Filter/AHU Inquiry: *Approach*

- Developed diagnostic protocol
- Over 60+ air handler systems tested to date
- Evaluate opportunity for MERV 13 plus 24/7 operation

Next up:

- Rhett Major, The Energy Doctor
  - Description of the diagnostic visit & intervention


16 x 25 x 1
MICROPARTICLE
TRUST
WE PROVIDE THE BEST FOR YOU
90 Days Effective Protection Against These Common Household Contaminants
10

We want cleaner air, but can our systems
take the extra restrictions presented by the filter?

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1” high MERV filters tend to be very restrictive.

Total External Static Pressure

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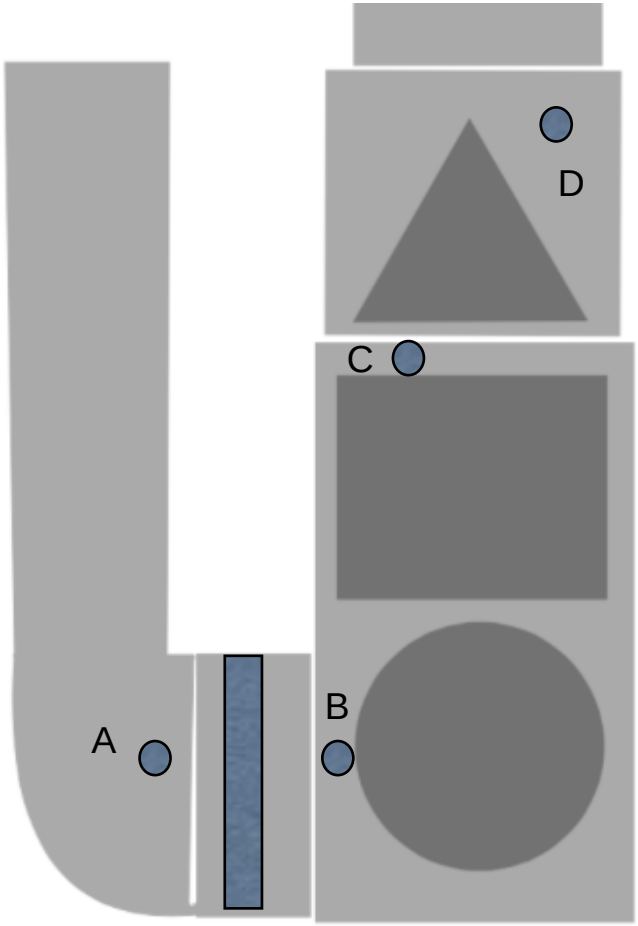
Test Holes



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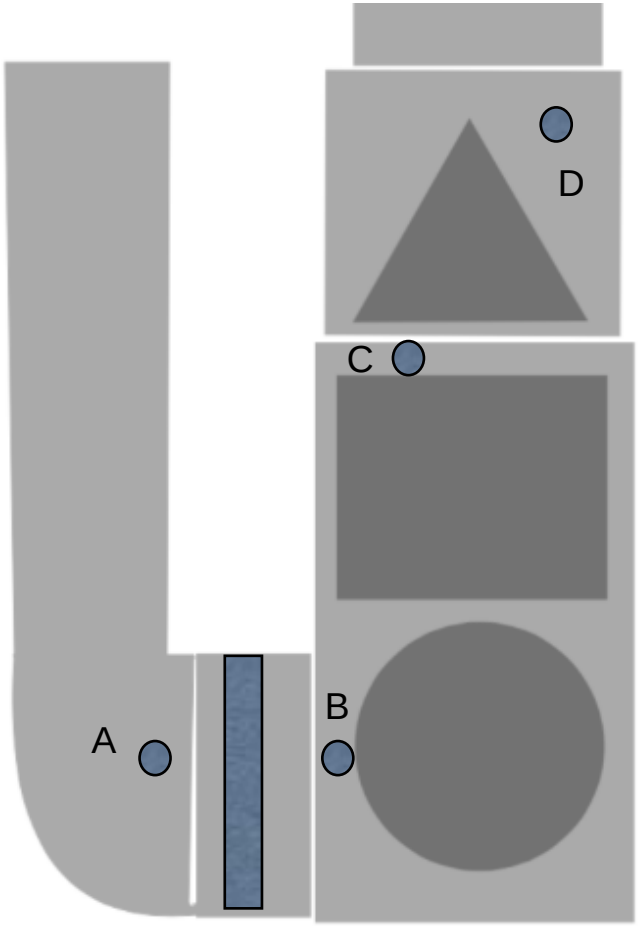

Drill test holes very carefully!

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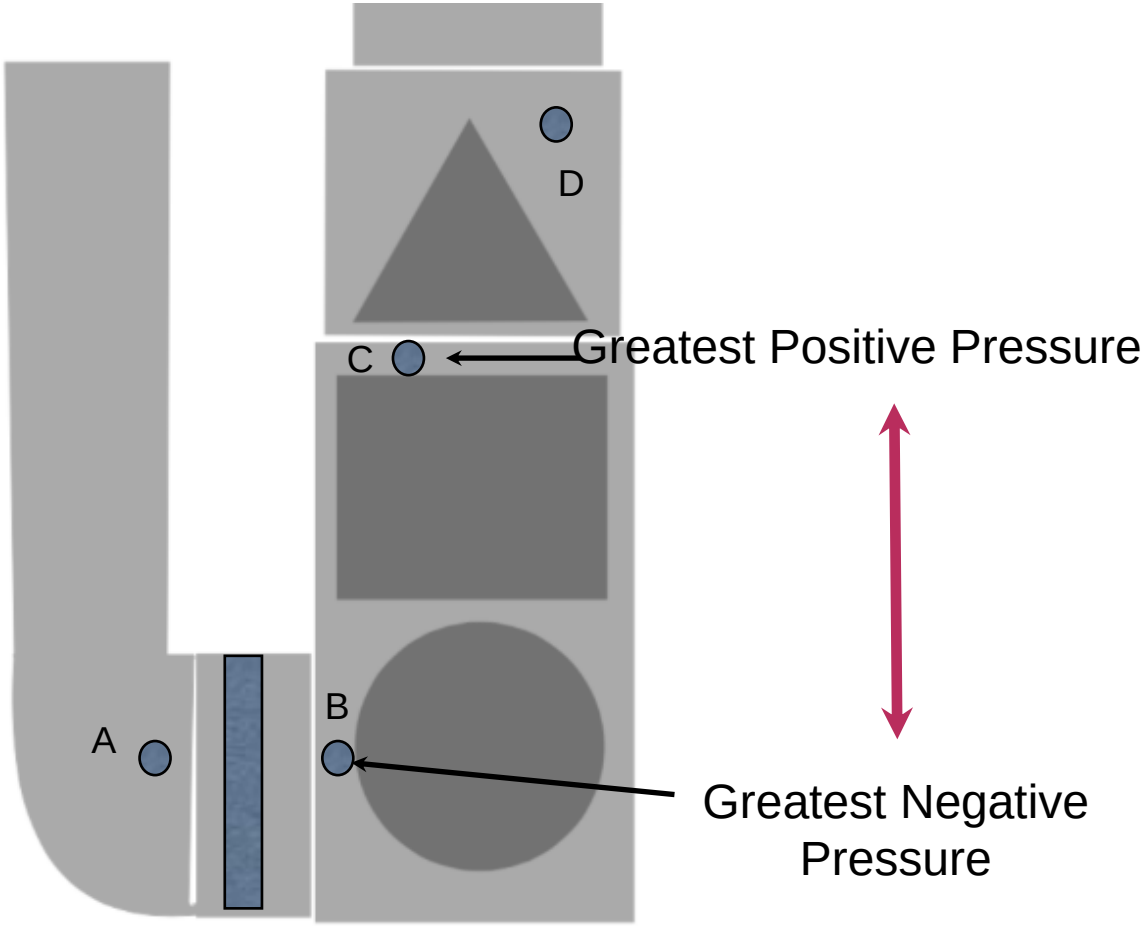

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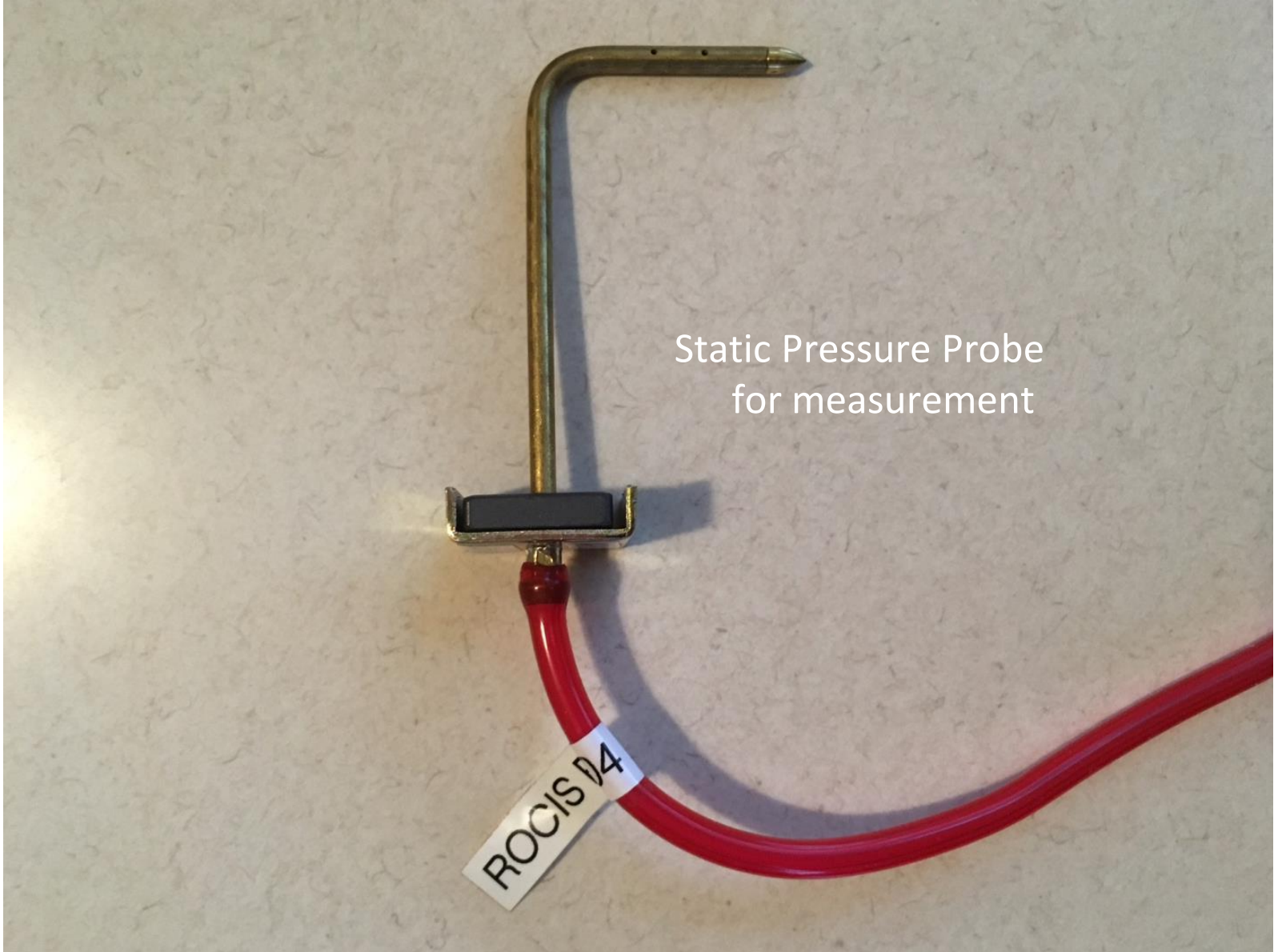
Static Pressure Probe
for measurement
ROCIS 04

Digital Manometer

reading in Pascals

OUTPUT SORTIE See Note Below Voir La Note Ci-dessous	BTU/HR BTU PAR HRE	78,000	–	31,000
AIR TEMPERATURE RISE AUGMENTATION DE LA TEMPERATEUR DE L'AIR	DEG. F	40 – 70	50 – 80	35 – 65
	DEG. C	22 – 39	28 – 44	19 – 36
DESIGN MAX. OUTLET AIR TEMPERATURE CONCU POUR UNE TEMPERATURE MAX. D'AIR DE SORTIE DE	DEG. F	185	195	195
	DEG. C	85	91	91

(FOR PURPOSE OF INPUT ADJUSTMENT) (POUR L'ADJUSTMENT D'ENTREE)

ALTITUDE	MANIFOLD PRESSURE/PRESSION TUBULURE			
0 – 4,500 FT.	IN. W.C. / PO C.E.	3.2 – 3.8	1.3 – 1.8	0.50 – 0.65
0 – 1372 m	KPa	0.80 – 0.95	0.32 – 0.42	0.125 – 0.162
4,500 – 10,000 FT. 1372 – 3050 m	REFER TO INSTALLATION MANUAL RESPECTER LES INSTRUCTION D'INSTALLATION			

	IN.W.C. / PO C. E.	KPa.
MAX. HEATING EXT. STATIC PRESS. PRESS. STATIQUE EXT. MAX. EN MODE DE CHAUFFAGE	0.5	0.125
MAX. INLET GAS PRESSURE PRESS. MAX D'ADMISSION DE GAZ	13.6	3.39
MIN. INLET GAS PRESSURE PRESS. MIN D'ADMISSION DE GAZ	4.5	1.12

For installation in alcove or closet at Min. clearance from combustible material as shown here	TOP DESSUS	SIDES COTES	BACK ARRIERE	FRONT AVANT	VENT EVENT	FRONT SERVICE SERVICE DEVANT
INCHES (POUCES)	1	0	0	1	0	24
mm	25.4	0	0	25	0	610

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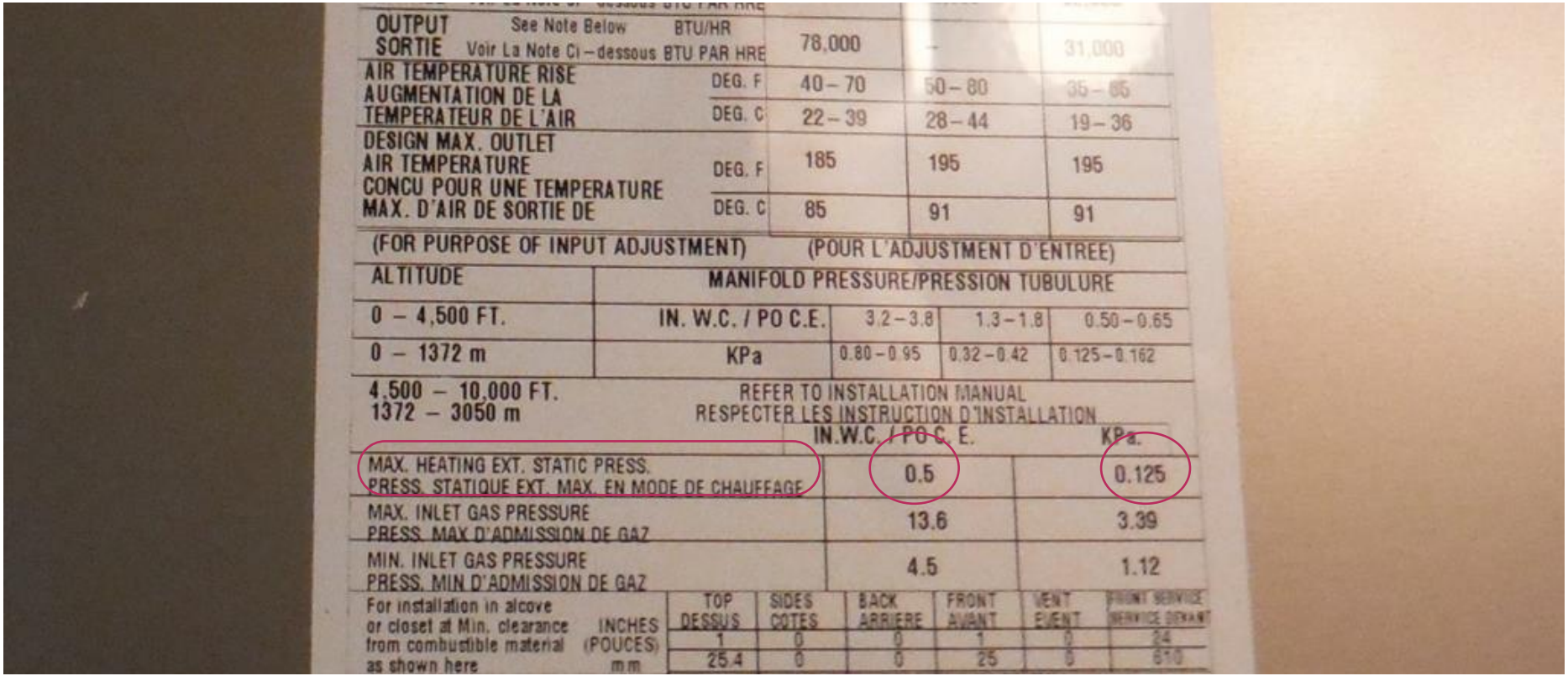

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Every furnace or air handler has the maximum static pressure on the manufacturers label.
I transfer this number to my static pressure test sheets.

Rated Input BTU_____ Output BTU_____
Temperature Rise range _____

1) Drill test holes - 3/8" (carefully located to avoid drilling into components) Check filter for cleanliness - replace if dirty

2) Start up furnace system - set to 85° - Measure spillage stop time _____ seconds
Allow system to run for 5 - 10 minutes - remember to open interior doors after spillage test.
As the system warms up, take static pressure measurements - IWC or Pascals

a. Before filter _____ (Return system)
b. After filter _____
c. Before coil _____
d. After coil _____ (Supply system)

3) Allowable TESP - from manufacturers nameplate _____ (IWC x 250 = pascals)
Measured TESP = Absolute value of [b] + [c]. _____

High TESP pressures indicate many possible problems - isolate where the restrictions are:

4) Ideal Return pressure - 20% of TESP _____ Measured return pressure is = a. _____

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I record the static pressure measurements from these 4 locations here,
& start doing the calculations

Temperature Rise range 35° - 65°
Filter - Carrier Electronic air cleaner

1) Static pressures:	AC speed	Lo Heating speed	High speed	constant speed
a. Before filter	-44	Before filter -39	Before filter -48	Before filter -31
b. After filter	-68	After filter -60	After filter -61	After filter -49
c. Before coil	+188	Before coil +182	Before coil +189	Before coil +137
d. After coil	+46	After coil +43	After coil +50	After coil +35
e. Wattage	630	wattage 500	wattage 610	wattage 400
f. CFM	1100	CFM 870	CFM NM	CFM 740

3) Allowable TESP - from manufacturers nameplate 125

Measured TESP	256	242	250	186

High TESP pressures indicate many possible problems - isolate where the restrictions are:

4) Ideal Return pressure - 20% of TESP -25

Measured return pressure	-44	-39	-48	-31

High values indicate return restrictions, lower values indicate duct leaks or low fan speed

5) Ideal max filter pressure drop = 20% x TESP 25

Pressure drop across Filter	24	21	13	18

High value indicates problems: Clogged or restrictive of filter - decreases airflow capacity

High Static pressure values indicate problems

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Measuring Watt Draw

- Clamp-on style Current Transformer (CT) (OWL, Energy Detective, Sense)

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- Wireless monitor display


Clamp-on style Current Sensor (CT)

The wireless monitor shows the instantaneous wattage draw for the fan.

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(This wattage is high, as it's capturing electric backup heat also.)

Total External Static Pressure

- What can increase TESP?

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- **Dirt** - primarily in the filter &/or coil

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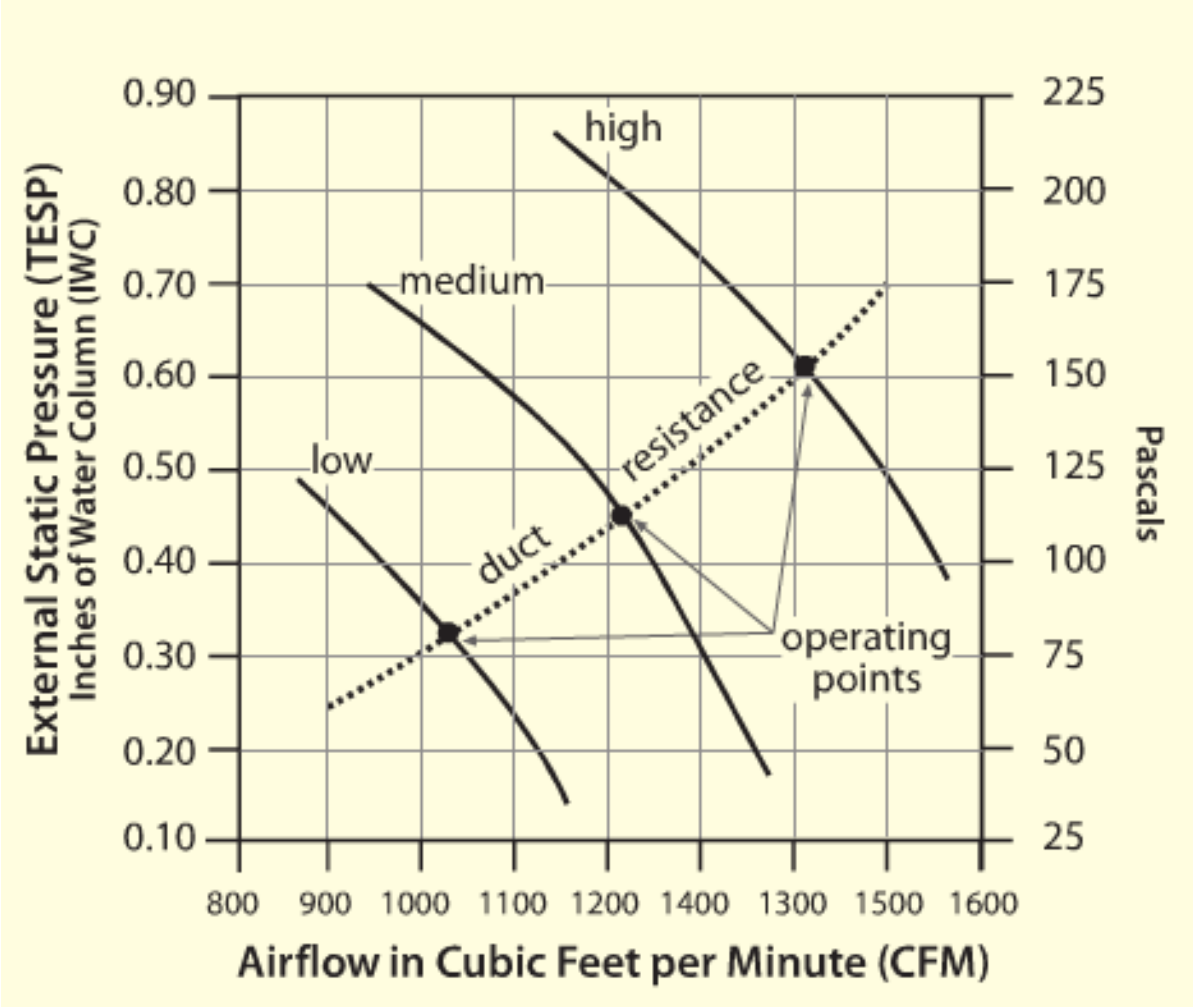
- The greater the TESP, the less the airflow with PSC motors, or the higher the wattage draw (with ECM)

Wrong fan speed - PSC



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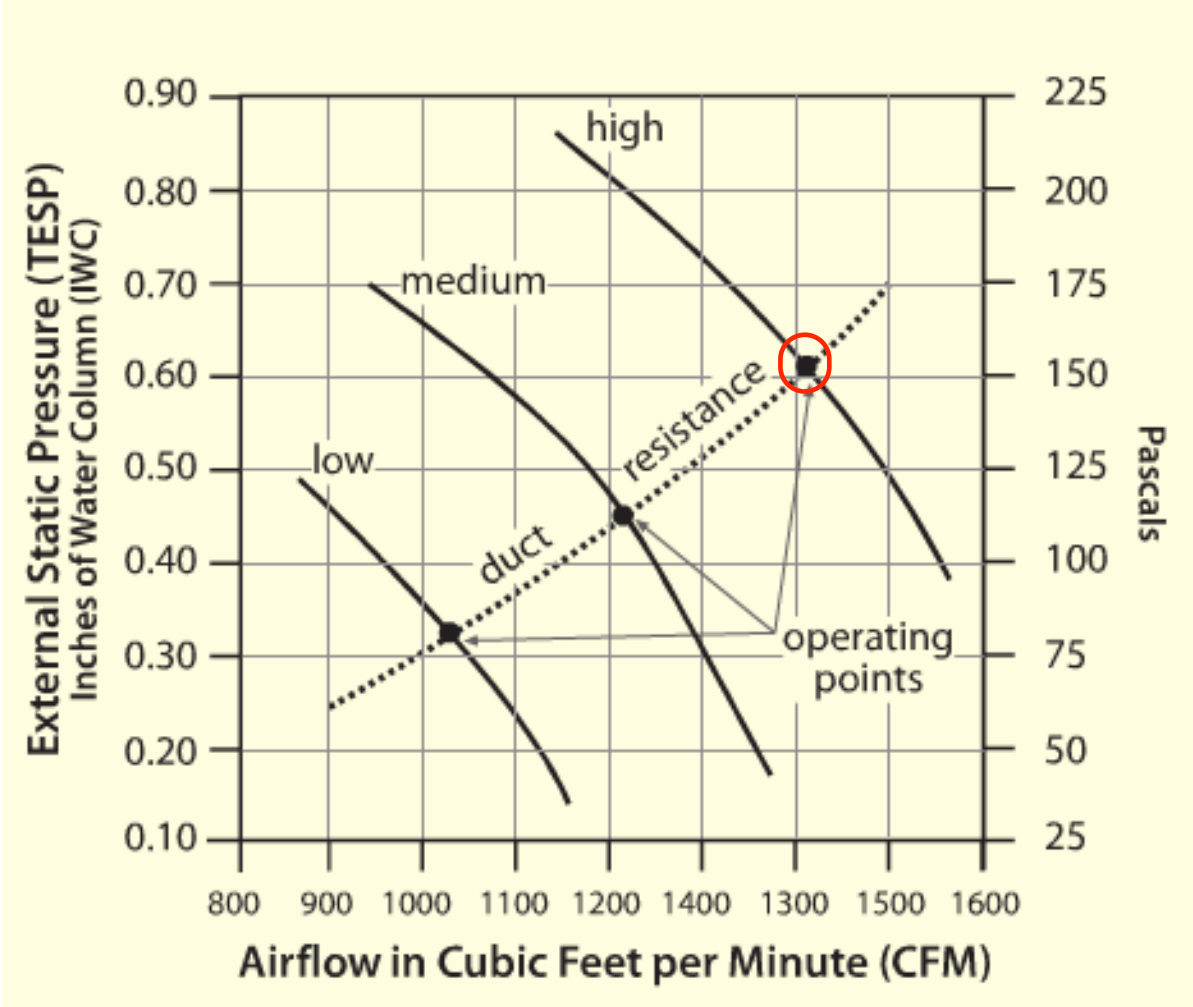

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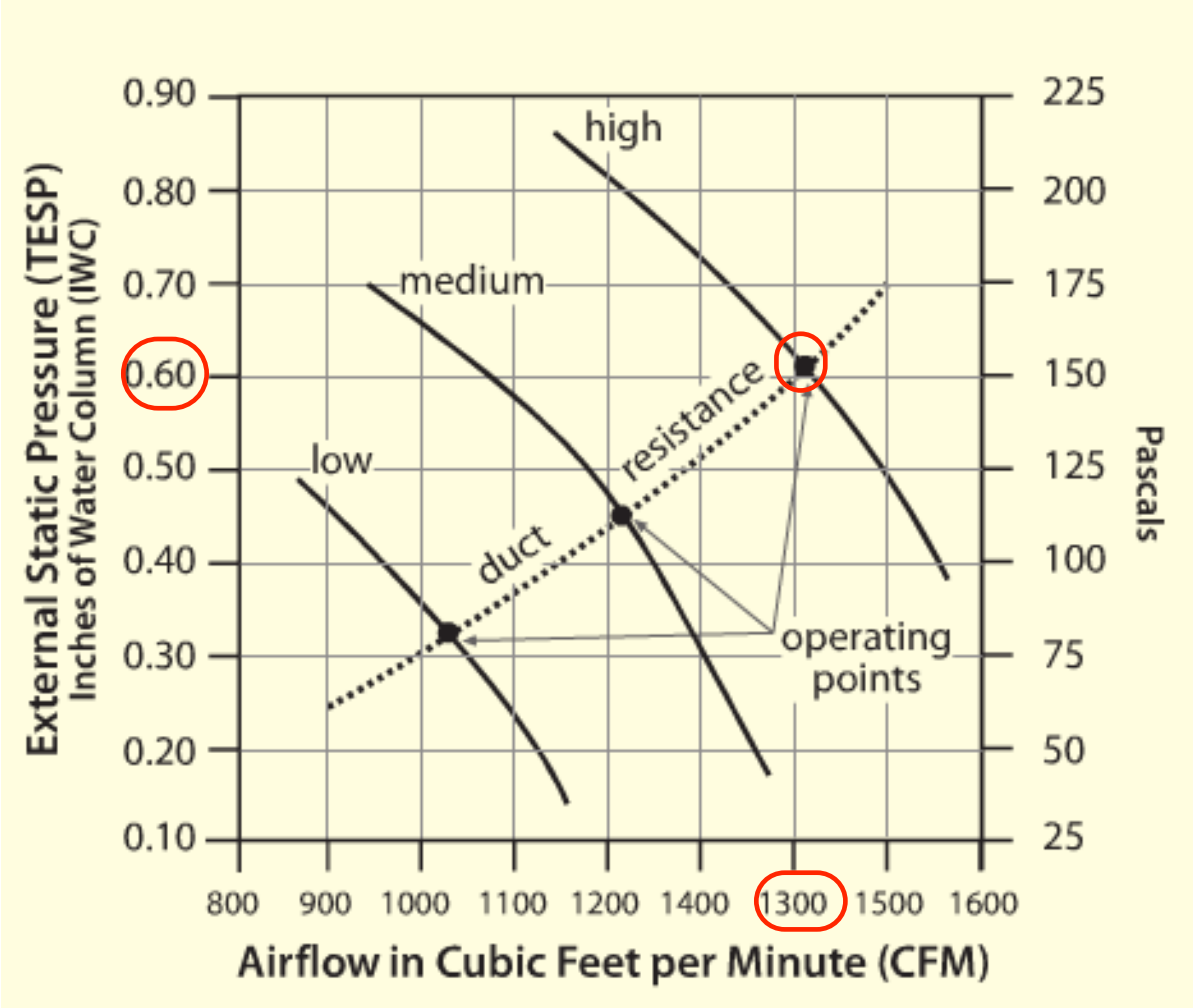

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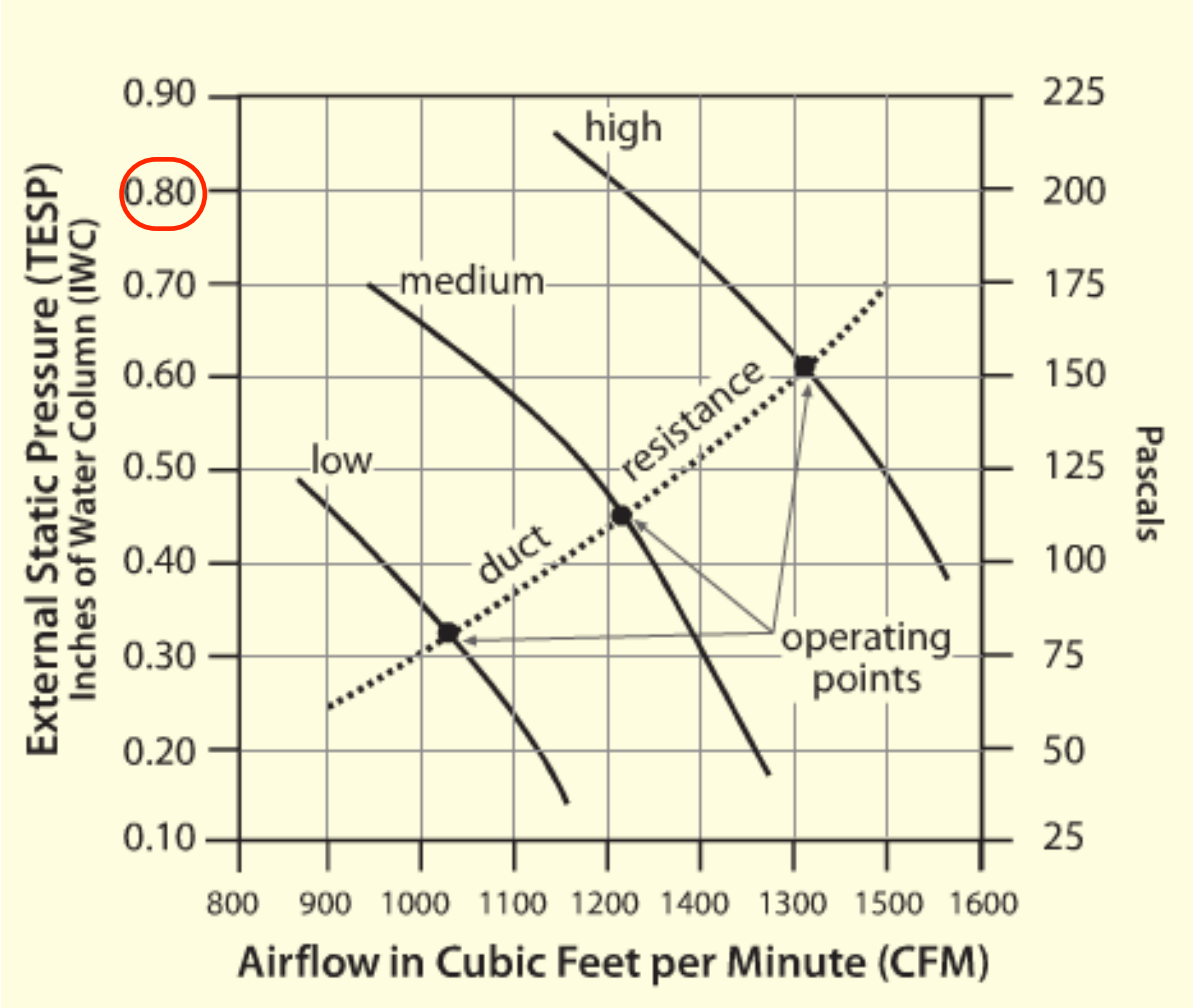

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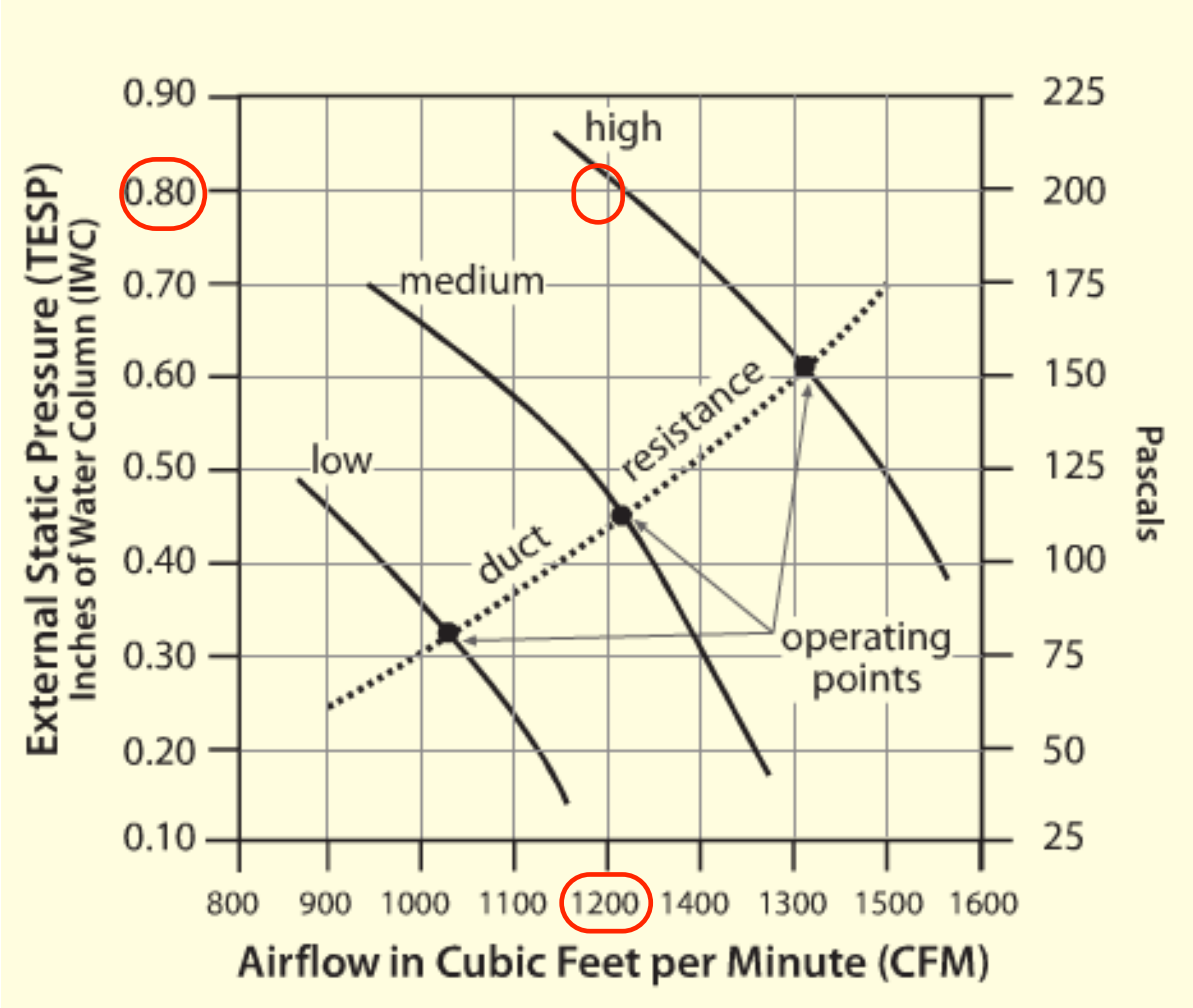

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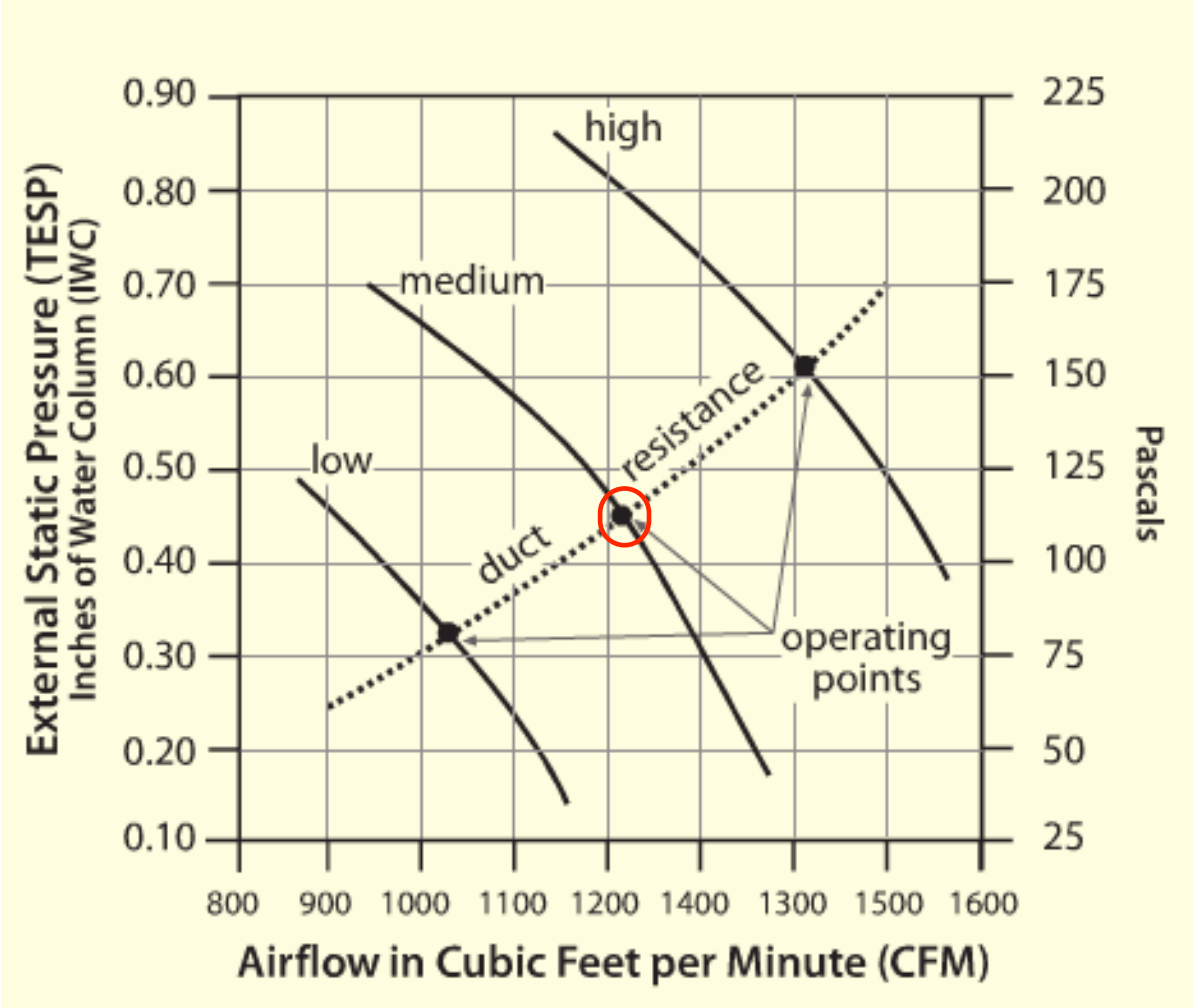

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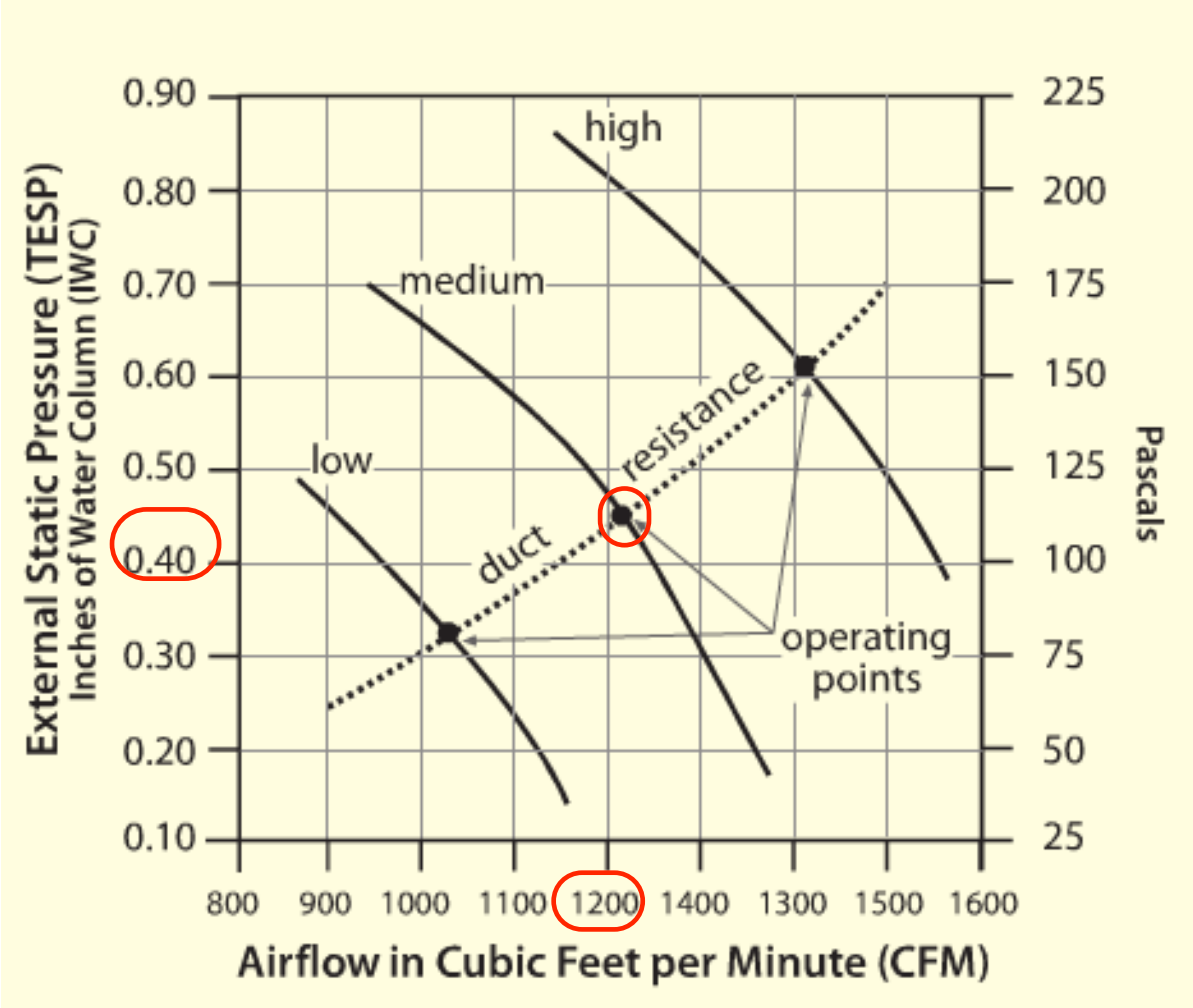

*UH2B080A9V3V FURNACE HEATING AIRFLOW (CFM) AND POWER (WATTS) VS. EXTERNAL STATIC PRESSURE WITH FILTER									
1st Stage Capacity = 50,440 2nd Stage Capacity = 77,600									
	AIRFLOW SETTING	DIP SWITCH SETTING			EXTERNAL STATIC PRESSURE				
		SW 7	SW 8		0.1	0.3	0.5	0.7	0.9
HEATING 1ST STAGE	LOW	ON	ON	CFM TEMP. RISE WATTS	800 56 105	800 56 140	800 56 180	800 56 220	800 56 265
	MEDIUM LOW	OFF	ON	CFM TEMP. RISE WATTS	860 52 115	880 51 165	890 50 215	920 48 265	910 49 320
	NORMAL **	ON	OFF	CFM TEMP. RISE WATTS	960 46 150	990 45 200	1000 44 230	1020 44 310	1010 44 350
	HIGH	OFF	OFF	CFM TEMP. RISE WATTS	1080 41 195	1110 40 255	1120 40 315	1120 40 365	1080 41 390
HEATING 2ND STAGE	LOW	ON	ON	CFM TEMP. RISE WATTS	1100 62 205	1100 62 260	1120 61 320	1120 61 370	1090 63 400
	MEDIUM LOW	OFF	ON	CFM TEMP. RISE WATTS	1210 57 265	1240 55 340	1260 54 410	1260 54 470	1130 61 430
	NORMAL **	ON	OFF	CFM TEMP. RISE WATTS	1360 50 365	1390 49 445	1400 49 500	1360 50 535	1210 57 475
	HIGH	OFF	OFF	CFM TEMP. RISE WATTS	1360 50 355	1390 49 450	1400 49 520	1350 51 535	1180 58 465

NOTES:
* First letter may be "A" or "T"
** Factory setting

Static Pressure - effect on ECM

	EXTERNAL STATIC PRESSURE				
	0.1	0.3	0.5	0.7	0.9
CFM	800	800	800	800	800
TEMP. RISE	56	56	56	56	56
WATTS	105	140	180	220	265
CFM	860	880	890	920	910
TEMP. RISE	52	51	50	48	49
WATTS	115	165	215	265	320
CFM	960	990	1000	1020	1010
TEMP. RISE	46	45	44	44	44
WATTS	150	200	230	310	350
CFM	1080	1110	1120	1120	1080
TEMP. RISE	41	40	40	40	41
WATTS	195	255	315	365	390

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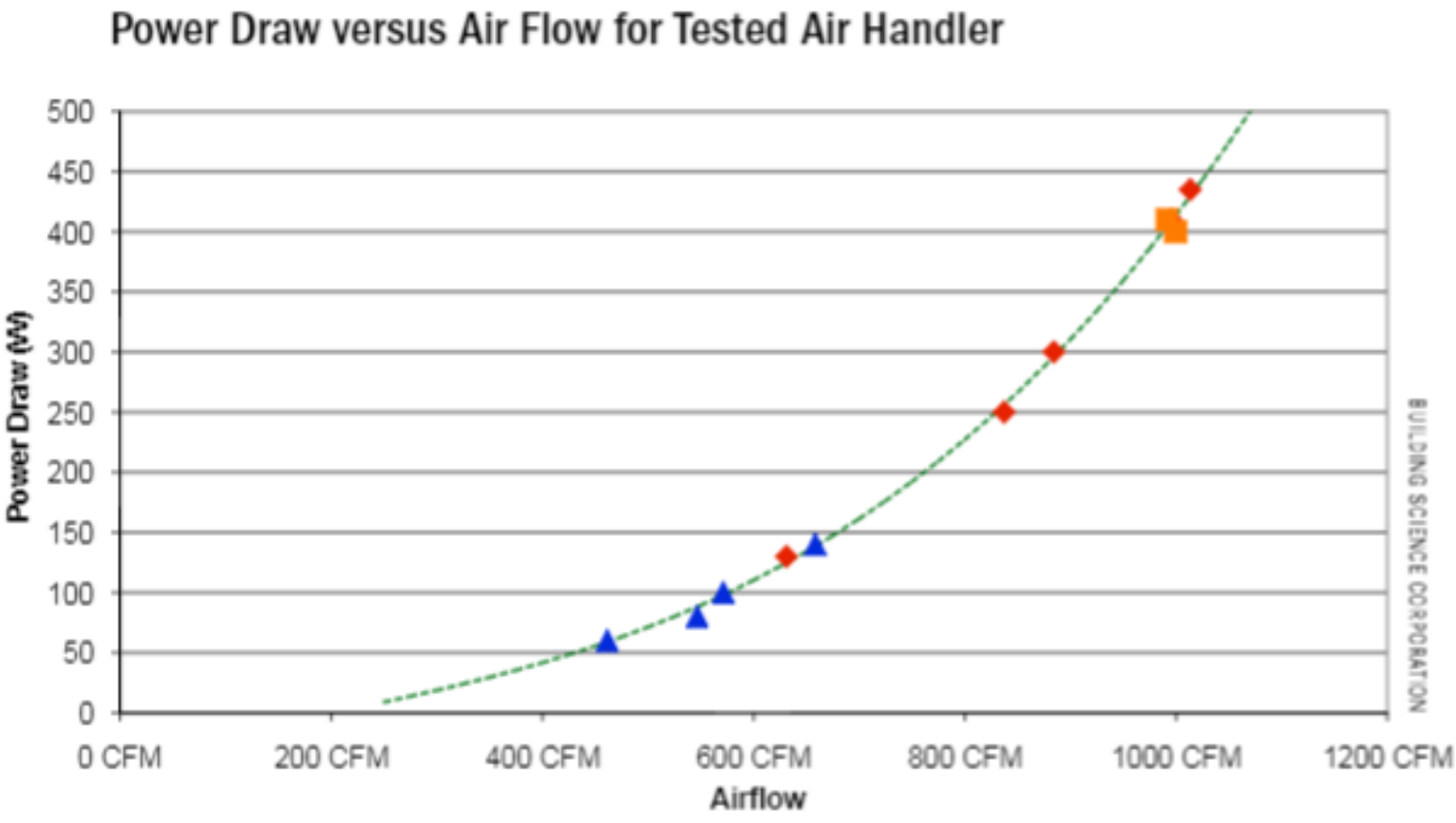

Slide credit: Building Science Corporation

I Check Heat-rise - to evaluate appropriateness of fan speed.

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DOWNFLOW W/O COIL USE SUB-BASE DEBIT DESCENDANT SANS SERPENTIN, UTILISER LA BASE	KGASB0201ALL

TYPE FSP CATEGORY IV DIRECT VENT FORCED AIR FURNACE.
TYPE FSP CATEGORIE IV. GENERATEUR D'AIR CHAUD A EVACUATION DIRECTE ET A AIR FORCE

FACTORY AUTHORIZED GAS CONVERSION KITS
ENSEMBLES DE CONVERSION AU GAZ AUTORIES PAR L'USINE

NATURAL GAS TO PROPANE KGANP5201VSP

Heat Rise/Temp Rise Basics

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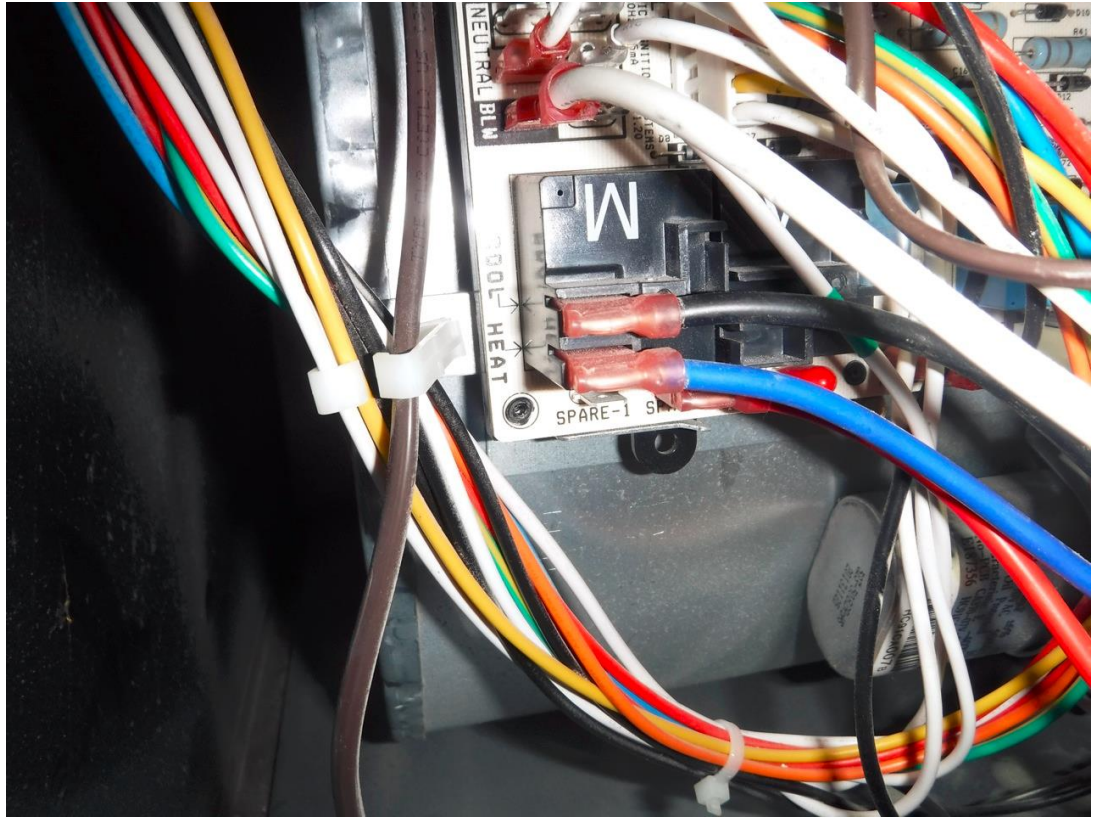
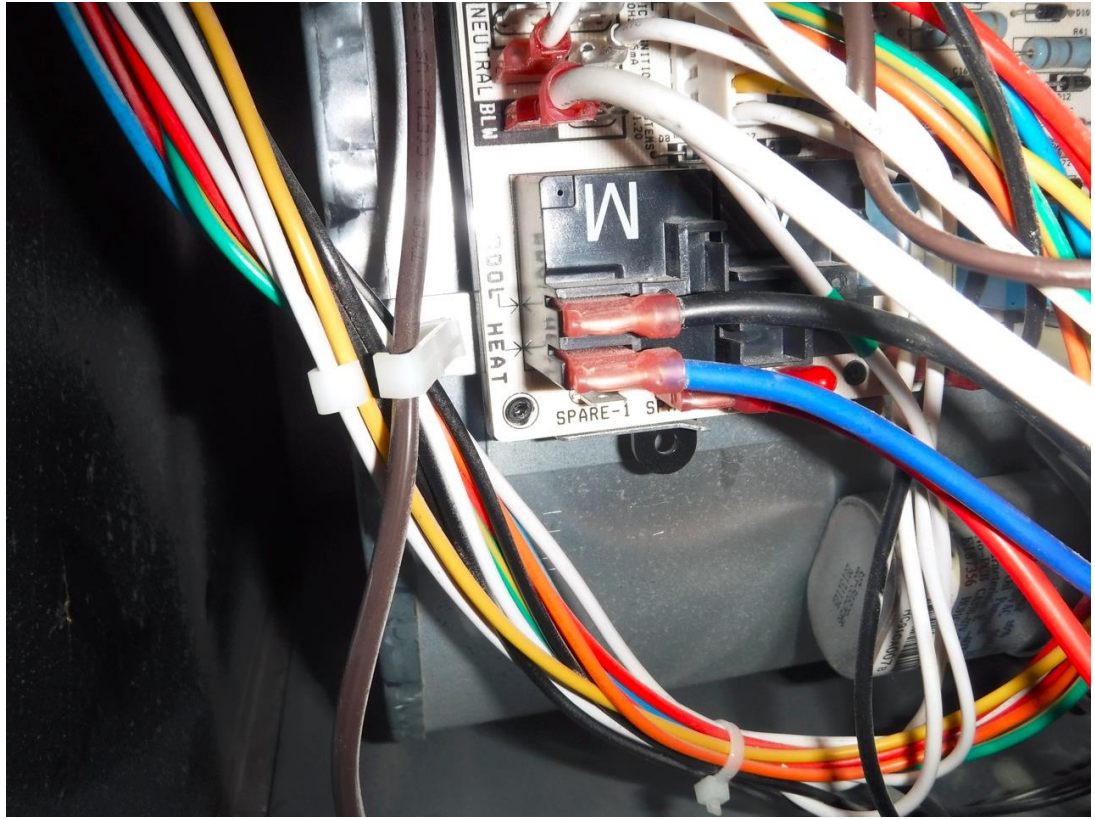
- The faster the airflow, the lower the heat rise.
- Compare this heat-rise to Manufacture’s spec on furnace.

Adjust Fan Speeds as needed



Adjust Fan Speeds as needed



Not as hard as you think!

Adjusting Fan Speeds

THERMOSTAT HEAT
ANTICIPATION SETTINGS

.65 AMP	HONEYWELL VALVE
.50 AMP	WHITE-RODGERS VALVE

	JACKPLUG CHART
J.P20	JACK/PLUG-GAS
J.P58	JACK/PLUG-BURNER CONTROL
J.P63	JACK/PLUG-BLOWER DECK
J.P64	JACK/PLUG-COMB. AIR BLOWER
J.P68	JACK/PLUG-BLOWER DECK
J.P156	JACK/PLUG-INDUCER(R33)
J.P159	JACK/PLUG-IGNITION

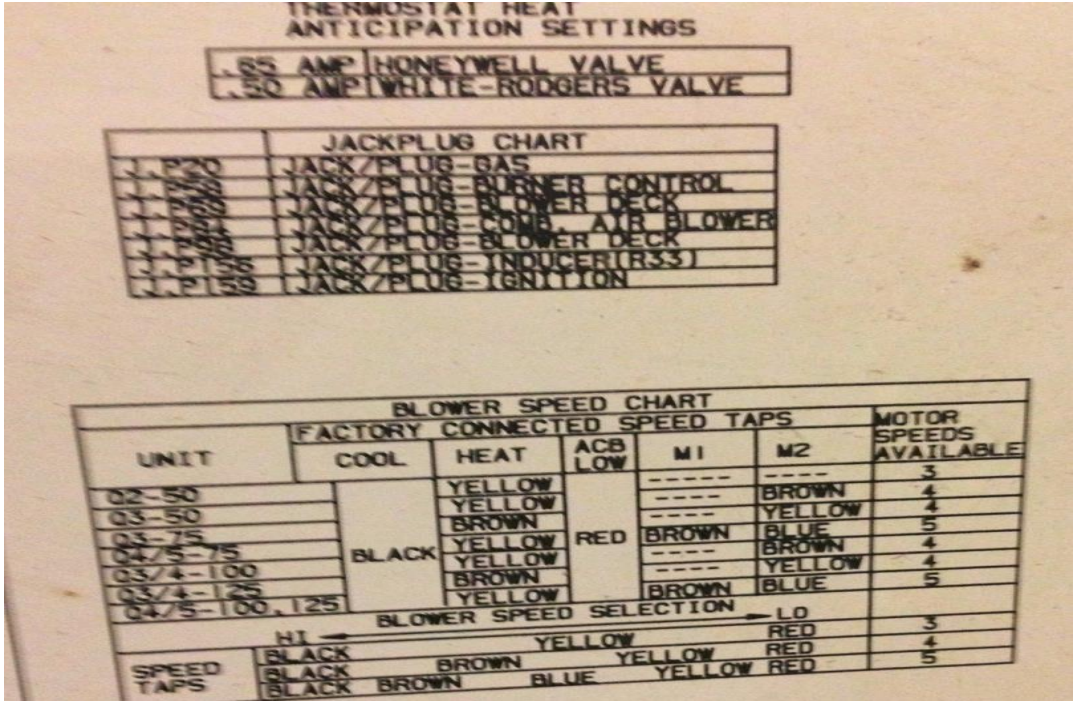
BLOWER SPEED CHART

UNIT	FACTORY CONNECTED SPEED TAPS					MOTOR SPEEDS AVAILABLE
	COOL	HEAT	ACB LOW	M1	M2	
Q2-50	BLACK	YELLOW	RED	-----	----	3
Q3-50		YELLOW		----	BROWN	4
Q3-75		BROWN		----	YELLOW	4
Q4/5-75		YELLOW		BROWN	BLUE	5
Q3/4-100		YELLOW		----	BROWN	4
Q3/4-125		BROWN		----	YELLOW	4
Q4/5-100,125		YELLOW		BROWN	BLUE	5

BLOWER SPEED SELECTION → LO

HI →			YELLOW		RED	3
SPEED TAPS	BLACK	BROWN		YELLOW	RED	4
	BLACK	BROWN	BLUE	YELLOW	RED	5

Adjusting Fan Speeds



THERMOSTAT HEAT ANTICIPATION SETTINGS

.65 AMP	HONEYWELL VALVE
.50 AMP	WHITE-RODGERS VALVE

	JACKPLUG CHART
J.P20	JACK/PLUG-GAS
J.P58	JACK/PLUG-BURNER CONTROL
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J.P159	JACK/PLUG-IGNITION

BLOWER SPEED CHART

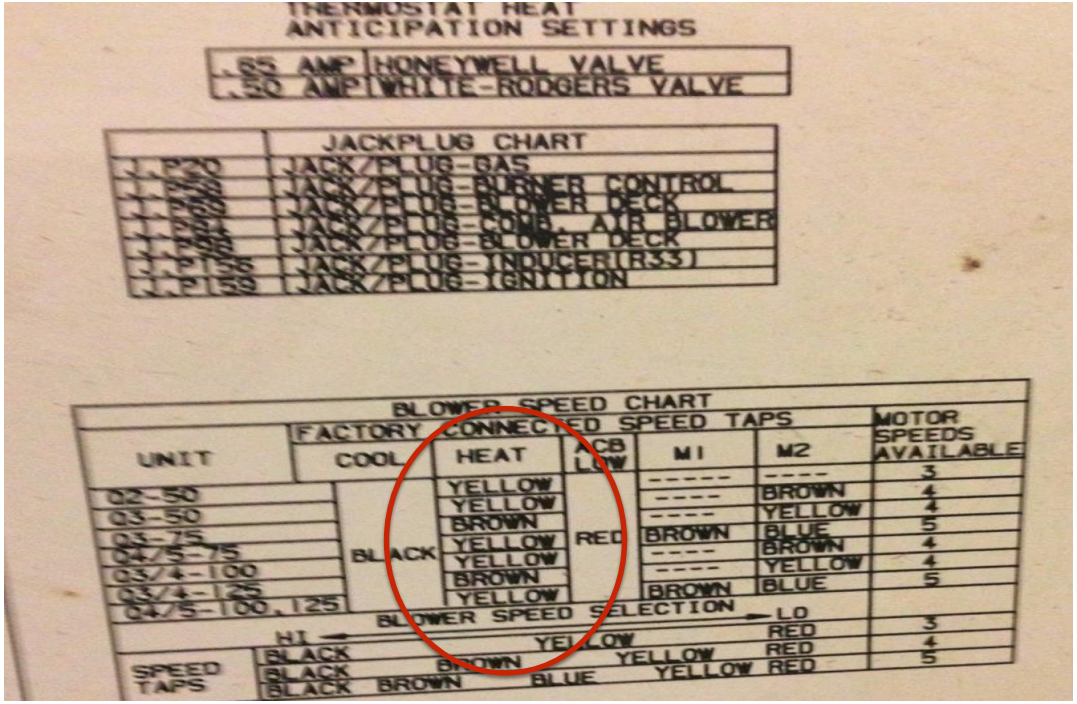
UNIT	FACTORY CONNECTED SPEED TAPS					MOTOR SPEEDS AVAILABLE
	COOL	HEAT	ACB LOW	M1	M2	
Q2-50	BLACK	YELLOW	RED	----	----	3
Q3-50		YELLOW		----	BROWN	4
Q3-75		BROWN		----	YELLOW	4
Q4/5-75		YELLOW		BROWN	BLUE	5
Q3/4-100		YELLOW		----	BROWN	4
Q3/4-125		BROWN		----	YELLOW	4
Q4/5-100,125		YELLOW		BROWN	BLUE	5

BLOWER SPEED SELECTION → LO

SPEED TAPS	HI →						LO	
	BLACK		YELLOW				RED	3
	BLACK	BROWN		YELLOW			RED	4
	BLACK	BROWN	BLUE		YELLOW		RED	5

The furnace installation manual usually has a color chart to tell you which colors represents which speed.

Adjusting Fan Speeds



THERMOSTAT HEAT ANTICIPATION SETTINGS

.65 AMP	HONEYWELL VALVE
.50 AMP	WHITE-RODGERS VALVE

JACKPLUG CHART

J.P20	JACK/PLUG-GAS
J.P58	JACK/PLUG-BURNER CONTROL
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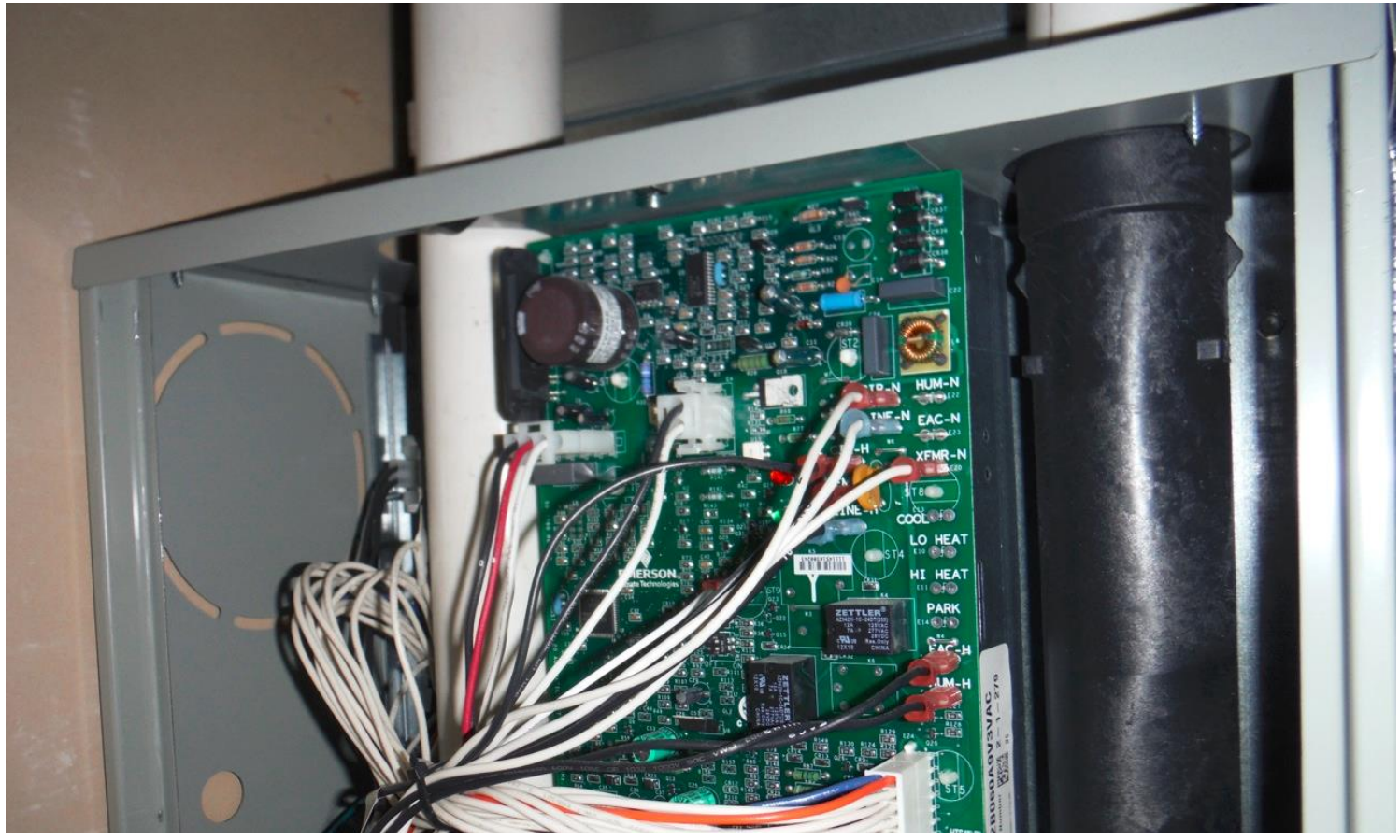
BLOWER SPEED CHART

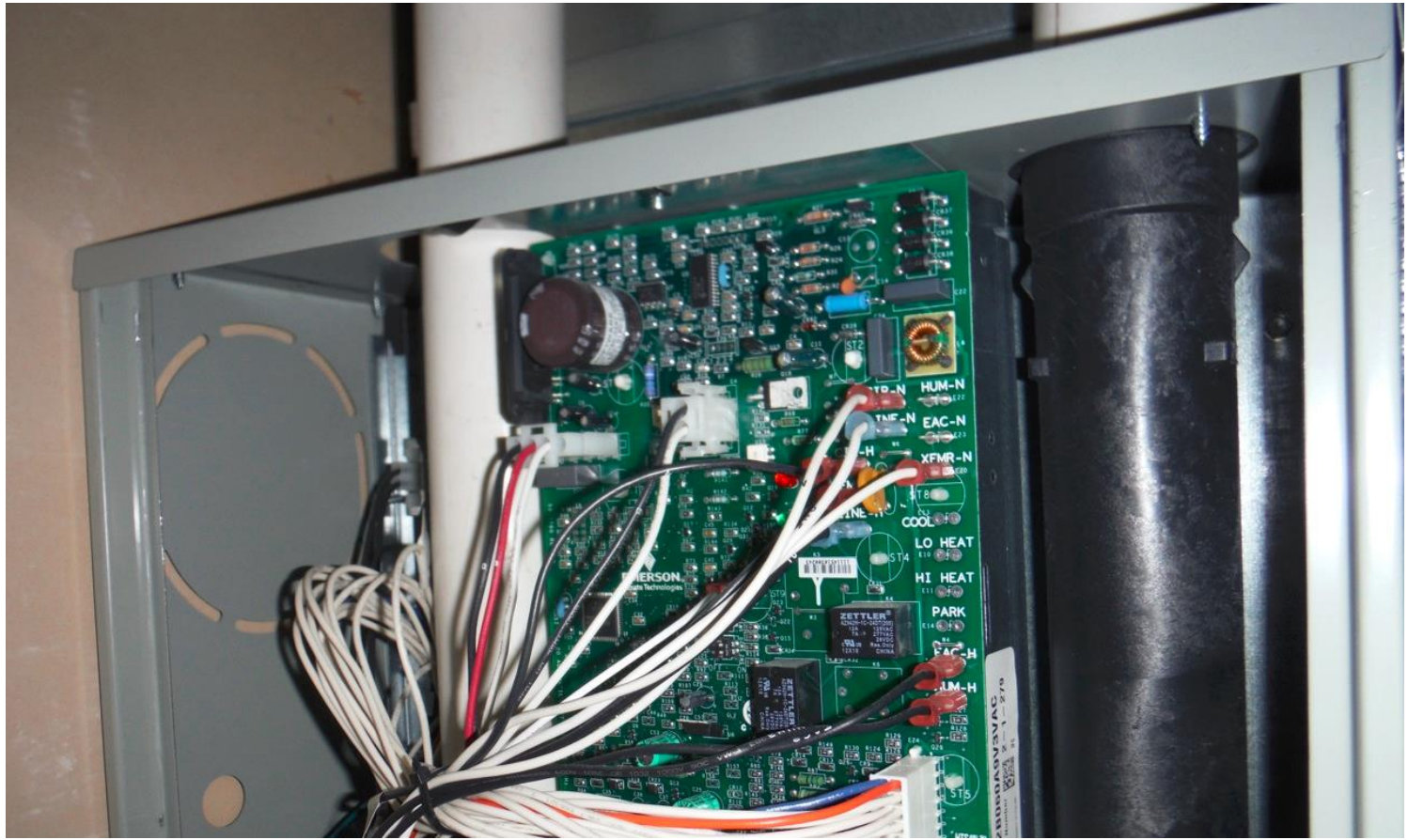
UNIT	FACTORY CONNECTED SPEED TAPS COOL	HEAT	ACB LOW	M1	M2	MOTOR SPEEDS AVAILABLE
Q2-50	BLACK	YELLOW	RED	----	----	3
Q3-50		YELLOW		----	BROWN	4
Q3-75		BROWN		----	YELLOW	4
Q4/5-75		YELLOW		BROWN	BLUE	5
Q3/4-100		YELLOW		----	BROWN	4
Q3/4-125		BROWN		----	YELLOW	4
Q4/5-100,125		YELLOW		BROWN	BLUE	5

BLOWER SPEED SELECTION

SPEED TAPS	HI →				← LO	
	BLACK	YELLOW			RED	3
	BLACK	BROWN	YELLOW		RED	4
	BLACK	BROWN	BLUE	YELLOW	RED	5

The furnace installation manual usually has a color chart to tell you which colors represents which speed.


HUM-N
EAC-N
XFMR-N
COOL
LO HEAT
HI HEAT
PARK
ZETTLER



Some models are a little more complex,
they have tiny dip switches that need to be adjusted
according to the desired settings

Re-Check Heat-rise/Temp-drop

Example 1

Air Handler/ furnace__NUGE100BG01
Rated Capacity__100,000 / 82,000____
Heat Rise 40° - 70°
4" Merv 13 filter (4 months old)
Ecobee thermostat - _1/2 HP PSC motor

1) Take static pressure measurements - IWC or Pascals

Heat mode mode		AC/ Circulation Mode	
a. Before filter	____-64_____ (Return system)	a. Before filter	__-71_____
b. After filter	____-176_____	b. After filter	___-188_____
c. Before coil	____+62_____	c. Before coil	__+62_____
d. After blower	____N/A_____ (Supply system)	d. After blower	___N/A_____
e. wattage	____680____	e. wattage	____840_____

2) Allowable Total External Static Pressure - TESP - from manufacturers nameplate

_____125_____ (IWC x 250 = pascals) _____125_____

Measured TESP = Absolute value of [c] + [d].

_____238____ _____250__

High TESP pressures indicate many possible problems - isolate where the restrictions are:

3) Ideal Return pressures = 20% of TES _____25_____ _____25_____
Measured return pressure is = a _____-64____ _____-71__

High values indicate restrictions in return system, lower values may indicate duct leakage or low fan speed

High TESP

Example 1

4) Ideal max filter pressure drop = 20% x TESP _____25_____ _____25_____
Pressure drop across Filter = [b] - [a] _____112_____ _____117_

High value indicates problems such as: Clogged filter or Too restrictive of filter - decreases airflow & cooling capacity

5) Ideal coil pressure drop = 40% of TESP _____50_____ _____50_____
Pressure drop across coil = c - b _____N/A_____ _____N/A___

High values may indicate Dirty coil - inspect if possible - decreases airflow & cooling capacity

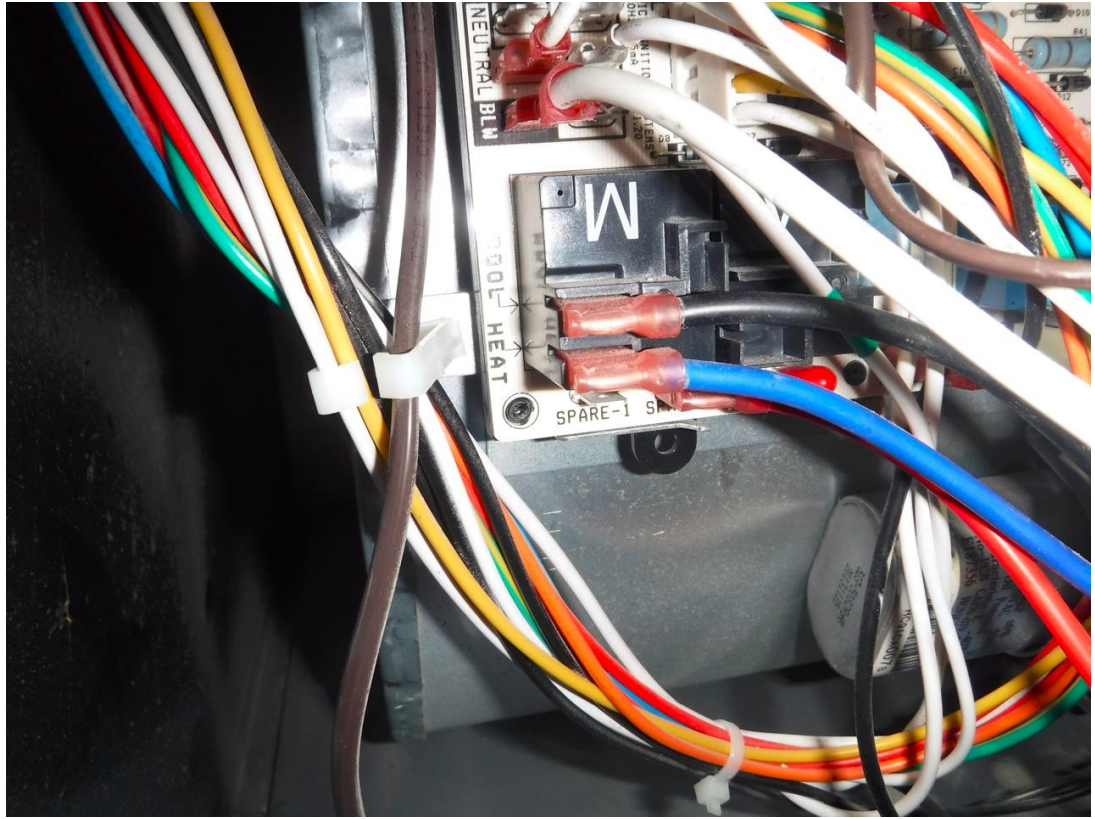
6) Ideal supply duct pressure = 20% of TESP _____25_____ _____25_____
Measured supply duct pressure = d. _____62____ _____62__

High values indicate restrictions in supply system. Lower values could indicate duct leakage or low fan speed)

7) Dry bulb temperature from return hole _____72.5____ _____
Dry bulb temp from supply hole _____127°____ _____
Heat rise = _____54.5____ _____

Low heat rise

Adjust Fan Speed down



Example 1 retest

2/8/17 - adjusted
Air Handler/ furnace__NUGE100BG01_1/2 HP
Rated Capacity__100,000 / 82,000____
Heat Rise 40° - 70°
4" Merv 13 filter (4 months old)
Ecobee thermostat - _1/2 HP PSC motor

1) Take static pressure measurements - IWC or Pascals

Heat mode mode		AC/ Circulation Mode	
a. Before filter	____-62.5_____ (Return system)	a. Before filter	___-63_____
b. After filter	____-165_____	b. After filter	__-165_____
c. Before coil	____+56_____	c. Before coil	____+55_____
d. After blower	_____N/A_____ (Supply system)	d. After blower	___N/A_____
e. wattage	____550____	e. wattage	_____480_____

2) Allowable Total External Static Pressure - TESP - from manufacturers nameplate
_____125_____ (IWC x 250 = pascals) _____125_____

Measured TESP = Absolute value of [c] + [d].
_____221____ _____220_____

High TESP pressures indicate many possible problems - isolate where the restrictions are:

3) Ideal Return pressures = 20% of TES _____25_____ _____25___
Measured return pressure is = a _____-62.5____ _____-63____

High values indicate restrictions in return system, lower values may indicate duct leakage or low fan speed

Lower TESP

Example 1 Retest

4) Ideal max filter pressure drop = 20% x TESP _____25_____ _____25____
Pressure drop across Filter = [b] - [a] _____-102.5_____ _____-102____

High value indicates problems such as: Clogged filter or Too restrictive of filter - decreases airflow & cooling capacity

5) Ideal coil pressure drop = 40% of TESP _____50_____ _____50__
Pressure drop across coil = c - b _____N/A_____ _____N/A____

High values may indicate Dirty coil - inspect if possible - decreases airflow & cooling capacity

6) Ideal supply duct pressure = 20% of TESP _____25____ _____25__
Measured supply duct pressure = d. _____56____ _____55__

High values indicate restrictions in supply system. Lower values could indicate duct leakage or low fan speed)

7) Dry bulb temperature from return hole ____68°_____ _____
Dry bulb temp from supply hole ___126°_____ _____
Heat rise = ___ 58°_____ _____

Lower speed = higher heat rise, and lower static pressures

What else can increase TESP?

- **Dirt - primarily in the filter &/or coil**

A wider filter (4") has about four times the surface area as the 1“ filter, and offers less restriction to the system.

The problem is they are expensive, so people don't want to change them as often as they ought to be changed.


Dirty Filters are a big problem


Example 2
Pre-retrofit
*CLEAN FILTER
MONTHLY

What else can increase TESP?

- **Dirt - primarily in the filter &/or coil**
- **Restrictions in the ductwork system or filter**

Example 2

Air Handler/ furnace__GMUH150-E5A___3/4 HP
Rated Capacity_150,000 INPUT 120,000 Output_____
HEAT RISE - 50°-80°
Filter - FPR -10 (MERV 12) 1" dirty

1) Take static pressure measurements - IWC or Pascals

Fan On - Circulation Mode		Heat Mode	
a. Before filter	____-50.8_____ (Return system)	a. Before filter	____-47_____
b. After filter	____-148_____	b. After filter	____-143_____
c. Before coil	____+115____	c. Before coil	_____+101_____
d. After blower	____+19_____ (Supply system)	d. After blower	____+18_____
e. wattage	____750_____	e. wattage	_____730____
f. CFM	___1050_____	f. CFM	_____1000____

2) Allowable Total External Static Pressure - TESP - from manufacturers nameplate

_____125_____	(IWC x 250 = pascals)	_____125_____
_____263____		_____244____

High TESP pressures indicate many possible problems - isolate where the restrictions are:

3) Ideal Return pressures = 20% of TES	_____25_____	_____25_____
Measured return pressure is = a	_____50.8____	_____-47___

High values indicate restrictions in return system, lower values may indicate duct leakage or low fan speed

4) Ideal max filter pressure drop = 20% x TESP	_____25_____	_____25_____
Pressure drop across Filter = [b] - [a]	_____97.2_____	_____

High value indicates problems such as: Clogged filter or Too restrictive of filter - decreases airflow & cooling capacity

Very High TESP

Example 2

decreases airflow & cooling capacity

5) Ideal coil pressure drop = 40% of TESP _____50_____ _____50_____
Pressure drop across coil = c - b _____97_____ _____83___

High values may indicate Dirty coil - inspect if possible - decreases airflow & cooling capacity

6) Ideal supply duct pressure = 20% of TESP _____25_____ _____25_____
Measured supply duct pressure = d. _____19___ _____18____

High values indicate restrictions in supply system. Lower values could indicate duct leakage or low fan speed)

7) Dry bulb temperature from return hole ___NO AC__ _____85°_____
Dry bulb temp from supply hole _____ _____160°+_____
Heat rise = _____ _____75°+_____

Low speed Wattage _750_ Cost per hour __$0.0975__ per year ___$ 854.1
__1050__ CFM measured w/ TruFlow CFM/ watt ___1.4_____
Heating speed Wattage _730_ Cost per hour _$ $0.0949
__1000___CFM measured w/ TruFlow CFM/ watt __1.37__

This fan speed is too low & should be adjusted up –
furnace shut down on high limit
But restrictions in the ductwork prevented proper airflow.

Total External Static Pressure

- What else can increase TESP?
- **Restrictions** in the ductwork system (harder to fix)


Dirty Coils are a bigger problem

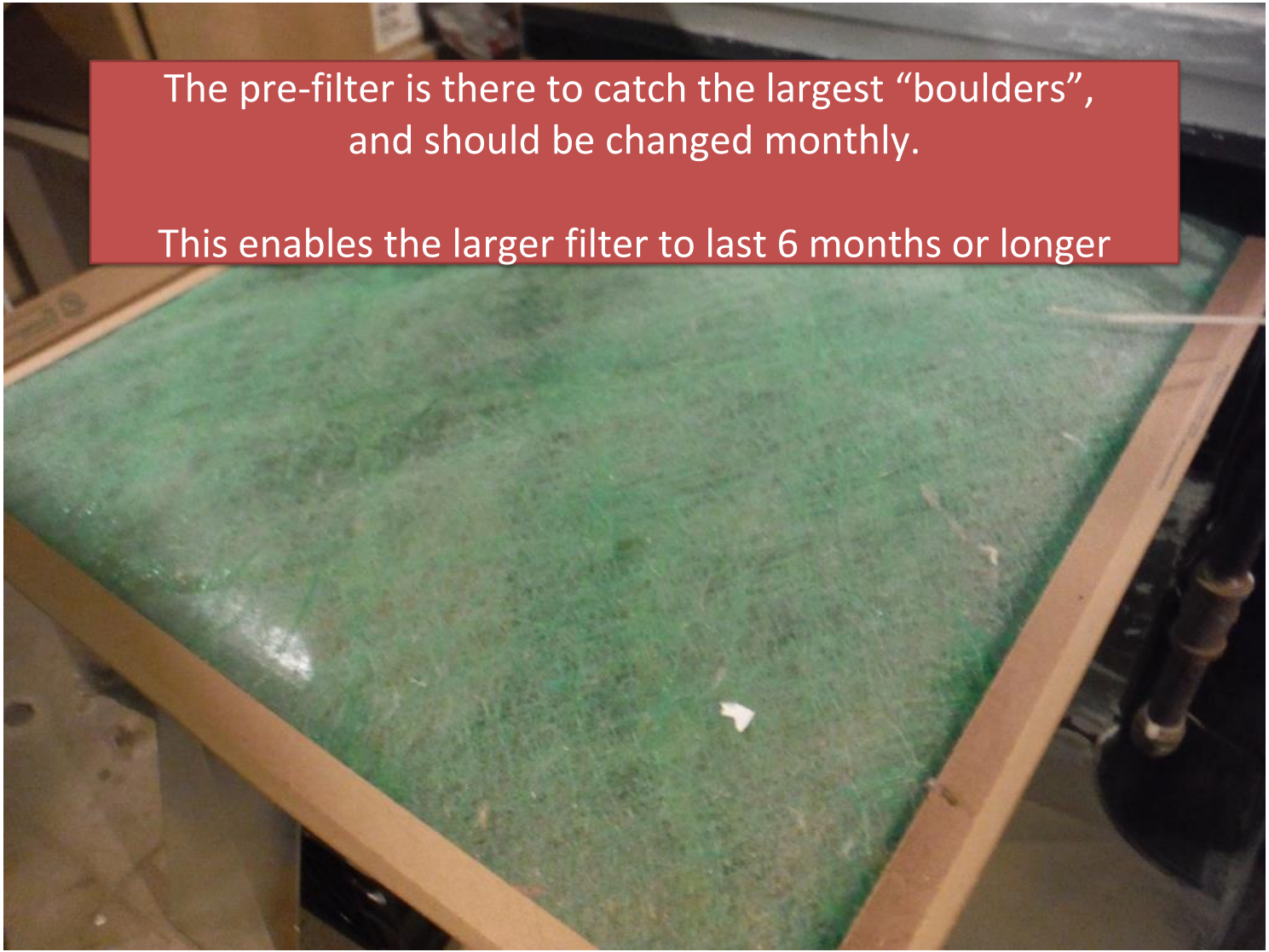

Example 2
Pre-retrofit
HVAC tech removed the dirty coil first


Example 2
Pre-retrofit
CLEAN FILTER
MONTHLY


Example 2
Post-retrofit
New ductwork & filters
About $500.00
(parts and labor)

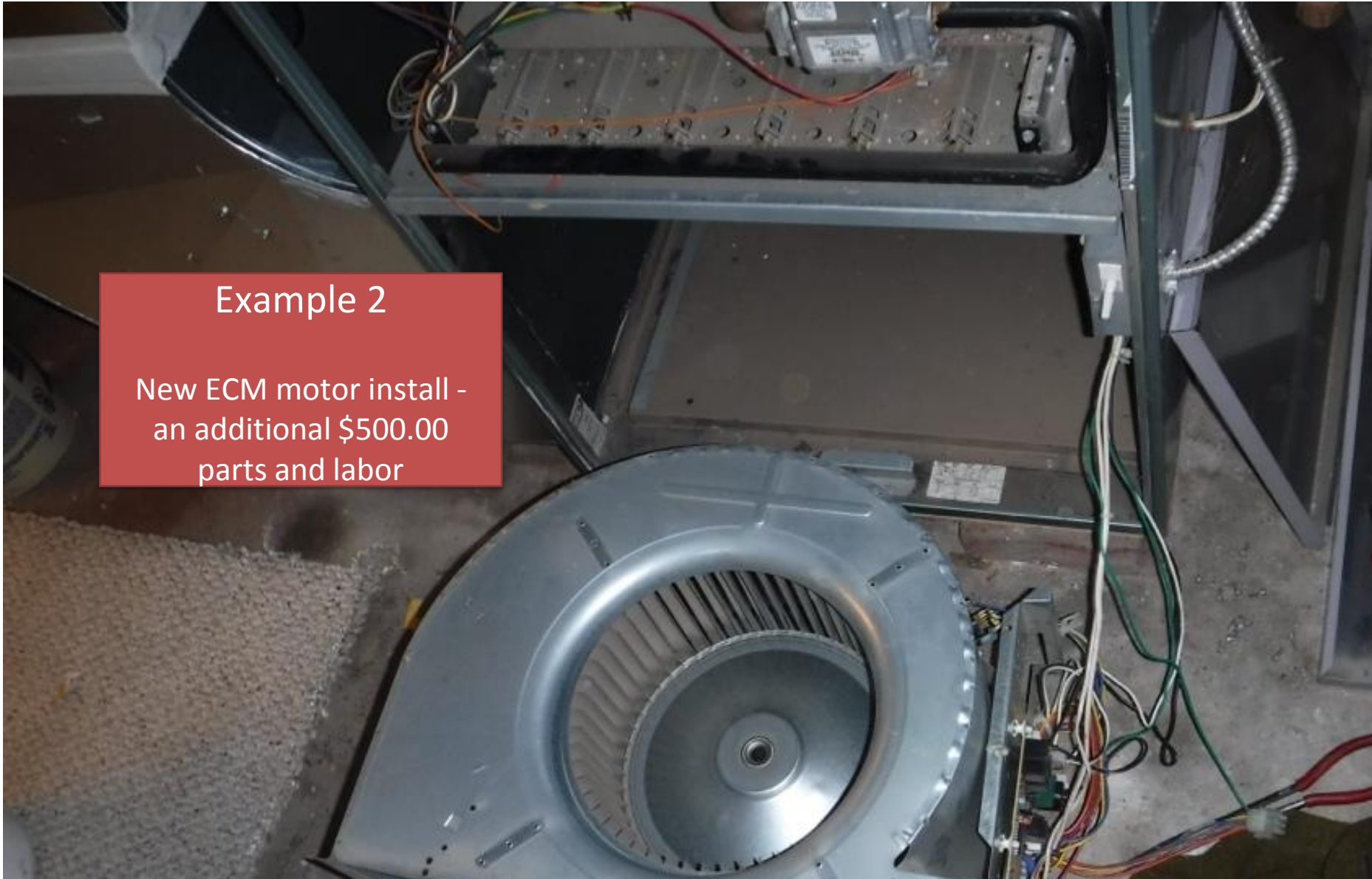
The new filter system - 4” Honeywell MERV 13 with a 1” fiberglass pre-filter

Much less restrictive than a clean 1” filter.


The pre-filter is there to catch the largest “boulders”,
and should be changed monthly.
This enables the larger filter to last 6 months or longer

After Improving air flow, we are able to change out the inefficient permanent split capacitor motor (PSC) with an replacement ECM. The drop in wattage (same airflow) is often very significant.

This model also allows us to set up a very low continuous movement of air for filtration, ~400 - 700 CFM, @120 - 180 Watts of power.


Example 2
New ECM motor install - an additional $500.00 parts and labor

Air Handler/ furnace__GMUH150-E5A___3/4 HP ECM
Rated Capacity_150,000 INPUT 120,000 Output_____
HEAT RISE - 50°-80°
Filter - New MERV 13 Horizontal, with pre-filter.

1) Take static pressure measurements - IWC or Pascals

Fan On - Circulation Mode			Heat Mode		
a. Before filter	-16	(Return system)	a. Before filter	-40	
b. After filter	-38		b. After filter	-88	
c. Before coil	+15		c. Before coil	+51	
d. After blower	+9	(Supply system)	d. After blower	+20	
e. wattage	177		e. wattage	644	
f. CFM	720		f. CFM	1230	

2) Allowable Total External Static Pressure - TESP - from manufacturers nameplate

125	(IWC x 250 = pascals)	125
53		139

High TESP pressures indicate many possible problems - isolate where the restrictions are:

3) Ideal Return pressures = 20% of TES	25	25
Measured return pressure is = a	-16	-40

High values indicate restrictions in return system, lower values may indicate duct leakage or low fan speed

4) Ideal max filter pressure drop = 20% x TESP	25	25
Pressure drop across Filter = [b] - [a]	22	48

High value indicates problems such as: Clogged filter or Too restrictive of filter - decreases airflow & cooling capacity

Example 2 - post retrofit - TESP nearly cut in half

Example 2 - post retrofit

5) Ideal coil pressure drop = 40% of TESP _____50_____ _____50_____
Pressure drop across coil = c - b _____6_____ _____31___

High values may indicate Dirty coil - inspect if possible - decreases airflow & cooling capacity

6) Ideal supply duct pressure = 20% of TESP _____25_____ _____25_____
Measured supply duct pressure = d. _____9___ _____20____

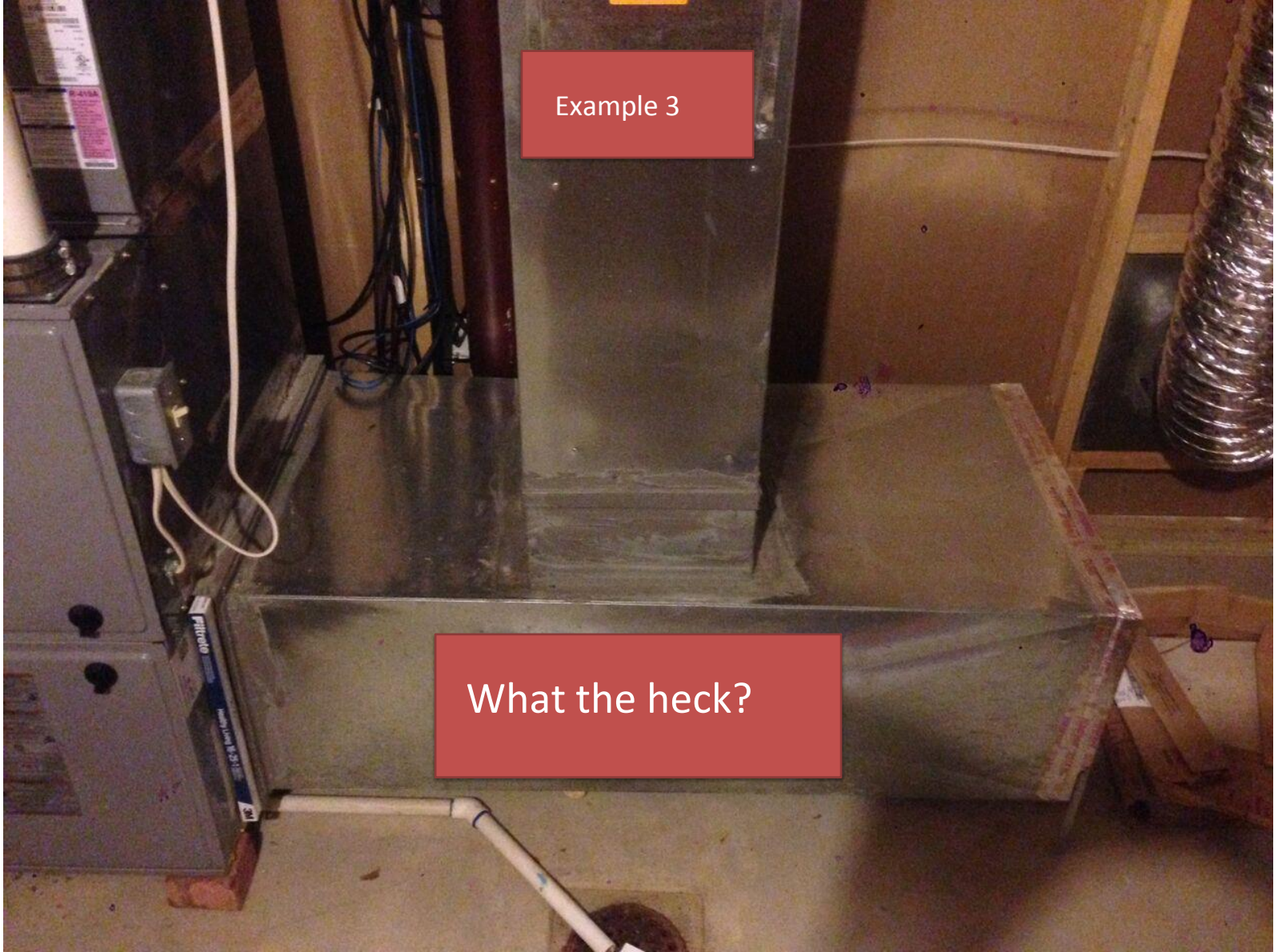
High values indicate restrictions in supply system. Lower values could indicate duct leakage or low fan speed)

7) Dry bulb temperature from return hole ___NO AC__ ____71°_____
Dry bulb temp from supply hole _____ ____147°_____
Heat rise = _____ _____76°_____

Low speed Wattage _177_ Cost per hour __$0.022__ per year ___$193.81
__720__ CFM measured w/ TruFlow CFM/ watt __4.07
Heating speed Wattage _644_ Cost per hour _$ $0.0805
__1230___CFM measured w/ TruFlow CFM/ watt __1.9__

24/7 Filtration for less than $200 a year (instead of $854.00 pre-retrofit)


Example 3


Example 3
What the heck?

Example 3

Air Handler/ furnace__N9SE0601714A1___
Rated Input BTU__60,000___ Output BTU__58,000____
Temperature Rise range ___40-70_____
Filter Used _ High Merv 1" filter Filtrete 2200_ Medium High speed

1)Take static pressure measurements - IWC or Pascals

Continuous mode		AC mode		
a. Before filter	____-28_____	a. Before filter	____-36_____	(Return System)
b. After filter	____-92_____	b. After filter	____-115_____	
c. Before coil	____+46_____	c. Before coil	____+59_____	
d. After coil	____+27_____	d. After coil	____+28_____	(Supply system)

2) Allowable TESP - ____125 pa_____ (IWC x 250 = pascals)
Measured TESP = Absolute value of [b] + [c].
____138_____ ____174_____
High TESP pressures indicate many possible problems - isolate where the restrictions are:

3) Ideal Return pressure - 20% of TESP __25___
Measured return pressure is = a.
____23_____ _____36_____
High values indicate return restrictions, lower values indicate duct leaks or low fan speed

4) Ideal max filter pressure drop = 20% x TESP __25___

Example 3

5) Ideal coil pressure drop = 40% of TESP __50__
Pressure drop across coil = c - d
____25_____ _____31_____
High values may indicate Dirty coil - inspect if possible

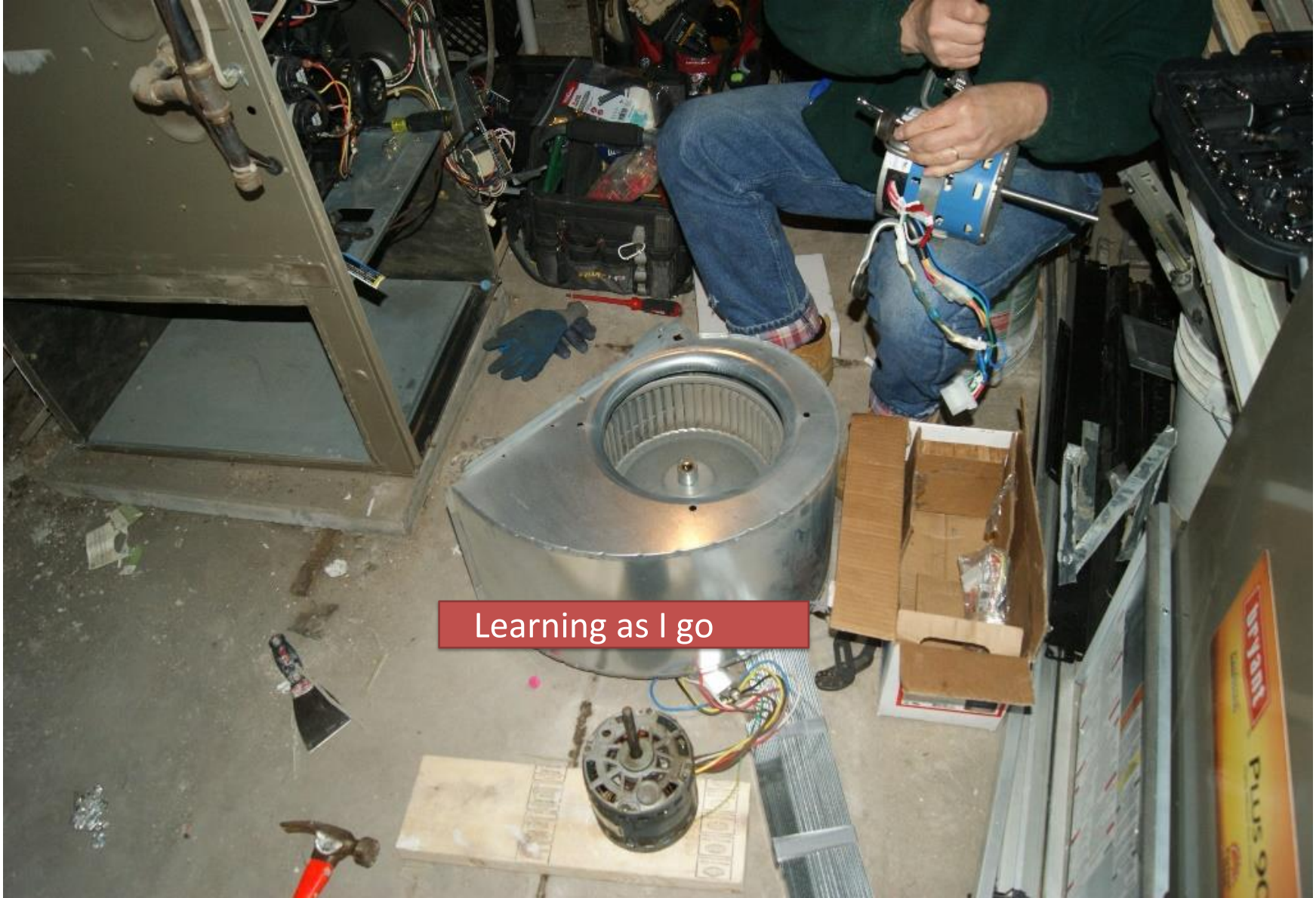
6) Ideal supply duct pressure = 20% of TESP ___25___
Measured supply duct pressure = d.
____21_____ _____28_____
High values indicate restrictions in supply system. Lower values could indicate duct leakage or low fan speed)

Cooling speed Wattage ___590____ Cost per hour ___$.0755___ Cost per year___661.65_____

Circulation speed Wattage ___520_____ Cost per hour __$.0665__ Cost per year____$583.07____

Cooling Measured / calculated CFM ____1110_____ method ___Static pressure charts

Removing Mastic from old ductwork


Learning as I go


Replaced PSC motor with ECM

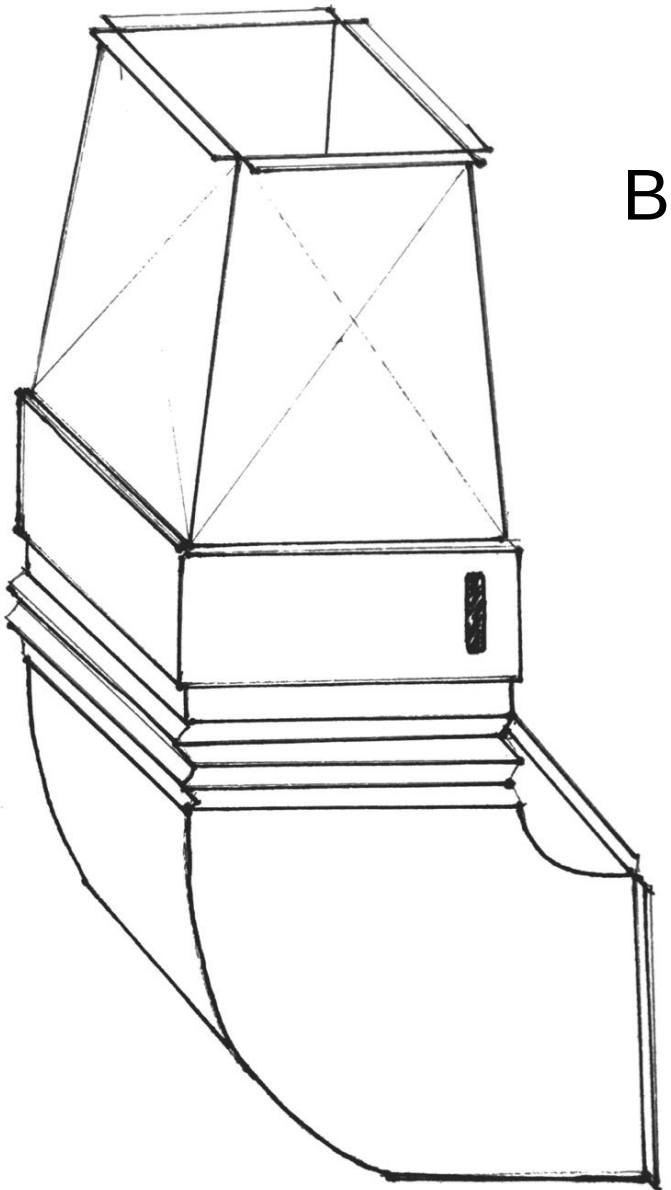
Lessons Learned: An Early Change-out

In search of an easy fix…. Don’t do this!!!

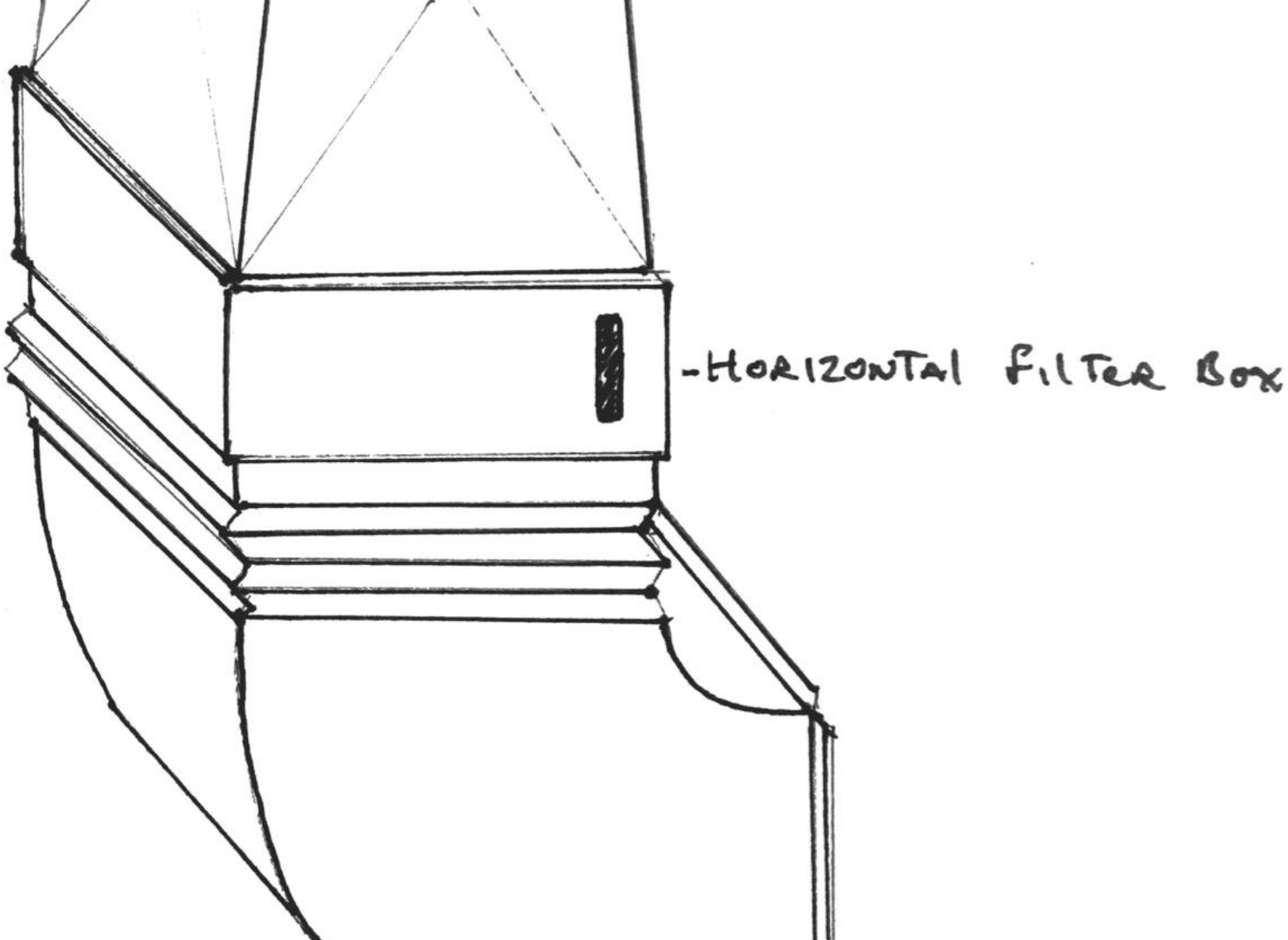
Not Effective!

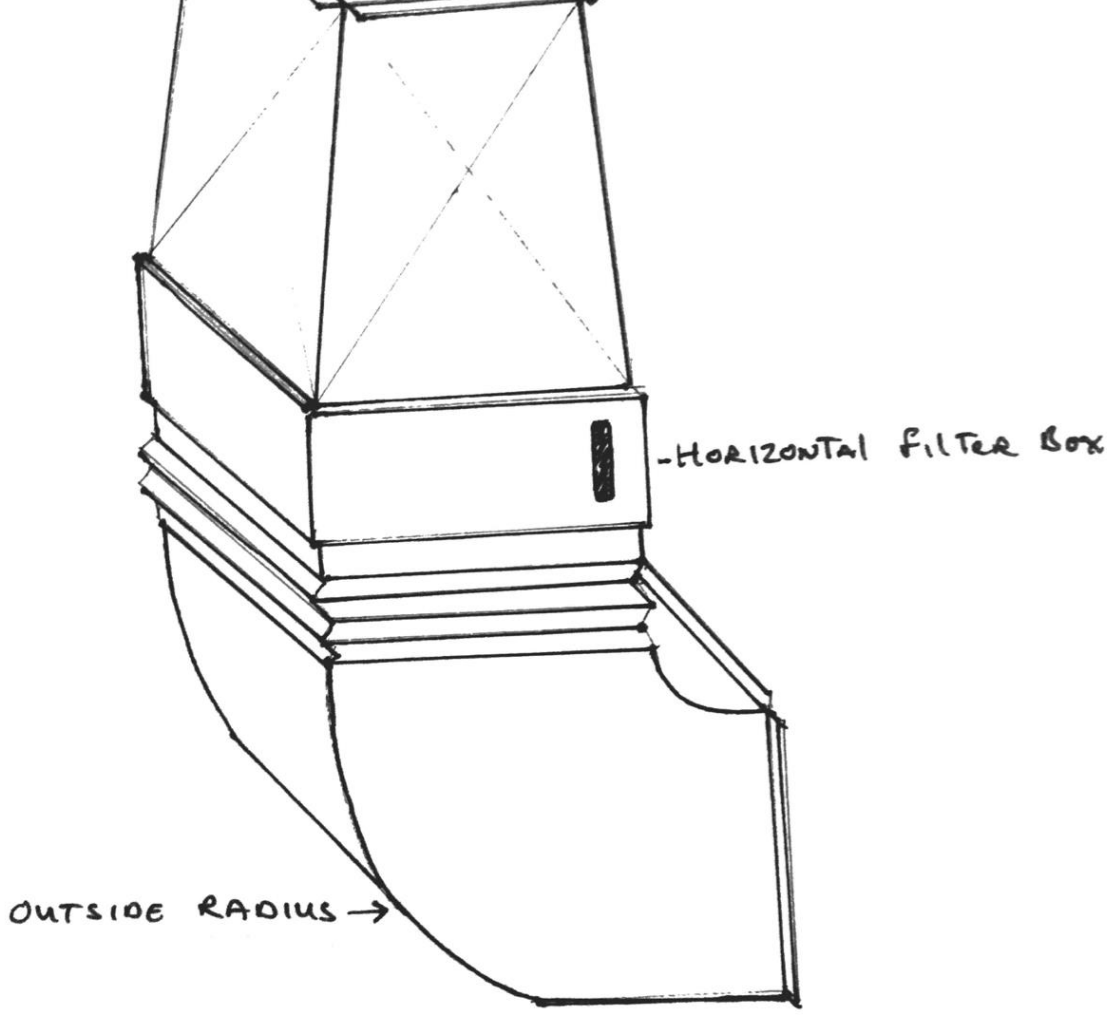
1) Return drop restricted due to size (8” x 25”)
2) Poor design at throat w hard 90 degree angle

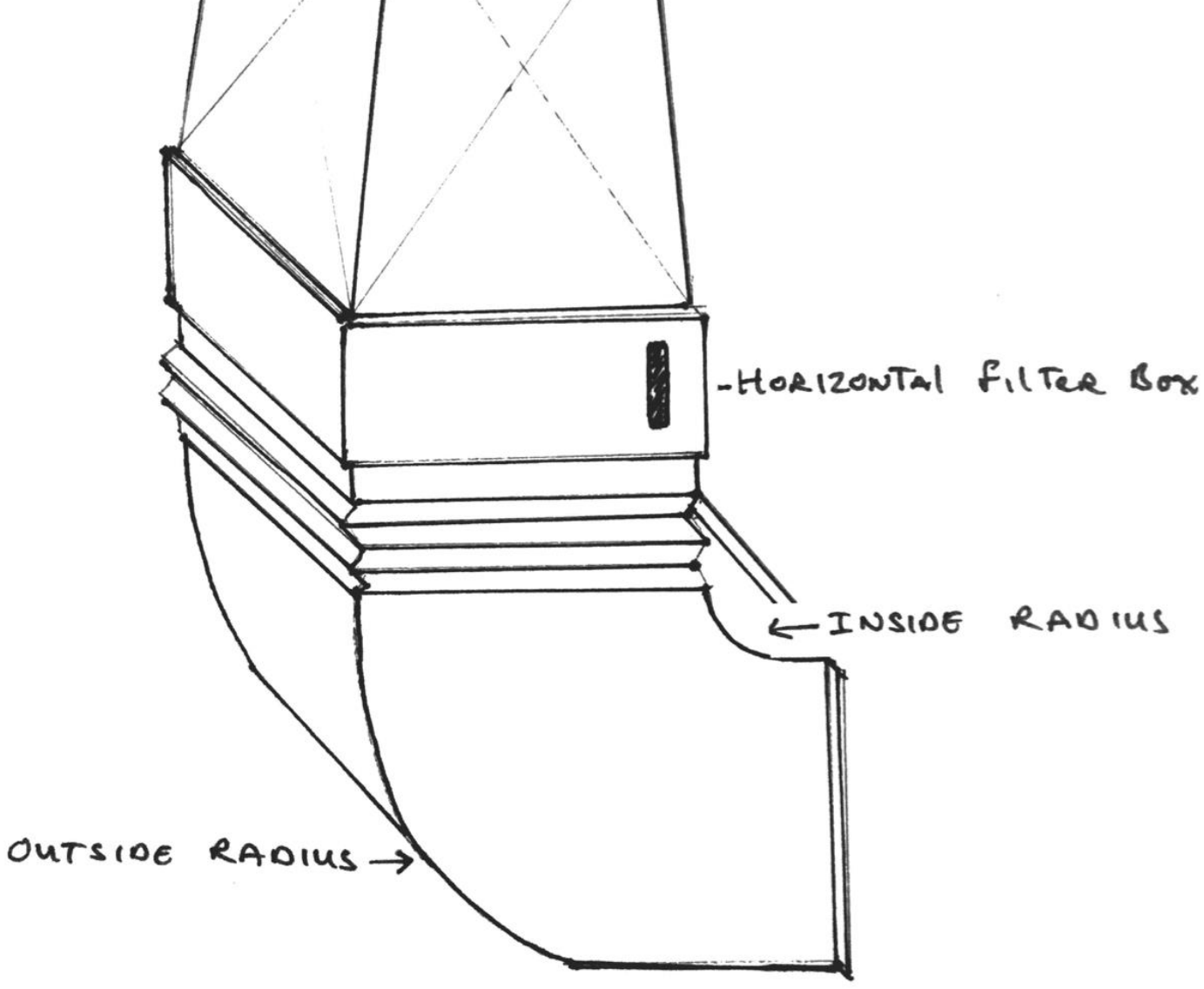
2) Filter still only 16” x 25”

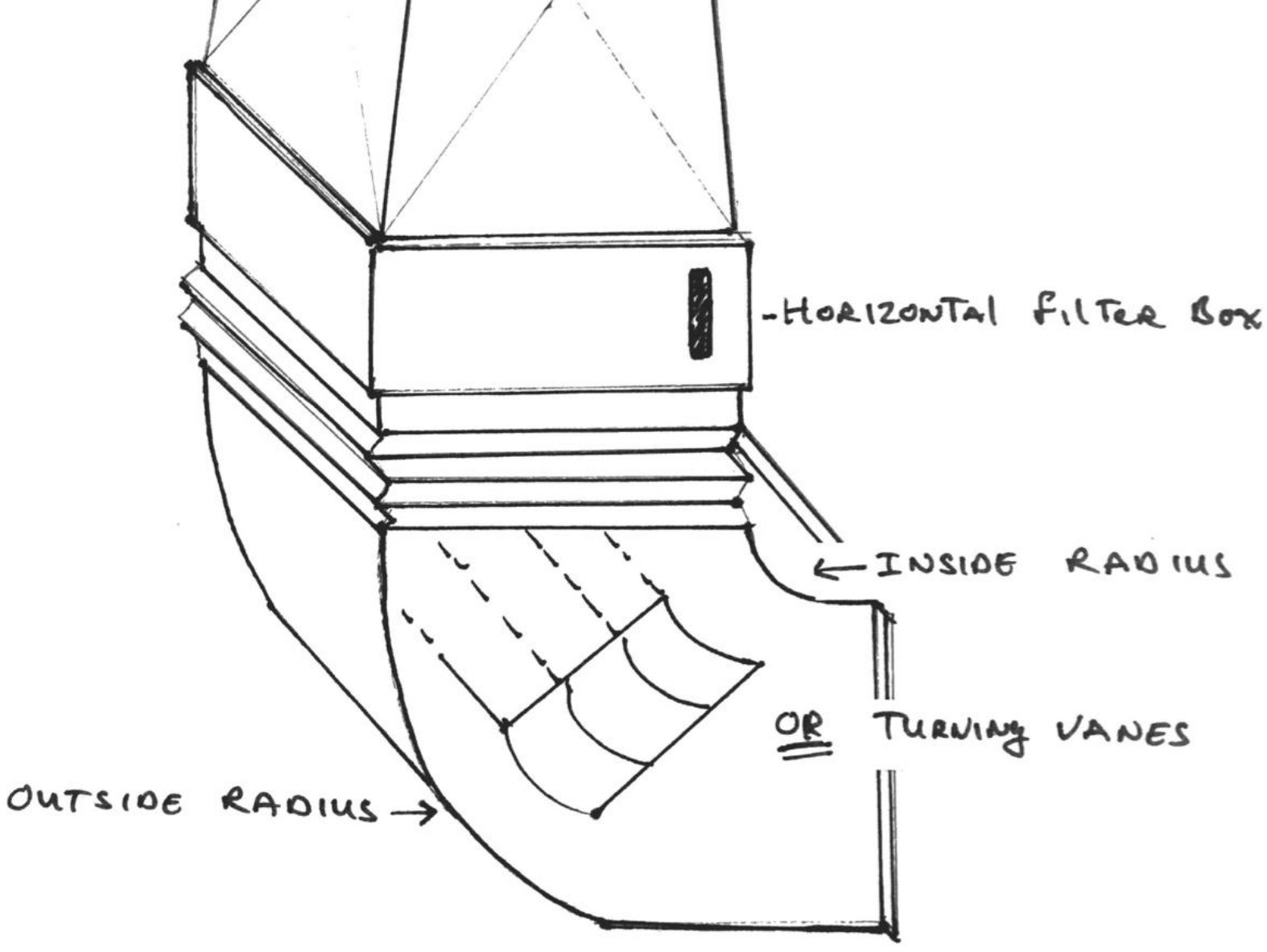


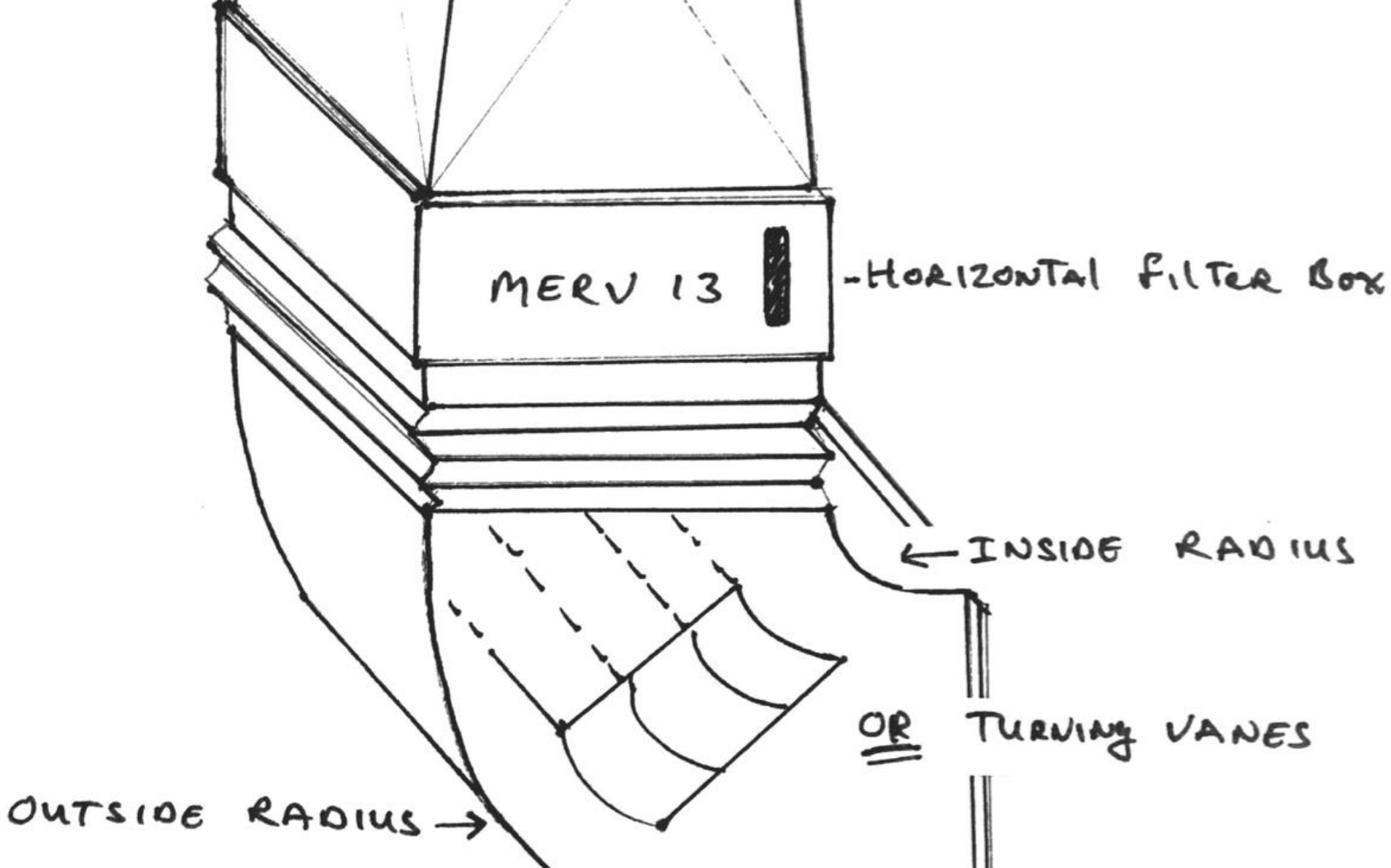
Best Practices

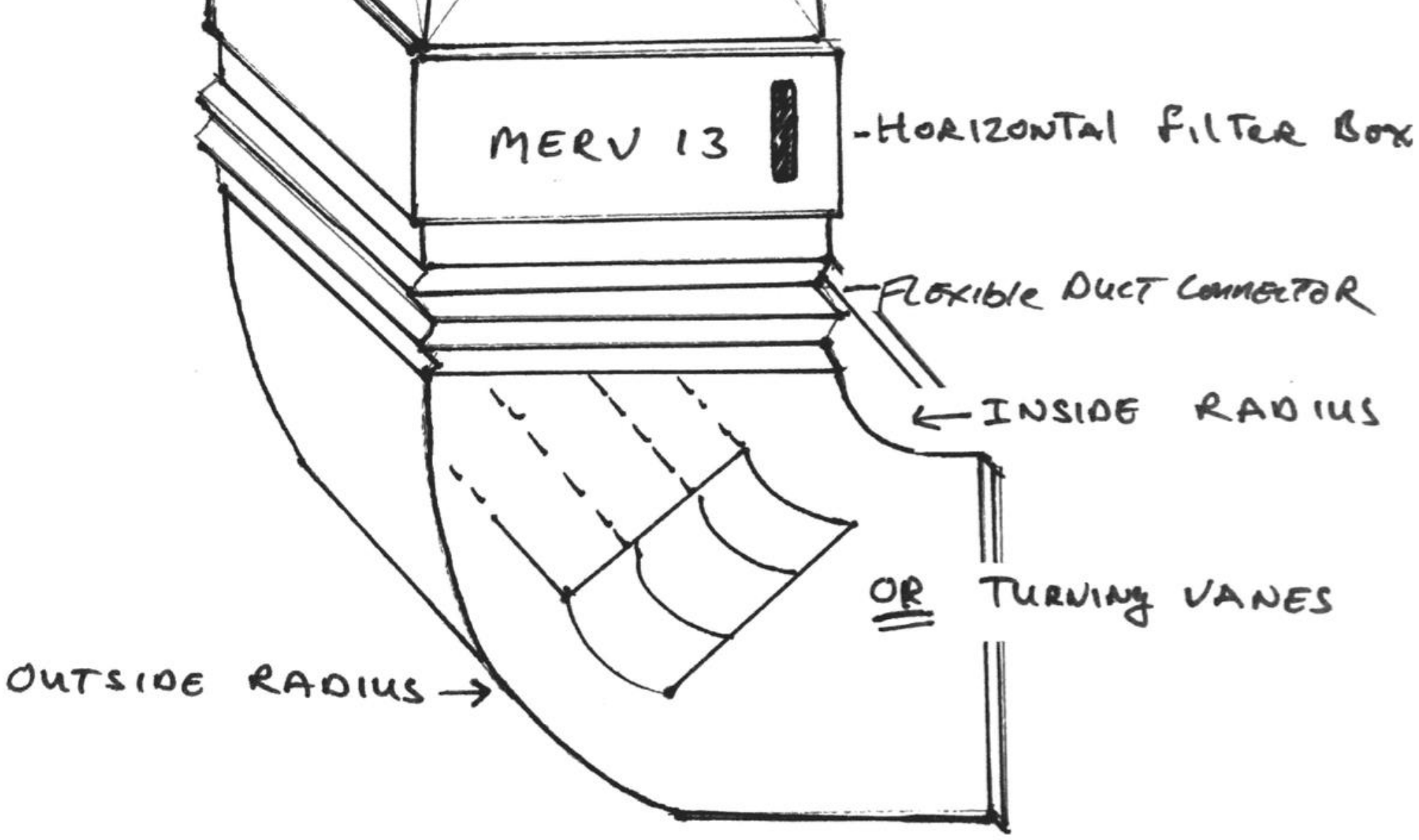

-HORIZONTAL FILTER BOX

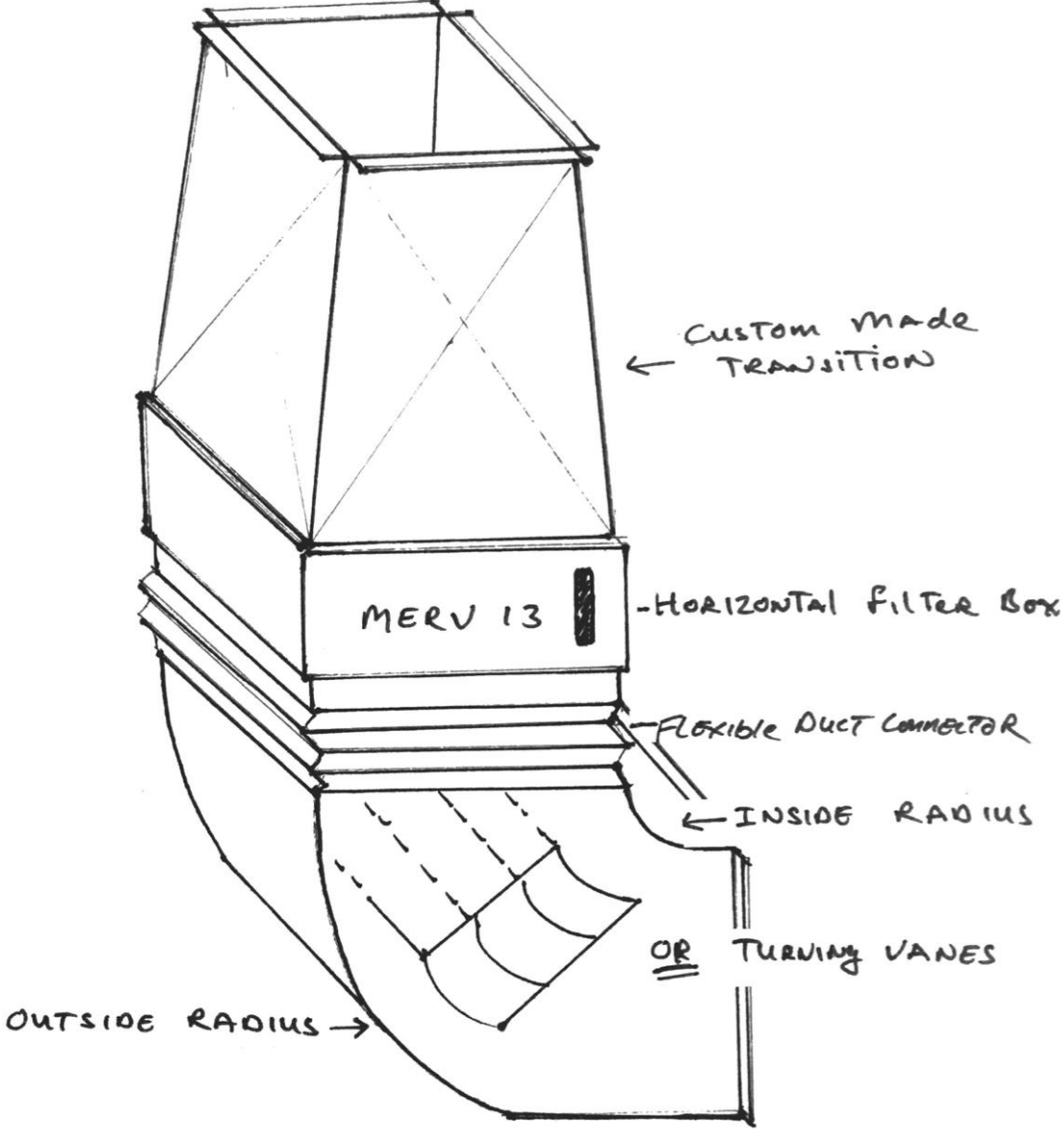

-HORIZONTAL FILTER BOX
OUTSIDE RADIUS →

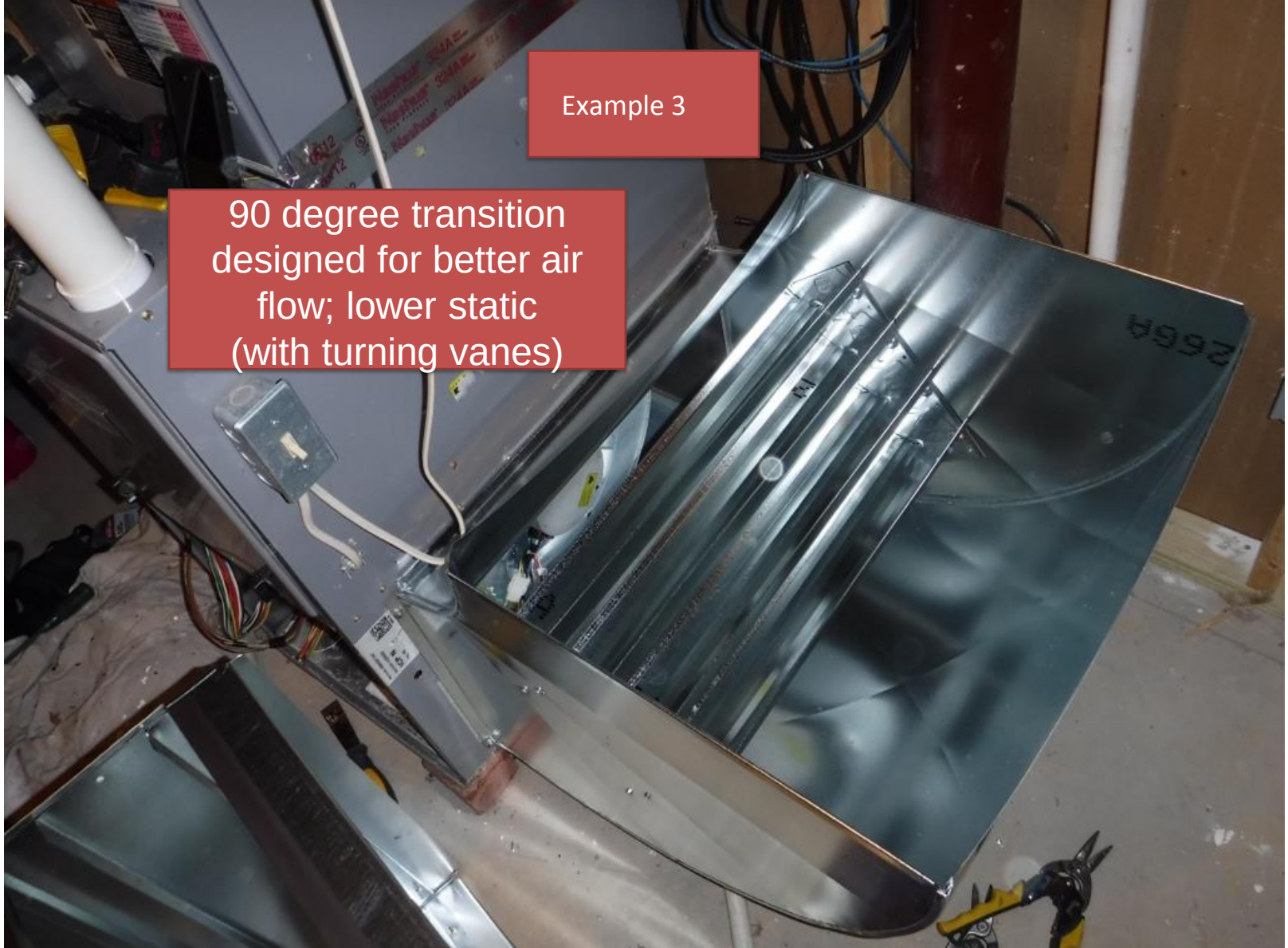

HORIZONTAL FILTER BOX
INSIDE RADIUS
OUTSIDE RADIUS


-HORIZONTAL FILTER BOX
← INSIDE RADIUS
OR TURNING VANES
OUTSIDE RADIUS →


MERV 13
-HORIZONTAL FILTER BOX
← INSIDE RADIUS
OR TURNING VANES
OUTSIDE RADIUS →


MERV 13
-HORIZONTAL FILTER BOX
-FLEXIBLE DUCT CONNECTOR
← INSIDE RADIUS
OR TURNING VANES
OUTSIDE RADIUS →


CUSTOM MADE TRANSITION
MERV 13
-HORIZONTAL FILTER BOX
FLEXIBLE DUCT CONNECTOR
INSIDE RADIUS
OR TURNING VANES
OUTSIDE RADIUS


Example 3
90 degree transition designed for better air flow; lower static (with turning vanes)


Larger return drop
2-part filter rack
(20” x 25”)
Horizontal
(4” MERV 13 +
2” pre or post filter)

Fan speed adjusted to optimize heating, cooling, & continuous performance.

Much Better Performance!

Example 3

Much Better Performance!

Example 3

RESULTS:

5 yr. old home
Significant comfort improvement!

About $1000 investment

Much Better Performance!

Example 3

RESULTS:

5 yr. old home
Significant comfort improvement!

About $1000 investment

In continuous mode:

- ➢3.38 CFM/watt
- ➢TESP Pre: 138, Post: 52

Much Better Performance!

Example 3

RESULTS:

5 yr. old home
Significant comfort improvement!

About $1000 investment

In continuous mode:

- ➢3.38 CFM/watt
- ➢TESP Pre: 138, Post: 52
- ➢360 Watts (reduction)

Much Better Performance!

Example 3

RESULTS:

5 yr. old home
Significant comfort improvement!

About $1000 investment

In continuous mode:

- 3.38 CFM/watt
- TESP Pre: 138, Post: 52
- 360 Watts (reduction)
- $142/ yr. elec. use ($583.00 Pre)

Much Better Performance!

Example 3

RESULTS:

5 yr. old home
Significant comfort improvement!

About $1000 investment

In continuous mode:

- 3.38 CFM/watt
- TESP Pre: 138, Post: 52
- 360 Watts (reduction)
- $142/ yr. elec. use ($583.00 Pre)
- $441/yr savings

Example 4: Air Handler Retrofit 2.0

Larger return drop

2-part filter rack (20” x 25”) Horizontal (4” MERV 13 + 2” pre or post filter)

90 degree transition designed for better air flow (heel & throat); lower static

ECM replacement

Fan speed adjusted to optimize heating, cooling, & continuous performance.

RESULTS:

In continuous mode:

- 4.27 CFM/watt
- 120 Watts

- Pressure drop across filter Pre: 93 Pa, Post: 16 Pa
- **Allowable TESP: 125 Pa**
- **(total system)**

Opportunities at Changeout time

Opportunities at Changeout time

New Furnace

Opportunities at Changeout time

New Furnace

Adding AC

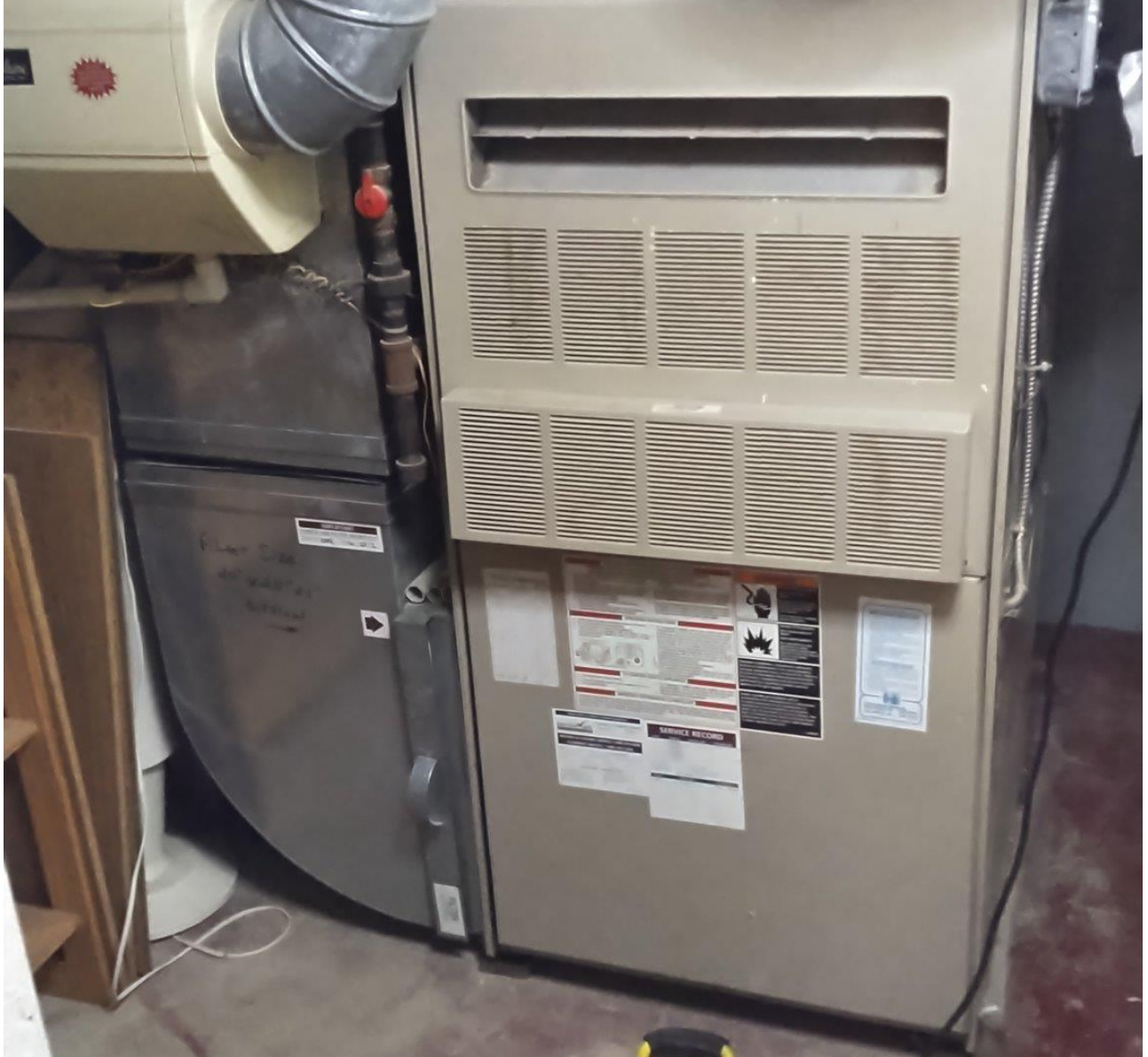
Opportunities at Changeout time

Downsize Furnace

Opportunities at Changeout time

Downsize Furnace

Change Return Drop & Filter


SERVICE RECORD


Air Flow
X4670
ENERGYGUIDE
95.1


Example 4
Comfortmaker
3M
Filtrete
16x25x1
10. 1. 2020 10:10

Example 4

1) Static pressures:	AC speed	Heating speed	Fan only speed	Adjusted fan speed
a. Before filter	_-61__	Be	Before filter _-61_	Before filter -52_
b. After filter	_-160_	After filter _-115	After filter _-160_	After filter _-117_
c. Before coil	__+66_	Before coil _+57.5	Before coil __+66	Before coil _58
d. After coil	_+38_	After coil +37	After coil __+38	After coil __32
e. Wattage	_340_	wattage _223	wattage __340	wattage _189__
f. CFM	1300	CFM 925	CFM 1300	CFM 920

3) Allowable TESP - from manufacturers nameplate _125__

Measured TESP _226_ __172.5___ __226__ ___175___

High TESP pressures indicate many possible problems - isolate where the restrictions are:

4) Ideal Return pressure - 20% of TESP ___-25__

Measured return pressure __-61__ __-56___ ___-61____ ___-52__

High values indicate return restrictions, lower values indicate duct leaks or low fan speed

5) Ideal max filter pressure drop = 20% x TESP __25__

Pressure drop across Filter _99___ __59__ ___99____ __65__

High value indicates problems: Clogged or restrictive of filter - decreases airflow capacity

6) Ideal coil pressure drop = 40% of TESP ___50___

Pressure drop across coil _28__ ___19.5__ __28___ ___26___

High values may indicate Dirty coil - inspect if possible

Example 4

1) Static pressures:	AC speed	Heating speed	Fan only speed	Adjusted fan speed
a. Before filter	_-61__	Be	Before filter _-61_	Before filter -52_
b. After filter	_-160_	After filter _-115	After filter _-160_	After filter _-117_
c. Before coil	__+66_	Before coil _+57.5	Before coil __+66	Before coil _58
d. After coil	_+38_	After coil +37	After coil __+38	After coil __32
e. Wattage	_340_	wattage _223	wattage __340	wattage _189__
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Flue gas
Nat. Gas
4.
3069 PPM CO
5.
20.9
6.
PPM CO-AF
7.
0.0 % ExAir
Print
Start
10. 1.2020 10:45

Rheem *Classic Plus*® Series Two-Stage Multi-position Gas Furnaces

R96T- Series

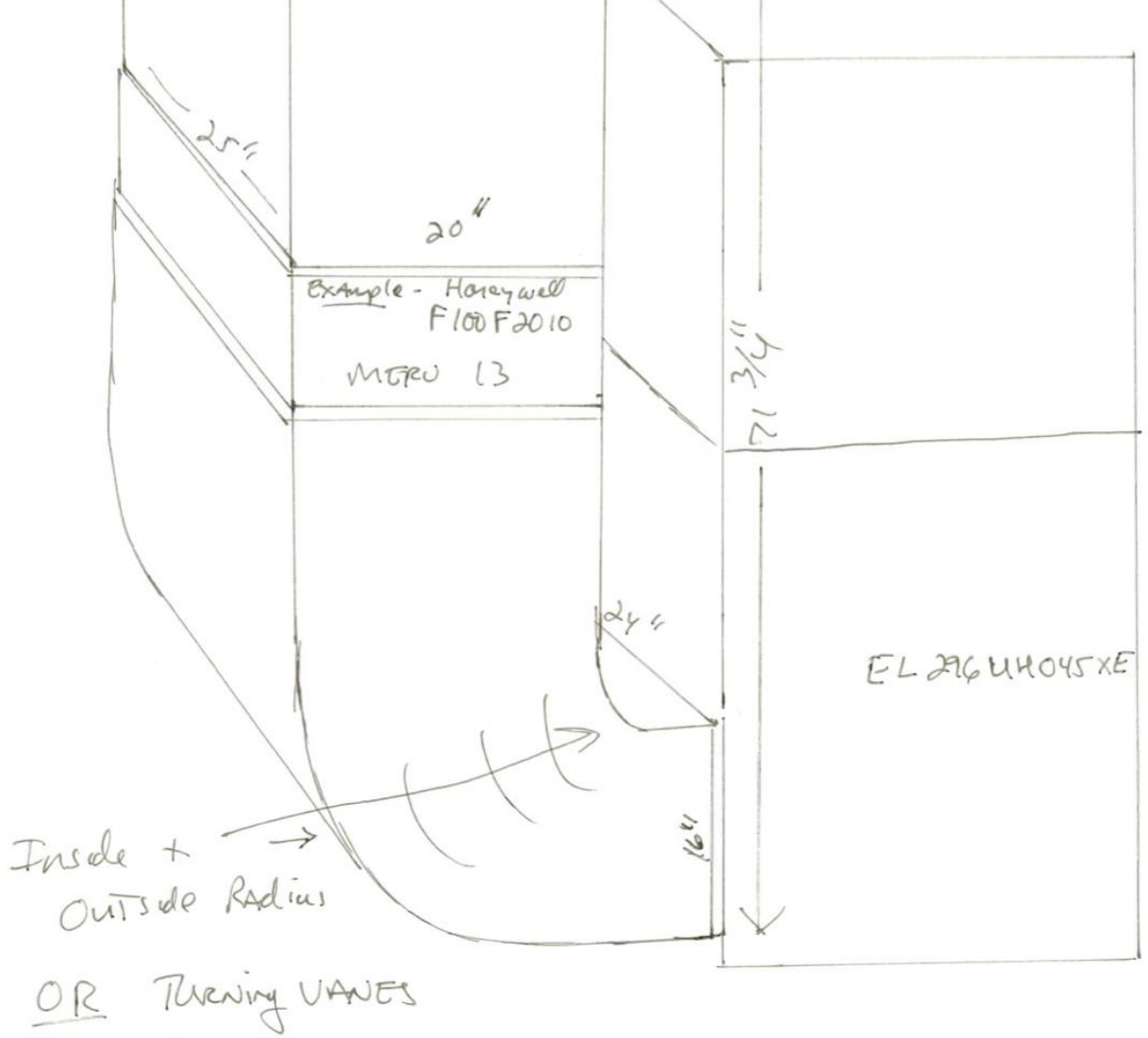
96% A.F.U.E.†*

Input Rates from 40 to 115 kBTU

[11.72 to 33.71 kW]

†A.F.U.E. (Annual Fuel Utilization Efficiency) calculated in accordance with Department of Energy test procedures.

*Up to 96% A.F.U.E.


25"
20"
Example - Honeywell
F100F2010
MERV 13
71 3/4"
24"
EL296UH045XE
16"
Inside + Outside Radius
OR Turning VANES


INSTALLATION INSTRUCTIONS

Use Genuine Healthy Climate®
Replacement Filters

Air Flow

Model HCF20-11
20" x 25" x 5"

Actual Filter Size 19 3/4" x 24 3/4" x 4 3/8"

Replacement Filter Part No

X6673

Direct Replacement for Following Filters

Brand	Air Cleaner Model	Replace Filter Part Number
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

Recommend upgrading to High Efficiency
MERV 11 Replacement Filter Part No AW73

MERV
11
MINIMUM EFFICIENCY
REPORTING VALUE

Air Flow


INSTALLATION INSTRUCTIONS
FOR CASED/UNCASED COILS FOR GAS FURNACES

Measured TESP __NA___ _____ _____ _____

High TESP pressures indicate many possible problems - isolate where the restrictions are:

4) Ideal Return pressure - 20% of TESP ___-25__
Measured return pressure __-16____ _-21___ ___-25_____ ___-16___

High values indicate return restrictions, lower values indicate duct leaks or low fan speed

5) Ideal max filter pressure drop = 20% x TESP __25__
Pressure drop across Filter __16__ __22__ _____27___ ___16___

High value indicates problems: Clogged or restrictive of filter - decreases airflow capacity

6) Ideal coil pressure drop = 40% of TESP ___50___
Pressure drop across coil __NA____ _____ _____ _____

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7) Ideal supply duct pressure = 20% of TESP ___25___
Measured supply duct pressure __+20__ _+25__ ___+33__ ____+19___

High values indicate restrictions in supply system.

8) Dry bulb temperature from return hole _____ ___68___ __68___
Dry bulb temp from supply hole _____ __104____ __98____
Heat rise = _____ __42°___ ___30°__

AC speed Wattage _260__ Cost per hour $0.0286
___770___ CFM measured w/ TruFlow CFM/ watt __2.96__
Low fire Wattage _352_ Cost per hour _$0.038_
__870__ CFM measured w/ TruFlow CFM/ watt __2.47____
Hi -Heating Wattage _495_ Cost per hour _$0.054
__1080___CFM measured w/ TruFlow CFM/ watt ___2.18__

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Hi -Heating Wattage _495_ Cost per hour _$0.054
__1080___CFM measured w/ TruFlow CFM/ watt ___2.18__
Constant speed Wattage _260_ Cost per hour $0.0286 Cost per Year 24/7/365 _$250.54
Cost at 30 min/hr $125.26
__770__ CFM measured w/ TruFlow CFM/ watt ___2.96_____

Rhett Major
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TheEnergyDoctor@Comcast.net