Modeling a Multi-Unit Accident

Part of the RASCAL Instructor-led Training

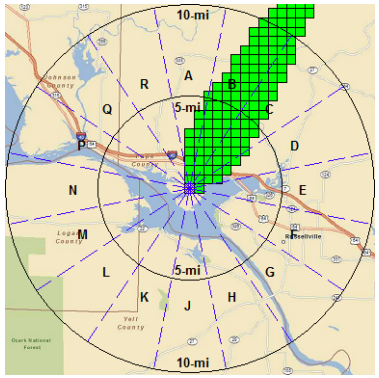
MULTI-UNIT - BACKGROUND

The need to be able to assess doses from multi-unit accidents was reinforced by the events at Fukushima Daiichi in March, 2011.

Multiple units were releasing at nearly the same time but each had a unique set of accident conditions and had to be handled separately. There was a need to assess the cumulative dose impact from the multiple releases.

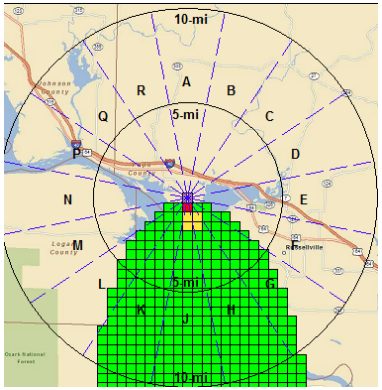
THE CHALLENGE IS TO BE ABLE TO COMBINE THE RESULTS OF THE ATD CALCULATIONS FROM EACH UNITS ASSESSMENT.

- Because each unit is having it's own accident the generation of the atmospheric source term is unique (composition and time).
- RASCAL can only model one accident at a time and that is OK.
- Each unit generates a plume as the material moves through the environment. The contribution of those plumes to dose may overlap in space and in time.



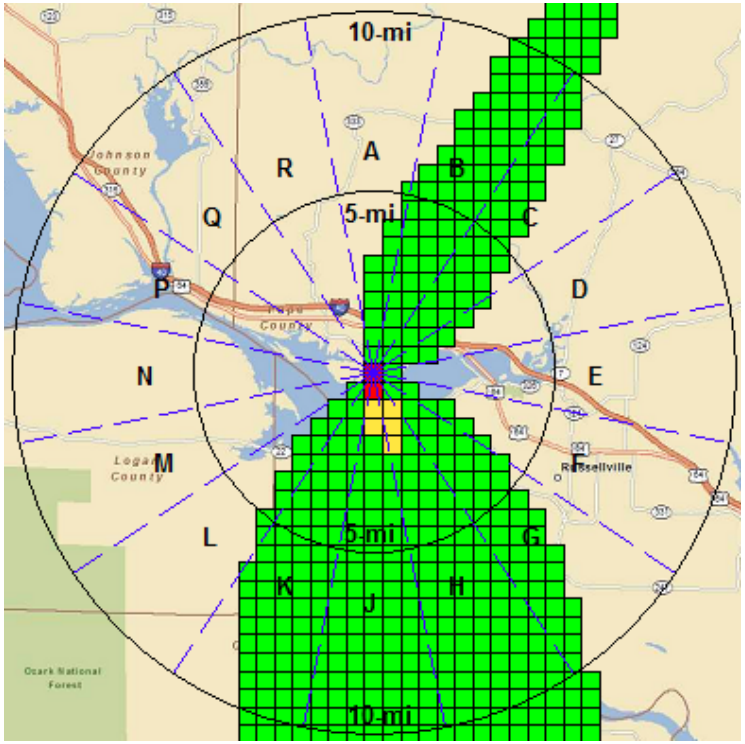
LOCA

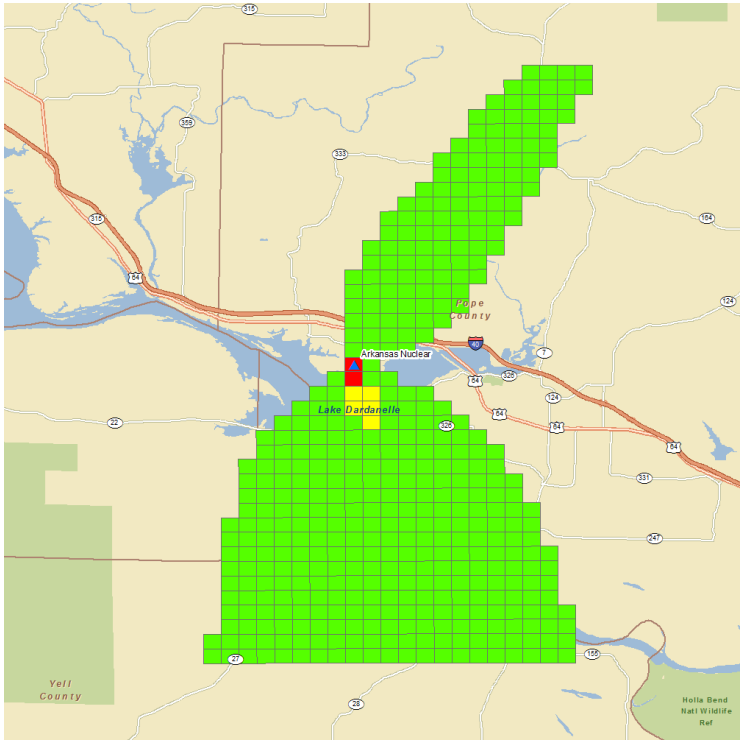
LTSBO



One method for combining the results of multiple RASCAL runs requires a geographic information system (GIS).

- Export dose footprints from STDose in GIS shapefile format
- Display those in the GIS and combine





If you do not have a GIS, RASCAL provides a tool to achieve the same thing.

The basic steps are:

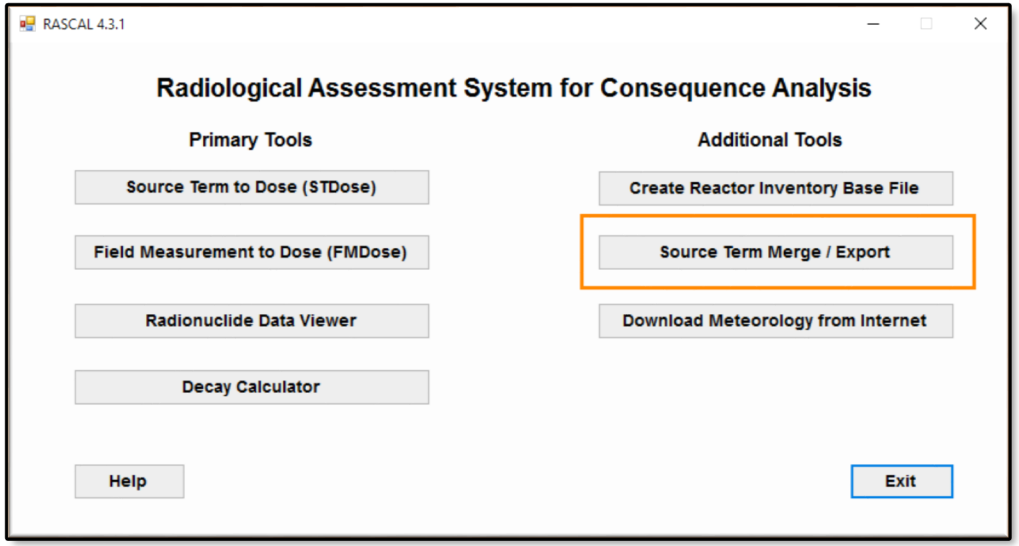
- Run STDose for each unit separately and save the case
- Run the merge / export tool to combine the atmospheric source terms
- Create a new STDose case and import the merged atmospheric source term
- Calculate doses using a complete set of met data and the resultant plume will reflect the combined source terms released from a single point

MULTI-UNIT - SCENARIO

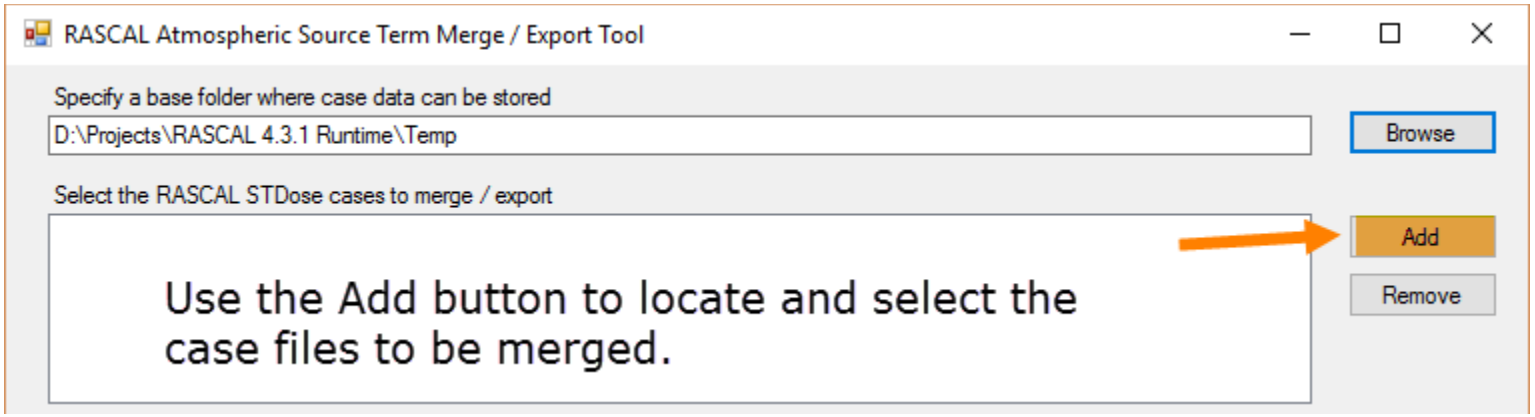
We earlier did a model run for a LOCA at the Arkansas Unit 1 nuclear plant. We later did a run for a LTSBO at Arkansas Unit 2. Each unit had a release to the environment and a resultant plume downwind. We are interested in the overall dose impact of the releases from both units.

Using the 2 cases saved earlier, merge the atmospheric source terms and then do a 3rd STDose calculations using the multi-unit source term.

RASCAL HAS A SEPARATE TOOL THAT CAN MERGE ATMOSPHERIC SOURCE TERMS TOGETHER. WE WILL START THERE.



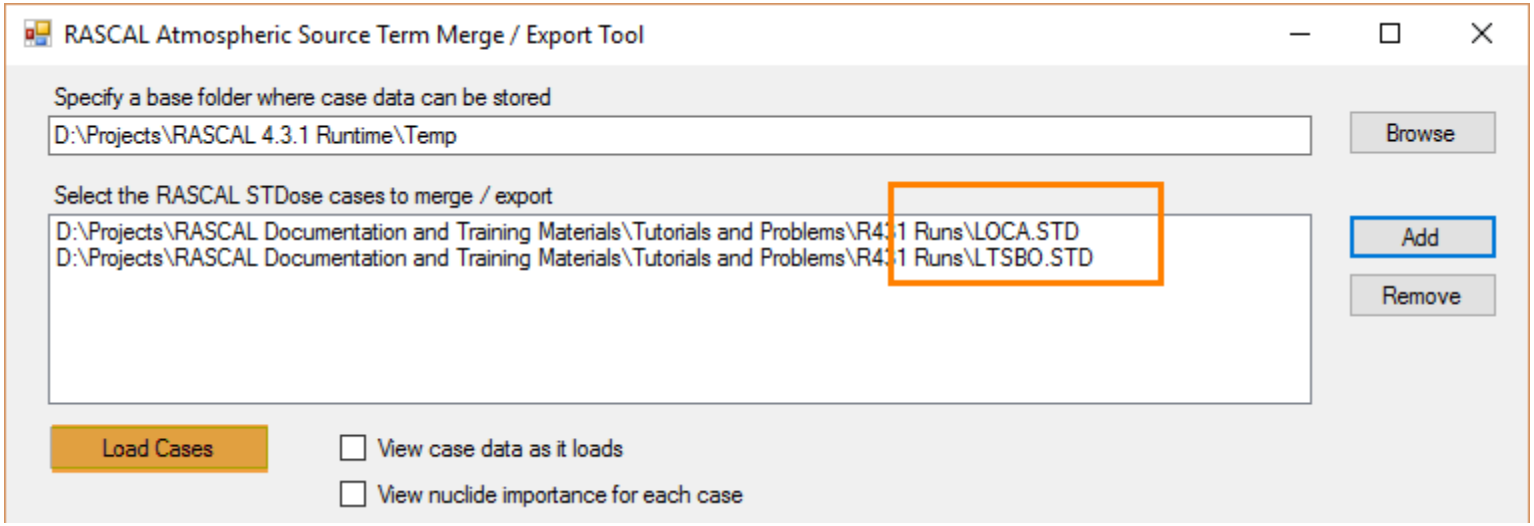
THE FIRST STEP IS SELECTING THE PREVIOUSLY RUN STDOSE CASES FOR EACH REACTOR UNIT.



RASCAL cases are saved by default in the folder:
C:\NRC\RASCAL43\Save Case

Navigate as needed to locate and select the 2 cases: LOCA and LTSBO

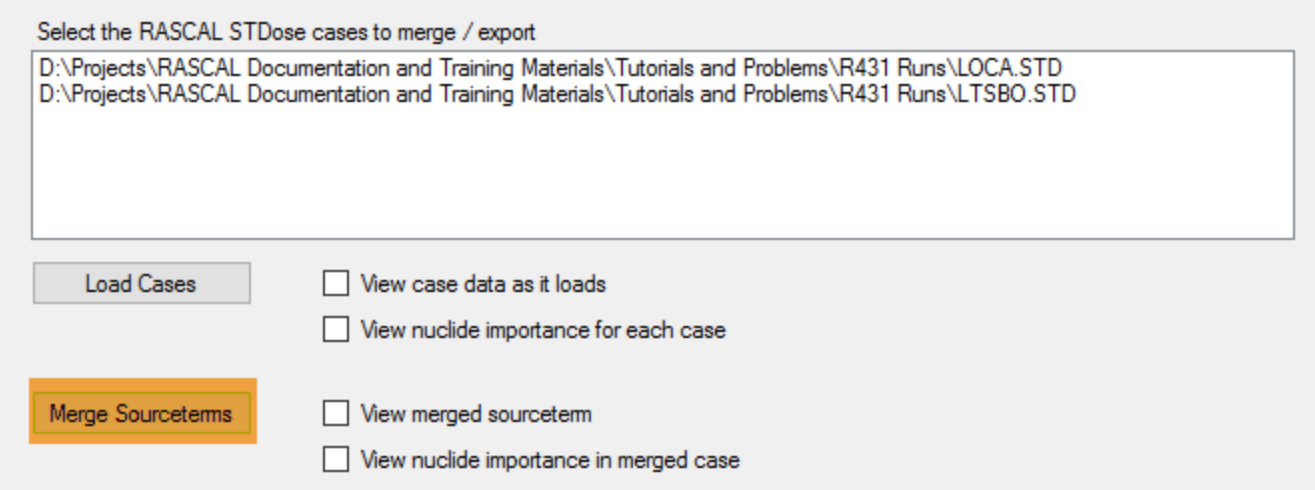
WITH THE 2 CASES SELECTED, THE NEXT STEP IS TO LOAD THEM INTO THE TOOL.



There are 2 “view” options when loading the cases – see all the case data and see the radionuclide importance for the source term.

Click the Load Cases button.

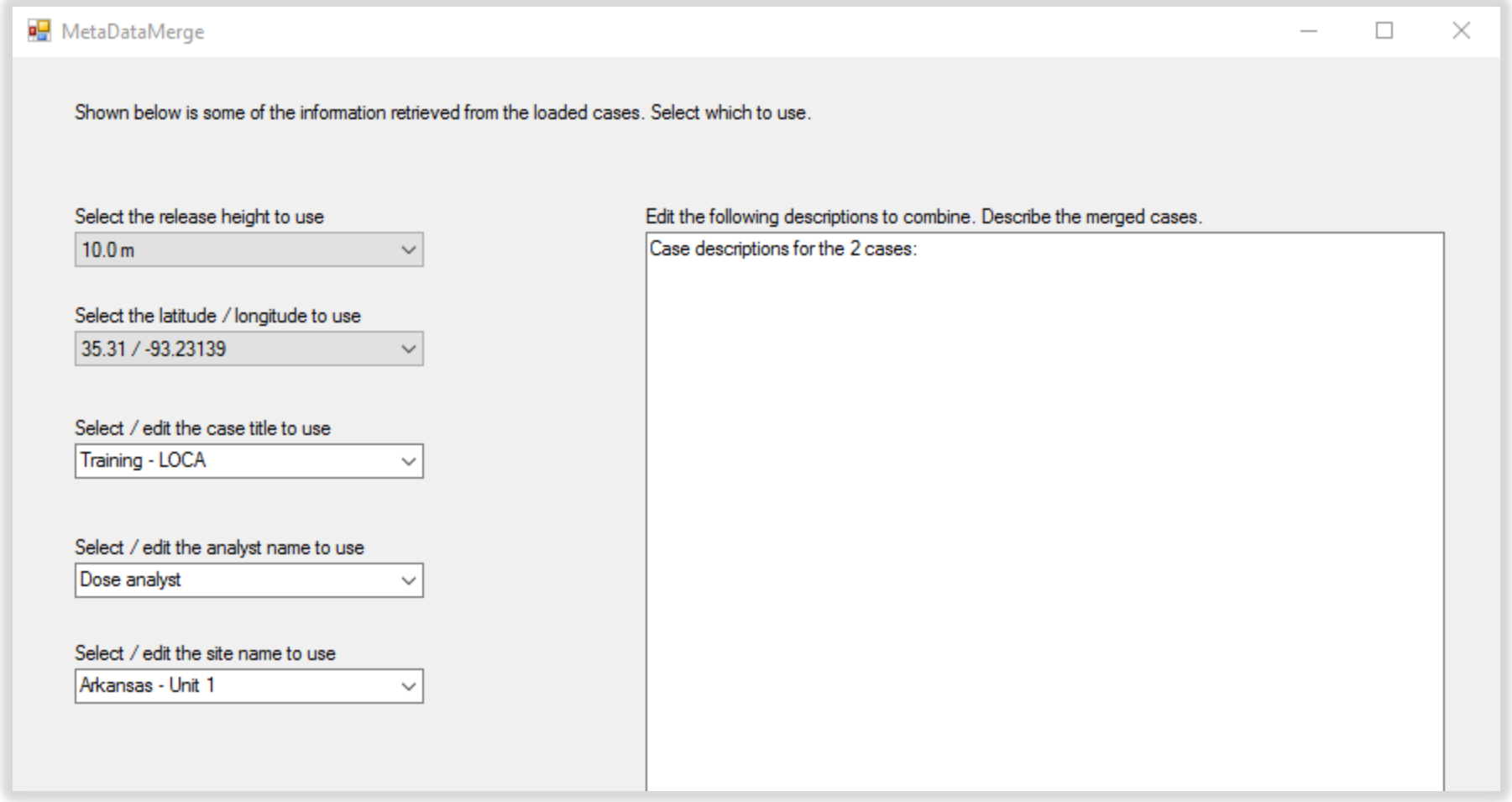
After the cases have been loaded the atmospheric source terms can be merged.



The Merge Sourceterm button becomes active one the cases are loaded.

Click it to start the merge process.

THE NEXT STEP IS TO MAKE SOME DECISIONS ON HOW TO DEFINE THE MERGED SOURCE TERM.



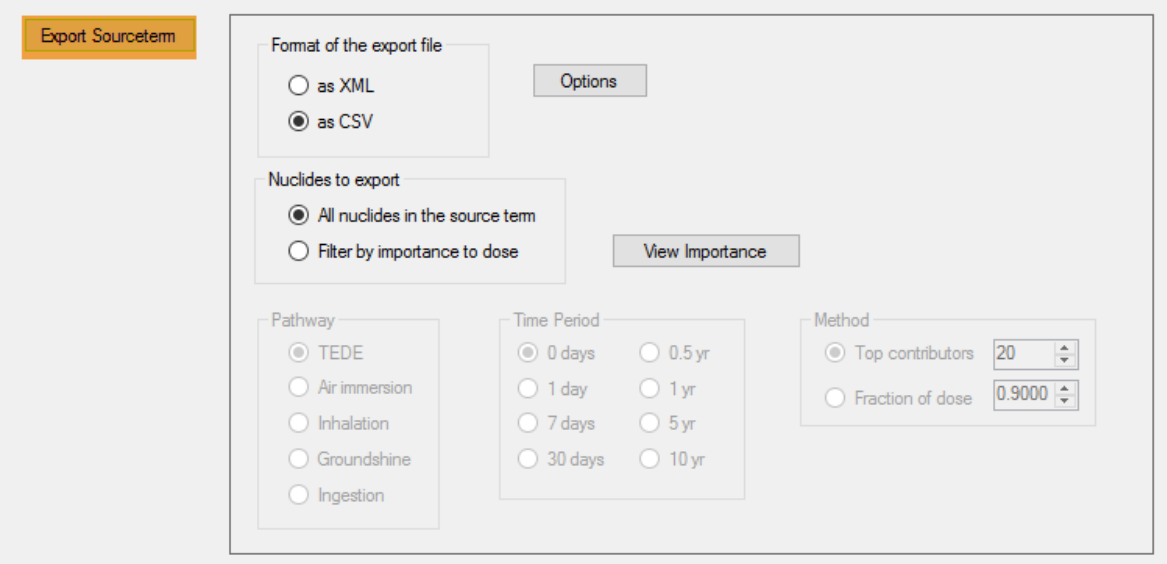
Complete the definition of the metadata.

- Release height – have to choose one of the heights used in the original cases; cannot set a mid-point
- Lat/Long – have to choose from original; they should be very close anyway
- Title – select from original or enter a new one
- Analyst – select from original or enter a new one
- Site name – usually enter something to indicate multi-unit
- Description – can edit the combination of the original descriptions

Click the OK button on the MetaData screen to start the merge process.

- Will see a progress bar. The merge may take some time if the cases are long in duration.
- When merge is complete, export button is active

THE FINAL STEP USING THE MERGE TOOL IS TO EXPORT THE NEW MERGED ATMOSPHERIC SOURCE TERM.



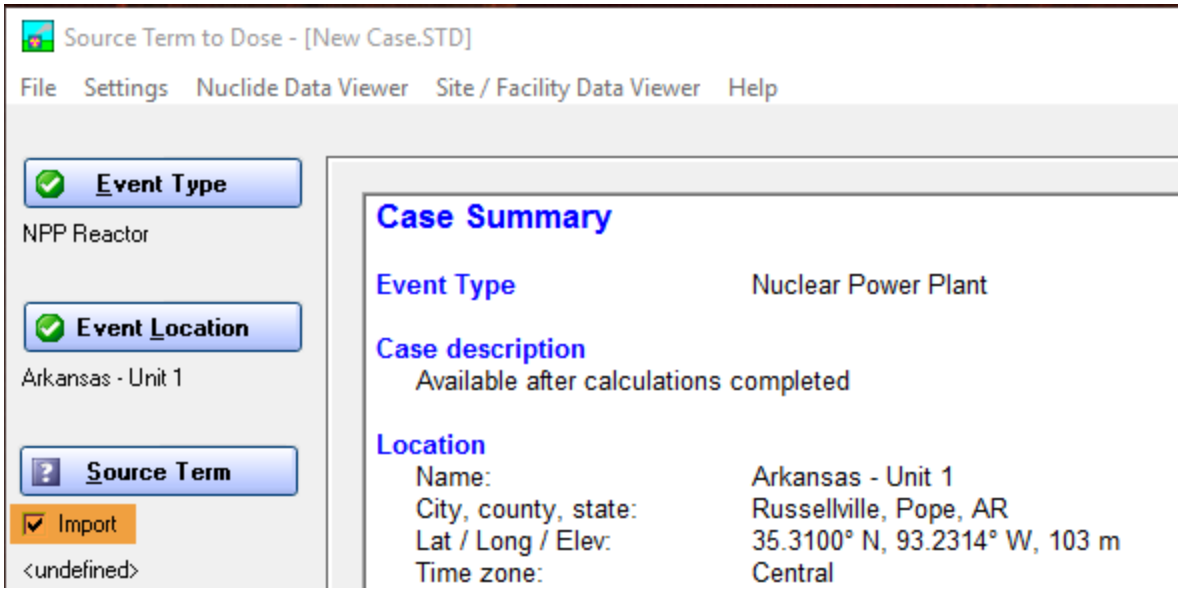
Options on the export include:
Format – XML or CSV
Whether to filter the list exported by importance to dose

Give the file a meaningful name and remember what folder is used – you will need to know both in the import step.

THE MERGED SOURCE TERM HAS BEEN CREATED AND EXPORTED.

- Close the merge / export tool by clicking the Exit button
- Return to or restart the STDose tool
- The following settings are needed:
  - Event type = Nuclear Power Plant
  - Event location = Arkansas Unit 1 or Unit 2

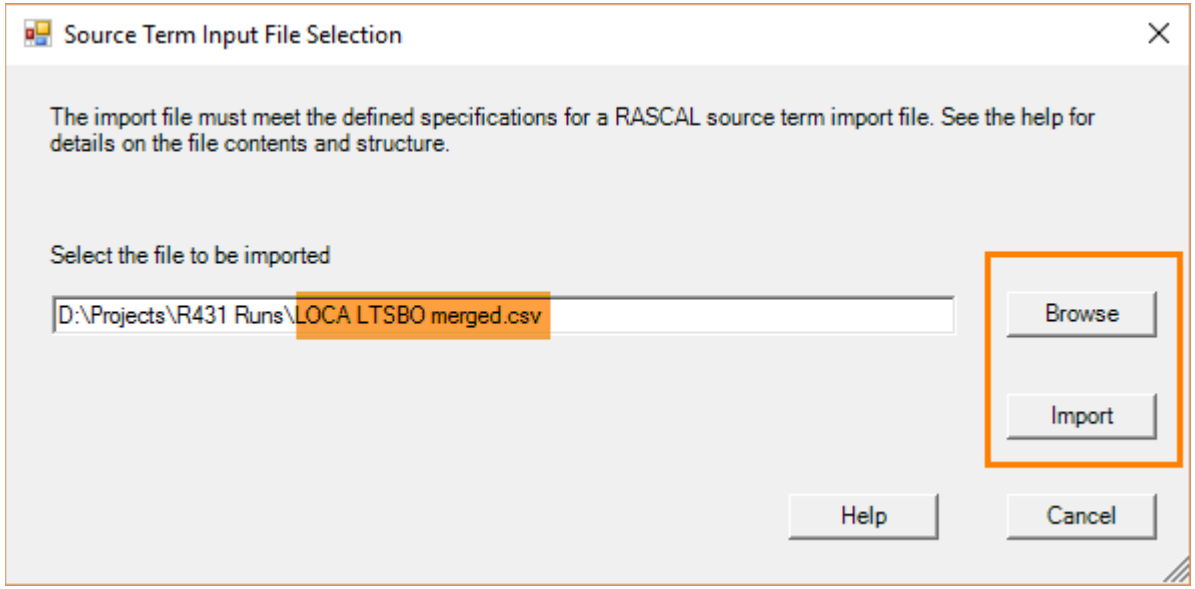
THE NEXT STEP IS TO IMPORT THE MERGED ATMOSPHERIC SOURCE TERM.



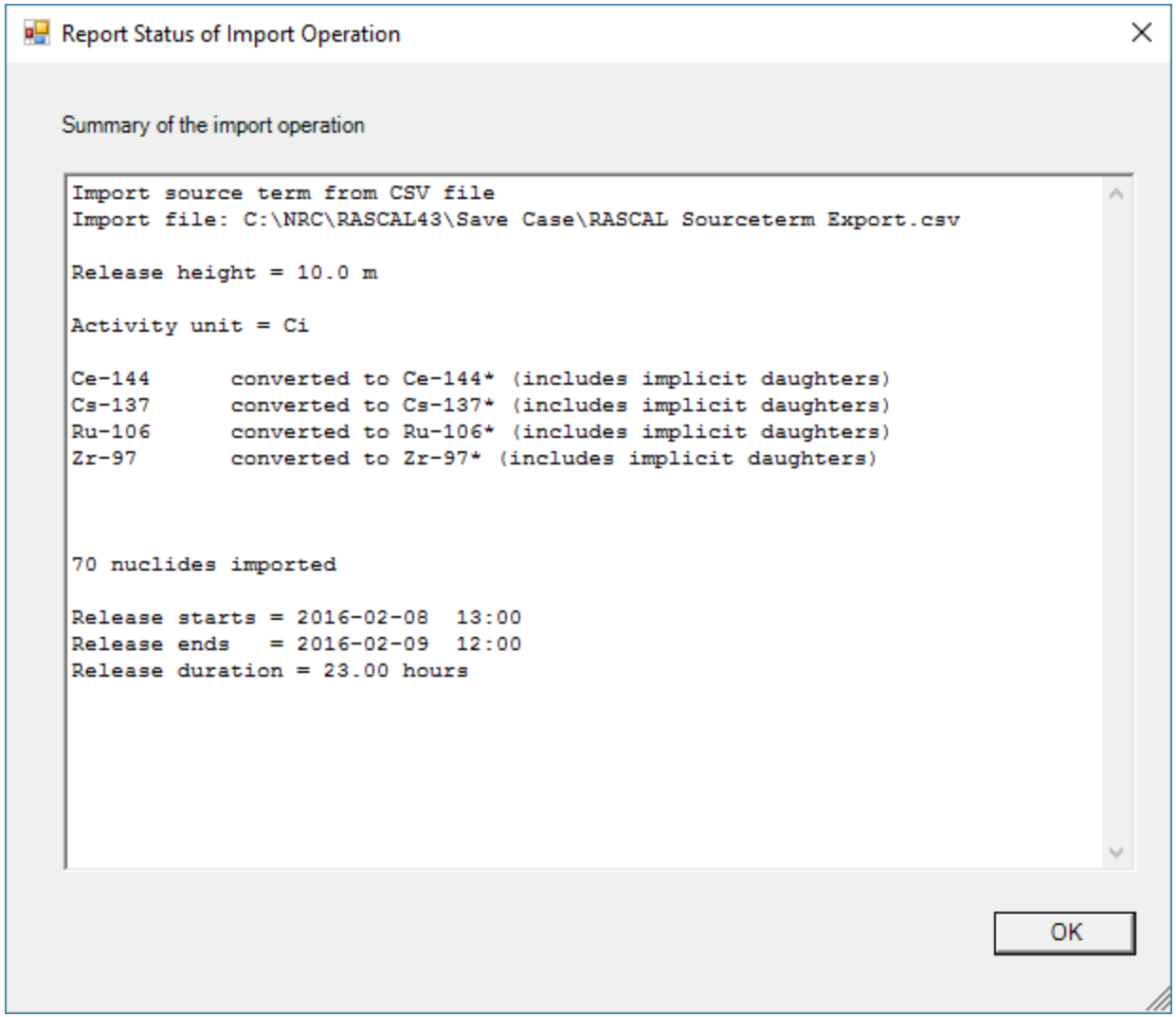
Check the Import box and then click the Source Term button.

Using an imported source term completely bypasses the usual specification of source term and release pathway.

Browse to find and select the file exported earlier then click the import button.



ONCE THE IMPORT IS COMPLETE A STATUS REPORT IS SHOWN.



Elements of the import status report

- Release height – this is what will be used in the calculation. If not in the import file or incorrect, 10m will be used.
- Activity unit – Ci or Bq accepted. If other or missing will default to Ci.
- Shows nuclides that have an implicit daughter in RASCAL (adds the *)
- Shows total number of radionuclides imported and the start and end of the release. Met and calc duration should support that interval.

MULTI-UNIT - TASK

- For meteorology, use the same weather that was used for the LTSBO problem earlier.
- For calculation duration make sure you go long enough for the 23 h release and some time for the plume to reach the edge of the model domain at 10 miles.
- Record the doses below and look at the footprints.

Dose	Distance from the Site	
	1.0 mi	5.0 mi
TEDE (rem)		
Adult Thyroid CDE (rem)		

MULTI-UNIT - RESULTS

Dose	Distance from the Site	
	1.0 mi	5.0 mi
TEDE (rem)	6.6	0.22
Adult Thyroid CDE (rem)	81	2.5

- How does this compare against the individual LOCA and LTSBO plumes?
- Conclusions?
  - The merge / export tool provides a way to do a multi-unit calculation of dose.
  - Assumptions in doing a merge
  - Limitation in doing a merge