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HyRAM Testing Script

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HyRAM Testing Script

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Abstract

The testing script is to provide a method of inspections to HyRAM (v1.0.0.244 Alpha) application features. This document will lead participants through the use of the application to make sure the application performs as designed. If a feature of the application becomes non-working, this script will relay useful information back to the designers of the application so that the feature can be fixed. This is essential to keep the application updated and performing as designed so that the users of this program can be satisfied. There will be frequent updates of this document to ensure proper testing of future application versions.

ACKNOWLEDGMENTS

The principle investigator, Katrina Groth, helped with the creation of this document by providing suggestions and improvements to make this document more readable. In addition, John Reynolds, the project development lead, was instrumental by providing the direction and the idea of this document's purpose. Without their guidance, this document would not have been possible.

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NOMENCLATURE

DOE	Department of Energy
SNL	Sandia National Laboratories
HyRAM	Hydrogen Risk Assessment Models
QRA	Quantitative Risk Assessment
PBD	Performance Based Design

INTRODUCTION

1.1 Purpose

The testing script is to provide a method of inspections to HyRAM (v1.0.0.244 Alpha) application features. This document will lead participants through the use of the application to make sure the application performs as designed. If a feature of the application becomes non-working, this script will relay useful information, with the help of the participants, back to the designers of the application so that the feature that broke can be fixed. This is essential to keep the application performing as designed and to ensure that any new features that are put into the application do not break other features. This enables the project development lead to guarantee that the users of the HyRAM program are satisfied. There will be frequent updates of this document in conjunction to HyRAM updates to ensure proper testing of future application versions.

1.2 Brief Description of HyRam

HyRAM is a software toolkit that integrates data and methods relevant to assessing the safety of hydrogen fueling and storage infrastructure. The HyRAM toolkit integrates deterministic and probabilistic models for quantifying accident scenarios, predicting physical effects, and characterizing the impact of hydrogen hazards (thermal effects from jet fires, thermal pressure effects from deflagrations) on people and structures. HyRAM incorporates generic probabilities for equipment failures for 9 types of components, and probabilistic models for the impact of heat flux on humans and structures, with computationally and experimentally validated models of hydrogen release and flame physics. Version 1 can be used to quantify the likelihood and thermal consequences associated with gaseous hydrogen releases from user-defined hydrogen installations.

1.3 Initial Notes

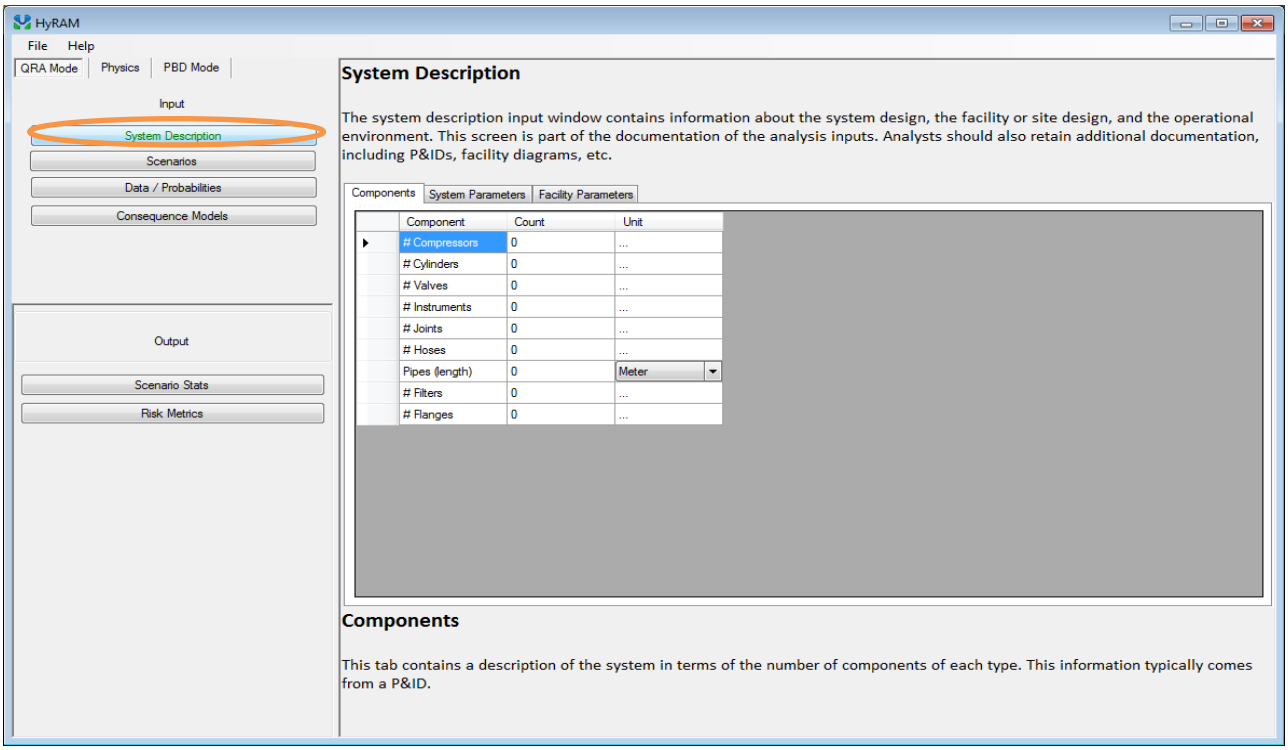
There is a syntax associated with this script. For example, when *italicized* text is seen, that represents the name of a file. Likewise, when **bold** text is seen, that denotes that there is a button or link that has the same name seen within the program. For example, if the document states, “first go to **File**, then to **Load Workspace**,” it is meant to be taken as “move mouse to the tab labeled file, then click. Then move mouse to Load Workspace, then click.”

2. QRA MODE

QRA Mode stands for quantitative risk assessment that uses algorithms to measure the risk associated hydrogen fueling stations. To test the Scenario Stats and Risk Metrics in QRA Mode, first load the workspace titled, *HyRAM Testing Script - QRA Mode.HyRAM*. To accomplish loading the workspace, first go to **File**, then to **Load Workspace**. Then navigate to where *HyRAM Testing Script - QRA Mode.HyRAM* is located and click the file. Then click **Open**. The instructions must be precisely followed to ensure proper testing of the application. In addition, the numerical results that are received should be EXACTLY the same as shown in this document.

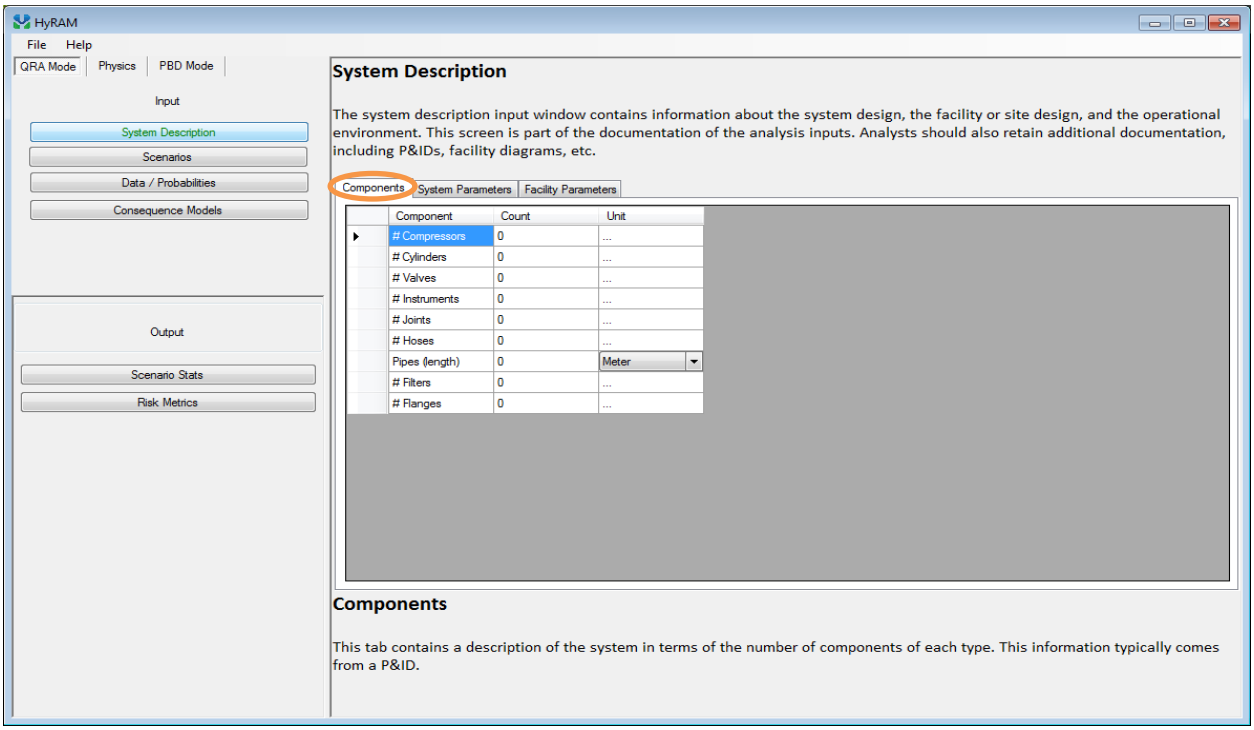
2.1 Edit System Description Input

To begin inputting values, first click the **System Description** button. It is circled in **orange**. The following screen should pop up:

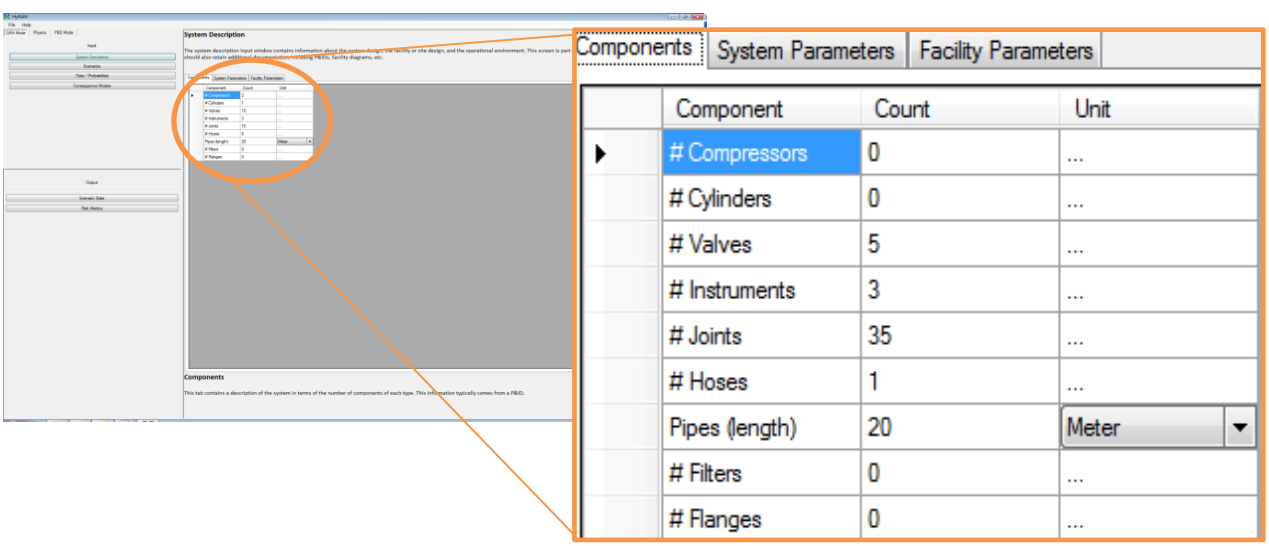


2.1.1 Edit Components

To start editing the parameters, click the tab labeled **Components** in the current window. It is circled in **orange:**



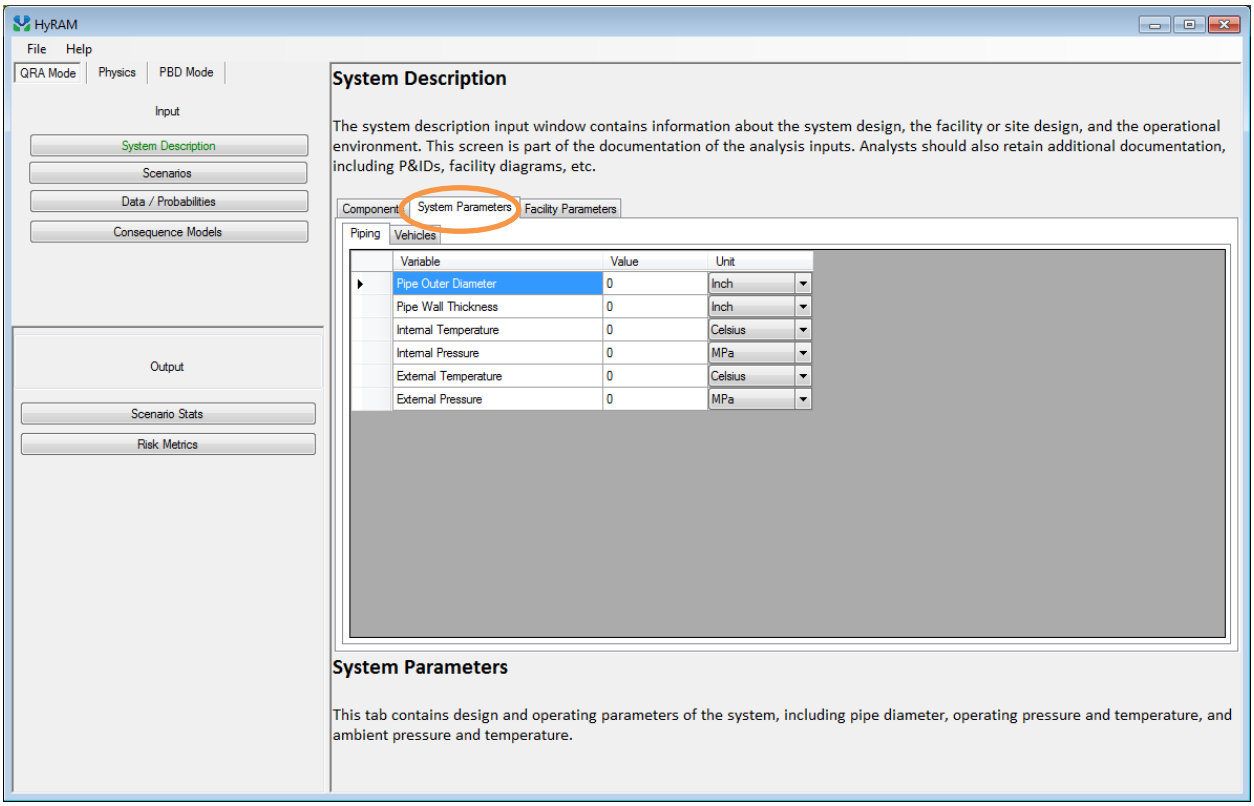
When that screen opens, continue to edit the values in the table to reflect the following:



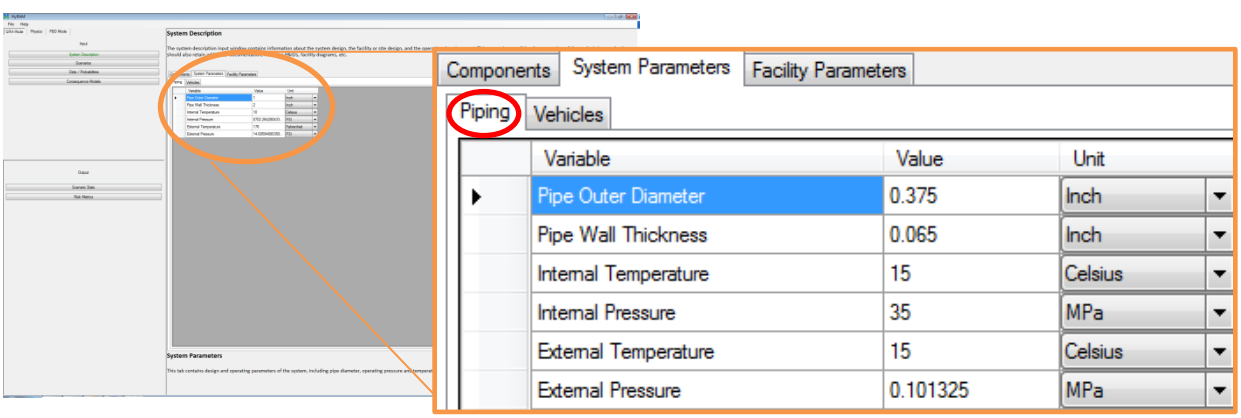
2.1.2 Edit System Parameters

2.1.2.1 Piping

To continue editing the parameters, click the next tab labeled **System Parameters** in the current window. It is circled in **orange:**



When that screen opens, make sure that the current tab that is selected is labeled **Piping**. It is circled in **red.** Then continue to edit the values in the table to reflect the following:

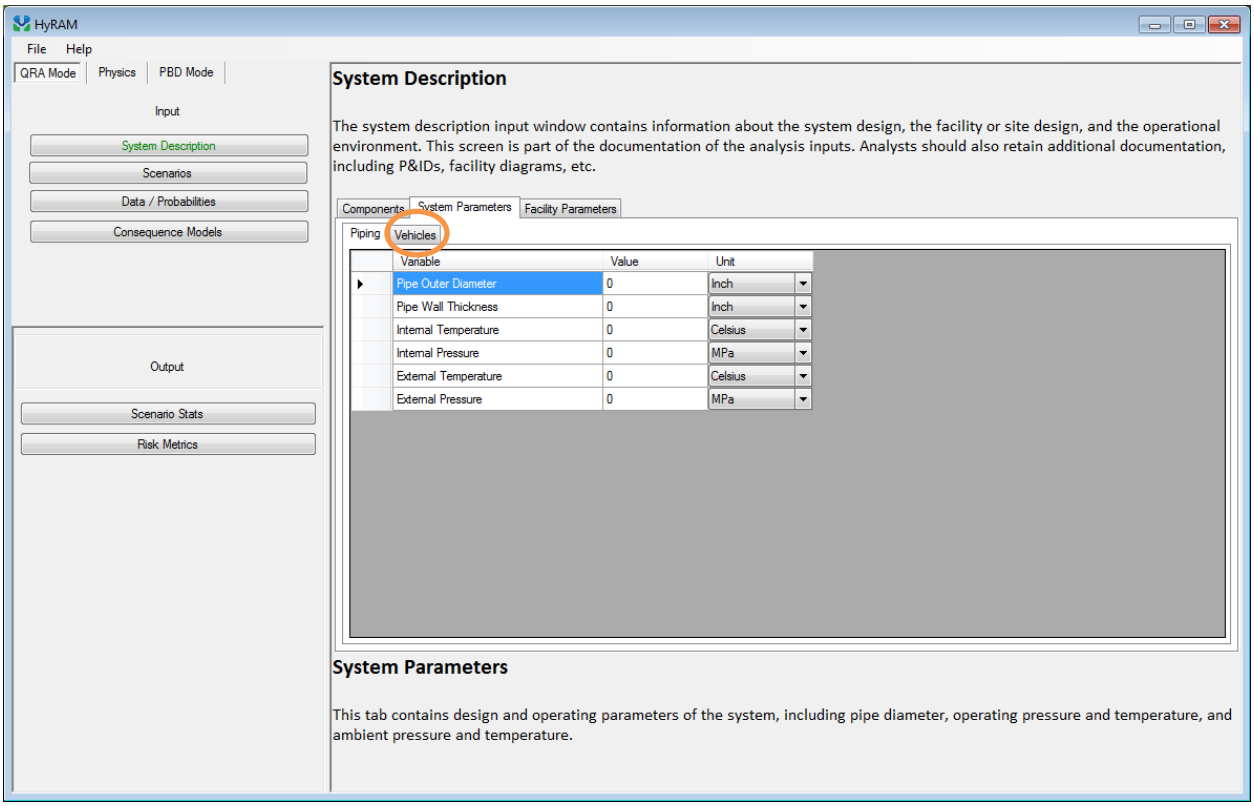


Note

We are currently editing the Piping tab within System Parameters.

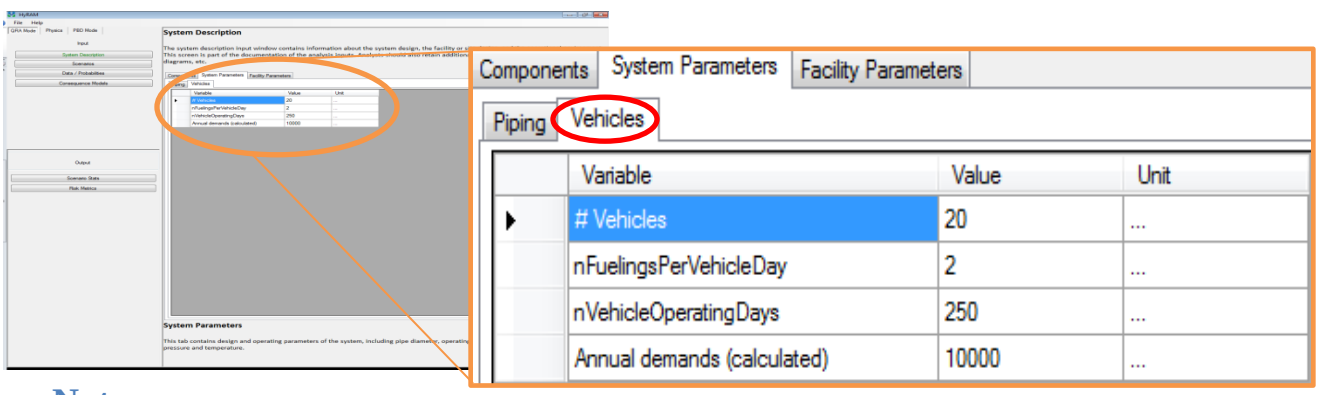
2.1.2.2 Vehicles

Then click the next tab to the right of Piping labeled **Vehicles**. It is circled in **orange**:



When that screen opens, make sure that the current tab is labeled **Vehicles**. It is circled in **red.**

Then continue to edit the values in the table to reflect the following:



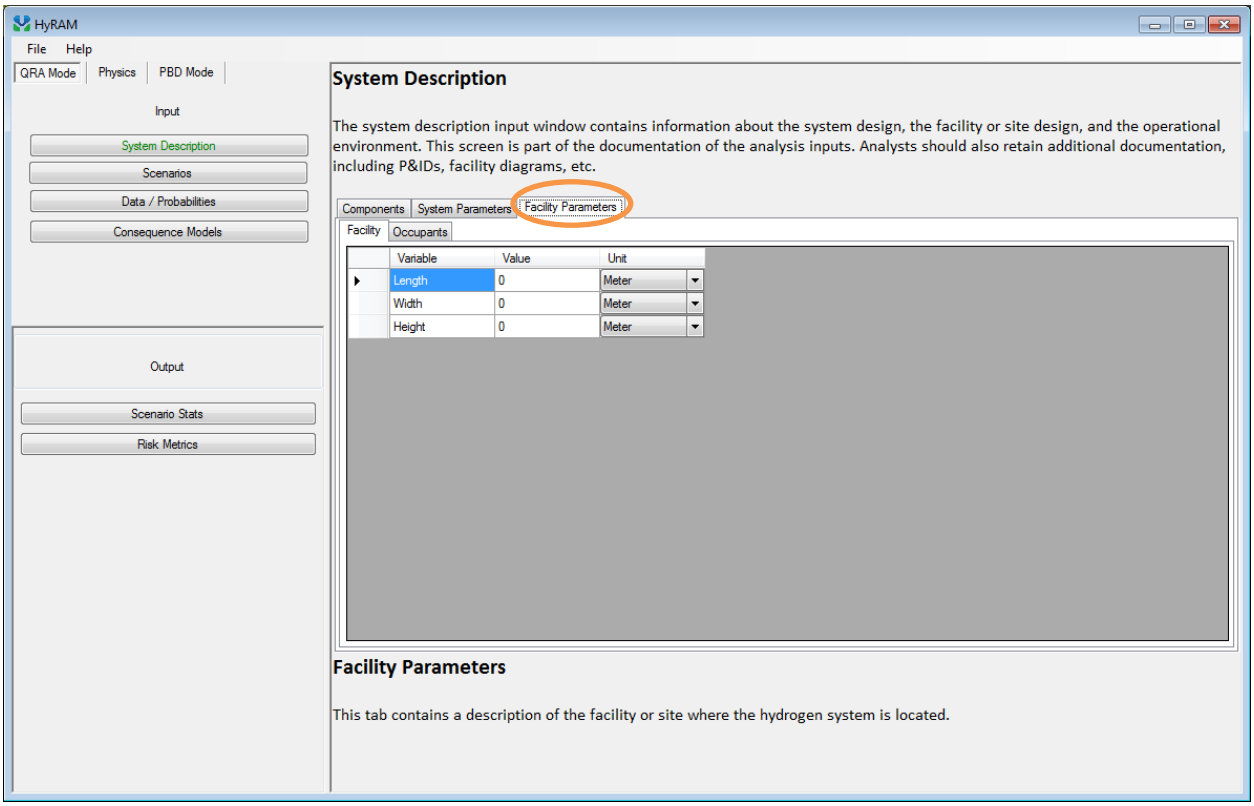
Note

We are currently editing the Vehicles tab within System Parameters.

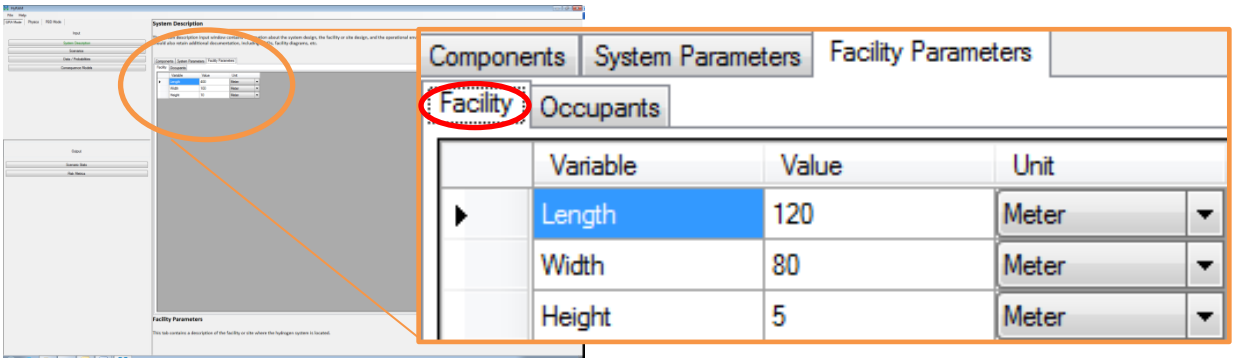
2.1.3 Edit Facility Parameters

2.1.3.1 Facility

To continue editing the parameters, click the next tab labeled **Facility Parameters** in the current window. It is circled in **orange**:



When that screen opens, make sure that the current tab is labeled **Facility**. It is circled in **red.** Then continue to edit the values in the table to reflect the following:



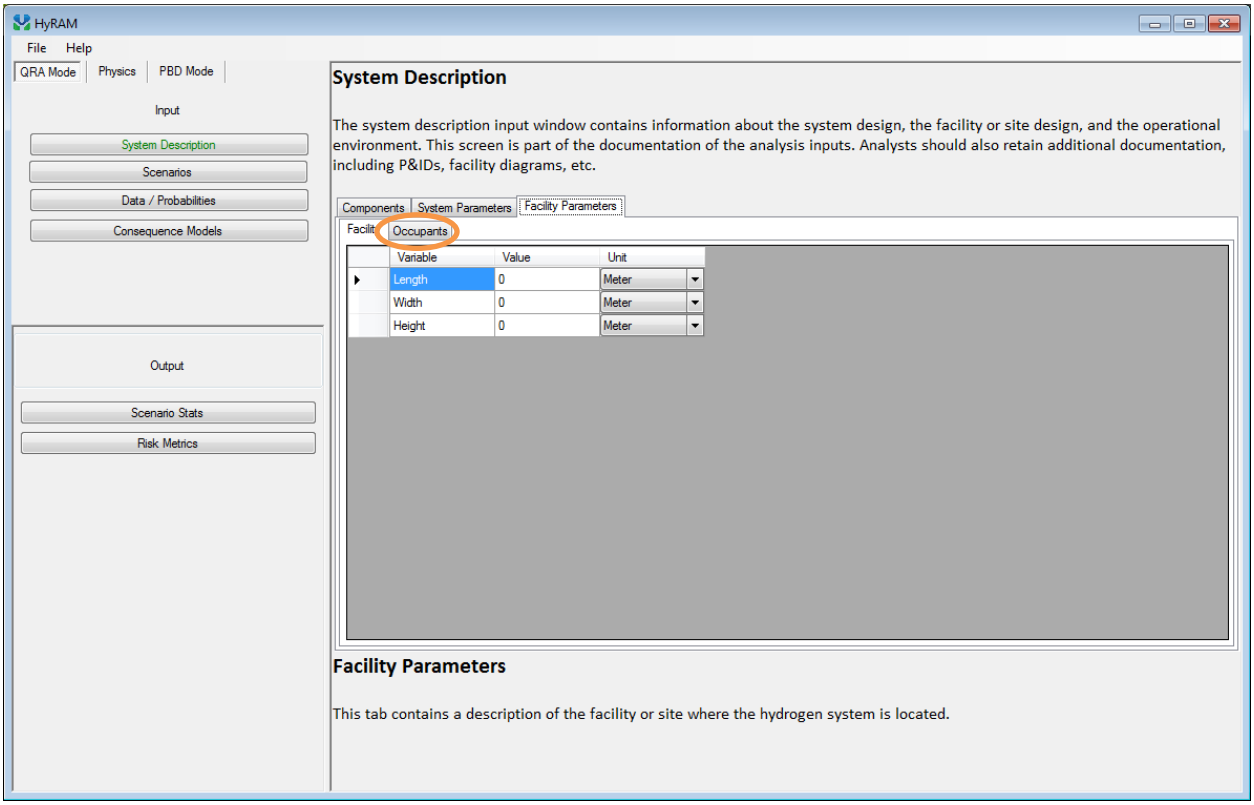
Note

We are currently editing the Facility tab within Facility Parameters

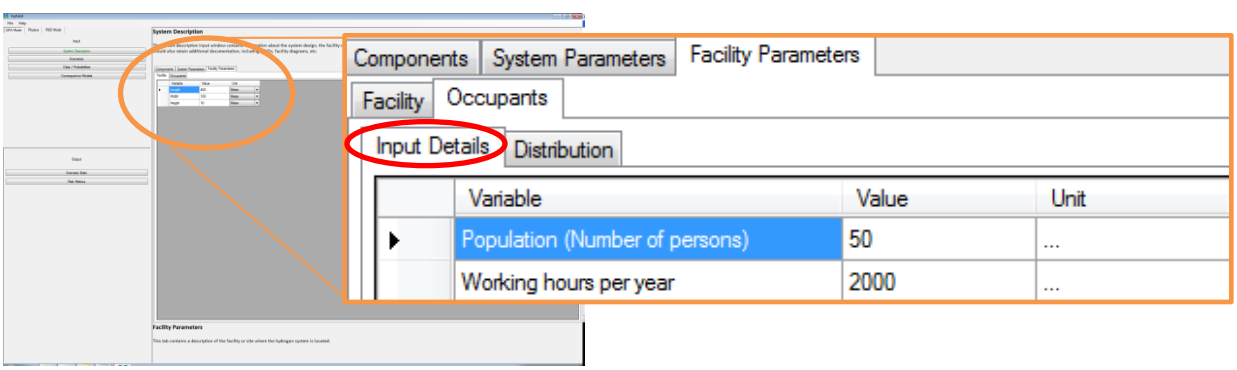
2.1.3.2 Occupants

2.1.3.2.1 INPUT DETAILS

Then click the next tab to the right of Facility labeled **Occupants**. It is circled in **orange**:



When that screen opens, make sure that the current tab is labeled **Input Details**. It is circled in **red**. Then continue to edit the values in the table to reflect the following:

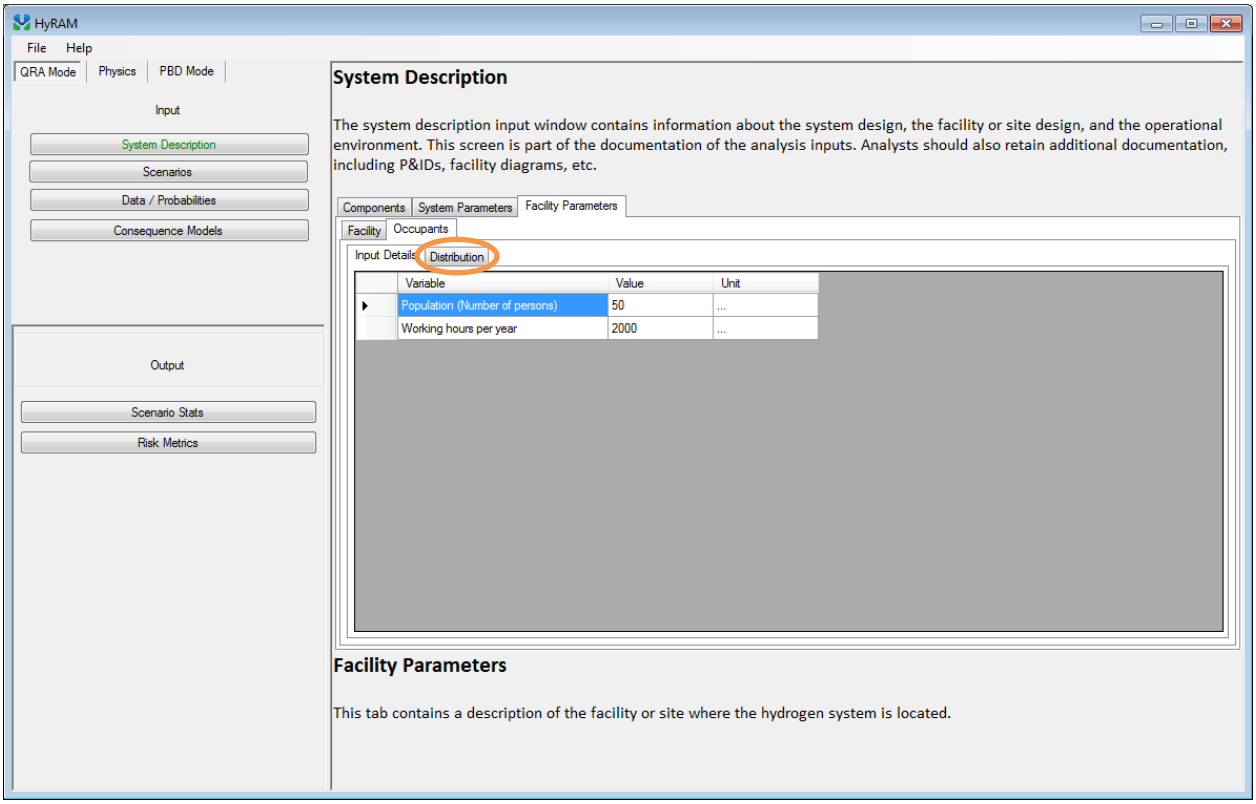


Note

We are currently editing within the Occupants tab within Facility Parameters. In addition, also note that the current tab is Input Details.

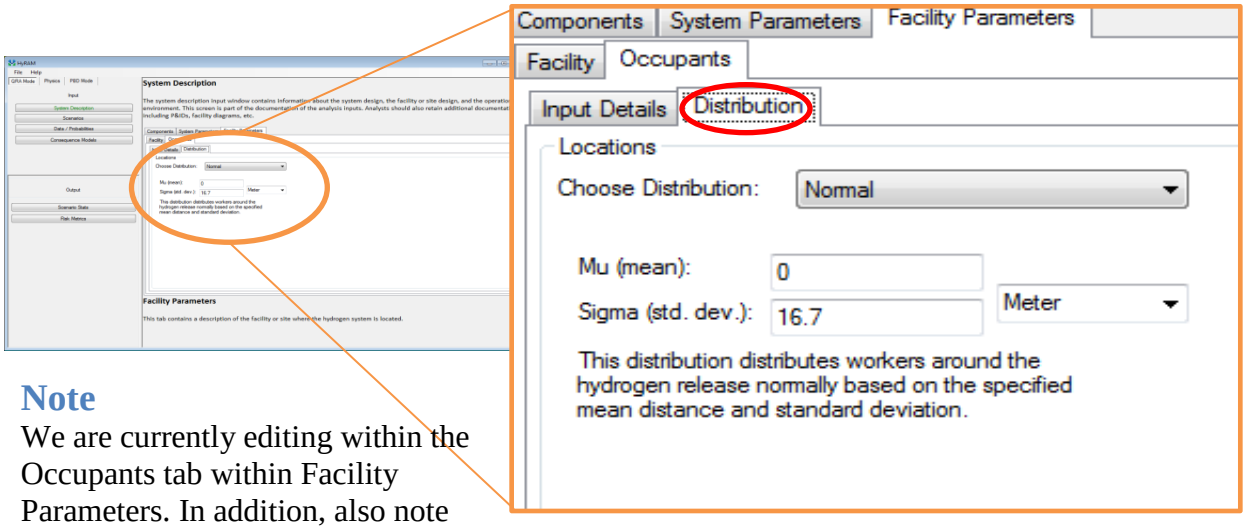
2.1.3.2.2 Distribution

Then click the next tab to the right of the Input Details labeled **Distribution**. It is circled in **orange:**



When that screen opens, make sure that the current tab is labeled **Distribution**. It is circle in **red**.

Then continue to edit the values in the box to reflect the following:



Note

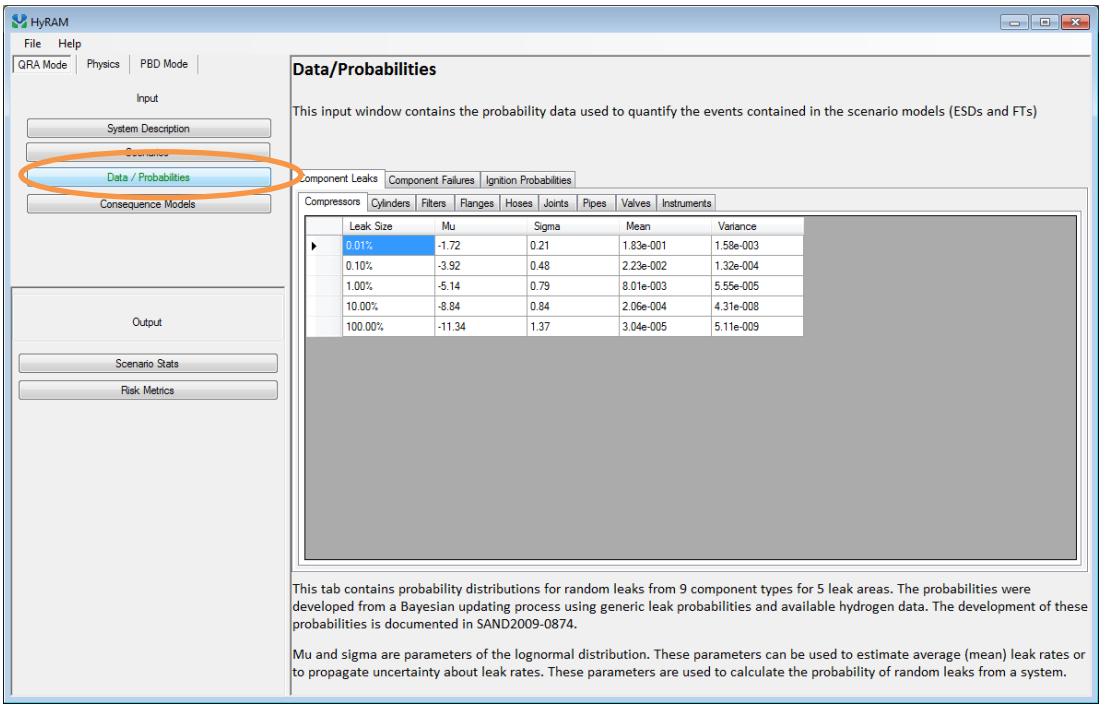
We are currently editing within the Occupants tab within Facility Parameters. In addition, also note that the current tab is Distribution.

2.2 Edit Scenarios – Feature Not Ready

Do not evaluate this section. This feature will be implemented at a later time. Please move onto the next section.

2.3 Edit Data / Probabilities Input

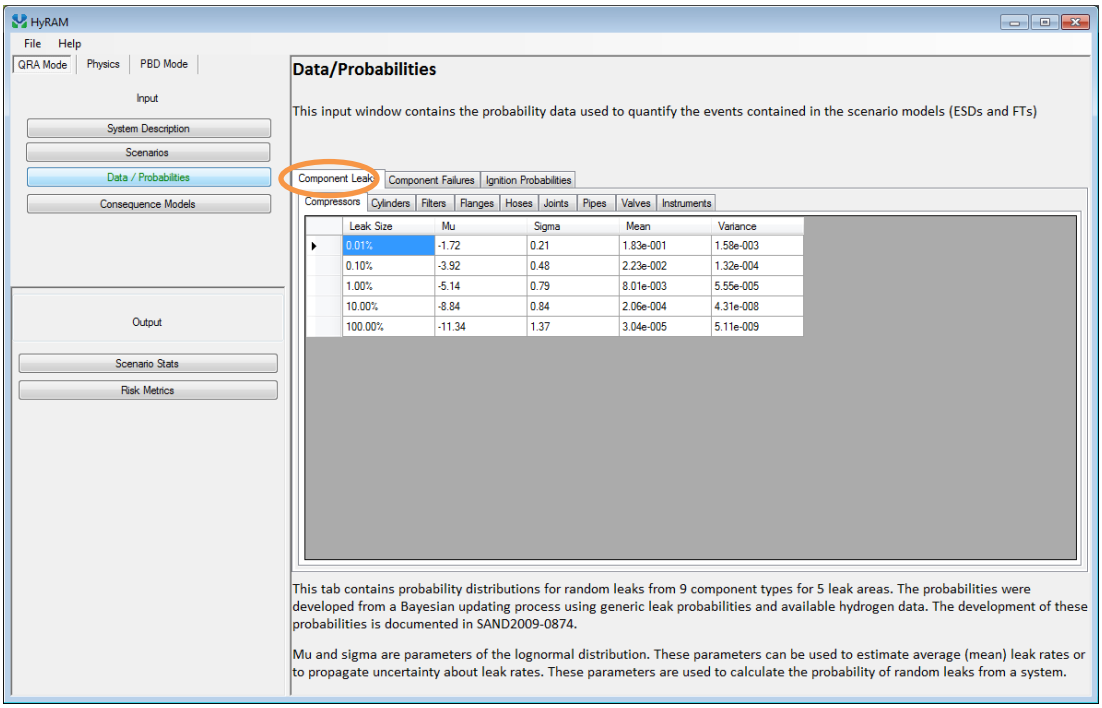
To continue editing parameters, click the **Data / Probabilities** button in the input section of the application. It is circled in **orange**:



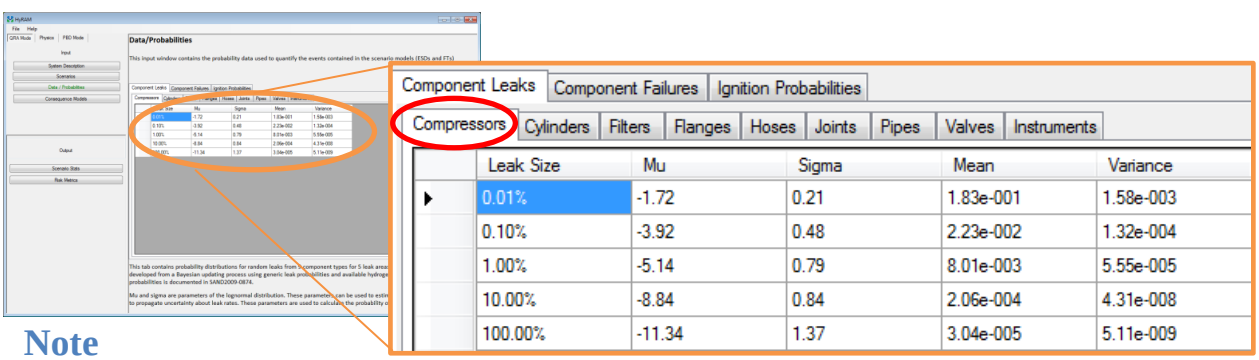
2.3.1 Component Leaks

2.3.1.1 Compressors

To continue editing parameters, click the **Component Leaks** tab. It is circled in **orange**:



When that screen opens, make sure that the current tab is labeled **Compressors**. It is circled in **red**. Then continue to edit the values in the table to reflect the following:

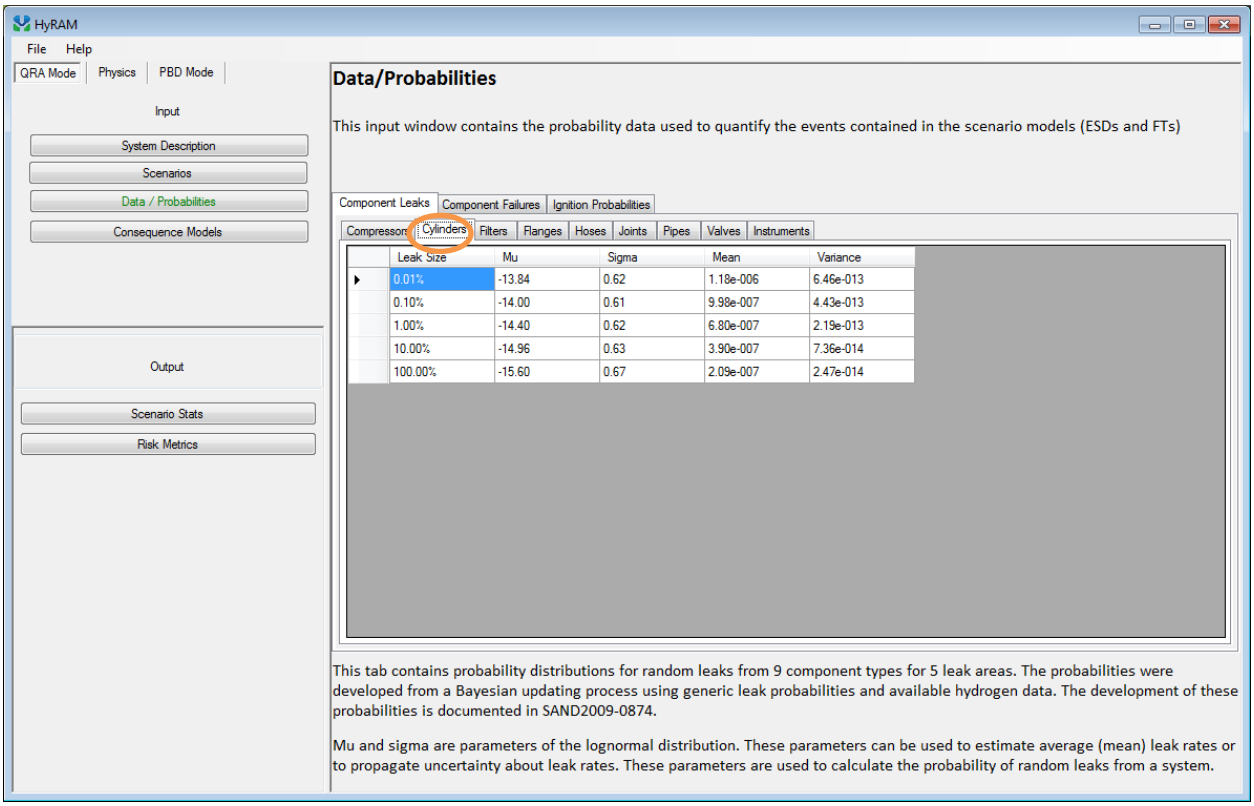


Note

Some values in the different tables are not available for editing. Such values in this case include the Leak Size, Mean, and Variance.

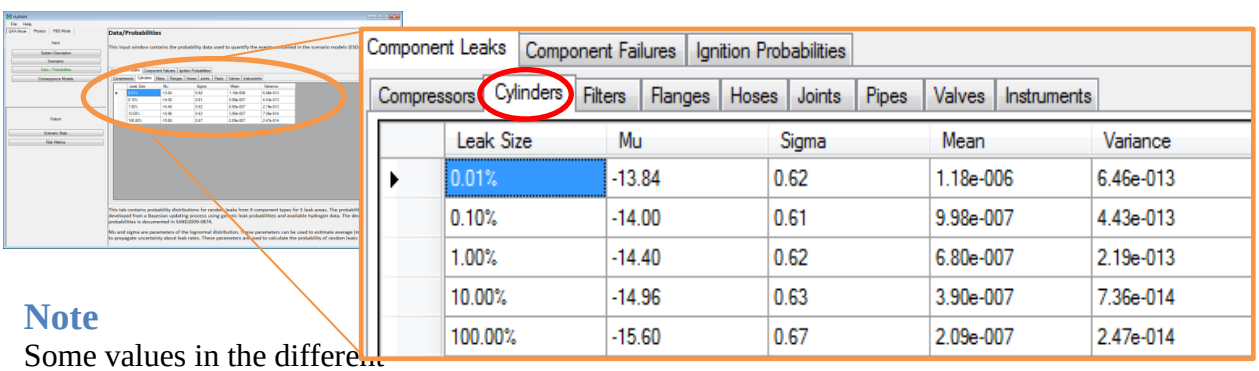
2.3.1.2 Cylinders

To continue editing parameters, click the next tab labeled **Cylinders**. It is circled in **orange**:



When that screen opens, make sure that the current tab is labeled **Cylinders**. It is circled in **red**.

Then continue to edit the values in the table to reflect the following:

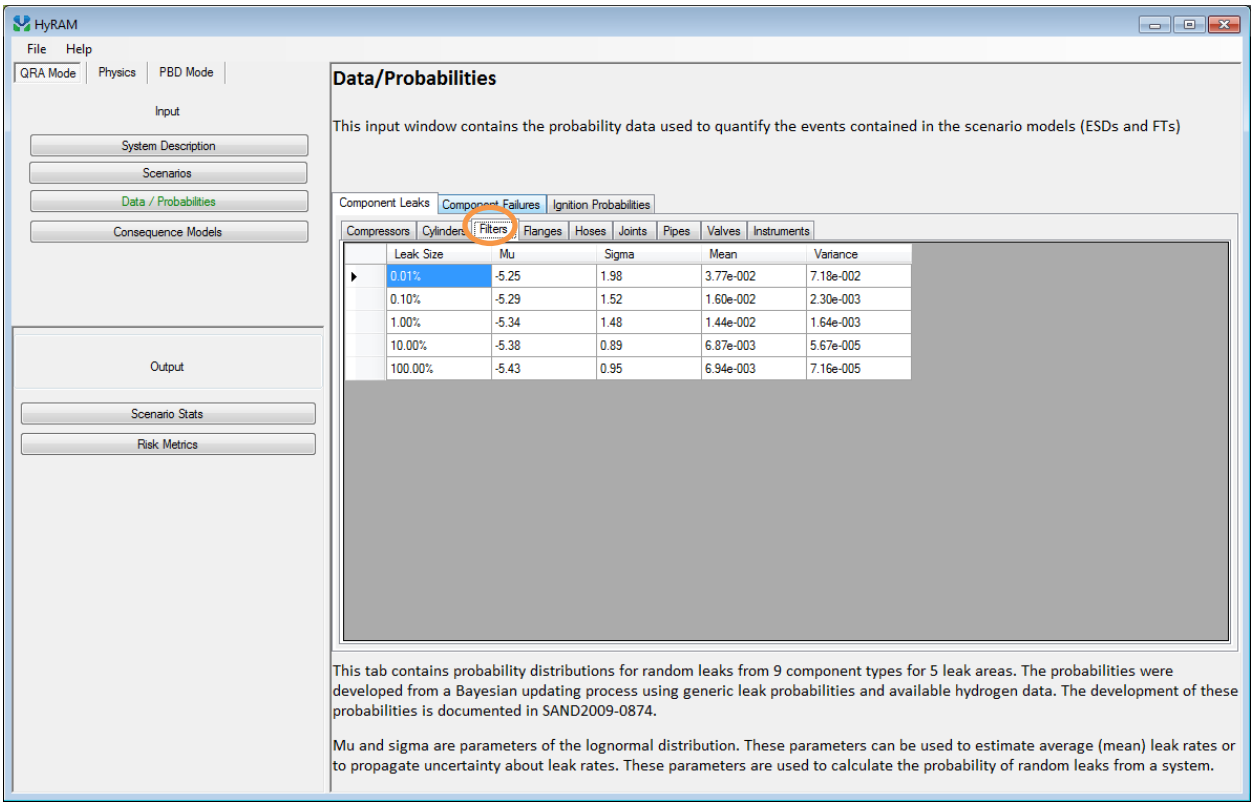


Note

Some values in the different tables are not available for editing. Such values in this case include the Leak Size, Mean, and Variance.

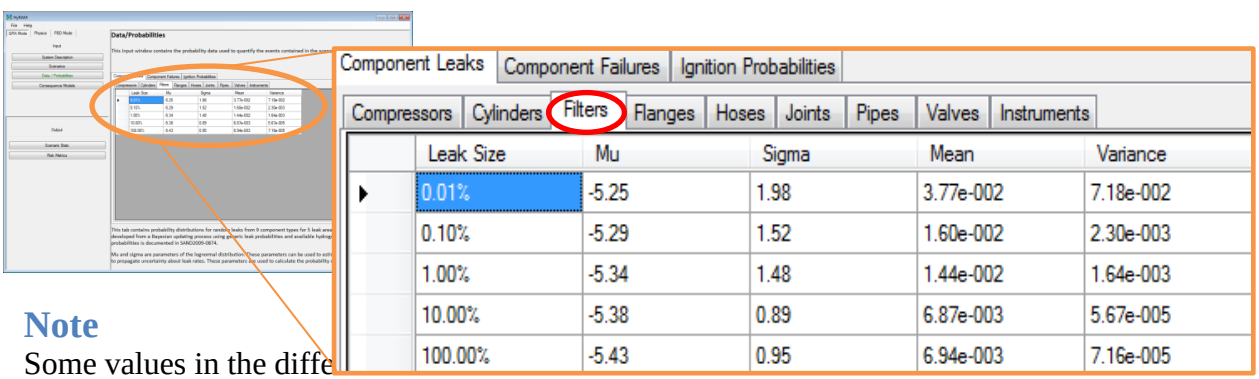
2.3.1.3 Filters

To continue editing parameters, click the next tab labeled **Filters**. It is circled in **orange:**



When that screen opens, make sure that the current tab is labeled **Filters**. It is circled in **red**.

Then continue to edit the values in the table to reflect the following:

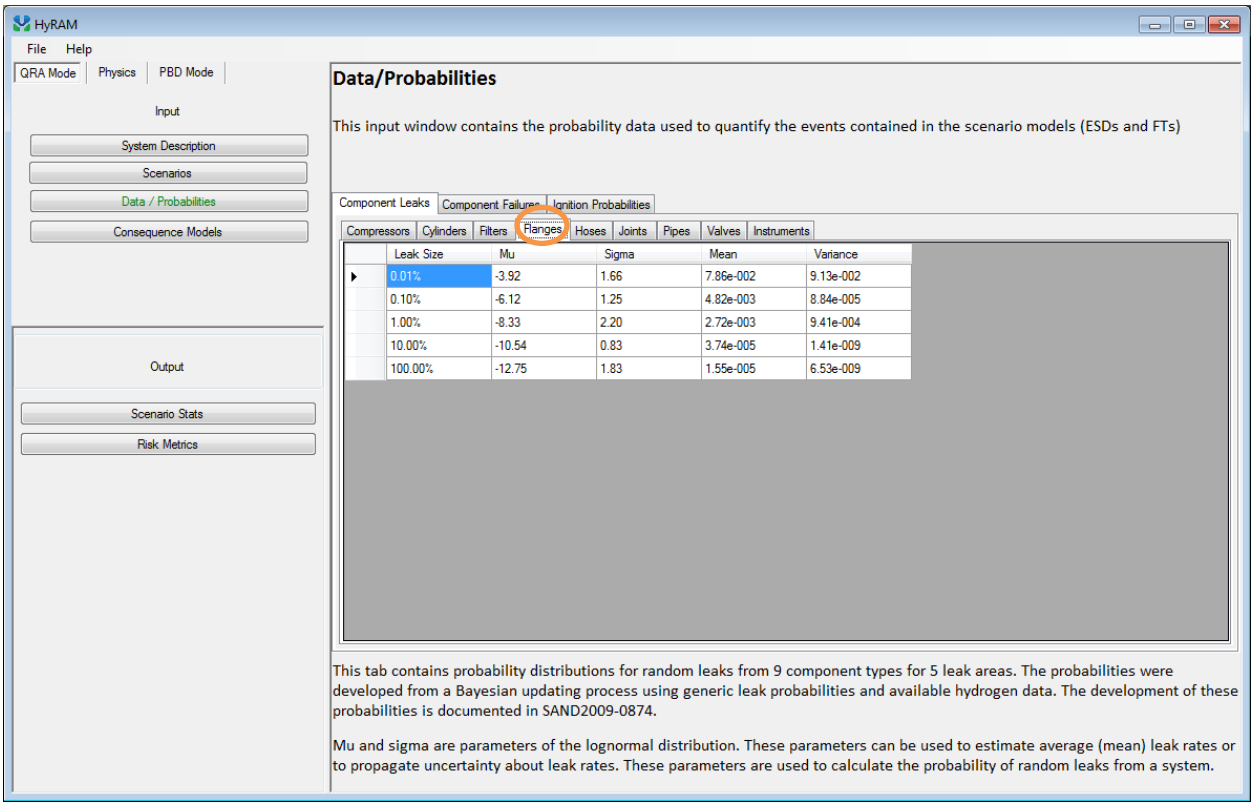


Note

Some values in the diffe
tables are not available for editing. Such values in this case include the Leak Size, Mean, and Variance.

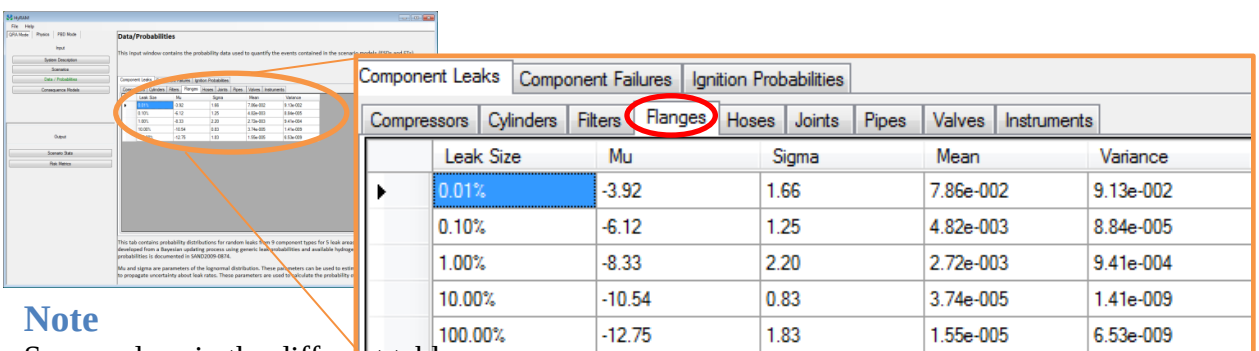
2.3.1.4 Flanges

To continue editing parameters, click the next tab labeled **Flanges**. It is circled in **orange:**



When that screen opens, make sure that the current tab is labeled **Flanges**. It is circled in **red**.

Then continue to edit the values in the table to reflect the following:

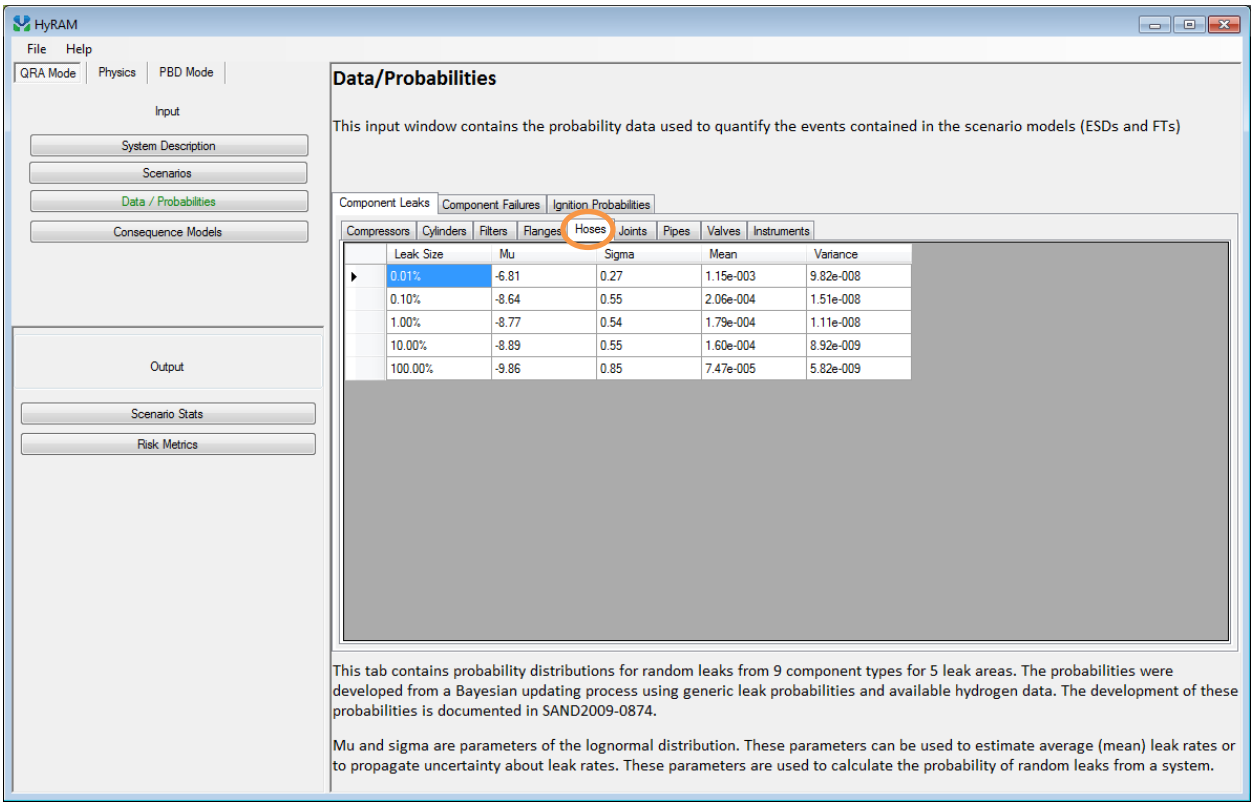


Note

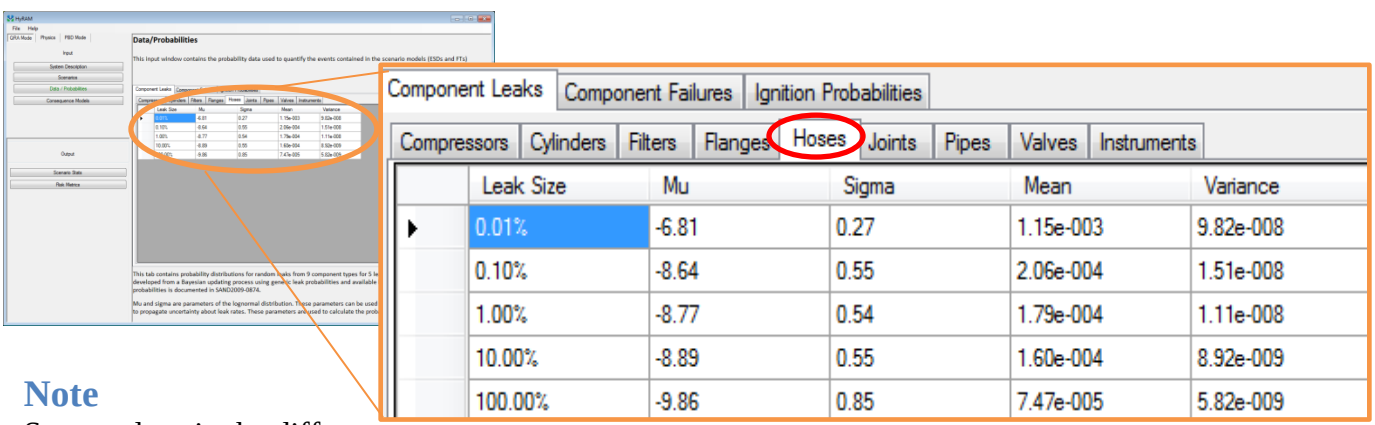
Some values in the different tables are not available for editing. Such values in this case include the Leak Size, Mean, and Variance.

2.3.1.5 Hoses

To continue editing parameters, click the next tab labeled **Hoses**. It is circled in **orange**:



When that screen opens, make sure that the current tab is labeled **Hoses**. It is circled in **red**. Then continue to edit the values in the table to reflect the following:

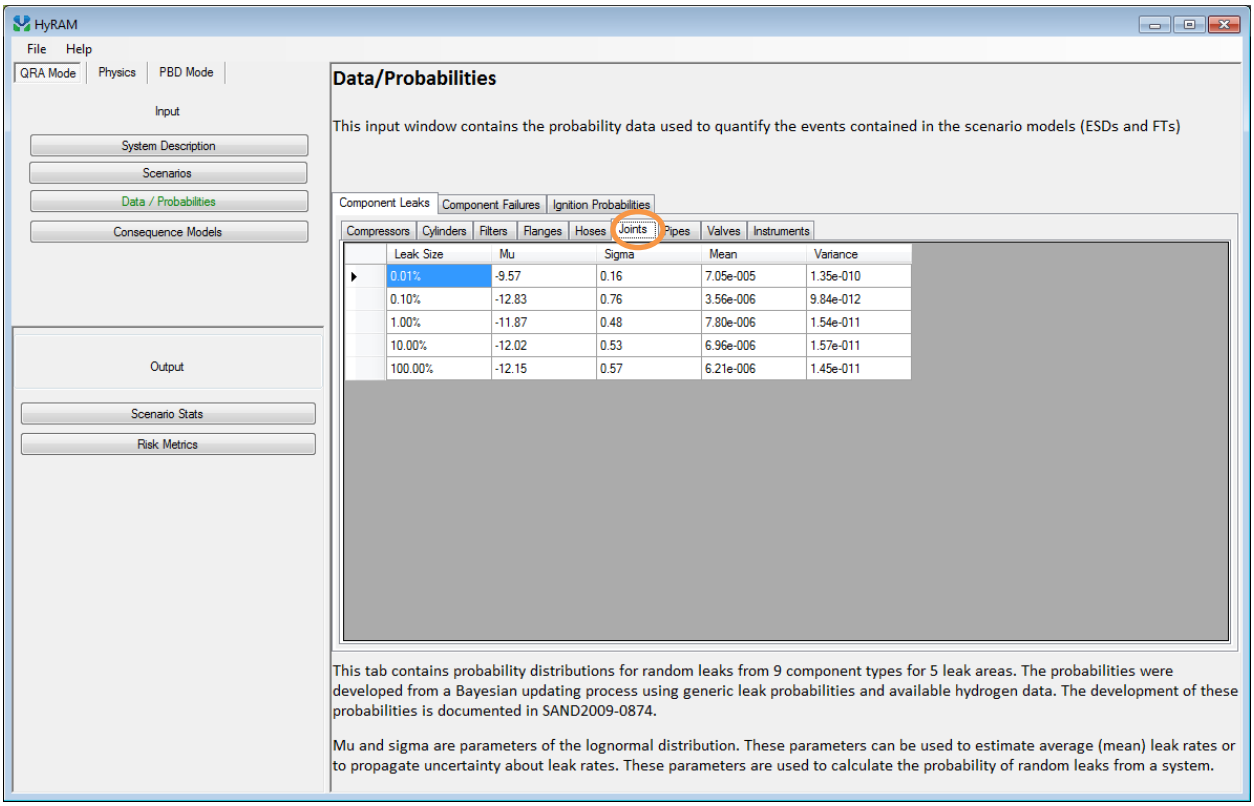


Note

Some values in the different tables are not available for editing. Such values in this case include the Leak Size, Mean, and Variance.

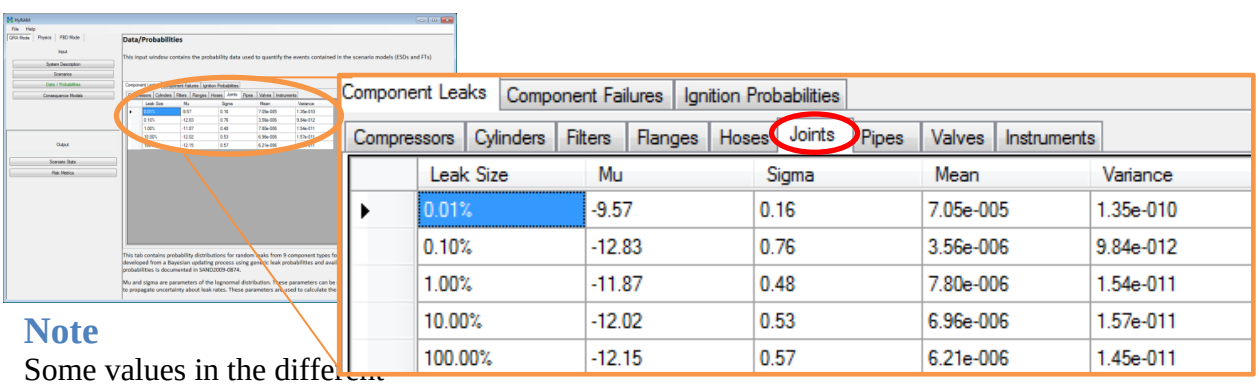
2.3.1.6 Joints

To continue editing parameters, click the next tab labeled **Joints**. It is circled in **orange**:



When that screen opens, make sure that the current tab is labeled **Joints**. It is circled in **red**.

Then continue to edit the values in the table to reflect the following:

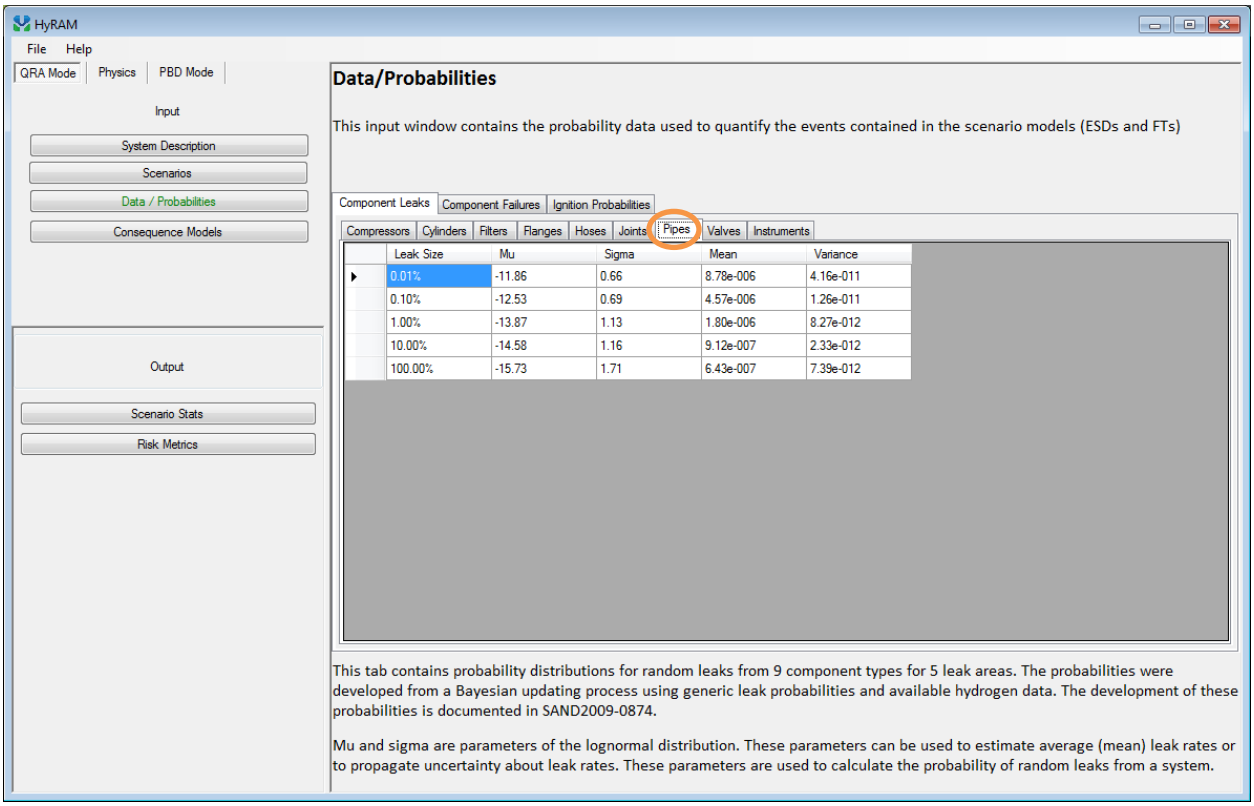


Note

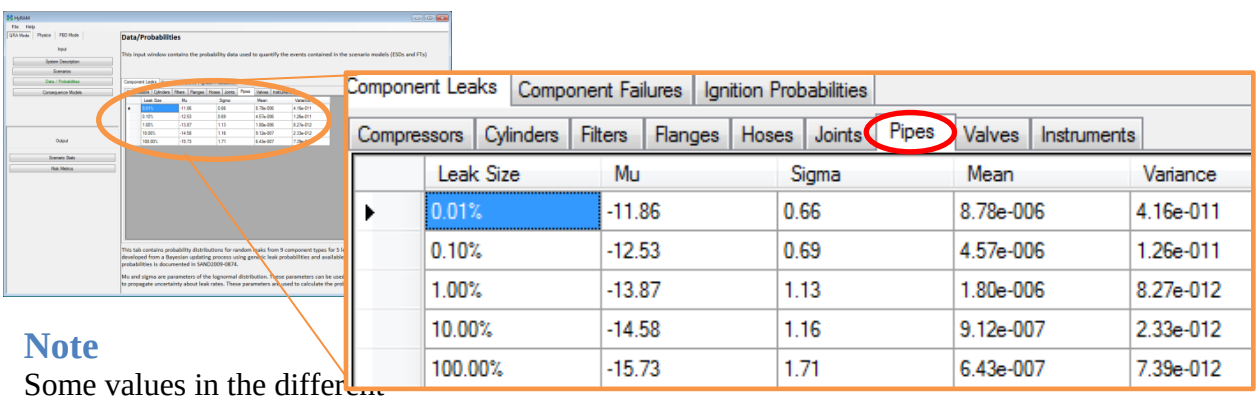
Some values in the different tables are not available for editing. Such values in this case include the Leak Size, Mean, and Variance.

2.3.1.7 Pipes

To continue editing parameters, click the next tab labeled **Pipes**. It is circled in **orange:**



When that screen opens, make sure that the current tab is labeled **Pipes**. It is circled in **red**. Then continue to edit the values in the table to reflect the following:

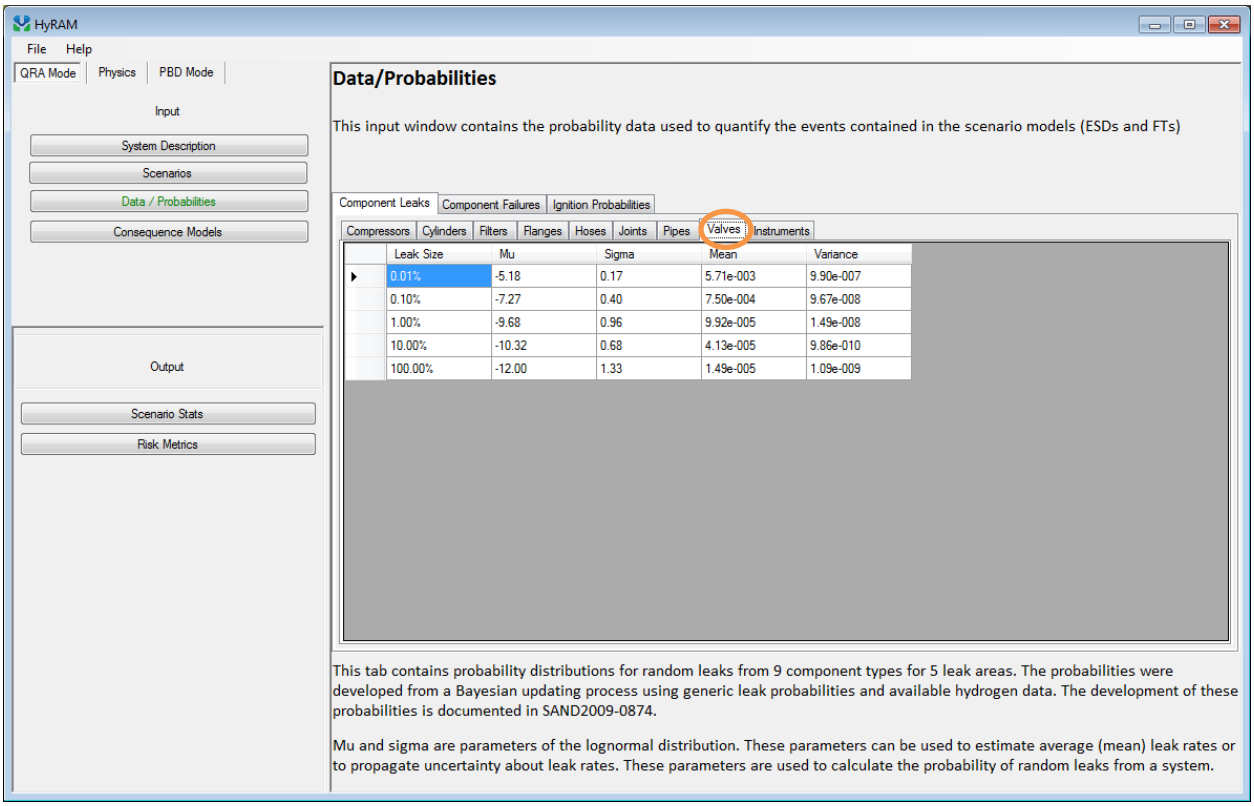


Note

Some values in the different tables are not available for editing. Such values in this case include the Leak Size, Mean, and Variance.

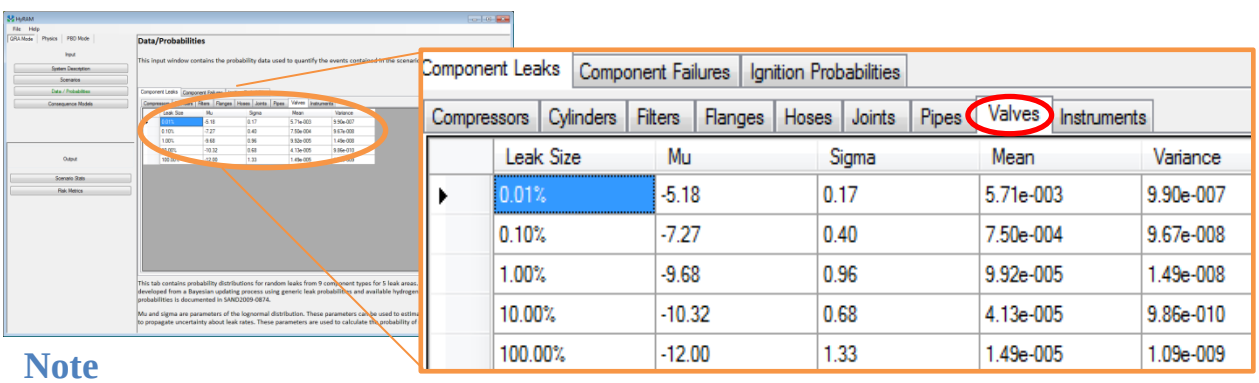
2.3.1.8 Valves

To continue editing parameters, click the next tab labeled **Valves**. It is circled in **orange**:



When that screen opens, make sure that the current tab is labeled **Valves**. It is circled in **red**.

Then continue to edit the values in the table to reflect the following:

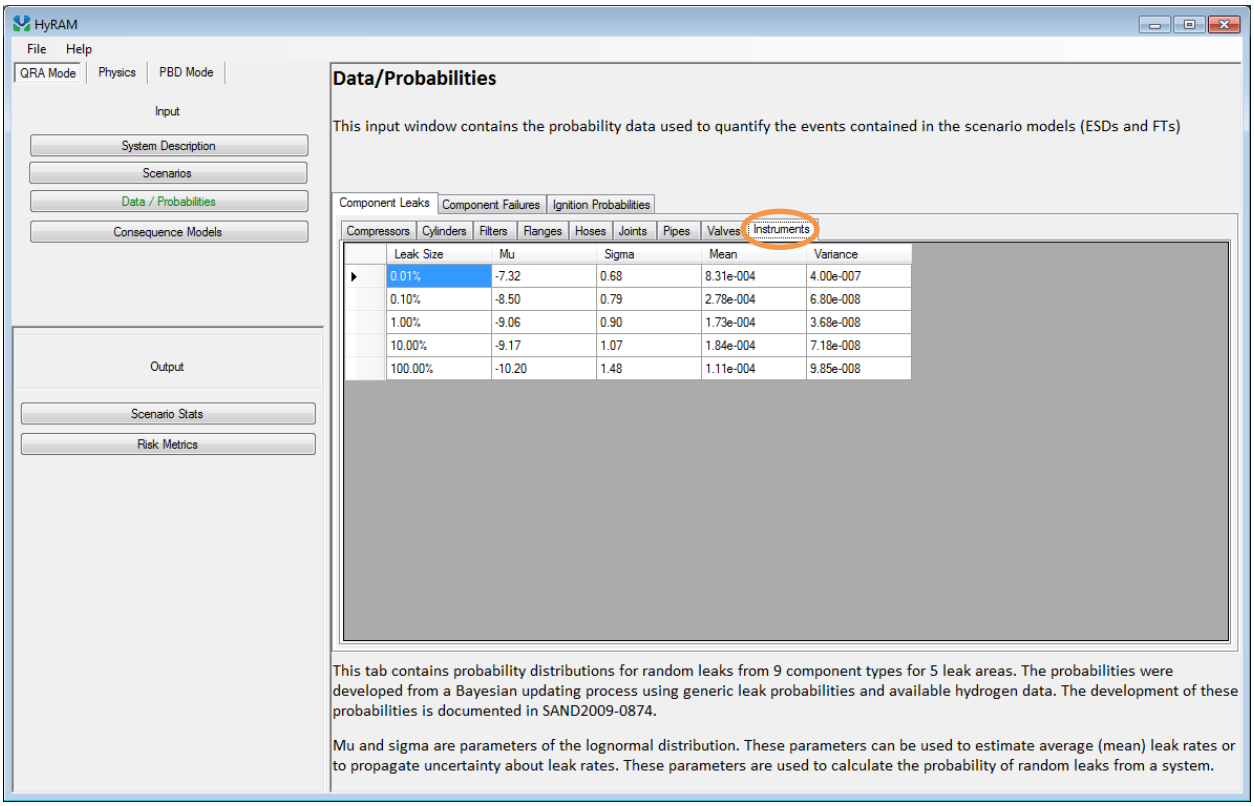


Note

Some values in the different tables are not available for editing. Such values in this case include the Leak Size, Mean, and Variance.

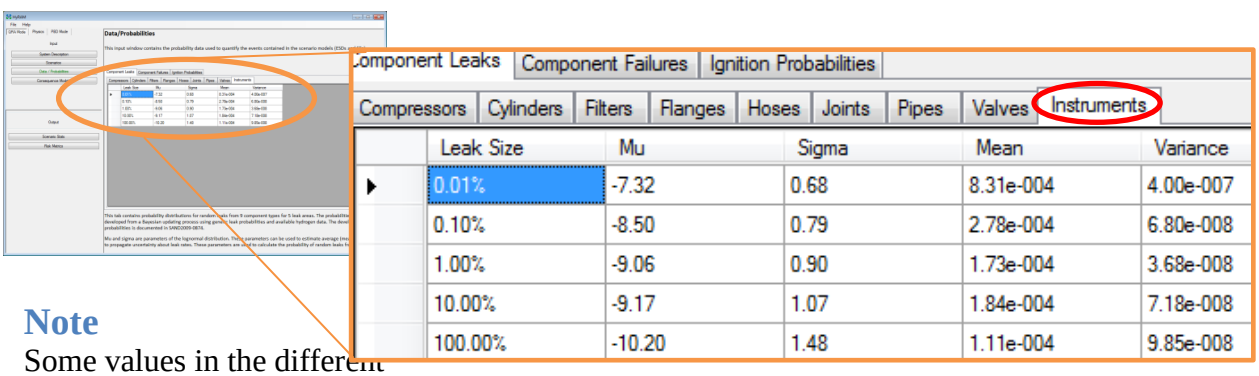
2.3.1.9 Instruments

To continue editing parameters, click the next tab labeled **Instruments**. It is circled in **orange:**



When that screen opens, make sure that the current tab is labeled **Instruments**. It is circle in **red**.

Then continue to edit the values in the table to reflect the following:



Note

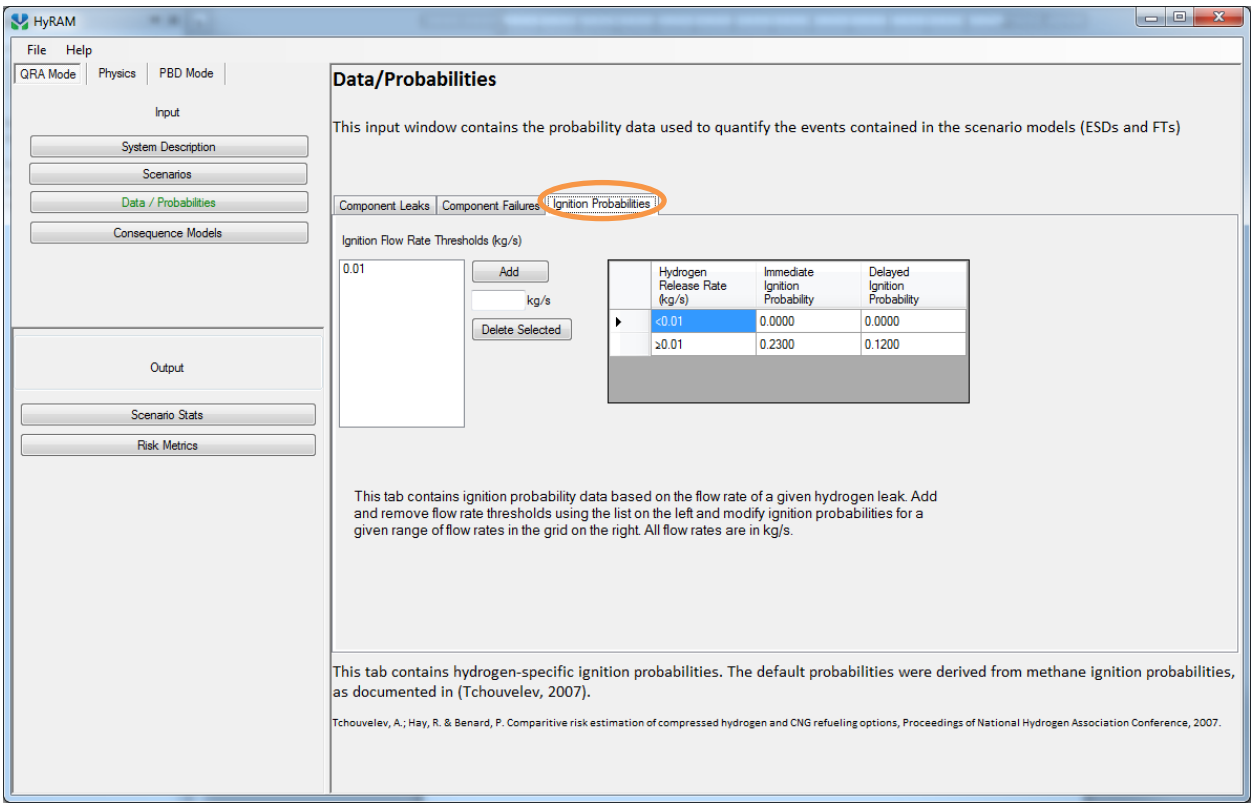
Some values in the different tables are not available for editing. Such values in this case include the Leak Size, Mean, and Variance.

2.3.2 Component Failures – Feature Not Ready

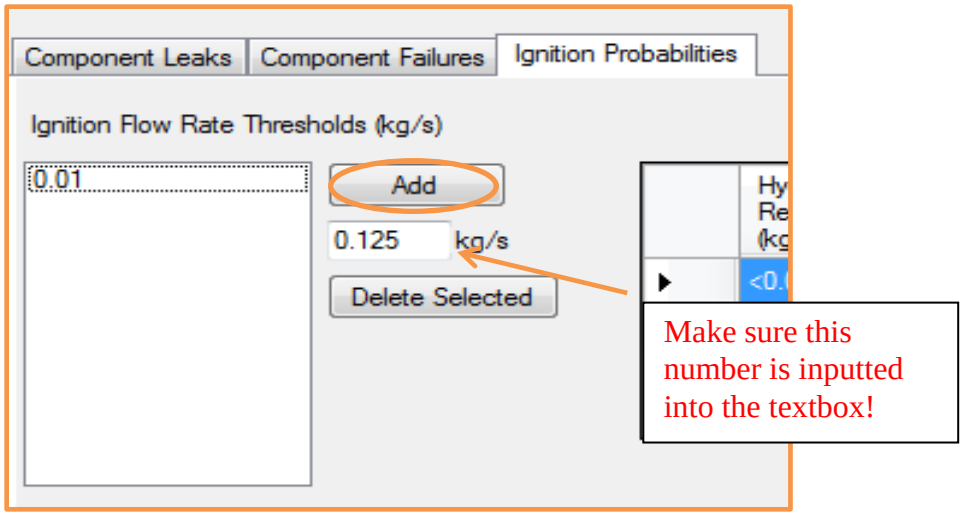
Do not evaluate this section. This feature will be implemented at a later time. Please move onto the next section.

2.3.3 Ignition Probabilities

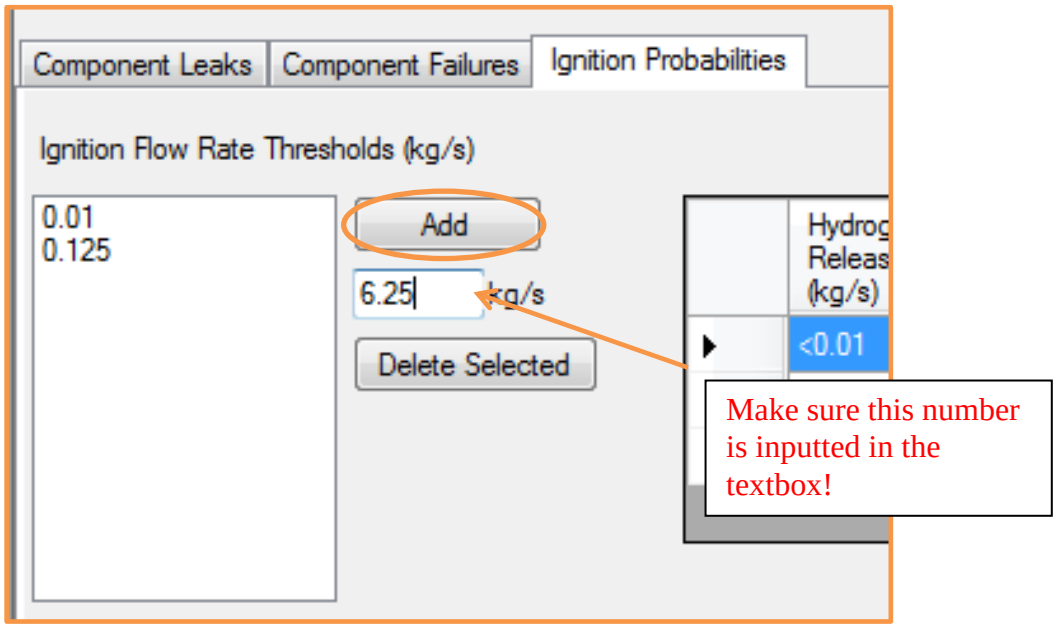
To continue editing parameters, click the **Ignition Probabilities** tab. It is circled in **orange:**



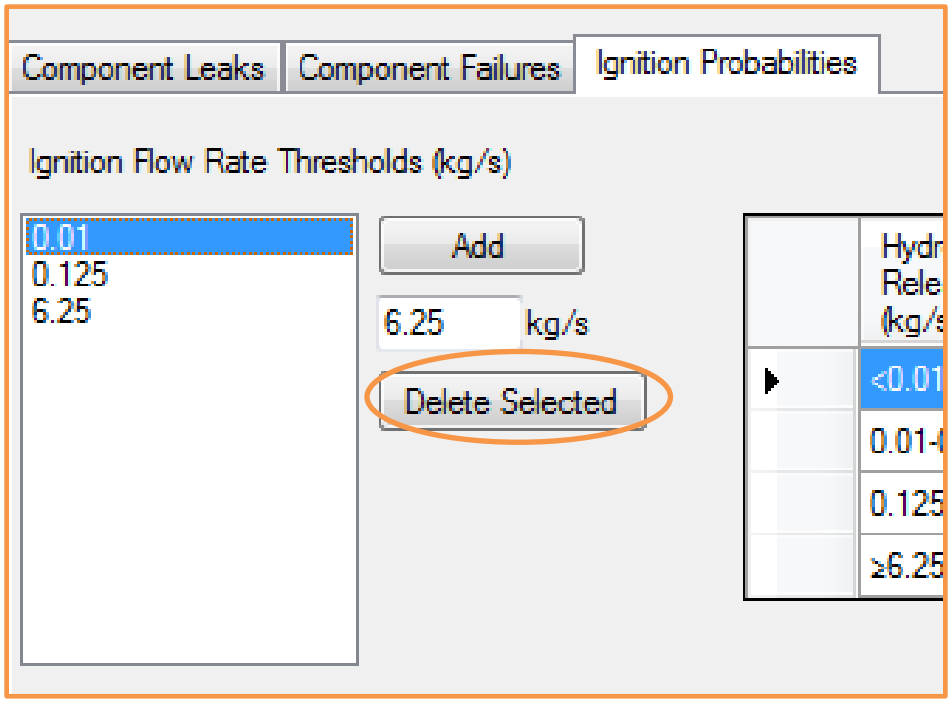
When that screen opens, add a new Ignition Flow Rate Thresholds by typing in the following number and click **add**. **Add** is circled in **orange:**



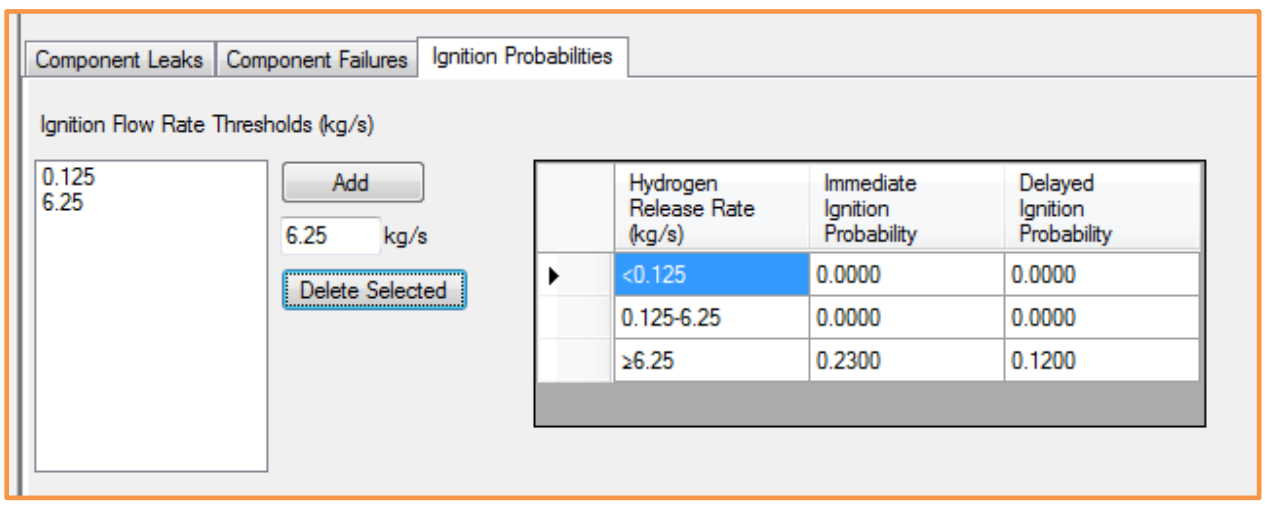
Do the same for another Ignition Flow Rate Threshold. The diagram is below:



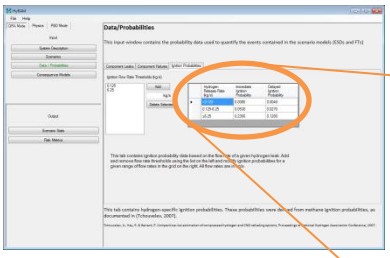
Select the lowest (0.01) ignition flow rat threshold, and then press **Delete Selected**. The button to **Delete** Selected is circled in **orange**:



After deleting the lowest threshold value, the threshold list should look like the following:



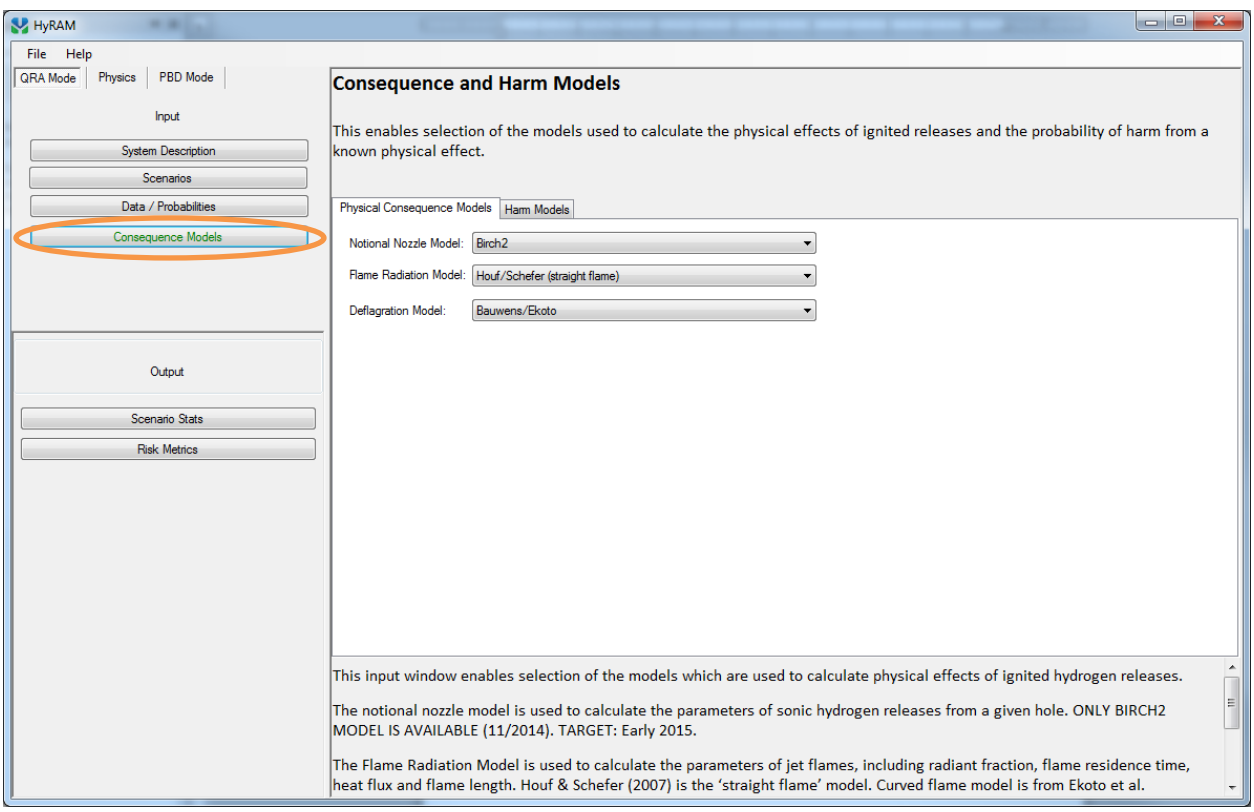
To continue editting values, edit the values in the table to reflect the following:



Hydrogen Release Rate (kg/s)	Immediate Ignition Probability	Delayed Ignition Probability
<0.125	0.0080	0.0040
0.125-6.25	0.0530	0.0270
≥6.25	0.2300	0.1200

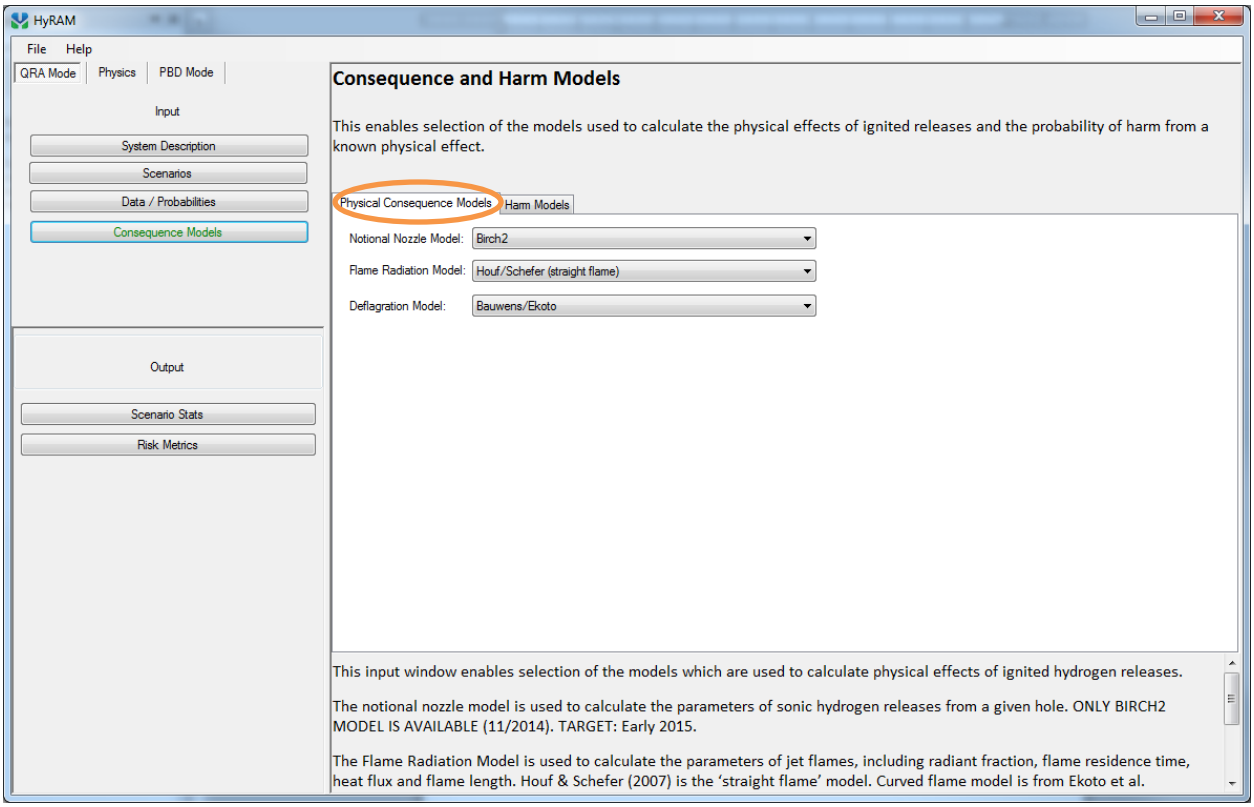
2.4 Select Consequence and Harm Models

To continue editing parameters, click the **Consequence Models** button in the input section of the application. It is circled in **orange**:

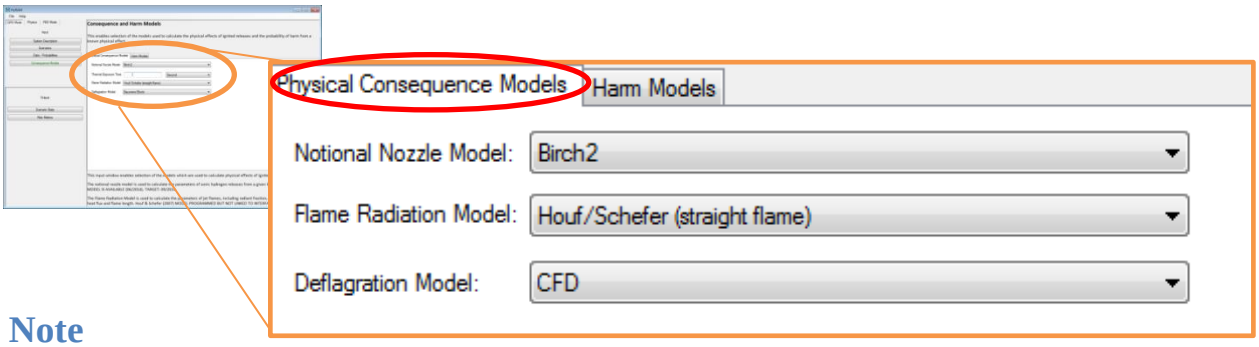


2.4.1 Physical Consequence Models

To continue editing parameters, click the **Physical Consequence Models** tab. It is circled in **orange**:



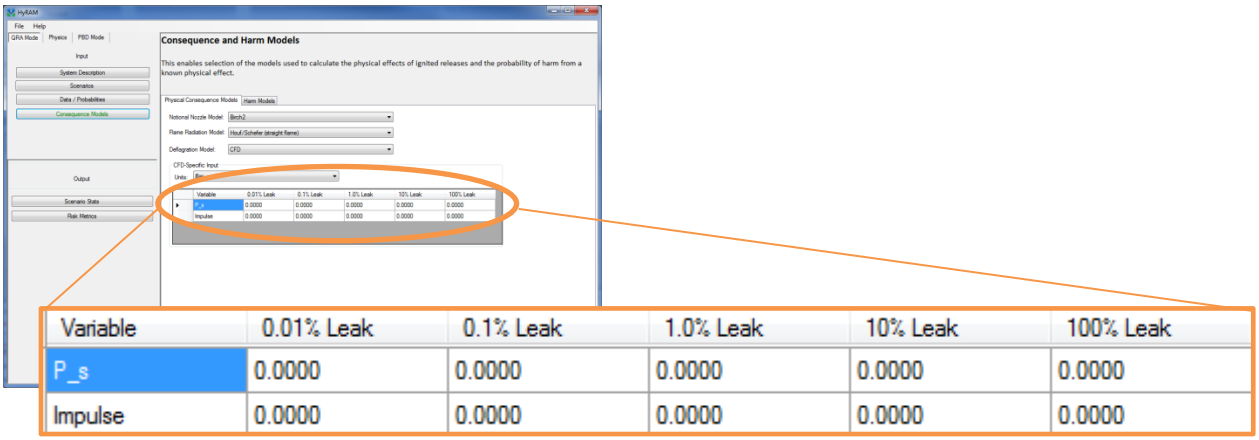
When that screen opens, make sure that the current tab is labeled **Physical Consequence Models**. It is circled in **red**. Then continue to edit the values in the form to reflect the following:



Note

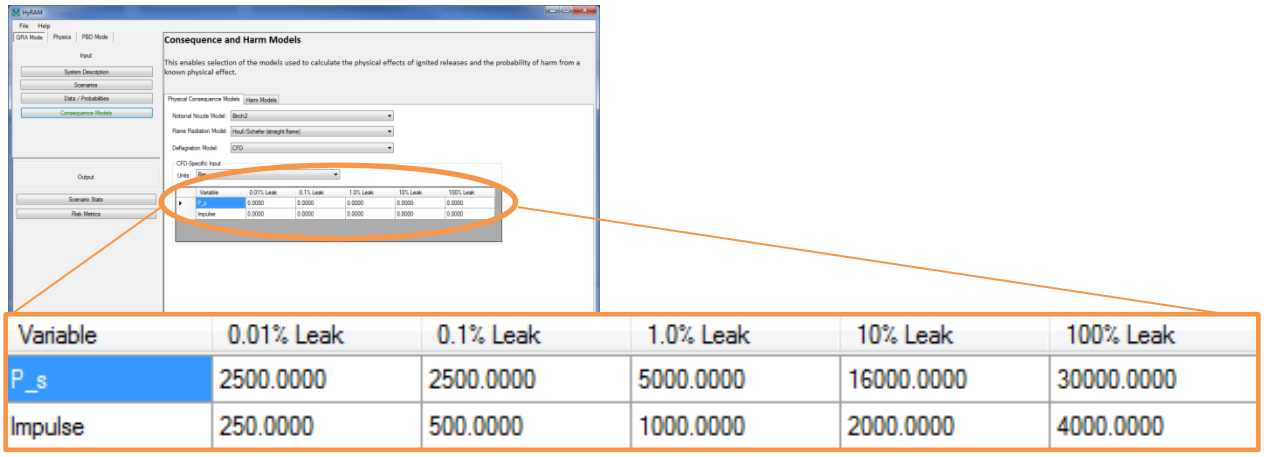
Only the Deflagration Model changed in this diagram.

When selected **CFD**, a new table should appear. It will look like this:



Variable	0.01% Leak	0.1% Leak	1.0% Leak	10% Leak	100% Leak
P_s	0.0000	0.0000	0.0000	0.0000	0.0000
Impulse	0.0000	0.0000	0.0000	0.0000	0.0000

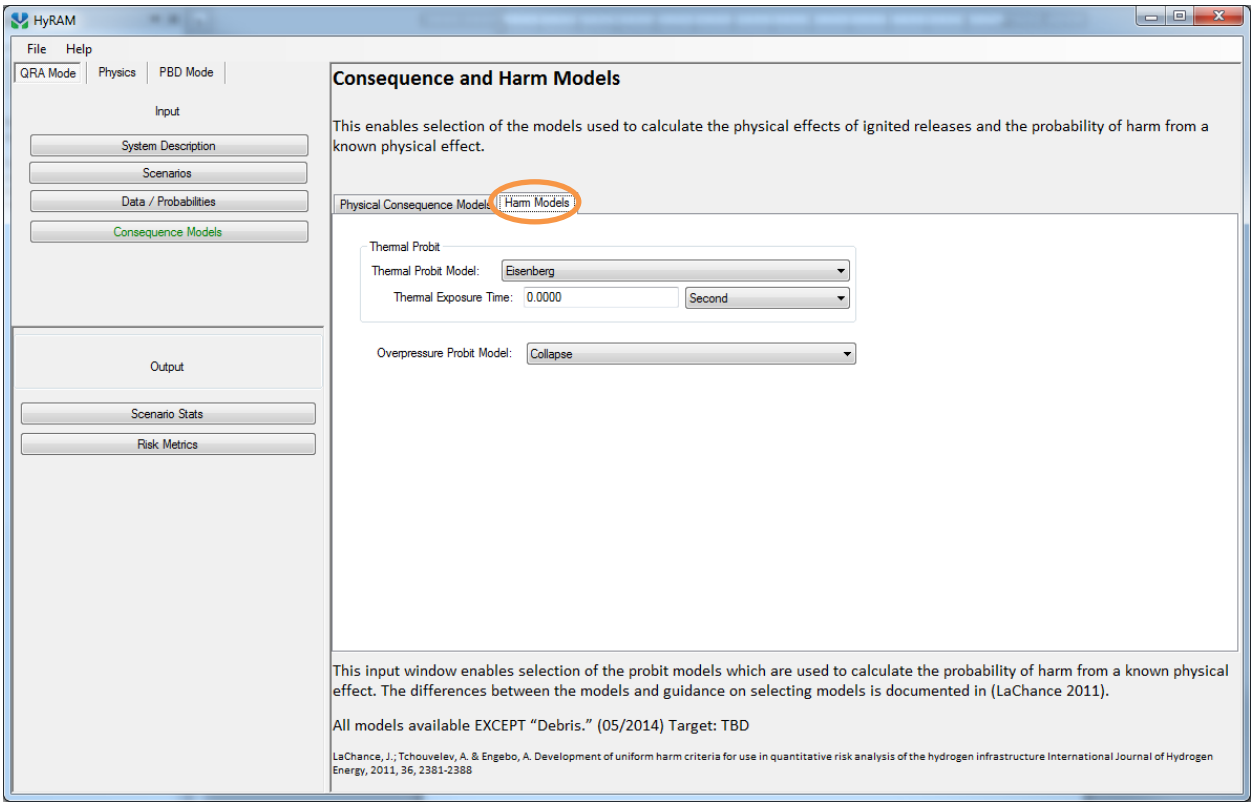
Edit the values inside that table to reflect the following:



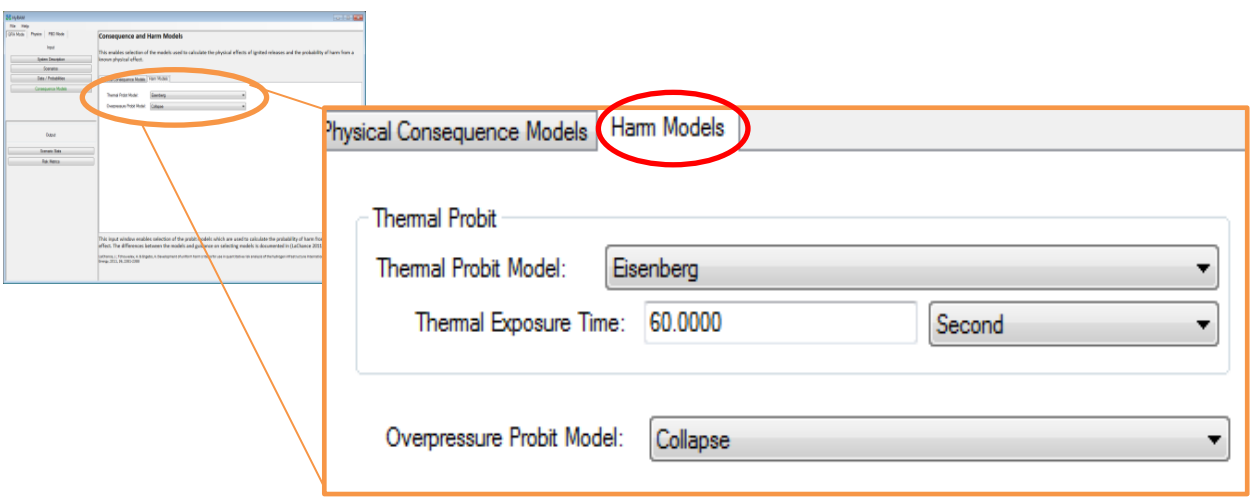
Variable	0.01% Leak	0.1% Leak	1.0% Leak	10% Leak	100% Leak
P_s	2500.0000	2500.0000	5000.0000	16000.0000	30000.0000
Impulse	250.0000	500.0000	1000.0000	2000.0000	4000.0000

2.4.2 Harm Models

To continue editing parameters, click the **Harm Models** tab. It is circled in **orange:**



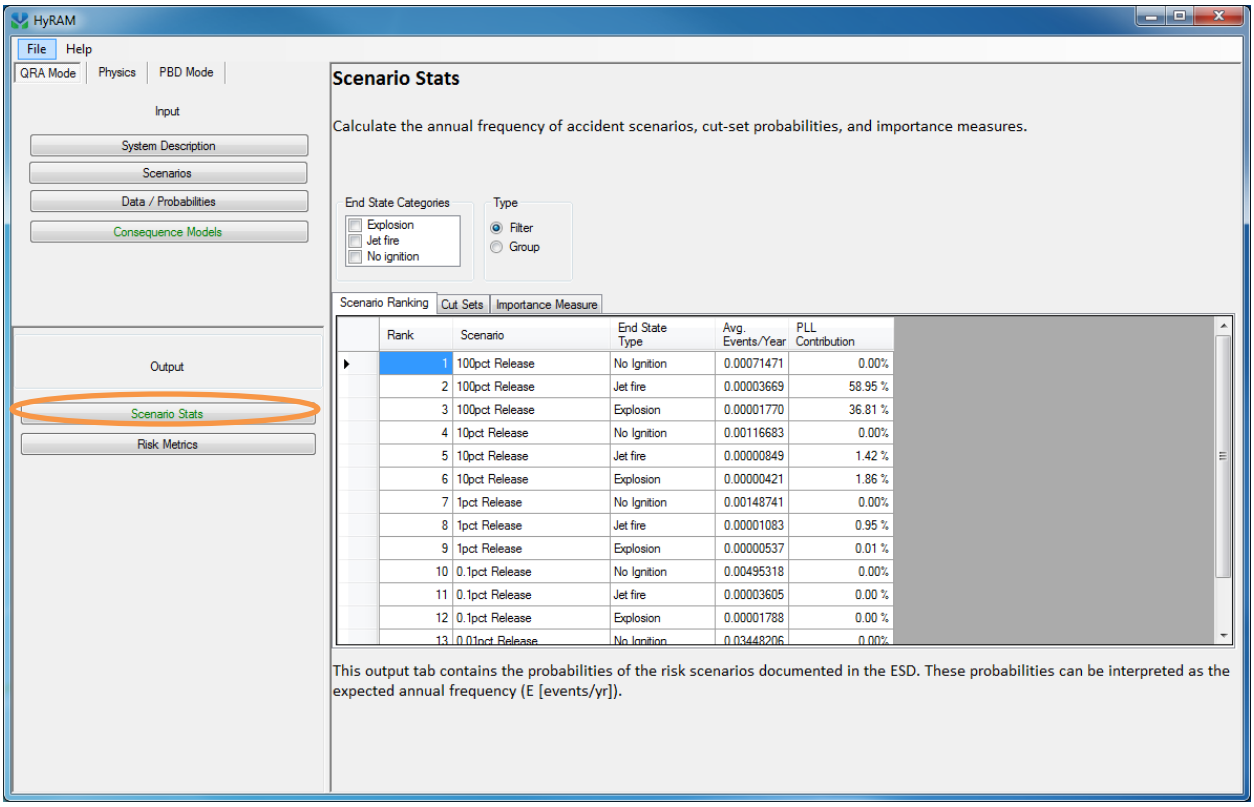
When that screen opens, make sure that the current tab is labeled **Harm Models**. It is circled in **red**. Then continue to edit the values in the table to reflect the following:



2.5 Output Results

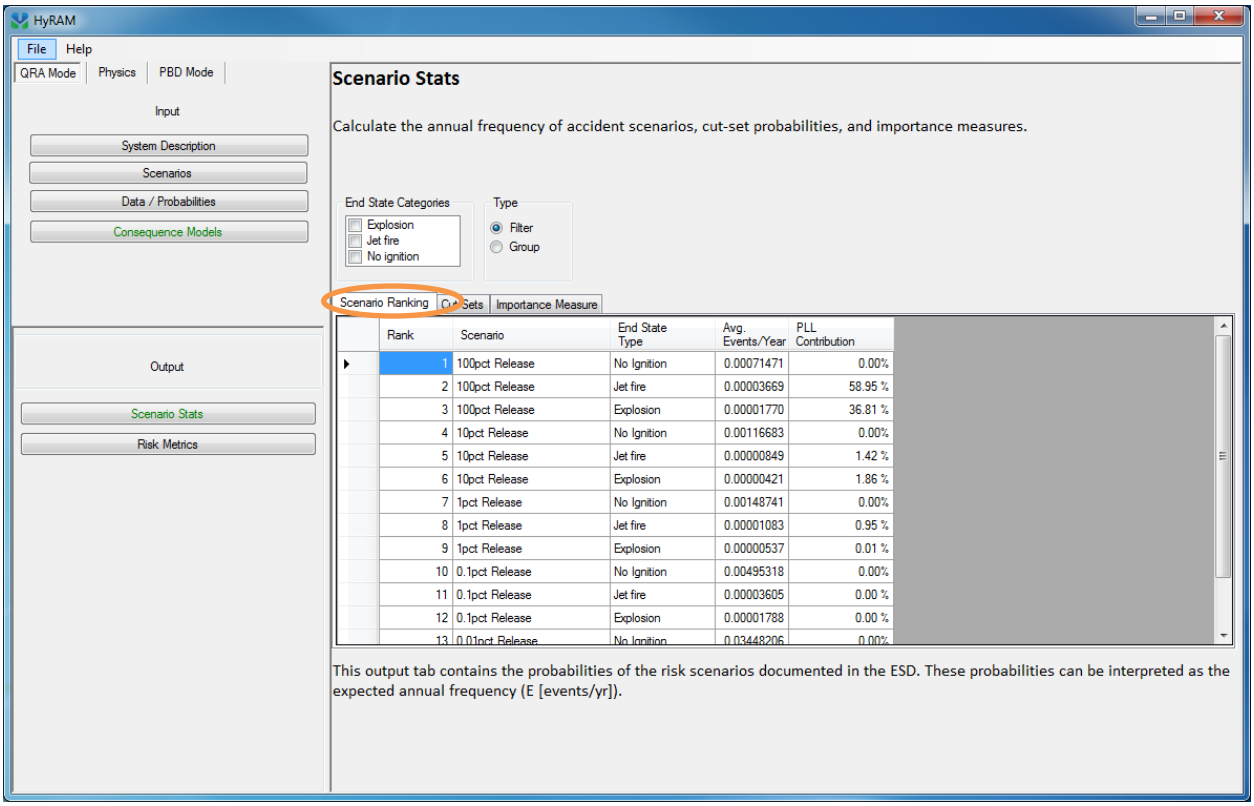
2.5.1 Scenario Stats

To output the scenario stats, click the **Scenario Stats** button. It is circled in **orange:**



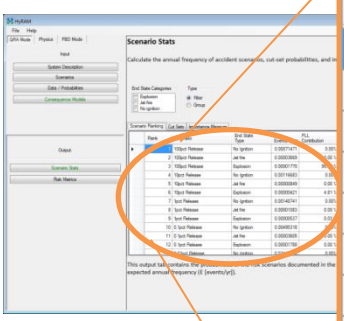
2.5.1.1 Scenario Ranking

To check the results, click the **Scenario Ranking** tab. It is circled in **orange:**



Rank	Scenario	End State Type	Avg. Events/Year	PLL Contribution
1	100pct Release	No Ignition	0.00071471	0.00%
2	100pct Release	Jet fire	0.00003669	58.95 %
3	100pct Release	Explosion	0.00001770	36.81 %
4	10pct Release	No Ignition	0.00116683	0.00%
5	10pct Release	Jet fire	0.00000849	1.42 %
6	10pct Release	Explosion	0.00000421	1.86 %
7	1pct Release	No Ignition	0.00148741	0.00%
8	1pct Release	Jet fire	0.00001083	0.95 %
9	1pct Release	Explosion	0.00000537	0.01 %
10	0.1pct Release	No Ignition	0.00495318	0.00%
11	0.1pct Release	Jet fire	0.00003605	0.00 %
12	0.1pct Release	Explosion	0.00001788	0.00 %
13	0.01pct Release	No Ignition	0.03448206	0.00%

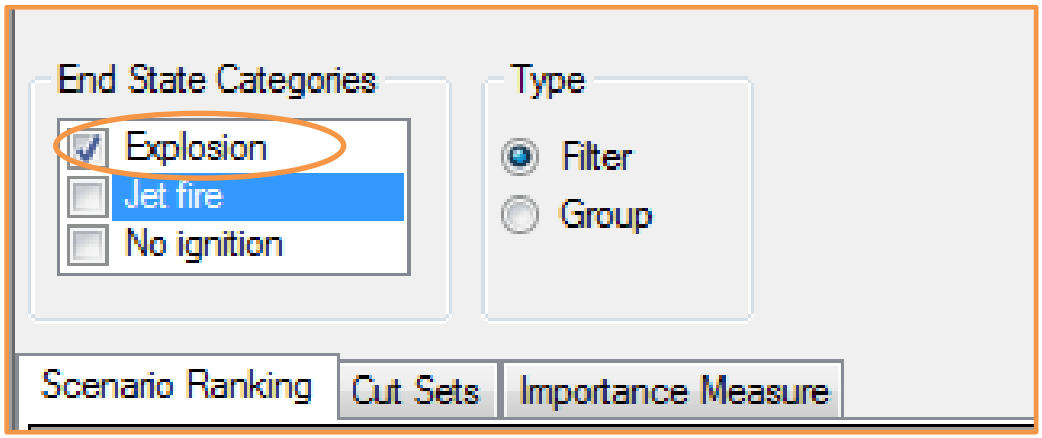
Then compare the received results to the following results:



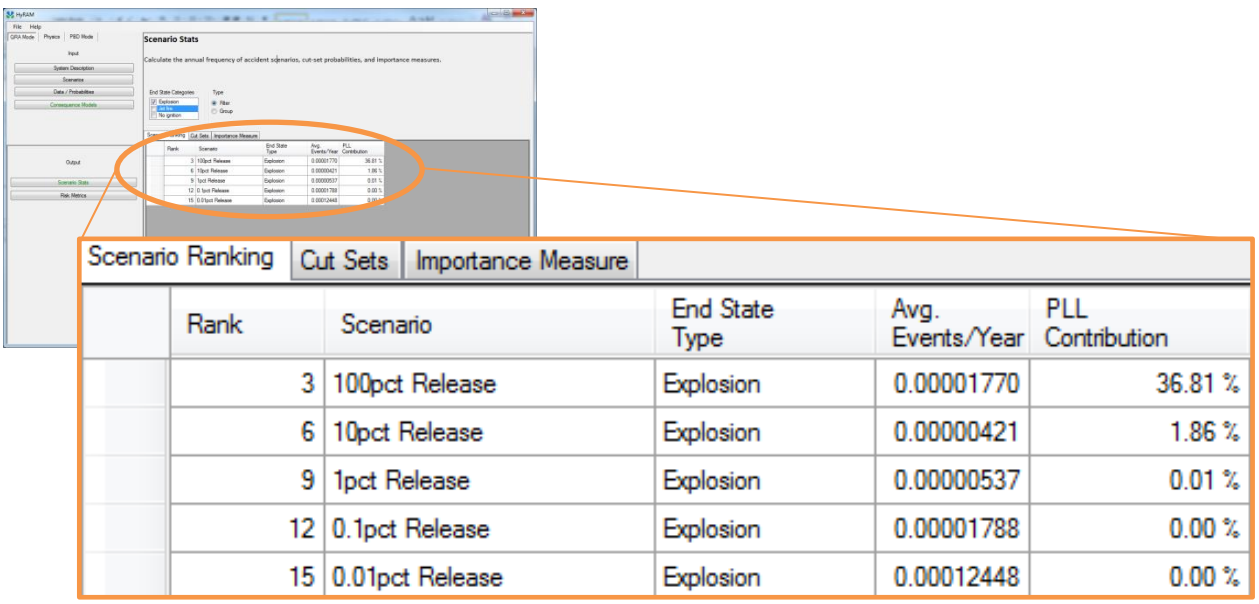
Rank	Scenario	End State Type	Avg. Events/Year	PLL Contribution
1	100pct Release	No Ignition	0.00071471	0.00%
2	100pct Release	Jet fire	0.00003669	58.95 %
3	100pct Release	Explosion	0.00001770	36.81 %
4	10pct Release	No Ignition	0.00116683	0.00%
5	10pct Release	Jet fire	0.00000849	1.42 %
6	10pct Release	Explosion	0.00000421	1.86 %
7	1pct Release	No Ignition	0.00148741	0.00%
8	1pct Release	Jet fire	0.00001083	0.95 %
9	1pct Release	Explosion	0.00000537	0.01 %
10	0.1pct Release	No Ignition	0.00495318	0.00%
11	0.1pct Release	Jet fire	0.00003605	0.00 %
12	0.1pct Release	Explosion	0.00001788	0.00 %
13	0.01pct Release	No Ignition	0.03448206	0.00%

2.5.1.2 Testing the Grouping and Filtering of Results

To filter the results, click the **Explosion** checkbox to filer results to only explosions. The Explosion checkbox is circled in **orange**.



The results will narrow down to the following:



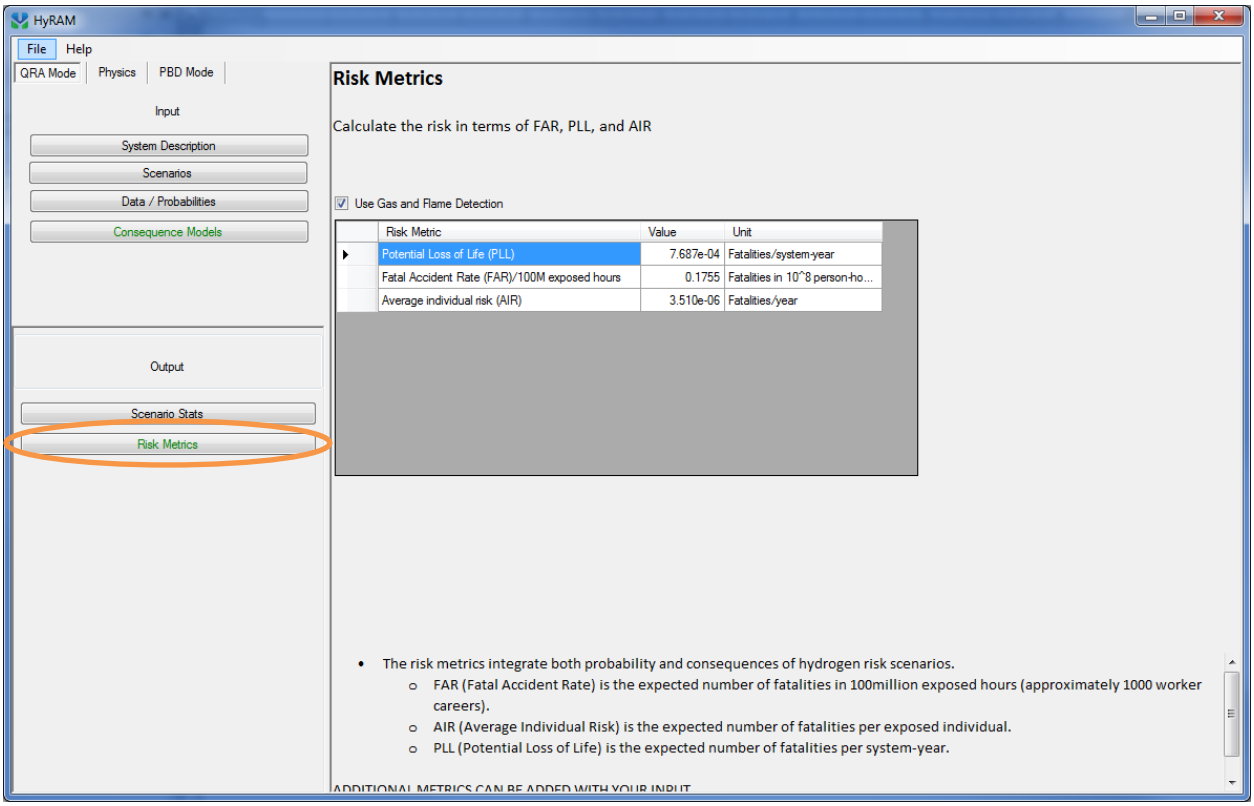
Scenario Ranking | Cut Sets | Importance Measure

Rank	Scenario	End State Type	Avg. Events/Year	PLL Contribution
3	100pct Release	Explosion	0.00001770	36.81 %
6	10pct Release	Explosion	0.00000421	1.86 %
9	1pct Release	Explosion	0.00000537	0.01 %
12	0.1pct Release	Explosion	0.00001788	0.00 %
15	0.01pct Release	Explosion	0.00012448	0.00 %

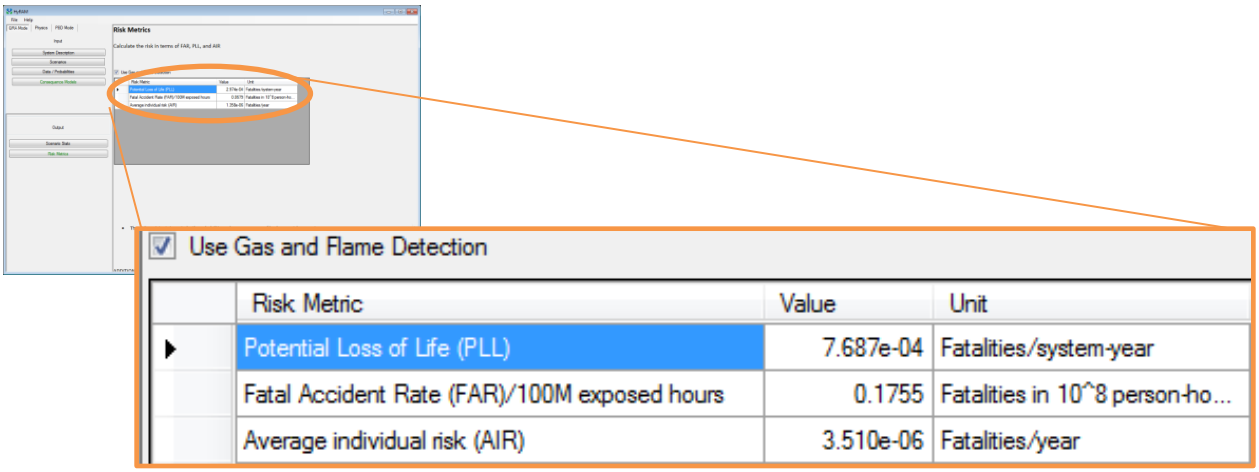
2.5.2 Risk Metrics

2.5.2.1 Gas and Flame Detection Used

To output the risk metrics, click the **Risk Metrics** button. It is circled in **orange:**

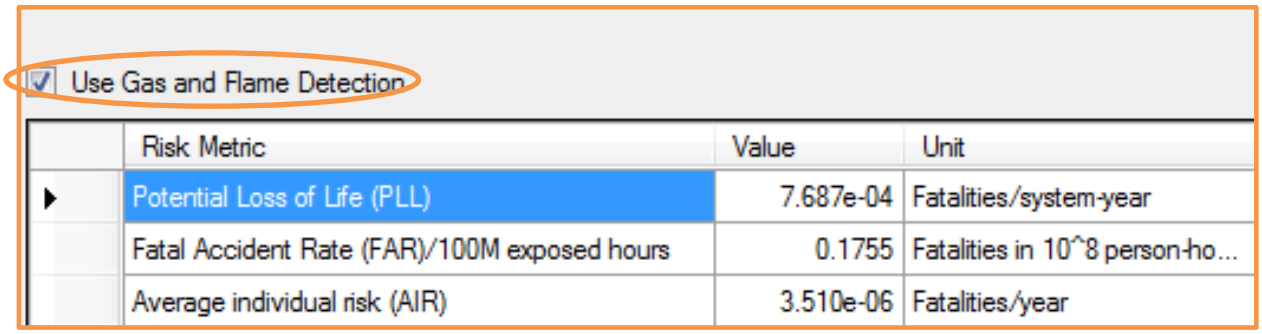


Then compare the received results to the following results:



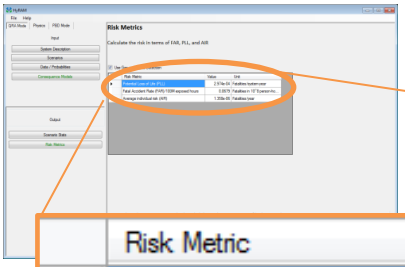
2.5.2.2 Gas and Flame Detection Off

To check the results with Gas and Flam Detection turned off, uncheck the checkbox labeled **Use Gas and Flame Detection**. It is circled in **orange**:



Risk Metric	Value	Unit
Potential Loss of Life (PLL)	7.687e-04	Fatalities/system-year
Fatal Accident Rate (FAR)/100M exposed hours	0.1755	Fatalities in 10^8 person-ho...
Average individual risk (AIR)	3.510e-06	Fatalities/year

Compare the following with the received results with the following:



Risk Metric	Value	Unit
Potential Loss of Life (PLL)	8.541e-04	Fatalities/system-year
Fatal Accident Rate (FAR)/100M exposed hours	0.1950	Fatalities in 10^8 person-ho...
Average individual risk (AIR)	3.900e-06	Fatalities/year

3. PHYSICS MODE

Physics mode is used to simulate hydrogen release and flame physics. To test the Jet Flame feature, first load the workspace titled, *HyRAM Testing Script - Physics Mode.HyRAM*. To accomplish loading the workspace, first go to **File**, then to **Load Workspace**. Then navigate to where the said file is located and click the file. Then click **Open**. The instructions must be precisely followed to ensure proper testing of the application. In addition, the numerical results that are received should be EXACTLY the same as shown in this document.

3.1 Gas Plume Dispersion – Feature Not Ready

Do not evaluate this section. Please move onto the next section

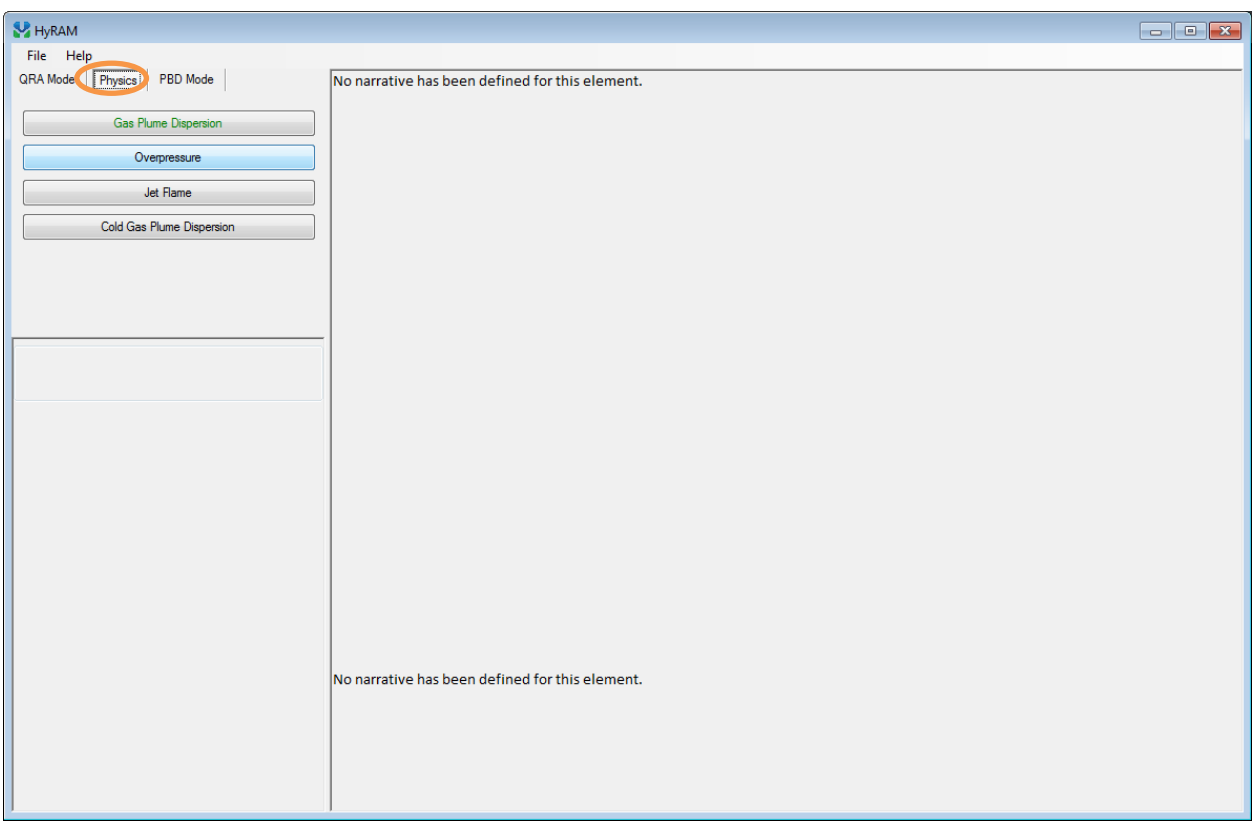
3.2 Overpressure – Feature Not Ready

Do not evaluate this section. Please move onto the next section

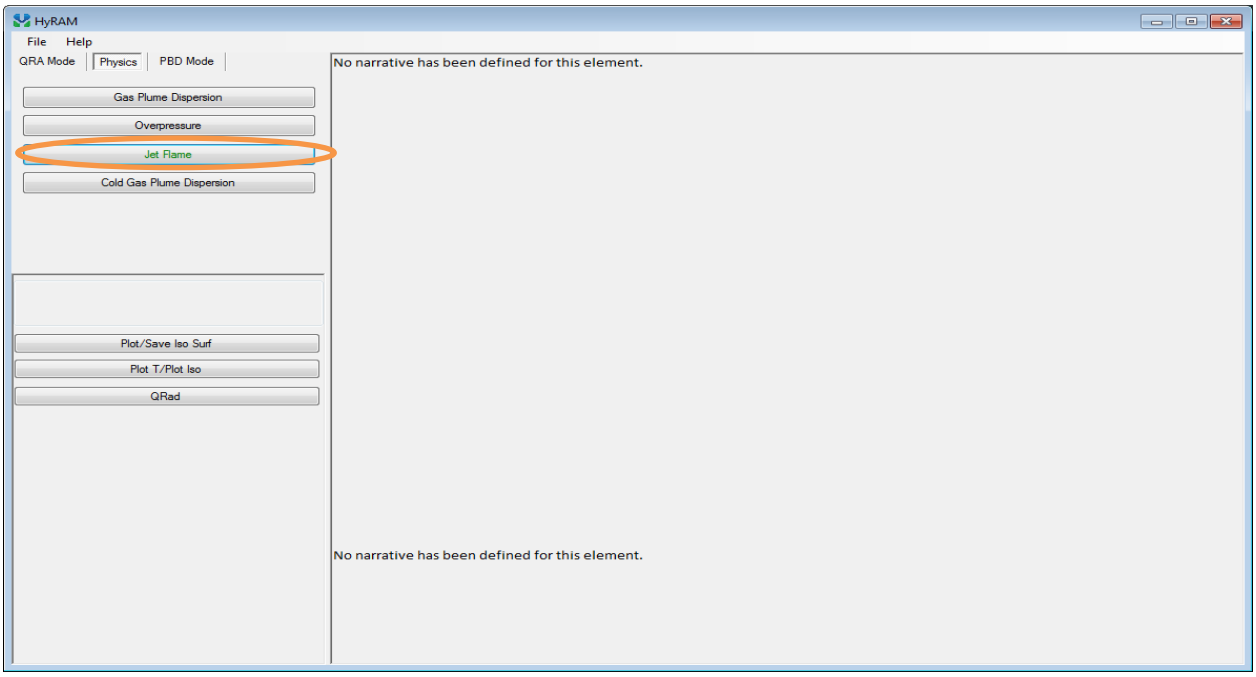
3.3 Jet Flame

3.3.1 Edit Plot T/Plot ISO Parameters

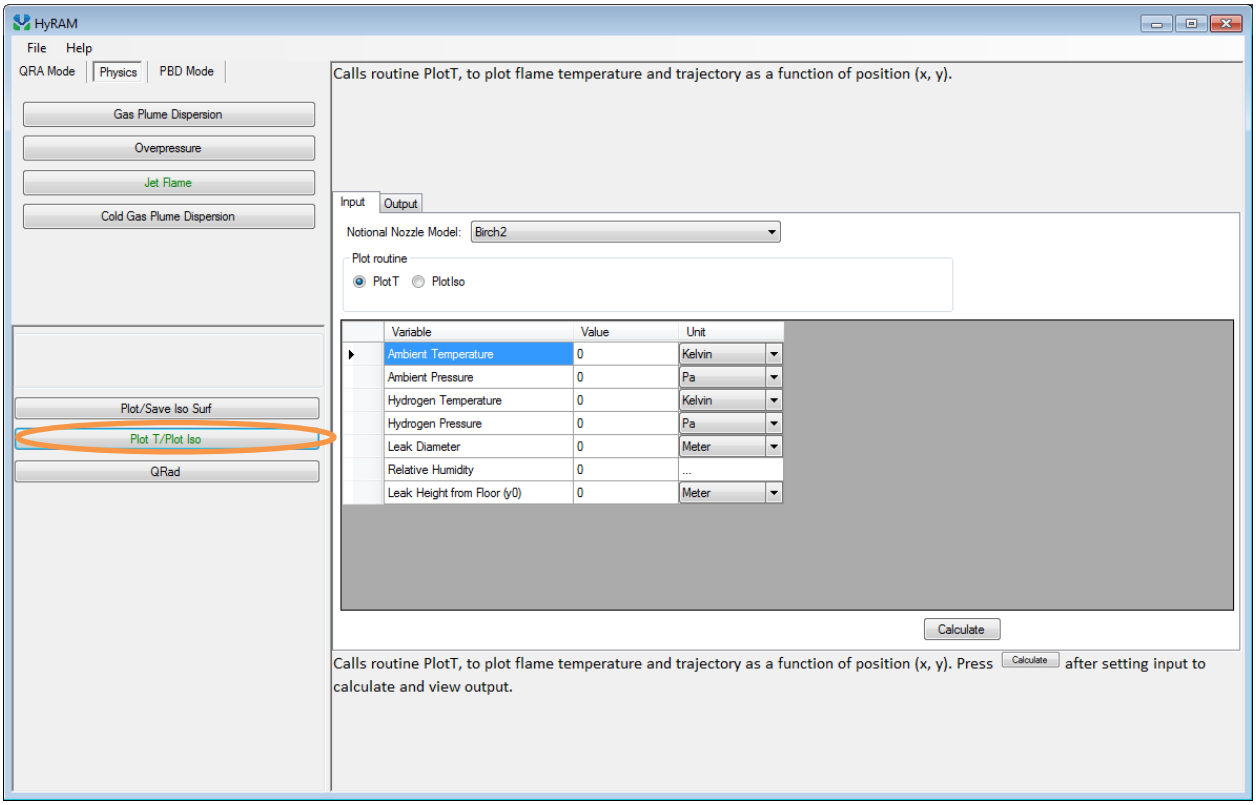
To start editing the Jet Flame parameters, first click the tab labeled **Physics**. It is circled in **orange**.



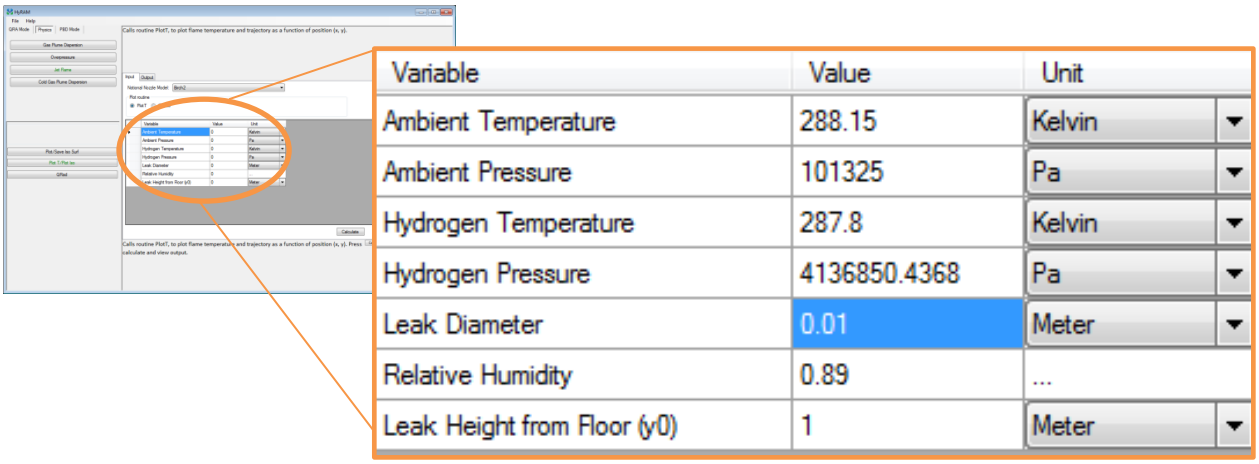
Then, select **Jet Flame**. It is circled in **orange**.



Then, select **Plot T/Plot Iso**. It is circled in **orange**.



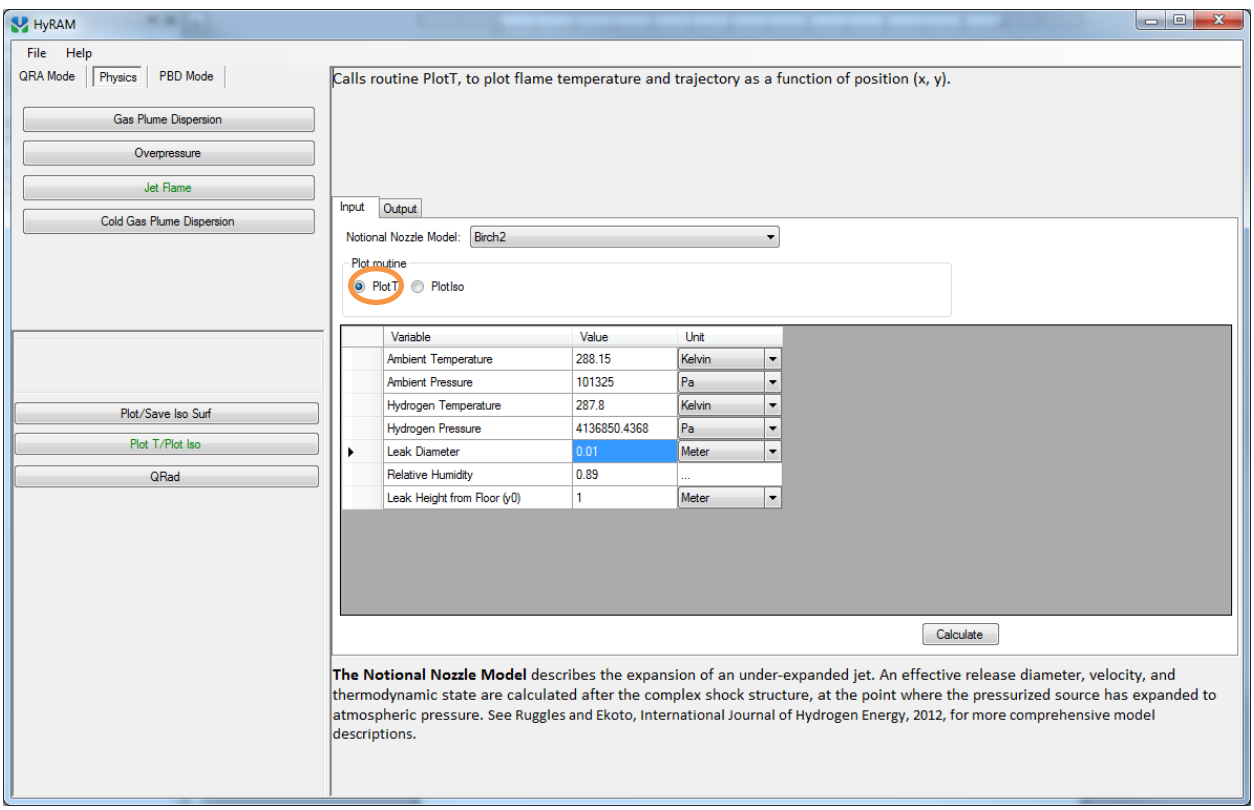
When that screen opens, continue to edit the values in the table to reflect the following:



Variable	Value	Unit
Ambient Temperature	288.15	Kelvin
Ambient Pressure	101325	Pa
Hydrogen Temperature	287.8	Kelvin
Hydrogen Pressure	4136850.4368	Pa
Leak Diameter	0.01	Meter
Relative Humidity	0.89	...
Leak Height from Floor (y0)	1	Meter

3.3.2 Output Results – PlotT

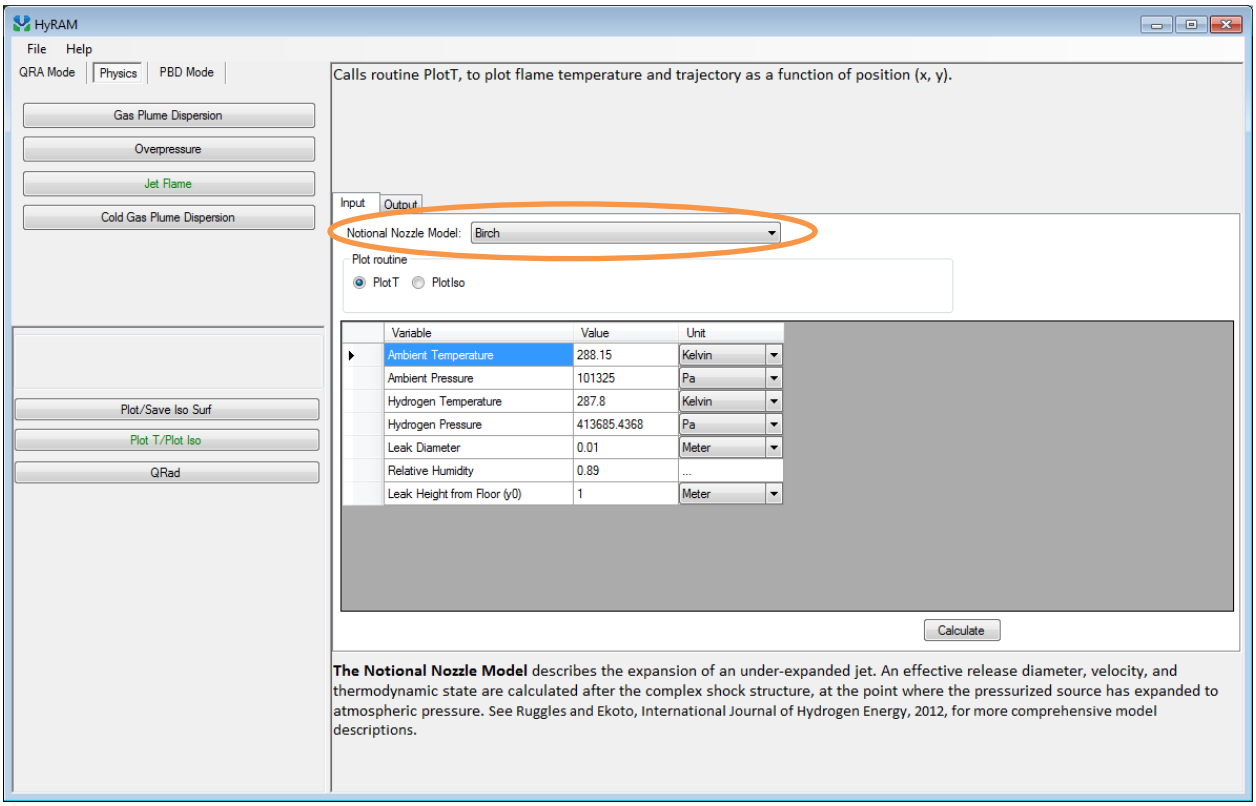
Before outputting the results for multiple models, the plot routine needs to be set as **PlotT**. To set the plot routine, click the radio button labeled **PlotT**. It is circled in **orange** below:



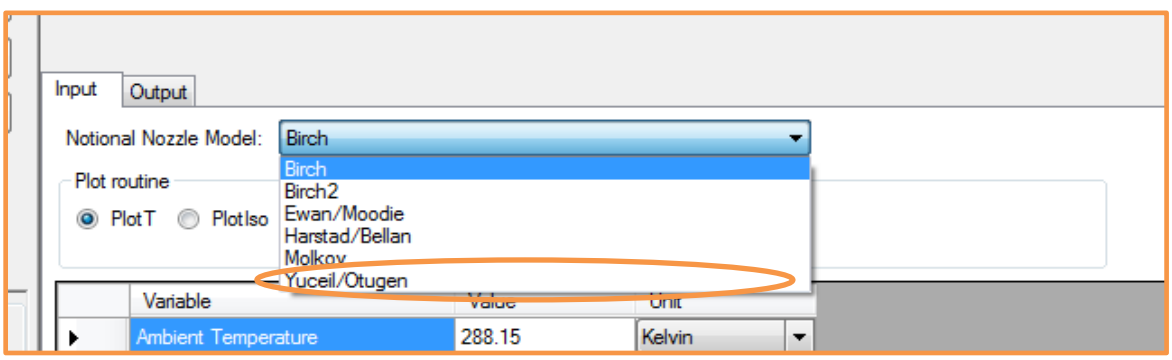
Now that the proper plot routine has been set, the outputs of multiple models must be checked.

3.3.2.1 Yuceil/Otugen Notional Nozzle Model

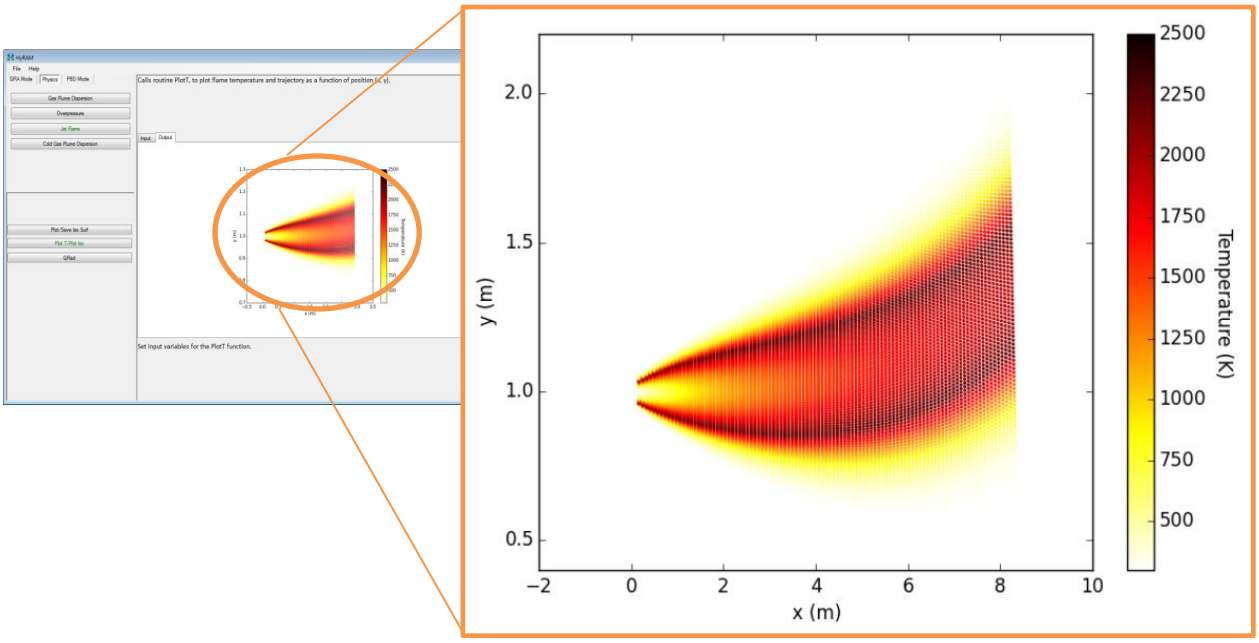
Check to make sure that the Notional Nozzle Model is set to **Yuceil/Otugen**. The location for the combo box is circled in **orange**.



Click the combo box and then select **Yuceil/Otugen**. **Yuceil/Otugen** is circled in **orange** below:



Then, to check the output, click **Calculate**. It is circled in **orange**. It may take a minute to finish the calculation. When it is finished calculating, the following should be displayed:

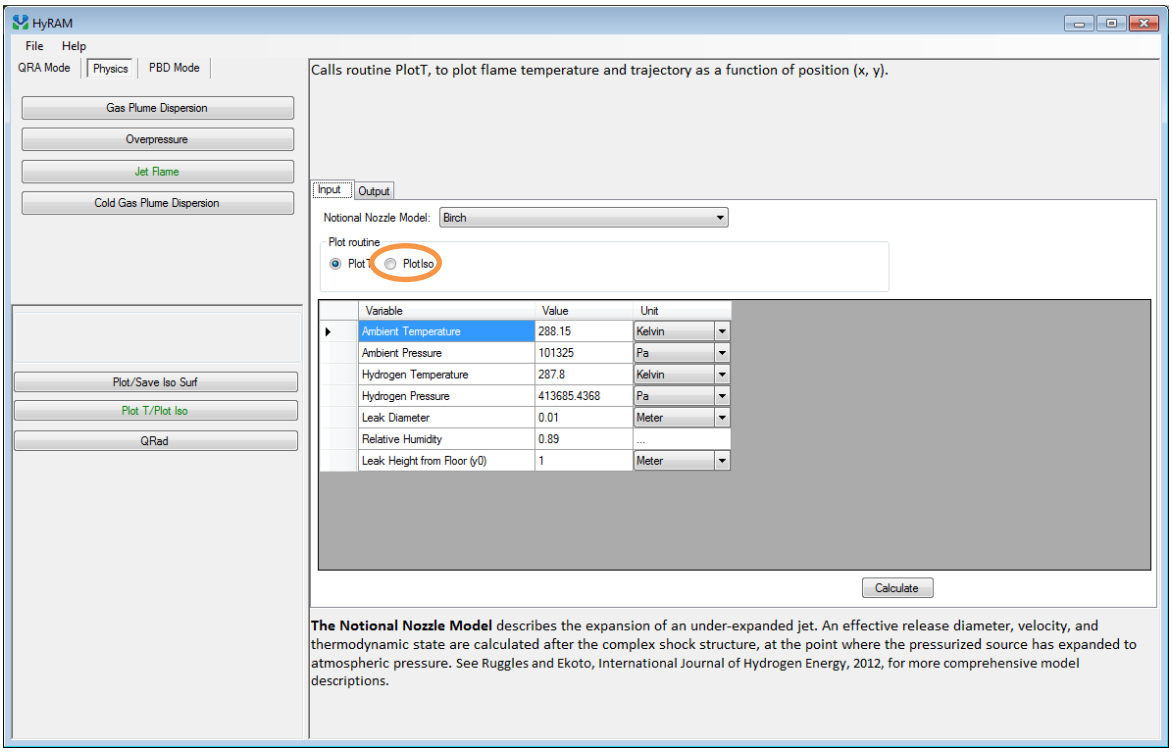


Compare the images. If the results does not match the image above, please see the last page in this document.

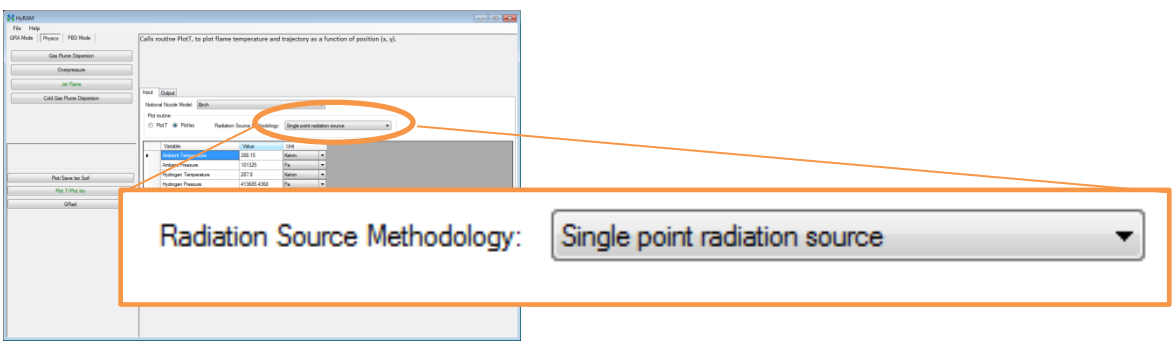
3.3.3 Output Results – PlotIso

3.3.3.1 Single Point Radiation Source

Before outputting the results for multiple models, the plot routine needs to be set as **PlotIso**. To set the plot routine, click the radio button labeled **PlotIso**. It is circled in **orange** below:

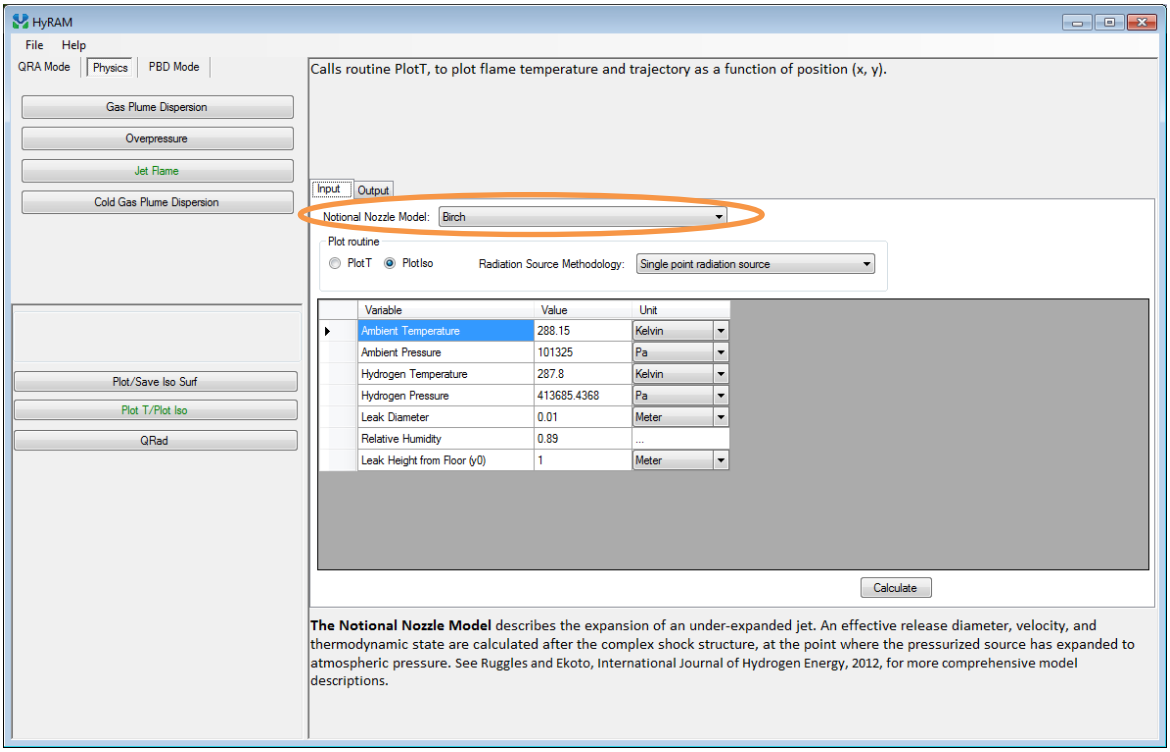


Then, check to make sure **Single point radiation source** is the selected option. It is circled in **orange** below:

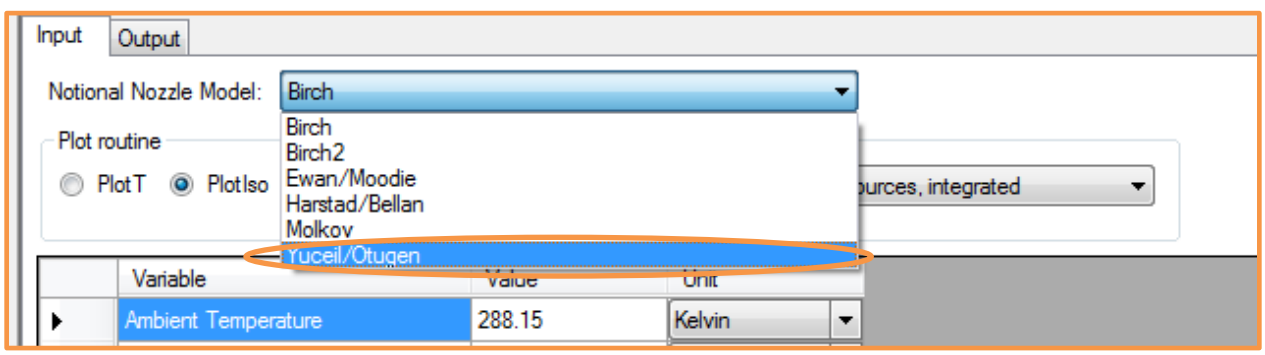


3.3.3.1.1 Yuceil/Otugen Notional Nozzle Model

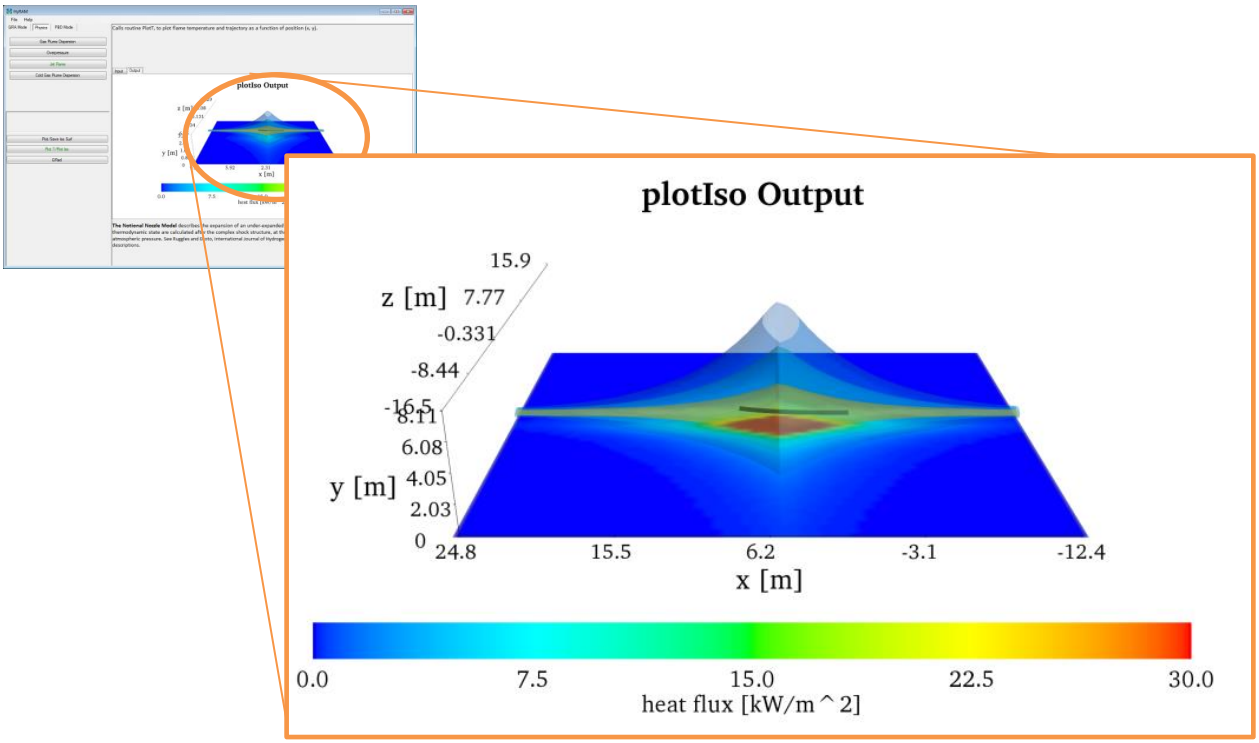
Check to make sure that the Notional Nozzle Model is set to **Yuceil/Otugen**. The location for the combo box is circled in **orange**.



Click the combo box and then select **Yuceil/Otugen**. **Yuceil/Otugen** is circled in **orange** below:



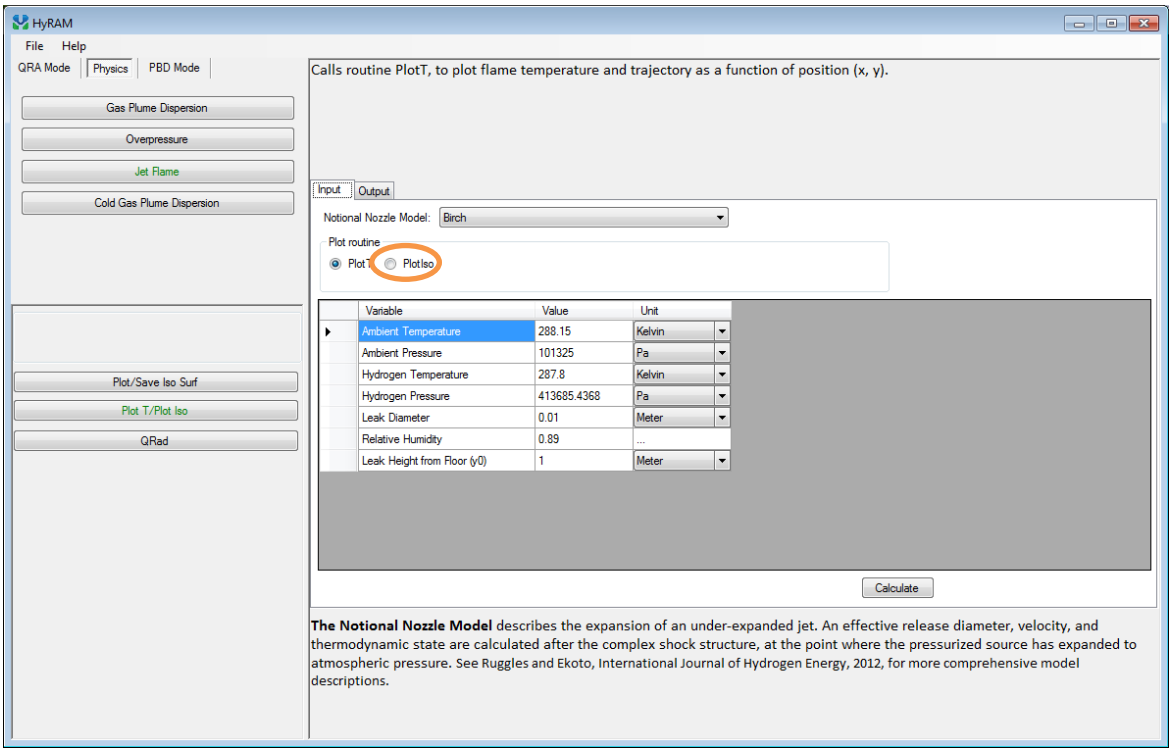
Then, to check the output, click **Calculate**. It may take a minute to finish the calculation. When it is finished calculating, the following should be displayed:



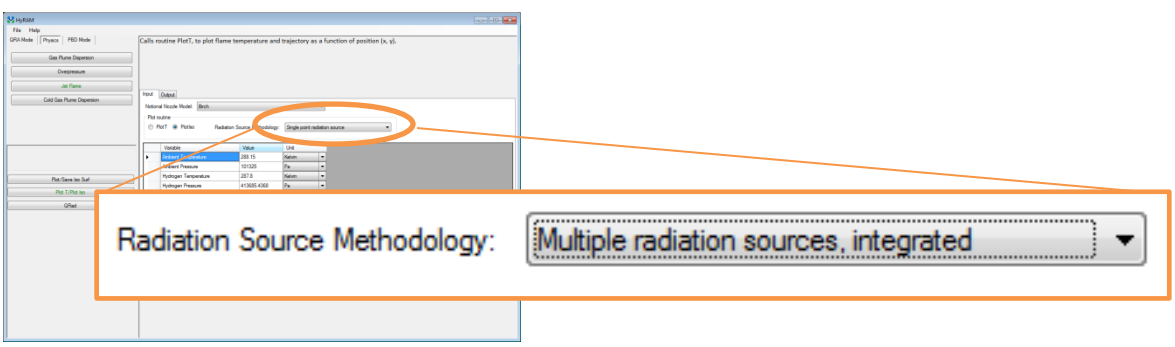
Compare the images. If the results does not match the image above, please see the last page in this document.

3.3.3.2 Multiple Radiation Sources, Integrated

Before outputting the results for multiple models, the plot routine needs to be set as **PlotIso**. To set the plot routine, click the radio button labeled **PlotIso**. It is circled in **orange** below:

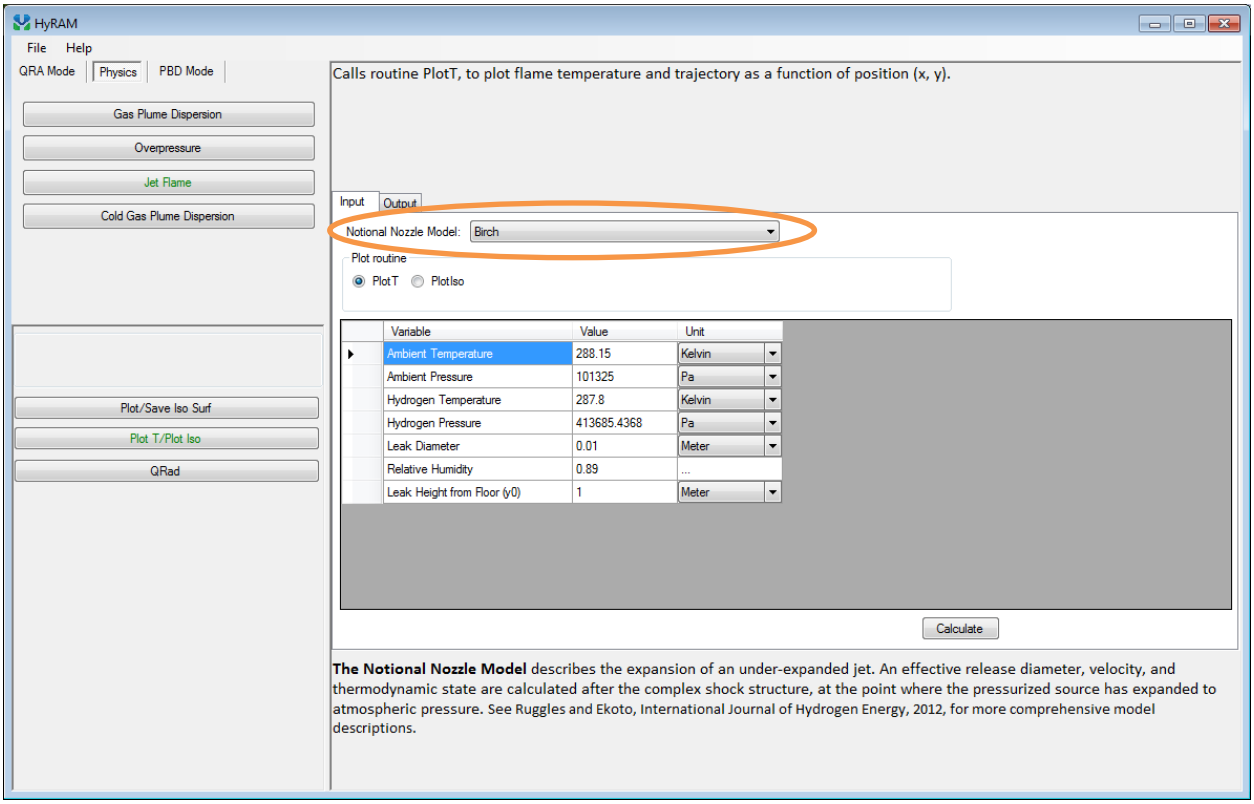


Then, check to make sure **Multiple radation srouces, integrated** is the selected option. It is circled in **orange** below:

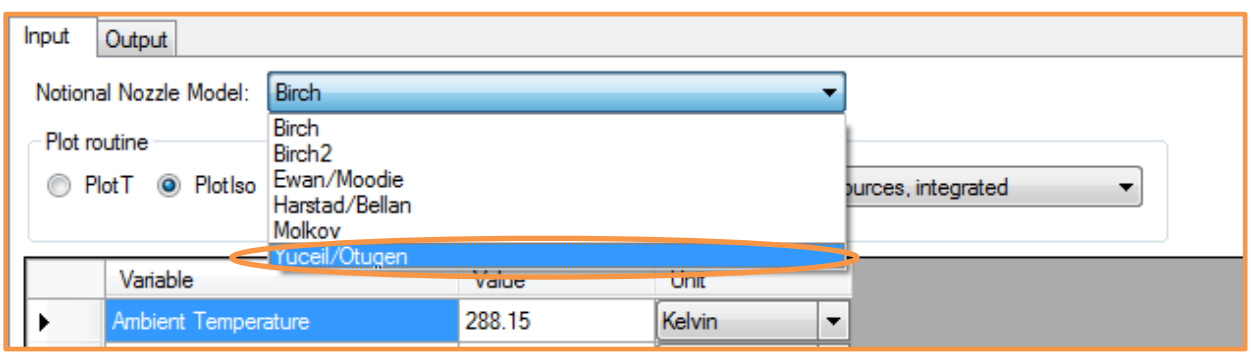


3.3.3.2.1 Yuceil/Otugen Notional Nozzle Model

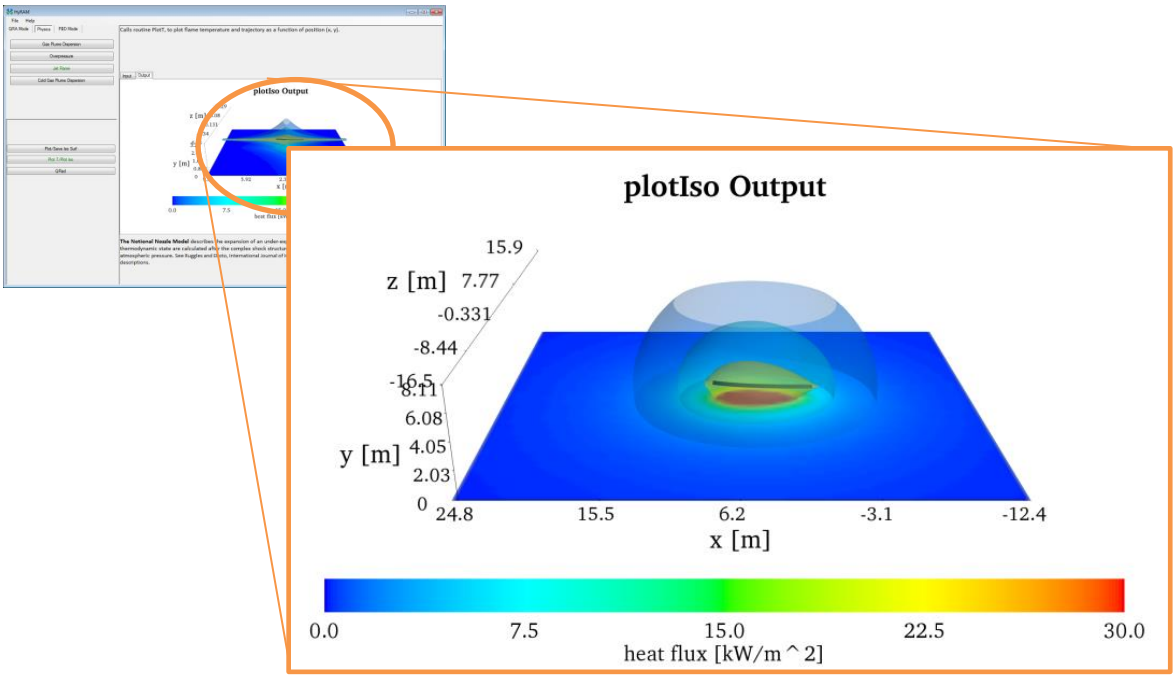
Check to make sure that the Notional Nozzle Model is set to **Yuceil/Otugen**. The location for the combo box is circled in **orange**.



Click the combo box and then select **Yuceil/Otugen**. **Yuceil/Otugen** is circled in **orange** below:



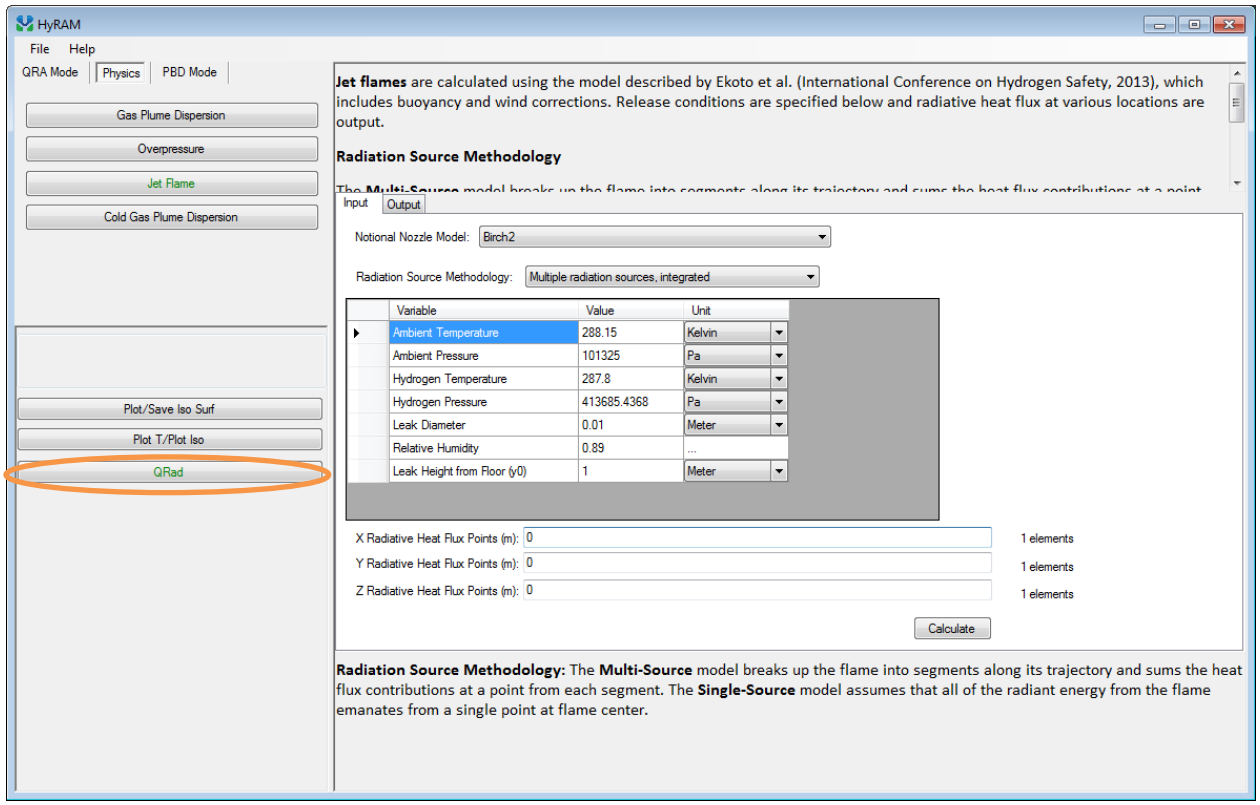
Then, to check the output, click **Calculate**. It may take a minute to finish the calculation. When it is finished calculating, the following should be displayed:



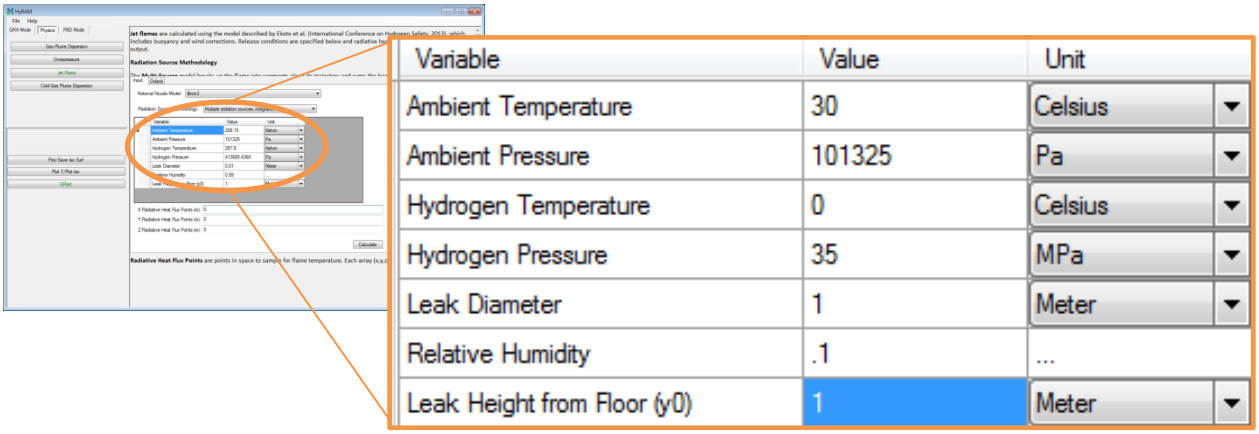
Compare the images. If the results does not match the image above, please see the last page in this document.

3.3.4 Edit QRad Parameters

To start editing the QRad Parameters, click the **QRad** button. It is circled in **orange**.

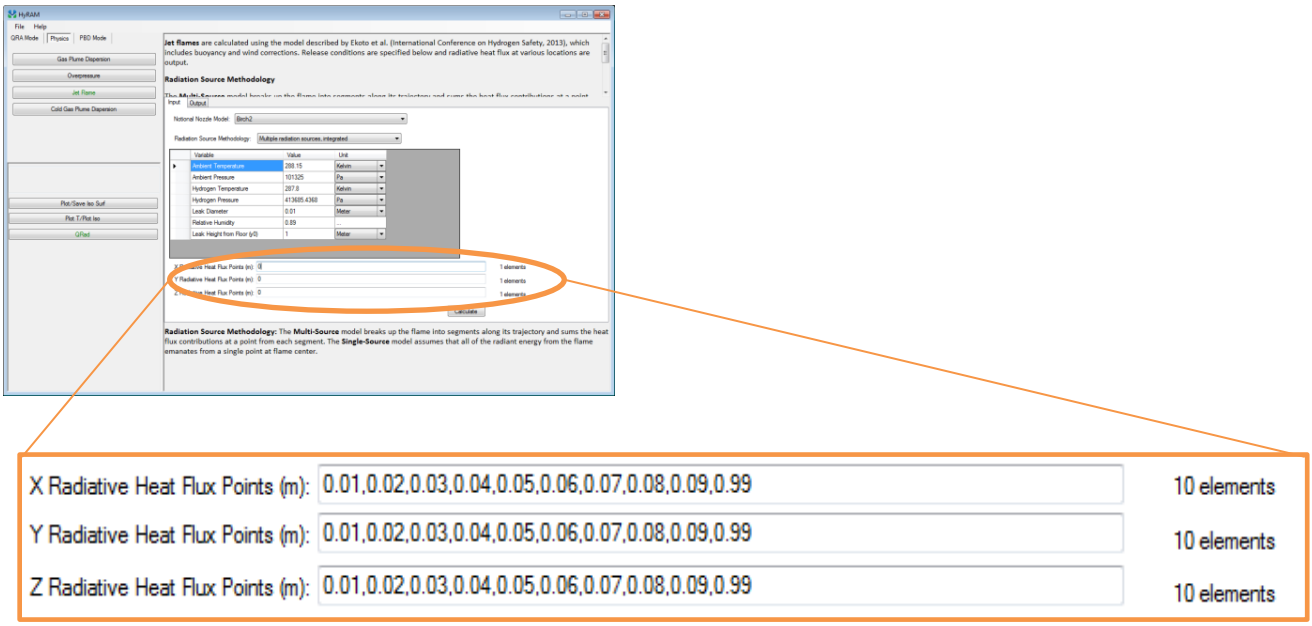


Then, check to make sure that the table reflects the following:



Variable	Value	Unit
Ambient Temperature	30	Celsius
Ambient Pressure	101325	Pa
Hydrogen Temperature	0	Celsius
Hydrogen Pressure	35	MPa
Leak Diameter	1	Meter
Relative Humidity	.1	...
Leak Height from Floor (y0)	1	Meter

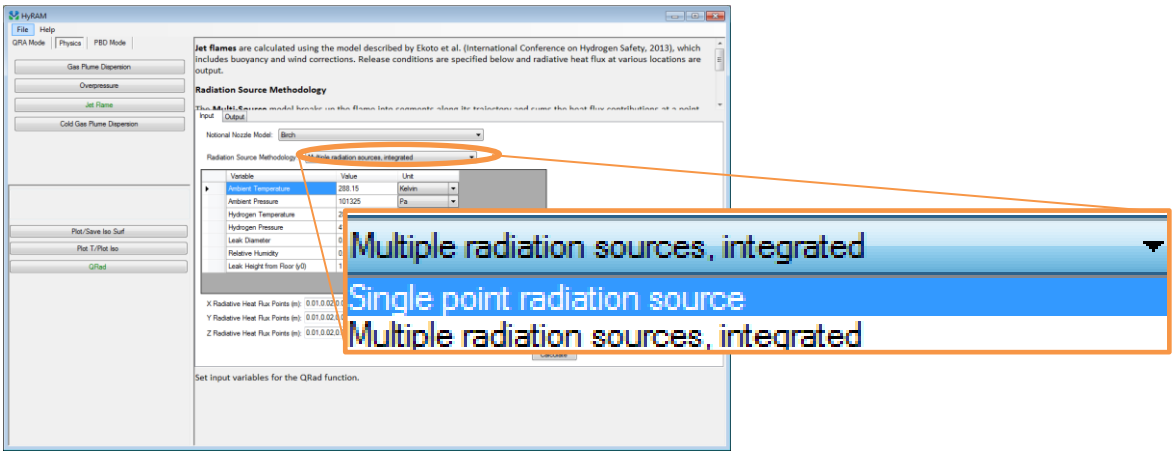
Then, edit the flux points to reflect the following. The flux points' textboxes are circled in **orange**.



3.3.5 Output Results

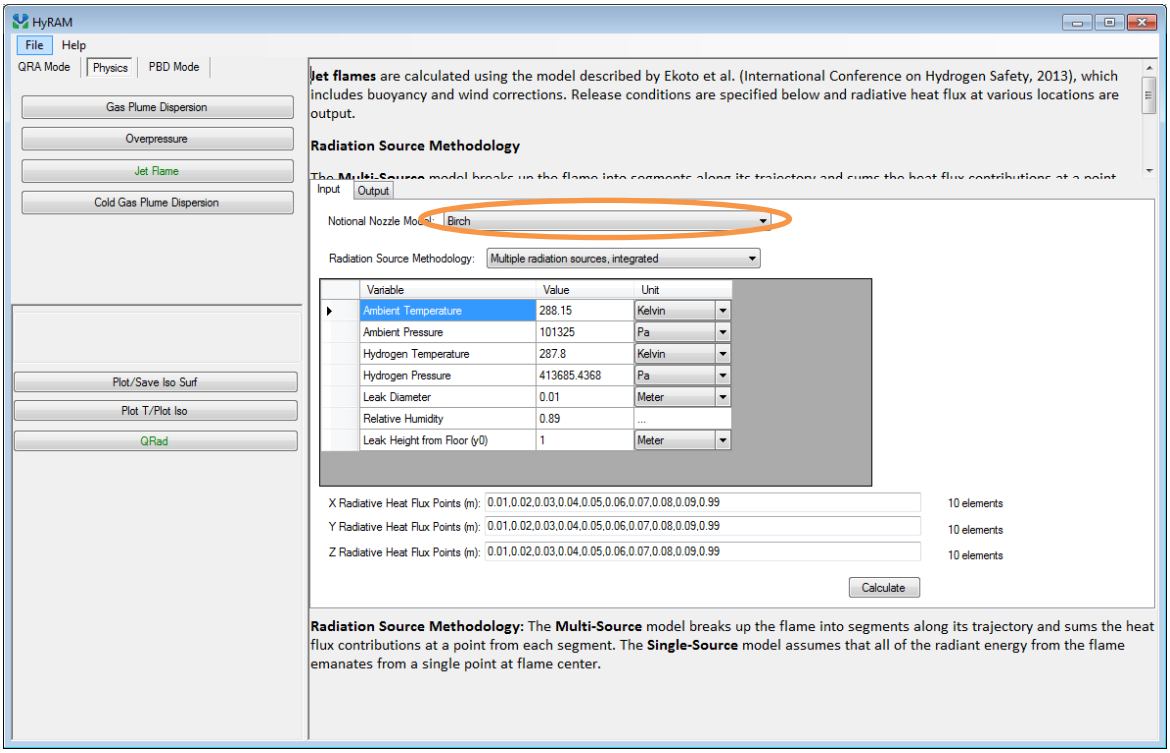
3.3.5.1 Single Point Radiation Source

Before outputting the results for multiple models, the plot routine needs to be set as **Single point radiation source**. To set the plot routine, click the combo box and then click **Single point radiation source**. The combo box is circled in **orange** below:

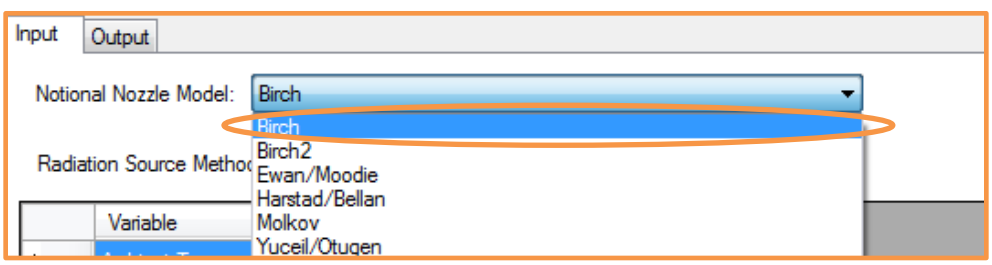


3.3.5.1.1 Birch Notional Nozzle Model

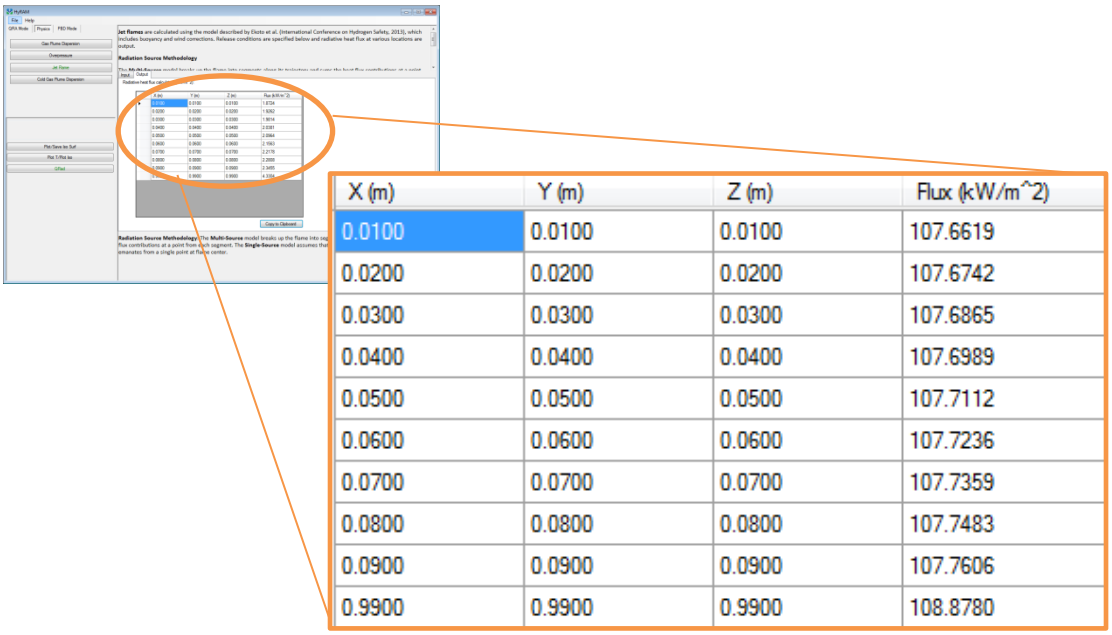
Check to make sure that the Notional Nozzle Model is set to **Birch**. The location for the combo box is circled in **orange**.



Click the combo box and then select **Birch**. **Birch** is circled in **orange** below:



Then, to check the output, click **Calculate**. It may take a minute to finish the calculation. When it is finished calculating, the following should be displayed:

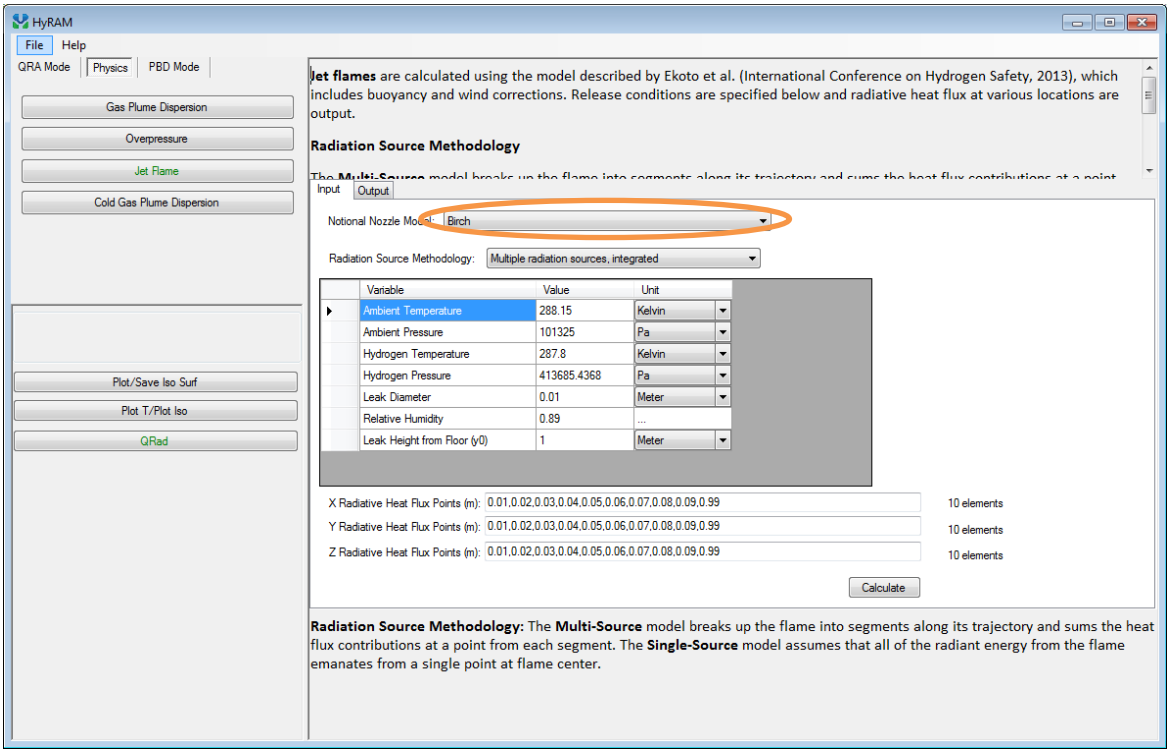


X (m)	Y (m)	Z (m)	Flux (kW/m^2)
0.0100	0.0100	0.0100	107.6619
0.0200	0.0200	0.0200	107.6742
0.0300	0.0300	0.0300	107.6865
0.0400	0.0400	0.0400	107.6989
0.0500	0.0500	0.0500	107.7112
0.0600	0.0600	0.0600	107.7236
0.0700	0.0700	0.0700	107.7359
0.0800	0.0800	0.0800	107.7483
0.0900	0.0900	0.0900	107.7606
0.9900	0.9900	0.9900	108.8780

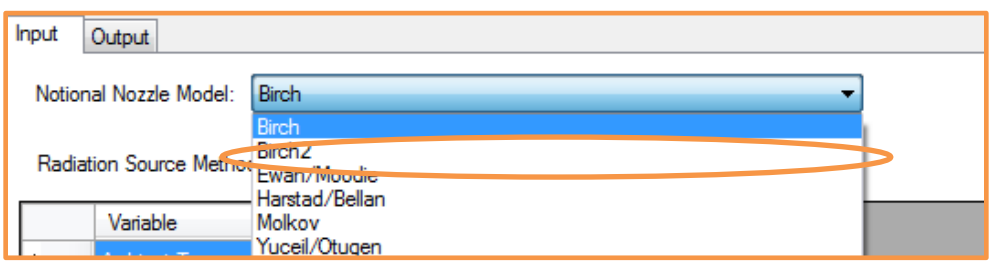
Compare the images. If the results does not match the image above, please see the last page in this document.

3.3.5.1.2 Birch2 Notional Nozzle Model

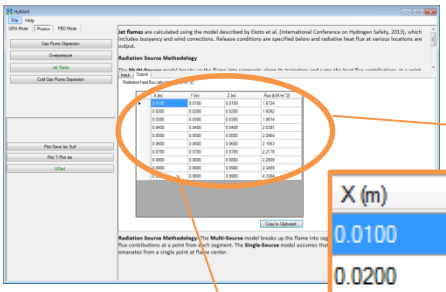
Check to make sure that the Notional Nozzle Model is set to **Birch2**. The location for the combo box is circled in **orange**.



Click the combo box and then select **Birch2**. **Birch2** is circled in **orange** below:



Then, to check the output, click **Calculate**. It may take a minute to finish the calculation. When it is finished calculating, the following should be displayed:

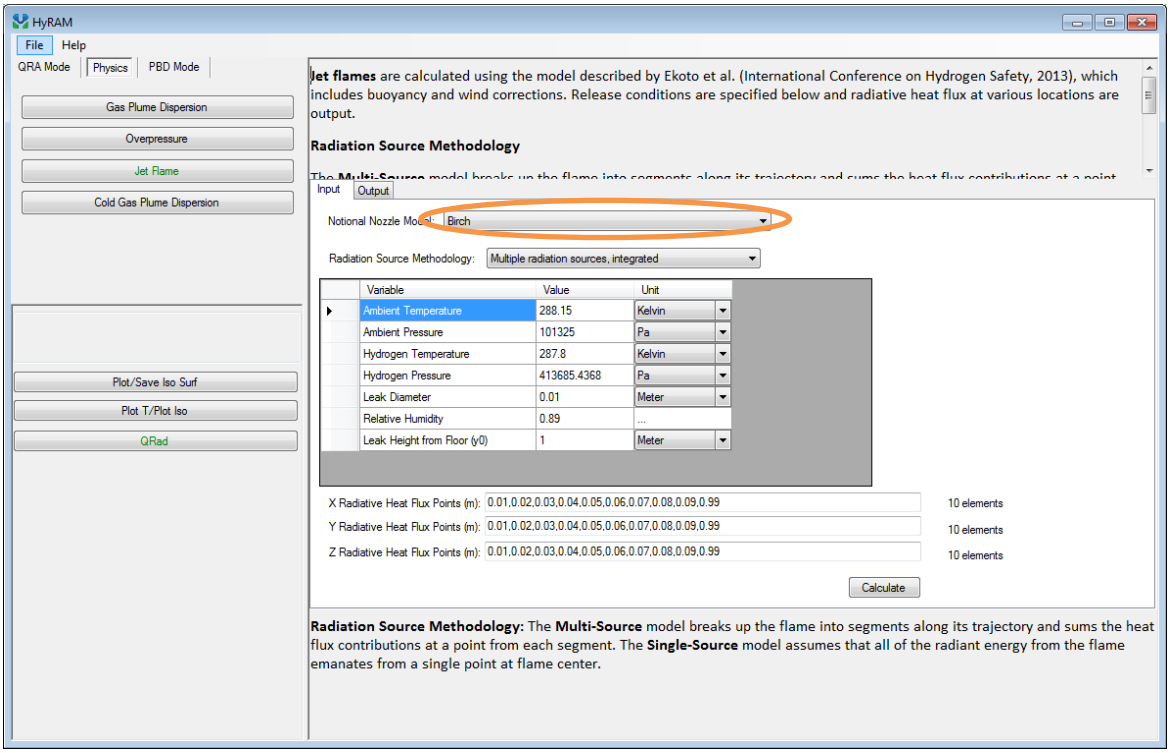


X (m)	Y (m)	Z (m)	Flux (kW/m^2)
0.0100	0.0100	0.0100	274.6325
0.0200	0.0200	0.0200	274.6792
0.0300	0.0300	0.0300	274.7259
0.0400	0.0400	0.0400	274.7725
0.0500	0.0500	0.0500	274.8192
0.0600	0.0600	0.0600	274.8659
0.0700	0.0700	0.0700	274.9126
0.0800	0.0800	0.0800	274.9593
0.0900	0.0900	0.0900	275.0061
0.9900	0.9900	0.9900	279.2436

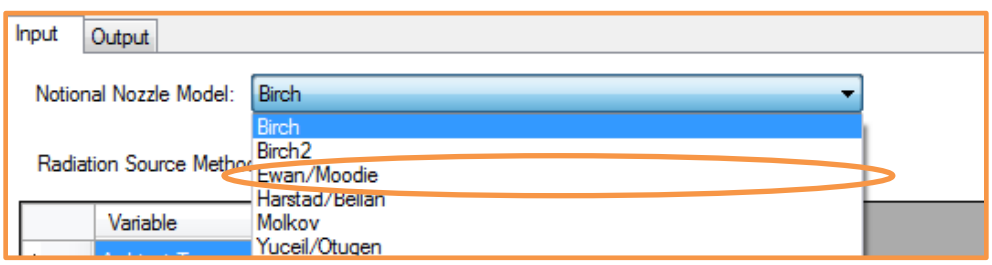
Compare the images. If the results does not match the image above, please see the last page in this document.

3.3.5.1.3 Ewan/Moodie Notional Nozzle Model

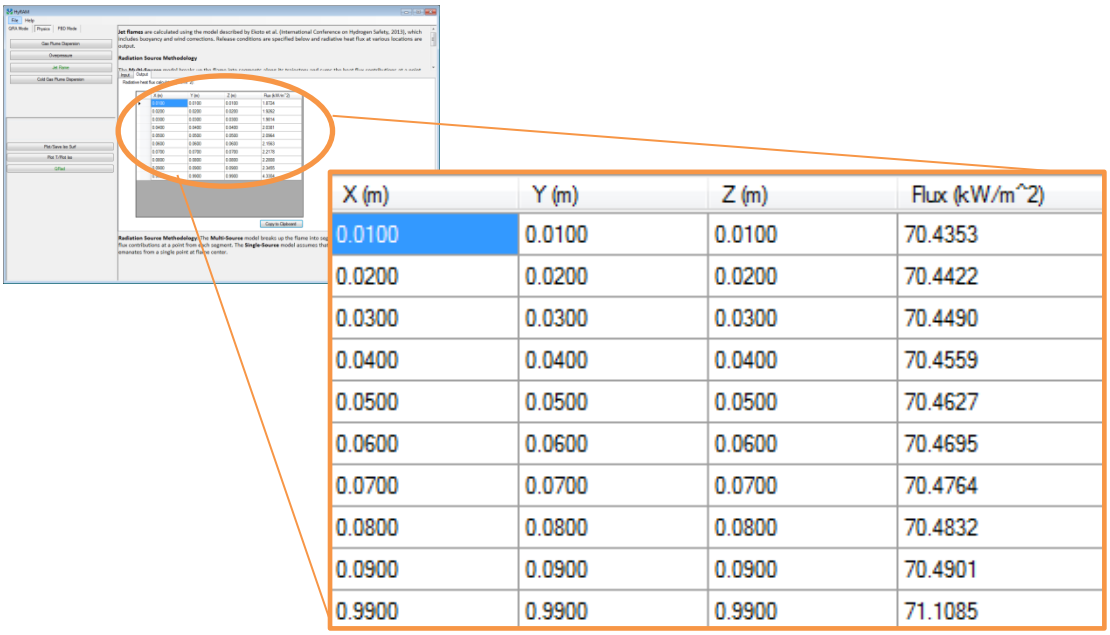
Check to make sure that the Notional Nozzle Model is set to **Ewan/Moodie**. The location for the combo box is circled in **orange**.



Click the combo box and then select **Ewan/Moodie**. **Ewan/Moodie** is circled in **orange** below:



Then, to check the output, click **Calculate**. It may take a minute to finish the calculation. When it is finished calculating, the following should be displayed:

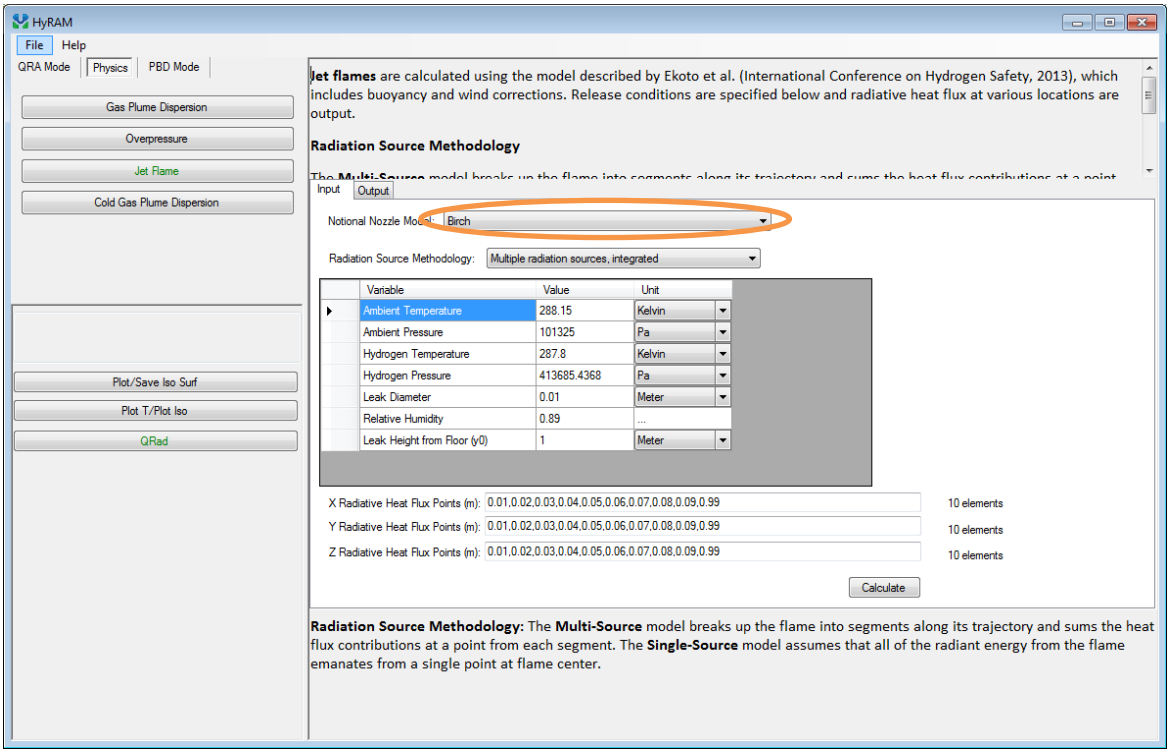


X (m)	Y (m)	Z (m)	Flux (kW/m^2)
0.0100	0.0100	0.0100	70.4353
0.0200	0.0200	0.0200	70.4422
0.0300	0.0300	0.0300	70.4490
0.0400	0.0400	0.0400	70.4559
0.0500	0.0500	0.0500	70.4627
0.0600	0.0600	0.0600	70.4695
0.0700	0.0700	0.0700	70.4764
0.0800	0.0800	0.0800	70.4832
0.0900	0.0900	0.0900	70.4901
0.9900	0.9900	0.9900	71.1085

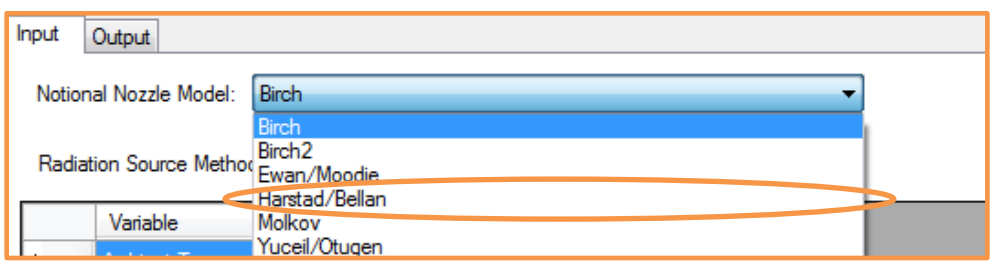
Compare the images. If the results does not match the image above, please see the last page in this document.

3.3.5.1.4 Harstad/Bellan Notional Nozzle Model

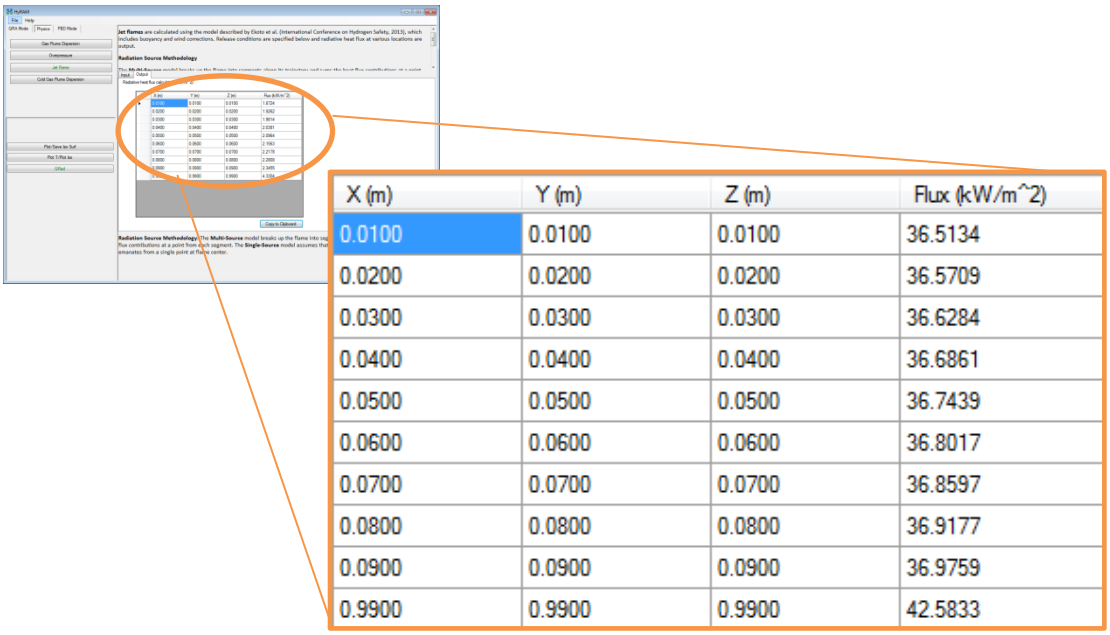
Check to make sure that the Notional Nozzle Model is set to **Harstad/Bellan**. The location for the combo box is circled in **orange**.



Click the combo box and then select **Harstad/Bellan**. **Harstad/Bellan** is circled in **orange** below:



Then, to check the output, click **Calculate**. It may take a minute to finish the calculation. When it is finished calculating, the following should be displayed:

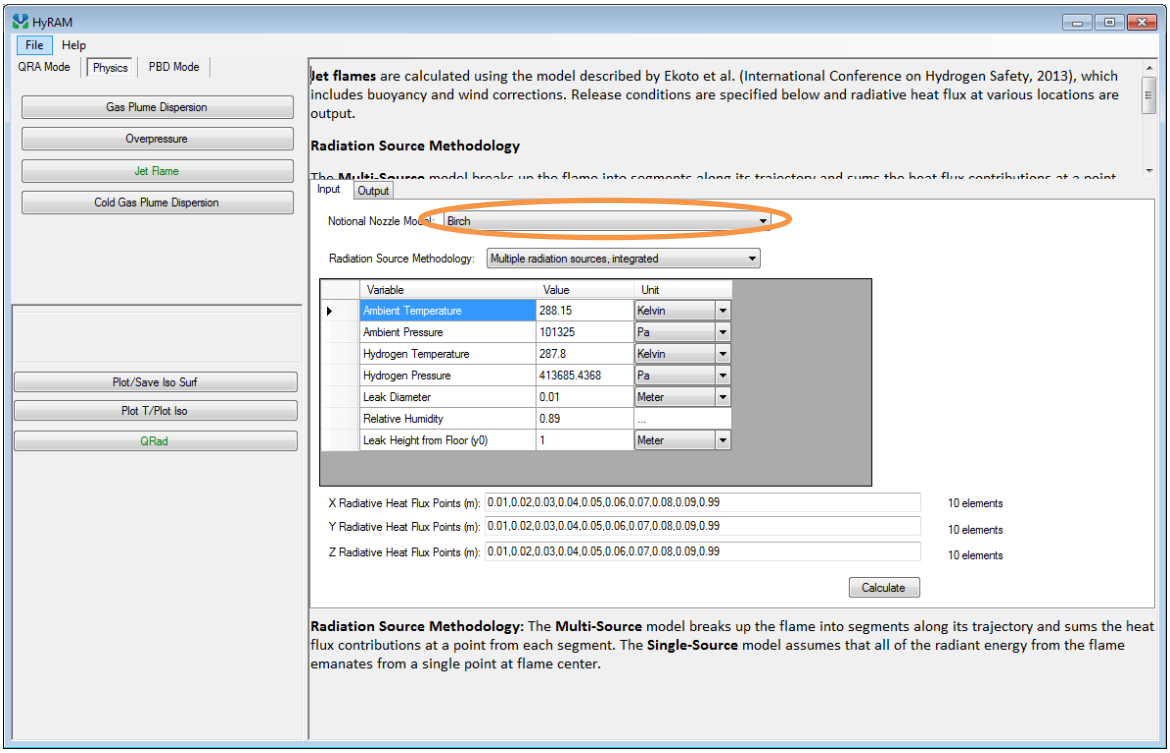


X (m)	Y (m)	Z (m)	Flux (kW/m^2)
0.0100	0.0100	0.0100	36.5134
0.0200	0.0200	0.0200	36.5709
0.0300	0.0300	0.0300	36.6284
0.0400	0.0400	0.0400	36.6861
0.0500	0.0500	0.0500	36.7439
0.0600	0.0600	0.0600	36.8017
0.0700	0.0700	0.0700	36.8597
0.0800	0.0800	0.0800	36.9177
0.0900	0.0900	0.0900	36.9759
0.9900	0.9900	0.9900	42.5833

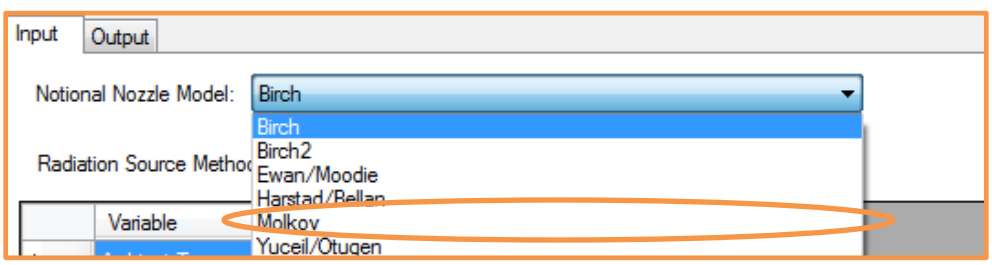
Compare the images. If the results does not match the image above, please see the last page in this document.

3.3.5.1.5 Molkov Notional Nozzle Model

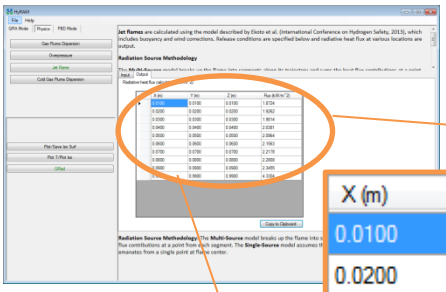
Check to make sure that the Notional Nozzle Model is set to **Molkov**. The location for the combo box is circled in **orange**.



Click the combo box and then select **Molkov**. **Molkov** is circled in **orange** below:



Then, to check the output, click **Calculate**. It may take a minute to finish the calculation. When it is finished calculating, the following should be displayed:

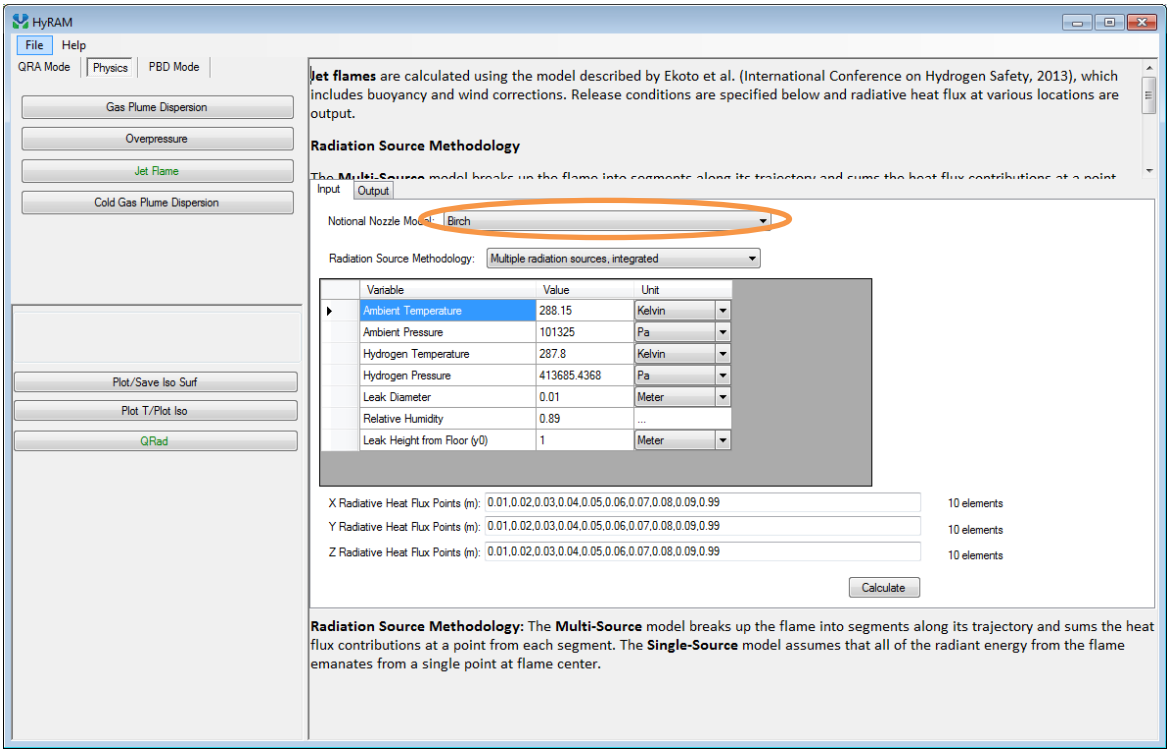


X (m)	Y (m)	Z (m)	Flux (kW/m^2)
0.0100	0.0100	0.0100	75.0869
0.0200	0.0200	0.0200	75.0944
0.0300	0.0300	0.0300	75.1018
0.0400	0.0400	0.0400	75.1093
0.0500	0.0500	0.0500	75.1168
0.0600	0.0600	0.0600	75.1243
0.0700	0.0700	0.0700	75.1317
0.0800	0.0800	0.0800	75.1392
0.0900	0.0900	0.0900	75.1467
0.9900	0.9900	0.9900	75.8224

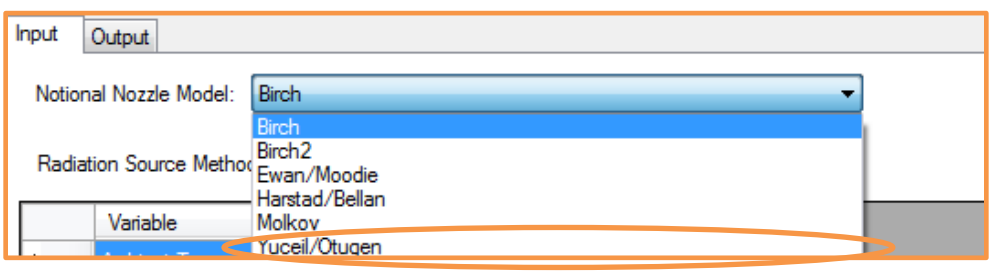
Compare the images. If the results does not match the image above, please see the last page in this document.

3.3.5.1.6 Yuceil/Otugen Notional Nozzle Model

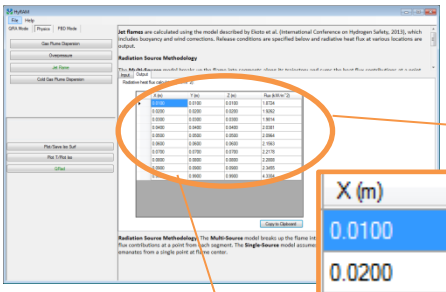
Check to make sure that the Notional Nozzle Model is set to **Yuceil/Otugen**. The location for the combo box is circled in **orange**.



Click the combo box and then select **Yuceil/Otugen**. **Yuceil/Otugen** is circled in **orange** below:



Then, to check the output, click **Calculate**. It may take a minute to finish the calculation. When it is finished calculating, the following should be displayed:

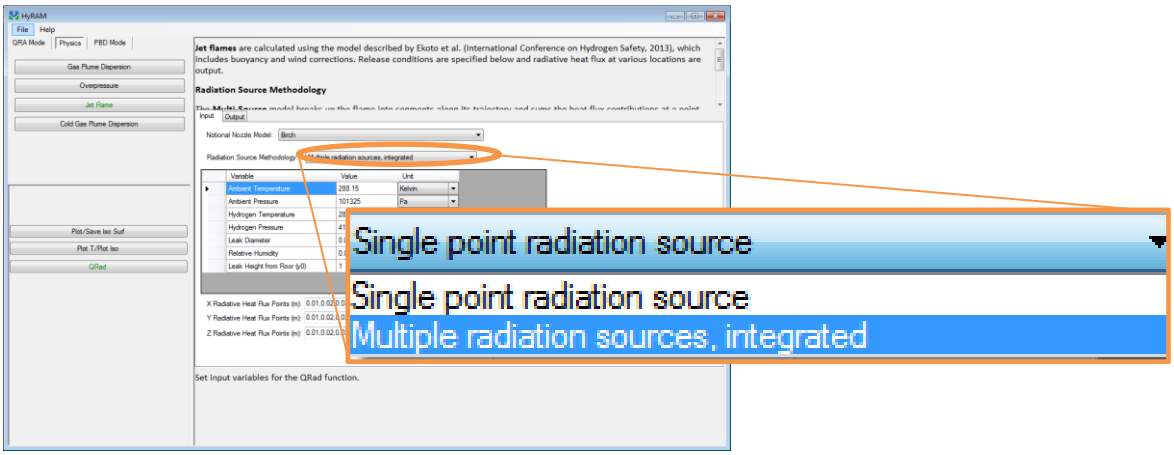


X (m)	Y (m)	Z (m)	Flux (kW/m^2)
0.0100	0.0100	0.0100	105.2708
0.0200	0.0200	0.0200	105.2828
0.0300	0.0300	0.0300	105.2948
0.0400	0.0400	0.0400	105.3068
0.0500	0.0500	0.0500	105.3188
0.0600	0.0600	0.0600	105.3308
0.0700	0.0700	0.0700	105.3428
0.0800	0.0800	0.0800	105.3548
0.0900	0.0900	0.0900	105.3668
0.9900	0.9900	0.9900	106.4530

Compare the images. If the results does not match the image above, please see the last page in this document.

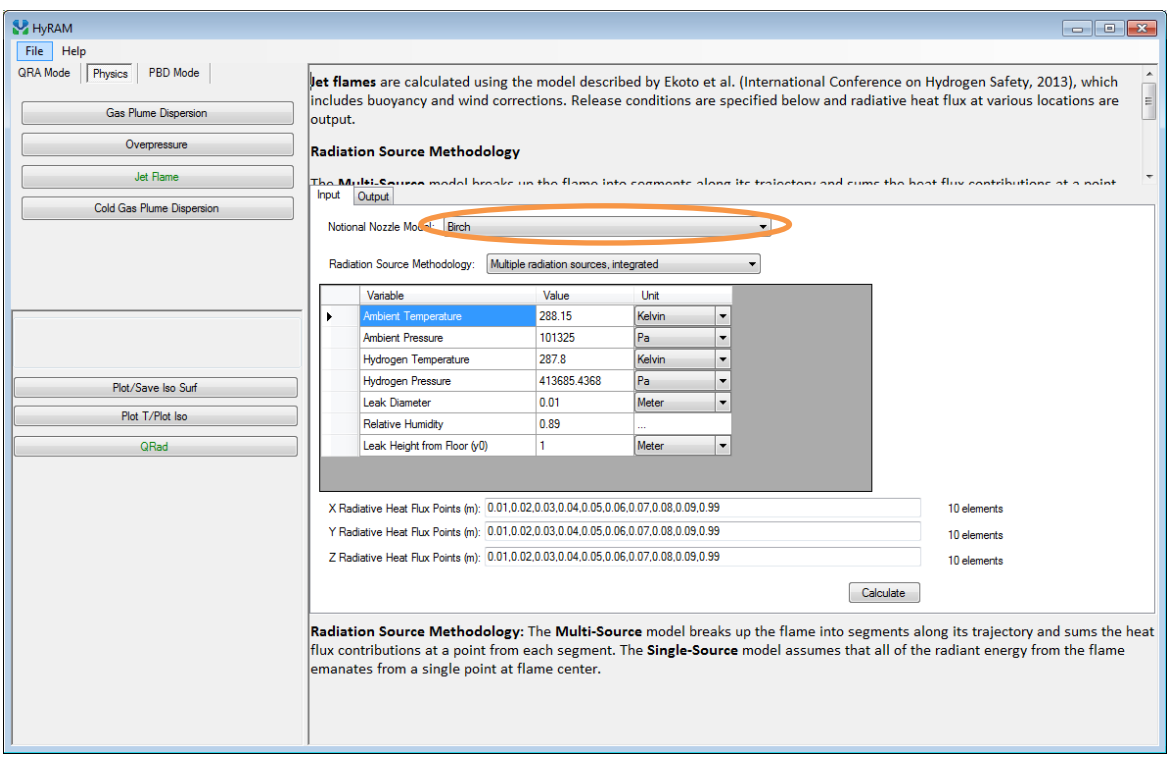
3.3.5.2 Multiple Radiation Sources, Integrated

Before outputting the results for multiple models, the plot routine needs to be set as **Multiple radiation sources, integrated**. To set the plot routine, click the combo box and then click **Multiple radiation sources, integrated**. The combo box is circled in **orange** below:

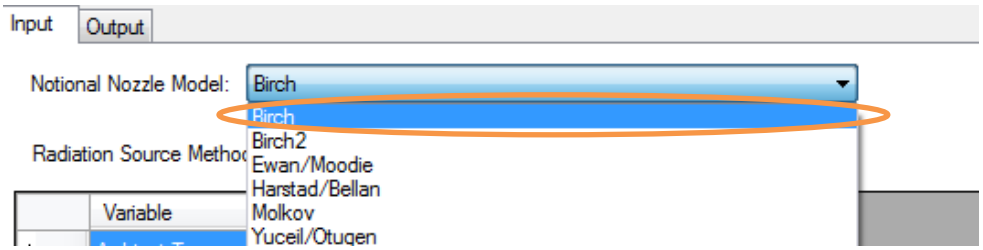


3.3.5.2.1 Birch Notional Nozzle Model

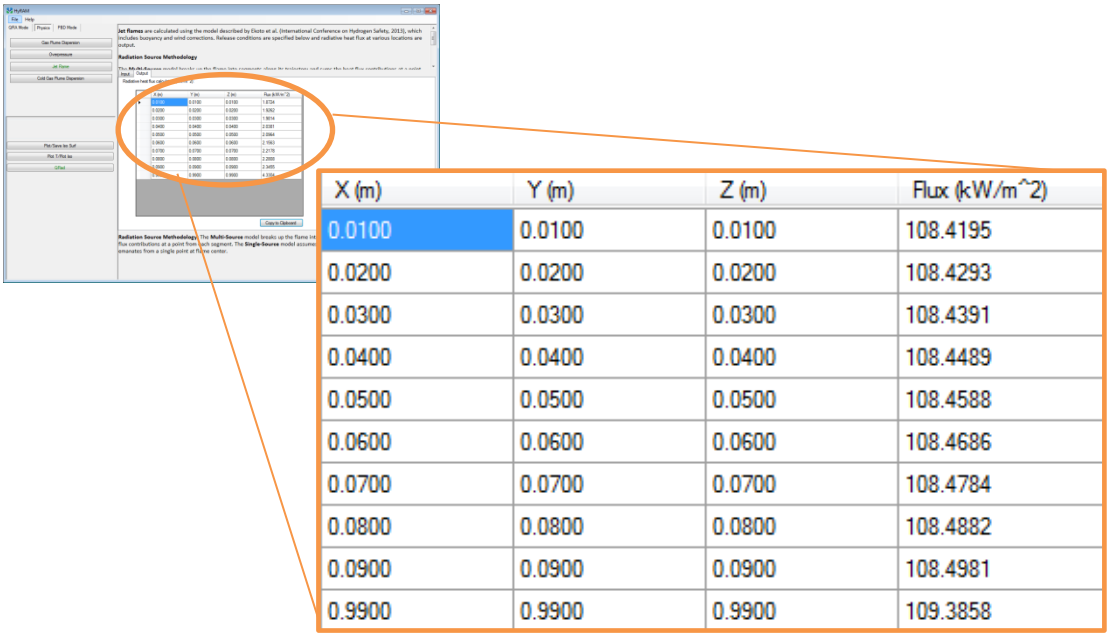
Check to make sure that the Notional Nozzle Model is set to **Birch**. The location for the combo box is circled in **orange**.



Click the combo box and then select **Birch**. **Birch** is circled in **orange** below:



Then, to check the output, click **Calculate**. It may take a minute to finish the calculation. When it is finished calculating, the following should be displayed:

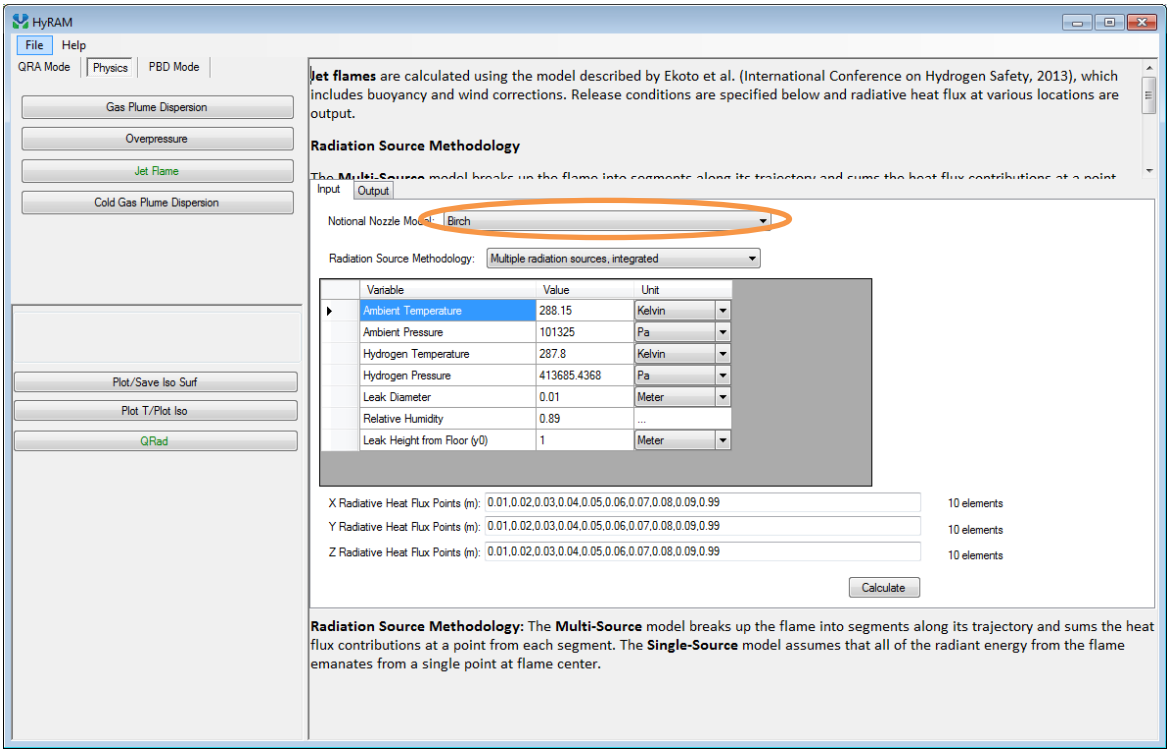


X (m)	Y (m)	Z (m)	Flux (kW/m^2)
0.0100	0.0100	0.0100	108.4195
0.0200	0.0200	0.0200	108.4293
0.0300	0.0300	0.0300	108.4391
0.0400	0.0400	0.0400	108.4489
0.0500	0.0500	0.0500	108.4588
0.0600	0.0600	0.0600	108.4686
0.0700	0.0700	0.0700	108.4784
0.0800	0.0800	0.0800	108.4882
0.0900	0.0900	0.0900	108.4981
0.9900	0.9900	0.9900	109.3858

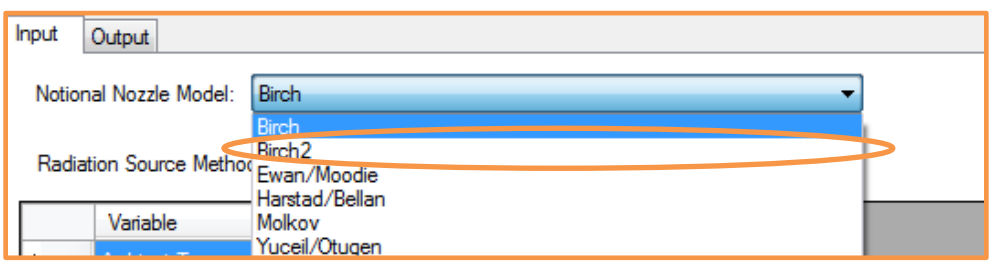
Compare the images. If the results does not match the image above, please see the last page in this document.

3.3.5.2.2 Birch2 Notional Nozzle Model

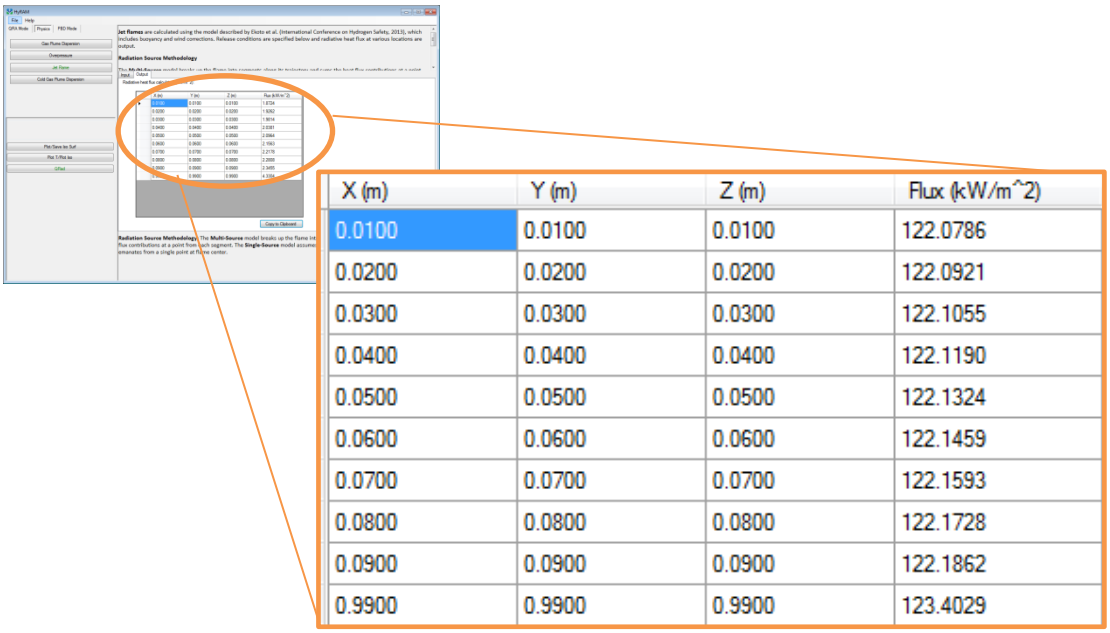
Check to make sure that the Notional Nozzle Model is set to **Birch2**. The location for the combo box is circled in **orange**.



Click the combo box and then select **Birch2**. **Birch2**is circled in **orange** below:



Then, to check the output, click **Calculate**. It may take a minute to finish the calculation. When it is finished calculating, the following should be displayed:

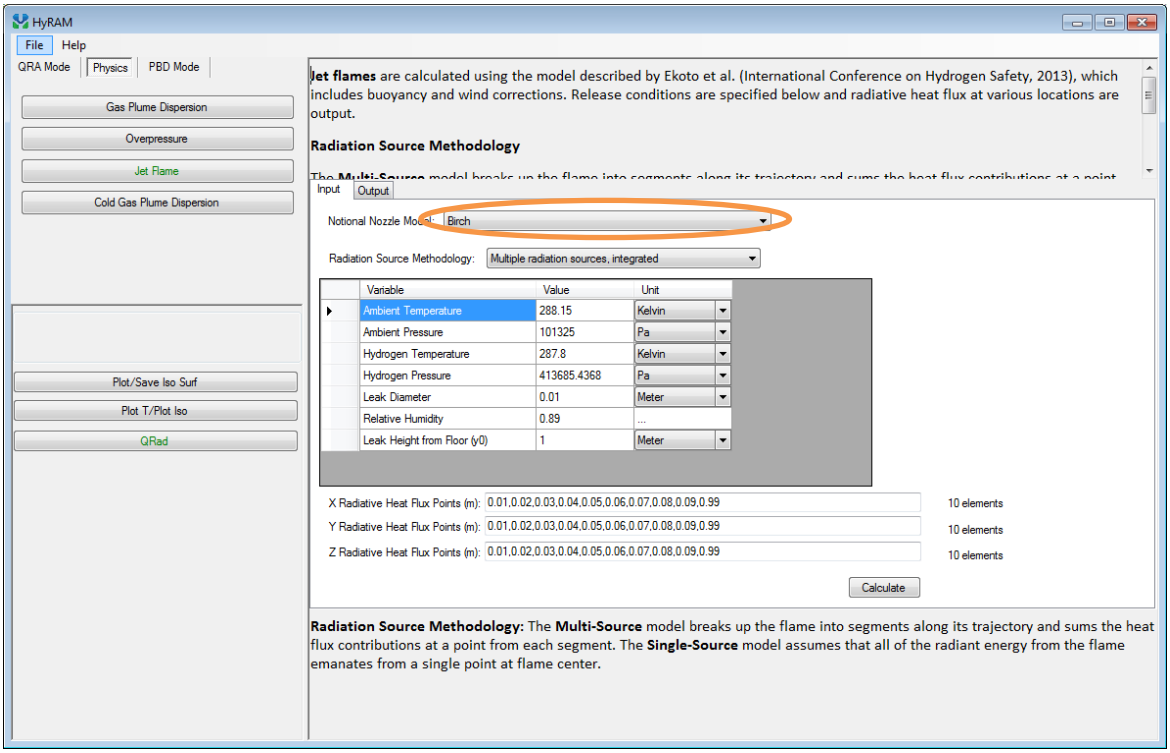


X (m)	Y (m)	Z (m)	Flux (kW/m^2)
0.0100	0.0100	0.0100	122.0786
0.0200	0.0200	0.0200	122.0921
0.0300	0.0300	0.0300	122.1055
0.0400	0.0400	0.0400	122.1190
0.0500	0.0500	0.0500	122.1324
0.0600	0.0600	0.0600	122.1459
0.0700	0.0700	0.0700	122.1593
0.0800	0.0800	0.0800	122.1728
0.0900	0.0900	0.0900	122.1862
0.9900	0.9900	0.9900	123.4029

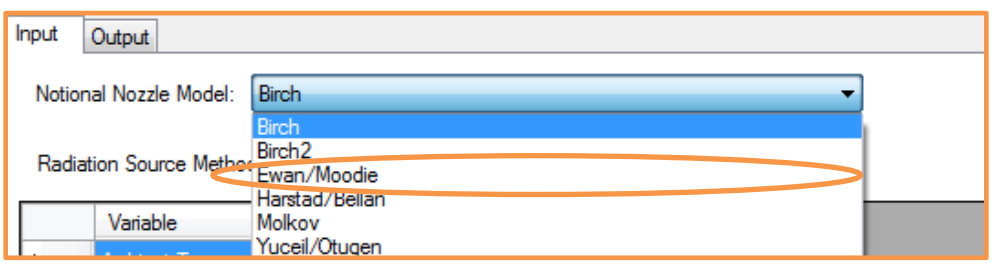
Compare the images. If the results does not match the image above, please see the last page in this document.

3.3.5.2.3 Ewan/Moodie Notional Nozzle Model

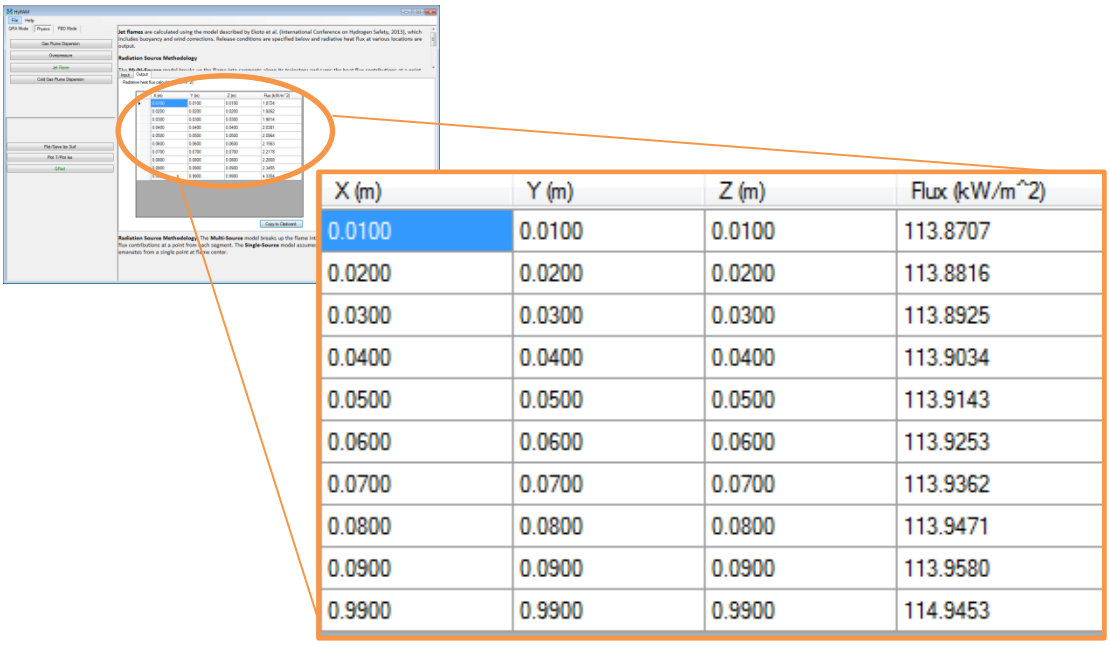
Check to make sure that the Notional Nozzle Model is set to **Ewan/Moodie**. The location for the combo box is circled in **orange**.



Click the combo box and then select **Ewan/Moodie**. **Ewan/Moodie** is circled in **orange** below:



Then, to check the output, click **Calculate** It may take a minute to finish the calculation. When it is finished calculating, the following should be displayed:

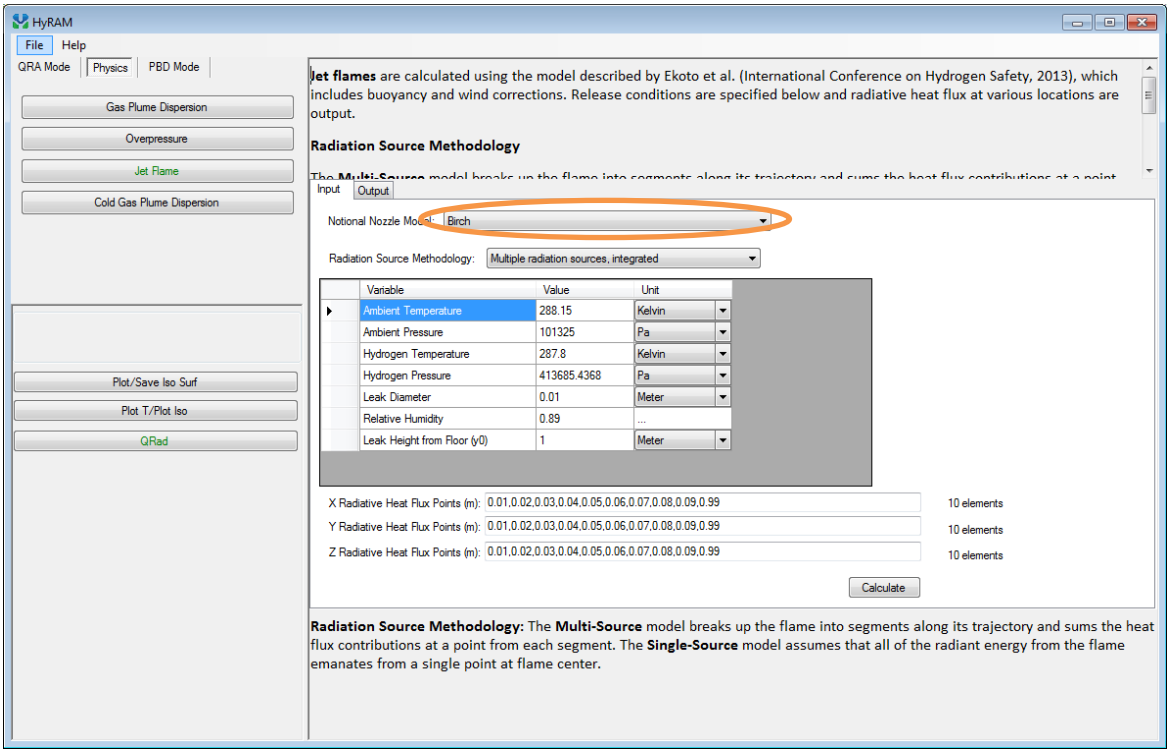


X (m)	Y (m)	Z (m)	Flux (kW/m^2)
0.0100	0.0100	0.0100	113.8707
0.0200	0.0200	0.0200	113.8816
0.0300	0.0300	0.0300	113.8925
0.0400	0.0400	0.0400	113.9034
0.0500	0.0500	0.0500	113.9143
0.0600	0.0600	0.0600	113.9253
0.0700	0.0700	0.0700	113.9362
0.0800	0.0800	0.0800	113.9471
0.0900	0.0900	0.0900	113.9580
0.9900	0.9900	0.9900	114.9453

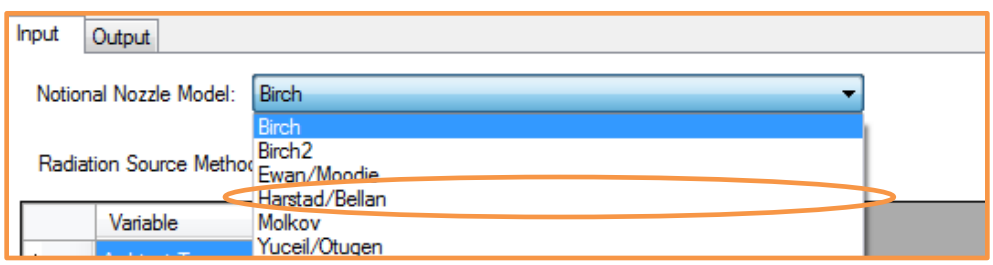
Compare the images. If the results does not match the image above, please see the last page in this document.

3.3.5.2.4 Harstad/Bellan Notional Nozzle Model

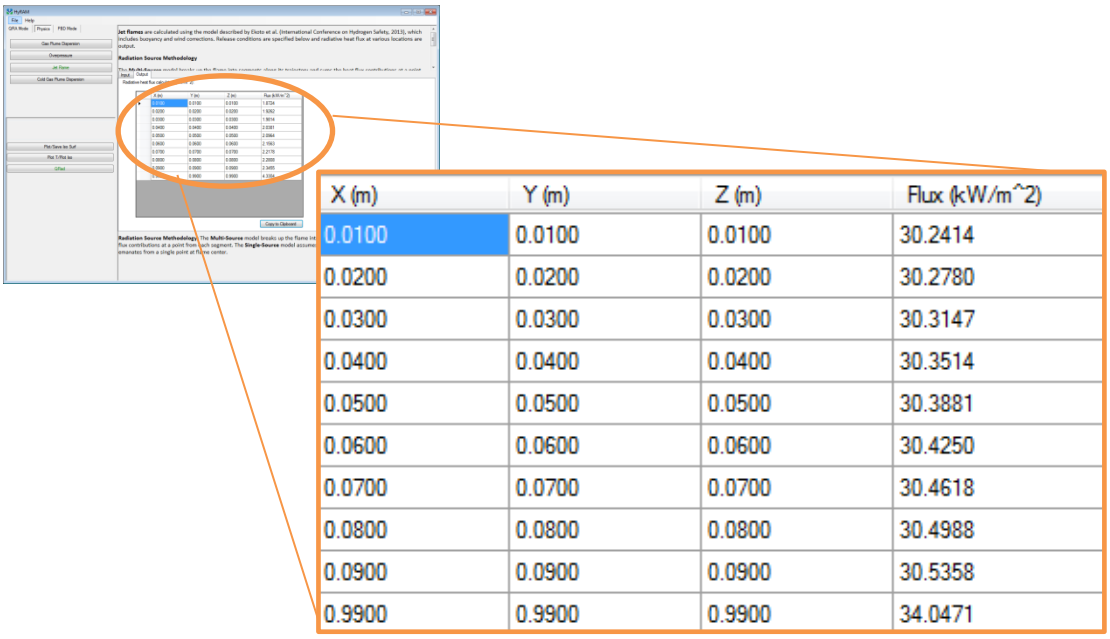
Check to make sure that the Notional Nozzle Model is set to **Harstad/Bellan**. The location for the combo box is circled in **orange**.



Click the combo box and then select **Harstad/Bellan**. **Harstad/Bellan** is circled in **orange** below:



Then, to check the output, click **Calculate**. It may take a minute to finish the calculation. When it is finished calculating, the following should be displayed:

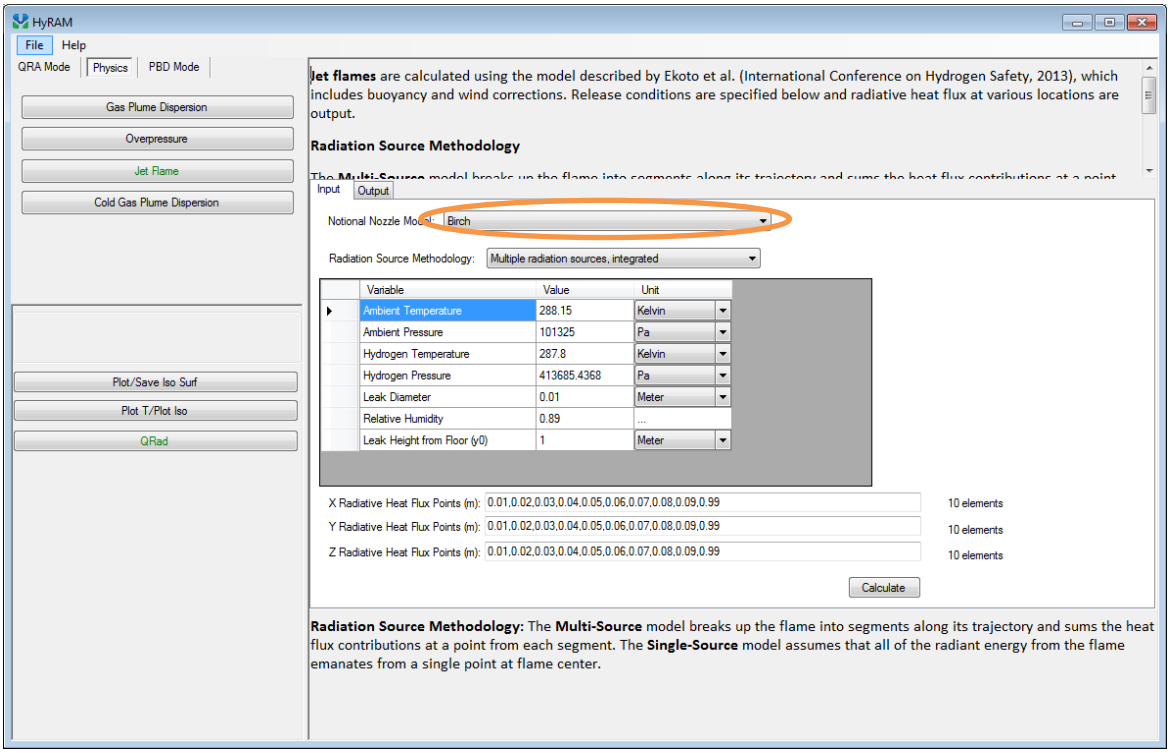


X (m)	Y (m)	Z (m)	Flux (kW/m^2)
0.0100	0.0100	0.0100	30.2414
0.0200	0.0200	0.0200	30.2780
0.0300	0.0300	0.0300	30.3147
0.0400	0.0400	0.0400	30.3514
0.0500	0.0500	0.0500	30.3881
0.0600	0.0600	0.0600	30.4250
0.0700	0.0700	0.0700	30.4618
0.0800	0.0800	0.0800	30.4988
0.0900	0.0900	0.0900	30.5358
0.9900	0.9900	0.9900	34.0471

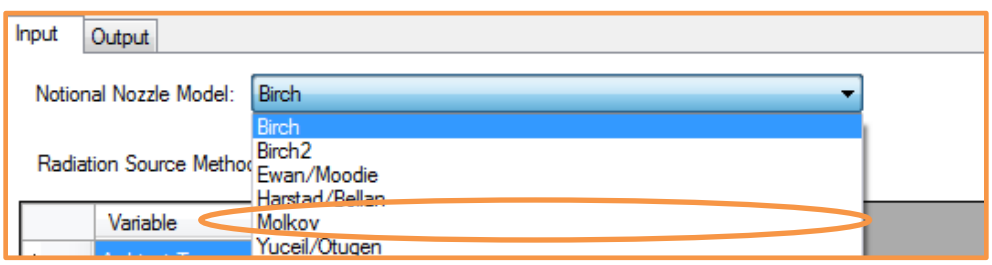
Compare the images. If the results does not match the image above, please see the last page in this document.

3.3.5.2.5 Molkov Notional Nozzle Model

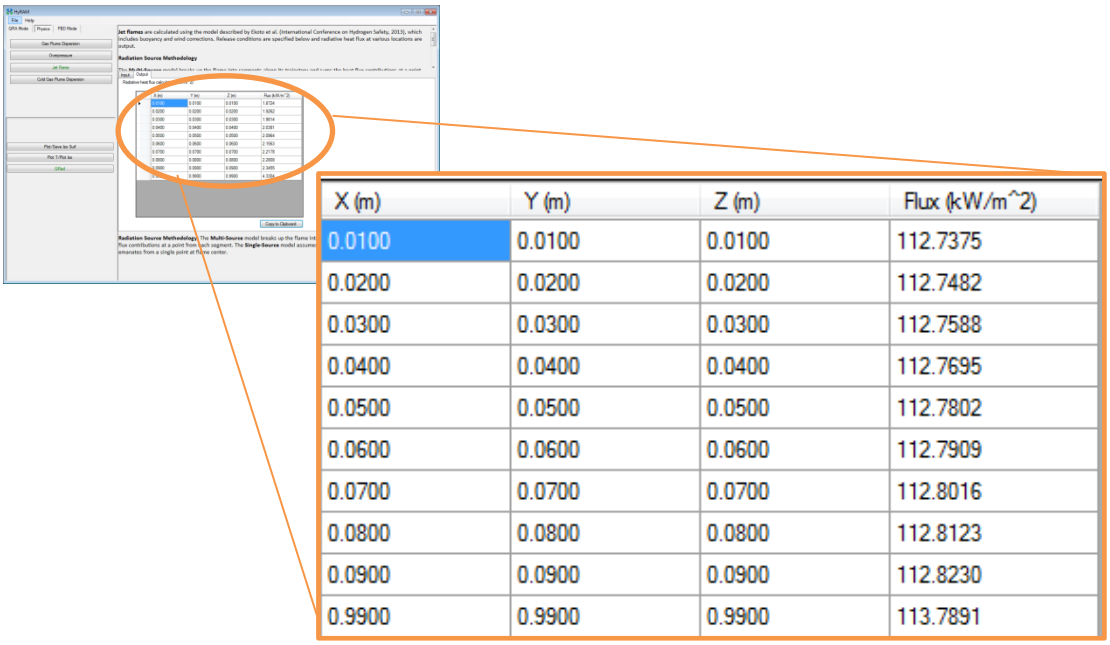
Check to make sure that the Notional Nozzle Model is set to **Molkov**. The location for the combo box is circled in **orange**.



Click the combo box and then select **Molkov**. **Molkov** is circled in **orange** below:



Then, to check the output, click **Calculate**. It is circled in **orange**. It may take a minute to finish the calculation. When it is finished calculating, the following should be displayed:

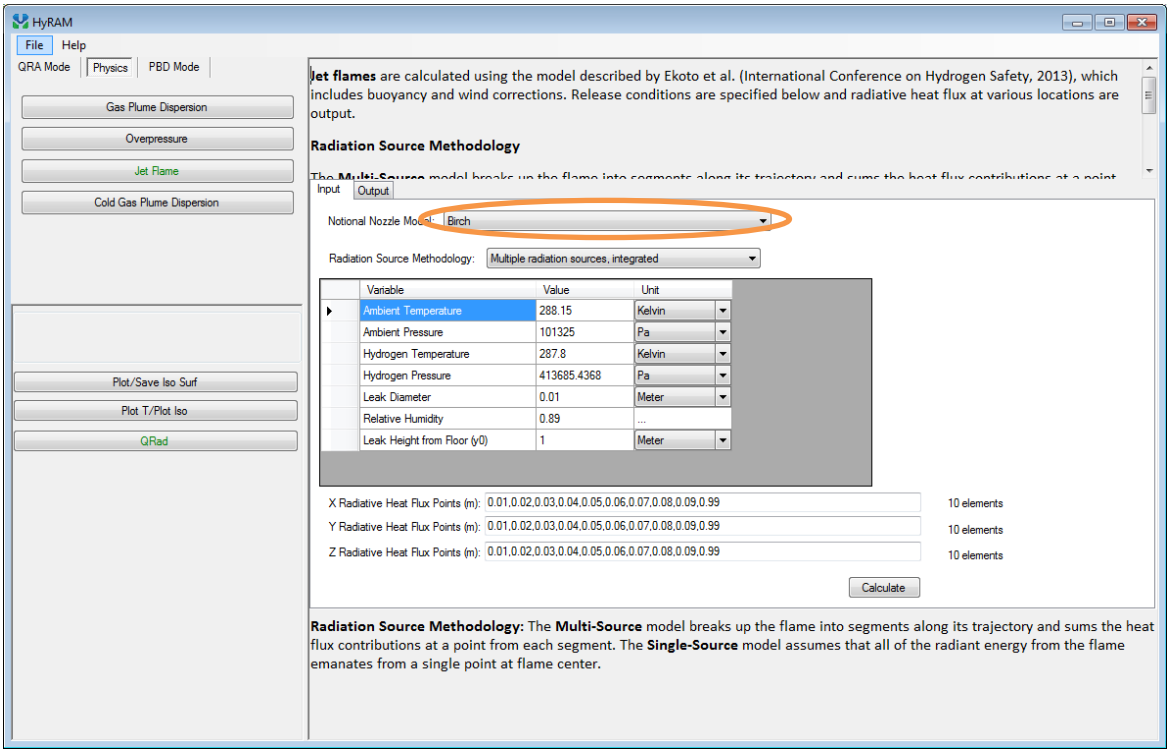


X (m)	Y (m)	Z (m)	Flux (kW/m^2)
0.0100	0.0100	0.0100	112.7375
0.0200	0.0200	0.0200	112.7482
0.0300	0.0300	0.0300	112.7588
0.0400	0.0400	0.0400	112.7695
0.0500	0.0500	0.0500	112.7802
0.0600	0.0600	0.0600	112.7909
0.0700	0.0700	0.0700	112.8016
0.0800	0.0800	0.0800	112.8123
0.0900	0.0900	0.0900	112.8230
0.9900	0.9900	0.9900	113.7891

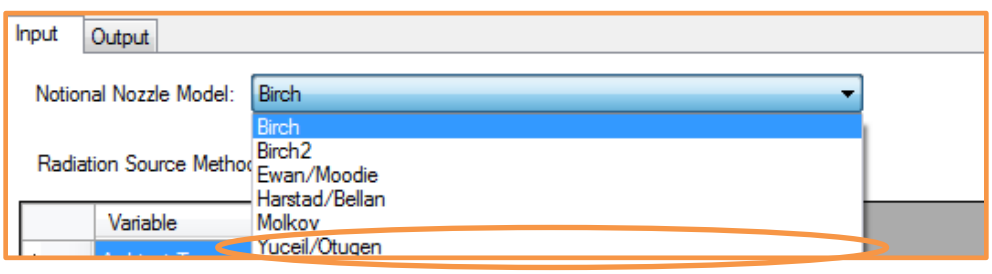
Compare the images. If the results does not match the image above, please see the last page in this document.

3.3.5.2.6 Yuceil/Otugen Notional Nozzle Model

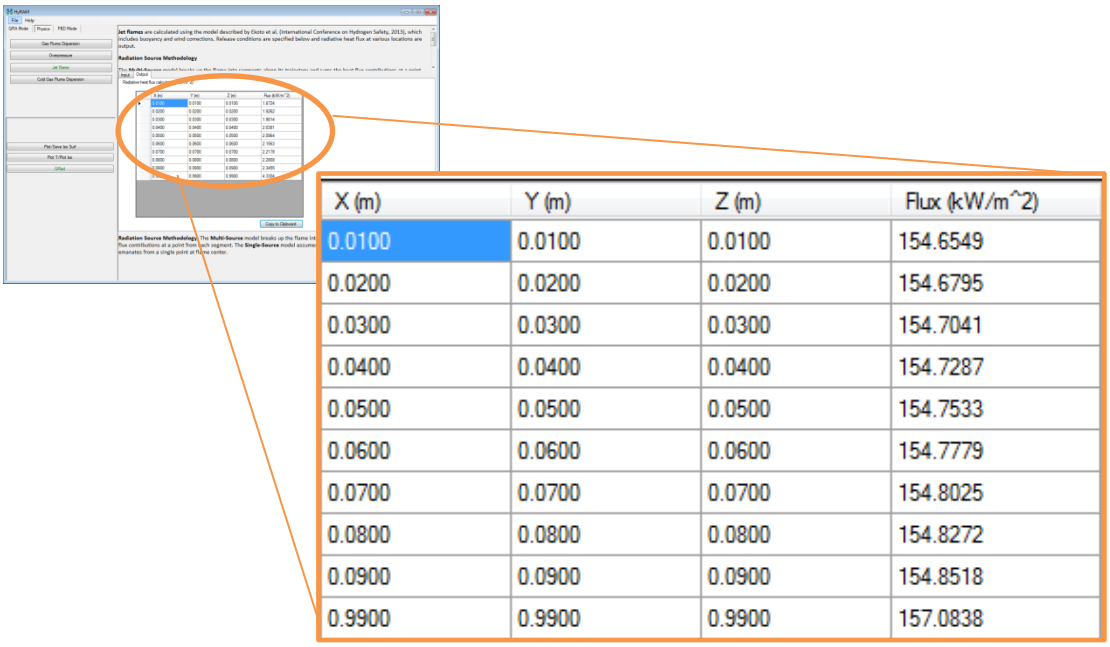
Check to make sure that the Notional Nozzle Model is set to **Yuceil/Otugen**. The location for the combo box is circled in **orange**.



Click the combo box and then select **Yuceil/Otugen**. **Yuceil/Otugen** is circled in **orange** below:



Then, to check the output, click **Calculate**. It is circled in **orange**. It may take a minute to finish the calculation. When it is finished calculating, the following should be displayed:

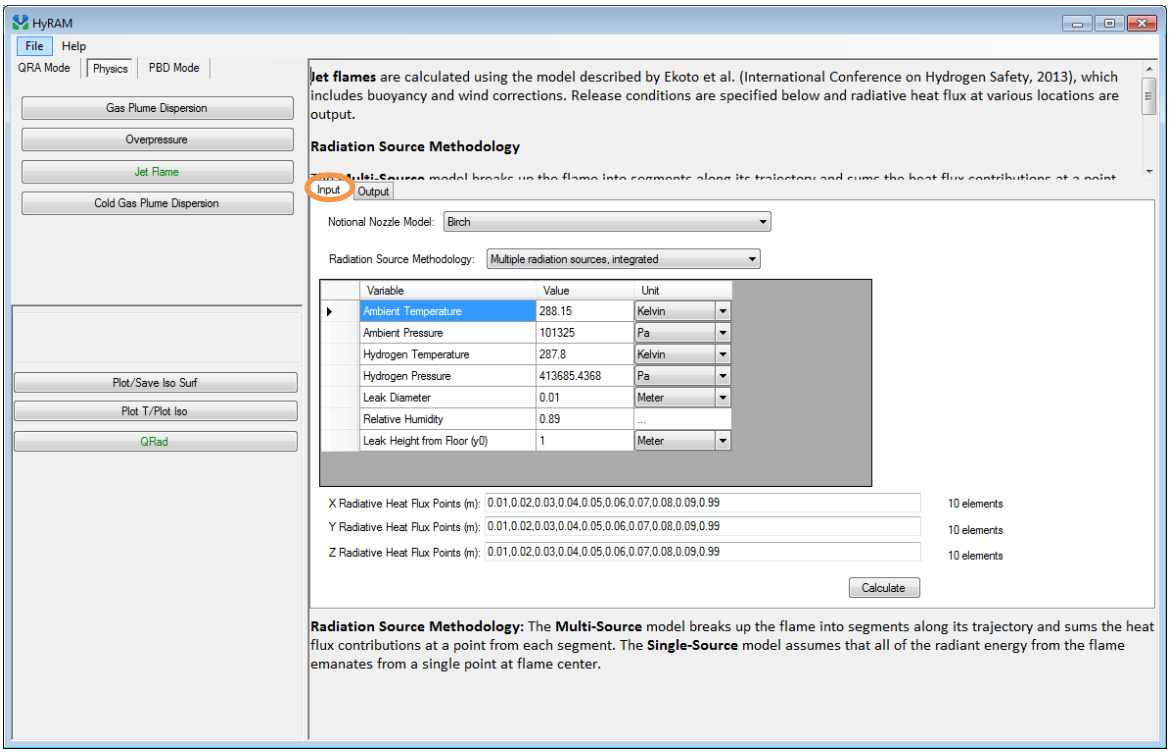


X (m)	Y (m)	Z (m)	Flux (kW/m^2)
0.0100	0.0100	0.0100	154.6549
0.0200	0.0200	0.0200	154.6795
0.0300	0.0300	0.0300	154.7041
0.0400	0.0400	0.0400	154.7287
0.0500	0.0500	0.0500	154.7533
0.0600	0.0600	0.0600	154.7779
0.0700	0.0700	0.0700	154.8025
0.0800	0.0800	0.0800	154.8272
0.0900	0.0900	0.0900	154.8518
0.9900	0.9900	0.9900	157.0838

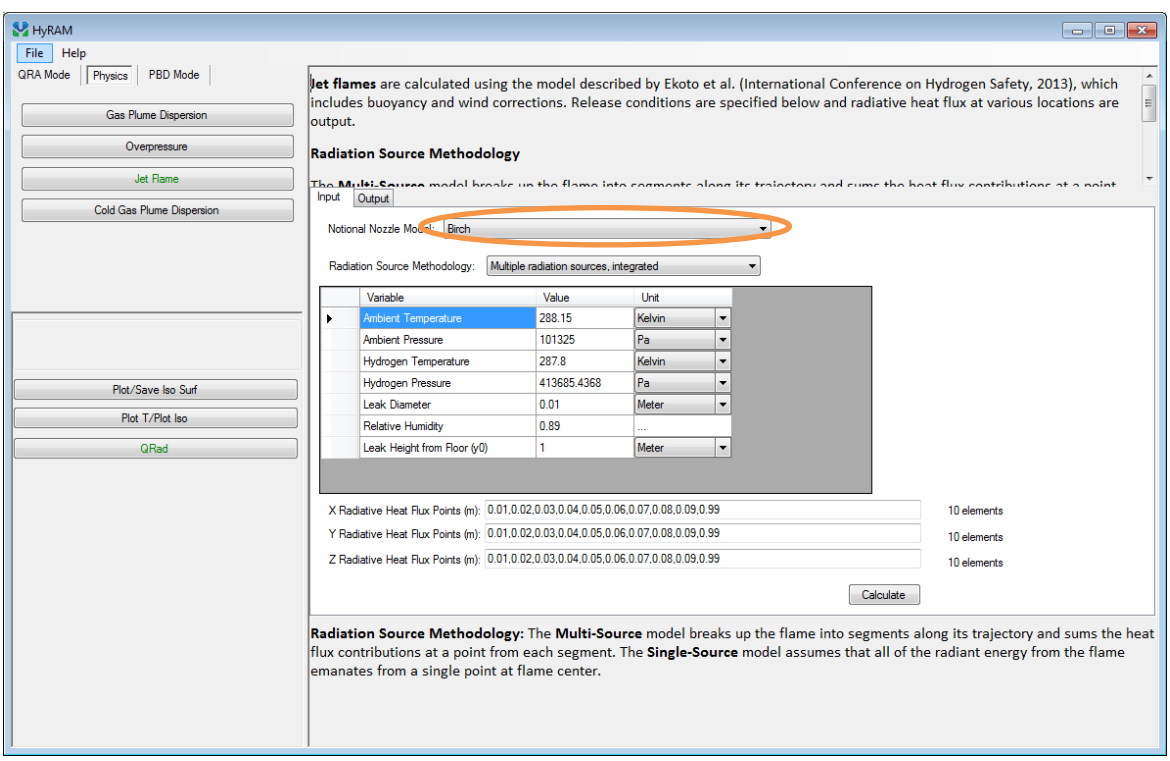
Compare the images. If the results does not match the image above, please see the last page in this document.

3.3.6 Re-edit QRad Parameters

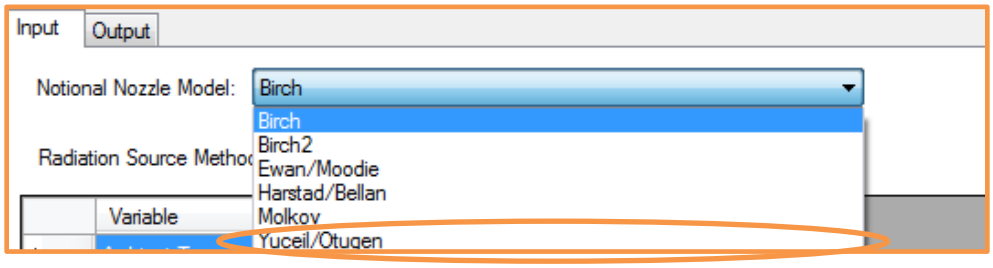
To reedit the QRad Parameters, click the **Input** tab. It is circled in **orange**:



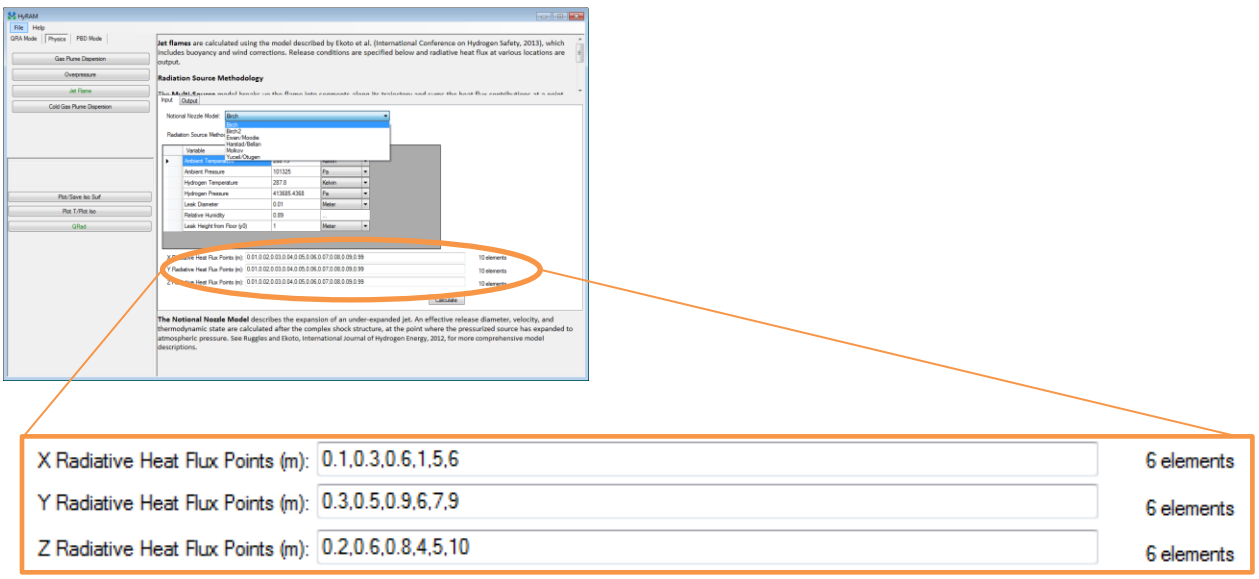
Check to make sure that the Notional Nozzle Model is set to **Yuceil/Otugen**. The location for the combo box is circled in **orange**.



Click the combo box and then select **Yuceil/Otugen**. **Yuceil/Otugen** is circled in **orange** below:

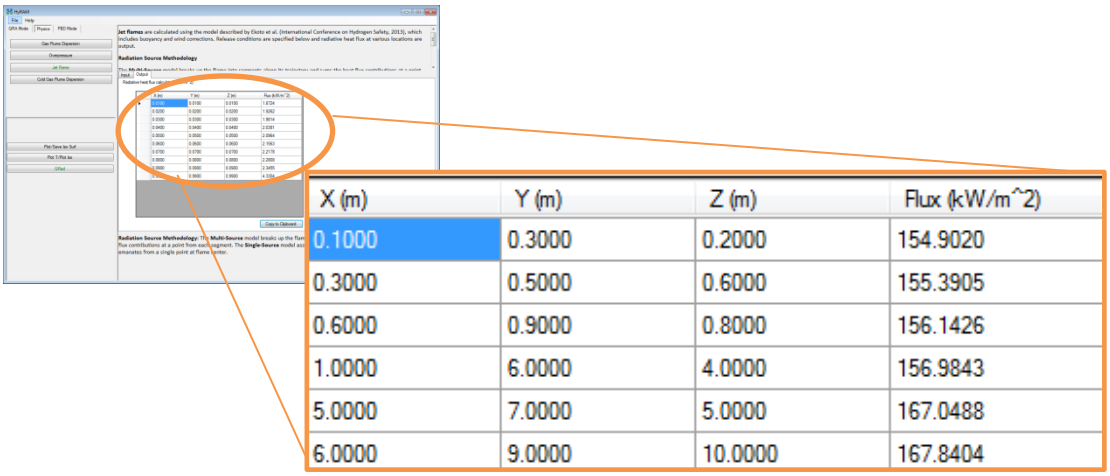


Then, edit the flux points to reflect the following. The flux points' textboxes are circled in **orange**.



3.3.6.1 Check Output of Modified Parameters

To check the output, click **Calculate**. It may take a minute to finish the calculation. When it is finished calculating, the following should be displayed:



X (m)	Y (m)	Z (m)	Flux (kW/m^2)
0.1000	0.3000	0.2000	154.9020
0.3000	0.5000	0.6000	155.3905
0.6000	0.9000	0.8000	156.1426
1.0000	6.0000	4.0000	156.9843
5.0000	7.0000	5.0000	167.0488
6.0000	9.0000	10.0000	167.8404

Compare the images. If the results does not match the image above, please see the last page in this document.

3.4 Cold Gas Plume Dispersion – Feature Not Ready

Do not evaluate this section. This feature will be implemented at a later time. Please move onto the next section.

3.5 PBD Mode– Feature Not Ready

Do not evaluate this section. This feature will be implemented at a later time. Please move onto the next section.

4. USER SURVEY

☐Did you receive the same values as shown in this document? If not, please give more information about what you received and possible steps to reproduce the results in the area provided.

☐Was the document correct about the steps that were required to take to complete the task? If not, please elaborate in the area provided.

☐Was there at any time during the course of this document, that the steps described to you were unclear? If so, please give more information in the area provided.

Additional Comments\Questions\Suggestions\Concerns

Thank you for your feedback.

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