State of MN
Energy Code /HVAC Review
Findings from the Field
for 2019
Energy Design Conference

By

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In accordance with the Department of Labor and Industry's statute 326.0981, Subd. 11,

"This educational offering is recognized by the Minnesota Department of Labor and Industry as satisfying **1.5 hours** of credit toward **Building Officials and Residential Contractors code /1 hour energy** continuing education requirements."

For additional continuing education approvals, please see your credit tracking card.

Agenda

- Codes being followed? Enforced?
- Design house layout
- Wants, needs, expectation
- Lack of skilled trades force
- Findings Energy
- Findings HVAC

Codes

- Are codes being followed ?
- In areas that there is no enforcement, do what ever ?
- In areas that have inspection , this does not ensure operation and performance
- Codes and standards are not perfect… but a lot of time and thought goes into the code making process
- Building to code is a base line, talk to homeowner on how to achieve performance above the code line

House design and HVAC

- Does the layout of the house make sense with the HVAC design?
- Is the HVAC bid price or performance driven?
- Expectations of the home owner?
- Input from the Sub Contractors
- Track record (proven history) with equipment, installations, suppliers, service tech ,tech support, manufactures and warranties

Meeting with all parties, explain what testing is to be done

Findings from the Field- ENERGY

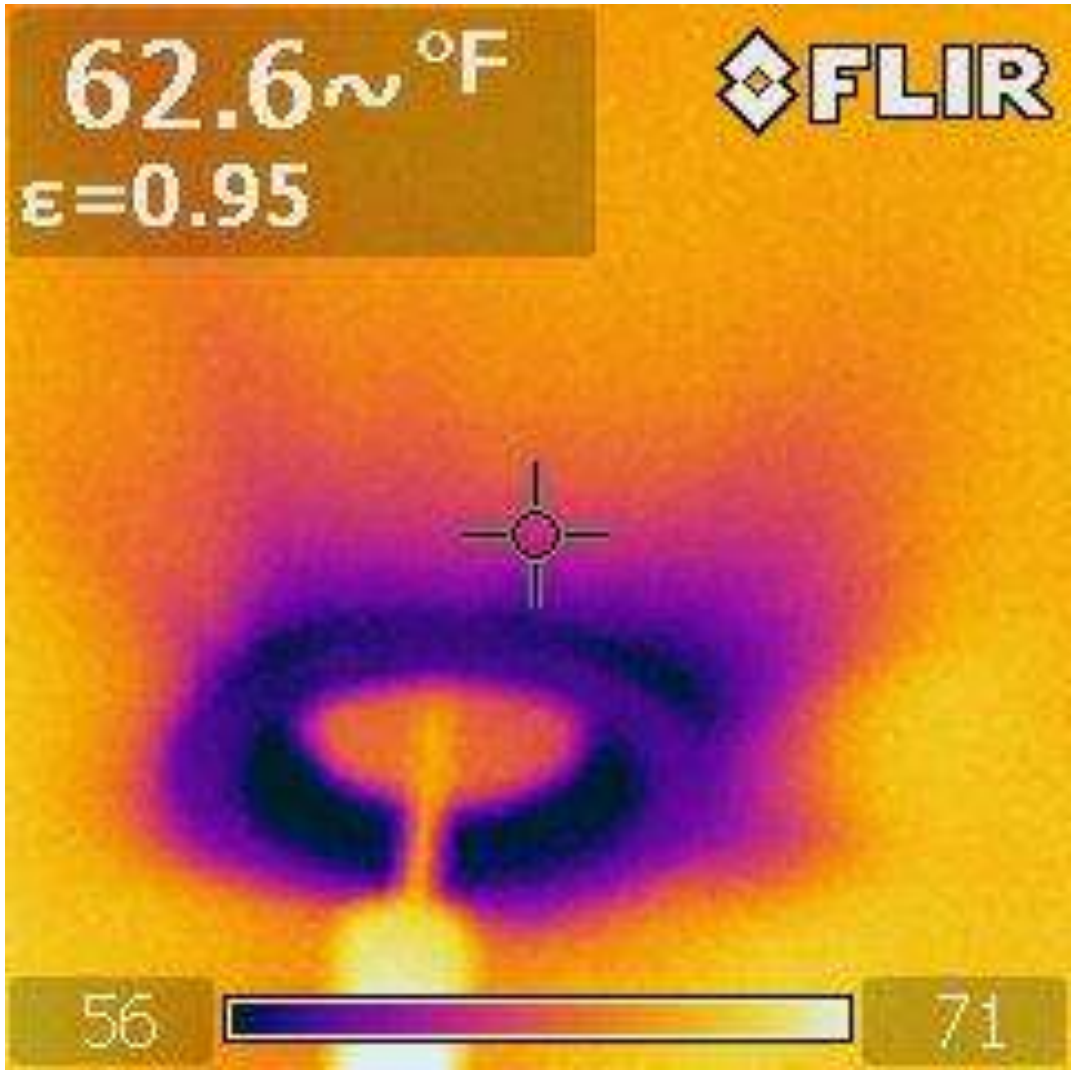
- Blower door for all homes
- Duct leakage test… duct blaster
- Makeup air
- Ventilation systems

Air leakage test- Blower Door test

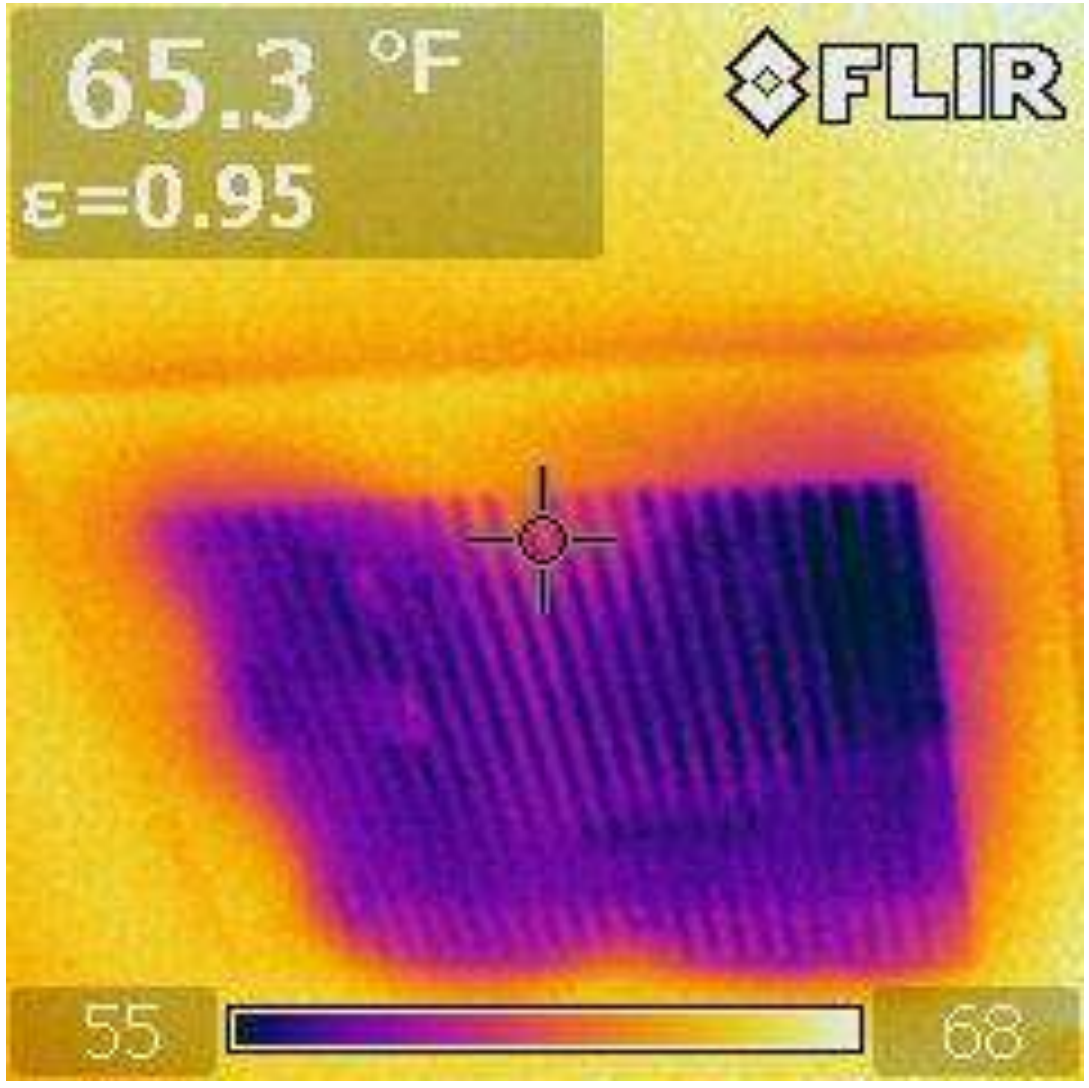
A few ideas on how to pass a blower door test

- Overview of the 2015 MN Energy Code regarding building tightness and ducting/ testing requirements
- Slab on grade half the house small metric
- Work with all trades, insulator and energy auditer/blower door tech on air sealing
- Do walk thru at framing
- Do a blower door with infrared camera
- Training learning curve
- Air sealing is different then insulating
- Get more training, on site

Can light



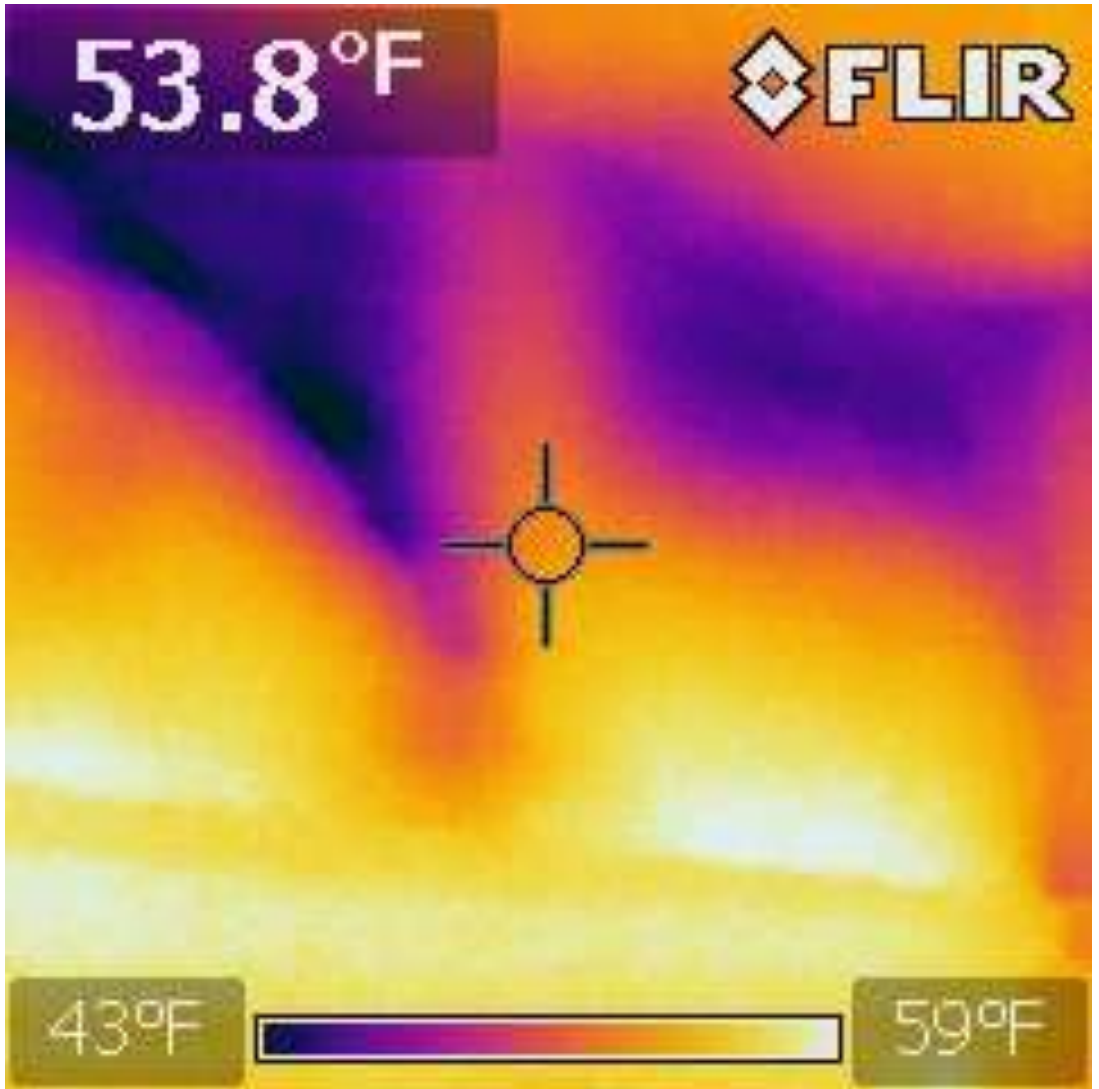
Cold air thru bath fan , damper open



Condensation in the Building Assemblies

- Can lead to mold and rot
- Can cause building failures in, siding, rim joists, walls, frost and moisture in attic
- Can lead to litigation and some very $ expenses repairs
- The higher the RH% is in the winter the more the structure has a potential for problems
- Proper RH% and air sealing/insulating can solve these problems
- **Follow Systems Approach**

Wall cavity poor insulation detail



Duct Leakage Test

- Both return and supply shall be tested if duct work is out side thermal building envelope
- Two options for testing
  1. Rough in test , when duct work is complete but furnace cabinet has not been installed
  2. Post construction , this is when furnace cabinet has be installed

  The duct blaster test can pressurize or depressurize the duct work

  The standard does not say you have to do both

Feed back from the field

- Temp heat for mastic or aero seal
- Aero seal return and supply individually , report on duct work
- Some builders are using aero seal even when duct work is with in shell
- Duct work in exterior walls is rare
- Design shift for Builder and HVAC , chase ways, closets, extended trunk more common for duct work

Feed back from the field

- We are working thru the learning curve
- Double testing on duct work is not needed by code
- Exception on duct leakage test, Bonus rooms , R-30 insulation
- Tape is being accepted more
- Flex duct is tight, sheet metal more joint to seal, but is much better for air flow
- HVAC is passing test with duct mastic , and aero seal

How to make ductwork tight

- Duct mastic water or oil
- Aero seal
- Sealed duct fittings
- New stuff all the time
- A listed tape

Will the duct work hold water

Or do not install ducts out of the envelope

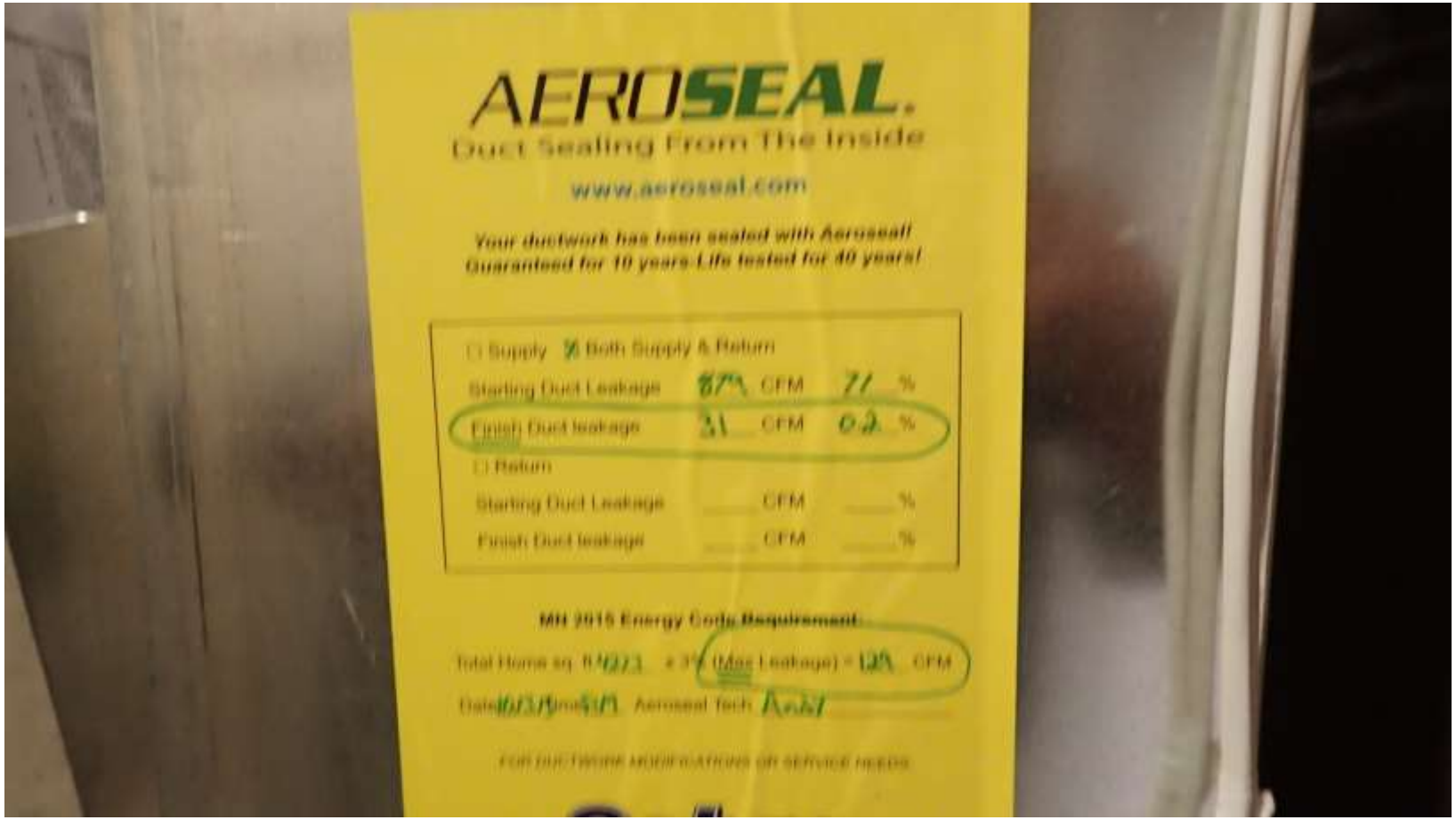
Mastic vs tape

- It has been proven in many programs thought out the country and performance testing over many years that mastic is better sealing the duct work when doing the air tightness testing on the duct system
- Spread the mastic on nickel thick.. With brush is generally the best
- To my understanding no tape meets the UL 181 (A or B ?) listing
- Talk to your inspector

Spray foam attic

Duct work needs to be covered with insulation

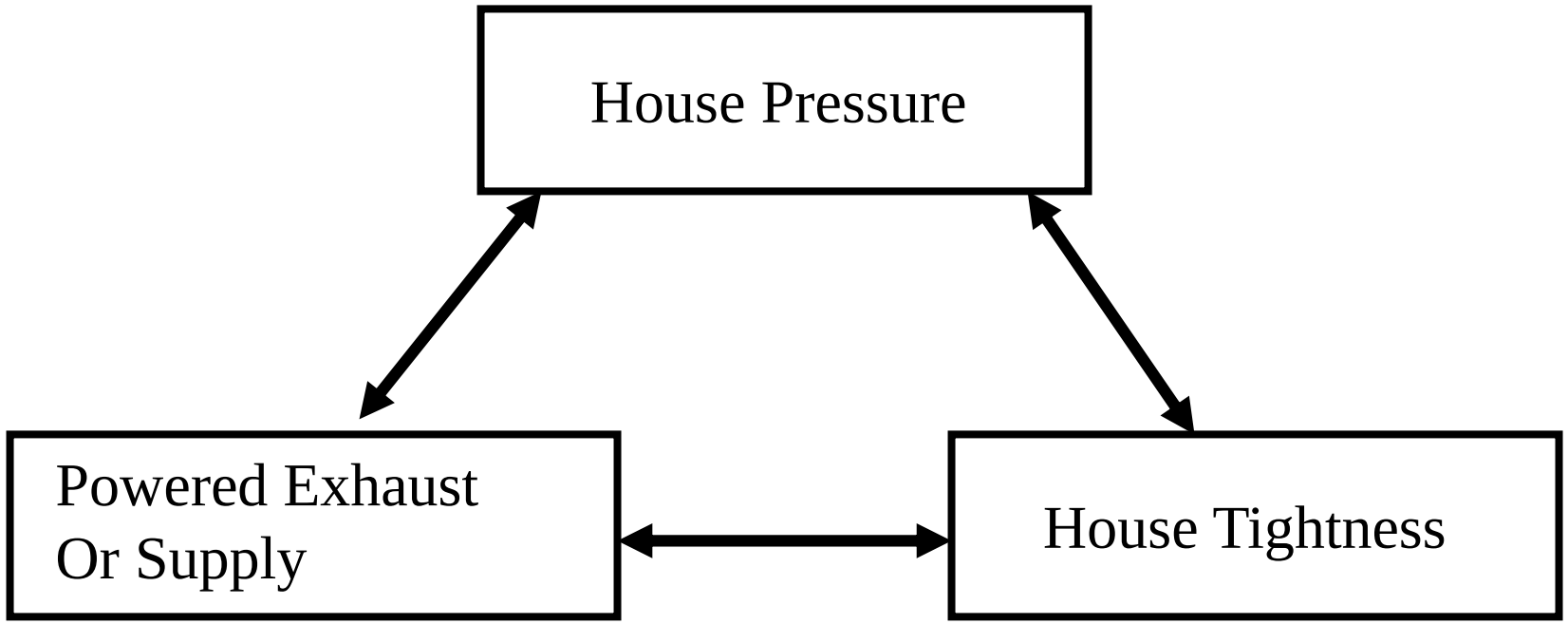
Air bourn sealant that seals the holes



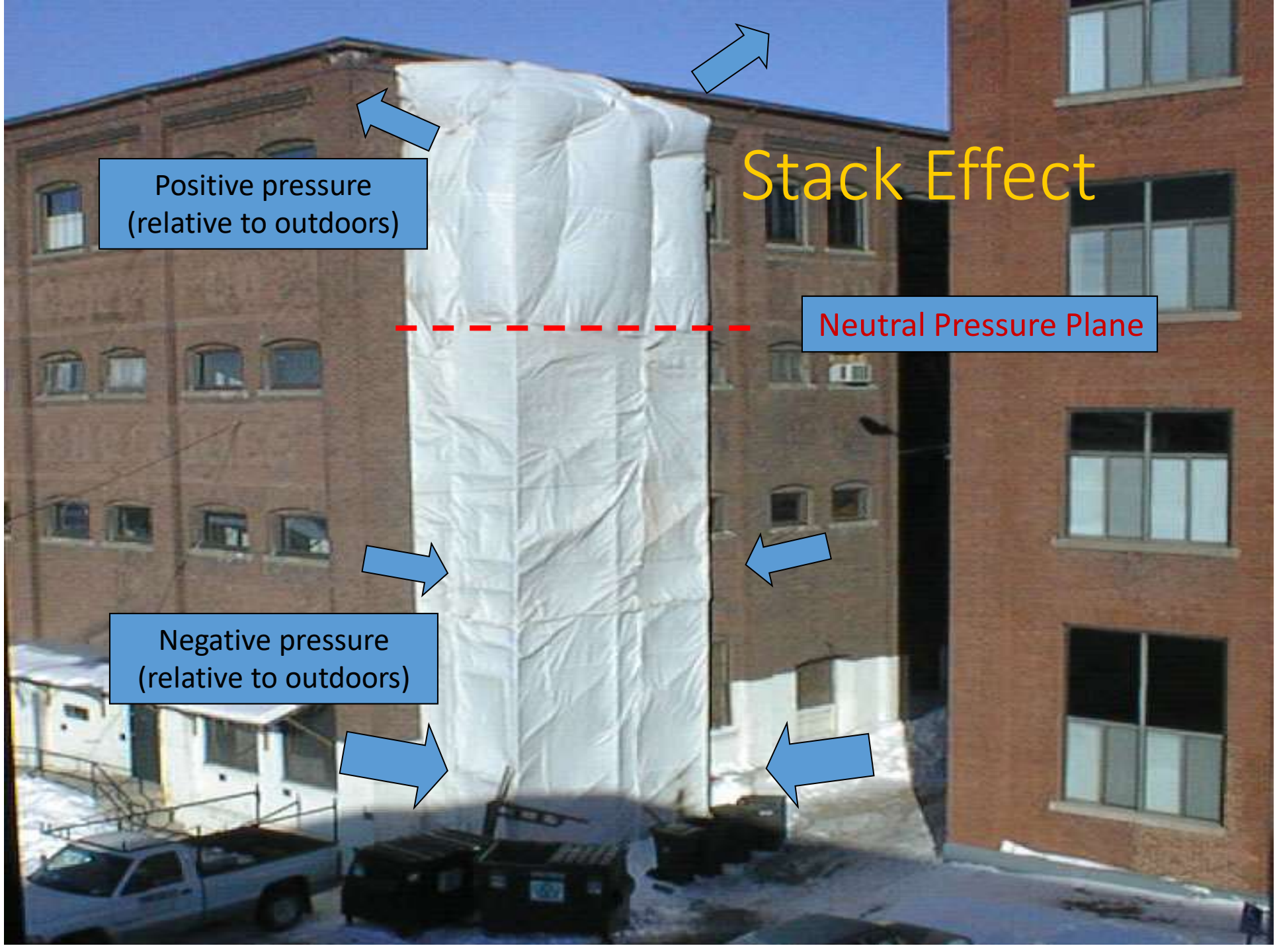
Make up air

- Code 501
- Exercise
- Building science examples
- Flags
- Testing

Make-up Air Fundamentals



Each element affects the other


Stack Effect
Positive pressure
(relative to outdoors)
Neutral Pressure Plane
Negative pressure
(relative to outdoors)


WHERE DO I GET MY AIR FROM ?

DEPRESSURIZATION TESTING

- WALK THROUGH

1. DETERMINE WATER HEATER, SPACE HEATING EQUIPMENT AND ANY WOOD BURNING EQUIPMENT

- THREE LARGEST FANS, THIS IS PART OF THE TEST
- READ THE PROTOCOL TABLES
- PREP HOUSE AND DO TEST
- RECORD
- RETURN HOUSE TO ORIGINAL SETTINGS
- BPI standards, CAZ test

COMBUSTION AIR

What/Why?

- Often Confused With Make-up Air
- Combustion, Ventilation, and Dilution of Flue Gases
  - Fuel Needs Oxygen to Burn
  - Ventilation/Venting
  - Dilution of Flue Gases
    - Cooling/Drying Effect

What can cause building depressurization

- Fire places
- Kit hoods
- Stack effect
- Hrv/Erv that is not balanced
- Bath fans
- Duct work, zone pressure

Large cfm kitchen hood

Open return in Mech. room

SOOTING/BACKDRAFTING

FIRE PLACE

2015 MN Residential Energy Code R403.5 Mechanical Ventilation

What is happening

- A lot of equipment coming into market that do not meet code or are not being installed to code
  - ❖ No dampers to the outside
  - ❖No energy rating, or HVI listing,
  - ❖Rated only to 32 degrees
  - ❖Not balanced
  - ❖Code not being enforced
  - ❖Builder and Homeowner lose in the short and long term

Mechanical Ventilation

- Shall be provide with balanced ventilation that is +/- 10 percent f design capacity
- All conditioned areas… no change from previous code
- Outdoor air intakes and exhaust shall have automatic or gravity dampers that close when the ventilation system is not operating
- Kit and bath fans exempt
- 1 hour period

R403.5.5 Balanced and HRV/ERV systems

- Balanced with in 10% air flow
- HVI tested to – 13 Fahrenheit or certified by engineer
- Total and continuous shall be balanced or exception
- Continuous can be balanced and low sone fan to meet intermittent

R403.5.10 DAMPERS

- Ventilation system supply and exhaust shall have accessible backflow dampers to minimize flow to the outside when system is off

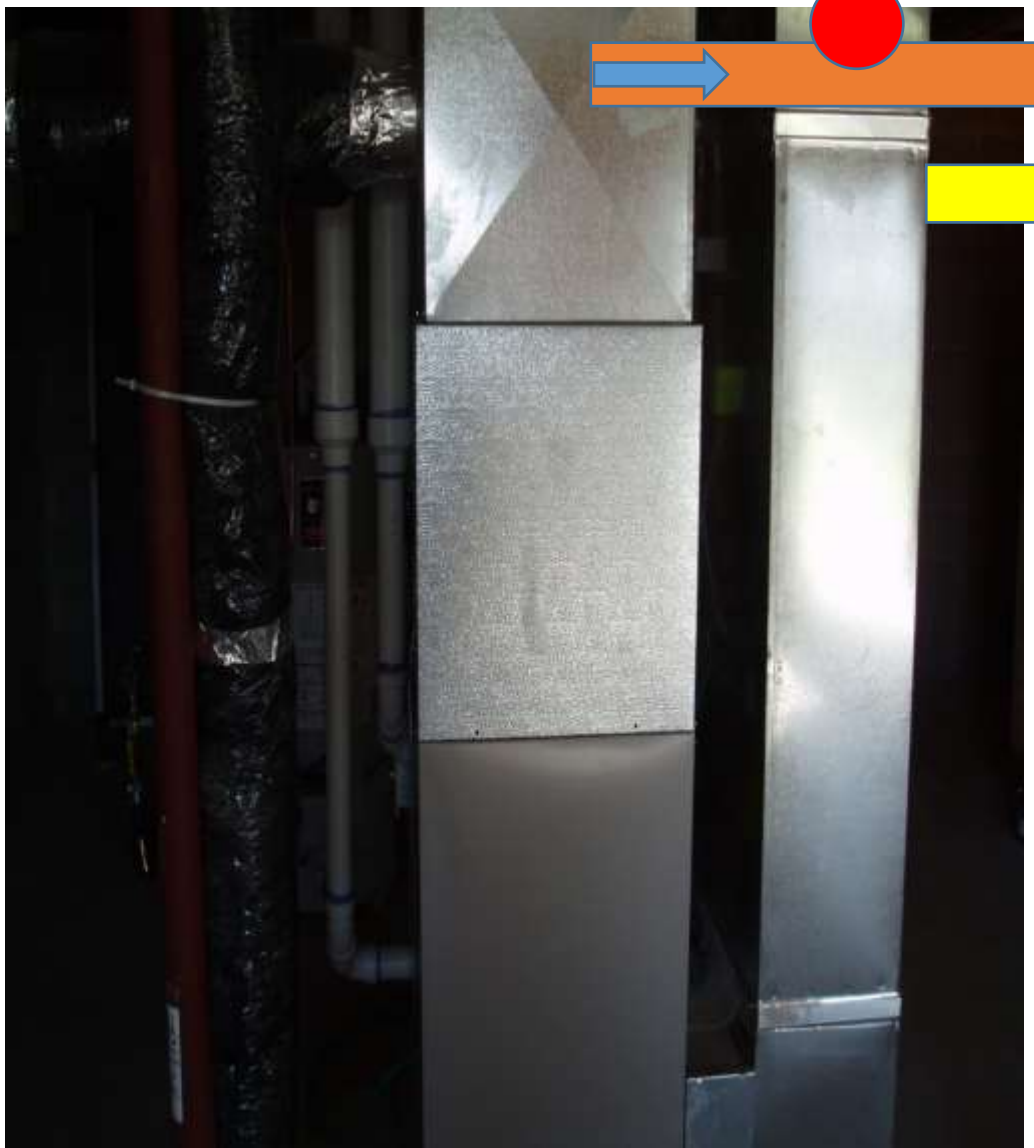
DAMPERS ARE CITED THREE TIMES IN THIS SECTION OF THE CODE

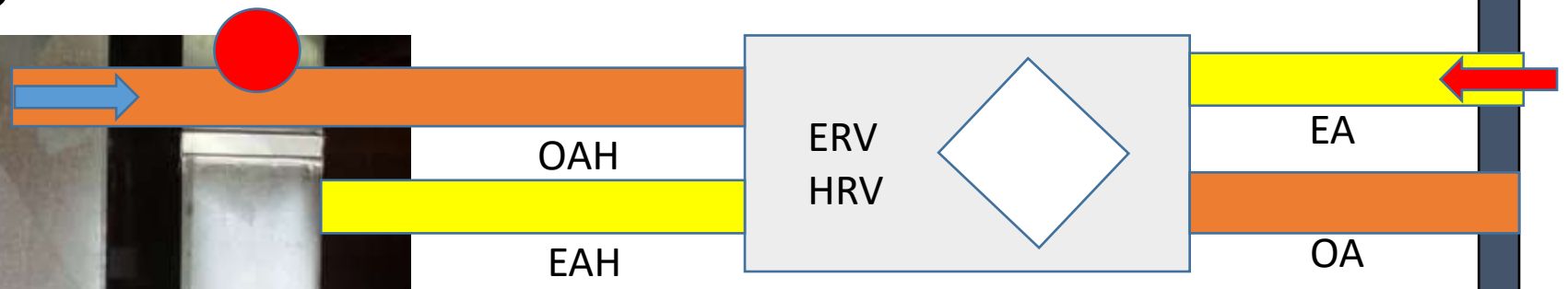
- R403.5
- R403.5.10
- R403.5.14

AT THIS TIME EQUIPMENT AND SYSTEM THAT ARE BEING INSTALLED THAT DOES NOT MEET THESE REQUIREMENTS

HRV/ERV SYSTEM WITH NO DAMPERS

SUPPLY- RETURN DUCT DESIGN, NO DAMPERS

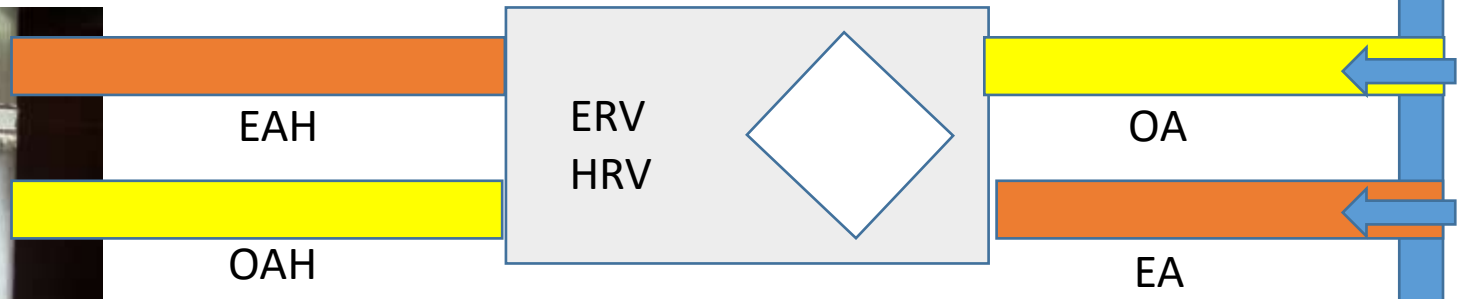




- SEASON SUMMER
- CALL FOR COOLING OR FAN ON
- ERV OR HRV IS OFF
- ACTUAL MEASURED FLOWS 6 INCH DUCT
  1. OUTSIDE AIR TO HOUSE DUCT, IS NOW REVERSE IN FLOW AND IS BLOWING 110 CFM OF 50 DEGREE TO THE OUTSIDE
  2. EXHAUST AIR TO OUTSIDE DUCT IS ALSO IN REVERSE FLOW IT IS SUCKING IN 65 CFM OF 85 DEGREE 58 DEGREE DEWPOINT FROM OUTSIDE

APPLY THIS TO WINTER OPERATION #?!

RETURN- RETURN DUCT DESIGN, NO DAMPERS



- SEASON WINTER
- CALL FOR HEATING OR FAN ON
- ERV OR HRV IS OFF
- ACTUAL MEASURED FLOWS 6 INCH DUCT
  1. OUTSIDE AIR TO HOUSE DUCT, IS NOW SUCKING IN 50 TO 80 CFM OF 10 DEGREE AIR AT 5% RH
  2. EXHAUST AIR TO OUTSIDE DUCT IS ALSO IN REVERSE FLOW IT IS SUCKING IN 50 to 80 CFM OF 10 DEGREE AIR AT 5% RH

APPLY THIS TO SUMMER OPERATION #?!

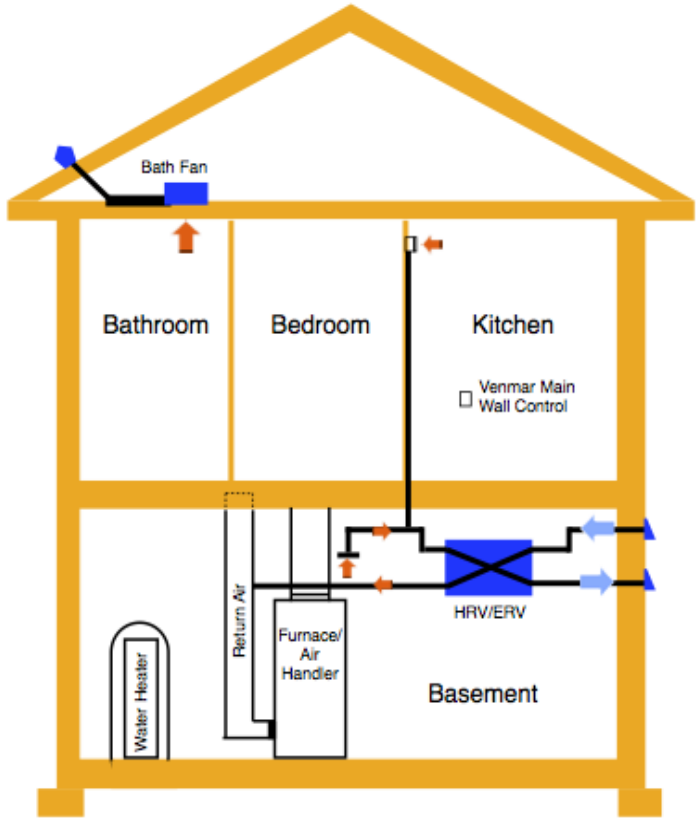
9-18 back flow, no dampers to the out side

VIBRATION FLEX- DUCT DETAIL

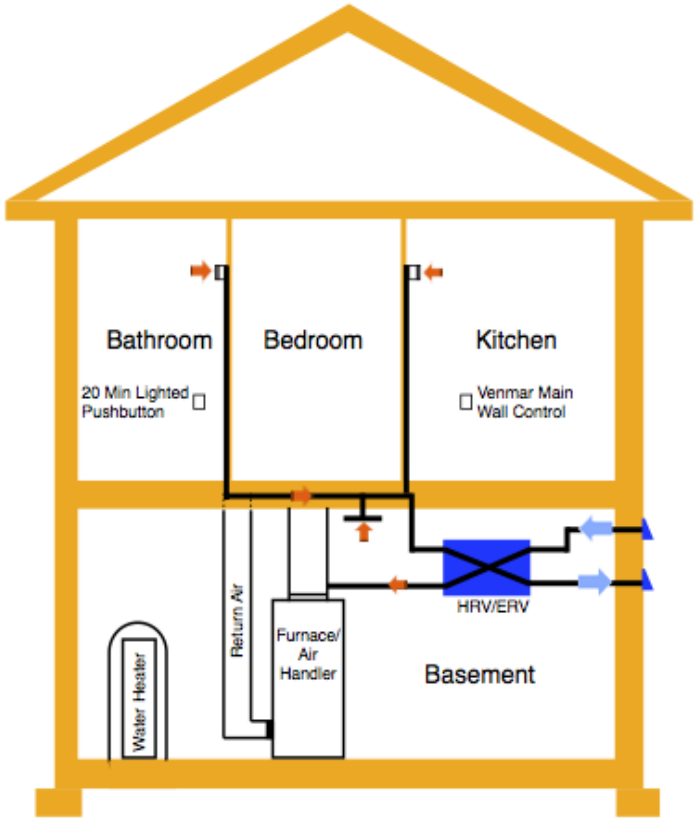
R403.5.6.1 Air distribution/circulation

- 0.075 cfm per conditioned floor area
- No less then 40 degrees at grill

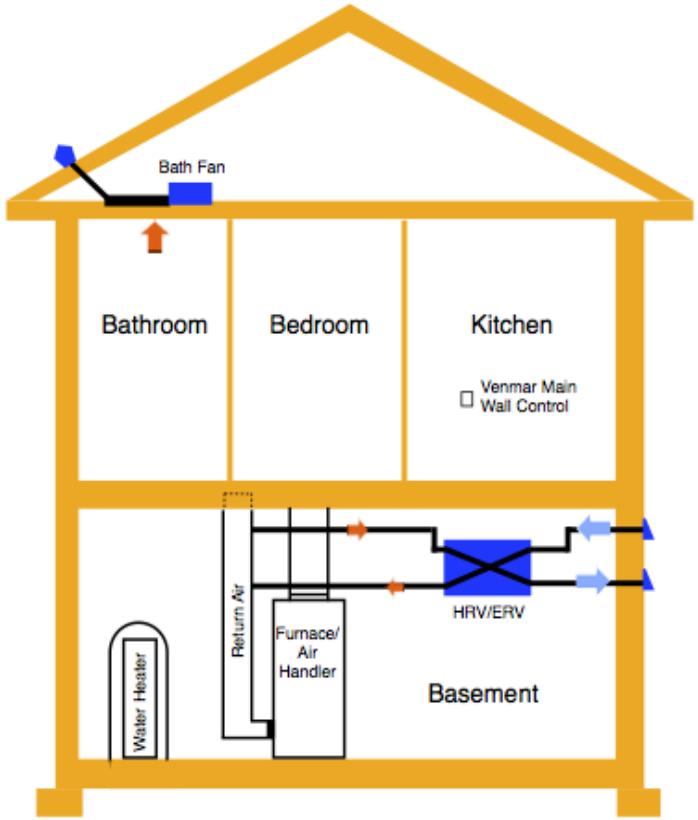
Installation Options



General Ventilation
(one exhaust per level)



Source Point Ventilation



Volume Ventilation
(return/return or return supply)

General Ventilation

- Air is exhausted from the basement (musty smells, moisture) and the kitchen area (moisture, cooking odors, gas stove by-products)
- Tempered fresh Air is ducted to furnace return or supply

Source Point Ventilation

- Air is exhausted from the kitchen area and can replace bathroom fans-- in applications where duct lengths are not excessive.
- Tempered air is ducted to furnace return or supply.

Volume Ventilation

- The existing furnace ductwork is used to exhaust and supply fresh air to the building.
- Tempered air is ducted to furnace return or supply.

Furnace fan needs to run on a return/return strategy

SOURCE POINT DESIGN AND BATH FANS

- DEPENDING ON DUCT LENGTH , TYPE AND SIZE OF THE BATH ROOM

ONE MAY USE HRV/ERV AS BATHROOM EXHAUST SYSTEM… 5 TO 6 ACH. NO BATH FAN NEEDED

- ZONING OF HRV/ERV IS AN OPTION
- AN EXHAUST POINT FROM HRV/ERV AND BATH FAN IN THE SAME BATHROOM IS AN OPTION

DESIGN DETAILS

- THERE IS A LOT OF EXPERIECE AND HISTORY ON HOW SYSTEM ARE INSTALLED ….LOWEST COST IS NOT ALL WAYS THE BEST OPTION , THE INDUSTY IS 30 PLUS YEARS OLD, REVIEW THESE DESIGNS WITH SOME ONE THAT HAS DIRECT EXPERIECE WITH ALL THESE VENTILATION DESIGNS, SIT DOWN WITH AN HVAC PROFESSIONAL AND REVIEW YOUR OPTION FOR THE HOMES THAT YOU ARE BUILDING

BALANCING R403.5.6.1.3 Airflow Verification

- Greater then 30 cfm
- Consequence if you don’t balance your system
- Building pressure
- Method of testing air flow

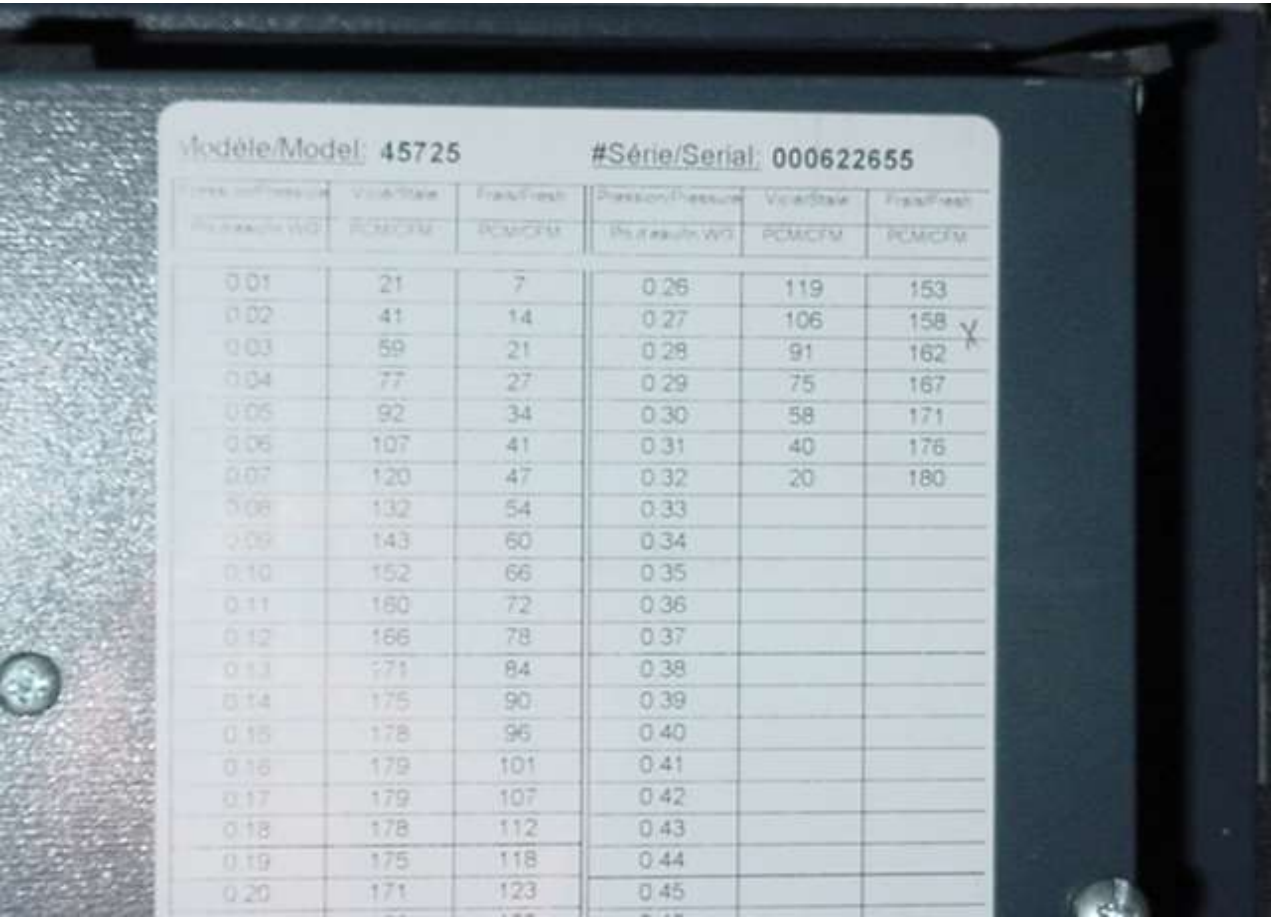
WHAT IF SYSTEM IS NOT BALANCED ?

- Comfort complaints, call backs
- Core freeze up and blockage
- Waste of energy
- House can get to dry in winter, to humid in summer
- Building pressure issues

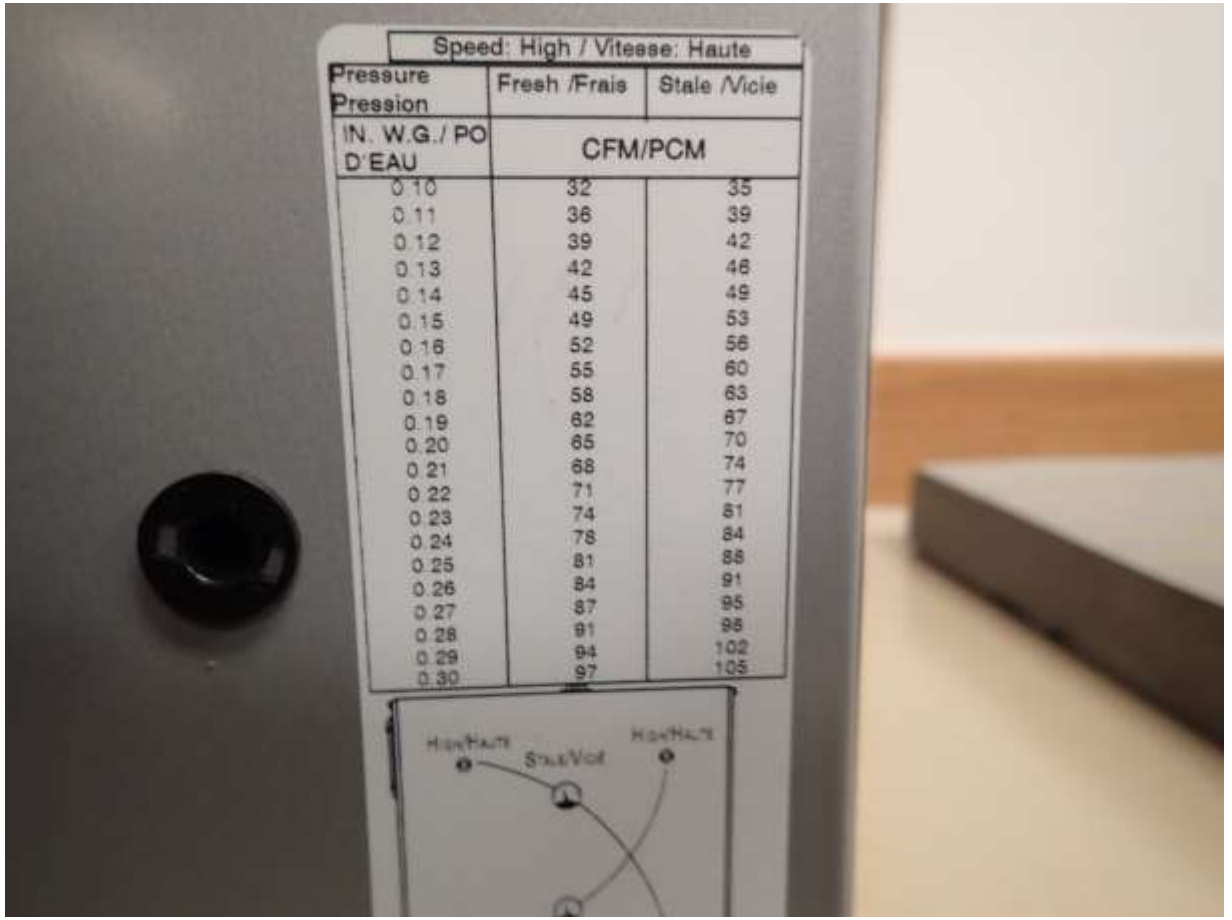
AIR FLOW VERIFICATION

Balancing air flows required by code

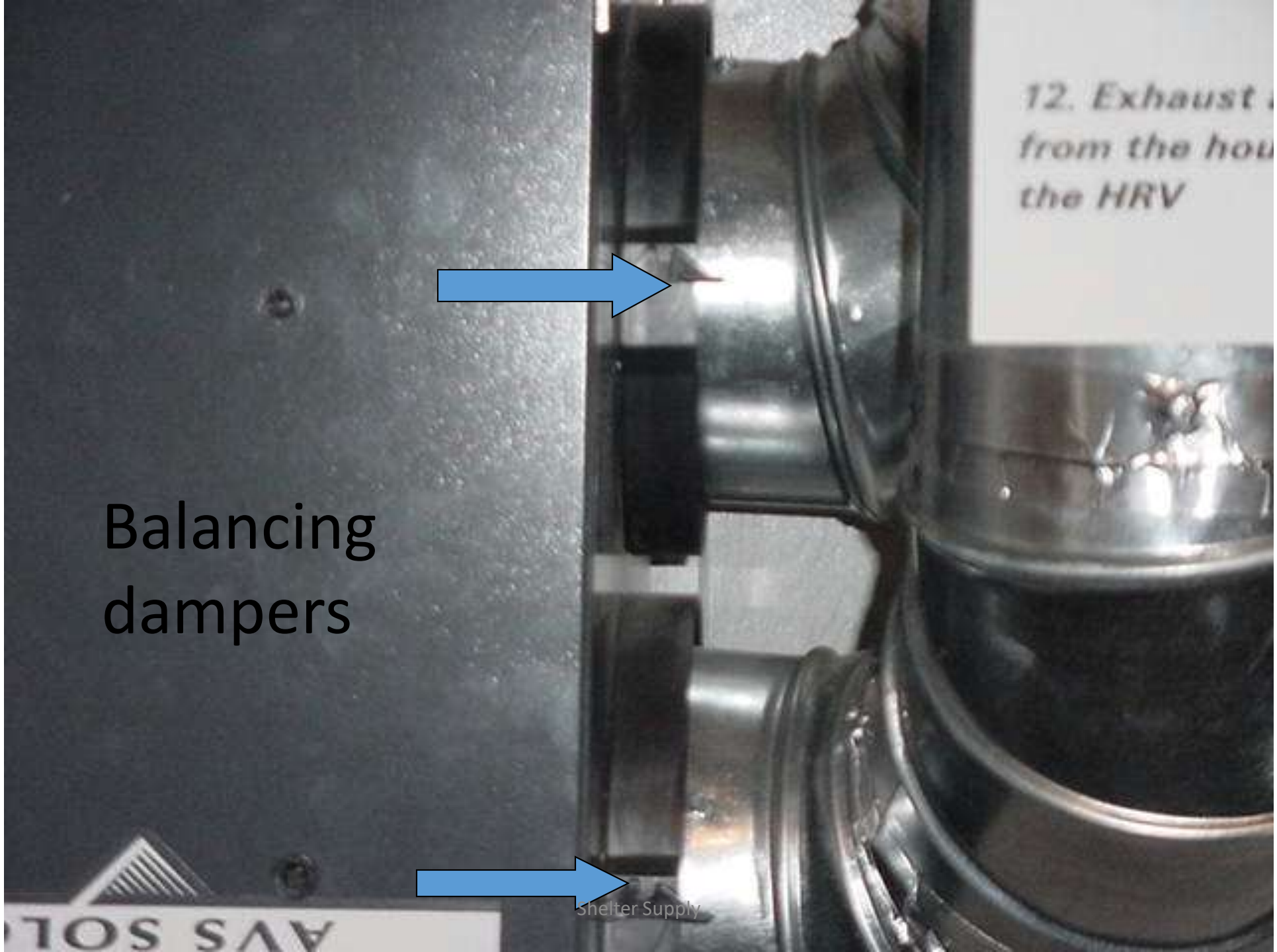
BALANCING CHART



Pression/Pressure Po d'eau/in. W.G.	Vicié/Stale PCM/CFM	Frais/Fresh PCM/CFM	Pression/Pressure Po d'eau/in. W.G.	Vicié/Stale PCM/CFM	Frais/Fresh PCM/CFM
0.01	21	7	0.26	119	153
0.02	41	14	0.27	106	158
0.03	59	21	0.28	91	162
0.04	77	27	0.29	75	167
0.05	92	34	0.30	58	171
0.06	107	41	0.31	40	176
0.07	120	47	0.32	20	180
0.08	132	54	0.33		
0.09	143	60	0.34		
0.10	152	66	0.35		
0.11	160	72	0.36		
0.12	166	78	0.37		
0.13	171	84	0.38		
0.14	175	90	0.39		
0.15	178	96	0.40		
0.16	179	101	0.41		
0.17	179	107	0.42		
0.18	178	112	0.43		
0.19	175	118	0.44		
0.20	171	123	0.45		



Speed: High / Vitesse: Haute		
Pressure Pression	Fresh /Frais	Stale /Vicie
IN. W.G./ PO D'EAU	CFM/PCM	
0.10	32	35
0.11	36	39
0.12	39	42
0.13	42	46
0.14	45	49
0.15	49	53
0.16	52	56
0.17	55	60
0.18	58	63
0.19	62	67
0.20	65	70
0.21	68	74
0.22	71	77
0.23	74	81
0.24	78	84
0.25	81	88
0.26	84	91
0.27	87	95
0.28	91	98
0.29	94	102
0.30	97	105


12. Exhaust
from the hou
the HRV
Balancing
dampers

Tools to measure air flow

- integrated pressure taps built into the ventilator
- Flow stations
- Pitot tube
- Anemometer
- Airflow should be measured at unit

DIFFERENCE BETWEEN HRV AND ERV

- HRV are by far most common type installed units
- HRV is best to reduce window condensation
- ERV will retain more humidity in home in the winter
- ERV will bring in less humidity in summer
- Climate, cost and application is the driving factor on what type is selected

	Climate	Moisture Issues	AC	Allergies/ Respiratory Concerns
HRV	cold	Window condensation	Minimal AC load	Good choice
ERV	warm	Overly dry in winter, humid in summer	High AC load	Best choice

HUMIDITY IN WINTER

Understand what is the relationship between the ventilation strategy and how to humidify the home in the cold weather months

Condensation

- LIFESTYLE ?
- VENTILATION ?
- HUMIDIFIER OPERATION ?
- TEMP. OUTSIDE AND INSIDE ?
- RH% RELATIVE HUMIDITY?

Findings from the Field -HVAC

- Cooling
- Dehumidification
- Heating
- Minisplits

Sizing HVAC system

- Manual J
- Manual S
- 40 % over size for the heating
- 15% over size for the cooling

Cooling

- Code - a lot of HVAC shops or Wholesaler are doing load calculation
- But still seeing over sizing on cooling loads
- Over sizing will give you poor humidity removal - cold and clammy
- System will come on for a short time and drop temperature but remove very little moisture in the air
- What has changed – blower door testing
  - Better insulation, tighter construction this equals comfort and lower energy bills
  - Some homes are running at a consistent higher relative humidity even with proper sizing

Dehumidification

- Climate change… believe what you want, summers are longer and warmer ?%!
- Have you ever heard its not the temp it is the humidity, in the tech side of comfort we call that sensible and latent energy
- Our homes that we build are need less temp removal (sensible) and more (latent) removal
- Summer ventilation adds a little sensible and a lot of latent energy load
- 90 CFM equals over a ½ ton or 6000 BTUs to cooling load
- Offer whole house dehumidification on every house

RH%, TEMP, DEWPOINT DATA FORM

DATE	7/20/2008			EQUIPMENT		ultra air 65 H			
CUSTOMER		wilson							
ADDRESS		hackensack mn							
OUTSIDE CONDITION		80 f 70 RH							
		1 TEST *TD*		2 TEST *TD*		3 TEST *TD*			
SENSOR LOCATION		basement on counter		900 SQ FT					
RH%		65		45					
TEMP		71		75					
DEWPOINT		60		51					
PINTS, REMOVAL		8 HRS-		14					
SENSOR LOCATION		WOOD SHOP 400 SQ FT							
RH%		76		51					
TEMP		68		68					
DEWPOINT		61		49					
PINTS, REMOVAL		9 HRS		20					
TESTO HUMIDITY STICK									
SENSOR LOCATION									
RH%									
TEMP									
DEWPOINT									
PINTS, REMOVAL									
SENSOR LOCATION									
RH%									
TEMP									
DEWPOINT									
PINTS, REMOVAL									
SENSOR LOCATION									
RH%									
TEMP									
DEWPOINT									
PINTS, REMOVAL									
TD= TIME DURATION									

Heating

- 2 stage furnace
- ECM blowers
- Geo
- Boilers
- Control systems
- Internet –wi-fi stats
- Passive solar
- Wood

Hydronic – radiant heating

Ground source heat pumps

Thermostats

Why use a Mini- Split Unit

- No ducting needed…… or maybe a little duct work
- Very quiet operation, both inside and out
- Excellent at removing moisture, lower RH%
- Improves IAQ and comfort
- Energy credits
- Proven Technology
- Accepted by HVAC contractors

Inverter Technology

- Very even temp and operation, Wants to run
- ECM drive, DC drive like on furnace fan
- 50 % more efficient then non – inverter unit
- Design and sizing is more flexible
- Can be used in more application
- Less service issues

Benefits of ducted mini split for low energy homes

- Modulates to building loads heating and cooling
- Can add post heat - duct heater
- Independent fan mode
- Zoned by design – you can install multiple air handlers or heads
- Simple ventilation integration
- Quiet operation
- Can be installed vertically or horizontally
- Small compact great for design and duct layout
- Can be installed within building shell or unconditioned area ?%$#

Design and Expectation

- Primary for cooling
- Primary for heating
- Seasonal home
- Utility program
- What is heating, cooling load
- Where is duct work to be installed
- Operation by end user, what do they want, expectations

Wagner/Zaun project

- Passive house details
- 14,000 btu winter design load, Duluth MN
- 57 cfm of leakage at 50 pascals, EXCELLENT WOW
- Square ft 1800
- 12,000 btu Fujitsu slim duct
- Data logged for a year total heating and cooling 2017 was 2040 kWh 98 kWh from cove heaters
- Source point Broan ERV, this acted as bath fan system
- Small make up air system, Electro Industries

Duluth, MN 14,000 BTU house

Small mechanical room, u turn was ok

Findings from the Field – other

- Pools and hot tubs
- Sport courts / Gyms in houses
- Low energy homes

Pools and Hot tubs

Design and Commissioning

- Care full planning on how and what to use for heating
- Pool cover
- Building pressure
- Window type
- Envelope / shell details
- Testing and verification a must

Can light and mold

WATER AND WINDOWS?

Sport courts/gyms

- Seeing more of these
- Big volume
- Lower level
- Poor IAQ
- All kinds of ways to condition , but not always good design
- Operation by homeowner

Low Energy buildings

- New set of rules
- Smaller equipment not as common
- Commissioning ?
- Systems Approach for design and installation a must
- Design professionals Architects, HVAC design consultants
- Coach trades on what is different
- Do not oversize equipment
- End user operation?

Passive House, La Crosse WI

Dropped ceiling for ducting in hallway

Thank you for your time

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