**Santiago High Architecture Design 2A/2B**

**Revit MEP 2017 Demo: Mechanical**

Students will create a mechanical plan of the Retail Store. In order, we will:

Create the building in Revit Architecture.

Link our Revit Architecture model into Revit MEP

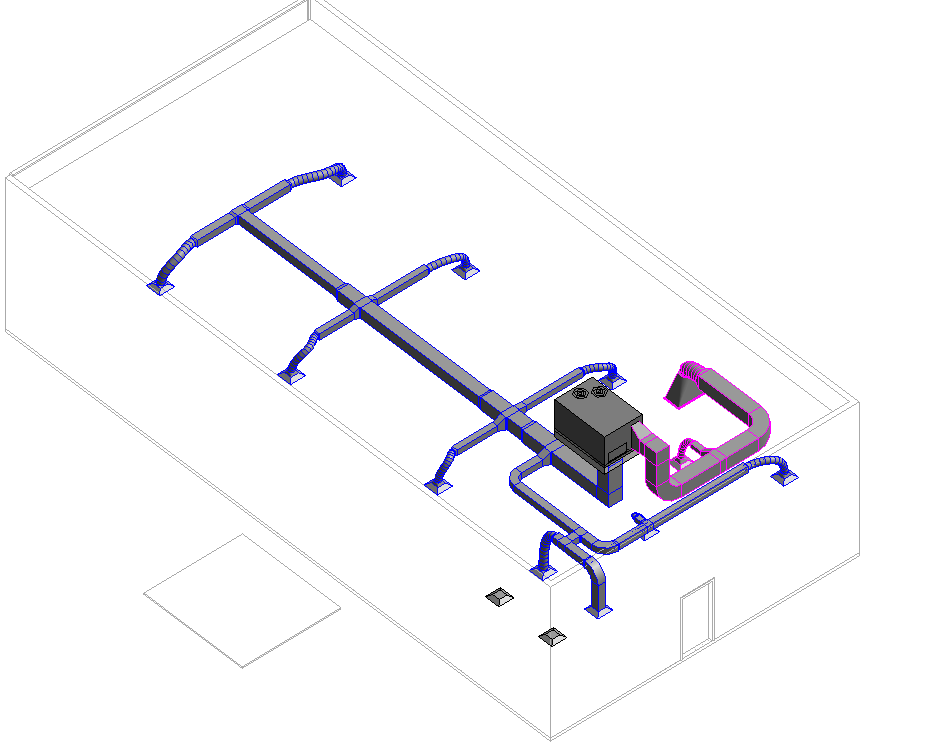
Place the Supply, Return and Exhaust Diffusers

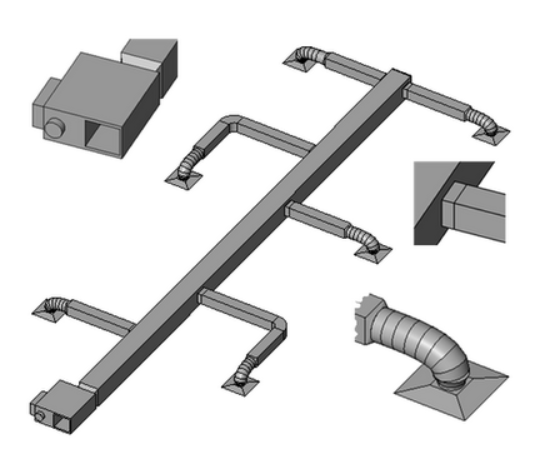
Calculate the duct sizes

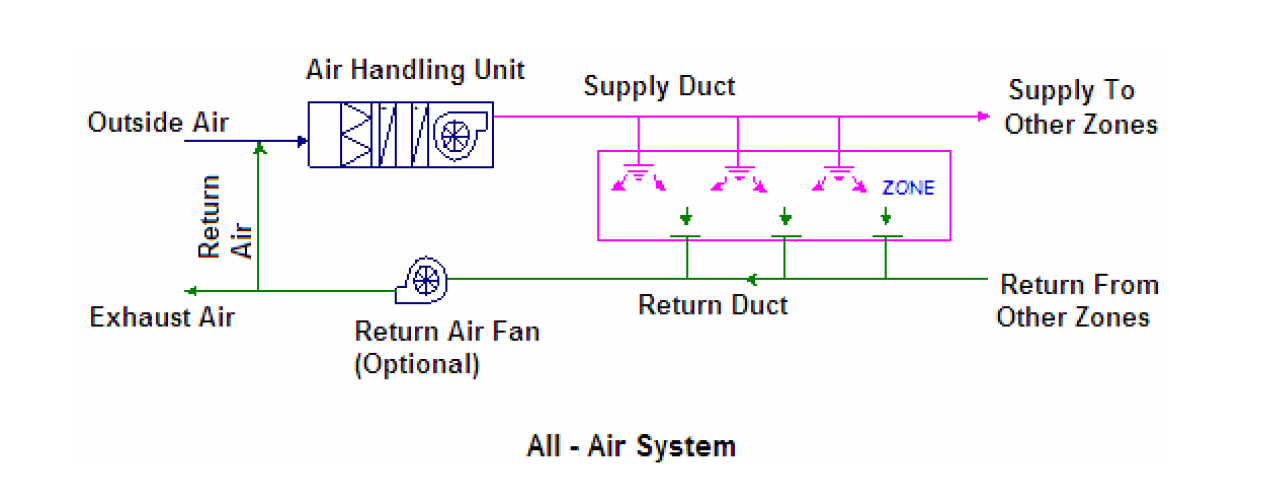
Draw the duct runs

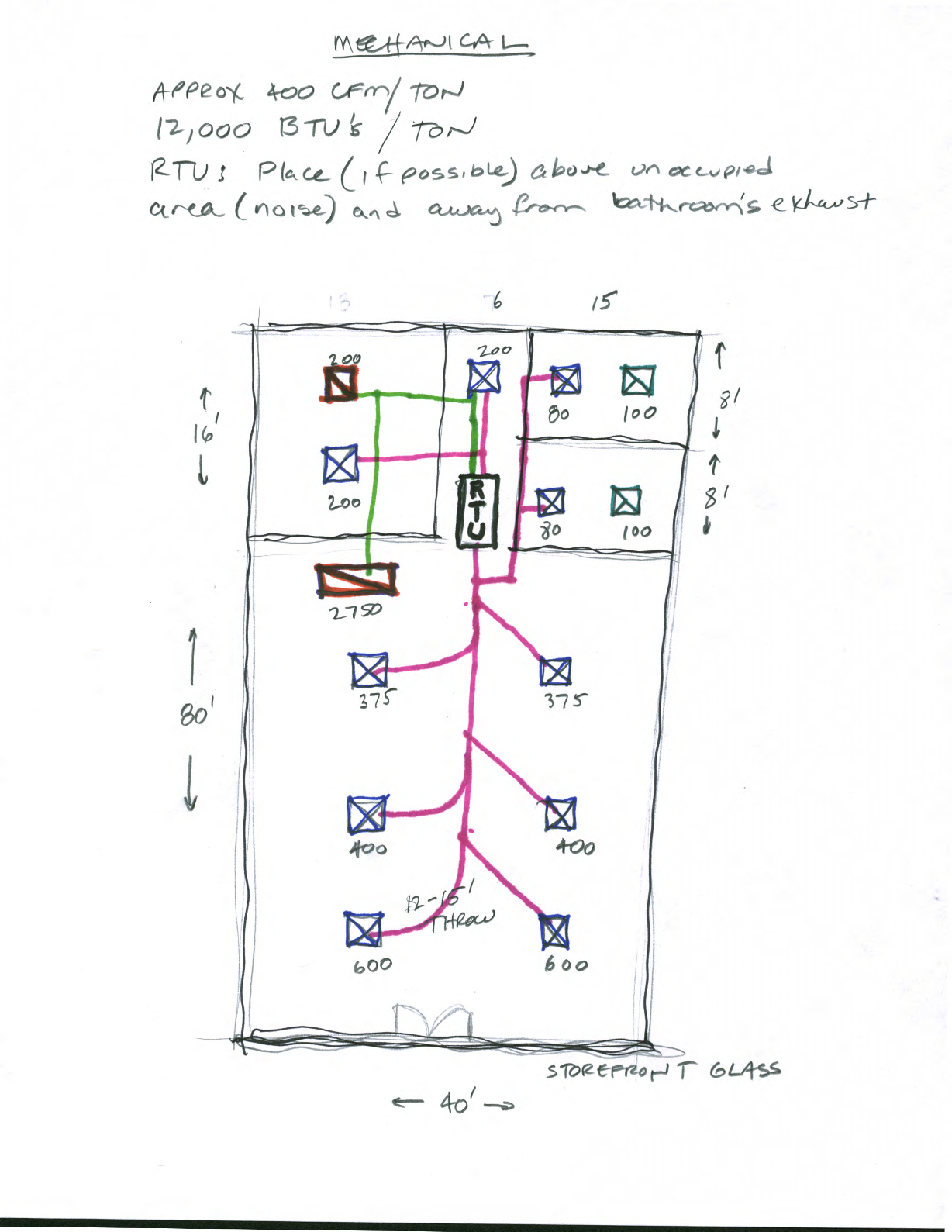
Use EnergyPro to calculate our Heating and Cooling Loads

Find and place the proper Roof Top Air Conditioner

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**Create Building per Sketch in Revit Architecture**

It should have walls, storefront, ceilings, doors, 3D Text sign, foundation, and tile flooring. No plumbing or electrical fixtures. We will do that in Revit MEP.

Some details:

Double Glass Curtain door

14’ Level 2 (name it Roof)

11’ 2X2 ACT Ceilings everywhere but Restroooms

9’ 2X2 ACT Ceilings in Restrooms

Ext walls will have a 4’ parapet, making them 18’ total

Make Roof a Generic 12 to start, at the Roof Level (14’)

5” Slab Foundation with footings

Put ¼” ceramic tile on the floor in all rooms. Offset ¼” to go on top of Foundation slab

Paint on walls. You will have to split some walls and “Split Face” some walls.

Place base molding

Save as: Revit Arch Building for MEP.rvt

**Linking the Building into Revit MEP**

Generally the architect designs the building, then hands it off to the Mechanical Engineer (you) to do the Mechanical, Electrical, and Plumbing plans. We will try to use that workflow….

Open Revit

Mechanical Template

File: Save as Store Mechanical 2017.rvt

In Floor Plan 1-Mech

Insert

Link Revit

Revit Arch Building for MEP.rvt …WAIT…don’t hit OK….see next step!

Position: Auto Origin to Origin…..Open (**this is important**)

The building should be there. ***Discuss Linked Files***

Note the new Browser setup

***Discuss layout by Discipline***

***Show Properties….Discipline…Mechanical….Plumbing, etc***

***Show subdiscipline….HVAC…..***

Mechanical 1-Mech

VV

Note Lighting, Electrical equipment OFF, but Ducts, Air Terminals ON.

East Elevation Plumbing

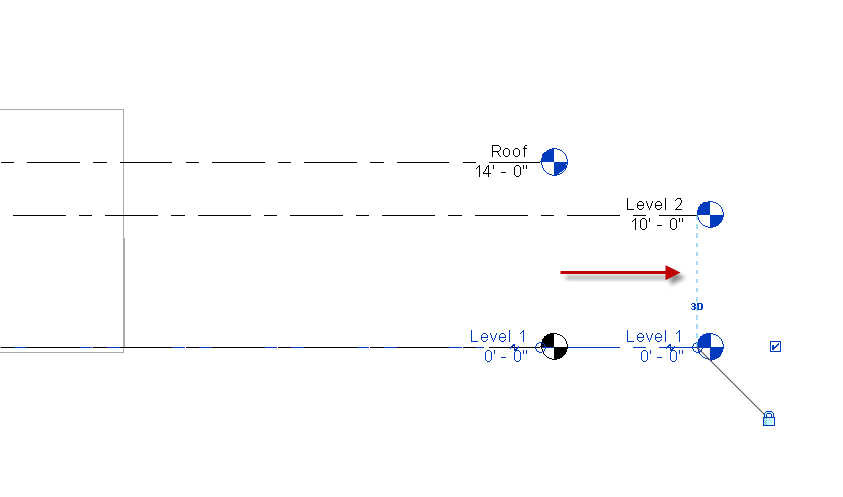
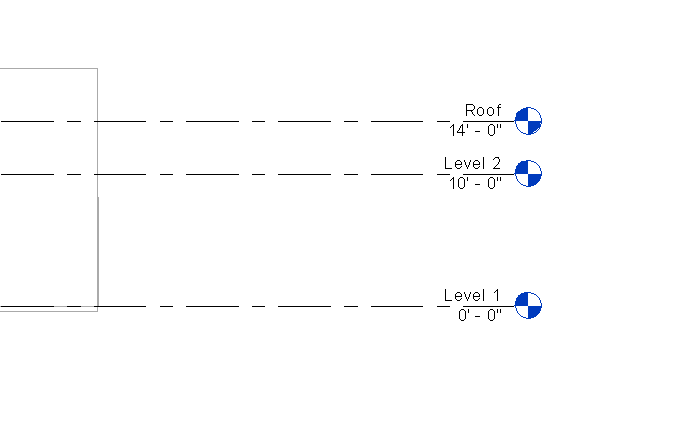
VV

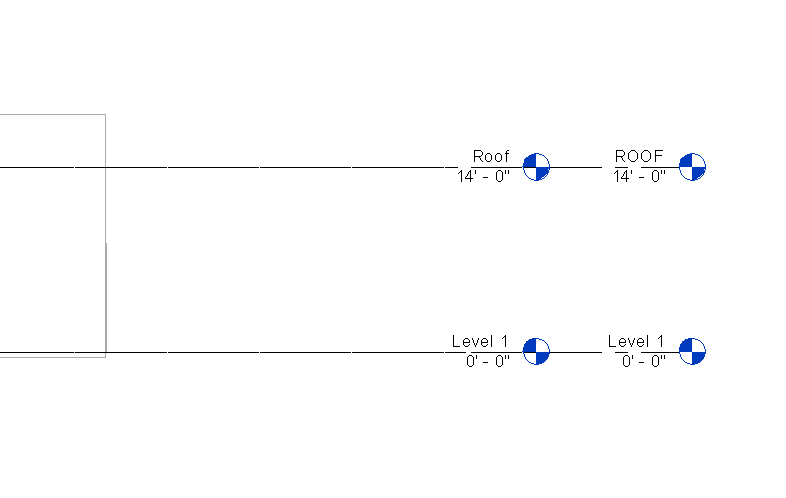
Note Pipe and plumbing fixtures ON, but Lighting, ducts, air terminals OFF

Get it??

Go to Elevation View. The linked building and the template need to have the Levels aligned.

Drag the levels away from each other.





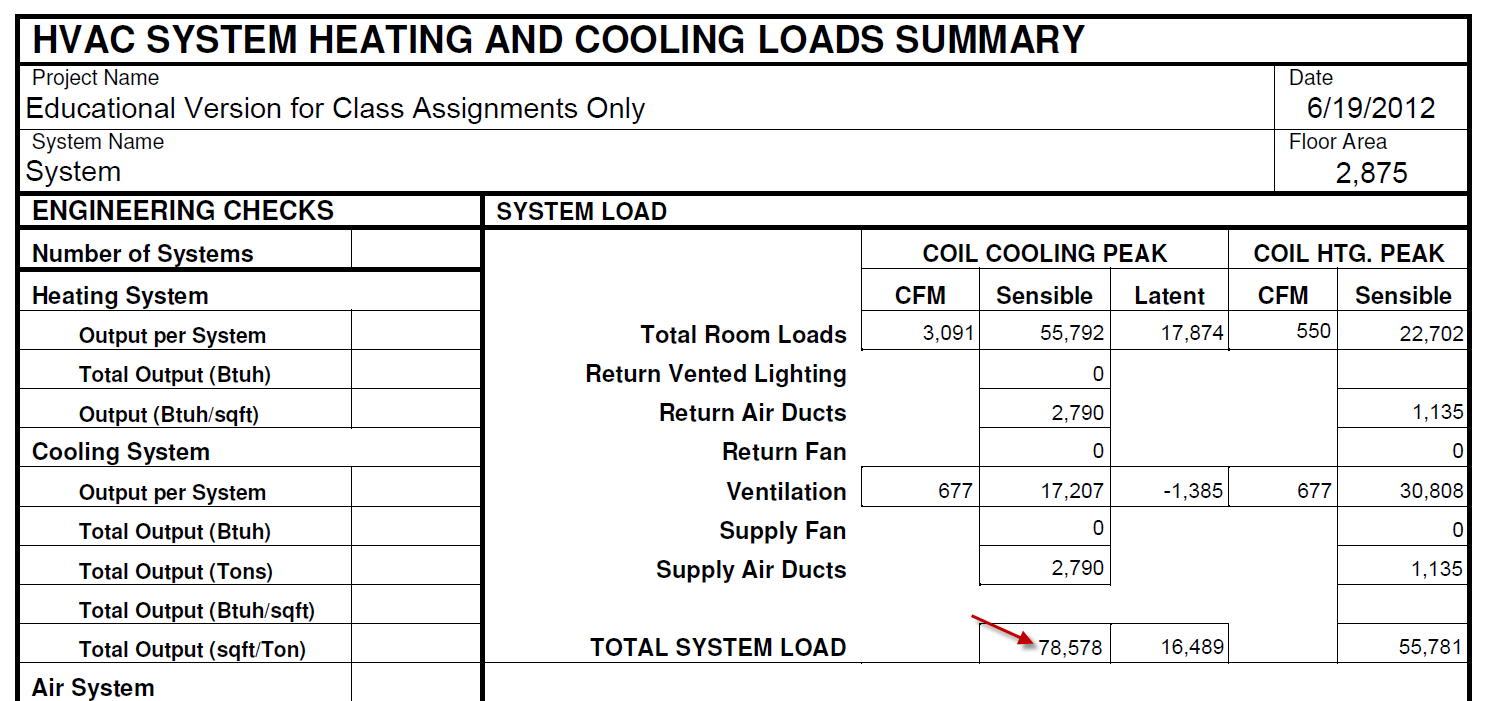
Note Level 1’s are OK

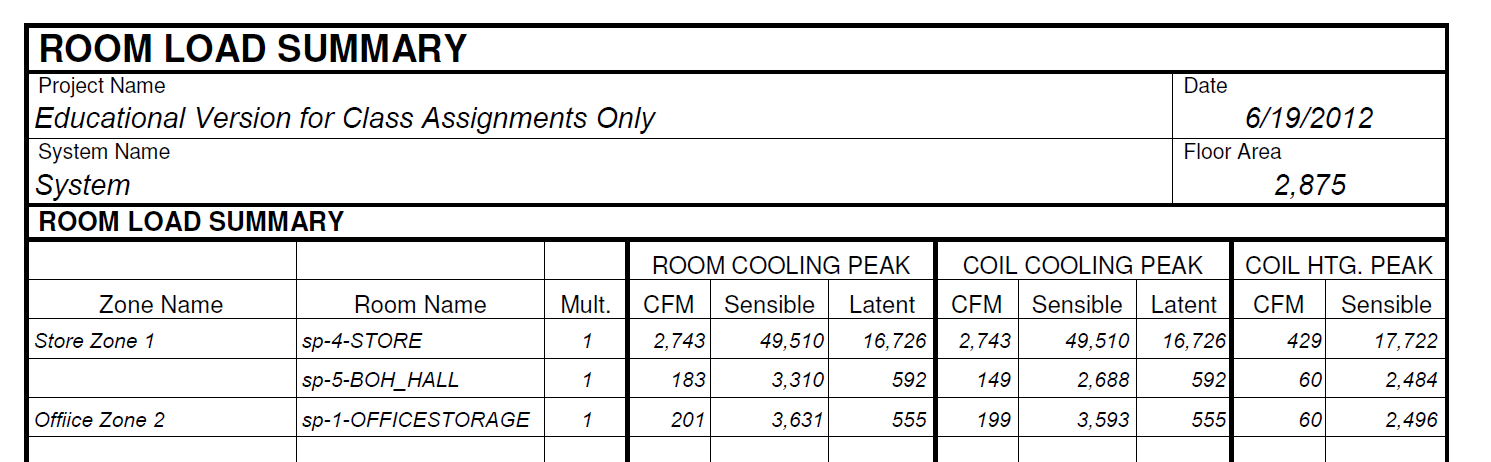
Rename Level 2 to **ROOF** and move it to the other “Roof” level using the Align command

Save as Store Mechanical 2017.rvt

Creating the Mechanical System: Leveraging EnergyPro data

Before we start throwing in Air Conditioners, ducts, supplies, returns, etc, we need to know what the building requires! We created an energy model in EnergyPro to give us load information of the Store.

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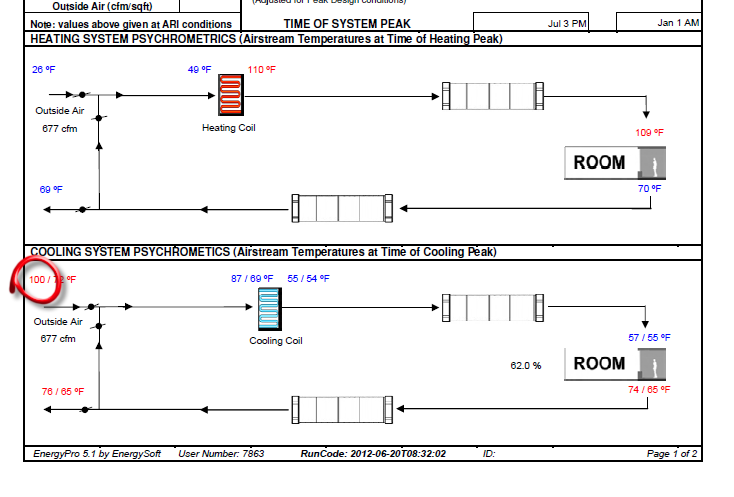
So we have a sensible load of 78,500 BTU. We know that sensible load is about 70% of the Actual Load…

So 78,500/.7=112,000 BTU 12,000BTU in a ton 112000/12000=9.3 tons

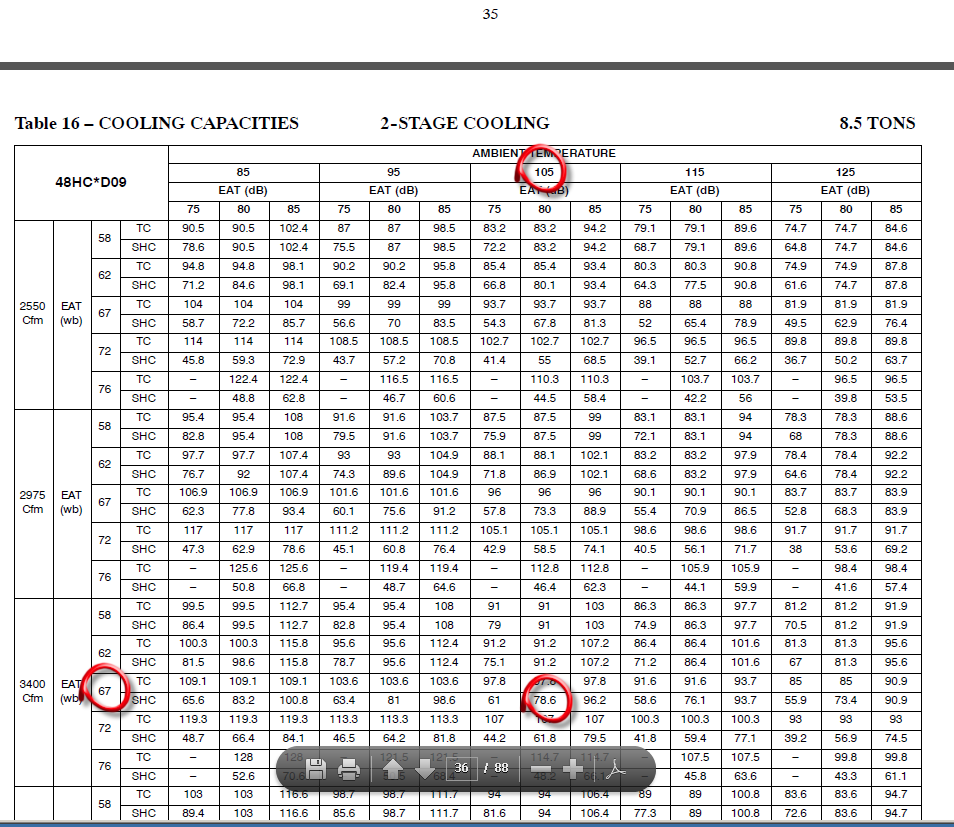
Now that does NOT mean we necessarily need a 9.3 ton unit…but that is a good size to start with when looking at cut sheets. We really need a unit that gives us 78,500 Sensible BTU’s. We could even use 2 units at about 9.3/2=4.65 tons….if needed….discuss advantages.

**Carrier’s website for our Rooftop Unit**

[**http://www.commercial.carrier.com/commercial/hvac/carrier/0,3068,CLI1\_DIV12\_ETI12668\_MID4403,00.html**](http://www.commercial.carrier.com/commercial/hvac/carrier/0,3068,CLI1_DIV12_ETI12668_MID4403,00.html)

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Ambient temperature from EnergyPro. We need this when we look at the cut sheet



This is page 47 in the document…..

TC=Total Cooling

SHC= Sensible

EAT=Entering Air Temp

EAT (wb) = Entering Air Temp wet bulb

EAT (db) = Entering Air Temp dry bulb

The Ambient (dry bulb) temp is 100 (from EnergyPro report above)…..so we will use 105

The wet bulb will be 67.

Our Sensible load was 78,500……see the 78.6? Looks like a perfect match!

Looks like our first RTU option is the **Carrier 48HC\*D09 8.5 Ton Unit**. The 9.3 ton was a ballpark number….this unit is pretty efficient……got us down to 8.5 tons.



Revit file

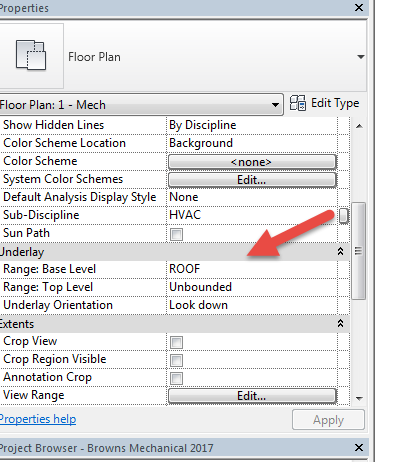
Here is the site that has the Revit family:

<http://www.commercial.carrier.com/commercial/hvac/general/0,3055,CLI1_DIV12_ETI13197,00.html>

Before we place the family, we will set the Plan view so we can see it:

Floor plan Mech 1..Underlay: Roof

Underlay Orientation: Plan



Load the family:

Systems…..Mech Equip….Load Family

X:/Labs/Brown/Readonly/ArchDesign 2A-2B 2014/MEP Families/

Carrier unit you downloaded

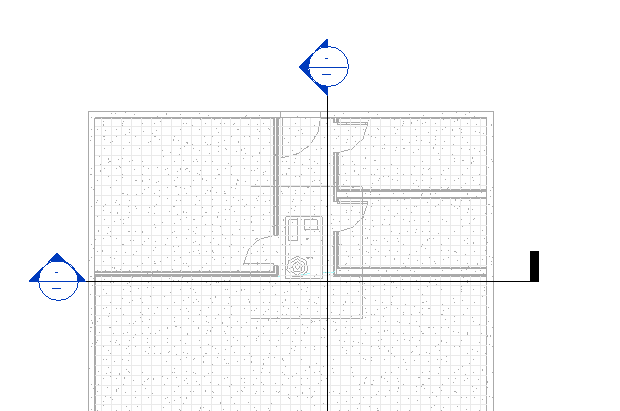
Level: Roof

Offset: 2’2” (there will be a platform it sits on) Roof 12”+ 14”Platform=26” (2’2”)

Place it per sketch.

Save as: STORE\_MECHANICAL\_2017.rvt

Create 2 sections as shown:



Display: Wireframe

Display: Fine (so we can see the complete objects)

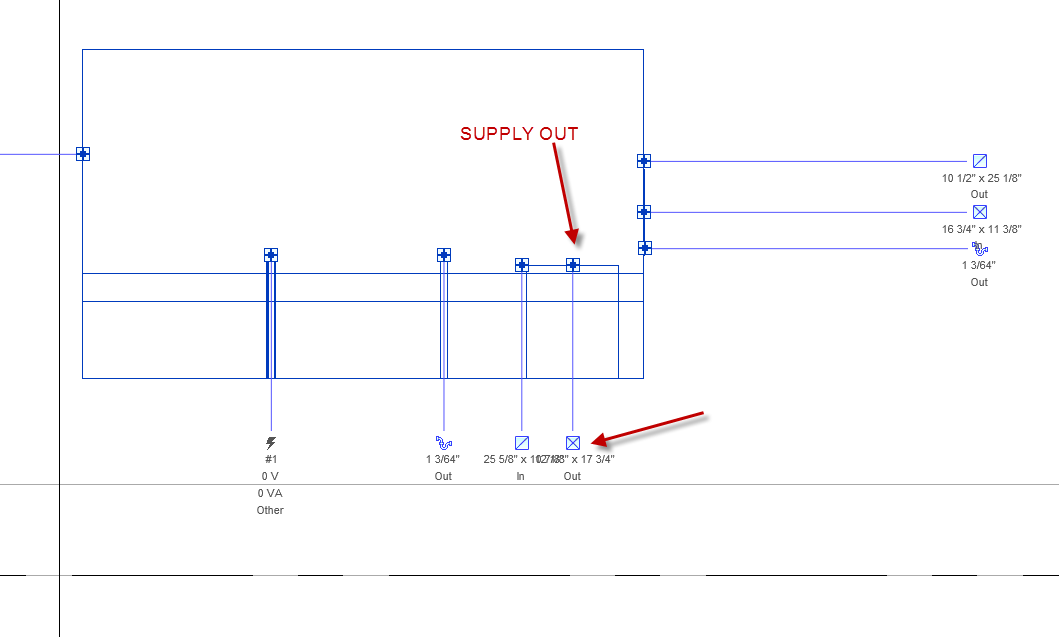
Set Scale to ¼”=1’0”

In Vertical Section, pick RTU

Set Display to Fine. Turn off lineweights. HL

Set Scale to ¼”=1’0”

See Supply “OUT” w + sign



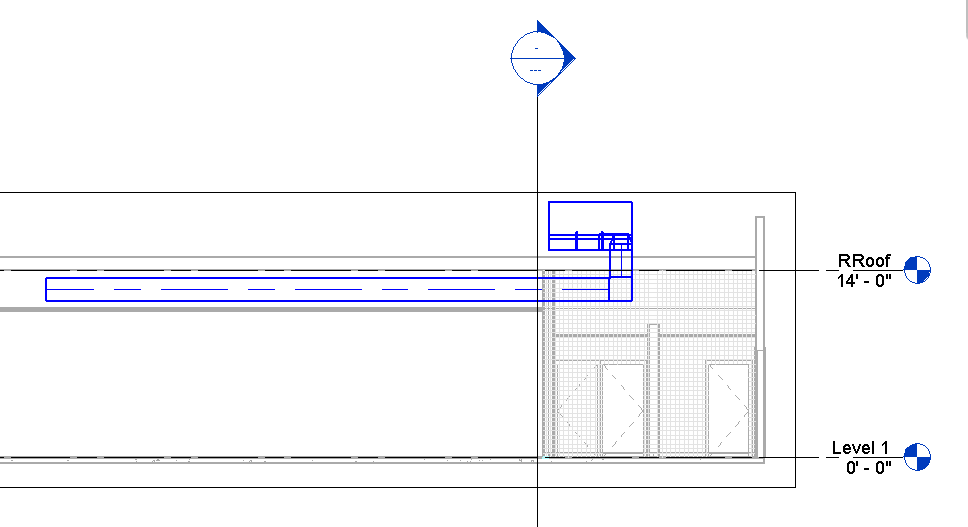
RC…Draw Duct

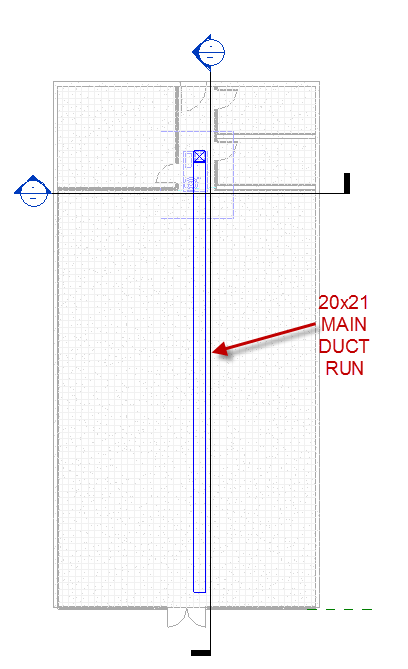
W: 20” H: 21” (we’ll discuss how we got this size in a bit…)

Draw the duct down, into the space between ceiling and roof

Make a left turn and head toward storefront (see sketch)

We’ll call that “Main Duct Run”





**Adding Supply Air Terminals**

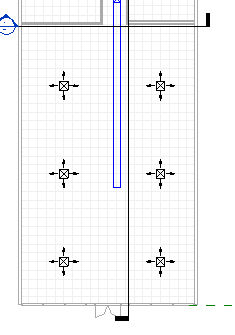
Ceiling plan Mech Level 1

Systems

Air Terminals

Offset: 11’ (our ceiling height)

See sketch



Place 6 supply air terminals in STORE

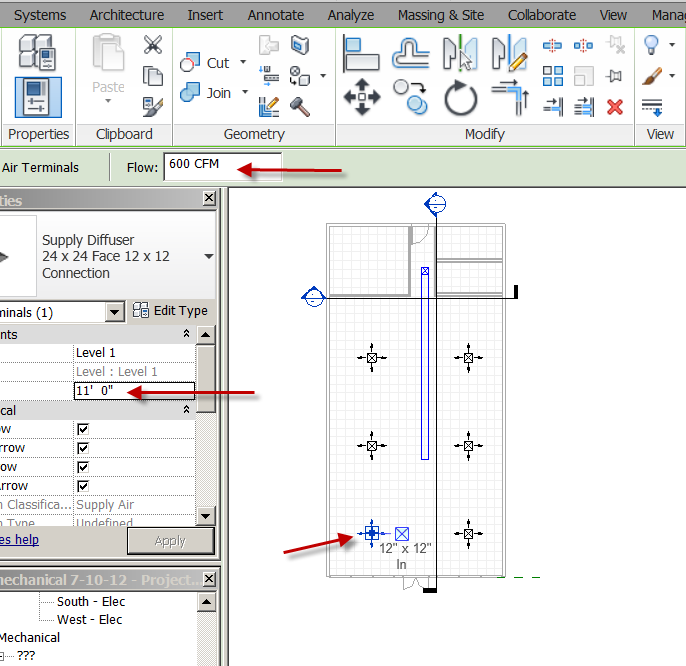
Should look like above….

We need 2743 CFM

2743/6=457…so in theory we would have six 457 CFM supply diffusers…..but no so fast…

We want more Supply Air toward the front of the STORE….where that glass storefront is. It will be hotter there than anywhere else in the store….. get it??

We will assign the closest 2 to the glass to be 600 CFM



We will assign the middle 2 to the glass to be 400 CFM

We will assign the farthest 2 to the glass to be 375 CFM

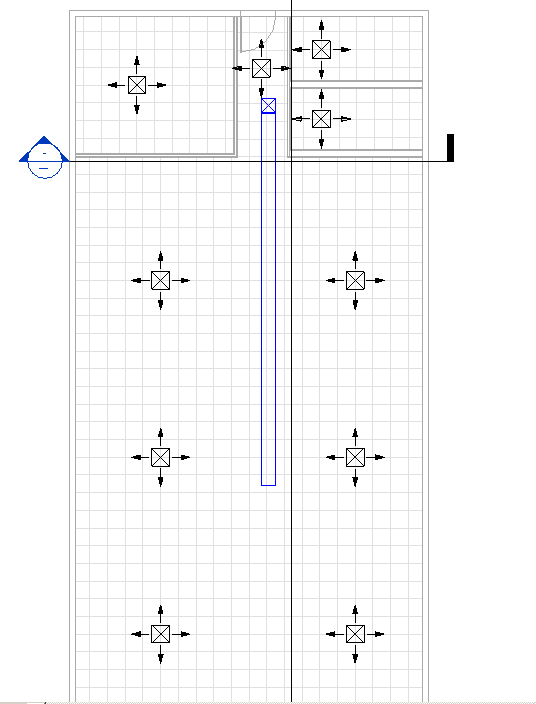
That makes 1200+800+750=2750 CFM

BOH Hall required 183, so we will do 200 CFM

Office required 201, so we will do 200 CFM

Place the supply diffusers in the BOH, Office, and Restrooms per sketch and assign CFM

Note: The ceiling in the Restrooms are 9’0”. The Diffusers in there will offset 9’0”….not 11’.



Setting up a “System”

Pick all 10 supply diffusers (you can “select all instances in view”)

Duct

Supply Air

Mech Supply Air 2

OK

Now pick on a Supply diffuser…TAB….see the “System”?

**Adding Return Air Terminals**

System

Air Terminal

Load Family

Mechanical…MEP…..Air Side Components….Air Terminals…

Get 2:

Return Grille Rect Hosted

Return Grille w/ Trim Ceiling Mounted

Open

Place Return Grille w/ Trim Ceiling Mounted 51X27 Face 48X24 Neck per sketch on ceiling near OFFICE/STORE wall

Place on Face

Set FLOW to 2750+200=**2950** CFM

System

Air Terminal

Return Diffuser

24X24 Face 12X12 Conn

11’ Offset

Place in OFFICE….. Set CFM to 200

**Adding Exhaust Air Terminals**

Place Exhaust

System

Air Terminal

Exhaust Grille

24X24 Face 12X12 Conn

Offset: 9’0”

Place above toilets per sketch

Set them at 100 CFM



Since it has been decided to have Supply Air in the Restrooms….we have to do it right….

Important: Supply CFM must be **LESS** than Exhaust air (you want to suck out the poopy air). If supply air is greater, it would push the poopy air out into the BOH Hall….get it??

Let’s assign 80 CFM

**Spaces**

Let’s make the 5 “Spaces”

Analyse

Space

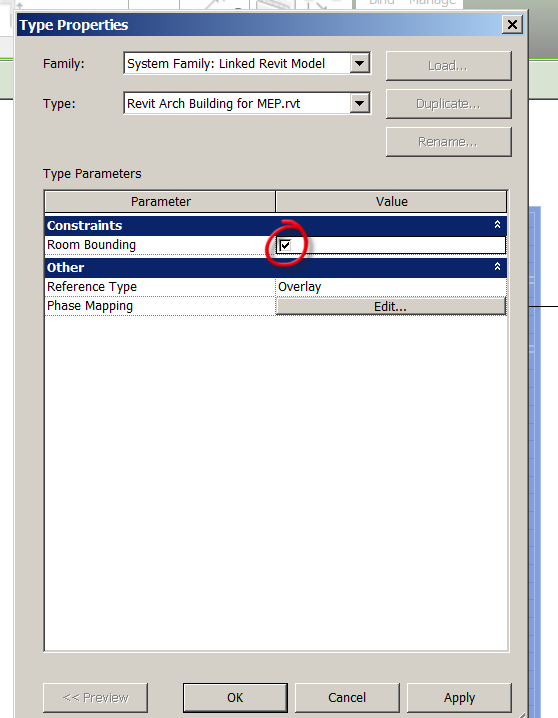
Place in rooms

Not working? Here’s why…

Pick Link

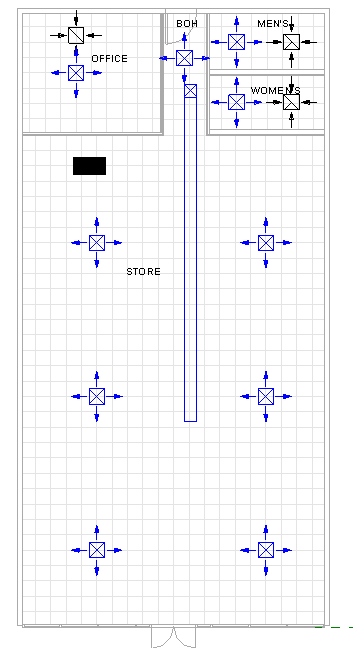
Edit Type

Check “Room Bounding”….OK



Now try…..good?

Name them: STORE, BOH HALL, OFFICE/STORAGE, MEN’S, WOMEN’S



Save as: Store\_Mechanical\_2017.rvt

**Duct Sizing**

Ducts are sized by the air flow going through them (in CFM).

There are 2 ways to easily find the size of your ducts.

**Ductulator**

The first is a “Ductulator”. It is a hand-held rotating calculator that allows you to dial in your information and get a result.

Let’s try it!

Our air flow coming out of the RTU will be about 3150 CFM.

Friction loss will be .08/100ft of duct (that’s what Design West Engineering uses…)

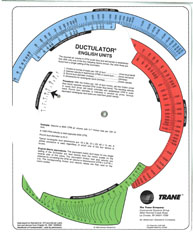
Match the .08 with the 3150 CFM (the light blue area)

The result:

Looks like about 22.5 diameter duct (see black area)

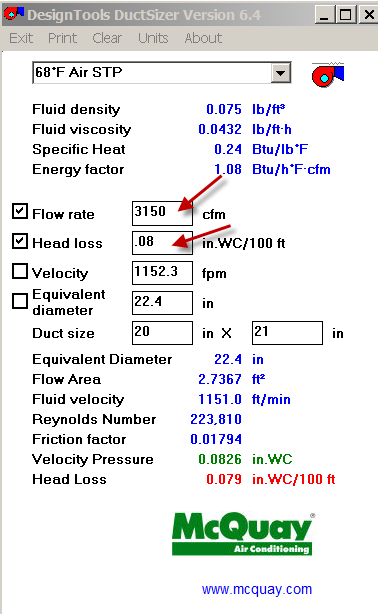
Looks like about 22X20 rectangular (see green area). Note: the more square the better..but sometimes duct has to be more rectangular to fit in tight spaces)

Looks like velocity is about 1100 FPM

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**Duct Sizing Software**

The second way is McQuay Ductsizing Software (it’s a free download)



Enter 3150 for Flow Rate

Enter **.08** for heat loss

Note 22.4 for diameter comes up automatically!

Now enter 20 for one of the duct sizes….see 21 in automatically?

See 1151 FPM for velocity (a little more exact)

Different tools, same result!

You will use one/both of these tools to calculate how big your duct needs to be to meet the needs of the diffusers.

**Duct Shapes**

Note: Round duct is more efficient than rectangular duct.

Note: Bends in duct decrease efficiency

Note: You want larger CFM toward end of circuit



Round Duct is the most efficient and economical means of conveying air. When you cannot use round duct because ceiling space is limited or interference from other obstructions, use flat oval duct, which is nearly as efficient.

Round and oval duct have lower initial installed costs than rectangular duct. Their shape results in lower pressure drops, thereby requiring less fan horsepower to move the air and, consequently, smaller equipment. The shape also has less surface area and requires less insulation when externally wrapped. Spiral round and oval duct is available in longer lengths than rectangular duct, thereby eliminating costly field joints. Spiral lock-seams add rigidity; therefore spiral duct can be fabricated using lighter gauges than longitudinal seam duct.

Operating costs are also lower. The smaller surface areas of round and oval allow less heat loss or gain and are therefore more energy efficient. Also, seams and joints are more tightly sealed resulting in less leakage and wasted energy.

The acoustic performance of round and oval duct is superior because their curved surfaces allow less breakout noise.

These ducts not only perform better, they also look better. Many architects and designers are using the aesthetically pleasing shapes of round and oval as unique and integral elements in their designs.

Finally, round and oval duct can help promote healthier indoor environments. Less surface area, no corners and better airflow reduce the chance of dirt and grime accumulating inside the duct and becoming a breeding ground for bacterial growth.

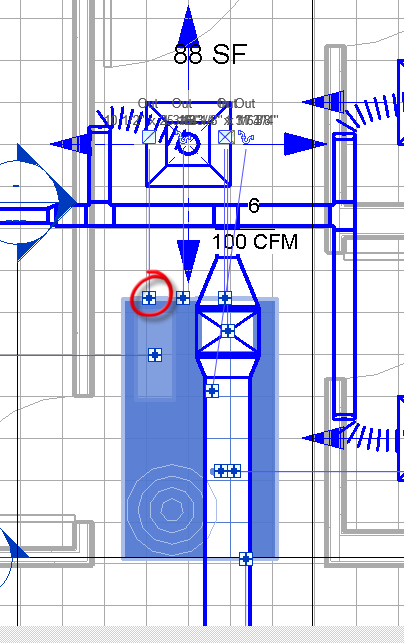
We will start with rectangular duct…then swap out for round duct later…..

**Return Air**

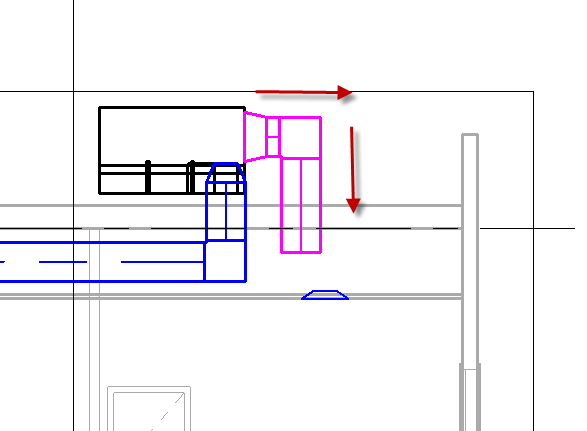
1-Mech

Pick RTU

See Return Out?



Go to the right side section



RC on the + sign

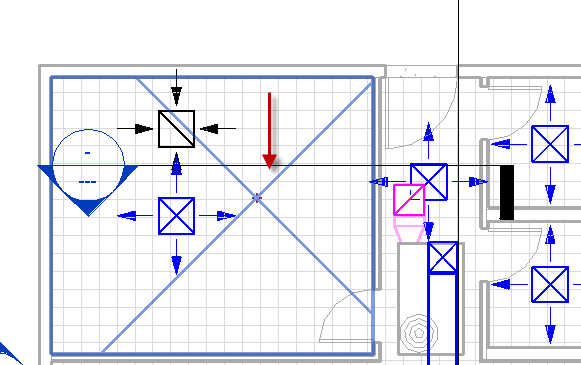
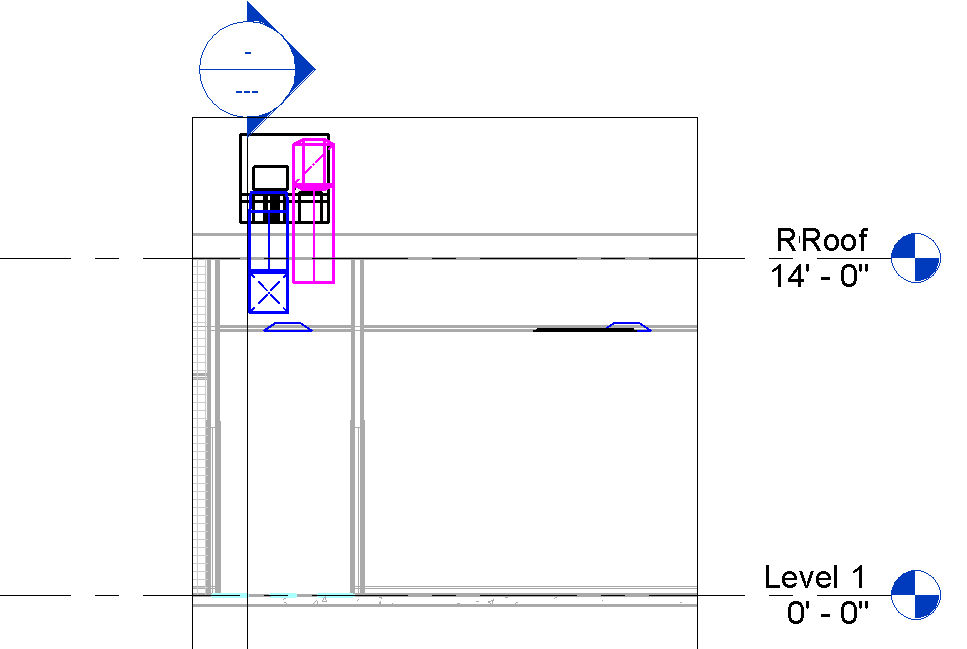
Draw Duct as shown…getting it into the proper space.

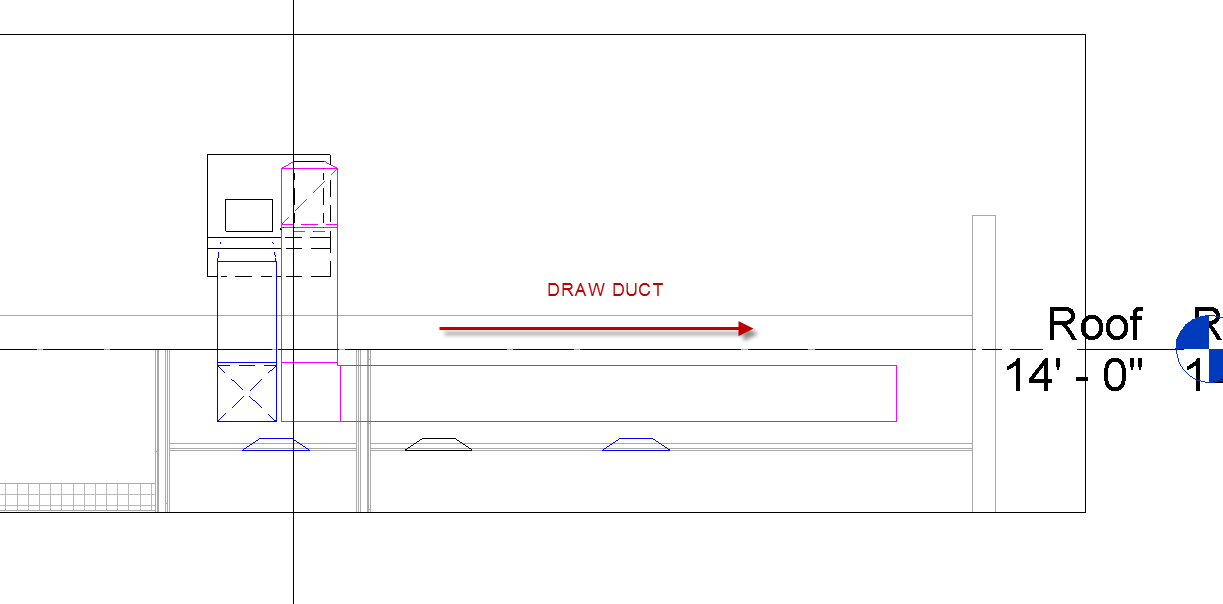
Our duct is going to 2950 CFM (total from Store and Office)

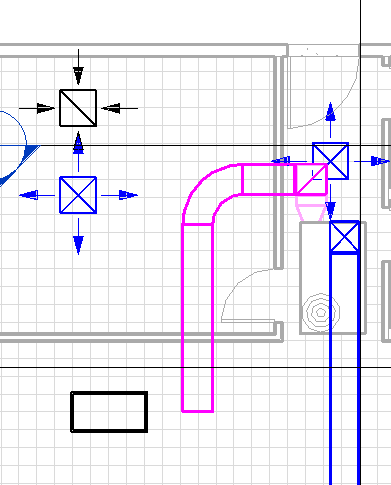
Make it: W=20” H=20”

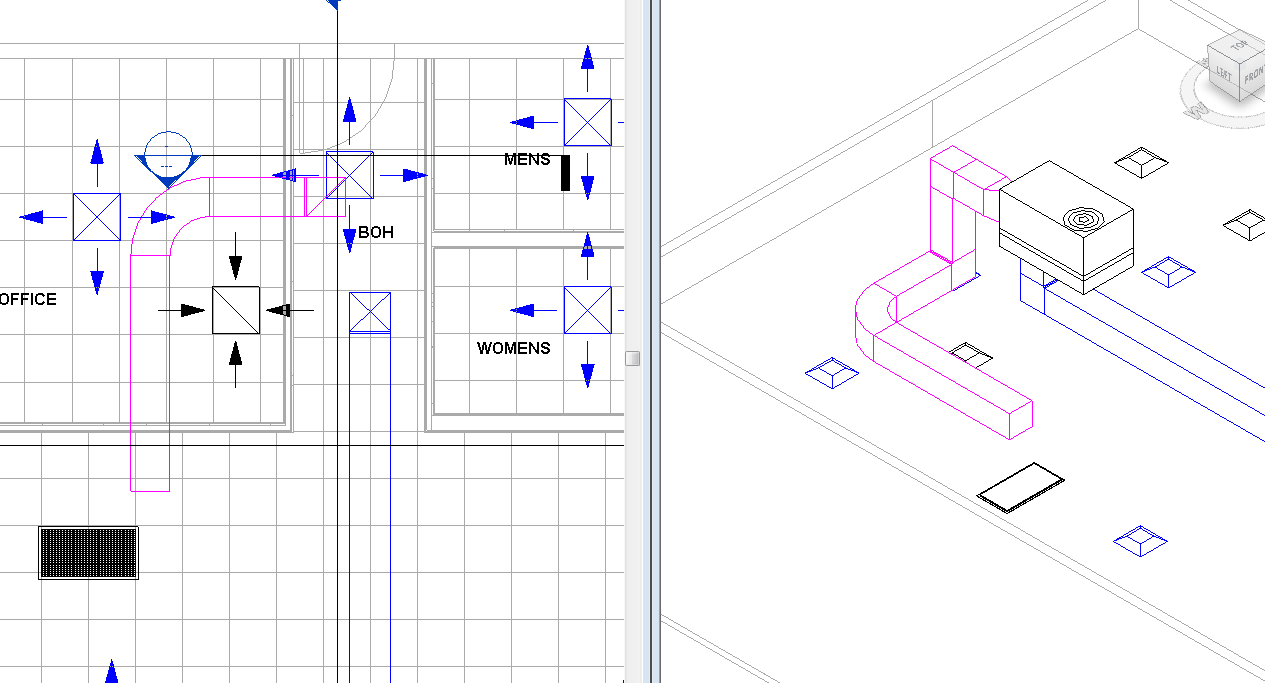
Create a section to look at the back of the RTU…and see the end of the duct….

Set Display to Fine

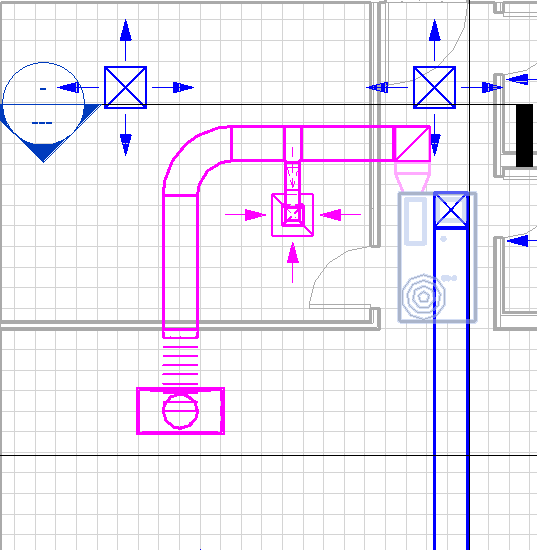
 







You will need to use Flex Duct to attach to the big Return Diffuser

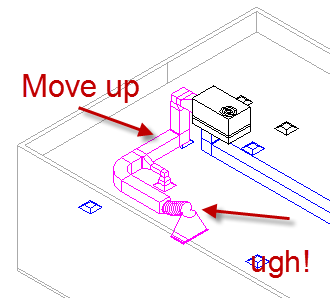


We need to continue the duct to the 200 CFM Return in the Office. We need a connector on that L turn…Rect Elbow 1.5W

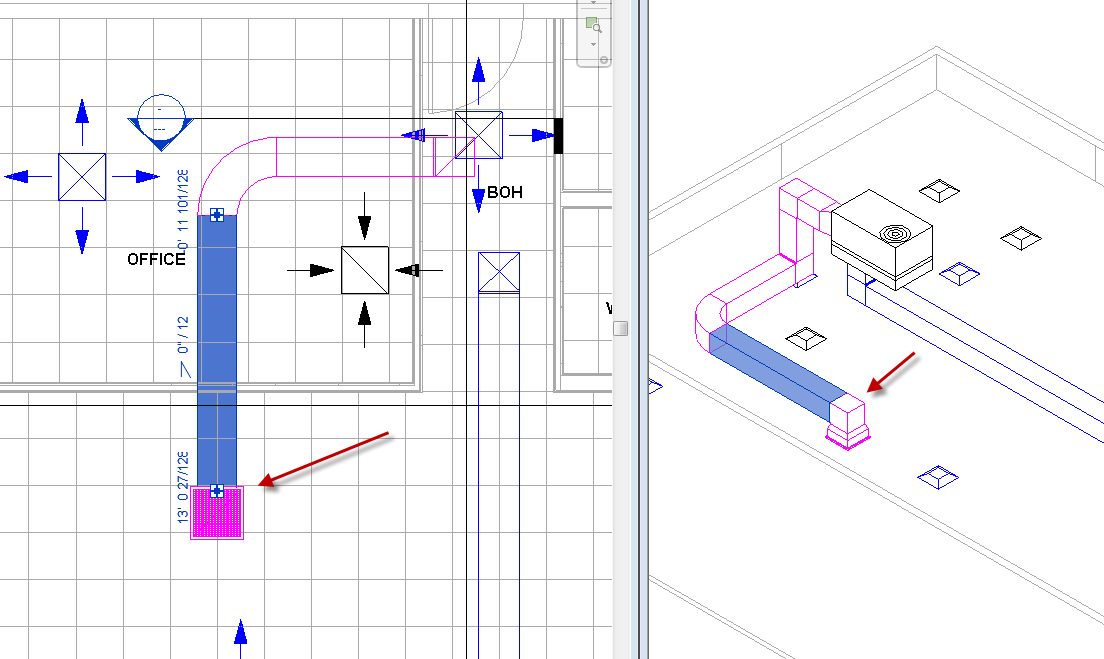
Select Rectangular Duct Fitting…create similiar

8”X7” (Start at the 200 Return Diffuser and work toward the 20x20 duct.

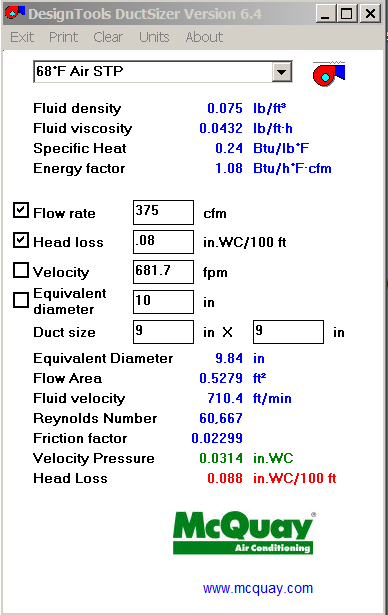
See in 3D!



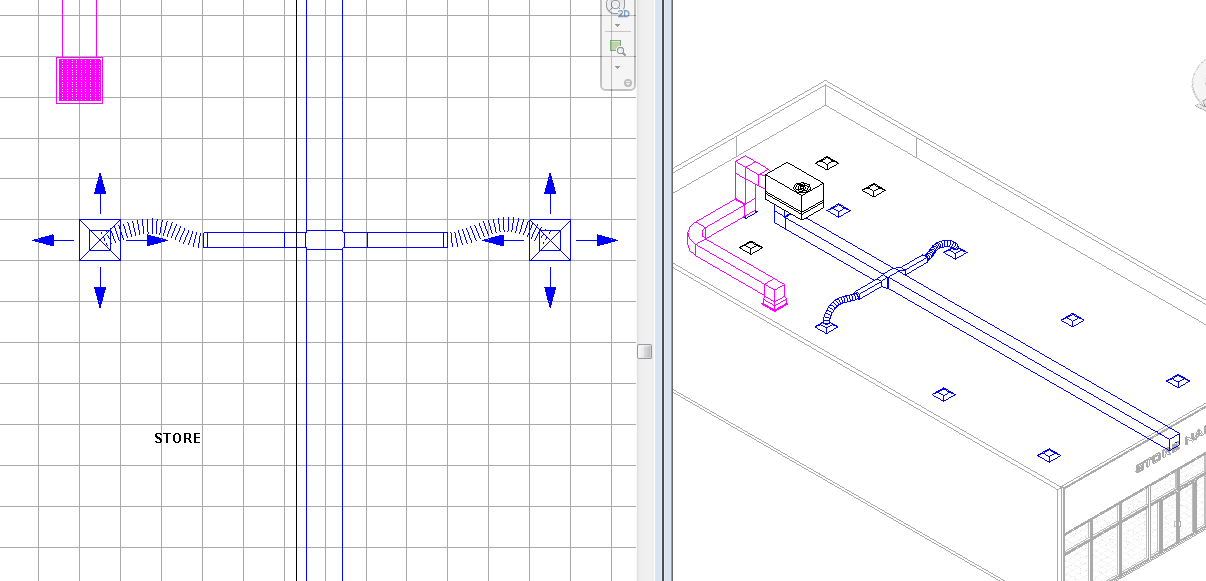
**The problem is that our Return Grill is just too big at 51X27 to allow the transition to happen. Let’s change it to a 27X27 Grille…get rid of the Flex Duct…and just drag the 20X20 duct over the Return Diffuser.**

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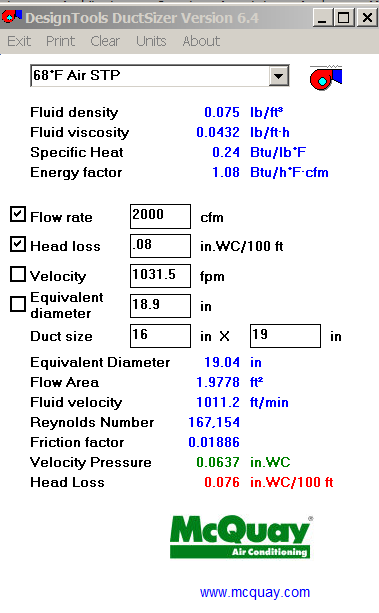
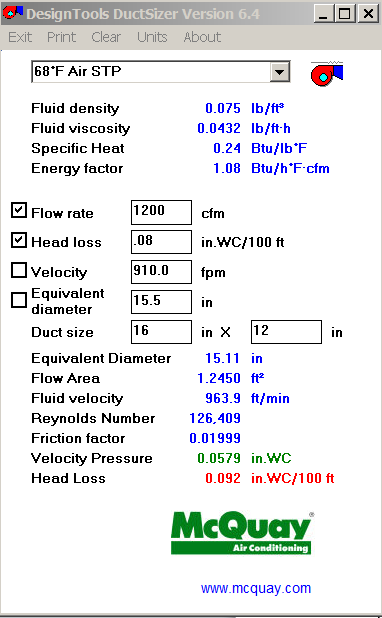
**Supply Duct**

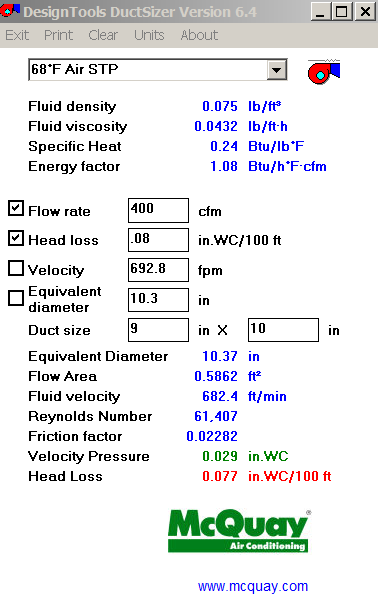
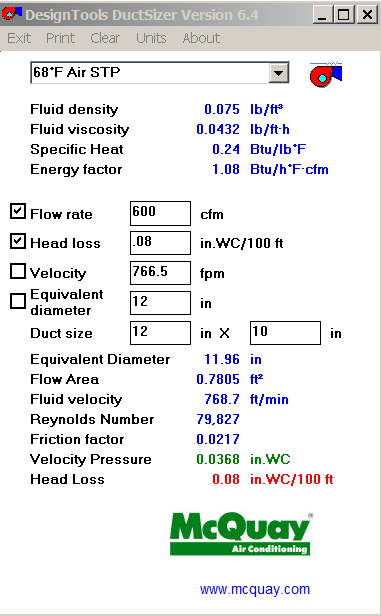
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**So we will use 9X9 rect duct…with Flex Duct connecting the Return Diffuser**

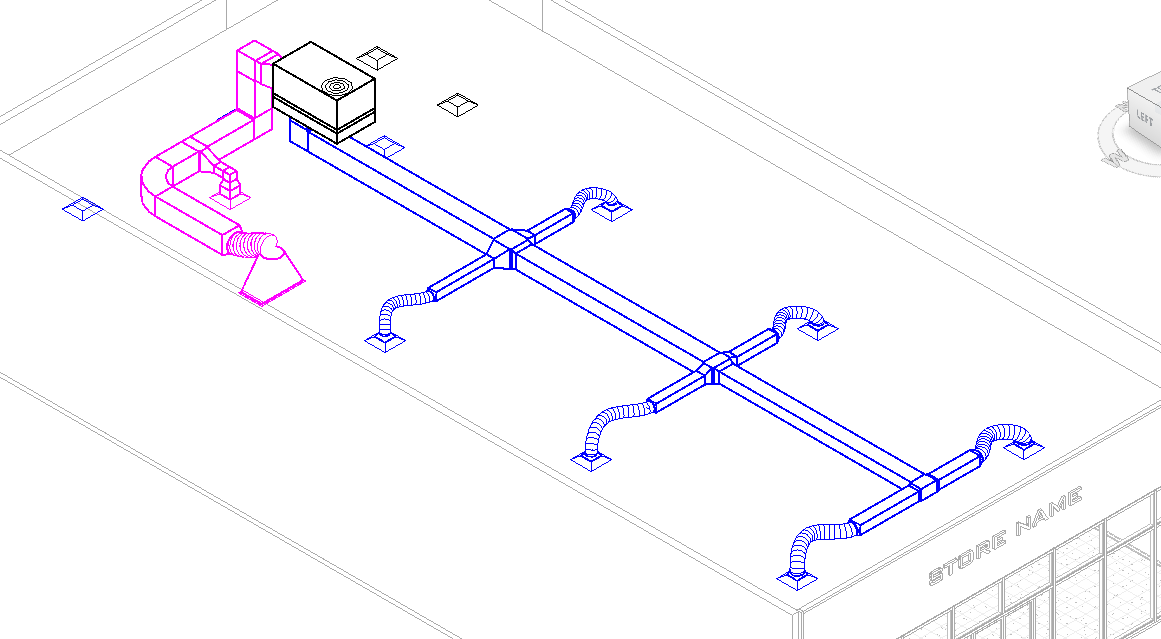
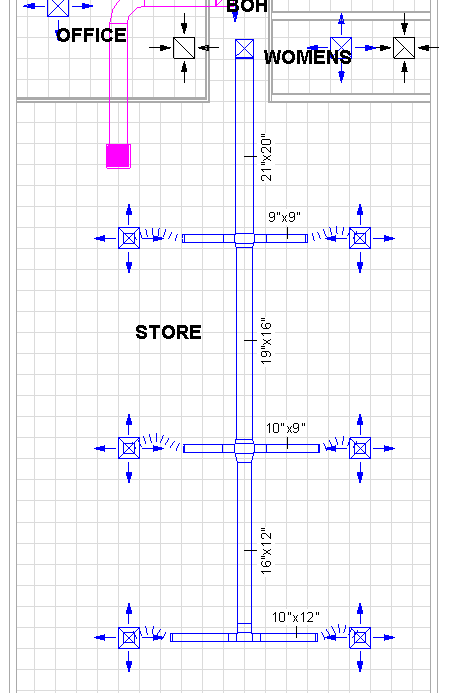
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**Continue per sketch….**

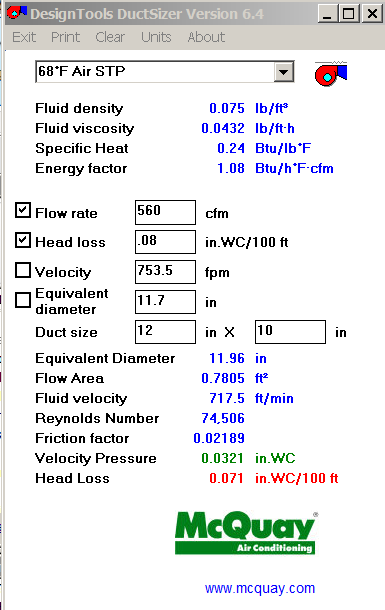
** **

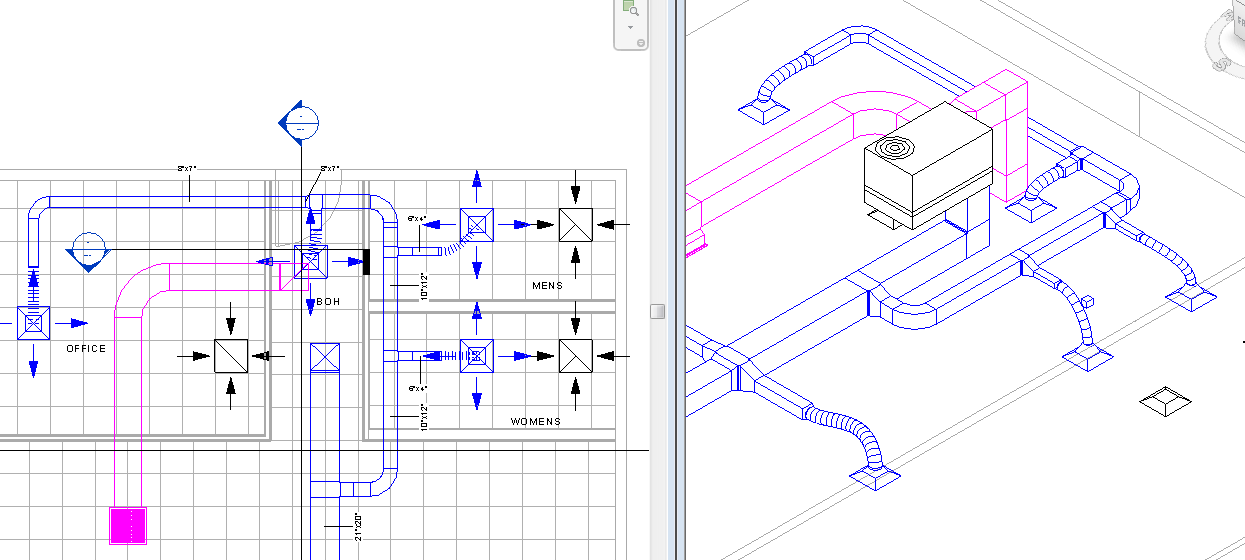
** **

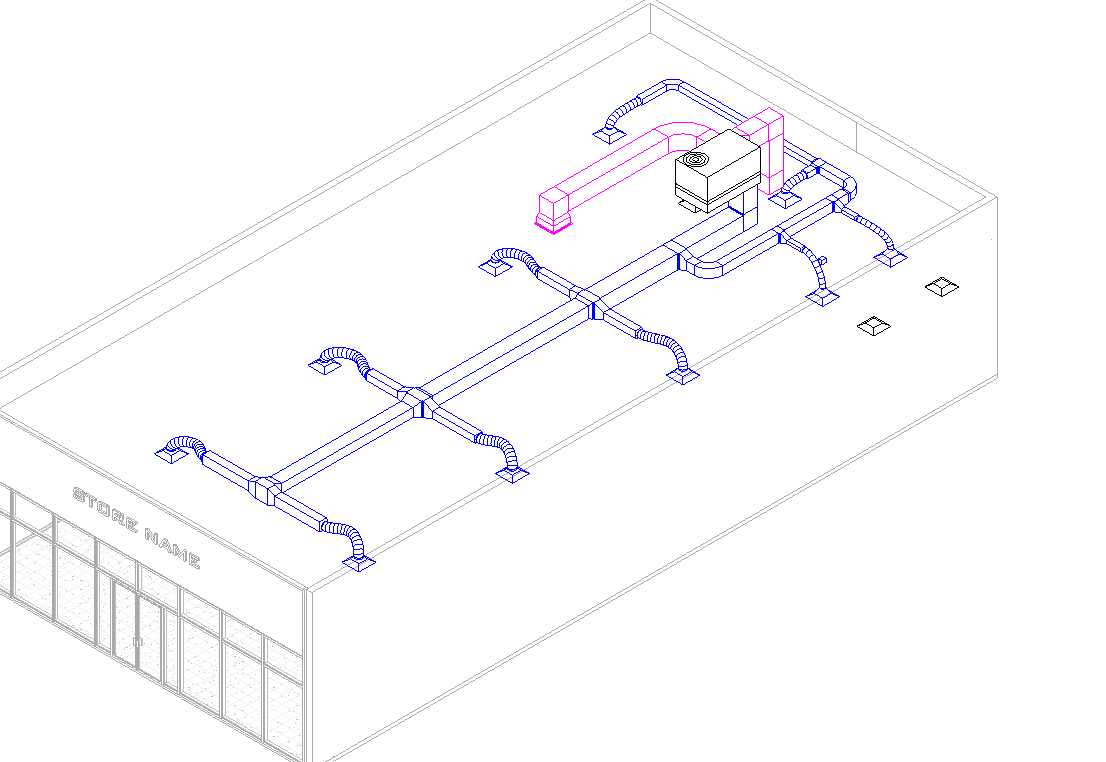
The system will look as follows:



Now for the Bathrooms, BOH, and Office…. 200+200+80+80=560 to start.







**REVISION!**

The mechanical engineer has called for a change in your design. See sketch.

The building will have linear supply diffusers at the storefront glass to more effectively cool the glass Storefront area.

The mechanical engineer is calling for a return diffuser near the Storefront to take the hot air out before it reaches the inner part of the store.

The client does not want to pay for AC in the bathroom. The bathroom door will be “undercut” and the air will be drawn into the bathroom from the BOH area as the Exhaust fan is turned on. The Exhaust fan will be on an Occupancy Sensor, controlled when the (occupancy controlled) light goes on.

The mechanical engineer is calling for **2 RTU Units**. This will cost less, allow for smaller duct sizes (less BTU’s means smaller ducts), and make rooftop installation easier with smaller units (lighter on roof, smaller footprint).

So you will have a RTU @4.5 tons controlling the Storefront area and a 4 ton RTU controlling the back Store area, Office, and BOH. The 8.5 tons split up……

Find 2 RTU’s that meet the requirements of the building.

Replace the 8.5 Ton RTU with the 4 Ton Unit you found

Add the 4.5 Ton Unit near the front, per sketch.

Layout supply diffusers per sketch

Create proper duct design to connect the Supply diffusers

Create proper duct design to connect the Return diffusers

Watch out for collisions with Lighting and other ductwork!

Save as **FirstLastMechrevision.rvt**

