.96 1.07 1.01 0.99 1.06 1.12 1.03 1.05 1.10 1.26 1.11 1.16
 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
 2.24 2.22 1.92 1.82 1.92 1.79 1.92 1.67 1.67 2.12 1.87 1.74 1.97 1.63 1.82 2.34
 3.16 2.62 2.33 2.10 2.63 2.91 2.72 2.74 3.13 3.60 3.72 3.23 3.17 3.47 3.60 3.51
 3.87 3.35 3.00 2.76 2.98 3.71 3.69 3.31 4.35 4.81 5.47 4.86 4.83 4.87 5.03 4.55
 4.68 4.47 3.43 2.82 3.40 4.38 4.66 3.92 4.45 6.36 4.53 4.65 5.61 7.19 7.20 5.27
 3.29 2.57 2.27 2.17 2.73 2.61 2.24 2.37 2.15 2.15 2.45 2.57 2.41 2.81 3.41 3.22
 1.53 1.45 1.49 1.36 1.28 1.49 1.38 1.33 1.47 1.58 1.42 1.45 1.54 1.77 1.55 1.64
 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
    0.1506    0.1029    0.0912    0.3900    0.1148    0.1506    0.0000
    0.2884    0.1192    0.1003    0.2162    0.0752    0.2007    0.0000
    0.3306    0.0907    0.0868    0.2027    0.0497    0.2395    0.0000
    0.3248    0.0726    0.0597    0.2272    0.0569    0.2588    0.0000
    0.2070    0.0798    0.0872    0.3040    0.0848    0.2371    0.0000
    0.1207    0.0809    0.1096    0.4019    0.1181    0.1688    0.0000
    0.0716    0.0688    0.1137    0.5539    0.0926    0.0993    0.0000
    0.0467    0.0513    0.0825    0.5427    0.1415    0.1354    0.0000
    0.0701    0.0252    0.0937    0.4913    0.1090    0.2107    0.0000
    0.0712    0.0417    0.0859    0.5522    0.0502    0.1988    0.0000
    0.1450    0.0500    0.0439    0.2702    0.0879    0.4031    0.0000
    0.0978    0.0827    0.0525    0.2180    0.0670    0.4819    0.0000
    0.0759    0.0506    0.1092    0.3862    0.0923    0.2858    0.0000
    0.0305    0.0238    0.0569    0.7218    0.0690    0.0980    0.0000
    0.0200    0.0226    0.0717    0.7395    0.0789    0.0673    0.0000
    0.0742    0.0849    0.1184    0.4725    0.1328    0.1173    0.0000
```

**PBFL21.WND**

```
   4.43790
0.07660.04410.01910.01070.01960.06030.15050.10660.05750.02950.02450.02310.03500.10590.15030.0867
 2.04 1.30 1.52 1.48 1.65 1.62 1.94 1.41 1.15 1.12 1.20 1.66 1.16 1.51 1.60 1.45
 2.85 2.96 3.15 3.00 1.91 2.70 3.24 2.00 1.75 2.14 2.68 2.09 2.31 2.82 2.81 3.23
 4.19 3.92 4.82 3.75 2.59 3.89 3.15 2.63 2.67 1.75 2.55 2.11 4.67 3.23 3.98 3.60
 4.14 4.26 4.25 3.77 3.29 3.58 3.98 3.63 3.16 3.74 3.07 3.93 4.36 6.95 6.70 4.22
 2.38 2.75 2.12 2.31 2.48 3.22 2.90 2.00 1.44 1.32 1.10 1.41 1.38 1.86 1.75 2.06
 1.03 1.14 1.07 1.08 1.09 1.11 1.07 1.07 1.01 0.93 1.01 0.99 1.00 0.99 0.92 1.08
 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
 2.37 1.82 2.04 2.00 2.14 2.12 2.32 1.93 1.62 1.58 1.69 2.15 1.63 2.03 2.10 1.97
 3.69 3.61 3.37 3.19 2.31 3.26 3.47 2.57 2.38 2.79 3.47 2.85 2.95 3.42 3.43 3.62
 4.54 4.16 5.02 4.22 3.80 4.35 3.77 3.19 3.34 2.71 3.79 3.29 4.99 4.60 4.86 4.36
 5.62 5.09 5.25 4.42 4.02 4.27 5.28 5.10 4.94 5.44 5.20 5.69 6.21 8.21 8.02 5.73
 3.14 3.50 3.07 3.33 3.08 3.59 3.45 2.87 2.08 1.90 1.54 2.12 2.40 2.72 2.68 2.98
 1.41 1.60 1.48 1.50 1.53 1.55 1.49 1.49 1.37 1.22 1.38 1.34 1.35 1.34 1.19 1.51
 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
    0.0406    0.0556    0.0781    0.4984    0.1381    0.1891    0.0000
    0.0315    0.0497    0.0549    0.4751    0.1723    0.2166    0.0000
    0.1024    0.0543    0.0726    0.3730    0.1087    0.2889    0.0000
    0.2041    0.0326    0.0652    0.2255    0.0755    0.3970    0.0000
    0.1470    0.0413    0.0592    0.2414    0.1470    0.3640    0.0000
    0.0763    0.0345    0.0419    0.4770    0.2252    0.1451    0.0000
    0.0543    0.0336    0.0864    0.5964    0.1369    0.0925    0.0000
    0.0852    0.0431    0.0993    0.5319    0.1219    0.1186    0.0000
    0.1619    0.0540    0.1002    0.3998    0.0801    0.2040    0.0000
    0.1913    0.0315    0.0783    0.3045    0.0939    0.3004    0.0000
    0.2581    0.0567    0.0750    0.2116    0.0656    0.3331    0.0000
    0.1495    0.0648    0.0497    0.2790    0.0795    0.3775    0.0000
    0.1580    0.0626    0.0594    0.3253    0.0694    0.3253    0.0000
    0.0685    0.0392    0.0555    0.6759    0.0402    0.1207    0.0000
    0.0383    0.0399    0.0927    0.6921    0.0506    0.0865    0.0000
    0.0518    0.0704    0.1143    0.5284    0.0824    0.1527    0.0000
```

**RWML21.WND**

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   4.43514
0.02910.02210.01790.01400.02200.05970.11350.05310.02350.02370.02830.04460.07730.13160.22790.1118
 1.59 1.38 1.27 1.47 1.68 1.53 1.54 1.25 0.96 1.09 1.49 1.14 1.08 1.34 1.49 1.81
 2.87 3.19 2.22 3.55 2.98 3.07 3.08 2.43 1.61 2.03 1.96 3.12 2.01 2.58 2.69 3.08
 3.91 3.96 3.86 4.18 4.07 3.90 3.67 2.65 3.57 2.81 2.69 4.04 3.39 3.99 4.31 4.11
 4.40 4.64 3.74 3.61 2.93 4.01 4.30 3.05 2.87 3.38 3.98 2.78 2.91 5.19 5.58 5.09
 1.67 0.97 1.19 1.21 1.51 2.13 2.19 2.34 1.55 1.74 1.57 1.18 1.42 1.53 2.09 2.55
 1.06 1.10 0.88 1.03 1.03 0.93 1.11 0.97 0.99 1.05 1.05 1.04 0.95 0.97 1.15 1.20
 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
 2.09 1.90 1.78 2.00 2.16 2.05 2.06 1.75 1.27 1.52 2.01 1.61 1.51 1.86 2.01 2.25
 3.34 3.42 3.09 3.77 3.17 3.29 3.29 2.87 2.57 2.57 2.57 3.34 2.80 3.39 3.30 3.54
 4.77 4.44 4.40 4.48 4.29 4.27 4.09 3.44 3.94 3.91 4.23 4.36 4.44 4.65 4.97 4.61
 5.26 5.33 4.44 4.10 3.94 5.50 5.70 4.21 3.63 4.73 5.49 3.96 4.51 7.27 6.81 5.81
 2.45 1.29 1.67 1.88 2.42 3.06 3.09 3.16 2.21 2.43 2.22 1.69 2.16 2.44 2.90 3.28
 1.47 1.54 1.10 1.42 1.41 1.21 1.55 1.30 1.35 1.45 1.45 1.44 1.26 1.31 1.62 1.69
 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
    0.2362    0.1024    0.1179    0.3228    0.0591    0.1616    0.0000
    0.3056    0.0986    0.0986    0.3522    0.0362    0.1090    0.0000
    0.3076    0.0900    0.0833    0.2696    0.0380    0.2114    0.0000
    0.3858    0.0494    0.0565    0.1475    0.0651    0.2956    0.0000
    0.2294    0.1249    0.0727    0.2758    0.1199    0.1772    0.0000
    0.1574    0.1114    0.1363    0.3588    0.1497    0.0864    0.0000
    0.0636    0.0353    0.1040    0.5687    0.1536    0.0747    0.0000
    0.0712    0.0648    0.0863    0.3823    0.2333    0.1621    0.0000
    0.0877    0.0635    0.0537    0.3122    0.1461    0.3369    0.0000
    0.1160    0.0333    0.0481    0.2417    0.1257    0.4353    0.0000
    0.1173    0.0240    0.0731    0.2713    0.1254    0.3889    0.0000
    0.0386    0.0179    0.0410    0.3084    0.2057    0.3883    0.0000
    0.0400    0.0342    0.0460    0.3858    0.1750    0.3191    0.0000
    0.0331    0.0270    0.0513    0.6855    0.0828    0.1202    0.0000
    0.0241    0.0236    0.0815    0.7788    0.0442    0.0478    0.0000
    0.0687    0.0708    0.1159    0.6349    0.0472    0.0626    0.0000
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**TRAL21.WND**

```
   4.32871
0.04760.02670.01730.01490.02250.05220.11970.09320.06710.02770.02430.02840.04150.11290.21150.0924
 1.48 1.23 1.34 1.25 1.49 1.31 1.27 1.35 1.38 0.96 1.26 1.54 1.19 1.33 1.33 1.52
 2.83 1.74 2.20 2.33 1.78 2.37 2.18 2.01 2.32 1.64 1.38 1.86 2.90 2.26 3.06 2.86
 3.50 3.13 3.96 3.52 3.28 2.98 2.96 2.61 2.78 2.35 3.03 3.48 4.32 4.31 3.97 3.38
 3.98 4.22 3.60 3.29 2.56 3.73 3.77 3.12 2.99 2.54 3.29 3.13 3.71 5.39 5.90 4.28
 2.30 2.45 2.22 1.29 1.55 1.68 1.66 2.03 1.94 1.37 1.58 1.38 1.89 2.42 2.66 2.26
 1.21 0.96 0.90 0.95 1.29 1.08 1.20 1.15 1.06 0.97 1.01 1.03 1.05 1.09 1.02 1.18
 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
 2.00 1.72 1.86 1.75 2.01 1.83 1.78 1.87 1.91 1.27 1.77 2.05 1.67 1.85 1.85 2.03
 3.40 2.57 2.57 2.94 2.57 2.99 2.79 2.90 3.10 2.13 2.19 2.76 3.06 3.02 3.54 3.47
 4.09 3.81 4.26 3.87 3.61 3.84 3.59 3.18 3.84 3.59 4.12 4.96 4.55 5.13 4.71 4.55
 5.21 5.24 4.42 4.16 3.29 4.49 4.87 4.15 4.57 3.78 5.10 5.20 5.10 7.03 7.41 5.71
 3.01 3.24 3.09 1.81 2.21 2.25 2.21 2.61 2.57 2.00 2.31 1.91 2.66 3.32 3.47 3.02
 1.71 1.28 1.13 1.26 1.80 1.51 1.69 1.62 1.46 1.30 1.37 1.41 1.46 1.53 1.40 1.66
 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
    0.1822    0.0934    0.0768    0.3957    0.1272    0.1247    0.0000
    0.2178    0.1029    0.0898    0.3585    0.0812    0.1497    0.0000
    0.3177    0.0725    0.0661    0.2516    0.0933    0.1988    0.0000
    0.3542    0.0768    0.0997    0.2155    0.0539    0.2000    0.0000
    0.3758    0.1324    0.0911    0.2079    0.0506    0.1422    0.0000
    0.2080    0.0942    0.1664    0.3717    0.0372    0.1226    0.0000
    0.0764    0.0630    0.1698    0.5677    0.0430    0.0801    0.0000
    0.0503    0.0269    0.0834    0.5759    0.1201    0.1433    0.0000
    0.0459    0.0289    0.0392    0.5674    0.1499    0.1687    0.0000
    0.0743    0.0162    0.0534    0.3249    0.1688    0.3624    0.0000
    0.0423    0.0234    0.0510    0.2729    0.1595    0.4509    0.0000
    0.0844    0.0362    0.0520    0.3572    0.1526    0.3175    0.0000
    0.0439    0.0302    0.0634    0.4521    0.1653    0.2451    0.0000
    0.0354    0.0162    0.0476    0.6781    0.1336    0.0891    0.0000
    0.0324    0.0340    0.0621    0.7258    0.0901    0.0556    0.0000
    0.0952    0.0668    0.1297    0.5068    0.0989    0.1026    0.0000
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**IDAL21.WND**

```
   2.89477
0.06030.02810.01840.01270.01460.01620.02900.07420.14730.10020.02970.01330.01540.04640.19420.2000
 1.49 1.50 1.12 0.86 0.87 0.94 0.95 1.10 1.09 1.18 1.15 1.28 1.39 1.65 1.89 1.76
 2.54 2.98 1.23 0.77 1.77 1.17 1.92 1.63 1.50 2.16 2.47 2.25 2.14 3.05 3.57 3.27
 3.97 3.33 2.58 1.62 1.96 3.39 3.10 3.12 2.29 2.15 1.68 3.41 3.91 5.06 4.69 4.72
 2.95 1.28 1.40 2.21 1.04 2.22 2.67 3.16 2.46 1.39 2.11 2.56 3.82 5.27 4.88 4.29
 1.49 1.22 1.24 0.93 0.97 1.12 1.28 1.09 1.29 1.12 1.01 0.97 1.37 1.80 2.55 2.07
 0.97 0.83 0.92 0.85 0.85 0.84 0.81 0.87 0.88 0.89 0.85 0.99 0.97 1.12 1.37 1.26
 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
 2.01 2.02 1.58 1.03 1.05 1.23 1.26 1.54 1.53 1.66 1.62 1.79 1.92 2.14 2.29 2.22
 3.06 3.17 2.09 0.77 2.22 1.91 2.57 2.52 2.21 2.60 2.97 2.76 3.23 3.42 3.80 3.62
 4.55 3.57 3.79 2.86 2.57 3.89 4.07 4.16 3.02 2.98 2.35 3.65 4.07 5.32 4.84 4.88
 3.89 2.20 2.35 3.09 1.44 2.78 3.83 4.47 3.33 2.07 3.42 5.20 4.13 6.15 5.46 4.83
 2.01 1.71 1.74 1.22 1.29 1.58 1.79 1.55 1.81 1.57 1.41 1.29 1.90 2.31 2.79 2.44
 1.31 0.95 1.19 1.00 1.00 0.98 0.90 1.06 1.10 1.12 1.01 1.33 1.30 1.57 1.89 1.76
 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
    0.1156    0.1196    0.1120    0.3149    0.1651    0.1727    0.0000
    0.1464    0.0853    0.0366    0.1706    0.2807    0.2804    0.0000
    0.2359    0.0245    0.0495    0.2054    0.1614    0.3234    0.0000
    0.1891    0.0087    0.0536    0.1355    0.1805    0.4326    0.0000
    0.3053    0.0389    0.0464    0.0622    0.1093    0.4378    0.0000
    0.2746    0.0776    0.0419    0.0634    0.0634    0.4791    0.0000
    0.2649    0.0670    0.1226    0.1741    0.0908    0.2805    0.0000
    0.1080    0.1002    0.1497    0.3242    0.1033    0.2146    0.0000
    0.1002    0.1057    0.1399    0.2634    0.2152    0.1756    0.0000
    0.1221    0.0788    0.0468    0.1586    0.2969    0.2968    0.0000
    0.2039    0.0538    0.0616    0.1114    0.2153    0.3540    0.0000
    0.3361    0.0859    0.0430    0.0867    0.0603    0.3881    0.0000
    0.3260    0.0817    0.0888    0.0888    0.0590    0.3558    0.0000
    0.3104    0.1256    0.1010    0.1206    0.0517    0.2908    0.0000
    0.1331    0.1550    0.1997    0.3012    0.0772    0.1338    0.0000
    0.0961    0.1276    0.1728    0.4159    0.0933    0.0944    0.0000
```

# Appendix B

# Distance and Direction to INL Site Receptor Locations

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# Appendix B

# Distance and Direction to INL Site Receptor Locations

Table B-1. Location (direction and distance[a]) from INL facilities to the 62 INL Site receptor locations.

| | CFA | | CITRC | | INTEC, INTEC-MS | | MFC, MFC-MS, MFC-TREAT | | NRF | | ATR, ATR-ATR, ATR-MTR | | RWMC | | SMC, RRTR-North | | 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) |
| 1 | SW | 14359 | SW | 20140 | SSW | 18718 | WSW | 37219 | SSW | 26675 | SSW | 19172 | SSW | 7976 | SSW | 54405 | SSW | 54611 |
| 2 | WSW | 20330 | WSW | 26875 | SW | 23745 | WSW | 44645 | SW | 30375 | SW | 22957 | WSW | 12222 | SW | 58080 | SW | 58610 |
| 3 | WNW | 21989 | WNW | 27497 | WNW | 21738 | W | 43802 | W | 23023 | W | 18786 | NW | 17664 | SW | 46845 | WSW | 47969 |
| 4 | WNW | 24403 | WNW | 30003 | W | 24266 | W | 46349 | W | 25502 | W | 21330 | NW | 19688 | WSW | 48839 | WSW | 50024 |
| 5 | NNW | 23620 | NW | 26184 | NW | 20592 | WNW | 38136 | WNW | 16366 | NW | 17421 | N | 24171 | WSW | 33891 | WSW | 35279 |
| 6 | N | 25733 | NNW | 25470 | N | 21407 | NW | 32205 | NNW | 13714 | N | 19192 | N | 29415 | WSW | 23002 | WSW | 24430 |
| 7 | N | 28765 | N | 27240 | N | 24181 | NW | 30604 | N | 15825 | N | 22547 | NNE | 33489 | WSW | 17388 | WSW | 18890 |
| 8 | N | 29943 | N | 27740 | N | 25289 | NW | 29197 | N | 16845 | NNE | 24005 | NNE | 35223 | WSW | 14328 | WSW | 15784 |
| 9 | NNE | 58201 | NNE | 54683 | NNE | 53549 | N | 48337 | NNE | 45272 | NNE | 52738 | NNE | 64121 | N | 18921 | N | 19860 |
| 10 | NNE | 60643 | NNE | 56854 | NNE | 56016 | N | 49492 | NNE | 47836 | NNE | 55357 | NNE | 66788 | NNE | 20746 | N | 21349 |
| 11 | NNE | 63036 | NNE | 59177 | NNE | 58415 | N | 51453 | NNE | 50259 | NNE | 57788 | NNE | 69225 | NNE | 23025 | N | 23521 |
| 12 | NNE | 62130 | NNE | 58050 | NNE | 57543 | N | 49661 | NNE | 49501 | NNE | 57061 | NNE | 68523 | NNE | 21897 | NNE | 22159 |
| 13 | NNE | 61499 | NNE | 57276 | NNE | 56938 | N | 48454 | NNE | 48981 | NNE | 56552 | NNE | 68019 | NNE | 21218 | NNE | 21314 |
| 14 | NNE | 60140 | NNE | 55861 | NNE | 55592 | N | 46930 | NNE | 47678 | NNE | 55251 | NNE | 66718 | NNE | 19864 | NNE | 19891 |
| 15 | NNE | 59125 | NNE | 54803 | NNE | 54586 | N | 45793 | NNE | 46705 | NNE | 54279 | NNE | 65744 | NNE | 18863 | NNE | 18834 |
| 16 | NNE | 56684 | NNE | 52264 | NNE | 52171 | N | 43075 | NE | 44374 | NE | 51946 | NE | 63402 | NE | 16506 | NNE | 16323 |
| 17 | NNE | 55818 | NNE | 51353 | NNE | 51317 | N | 42070 | NE | 43560 | NE | 51129 | NE | 62579 | NE | 15703 | NNE | 15441 |
| 18 | NNE | 54736 | NNE | 50159 | NNE | 50267 | N | 40559 | NE | 42609 | NE | 50165 | NE | 61597 | NE | 14835 | NE | 14374 |
| 19 | NNE | 52856 | NNE | 48247 | NNE | 48399 | N | 38677 | NE | 40784 | NE | 48332 | NE | 59754 | NE | 13091 | NE | 12522 |
| 20 | NNE | 53686 | NNE | 48957 | NE | 49264 | N | 38896 | NE | 41749 | NE | 49278 | NE | 60676 | NE | 14225 | NE | 13483 |
| 21 | NE | 54320 | NNE | 49504 | NE | 49925 | N | 39089 | NE | 42485 | NE | 49998 | NE | 61374 | NE | 15110 | NE | 14258 |
| 22 | NE | 55562 | NNE | 50591 | NE | 51221 | NNE | 39532 | NE | 43926 | NE | 51402 | NE | 62731 | ENE | 16871 | NE | 15844 |
| 23 | NE | 52970 | NNE | 47848 | NE | 48695 | NNE | 36404 | NE | 41600 | NE | 49011 | NE | 60265 | ENE | 15318 | ENE | 13959 |
| 24 | NE | 51859 | NE | 46671 | NE | 47617 | NNE | 35052 | NE | 40619 | NE | 47994 | NE | 59209 | ENE | 14795 | ENE | 13286 |
| 25 | NE | 49936 | NNE | 44847 | NE | 45655 | NNE | 33750 | NE | 38564 | NE | 45970 | NE | 57223 | ENE | 12622 | ENE | 11103 |
| 26 | NE | 48191 | NE | 42947 | NE | 43985 | NNE | 31396 | NE | 37120 | NE | 44439 | NE | 55600 | E | 12423 | ENE | 10590 |
| 27 | NE | 47719 | NE | 42442 | NE | 43531 | NNE | 30799 | NE | 36719 | NE | 44016 | NE | 55153 | E | 12370 | E | 10472 |
| 28 | NE | 47415 | NE | 42123 | NE | 43236 | NNE | 30447 | NE | 36450 | NE | 43736 | NE | 54862 | E | 12298 | E | 10365 |
| 29 | NE | 47138 | NE | 41823 | NE | 42971 | NNE | 30080 | NE | 36223 | NE | 43493 | NE | 54602 | E | 12315 | E | 10344 |
| 30 | NE | 48826 | NE | 43453 | NE | 44684 | NNE | 31334 | NE | 37986 | NE | 45239 | NE | 56323 | E | 13887 | E | 11989 |
| 31 | NE | 49727 | NE | 44277 | NE | 45626 | NNE | 31781 | NE | 39025 | NE | 46238 | NE | 57274 | E | 15147 | E | 13245 |

| | CFA | | CITRC | | INTEC, INTEC-MS | | MFC, MFC-MS, MFC-TREAT | | NRF | | ATR, ATR-ATR, ATR-MTR | | RWMC | | SMC, RRTR-North | | 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) |
| 32 | NE | 49844 | NE | 44352 | NE | 45767 | NNE | 31676 | NE | 39228 | NE | 46414 | NE | 57419 | E | 15591 | E | 13664 |
| 33 | NE | 49255 | NE | 43718 | NE | 45207 | NNE | 30900 | NE | 38751 | NE | 45899 | NE | 56864 | E | 15601 | E | 13612 |
| 34 | NE | 49159 | NE | 43437 | NE | 45234 | NNE | 29857 | ENE | 39098 | NE | 46093 | NE | 56890 | E | 17332 | E | 15241 |
| 35 | NE | 48617 | NE | 42673 | NE | 44874 | NNE | 28157 | ENE | 39203 | ENE | 45957 | NE | 56488 | ESE | 19512 | ESE | 17329 |
| 36 | NE | 50618 | NE | 44522 | ENE | 47017 | NE | 29235 | ENE | 41660 | ENE | 48246 | NE | 58572 | ESE | 22639 | ESE | 20457 |
| 37 | NE | 49488 | NE | 43461 | NE | 45820 | NNE | 28532 | ENE | 40318 | ENE | 46981 | NE | 57405 | ESE | 21046 | ESE | 18860 |
| 38 | ENE | 52636 | NE | 46349 | ENE | 49259 | NE | 30150 | ENE | 44399 | ENE | 50702 | ENE | 60685 | ESE | 26745 | ESE | 24545 |
| 39 | ENE | 53165 | NE | 46861 | ENE | 49810 | NE | 30574 | ENE | 44992 | ENE | 51271 | ENE | 61220 | ESE | 27368 | ESE | 25171 |
| 40 | ENE | 54566 | NE | 48223 | ENE | 51265 | NE | 31734 | ENE | 46549 | ENE | 52770 | ENE | 62638 | ESE | 28984 | ESE | 26794 |
| 41 | ENE | 53898 | ENE | 47504 | ENE | 50682 | NE | 30803 | ENE | 46170 | ENE | 52265 | ENE | 61990 | ESE | 29487 | ESE | 27275 |
| 42 | ENE | 53653 | ENE | 47245 | ENE | 50463 | NE | 30486 | ENE | 46012 | ENE | 52068 | ENE | 61751 | ESE | 29606 | ESE | 27389 |
| 43 | ENE | 54721 | ENE | 48274 | ENE | 51600 | NE | 31325 | ENE | 47288 | ENE | 53260 | ENE | 62832 | ESE | 31136 | ESE | 28919 |
| 44 | ENE | 56369 | ENE | 49878 | ENE | 53335 | NE | 32719 | ENE | 49188 | ENE | 55059 | ENE | 64492 | ESE | 33274 | ESE | 31060 |
| 45 | ENE | 55503 | ENE | 48836 | ENE | 53180 | ENE | 30949 | E | 50559 | E | 55399 | ENE | 63580 | ESE | 39966 | ESE | 37729 |
| 46 | ENE | 54206 | ENE | 47540 | ENE | 51882 | ENE | 29654 | E | 49284 | E | 54104 | ENE | 62284 | ESE | 39043 | ESE | 36809 |
| 47 | ENE | 53447 | ENE | 46786 | ENE | 51062 | ENE | 28919 | E | 48351 | E | 53249 | ENE | 61538 | ESE | 37917 | ESE | 35683 |
| 48 | ENE | 49609 | ENE | 42939 | E | 47369 | ENE | 25043 | E | 45037 | E | 49654 | ENE | 57672 | SE | 36775 | SE | 34577 |
| 49 | ENE | 47875 | ENE | 41210 | ENE | 45560 | ENE | 23329 | E | 43113 | E | 47807 | ENE | 55957 | SE | 34988 | SE | 32802 |
| 50 | E | 49423 | E | 42795 | E | 47738 | E | 25196 | E | 46518 | E | 50311 | E | 57303 | SE | 41699 | SE | 39559 |
| 51 | E | 50552 | E | 44021 | E | 49244 | E | 26953 | E | 48721 | E | 51977 | E | 58247 | SE | 45695 | SE | 43584 |
| 52 | E | 50835 | E | 44434 | E | 49870 | ESE | 28044 | ESE | 49980 | E | 52731 | E | 58325 | SE | 48738 | SE | 46668 |
| 53 | E | 48971 | E | 42582 | E | 48037 | ESE | 26304 | ESE | 48248 | E | 50914 | E | 56449 | SE | 47694 | SE | 45654 |
| 54 | E | 27846 | E | 21553 | ESE | 27194 | SSE | 8678 | ESE | 28758 | ESE | 30222 | E | 35320 | SSE | 38138 | SSE | 36721 |
| 55[b] | E | 23252 | E | 17457 | ESE | 23357 | S | 10843 | SE | 26467 | ESE | 26561 | E | 30295 | S | 40381 | S | 39220 |
| 56 | SE | 14487 | ESE | 12230 | SSE | 17143 | SW | 20850 | SSE | 23988 | SE | 20266 | ESE | 19232 | S | 46268 | SSW | 45677 |
| 57 | SE | 12453 | ESE | 10775 | SSE | 15333 | SW | 21392 | SSE | 22502 | SE | 18388 | ESE | 17121 | SSW | 45689 | SSW | 45196 |
| 58 | E | 49563 | ENE | 42924 | E | 47814 | E | 25258 | E | 46466 | E | 50356 | ENE | 57469 | SE | 41229 | SE | 39079 |
| 59 | SE | 16416 | ESE | 13330 | SE | 18656 | SSW | 19461 | SSE | 24968 | SE | 21866 | ESE | 21578 | S | 45980 | S | 45275 |
| 60 | NE | 50271 | NE | 44445 | NE | 46421 | NNE | 30355 | ENE | 40461 | NE | 47370 | NE | 58065 | E | 19131 | E | 17035 |
| 61 | NE | 48990 | NE | 42959 | NE | 45327 | NNE | 28039 | ENE | 39846 | ENE | 46496 | NE | 56909 | ESE | 20803 | ESE | 18607 |
| 62 | ENE | 53246 | ENE | 46809 | ENE | 50110 | NE | 29925 | ENE | 45789 | ENE | 51763 | ENE | 61353 | ESE | 29941 | ESE | 27715 |

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

b. Receptor 55 at the top of East Butte is the only receptor location on the INL. Receptor 55 does not currently qualify as a NESHAP receptor location. Privately owned communication (TV, radio, cell) towers are located on top of the Butte, but there are no dwellings or places of business, and currently the site is visited only occasionally by maintenance workers. Nevertheless, doses are calculated at this point in the case the occupancy situation changes.

# 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 concatenate 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\\FY2022\\NESHAP\\CAP88\\";

# --- Path to the wind files
      $windpath="C:\\Projects\\FY2022\\NESHAP\\Windfiles\\";

# --- Path to the nuclide template files
      $nuctemplate="C:\\Users\\OVERKB\\Documents\\cap88NucTemp\\";

# --- Names of the template files - same name for each facility
      @tempfnames = ("v4TempA.dat","v4TempB.dat","v4TempC.dat","v4TempD.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..3)
        {

          $fname=$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

          $ffname=$fname."C.dat";
          $outfile=$fname."C.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]."\\".$tempfnames[2]." + ".$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."C.";
              print OFILE "$capname \n";
            }
        else
            {
              print OFILE "$zline[$l]";
            }
          }
# AJS End of AJS changes

          $ffname=$fname."D.dat";
          $outfile=$fname."D.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]."\\".$tempfnames[3]." + ".$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."D.";
              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\\FY2022\\NESHAP\\CAP88\\";
      $wrkdir="C:\\Projects\\FY2022\\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\\FY2022\\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\\FY2022\\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=62;
# --- 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\\FY2022\\NESHAP\\CAP88IRC\\CAP88\\";

# --- Path to the wind files
      $windpath="C:\\Projects\\FY2022\\NESHAP\\Windfiles\\";

# --- Path to the nuclide template files
      $nuctemplate="C:\\Users\\OVERKB\\Documents\\cap88NucTemp\\";

# --- Names of the template files - same name for each facility
      @tempfnames = ("v41Template.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..0)
        {

          $fname=$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.".dat";
          $outfile=$fname.".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.".";
              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\\FY2022\\NESHAP\\CAP88IRC\\CAP88\\";
      $wrkdir="C:\\Projects\\FY2022\\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\\FY2022\\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\\AJS\\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 "Cap88v4Fortran.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\\FY2022\\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=16;
# --- 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 | 6.00E-13 |
| CFA-625 | CFA | Non-Fugitive | Ag-109m | 1.09E-13 |
| CFA-625 | CFA | Non-Fugitive | Ag-110 | 1.81E-20 |
| CFA-625 | CFA | Non-Fugitive | Ag-110m | 1.23E-14 |
| CFA-625 | CFA | Non-Fugitive | Ag-111 | 6.72E-13 |
| CFA-625 | CFA | Non-Fugitive | Ag-112 | 2.37E-12 |
| CFA-625 | CFA | Non-Fugitive | Am-241 | 7.50E-12 |
| CFA-625 | CFA | Non-Fugitive | Am-243 | 1.08E-12 |
| CFA-625 | CFA | Non-Fugitive | Ar-41 | 2.70E-05 |
| CFA-625 | CFA | Non-Fugitive | As-73 | 1.15E-21 |
| CFA-625 | CFA | Non-Fugitive | As-76 | 7.11E-18 |
| CFA-625 | CFA | Non-Fugitive | As-77 | 5.13E-14 |
| CFA-625 | CFA | Non-Fugitive | As-78 | 1.21E-14 |
| CFA-625 | CFA | Non-Fugitive | Ba-133 | 1.81E-15 |
| CFA-625 | CFA | Non-Fugitive | Ba-137m | 7.11E-13 |
| CFA-625 | CFA | Non-Fugitive | Ba-139 | 9.99E-14 |
| CFA-625 | CFA | Non-Fugitive | Ba-140 | 1.98E-12 |
| CFA-625 | CFA | Non-Fugitive | Bi-207 | 7.50E-15 |
| CFA-625 | CFA | Non-Fugitive | Bi-211 | 8.37E-17 |
| CFA-625 | CFA | Non-Fugitive | Bi-212 | 4.98E-17 |
| CFA-625 | CFA | Non-Fugitive | Bi-214 | 1.72E-16 |
| CFA-625 | CFA | Non-Fugitive | Br-80 | 5.96E-09 |
| CFA-625 | CFA | Non-Fugitive | Br-82 | 8.29E-07 |
| CFA-625 | CFA | Non-Fugitive | Br-83 | 7.98E-04 |
| CFA-625 | CFA | Non-Fugitive | Br-84 | 3.42E-10 |
| CFA-625 | CFA | Non-Fugitive | C-14 | 2.82E-14 |
| CFA-625 | CFA | Non-Fugitive | Cd-109 | 5.94E-16 |
| CFA-625 | CFA | Non-Fugitive | Cd-113m | 1.53E-16 |
| CFA-625 | CFA | Non-Fugitive | Cd-115 | 9.75E-13 |
| CFA-625 | CFA | Non-Fugitive | Cd-115m | 7.98E-15 |
| CFA-625 | CFA | Non-Fugitive | Cd-117 | 1.77E-13 |
| CFA-625 | CFA | Non-Fugitive | Ce-139 | 4.17E-14 |
| CFA-625 | CFA | Non-Fugitive | Ce-141 | 1.13E-12 |
| CFA-625 | CFA | Non-Fugitive | Ce-143 | 7.83E-12 |

| SourceID | FacilityID | Fugitive/Non-Fugitive | Radionuclide | Q (Ci/yr) |
|---|---|---|---|---|
| CFA-625 | CFA | Non-Fugitive | Ce-144 | 6.66E-13 |
| CFA-625 | CFA | Non-Fugitive | Cm-244 | 1.46E-11 |
| CFA-625 | CFA | Non-Fugitive | Co-57 | 7.11E-15 |
| CFA-625 | CFA | Non-Fugitive | Co-58 | 1.65E-10 |
| CFA-625 | CFA | Non-Fugitive | Co-60 | 2.11E-11 |
| CFA-625 | CFA | Non-Fugitive | Cr-51 | 9.63E-13 |
| CFA-625 | CFA | Non-Fugitive | Cs-134 | 2.09E-11 |
| CFA-625 | CFA | Non-Fugitive | Cs-135 | 1.99E-13 |
| CFA-625 | CFA | Non-Fugitive | Cs-136 | 3.51E-12 |
| CFA-625 | CFA | Non-Fugitive | Cs-137 | 3.75E-08 |
| CFA-625 | CFA | Non-Fugitive | Cs-138 | 2.97E-11 |
| CFA-625 | CFA | Non-Fugitive | Cu-67 | 2.05E-15 |
| CFA-625 | CFA | Non-Fugitive | Dy-159 | 3.18E-21 |
| CFA-625 | CFA | Non-Fugitive | Dy-165 | 2.90E-16 |
| CFA-625 | CFA | Non-Fugitive | Dy-166 | 4.74E-16 |
| CFA-625 | CFA | Non-Fugitive | Er-169 | 1.77E-19 |
| CFA-625 | CFA | Non-Fugitive | Eu-152 | 1.08E-13 |
| CFA-625 | CFA | Non-Fugitive | Eu-154 | 2.68E-13 |
| CFA-625 | CFA | Non-Fugitive | Eu-155 | 7.86E-14 |
| CFA-625 | CFA | Non-Fugitive | Eu-156 | 4.38E-14 |
| CFA-625 | CFA | Non-Fugitive | Eu-157 | 1.89E-13 |
| CFA-625 | CFA | Non-Fugitive | Eu-158 | 2.23E-18 |
| CFA-625 | CFA | Non-Fugitive | Fe-55 | 1.05E-12 |
| CFA-625 | CFA | Non-Fugitive | Fe-59 | 5.10E-13 |
| CFA-625 | CFA | Non-Fugitive | Ga-72 | 1.96E-12 |
| CFA-625 | CFA | Non-Fugitive | Ga-73 | 7.74E-12 |
| CFA-625 | CFA | Non-Fugitive | Gd-153 | 4.86E-13 |
| CFA-625 | CFA | Non-Fugitive | Gd-159 | 6.36E-14 |
| CFA-625 | CFA | Non-Fugitive | Ge-75 | 2.33E-16 |
| CFA-625 | CFA | Non-Fugitive | Ge-77 | 7.56E-14 |
| CFA-625 | CFA | Non-Fugitive | Ge-78 | 1.41E-15 |
| CFA-625 | CFA | Non-Fugitive | H-3 | 6.90E-02 |
| CFA-625 | CFA | Non-Fugitive | Hf-175 | 1.74E-14 |
| CFA-625 | CFA | Non-Fugitive | Hf-181 | 6.00E-13 |
| CFA-625 | CFA | Non-Fugitive | Hg-203 | 6.00E-17 |
| CFA-625 | CFA | Non-Fugitive | Ho-166m | 1.38E-20 |
| CFA-625 | CFA | Non-Fugitive | I-125 | 2.32E-20 |
| CFA-625 | CFA | Non-Fugitive | I-126 | 3.66E-21 |
| CFA-625 | CFA | Non-Fugitive | I-128 | 3.30E-13 |
| CFA-625 | CFA | Non-Fugitive | I-129 | 1.29E-18 |
| CFA-625 | CFA | Non-Fugitive | I-130 | 2.15E-15 |
| CFA-625 | CFA | Non-Fugitive | I-131 | 2.51E-12 |
| CFA-625 | CFA | Non-Fugitive | I-132 | 6.24E-12 |

| SourceID | FacilityID | Fugitive/Non-Fugitive | Radionuclide | Q (Ci/yr) |
|---|---|---|---|---|
| CFA-625 | CFA | Non-Fugitive | I-133 | 1.45E-11 |
| CFA-625 | CFA | Non-Fugitive | I-134 | 3.60E-14 |
| CFA-625 | CFA | Non-Fugitive | I-135 | 1.14E-11 |
| CFA-625 | CFA | Non-Fugitive | In-114 | 9.81E-21 |
| CFA-625 | CFA | Non-Fugitive | In-114m | 1.01E-20 |
| CFA-625 | CFA | Non-Fugitive | In-115m | 4.56E-13 |
| CFA-625 | CFA | Non-Fugitive | In-117 | 4.50E-13 |
| CFA-625 | CFA | Non-Fugitive | K-40 | 1.92E-14 |
| CFA-625 | CFA | Non-Fugitive | Kr-83m | 1.79E-11 |
| CFA-625 | CFA | Non-Fugitive | Kr-85 | 6.65E-06 |
| CFA-625 | CFA | Non-Fugitive | Kr-85m | 4.80E-06 |
| CFA-625 | CFA | Non-Fugitive | Kr-87 | 7.08E-05 |
| CFA-625 | CFA | Non-Fugitive | Kr-88 | 3.75E-03 |
| CFA-625 | CFA | Non-Fugitive | La-140 | 1.03E-12 |
| CFA-625 | CFA | Non-Fugitive | La-141 | 5.25E-12 |
| CFA-625 | CFA | Non-Fugitive | La-142 | 1.49E-13 |
| CFA-625 | CFA | Non-Fugitive | Mn-52 | 1.15E-15 |
| CFA-625 | CFA | Non-Fugitive | Mn-54 | 3.42E-13 |
| CFA-625 | CFA | Non-Fugitive | Mn-56 | 5.70E-15 |
| CFA-625 | CFA | Non-Fugitive | Mo-93 | 1.67E-16 |
| CFA-625 | CFA | Non-Fugitive | Mo-99 | 8.19E-12 |
| CFA-625 | CFA | Non-Fugitive | Na-22 | 6.18E-10 |
| CFA-625 | CFA | Non-Fugitive | Na-24 | 2.11E-09 |
| CFA-625 | CFA | Non-Fugitive | Nb-93m | 2.37E-16 |
| CFA-625 | CFA | Non-Fugitive | Nb-94 | 3.90E-20 |
| CFA-625 | CFA | Non-Fugitive | Nb-95 | 1.89E-12 |
| CFA-625 | CFA | Non-Fugitive | Nb-95m | 1.09E-14 |
| CFA-625 | CFA | Non-Fugitive | Nb-96 | 2.02E-16 |
| CFA-625 | CFA | Non-Fugitive | Nb-97 | 1.39E-11 |
| CFA-625 | CFA | Non-Fugitive | Nd-147 | 1.04E-12 |
| CFA-625 | CFA | Non-Fugitive | Nd-149 | 1.03E-13 |
| CFA-625 | CFA | Non-Fugitive | Ni-57 | 8.94E-14 |
| CFA-625 | CFA | Non-Fugitive | Ni-59 | 1.44E-13 |
| CFA-625 | CFA | Non-Fugitive | Ni-63 | 1.41E-11 |
| CFA-625 | CFA | Non-Fugitive | Ni-66 | 8.19E-17 |
| CFA-625 | CFA | Non-Fugitive | Np-237 | 3.60E-12 |
| CFA-625 | CFA | Non-Fugitive | Np-239 | 1.54E-16 |
| CFA-625 | CFA | Non-Fugitive | P-32 | 3.00E-10 |
| CFA-625 | CFA | Non-Fugitive | Pa-231 | 1.51E-20 |
| CFA-625 | CFA | Non-Fugitive | Pa-233 | 1.33E-14 |
| CFA-625 | CFA | Non-Fugitive | Pa-234 | 3.21E-17 |
| CFA-625 | CFA | Non-Fugitive | Pa-234m | 2.02E-14 |
| CFA-625 | CFA | Non-Fugitive | Pb-210 | 6.60E-16 |

| SourceID | FacilityID | Fugitive/Non-Fugitive | Radionuclide | Q (Ci/yr) |
|---|---|---|---|---|
| CFA-625 | CFA | Non-Fugitive | Pb-211 | 8.37E-17 |
| CFA-625 | CFA | Non-Fugitive | Pb-212 | 4.98E-17 |
| CFA-625 | CFA | Non-Fugitive | Pb-214 | 2.34E-16 |
| CFA-625 | CFA | Non-Fugitive | Pd-107 | 6.03E-20 |
| CFA-625 | CFA | Non-Fugitive | Pd-109 | 2.53E-12 |
| CFA-625 | CFA | Non-Fugitive | Pm-146 | 9.90E-22 |
| CFA-625 | CFA | Non-Fugitive | Pm-147 | 1.73E-11 |
| CFA-625 | CFA | Non-Fugitive | Pm-148 | 8.94E-20 |
| CFA-625 | CFA | Non-Fugitive | Pm-148m | 1.85E-18 |
| CFA-625 | CFA | Non-Fugitive | Pm-149 | 2.44E-12 |
| CFA-625 | CFA | Non-Fugitive | Pm-150 | 1.05E-17 |
| CFA-625 | CFA | Non-Fugitive | Pm-151 | 1.73E-12 |
| CFA-625 | CFA | Non-Fugitive | Po-210 | 3.00E-17 |
| CFA-625 | CFA | Non-Fugitive | Po-212 | 3.18E-17 |
| CFA-625 | CFA | Non-Fugitive | Po-215 | 8.37E-17 |
| CFA-625 | CFA | Non-Fugitive | Po-216 | 4.98E-17 |
| CFA-625 | CFA | Non-Fugitive | Pr-143 | 8.73E-13 |
| CFA-625 | CFA | Non-Fugitive | Pr-144 | 5.43E-13 |
| CFA-625 | CFA | Non-Fugitive | Pr-144m | 4.41E-15 |
| CFA-625 | CFA | Non-Fugitive | Pr-145 | 5.82E-12 |
| CFA-625 | CFA | Non-Fugitive | Pu-238 | 6.33E-15 |
| CFA-625 | CFA | Non-Fugitive | Pu-239 | 1.28E-11 |
| CFA-625 | CFA | Non-Fugitive | Pu-240 | 1.25E-12 |
| CFA-625 | CFA | Non-Fugitive | Pu-241 | 8.67E-14 |
| CFA-625 | CFA | Non-Fugitive | Pu-242 | 9.72E-14 |
| CFA-625 | CFA | Non-Fugitive | Pu-244 | 2.55E-23 |
| CFA-625 | CFA | Non-Fugitive | Ra-223 | 8.37E-17 |
| CFA-625 | CFA | Non-Fugitive | Ra-224 | 4.98E-17 |
| CFA-625 | CFA | Non-Fugitive | Ra-226 | 3.00E-15 |
| CFA-625 | CFA | Non-Fugitive | Rb-83 | 7.20E-18 |
| CFA-625 | CFA | Non-Fugitive | Rb-84 | 8.28E-17 |
| CFA-625 | CFA | Non-Fugitive | Rb-86 | 6.39E-15 |
| CFA-625 | CFA | Non-Fugitive | Rb-88 | 1.27E-09 |
| CFA-625 | CFA | Non-Fugitive | Rb-89 | 3.30E-11 |
| CFA-625 | CFA | Non-Fugitive | Re-188 | 5.40E-15 |
| CFA-625 | CFA | Non-Fugitive | Rh-102 | 1.75E-21 |
| CFA-625 | CFA | Non-Fugitive | Rh-102m | 4.23E-22 |
| CFA-625 | CFA | Non-Fugitive | Rh-103m | 7.23E-13 |
| CFA-625 | CFA | Non-Fugitive | Rh-105 | 6.69E-12 |
| CFA-625 | CFA | Non-Fugitive | Rh-106 | 4.23E-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 | 1.11E-12 |

| SourceID | FacilityID | Fugitive/Non-Fugitive | Radionuclide | Q (Ci/yr) |
|---|---|---|---|---|
| CFA-625 | CFA | Non-Fugitive | Ru-105 | 4.56E-12 |
| CFA-625 | CFA | Non-Fugitive | Ru-106 | 4.26E-13 |
| CFA-625 | CFA | Non-Fugitive | Sb-122 | 1.98E-17 |
| CFA-625 | CFA | Non-Fugitive | Sb-124 | 2.67E-14 |
| CFA-625 | CFA | Non-Fugitive | Sb-125 | 1.57E-13 |
| CFA-625 | CFA | Non-Fugitive | Sb-126 | 1.68E-15 |
| CFA-625 | CFA | Non-Fugitive | Sb-126m | 1.15E-18 |
| CFA-625 | CFA | Non-Fugitive | Sb-127 | 1.71E-12 |
| CFA-625 | CFA | Non-Fugitive | Sb-128 | 4.98E-13 |
| CFA-625 | CFA | Non-Fugitive | Sb-129 | 2.76E-12 |
| CFA-625 | CFA | Non-Fugitive | Sb-130 | 7.80E-18 |
| CFA-625 | CFA | Non-Fugitive | Sc-46 | 4.89E-15 |
| CFA-625 | CFA | Non-Fugitive | Sc-47 | 1.76E-12 |
| CFA-625 | CFA | Non-Fugitive | Sc-48 | 6.96E-15 |
| CFA-625 | CFA | Non-Fugitive | Se-79 | 8.55E-20 |
| CFA-625 | CFA | Non-Fugitive | Se-81 | 1.77E-17 |
| CFA-625 | CFA | Non-Fugitive | Sm-151 | 1.08E-15 |
| CFA-625 | CFA | Non-Fugitive | Sm-153 | 6.81E-13 |
| CFA-625 | CFA | Non-Fugitive | Sm-156 | 2.74E-13 |
| CFA-625 | CFA | Non-Fugitive | Sn-113 | 3.21E-15 |
| CFA-625 | CFA | Non-Fugitive | Sn-117m | 2.96E-18 |
| CFA-625 | CFA | Non-Fugitive | Sn-119m | 5.85E-15 |
| CFA-625 | CFA | Non-Fugitive | Sn-121 | 1.42E-12 |
| CFA-625 | CFA | Non-Fugitive | Sn-121m | 3.33E-16 |
| CFA-625 | CFA | Non-Fugitive | Sn-123 | 2.27E-14 |
| CFA-625 | CFA | Non-Fugitive | Sn-125 | 1.07E-13 |
| CFA-625 | CFA | Non-Fugitive | Sn-126 | 1.15E-18 |
| CFA-625 | CFA | Non-Fugitive | Sn-127 | 1.10E-13 |
| CFA-625 | CFA | Non-Fugitive | Sn-128 | 1.56E-15 |
| CFA-625 | CFA | Non-Fugitive | Sr-85 | 3.54E-16 |
| CFA-625 | CFA | Non-Fugitive | Sr-89 | 6.75E-13 |
| CFA-625 | CFA | Non-Fugitive | Sr-90 | 2.10E-12 |
| CFA-625 | CFA | Non-Fugitive | Sr-91 | 9.57E-12 |
| CFA-625 | CFA | Non-Fugitive | Sr-92 | 1.77E-12 |
| CFA-625 | CFA | Non-Fugitive | Ta-182 | 1.53E-14 |
| CFA-625 | CFA | Non-Fugitive | Ta-183 | 2.97E-13 |
| CFA-625 | CFA | Non-Fugitive | Tb-157 | 3.09E-22 |
| CFA-625 | CFA | Non-Fugitive | Tb-158 | 2.06E-21 |
| CFA-625 | CFA | Non-Fugitive | Tb-160 | 2.95E-17 |
| CFA-625 | CFA | Non-Fugitive | Tb-161 | 3.36E-15 |
| CFA-625 | CFA | Non-Fugitive | Tc-97m | 1.28E-21 |
| CFA-625 | CFA | Non-Fugitive | Tc-99 | 2.00E-14 |
| CFA-625 | CFA | Non-Fugitive | Tc-99m | 2.83E-12 |

| SourceID | FacilityID | Fugitive/Non-Fugitive | Radionuclide | Q (Ci/yr) |
|---|---|---|---|---|
| CFA-625 | CFA | Non-Fugitive | Te-123m | 2.60E-17 |
| CFA-625 | CFA | Non-Fugitive | Te-125m | 1.76E-14 |
| CFA-625 | CFA | Non-Fugitive | Te-127 | 2.90E-12 |
| CFA-625 | CFA | Non-Fugitive | Te-127m | 1.70E-12 |
| CFA-625 | CFA | Non-Fugitive | Te-129 | 3.24E-12 |
| CFA-625 | CFA | Non-Fugitive | Te-129m | 7.17E-14 |
| CFA-625 | CFA | Non-Fugitive | Te-131 | 2.10E-13 |
| CFA-625 | CFA | Non-Fugitive | Te-131m | 1.75E-13 |
| CFA-625 | CFA | Non-Fugitive | Te-132 | 6.03E-12 |
| CFA-625 | CFA | Non-Fugitive | Te-133 | 2.94E-16 |
| CFA-625 | CFA | Non-Fugitive | Te-134 | 5.97E-17 |
| CFA-625 | CFA | Non-Fugitive | Th-227 | 8.25E-17 |
| CFA-625 | CFA | Non-Fugitive | Th-228 | 5.04E-17 |
| CFA-625 | CFA | Non-Fugitive | Th-230 | 8.82E-18 |
| CFA-625 | CFA | Non-Fugitive | Th-231 | 3.27E-14 |
| CFA-625 | CFA | Non-Fugitive | Th-234 | 2.02E-14 |
| CFA-625 | CFA | Non-Fugitive | Tl-207 | 8.34E-17 |
| CFA-625 | CFA | Non-Fugitive | Tl-208 | 1.78E-17 |
| CFA-625 | CFA | Non-Fugitive | Tm-168 | 9.27E-21 |
| CFA-625 | CFA | Non-Fugitive | Tm-170 | 7.71E-19 |
| CFA-625 | CFA | Non-Fugitive | Tm-171 | 1.62E-16 |
| CFA-625 | CFA | Non-Fugitive | U-232 | 9.84E-15 |
| CFA-625 | CFA | Non-Fugitive | U-233 | 2.02E-15 |
| CFA-625 | CFA | Non-Fugitive | U-234 | 6.57E-12 |
| CFA-625 | CFA | Non-Fugitive | U-235 | 2.41E-13 |
| CFA-625 | CFA | Non-Fugitive | U-236 | 1.99E-13 |
| CFA-625 | CFA | Non-Fugitive | U-237 | 1.19E-10 |
| CFA-625 | CFA | Non-Fugitive | U-238 | 3.57E-13 |
| CFA-625 | CFA | Non-Fugitive | V-48 | 3.72E-15 |
| CFA-625 | CFA | Non-Fugitive | W-187 | 3.60E-15 |
| CFA-625 | CFA | Non-Fugitive | Xe-127 | 2.33E-12 |
| CFA-625 | CFA | Non-Fugitive | Xe-131m | 1.82E-07 |
| CFA-625 | CFA | Non-Fugitive | Xe-133 | 1.26E-02 |
| CFA-625 | CFA | Non-Fugitive | Xe-133m | 4.13E-04 |
| CFA-625 | CFA | Non-Fugitive | Xe-135 | 6.30E-02 |
| CFA-625 | CFA | Non-Fugitive | Xe-135m | 7.30E-06 |
| CFA-625 | CFA | Non-Fugitive | Xe-138 | 5.90E-05 |
| CFA-625 | CFA | Non-Fugitive | Y-88 | 1.71E-16 |
| CFA-625 | CFA | Non-Fugitive | Y-89m | 2.41E-17 |
| CFA-625 | CFA | Non-Fugitive | Y-90 | 8.91E-13 |
| CFA-625 | CFA | Non-Fugitive | Y-91 | 7.65E-13 |
| CFA-625 | CFA | Non-Fugitive | Y-91m | 7.29E-14 |
| CFA-625 | CFA | Non-Fugitive | Y-92 | 9.33E-12 |

| SourceID | FacilityID | Fugitive/Non-Fugitive | Radionuclide | Q (Ci/yr) |
|---|---|---|---|---|
| CFA-625 | CFA | Non-Fugitive | Y-93 | 1.13E-11 |
| CFA-625 | CFA | Non-Fugitive | Zn-65 | 9.45E-14 |
| CFA-625 | CFA | Non-Fugitive | Zn-69 | 2.35E-18 |
| CFA-625 | CFA | Non-Fugitive | Zn-69m | 2.82E-18 |
| CFA-625 | CFA | Non-Fugitive | Zn-72 | 3.21E-15 |
| CFA-625 | CFA | Non-Fugitive | Zr-93 | 5.10E-19 |
| CFA-625 | CFA | Non-Fugitive | Zr-95 | 1.51E-12 |
| CFA-625 | CFA | Non-Fugitive | Zr-97 | 1.30E-11 |
| CFA-Tritium | CFA | Fugitive | H-3 | 4.50E-01 |
| PBF-612 | CITRC | Fugitive | Ga-68 | 1.50E-08 |
| PBF-612 | CITRC | Fugitive | Tc-99m | 5.00E-12 |
| PBF-623 | CITRC | Fugitive | Ga-68 | 7.00E-09 |
| PBF-623 | CITRC | Fugitive | Tc-99m | 1.00E-12 |
| CPP-1608-001 | INTEC | Non-Fugitive | Am-241 | 3.01E-12 |
| CPP-1608-001 | INTEC | Non-Fugitive | Cm-242 | 1.00E-13 |
| CPP-1608-001 | INTEC | Non-Fugitive | Cm-244 | 6.16E-14 |
| CPP-1608-001 | INTEC | Non-Fugitive | Co-60 | 5.73E-14 |
| CPP-1608-001 | INTEC | Non-Fugitive | Cs-137 | 1.45E-11 |
| CPP-1608-001 | INTEC | Non-Fugitive | Eu-154 | 2.32E-14 |
| CPP-1608-001 | INTEC | Non-Fugitive | Np-237 | 6.22E-17 |
| CPP-1608-001 | INTEC | Non-Fugitive | Pu-238 | 5.71E-13 |
| CPP-1608-001 | INTEC | Non-Fugitive | Pu-239 | 5.86E-12 |
| CPP-1608-001 | INTEC | Non-Fugitive | Pu-240 | 4.06E-13 |
| CPP-1608-001 | INTEC | Non-Fugitive | Pu-241 | 2.99E-13 |
| CPP-1608-001 | INTEC | Non-Fugitive | Pu-242 | 2.08E-16 |
| CPP-1608-001 | INTEC | Non-Fugitive | Sr-90 | 1.52E-11 |
| CPP-1608-001 | INTEC | Non-Fugitive | U-233 | 3.06E-14 |
| CPP-1608-001 | INTEC | Non-Fugitive | U-234 | 1.22E-14 |
| CPP-1608-001 | INTEC | Non-Fugitive | U-235 | 1.45E-16 |
| CPP-1608-001 | INTEC | Non-Fugitive | U-238 | 9.34E-17 |
| 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 | 2.52E-04 |
| CPP-603-001 | INTEC | Non-Fugitive | Ag-108m | 1.31E-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 | 4.23E-17 |
| CPP-603-001 | INTEC | Non-Fugitive | Co-60 | 1.53E-16 |
| CPP-603-001 | INTEC | Non-Fugitive | Cs-137 | 1.29E-14 |
| CPP-603-001 | INTEC | Non-Fugitive | Eu-152 | 1.33E-16 |
| CPP-603-001 | INTEC | Non-Fugitive | Ni-63 | 4.51E-16 |
| CPP-603-001 | INTEC | Non-Fugitive | Pu-238 | 7.29E-17 |

| SourceID | FacilityID | Fugitive/Non-Fugitive | Radionuclide | Q (Ci/yr) |
|---|---|---|---|---|
| CPP-603-001 | INTEC | Non-Fugitive | Pu-239 | 1.33E-17 |
| CPP-603-001 | INTEC | Non-Fugitive | Ru-106 | 1.02E-16 |
| CPP-603-001 | INTEC | Non-Fugitive | Sb-125 | 1.13E-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 | 6.53E-17 |
| CPP-653-001 | INTEC | Non-Fugitive | U-234 | 1.93E-12 |
| CPP-653-001 | INTEC | Non-Fugitive | U-235 | 3.69E-14 |
| CPP-653-001 | INTEC | Non-Fugitive | U-238 | 8.73E-17 |
| CPP-659-033 | INTEC | Non-Fugitive | Cs-137 | 5.07E-08 |
| CPP-659-033 | INTEC | Non-Fugitive | Sr-90 | 6.36E-08 |
| CPP-659-033 | INTEC | Non-Fugitive | U-238 | 6.33E-10 |
| 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 |
| 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 | 8.05E-03 |
| CPP-767-001 | INTEC | Non-Fugitive | Sr-90 | 1.33E-07 |
| ICDF-Landfill | INTEC | Fugitive | Am-241 | 3.14E-04 |
| ICDF-Landfill | INTEC | Fugitive | C-14 | 3.15E-02 |
| ICDF-Landfill | INTEC | Fugitive | Cl-36 | 4.08E-06 |
| ICDF-Landfill | INTEC | Fugitive | Co-60 | 1.64E-05 |
| ICDF-Landfill | INTEC | Fugitive | Cs-137 | 1.91E-04 |
| ICDF-Landfill | INTEC | Fugitive | Pu-238 | 2.12E-06 |
| ICDF-Landfill | INTEC | Fugitive | Pu-239 | 1.16E-04 |
| ICDF-Landfill | INTEC | Fugitive | Pu-240 | 1.15E-04 |
| ICDF-Landfill | INTEC | Fugitive | Pu-241 | 1.00E-04 |

| SourceID | FacilityID | Fugitive/Non-Fugitive | Radionuclide | Q (Ci/yr) |
|---|---|---|---|---|
| ICDF-Landfill | INTEC | Fugitive | Sr-90 | 4.74E-05 |
| ICDF-Ponds | INTEC | Fugitive | C-14 | 4.90E-06 |
| ICDF-Ponds | INTEC | Fugitive | Cl-36 | 9.44E-07 |
| ICDF-Ponds | INTEC | Fugitive | Cs-137 | 2.57E-05 |
| ICDF-Ponds | INTEC | Fugitive | H-3 | 8.45E-03 |
| ICDF-Ponds | INTEC | Fugitive | I-129 | 3.31E-05 |
| ICDF-Ponds | INTEC | Fugitive | Sr-90 | 5.19E-06 |
| ICDF-Ponds | INTEC | Fugitive | Tc-99 | 4.61E-08 |
| ICDF-Ponds | INTEC | Fugitive | U-234 | 1.76E-07 |
| ICDF-Ponds | INTEC | Fugitive | U-235 | 1.02E-08 |
| ICDF-Ponds | INTEC | Fugitive | U-238 | 1.28E-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 | 3.10E-07 |
| 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 | 1.28E-03 |
| 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 | 9.81E-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 |
| MFC-1702-001 | MFC | Non-Fugitive | Am-241 | 2.77E-11 |
| MFC-1702-001 | MFC | Non-Fugitive | Am-243 | 2.64E-11 |
| MFC-1702-001 | MFC | Non-Fugitive | Cd-109 | 1.06E-05 |
| MFC-1702-001 | MFC | Non-Fugitive | Ce-141 | 1.32E-12 |
| MFC-1702-001 | MFC | Non-Fugitive | Ce-144 | 2.11E-12 |
| MFC-1702-001 | MFC | Non-Fugitive | Cl-36 | 2.54E-05 |
| MFC-1702-001 | MFC | Non-Fugitive | Co-60 | 1.97E-12 |
| MFC-1702-001 | MFC | Non-Fugitive | Cs-134 | 8.61E-06 |
| MFC-1702-001 | MFC | Non-Fugitive | Cs-135 | 5.83E-06 |
| MFC-1702-001 | MFC | Non-Fugitive | Cs-137 | 2.60E-01 |
| 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 | 8.49E-09 |
| MFC-1702-001 | MFC | Non-Fugitive | Pm-147 | 1.05E-11 |
| MFC-1702-001 | MFC | Non-Fugitive | Pu-238 | 1.60E-08 |
| MFC-1702-001 | MFC | Non-Fugitive | Pu-239 | 1.73E-09 |
| MFC-1702-001 | MFC | Non-Fugitive | Pu-240 | 3.58E-11 |

| SourceID | FacilityID | Fugitive/Non-Fugitive | Radionuclide | Q (Ci/yr) |
|---|---|---|---|---|
| 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 | 3.90E-11 |
| MFC-1702-001 | MFC | Non-Fugitive | U-234 | 4.18E-12 |
| MFC-1702-001 | MFC | Non-Fugitive | Y-90 | 6.51E-11 |
| MFC-1729-001 | MFC | Non-Fugitive | Pu-239 | 2.34E-08 |
| MFC-1729-001 | MFC | Non-Fugitive | Sr-90 | 3.02E-07 |
| MFC-704-008 | MFC | Non-Fugitive | Pu-239 | 1.28E-08 |
| MFC-704-008 | MFC | Non-Fugitive | Sr-90 | 7.32E-08 |
| MFC-752-004 | MFC | Non-Fugitive | I-131 | 1.70E-06 |
| MFC-752-004 | MFC | Non-Fugitive | Pu-239 | 4.52E-08 |
| MFC-752-004 | MFC | Non-Fugitive | Sr-90 | 5.53E-07 |
| MFC-752-005 | MFC | Non-Fugitive | Pu-239 | 2.29E-08 |
| MFC-752-005 | MFC | Non-Fugitive | Sr-90 | 5.23E-08 |
| MFC-768-105 | MFC | Non-Fugitive | H-3 | 1.90E-04 |
| MFC-768-108 | MFC | Non-Fugitive | H-3 | 1.43E-03 |
| MFC-774-026 | MFC | Non-Fugitive | Cd-109 | 1.31E-03 |
| MFC-774-026 | MFC | Non-Fugitive | Cd-115m | 7.91E-05 |
| MFC-774-026 | MFC | Non-Fugitive | Ce-141 | 5.24E-11 |
| MFC-774-026 | MFC | Non-Fugitive | Ce-144 | 8.01E-11 |
| MFC-774-026 | MFC | Non-Fugitive | Cl-36 | 1.79E-03 |
| MFC-774-026 | MFC | Non-Fugitive | Cs-134 | 8.19E-12 |
| MFC-774-026 | MFC | Non-Fugitive | Cs-137 | 8.65E-11 |
| MFC-774-026 | MFC | Non-Fugitive | Eu-154 | 1.45E-12 |
| MFC-774-026 | MFC | Non-Fugitive | H-3 | 9.08E-02 |
| MFC-774-026 | MFC | Non-Fugitive | I-129 | 9.35E-07 |
| MFC-774-026 | MFC | Non-Fugitive | I-131 | 2.35E-02 |
| MFC-774-026 | MFC | Non-Fugitive | Kr-85 | 1.58E-02 |
| MFC-774-026 | MFC | Non-Fugitive | Na-22 | 8.62E-06 |
| MFC-774-026 | MFC | Non-Fugitive | Na-24 | 1.38E-04 |
| MFC-774-026 | MFC | Non-Fugitive | P-32 | 2.16E-04 |
| MFC-774-026 | MFC | Non-Fugitive | P-33 | 1.26E-07 |
| MFC-774-026 | MFC | Non-Fugitive | Pu-238 | 1.54E-12 |
| MFC-774-026 | MFC | Non-Fugitive | Pu-239 | 1.40E-12 |
| MFC-774-026 | MFC | Non-Fugitive | Pu-241 | 1.34E-11 |
| MFC-774-026 | MFC | Non-Fugitive | Rn-220 | 1.71E-09 |
| MFC-774-026 | MFC | Non-Fugitive | S-35 | 5.32E-04 |
| MFC-774-026 | MFC | Non-Fugitive | Sb-125 | 1.12E-11 |
| MFC-774-026 | MFC | Non-Fugitive | Sr-89 | 4.68E-11 |

| SourceID | FacilityID | Fugitive/Non-Fugitive | Radionuclide | Q (Ci/yr) |
|---|---|---|---|---|
| MFC-774-026 | MFC | Non-Fugitive | Sr-90 | 7.17E-11 |
| MFC-774-026 | MFC | Non-Fugitive | Te-129m | 1.08E-02 |
| MFC-774-026 | MFC | Non-Fugitive | Zn-65 | 8.31E-02 |
| MFC-774-027 | MFC | Non-Fugitive | Cd-109 | 1.31E-03 |
| MFC-774-027 | MFC | Non-Fugitive | Cd-115m | 7.91E-05 |
| MFC-774-027 | MFC | Non-Fugitive | Ce-141 | 5.24E-11 |
| MFC-774-027 | MFC | Non-Fugitive | Ce-144 | 8.01E-11 |
| MFC-774-027 | MFC | Non-Fugitive | Cl-36 | 1.79E-03 |
| MFC-774-027 | MFC | Non-Fugitive | Cs-134 | 8.19E-12 |
| MFC-774-027 | MFC | Non-Fugitive | Cs-137 | 8.65E-11 |
| MFC-774-027 | MFC | Non-Fugitive | Eu-154 | 1.45E-12 |
| MFC-774-027 | MFC | Non-Fugitive | H-3 | 9.08E-02 |
| MFC-774-027 | MFC | Non-Fugitive | I-129 | 9.35E-07 |
| MFC-774-027 | MFC | Non-Fugitive | I-131 | 2.35E-02 |
| MFC-774-027 | MFC | Non-Fugitive | Kr-85 | 1.58E-02 |
| MFC-774-027 | MFC | Non-Fugitive | Na-22 | 8.62E-06 |
| MFC-774-027 | MFC | Non-Fugitive | Na-24 | 1.38E-04 |
| MFC-774-027 | MFC | Non-Fugitive | P-32 | 2.16E-04 |
| MFC-774-027 | MFC | Non-Fugitive | P-33 | 1.26E-07 |
| MFC-774-027 | MFC | Non-Fugitive | Pu-238 | 1.54E-12 |
| MFC-774-027 | MFC | Non-Fugitive | Pu-239 | 1.40E-12 |
| MFC-774-027 | MFC | Non-Fugitive | Pu-241 | 1.34E-11 |
| MFC-774-027 | MFC | Non-Fugitive | Rn-220 | 1.71E-09 |
| MFC-774-027 | MFC | Non-Fugitive | S-35 | 5.32E-04 |
| MFC-774-027 | MFC | Non-Fugitive | Sb-125 | 1.12E-11 |
| MFC-774-027 | MFC | Non-Fugitive | Sr-89 | 4.68E-11 |
| MFC-774-027 | MFC | Non-Fugitive | Sr-90 | 7.17E-11 |
| MFC-774-027 | MFC | Non-Fugitive | Te-129m | 1.08E-02 |
| MFC-774-027 | MFC | Non-Fugitive | Zn-65 | 8.31E-02 |
| MFC-774-028 | MFC | Non-Fugitive | Cd-109 | 1.31E-03 |
| MFC-774-028 | MFC | Non-Fugitive | Cd-115m | 7.91E-05 |
| MFC-774-028 | MFC | Non-Fugitive | Ce-141 | 5.24E-11 |
| MFC-774-028 | MFC | Non-Fugitive | Ce-144 | 8.01E-11 |
| MFC-774-028 | MFC | Non-Fugitive | Cl-36 | 1.79E-03 |
| MFC-774-028 | MFC | Non-Fugitive | Cs-134 | 8.19E-12 |
| MFC-774-028 | MFC | Non-Fugitive | Cs-137 | 8.65E-11 |
| MFC-774-028 | MFC | Non-Fugitive | Eu-154 | 1.45E-12 |
| MFC-774-028 | MFC | Non-Fugitive | H-3 | 9.08E-02 |
| MFC-774-028 | MFC | Non-Fugitive | I-129 | 9.35E-07 |
| MFC-774-028 | MFC | Non-Fugitive | I-131 | 2.35E-02 |
| MFC-774-028 | MFC | Non-Fugitive | Kr-85 | 1.58E-02 |
| MFC-774-028 | MFC | Non-Fugitive | Na-22 | 8.62E-06 |
| MFC-774-028 | MFC | Non-Fugitive | Na-24 | 1.38E-04 |

| SourceID | FacilityID | Fugitive/Non-Fugitive | Radionuclide | Q (Ci/yr) |
|---|---|---|---|---|
| MFC-774-028 | MFC | Non-Fugitive | P-32 | 2.16E-04 |
| MFC-774-028 | MFC | Non-Fugitive | P-33 | 1.26E-07 |
| MFC-774-028 | MFC | Non-Fugitive | Pu-238 | 1.54E-12 |
| MFC-774-028 | MFC | Non-Fugitive | Pu-239 | 1.40E-12 |
| MFC-774-028 | MFC | Non-Fugitive | Pu-241 | 1.34E-11 |
| MFC-774-028 | MFC | Non-Fugitive | Rn-220 | 1.71E-09 |
| MFC-774-028 | MFC | Non-Fugitive | S-35 | 5.32E-04 |
| MFC-774-028 | MFC | Non-Fugitive | Sb-125 | 1.12E-11 |
| MFC-774-028 | MFC | Non-Fugitive | Sr-89 | 4.68E-11 |
| MFC-774-028 | MFC | Non-Fugitive | Sr-90 | 7.17E-11 |
| MFC-774-028 | MFC | Non-Fugitive | Te-129m | 1.08E-02 |
| MFC-774-028 | MFC | Non-Fugitive | Zn-65 | 8.31E-02 |
| MFC-774-029 | MFC | Non-Fugitive | Cd-109 | 1.31E-03 |
| MFC-774-029 | MFC | Non-Fugitive | Cd-115m | 7.91E-05 |
| MFC-774-029 | MFC | Non-Fugitive | Ce-141 | 5.24E-11 |
| MFC-774-029 | MFC | Non-Fugitive | Ce-144 | 8.01E-11 |
| MFC-774-029 | MFC | Non-Fugitive | Cl-36 | 1.79E-03 |
| MFC-774-029 | MFC | Non-Fugitive | Cs-134 | 8.19E-12 |
| MFC-774-029 | MFC | Non-Fugitive | Cs-137 | 8.65E-11 |
| MFC-774-029 | MFC | Non-Fugitive | Eu-154 | 1.45E-12 |
| MFC-774-029 | MFC | Non-Fugitive | H-3 | 9.08E-02 |
| MFC-774-029 | MFC | Non-Fugitive | I-129 | 9.35E-07 |
| MFC-774-029 | MFC | Non-Fugitive | I-131 | 2.35E-02 |
| MFC-774-029 | MFC | Non-Fugitive | Kr-85 | 1.58E-02 |
| MFC-774-029 | MFC | Non-Fugitive | Na-22 | 8.62E-06 |
| MFC-774-029 | MFC | Non-Fugitive | Na-24 | 1.38E-04 |
| MFC-774-029 | MFC | Non-Fugitive | P-32 | 2.16E-04 |
| MFC-774-029 | MFC | Non-Fugitive | P-33 | 1.26E-07 |
| MFC-774-029 | MFC | Non-Fugitive | Pu-238 | 1.54E-12 |
| MFC-774-029 | MFC | Non-Fugitive | Pu-239 | 1.40E-12 |
| MFC-774-029 | MFC | Non-Fugitive | Pu-241 | 1.34E-11 |
| MFC-774-029 | MFC | Non-Fugitive | Rn-220 | 1.71E-09 |
| MFC-774-029 | MFC | Non-Fugitive | S-35 | 5.32E-04 |
| MFC-774-029 | MFC | Non-Fugitive | Sb-125 | 1.12E-11 |
| MFC-774-029 | MFC | Non-Fugitive | Sr-89 | 4.68E-11 |
| MFC-774-029 | MFC | Non-Fugitive | Sr-90 | 7.17E-11 |
| MFC-774-029 | MFC | Non-Fugitive | Te-129m | 1.08E-02 |
| MFC-774-029 | MFC | Non-Fugitive | Zn-65 | 8.31E-02 |
| MFC-777-002 | MFC | Non-Fugitive | Pu-239 | 1.80E-08 |
| MFC-777-002 | MFC | Non-Fugitive | Sr-90 | 5.38E-08 |
| MFC-784-001 | MFC | Non-Fugitive | U-234 | 6.52E-02 |
| MFC-784-001 | MFC | Non-Fugitive | U-235 | 2.19E-02 |
| MFC-784-001 | MFC | Non-Fugitive | U-238 | 1.10E-01 |

| SourceID | FacilityID | Fugitive/Non-Fugitive | Radionuclide | Q (Ci/yr) |
|---|---|---|---|---|
| MFC-785-018 | MFC | Non-Fugitive | Pu-239 | 8.52E-08 |
| MFC-785-018 | MFC | Non-Fugitive | Sr-90 | 1.05E-06 |
| MFC-787-001 | MFC | Non-Fugitive | Pu-239 | 1.62E-08 |
| MFC-787-001 | MFC | Non-Fugitive | Sr-90 | 1.28E-07 |
| MFC-792A-001 | MFC | Non-Fugitive | Pu-238 | 1.41E-17 |
| MFC-792A-001 | MFC | Non-Fugitive | Pu-239 | 2.76E-18 |
| MFC-792A-001 | MFC | Non-Fugitive | Pu-240 | 3.45E-19 |
| MFC-793-001 | MFC | Non-Fugitive | Pu-239 | 2.30E-10 |
| MFC-793-001 | MFC | Non-Fugitive | Sr-90 | 2.17E-09 |
| MFC-794-002 | MFC | Non-Fugitive | U-234 | 2.10E-08 |
| MFC-794-002 | MFC | Non-Fugitive | U-235 | 7.05E-10 |
| MFC-794-002 | MFC | Non-Fugitive | U-238 | 3.09E-08 |
| MFC-794-006 | MFC | Non-Fugitive | Pu-239 | 3.05E-09 |
| MFC-794-006 | MFC | Non-Fugitive | Sr-90 | 1.75E-08 |
| MFC-764-001 | MFC-MS | Non-Fugitive | Pu-239 | 1.74E-08 |
| MFC-764-001 | MFC-MS | Non-Fugitive | Sr-90 | 9.05E-08 |
| MFC-720-007 | MFC-TREAT | Non-Fugitive | Ar-41 | 8.09E+01 |
| MFC-720-007 | MFC-TREAT | Non-Fugitive | Cs-139 | 6.79E-01 |
| MFC-720-007 | MFC-TREAT | Non-Fugitive | Cs-140 | 6.89E-01 |
| MFC-720-007 | MFC-TREAT | Non-Fugitive | Kr-85m | 9.99E+00 |
| MFC-720-007 | MFC-TREAT | Non-Fugitive | Kr-87 | 1.05E+01 |
| MFC-720-007 | MFC-TREAT | Non-Fugitive | Kr-88 | 9.51E+00 |
| MFC-720-007 | MFC-TREAT | Non-Fugitive | Kr-89 | 3.42E+01 |
| MFC-720-007 | MFC-TREAT | Non-Fugitive | Pu-239 | 8.20E-09 |
| MFC-720-007 | MFC-TREAT | Non-Fugitive | Rb-90 | 5.36E+00 |
| MFC-720-007 | MFC-TREAT | Non-Fugitive | Sr-91 | 1.14E-03 |
| MFC-720-007 | MFC-TREAT | Non-Fugitive | Sr-92 | 6.24E-07 |
| MFC-720-007 | MFC-TREAT | Non-Fugitive | Xe-133 | 2.09E-01 |
| MFC-720-007 | MFC-TREAT | Non-Fugitive | Xe-135 | 2.62E+00 |
| MFC-720-007 | MFC-TREAT | Non-Fugitive | Xe-135m | 2.71E-01 |
| MFC-720-007 | MFC-TREAT | Non-Fugitive | Xe-137 | 1.52E+01 |
| MFC-720-007 | MFC-TREAT | Non-Fugitive | Xe-138 | 1.62E+01 |
| NRF | NRF | Fugitive | Cs-137 | 6.3E-05 |
| NRF | NRF | Non-Fugitive | C-14 | 5.5E-01 |
| NRF | NRF | Non-Fugitive | H-3 | 1.1E-02 |
| NRF | NRF | Non-Fugitive | I-129 | 1.2E-05 |
| NRF | NRF | Non-Fugitive | I-131 | 5.2E-06 |
| NRF | NRF | Non-Fugitive | Kr-85 | 5.3E-03 |
| NRF | NRF | Non-Fugitive | Pu-239 | 3.8E-06 |
| NRF | NRF | Non-Fugitive | Sr-90 | 6.9E-05 |
| 670-074 | RTC | Non-Fugitive | Ba-141 | 2.56E-09 |
| 670-074 | RTC | Non-Fugitive | Ce-144 | 6.44E-12 |
| 670-074 | RTC | Non-Fugitive | Co-58 | 1.43E-12 |

| SourceID | FacilityID | Fugitive/Non-Fugitive | Radionuclide | Q (Ci/yr) |
|---|---|---|---|---|
| 670-074 | RTC | Non-Fugitive | Co-60 | 1.77E-11 |
| 670-074 | RTC | Non-Fugitive | Cr-51 | 1.53E-09 |
| 670-074 | RTC | Non-Fugitive | H-3 | 2.40E-02 |
| 670-074 | RTC | Non-Fugitive | Hf-181 | 1.02E-12 |
| 670-074 | RTC | Non-Fugitive | I-128 | 3.05E-05 |
| 670-074 | RTC | Non-Fugitive | I-131 | 4.53E-08 |
| 670-074 | RTC | Non-Fugitive | I-133 | 5.58E-08 |
| 670-074 | RTC | Non-Fugitive | I-135 | 2.51E-07 |
| 670-074 | RTC | Non-Fugitive | Mn-54 | 1.18E-12 |
| 670-074 | RTC | Non-Fugitive | Mo-99 | 2.13E-12 |
| 670-074 | RTC | Non-Fugitive | Na-24 | 1.71E-08 |
| 670-074 | RTC | Non-Fugitive | Re-188 | 7.63E-12 |
| 670-074 | RTC | Non-Fugitive | Sr-91 | 8.83E-11 |
| 670-074 | RTC | Non-Fugitive | Sr-92 | 5.02E-11 |
| 670-074 | RTC | Non-Fugitive | Tc-99m | 1.04E-09 |
| 670-086 | RTC | Non-Fugitive | Ba-141 | 1.35E-05 |
| 670-086 | RTC | Non-Fugitive | Ce-144 | 3.41E-08 |
| 670-086 | RTC | Non-Fugitive | Co-58 | 7.58E-09 |
| 670-086 | RTC | Non-Fugitive | Co-60 | 9.34E-08 |
| 670-086 | RTC | Non-Fugitive | Cr-51 | 8.08E-06 |
| 670-086 | RTC | Non-Fugitive | Cs-137 | 8.42E-06 |
| 670-086 | RTC | Non-Fugitive | H-3 | 3.81E-02 |
| 670-086 | RTC | Non-Fugitive | Hf-181 | 5.42E-09 |
| 670-086 | RTC | Non-Fugitive | I-128 | 4.84E-05 |
| 670-086 | RTC | Non-Fugitive | I-131 | 1.69E-06 |
| 670-086 | RTC | Non-Fugitive | I-133 | 8.85E-08 |
| 670-086 | RTC | Non-Fugitive | I-135 | 3.99E-07 |
| 670-086 | RTC | Non-Fugitive | Kr-88 | 5.18E-03 |
| 670-086 | RTC | Non-Fugitive | Mn-54 | 6.23E-09 |
| 670-086 | RTC | Non-Fugitive | Mo-99 | 1.12E-08 |
| 670-086 | RTC | Non-Fugitive | Na-24 | 9.04E-05 |
| 670-086 | RTC | Non-Fugitive | Re-188 | 4.03E-08 |
| 670-086 | RTC | Non-Fugitive | Sr-91 | 4.67E-07 |
| 670-086 | RTC | Non-Fugitive | Sr-92 | 2.65E-07 |
| 670-086 | RTC | Non-Fugitive | Tc-99m | 5.50E-06 |
| 670-098 | RTC | Non-Fugitive | Ba-141 | 2.22E-10 |
| 670-098 | RTC | Non-Fugitive | Ce-144 | 5.60E-13 |
| 670-098 | RTC | Non-Fugitive | Co-58 | 1.25E-13 |
| 670-098 | RTC | Non-Fugitive | Co-60 | 1.54E-12 |
| 670-098 | RTC | Non-Fugitive | Cr-51 | 1.33E-10 |
| 670-098 | RTC | Non-Fugitive | H-3 | 2.09E-03 |
| 670-098 | RTC | Non-Fugitive | Hf-181 | 8.91E-14 |
| 670-098 | RTC | Non-Fugitive | I-128 | 2.66E-06 |

| SourceID | FacilityID | Fugitive/Non-Fugitive | Radionuclide | Q (Ci/yr) |
|---|---|---|---|---|
| 670-098 | RTC | Non-Fugitive | I-131 | 3.94E-09 |
| 670-098 | RTC | Non-Fugitive | I-133 | 4.85E-09 |
| 670-098 | RTC | Non-Fugitive | I-135 | 2.19E-08 |
| 670-098 | RTC | Non-Fugitive | Mn-54 | 1.03E-13 |
| 670-098 | RTC | Non-Fugitive | Mo-99 | 1.85E-13 |
| 670-098 | RTC | Non-Fugitive | Na-24 | 1.49E-09 |
| 670-098 | RTC | Non-Fugitive | Re-188 | 6.64E-13 |
| 670-098 | RTC | Non-Fugitive | Sr-91 | 7.68E-12 |
| 670-098 | RTC | Non-Fugitive | Sr-92 | 4.36E-12 |
| 670-098 | RTC | Non-Fugitive | Tc-99m | 9.04E-11 |
| 670-ATR-Canal | RTC | Non-Fugitive | Ce-144 | 2.05E-05 |
| 670-ATR-Canal | RTC | Non-Fugitive | Co-58 | 4.56E-06 |
| 670-ATR-Canal | RTC | Non-Fugitive | Co-60 | 4.85E-05 |
| 670-ATR-Canal | RTC | Non-Fugitive | Cr-51 | 4.20E-05 |
| 670-ATR-Canal | RTC | Non-Fugitive | H-3 | 2.29E+01 |
| 670-ATR-Canal | RTC | Non-Fugitive | Hf-181 | 3.26E-06 |
| 670-ATR-Canal | RTC | Non-Fugitive | Mn-54 | 3.75E-06 |
| 670-ATR-Canal | RTC | Non-Fugitive | Mo-99 | 6.76E-06 |
| 670-ATR-Canal | RTC | Non-Fugitive | Re-188 | 2.43E-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 | 9.58E-13 |
| TRA-1627 | RTC | Non-Fugitive | Am-243 | 3.97E-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 | 4.04E-10 |
| 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 | 1.19E-14 |
| 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-59 | 1.07E-15 |
| 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 |

| SourceID | FacilityID | Fugitive/Non-Fugitive | Radionuclide | Q (Ci/yr) |
|---|---|---|---|---|
| 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 | 1.14E-10 |
| 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 | 1.52E-18 |
| TRA-1627 | RTC | Non-Fugitive | Po-210 | 1.20E-13 |
| TRA-1627 | RTC | Non-Fugitive | Pu-236 | 1.60E-14 |
| 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 | 1.25E-13 |
| TRA-1627 | RTC | Non-Fugitive | Ra-226 | 2.89E-14 |

| SourceID | FacilityID | Fugitive/Non-Fugitive | Radionuclide | Q (Ci/yr) |
|---|---|---|---|---|
| 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 | 2.11E-11 |
| 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 | 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-666 | RTC | Non-Fugitive | Ar-39 | 1.48E-19 |
| TRA-666 | RTC | Non-Fugitive | Ba-133 | 7.65E-16 |
| TRA-666 | RTC | Non-Fugitive | Be-10 | 5.43E-20 |

| SourceID | FacilityID | Fugitive/Non-Fugitive | Radionuclide | Q (Ci/yr) |
|---|---|---|---|---|
| TRA-666 | RTC | Non-Fugitive | Bi-210 | 7.68E-22 |
| TRA-666 | RTC | Non-Fugitive | Bi-210m | 5.73E-28 |
| TRA-666 | RTC | Non-Fugitive | C-14 | 1.35E-14 |
| TRA-666 | RTC | Non-Fugitive | Ca-45 | 3.27E-14 |
| TRA-666 | RTC | Non-Fugitive | Co-57 | 1.16E-13 |
| TRA-666 | RTC | Non-Fugitive | Co-58 | 9.13E-10 |
| TRA-666 | RTC | Non-Fugitive | Co-60 | 1.11E-09 |
| TRA-666 | RTC | Non-Fugitive | Co-60m | 1.03E-19 |
| TRA-666 | RTC | Non-Fugitive | Cr-51 | 2.77E-11 |
| TRA-666 | RTC | Non-Fugitive | Cs-134 | 3.80E-13 |
| TRA-666 | RTC | Non-Fugitive | Cs-137 | 5.70E-11 |
| TRA-666 | RTC | Non-Fugitive | Eu-152 | 1.53E-12 |
| TRA-666 | RTC | Non-Fugitive | Eu-154 | 3.18E-13 |
| TRA-666 | RTC | Non-Fugitive | Eu-155 | 8.52E-13 |
| TRA-666 | RTC | Non-Fugitive | Fe-55 | 1.69E-09 |
| TRA-666 | RTC | Non-Fugitive | Fe-59 | 7.72E-12 |
| TRA-666 | RTC | Non-Fugitive | Fe-60 | 1.03E-19 |
| TRA-666 | RTC | Non-Fugitive | Ge-68 | 6.00E-12 |
| TRA-666 | RTC | Non-Fugitive | Ge-71 | 3.21E-19 |
| TRA-666 | RTC | Non-Fugitive | H-3 | 5.88E-01 |
| TRA-666 | RTC | Non-Fugitive | Hf-178m | 2.35E-20 |
| TRA-666 | RTC | Non-Fugitive | Hf-179m | 5.34E-20 |
| TRA-666 | RTC | Non-Fugitive | Hf-181 | 2.88E-15 |
| TRA-666 | RTC | Non-Fugitive | Hf-182 | 2.55E-23 |
| TRA-666 | RTC | Non-Fugitive | Hg-203 | 4.77E-21 |
| TRA-666 | RTC | Non-Fugitive | Ir-192 | 2.80E-13 |
| TRA-666 | RTC | Non-Fugitive | Mn-53 | 7.20E-23 |
| TRA-666 | RTC | Non-Fugitive | Mn-54 | 1.41E-11 |
| TRA-666 | RTC | Non-Fugitive | Mo-93 | 1.01E-09 |
| TRA-666 | RTC | Non-Fugitive | Na-22 | 6.03E-10 |
| TRA-666 | RTC | Non-Fugitive | Ni-59 | 1.67E-11 |
| TRA-666 | RTC | Non-Fugitive | Ni-63 | 2.02E-08 |
| TRA-666 | RTC | Non-Fugitive | Os-185 | 2.63E-12 |
| TRA-666 | RTC | Non-Fugitive | Os-191 | 7.38E-21 |
| TRA-666 | RTC | Non-Fugitive | P-32 | 5.88E-18 |
| TRA-666 | RTC | Non-Fugitive | P-33 | 3.15E-21 |
| TRA-666 | RTC | Non-Fugitive | Pb-205 | 1.72E-21 |
| TRA-666 | RTC | Non-Fugitive | Pb-210 | 7.68E-22 |
| TRA-666 | RTC | Non-Fugitive | Po-210 | 3.03E-21 |
| TRA-666 | RTC | Non-Fugitive | Re-184 | 5.96E-14 |
| TRA-666 | RTC | Non-Fugitive | Re-184m | 1.85E-11 |
| TRA-666 | RTC | Non-Fugitive | Re-186 | 8.28E-20 |
| TRA-666 | RTC | Non-Fugitive | Re-186m | 7.44E-14 |

| SourceID | FacilityID | Fugitive/Non-Fugitive | Radionuclide | Q (Ci/yr) |
|---|---|---|---|---|
| TRA-666 | RTC | Non-Fugitive | Re-187 | 3.45E-17 |
| TRA-666 | RTC | Non-Fugitive | Re-188 | 1.74E-08 |
| TRA-666 | RTC | Non-Fugitive | Sc-46 | 2.75E-13 |
| TRA-666 | RTC | Non-Fugitive | Si-32 | 5.34E-18 |
| TRA-666 | RTC | Non-Fugitive | Ta-179 | 1.34E-14 |
| TRA-666 | RTC | Non-Fugitive | Ta-180m | 5.01E-33 |
| TRA-666 | RTC | Non-Fugitive | Ta-182 | 1.32E-10 |
| TRA-666 | RTC | Non-Fugitive | Tl-204 | 3.81E-21 |
| TRA-666 | RTC | Non-Fugitive | U-234 | 1.40E-10 |
| TRA-666 | RTC | Non-Fugitive | U-235 | 1.02E-11 |
| TRA-666 | RTC | Non-Fugitive | U-238 | 7.73E-10 |
| TRA-666 | RTC | Non-Fugitive | V-49 | 3.21E-19 |
| TRA-666 | RTC | Non-Fugitive | W-181 | 2.15E-08 |
| TRA-666 | RTC | Non-Fugitive | W-185 | 1.38E-06 |
| TRA-666 | RTC | Non-Fugitive | W-188 | 5.00E-08 |
| TRA-666 | RTC | Non-Fugitive | Zn-65 | 9.45E-10 |
| TRA-678 | RTC | Non-Fugitive | Ag-110m | 1.23E-11 |
| TRA-678 | RTC | Non-Fugitive | Am-241 | 2.65E-12 |
| TRA-678 | RTC | Non-Fugitive | Am-243 | 6.60E-16 |
| 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 | 1.72E-11 |
| TRA-678 | RTC | Non-Fugitive | Ce-139 | 5.98E-13 |
| 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 | 5.50E-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 | 5.06E-10 |
| TRA-678 | RTC | Non-Fugitive | Eu-154 | 8.44E-11 |
| TRA-678 | RTC | Non-Fugitive | Eu-155 | 1.42E-11 |
| TRA-678 | RTC | Non-Fugitive | Eu-156 | 1.74E-11 |
| TRA-678 | RTC | Non-Fugitive | Fe-55 | 1.05E-09 |

| SourceID | FacilityID | Fugitive/Non-Fugitive | Radionuclide | Q (Ci/yr) |
|---|---|---|---|---|
| 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 | He-3 | 7.40E-08 |
| 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 | 1.37E-12 |
| TRA-678 | RTC | Non-Fugitive | I-128 | 1.10E-06 |
| TRA-678 | RTC | Non-Fugitive | I-129 | 1.62E-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-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 |
| 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 | 3.12E-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 |

| SourceID | FacilityID | Fugitive/Non-Fugitive | Radionuclide | Q (Ci/yr) |
|---|---|---|---|---|
| TRA-678 | RTC | Non-Fugitive | Sb-125 | 1.16E-11 |
| TRA-678 | RTC | Non-Fugitive | Sc-46 | 4.50E-15 |
| TRA-678 | RTC | Non-Fugitive | Sn-113 | 3.97E-12 |
| TRA-678 | RTC | Non-Fugitive | Sr-85 | 1.81E-12 |
| 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 | 3.39E-12 |
| 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-715-001 | RTC | Fugitive | Ag-110m | 3.33E-06 |
| TRA-715-001 | RTC | Fugitive | Am-241 | 2.19E-05 |
| TRA-715-001 | RTC | Fugitive | Ba-140 | 3.00E-08 |
| TRA-715-001 | RTC | Fugitive | Ce-144 | 2.10E-06 |
| TRA-715-001 | RTC | Fugitive | Co-58 | 5.03E-06 |
| TRA-715-001 | RTC | Fugitive | Co-60 | 7.02E-03 |
| TRA-715-001 | RTC | Fugitive | Cr-51 | 1.71E-03 |
| TRA-715-001 | RTC | Fugitive | Cs-134 | 2.45E-06 |
| TRA-715-001 | RTC | Fugitive | Cs-137 | 5.47E-03 |
| TRA-715-001 | RTC | Fugitive | Eu-152 | 7.17E-05 |
| TRA-715-001 | RTC | Fugitive | Eu-154 | 6.06E-05 |
| TRA-715-001 | RTC | Fugitive | Eu-155 | 5.36E-06 |
| TRA-715-001 | RTC | Fugitive | Fe-59 | 1.51E-06 |

| SourceID | FacilityID | Fugitive/Non-Fugitive | Radionuclide | Q (Ci/yr) |
|---|---|---|---|---|
| TRA-715-001 | RTC | Fugitive | H-3 | 5.11E+01 |
| TRA-715-001 | RTC | Fugitive | Hf-181 | 1.91E-05 |
| TRA-715-001 | RTC | Fugitive | I-131 | 1.00E-08 |
| TRA-715-001 | RTC | Fugitive | La-140 | 2.00E-08 |
| TRA-715-001 | RTC | Fugitive | Mn-54 | 5.53E-06 |
| TRA-715-001 | RTC | Fugitive | Mo-99 | 1.00E-08 |
| TRA-715-001 | RTC | Fugitive | Na-24 | 3.10E-07 |
| TRA-715-001 | RTC | Fugitive | Nb-95 | 4.39E-04 |
| TRA-715-001 | RTC | Fugitive | Np-239 | 1.10E-07 |
| TRA-715-001 | RTC | Fugitive | Pu-239 | 8.44E-06 |
| TRA-715-001 | RTC | Fugitive | Ru-103 | 1.10E-07 |
| TRA-715-001 | RTC | Fugitive | Sb-122 | 1.00E-08 |
| TRA-715-001 | RTC | Fugitive | Sb-124 | 4.87E-06 |
| TRA-715-001 | RTC | Fugitive | Sr-89 | 1.52E-11 |
| TRA-715-001 | RTC | Fugitive | Sr-90 | 2.65E-02 |
| TRA-715-001 | RTC | Fugitive | Ta-182 | 7.66E-06 |
| TRA-715-001 | RTC | Fugitive | W-187 | 3.60E-07 |
| TRA-715-001 | RTC | Fugitive | Zn-65 | 9.52E-06 |
| TRA-715-001 | RTC | Fugitive | Zr-95 | 2.59E-06 |
| TRA-770-001 | RTC-ATR | Non-Fugitive | Am-241 | 5.79E-07 |
| TRA-770-001 | RTC-ATR | Non-Fugitive | Ar-41 | 3.47E+02 |
| TRA-770-001 | RTC-ATR | Non-Fugitive | Ba-139 | 3.75E-03 |
| TRA-770-001 | RTC-ATR | Non-Fugitive | Ba-140 | 1.90E-06 |
| TRA-770-001 | RTC-ATR | Non-Fugitive | Co-60 | 4.93E-06 |
| TRA-770-001 | RTC-ATR | Non-Fugitive | Cr-51 | 1.72E-04 |
| TRA-770-001 | RTC-ATR | Non-Fugitive | Cs-137 | 4.38E-05 |
| TRA-770-001 | RTC-ATR | Non-Fugitive | Cs-138 | 1.13E-01 |
| TRA-770-001 | RTC-ATR | Non-Fugitive | H-3 | 3.80E+02 |
| TRA-770-001 | RTC-ATR | Non-Fugitive | Hg-203 | 3.57E-06 |
| TRA-770-001 | RTC-ATR | Non-Fugitive | I-131 | 5.10E-07 |
| TRA-770-001 | RTC-ATR | Non-Fugitive | Kr-85m | 1.15E+00 |
| TRA-770-001 | RTC-ATR | Non-Fugitive | Kr-87 | 3.11E+00 |
| TRA-770-001 | RTC-ATR | Non-Fugitive | Na-24 | 1.27E-03 |
| TRA-770-001 | RTC-ATR | Non-Fugitive | Np-239 | 1.70E-06 |
| TRA-770-001 | RTC-ATR | Non-Fugitive | Os-191 | 1.28E-05 |
| TRA-770-001 | RTC-ATR | Non-Fugitive | Rb-88 | 3.79E-02 |
| TRA-770-001 | RTC-ATR | Non-Fugitive | Rb-89 | 6.20E-02 |
| TRA-770-001 | RTC-ATR | Non-Fugitive | Re-188 | 2.32E-04 |
| TRA-770-001 | RTC-ATR | Non-Fugitive | Tc-99m | 1.40E-04 |
| TRA-770-001 | RTC-ATR | Non-Fugitive | Xe-135 | 6.18E+00 |
| TRA-770-001 | RTC-ATR | Non-Fugitive | Xe-135m | 2.94E+00 |
| TRA-770-001 | RTC-ATR | Non-Fugitive | Xe-138 | 1.13E+01 |
| ARP-II | RWMC | Non-Fugitive | Am-241 | 2.84E-09 |

| SourceID | FacilityID | Fugitive/Non-Fugitive | Radionuclide | Q (Ci/yr) |
|---|---|---|---|---|
| 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-09 |
| ARP-III | RWMC | Non-Fugitive | Pu-238 | 1.65E-11 |
| ARP-III | RWMC | Non-Fugitive | Pu-239 | 5.46E-10 |
| ARP-III | RWMC | Non-Fugitive | Pu-240 | 1.23E-10 |
| ARP-III | RWMC | Non-Fugitive | Sr-90 | 7.12E-16 |
| ARP-III | RWMC | Non-Fugitive | U-235 | 1.35E-14 |
| ARP-III | RWMC | Non-Fugitive | U-238 | 7.31E-13 |
| ARP-IV | RWMC | Non-Fugitive | Am-241 | 5.60E-09 |
| ARP-IV | RWMC | Non-Fugitive | Pu-238 | 2.34E-11 |
| ARP-IV | RWMC | Non-Fugitive | Pu-239 | 7.80E-10 |
| ARP-IV | RWMC | Non-Fugitive | Pu-240 | 1.76E-10 |
| ARP-IV | RWMC | Non-Fugitive | Sr-90 | 2.41E-11 |
| ARP-IV | RWMC | Non-Fugitive | U-235 | 5.88E-14 |
| ARP-IV | RWMC | Non-Fugitive | U-238 | 4.40E-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 | 4.98E-09 |
| ARP-V | RWMC | Non-Fugitive | Pu-238 | 4.12E-10 |
| ARP-V | RWMC | Non-Fugitive | Pu-239 | 9.65E-09 |
| ARP-V | RWMC | Non-Fugitive | Pu-240 | 2.21E-09 |
| ARP-V | RWMC | Non-Fugitive | Sr-90 | 2.26E-16 |
| ARP-V | RWMC | Non-Fugitive | U-235 | 8.81E-15 |
| ARP-V | RWMC | Non-Fugitive | U-238 | 1.71E-13 |
| ARP-VII | RWMC | Non-Fugitive | Am-241 | 7.97E-05 |
| ARP-VII | RWMC | Non-Fugitive | Pu-238 | 2.15E-06 |
| ARP-VII | RWMC | Non-Fugitive | Pu-239 | 3.36E-05 |
| ARP-VII | RWMC | Non-Fugitive | Pu-240 | 9.65E-06 |
| ARP-VII | RWMC | Non-Fugitive | Sr-90 | 2.21E-08 |
| ARP-VII | RWMC | Non-Fugitive | U-235 | 1.66E-10 |
| ARP-VII | RWMC | Non-Fugitive | U-238 | 7.84E-09 |
| 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 |

| SourceID | FacilityID | Fugitive/Non-Fugitive | Radionuclide | Q (Ci/yr) |
|---|---|---|---|---|
| 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 |
| H3-GrdWater | RWMC | Fugitive | H-3 | 1.41E-05 |
| WMF-601 | RWMC | Non-Fugitive | Pu-239 | 5.76E-11 |
| WMF-601 | RWMC | Non-Fugitive | Sr-90 | 4.43E-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 | 8.85E-19 |
| WMF-634-001 | RWMC | Non-Fugitive | Co-60 | 3.66E-20 |
| WMF-634-001 | RWMC | Non-Fugitive | Cs-137 | 3.66E-21 |
| WMF-634-001 | RWMC | Non-Fugitive | K-40 | 2.25E-18 |
| WMF-634-001 | RWMC | Non-Fugitive | Pb-210 | 5.08E-19 |
| WMF-634-001 | RWMC | Non-Fugitive | Pu-239 | 6.91E-18 |
| WMF-634-001 | RWMC | Non-Fugitive | Sr-90 | 8.79E-18 |
| WMF-636-001 | RWMC | Non-Fugitive | Am-241 | 1.10E-07 |
| WMF-636-001 | RWMC | Non-Fugitive | Pu-238 | 1.56E-08 |
| WMF-636-001 | RWMC | Non-Fugitive | Pu-239 | 5.24E-07 |
| WMF-676-003 | RWMC | Non-Fugitive | Pu-238 | 1.37E-10 |
| WMF-676-003 | RWMC | Non-Fugitive | Pu-239 | 9.19E-11 |
| RRTR-North | SMC | Fugitive | Ag-106 | 6.42E-12 |
| RRTR-North | SMC | Fugitive | Ag-109m | 3.96E-13 |
| RRTR-North | SMC | Fugitive | Ag-110 | 7.87E-11 |
| RRTR-North | SMC | Fugitive | Ag-110m | 5.92E-09 |
| RRTR-North | SMC | Fugitive | Ag-111 | 1.03E-13 |
| RRTR-North | SMC | Fugitive | Ar-39 | 5.72E-06 |
| RRTR-North | SMC | Fugitive | Ar-41 | 8.69E-11 |
| RRTR-North | SMC | Fugitive | Ar-42 | 8.58E-17 |
| RRTR-North | SMC | Fugitive | As-76 | 4.27E-05 |
| RRTR-North | SMC | Fugitive | Br-82 | 1.03E+01 |
| RRTR-North | SMC | Fugitive | Cd-109 | 1.29E-16 |
| RRTR-North | SMC | Fugitive | Cl-36 | 2.71E-09 |
| RRTR-North | SMC | Fugitive | Cu-64 | 1.39E-08 |
| RRTR-North | SMC | Fugitive | Cu-67 | 5.52E-11 |
| RRTR-North | SMC | Fugitive | Ga-72 | 3.79E-21 |
| RRTR-North | SMC | Fugitive | Ir-192 | 3.25E-12 |
| RRTR-North | SMC | Fugitive | Ir-194 | 1.28E-11 |
| RRTR-North | SMC | Fugitive | K-40 | 1.37E-07 |

| SourceID | FacilityID | Fugitive/Non-Fugitive | Radionuclide | Q (Ci/yr) |
|---|---|---|---|---|
| RRTR-North | SMC | Fugitive | K-42 | 2.80E-01 |
| RRTR-North | SMC | Fugitive | Kr-79 | 5.84E-11 |
| RRTR-North | SMC | Fugitive | Kr-81 | 1.74E-13 |
| RRTR-North | SMC | Fugitive | Kr-83m | 9.42E-15 |
| RRTR-North | SMC | Fugitive | Kr-85 | 8.70E-12 |
| RRTR-North | SMC | Fugitive | Kr-87 | 1.74E-20 |
| RRTR-North | SMC | Fugitive | Ni-63 | 7.23E-14 |
| RRTR-North | SMC | Fugitive | Ni-65 | 1.46E-15 |
| RRTR-North | SMC | Fugitive | Pd-107 | 1.14E-20 |
| RRTR-North | SMC | Fugitive | Pd-109 | 3.86E-13 |
| RRTR-North | SMC | Fugitive | Rb-86 | 1.17E-05 |
| RRTR-North | SMC | Fugitive | Rb-87 | 1.85E-10 |
| RRTR-North | SMC | Fugitive | Rh-105 | 8.62E-23 |
| RRTR-North | SMC | Fugitive | Se-79 | 5.10E-10 |
| RRTR-North | SMC | Fugitive | Se-81m | 5.13E-23 |
| RRTR-North | SMC | Fugitive | Zn-65 | 4.27E-08 |
| RRTR-North | SMC | Fugitive | Zn-69 | 4.85E-20 |
| SMC-All | SMC | Non-Fugitive | U-234 | 1.65E-08 |
| SMC-All | SMC | Non-Fugitive | U-235 | 1.15E-09 |
| SMC-All | SMC | Non-Fugitive | U-238 | 9.16E-08 |
| OU-1-07B | TAN-TSF | Non-Fugitive | H-3 | 3.26E-02 |
| OU-1-07B | TAN-TSF | Non-Fugitive | Sr-90 | 1.02E-06 |

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) |
|---|---|---|---|---|
| IF-603-IRC-AM | IRC | Non-Fugitive | Ag-110m | 2.00E-14 |
| IF-603-IRC-AM | IRC | Non-Fugitive | Ce-144 | 1.70E-12 |
| IF-603-IRC-AM | IRC | Non-Fugitive | Co-60 | 2.00E-17 |
| IF-603-IRC-AM | IRC | Non-Fugitive | Cs-134 | 9.37E-07 |
| IF-603-IRC-AM | IRC | Non-Fugitive | Cs-137 | 9.40E-08 |
| IF-603-IRC-AM | IRC | Non-Fugitive | Eu-154 | 1.50E-13 |
| IF-603-IRC-AM | IRC | Non-Fugitive | Nb-95 | 5.00E-17 |
| IF-603-IRC-AM | IRC | Non-Fugitive | Zn-65 | 4.70E-08 |
| IF-603-IRC-BC | IRC | Non-Fugitive | Sc-46 | 1.11E-10 |
| IF-603-IRC-BC | IRC | Non-Fugitive | Th-232 | 1.33E-13 |
| IF-603-IRC-BC | IRC | Non-Fugitive | U-234 | 4.31E-12 |
| IF-603-IRC-BC | IRC | Non-Fugitive | U-235 | 2.09E-13 |
| IF-603-IRC-BC | IRC | Non-Fugitive | U-238 | 1.23E-12 |
| IF-611 | IRC | Non-Fugitive | Kr-85 | 1.15E-02 |
| IF-611 | IRC | Non-Fugitive | Xe-131m | 3.09E-04 |
| IF-611 | IRC | Non-Fugitive | Xe-133 | 4.63E-01 |
| IF-611 | IRC | Non-Fugitive | Xe-135 | 1.24E-04 |
| RESL_IF-683 | IRC | Non-Fugitive | Ac-227 | 5.39E-09 |
| RESL_IF-683 | IRC | Non-Fugitive | Am-241 | 1.02E-07 |
| RESL_IF-683 | IRC | Non-Fugitive | Am-243 | 1.04E-09 |
| RESL_IF-683 | IRC | Non-Fugitive | Ba-133 | 3.59E-07 |
| RESL_IF-683 | IRC | Non-Fugitive | Ba-140 | 2.99E-51 |
| RESL_IF-683 | IRC | Non-Fugitive | C-14 | 1.05E-07 |
| RESL_IF-683 | IRC | Non-Fugitive | Cd-109 | 4.69E-09 |
| RESL_IF-683 | IRC | Non-Fugitive | Ce-139 | 2.60E-13 |
| RESL_IF-683 | IRC | Non-Fugitive | Cf-252 | 1.19E-14 |
| RESL_IF-683 | IRC | Non-Fugitive | Cm-244 | 3.70E-10 |
| RESL_IF-683 | IRC | Non-Fugitive | Co-57 | 9.11E-08 |
| RESL_IF-683 | IRC | Non-Fugitive | Co-60 | 1.16E-08 |
| RESL_IF-683 | IRC | Non-Fugitive | Cs-134 | 2.57E-08 |
| RESL_IF-683 | IRC | Non-Fugitive | Cs-137 | 7.18E-08 |
| RESL_IF-683 | IRC | Non-Fugitive | Eu-152 | 4.49E-08 |
| RESL_IF-683 | IRC | Non-Fugitive | Eu-154 | 7.69E-08 |
| RESL_IF-683 | IRC | Non-Fugitive | Eu-155 | 6.73E-08 |
| RESL_IF-683 | IRC | Non-Fugitive | Fe-55 | 4.44E-08 |
| RESL_IF-683 | IRC | Non-Fugitive | Gd-148 | 9.01E-10 |
| RESL_IF-683 | IRC | Non-Fugitive | H-3 | 1.51E-07 |
| RESL_IF-683 | IRC | Non-Fugitive | Hg-203 | 1.30E-09 |
| RESL_IF-683 | IRC | Non-Fugitive | I-125 | 4.88E-08 |
| RESL_IF-683 | IRC | Non-Fugitive | I-129 | 1.10E-10 |
| RESL_IF-683 | IRC | Non-Fugitive | I-131 | 4.24E-25 |

| Source ID | Facility ID | Fugitive/Non-Fugitive | Radionuclide | Q (Ci/yr) |
|---|---|---|---|---|
| RESL_IF-683 | IRC | Non-Fugitive | Ir-192 | 1.24E-17 |
| RESL_IF-683 | IRC | Non-Fugitive | Mn-54 | 5.10E-08 |
| RESL_IF-683 | IRC | Non-Fugitive | Ni-63 | 9.37E-09 |
| RESL_IF-683 | IRC | Non-Fugitive | Np-237 | 6.48E-09 |
| RESL_IF-683 | IRC | Non-Fugitive | Pa-231 | 1.15E-09 |
| RESL_IF-683 | IRC | Non-Fugitive | Pu-238 | 7.83E-08 |
| RESL_IF-683 | IRC | Non-Fugitive | Pu-239 | 1.32E-07 |
| RESL_IF-683 | IRC | Non-Fugitive | Ra-226 | 7.53E-08 |
| RESL_IF-683 | IRC | Non-Fugitive | Ru-103 | 7.55E-23 |
| RESL_IF-683 | IRC | Non-Fugitive | Ru-106 | 6.27E-09 |
| RESL_IF-683 | IRC | Non-Fugitive | Sb-125 | 1.69E-08 |
| RESL_IF-683 | IRC | Non-Fugitive | Se-75 | 2.30E-13 |
| RESL_IF-683 | IRC | Non-Fugitive | Sm-151 | 1.02E-07 |
| RESL_IF-683 | IRC | Non-Fugitive | Sn-113 | 7.46E-14 |
| RESL_IF-683 | IRC | Non-Fugitive | Sr-85 | 1.04E-07 |
| RESL_IF-683 | IRC | Non-Fugitive | Sr-89 | 2.61E-21 |
| RESL_IF-683 | IRC | Non-Fugitive | Sr-90 | 7.04E-08 |
| RESL_IF-683 | IRC | Non-Fugitive | Tc-99 | 5.00E-09 |
| RESL_IF-683 | IRC | Non-Fugitive | Tc-99m | 4.18E-07 |
| RESL_IF-683 | IRC | Non-Fugitive | Th-229 | 9.98E-11 |
| RESL_IF-683 | IRC | Non-Fugitive | Th-230 | 9.10E-11 |
| RESL_IF-683 | IRC | Non-Fugitive | U-232 | 3.18E-08 |
| RESL_IF-683 | IRC | Non-Fugitive | U-233 | 1.64E-07 |
| RESL_IF-683 | IRC | Non-Fugitive | U-234 | 3.69E-11 |
| RESL_IF-683 | IRC | Non-Fugitive | U-235 | 3.50E-11 |
| RESL_IF-683 | IRC | Non-Fugitive | U-238 | 3.83E-11 |
| RESL_IF-683 | IRC | Non-Fugitive | Y-88 | 4.47E-11 |
| RESL_IF-683 | IRC | Non-Fugitive | Zn-65 | 8.41E-08 |
| RESL_IF-683 | IRC | Non-Fugitive | Zr-95 | 9.19E-15 |

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# Appendix E

# Radionuclides Reported During CY 2021

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# Appendix E

# Radionuclides Reported During CY 2021

Table E-1. Radionuclides reported in use and potentially emitted to the atmosphere from the INL Site facilities in CY 2021.

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

| | | | |
|---|---|---|---|
| C-14 | Kr-83m | Rb-88 | Th-232 |
| Ca-45 | Kr-85 | Rb-89 | Th-234 |
| Cd-109 | Kr-85m | Re-184 | Tl-204 |
| Cd-113 | Kr-87 | Re-184 | Tl-207 |
| Cd-115 | Kr-88 | Re-186 | Tl-208 |
| Cd-115 | Kr-89 | Re-186 | Tm-168 |
| Cd-117 | Kr-90 (Rb-90) [b] | Re-187 | Tm-170 |
| Ce-139 | Kr-91 (Sr-91) [b] | Re-188 | Tm-171 |
| Ce-141 | Kr-92 (Sr-92) [b] | Rh-102 | U-232 |
| Ce-143 | La-140 | Rh-102 | U-233 |
| Ce-144 | La-141 | Rh-103 | U-234 |
| Cl-36 | La-142 | Rh-105 | U-235 |
| Cm-242 | Mn-52 | Rh-106 | U-236 |
| Cm-243 | Mn-53 | Rh-106 | U-237 |
| Cm-244 | Mn-54 | Rn-219 | U-238 |
| Co-57 | Mn-56 | Rn-220 | V-48 |
| Co-58 | Mo-93 | Ru-103 | V-49 |
| Co-59 [a] | Mo-99 | Ru-105 | W-181 |
| Co-60 | Na-22 | Ru-106 | W-185 |
| Co-60m | Na-24 | S-35 | W-187 |
| Cr-51 | Nb-92m | Sb-122 | W-188 |
| Cs-134 | Nb-93m | Sb-124 | Xe-127 |
| Cs-135 | Nb-94 | Sb-125 | Xe-131m |
| Cs-136 | Nb-95 | Sb-126 | Xe-133 |
| Cs-137 | Nb-95m | Sb-126 | Xe-133 |
| Cs-138 | Nb-96 | Sb-127 | Xe-135 |
| Cu-64 | Nb-97 | Sb-128 | Xe-135 |
| Cu-67 | Nd-147 | Sb-129 | Xe-137 |
| Dy-159 | Nd-149 | Sb-130 | Xe-138 |
| Dy-165 | Ni-57 | Sc-46 | Xe-139 (Cs-139) [b] |
| Dy-166 | Ni-59 | Sc-47 | Xe-140 (Cs-140) [b] |
| Er-169 | Ni-63 | Sc-48 | Y-88 |
| Eu-152 | Ni-65 | Se-79 | Y-89m |
| Eu-154 | Ni-66 | Se-81 | Y-90 |
| Eu-155 | Np-237 | Se-81m | Y-91 |
| Eu-156 | Np-239 | Si-32 | Y-91m |
| Eu-157 | Os-185 | Sm-151 | Y-92 |
| Eu-158 | Os-191 | Sm-153 | Y-93 |
| Fe-55 | P-32 | Sm-156 | Zn-65 |

| | | | |
|---|---|---|---|
| Fe-59 | P-33 | Sn-113 | Zn-69 |
| Fe-60 | Pa-231 | Sn-117 | Zn-69m |
| Ga-68 | Pa-233 | Sn-119 | Zn-72 |
| Ga-72 | Pa-234 | Sn-121 | Zr-93 |
| Ga-73 | Pa-234 | Sn-121 | Zr-95 |
| Gd-153 | Pb-205 | Sn-123 | Zr-97 |
| Gd-159 | Pb-210 | Sn-125 | |
| Ge-68 | Pb-211 | Sn-126 | |

[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 2021.

| | | |
|---|---|---|
| Ac-227 | H-3 | Sn-113 |
| Ag-110m | Hg-203 | Sr-85 |
| Am-241 | I-125 | Sr-89 |
| Am-243 | I-129 | Sr-90 |
| Ba-133 | I-131 | Tc-99 |
| Ba-140 | Ir-192 | Tc-99m |
| C-14 | Kr-85 | Th-229 |
| Cd-109 | Mn-54 | Th-230 |
| Ce-139 | Nb-95 | Th-232 |
| Ce-144 | Ni-63 | U-232 |
| Cf-252 | Np-237 | U-233 |
| Cm-244 | Pa-231 | U-234 |
| Co-57 | Pu-238 | U-235 |
| Co-60 | Pu-239 | U-238 |
| Cs-134 | Ra-226 | Xe-131m |
| Cs-137 | Ru-103 | Xe-133 |
| Eu-152 | Ru-106 | Xe-135 |
| Eu-154 | Sb-125 | Y-88 |
| Eu-155 | Sc-46 | Zn-65 |
| Fe-55 | Se-75 | Zr-95 |
| Gd-148 | Sm-151 | |

**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™ Si7-10700 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\FY2022\NESHAP\QAchk_Modtest\Modtest_check\Cmd_line_output_5-10-
21\Modtest.dat INPUT.DAT
del input.pop
del input.wnd
copy C:\Projects\FY2022\NESHAP\QAchk_Modtest\Modtest_check\Cmd_line_output_5-10-
21\PORTS.POP input.pop
copy C:\Projects\FY2022\NESHAP\QAchk_Modtest\Modtest_check\Cmd_line_output_5-10-
21\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 13 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 13 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\FY2022\NESHAP\QAchk_Modtest\FacilityTest.

**Modtest.dat** (run with GUI for Check 1)

```
4.1
Modtest41.
Apr 14, 2022 10:51 AM
May 2, 2022 09:10 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         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
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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
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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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0.000e+00 0.000e+00 0.000e+00 0.000e+00
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
1.650e-17 1.770e-17 3.110e-17 1.730e-17 2.000e-17 1.760e-17 1.710e-17 1.740e-17 1.780e-17 1.790e-17 1.770e-17
2.030e-17 1.670e-17 1.620e-17 1.870e-17 9.340e-15 1.780e-17 2.070e-17 1.720e-17 1.900e-17 1.640e-17 1.730e-17
1.700e-17 1.560e-17 1.850e-17 1.120e-16
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
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
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
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
3.690e-11 2.667e-10 7.501e-11 5.392e-11 1.368e-11 5.057e-11 1.834e-11 4.704e-12 9.918e-13 1.374e-10 1.630e-11
1.525e-10 9.918e-13 9.996e-12 4.194e-10
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
1.473e-11 4.067e-11 1.988e-11 1.952e-11 6.932e-12 1.610e-11 3.971e-12 1.964e-11 1.042e-11 2.494e-11 2.305e-11
2.401e-11 2.335e-09 1.011e-09 2.461e-10
5.760e-14 5.730e-14 1.160e-13 7.420e-14 7.950e-14 6.180e-14 5.600e-14 5.790e-14 5.710e-14 6.230e-14 6.270e-14
6.780e-14 5.690e-14 5.520e-14 6.760e-14 9.510e-14 6.300e-14 6.990e-14 6.490e-14 7.150e-14 5.710e-14 6.140e-14
5.440e-14 5.840e-14 6.940e-14 6.670e-14
1.210e-15 1.290e-15 2.070e-15 1.270e-15 1.420e-15 1.280e-15 1.260e-15 1.270e-15 1.310e-15 1.300e-15 1.290e-15
1.460e-15 1.240e-15 1.190e-15 1.370e-15 2.750e-15 1.290e-15 1.480e-15 1.250e-15 1.380e-15 1.200e-15 1.270e-15
1.250e-15 1.160e-15 1.340e-15 1.380e-15
7.340e-15 3.590e-12 4.060e-11 9.400e-14 1.650e-13 3.140e-15 1.940e-15 5.600e-14 4.330e-13 2.280e-13 4.090e-14
8.990e-16 3.530e-13 1.040e-12 4.660e-11
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
4.300e-15 1.470e-13 3.850e-13 2.310e-11
6.720e-17 2.490e-16 5.940e-16 9.500e-17 6.790e-16 1.100e-17 9.490e-18 3.840e-16 8.090e-17 1.390e-16 3.240e-17
2.280e-17 3.790e-16 8.960e-16 3.640e-15
1.330e-18 5.170e-18 1.330e-17 1.960e-18 1.310e-17 1.970e-19 2.740e-19 6.860e-18 1.760e-18 3.120e-18 6.760e-19
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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0.000e+00 0.000e+00 9.984e-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
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
1.330e-07 1.330e-07 1.330e-07 3.924e-07 1.330e-07 1.330e-07 1.330e-07 1.330e-07 1.330e-07 1.330e-07 1.330e-07
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
5
U-235     Particulate                              M         1.0000    2.222e+16 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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0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00
2.567e-08 2.576e-08 7.405e-07 2.562e-08 2.558e-08 2.674e-08 2.850e-08 4.290e-08 7.816e-08 2.655e-07 9.959e-08
2.563e-08 2.584e-08 2.565e-08 7.585e-08 2.559e-08 2.563e-08 2.560e-08 2.560e-08 2.561e-08 2.568e-08 2.561e-08
2.571e-08 2.561e-08 2.562e-08 4.670e-08
1.240e-07 1.238e-07 3.580e-06 1.235e-07 1.237e-07 1.238e-07 1.240e-07 1.269e-07 1.340e-07 1.286e-06 4.824e-07
1.236e-07 1.235e-07 1.238e-07 3.668e-07 1.234e-07 1.237e-07 1.233e-07 1.239e-07 1.236e-07 1.236e-07 1.242e-07
1.235e-07 4.419e-06 1.843e-05 2.404e-06
5.650e-15 5.880e-15 1.940e-14 7.300e-15 8.600e-15 6.210e-15 5.380e-15 5.670e-15 5.430e-15 6.320e-15 6.350e-15
7.000e-15 5.230e-15 5.350e-15 6.530e-15 9.150e-15 6.350e-15 7.480e-15 6.780e-15 7.480e-15 5.500e-15 6.140e-15
5.270e-15 5.450e-15 7.160e-15 6.870e-15
1.300e-16 1.380e-16 3.320e-16 1.340e-16 1.600e-16 1.390e-16 1.300e-16 1.350e-16 1.350e-16 1.380e-16 1.390e-16
1.590e-16 1.310e-16 1.260e-16 1.440e-16 2.060e-16 1.400e-16 1.620e-16 1.330e-16 1.470e-16 1.280e-16 1.340e-16
1.310e-16 1.190e-16 1.470e-16 1.490e-16
2.000e-11 5.750e-11 7.080e-10 1.390e-10 1.410e-10 8.740e-11 1.440e-12 2.790e-11 2.330e-11 4.910e-11 1.590e-10
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
1.660e-11 1.220e-10 7.180e-10 2.570e-07
6.270e-18 2.510e-17 5.750e-17 9.620e-18 7.000e-17 1.840e-18 9.130e-19 4.150e-17 7.440e-18 1.420e-17 3.290e-18
2.380e-18 3.670e-17 8.930e-17 3.660e-16
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
4.680e-20 8.080e-19 2.060e-18 8.070e-18
Th-231    Particulate                              S         1.0000    9.187e+04 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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0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00 0.000e+00
4.912e-13 2.863e-12 5.785e-12 1.780e-14 6.054e-14 1.936e-10 4.374e-10 1.918e-09 3.378e-09 1.376e-12 9.872e-13
1.343e-12 1.778e-11 1.524e-12 1.833e-12 2.888e-13 9.686e-13 5.707e-13 4.358e-14 1.983e-14 4.473e-12 2.013e-13
4.864e-12 1.983e-14 1.253e-13 3.337e-10
7.058e-13 5.860e-13 5.641e-11 2.098e-13 6.716e-13 3.112e-11 6.958e-11 3.048e-10 5.366e-10 1.167e-12 2.261e-12
9.335e-13 3.302e-12 6.972e-13 2.753e-12 2.796e-13 6.751e-13 5.705e-13 7.987e-13 3.425e-13 9.508e-13 1.358e-12
9.000e-13 8.519e-10 1.570e-09 2.426e-10
3.200e-16 3.530e-16 1.650e-15 4.220e-16 6.760e-16 3.730e-16 2.990e-16 3.220e-16 3.010e-16 3.950e-16 3.800e-16
4.770e-16 2.780e-16 2.880e-16 3.750e-16 2.490e-15 3.780e-16 5.400e-16 4.260e-16 5.040e-16 3.110e-16 3.580e-16
2.880e-16 2.880e-16 4.410e-16 4.630e-16
8.690e-18 1.050e-17 4.700e-17 8.740e-18 2.590e-17 1.030e-17 8.550e-18 9.130e-18 8.870e-18 1.140e-17 1.030e-17
1.960e-17 8.920e-18 8.030e-18 1.070e-17 7.980e-17 1.020e-17 2.300e-17 1.120e-17 1.390e-17 8.760e-18 9.660e-18
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8.060e-17 1.150e-12 4.700e-11 2.470e-15 2.640e-15 6.020e-16 4.500e-17 6.960e-16 3.470e-14 9.910e-15 9.650e-16
1.410e-17 1.300e-14 2.810e-14 4.830e-11
1.180e-15 2.230e-13 9.070e-12 2.750e-15 2.260e-11 2.810e-15 2.750e-17 3.990e-15 7.620e-15 2.120e-15 5.230e-16
1.130e-16 5.250e-15 1.650e-14 3.190e-11
3.310e-19 1.510e-18 3.230e-18 5.760e-19 4.310e-18 1.570e-19 2.480e-19 3.270e-18 3.950e-19 8.540e-19 2.050e-19
1.600e-19 2.100e-18 5.380e-18 2.270e-17
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
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
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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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Th-227 Particulate S 1.0000 1.614e+06 1.800e-03 1.000e-07 5.480e-05
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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
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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
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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
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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
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5
U-234 Particulate M 1.0000 7.747e+12 1.800e-03 1.000e-07 5.480e-05
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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
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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
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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
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Th-230 Particulate S 1.0000 2.379e+12 1.800e-03 1.000e-07 5.480e-05
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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
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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
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5.320e-21 7.070e-20 1.830e-19 7.640e-19
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Ra-226 Particulate M 1.0000 5.049e+10 1.800e-03 1.000e-07 5.480e-05
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4.018e-08 4.022e-08 4.020e-08 2.796e-07
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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
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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
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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

```
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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0.000e+00 0.000e+00 0.000e+00 0.000e+00
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
0.000e+00 0.000e+00 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
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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
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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7.160e-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 02 09:10:11 2022



            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: Modtest41.
Dataset Date: Apr 14, 2022 10:51 AM
Wind File: C:\Users\OVERKB\Documents\CAP88\Wind Files\PORTS30.WND
p File: C:\Users\OVERKB\Documents\CAP88\Population Files\PORTS.POP

Mon May 02 09:10:11 2022 SYNOPSIS
Page 1

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): (Heat Release Rate) | 1.00 |

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) x 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-2021 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 x UDF) (mrem/yr) | Dose from MS Access Database (mrem/yr) |
|---|---|---|---|---|---|---|---|---|---|---|
| MFC | MFC-1702-001 | Cs-137 | Cs137A.DAT | Cs137A.SUM | SSE | 8678 | 2.60E-01 | 1.40E-01 | **3.64E-02** | **3.64E-02** |
| RWMC | Beryllium Blocks | H-3 | H3A. DAT | H3A.SUM | E | 35320 | 4.81E+01 | 7.60E-06 | **3.66E-04** | **3.66E-04** |
| SMC | RRTR-North | Br-82 | Br82C. DAT | Br82C.SUM | SSE | 38138 | 1.03E+01 | 3.40E-05 | **3.50E-04** | **3.50E-04** |
| RTC-ATR | TRA-770-001 | Ar-41 | Ar41A. DAT | Ar41A.SUM | ESE | 30222 | 3.47E+02 | 9.00E-08 | **3.13E-05** | **3.13E-05** |

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 54).
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. Unit Dose Factors (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-2021 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 x UDF) (mrem/yr) | Dose from MS Access Database (mrem/yr) |
|---|---|---|---|---|---|---|---|---|---|---|
| IRC | RESL_IF-683 | I-125 | I125.DAT | I125.SUM | SSE | 115 | 4.88E-08 | 4.60E+02 | **2.24E-05** | **2.24E-05** |
| IRC | IF-603-IRC-AM | Cs-137 | Cs137.DAT | Cs137.SUM | SSE | 115 | 9.40E-08 | 1.10E+03 | **1.03E-04** | **1.03E-04** |
| IRC | IF-611 | Xe-133 | Xe133.DAT | Xe133.SUM | SSE | 115 | 4.63E-01 | 2.20E-03 | **1.02E-03** | **1.02E-03** |
| IRC | RESL_IF-683 | H-3 | H3.DAT | H3.SUM | SSE | 115 | 1.51E-07 | 7.00E-02 | **1.06E-08** | **1.06E-08** |

a. The INL in-town MEI is located 115 m SSE from the source. All sources are assumed to be collocated at RESL.
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. Unit Dose Factors (UDFs) are taken from the tempdoses.txt file and checked against the output contained in the *.SUM files according to the direction and distance.