



Sandia  
National  
Laboratories

# Turbo FRMAC and RASCAL

Lainy Cochran, CHP

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Sandia National Laboratories is a multimission laboratory managed and operated by National Technology & Engineering Solutions of Sandia, LLC, a wholly owned subsidiary of Honeywell International Inc., for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-NA0003525.

**SAND2022-14531 PE**



- Turbo FRMAC introduction
- Accessing Turbo FRMAC and web-based training opportunities
- Demonstration of how to import a RASCAL-generated source term into Turbo FRMAC



# Introduction

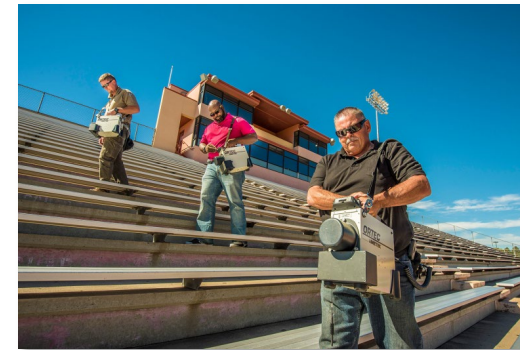




# Introduction



- Sandia National Laboratories (SNL), located in Albuquerque, New Mexico, USA
- Government owned, contractor operated
- Provide research and technical solutions, expert analysis, and highly trained emergency response professionals to support the U.S. government's response to a nuclear or radiological accident



# Federal Radiological Monitoring and Assessment Center (FRMAC)



**Mission:** Provide timely, high-quality predictions, measurements, analyses, and assessments to promote efficient and effective emergency response for the protection of the public from the consequences of nuclear or radiological incidents



Aerial Measurements



Field Monitoring



Sample Control and Analysis






Data Assessment

- Software performs complex calculations to quickly evaluate radiological hazards during an emergency response by assessing impacts to the public, workers, and the food supply
- Deployable software application developed by SNL
- Does not require internet connection
- Automates FRMAC Assessment Manual methods
- Updated periodically to implement new and revised methods
- NOT a replacement for health physics knowledge and experience



Results are used to support protective action decisions, such as:

- Should a population be sheltered, evacuated, or relocated?
- When can a relocated population return home?
- What field measurements would indicate that a protective action is warranted?
- How long can a worker remain in a contaminated area?
- Might a food crop in an area need to be considered for removal from commerce?
- When can a crop be planted so as not to exceed food contamination guidelines?

	<b>Public Protection</b> Evaluate the potential impacts to members of the public from exposure to radiological materials in the air and/or deposited on the ground.
	<b>Worker Protection</b> Establish worker protection guidelines (e.g., stay-times, turn-back limits).
	<b>Ingestion</b> Evaluate the potential impacts from radiologically contaminated food.







\*New Derived Response Levels Calculation - Turbo FRMAC

File NEW CALCULATION TOOLS HELP

Cancel Calculation Cancel

Start Your Calculation | Choose the type of Calculation you wish to perform.

1 Browse Categories 2 Select Calculation 3 Choose Template

**Public Protection**  
Evaluate the potential impacts to members of the public from exposure to radiological materials in the air and/or deposited on the ground.

**Worker Protection**  
Establish worker protection guidelines (e.g., stay-times, turn-back limits).

**Ingestion**  
Evaluate the potential impacts from radiologically contaminated food.

**Supplemental**  
Perform additional calculations to support radiological assessments.

**Derived Response Levels**  
Calculate the areal or integrated air activity of radionuclides at which the total dose from the mixture equals the PAG over the time phase.

**Projected Public Dose**  
Calculate the dose from exposure to a release of radioactive material.

**Dose Parameters**  
Calculate the External, Inhalation, and Total Dose Parameters.

**Nuclear Fallout Calculations**

**Nuclear Fallout Doses**  
Calculate the Doses for a deposition of radioactive fallout after a nuclear detonation.

**Nuclear Fallout Stay Time**  
Calculate the Stay Time for a deposition of radioactive fallout after a nuclear detonation.

**Nuclear Fallout DRLs**  
Calculate the Nuclear Fallout DRLs for a deposition of radioactive fallout after a nuclear detonation.

**Time Varying Calculations**

**Varying Evaluation Time**  
Calculate a curve of the DRL for a fixed time phase at different evaluation times.

**Projected Return Time**  
Calculate a curve of the DRL at the fixed evaluation time for shifting time phases. Answers questions like: 'When can I go home?' or 'When will the limit not be exceeded?'

**Return Thresholds**  
Calculate the DRL for the beginning of the time phase for a shifting time phase. Answers questions like: 'Can they go home today?' or 'Will the limit be exceeded now?'

**Projected Public Dose Over Time**  
Calculates a curve of the dose from exposure to a release of radioactive material over time intervals for a selected Time Phase.

**Blank**  
Create a Calculation using all default inputs.

**Copy from Existing**  
Make a copy of a saved Calculation to get started.

Ready. Memory Usage: 17%

**\*New Derived Response Levels Calculation - Turbo FRMAC**

HOME SHARE TOOLS HELP

Required Other **Show All** 1992 EPA PAG Manual Emulation Mode Reset Inputs

Dose and Exposure Deposition Integrated Air Dose Parameters Age Group: Adult Organ: Whole Body Dose Rollup Tool Input Report Briefing Products Search Collapse All Expand All Details Switch Calculations

**1** ✖ **Radionuclide Mixture:** The Mixture must contain 1 or more Radionuclides. Add Radionuclides or Import a Mixture. ⚠ **Other Inputs Warning:** Only users with a sufficient understanding of these inputs and their effects on the calculated values should modify these inputs. Use caution when editing these values!

**Derived Response Levels** | show all inputs (both Required and Other) that can impact the calculations.

Show All Inputs

- Name and Description
- Time Settings
- Radionuclide Mixture ✖
- ICRP Guidance
- Protective Action Guides (PAGs)
- Relative Biological Effectiveness
- Breathing Rates
- Building Protection Factors
- Exposure to Dose Factors
- ICRP and Lung Clearance
- Instrument Thresholds
- KI Protection Factors
- Occupancy Factors
- Particle Size Distribution
- Resuspension
- Weathering Correction

**Radionuclide Mixture**

Name: Unknown

Description:

Mixture and Measurement Type

☒ Generic ☐ Activity per Area ☐ Mass per Area

What Values are Known for the Mixture?

☒ Activity per Area *Integrated Air Concentration values will be calculated using the Deposition Velocity.*  
☐ Integrated Air Concentration  
☐ Both

Add Radionuclide: Search... Import Export & Email Manage Daughters Age Scale View

Form	Radionuclide	Activity per Area	Integrated Air Concentration	Deposition Velocity	Particle Size Distribution
0 parents, 0 daughters, 0 total radionuclides, 0 total forms					
		$\mu\text{Ci} / \text{m}^2$	$(\mu\text{Ci} \cdot \text{s}) / \text{m}^3$	$\text{m} / \text{s}$	
		[-4.86E303, 4.86E303]	[-4.86E303, 4.86E303]	[-∞, ∞]	

Daughters are assigned the Deposition Velocity of their parent.

✖ The Mixture must contain 1 or more Radionuclides. Add Radionuclides or Import a Mixture.

**ICRP Guidance**

ICRP Guidance: ICRP 60

Commitment Period: Chronic

**Protective Action Guides (PAGs)**

Evacuation/Shelter/Relocation

	Early Phase (TD)	Early Phase (AD)	First Year	Second Year	Fifty Year
Total Effective Dose (TED)	1.00	1.00	2.00	0.500	5.00
Thyroid	5.00	5.00	10.0	2.50	25.0
Skin	50.0	50.0	100	25.0	2.50E2

Ready. Memory Usage: 12%

**Derived Response Level (DRL) -**  
 A level of radioactivity in an environmental medium that would be expected to produce a dose equal to the corresponding PAG





# Accessing Turbo FRMAC



1



# Turbo FRMAC and RAMP

- Turbo FRMAC is a part of RAMP to promote awareness of the software and provide training opportunities to RAMP members
- We currently cannot recognize RAMP registrants and maintain a separate process for gaining Turbo FRMAC access

Sponsored by the U.S. Nuclear Regulatory Commission - NRC.gov

Register Log in

Search...



**RAMP Website**  
Radiation Protection Computer Code  
Analysis and Maintenance Program

CODES + MEMBERSHIP + MEETINGS + PARTNERS ABOUT + CONTACT

Home > Codes > Turbo FRMAC

## Code Menu

- Turbo FRMAC Overview
- Documentation
- Request Support

## Turbo FRMAC

Assess radiological hazards during an emergency response



## Updates

- 

**RAMPED UP - April 2021**  
April 08, 2021
- 

**Oct.-Nov. 2020 User Group Virtual Webinar**  
October 12, 2020
- 

**RAMPED UP - May 2020**  
May 01, 2020

VIEW ALL NEWS

## Related Codes

- 

**RASCAL**  
Radiological Assessment System for Consequence...

VIEW ALL CODES




The Turbo FRMAC analysis tool performs complex calculations to quickly evaluate radiological hazards during an emergency response by assessing impacts to the public, workers, and the food supply. Turbo FRMAC can be used to evaluate the hazard from a wide variety of radiological incidents, such as:

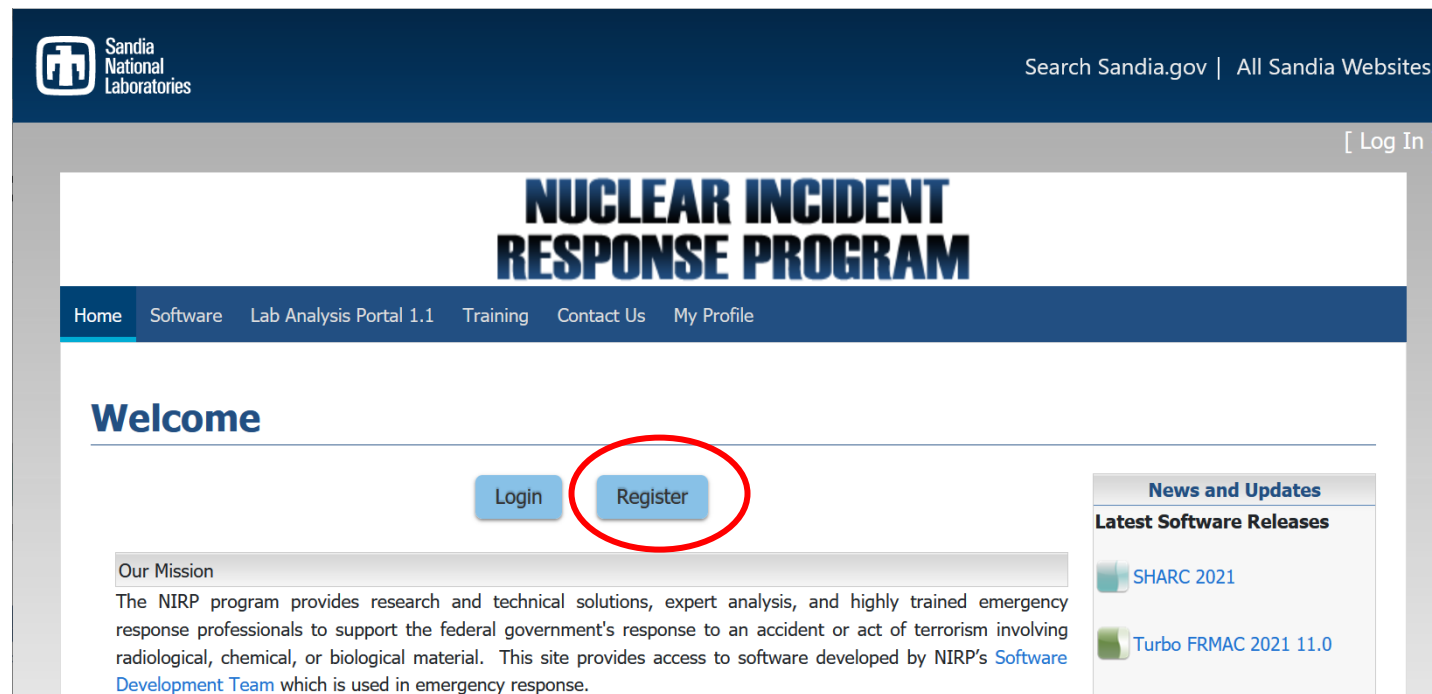
- Radiological Dispersal Devices (RDDs)
- Nuclear Power Plant Emergencies
- Fuel Handling Accidents
- Transportation Accidents
- Nuclear Detonations



# Accessing Turbo FRMAC





- Software may be issued to response organizations/individuals with justification
- Registration required via the following site: <https://nirp.sandia.gov>



# Registration Page

<https://nirp.sandia.gov/register>

- Once you create an account, check your email for an email verification link
- Once your email has been verified, you can then start requesting access to software


Search Sandia.gov | All Sandia Websites


## NUCLEAR INCIDENT RESPONSE PROGRAM

Home Software Lab Analysis Portal 1.1 Training Contact Us My Profile

### Create a New Account

Use the form below to create a new user account.

[Click here for help and instructions on how to create an account.](#)

#### Contact and Licensee Information

First Name:

Last Name:

*Note: We strongly recommend that you enter your work/organization email address to register for software access.*

Email:

Confirm Email:

Work Phone:

Company/Organization Name:

Company/Organization Address:

Title/Position:

Are you a U.S. Person (e.g. U.S. citizen or legal permanent resident)?

☐ Yes ☐ No

The company/organization listed is a(n):

☐ Small U.S. business

☐ Large U.S. business (500 or more employees)

☐ Non-profit organization or business under the U.S. Internal Revenue Code

☐ U.S. state or local government entity

☐ U.S. federal government agency

☐ U.S. institution of higher education

☐ Department of Energy National Laboratory

☐ Foreign company / Foreign government entity / Foreign institution of higher education

☐ Other

Why do you need this software access?

Explanation of Need:

Will there be any **non**-U.S. Persons using any of nirp.sandia.gov software?  
(Green card holders are considered U.S. Persons.)



# Turbo FRMAC Page

<https://nirp.sandia.gov/Software/TurboFRMAC/>

- After logging in, request access to Turbo FRMAC at bottom of software page
- Once access is approved, page will list available installers for download

What's New

A complete list of improvements and bug fixes for the latest versions of Turbo FRMAC is available by viewing the Release Notes.

[View Release Notes](#)

Software & Downloads

## Turbo FRMAC Downloads

All recent installers are expected to function properly on Windows 11, however the applications have not yet been tested on Windows 11. Please report any issues to [nirp-fogbugz@sandia.gov](mailto:nirp-fogbugz@sandia.gov).

[View System Requirements & Troubleshooting](#)

Windows Downloads

Runs on: Windows 10, 8, 7, Vista

\* The Single Installer installs only the Turbo FRMAC application to your computer. [Mixture Manager](#) and [Radionuclide Viewer](#) can be launched from within Turbo FRMAC.

\* For information on silent, noninteractive installation of Turbo FRMAC, please refer to documentation on [running an installer silently](#) and [creating an installation properties file](#).

**Turbo FRMAC - Version 11.2 | Released 10/18/2022**

Download Link	Description
<a href="#">Download 64-bit</a>	Single Installer Windows 64-bit Turbo FRMAC Version 11.2 SHA1 checksum value : b963015fb2262ea0feb2d3ac260968890e4eac38

Search Sandia.gov | All Sandia Websites

# NUCLEAR INCIDENT RESPONSE PROGRAM

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[What's New](#)
[Features](#)
[Software & Downloads](#)

Overview

The Turbo FRMAC (TF) software automates the calculations described in Volume 1 of "The Federal Manual for Assessing Environmental Data During a Radiological Emergency". The manual upon which the software is based is unclassified and freely available by [clicking here](#).

Using values generated by field samples, instrument readings, or computer dispersion models, TF assesses the generated results into values that are meaningful and actionable for a decision maker at a radiological emergency. TF provides calculated results to answer questions such as:

- Do radiation values exceed city, state, or federal limits?
- Should crops be destroyed or can they be utilized?
- Do residents need to be evacuated, sheltered in place, or should another action be taken?
- How long can emergency workers work in a given area?

The software uses formulas generated by the Environmental Protection Agency (EPA), Food and Drug Administration (FDA), and other federal agencies to generate field-observable values specific to the radiological event that can be used to determine where regulatory limit values are exceeded. TF calculates values that indicate:

- How long an emergency worker can work in the contaminated area during a radiological emergency?
- The dose received from drinking contaminated water or milk.
- The dose from eating contaminated food.
- The dose expected down or upwind of a given field sample.
- Other similar radiological health values.

TF is designed to help the decision maker in a radiological emergency understand the significance of the field sample results and modeling information, so that proper response actions can be implemented. The software provides information about the impacts a radiological emergency will have on people affected by the event. It is intended to aid the leadership in identifying the proper action needed in order to protect the public without causing widespread panic.

Turbo FRMAC is a member of RAMP. The purpose of the [Radiation Protection Computer Code Analysis and Maintenance Program \(RAMP\)](#) is to develop, maintain, improve, distribute and provide training on NRC-sponsored radiation protection and dose assessment computer codes. Training for Turbo FRMAC is available to RAMP members.

**Turbo FRMAC Factsheet**

[View](#)

**FRMAC Assessment Manual**

[View](#)

Features

- Formulas located in Volume 1 of the FRMAC Assessment Manual.
- Includes DCFPAK 2015, containing six different vintages of data with published coefficients ranging from years 1983 to 2015.
- A radionuclide viewer for viewing nuclide information, such as decay modes, and radionuclide decay chains.
- Integration with Radionuclide Mixture Manager which allows for importation of existing mixtures, ability to create and reuse mixtures, import mixtures from RASCAL, etc.
- Complex Particle Size Distribution that allows for calculation of values under realistic complex particle distribution scenarios.
- ICRP 60 with both true Monodispersed Dose Coefficients and Lognormal based coefficients.
- ICRP 107 radiation decay data.
- ICRP 56 (FDA) data for calculation of FDA DILs.
- Instrument Thresholds: allows indication of what energy levels field instruments can register to dynamically changes values to be consistent with instruments in use.
- Decay Curve Export: exports the decay curve of a mixture for importation into other software tools for further analysis. Charts allow for analysis of the decay curve inside TF.
- Ability to export table data to Microsoft Excel™.
- Ability to share calculations via email. Import and export calculations to TFV files.

# Approval Process



- The software licensing process may take up to 10 business days to complete for a U.S. person and up to 30 days to complete for international users
- If a license agreement is not in place for your organization, you will be asked to complete a Participant Data Sheet
- If a license agreement is already in place for your organization, the process is faster
- If you have not heard anything after 10 business days, contact [NIRP-support-fogbugz@sandia.gov](mailto:NIRP-support-fogbugz@sandia.gov)

# Nuclear Incident Response Self-Paced Learning Opportunities



## AS-100: Introduction to Assessment Science

24 ABHP CECs

- 22 module course covering FRMAC Assessment methods for public protection, worker protection, and ingestion pathway [PNNS-KDXC](#)

## Turbo FRMAC Advanced Methods

1 ABHP CEC each

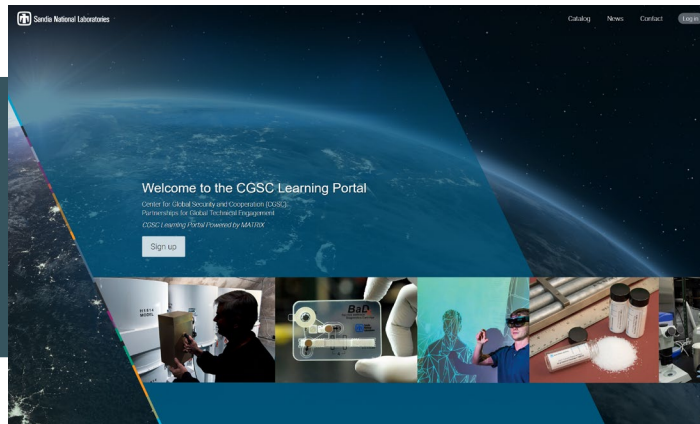
- Administration of Potassium Iodide  
Derived Response Level Calculation [OMXL-NMBV](#)
- Analytical Action Level Calculation [HZAK-EWAX](#)

## LA-050: Support Laboratory Briefing (Coming soon!)

- What labs should expect when called to help FRMAC

## Gamma Spectroscopy (Coming soon!)

- Detector Calibration Methods
- Sample Analysis
- Software Functions
- Mathematical Instrument Calibration
- True Coincidence Summing Corrections
- In-Situ Gamma Spectrometry



Sandia and partners have developed *free, online* training!  
Learn more: <https://snl.matrixlms.com/>





# Demonstration



1

# Initial Assessment Process



Nuclear power plant source terms initially used by FRMAC could come from RASCAL



Determine initial source term

Potential data sources include regulatory agencies, intel, models, and measurements



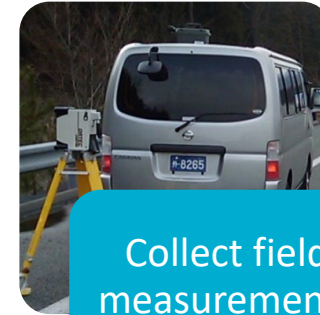
Calculate DRL

Turbo FRMAC is used to calculate DRLs



Run atmospheric dispersion models and contour DRL

Resulting map products are used by local officials to decide where to take protective actions



Collect field measurements and use to refine source term

DRLs can also be calculated for specific areas and compared to field measurements



# RASCAL Import Feature



File Type	Purpose
STDose Source Term vs. Time	Used in Turbo FRMAC and NARAC models for initial protective action products
STDose Total Surface Concentration by Nuclide	Used in Turbo FRMAC to calculate projected doses at a specific location
Atmospheric Source Term Merge/Export	Used in Turbo FRMAC and NARAC models for initial protective action products



# How do you import RASCAL source terms into Turbo FRMAC?



# Generating a Source Term in RASCAL STDose



Source Term to Dose - [New Case.STD]

File Settings Nuclide Data Viewer Help

**Event Type**  
NPP Reactor

**Event Location**  
Arkansas - Unit 1

**Source Term**  
☐ Import  
LOCA (NUREG-1465)

**Release Path**  
PWR Dry

**Meteorology**  
Predefined Conditions

**Calculate Doses**

**Detailed Results**

**Save Case**

### Source Term

**Summary of activity released to atmosphere**

	Ci	% of total	
Noble gas	9.2E+04	64.7	Noble gas / I-131 ratio = 11:1
Iodines	2.9E+04	20.2	
Other	2.1E+04	15.0	
<b>Total</b>	<b>1.4E+05</b>	<b>100.0</b>	

**Approximate activity balance at end of simulation**

Core	2.8E+09 Ci
Containment	2.2E+08 Ci
RCS	0.0E+00 Ci
Steam generator	0.0E+00 Ci
Environment	1.4E+05 Ci

**List of all radionuclides released with total activity**

Nuclide	Ci	Nuclide	Ci	Nuclide	Ci
Am-241	5.6E-05	La-142	2.8E-03	Sr-90	1.5E+02
Ba-139	2.1E-02	Mo-99	1.0E+02	Sr-91	4.0E+02
Ba-140	3.6E+03	Nb-95	1.7E+02	Sr-92	5.1E+00
Ce-141	1.6E+02	Nb-95m	2.1E-01	Tc-99m	9.9E+01
Ce-143	9.1E+01	Nb-97	3.2E+00	Te-127	5.0E+02

Display units  
☒ English  
☐ Metric

View Balance View Importance **Release vs. Time** Print

Case Summary **Source Term** Maximum Dose Values

# Exporting a RASCAL STDose Source Term



Source Term vs. Time



Activity (Ci) released to atmosphere (by nuclide and time step)

Interval	2022/10/11	2022/10/11	2022/10/11	2022/10/11	2022/10/11	2022/10/11	2022/10/11	2022/10/11
Start	20:00	20:15	20:30	20:45	21:00	21:15	21:30	21:45
Am-241	0.00E+00	0.00E+00	1.89E-08	3.36E-08	4.50E-08	5.39E-08	6.09E-08	6.89E-08
Ba-139	0.00E+00	0.00E+00	2.39E-04	3.67E-04	4.27E-04	4.43E-04	4.34E-04	4.25E-04
Ba-140	0.00E+00	0.00E+00	6.93E+00	1.21E+01	1.58E+01	1.86E+01	2.07E+01	2.27E+01
Ce-141	0.00E+00	0.00E+00	1.65E-01	2.87E-01	3.78E-01	4.45E-01	4.94E-01	5.34E-01
Ce-143	0.00E+00	0.00E+00	9.90E-02	1.72E-01	2.25E-01	2.64E-01	2.92E-01	3.12E-01
Ce-144*	0.00E+00	0.00E+00	1.35E-01	2.34E-01	3.08E-01	3.63E-01	4.03E-01	4.34E-01
Cm-242	0.00E+00	0.00E+00	1.70E-03	2.96E-03	3.90E-03	4.59E-03	5.09E-03	5.59E-03
Cs-134	3.62E+00	6.30E+00	1.16E+01	1.56E+01	1.85E+01	2.06E+01	2.22E+01	2.38E+01
Cs-136	1.41E+00	2.46E+00	4.54E+00	6.07E+00	7.20E+00	8.05E+00	8.67E+00	9.17E+00
Cs-137*	2.50E+00	4.36E+00	8.05E+00	1.08E+01	1.28E+01	1.43E+01	1.54E+01	1.65E+01
Cs-138	2.24E-10	2.83E-10	3.77E-10	3.66E-10	3.15E-10	2.55E-10	1.99E-10	1.43E-10
I-131	2.49E+01	4.34E+01	9.90E+01	1.40E+02	1.71E+02	1.94E+02	2.10E+02	2.27E+02
I-132	3.26E+01	5.50E+01	1.25E+02	1.76E+02	2.11E+02	2.37E+02	2.57E+02	2.77E+02
I-133	2.75E+01	4.76E+01	1.08E+02	1.52E+02	1.84E+02	2.06E+02	2.22E+02	2.38E+02
I-134	7.94E-06	1.13E-05	2.13E-05	2.48E-05	2.48E-05	2.30E-05	2.05E-05	1.80E-05
I-135	6.28E+00	1.06E+01	2.38E+01	3.28E+01	3.89E+01	4.28E+01	4.54E+01	4.79E+01
Kr-83m	2.11E-03	3.83E-03	1.62E-02	2.63E-02	3.45E-02	4.10E-02	4.59E-02	5.08E-02
Kr-85	2.89E-01	5.78E-01	2.69E+00	4.81E+00	6.91E+00	9.00E+00	1.12E+01	1.34E+01
Kr-85m	3.76E-01	7.24E-01	3.24E+00	5.56E+00	7.70E+00	9.72E+00	1.15E+01	1.33E+01

Plot

Print

Export

OK

Help



# Exporting a RASCAL STDose Source Term



- Choose your desired file format and click Export

Export Atmospheric Source Term

Format of the export file:

- ☒ as XML
- ☐ as CSV

Export file options:

- ☒ Strip \* characters from nuclide names
- ☐ Use the RASCAL 4.2 format (CSV only)

Nuclides to export:

- ☒ All nuclides in the source term
- ☐ Filter by importance to dose

[View Importance](#)

Pathway:

- ☒ TEDE
- ☐ Air immersion
- ☐ Inhalation
- ☐ Groundshine
- ☐ Ingestion

Time Period:

- ☒ 0 days
- ☐ 1 day
- ☐ 7 days
- ☐ 30 days
- ☐ 0.5 yr
- ☐ 1 yr
- ☐ 5 yr
- ☐ 10 yr

Method:

- ☒ Top contributors
- ☐ Fraction of dose

[Export](#)

[Help](#) [Exit](#)

# Importing a RASCAL Source Term into Turbo FRMAC



Select the Radionuclide Mixture button. Select Import, then RASCAL File...

Required Inputs

- Name and Description
- Time Settings
- Radionuclide Mixture
- ICRP Guidance
- Protective Action Guides (PAGs)

**Radionuclide Mixture**

Name: Unknown

Description:

Mixture and Measurement Type

Generic ☒ Activity per Area ☐ Mass per Area

What Values are Known for the Mixture?

☐ Activity per Area *Activity per Area values will be calculated using the Deposition Velocity.*

☒ Integrated Air Concentration

☐ Both

Add Radionuclide:

Search...

Import Export & Email Manage Daughters Scale View

Form Radionuclide Activity per Area

0 parents, 0 daughters, 0 total radionuclides, 0 total forms

$\mu\text{Ci}$  /  $\text{m}^2$

Daughters are assigned the Deposition Velocity of their parents

The Mixture must contain 1 or more Radionuclides. Add Radionuclide

ICRP Guidance

**Recent Mixtures**

Import a recently used Mixture from Mixture Manager.

**From Mixture Manager...**

Import a Mixture from Mixture Manager.

**Paste Mixture From...**

Paste Mixture data from other sources using the Clipboard.

**RMIX File...**

Import a Radionuclide Mixture from a file.

**RASCAL File...**

Import a Radionuclide Mixture from RASCAL.

2015 ICRP 60

Particle Size Distribut... Resuspension Partic...

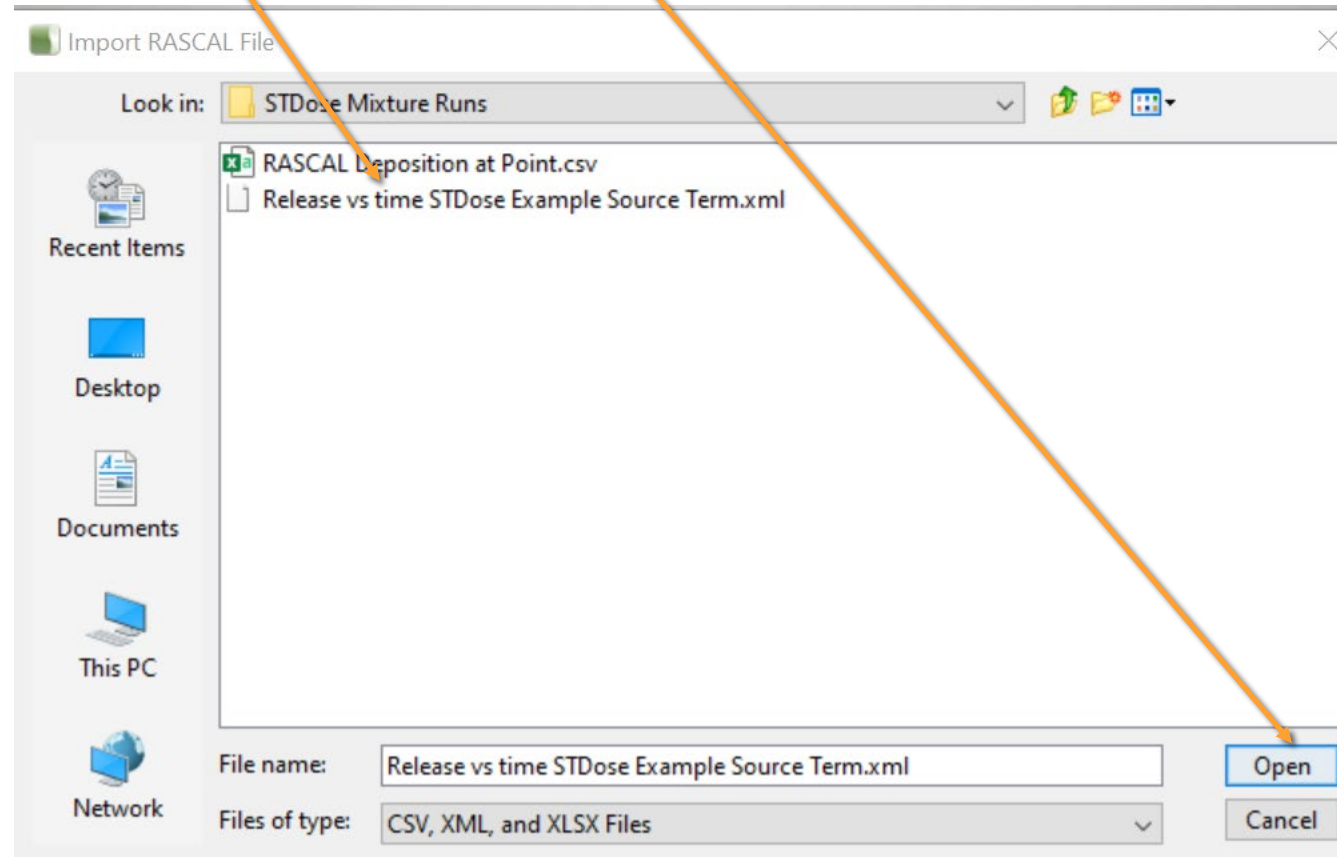
Truncation: ON Equilibrium: ON

Help

# Importing a RASCAL Source Term into Turbo FRMAC



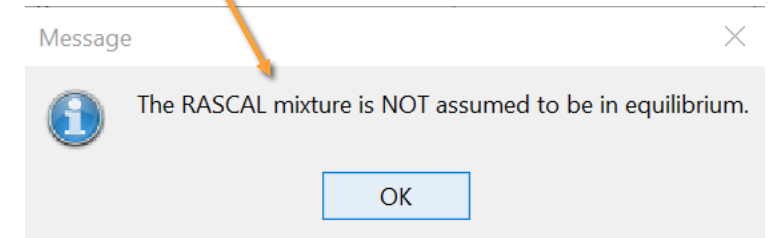
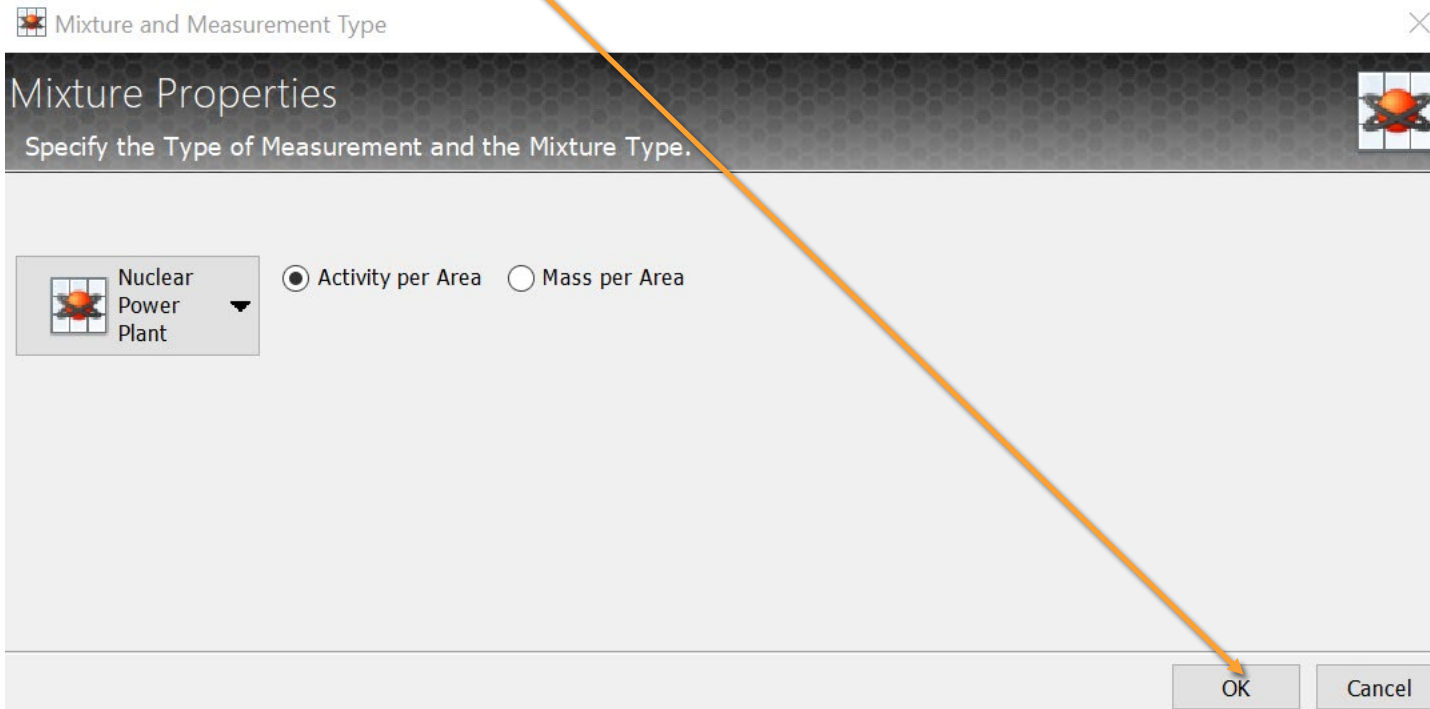
Select the appropriate RASCAL file, then click Open.



# Importing a RASCAL Source Term into Turbo FRMAC



When importing a mixture, a transitional panel appears that defaults to Nuclear Power Plant release type. Click OK (no changes needed) for this calculation. A warning message will then appear. Click OK.





## Nuclear Power Plant mixture type



Iodine released from a nuclear power plant under accident conditions is partitioned as follows in order to be consistent with NRC calculations as described in NUREG-1940

Form	Partition	Deposition Velocity (m/s)
Methyl Iodide/Non-reactive Gas ( $\text{CH}_3\text{I}$ )	45%	0
Iodine Vapor/Reactive Gas ( $\text{I}_2$ )	30%	6.4E-03
Particulate	25%	6.5E-03

# Importing a RASCAL Source Term into Turbo FRMAC



RASCAL source term is populated in TF

Derived Response Levels | Review and edit the most commonly used inputs for the calculations.

Required Inputs

- Name and Description
- Time Settings
- Radionuclide Mixture
- ICRP Guidance
- Protective Action Guides (PAGs)

Radionuclide Mixture

Name: Am-241,Ba-139,Ba-140,Ce-141,Ce-143,Ce-144,Cm-24...

Description:

Mixture and Measurement Type

☒ Activity per Area ☐ Mass per Area

What Values are Known for the Mixture?

☐ Activity per Area *Activity per Area values will be calculated using the Deposition Velocity.*

☒ Integrated Air Concentration

☐ Both

Add Radionuclide: Search...

Import Export & Email Manage Daughters Age Scale View 2015 ICRP 60

Form	Radionuclide	Activity per Area	Integrated Air Concentration	Deposition Velocity
<input type="checkbox"/> P	$^{241}\text{Am}$	0.17	56.01	3.0
<input type="checkbox"/> P	$^{139}\text{Ba}$	62.2	2.07E4	3.0
<input type="checkbox"/> P	$^{140}\text{Ba}$	1.08E7	3.60E9	3.0
<input type="checkbox"/> P	$^{141}\text{Ce}$	4.95E5	1.65E8	3.0
<input type="checkbox"/> P	$^{143}\text{Ce}$	2.73E5	9.10E7	3.0
<input type="checkbox"/> P	$^{144}\text{Ce}$	4.05E5	1.35E8	3.0

69 parents, 317 daughters, 386 total radionuclides, 442 total forms

Truncation: OFF Equilibrium: OFF

$\mu\text{Ci} / \text{m}^2$  [ 0.0, 1.75E29 ]  $(\mu\text{Ci} \cdot \text{s}) / \text{m}^3$  [ 0.0, 1.75E29 ]  $\text{m} / \text{s}$  [ 0.0, 100.0 ]

Daughters are assigned the Deposition Velocity of their parent.

Mixtures containing more than 300 radionuclides (including multiple forms) may result in memory issues for the application.

# Mixture Handling in Turbo FRMAC



Turbo FRMAC automatically generates the full decay chains for the parent radionuclides in a RASCAL mixture. This can expand a mixture of 30 to 60 parent radionuclides in RASCAL to 300+ radionuclides in Turbo FRMAC

RASCAL mixtures are imported with equilibrium turned off, so daughters in the decay chain are populated with zero values

Radionuclide Mixture

Name: Am-241, Ba-139, Ba-140, Ce-141, Ce-143, Ce-144, Cm-24...

Description:

Mixture and Measurement Type

☒ Nuclear ☐ Activity per Area ☐ Mass per Area

What Values are Known for the Mixture?

☐ Activity per Area ☒ Integrated Air Concentration ☐ Both

Activity per Area values will be calculated using the Deposition Velocity.

Add Radionuclide: Search...

Import Export & Email Manage Daughters Scale View

Form	Radionuclide	Activity per Area	Integrated Air Concentration	Deposition Velocity
<input type="checkbox"/> P	241Am	0.17	56.01	3.0
	237Np	0.0	0.0	3.0
	233Pa	0.0	0.0	3.0
	233U	0.0	0.0	3.0
	229Th	0.0	0.0	3.0
	225Ra	0.0	0.0	3.0
	225Ac	0.0	0.0	3.0
	221Fr	0.0	0.0	3.0
	217At	0.0	0.0	3.0
	213Bi	0.0	0.0	3.0
	213Po	0.0	0.0	3.0
	209Pb	0.0	0.0	3.0
	209Tl	0.0	0.0	3.0
	209Pb	0.0	0.0	3.0
<input type="checkbox"/> P	139Ba	62.2	2.07E4	3.0
<input type="checkbox"/> P	140Ba	1.08E7	3.60E9	3.0
	140La	0.0	0.0	3.0

69 parents, 317 daughters, 386 total radionuclides, 442 total forms

Truncation: OFF Equilibrium: OFF

Daughters are assigned the Deposition Velocity of their parent.

Mixtures containing more than 300 radionuclides (including multiple forms) may result in memory issues for the application.





Thank You

Lainy Cochran

[Idcochr@sandia.gov](mailto:Idcochr@sandia.gov)

