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ES122429-L

Perfecting the System for Revit – HVAC System Exercises

David A. Butts
Gannett Fleming

Learning Objectives

- Learn comprehensive steps for controlling project system settings, including mechanical and electrical system project settings
- Learn how to capitalize on the system sizing and analysis tools, and learn how to maximize project performance when you don't need these features
- Understand how to create the target and source relationship between equipment without routing a duct, pipe, or wire
- Learn how to improve the quality of your construction documents by capitalizing on system-based features

Description

Revit software systems help us to define the MEP (mechanical, electrical, and plumbing) design in several ways, but the main purpose is to understand the relationships between system equipment, such as air terminals to air handling units, or from light fixture to panel. This hands-on lab will teach you the comprehensive steps needed for controlling project system settings, and then it will demonstrate how to capitalize on (or disable) sizing and analysis tools related to the system. We'll cover creating the target-source relationship between parts, and then we'll review using the systems to improve the quality of your documentation. On top of this, you'll get a project template that already defines everything in the class, so you can take advantage of these topics right away. The class will cover HVAC (heating, ventilating, and air conditioning) and piping, so come and join us for this fast-paced but thorough lab—you'll be glad you did! This session features Revit MEP and Revit.

Your AU Expert

David Butts is an Autodesk Expert Elite Team member and Building Information Modeling (BIM) specialist for Gannett Fleming with over 30 years of experience in the architecture, engineering, and construction field. He is responsible for implementation, training, BIM project support, and management for engineering design applications, including Revit, AutoCAD P&ID, AutoCAD MEP, Navisworks, and more. He was an Autodesk Authorized Training Center (ATC) training manager and application engineer for an Autodesk Reseller for 13 years, providing implementation and training services across the United States, and serving as a subject matter expert for Autodesk, Inc.'s, Building Design Solutions. He has design experience for a variety of project types, and is an Autodesk University top-rated speaker for labs and lectures. He authored training videos for 4D Technologies through the 2018 product cycle and presents BIM topics for other industry associations annually.

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Perfecting the HVAC System for Revit

When you are designing a project, there's a big difference in how you approach your work in CAD project versus a BIM project. In BIM there are tasks you have to complete that never came up in a 2D project, but then there was a high likelihood of signals getting crossed, and systems being incorrectly defined. Revit's system tools, which have been around since the beginning of the MEP tools, continue to be refined and improved. That is the focus of this session, and hopefully you will take away some information to help you leverage the benefits for these tools.

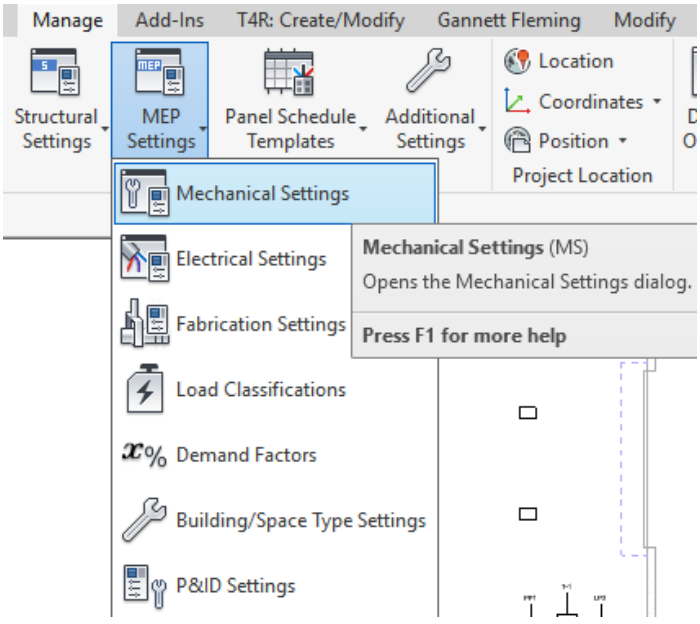
In this document, the specific steps for editing HVAC system settings, and creating the systems, are covered. Refer to the document, *BES227181-LPerfecting the System Intro - DB*, for the work process overview.

For this exercise, begin by opening the **BES227181-L-MEP.RVT** model. Make sure the **HVAC FIRST FLOOR** view is the current view.

Defining Project HVAC System Settings

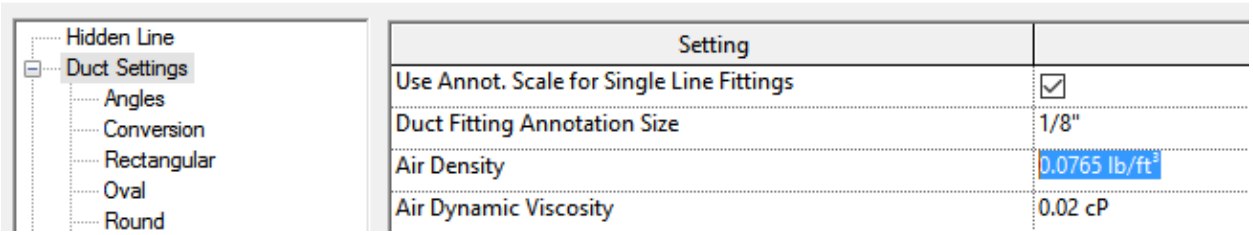
When you start from a template, you can include predefined settings that apply to the most common project types. Behind the scenes, there are common project tools that impact how duct, pipe, circuiting and more are defined in the project model, so it is a logical place to start when working with systems. To begin, review the MEP project settings that affect all systems in the project.

1. From the **Manage** tab, settings panel, click **MEP Settings**:



2. Click **Mechanical Settings**, and then click **Duct Settings**:

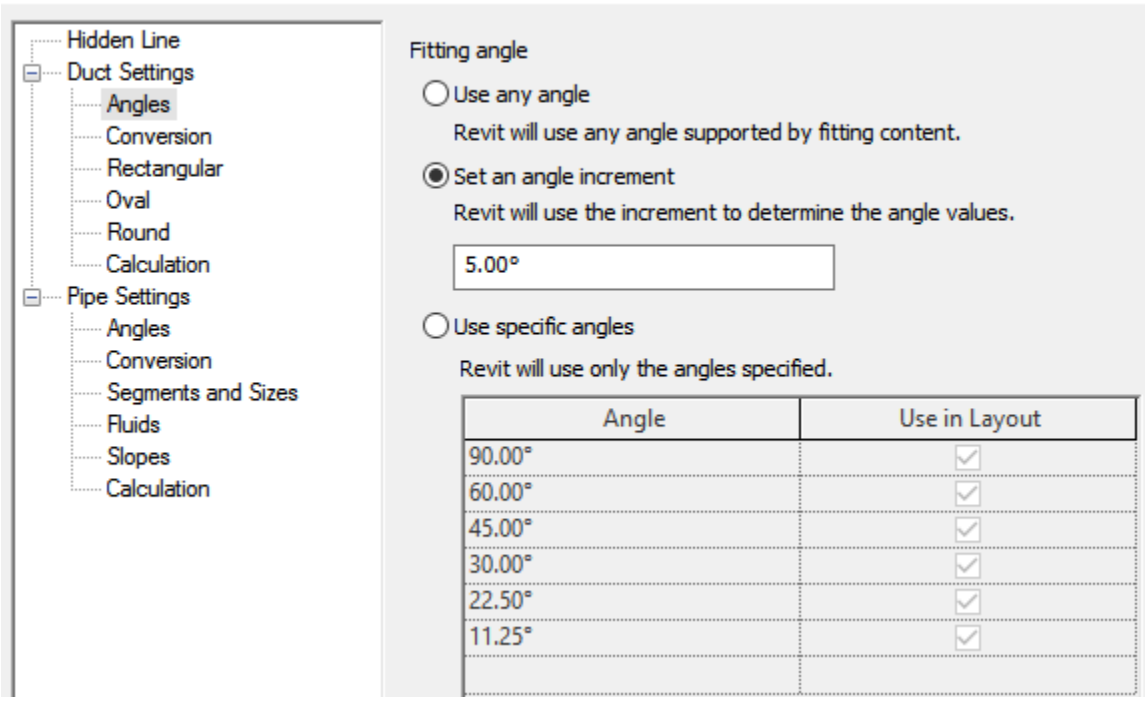
Mechanical Settings



Set the **Air Density** to **0.0765**.
Air Density and **Air Dynamic viscosity** are project specific settings used in duct system sizing.

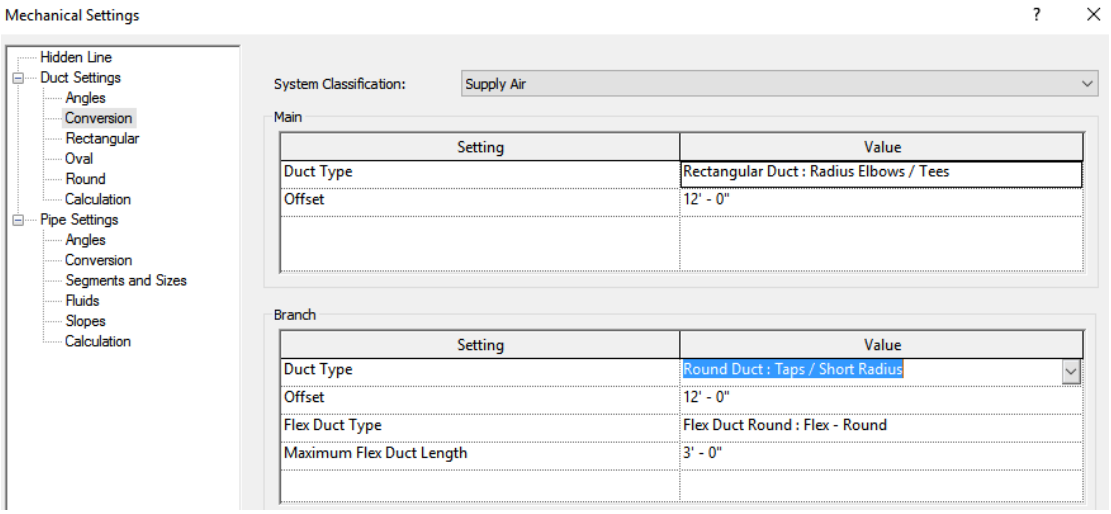
3. Select **Angles:**

Mechanical Settings



Select **Set an Angle Increment** as the default for duct elbow fitting settings, and set the value to **5** degrees. This forces all ducts in a project, included layouts defined by the system, to be placed in specific angle increments.

4. Select **Conversion:**



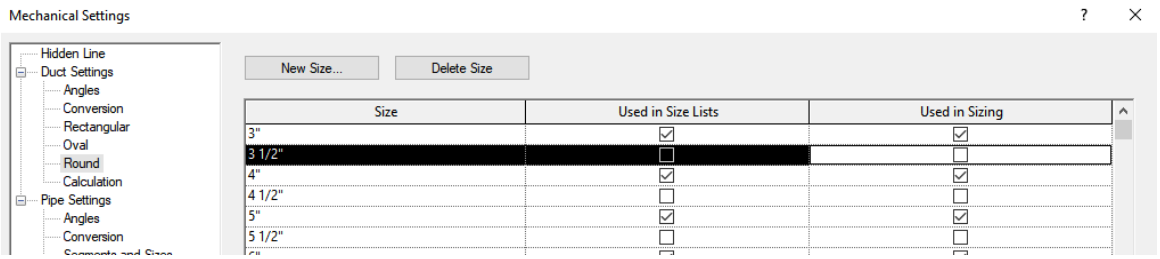
Change the **Branch Duct Type** to use **Round Duct: Taps / Short Radius**.

This sets the default duct type and routing offset elevation for mains and branches, and comes in handy when using the auto-layout tools for connected HVAC system classifications (based on *supply, return* and *exhaust* air).

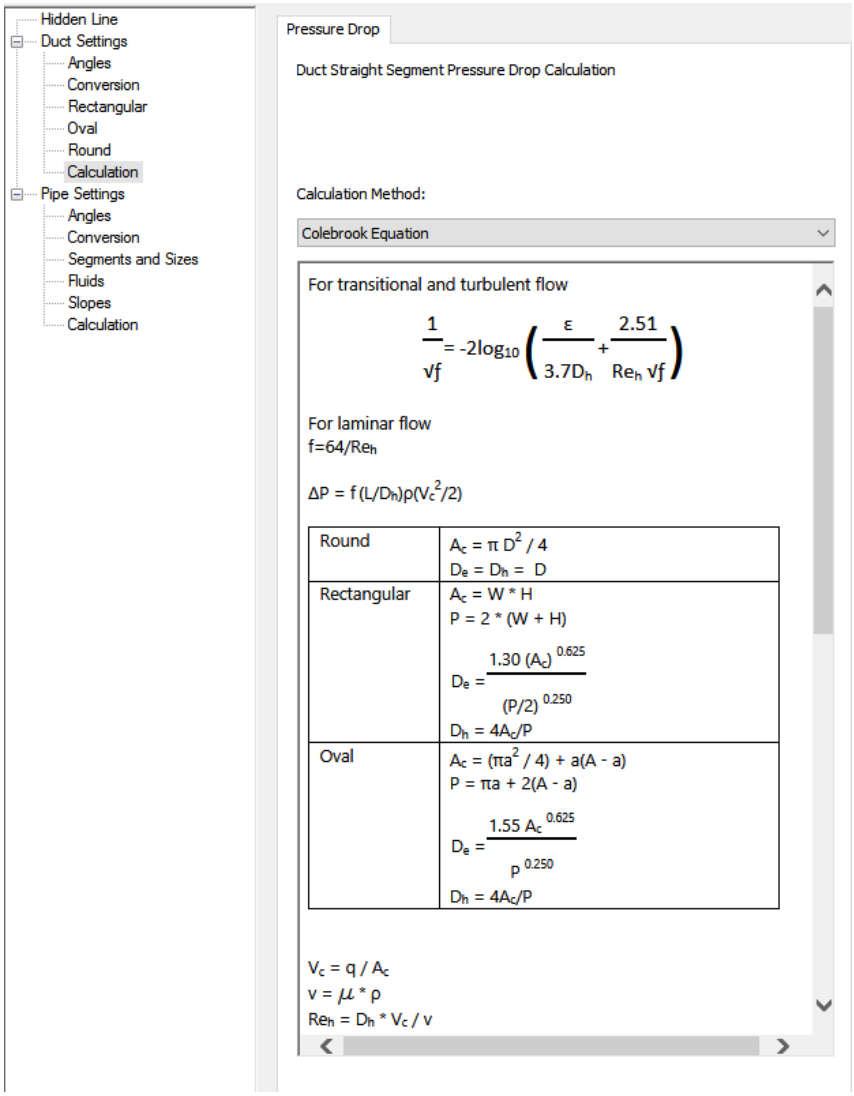
5. Select **Round** to see the default round duct sizes**:**

Deselect all **½" sizes** from the **Used in Size Lists** and **Used in Sizing** columns.

Default *sizes* for *rectangular/oval/round* duct and what is used for the size list, as well as for default sizes used by the duct system sizing tool.



6. Select **Calculation:**



For **Calculation Method**, select the **Colebrook Equation** pressure drop calculation.

In earlier releases, you could only use the built in formulas while making minor modifications in the duct system. Now, you can choose between different formulas to calculate *pressure drop*, including the *Colebrook, Haaland* and *Altshul-Tsal* equations:

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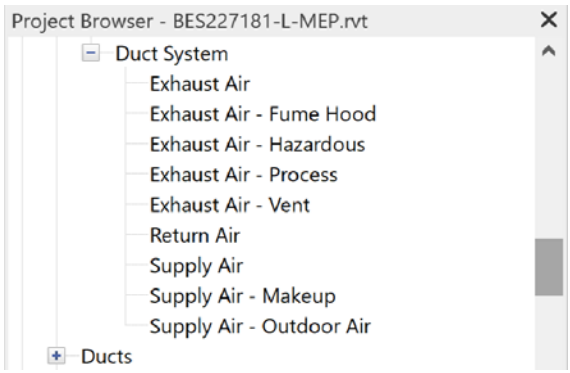
Defining Project HVAC System Types

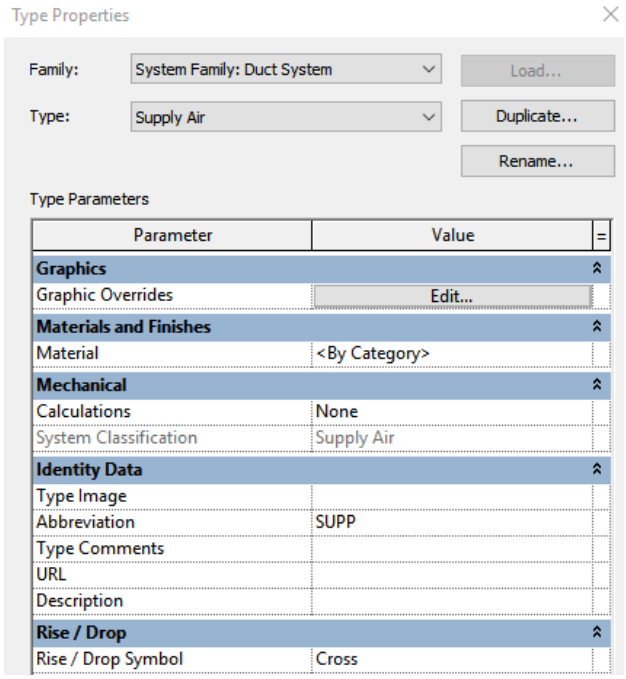
Revit gives you the ability to add your own system types, which are based on predefined system classifications. While the classifications control the calculations used, the type lets you define specific settings, such as whether calculations are performed, the graphics settings that appear in a view, the abbreviation used in a label, and rise/drop symbology. The system types can be predefined in a project, and are accessed using the Project Browser tool.

1. From the **Project Browser**, expand the Families section, and expand **Duct Systems:**

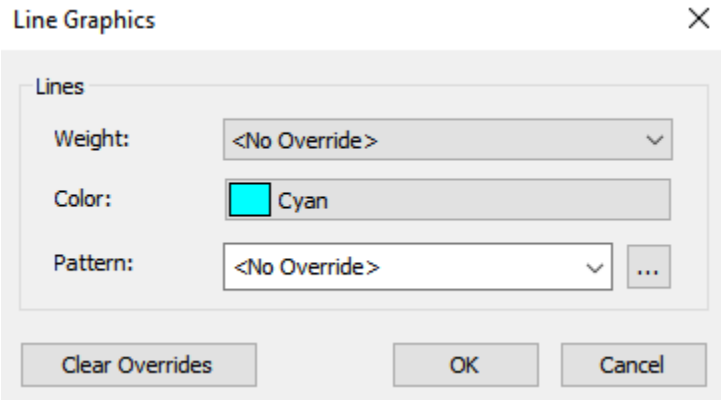


   These are examples of **duct system types** that can be used in a project, and can be added to your project template using the **Transfer Project Standards** tool located on the **Manage** tab from this project when you get back to the office.

2. Double click on **Supply Air** to open the **type properties:**



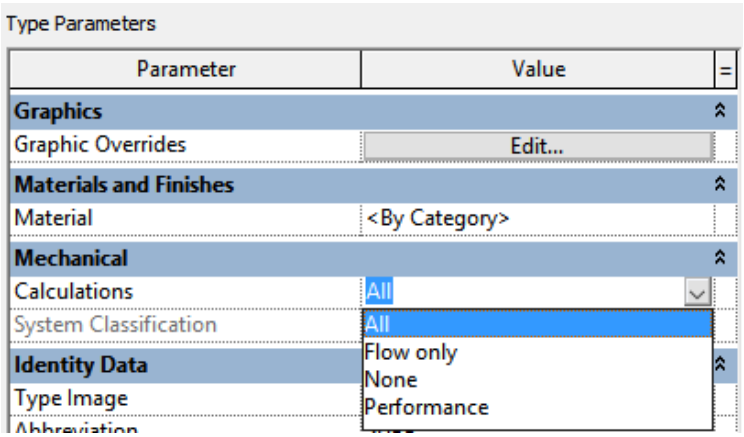
3. Click **Edit** for **Graphics Overrides:**



Select **Color**, and then choose **Cyan** as the color for the line graphics. Click **OK** to exit the Line Graphics dialog.

This will override the default object style settings for any view the duct appears in (but can be overridden by a view filter or object override)

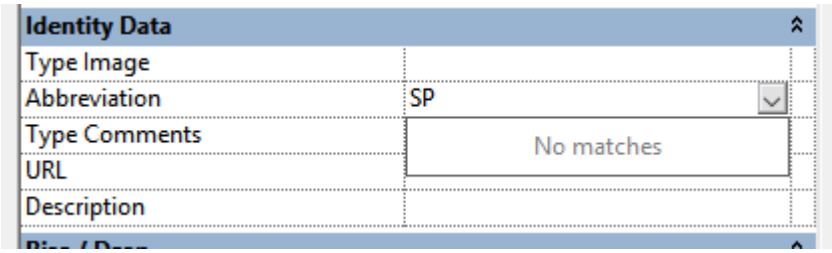
4. Click **Calculations:**



Choose **All** for the default.

If you are not using duct sizing, leave this set to **None** or **Performance** only. Revit runs calculations as items are placed, and continues running when set to **All**, but P**erformance** only runs calculations on demand.

5. Set the **Abbreviation** to SP:



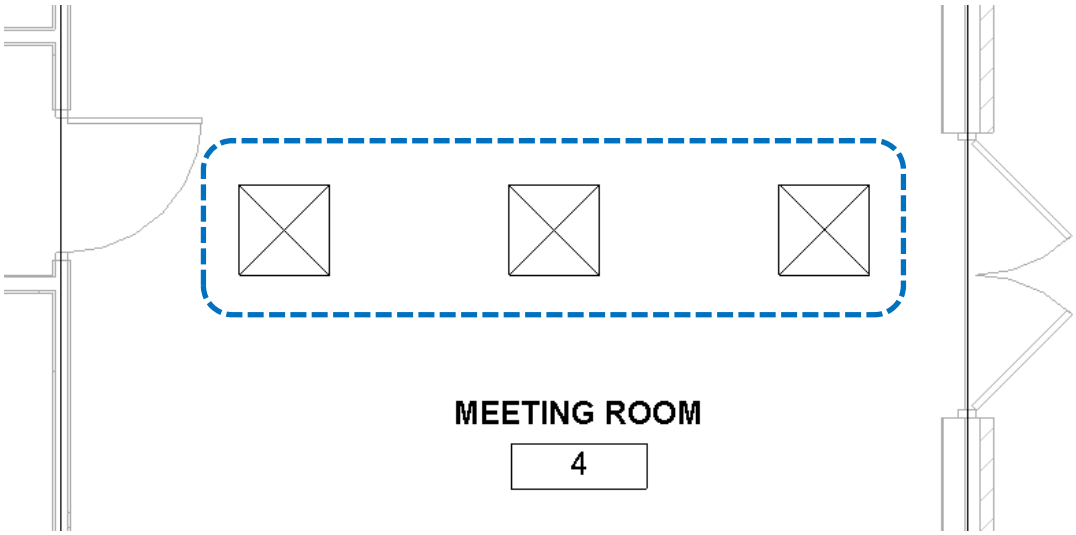
Revit will track the abbreviations stored as a list in a project, allowing you to select from different options as the project progresses.

6. Click **OK** to exit the system type properties dialog.

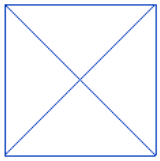
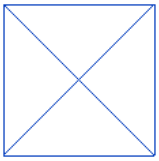
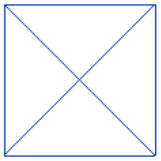
Defining an HVAC System

In a project, a system is defined by a target, which is a piece of equipment that receives air, fluid or power. When associated with a system, the target defines the flow or load associated with the system. In order to have a well-formed system, a piece of equipment may be required, and be the source for the air, fluid or power. When sizing systems, a well-formed system is defined by having a target and source associated with each other. When defining the system, the place to start is with the target.

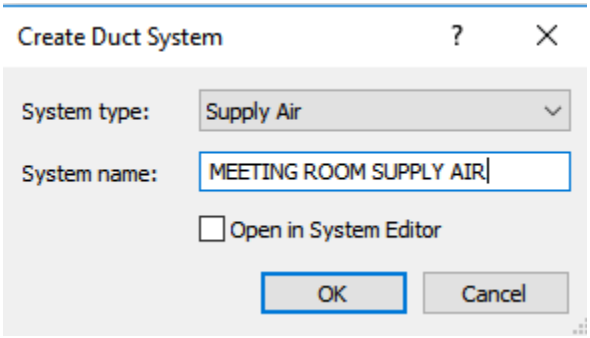
1. From the **HVAC FIRST FLOOR VIEW**, use a selection window to pick the air terminals:



2. Once the terminals are all selected, click **Duct** from the **Modify | Air Terminals** tab:

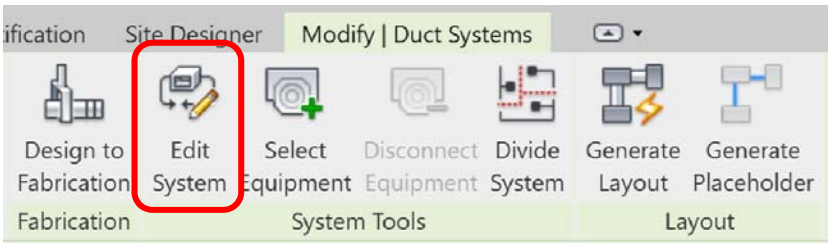




3. When the **Create Duct System** dialog appears, enter then name **MEETING ROOM SUPPLY AIR**, and then click **OK**.

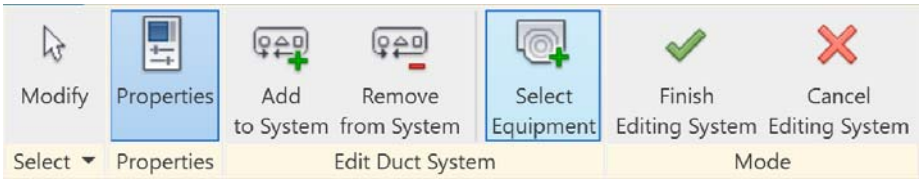


Naming the system makes it easier to track when adding schedules or using the System Browser.

4. Select the **Edit System** tool from **Modify | Duct Systems** tab, **System Tools** Panel:

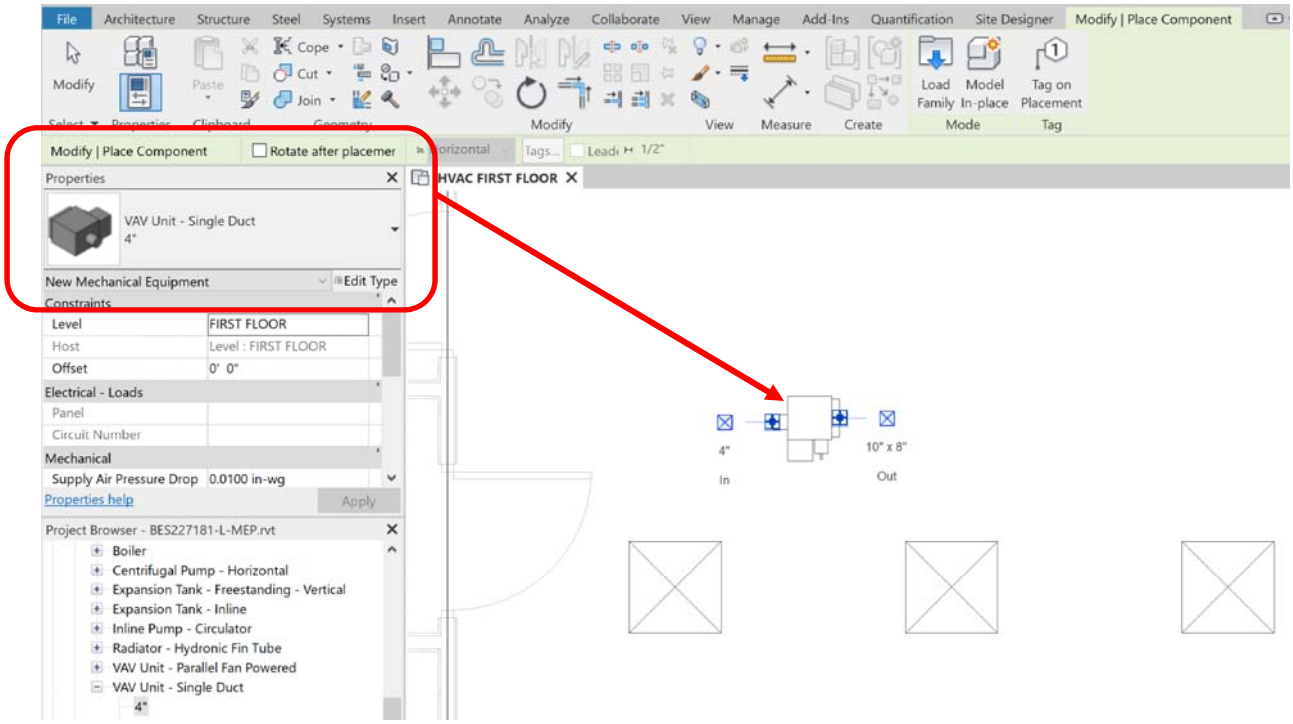


The source equipment can be selected at several different points, including the **Modify | Duct System** tab when the system is first defined, or after the initial system has been created.

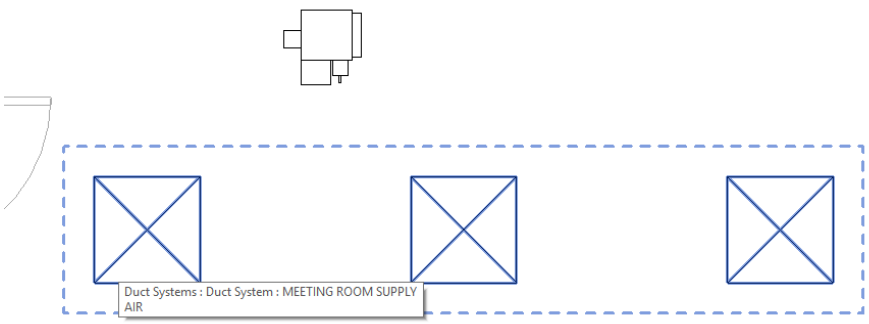


Click **Cancel** to exit without saving changes.

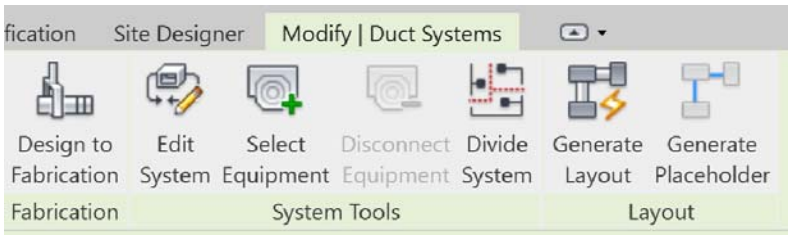
5. From the ribbon, System tab, Mechanical tab, click Mechanical Equipment. From the Type Selector on the Properties palette, make sure the **VAV Unit – Single Duct, 4”** size is the current family and type. Set the offset elevation to **11’ 7 ¼”** (you’ll see why in a minute). Place the unit above the three air terminals as shown:



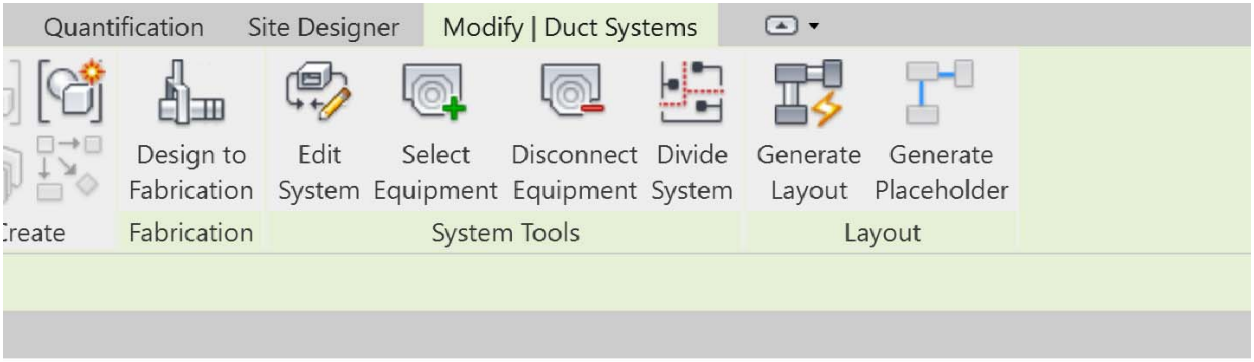
6. Click **Modify** to complete placement of the equipment. Next, to edit the system and add the equipment, place your mouse over one of the previous air terminals, and then tap the **TAB** key. The current duct system will be highlighted:

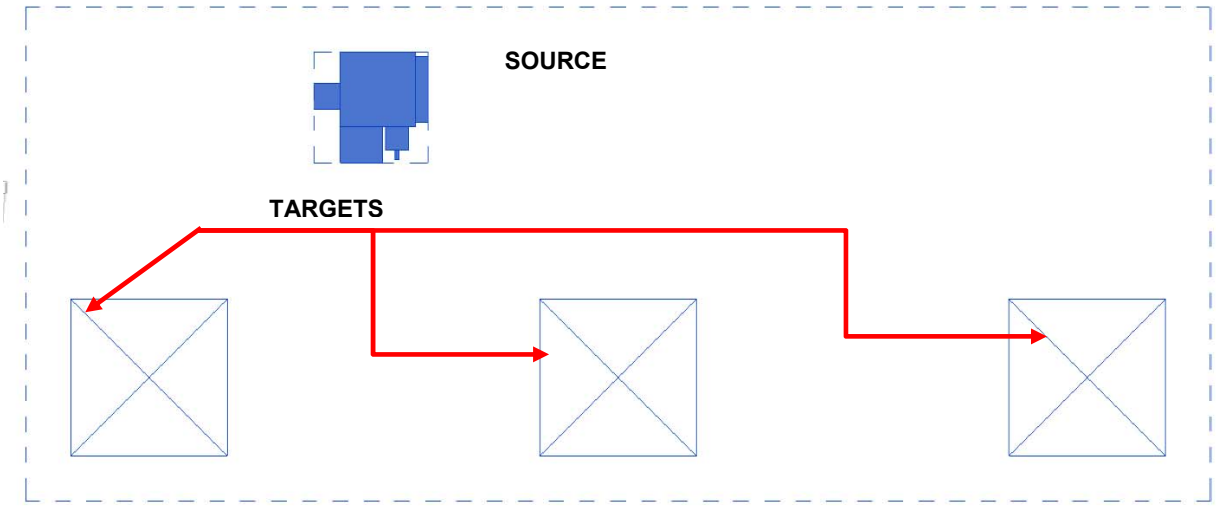


Note: You can also edit a duct system by selecting an air terminal, and then clicking the Duct System tab when it appears:



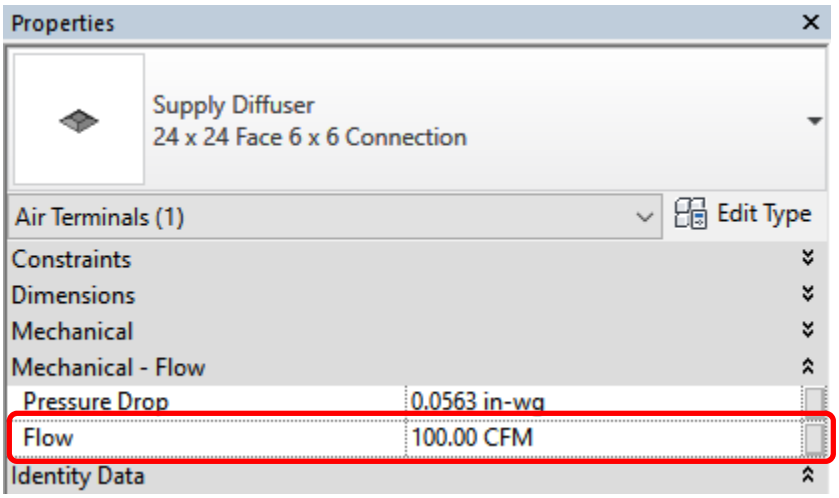
7. Choose **Select Equipment**, and select the **VAV Unit**:





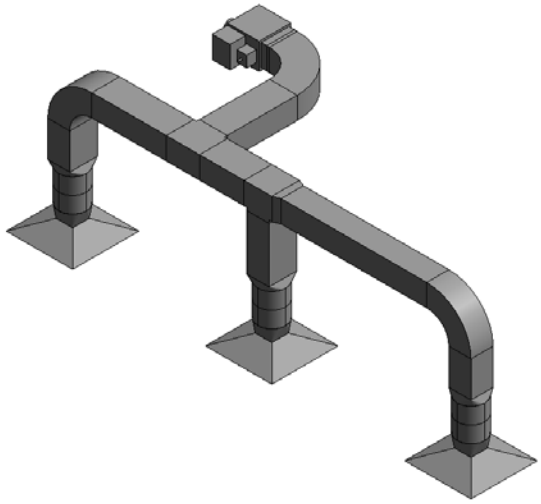
The system is now a well-formed system, and includes **targets** (the air terminals) and a **source** (the VAV unit).

8. Check the air terminal instance values related to flow – air flow and pressure drop are used in system sizing calculations. Set the **Airflow** for **each** diffuser to **100** CFM:



The system is now ready for sizing, and the connected duct will track the air flow values.

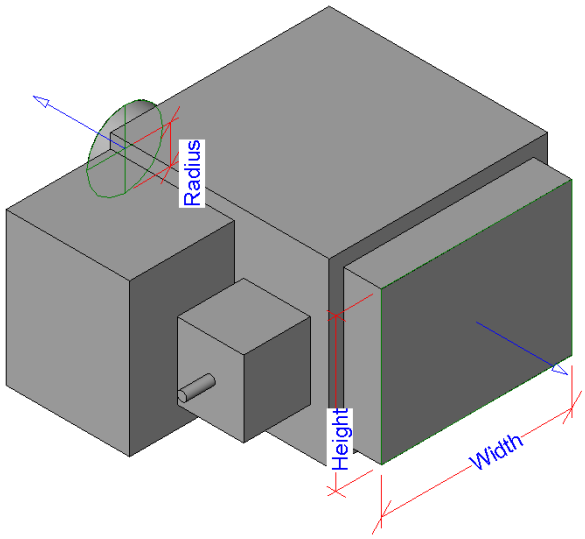
At this point, you can choose to use the Generate Layout tool, which uses the system settings to route the duct based on variety of solutions, or you can manually add duct to the view. When the system is not defined, the act of routing the duct will create the system – so either method can be used.



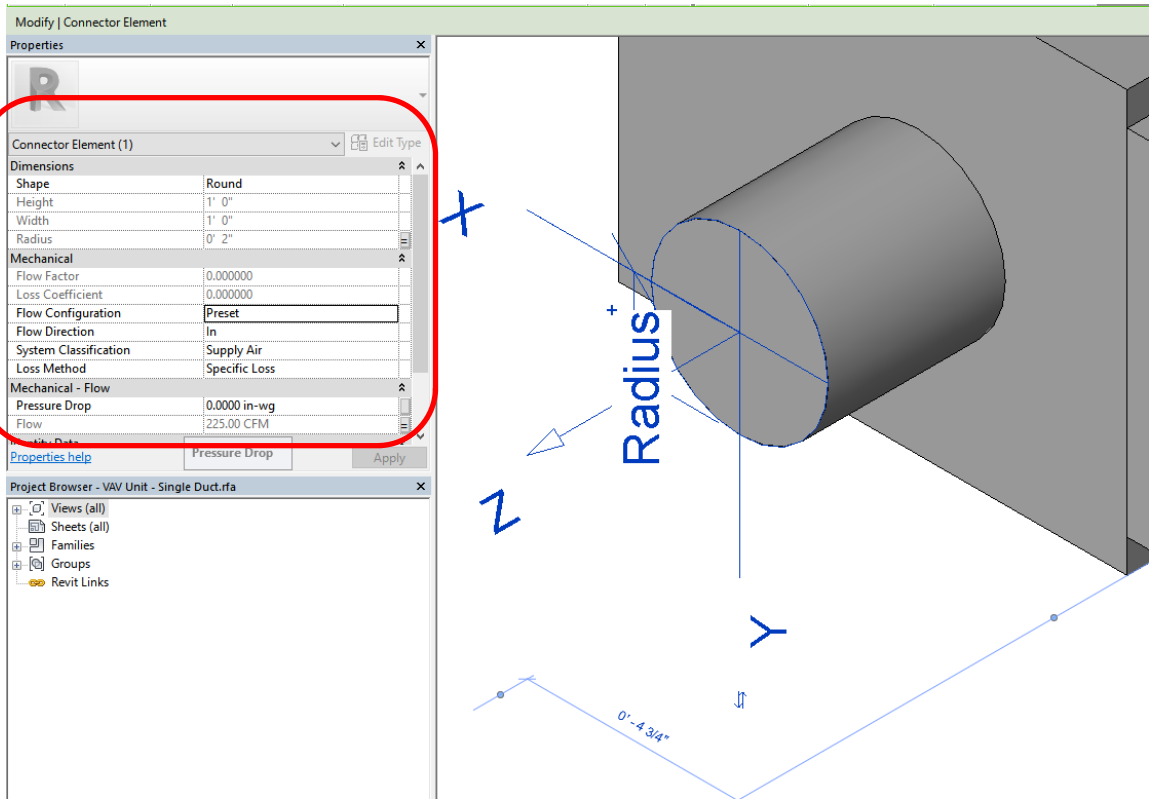
The Role of the Connector

The MEP connector is what distinguishes engineering content from architectural versions. The connector defines the system and key parameters that help share key data needed for analysis and sizing.

The connector is edited in the Revit family. Begin by opening the **VAV Unit – Single Duct.rfa** file.



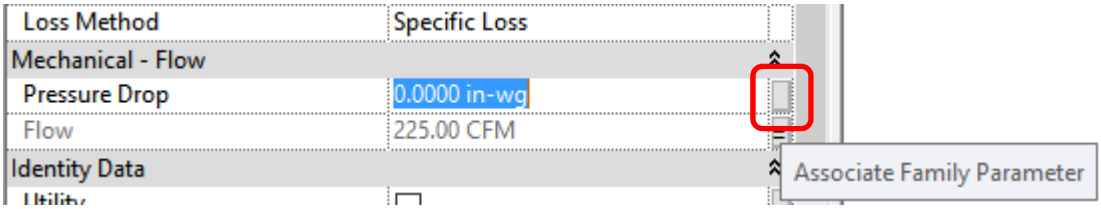
1. From the 3D view, rotate the view to show the **round connector**. Select the round **duct connector element** and then review the **Properties**:



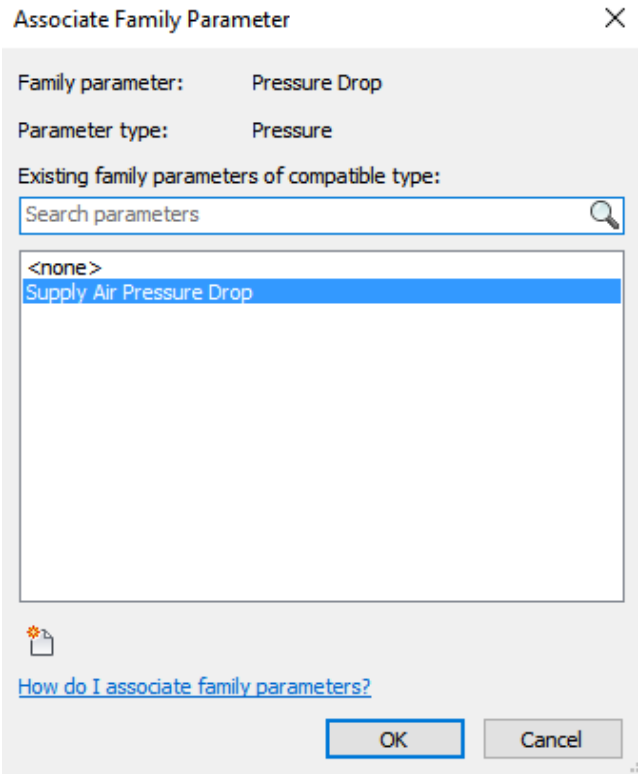
2. The connectors in this family are considered the **parent** connection in a system. **Flow configuration** determines how the flow is calculated, and **flow direction** is the data associated with the connector. For example, the airflow is considered *out* from the main air handler *in* to the VAV unit, so leave the direction set to **in**.

3. **Loss method** can be set to **specific pressure loss** (provided by the manufacturer), loss **coefficient** and **not defined**. The last option should only be set when the **system calculation method** is set to **none**. Since this part requires that specific loss value be entered, the **Pressure drop** parameter is **active**.

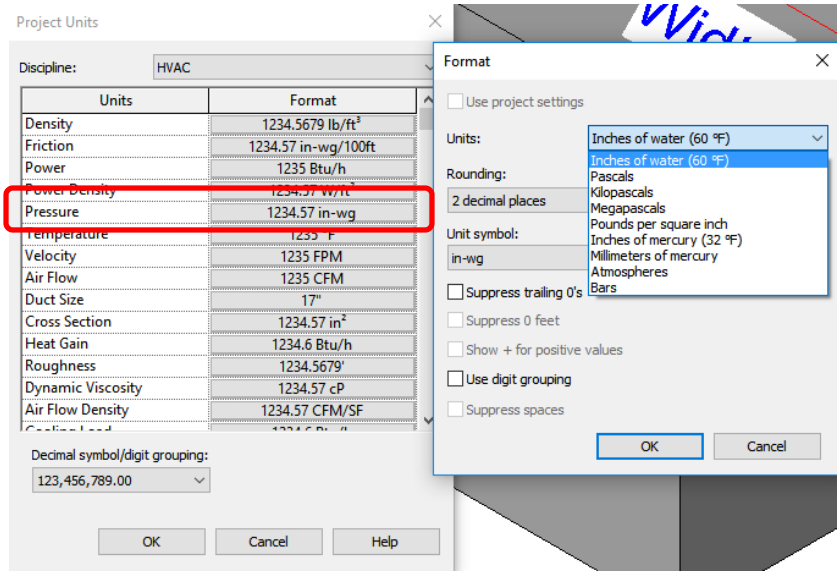
To allow the part to be edited in a project (instead of opening the family to make a change), you must **associate** the parameter to either a family parameter or shared parameter. Select the **icon** on the right side of the **Pressure drop** line in **Properties**:



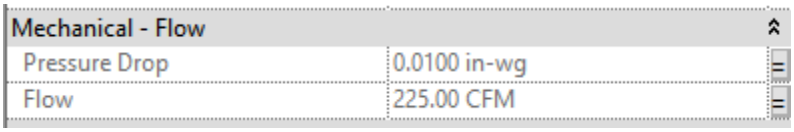
4. The **Associate Family Parameter** dialog appears. You can select **Supply Air Pressure Drop** from the available parameters, which match the formatting of the data:



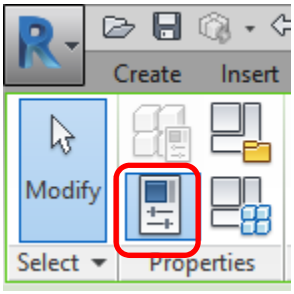
*Note: this value can be changed from "in-wg" to "PSI" or other format from the **Manage** tab, **Settings** panel, **Project Units** tool, and selecting the **HVAC** discipline, **Pressure value:***



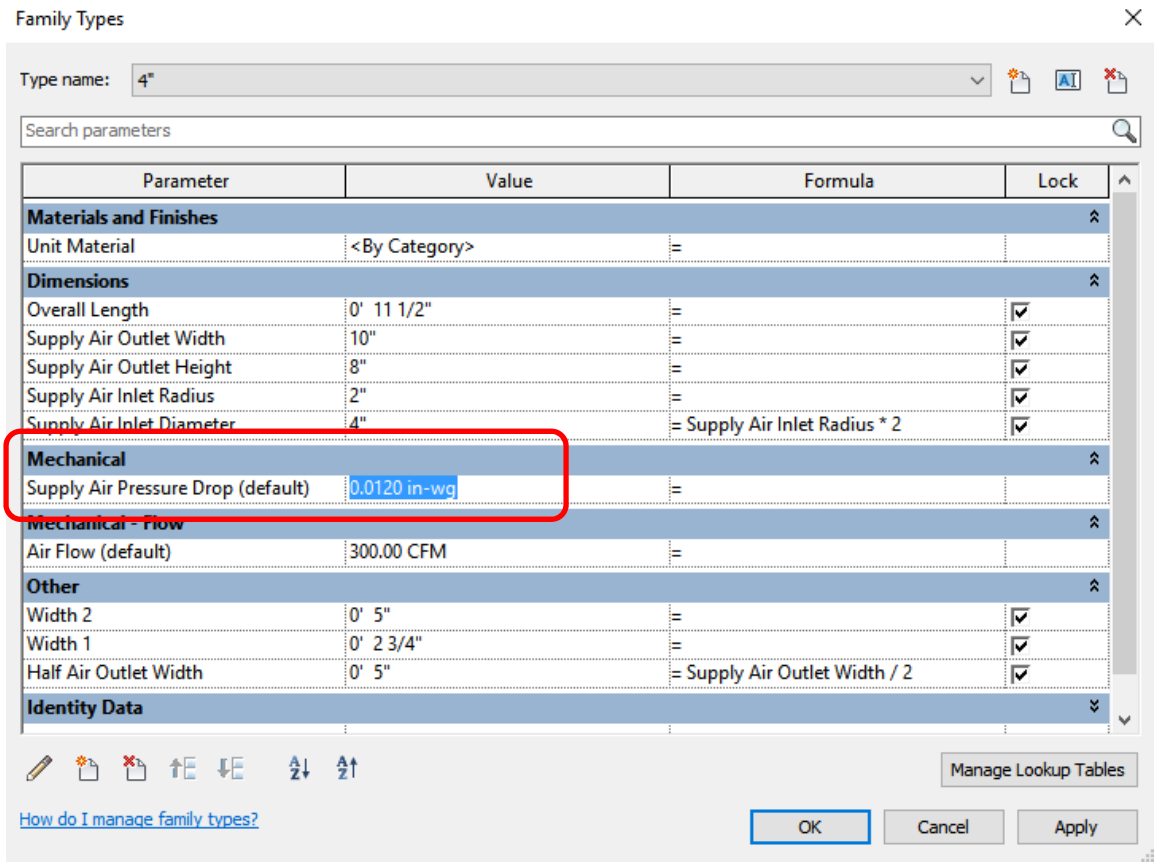
5. After selecting the parameter, the **pre-assigned value** will appear on properties, and will be **greyed out**:



6. To change this value, select the **family types** tool located on the **Properties** panel:



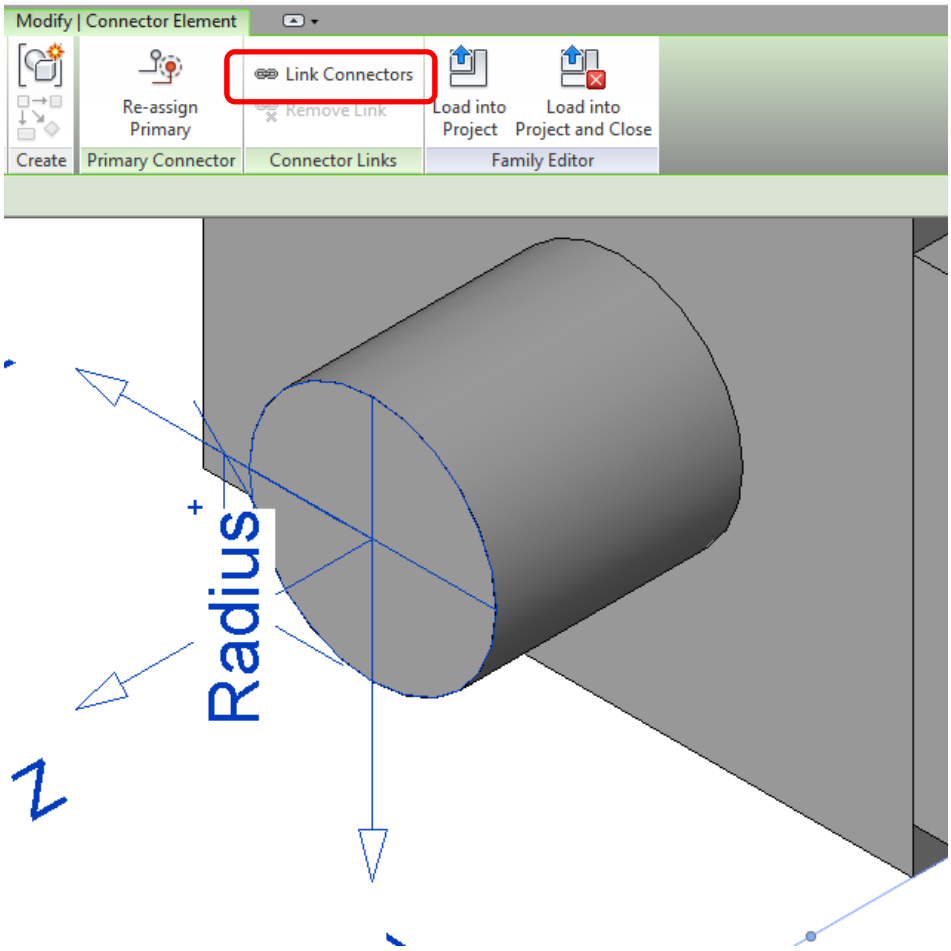
7. The default type is the **4”** inlet connection type. Under **Mechanical**, for **Supply Air Pressure Drop**, change the value to **0.012**. Under **Mechanical – Flow**, set the **Air Flow** to **300** cfm:



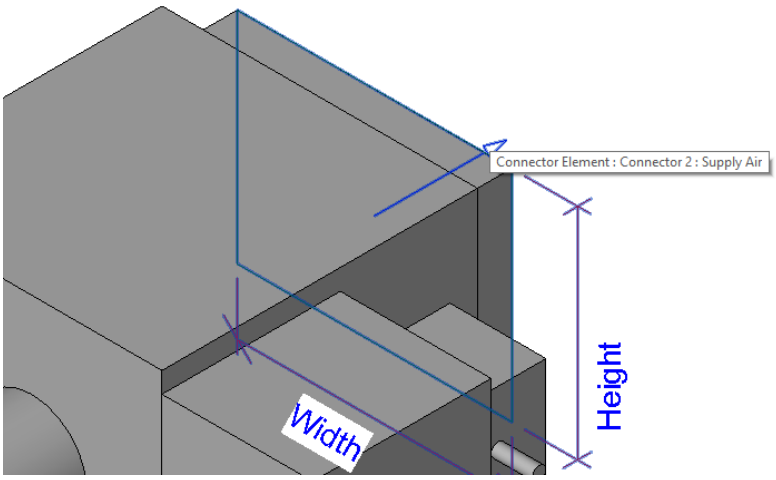
8. After making the adjustments, click **OK** to save the changes.
9. **This step is Optional:** The **Connector Link** tools can help the family pass the connector information from one connector to another. In order for the information to be passed, the connector **System Type** must be set to **Global**, instead of Supply Air. Flow direction and flow values can pass when these cases are met.

   Note that while this step is not required for this part since it is considered an end-of-line source, it can be useful if the VAV unit is defined as a **duct accessory**, and placed as an inline component.

   To allow the air flow and pressure values to be linked from the primary supply inlet to the supply air outlet, select the **connector** in the model, and then click **Link Connectors**, from the **Modify | Connector Element** tab:



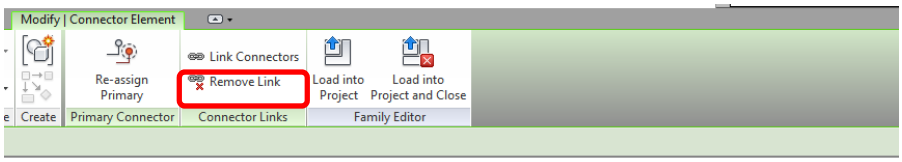
Once the tool is selected, click on the **rectangular outlet connection**:

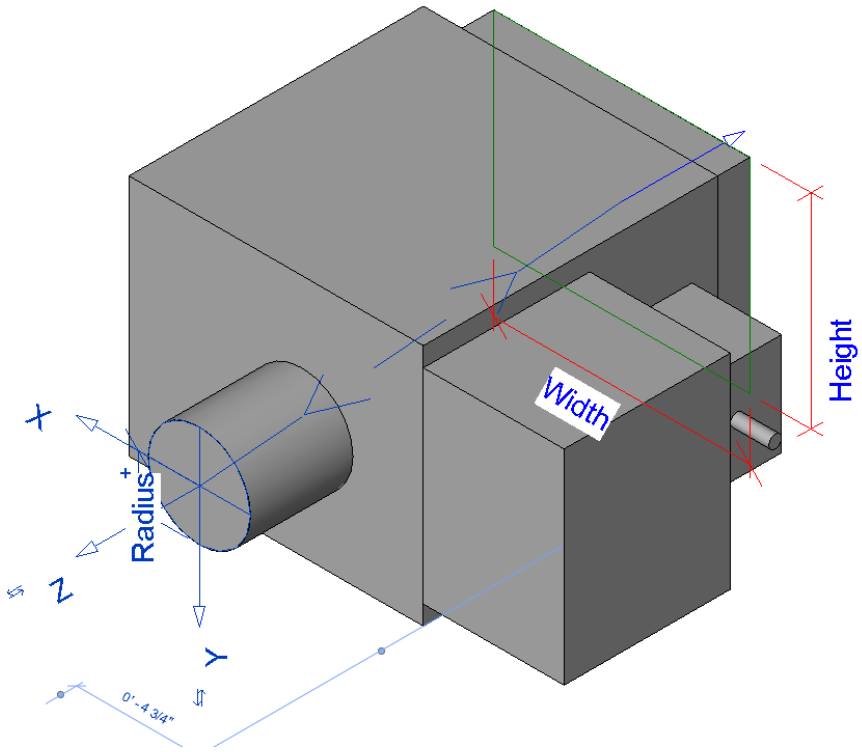


The two connectors are linked, and the round connector is defined as the **primary connector**. Information from this connector will pass to the outlet connector #2.

Again, the link is only required when the part is used as a **duct accessory**, or intermediary object, such as damper or inline filter. The parameters for flow can be linked via formula, when the family is used as mechanical equipment.

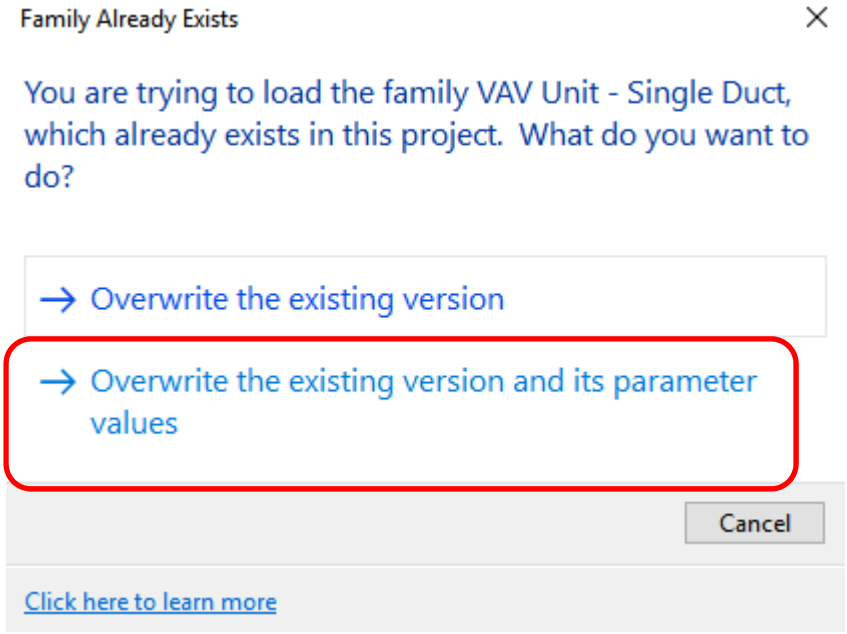
To remove the link, select one of the connectors, and click **Remove Link**:





Once the link is removed, the total air flow and pressure drop on the rectangular connector will be based on the values assigned to the air terminals that make up the system. The properties assigned to the round connector, the inlet, will be used to define data as a target, and will be transmitted to the air handling unit servicing this unit.

10. Next, load the unit into the model. From the **Modify** tab, **Family Editor** panel, click **Load into Project and Close**. When prompted, click **Overwrite the existing version and its parameter values**:



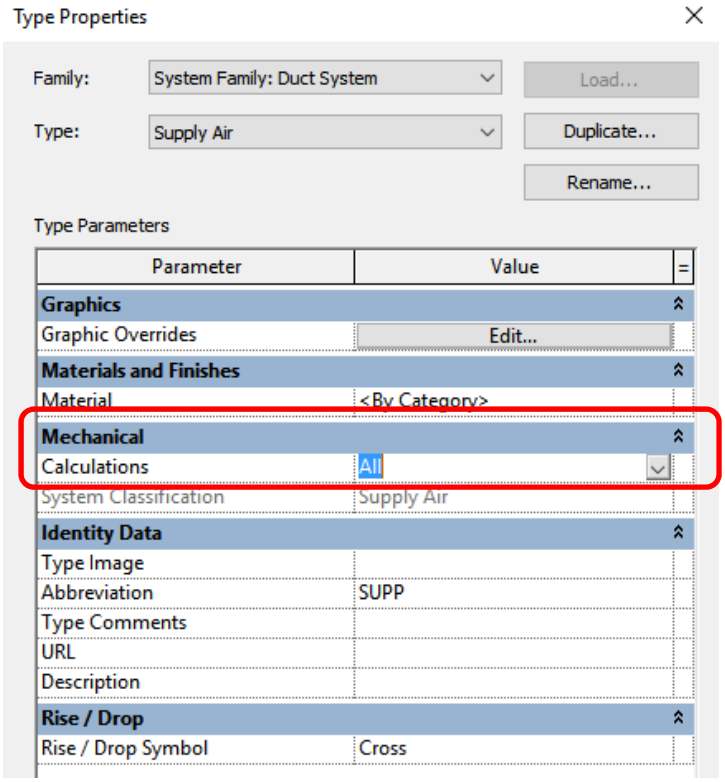
11. The current version in the model will be updated.

Using the Duct Sizing Tools

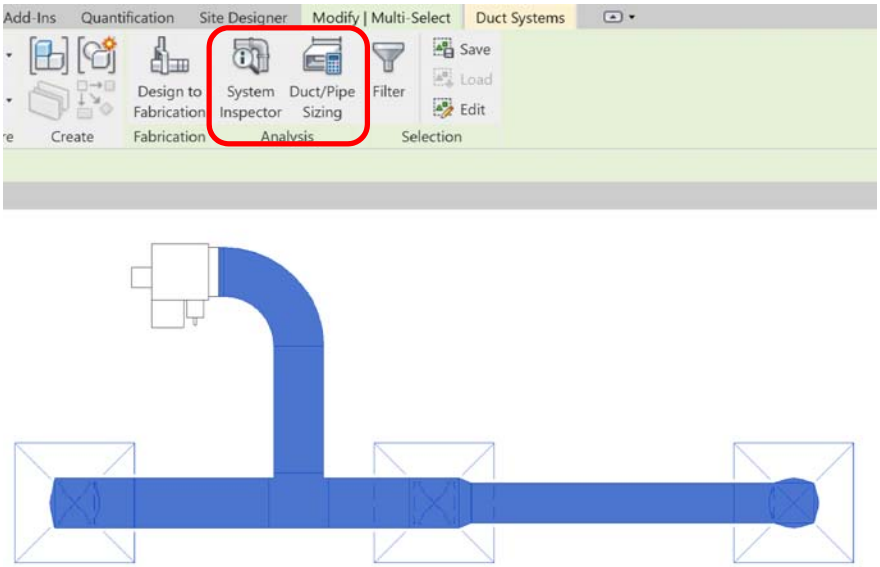
Once you have all of the systems types, connectors and systems defined, the next step is to leverage the system to check the duct sizes. While most ducts are sized using external analysis programs such as HVAC Solutions, Trace, IES and more, it's nice to be able to make adjustments as needed, without having to return to the analysis application.

Begin by opening the model, **BES227181-L-MEP-Analysis.rvt**. Open the view, **HVAC FIRST FLOOR**.

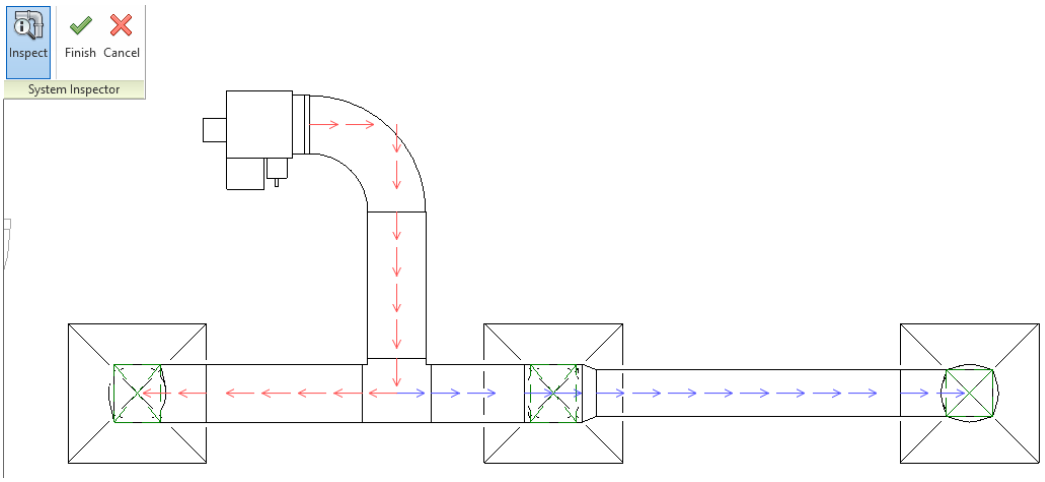
1. From the **Project Browser**, expand **Families**, and then expand **Duct systems**. Double click **Supply Air**, or right click and select **Type Properties**. Change the **Calculations** parameter to **All**:



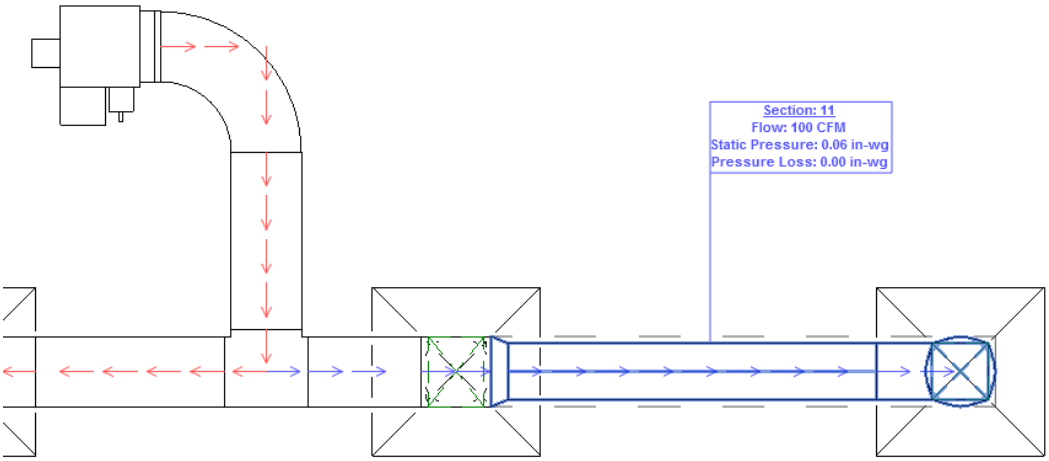
2. Click **Ok** to close the dialog.
3. From the **HVAC FIRST FLOOR** view, use the **TAB** selection method to select all of the duct and air terminals:



4. Once the items are selected, select the **System Inspector** tool – the **System Inspector** dialog will appear:
5. Click **Inspect** and note the location of the *primary* (red) and *secondary* (blue) flow paths:

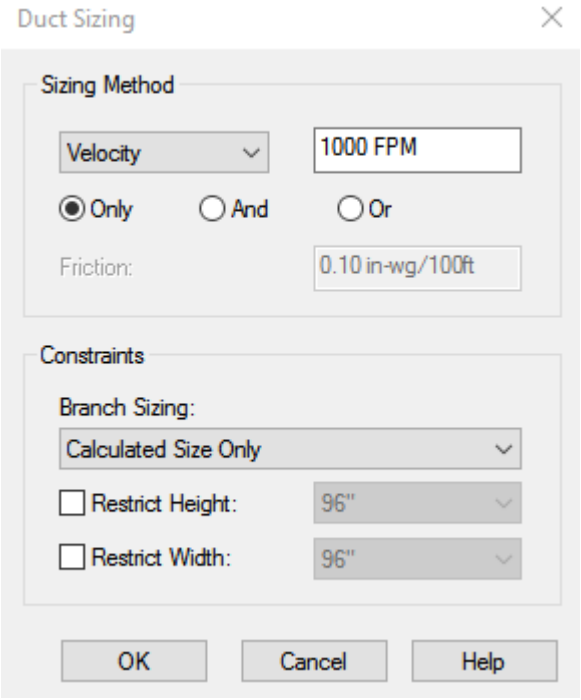


6. As you select a duct, the **analytical data** about the segment will appear:

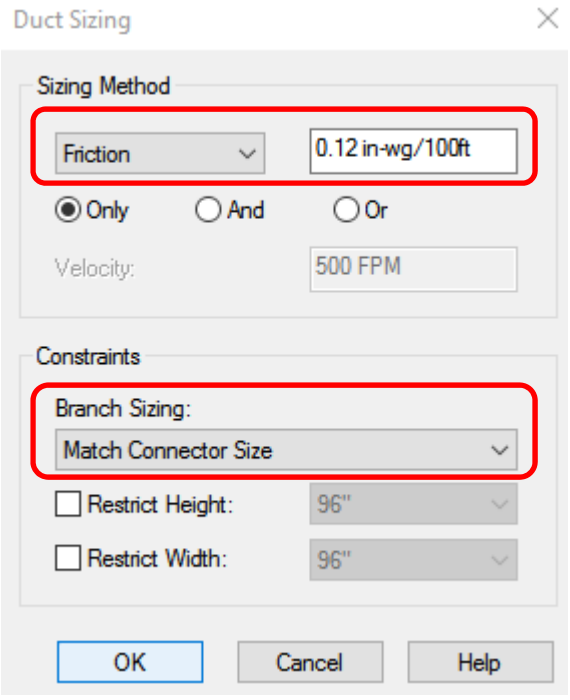


Test several segments and note the differences. Click **Finish** to complete the command.

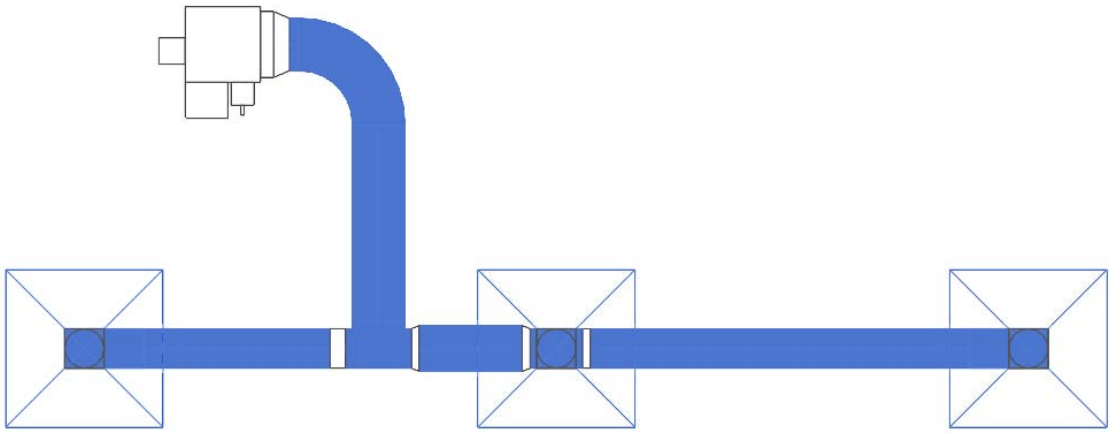
7. Next, use the **TAB** selection tool again, and then select the **Duct/Pipe Sizing** tool from the **Analysis** panel. The **Duct Sizing** dialog will appear:



8. Make sure **Velocity** is set to **1000**. Change the **Sizing Method** to **Friction**, making sure the value is set to **0.12**, and then set the **Branch Sizing** to **Match Connector Size**:



9. Click **OK**, and the duct will be resized.



Note that there may wind up being a few pieces that don't size the exact direction you want – but these can be easily modified. Using the System Inspector in conjunction with the sizing tools can get you the best results.