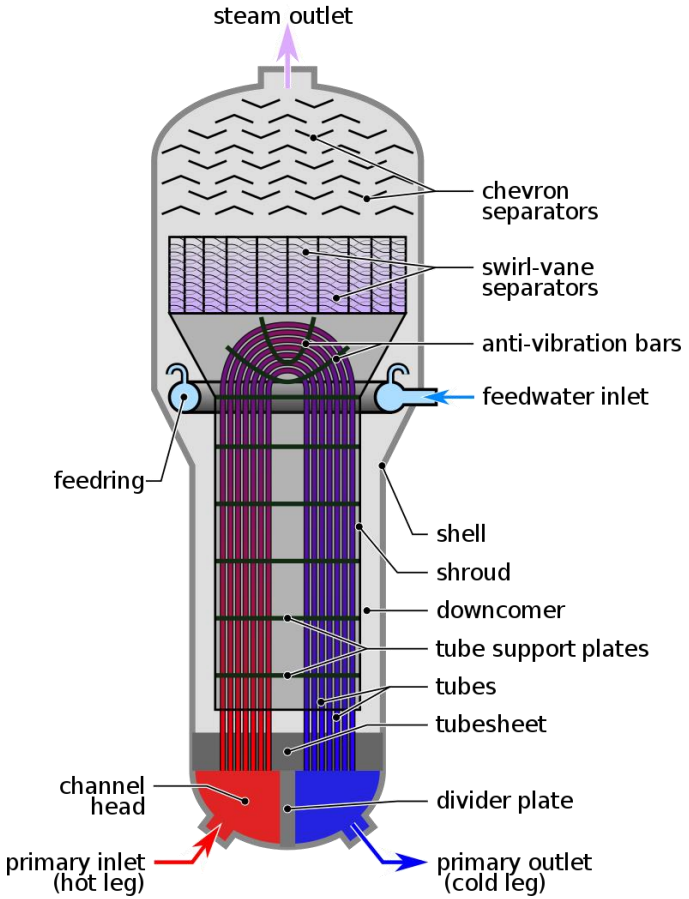
SNAP/RADTRAD Exercise 4:

Steam Generator Tube Rupture (SGTR) Accident

Steam Generator Tube Rupture Overview

- The complete severance of a single steam generator is assumed to occur.
- The pressure difference between the primary and secondary systems discharges radioactive reactor coolant into the secondary systems.
- A portion of the radioactivity is released through the atmospheric relief valves (ARVs) and through the intact steam generators.
- A portion of the break's flow is assumed to be released to the environment through flashing.

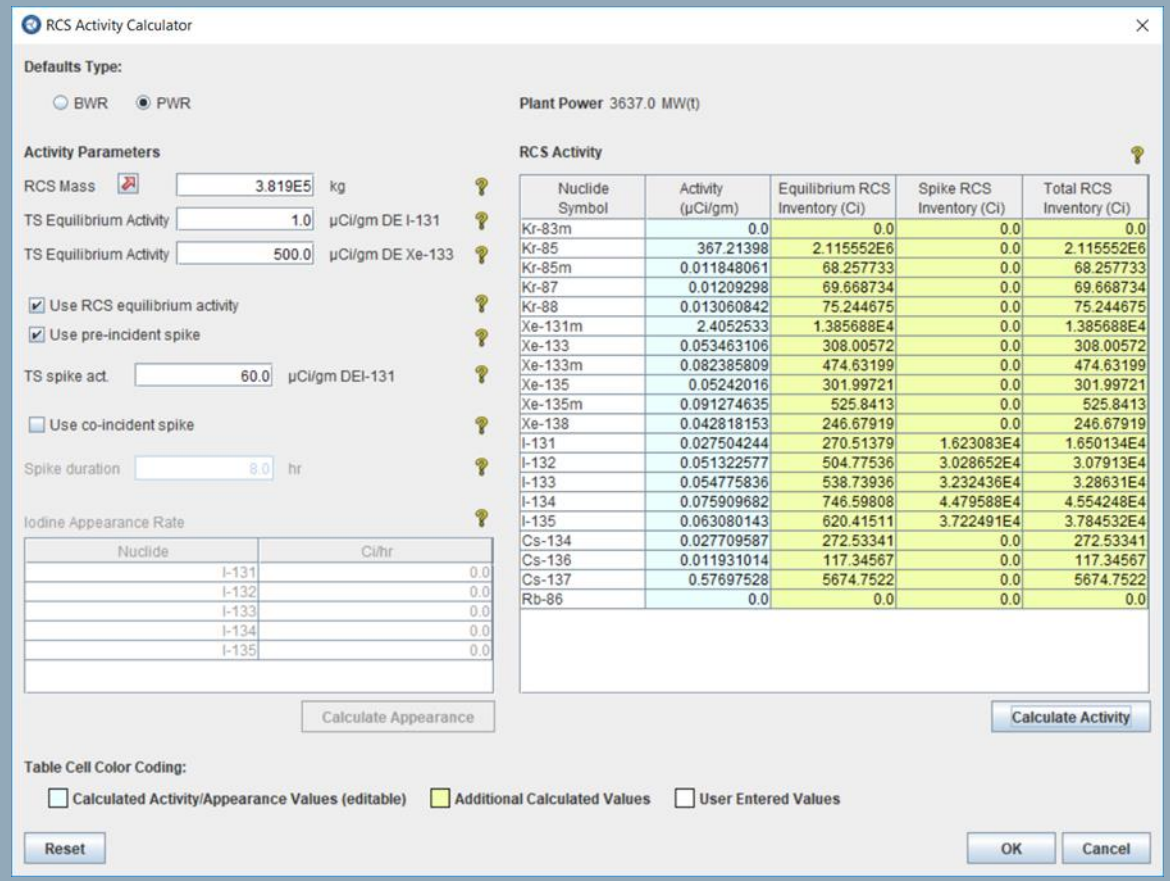


Step 1: Preliminary Setup

- You should have Exercise 3 (REA) open in your Model Editor
- In the Navigator Window, select “Model Options”
- Change the Title to “PWR_SGTR”
- Select the job stream in the Navigator Window and change the “Name” to “PWR_SGTR”
- Change the “Relative Location” in your job stream
  - Consider changing the location to “PWR_SGTR” in order to prevent the files from the previous exercise from being overwritten
- Save the model as “PWR_SGTR.med”

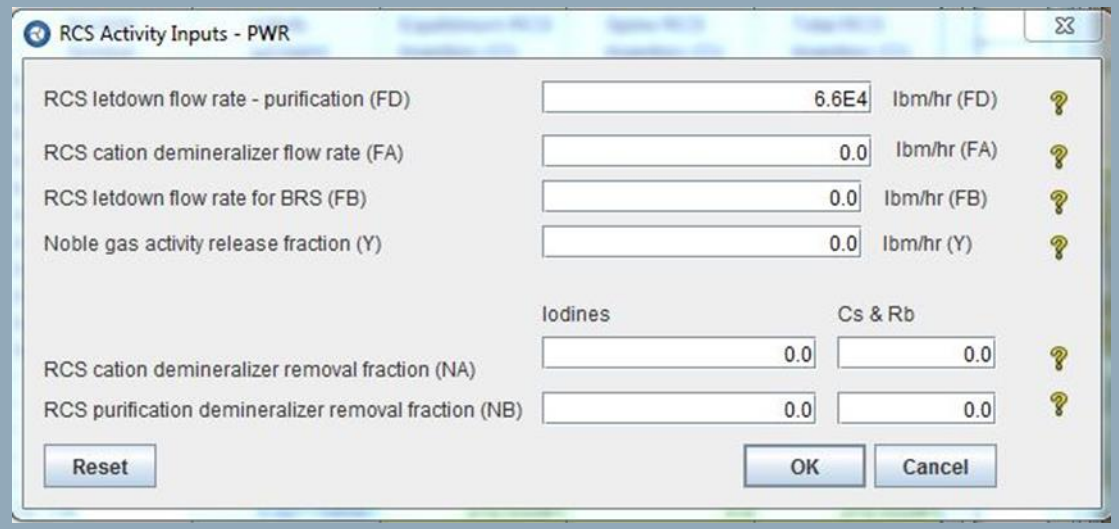
Step 2: Calculating the RCS Concentration

- Click on Nuclide Data then expand box ( ) next to Total Inventories
- Click on the icon to activate the RCS Activity Calculator
- Check the boxes for "Use RCS equilibrium activity" and "Use pre-incident spike".
- Fill out the information for RCS Mass, the two TS Equilibrium activities, and the TS spike act as shown in the image.
- Make sure the bubble next to PWR at the top is selected.



Step 2: Calculating the RCS Concentration (Continued)

- Click on the Calculate Activity box in the bottom right and fill in the window that pops up with the following information:

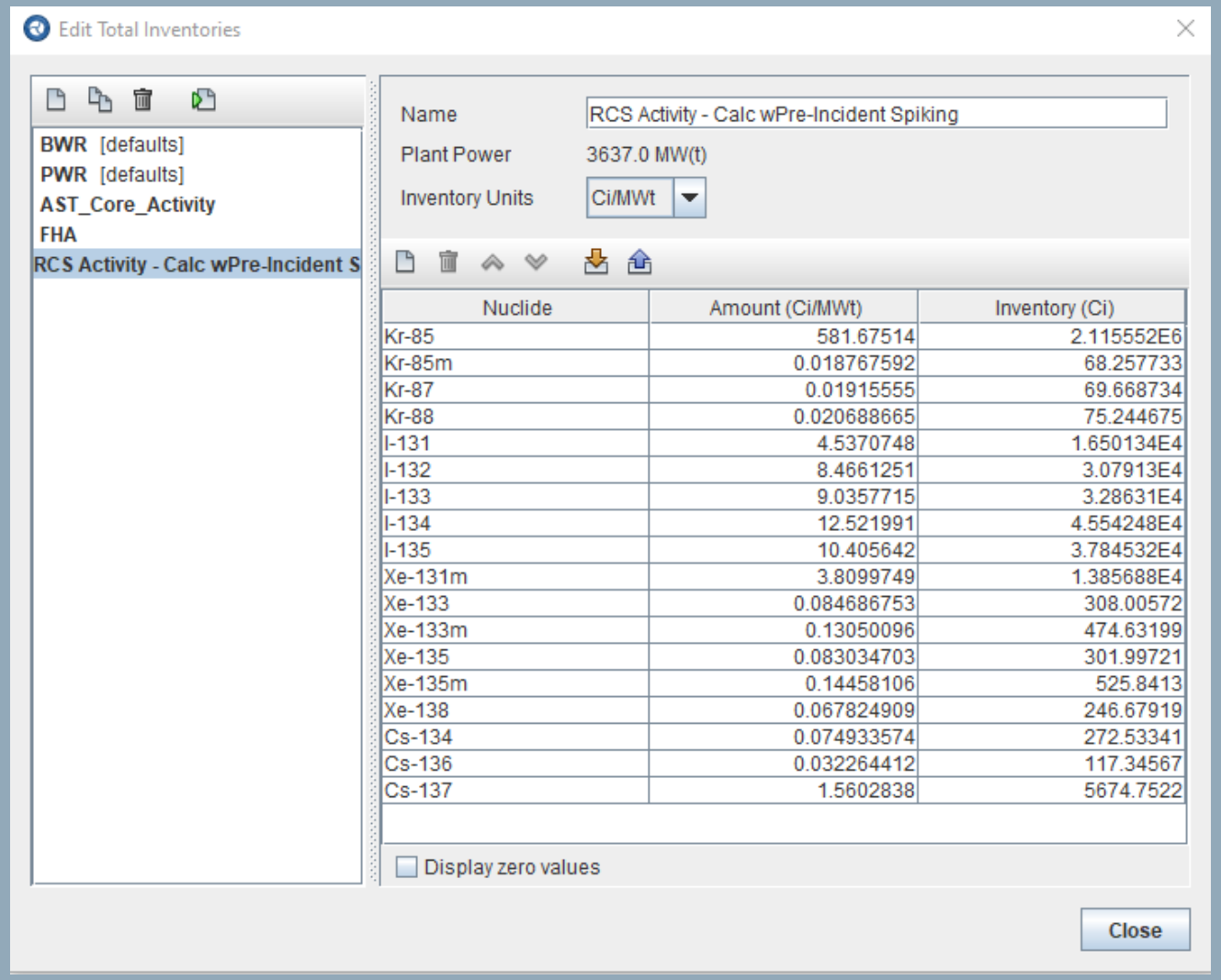


- Then press OK to the RCS Activity input pop up and the RCS Activity calculator.

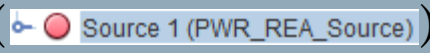
Step 2: Calculating the RCS Concentration (Continued)

- Then rename the Inventory created to “RCS Activity – Calc wPre-Incident Spiking” and your inventories tab should look like the image.

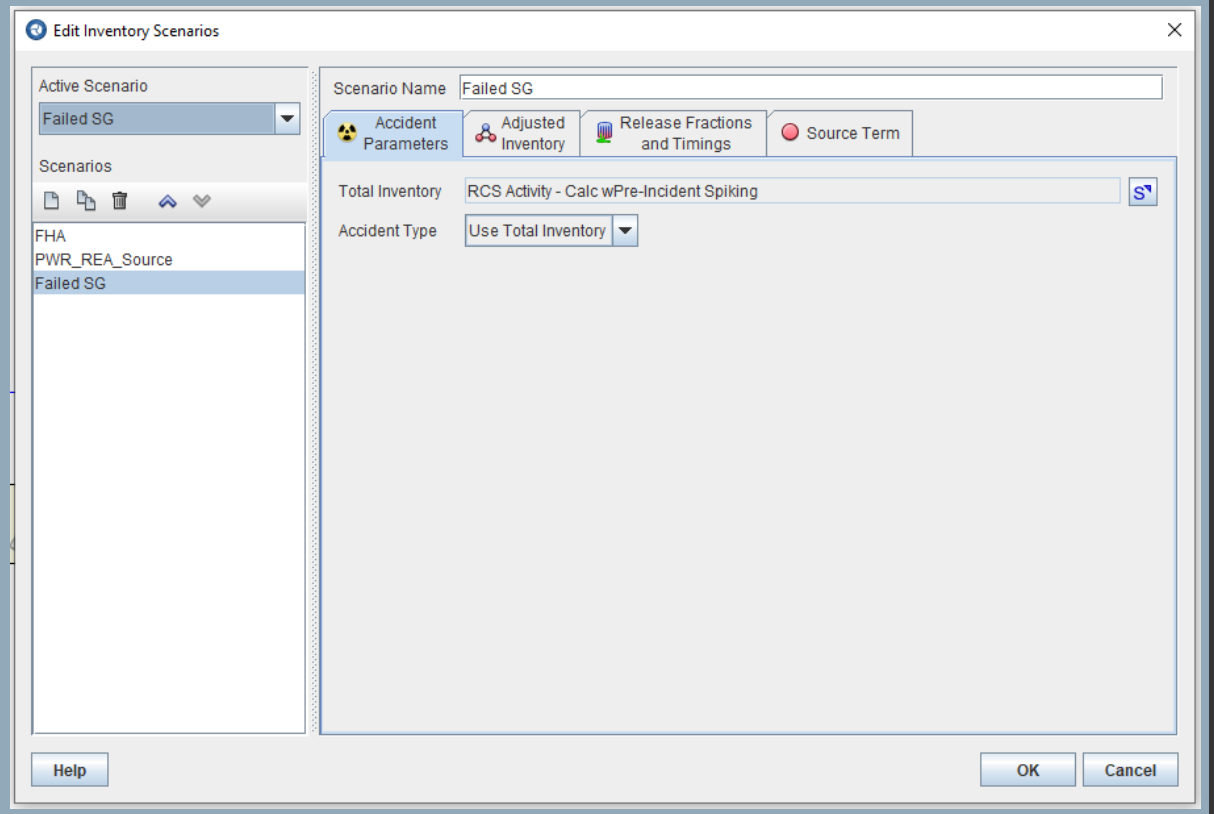
NOTE: If your inventory shows more isotopes with 0 values, check the box (Display zero values) down at the bottom.



Step 3: Creating 2 Source Scenarios

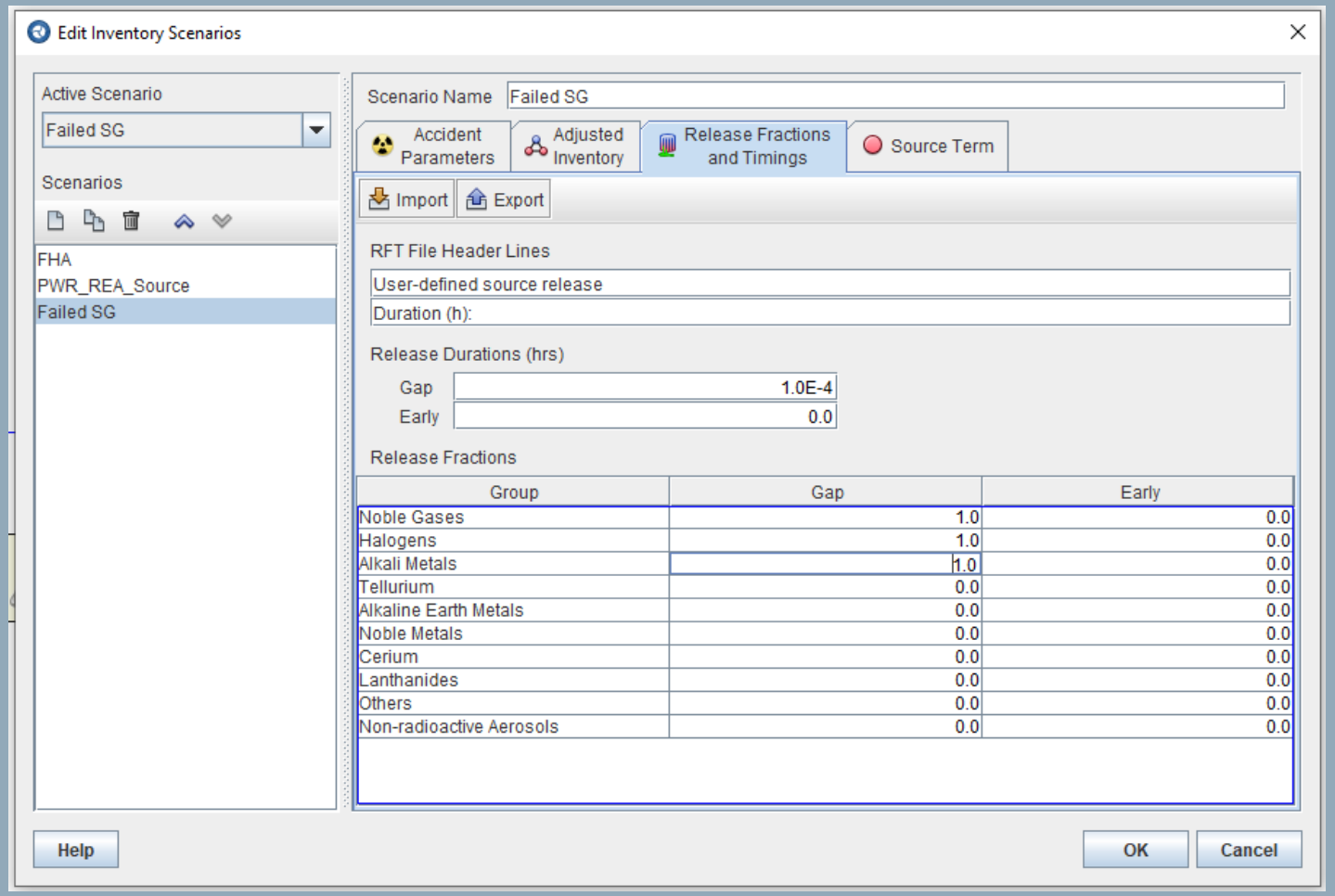
- We will need to create two source terms. One will be used for the 3 intact steam generators, and one will be used for the steam generator that had the ruptured tube.
- We will start with the failed SG. Click on Source 1 (

) and expand Source Scenarios. Then, click on () and select the RCS Activity – Calc wPre-Incident Spiking inventory we created.
- Then change the scenario name to "Failed SG" and your Edit Inventory Scenarios window should look like the image.



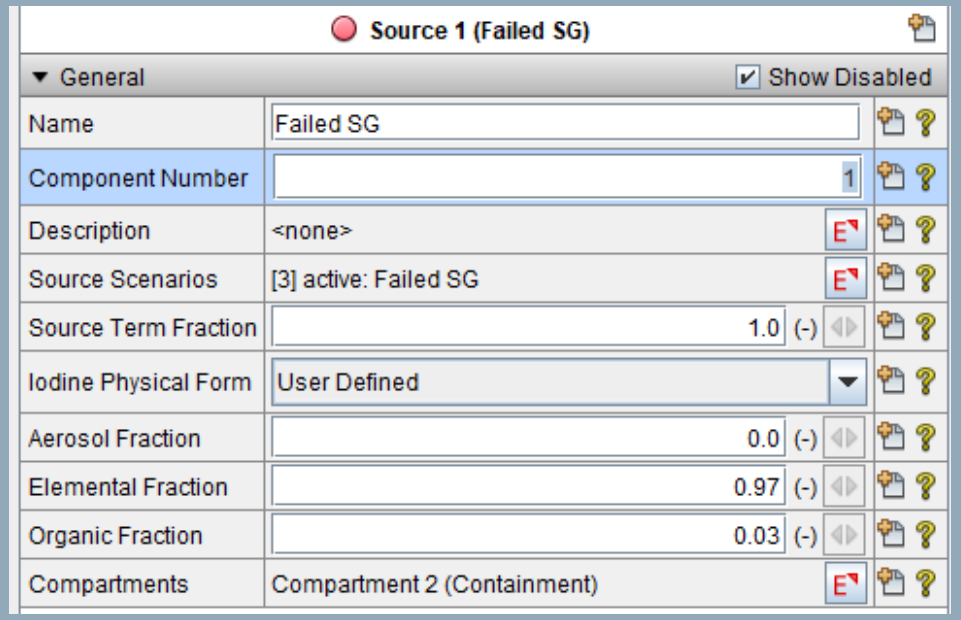
Step 3: Creating 2 Source Scenarios (Continued)

- Next, click on the "Release Fractions and Timings" tab and set the Gap duration to 1.0E-4, and change the gap values for the Noble Gases, Halogens, and Alkali Metals from 0.0 to 1.0 as shown below:



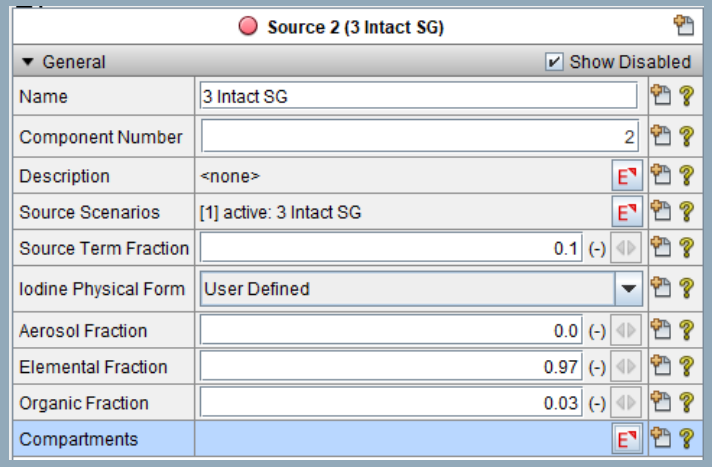
Step 3: Creating 2 Source Scenarios (Continued)

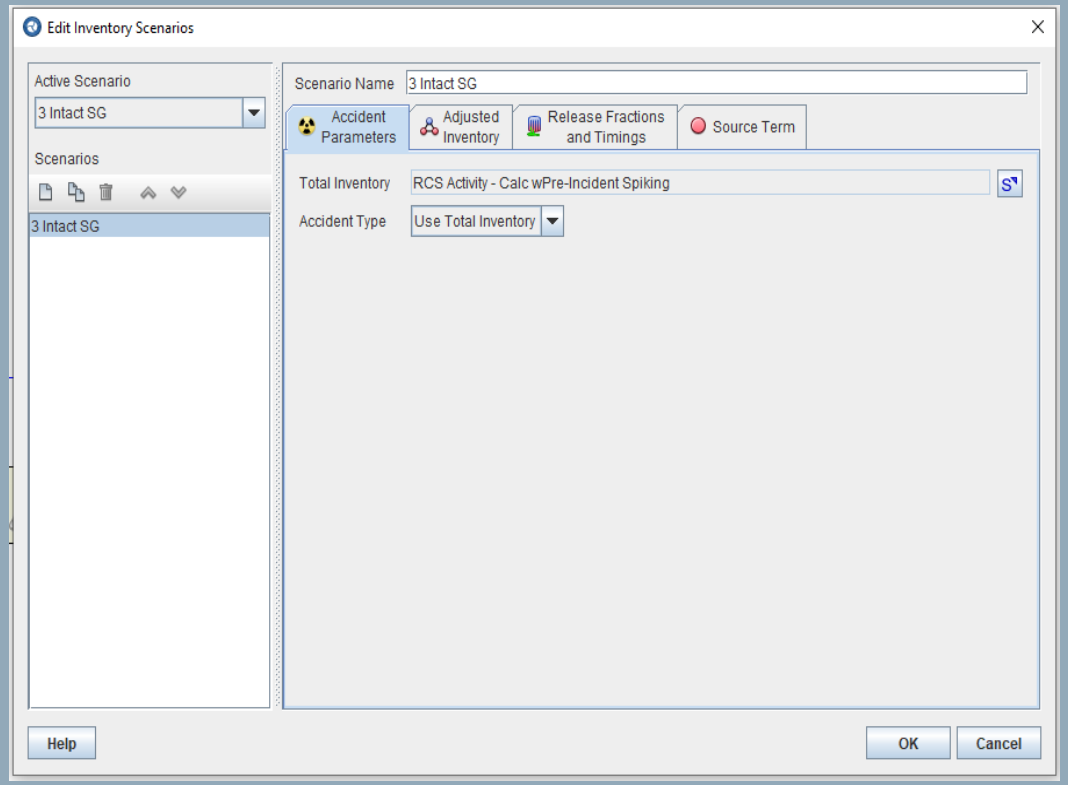
- Once the Source Scenarios is setup, set the Iodine Physical Form and fractions as shown in the image.
- Create a new source called “3 Intact SG” and repeat the steps used to create the “Failed SG” source. Except the Source Term Fraction for the intact SG source should be set to 0.1.

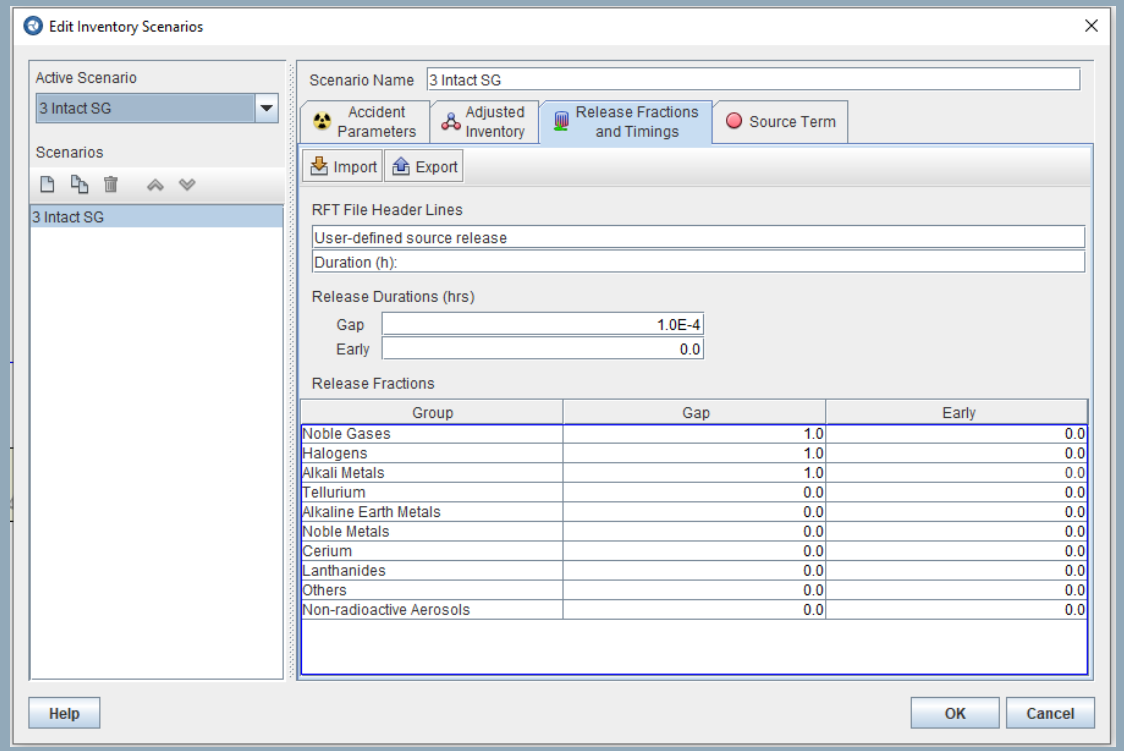


Step 3: Continued

Once completed, the 3 Intact SG Source should include the following:





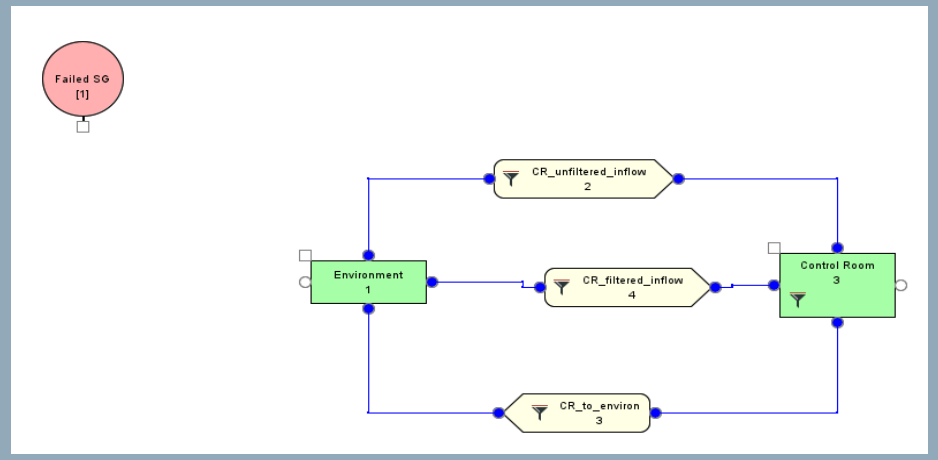


Step 4: Two Release Pathways

- In exercise 3, we had a source in a containment compartment that leaked to the environment and control room. In this exercise, we will remove the containment compartment and leak to environment flow path and replace it with two pathways.
- The first pathway will include the 3 Intact SG Source along with a compartment for the unaffected SGs and a flow path for the steam released by these SGs.
- The second pathway will include a compartments for the reactor vessel and ruptured SG and flow paths for the flashed and non-flashed break flow, primary to secondary (pri-sec) leakage, leakage to the environment.

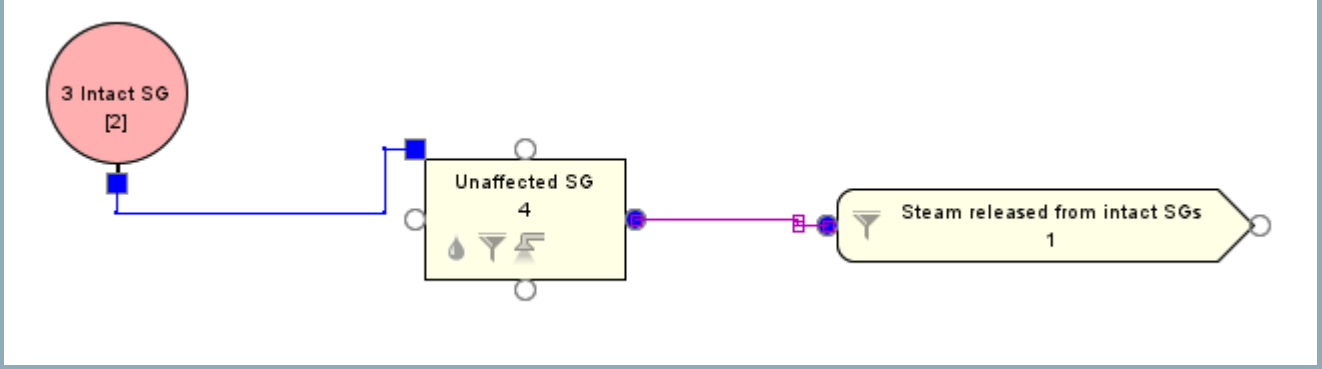
Step 4: First Pathway

- After removing the containment compartment and leak to environment flow path, your model should look like the image.
- An error will occur if the component numbers are sequential (i.e., an error will occur if your pathway component numbers go 1, 3, 4 instead of 1, 2, 3).
- Component numbers can differ between what you have, and the examples shown.
- These components won't be needed for the first pathway and it's easiest if they are put off to the side for now. This can be done by highlighting each component by clicking on the white space and dragging so that the red box completely covers each component. Then after each component is highlighted, you can click and drag on a single component to move them all at once.



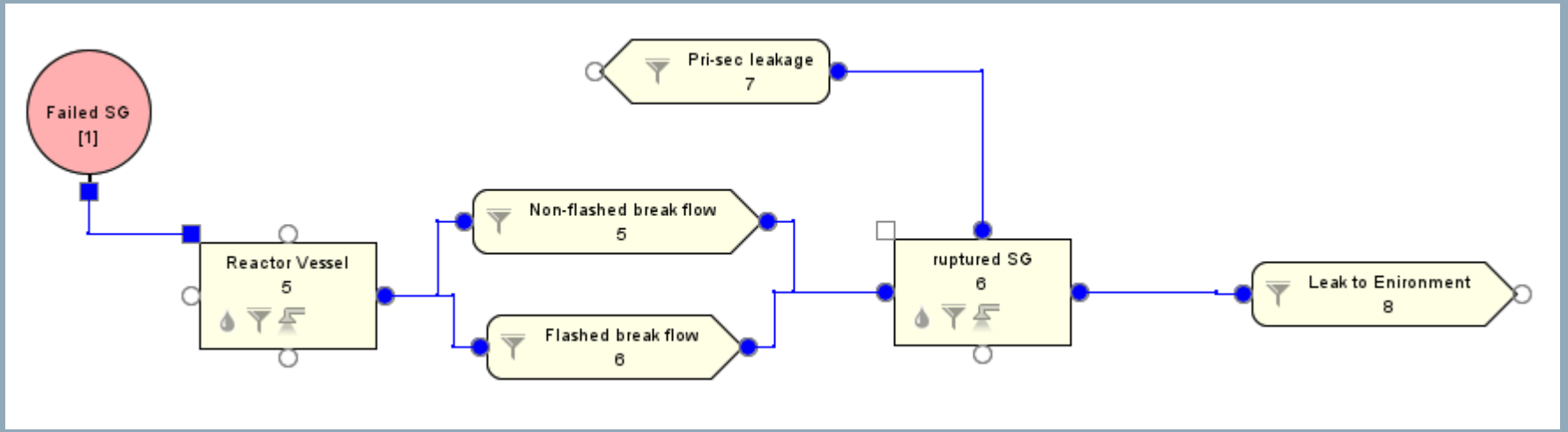
Step 4: First Flow Path (Continued)

- For the first flow path, the 3 Intact SG source will need to be added to the view, a compartment “Unaffected SG” will need to be created, and a flow path “ Steam released from intact SGs” will need to be created as well.
- Create the compart and flow path without worrying about the information for each for now.
- The first flow path should look like the image provided.
- NOTE: component numbers may differ.



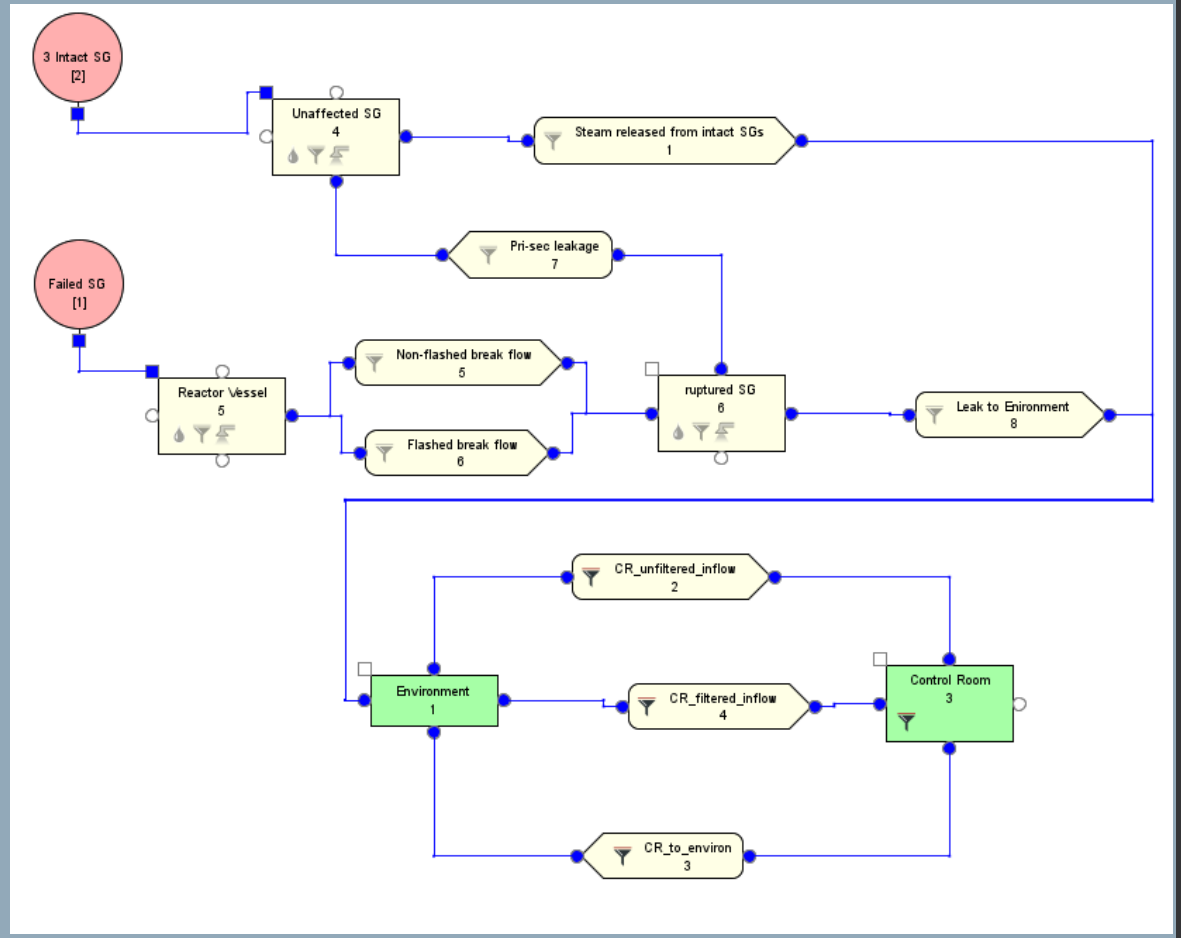
Step 4: Second Flow Path

- The second flow path will include two new comparts for the (1) Reactor Vessel and the (2) ruptured SG.
- It will also include 4 new pathways for the (1) Non-flashed break flow, (2) Flashed break flow, (3) Pri-sec leakage, and (4) Leak to Environment.
- After creating the compartments and pathways, the second flow path should look like the provided image.
- NOTE: To change the drawing orientation of the Pri-sec leakage, right-click on the pathway with the selector ( ) selected -> Drawn Orientation -> Left



Step 5: Connecting Everything

- Now that the two flow paths are created, they will need to be connected to each other and connected to the previous environment and control room as well.
- The Pri-sec leakage pathway will connect to the unaffected SG compartment, and both the steam released from intact SGs and Leak to Environment pathways will connect to the Environment compartment.
- Your model should look like the provide image.
- NOTE: You can move the blue lines by selecting them, then moving the blue boxes at each bend.



Step 5: Filtration and Compartment Data

- 5 more filters will need to be created (9 in total) for the created pathways. The name of the filters match the name of the corresponding pathway to keep things organized.
- All the filter data can be copied and pasted from the ExerciseData spreadsheet or entered manually.

Steam released from intact SGs

Time h	Flow Rate ft³/min	Aerosol Re... %	Elemental I ... %	Organic I Re... %
0.0	6.492115E5	99.0	99.0	99.0
0.01	3993.0	99.0	99.0	99.0
0.31	0.0	99.0	99.0	99.0
0.97	1.644897E4	99.0	99.0	99.0
1.07	5995.41	99.0	99.0	99.0
1.43	2482.87	99.0	99.0	99.0
2.09	2768.36	99.0	99.0	99.0
12.0	0.0	99.0	99.0	99.0

Non-flashed break flow

Time h	Flow Rate ft³/min	Aerosol Re... %	Elemental I ... %	Organic I Re... %
0.0	2570.19	99.0	99.0	99.0
0.01	2464.57	99.0	99.0	99.0
0.31	2946.24	99.0	99.0	99.0
0.81	3299.12	99.0	99.0	99.0
0.97	3178.74	99.0	99.0	99.0
1.07	2820.0	99.0	99.0	99.0
1.43	1041.31	99.0	99.0	99.0
2.09	0.0	99.0	99.0	99.0

Flashed break flow

Time h	Flow Rate ft³/min	Aerosol Re... %	Elemental I ... %	Organic I Re... %
0.0	506.42	0.0	0.0	0.0
0.01	165.82	0.0	0.0	0.0
0.31	447.74	0.0	0.0	0.0
0.81	263.56	0.0	0.0	0.0
0.97	105.72	0.0	0.0	0.0
1.07	0.0	0.0	0.0	0.0

Leak to Environment

Time h	Flow Rate ft³/min	Aerosol Re... %	Elemental I ... %	Organic I Re... %
0.0	2.170385E5	0.0	0.0	0.0
0.01	1569.67	0.0	0.0	0.0
0.31	4995.03	0.0	0.0	0.0
0.81	0.0	0.0	0.0	0.0
2.09	4.26	0.0	0.0	0.0
12.0	0.0	0.0	0.0	0.0

Pri-sec Leakage

Time h	Flow Rate ft³/min	Aerosol Re... %	Elemental I ... %	Organic I Re... %
0.0	0.1337	0.0	0.0	0.0
720.0	0.1337	0.0	0.0	0.0

Step 6: Filtration (Continued)

- With the steam tube rupture, we are assuming that the control room is in emergency mode. Because of this, no changes need are needed to the filters to and from the control room.

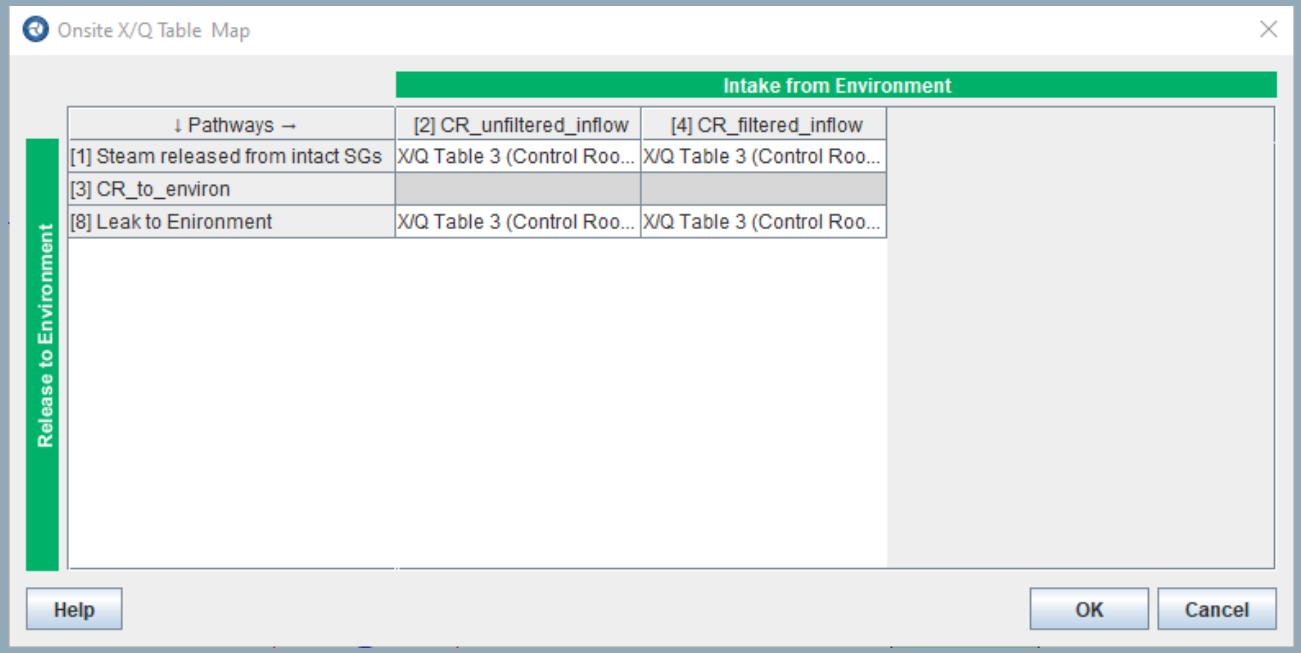
Step 5: Compartment Data

- The information needed for all compartments is as listed:

Component	Type	Volume
Unaffected SG	Normal	5.85E5
Reactor Vessel	Normal	3.99E5
Ruptured SG	Normal	7.00E4

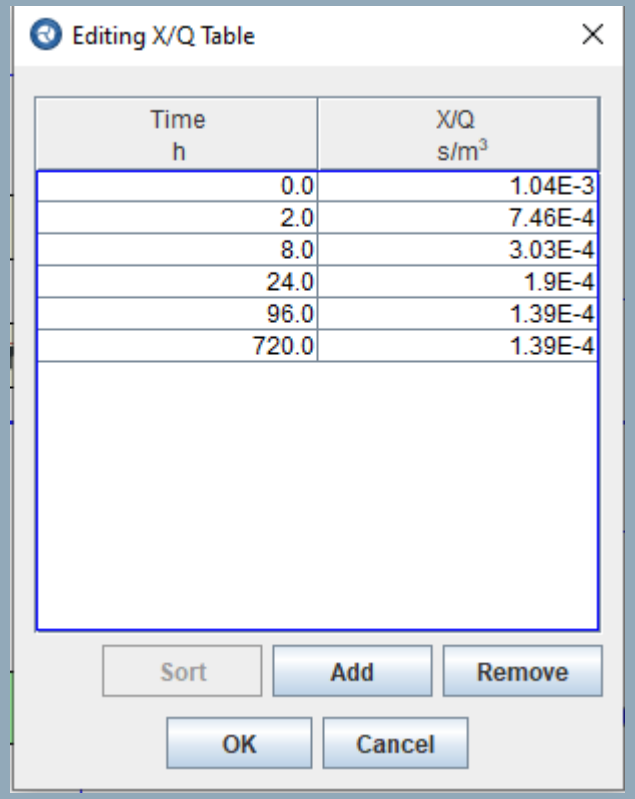
Step 7: X/Q Tables

- Because we added another pathway to the environment, the Onsite X/Q Tables need to be adjusted.
- Select the Environment component then expand ( ) the Onsite X/Q Tables option.
- We want to make sure we are using the Control Room X/Q table, Table 3 for the pathway for the two pathways as shown below.



Step 7: X/Q Tables (Continued)

- Next, we need to adjust the X/Q table for the control room to match this scenario. The X/Q values for the control room X/Q table (table 3) are given in the ExerciseData spreadsheet or can be entered manually as shown in the image.
- NOTE: X/Q Tables are always in units of seconds per cubic meter even when British units are selected.



Step 8: Submitting the Job

- Click on the  button to make sure there are no errors in your model.
- Once any errors are fixed, then Select Tools > Submit Job.
- Open the SGTR_Accident folder, click on Base Job, then press the  icon.
- Then go to Text File and select the radtrad.out file and scroll to the bottom.
- The results should look like the following:

```
################################################################################
                        Worst Two-Hour Doses
################################################################################

Exclusion Area Boundary
     Time          Whole Body     Thyroid         TEDE
     (hr)            (rem)         (rem)          (rem)
    0.0-2.0       2.0903e-01    3.165le+01    1.4488e+00

################################################################################
                             Final Doses
################################################################################

Low Population Zone
   Time    Whole Body     Thyroid         TEDE
   (hr)      (rem)         (rem)          (rem)
  720.0    6.8846e-02    1.0313e+01    4.7281e-01

Control Room
   Time    Whole Body     Thyroid         TEDE
   (hr)      (rem)         (rem)          (rem)
  720.0    2.6152e-02    1.586le+01    6.4740e-01

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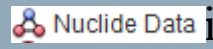
Exporting SGTR Nuclide Inventory

- The inventory for the SGTR will be needed in the next exercise.
- To export the inventory, select 

in the navigator window and then expand total inventories.
- Select the RCS Activity – Calc wPre-Incident Spiking inventory and press the  icon to export the inventory.
- Save the inventory as SGTR_RCS.