

## Session 11

# Creating Pipe Fittings in Revit MEP

Jose Fandos, Andekan, LLC.

### Class Description

Pipe fittings are the one of the most complex and misunderstood component families in Revit. This presentation will begin by outlining the key considerations and major steps for creating pipe fitting families in Revit MEP. Attendees will then be led through a hands-on process of creating their own pipe fittings family from scratch.

### About the Speaker:

Jose Fandos is the founder and CEO of Andekan, a company dedicated to Revit content creation and management. Since 2008, Jose has led Andekan in providing Revit content services to major AEC firms, manufacturers, and software makers. Prior to founding Andekan, Jose worked as a CAD manager in the UK, where he led his firm's adoption of Revit. He later served as co-founder and CTO of Broutek Ltd., a pioneering start-up in Revit content creation. Jose is considered one of the industry's most knowledgeable Revit content creators, and is a member of the AEC (UK) BIM Standards Committee and the UK Chartered Institution of Building Services Engineers (CIBSE) Breakout Group on Revit Content Standards. Jose lives and works in London, and can usually be found at meetings of the London Revit User Group.

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A decorative blue swoosh graphic located in the bottom right corner of the page, consisting of several overlapping curved lines that sweep upwards and to the right.

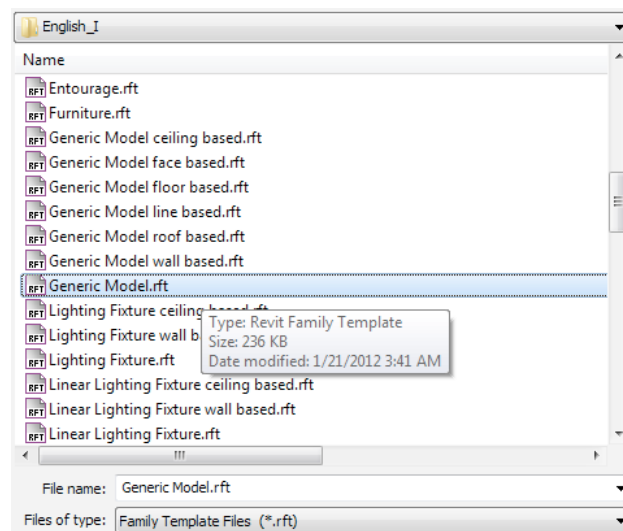
# Creating Pipe Fittings in Revit MEP

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In this lab we will create a pipe fitting, in this case an elbow, from scratch. While doing so we will cover a number of issues that apply to all other pipe fittings.

Let's start.

1. Selecting a template. For pipe fittings the best template to use is the Generic Non-Hosted template.



2. Setting up all the metadata.

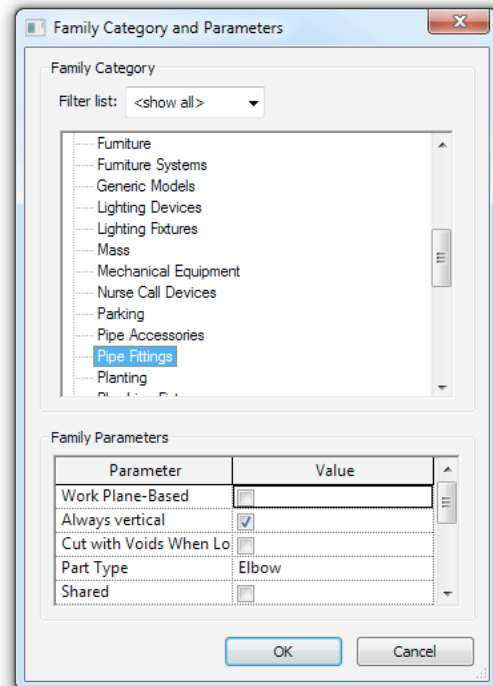
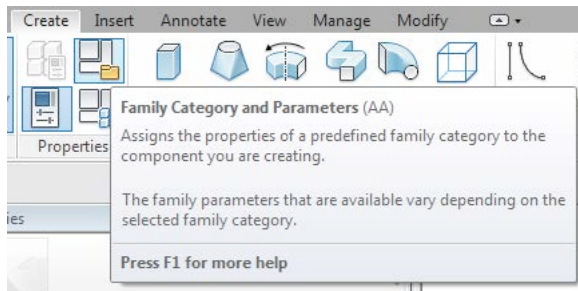
## 2a. Family Category and Parameters.

- 1) Open the Family Category and Parameters dialog box.
- 2) Select the Revit Category for the fittings. This will be Pipe Fittings.
- 3) Choose the Part Type under Family Parameters. The right Part Type for this elbow will be the eponymous Elbow part type.

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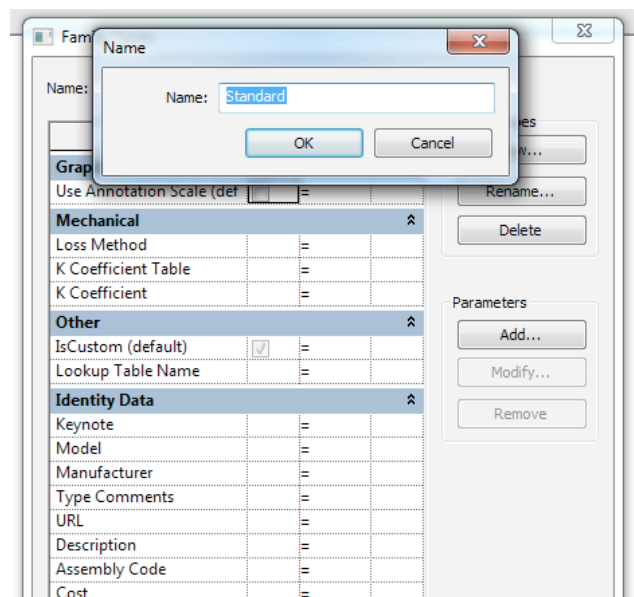
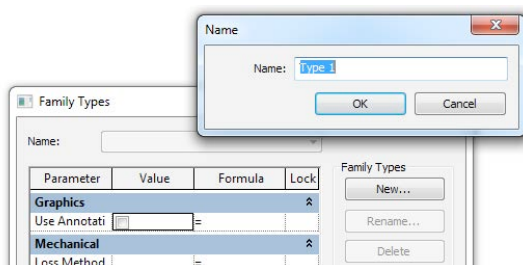
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- 4) Optionally, select the corresponding OmniClass. We will set it to the old 23.60.30.11.14 Pipework Fittings.



## 2b. Family Types.

Let's create a type. Following Autodesk's examples here, with no reason to deviate, let's call our type "Standard".



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Next, let's enter the parameters that we will use for the creation of the pipe fitting. The list is shown below. The list below comes from experience. It will take you no more than a handful of fittings to know them by heart. The shorthand preceding each parameter is what we will use in the Lookup Table we will create next.

Nominal Diameter	Piping	Pipe Size	Dimensions
Nominal Radius	Piping	Pipe Size	Dimensions
Angle	Common	Angle	Dimensions/Other
Fitting Outside Diameter	Piping	Pipe Size	Dimensions
Fitting Outside Radius	Piping	Pipe Size	Other
Tick Size	Piping	Pipe Size	Dimensions
Center Radius	Piping	Pipe Size	Dimensions/Other
Center to End	Piping	Pipe Size	Dimensions

The grouping of the parameters follows Autodesk's tradition. It doesn't mean that it can't be changed or that there is anything more to it than how the information is grouped. Having said that, and to clarify how Autodesk's goes about it, Nominal Radius/Diameter go always in Dimensions. Anything else, goes under Dimensions if it is controlled by a Lookup Table formula. The exception would be the Center Radius and Angle, which you might find in either Dimensions and Other with or without a Lookup Table formula driving the parameter. Again, there is no need to follow this at all. But if you have no reason to deviate from it, might as well follow it.

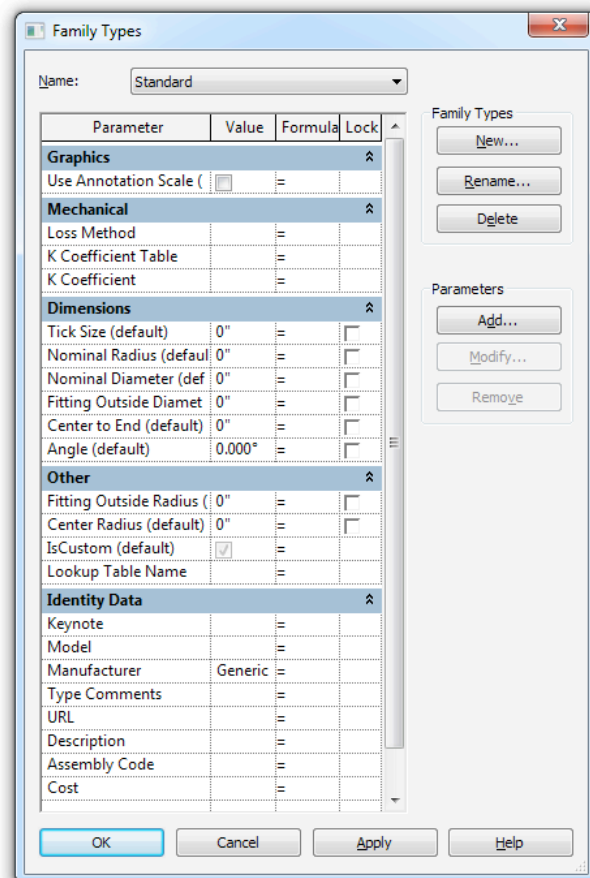
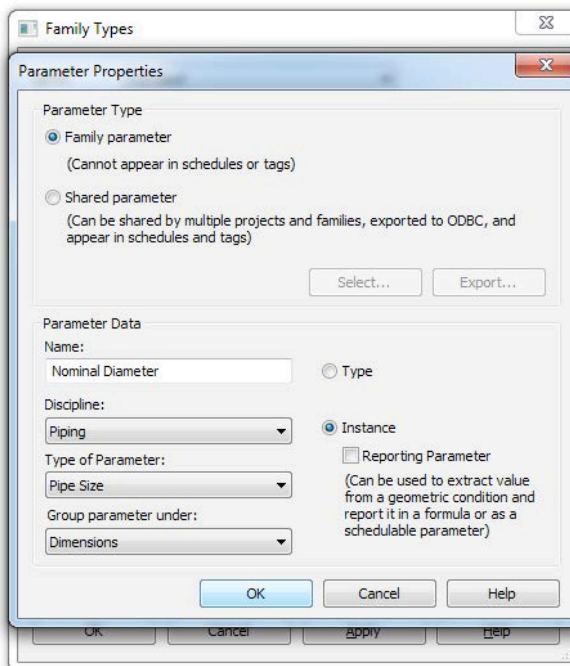
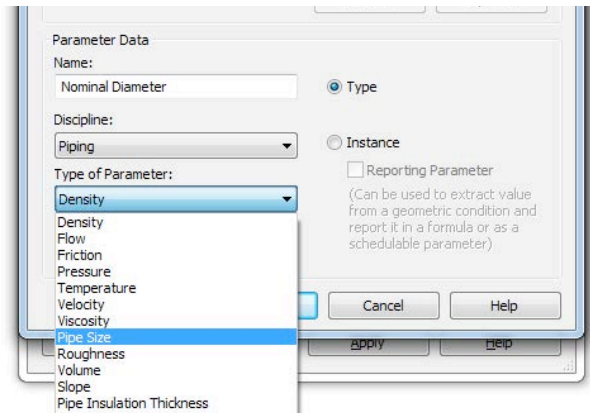
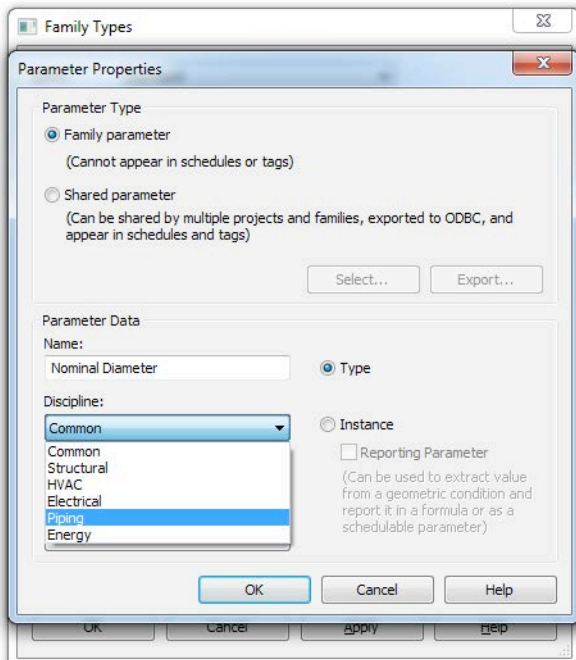
We will also enter the Loss Method (K Coefficient from Table) and choose a K Coefficient Table (Regular 45, 90 and 180 Elbow).

While we are adding data to the family we might as well enter any other information that we might have at hand for use in the Identity Data group. At a minimum, if this is a generic family, we can enter "Generic" under the Manufacturer field, unless this conflicts with our company's standards. The Assembly Code can also be entered at this stage if you know it.

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Finally, we need to take care of the formulas that relate one parameter to another. Before we do that however, we need to look at the geometry and exactly what relation we want.



At this point, let's save the family with the name Elbow RTCUSA.rfa

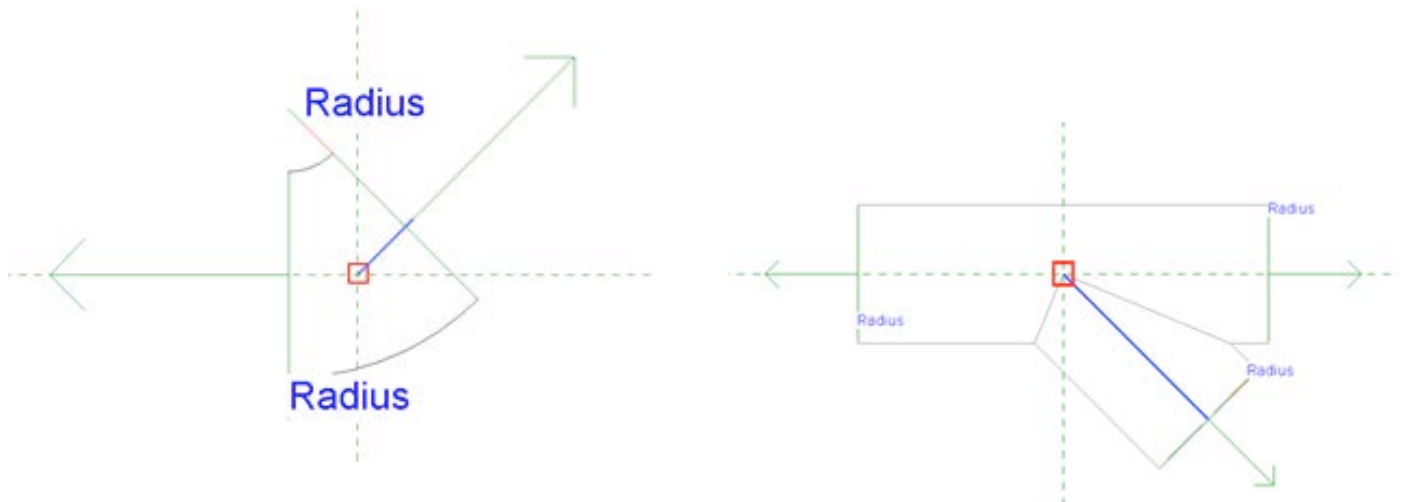
# Creating Pipe Fittings in Revit MEP

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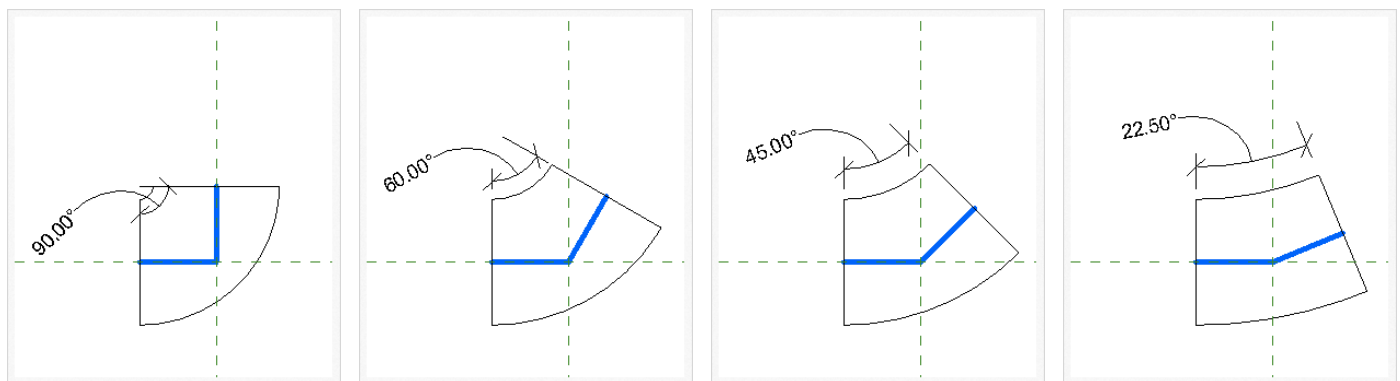
## 3. Creating 3D Geometry

Now that the parameters and data are completed, we need to look at the geometry. With pipe fittings, we will draw the fittings on the reference level (plan view). Primary connector will always sit on the left side of the view.

The position of the center of the fitting will be defined by the intersection of the reference planes Center (Left/Right) (CLR from here on) and Center (Front/Back) (CFB from here on). The position of that intersection within the family will affect the behavior of the family within a project. Generally, it sits at the intersection of lines drawn from the center of the connectors as shown in the images below.



For the elbow we are going to build, below there is a sequence of images showing how the lines perpendicular to the connectors maintain their intersection at the intersection of the CLR and CFB planes.



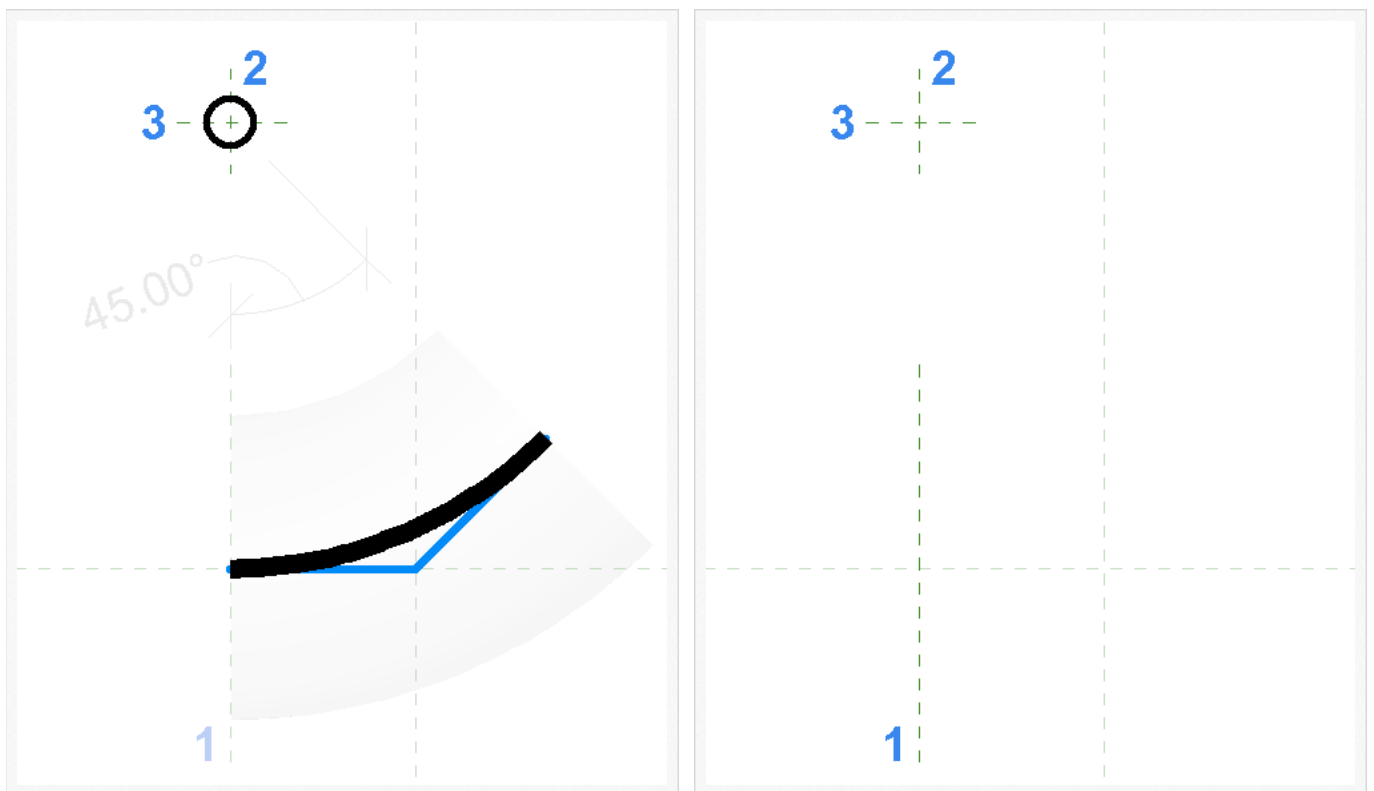
## Creating Pipe Fittings in Revit MEP

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The thick lines are perpendicular to the connectors and meet at the crossing of the reference planes CLR (vertical dashed line) and CFB (horizontal dashed line). The length of each of the blue lines, being the same, will be our Center to End length.

The 3D geometry for the elbow will be a sweep. We will use this for the fine level of detail. In order to draw the sweep and have it constrained as in the images above, we will need to add two reference planes – ref. plane #2 and #3 as shown in the images below – defining the center of the arc we will use to draw the pipe. Note that we are adding reference plane #1. This reference plane is not necessary for the generic version of this family (since we could make do with ref. plane #2 alone), but we will need it later for an update to the family.

Let's draw the three reference planes. We should end up with something that looks like the image on the right, below.

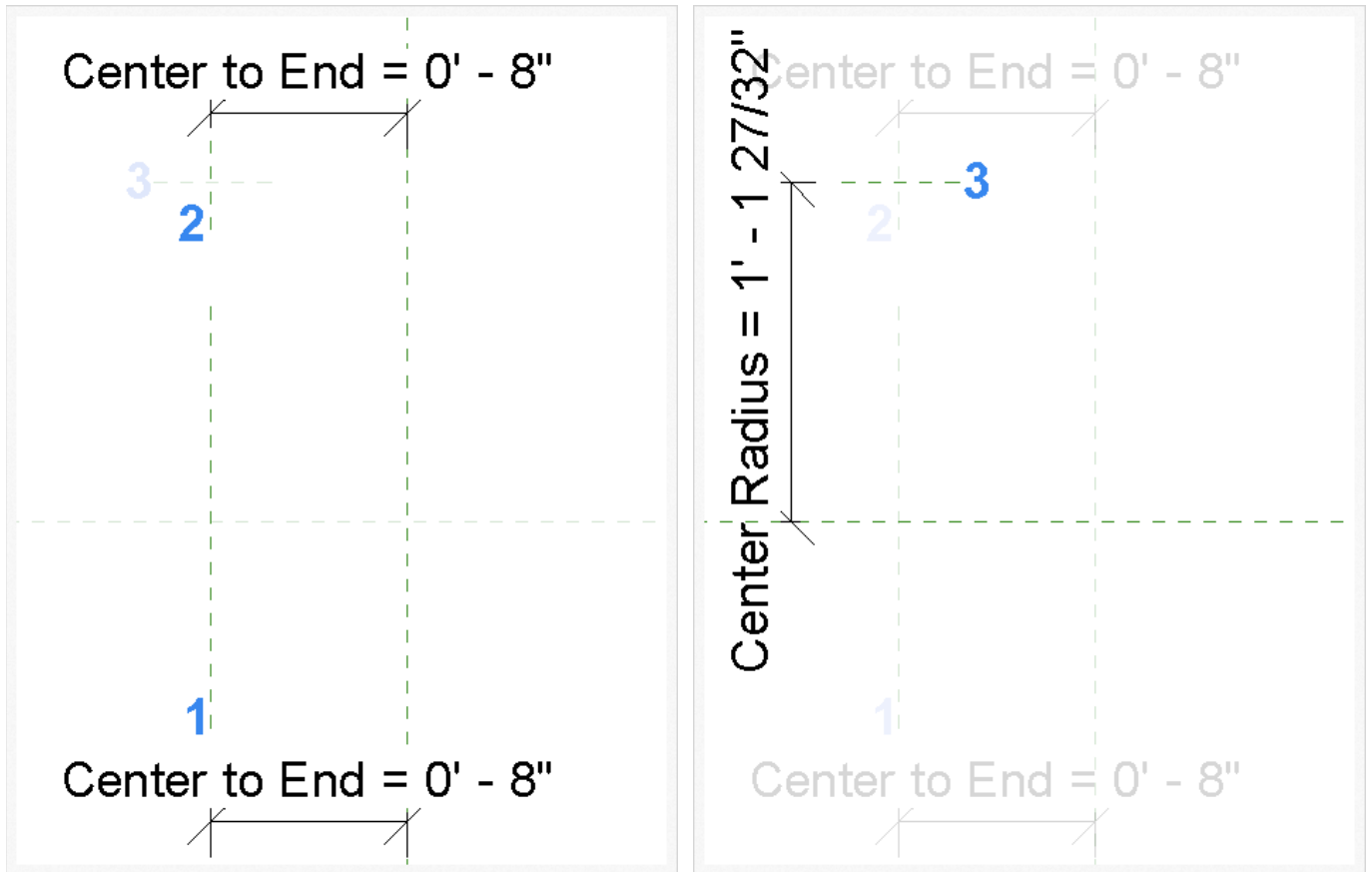




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After drawing the 3 reference planes we add dimensions to them. The dimension from reference plane #1 to the CLR plane will be labelled with the parameter Center to End. The same goes for ref. plane #2. The dimension used from ref. plane #3 to CFB will be labelled as Center Radius.

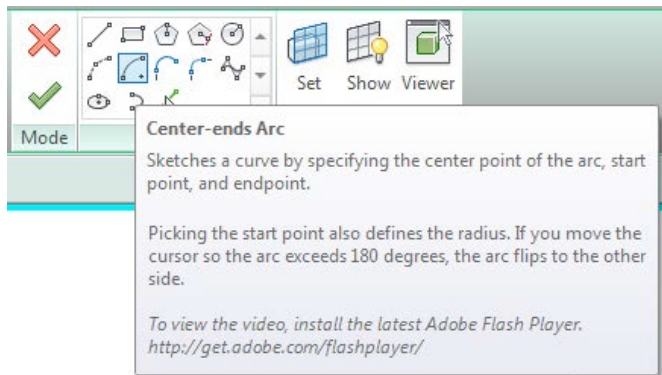


With the dimensions in place, let's now draw the sweep (Create > Sweep > Sketch Path). Starting by sketching the path, we will use the Center-ends Arc tool to draw an arc from its center at the intersection of ref. planes #2 and #3.

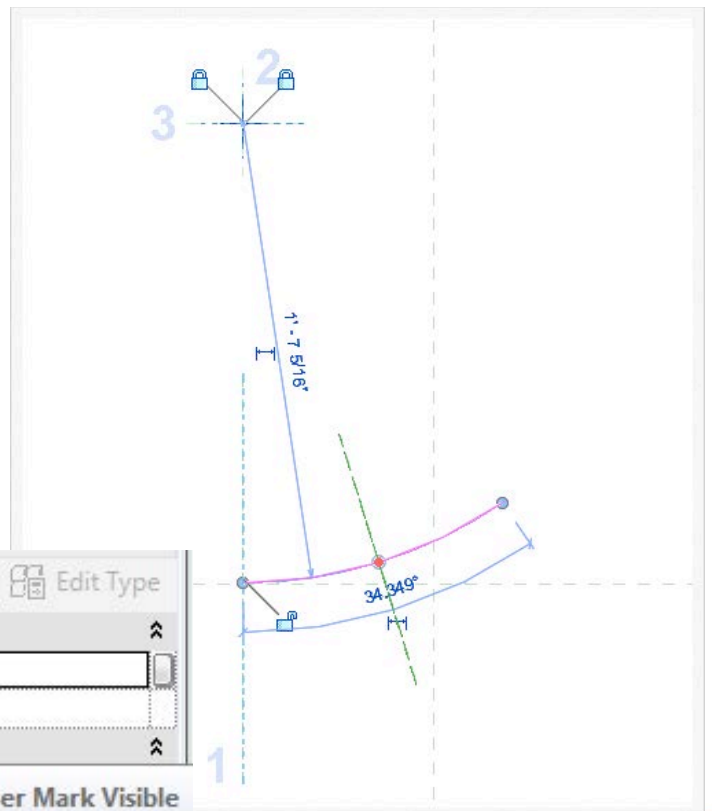
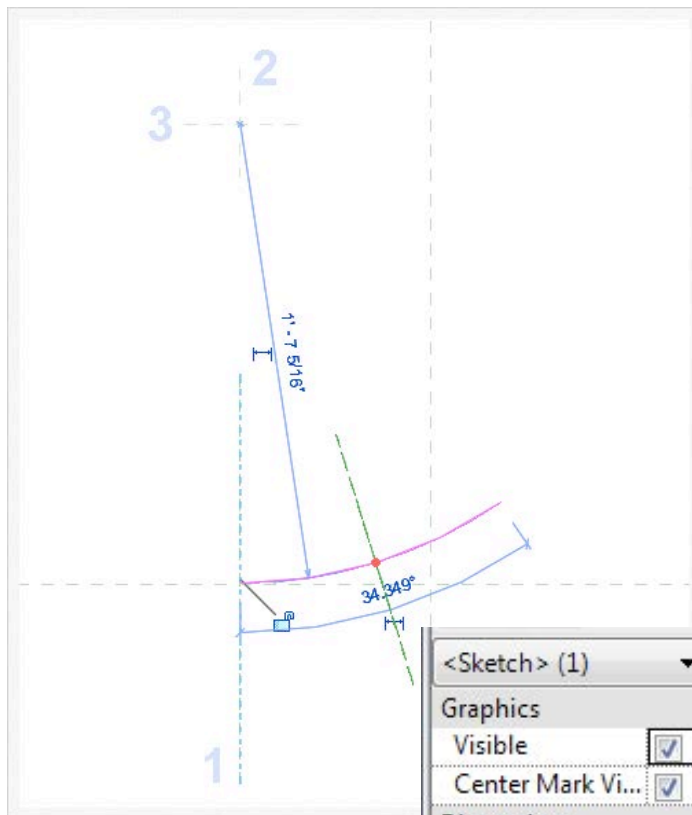
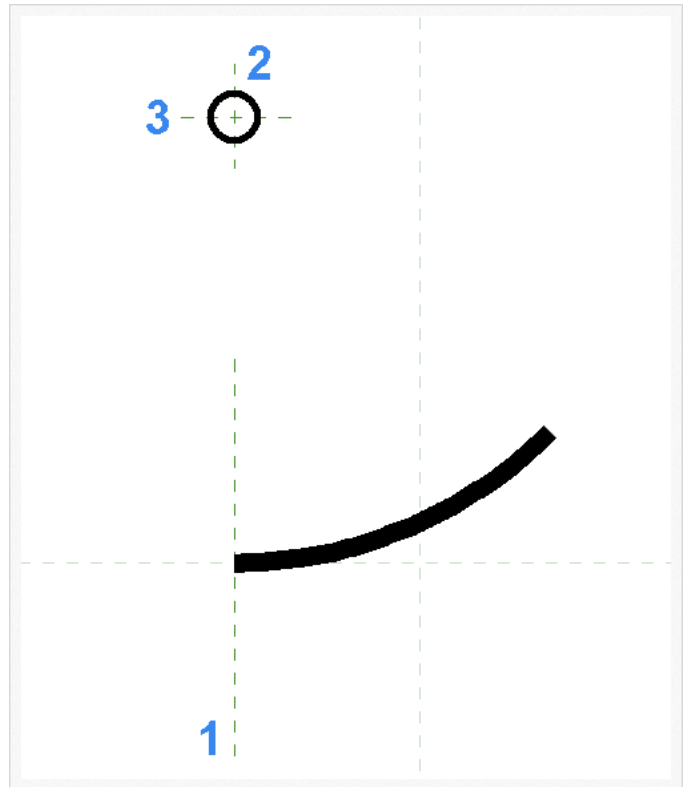


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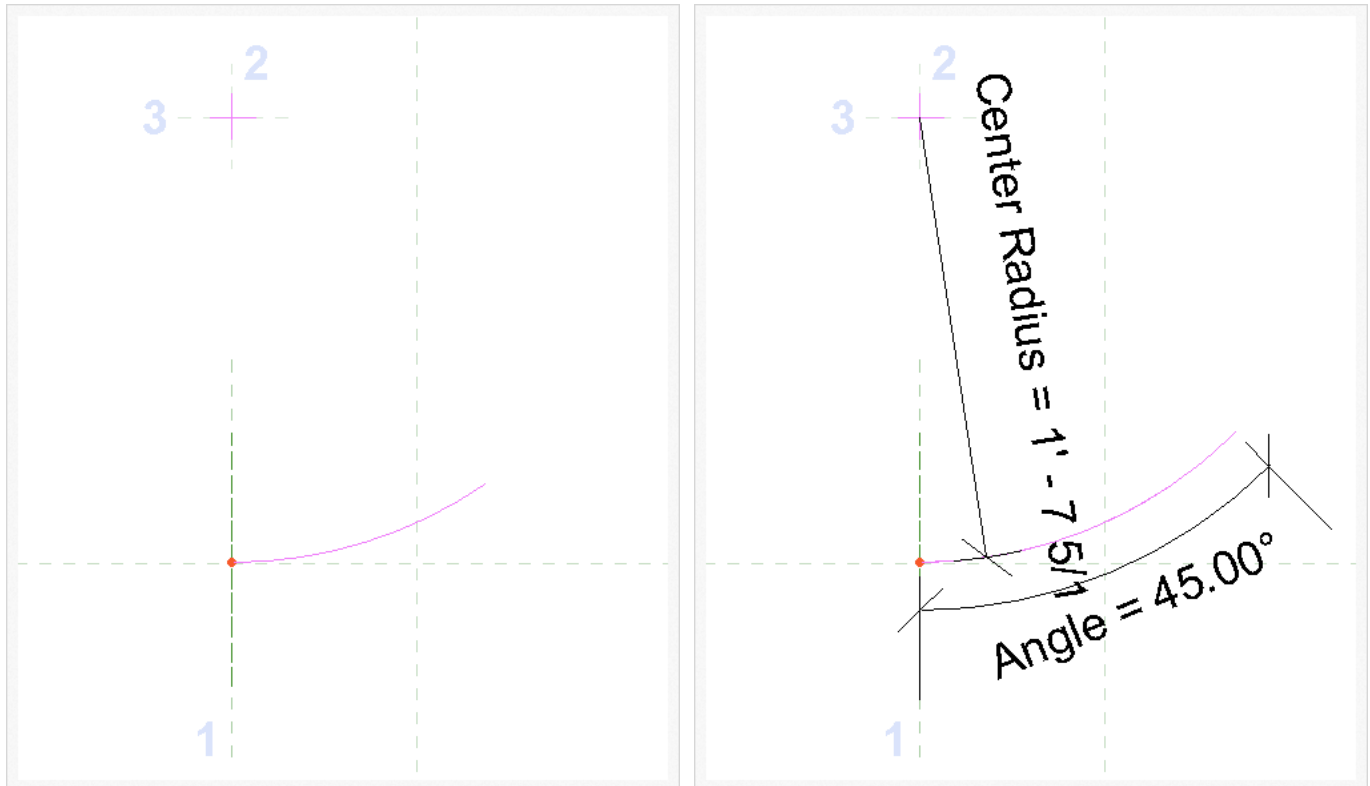
With the path selected we will turn on its Center Mark Visible option and proceed to align the center of the arc to both ref. planes #2 and #3 and lock them.



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Next, while still in this mode, we will move the reference plane for the profile of the sweep over to ref. plane #1 so that it is easier to work on it later on. Following that, we will make the angle and radius dimensions permanent and then label each of them with the Angle and Center Radius parameters respectively.

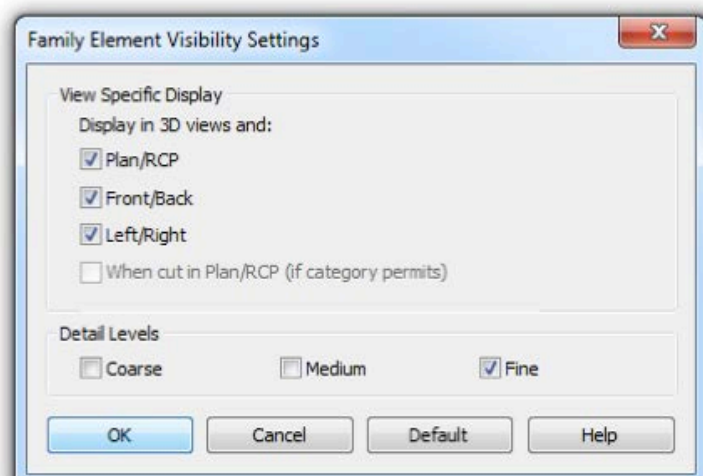
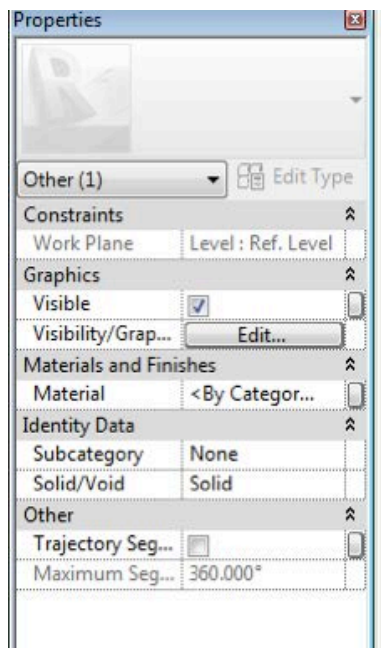
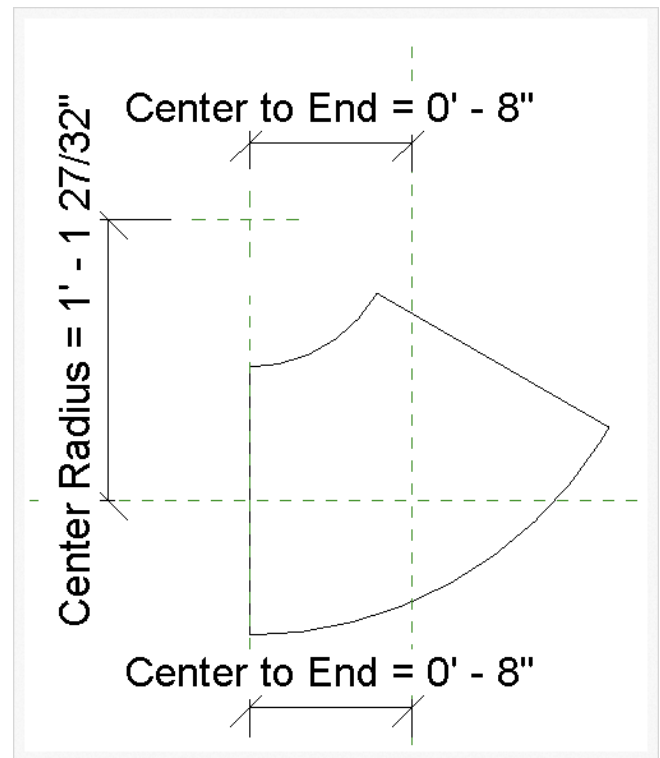


With this completed, click on Finish Edit Mode to finish the path and then Edit Profile -> Elevation: Left. Draw a circular profile and lock the center (make it visible by checking Center Mark Visible) to the ref. planes defining the profile. Make the radius dimension permanent and label it with Fitting Outside Radius parameter. Click on Finish Edit Mode twice (once to accept the changes to the profile and the next one to accept the changes to the sweep). Double click on the Ref. Level view. You should see something like what is displayed below.

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Before we are done with the sweep, let's make sure it only appears at the fine level of detail by selecting the geometry and in the properties, editing the Visibility/Graphic Overrides and unchecking the Coarse and Medium options.

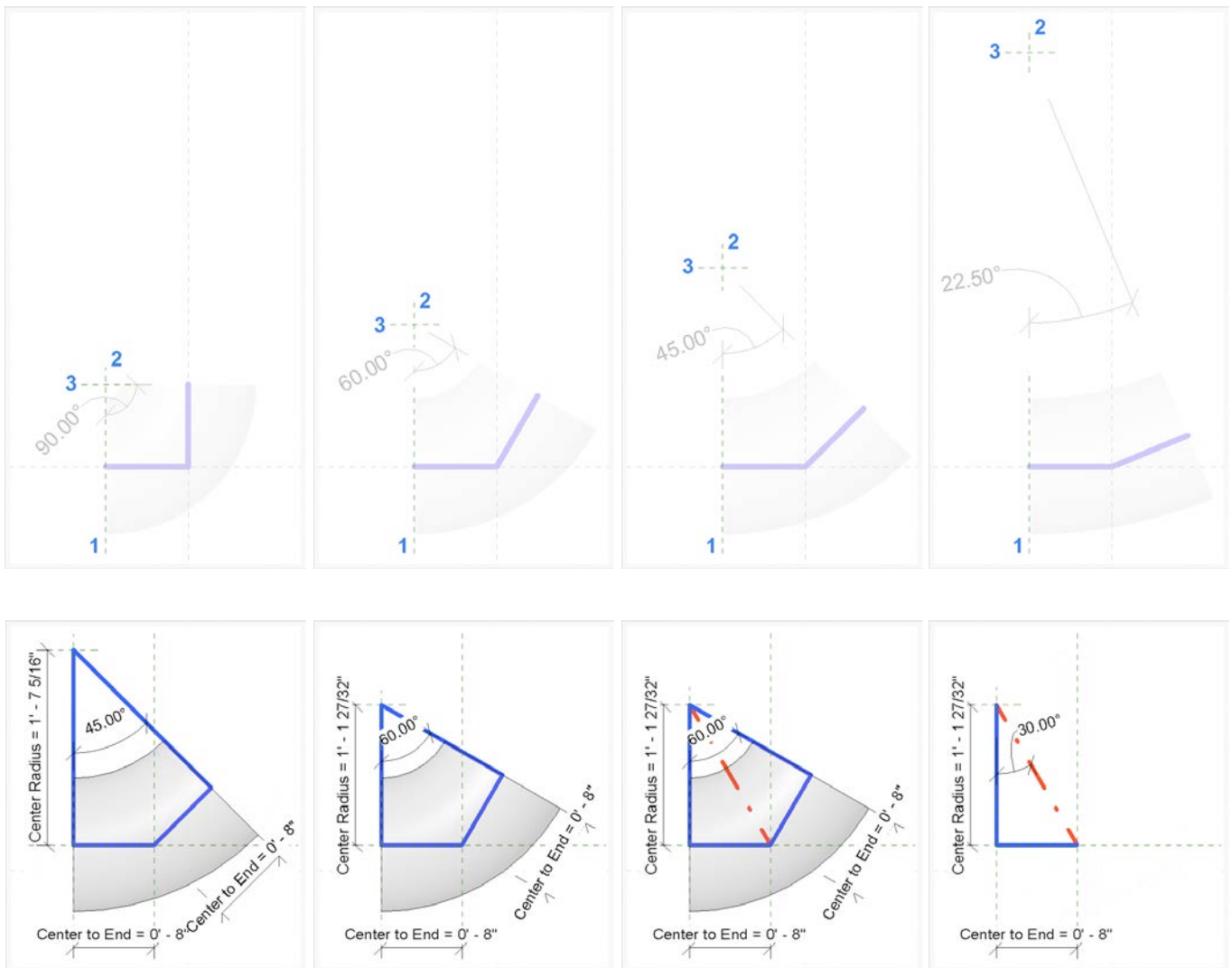


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## 4. Formulas

This is a good time to go back to the Family properties and fill in the formulas and some default values. There is a relationship between Center to End, the Angle and the Center Radius. Since we are working on an elbow, let's create this generic fitting so that we can set the Center Radius to be a multiple of the Nominal Diameter. We can then create it a long radius elbow by setting the Center Radius to 1.5 times the Nominal Diameter, or a short radius elbow by setting it up to just the Nominal Diameter.



## Creating Pipe Fittings in Revit MEP

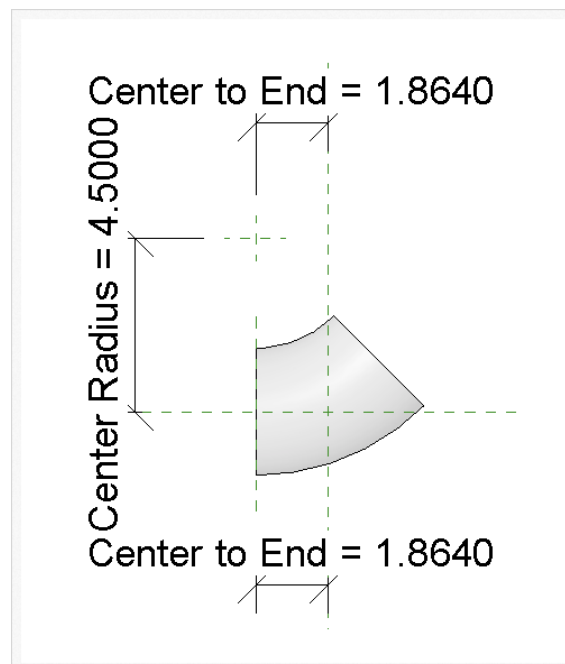
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By use of trigonometry we get the relation we are after. Drawing a series of lines to simplify the drawing and invoking SOH-CAH-TOA!! Or just the TOA! and we are done:  $\text{Tangent}(\text{Angle}) = \text{Opposite}/\text{Adjacent}$ .

Through the trigonometric formula we get that  $\text{Center to End} = \text{Center Radius} * \tan(\text{Angle}/2)$ . Let's make this a long radius bend, too. With the formula solved and knowing we want to have a long radius bend, we update the formulas within the Family Types dialog to suit.

Nominal Diameter	3"	= Nominal Radius * 2
Nominal Radius	1.5"	
Angle	45°	
Fitting Outside Diameter	3.3"	= Nominal Diameter * 1.1
Fitting Outside Radius	1.65"	= Fitting Outside Diameter / 2
Tick Size	1.32"	= Fitting Outside Diameter * 0.4
Center Radius	4.5"	= Nominal Diameter * 1.5
Center to End	1.864"	= Center Radius * $\tan(\text{Angle}/2)$

The fitting should now look like the image below.

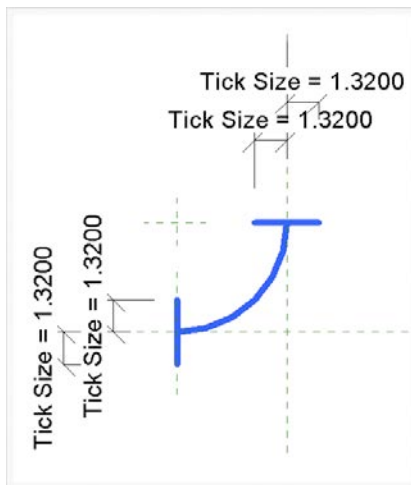


# Creating Pipe Fittings in Revit MEP

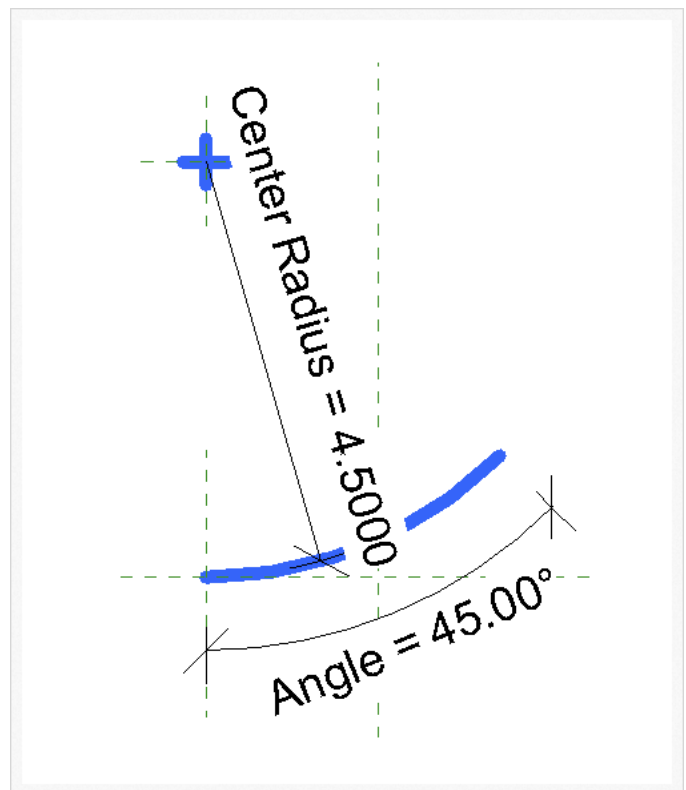
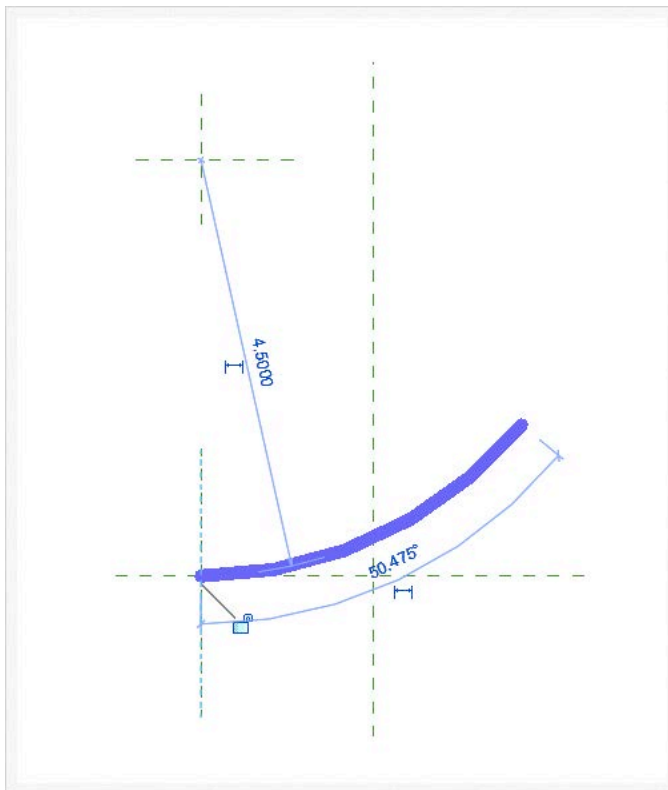
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## 5. Creating 2D Geometry

We have now covered the geometry in fine level of detail. Let's add the coarse and medium level of details. Following Autodesk's OOTB content, the coarse and medium levels of detail will be one and the same and we will use model lines to draw them. See the image below for what we are going to create next. Notice what is it that we are calling Tick Size.



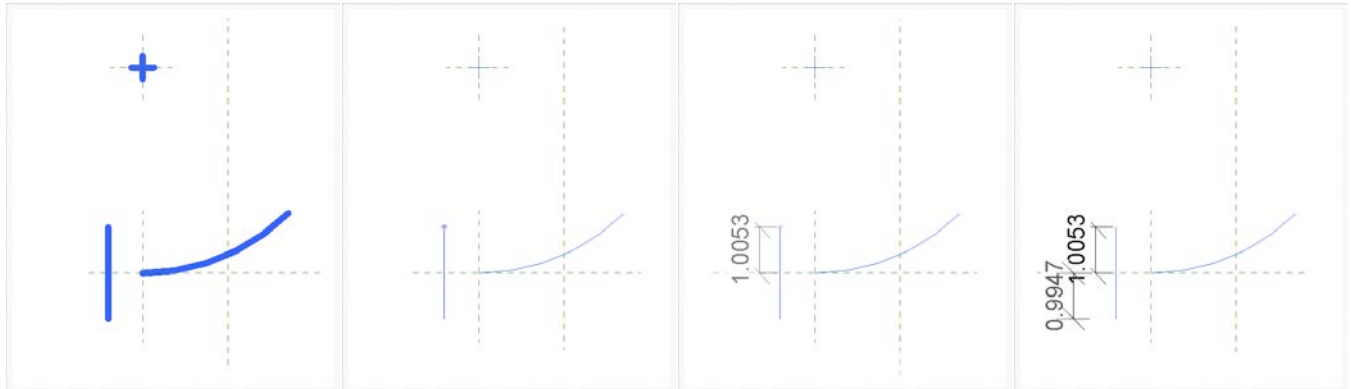
The first model line we will draw will be the arc that follows our previous sweep path. And as such we will use the exact same procedure to draw it. Just as we did with the path, let's make the center visible and lock it to both reference planes #2 and #3. Next make its angle and radius dimensions permanent, labelling them with Angle and Center Radius respectively.



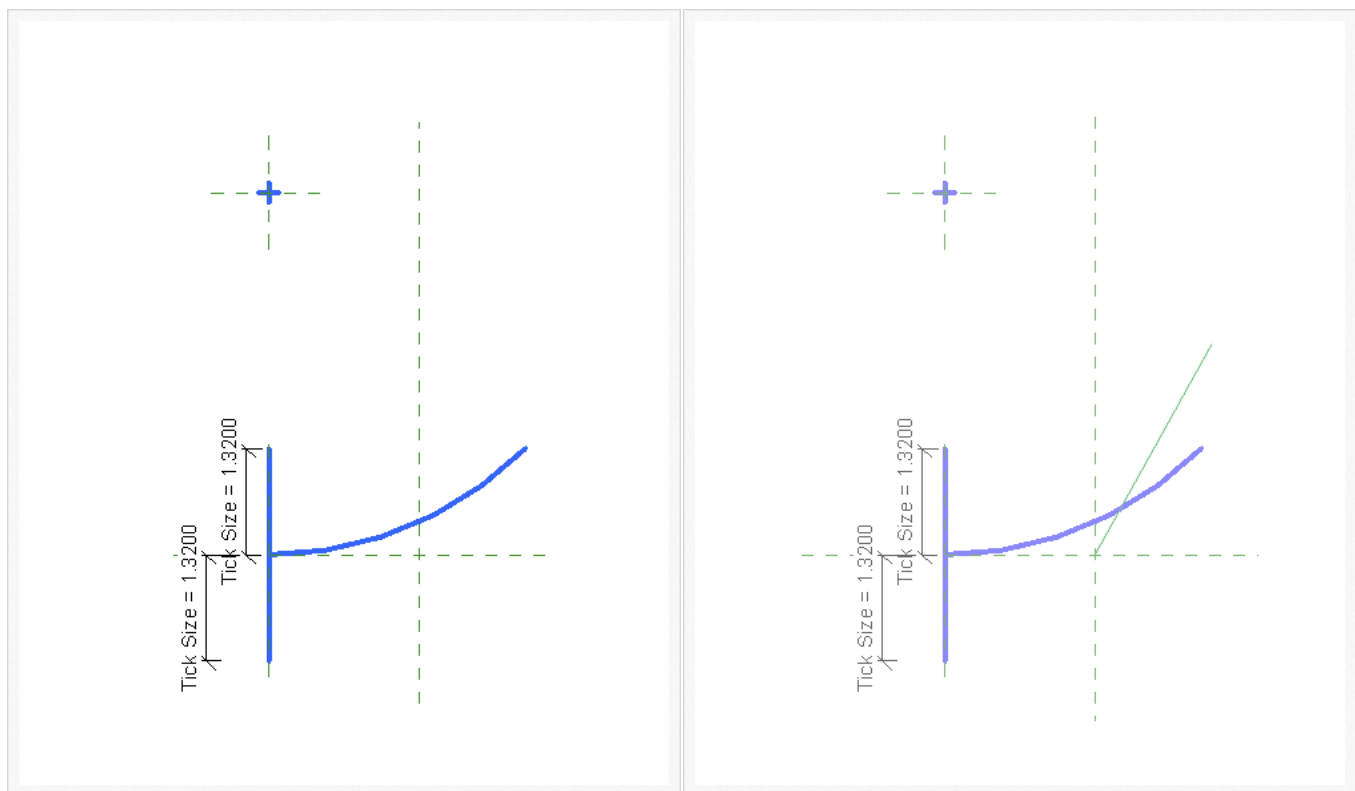
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Next we need to add the ticks. We start with the ones on the left that are always vertical, in line with ref. plane #1. Drawing just one line to the left of ref. plane #1, we dimension from its top extremity to the CFB ref. plane and again from the bottom extremity to the CFB ref. plane.



We now select the two dimensions and label both as Tick Size. Finally, we align and lock the tick marks' line to ref. plane #1. For the ticks on the right, given that they will rotate and update size at the same time, we are going to save time by using a reference line as their base. We draw a reference line from the origin of the family in the direction of the second connector.

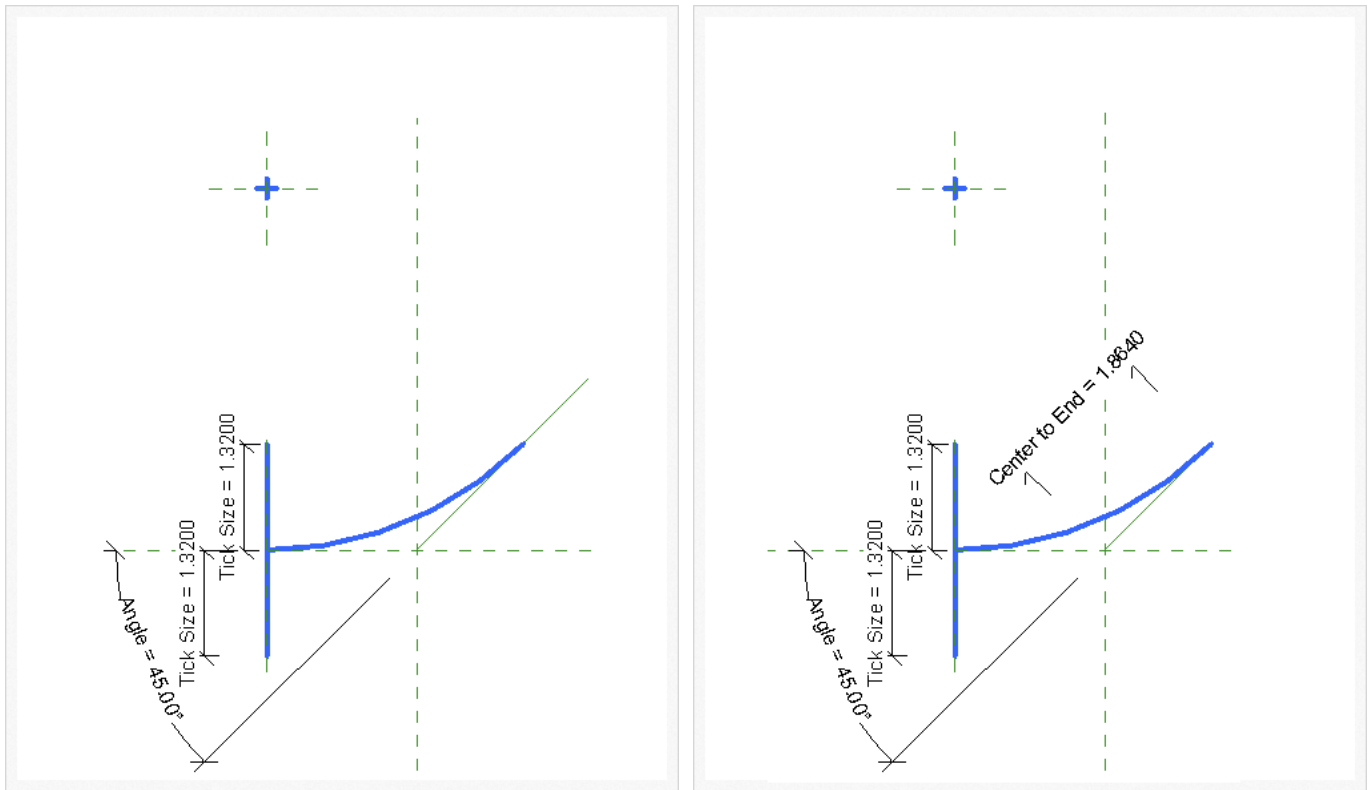




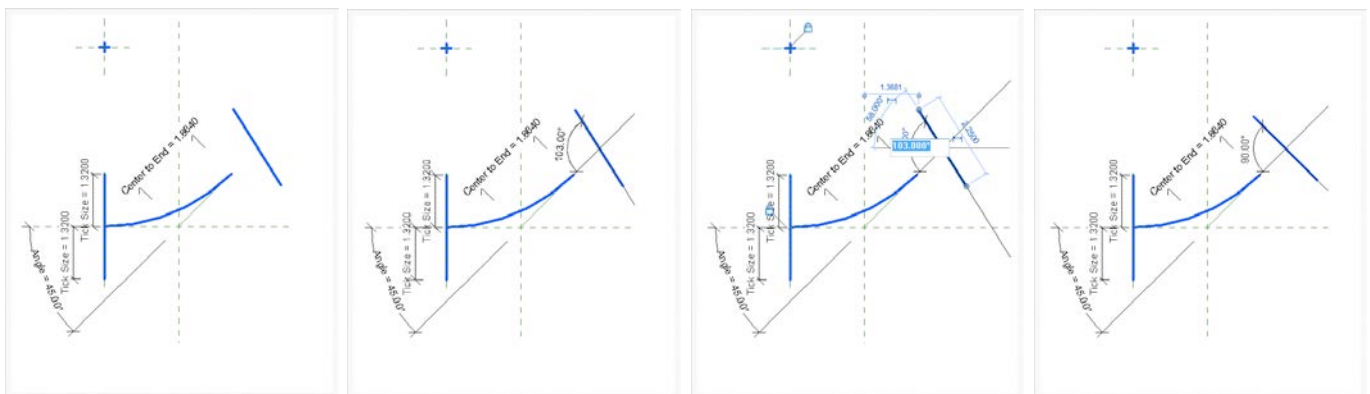
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We lock the reference line to both CFB and CLR planes, add an angular dimension from the reference line to the CFB plane and label this dimension with Angle. Next we dimension from one edge of the reference line to the other one and label the dimension with Center to End.



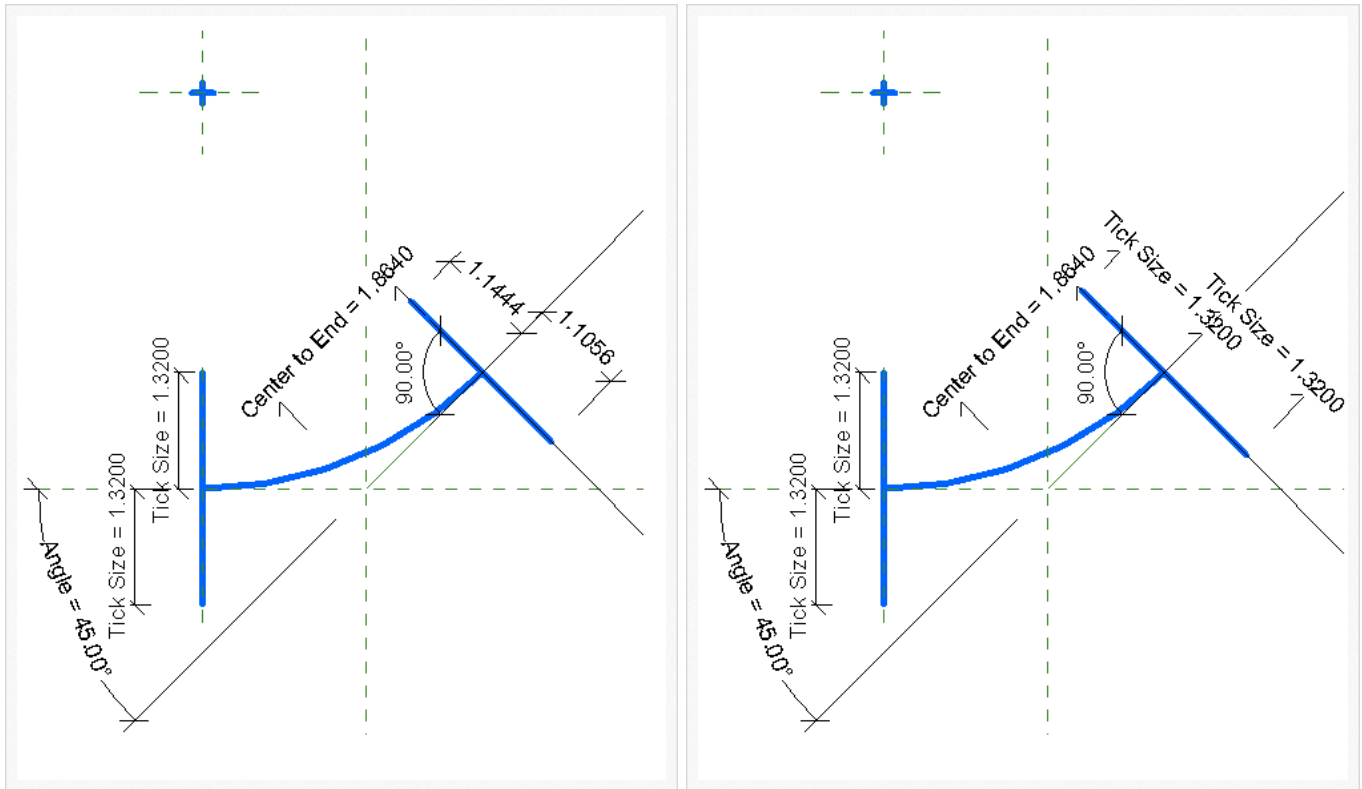
Next we draw the model line for the right ticks as shown in the image below, adding an angular dimension from the ticks line (model line) to the reference line and setting the value to 90°.



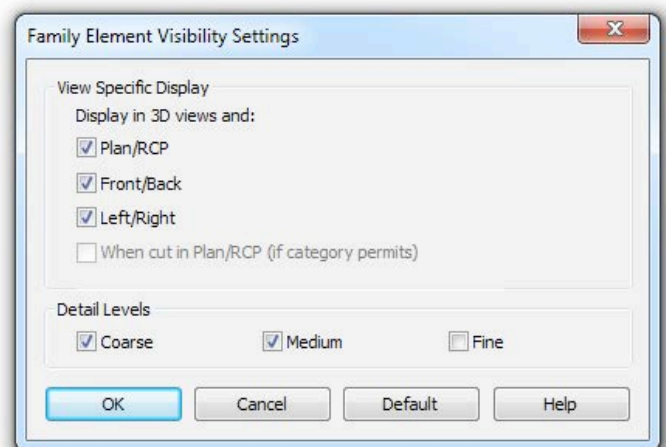
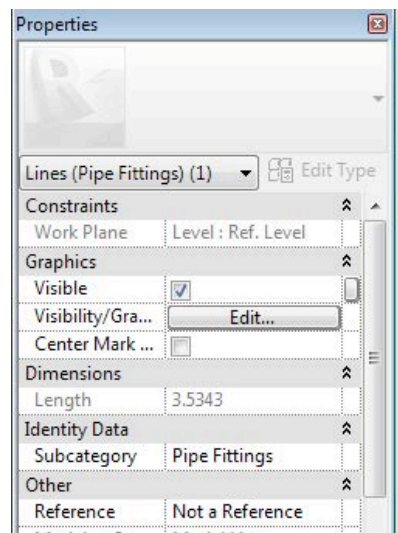
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Align the ticks line to the end of the reference line and dimension the edges of the model line to the reference line just as we did with the model line for the left ticks.



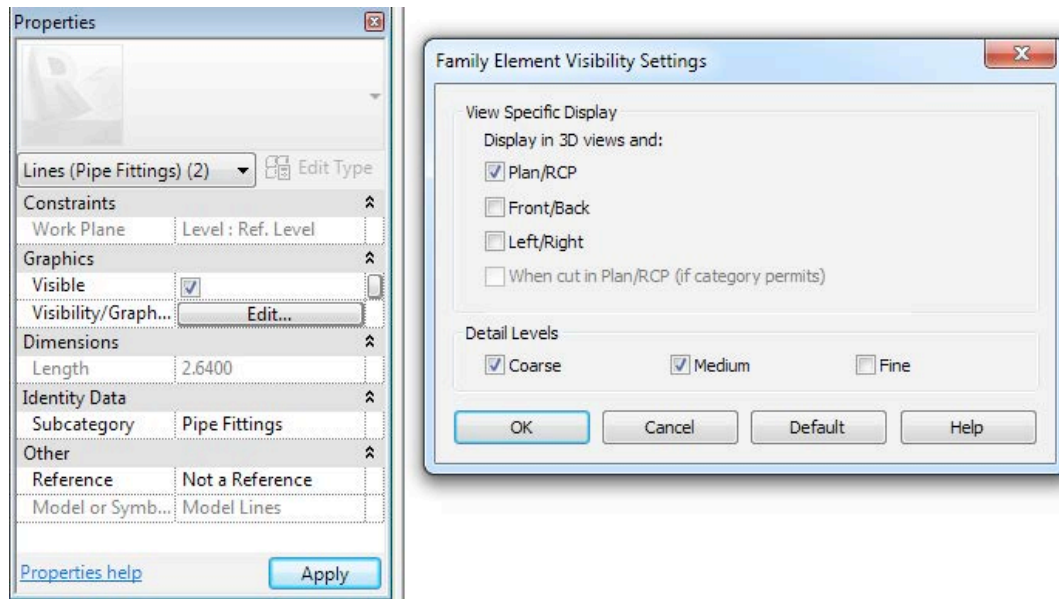
Selecting the arc line, we hide the center of the arc and change the visibility settings so that we only see the line in medium and coarse views and not in fine views. We also take the opportunity to set the model line as Not a Reference.



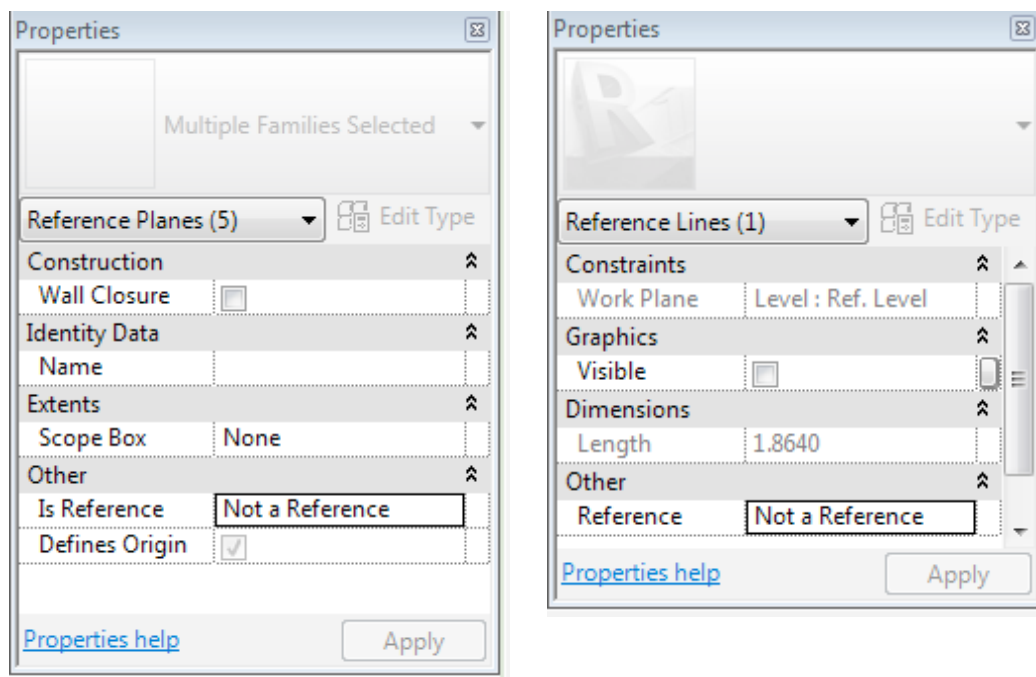
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Next we do the same with the model lines for the ticks, with a slight change in the visibility settings where we will uncheck "Fine" under detail levels and also "Front/Back" and "Left/Right" under View Specific Display.



To finish the geometry, we select all the reference planes and set them as Not a Reference. Next we select the reference line, set it to Not a Reference as well and uncheck its visibility setting.

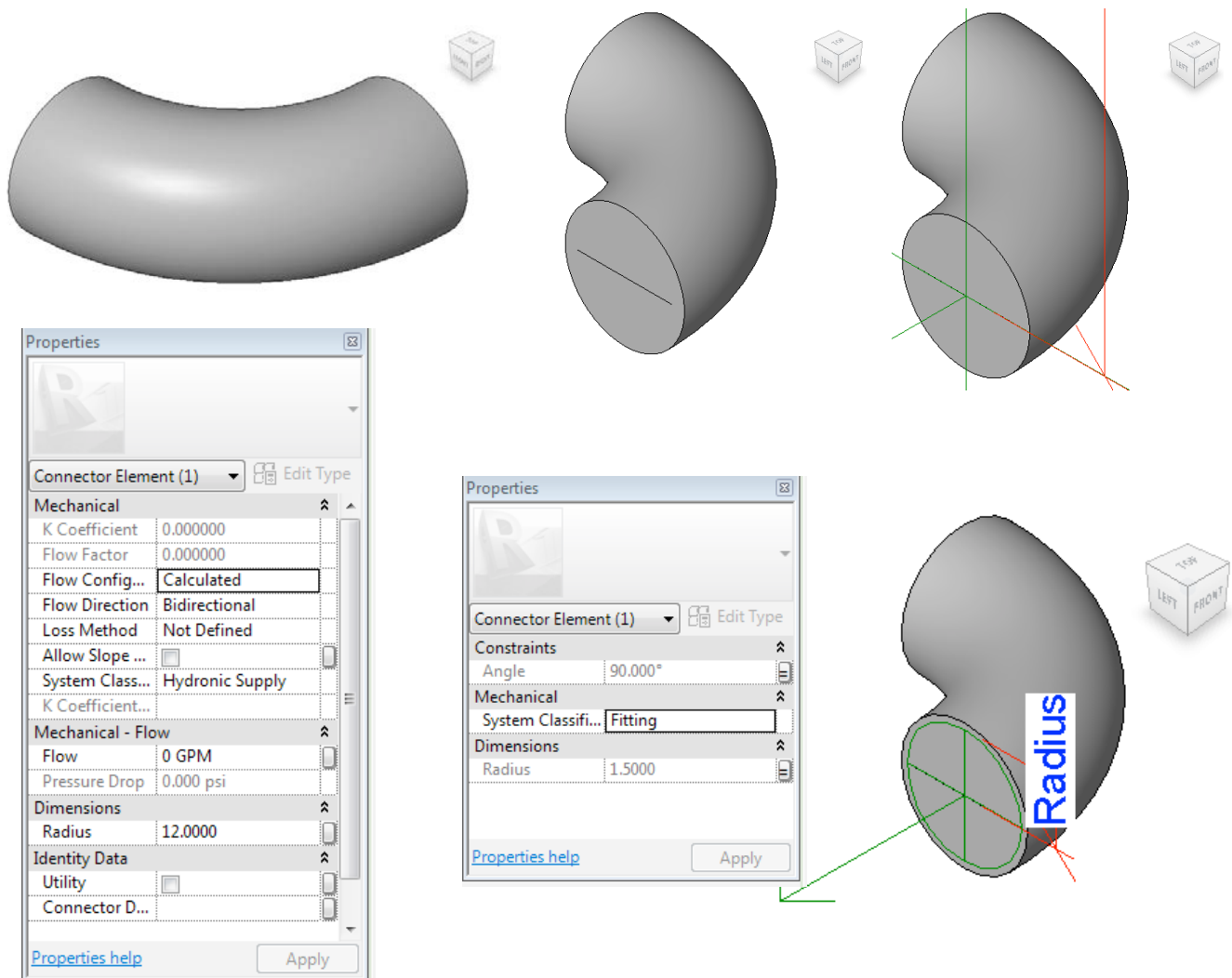


# Creating Pipe Fittings in Revit MEP

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## 6. Connectors

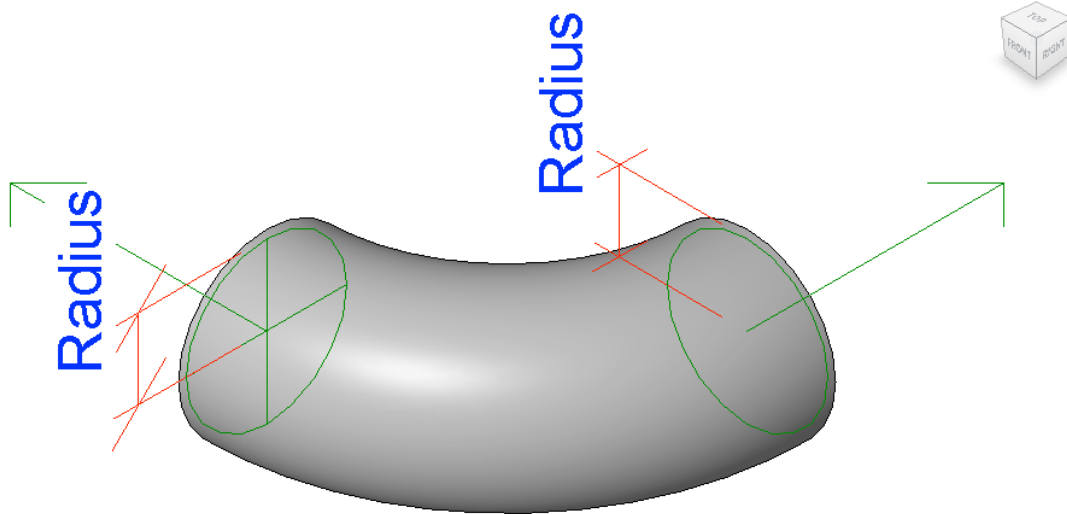
The final step in the creation of the family is to add the connectors. To place the connectors, a 3D view will be the best option. The first connector should be placed on the left side. Once placed into the family we update the connector's properties. Since we are creating a fitting, the first parameter to change will be the System Classification, changing it from its default of Hydronic Supply to Fitting. This greatly simplifies the properties dialog of the connector. Next we associate the Angle and Radius properties of the connector to the Angle and Nominal Radius parameters, respectively.



## Creating Pipe Fittings in Revit MEP

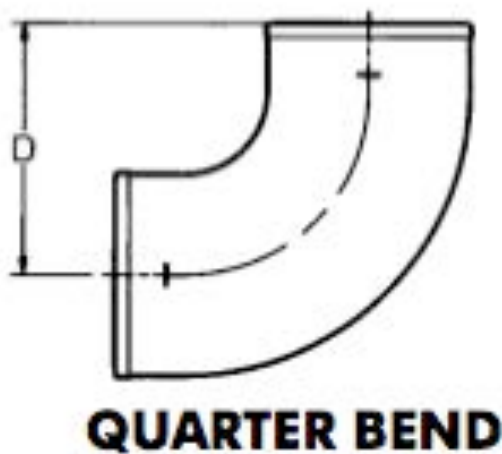
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We repeat the procedure to add the other connector to the fitting. Finally, we link the two connectors and we are done!



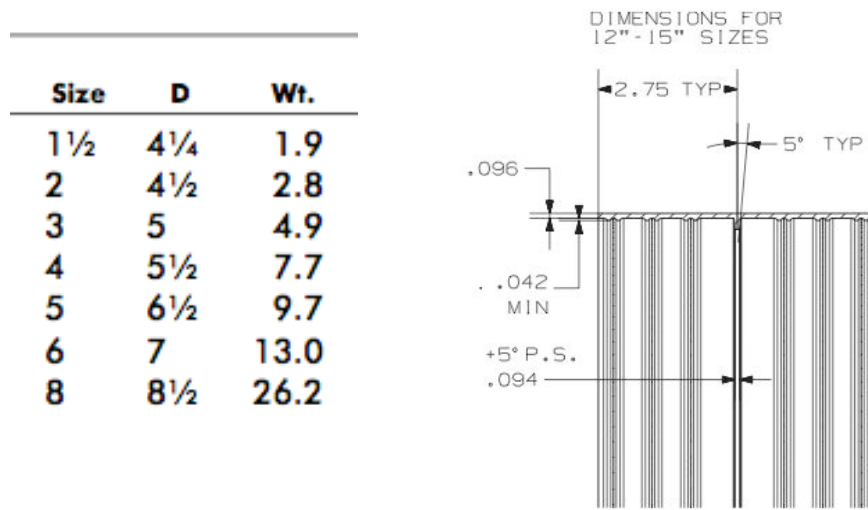
### 7. Lookup Tables

With the generic family done, we will now use it as the basis for a manufacturer-specific fitting. Below are the details of the manufacturer fitting we want to create.



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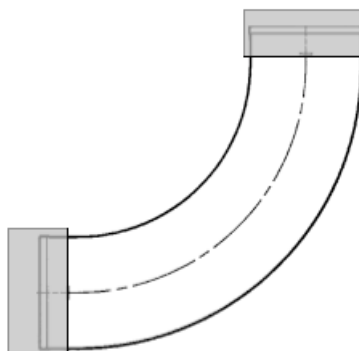


DIMENSIONS IN INCHES										
	1½"	2"	3"	4"	5"	6"	8"	10"	12"	15"
B	2.125	2.125	2.125	2.125	3.000	3.000	4.000	4.000	5.500	5.500

With a lookup table we can feed the manufacturer specific values into the family, To facilitate the creation of the lookup table we can make use of the option to export family types which creates a .txt file that we can use as the basis for the final lookup table. Before exporting the family types we will add an additional parameter to the family, the Cut Length.

Cut Length      Piping      Pipe Size      Dimensions

In Revit we don't want to model the geometry that won't be visible, so in the case of a no-hub fitting like the one shown, we need to remove the length of the fitting from each end that goes into the coupling. The Cut Length parameter will keep that information for use within the family.

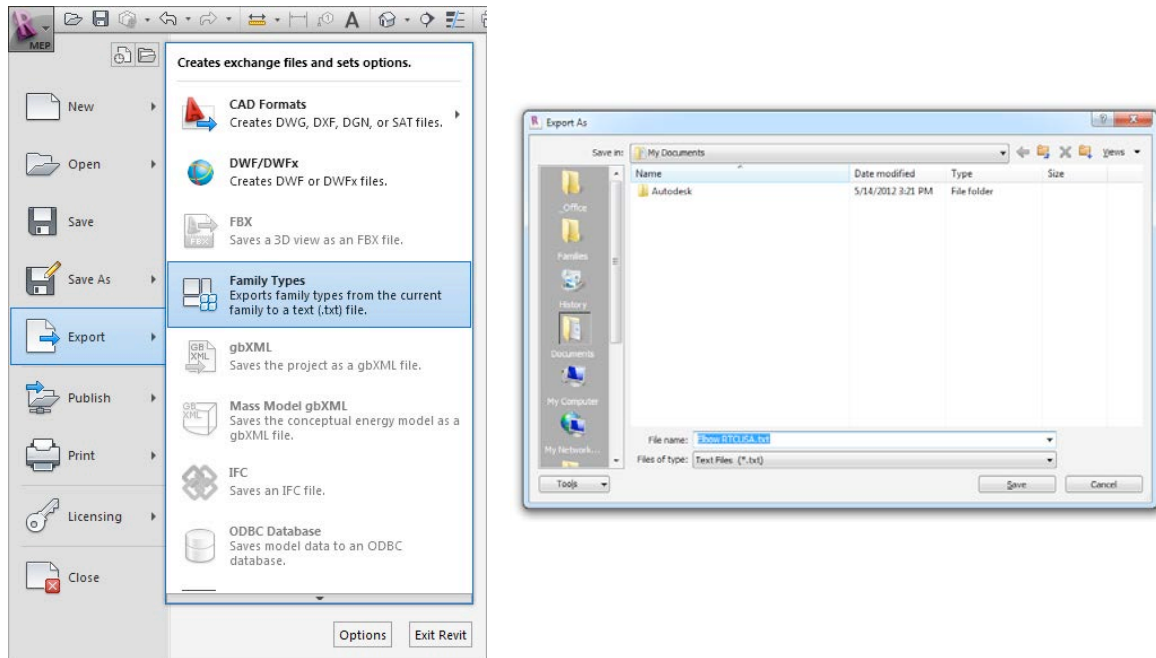




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To export the family types we select the Application icon > Export > Family Types and choose a folder where to save the file. We can save it to the desktop and accept the default name given by Revit, which matches the family name.



Next we import the txt file that we've just created into Excel:

- 1) Open Microsoft Excel.
- 2) Open the file Elbow RTCUSA.txt. Excel will display the Text Import Wizard dialog box.
- 3) Choose "Delimited" and then press the Next button.
- 4) Check "Comma" under Delimiters and press the Finish button.

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
	Tick Size##PIPE_SIZE##INCHES	Nominal Radius##PIPE_SIZE##INCHES	Nominal Diameter##PIPE_SIZE##INCHES	Manufacturer##OTHER##	Loss Method##OTHER##	K Coefficient	Fitting Outside Radius##PIPE_SIZE##INCHES	Fitting Outside Diameter##PIPE_SIZE##INCHES	Cut Length##PIPE_SIZE##INCHES	Center to End##PIPE_SIZE##INCHES	Center Radius##PIPE_SIZE##INCHES	Angle##ANGLE##DEGREES			
Standard	1.32	1.5	3	Generic	1	Regular 45, 90 and 180 Elbow	1.65	3.3	0	4.5	4.5	90			



## Creating Pipe Fittings in Revit MEP

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With this file we can now delete the columns that are not going to be necessary, change the order, and add the manufacturer data to it.

For a document explaining the creation of Lookup Tables, check Martin Schmid's AU 2008 class. You can find a link to the document at [http://inside-the-system.typepad.com/my\\_weblog/2008/11/revit-mep-text\\_file\\_lookup-and-lookup-tables.html](http://inside-the-system.typepad.com/my_weblog/2008/11/revit-mep-text_file_lookup-and-lookup-tables.html)

The end result would look similar like the image below once we've deleted the columns that we won't need and added the details for other angles.

A	B	C	D	E	F	G	H
			ND##length##inches	Angle##angle##degrees	FOD##length##inches	CLE##length##inches	Wgt##FORCE##POUNDS
1.5	1.5	90	1.9	3.2345	1.9		
2	2	90	2.35	3.4845	2.8		
3	3	90	3.35	3.9845	4.9		
4	4	90	4.38	4.4845	7.7		
5	5	90	5.3	5.047	9.7		
6	6	90	6.3	5.547	13		
8	8	90	8.38	6.547	26.2		
2	2	72	2.35	2.672	2		
3	3	72	3.35	3.047	3.5		
4	4	72	4.38	3.422	5.5		
2	2	60	2.35	2.4845	2		
3	3	60	3.35	2.4845	3		
4	4	60	4.38	2.797	5.1		
1.5	1.5	45	1.9	1.6095	1.1		
2	2	45	2.35	1.7345	2.1		
3	3	45	3.35	1.9845	3.3		
4	4	45	4.38	2.1095	4.4		
5	5	45	5.3	2.422	6.8		
6	6	45	6.3	2.6095	8.5		
8	8	45	8.38	3.047	15		
10	10	45	10.56	3.9845	30.7		
12	12	45	12.5	3.8595	39		
15	15	45	15.83	4.4845	70		

The lookup table has the same format as a type catalog, but the extension is different. Once finished editing the lookup table, we can save it as a Windows Comma Separated Values file. Finally, we place the .csv lookup table file into the lookup table folder. The default folder is C:\ProgramData\Autodesk\RME 2013\Lookup Tables\Pipe. With the lookup table in place, the family can now be updated to make use of it.

# Creating Pipe Fittings in Revit MEP

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## Generic

Nominal Diameter	= Nominal Radius * 2
Nominal Radius	
Angle	
Fitting Outside Diameter	= Nominal Diameter * 1.1
Fitting Outside Radius	= Fitting Outside Diameter / 2
Tick Size	= Fitting Outside Diameter * 0.4
Center Radius	= Nominal Diameter * 1.5
Center to End	= Center Radius * tan (Angle/2)

## Manufacturer Specific

Nominal Diameter	= Nominal Radius * 2
Nominal Radius	
Angle	
Fitting Outside Diameter	= text_file_lookup(Lookup Table Name, "FOD", Nominal Diameter * 1.08, Nominal Diameter)
Fitting Outside Radius	= Fitting Outside Diameter / 2
Tick Size	= Fitting Outside Diameter * 0.4
Center Radius	= Center to End / tan(Angle / 2)
Center to End	= text_file_lookup(Lookup Table Name, "CtE", sin(Angle) * (0.51 * Nominal Diameter + 2.88"), Nominal Diameter, Angle)

We can also now add Weight to the parameter list and get the information from the lookup table. And with that we are finished.

Weight	Structural	Force	Identity Data
Weight	= text_file_lookup(Lookup Table Name, "Wgt", 0 lbf, Nominal Diameter, Angle)		