Depo Cal

DEPOSITION CALCULATOR
USER'S MANUAL

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1 INTRODUCTION

Deposition is software for evaluating penetration of aerosol through aerosol sampling systems. The Deposition Calculator version 1.0 represents a complete rebuild of the software using an object-oriented design.

2 PROGRAM BASICS

2.1 System requirements

Deposition Calculator requires a computer running Windows 7, Windows 8 or Windows 10.

2.2 Installing and starting Deposition for Windows

Deposition Calculator is compiled into a single executable file. Installation simply involves moving the file DepoCal.exe to the folder that the user desires. The program defaults to this folder when a file is saved. Double-click the Deposition Calculator icon to launch the program.

2.3 Transport system definition

An aerosol transport system is a collection of flow components such as tubes, bends, and probes that allows for the extraction and conveyance of an aerosol sample from one location to another. The term sample line is often used interchangeably with the term transport system. Deposition Calculator software allows the user to analyze a model of a transport system or sample line to determine the fraction of particles of a given size that are conveyed from the system inlet to the outlet, otherwise known as the *sampling efficiency* or particle *penetration*. Typically, some fraction of particles will be lost to the walls of the system due to mechanisms such as gravitational sedimentation, diffusion, or inertial impaction. In Deposition Calculator, a transport system is represented by a linked list of components that represent the mechanical elements of the physical transport system. Only transport components that have published efficiency models are represented in Deposition Calculator. Actual transport systems may contain features or exhibit deposition mechanisms (e.g. electrostatic deposition) that are not modeled by Deposition Calculator. Failure to accurately model the physical system may lead to prediction of transport efficiency that does not match that of the physical system.

2.4 *Basic Screen Navigation*

The Deposition Calculator screen is divided into 7 primary sections as depicted below in Figure 1.

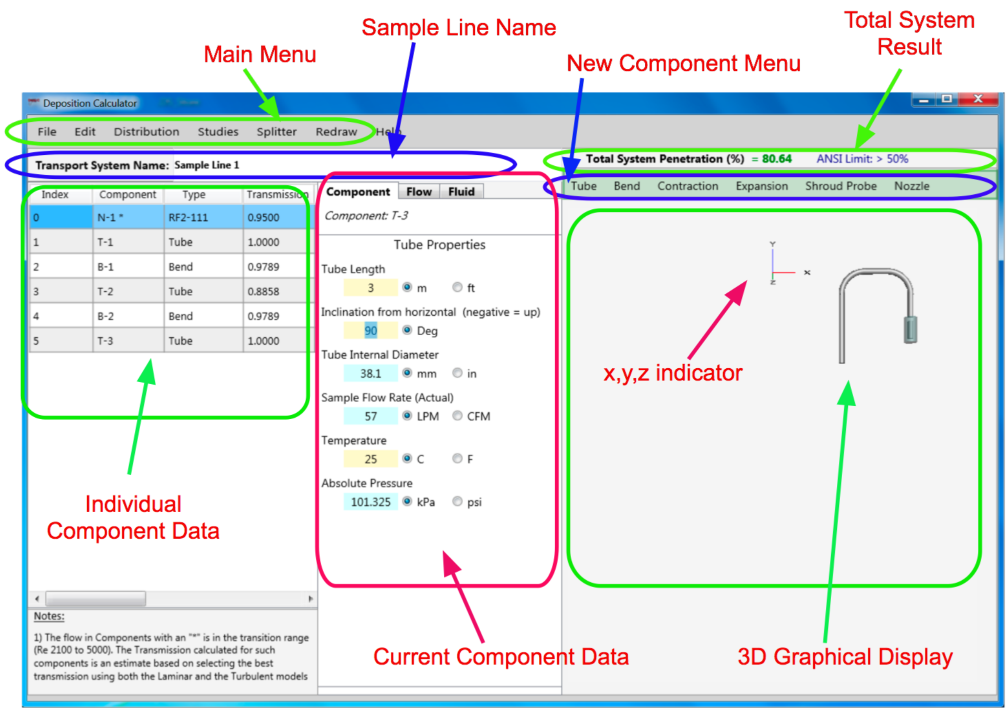

Figure 1: Primary screen layout

2.4.1 *Main Menu*

This section is used for general functions related to the entire program.

2.4.2 *Sample Line Name*

The Sample Line Name is an editable field. The user can name the transport system here.

2.4.3 *New Component Menu*

The New Component Menu is used to select a new component for the sample line. The new component will be placed at the end of the sample line. The user can move the new component with the EDIT menu item.

2.4.4 *Total System Results*

The percent penetration for the entire sample line is presented here. The transport efficiencies (Transmission) of the individual components are presented in the Individual Component Data section. The transmission is the percent penetration given in decimal format or simply the percent penetration divided by 100. In the default case, the results are based on a monodispersed particle size of 10 µm Aerodynamic Equivalent Diameter (AED)[1]. ANSI N13.1-1999/2011[2] requires that at least 50% of the 10 µm AED particles entering the transport system penetrate the system to the sample collector.

When the total transport system penetration is greater than 50%, the value will be green. Once the penetration is either equal to or less than 50%, the value turns red. This provides a visual indicator of compliance with ANSI N13.1-1999/2011.

2.4.5 Individual Component Data panel
This section is used to tabulate the components in the sample line. The Index is used in the Edit menu items. The particle transmission for each individual component is presented in the section. Other component data such as the inlet diameter, outlet diameter, temperature, length of a tube section, bend angle and bend radius are also available in this section.

2.4.6 Current Component Data panel
This section is used to input the Component specific data. Fields that have a blue background are considered global fields. Changes to a blue field will affect the same change in all Components; e.g. changing the Absolute Pressure from 101 to 90 in one Component would force that same change in all Components. A change in Internal Diameter will force a change in all Components, however if an expansion or contraction is included in the sample line, the program will use the ratio of inlet to outlet to effect the change for those components. In this case the program will notify the user to check the outlets of those components.

2.4.7 3D Graphic Display
This section provides a 3-Dimensional (3D) Graphic Display that can be rotated as needed. It contains an x, y, z indicator that is always available for orientation purposes.

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1 AED is the diameter of a sphere, with density = 1 g/cm3, that has the same terminal settling velocity under gravity as the airborne particle being considered.
2 American National Standard – Sampling and Monitoring Releases of Airborne Radioactive Substances from the Stacks and Ducts of Nuclear Facilities, Health Physics Society, 1999/2011

3 CREATING A TRANSPORT SYSTEM

3.1 New Sample Line

As shown below in Figure 2, selecting New Sample Line under File menu item of the Main Menu creates a new sample line or transport system

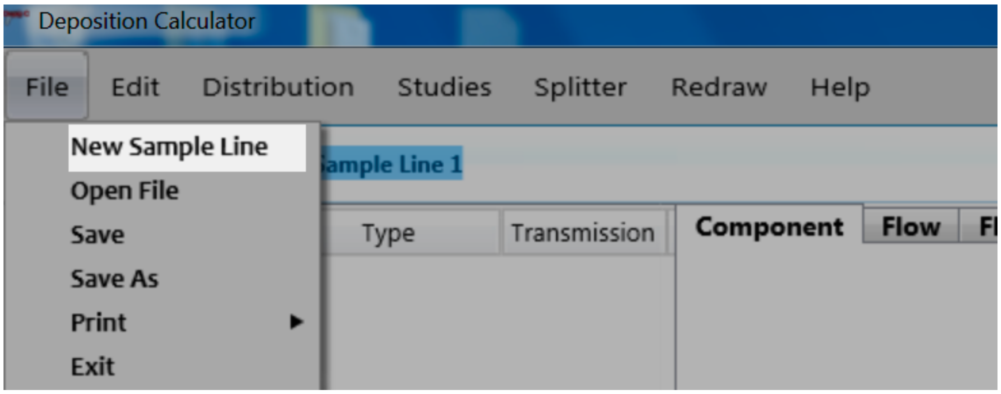


Figure 2: New sample line menu item

The New Sample Line menu item clears all three panels of the primary User Interface (UI) of any components and associated data. The only object that should appear is the x, y, z axis indicator on the *3D graphic display*. When the New Sample Line menu item is selected the user is prompted to save the existing sample line data.

A default sample line name of "Sample Line 1" is populated for every new sample line. The user can replace this default sample line name with another name.

Components are added by clicking on a component name in the *New Component Menu*. Any time a new component is added to the transport system four actions occur:

1. A new line is added to the *Individual Component Data* panel. Details of this panel are provided in Section 4.1.
2. The *Component Data* panel displays the default information for the component. This pane is where the user would make changes to the component properties. Details for each component are presented below in this section.
3. The *3D Graphic Display* is updated to reflect the new component. More details on the graphical display are provided in Section 4.3.
4. The *Total System Results* are updated.

<u>Note</u>

When a probe or nozzle is included in the transport system, it must be selected as the first item. A probe or nozzle cannot be added after any other component. If the probe or nozzle is not included as the first component in the transport system, then the only solution is to start a new sample line.

3.2 Component Data panel

The *Component Data* panel has three tabs; the *Component tab*, the *Flow tab* and the *Fluid tab*. An example of each is shown as Figure 3. The *Component tab* has data that the user can change, while the other two tabs provide information from calculations done by the software based on the properties of the component.

Note

The TAB Key should not be used navigate in the Component tabs. The RETURN or ENTER key and the ARROW keys work just fine. Also moving the mouse curser and clicking in a data entry box also is an acceptable form of navigation.

The text boxes in the *Component tab* are color-coded. A yellow color indicates that the data is specific to that one component. A light blue color indicates that changes to that data will reflect a similar change for all components. For example, the `Tube Internal Diameter` should not change unless an ***Expansion*** or ***Contraction*** component is added to transport system. Therefore, once the `Tube Internal Diameter` is set, it will be the default for the next component. If the `Tube Internal Diameter` is changed at any component, the `Tube Internal Diameter` will change in all components before and after that component. A change in the `Tube Internal Diameter` will affect the `Tube Internal Diameter` of components after an ***Expansion*** or ***Contraction*** component, however the details of those changes is discussed more fully in the Expansion and Contraction sections of this manual. Similarly the `Sample Flow Rate` and `Absolute Pressure` parameters remain constant throughout the transport system.

Most of the parameters in the *Component tab* can take data in either Systeme International d'Unites (SI) or American units. The units are selected with Radio buttons. The user is cautioned that changing units by selecting a new Radio Button will not change the value in the number boxes. The use must manually change both the value and the Radio Button. For example, if the `Tube Length` is set to 1 meter (m) and the user selects the feet (ft) Radio Button, the value of the **Tube Length** will not change to 3.28 but will remain at 1 ft. until the user enters a new value.

The *Flow tab* provides data that the designer will find useful. The flow characteristics at the inlet of the component and at the outlet of the component are presented. For most components these values will be the same, however for the ***Expansion, Contraction, Shrouded Probe***, and ***Nozzle*** components, the `Mean Cross-Section Velocity` and the `Flow Reynolds Number` values will differ between the inlet and outlet.

The *Fluid tab* provides the designer with the basic fluid properties used in the model. These fluid properties are based on the temperature and pressure of the sampling system.

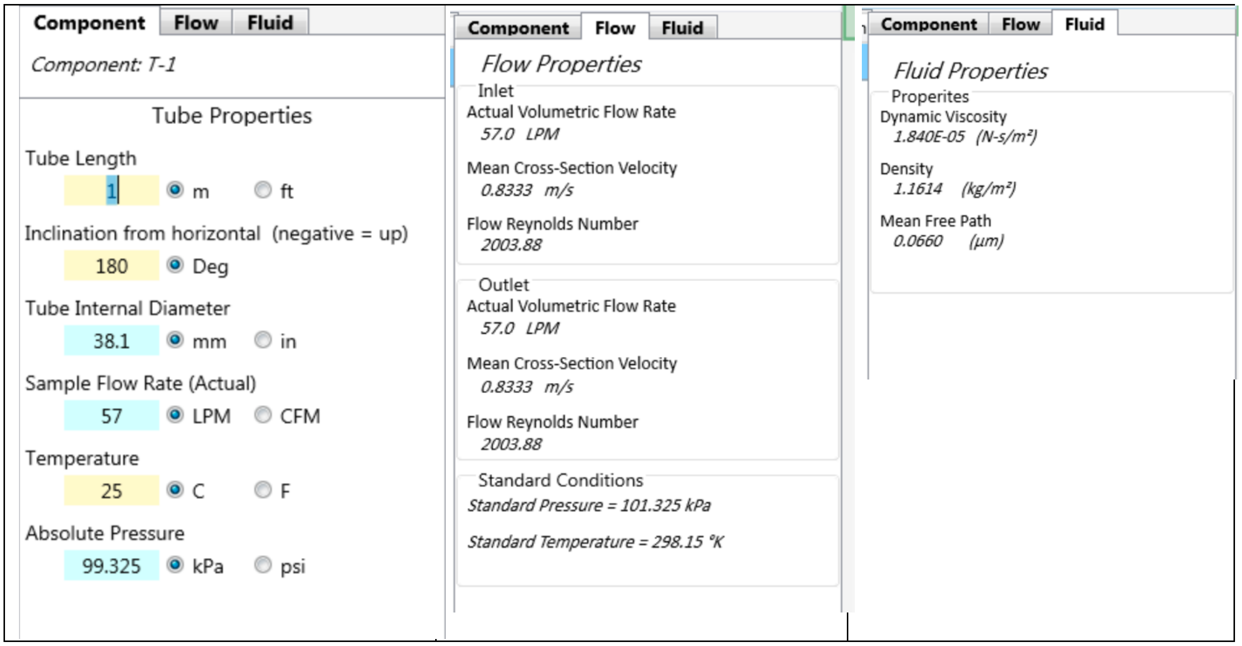


Figure 3: Component data tabs

Each component type is discussed below in the order that it appears in the *New Component Menu*.

3.3 Tube component

The ***Tube*** menu item can have the following properties, which can be changed by the user in the *Current Component Data* panel. Note that a ***Tube*** component is named with a "T" and a sequential number beginning at 1. For example the first ***Tube*** component in the transport system would be named "T-1" and the second ***Tube*** component would be named "T-2", and so on.

`Tube Length`: The length of a straight section of sample tube. Units are either meters or feet.

`Inclination from horizontal`: The angle that the axis of the component *inlet* makes with a horizontal reference plane (Figure 4. A negative inclination indicates the inlet flow is upward with respect to the vertical, positive inclination indicates the flow is downward. The inclination angel is given in degrees. Important cases include:

- vertically downward: inclination angle = 90°
- vertical upward: inclination angle = -90°
- horizontal, flow to the left: inclination angle = 0°
- horizontal, flow to the right: inclination angle = 180°

`Tube Internal Diameter:`	The diameter of the *internal* surface of the tube. Units are either millimeters (mm) or inches (in).
`Sample Flow Rate (actual):`	The volumetric flow rate of the air at the component inlet at the temperature and pressure of the component. Units are either liters per minute (LPM) or cubic feet per minute (CFM).
`Temperature:`	The temperature of airflow in the component. This can change for systems that are heat traced or that travel outside of a controlled environment. When a straight tube penetrates a barrier and a temperature change occurs, the user can split the sample tube into two ***Tube*** components and set separate temperature for each component. Units are either degrees Centigrade (C) or degrees Fahrenheit (F).
`Absolute Pressure:`	The absolute pressure of the air in the component will typically be either ambient or just below ambient. Slight changes will have little effect on the deposition results. Units are either kilo Pascal (kPa) or pounds per square inch (psi).

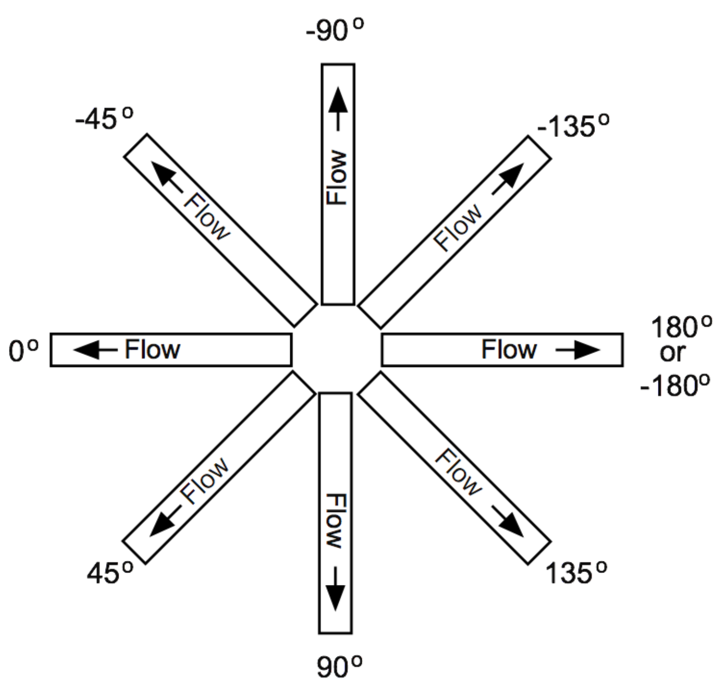


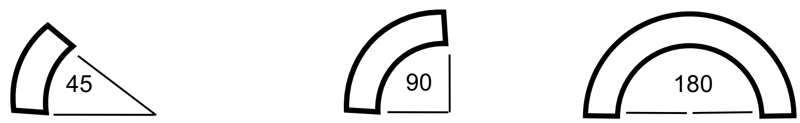
Figure 4: A tube at various inclination angles

3.4 Bend component

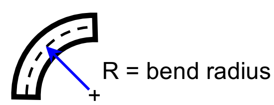
The ***Bend*** menu item can have the following properties, which can be changed by the user in the *Current Component Data* panel. Note that a ***Bend*** component is named with a "B" and a sequential number beginning at 1. For example the first ***Bend*** component in the transport system would be named "B-1" and the second ***Bend*** component would be named "B-2", and so on.

`Bend Angle`: The angle through which the flow turns in flowing through the bend. Valid **bend angles** are from 0° to 180°. In the latter case, the flow would be redirected in the direction opposite from which it entered the bend. The default value for bend angle is 90°. Units are in degrees.

Examples are

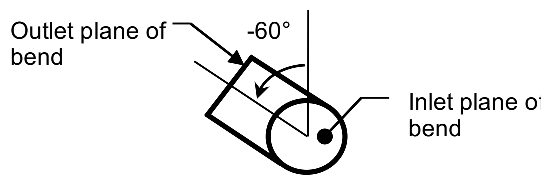


`Bend Radius:` The radius of curvature of the bend path measured from the center of the bend arc to the midline of the bend tubing. Note that the `bend radius` should be at least four times the tube internal diameter.



`Bend Orientation:`

This property defines the direction the outlet flow relative to the inlet. The bend orientation is defined *relative to the direction perpendicular to the inlet plane* of the flow entering the bend. A `bend orientation` of 0° indicates the bend is vertically upward relative to the inlet direction, a bend orientation of 90° indicates that the bend is right of the inlet direction, 180° indicates the bend is vertically downward, and -90° indicates that the bend is left of the inlet direction. `Bend orientation` can be best understood by considering the special case of a bend having an inclination angle of 0° (the inlet flow direction is horizontal) and a bend angle of 90° (a right-angle bend). In this case a `bend orientation` of 0° will result in the outlet flow being vertically upward. A `bend orientation` of 90° will result in the outlet flow remaining horizontal, but making a right turn relative to the path of the inlet flow. A `bend orientation` of -90° would result in the outlet flow also remaining in the horizontal plane, but making a left turn relative to the inlet flow. Lastly, a `bend orientation` of 180° will result in the outlet flow direction to be vertically downward.



`Inclination from horizontal:`

The angle that the axis of the component *inlet* makes with a horizontal reference plane (Figure 4). A negative inclination indicates the inlet flow is upward with respect to the vertical, positive inclination indicates the flow is downward. The inclination angle is given in degrees. Important cases include:

- vertically downward: inclination angle = 90°
- vertical upward: inclination angle = -90°
- horizontal, flow to the left: inclination angle = 180°
- horizontal, flow to the right: inclination angle = 0°

Note that for the *Bend* component the horizontal direction is a mirror image of all other components.

`Tube Internal Diameter:`

The diameter of the *internal* surface of the tube. Units are either millimeters (mm) or inches (in).

`Sample Flow Rate:` The volumetric flow rate of the air at the component inlet at the temperature and pressure of the component. Units are either liters per minute (LPM) or cubic feet per minute (CFM).

`Temperature:` The temperature of air flow in the component. Units are either degrees Centigrade (C) or degrees Fahrenheit (F).

`Absolute Pressure:` The absolute pressure of the air in the component will typically be either ambient or just below ambient. Slight changes will have little effect on the deposition results. Units are either kilo Pascal (kPa) or pounds per square inch (psi).

3.5 Contraction component

The ***Contraction*** menu item can have the following properties, which can be changed by the user in the *Current Component Data* panel. Note that a ***Contraction*** component is named with a "C" and a sequential number beginning at 1. For example the first ***Contraction*** component in the transport system would be named "C-1" and the second ***Contraction*** component would be named "C-2", and so on.

`Inlet Internal Diameter:` The diameter of the *internal* surface of the inlet. Units are either millimeters (mm) or inches (in).

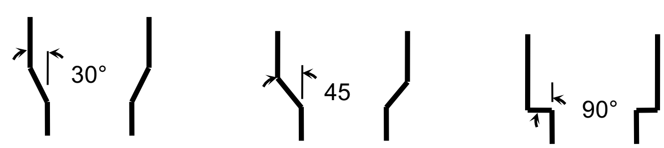
`Outlet Internal Diameter:`

The diameter of the outlet of the contraction. Units are either millimeters (mm) or inches (in).

By definition, a contraction must have outlet diameter less than inlet diameter. By default Deposition Calculator sets the initial `outlet internal diameter` to 1/1.5 of the inlet diameter. The user can change the `outlet internal diameter` to match the actual component in the transport system. Note that this new ratio is used by Deposition Calculator to estimate a new outlet diameter of the ***Contraction*** and all additional downstream components should the internal diameter of a upstream component be changed during later edits. Similarly, Deposition Calculator will use this new ratio to set the internal diameter of the ***Contraction*** and all upstream components if the internal diameter of a component downstream of the contraction is changed during later editing. Therefore, user should always check the internal diameter of components upstream and downstream of a ***Contraction*** component to ensure the internal diameter is correct. An easy way to make corrections is at the ***Contraction*** component by setting the `Inlet Diameter` and the `Outlet Diameter` to the correct values. This will result in all components both upstream and downstream of the ***Contraction*** component being set to the correct internal diameter.

`Contraction Half Angle:`

The angle of taper of the ***Contraction***. Allowable values are from 0° to 90°. Note that a 90° contraction angle should be used when tubes of different diameters are joined in a butt-weld or counter-bore configuration. The `Contraction Half Angle` is given in degrees.



`Inclination from horizontal:` The angle that the axis of the component *inlet* makes with a horizontal reference plane (Figure 4). A negative inclination indicates the inlet flow is upward with respect to the vertical, positive inclination indicates the flow is downward. The inclination angle is given in degrees. Important cases include:

- vertically downward: inclination angle = 90°
- vertical upward: inclination angle = -90°
- horizontal, flow to the left: inclination angle = 0°
- horizontal, flow to the right: inclination angle = 180°

`Sample Flow Rate (actual):` The volumetric flow rate of the air at the component inlet at the temperature and pressure of the component. Units are either liters per minute (LPM) or cubic feet per minute (CFM).

`Temperature:` The temperature of airflow in the component. Units are either degrees Centigrade (C) or degrees Fahrenheit (F).

`Absolute Pressure:` The absolute pressure of the air in the component will typically be either ambient or just below ambient. Slight changes will have little effect on the deposition results. Units are either kilo Pascal (kPa) or pounds per square inch (psi).

3.6 Expansion component

The ***Expansion*** menu item can have the following properties, which can be changed by the user in the *Current Component Data* panel. Note that a ***Expansion*** component is named with an "E" and a sequential number beginning at 1. For example the first ***Expansion*** component in the transport system would be named "E-1" and the second ***Expansion*** component would be named "E-2", and so on.

`Inlet Internal Diameter:` The diameter of the *internal* surface of the inlet. Units are either millimeters (mm) or inches (in).

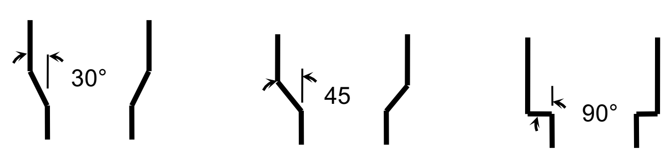
`Outlet Internal Diameter:`

The diameter of the outlet of the expansion. Units are either millimeters (mm) or inches (in).

By definition, an expansion must have outlet diameter greater than inlet diameter. By default Deposition Calculator sets the initial `outlet internal diameter` to 1.5 times the inlet diameter. The user can change the `outlet internal diameter` to match the actual component in the transport system. Note that this new ratio is used by Deposition Calculator to estimate a new outlet diameter of the ***Expansion*** and all additional downstream components should the internal diameter of a upstream component be changed during later edits. Similarly, Deposition Calculator will use this new ratio to set the internal diameter of the ***Expansion*** and all upstream components if the internal diameter of a component downstream of the contraction is changed during later editing. Therefore, user should always check the internal diameter of components upstream and downstream of an ***Expansion*** component to ensure the internal diameter is correct. An easy way to make corrections is at the ***Expansion*** component by setting the `Inlet Diameter` and the `Outlet Diameter` to the correct values. This will result in all components both upstream and downstream of the ***Expansion*** component being set to the correct internal diameter.

`Expansion Half Angle:`

The angle of taper of the ***Expansion***. Allowable values are from 0° to 90°. Note that a 90° expansion angle should be used when tubes of different diameters are joined in a butt-weld or counter-bore configuration. The `Expansion Half Angle` is given in degrees.



`Inclination from horizontal:`	The angle that the axis of the component *inlet* makes with a horizontal reference plane (Figure 4). A negative inclination indicates the inlet flow is upward with respect to the vertical, positive inclination indicates the flow is downward. The inclination angle is given in degrees. Important cases include: • vertically downward: inclination angle = 90° • vertical upward: inclination angle = -90° • horizontal, flow to the left: inclination angle = 0° • horizontal, flow to the right: inclination angle = 180°
`Sample Flow Rate (actual):`	The volumetric flow rate of the air at the component inlet at the temperature and pressure of the component. Units are either liters per minute (LPM) or cubic feet per minute (CFM).
`Temperature:`	The temperature of airflow in the component. Units are either degrees Centigrade (C) or degrees Fahrenheit (F).
`Absolute Pressure:`	The absolute pressure of the air in the component will typically be either ambient or just below ambient. Slight changes will have little effect on the deposition results. Units are either kilo Pascal (kPa) or pounds per square inch (psi).

3.7 Shrouded Probe component

The ***Shrouded Probe*** menu item can have the following properties, which can be changed by the user in the *Current Component Data* panel. Note that a ***Shrouded Probe*** component is named "N-1". There can only be one Shrouded Probe or Nozzle in a Transport System and the Shrouded Probe must be the first item in transport system. It cannot be added later during the edit process.

ANSI N13.1-1999/2011 requires that the Aspiration Ratio be between 0.8 and 1.5. The Aspiration Ratio is the ratio of the aerosol concentration at the nozzle inlet plane divided by the aerosol concentration in the undisturbed stream at the point where the nozzle is located. This value is presented at the top of the *Shrouded Probe* tab, along with the ANSI limits. When the Aspiration Ratio is within limits the value is green and when it is out of limits it is red.

Shrouded probes models are available for three commercial probes (RF2-111, RF2-112, and RF2-113), and three Department of Energy-designed probes (CMR4CFM-HI, CMR4CFM-MI, WIPP6CFM). The geometric information used by Deposition Calculator for each probe type is coded in the Calculation modules.

`Sample Flow Rate (actual):`	The volumetric flow rate of the air at the component inlet at the temperature and pressure of the component. Units are either liters per minute (LPM) or cubic feet per minute (CFM).
`Free Stream Velocity:`	The velocity of the free stream flow at the location of the nozzle placement. The model assumes that the direction of the free stream flow and the nozzle inlet plane perpendicular are equal (isoaxial sampling condition). Units are either meters per second (m/s) or feet per second (ft/s)
`Inclination from horizontal:`	The angle that the axis of the component *inlet* makes with a horizontal reference plane (Figure 4). A negative inclination indicates the inlet flow is upward with respect to the vertical, positive inclination indicates the flow is downward. The inclination angel is given in degrees. Important cases include: • vertically downward: inclination angle = 90° • vertical upward: inclination angle = -90° • horizontal, flow to the left: inclination angle = 0° • horizontal, flow to the right: inclination angle = 180°
`Temperature:`	The temperature of air flow in the component. Units are either degrees Centigrade (C) or degrees Fahrenheit (F).
`Absolute Pressure:`	The absolute pressure of the air in the component will typically be either ambient or just below ambient. Slight changes will have little effect on the deposition results. Units are either kilo Pascal (kPa) or pounds per square inch (psi).
`Probe Types:`	The six Shrouded Probes with test data are presented in this section. The user can select a probe by selecting a Radio Button. Note that the out diameter of the probe is given. In cases where the sample line is smaller or larger than the probe outlet, a ***Contraction*** or ***Expansion*** component should be used in the transport system to account for the change in internal diameters.

3.8 Nozzle component

The ***Nozzle*** menu item can have the following properties, which can be changed by the user in the *Current Component Data* panel. Note that a ***Nozzle*** component is named "N-1". There can only be one Shrouded Probe or Nozzle in a Transport System and the Shrouded Probe must be the first item in transport system. It cannot be added later during the edit process.

ANSI N13.1-1999/2011 requires that the Aspiration Ratio be between 0.8 and 1.5. The Aspiration Ratio is the ratio of the aerosol concentration at the nozzle inlet plane divided by the aerosol concentration in the undisturbed stream at the point where the nozzle is located. This value is presented at the top of the *Nozzle* tab, along with the ANSI limits. When the Aspiration Ratio is within limits the value is green and when it is out of limits it is red.

`Inlet Internal Diameter:`	The diameter of the aspiration nozzle inlet facing the free stream flow. Units are either millimeters (mm) or inches (in).
`Outlet Internal Diameter:`	At present the nozzle model includes only straight-tube nozzles, therefore the diameter of the nozzle outlet should be the same as the inlet. At present the nozzle model does not use the `Outlet Internal Diameter` in the calculations. However the ***Nozzle*** `Outlet Internal Diameter` is used to select the `Tube Inlet Diameter` of the next component, which in many cases will be an ***Expansion*** component. Units are either millimeters (mm) or inches (in).
`Nozzle Length:`	The length of the nozzle tube, similar to length for a straight tube. Units are either millimeters (mm) or inches (in).
`Free Stream Velocity:`	The velocity of the free stream flow at the location of the nozzle placement. The model assumes that the direction of the free stream flow and the nozzle inlet plane perpendicular are equal (isoaxial sampling condition). Units are either meters per second (m/s) or feet per second (ft/s)
`Inclination from horizontal:`	The angle that the axis of the component *inlet* makes with a horizontal reference plane (Figure 4). A negative inclination indicates the inlet flow is upward with respect to the vertical, positive inclination indicates the flow is downward. The inclination angle is given in degrees. Important cases include: • vertically downward: inclination angle = 90° • vertical upward: inclination angle = -90° • horizontal, flow to the left: inclination angle = 0° • horizontal, flow to the right: inclination angle = 180°
`Sample Flow Rate (actual):`	The volumetric flow rate of the air at the component inlet at the temperature and pressure of the component. Units are either liters per minute (LPM) or cubic feet per minute (CFM).
`Temperature:`	The temperature of air flow in the component. Units are either degrees Centigrade (C) or degrees Fahrenheit (F).

`Absolute Pressure:` The absolute pressure of the air in the component will typically be either ambient or just below ambient. Slight changes will have little effect on the deposition results. Units are either kilo Pascal (kPa) or pounds per square inch (psi).

3.9 Splitter component

The ***Splitter*** is a special component in a transport system. The most common use in a transport system is allow for a single probe to be used to extract a sample and deliver that sample to both a media collection system, such as a filter paper, and to deliver the same sample to a sample device equipped with a detector.

Deposition Calculator treats the ***Splitter*** component as an individual component that is not implemented in the *3-D Graphic Display* area. The ***Splitter*** component is selected by clicking the Splitter menu item of the Main *menu* (Figure 5).

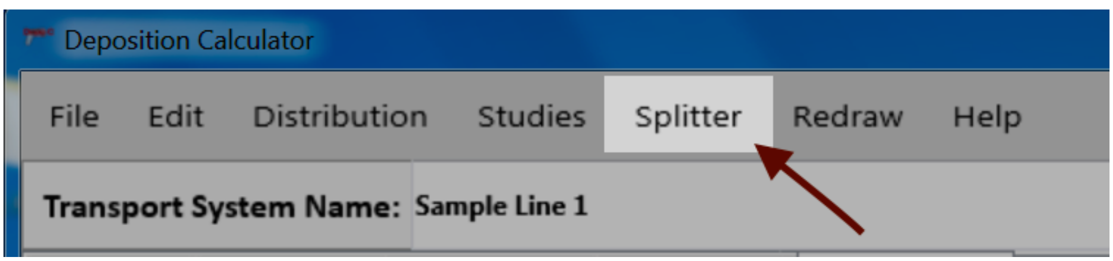


Figure 5: Splitter menu item

A new pop-up form is displayed for the ***Splitter*** component when the Splitter menu item is selected. (Figure 6) The only splitter that is programmed into Deposition Calculator is one that meets the geometrical dimensions of the drawing included in the Splitter form. Other splitter designs have not been implemented in this version of Deposition Calculator.

The model in the Deposition Calculator can also be used to design the ***Splitter*** component. When the user enters the data in the *Interactive Panel* of the form, the model calculates the remaining geometric parameters required for the splitter design some flow characteristics and the percent transmission of the particles of interest. The geometric parameters and the flow characteristics are present below the *Interactive Panel* in the *Design Information Panel* and the `component transmission`, given as a percentage, is presented at the top of the form. This approach ensures that only a splitter that meets all the geometric conditions of those tested are analyzed with this model. There are some limitations to this splitter model, which are presented in the *Limitation Panel*. This splitter design also assumes that the flow rate out each leg of the split is equal.

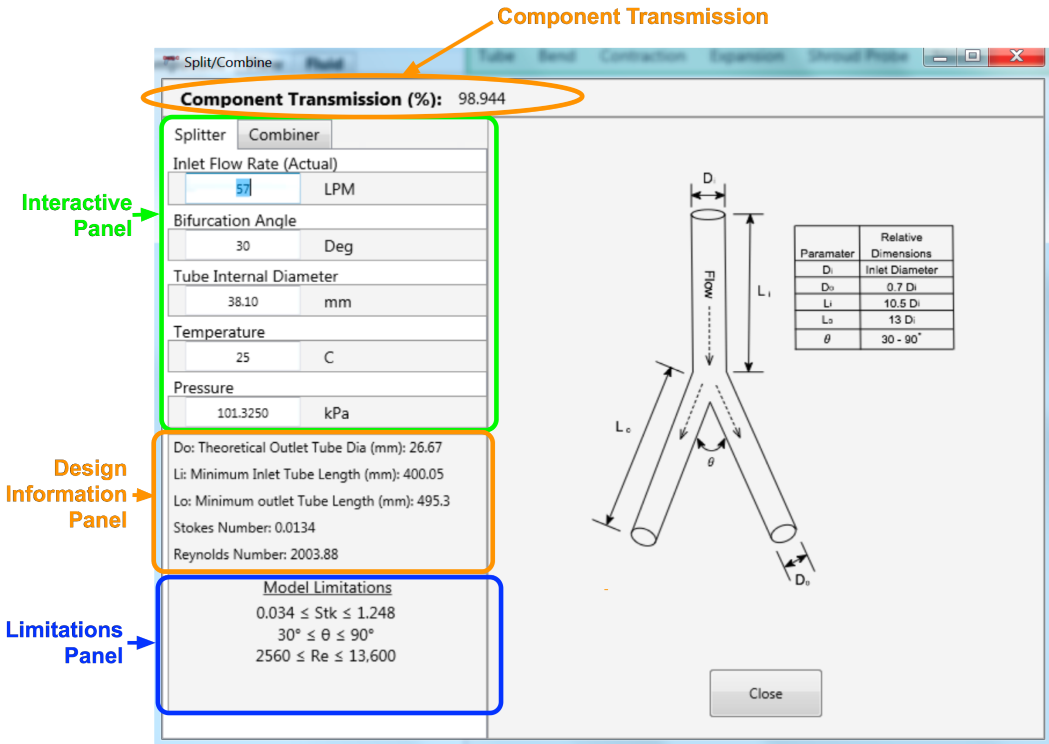


Figure 6: Splitter form

Once finished, the user should note the Transmission value, which would be applied to both legs of the split, and then select the **Close** button. At his time, there is not a print function for this form. If the user desires, a screen shot can be made using one of the programs designed for that purpose.

The following parameters are found in the *Interactive Panel*:

`Inlet Flow Rate (actual):` The volumetric flow rate of the air at the component inlet at the temperature and pressure of the component. Units are liters per minute (LPM).

`Bifurcation Angle:` The angle between the legs of the splitter. Shown as θ in Figure 6. Units are in degrees.

`Tube Internal Diameter:` The diameter of the *internal* surface of the inlet. Units are millimeters (mm).

`Temperature:`	The temperature of airflow in the component. Units are degrees Centigrade (C).
`Absolute Pressure:`	The absolute pressure of the air in the component will typically be either ambient or just below ambient. Slight changes will have little effect on the deposition results. Units are kilo Pascal (kPa).

The following parameters are found in the *Design Information Panel*:

D_o: `Theoretical Outlet Tube Diameter (mm):`	The diameter of the *internal* surface of the outlet. Generally the final component's outlet tube diameter should be with 5% of this value. Units are millimeters (mm).
L_i: `Minimum Inlet Tube Length (mm):`	The theoretical length of the inlet tube from the splitter entrance to the bifurcation angle. Generally the final component's inlet tube length should be with 5% of this value. For values greater than 5%, the user should add a tube section to the transport system to account for the additional length. Units are millimeters (mm).
L_0: `Minimum Outlet Tube Length (mm):`	The theoretical length of the outlet tube from the bifurcation angle to the outlet of the splitter. Generally the final component's outlet tube length should be with 5% of this value. For values greater than 5%, the user should add a tube section to the transport system to account for the additional length. Units are millimeters (mm).
`Stokes Number:`	The Stokes number is presented here for comparison to the Model limitations section. The Stokes number should be within the limits of the model.
`Reynolds Number`	The Reynolds number is presented here for comparison to the Model limitations section. The Reynolds number should be within the limits of the model

4 ANALYSIS RESULTS

As the transport system is being constructed Deposition Calculator provides transmission or penetration results with every new component and with any change to a component. The results are presented to the user by three methods, which are discussed below.

4.1 Individual Component Data Panel

Referring to Figure 1, the *Individual Component Data Panel* is located on the left side of the main UI. This panel provides data for each individual component of the transport system. The first four columns of this panel are displayed when Deposition Calculator begins, but there are a total of 10 columns. The units presented are those selected by the user for each parameter of that component. Therefore, both SI and English units may appear for any one component. When a parameter is not applicable for a particular component the value for that parameter is populated with an "NA". An example of the data that would be present for the transport system shown in Figure 1 is presented below as Table 1.

Table 1: Individual Component Data Panel for transport system depicted in Figure 1

Index	Component	Type	Transmission	Tube Length	Bend Angle	Bend Radius	Inlet Diameter	Outlet Diameter	Temperature
0	N-1 *	RF2-111	0.9500	NA	NA	NA	NA	NA	25.0 C
1	T-1	Tube	1.0000	1.00 m	NA	NA	38.10 mm	38.10 mm	25.0 C
2	B-1	Bend	0.9789	NA	90.00 Deg	0.102 m	38.10 mm	38.10 mm	25.0 C
3	T-2	Tube	0.8858	1.00 m	NA	NA	38.10 mm	38.10 mm	25.0 C
4	B-2	Bend	0.9789	NA	90.00 Deg	0.102 m	38.10 mm	38.10 mm	25.0 C
5	T-3	Tube	1.0000	3.0 m	NA	NA	38.10 mm	38.10 mm	25.0 C

4.2 Total System Results

Referring to Figure 1, the *Total System Results Panel* is located on the upper right side of the main UI. This value is the result of multiplying each individual Transmission value, as shown in the Individual Component Data Panel, by each other and then converting to a percentage. For this case:

(0.9500)(1.0000)(0.9789)(0.8858)(0.9789)(1.0000) = 0.8064 or 80.64%

As discussed in Section 2.4.4, ANSI N13.1-1999/2011 requires that at least 50% of the 10-μm AED particles entering the transport system penetrate the system to the sample collector. This limit has been annotated in the *Total System Results Panel* as a reminder to the user.

4.3 3D Graphic Display

As a visual aid to the user a 3D graphic of the transport system is provided in the *3D Graphic Display* area on the right of the main UI. The graphic can be rotated in any direction by first placing the cursor in the 3D Graphic Display area, then holding the left mouse button and moving the mouse. The Redraw menu item can be used to return the graphic to a default presentation.

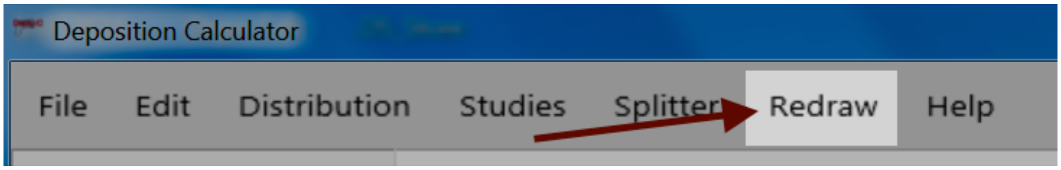


Figure 7: Redraw menu item

Note that the graphic is presented for visual affects only and is not always maintained to scale. The graphic can be printed, as will be discussed later in this manual.

5 MENU ITEMS

The main menu (Figure 8) is located in the upper left side of the main UI. Each menu item is discussed in this section.

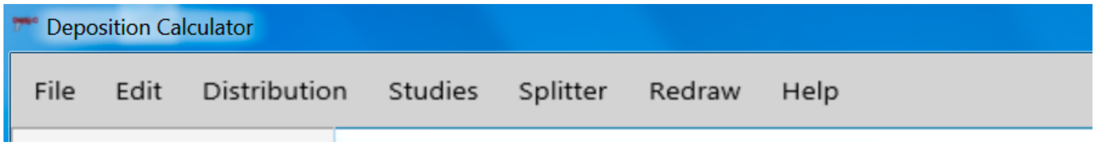


Figure 8: Deposition Calculator Main menu

5.1 File menu item

The File menu item has 6 sub-menu items (Figure 9).

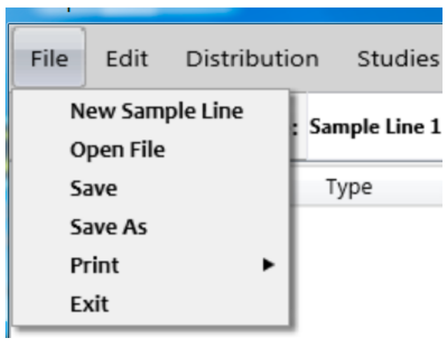


Figure 9: File sub-menu items

5.1.1 New Sample Line

The New Sample Line sub-menu item is used to create a new sample line or transport system. When selected the New Sample Line sub-menu item clears all three panels of the primary UI of any components and associated data. The only object that should appear is the “x, y, z indicator” on the *3D graphic display*. When the New Sample Line menu item is selected the user is prompted to save the existing sample line data. Additional detains are presented in Section 2.4.2 of this manual.

5.1.2 Open File

Previously saved transport systems can be re-opened for editing or analysis. To open a previously saved transport system, select Open File submenu item, and migrate the open file dialog to the appropriate folder containing the transport system file.

5.1.3 Save

Transport systems can be saved for later analysis or modification. To save a transport system, select either the Save or Save As sub-menu item. The Save sub-menu item will save the file by overwriting any existing file with the current file name. By default Deposition Calculator will save a file to the same director that it resides in.

5.1.4 Save As

Transport systems can be saved for later analysis or modification. To save a transport system, select either the Save or Save As sub-menu item. The Save As sub-menu item allows the user to specify a new name for the file. By default Deposition Calculator will save a file to the same director that it resides in.

5.1.5 Print

The Print sub-menu item can be used to print a *Results* Report or the *drawing*. Both of these printouts for the example transport system presented in Figure 1 are provided below as Figure 10 and Figure 11.

Results Report
Sample Line Name: 90
Total System Penetration = 80.64
Sample Flow Rate = 57.00 LPM

Free Stream Velocity = 10.00 m/s

Node	Penetration	Component
N-1 *	95.0 %	RF2-111; Ae = 1.11; WL = 0.15; Φ =-90.0 °
T-1	100.0 %	Tube; Di = 38.10 mm; L = 1.00 m; Φ = -90.0 °
B-1	97.9 %	Bend; Θ = 90.0 °; Ro= 3.8; Φ = -90.0 °
T-2	88.6 %	Tube; Di = 38.10 mm; L = 1.00 m; Φ = 0.0 °
B-2	97.9 %	Bend; Θ = 90.0 °; Ro= 3.8; Φ = 180.0 °
T-3	100.0 %	Tube; Di = 38.10 mm; L = 3.00 m; Φ = 90.0 °

Notes:
1) The values of % Penetration are estimates based upon correlations.
2) Calculations were made with the best possible extrapolations of the models.
3) ANSI N13.1-2011 states that the Curvature Ratio (Ro) shall be at least 3.0
4) The flow in Components with an "*" is in the transition range. The Transmission calculated for such components is an estimate based on selecting the best transmission using both the Laminar and the Turbulent models.

Nomenclature:

Di = Inlet Diameter	Do = Outlet Diameter
Θ = Bend Angle	Φ = Inclination from Horizontal
Ae = Aspiration ratio	WL = Wall Loss Fraction

Figure 10: Example printout of Results Report

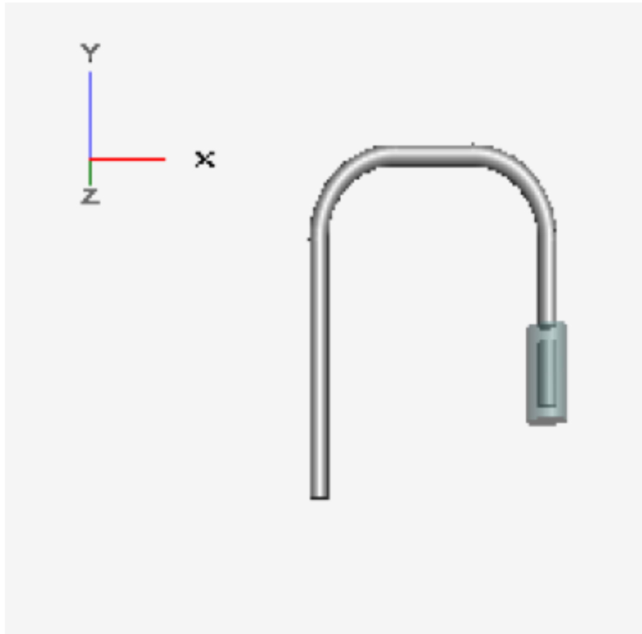


Figure 11: Example transport system printout

5.1.6 Exit

The Exit sub-menu item can be used to close the program. Deposition Calculator can also be closed with the standard windows x-icon in the upper right corner of the window.

5.2 Edit menu item

Using the sub-menu items (see Figure 12) in the Edit menu the user can modify a components properties, move a component to a different location in the transport system, or completely delete a component form the transport system.

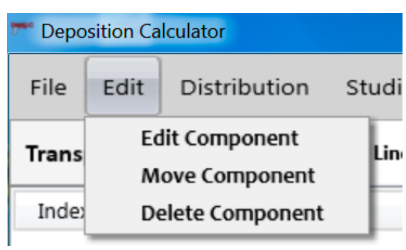
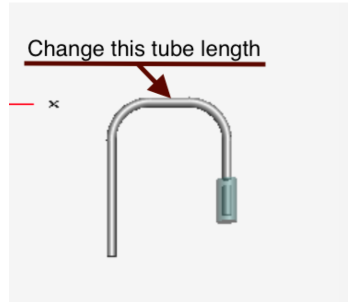


Figure 12: Edit sub-menu items

The following example illustrates how to change the length of component T-2 in the Figure 1 example transport system form 1 meter to 2 meters in length.

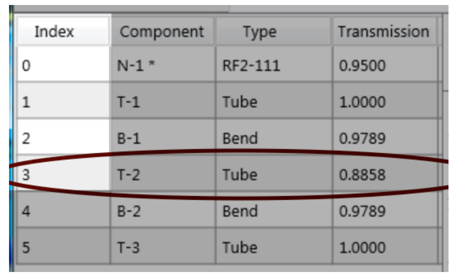
Step 1 Determine the component to change.

This is Component T-2; i.e. tube component number 2 in the transport system



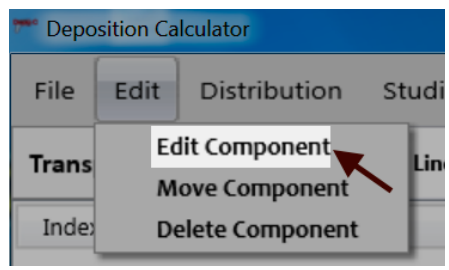
Step 2 Determine the Index number for the item. The index number can be found in the first column of the Individual Component Data panel.

In this Case Index number = 3

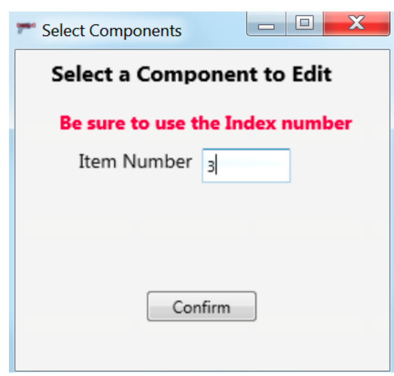


Index	Component	Type	Transmission
0	N-1 *	RF2-111	0.9500
1	T-1	Tube	1.0000
2	B-1	Bend	0.9789
3	T-2	Tube	0.8858
4	B-2	Bend	0.9789
5	T-3	Tube	1.0000

Step 3 Click on the Edit menu item and select the Edit Component sub-menu item.

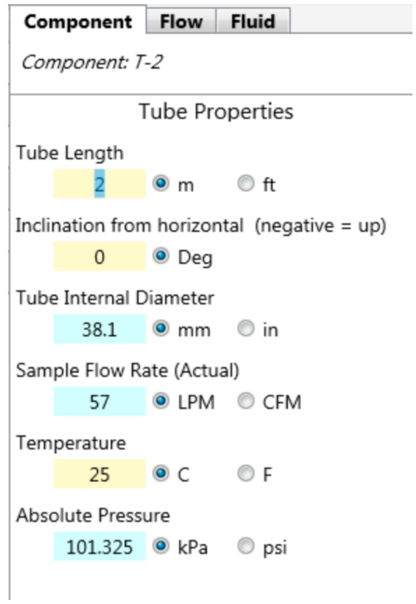


Step 4 A Pop-up window will appear where the Index number for the item is entered. In this case 3.
Then click the **Confirm** Button.



Step 5 The *Component tab* for the component to be edited will be populated and will appear in the *Current Component Data panel*.

Change the `Tube Length` to 2 meters.



Step 6 The 3D graphic will indicate the change, as will the values for T-2 in the *Individual Component Data Panel.* Note that the Transmission has changed from 0.8858 to 0.7795.

Index	Component	Type	Transmission
0	N-1 *	RF2-111	0.9500
1	T-1	Tube	1.0000
2	B-1	Bend	0.9789
3	T-2	Tube	0.7795
4	B-2	Bend	0.9789
5	T-3	Tube	1.0000

The procedure to move a component follow the same procedure, except both the index number of the component to be moved and the index location where the component will be moved are required.

The procedure for deleting a component only requires the index number of the component to delete.

5.3 Distribution menu item

The default particle distribution is a monodispersed 10 µm AED particle. However, Deposition Calculator can determine particle penetration for any particle size of particle distribution. To change either the particle size or to set a particle distribution, use the Distribution menu item.

When the Distribution menu item is clicked, a new pop-up window appears (Figure 13).

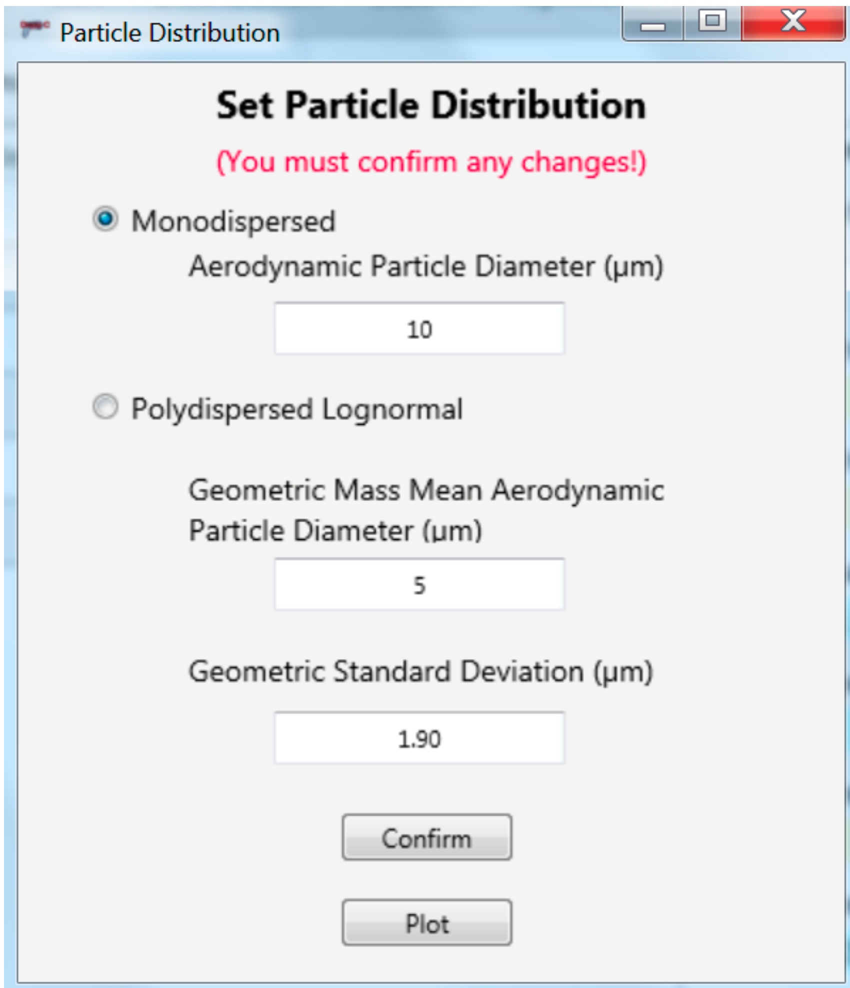


Figure 13: Particle distribution form

To change the particle size for a monodispersed, simply change the value in the `Aerodynamic Particle Diameter` field and leave the **Monodispersed Radio** Button checked. Click the **Confirm** button and the penetration analysis will be done with this new particle size.

Should a polydipsersed particle distribution be desired, then click the **Polydispered Lognormal** button; enter the `Geometric Mean Aerodynamic Particle Diameter` and the `Geometric Standard Deviation`. A plot of this distribution is available by clicking the

Plot button. A plot of a distribution with a 5 µm Geometric Mean Aerodynamic Particle Diameter and a 1.9 Geometric Standard Deviation is shown in Figure 14. When the **Confirm** button is clicked on the *Particle Distribution* form, Deposition Calculator will determine the particle penetration for the new distribution.

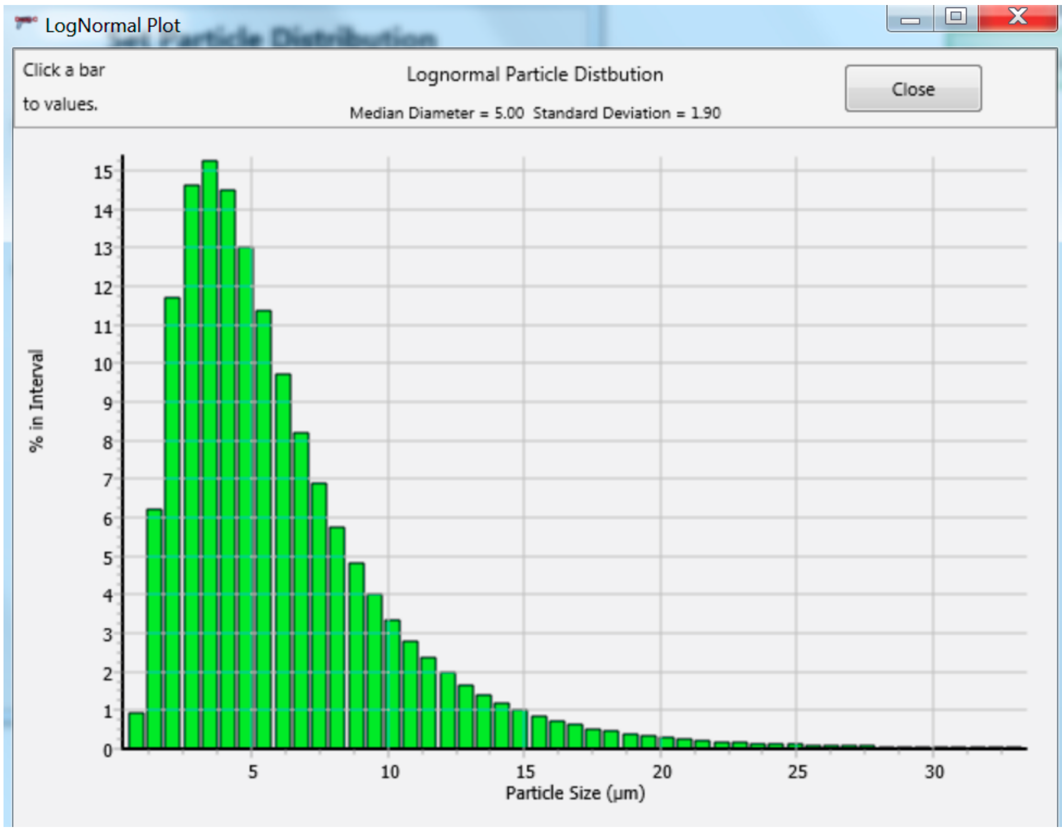


Figure 14: Lognormal particle distribution of a 5 µm geometric mean aerodynamic particle diameter and a 1.9 geometric standard deviation

Particle sizes used in Deposition Calculator are based on the Aerodynamic Diameter (AD) concept, where the particles are assumed to be spherical in shape and have a density of 1000 kg/m^3. Conversion of other particle densities to the AD can be performed by the user with the following equation, which is not included in the Deposition Calculator code.

$$D_{AD} = D_i \left(\frac{\rho_i}{1000\ kg/m^3} \right)^{0.5}$$

Where:

D_{AD} = aerodynamic diameter of a subject particle, m

D_i = actual diameter of a subject particle, m

ρ_i = density of a subject particle, kg/m^3

For example: A facility uses 3 μm plutonium dioxide particles with a density of 11.5 g/cm^3, what is the aerodynamic diameter that should be used in Deposition Calculator.

$$\mathrm{D_{AD}} = \mathrm{D_i}\left(\frac{\rho_i}{1000\ \mathrm{kg/m^3}}\right)^{0.5}$$

$$\mathrm{D_{AD}} = (3\ \mu m)(1\text{E-}06\ \mathrm{m}/\mu m)\left[\frac{(11.5\ g/cm^3)\left(1000\ \frac{kg/m^3}{g/cm^3}\right)}{1000\ \mathrm{kg/m^3}}\right]^{0.5}$$

$$\mathrm{D_{AD}} = 1.02\text{E-}06\ \mathrm{m}$$

or 10.2 μm.

This indicates that a 3 μm particle with a density of 11.5 g/cm^3 settles at the same velocity as a 10.2 μm particle with a density of 1 g/cm^3.

5.4 Studies menu item

Deposition Calculator has the ability to perform studies where a particular parameter is varied to determine the affect on transport system performance. The Studies menu item is used to get to these studies. When the *Studies* menu item is selected a new pop-up window appears (Figure 15). There are three parameters that can be varied: Tube Diameter, Flow rate, and Particle size. For the particle size study, only monodispersed particle distributes are allowed.

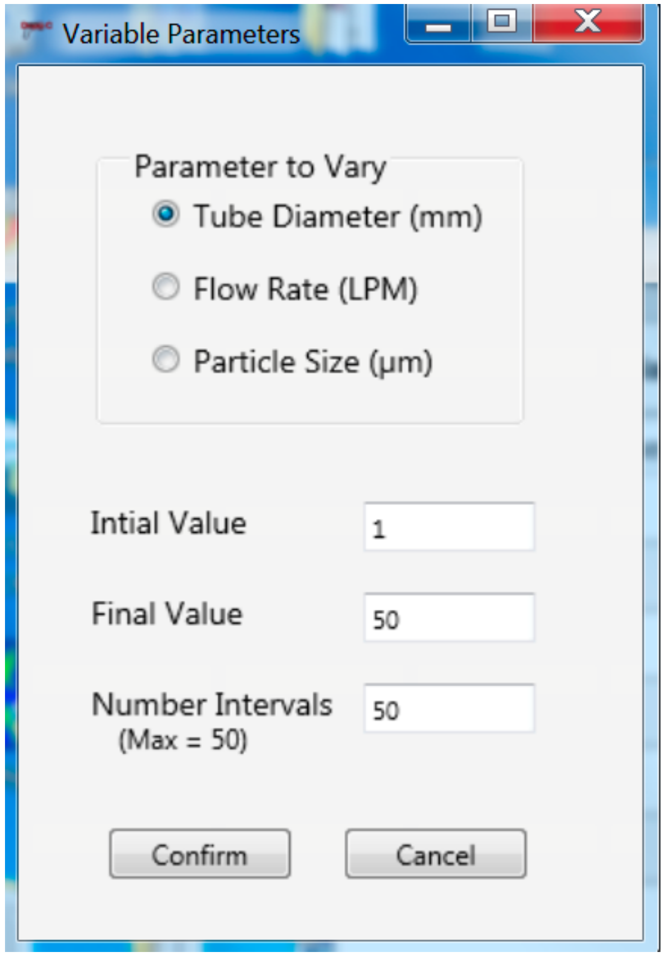


Figure 15: Variable parameters form

To perform a study, the user would select the study desired by clicking the appropriate radio button. Then enter the `Initial Value`, the **Final Value** and the `Number of Intervals` to evaluate. Using the example transport system for Figure 1, the follow plots are obtained for each type of study. The `Initial Value`, `Final Value` and `Number of Intervals` are given in the caption for each plot.

Upon closing the plot window, the data used to generate the plots can be saved to a '.csv' file. A '.cvs' file is a comma delimited file that can be opened in various spreadsheet and text programs.

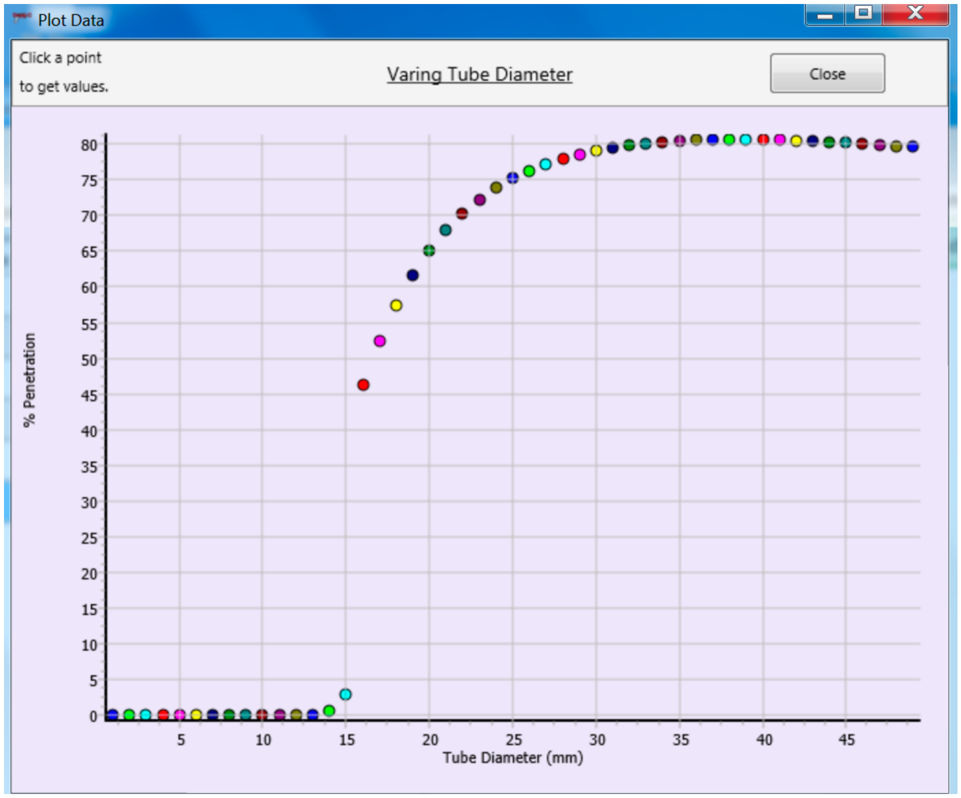


Figure 16: Vary tube size: Initial value =1 mm, Final value = 50 mm, 50 intervals

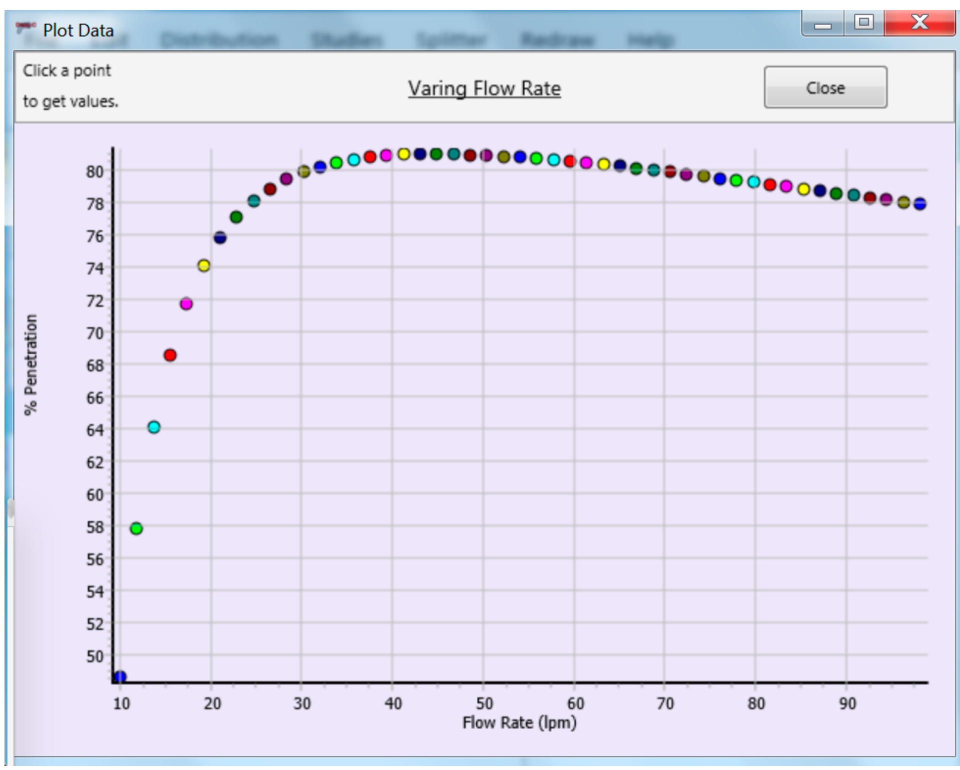


Figure 17: Vary flow rate: Initial value = 10 LPM, Final value 100 LPM, 50 intervals

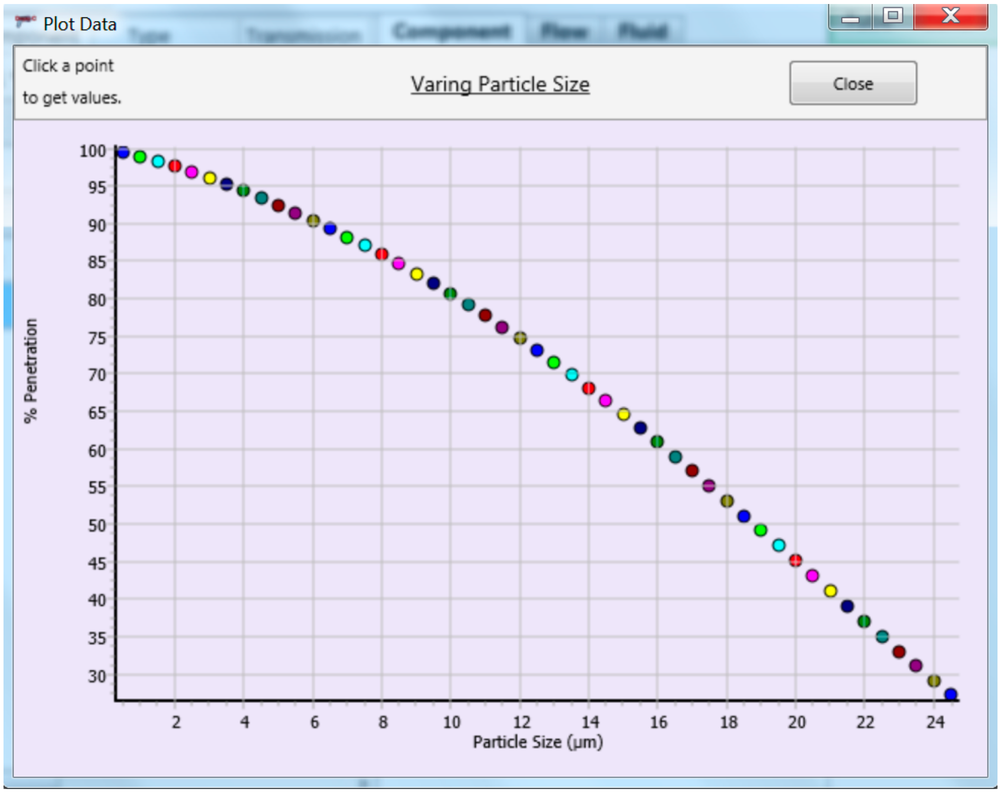


Figure 18: Vary particle size: Initial value = 0.5 μm, Final value 25 μm, 50 intervals

5.5 Splitter menu item

This menu item is discussed in detail in Section 3.9 of this manual.

5.6 Redraw menu item

As discussed in Section 4.3 of this manual, the Redraw menu item returns the 3D graphic to a default orientation. After manipulating the graphic, it is much fast to return to the starting orientation with this menu item.

5.7 Help menu item

The Help menu item currently only provides information, such as version number and copyright information.

6 TEST CASES

Two test cases are provided in this manual. These test cases can be used to validate that the Deposition Calculator software is operating correctly.

6.1 Test Case 1

Test case 1 is a simple transport system very similar to that shown in Figure 1 of this manual. A contraction has been added at the end of the vertical tube to accommodate the entry into an alpha monitor, which requires a 1-inch (25.4 mm) tube. The alpha monitor would be analyzed separately.

6.1.1 Description of transport system

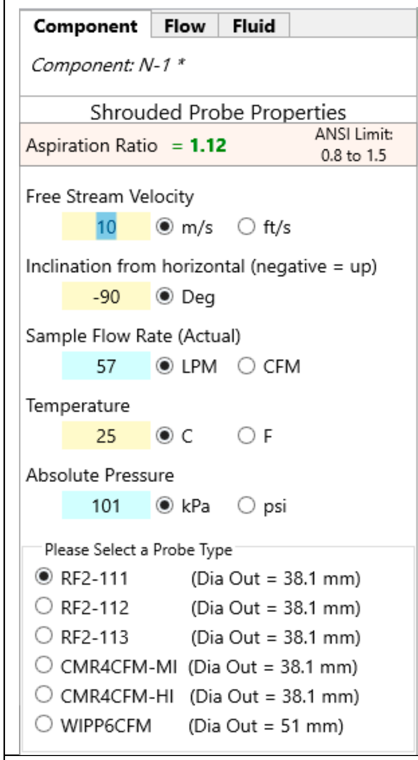
In this case study, the sampling system extracts aerosol particles from a vertical stack having a free stream velocity of 10 m/s, where the average temperature in the stack is 25 °C, and an absolute pressure 101 kPa. Particles having an aerodynamic diameter of 10 µm are extracted from the stack using an RF2-111 shrouded probe with a sample flow rate of 57 L/min (2 CFM). The probe is connected to a 1 m vertical tube before being redirected horizontally in a sweep elbow having a bend radius of 0.2 m. The sample flow continues through a horizontal tube having a length of 1 m through a port in the stack wall. Upon exit from the stack, the sample line is redirected vertically downward with a 90° elbow having a bend radius of 0.2 m. The sample continues down a 3 m sample line to a contraction. The contraction has a half angle of 45° and the exit diameter is 25.4 mm.

6.1.2 Modeling the system in Deposition Calculator

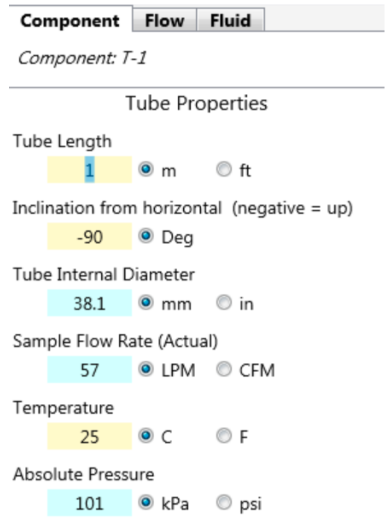
The Deposition Calculator component entry tab for each component is presented in Table 2.

Table 2: Component tabs for Case 1

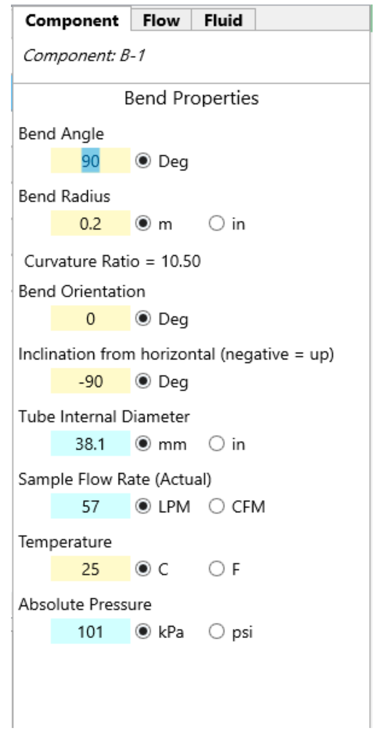
Index Item 0



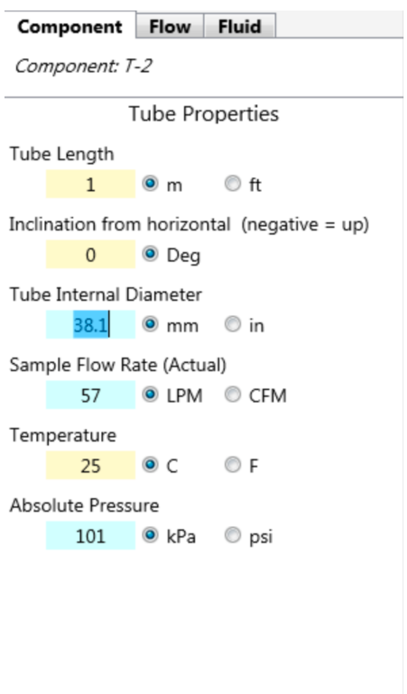
Index Item 1



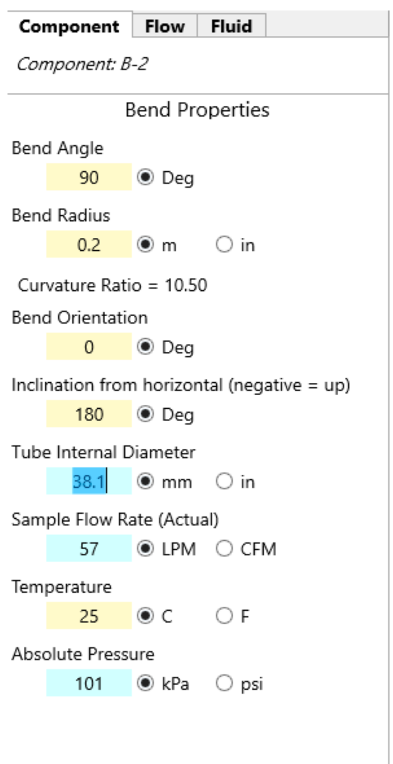
Index Item 2



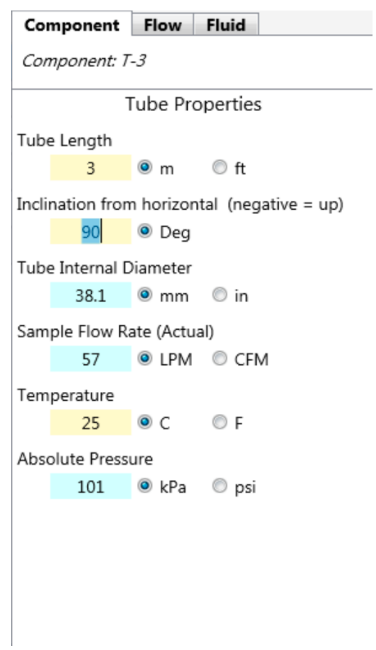
Index Item 3



Index Item 4



Index Item 5



The main Deposition Calculator form after entry of all components is presented as Figure 19. Note that the total particle penetration for Case 1 is 83.40%.

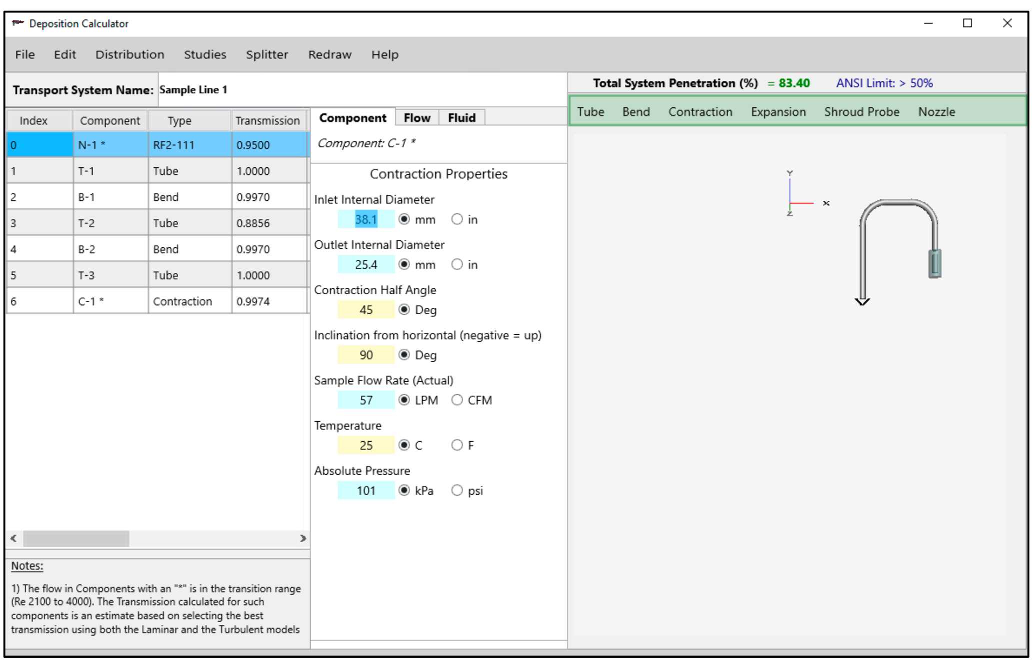


Figure 19: Case 1 Deposition Calculator Screen after entry of all components

6.1.3 Results from Case 1 analysis

Once all components are entered, the *Individual Component Data Panel* will be populated as shown in Table 3.

Table 3: Individual Component Data Panel for Case 1

Index	Component	Type	Transmission	Tube Length	Bend Angle	Bend Radius	Inlet Diameter	Outlet Diameter	Temperature
0	N-1 *	RF2-111	0.9500	NA	NA	NA	NA	NA	25.0 C
1	T-1	Tube	1.0000	1.00 m	NA	NA	38.10 mm	38.10 mm	25.0 C
2	B-1	Bend	0.9970	NA	90.00 Deg	0.200 m	38.10 mm	38.10 mm	25.0 C
3	T-2	Tube	0.8856	1.00 m	NA	NA	38.10 mm	38.10 mm	25.0 C
4	B-2	Bend	0.997	NA	90.00 Deg	0.200 m	38.10 mm	38.10 mm	25.0 C
5	T-3	Tube	1.0000	3.00 m	NA	NA	38.10 mm	38.10 mm	25.0 C
6	C-1 *	Contraction	0.9974	NA	NA	NA	38.10 mm	25.40 mm	25.0 C

The Results Report is presented as Figure 20. The user can check the Case 1 results by printing the Results Report from the File menu.

Results Report

Sample Line Name: Sample Line 1

Total System Penetration = 83.40

Sample Flow Rate = 57.00 LPM

Free Stream Velocity = 10.00 m/s

Node	Penetration	Component
N-1 *	95.0 %	RF2-111; Ac = 1.12; WL = 0.15; Φ = -90.0 °
T-1	100.0 %	Tube; Di = 38.10 mm; L = 1.00 m; Φ = -90.0 °
B-1	99.7 %	Bend; Θ = 90.0 °; Ro= 1.9; Φ = -90.0 °
T-2	88.6 %	Tube; Di = 38.10 mm; L = 1.00 m; Φ = 0.0 °
B-2	99.7 %	Bend; Θ = 90.0 °; Ro= 1.9; Φ = 180.0 °
T-3	100.0 %	Tube; Di = 38.10 mm; L = 3.00 m; Φ = 90.0 °
C-1 *	99.7 %	Contraction; Di = 38.10 mm; Do = 25.40 mm; Φ = 90.0 °

Notes:

1) The values of % Penetration are estimates based upon correlations.
2) Calculations were made with the best possible extrapolations of the models.
3) ANSI N13.1-2011 states that the Curvature Ratio (Ro) shall be at least 3.0
4) The flow in Components with an "*" is in the transition range. The Transmission calculated for such components is an estimate based on selecting the best transmission using both the Laminar and the Turbulent models.

Nomenclature:

Di = Inlet Diameter Do = Outlet Diameter

Θ = Bend Angle Φ = Inclination from Horizontal

Figure 20: Case 1 Results Report

6.2 Test Case 2

Test Case 2 is a more complex system and demonstrates how to include an isokinetic sample nozzle, which has an increasing internal diameter. This case also demonstrates a transport system that has a penetration of less than 50% and would not meet the ANSI N13.1-1999/2011 criteria.

6.2.1 Description of transport system

In this case study, the sampling system extracts aerosol particles from a vertical stack having a free stream velocity of 9 m/s, where the average temperature in the stack is 46 °C, and an absolute pressure 98 kPa. Particles having an aerodynamic diameter of 10 µm are extracted from the stack using an isokinetic nozzle with a sample flow rate of 56.6 L/min (2 CFM). In order to accommodate the isokinetic condition, the nozzle inlet size must be 11.5 mm. The sample flow at the nozzle exit is expanded to a diameter of 25.4 mm (1 inch) in a tapered expansion having an expansion angle of 30°. The extracted aerosol is then redirected horizontally in a sweep elbow having a bend radius of 0.15 m. The sample flow continues through a horizontal tube having a length of 3 m through a port in the stack wall. Upon exit from the stack, the sample line is redirected in the horizontal plane through a bend angle of 90° to avoid conflict with a support beam located just outside the stack wall. Finally, the sample line is redirected vertically downward with third 90° elbow having a bend radius of 0.2 m. After exiting the final sweep elbow the particles are collected on a filter sampler. In order to provide adequate face area of the filter sampler, the flow is expanded to a diameter of 95 mm just upstream of the filter surface (Figure 21). The 3D presentation of this sample line is presented below as Figure 22. Note that the expansion components appear as a tube with wings, where the wings expand in the direction of flow.

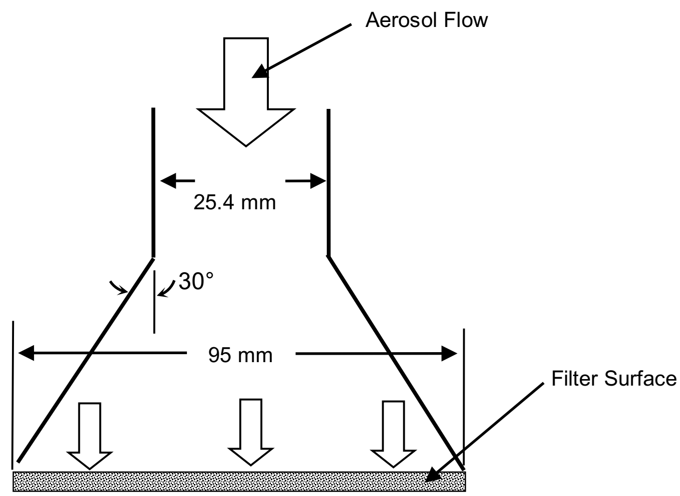


Figure 21: Internal flow path details of sample line connection to filter

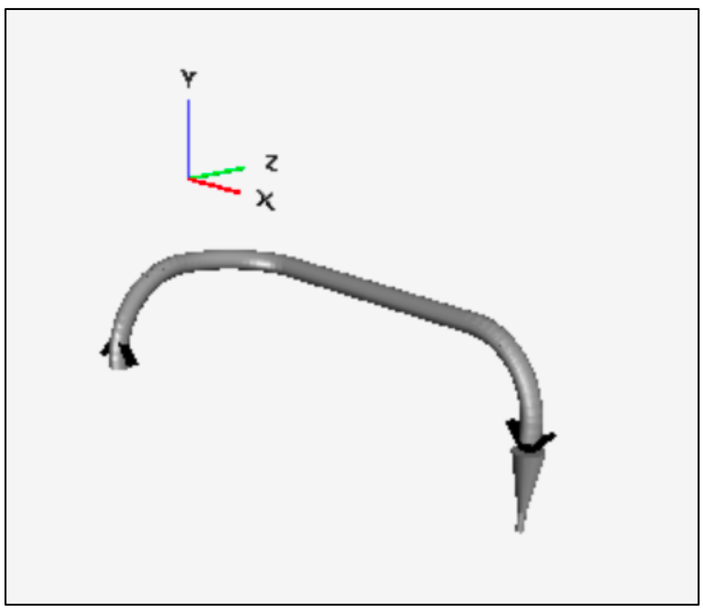


Figure 22: 3D presentation of Case 2 transport system

6.2.2 Modeling the system in Deposition Calculator

In order to model the physical system in Deposition, it is important to remember that physically continuous sample tubing or components may require more than one component for accurate representation. In the case considered here, the isokinetic nozzle will be modeled as two components: a short isokinetic nozzle (100 mm in length) and a tapered expansion. Both components are required in this case as the standard model for a sharp-edge sampling nozzle considers nozzles having parallel walls (inlet and outlet diameters equal). Since in the physical system the flow is gradually expanded from 11.5 mm to 25.4 mm after aspiration, an expansion model will be required. In addition, the filter sampler must also include an expansion model since the flow path expands to 95 mm prior to collection of particles on the filter surface. These two details may escape notice in the initial review of the physical system and illustrate the caution that must be exercised in developing a representative Deposition Calculation model. The remaining components between the inlet and outlet require no special treatment. The Deposition Calculator component entry tab for each component is presented in Table 4. Note that the aspiration ratio for the nozzle is 1.00, which by definition is isokinetic.

The main Deposition Calculator form after entry of all components is presented as Figure 23. Note that the total particle penetration for Case 2 is 32.57%.

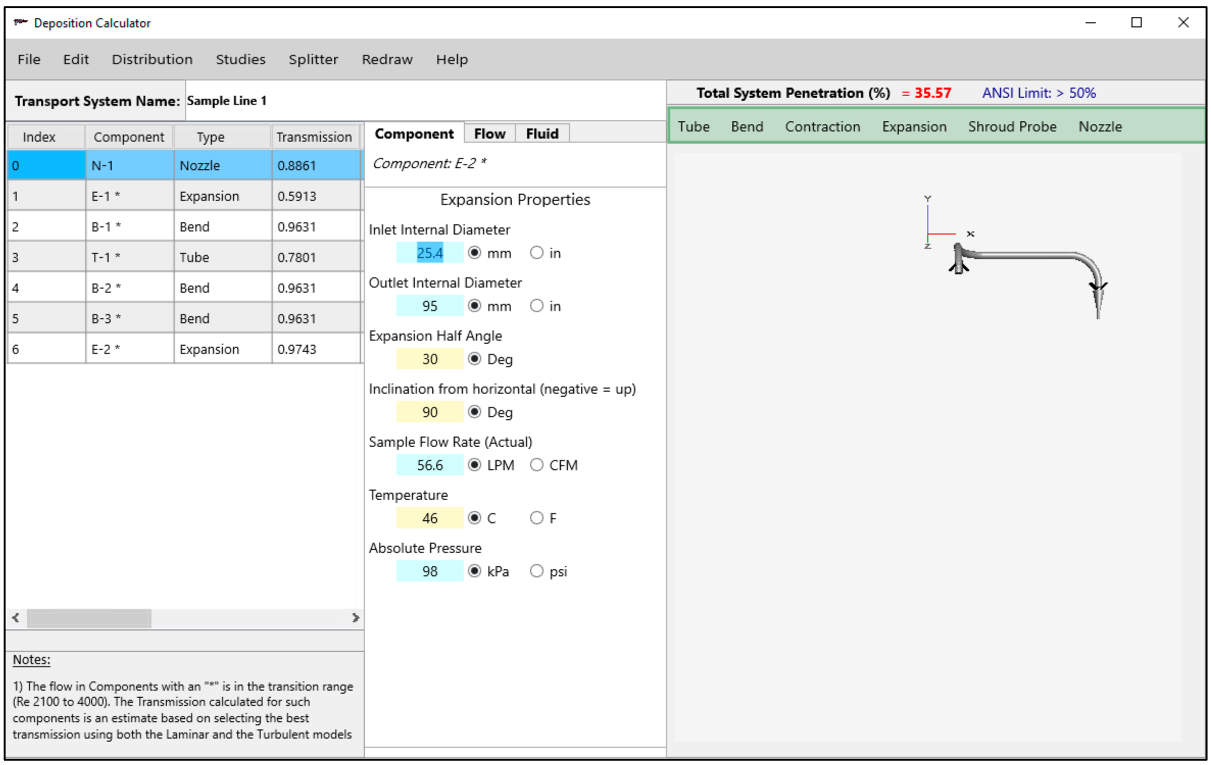
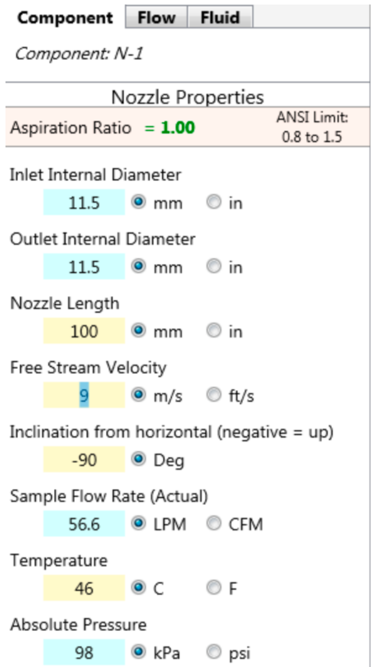


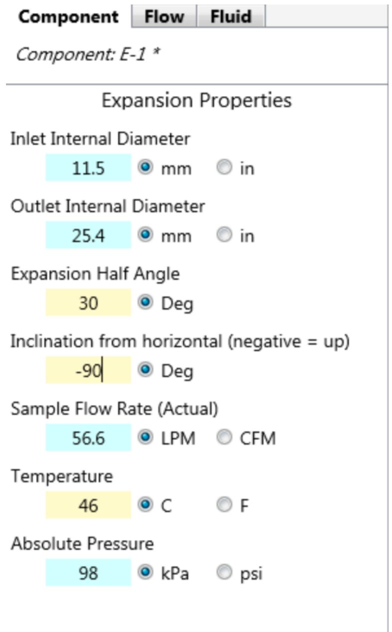
Figure 23: Case 2 Deposition Calculator Screen after entry of all components

Table 4: Component tabs for Case 2

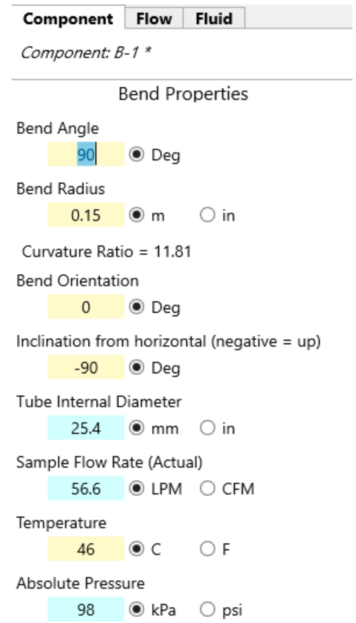
Index Item 0



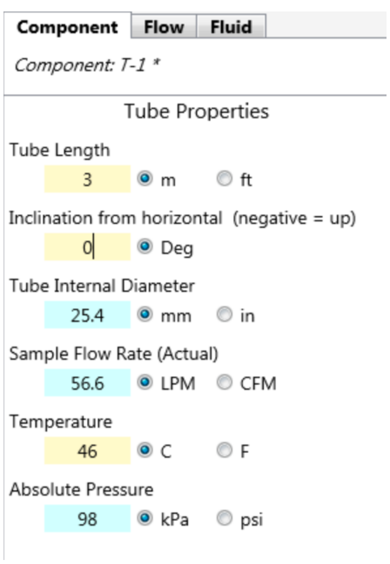
Index Item 1



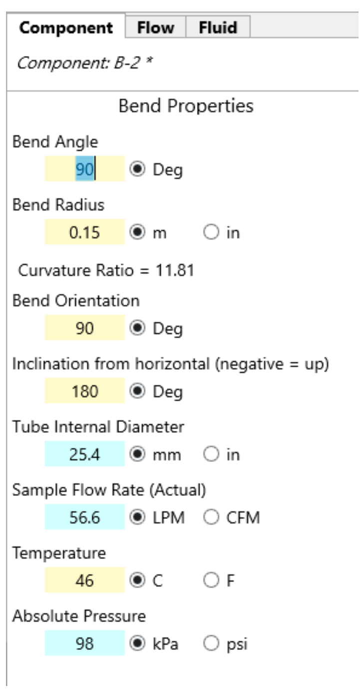
Index Item 2



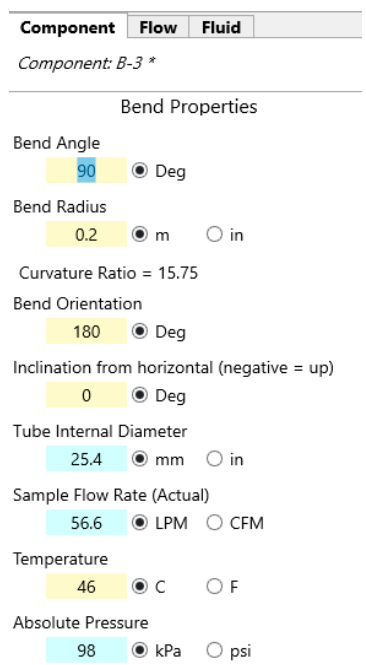
Index Item 3



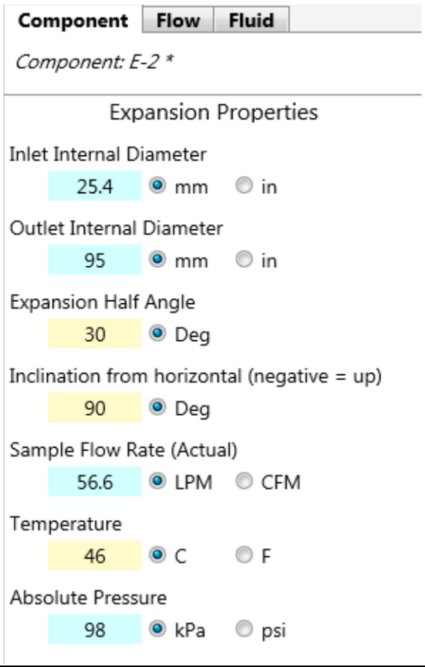
Index Item 4



Index Item 5



Index Item 6



6.2.3 *Results from Case 2 analysis*

Once all components are entered, the *Individual Component Data Panel* will be populated as shown in Table 5.

Table 5: Individual Component Data Panel for Case 2

Index	Component	Type	Transmission	Tube Length	Bend Angle	Bend Radius	Inlet Diameter	Outlet Diameter	Temperature
0	N-1*	Nozzle	0.8861	NA	NA	NA	NA	NA	46.0 C
1	E-1*	Expansion	0.5913	NA	NA	NA	11.50 mm	25.40 mm	46.0 C
2	B-1*	Bend	0.9631	NA	90.00 Deg	0.150 m	25.40 mm	25.40 mm	46.0 C
3	T-1*	Tube	0.7801	1.00 m	NA	NA	25.40 mm	25.40 mm	46.0 C
4	B-2*	Bend	0.9631	NA	90.00 Deg	0.150 m	25.40 mm	25.40 mm	46.0 C
5	B-3*	Bend	0.9631	NA	90.00 Deg	0.200 m	25.40 mm	25.40 mm	46.0 C
6	E-2*	Expansion	0.9743	NA	NA	NA	25.40 mm	95.00 mm	46.0 C

The Results Report is presented as Figure 24. The user can check the Case 2 results by printing the Results Report form the File menu.

Results Report

Sample Line Name: Sample Line 1

Total System Penetration = 35.57

Sample Flow Rate = 56.60 LPM

Free Stream Velocity = 9.00 m/s

Node	Penetration	Component
N-1	88.6 %	Nozzle; Di= 11.50 mm; Ac= 1.00; WL= 0.11; Φ = -90.0 °
E-1 *	59.1 %	Expansion; Di = 11.50 mm; Do = 25.40 mm; Φ = -90.0 °
B-1 *	96.3 %	Bend; Θ = 90.0 °; Ro= 1.7; Φ = -90.0 °
T-1 *	78.0 %	Tube; Di = 25.40 mm; L = 3.00 m; Φ = 0.0 °
B-2 *	96.3 %	Bend; Θ = 90.0 °; Ro= 1.7; Φ = 180.0 °
B-3 *	96.3 %	Bend; Θ = 90.0 °; Ro= 1.3; Φ = 0.0 °
E-2 *	97.4 %	Expansion; Di = 25.40 mm; Do = 95.00 mm; Φ = 90.0 °

Notes:

1) The values of % Penetration are estimates based upon correlations.
2) Calculations were made with the best possible extrapolations of the models.
3) ANSI N13.1-2011 states that the Curvature Ratio (Ro) shall be at least 3.0
4) The flow in Components with an "*" is in the transition range. The Transmission calculated for such components is an estimate based on selecting the best transmission using both the Laminar and the Turbulent models.

Nomenclature:

Di = Inlet Diameter   Do = Outlet Diameter

Θ = Bend Angle   Φ = Inclination from Horizontal

Figure 24: Case 2 Results Report

6.3 Test Case 3

Test Case 3 is a check of the splitter module. All of the entry fields and results are presented on the Splitter form. The user can verify that the splitter module is working proper by entering a splitter with a 65° bifurcation angle and an Inlet flow rate of 85 LPM. The results should match all the values in Figure 25.

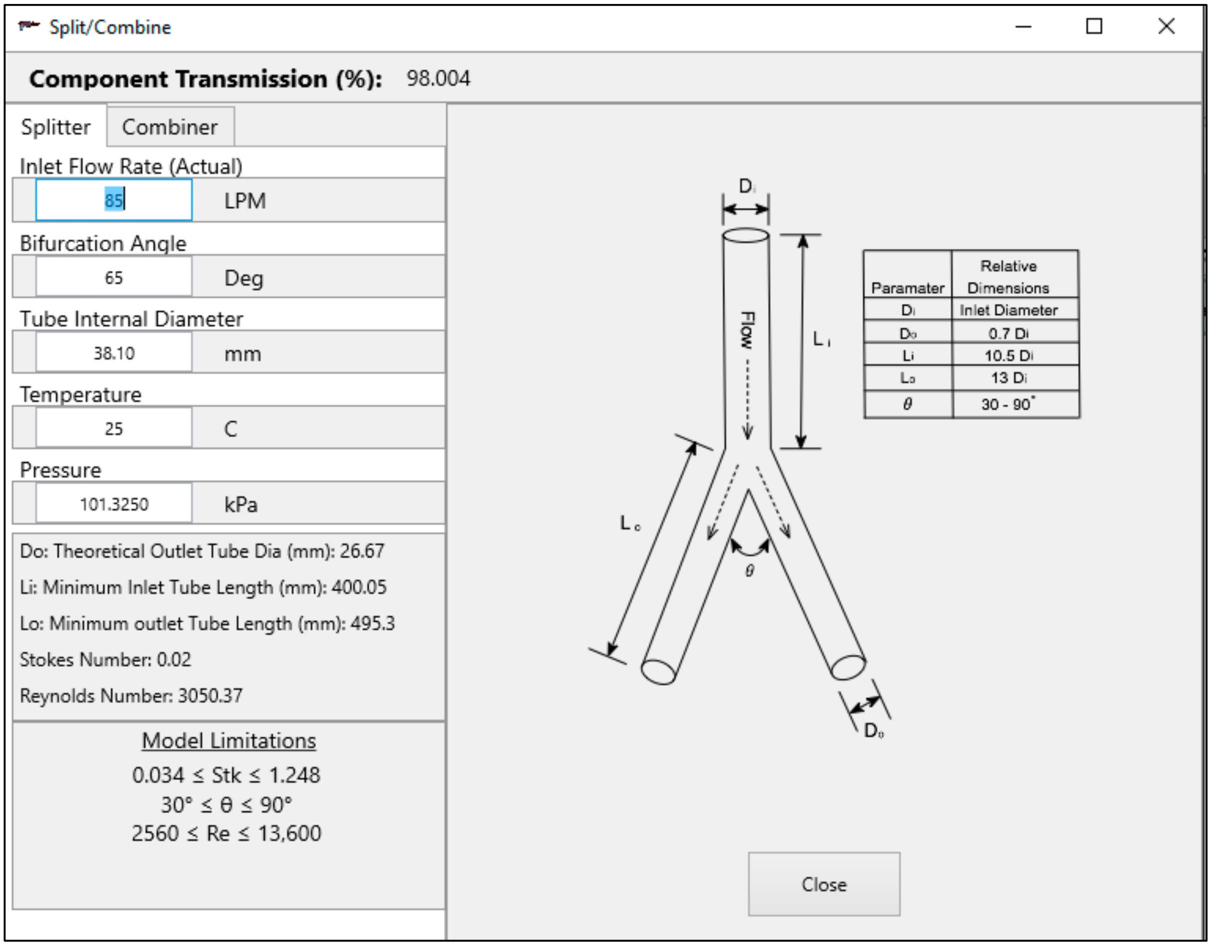


Figure 25: Case 3 form