AIR FILTRATION 2023

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FACTORY DIRECT

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Question #1:
What "Merv" rating should I use?

MERV, the acronym for **Minimum-Efficiency Reporting Value**, is a measure of the efficiency with which filters remove particles of specific sizes. The test protocol for determining MERV ratings is described in **ASHRAE Standard 52.2-2007**, "Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size."

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High Efficiency Filters Explained

The impact that the Covid-19 virus has had on the world is unmeasurable and its reach into so many different aspects of our lives is both far and wide. One of the areas of HVAC that has been brought to the forefront is filtration. The SARS-Cov2 virus is approximately .1-.3 microns in size, but since the virus doesn't travel in the air by itself the expelled respiratory droplets are approximately 1 micron in size. MERV 8 filters are only 20% effective at capturing particles in the 1-3 micron range while MERV 13 filters are at least 85% effective at capturing particles in the 1-3 micron range. MERV 14 are effective at capturing at least 90% in the 1-3 micron range and the higher you go the more filtering ability. Below in **Figure 1** is a filter application guide and as can be seen the standard MERV-1 through 12 filters are not very effective for smaller particles.

ASHRAE recommends using MERV 13 filters with MERV 14 being preferred but there are things that need to be taken in to account before any filter change is made. Increasing filter efficiency increases the static pressure drop in the system which can affect airflow, which in turn can increase energy usage or worse; it can cause equipment operation issues and unit failures.

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Figure 1

MERV Std 52.2	Intended Dust Spot Efficiency Std 52.1 (1)	Average Arrestance	Particle Size Ranges	Typical Applications	Typical Filter Type
1 - 4	<20%	60 to 80%	> 10.0 µm	Residential/Minimum Light Commercial/ Minimum Minimum Equipment Protection	Permanent / Self Charging (passive) Washable / Metal, Foam / Synthetics Disposable Panels Fiberglass / Synthetics
5 - 8	<20 to 60%	80 to 95%	3.0-10.0 µm	Industrial Workplaces Commercial Better / Residential Paint Booth / Finishing	Pleated Filters Extended Surface Filters Media Panel Filters
9 - 12	40 to 85%	>90 to 98%	1.0-3.0 µm	Superior/Residential Better/Industrial Workplaces Better/Commercial Buildings	Non-Supported / Pocket Filter / Rigid Box Rigid Cell / Cartridge V-Cells
13 - 16	70 - 98%	>95 to 99%	0.30-1.0 µm	Smoke Removal General Surgery Hospitals & Health Care Superior/ Commercial Buildings	Rigid Cell / Cartridge Rigid Box / Non-Supported / Pocket Filter V-Cells

Note: This table is intended to be a general guide to filter use and does not address specific applications or individual filter performance in a given application. Refer to manufacturer test results for additional information.

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Question #2:
Will a MERV 13 filter work with my York HVAC system?

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Study #1

Article: *Residential AC Filters* (*pdf*) by John Proctor, *ASHRAE Journal*, October 2012

The Air Conditioning Contractors of America (ACCA) protocols for HVAC design assume a pressure drop of 0.10 inches of water column (i.w.c.) across the filter. (Keep that number, 0.1 i.w.c., in mind as a reference point. I'll be coming back to it.) If a system is designed with a standard filter for that pressure drop, the pressure drop with a pleated filter of the same size will most likely be higher.

In addition, poorly designed and installed duct systems already have external static pressures that are too high. The typical furnace or air handler is rated for 0.5 i.w.c. but many run much higher pressure. David Richardson of the National Comfort Institute says that in the testing they've done, the average system is running at about 0.82 i.w.c.

Result: In the California study, Proctor et al. found that the pressure drop across the filter in 34 HVAC systems was **0.28 i.w.c**. That's nearly three times what ACCA protocols assume. It's also more than half of the rated external static pressure for the whole system.

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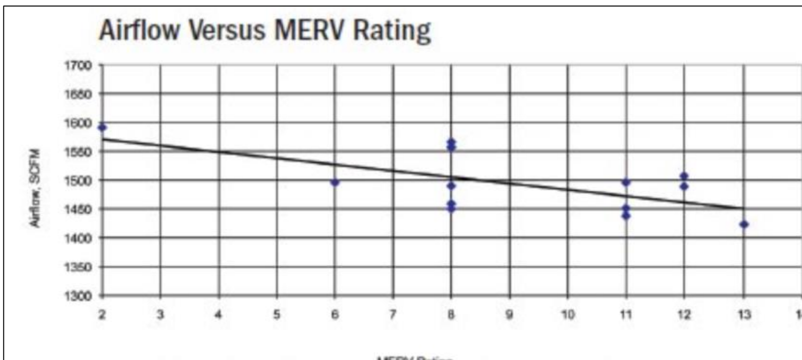

Figure 2. The graph shows a trend toward decreasing air flow when the blower was powered with a PSC motor. Note the wide variation in air flow for the different MERV 8 filters. Very little air flow variation was seen when the PSC motor was replaced with an ECM motor.

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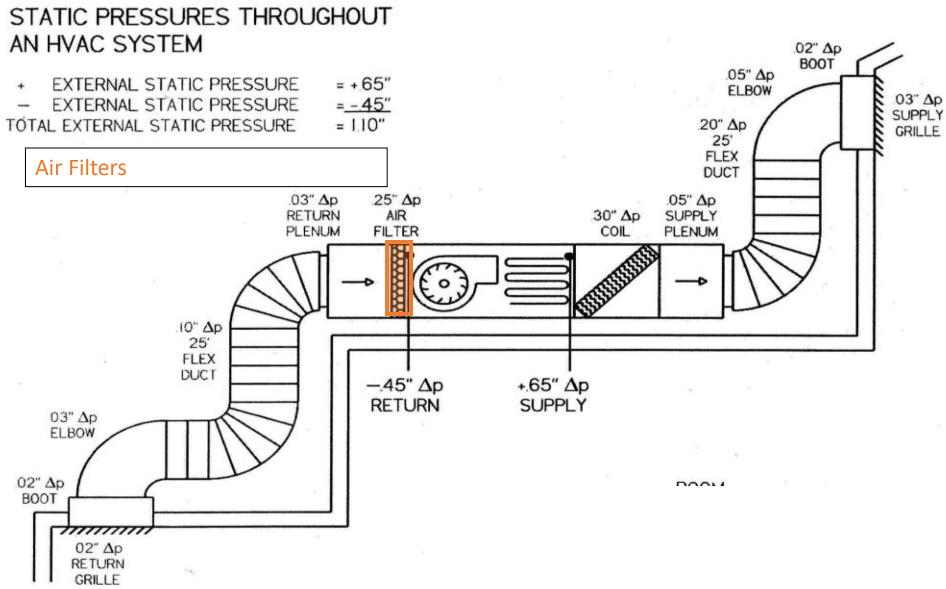
Sources of Pressure Drop



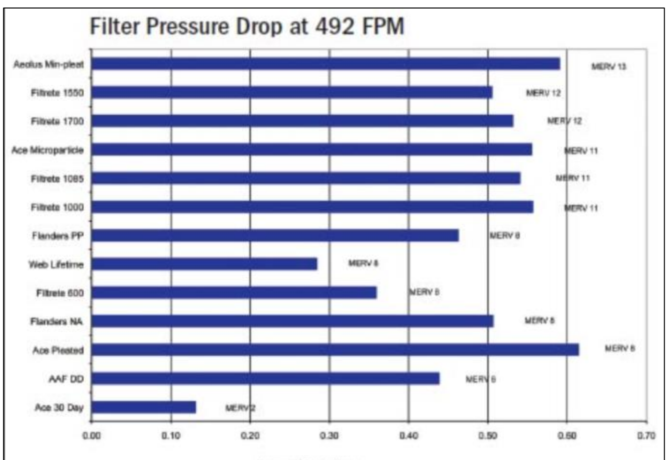


Figure 3. The MERV rating is not a direct indicator of filter pressure drop. The thicker (2-inch and 4-inch) filters did not provide as much advantage as expected, at least not in the clean condition in which all the filters were tested.

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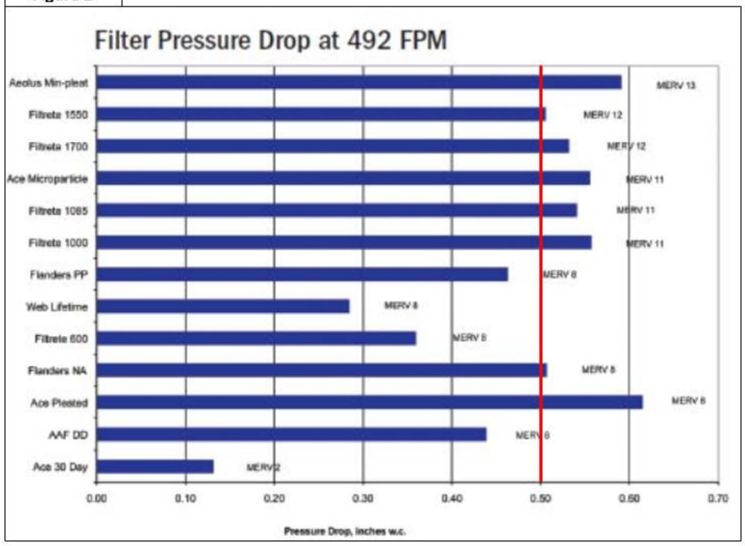
Figure 2



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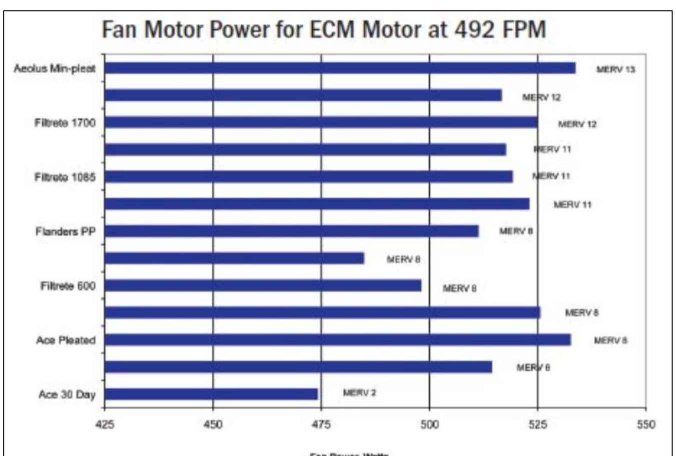

Figure 4. When the ECM motor was used to maintain a constant 492 feet per minute velocity we saw a considerable variation in fan energy. This graph appears similar to Figure 3 because the blower must work harder to push air against a higher static pressure.

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ECM - Performance

PSC vs. Constant Airflow

Hz	Voltage	HP	PF	Motor Type
60	115	1/2	0.9	PSC (Induction Motor)
High	Speed			
60	115	1/2	0.6	ECM (Constant Airflow)
3 Ton				

PSC (Induction Motor)

TESP	0.3	0.5	0.7	0.9
CFM	1345	1261	1158	1038
Watts	700	667	628	576
Amps	6.69	6.47	6.1	5.71
RPM	906	951	997	1029

ECM (Constant Airflow)

TESP	0.3	0.5	0.7	0.9
CFM	1246	1250	1234	1230
Watts	308	368	423	485
Amps	4.81	5.64	6.39	7.22
RPM	848	927	993	1065

% Improvement ECM vs. PSC

ECM (Constant Airflow)

TESP	0.3	0.5	0.7	0.9
CFM			6%	16%
Watts		-45%	-33%	-16%

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UNIT MODEL	COIL		CFM RANGE (MIN.-MAX.)	STAGE	COOLING				
	MODEL	WIDTH			RATED CFM	NET MBH		SEER [1]	EER
						TOTAL	SENS.		
YXT24B21S	CF/CM/CU24B	17.5	525 - 725	1	600	19.3	14.7	15.00	21.25
			600 - 1000	2	800	22.8	18.2		12.75
YXT24B21S	CF/CM/CU30B	17.5	525 - 725	1	600	19.5	14.8	15.00	21.60
			600 - 1000	2	800	23.4	18.3		13.00
YXT24B21S	CF/CM/CU36B	17.5	525 - 725	1	600	19.5	15.0	15.25	21.65
			600 - 1000	2	800	23.6	18.5		13.00
YXT24B21S	CF/CM/CU42C	21.0	525 - 725	1	600	19.7	14.8	15.50	22.00
			600 - 1000	2	800	23.8	18.8		13.25

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Airflow is KEY to comfort and efficiency

4.5 X **CFM** X Delta Enthalpy = Total Cooling BTU's

1.08 X **CFM** X Delta Temperature = Sensible BTU's

TABLE 16: Air Flow Data (CFM)[1]

		High/Low Speed Cooling and Heat Pump CFM											
Cool Tap	ADJ Tap[2]	AVC18B		AVC24B		AVC30B		AVC36B		AVC36C		AVC42C	
		High	Low	High	Low	High	Low	High	Low	High	Low	High	Low
A	B	810	527	1022	562	1060	731	1350	878	1350	878	1596	1037
B	B	675	439	795	437	1013	658	1238	804	1238	804	1400	910
A	A	720	468	900	495	1000	650	1200	780	1200	780	1425	926
B	A	600	390	700	385	900	585	1100	715	1100	715	1250	813
A	C	630	410	783	431	875	569	1050	683	1050	683	1268	824
C	B	534	347	766	421	844	548	1125	731	1125	731	1344	874
B	C	525	341	609	335	788	512	963	626	963	626	1113	723
D	B	450	293	568	312	703	457	900	585	900	585	1120	728
C	A	475	309	675	371	750	488	1000	650	1000	650	1200	780
D	A	400	260	500	275	625	406	800	520	800	520	1000	650
C	C	416	270	587	323	656	427	875	569	875	569	1068	694
D	C	350	228	435	239	547	355	700	455	700	455	890	579

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Overview-How is ductwork sized?

(This is not going to be a duct design class)

- Ductwork is sized using a duct calculator
- To use a calculator, you need a Friction Rate
- The calculator matches Friction Rate to a required CFM for a duct size
- The size can be either round or square duct
- Where does the Friction Rate come from?

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Friction Rate

- The equipment delivers a specific CFM at a given External Static Pressure (ESP)
- Other losses external to the equipment are subtracted from the ESP
  - Known as Device Pressure Losses
- The static remaining after all other losses are subtracted from the ESP is the Friction Rate (FR) for duct sizing
- But...

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Manual D Worksheet

Step 1) Manufacturer's Blower Data

External static pressure (ESP) = ______ IWC   Cfm = __________

Step 2) Component Pressure Losses (CPL)

Direct expansion refrigerant coil	______
Electric resistance heating coil	______
Hot water coil	______
Heat exchanger	______
Low efficiency filter	______
High or mid-efficiency filter	______
Electronic filter	______
Humidifier	______
Supply outlet	______
Return grille	______
Balancing damper	______
UV lights or other component	______
Total component losses (CPL)	______ IWC

Step 3) Available Static Pressure (ASP)

ASP = (ESP - CPL) = (______ - ______) = ______ IWC

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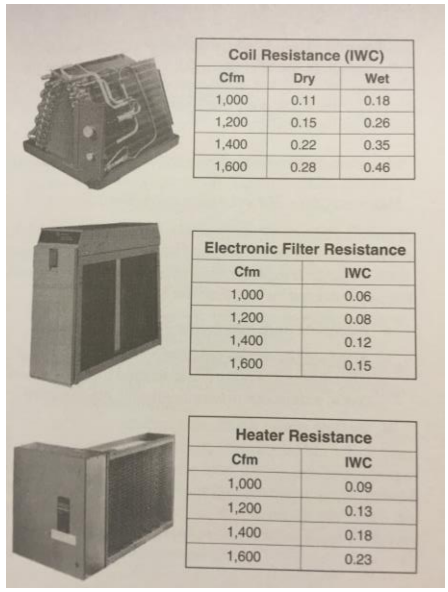
Air Device Pressure Losses



Coil Resistance (IWC)		
Cfm	Dry	Wet
1,000	0.11	0.18
1,200	0.15	0.26
1,400	0.22	0.35
1,600	0.28	0.46

Electronic Filter Resistance	
Cfm	IWC
1,000	0.06
1,200	0.08
1,400	0.12
1,600	0.15

Heater Resistance	
Cfm	IWC
1,000	0.09
1,200	0.13
1,400	0.18
1,600	0.23

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Friction Rate Calculation

ESP from Product Data	+ 0.60
Evaporator coil (Use wet pressure drop)	- 0.27
Volume damper	- 0.03
Supply register	- 0.03
Return grille	- 0.03
Filter	0
Static remaining	+ 0.24

The complete list of losses are shown in the ACCA Manual D worksheet.

Zero is used for filters only if the equipment airflow data is taken with the filter installed.

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What Is Total Effective Length?

- The length of the longest individual supply and return run
- Plus the equivalent length (in feet) of each fitting and duct connection along the path
  - Fittings affect the flow of air
  - They must be figured into the system losses
- The sum of these two sets of numbers is used to adjust the friction rate number

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How Fittings Affect Airflow

- Fittings are assigned an Equivalent Length (EL)
  - EL is the airflow loss equal to the same amount of straight duct
  - Losses are friction losses from the duct system
- The EL of each fitting adds to the Total Equivalent Length of the duct system
  - Linear length + EL of each fitting = TEL of duct system
  - The longer the duct, the more resistance to airflow
  - More resistance = less CFM
- High EL fittings also add to turbulence in the duct system

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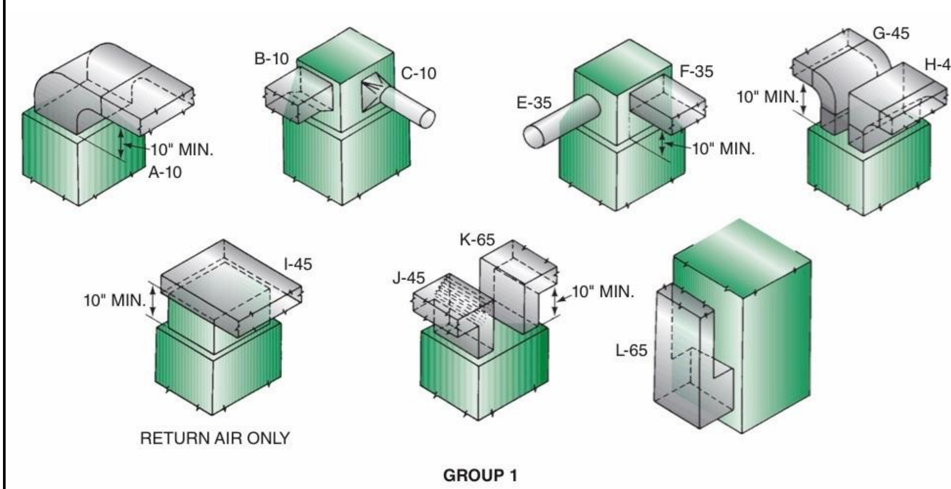

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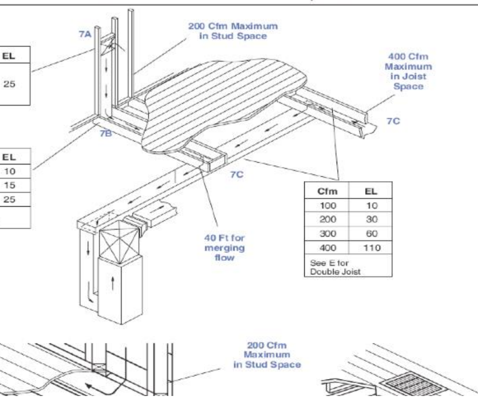
Current Manual D - EL

Return

Group 7
Panned Joists and Panned Stud Return Air Fittings
Reference Velocity = 700 Fpm
Reference Friction Rate = 0.08 IWC per 100 Feet



Cfm	EL
100	
150	25
200	

Cfm	EL
100	10
150	15
200	25
See D for Double Turn	

Cfm	EL
100	10
200	30
300	60
400	110
See E for Double Joist	

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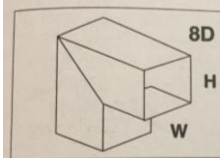
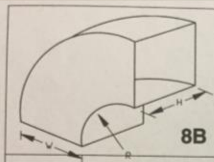
Current Manual D - EL



	Square Elbow EL Values		
	Hard Bend	H / W = 1	Easy Bend
No Vanes	80	80	65



	Radius Elbow EL Values		
R/W	Hard Bend	H / W = 1	Easy Bend
Mitered (R = 0)	90	75	65
0.25	35	30	25
0.5 or Larger	20	15	10

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How TEL Affects Duct Sizing

- TEL is used to determine the Friction Rate for Duct sizing
- The duct sizes in the calculator are based on a TEL of 100 feet of duct
- For duct systems with TEL *greater* than 100 feet, the Friction Rate must be corrected for a new Friction Rate

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Correcting The Friction Rate

- Longest supply run = 60 feet
- Longest return run = 40 feet
- But, all the fitting total to 75 feet
- Therefore, we have 175 feet of duct
  - Using our previous FR of 0.24
  - .24 x (100/175) = .137
  - New FR is 0.137 (for Supply and Return)

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Correcting The Friction Rate

- Longest supply run = 60 feet
- Longest return run = 30 feet
- But, all the fitting total to 275 feet
- Therefore, we have 365 feet of duct
  - Using our previous FR of 0.24
  - 100/365 = .27
  - .24 x .27 = .0648
  - New FR is 0.0648 (for Supply and Return)

THAT'S a LONG WAY from the Ole .1 used on the ductulator.

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Correcting The Friction Rate

Step 4) Total Effective Length (TEL)

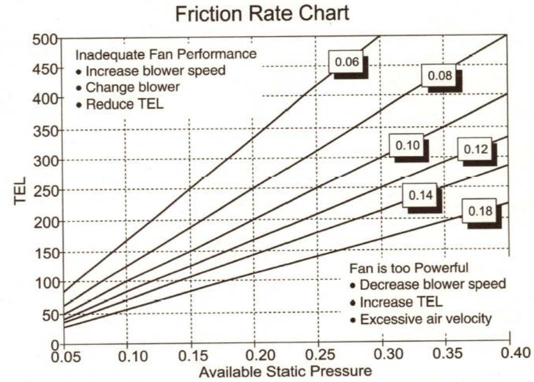
Supply-side TEL + Return-side TEL = (_______ + _______) = _______ Feet

Step 5) Friction Rate Design Value (FR)

FR value from friction rate chart = ______ IWC/100

$$FR = \frac{ASP \times 100}{TEL}$$

Friction Rate Chart



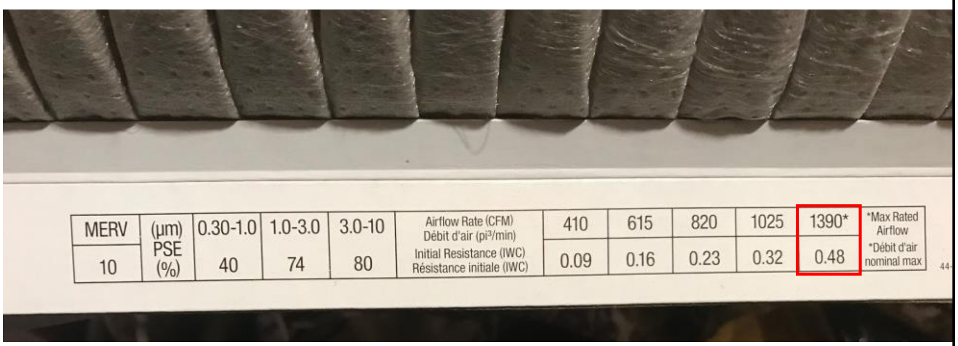
Question #2:
Will a MERV 13 filter work with my York HVAC system?

Now you realize this isn't an easy question and it can't be answered easily….

3.5 Ton HP System going out on high pressure switch

This is the filter that was in the system…….

Ask me how we fixed the system……….



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Consider what happens when you expand the filter from 1" wide to 4" wide; now you are able to use more media and create a less restrictive filter that still meets the Merv 13 or higher that consumers desire. Below in **Figure 6**, you see that the pressure drops (Merv 13 data outlined in red) across a list of cfm is much lower than the pressure drops of the 1" wide variety. This lowered pressure drop results in better airflow and easier blower operation.

Figure 6

Initial Airflow Resistance (inches w.c.)								
Series	Airflow (CFM)							
	600	800	1000	1200	1400	1600	1800	2000
M11PAC20252	.04	.06	.08	.11	.13	.16	.19	.22
M11PAC20202	.07	.10	.14	.19	.25	N/A	N/A	N/A
M11PAC16252	.05	.07	.09	.12	.15	.19	.22	.27
M13PAC20252	.06	.09	.12	.16	.20	.25	.30	.35
M13PAC20202	.09	.13	.18	.23	N/A	N/A	N/A	N/A
M13PAC16252	.06	.09	.13	.17	.22	.26	.31	.37

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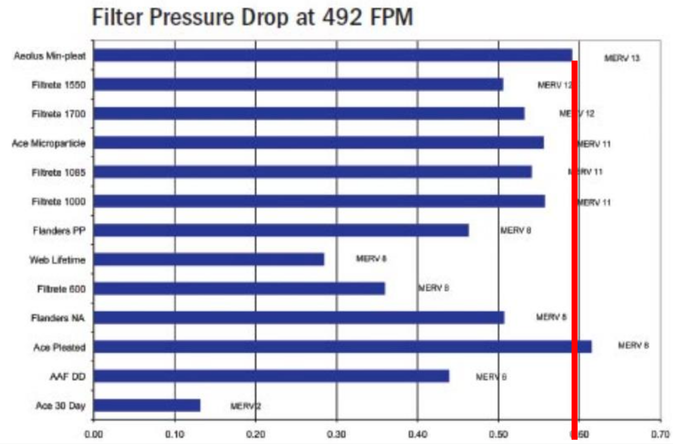
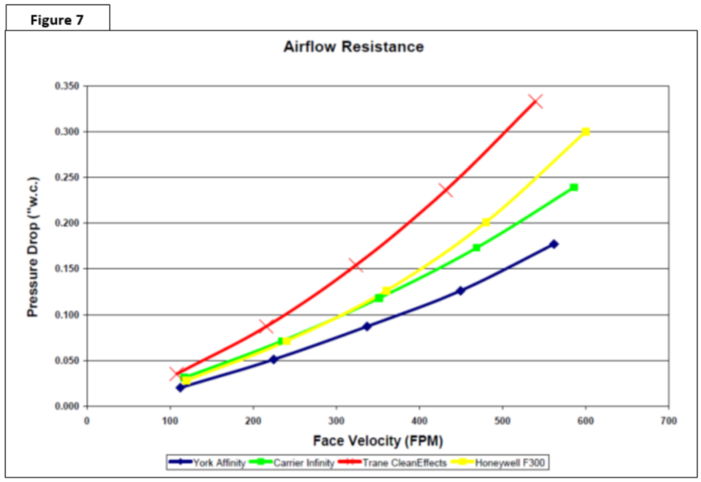


16x25
1,367 CFM

Initial Airflow Resistance (inches w.c.)								
Series	Airflow (CFM)							
	600	800	1000	1200	1400	1600	1800	2000
M11PAC20252	.04	.06	.08	.11	.13	.16	.19	.22
M11PAC20202	.07	.10	.14	.19	.25	N/A	N/A	N/A
M11PAC16252	.05	.07	.09	.12	.15	.19	.22	.27
M13PAC20252	.06	.09	.12	.16	.20	.25	.30	.35
M13PAC20202	.09	.13	.18	.23	N/A	N/A	N/A	N/A
M13PAC16252	.06	.09	.13	.17	.22	.26	.31	.37

The York Affinity Hybrid air cleaner equates to a Merv 16 (since it's a hybrid of media and electronic the rating system is slightly different), which means that it performs at the same level of a Merv 16. When you look at the airflow resistance in **Figure 7** (look at the blue line) and using 450 fpm as the guideline, we see that the Affinity filter has a pressure drop of only .13iwc.

Figure 7



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So What Do I Do?

- Take an external static pressure measurement with current clean filter.
- Is there any room in the reading to add additional restriction?
- Is it possible to increase the width of the filter?
- Is it possible to increase overall size of the filter?
- Is it possible to alter "easy to access" ductwork to decrease restriction to allow for additional filter restriction.

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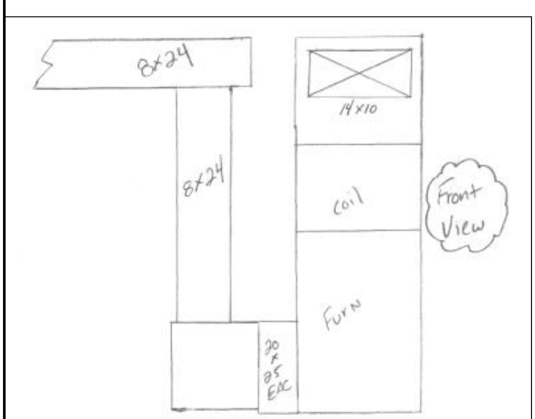
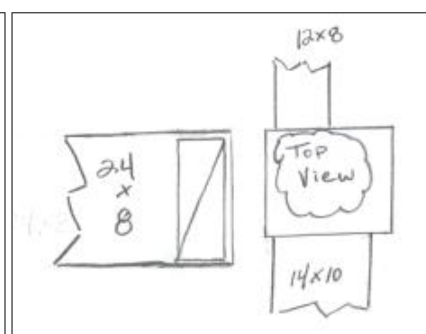
Calculate Mechanical Room Fittings EL



Front View



Top View

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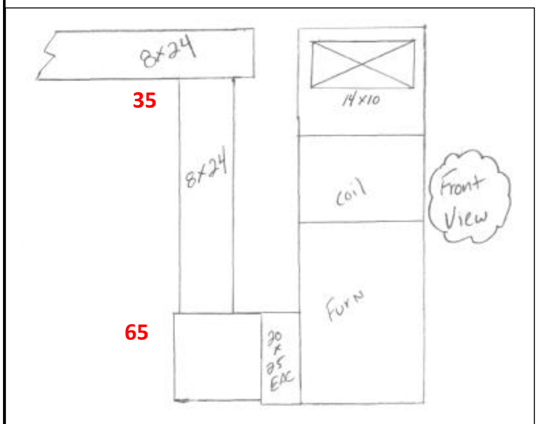
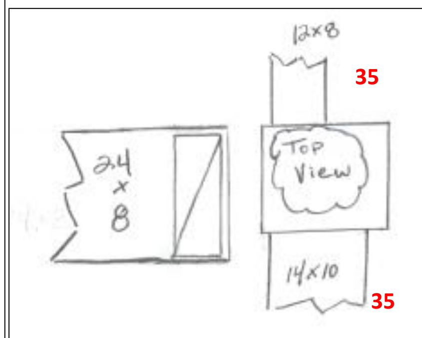
Calculate Mechanical Room Fittings EL





Top View

Front View

Fitting EL = 170ft

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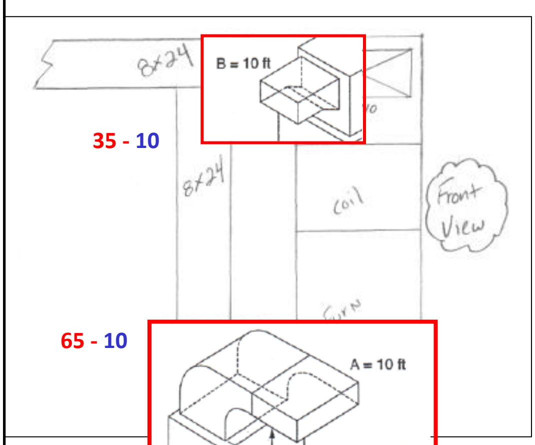
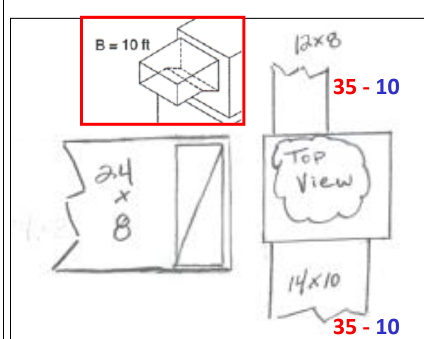
Calculate Mechanical Room Fittings EL





Top View

Front View

Fitting EL = 170ft

Fitting EL = 40

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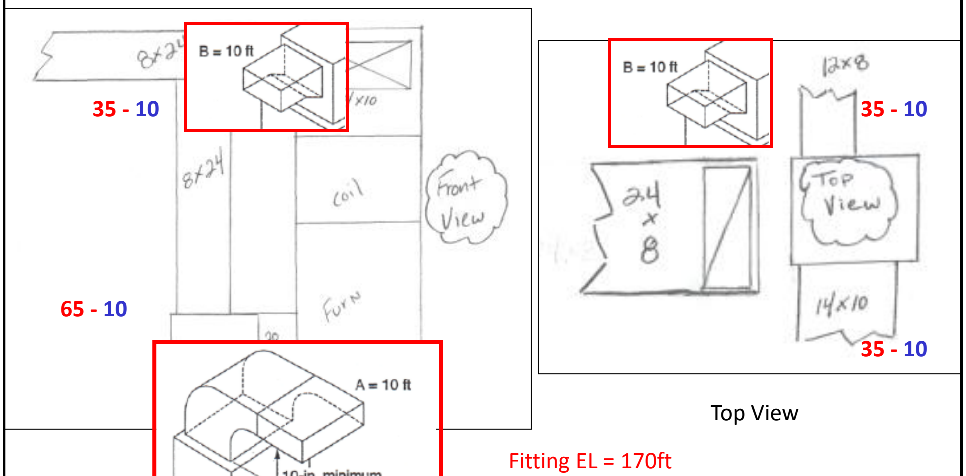
Calculate Mechanical Room Fittings EL



Top View

Fitting EL = 170ft

Fitting EL = 40

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Questions?

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