

# MODULE 1

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## INTRODUCTION TO RASCAL

This module is a brief overview of RASCAL and its tools

# **THE RASCAL ACRONYM STANDS FOR RADIOLOGICAL ASS<sub>ES</sub>MENT SYSTEM FOR CONSEQUENCE ANALYSIS**

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**RASCAL began with work in the mid-1990s to computerize the hand calculations and paper methods of the NRC's Response Technical Manual (RTM) and the source term document NUREG-1228.**

**RASCAL 4.3.3 is the current version, incorporating lessons learned from Fukushima and other exercises.**

# OPENING RASCAL IN WINDOWS

**Radiological Assessment System  
for Consequence Analysis**

# **RASCAL 4.3.3**

**September 2017**

**U.S. Nuclear Regulatory Commission**

**For more information visit: [www.usnrc-ramp.com](http://www.usnrc-ramp.com)**

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# THERE ARE 4 PRIMARY TOOLS AND 3 ADDITIONAL TOOLS ON THE RASCAL HOME PAGE.

The screenshot displays the RASCAL home page interface. At the top, the title "Radiological Assessment System for Consequence Analysis" is centered. Below the title, the interface is divided into two main columns: "Primary Tools" on the left and "Additional Tools" on the right. The "Primary Tools" column contains four buttons: "Source Term to Dose (STDose)", "Field Measurement to Dose (FMDose)", "Radionuclide Data Viewer", and "Decay Calculator". The "Additional Tools" column contains three buttons: "Create Reactor Inventory Base File", "Source Term Merge / Export", and "Download Meteorology from Internet". At the bottom left is a "Help" button, and at the bottom right is an "Exit" button. All buttons have a light gray background with a thin border and a slight gradient.

**Radiological Assessment System for Consequence Analysis**

**Primary Tools**

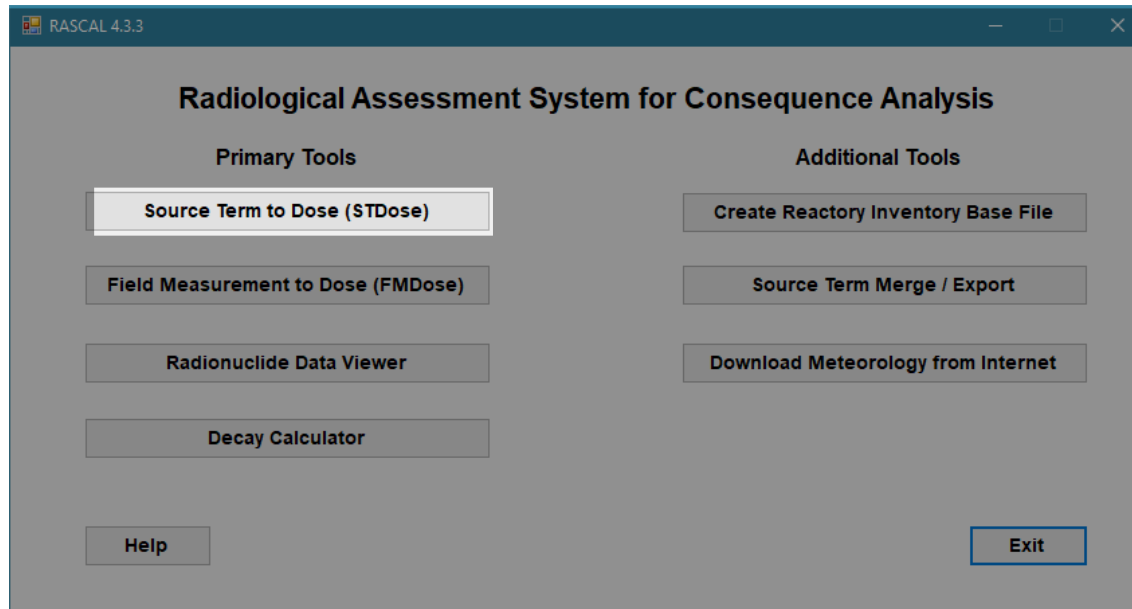
- Source Term to Dose (STDose)
- Field Measurement to Dose (FMDose)
- Radionuclide Data Viewer
- Decay Calculator

**Additional Tools**

- Create Reactor Inventory Base File
- Source Term Merge / Export
- Download Meteorology from Internet

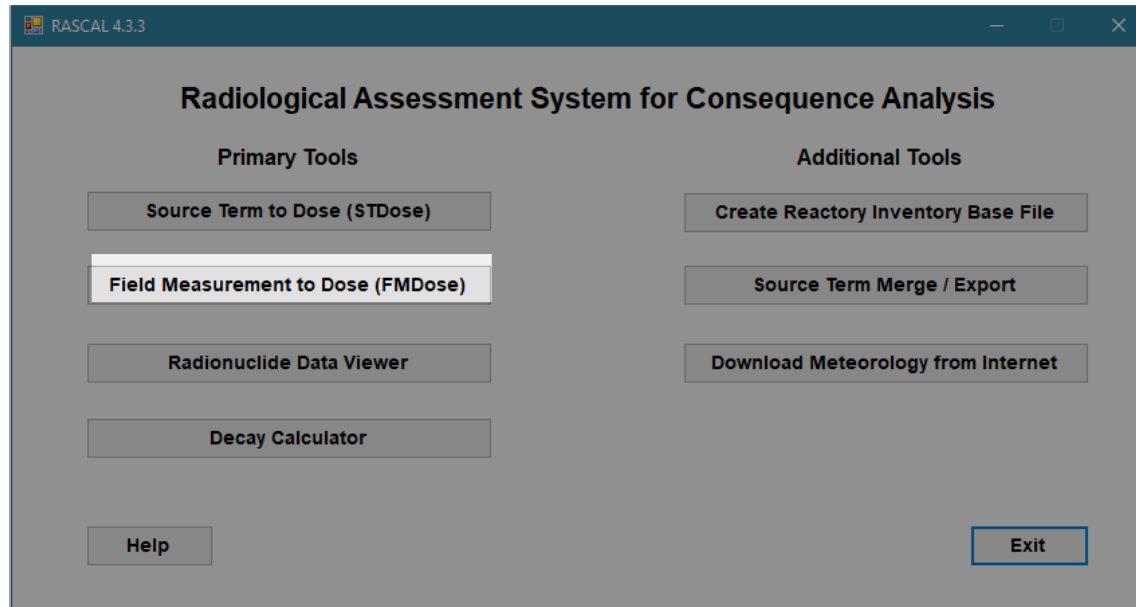
Help Exit

# SOURCE TERM TO DOSE (STDose)



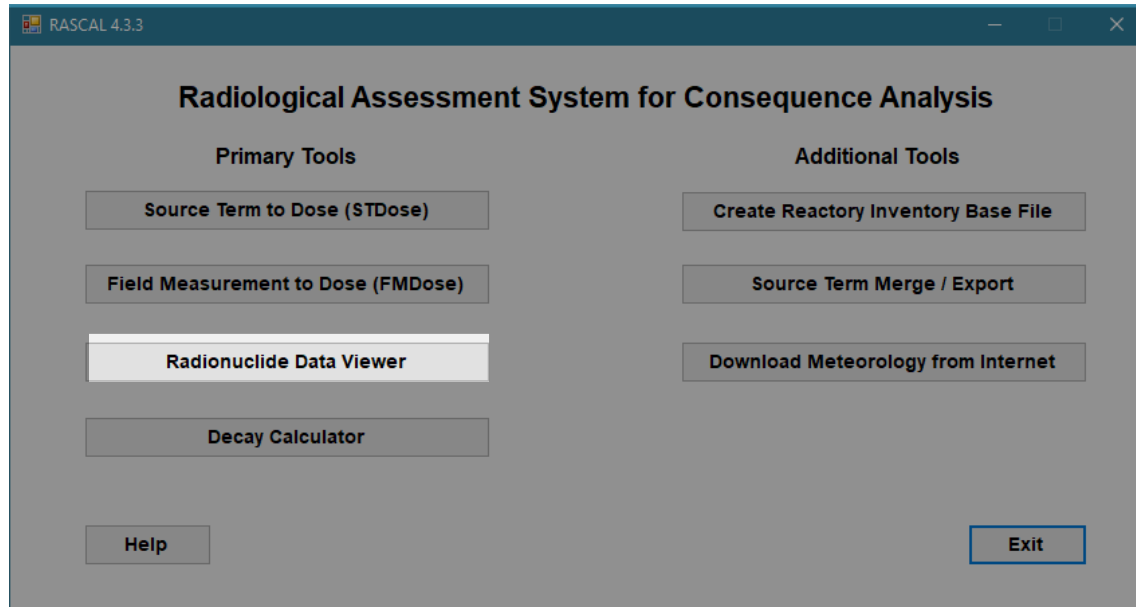
Processes scenario information to determine a radioactive source term, models the transportation of the material downwind, and calculates dose or concentration of material at given distances.

# FIELD MEASUREMENT TO DOSE (FMDose)



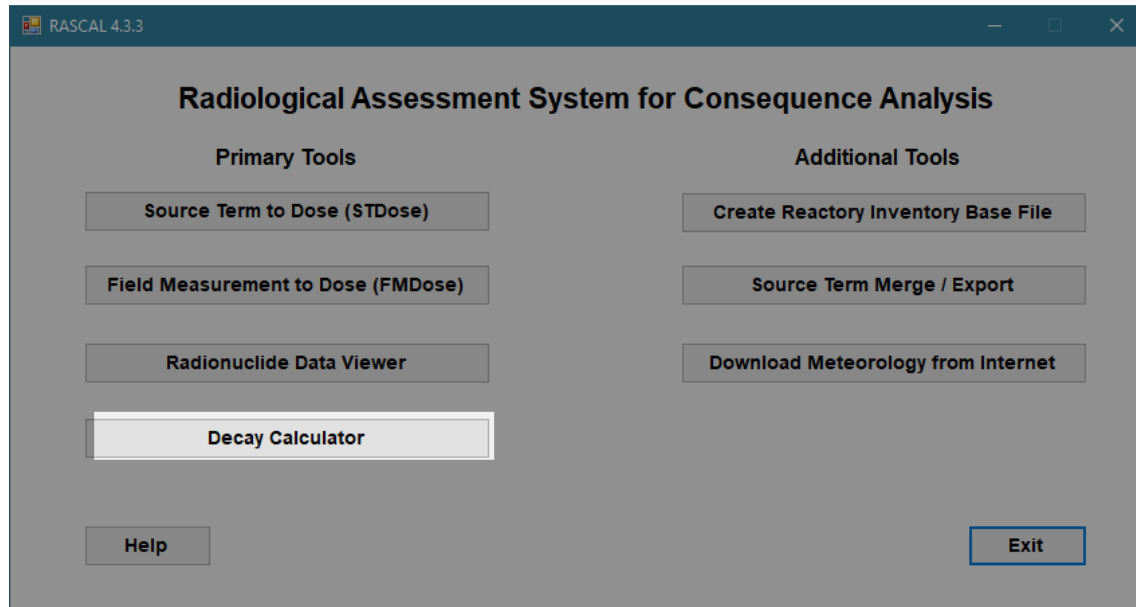
From an input concentration (field team measurement), calculates an estimated intermediate or long-term source term and dose at that given location

# RADIONUCLIDE DATA VIEWER



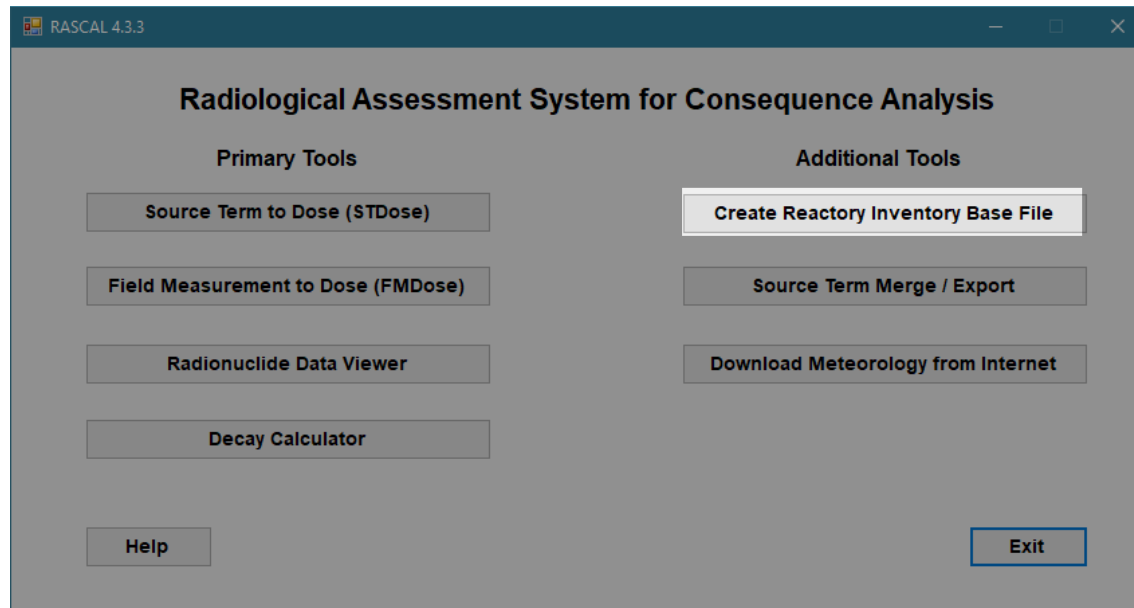
Contains all the dose and decay coefficients used by RASCAL's various models, which may support hand calculations or understanding potential differences between models.

# DECAY CALCULATOR



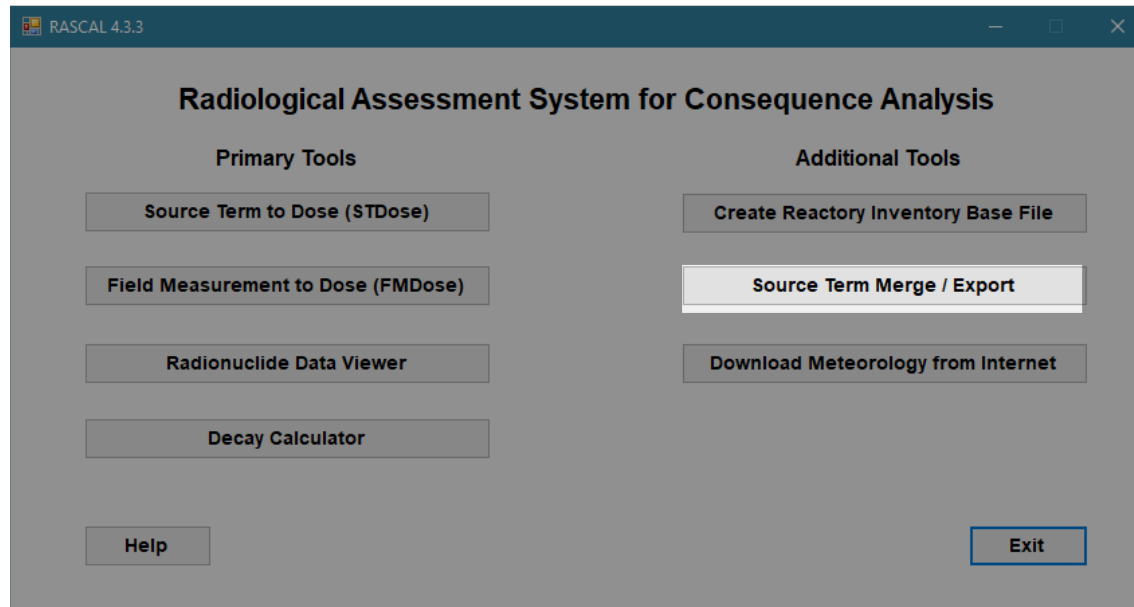
Simple tool (legacy) that takes an existing activity of one or more nuclides, and calculates remaining activity after a given time. It is still operational, but since decay calculators are common online, certain decay chains have not been fully updated.

# CREATE REACTOR INVENTORY BASE FILE



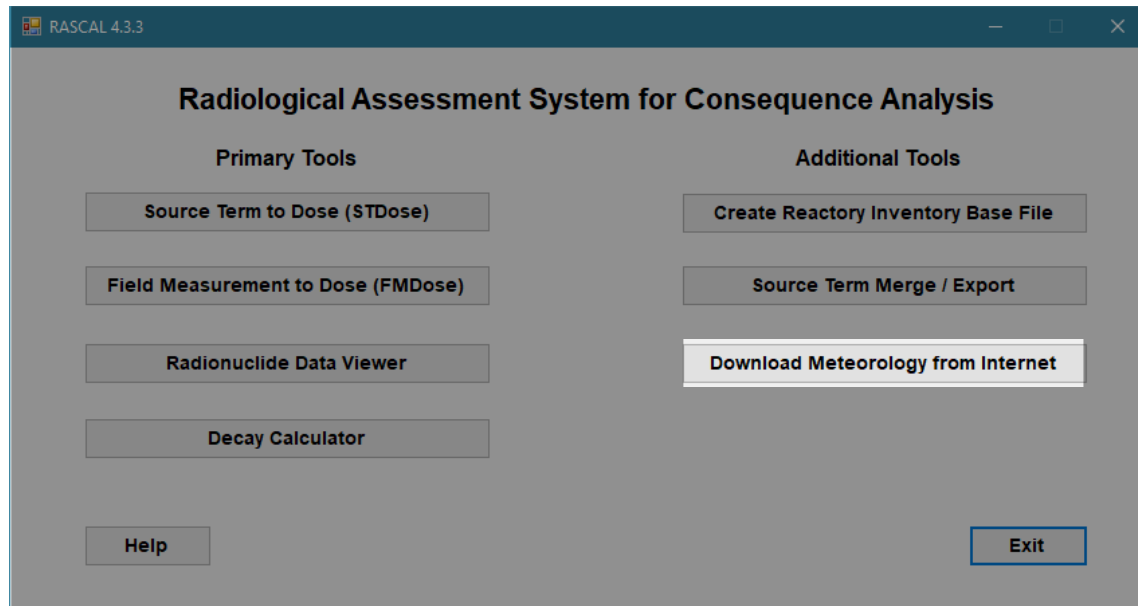
For refining an inventory for specific units based on their fuel management history. This tool can update fuel, coolant, and spent fuel radionuclide inventories if you have time and want a bit more precision in your data.

# SOURCE TERM MERGE / EXPORT



Combines STDose source terms and releases from a single height and geographic location to support multi-unit releases.

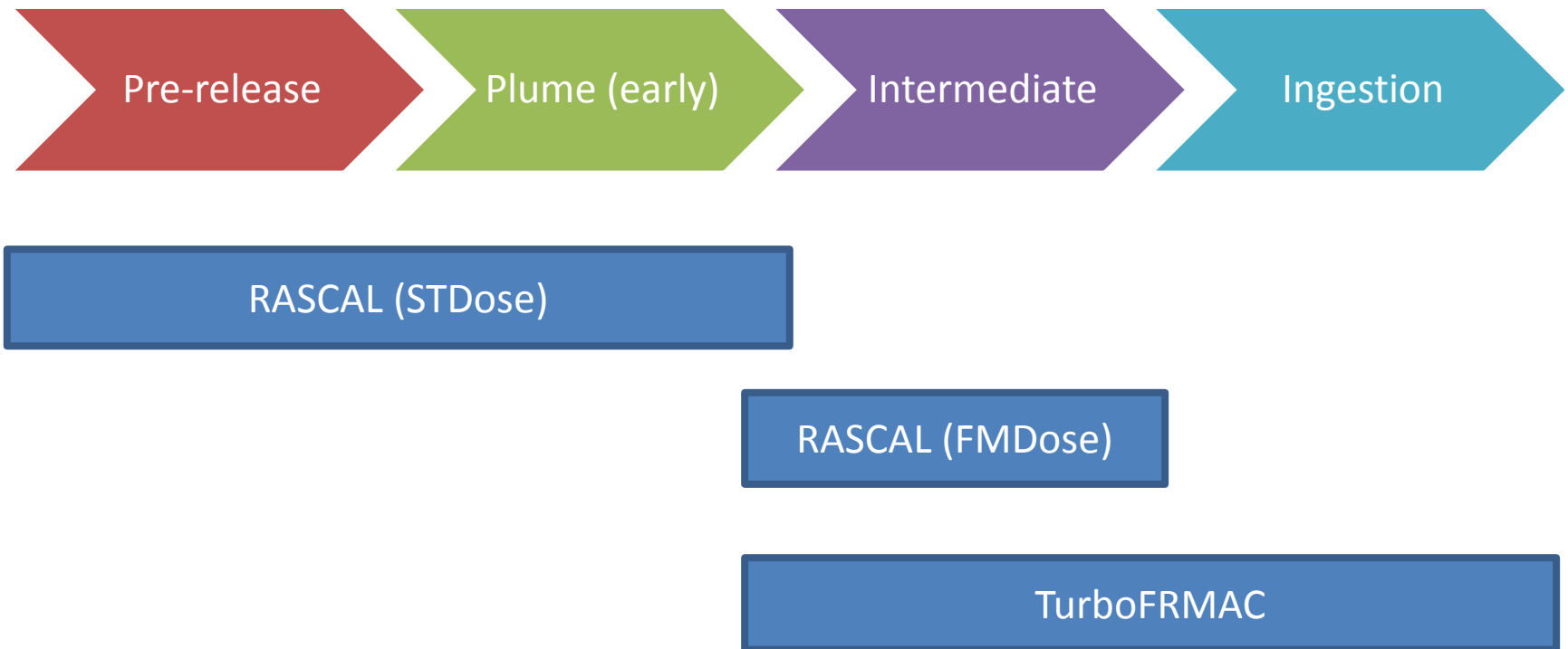
# DOWNLOAD METEOROLOGY FROM INTERNET



Obtains available weather forecast and observation data from the National Weather Service, making input of actual weather data more automated.

# WHERE DOES RASCAL FIT IN THE PHASES OF A RADIOLOGICAL EMERGENCY?

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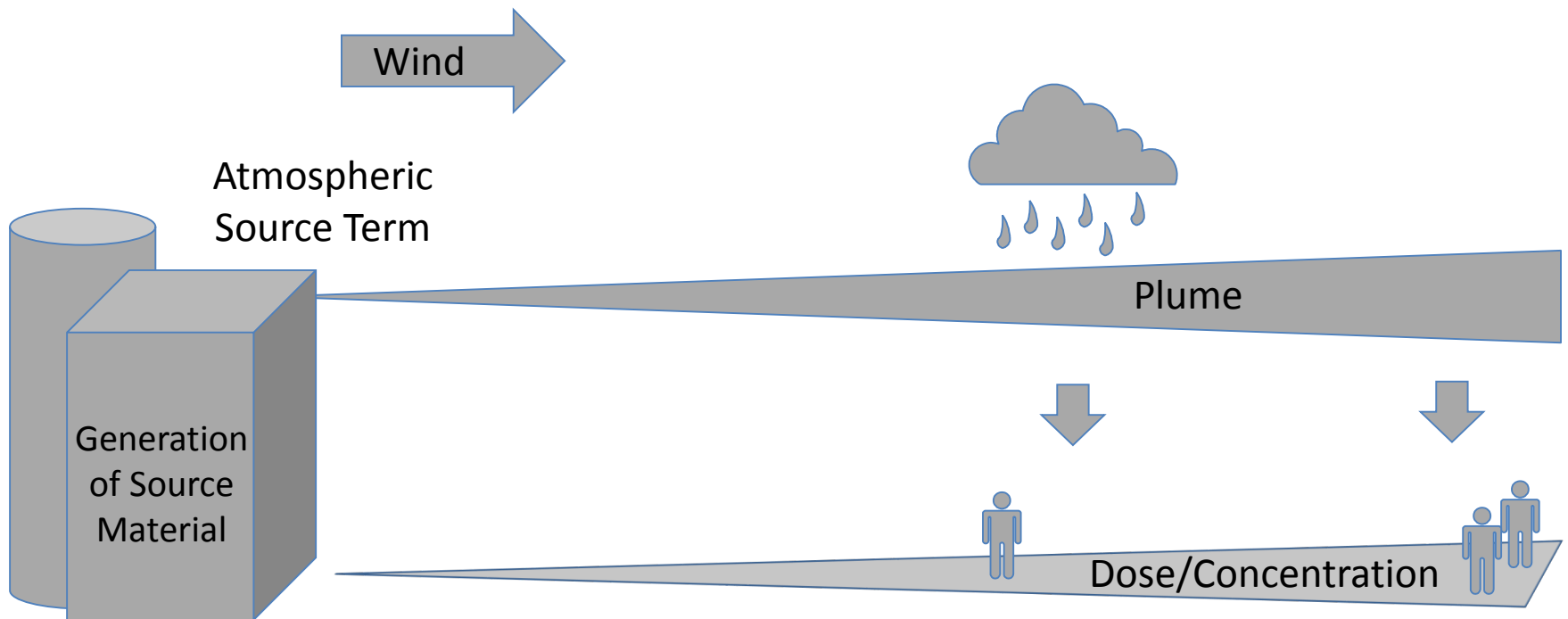
## WHY ARE YOU USING RASCAL?

- **Estimate doses**
- **Help generate Protective Action Recommendations / Protective Action Decisions**
- **Plan for “just-in-case” / Evaluate “what if”**
- **Compare against results from other tools**



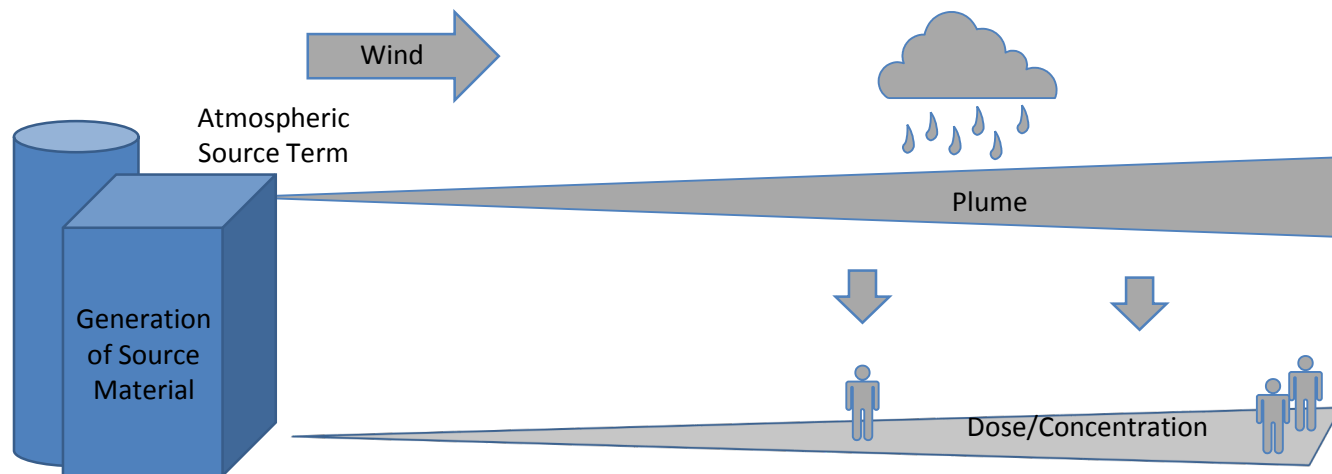
## THIS TRAINING WILL FOCUS ON STDose

**Source Term to Dose Module Creates Source Term, Processes Met Conditions, & Calculates Doses**



## RASCAL DEFINES ATMOSPHERIC SOURCE TERM

- **Determines radionuclides available for release**
  - May be single nuclide or complex core damage
  - Time-dependent isotopes and activity
- **Source material may be filtered, reduced, or decayed**

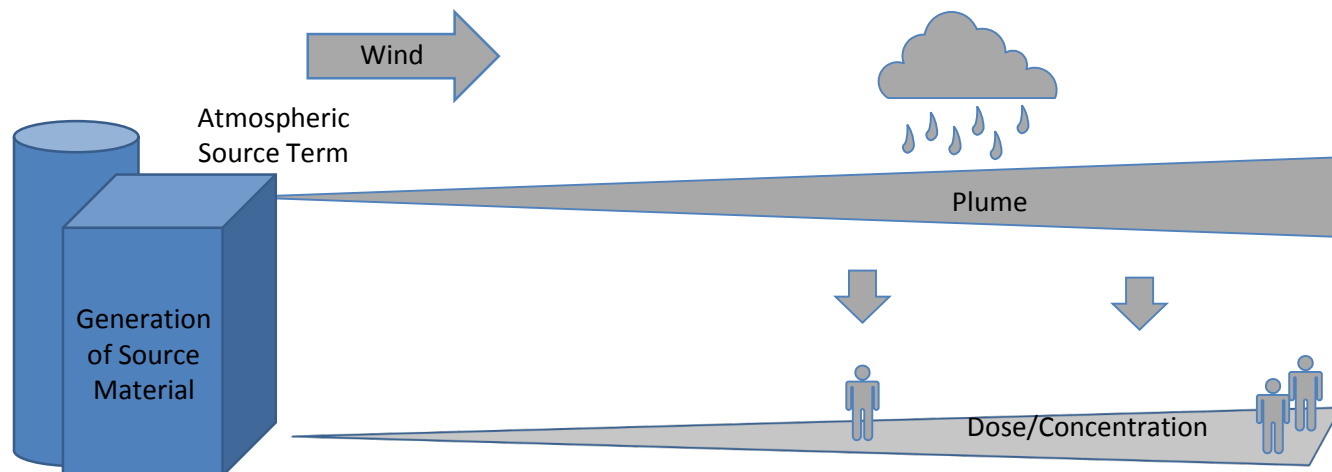


# RESULT IS RADIONUCLIDES RELEASED TO ENVIRONMENT OVER TIME (ATMOSPHERIC SOURCE TERM)

Isotopic activity  
over time (15 min)

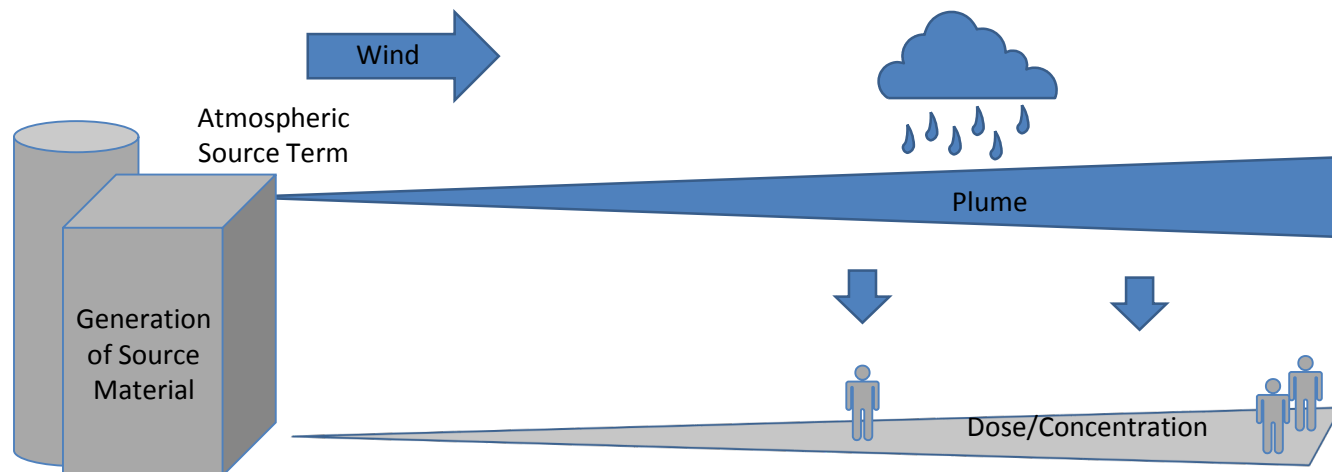
Activity (Ci) released to atmosphere (by nuclide and time step)

| Interval | 2016/02/02 00:00 | 2016/02/02 00:15 | 2016/02/02 00:30 | 2016/02/02 00:45 | 2016/02/02 01:00 | 2016/02/02 01:15 | 2016/02/02 01:30 | 2016/02/02 01:45 |
|----------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|
| Am-241   | 0.00E+00         | 0.00E+00         | 4.62E-10         | 1.46E-09         | 2.75E-09         | 4.17E-09         | 5.63E-09         | 7.10E-09         |
| Ba-139   | 0.00E+00         | 0.00E+00         | 5.62E+00         | 8.62E+00         | 9.99E+00         | 1.04E+01         | 1.02E+01         | 1.00E+01         |
| Ba-140   | 0.00E+00         | 0.00E+00         | 7.25E+00         | 1.26E+01         | 1.66E+01         | 1.95E+01         | 2.17E+01         | 2.39E+01         |
| Ce-141   | 0.00E+00         | 0.00E+00         | 1.67E-01         | 2.92E-01         | 3.83E-01         | 4.51E-01         | 5.01E-01         | 5.41E-01         |
| Ce-143   | 0.00E+00         | 0.00E+00         | 1.51E-01         | 2.61E-01         | 3.42E-01         | 4.01E-01         | 4.43E-01         | 4.79E-01         |
| Ce-144*  | 0.00E+00         | 0.00E+00         | 1.35E-01         | 2.35E-01         | 3.09E-01         | 3.64E-01         | 4.04E-01         | 4.39E-01         |
| Cm-242   | 0.00E+00         | 0.00E+00         | 1.71E-03         | 2.97E-03         | 3.91E-03         | 4.60E-03         | 5.11E-03         | 5.52E-03         |
| Cs-134   | 3.62E+00         | 6.30E+00         | 1.16E+01         | 1.56E+01         | 1.85E+01         | 2.07E+01         | 2.23E+01         | 2.39E+01         |
| Cs-136   | 1.48E+00         | 2.57E+00         | 4.73E+00         | 6.35E+00         | 7.53E+00         | 8.41E+00         | 9.09E+00         | 9.67E+00         |
| Cs-137*  | 2.50E+00         | 4.36E+00         | 8.05E+00         | 1.08E+01         | 1.28E+01         | 1.43E+01         | 1.54E+01         | 1.64E+01         |
| Cs-138   | 0.00E+00         | 1.73E+01         | 3.76E+01         | 5.65E+01         | 6.04E+01         | 5.41E+01         | 4.37E+01         | 3.43E+01         |
| I-131    | 2.65E+01         | 4.60E+01         | 1.05E+02         | 1.49E+02         | 1.81E+02         | 2.05E+02         | 2.23E+02         | 2.39E+02         |
| I-132    | 3.84E+01         | 6.49E+01         | 1.49E+02         | 2.07E+02         | 2.49E+02         | 2.81E+02         | 3.05E+02         | 3.29E+02         |
| I-133    | 5.37E+01         | 9.27E+01         | 2.11E+02         | 2.95E+02         | 3.57E+02         | 4.01E+02         | 4.32E+02         | 4.59E+02         |
| I-134    | 5.92E+01         | 8.46E+01         | 1.58E+02         | 1.85E+02         | 1.85E+02         | 1.72E+02         | 1.53E+02         | 1.34E+02         |
| I-135    | 5.13E+01         | 8.70E+01         | 1.94E+02         | 2.67E+02         | 3.18E+02         | 3.50E+02         | 3.71E+02         | 3.89E+02         |
| Kr-83m   | 4.08E+00         | 7.43E+00         | 3.14E+01         | 5.10E+01         | 6.69E+01         | 7.94E+01         | 8.91E+01         | 9.67E+01         |
| 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         |
| Rn-222m  | 8.25E+00         | 1.58E+01         | 7.11E+01         | 1.22E+02         | 1.69E+02         | 2.12E+02         | 2.52E+02         | 2.89E+02         |



# ATMOSPHERIC SOURCE TERM IS MOVED USING ATD MODELS

- **Atmospheric Transport and Dispersion Models**
  - Transport material based on weather conditions
  - Track material to where it falls/washes on ground
  - Accounts for dry/wet processes and particle size



# FINAL CALCULATIONS PROVIDE DOSES AND CONCENTRATIONS OVER CALCULATION AREA

- Dose calculation accounts for multiple pathways
  - External (Groundshine + cloudshine)
  - Internal (Inhalation + ~~ingestion~~)
- Results includes other display/calculation options

