Health, Comfort and Ventilation

How they are related, why they matter, and how to get to optimum levels of all three

Energy Design Conference & Expo
Duluth, MN 25 February 2015

Barry Stephens

1865: The Birth of Commercial Cigarettes

- 1881 – The first cigarette machine is invented
  10 Million Cigarettes Manufactured
- 1886 - 1 Billion Cigarettes Manufactured
- 1965 – US Congress Passes "Cigarette Labeling Advertising Act".

US Surgeon General's Warning!
"Cigarettes May Be Hazardous to Your Health"

Health Statistics

- The Number of People in the USA with Asthma grew from about 20 Million in 2001 to 25 Million in 2009. Asthma cost the USA about $3,300 per year, per person, for people with Asthma from 2002 to 2007.

  (Centers for Disease Control and Prevention – Vital Signs – May 2011)

- The EPA estimates that as many as 8 million homes throughout the country have elevated levels of radon. Based on current exposure and risk estimates, radon exposure in single-family houses may be a causal factor in as many as 20,000 of the total lung cancer fatalities which occur each year.

Figure 4. Total percent detections of common VOCs in background indoor air compiled from 15 studies conducted between 1990 and 2005. Range of reporting limits is shown in parentheses.

Toluene (0.03 -1.9)	96.4
m/p-Xylene (0.4 -2.2)	92.9
Benzene (0.05 -1.6)	91.1
o-Xylene (0.11 -2.2)	89
Ethylbenzene (0.01 -2.2)	85.7
Methylene chloride (0.12 -3.5)	79.1
Chloroform (0.02 -2.4)	68.5
Tetrachloroethylene (0.03 -3.4)	62.5
Methyl tert-butyl ether (MTBE) (0.05 -1.8)	54.5
Carbon tetrachloride (0.15 -1.3)	53.5
1,1,1-Trichloroethane (0.12 -2.7)	53.4
Trichloroethylene (0.02 -2.7)	42.6
1,1,2-Trichloro-1,2,2-trifluoroethane (0.25 -3.8)	37.5
1,2-Dichloroethane (0.08 -2.0)	13.8
1,1-Dichloroethylene (0.01 -0.25)	13
Vinyl chloride (0.01 -0.25)	9.2
cis 1,2-Dichloroethylene (0.25 -2.0)	4.9
1,1-Dichloroethane (0.08 -0.25)	1

From: "Background Indoor Air Concentrations of Volatile Organic Compounds in North American Residences (1990–2005): A Compilation of Statistics for Assessing Vapor Intrusion" EPA 530-R-10-001 June 2011

A recent study in Boston determined that within 8 miles of Logan Airport, pulmonary disease among children is elevated by 30%, likely as a result of elevated fine particulates from jet exhaust.

- 2012: ICC Building Code – 3 ACH/50
- 2090 – Congress Passes "Home Labeling and Truth in Advertising Act"

US Surgeon General's Warning!
This House May Be Hazardous To Your Health

Ventilation effectiveness comparison between extract ventilation and balanced ventilation in a scale model

Bart E. Cremers*

Knowledge Centre, Zehnder Group Nederland, Zwolle, The Netherlands

Open Window in Master Bedroom

One (1) Minute

Three (3) Minutes

Ten (10) Minutes

Table 1. Cleaning time of the child's bedroom.

Condition	MEV	MVHR
No Disturbance	8 Minutes	8 Minutes
Open Window MBR	20 Minutes	8 Minutes
Wind on MBR	1 Minute	8 Minutes

The cleaning time of a room is increased by an open window elsewhere in the house. Contrary to people's belief that windows may not be opened for an MVHR ventilation system, it is shown that the ventilation effectiveness of an MEV system may be negatively influenced by open windows somewhere in the house.

The cleaning time of a room at the lee side of the building is seemingly decreased by the wind in the scale experiments. However, with a continuous source of contamination elsewhere in the house, the room at the lee side does not get a supply of fresh air via the window grille, but is filled with stale air from elsewhere in the house. Because of the air tight envelope of a house with MVHR, the cleaning time of both rooms is not influenced at all by wind around the building.

Ventilation Effectiveness Study Final Report

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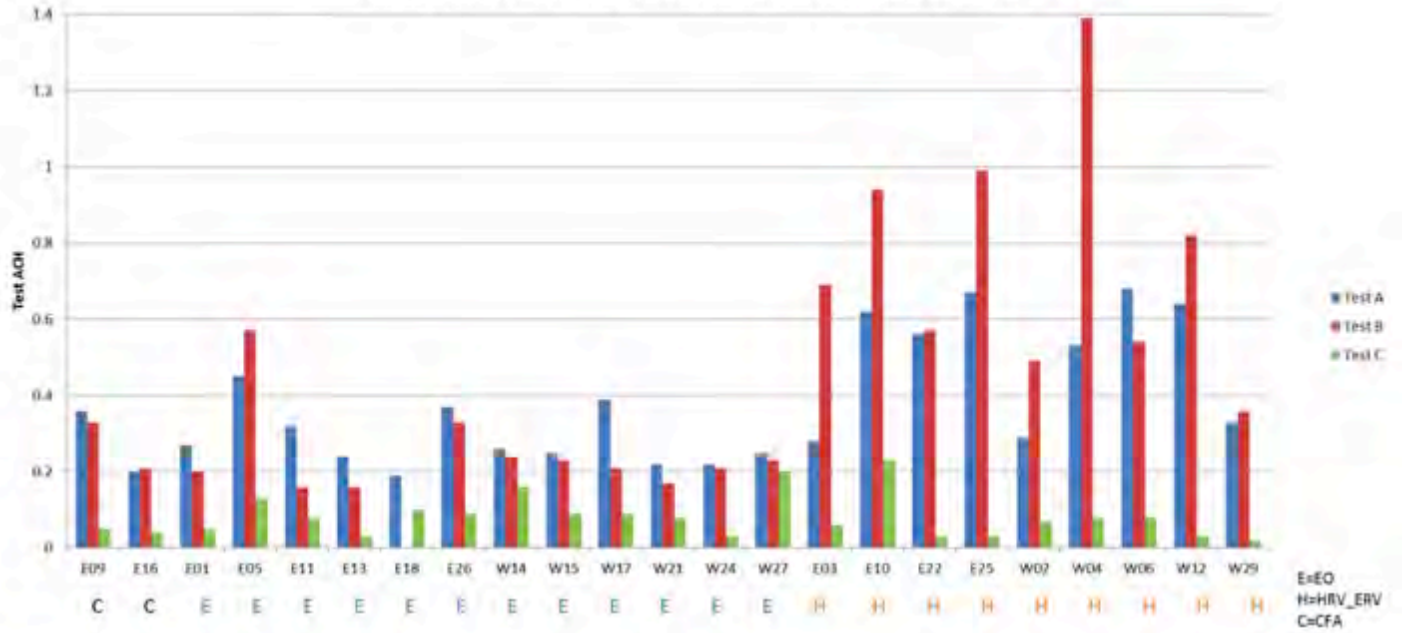
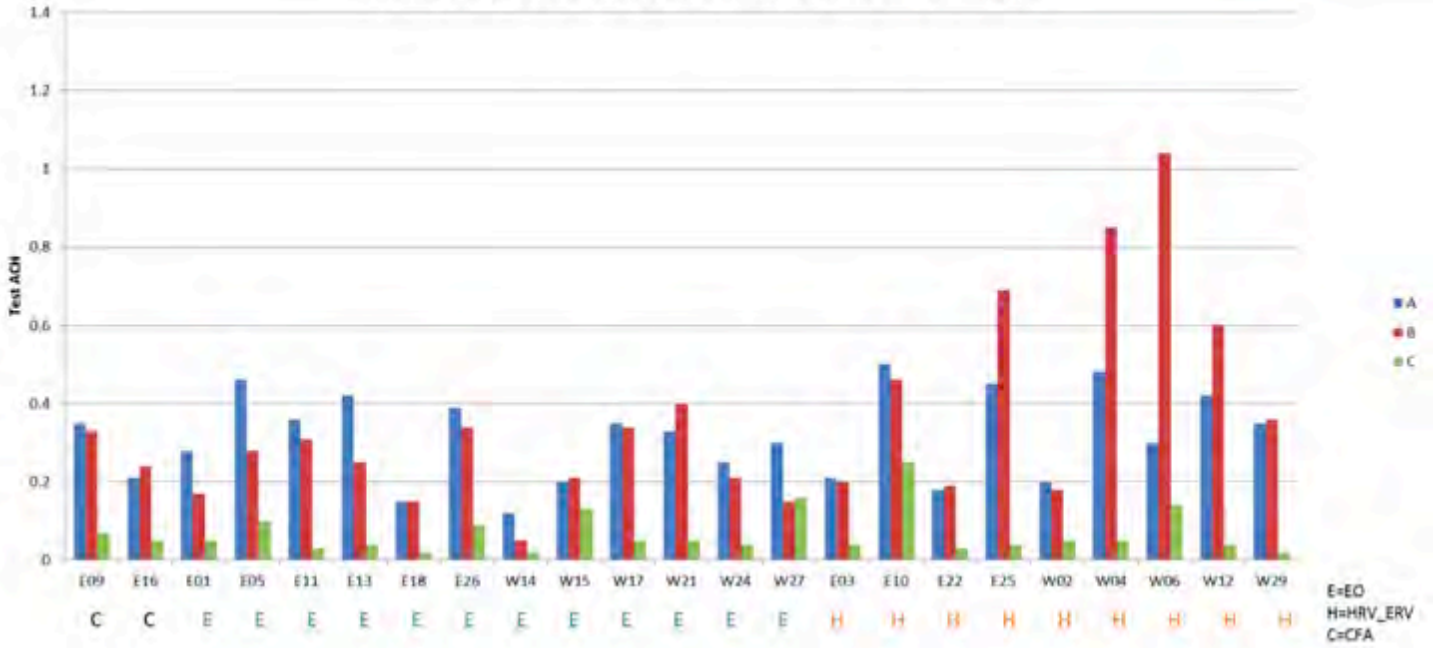
Short Term Test ACH by Test Protocol: Second Bedroom

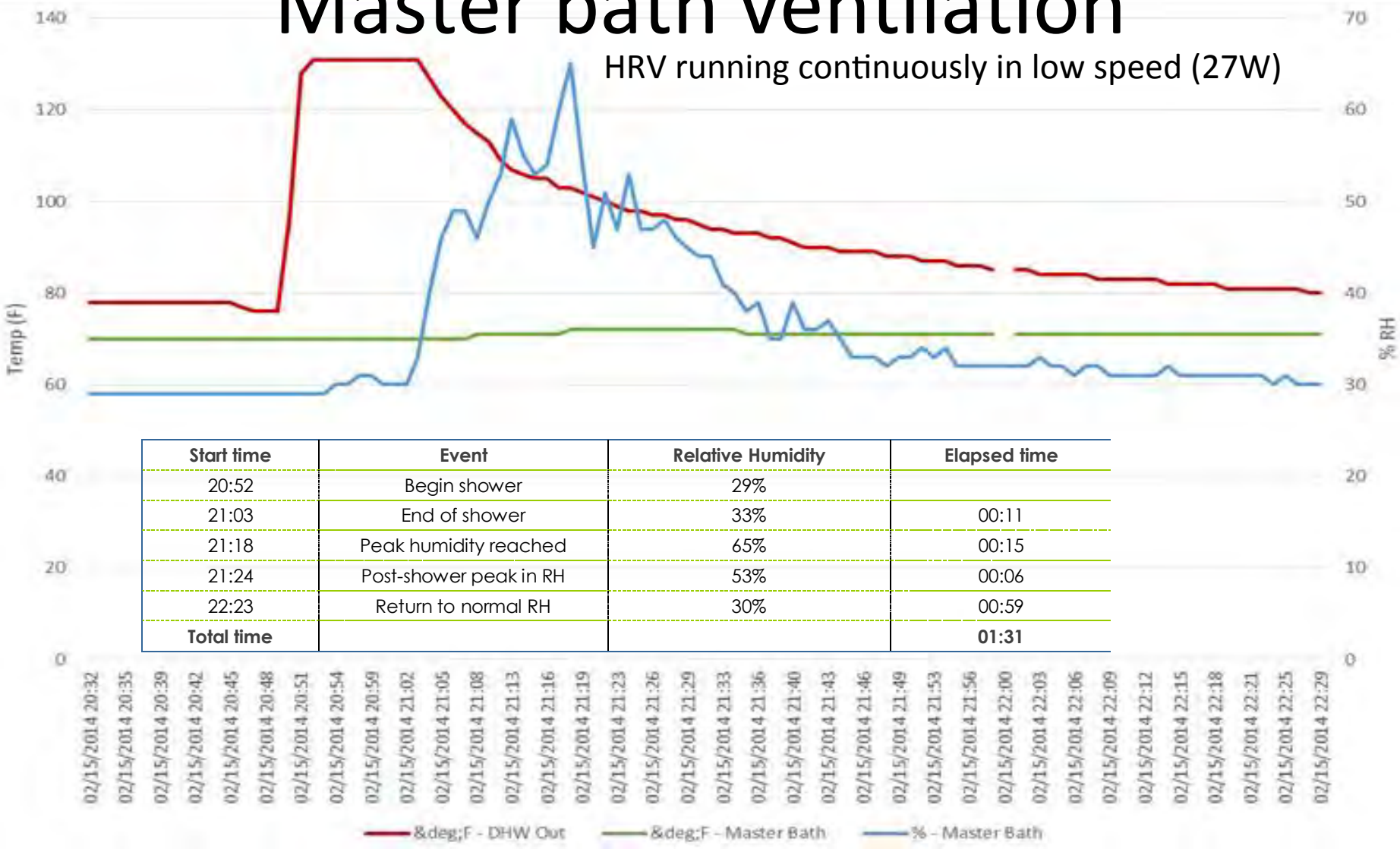


Short Term Test ACH by Test Protocol: Master Bedroom



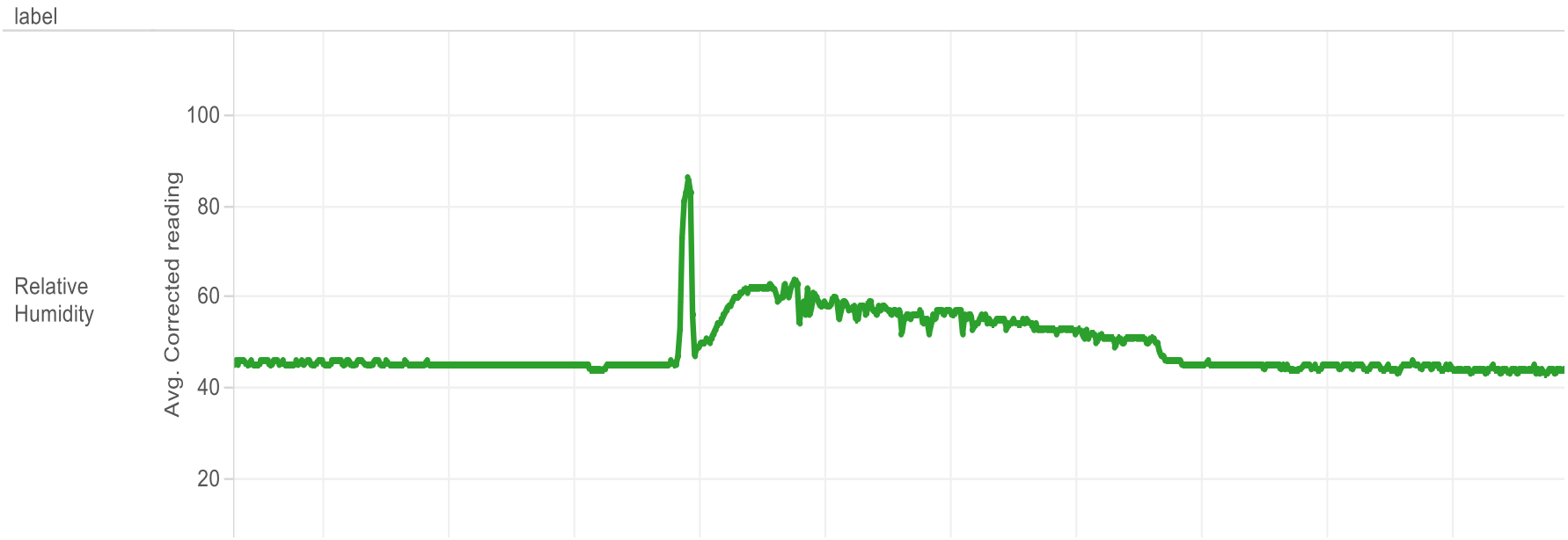
Master bath ventilation

HRV running continuously in low speed (27W)



Start time	Event	Relative Humidity	Elapsed time
20:52	Begin shower	29%	
21:03	End of shower	33%	00:11
21:18	Peak humidity reached	65%	00:15
21:24	Post-shower peak in RH	53%	00:06
22:23	Return to normal RH	30%	00:59
Total time			**01:31**

HRV as exhaust fan



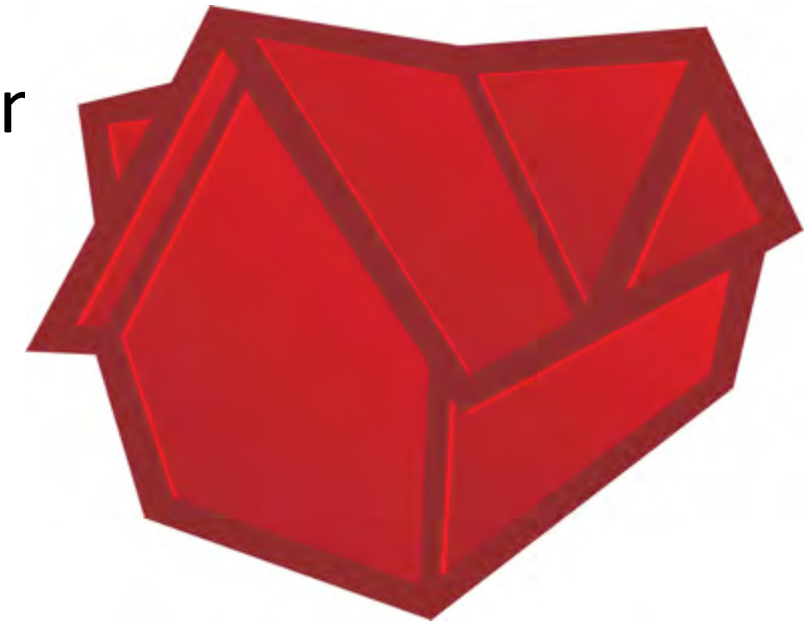
Start time	Event	Relative Humidity	Temperature	Elapsed time
05:44:00	Begin shower	45%	66.0 F	
05:54:00	Peak humidity reached	86%	68.0 F	00:10
06:06:00	End of shower	52%	68.0 F	00:12
06:34:00	Second peak	62%	67.0 F	00:28
10:56:00	Return to normal RH	44%	66.0 F	04:22
Total				**05:12**

Bath Fan vs. HRV Energy Usage

Assumptions:

- 3 Bedroom/1 bath home
- 1500 SF – 8 FT ceilings
- Passive House Ventilatior

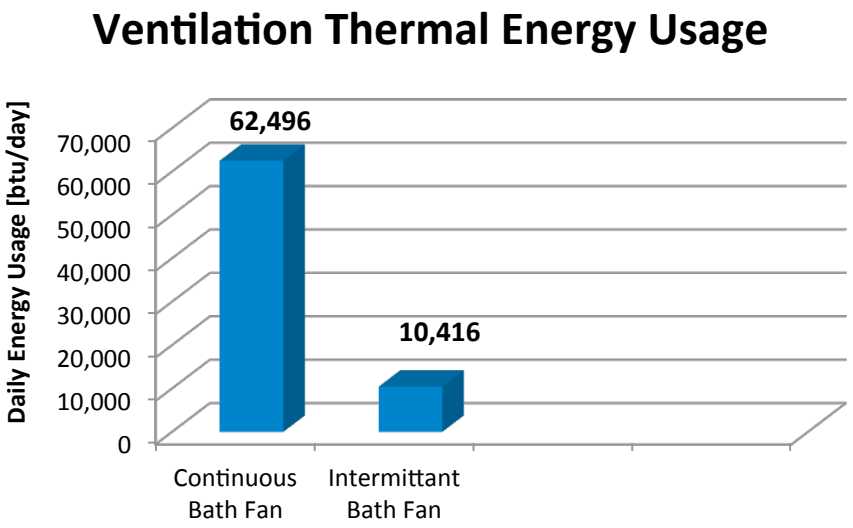
  0.3 ACH = 60 CFM
- Outside Air Temp: 30°F
- Inside Air Temp: 70°F

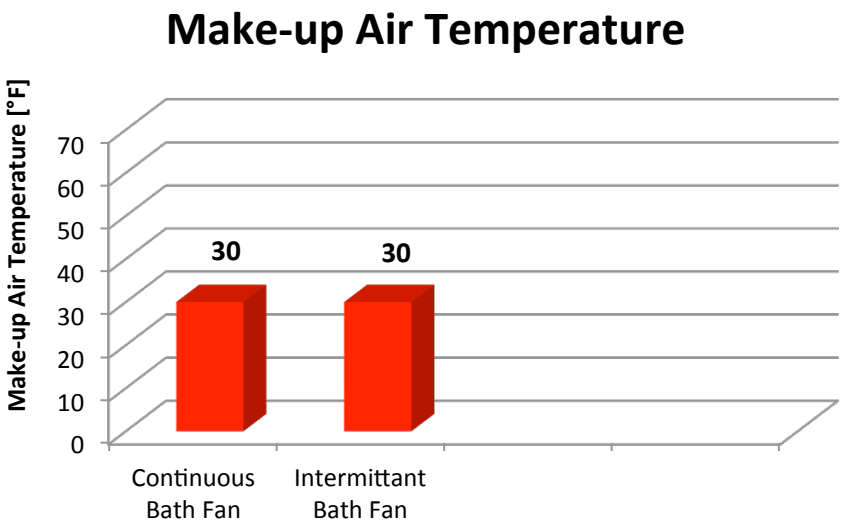


Bath Fan vs. HRV Energy Usage

Bath Fan case, 60 CFM continuous:
Energy Usage = (1.085)(60 CFM)(70°F - 30°F)(24 hours) = **62,496 Btu/Day**

Bath Fan Case, 120 CFM intermittent (2 hours per day):
Energy Usage = (1.085)(120 CFM)(70°F - 30°F)(2 hours) = **10,416 Btu/Day**



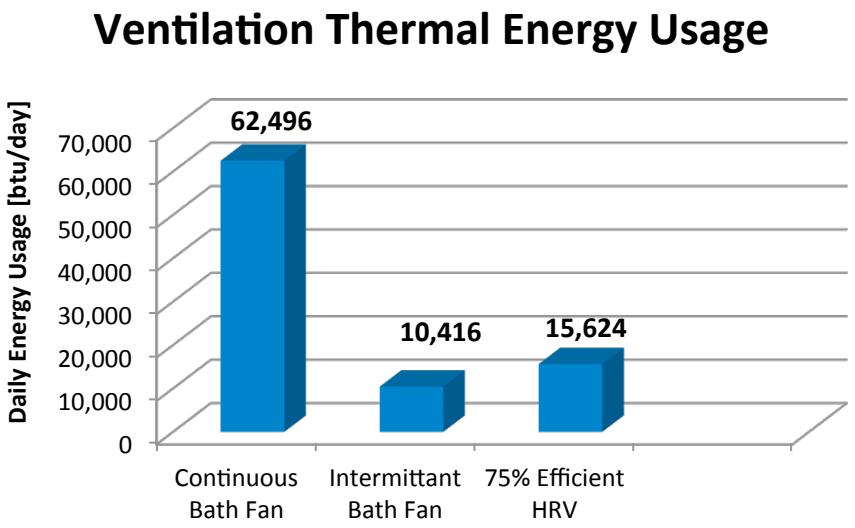


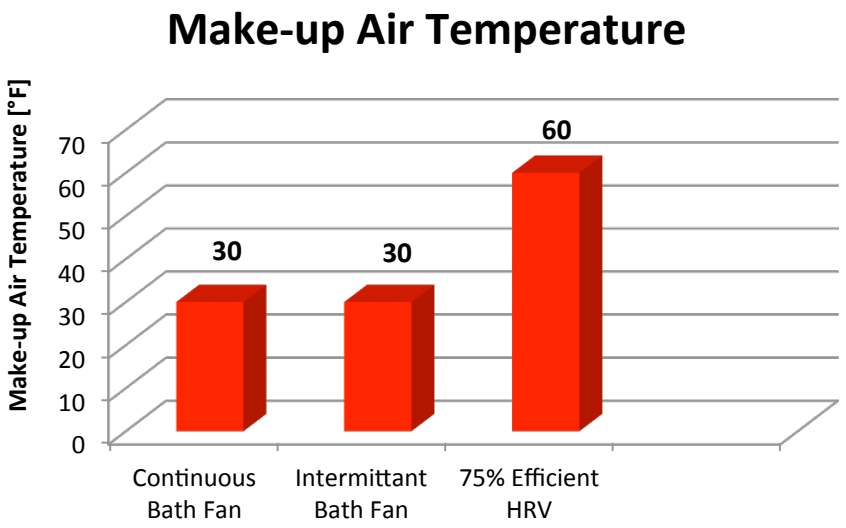
Bath Fan vs. HRV Energy Usage

75% Efficient HRV case, 60 CFM continuous:

Energy Usage = (1.085)(60 CFM)(70°F - 30°F)(24 hours)(1 – 0.75) = **15,624 Btu/Day**

Make-up air temperature = 30°F + (70°F - 30°F)*(0.75) = **60°F**



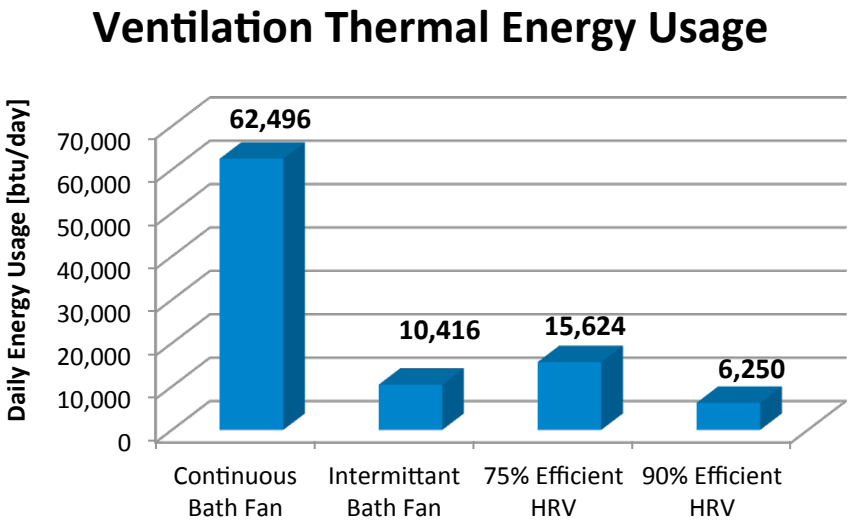


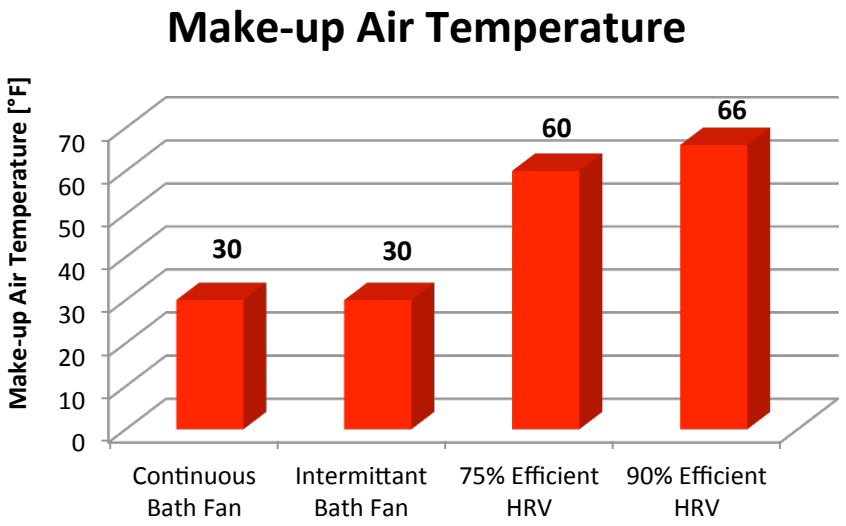
Bath Fan vs. HRV Energy Usage

90% Efficient HRV case, 60 CFM continuous:

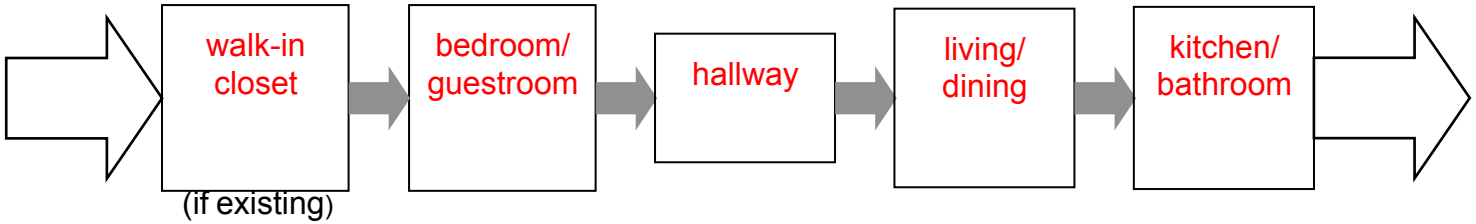
Energy Usage = (1.085)(60 CFM)(70°F - 30°F)(24 hours)(1 – 0.90) = **6,250 Btu/Day**

Make-up air temperature = 30°F + (70°F - 30°F)*(0.90) = **66°F**





Solution With HRV/ERV Ventilation


walk-in
closet
(if existing)
bedroom/
guestroom
hallway
living/
dining
kitchen/
bathroom

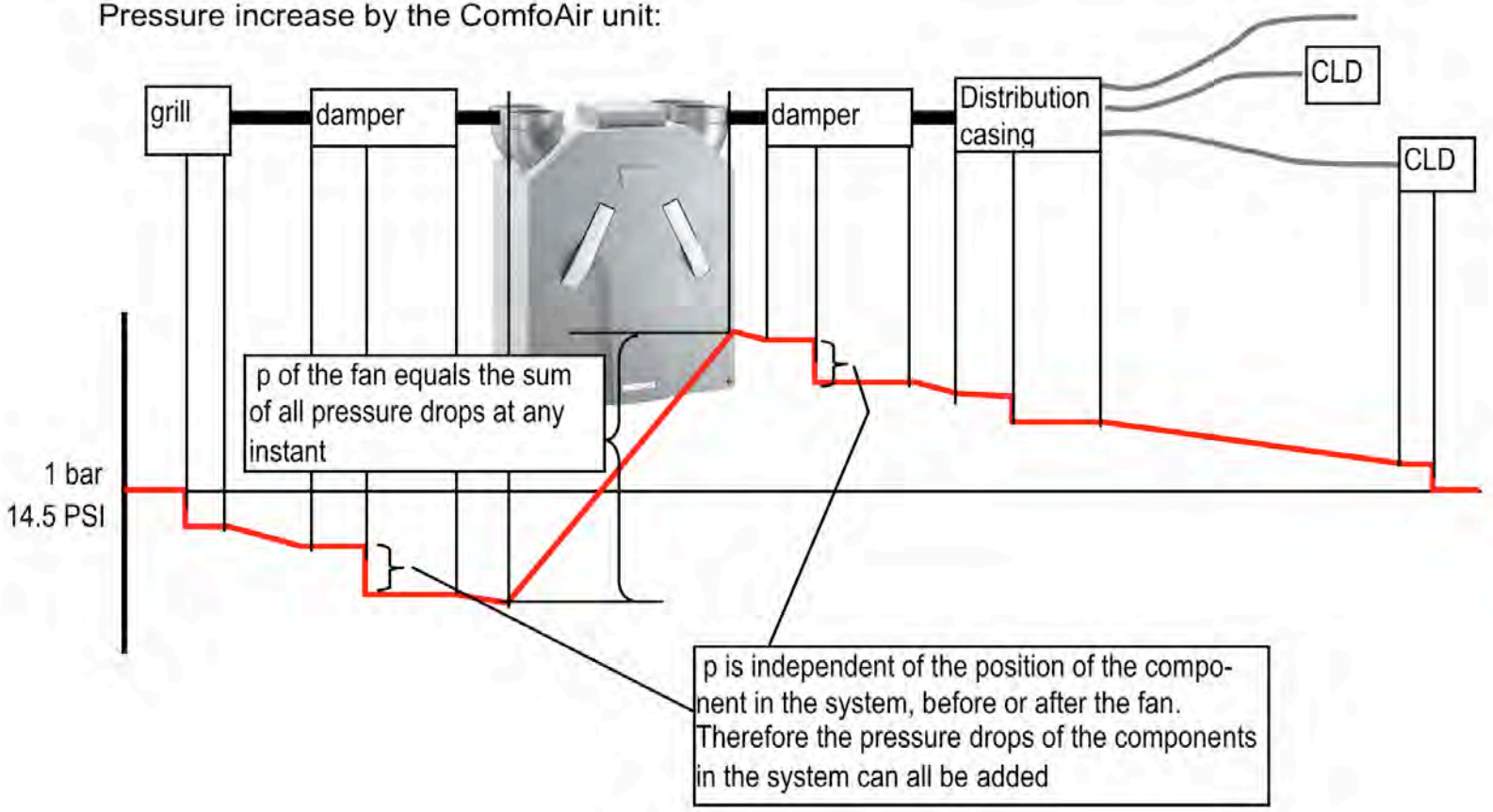
Effective, efficient heat recovery ventilation includes three elements

- Proper Planning/Design – H/ERV sized for continuous ventilation, supplies to bedrooms, living spaces, exhausts from bathrooms, kitchens, mud room, laundry.

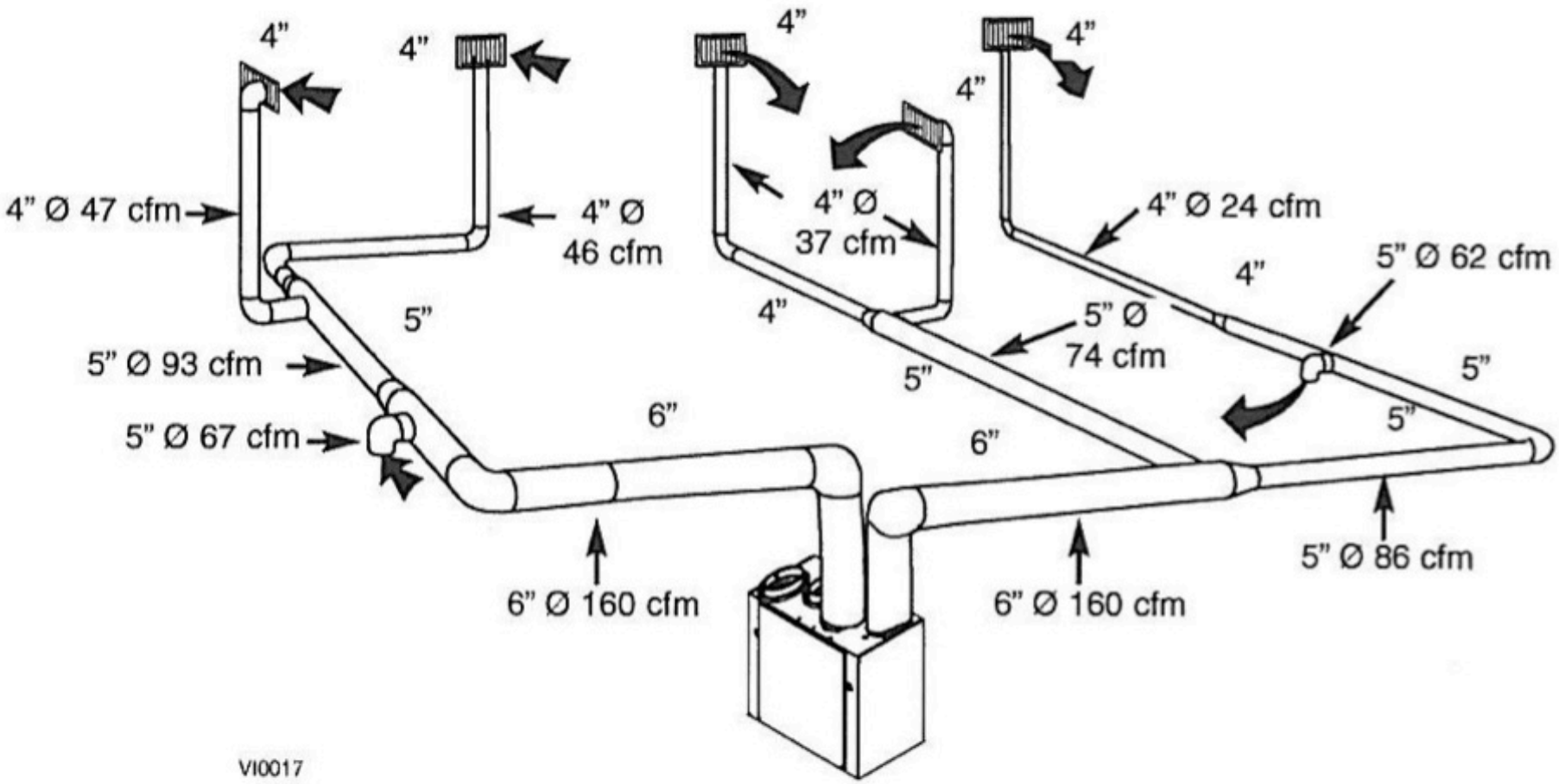
- Proper Installation – Follow design, clear path from intakes to H/ERV to Registers and/or Diffusers.

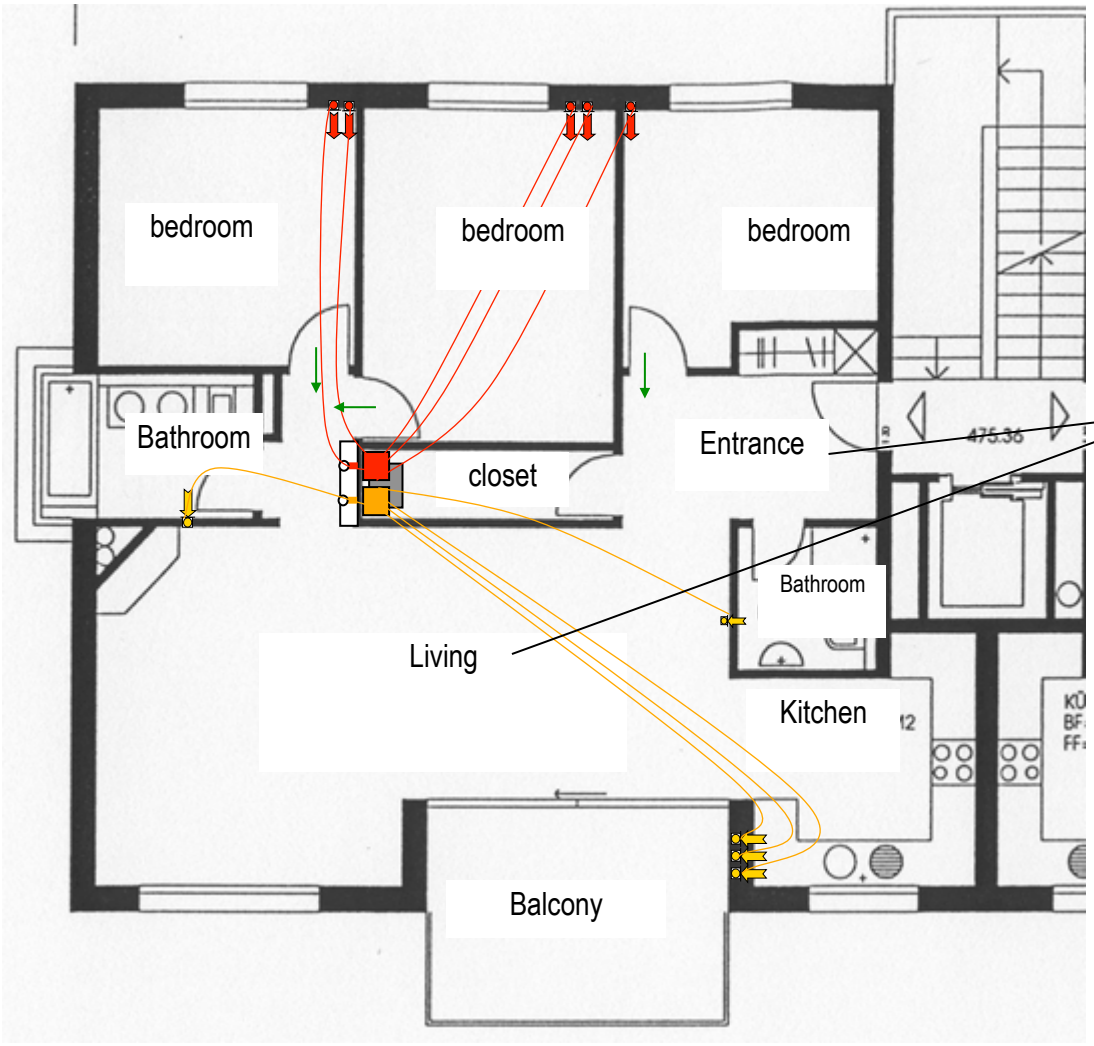
- Commissioning/QA – Confirmation of installation details, balancing of flows, and confirmation of proper ventilation rates.

Pressure increase by the ComfoAir unit:



Duct System


4"
4"
4" Ø 47 cfm
4" Ø
46 cfm
5"
5" Ø 93 cfm
5" Ø 67 cfm
6"
6" Ø 160 cfm
4"
4"
4" Ø
37 cfm
4"
5"
6"
6" Ø 160 cfm
4"
4"
4" Ø 24 cfm
4"
5" Ø 62 cfm
5" Ø
74 cfm
5"
5"
5" Ø 86 cfm
VI0017



Rooms in air passage
from bedrooms to kitchen
and bathrooms

Zehnder Comfosystems

540 Portsmouth Ave.
Greenland NH 03840

Quote number: **1-0025-8.11**
Project: **John Q. Public**
City: **Denver**
State: **CO**
Created by: **BST**
Date: **30-Sep-16**

Customer: **John**
To attention of: **Same**
Phone contact: **555-555-5555**

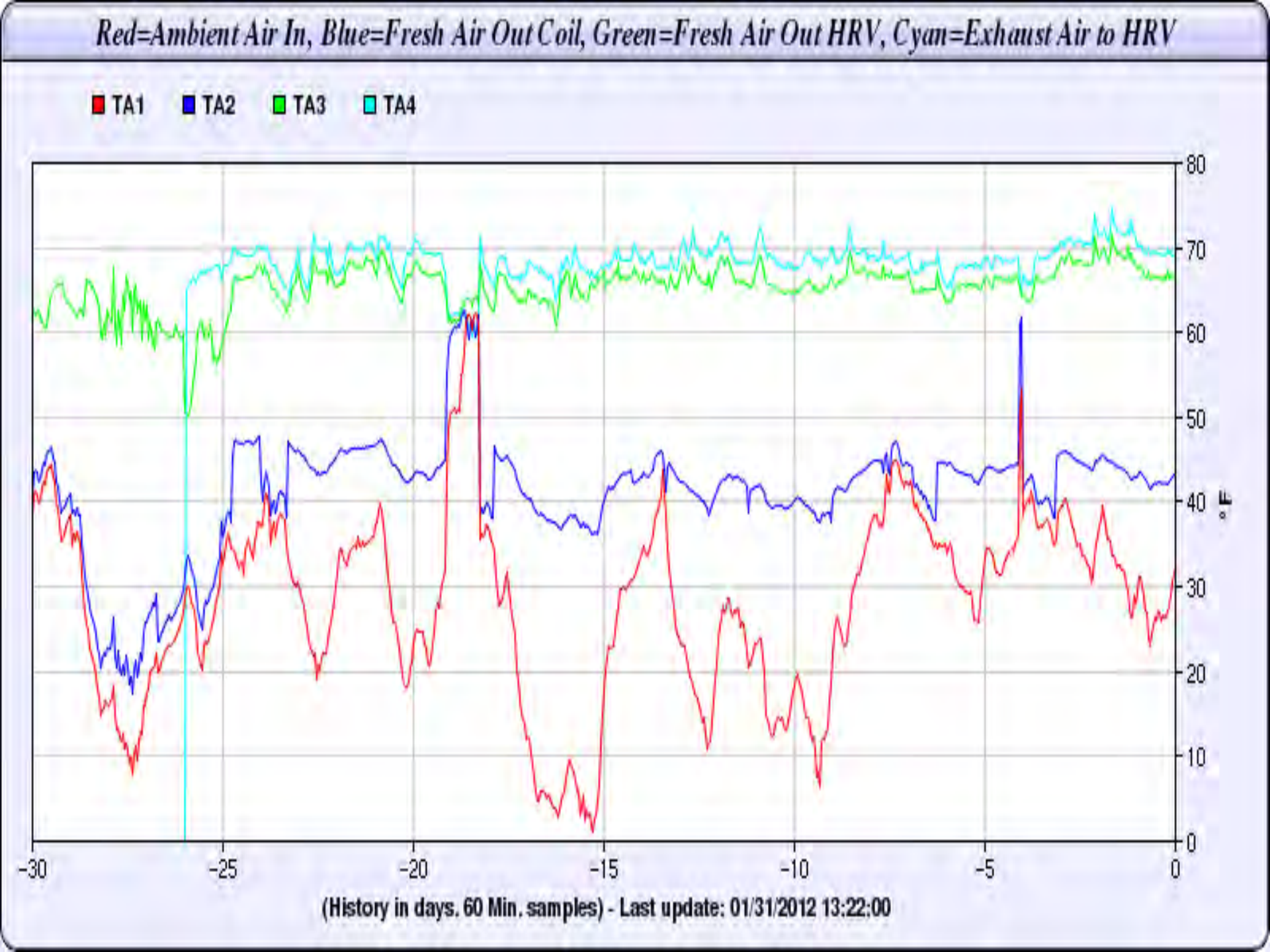
Remarks:

Calculation of the required air flow rates

Floor	Room	Area [ft²]	Height [ft]	Volume [ft³]	Air volume [cfm]	
					Supply Air	Exhaust Air
First Floor	MA BR	210	8.0	1,680	22	
"	MA BA	60	8.0	480		24
"	Dining	186	8.0	1,488	22	
"	Kitchen	180	8.0	1,440		36
"	Entry Powder	30	8.0	240		12
"	Den	180	8.0	1,440	20	
"	Mud Powder	32	8.0	256		12
Second Floor	Bedroom 1	160	8.0	1,280	22	
"	Bathroom 1	66	8.0	528		24
"	Bedroom 2	148	8.0	1,184	22	
Total		**1,252**		**10,016**	**108**	**108**

Number of tubes
Air exchange rate per hour **0.64**


RETURN
SUPPLY


Red=Ambient Air In, Blue=Fresh Air Out Coil, Green=Fresh Air Out HRV, Cyan=Exhaust Air to HRV
TA1
TA2
TA3
TA4
80
70
60
50
40
30
20
10
0
°F
-30
-25
-20
-15
-10
-5
0
(History in days. 60 Min. samples) - Last update: 01/31/2012 13:22:00

Filter Casing

MERV 15 Filter

Filter Casing

Activated Charcoal Filter


AIRFLOW™
LCA501
ESC
TSI
AIRFLOW™


AIRFLOW

COMMISSIONING REPORT

Customer:	Date:
Address:	Order Number:
City, State, Zip	Outdoor Temp:
Commissioning Agent:	
Installer:	Date:

always
around you

VENTILATION MEASUREMENTS

RETURN AIR	Planned CFM	Measured CFM				
	medium	high	medium	low	valve type	Valve position or ComfoSet disk 0-4
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
SUM:						

FRESH AIR	Planned CFM	Measured CFM				
	medium	high	medium	low	valve type	Valve position or ComfoSet disk 0-4
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
SUM:						

Trim	low	medium	high
Ventilator Setting Fresh Air:			
Ventilator Setting Return Air:			
Comfort Temperature			
Time-lag Comfoair Settings			
Weather			
Filter Condition			

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Questions?

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