Ventilation: What Do We Need Looking Forward Based on Regulatory and Health Needs?

Russell Pope
Immediate Past Chair, HVI Board of Directors
Industry Development Manager
Panasonic, IAQ Division
russell.pope@us.panasonic.com

Nick Agopian
Secretary, HVI Board of Directors
Vice President Sales and Marketing
RenewAire
nagopian@renewaire.com

- Certification Body & Trade Association for the North American Residential Ventilation Industry
- Over 50 Members
- ANAB (ANSI) & SCC Accredited
- Founded in 1955
- Certified Product Directory (CPD)
  - Over 3,500 certified product models
  - NOT LISTED = NOT CERTIFIED
- HVI Publications
  - Certification, Airflow, Sound, Label & Logo…

HVI Core Purpose:

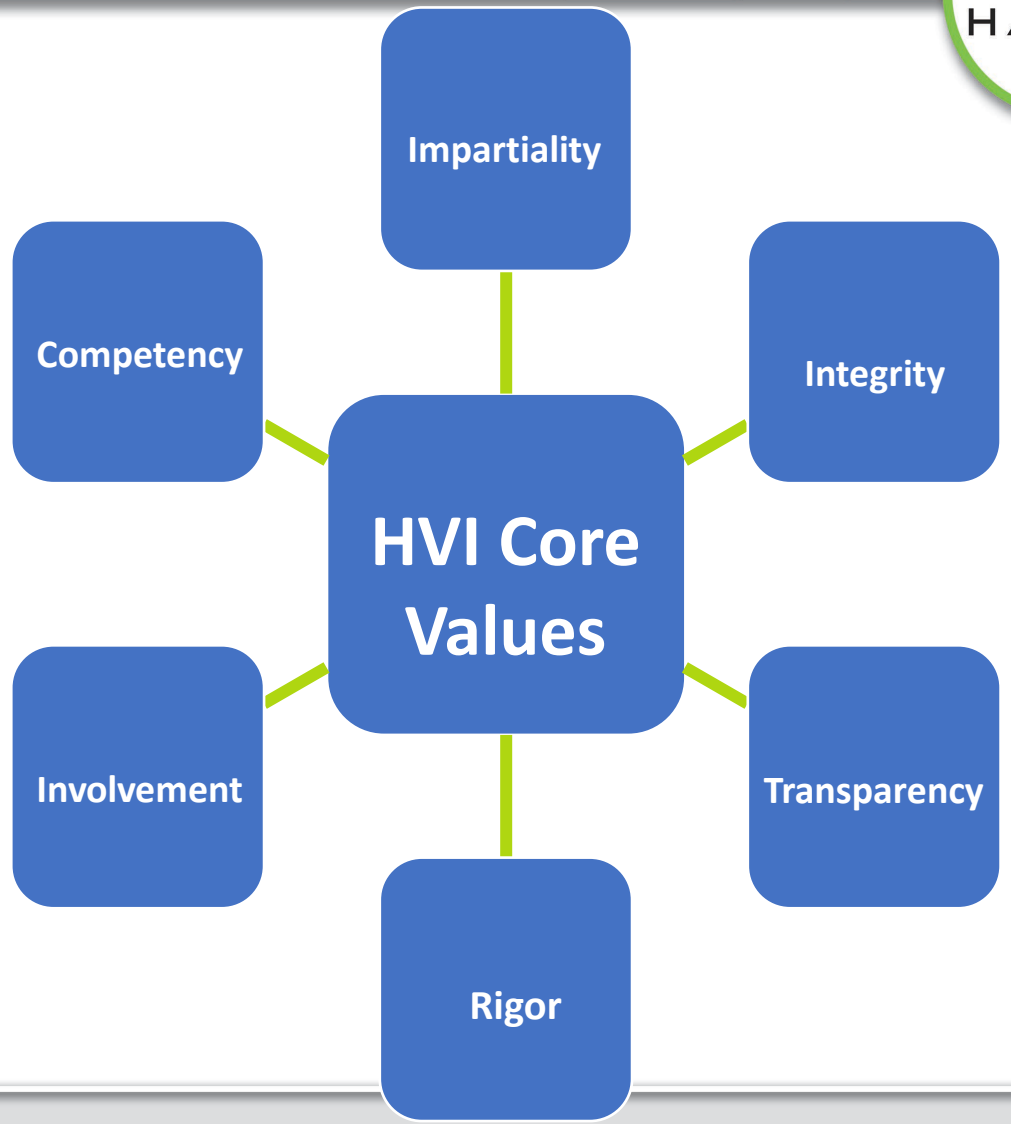
To make indoor air healthier.

HVI Product Categories

- Product Categories include:
  - Bathroom Exhaust Fans
  - Kitchen Range Hoods
  - Inline Fans
  - Heat & Energy Recovery Ventilators (H/ERVs)
  - More…

- Certified Ratings include:
  - Airflow
  - Sound
  - Energy-to-run-fan (Power)
  - More…

HVI Core Values



HVI Stakeholder & Partner Organizations

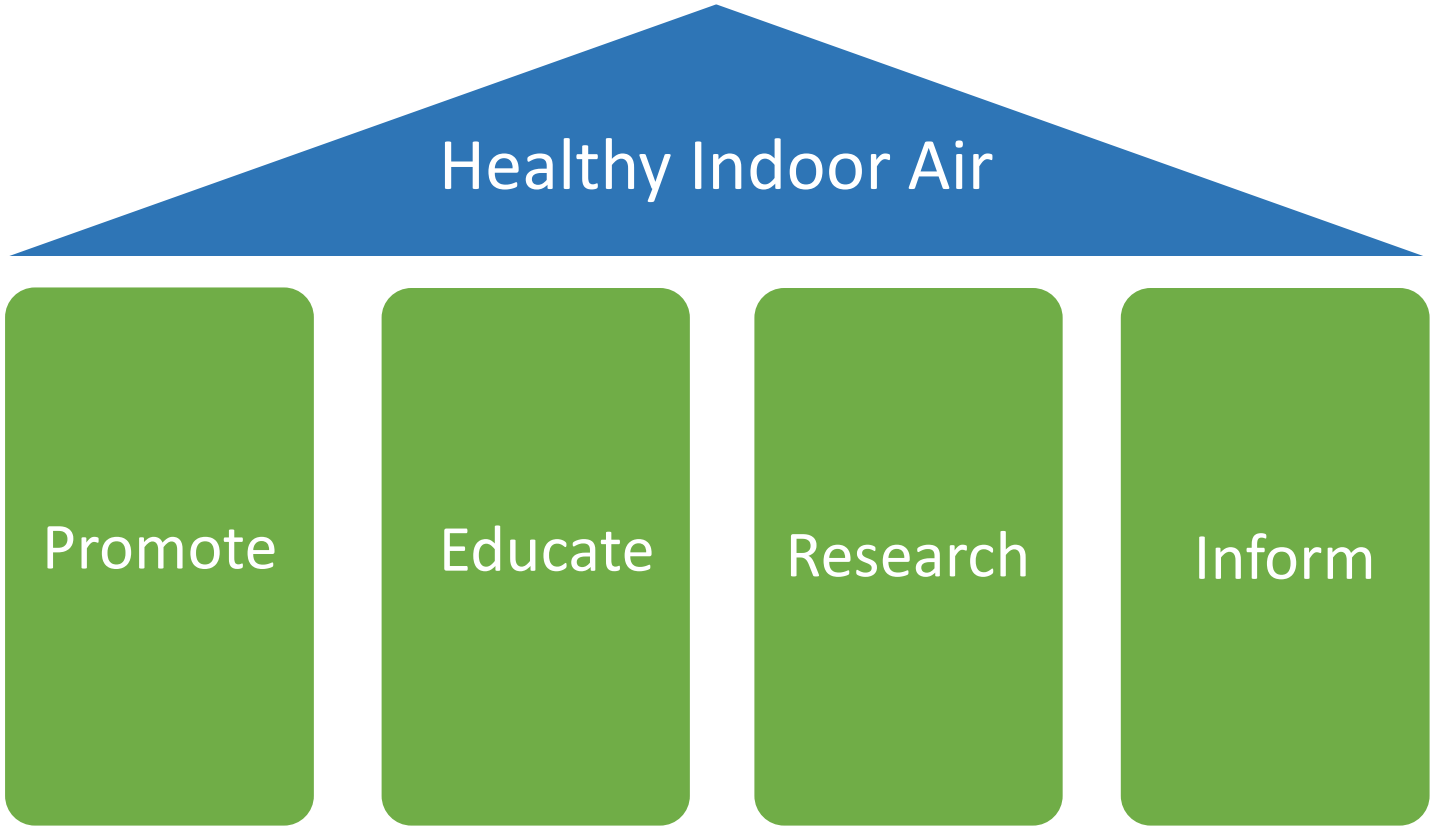
Stakeholder Organizations:

- American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)
- California Energy Commission (CEC)
- EPA ENERGY STAR
- EPA Indoor airPLUS
- Department of Energy (DOE)
- International Code Council (ICC)
- Indoor Air Quality Association (IAQA)
- Residential Energy Services Network (RESNET)
- Energy & Environmental Building Alliance (EEBA)

Healthy Air Research & Certification Authority (HARCA)

- HVI affiliate
- Provides oversight and risk assessment of the HVI Certified Ratings Program
- Founded in 2015
- Governed by a balanced BOD of industry stakeholders:
  - Manufacturers
  - Contractors/Installers
  - Trade Association
  - Building Science
  - Industry Education
  - Testing Laboratories
- Providing partial funding for IAQ Sensor ASTM standard development

HARCA Mission

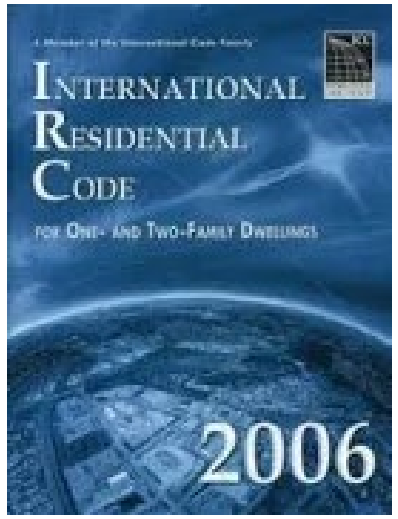


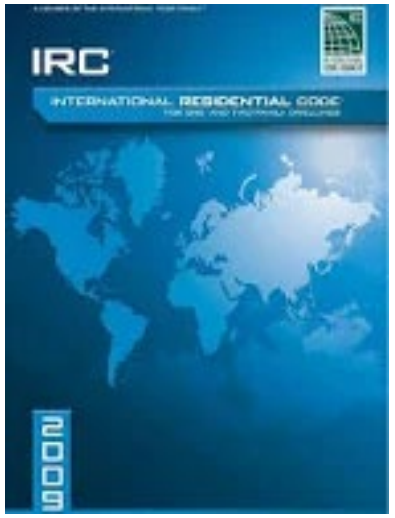
Regulatory Considerations

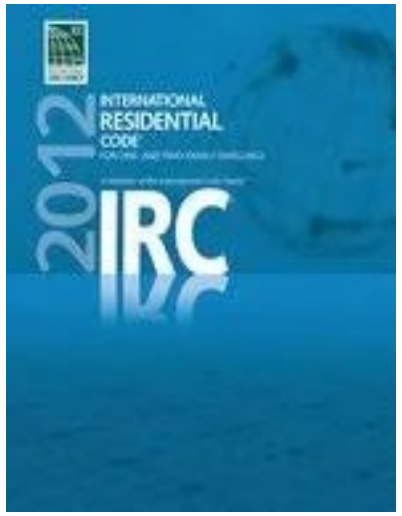
“Why do we need codes and standards in ventilation?”

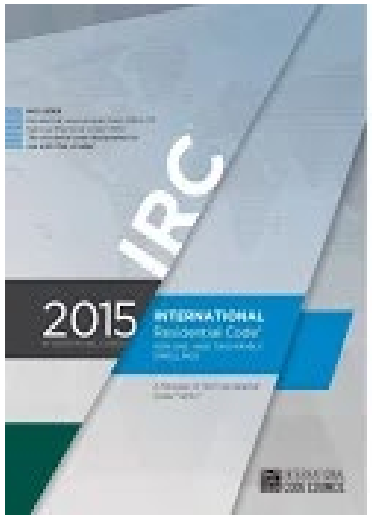
Without them, we would revert to the wild west!

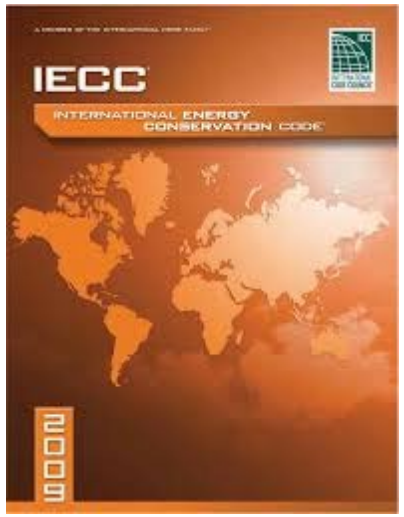
Codes tell you WHAT to do…

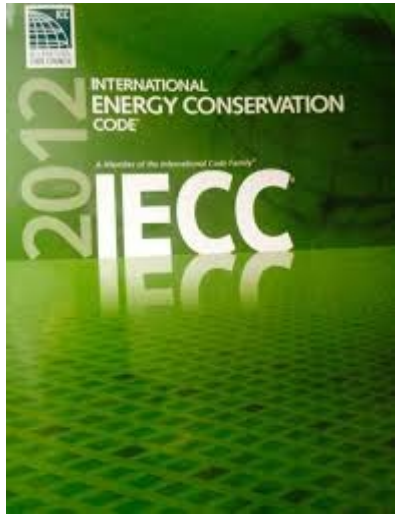


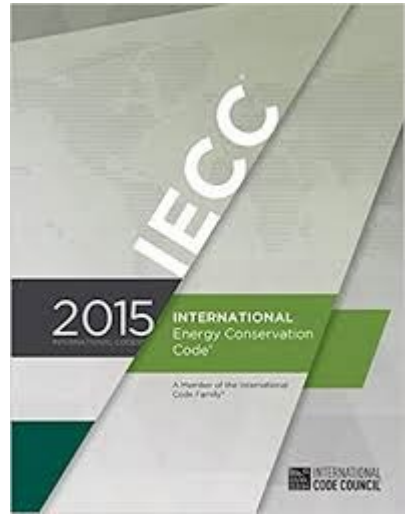




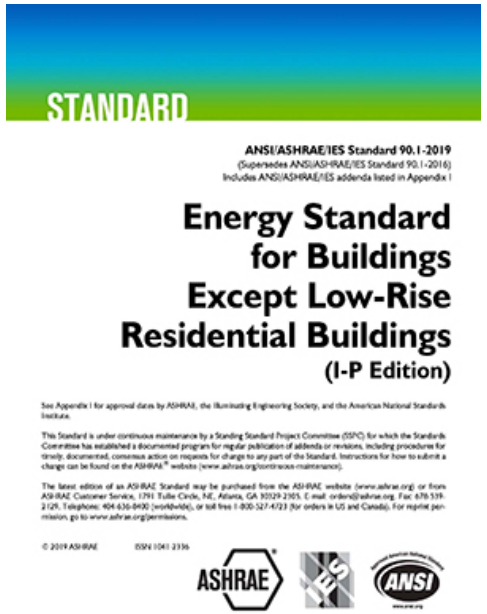


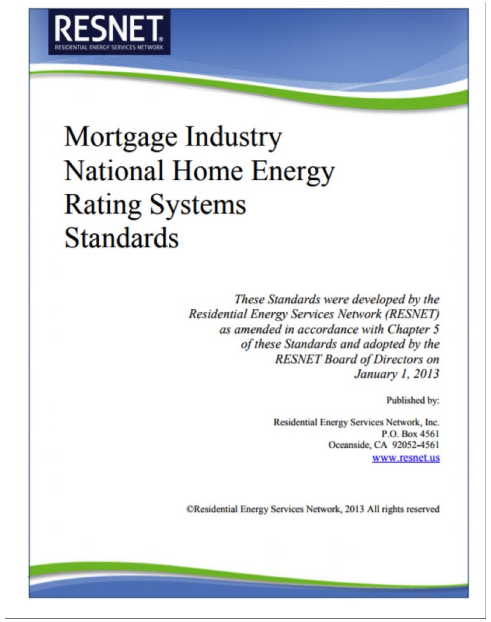




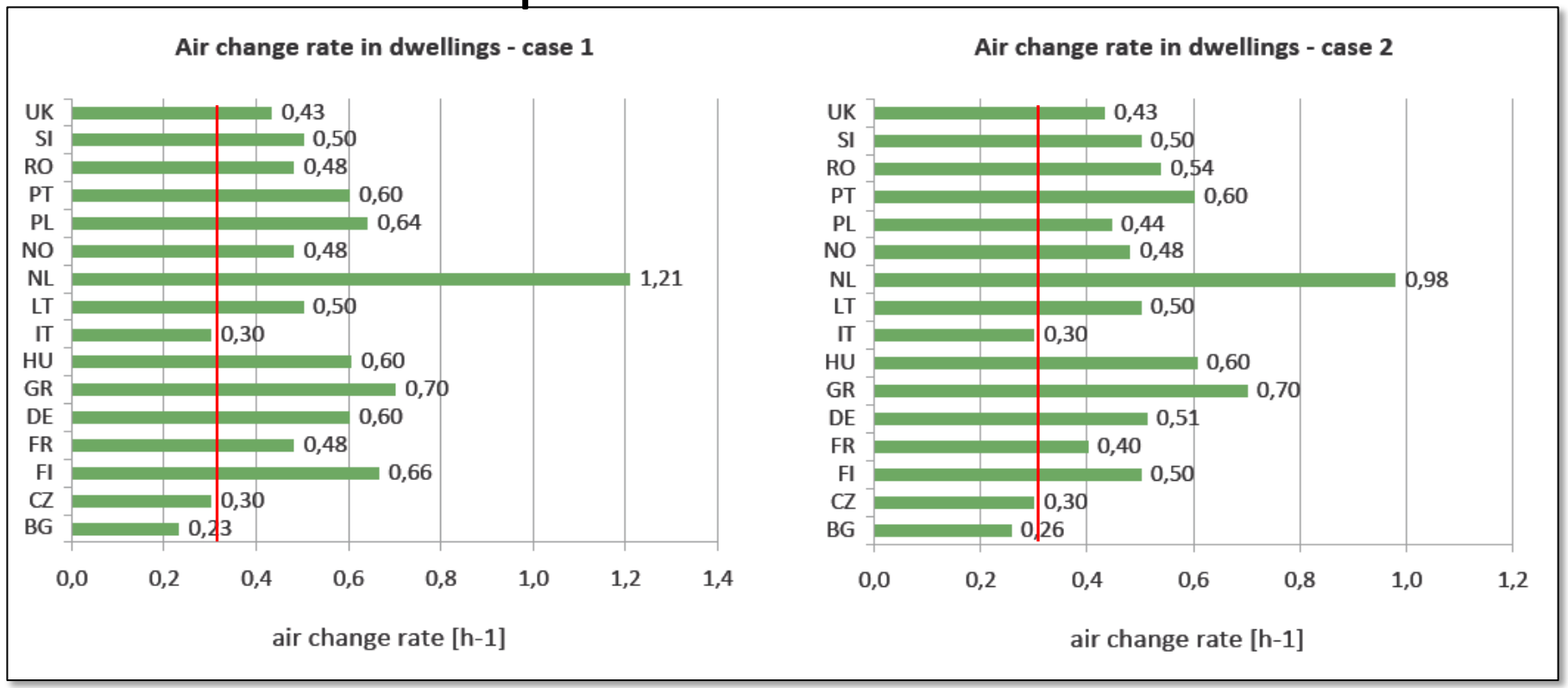


Standards tell you HOW to do it… (typically minimal)





European Ventilation Rates



ASHRAE 62.2-2016 rate ~ 0.3 – 0.35 ach

Source: Ventilation Rates and IAQ in National Regulations, Nejc Brelih, AIVC Conference, October 2011, Brussels, Belgium.

Courtesy: Rick Karg

IAQ and Ventilation in Perspective

- Structures have become tighter with lower infiltration rates.
- In early 1900s, there were approximately 50 materials used for construction. Less than 100 years later, this list has grown to about?

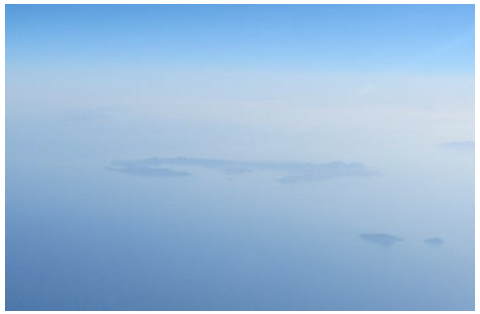
  55,000![+]
- High moisture can trigger asthma attacks.[++]

[+] Raw GJ. *Sick building syndrome: a review of the evidence on causes and solutions*. HSE Contract Research Report no. 42. Building Research Establishment, Garson Watford, 1992.

[++] ERT Associates. *Asthma and weatherization in Maine*. National Center for Heathy Housing, 2006.

Trivia

- How much water do we drink daily?
  - 4 lbs.
- How much food do we eat daily?
  - 4 lbs.
- How much air do we breathe daily?
  - 31 lbs., 405 cu ft

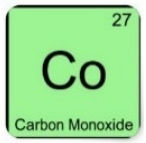


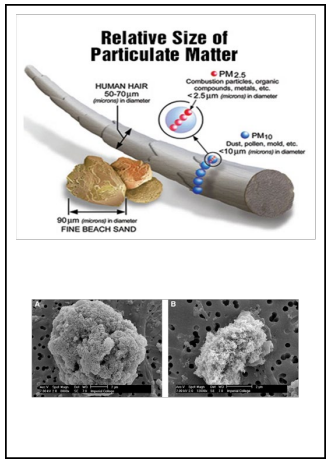
Why Ventilate - Contaminants

- What always comes to mind
  - Moisture and Mold
  - Odor

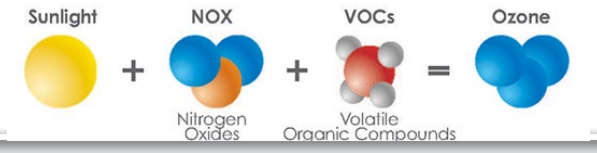


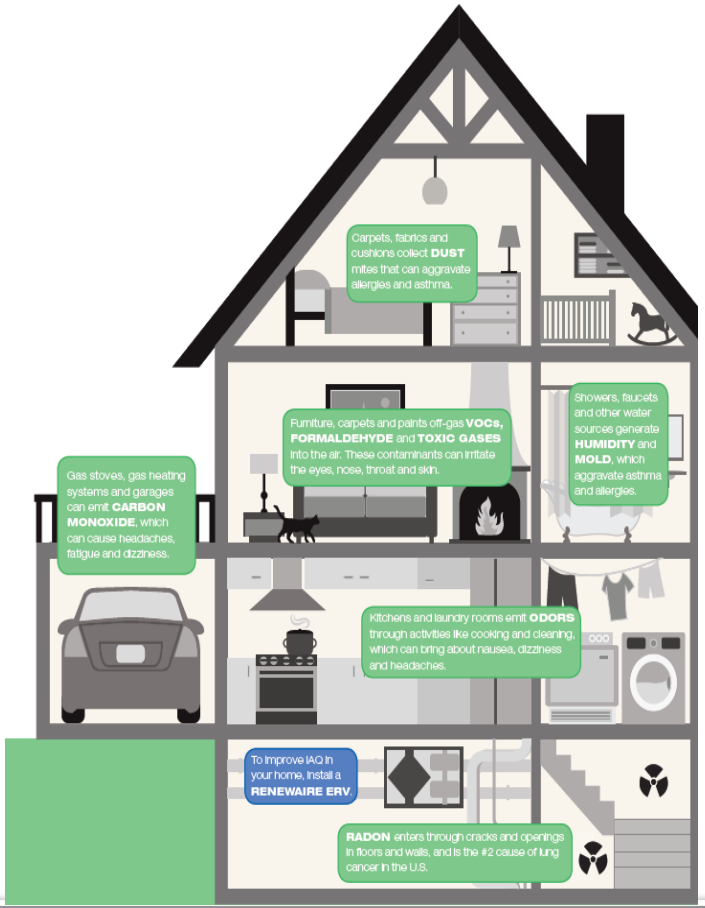
- What often comes to mind
  - Carbon Monoxide
  - Carbon Dioxide
  - Radon





- What occasionally comes to mind
  - Particles (PM2.5)
  - Nitrogen Dioxide
  - Formaldehyde
  - Ozone
  - **TVOC or SVOC**





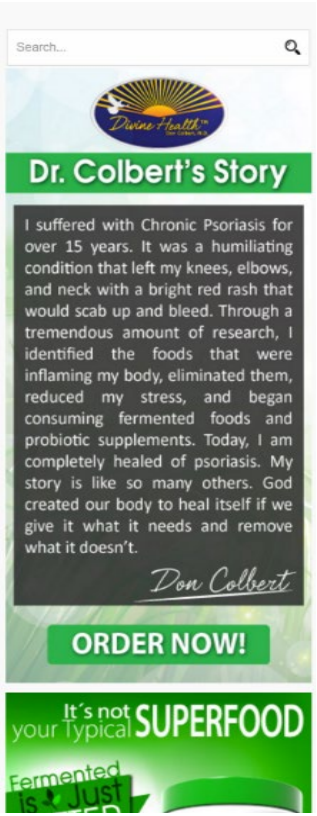
IAQ – It does not stop there

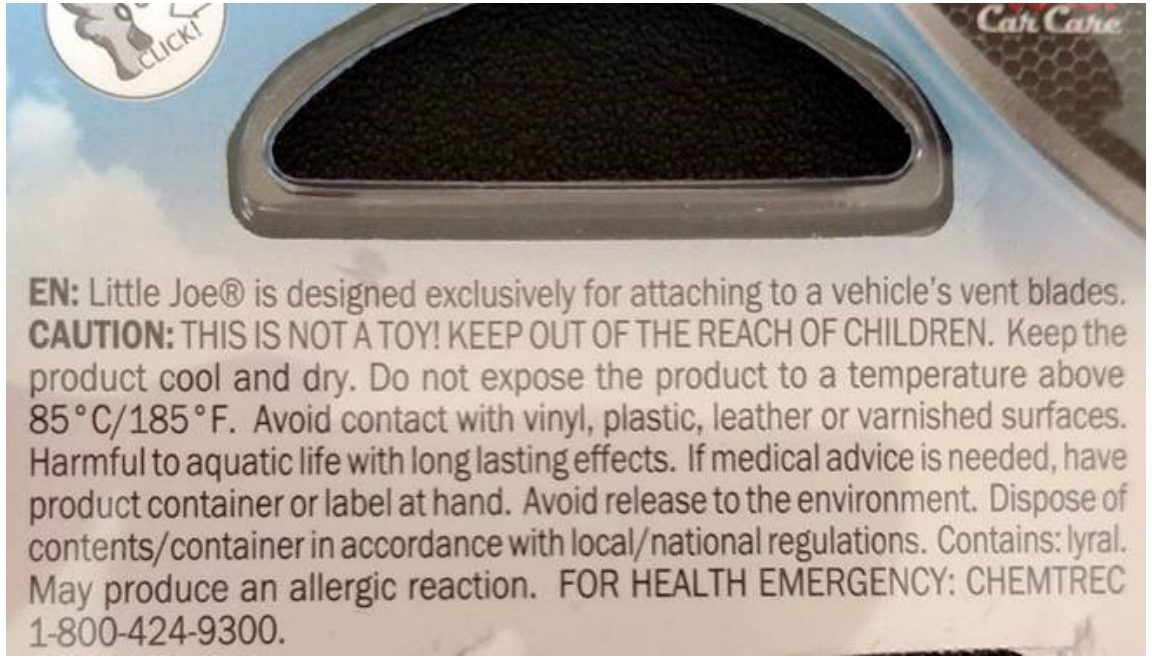
STUDY: ALARMING RESULTS FOUND IN SCENTED LAUNDRY DETERGENTS

11 APR, 2016 2407 AUTHOR: DR. DON COLBERT Share 19

Air Quality, Atmosphere, & Health recently published a study concerning air dryer vent emissions. Top selling products were used in the research project including scented laundry detergent and dryer sheets. The main researcher who found carcinogens in the liquid and sheets also led the dryer vent study.

Cancer Causing Concerns





Source: 11 APR, 2016 author: Dr. Don Colbert

CO_2 - Surrogate or CoC?

The effects of bedroom air quality on sleep and next-day performance

P. Strøm-Tejsen, D. Zukowska, P. Wargocki and D.P. Wyon.

International Centre for Indoor Environment and Energy, Department of Civil Engineering, Technical University of Denmark

Corresponding author mail id: peterstromtejsen@gmail.com

Abstract

The effects of bedroom air quality on sleep and next-day performance were examined in two field intervention experiments in single-occupancy student dormitory rooms. The occupants, half of them women, could adjust an electric heater to maintain thermal comfort but they experienced two bedroom ventilation conditions, each maintained for one week, in balanced order. In the initial pilot experiment (N=14) bedroom ventilation was changed by opening a window (the resulting average CO_2 level was 2585 or 660 ppm). In the second experiment (N=16) an inaudible fan in the air intake vent was either disabled or

Pawel Wargocki
>20 years of experience in research & monitoring of human requirements in buildin...
2w

Interview in ASHRAE Newsletter

ASHRAE JOURNAL Newsletter

Connecting Today's To Peer-Reviewed C

Volume 1, Number 18, October 10, 2017

Indoor Air Quality

Adjust Your Thermostat, Sleep Better

How Indoor Air Quality Tactics Help You Sleep Better at Night

A study revealed how increasing the clean outdoor air supply rate in bedrooms can improve sleep quality. Pawel Wargocki, Ph.D., Associate Member ASHRAE, of Denmark, discusses the study and how people can manipulate bedrooms' indoor air quality to help them get to sleep faster, stay asleep and be more productive the next day. In a *Journal* article from March 2013, Wargocki and David P. Wyon, Ph.D., Member ASHRAE, answer 40 questions about the effects of thermal comfort and indoor air quality on performance.

In this study, Wargocki and other researchers studied how well college students slept in different ventilation conditions.

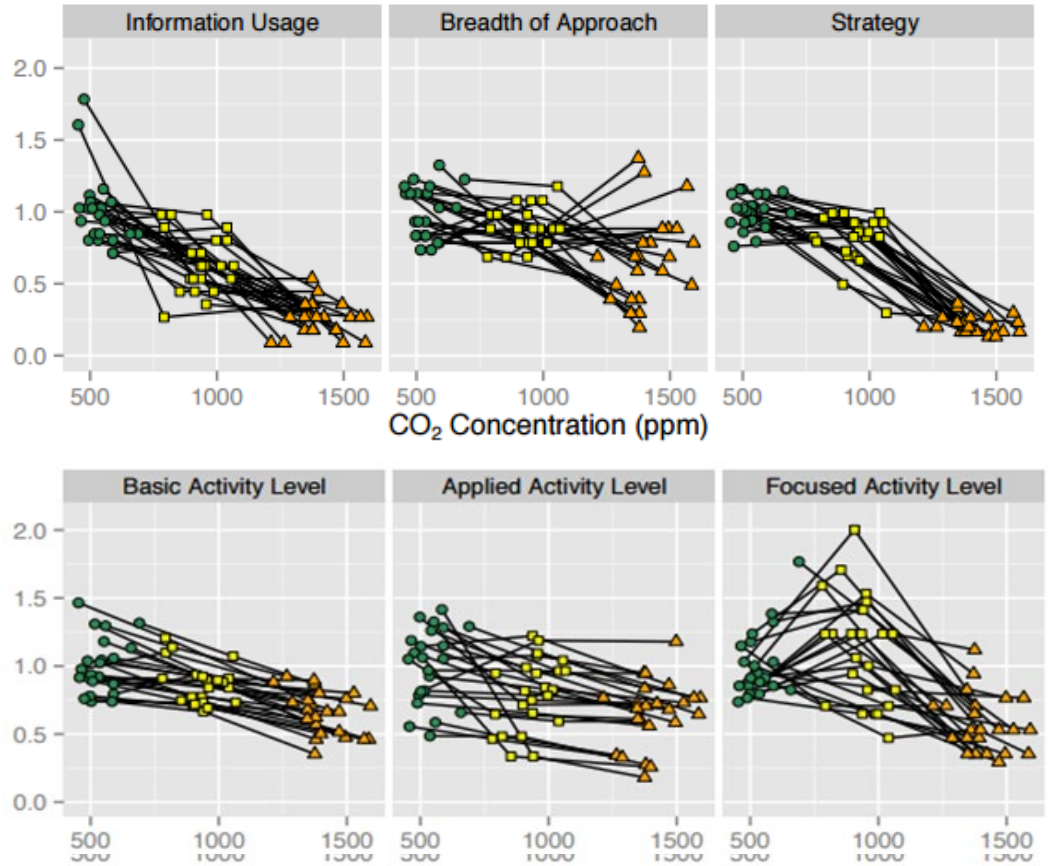
Effects of Prolonged CO_2 Exposure

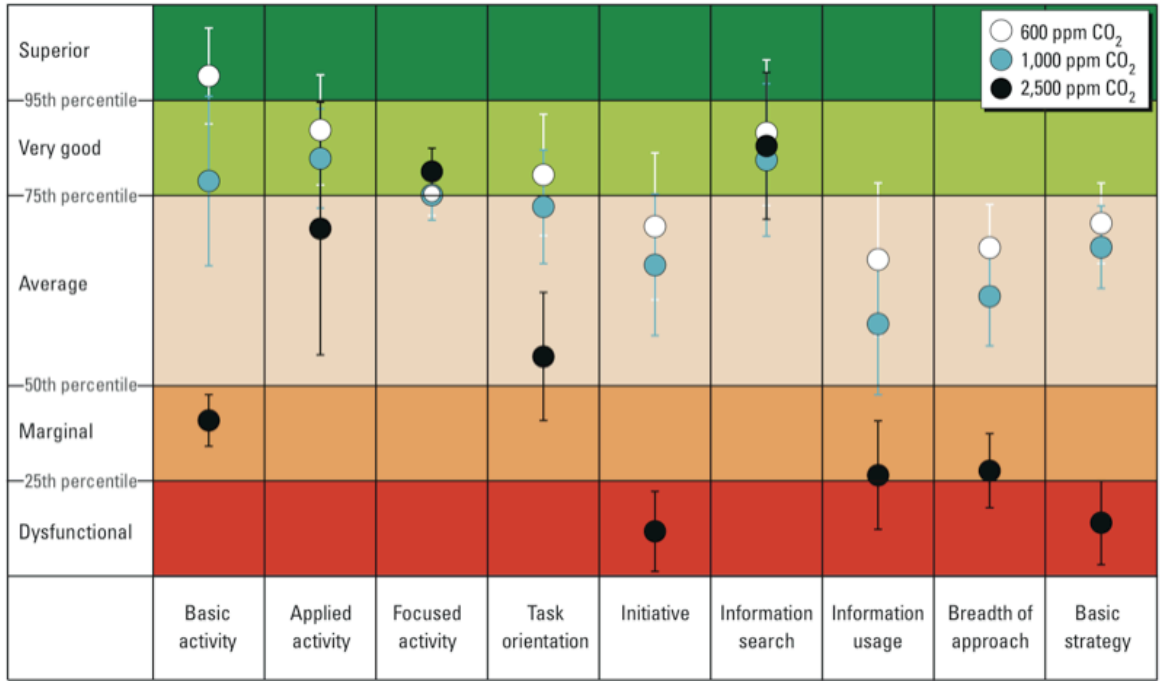
- At rest, humans generate 200ml of CO_2 per minute and 4.0L/min at maxima exercise (Williams 2009).
- Respiratory Acidosis occurs few mins after exposure to CO_2
- Leads to Pulmonary Response
- CO_2 is a potent vasodilator of cerebral blood vessels
- Elevated CO_2 levels lead to Renal Calculi

The effects of CO_2 toxicity can include dyspnea, increased respiratory and heart rate, headache, decreased alertness, anxiety, dizziness, muscle twitching, coma, or death. Symptom severity is related to the concentration of CO_2 and the length of the exposure. Headache is the symptom most commonly reported by ISS flight crew, typically when levels reach 0.7% CO_2 (5 mmHg) (Carr 2006).

Source: Chronic Exposure to Moderately Elevated CO_2 during Long-Duration Space Flights

CO_2 Friend or Foe – Continued Research





PEER REVIEW

Source: Satish et al. (2012) Is CO2 an Indoor Pollutant? Direct Effects of Low-to-Moderate CO2 Concentrations on Human Decision-Making Performance
Source: Allen et al (2015) Associations of Cognitive Function Scores with Carbon Dioxide, Ventilation, and Volatile Organic Compound Exposures in Office Workers

US DOE Ventilation Study

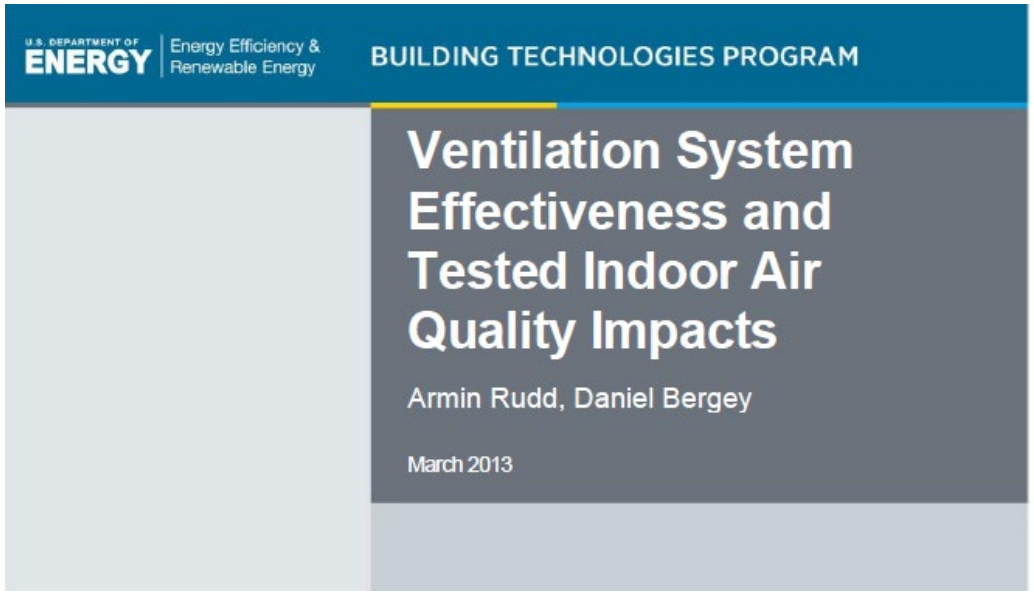
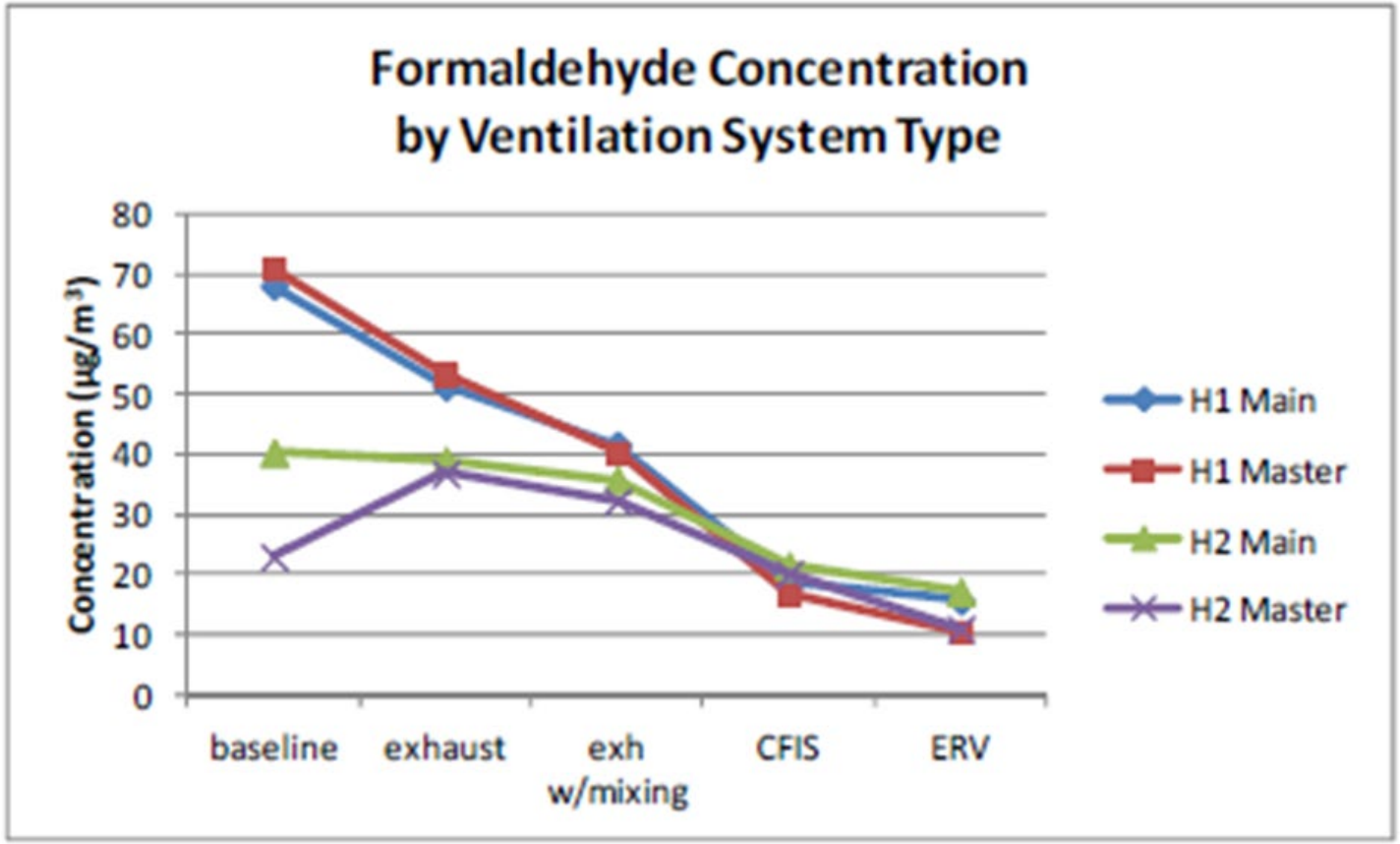
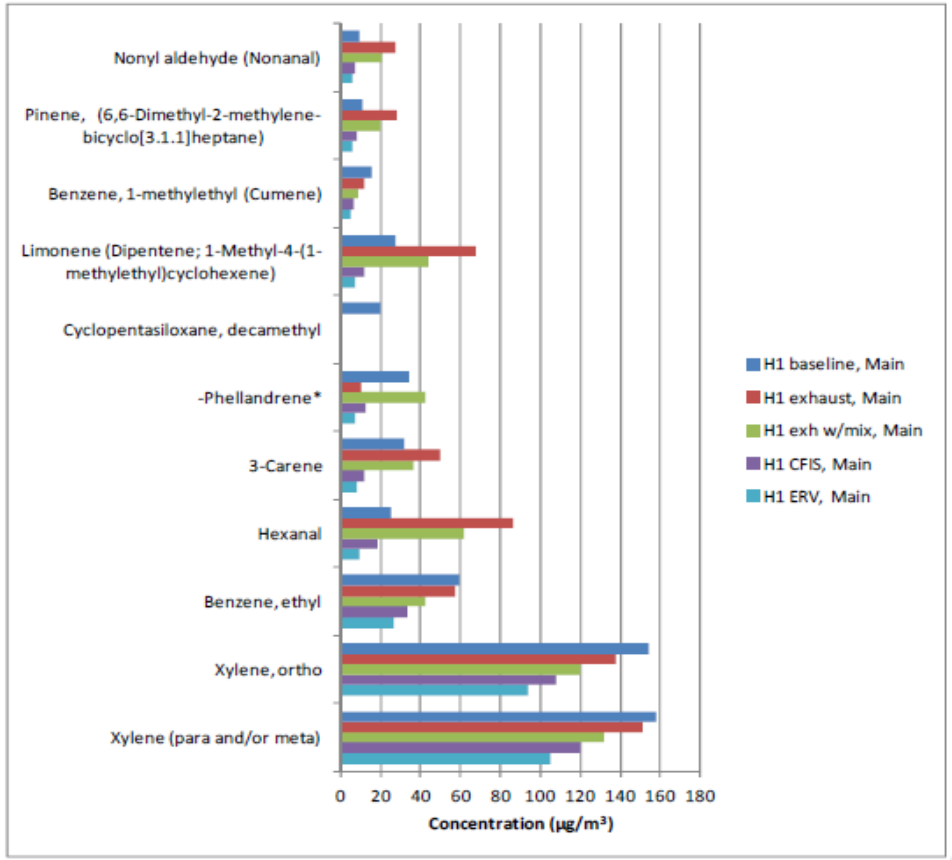


Table 2. Test number, name, and description of the five tests conducted in each house

Test Number	Test Name	Test Description
1	Baseline	No ventilation, bedroom doors closed, no central fan operation
2	Exhaust	Exhaust ventilation from master bathroom, bathroom door open to bedroom, bedroom doors closed, no central fan operation
3	Exh w/mixing	Exhaust ventilation from master bathroom, bathroom door open to bedroom, bedroom doors closed, 20% central fan operation (48 off / 12 on)
4	CFIS	Central-fan-integrated supply (CFIS) ventilation, bedrooms closed, 33% central fan duty cycle (20 off / 10 on)
5	ERV	Balanced (ERV) ventilation, bedrooms closed, no central fan operation

US DOE Ventilation Study



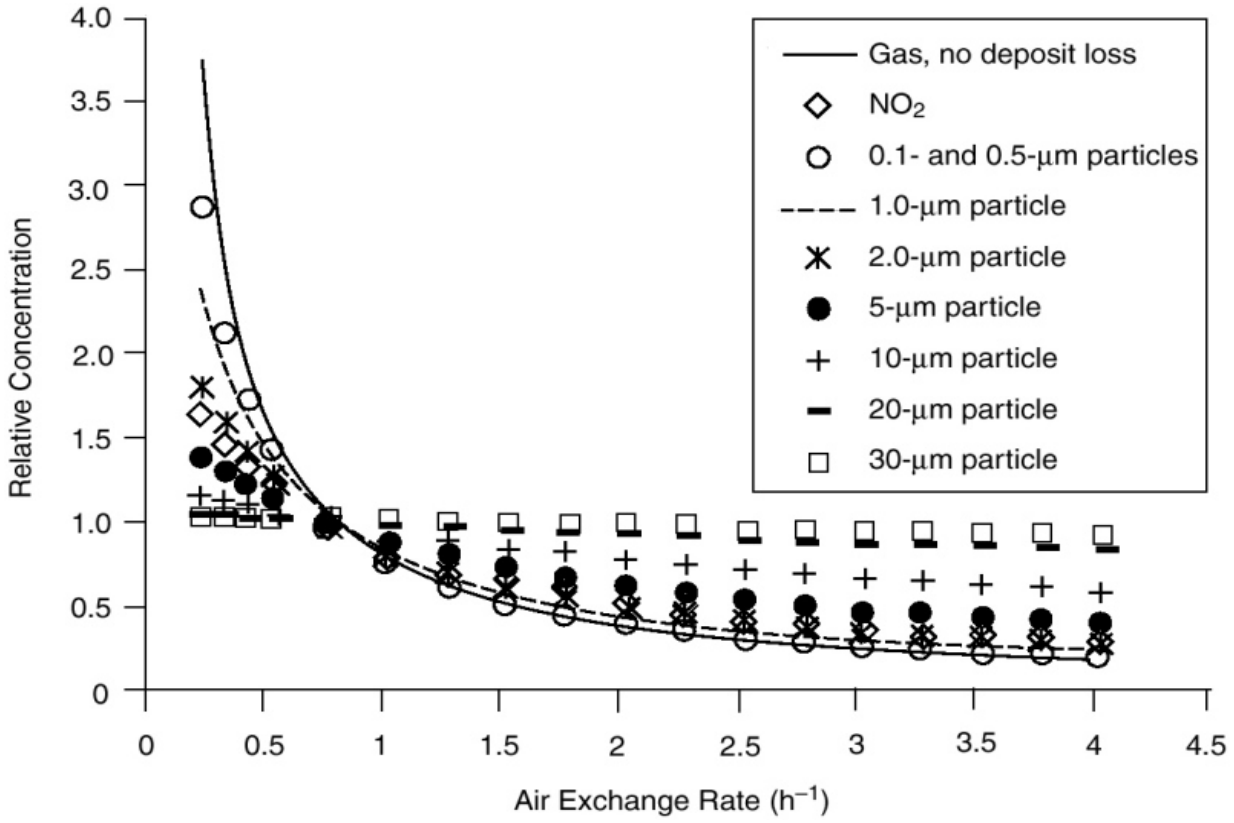


Enhancing IAQ

METHODS TO ENHANCE IAQ

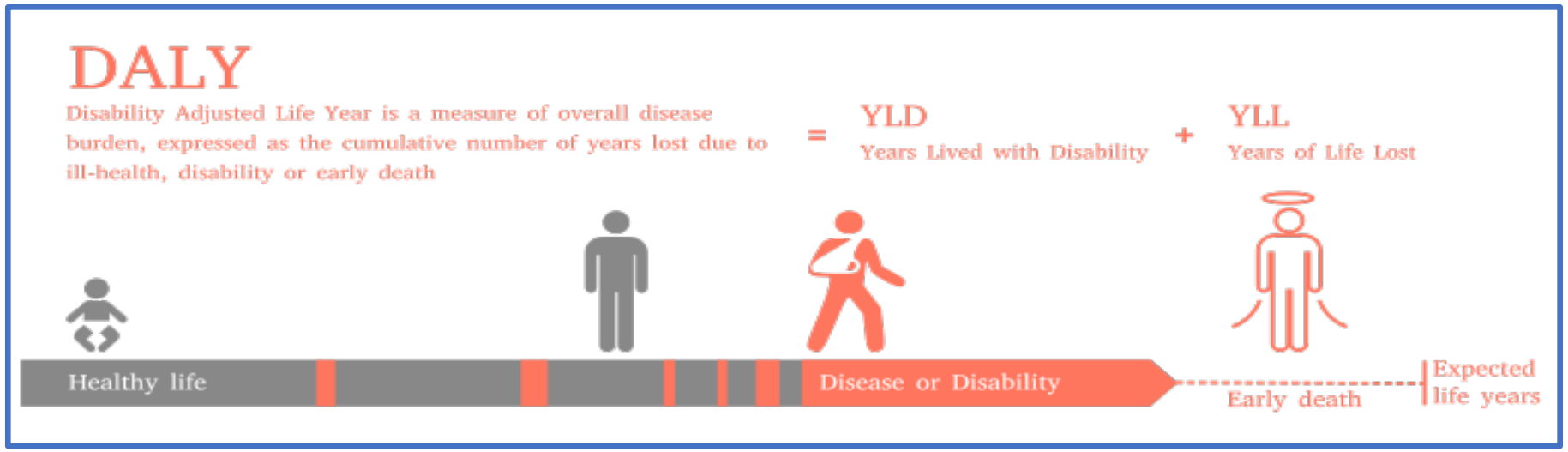
- Minimize Chemical Pollutants
- Moisture Control
- Filtration
- Proper Maintenance of HVAC Systems
- **Improved Ventilation – Simplest and Most Cost-effective Method**

"Ventilation is providing for acceptable IAQ through the simultaneous exhaust of stale air and supply of fresh outdoor air."

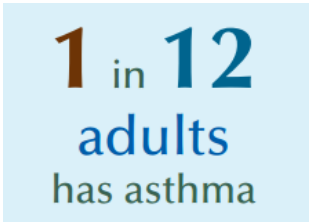


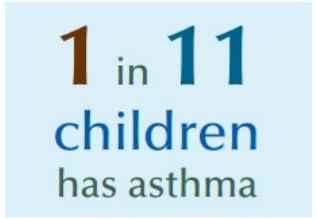
Source: Institute of Medicine (US) Committee on the Assessment of Asthma and Indoor Air. Washington (DC): National Academies Press (US) ; 2000.

Cost of Poor IAQ - DALY

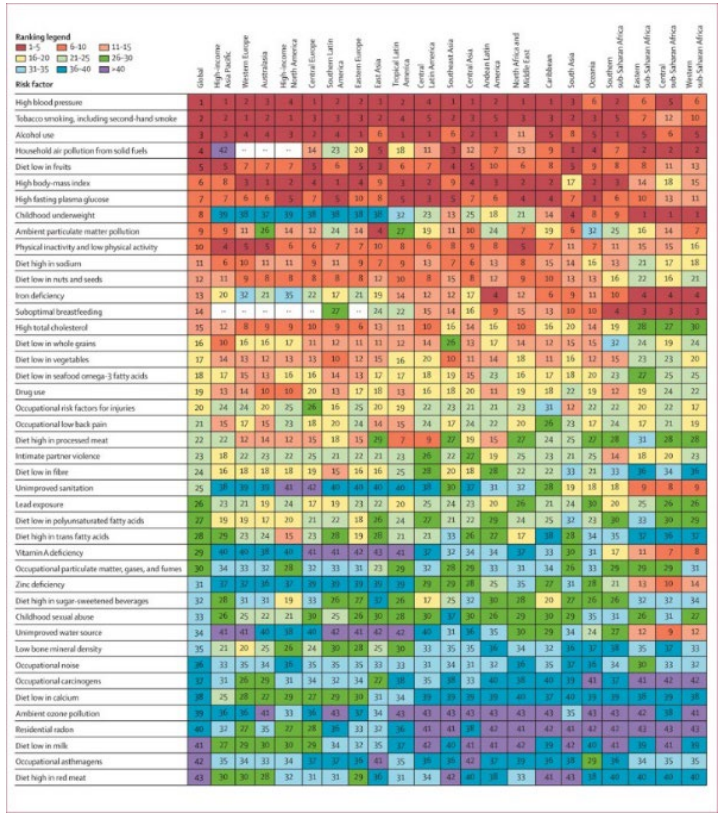


- Asthma
- Damage to Liver Kidneys and Central Nervous System
- Spread of Communicable Diseases, e.g. SARS
- Body Nervous and Endocrine System Problems



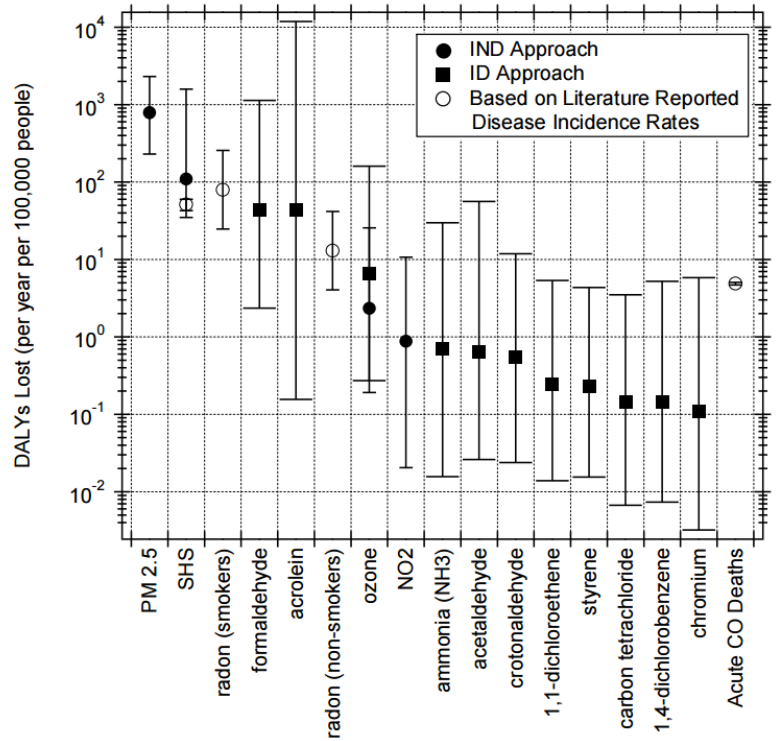


Disease Burden by Various Risks



Ranking legend
1–5 | 6–10 | 11–15
16–20 | 21–25 | 26–30
31–35 | 36–40 | >40

Risk factor	Global	High-income Asia Pacific	Western Europe	Australasia	High-income North America
High blood pressure	1	1	2	3	4
Tobacco smoking, including second-hand smoke	2	2	1	2	1
Alcohol use	3	3	4	4	3
Household air pollution from solid fuels	4	42	..	..	..
Diet low in fruits	5	5	7	7	7
High body-mass index	6	8	3	1	2
High fasting plasma glucose	7	7	6	6	5
Childhood underweight	8	39	38	37	39
Ambient particulate matter pollution	9	9	11	26	14
Physical inactivity and low physical activity	10	4	5	5	6
Diet high in sodium	11	6	10	11	11
Diet low in nuts and seeds	12	11	9	8	8
Iron deficiency	13	20	32	21	35
Suboptimal breastfeeding	14	..	..	..	..



Estimated population averaged annual cost, in DALYs, of chronic air pollutant inhalation in U.S. residences; results for the 15 pollutants with the highest mean damage estimates. [Whiskers indicate aggregate uncertainty (95% confidence)]

Source: Lancet 2012 Dec 15;380(9859):2224-60. doi: 10.1016/S0140-6736(12)61766-8

LBNL DALY and Disease Burden

Table 1. Energy use (E) in 10^{-3} quads and DALYs (D) per 100,000 households per year

Ventilation Cases	*Energy (quads /10^{-3})*	*ΔE ($\Delta E/E_{base\text{-}case}$)*	*DALYs lost (years)*	*ΔD ($\Delta D/ D_{base\text{-}case}$)*
Base Case-Infiltration only	3.5	-----	160	-----
Unbalanced Mechanical Ventilation	4.0	5 (14%)	90	70 (-41%)
Balanced Mechanical Ventilation	4.3	8 (21%)	70	90 (-54%)

Source: Logue et al., Assessment of Indoor Air Quality Benefits and Energy Costs of Mechanical Ventilation, June 2011, LBNL-4945-E

LBNL Study

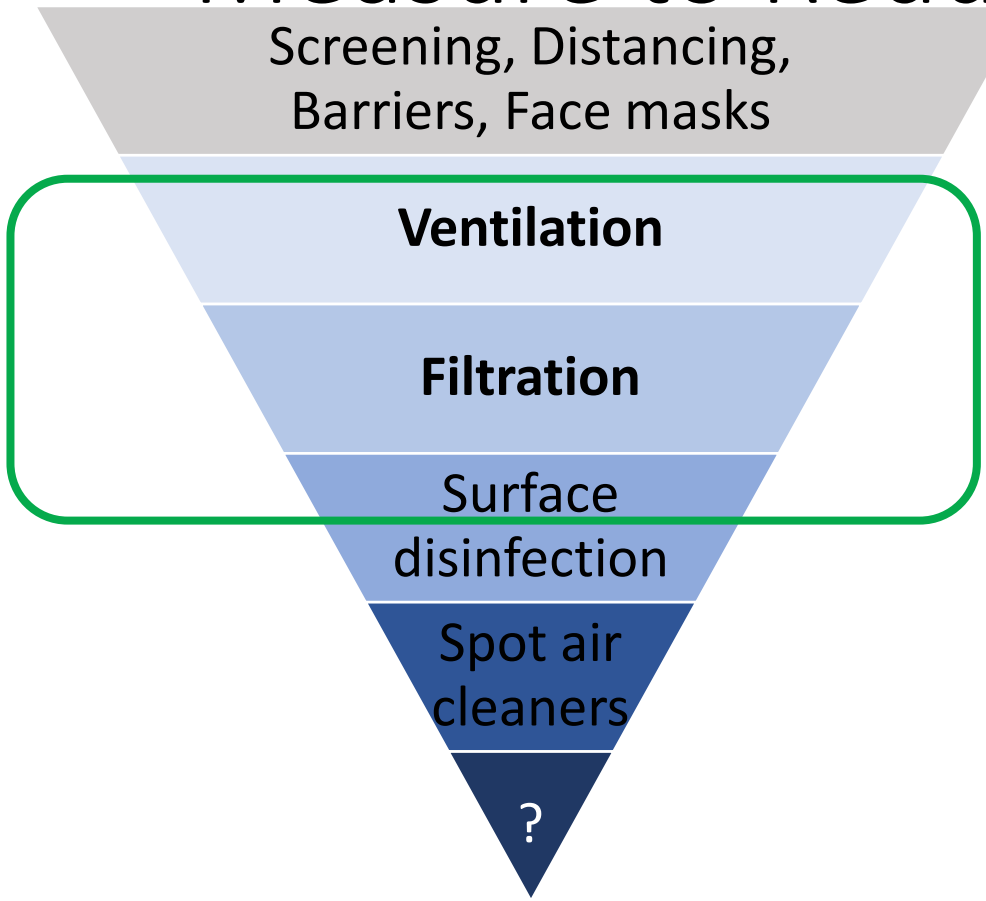
Ventilation Rates and Health
LBNL Indoor Environment Group, 2019

"Overall. . .the number of reported statistically significant improvements in health with increased ventilation rates far exceeded the anticipated chance improvements in health."

Hot Topic

COVID – Specific

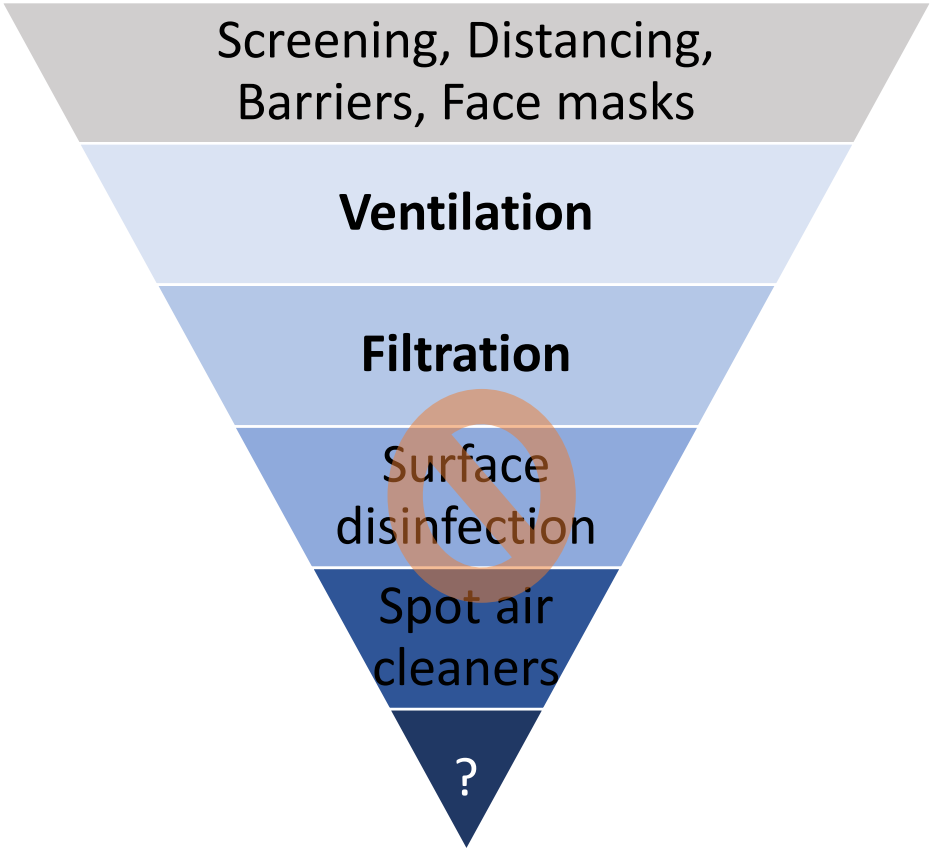
Measure to Reduce Viral Transmission Risk



Exposure = Intensity + Duration + Frequency

- Use your existing HVAC system to minimize transmission risk.
- First optimize the system that you have, then scope the most impactful measures to modify.
- Focus on ventilation and filtration to reduce the concentration of airborne contaminants.

Measure to Reduce Viral Transmission Risk



Exposure = Intensity + Duration + Frequency

New CDC research shows that:

- **The principal mode by which people are infected with SARS-CoV-2 is through exposure to respiratory droplets carrying infectious virus.**
- Surface transmission is not the main route by which SARS-CoV-2 spreads, risk from surfaces is considered low.
  - Surface cleaning with soap and water is enough to reduce risk in most situations.

Reducing the risk of viral transmission

Parameters that impact transmission:

- Temperature
- Relative humidity
- Air changes per hour
- Ventilation
- Particulates

*"**Ventilation and filtration**…**can reduce** the airborne concentration of **SARS-COV-2** and thus the **risk of transmission** through the air"*

– ASHRAE

Transmission modes

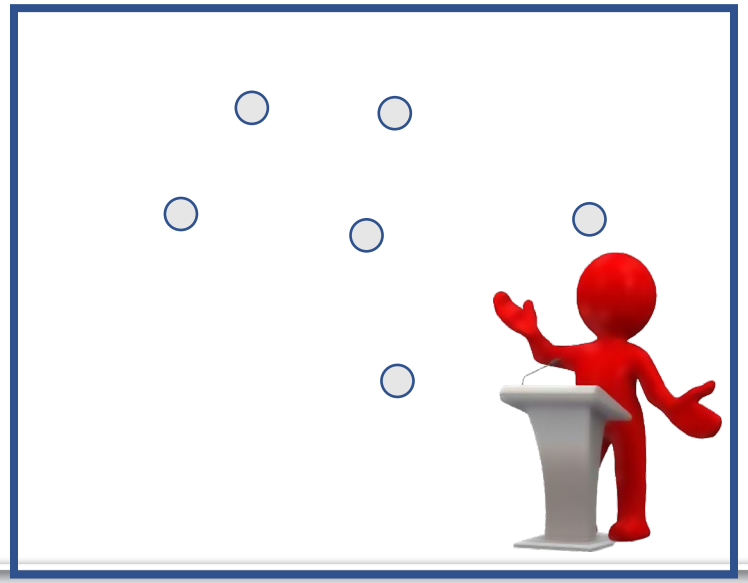
- ✓ Close contact large droplets
- ✓ Long range aerosols
- ~~✓ Fomite transmission~~

Ventilation = Dilution

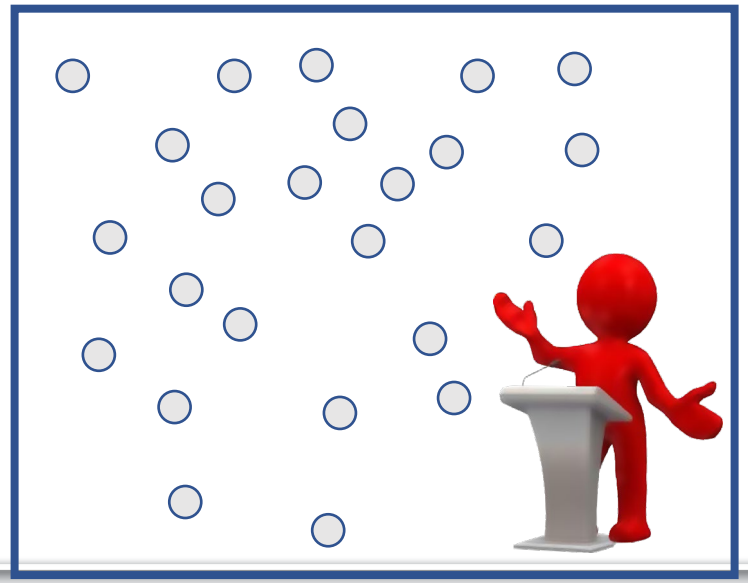
Without ventilation, the aerosols suspended in the air become increasingly concentrated over time.

This is why we get sick in the winter being indoors.

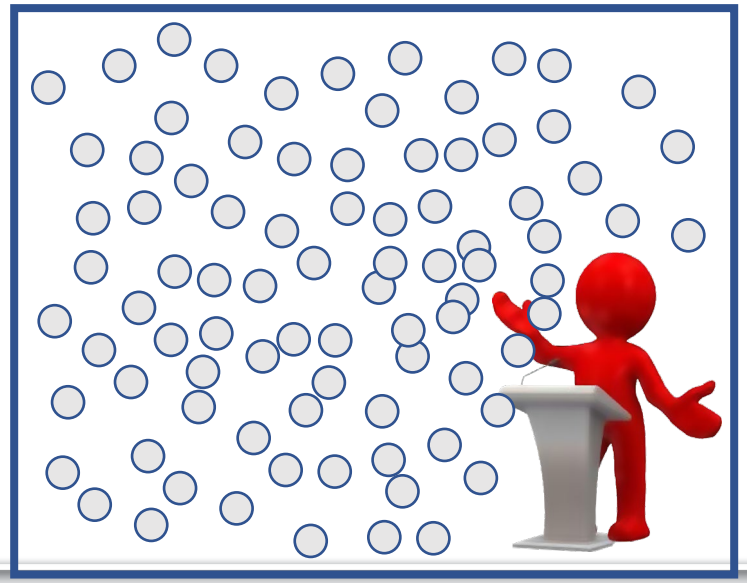
2 Minutes



15 Minutes



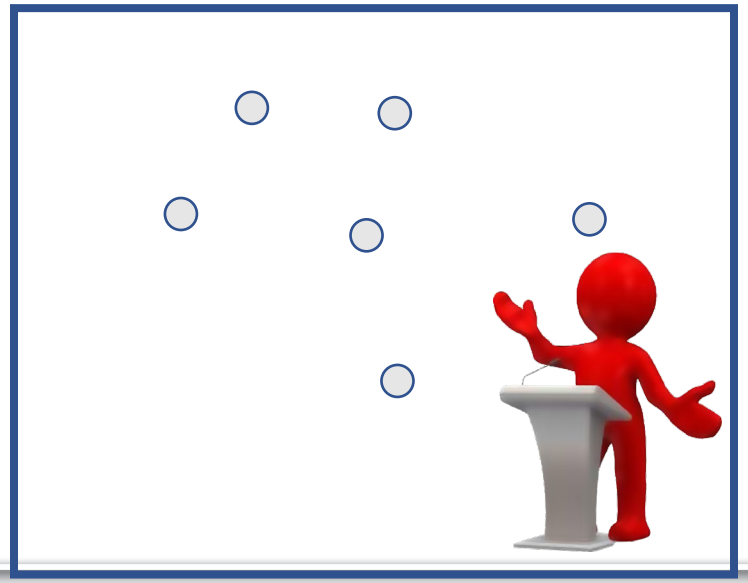
60 Minutes



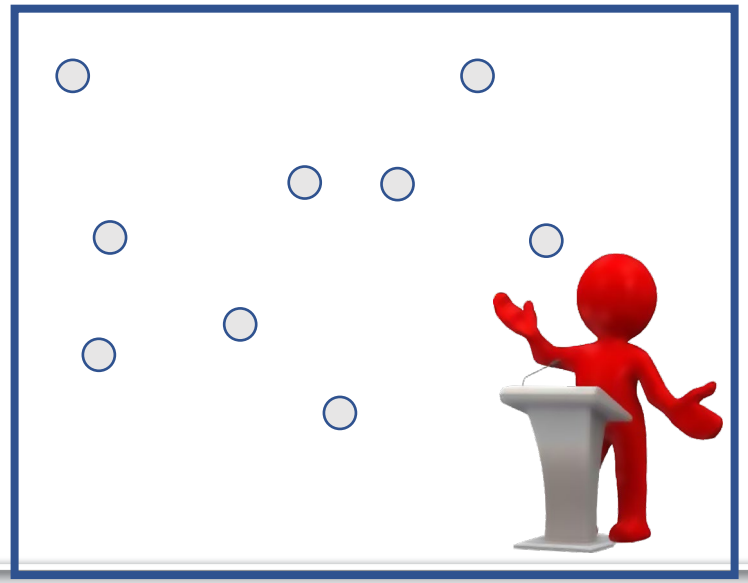
Ventilation = Dilution of Aerosols

With adequate ventilation, the aerosols and CO_2 is continuously diluted, reducing the intensity of exposure.

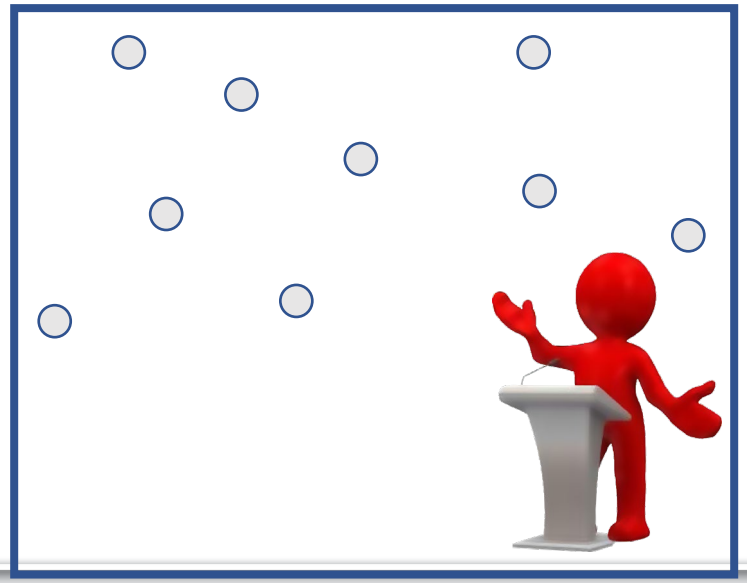
2 Minutes



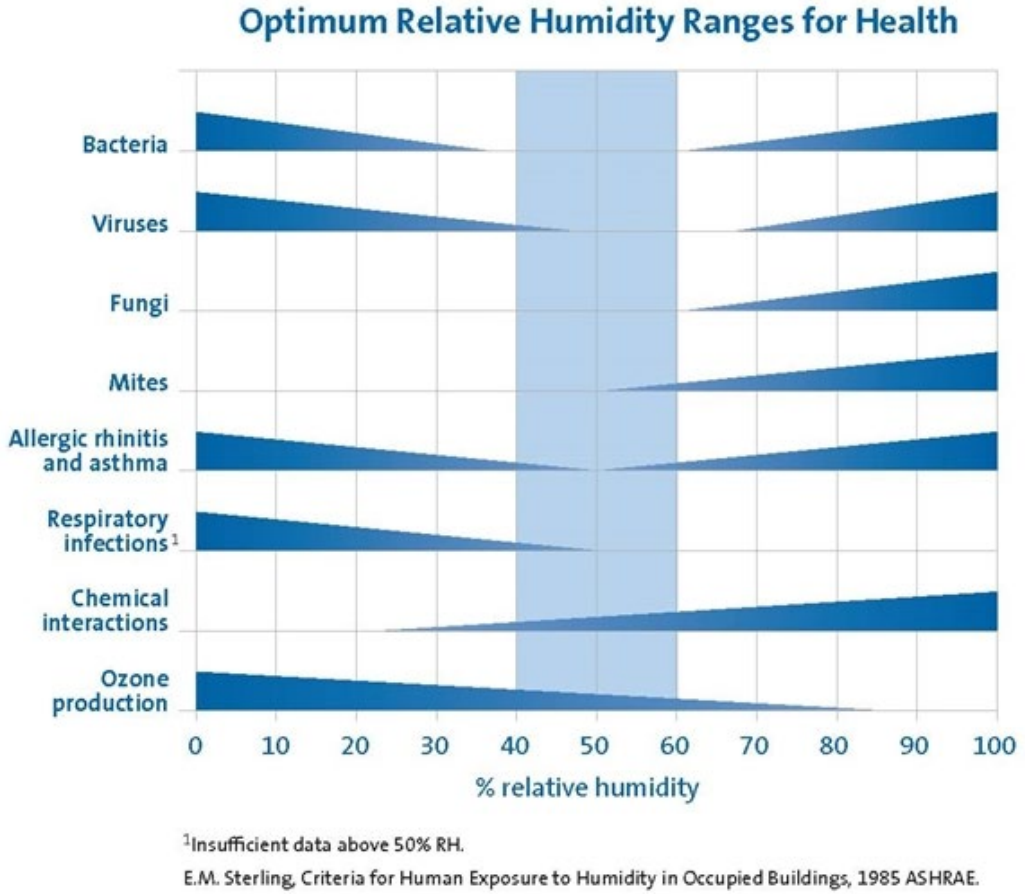
15 Minutes



60 Minutes



Relative Humidity 40-60%



*"**Relative humidity** of 40-60% in buildings **will reduce** respiratory **infections and save lives**."*

– DR. STEPHANIE TAYLOR, 40TO60.COM

Call to Action:

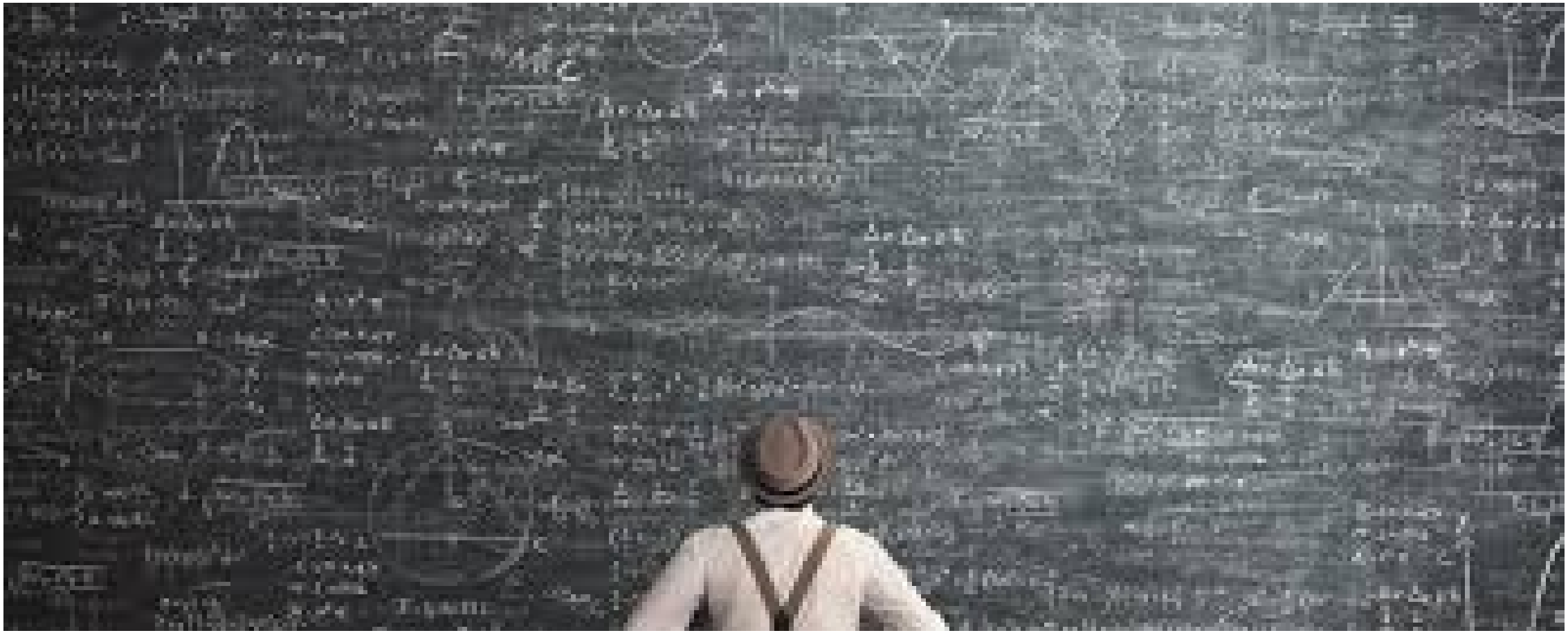
- Don't ignore RH as a design parameter
- Understand that ventilation will impact RH.

Key Take Away Points

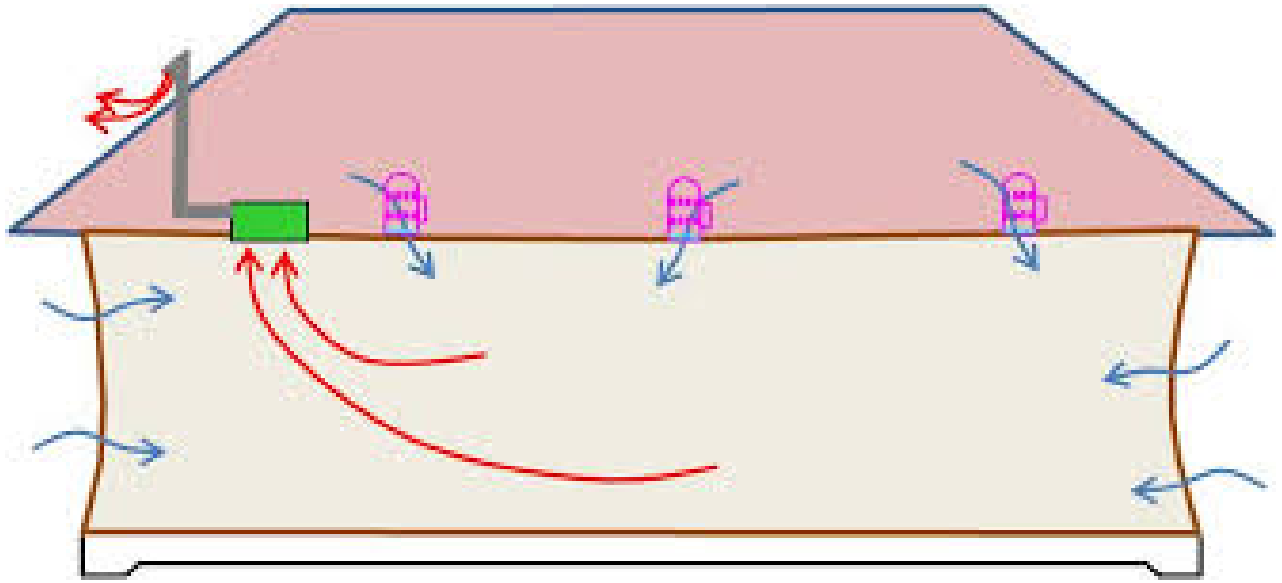
*"**CDC recommends a layered approach** to reduce exposures to SARS-CoV-2, the virus that causes COVID-19. This approach includes using multiple mitigation strategies, **including improvements to building ventilation**, to reduce the spread of disease and lower the risk of exposure."*

Ok, I get it, IAQ is important! So… whatcha gonna do about it?

Ventilation Strategies

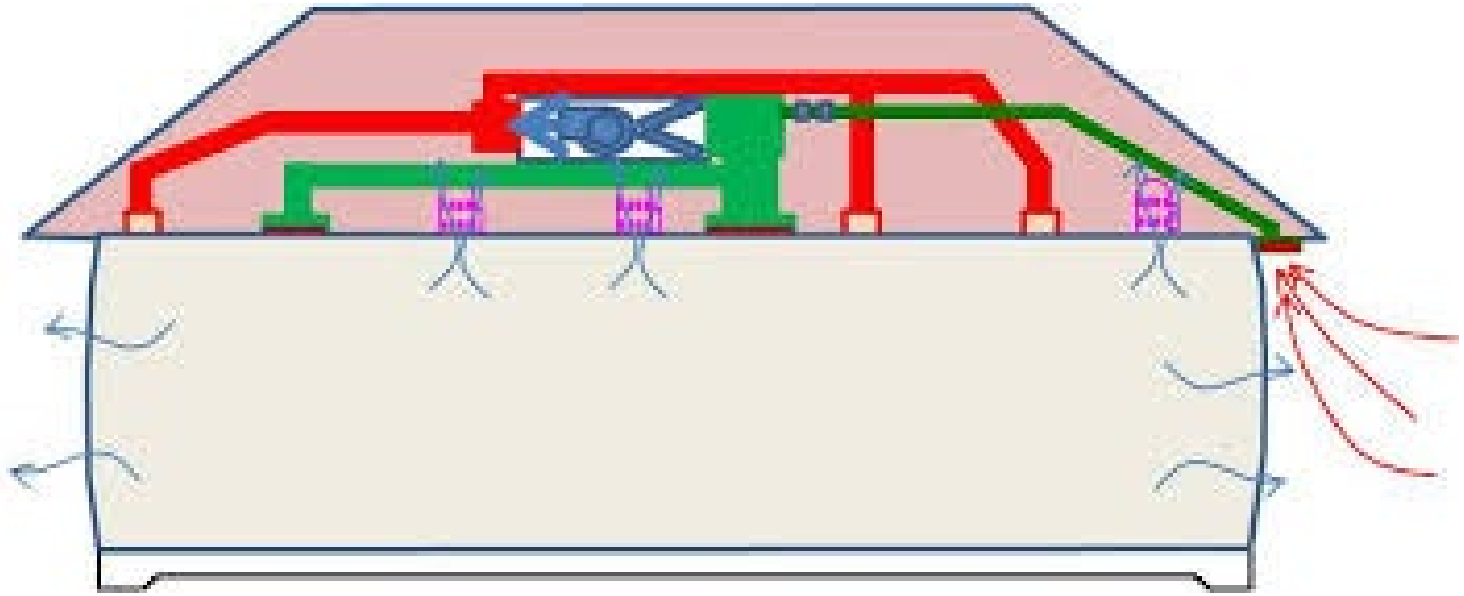


Negative Pressure
Exhaust Only Ventilation



Exhaust only ventilation can work in cold and dry climates, but should be avoided in hot, humid zones.

Positive Pressure Supply Ventilation

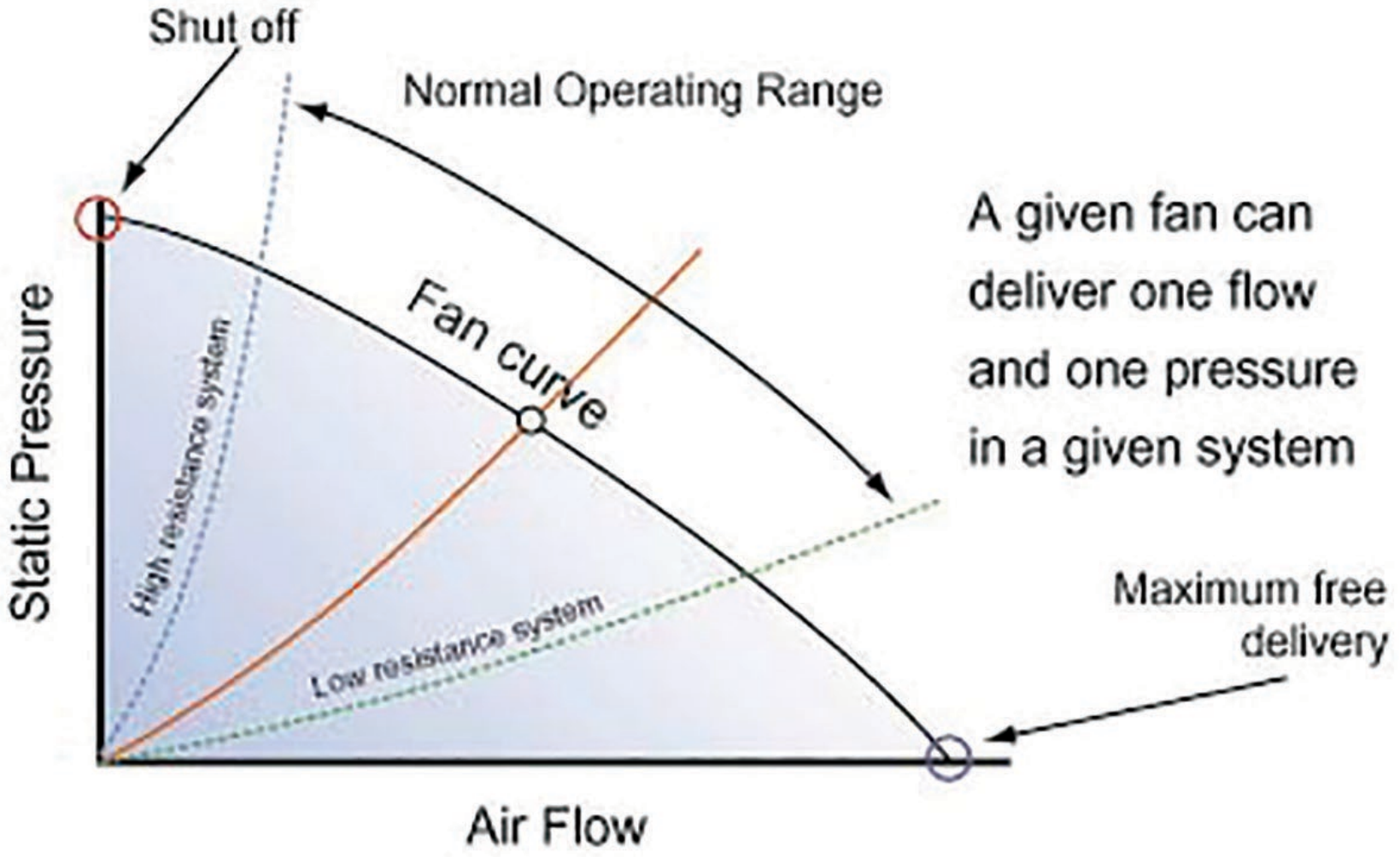


Supply only ventilation can work in hot and humid climates but should be avoided in cold dry climates.

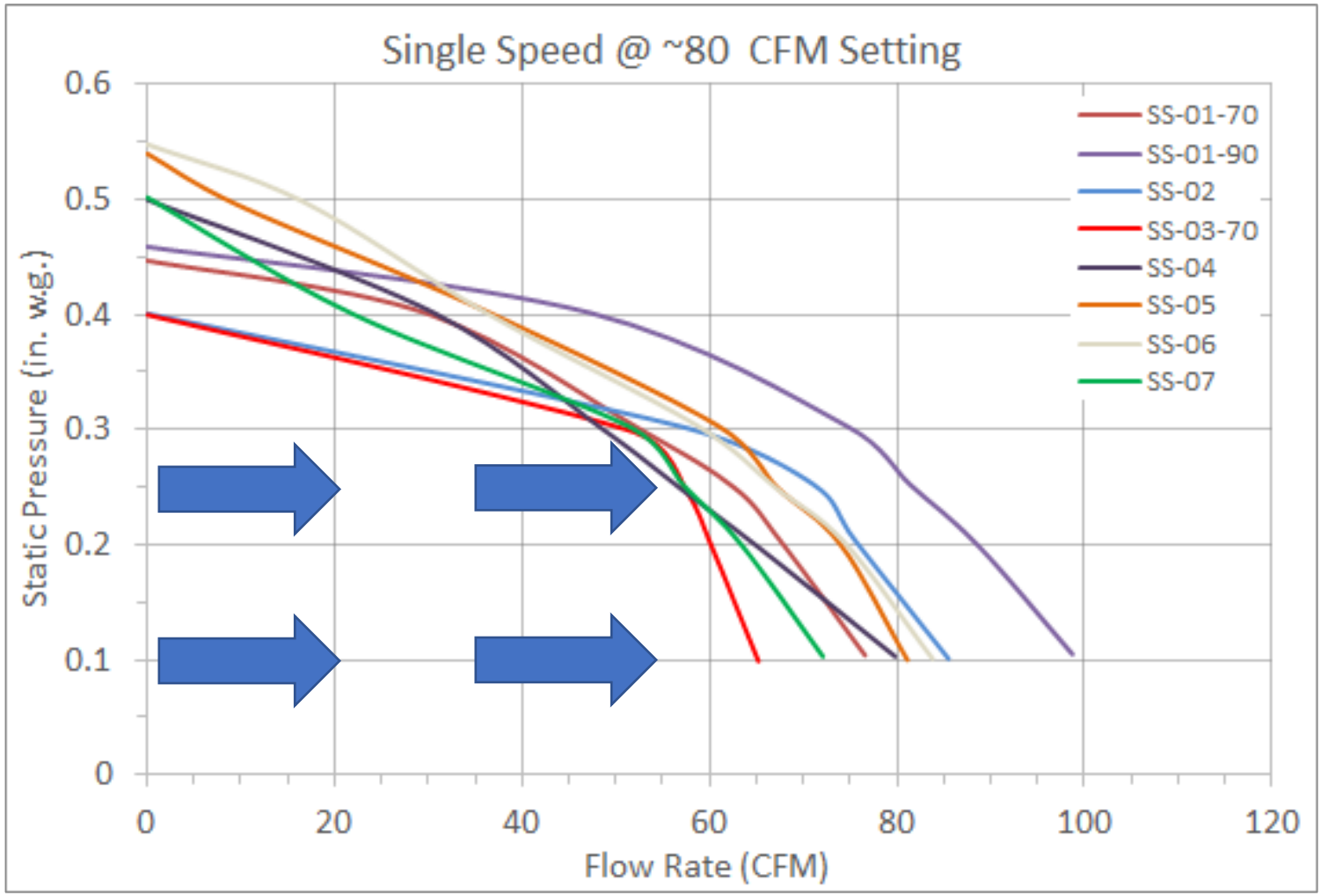
Selecting the Right Products with Performance Assurance through HVI

Fan Curve Basics

The fan curve is the best way for a specifying engineer to accurately estimate the performance that a product will achieve as installed in a system with ductwork and terminations.



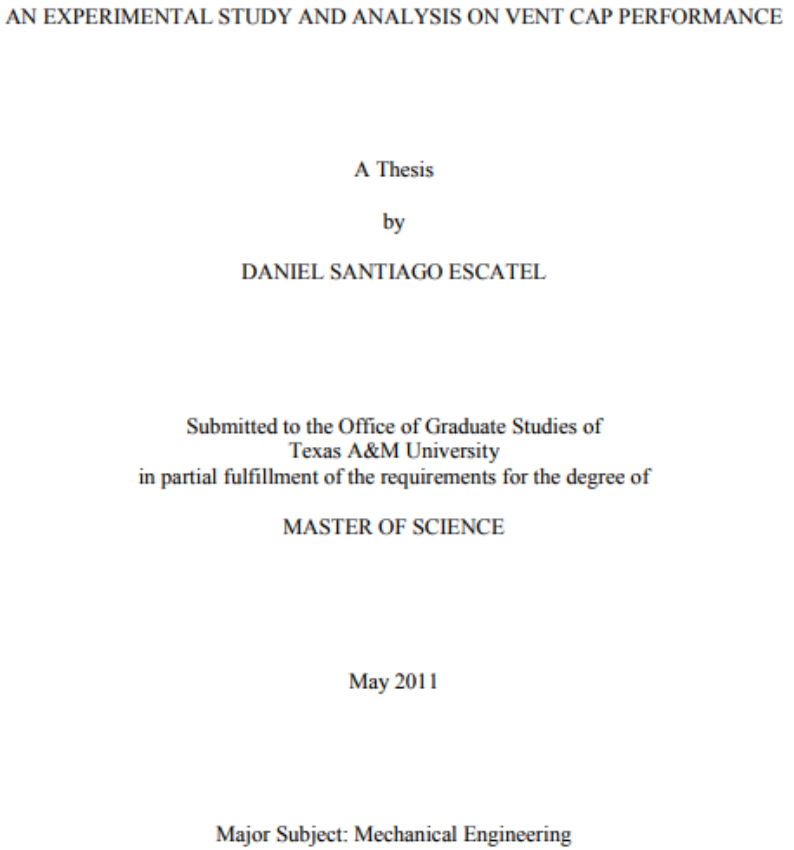
Common HVI and ENERGY STAR airflows at 0.1” and 0.25” Static Pressure



A Heavy Load – Duct End Terminations

Duct End Terminations –

Daniel Escatel Thesis



AN EXPERIMENTAL STUDY AND ANALYSIS ON VENT CAP PERFORMANCE

A Thesis

by

DANIEL SANTIAGO ESCATEL

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

May 2011

Major Subject: Mechanical Engineering

Table 5. Statistical Indicators for 4-inch Soffit Vent Caps.

Average Air Flow Rate (CFM)	20.4	40.4	60.6	80.2	100.4	120.2	140.7	160.4	180.3	200.5
Average Pressure Drop (in. w.c.)	0.064	0.092	0.155	0.215	0.299	0.378	0.484	0.599	0.726	0.829
Average Loss Coefficient	18.87	6.89	5.16	4.08	3.61	3.20	2.98	2.83	2.72	2.51
St. Dev. Pressure Drop (in. w.c.)	0.025	0.030	0.061	0.089	0.130	0.167	0.220	0.280	0.339	0.373
St. Dev. Loss Coefficient	7.49	2.16	2.04	1.70	1.55	1.42	1.34	1.32	1.27	1.13
Coefficient of Variance	0.39	0.32	0.39	0.41	0.43	0.44	0.45	0.47	0.47	0.45

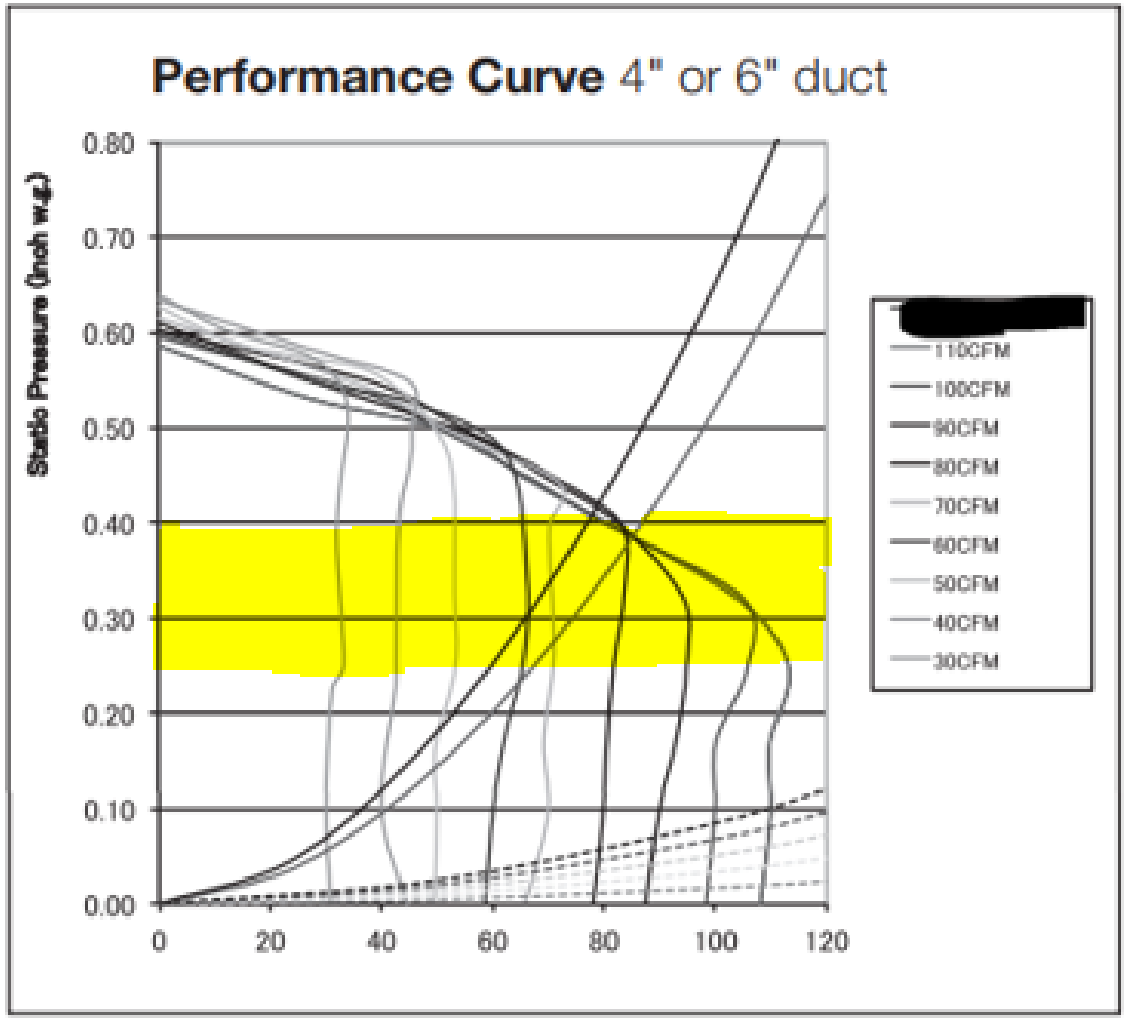
Table 6. Statistical Indicators for 4-inch Wall-Mounted Vent Caps.

Average Air Flow Rate (CFM)	20.3	40.5	60.4	80.4	100.2	120.4	140.5	160.2	180.6	200.4
Average Pressure Drop (in. w.c.)	0.023	0.040	0.070	0.108	0.156	0.216	0.283	0.355	0.423	0.496
Average Loss Coefficient	6.78	2.99	2.33	2.03	1.90	1.82	1.75	1.69	1.58	1.51
St. Dev. Pressure Drop (in. w.c.)	0.018	0.018	0.034	0.063	0.101	0.141	0.191	0.243	0.293	0.321
St. Dev. Loss Coefficient	5.41	1.33	1.16	1.17	1.23	1.19	1.18	1.16	1.09	0.98
Coefficient of Variance	0.80	0.45	0.49	0.58	0.64	0.65	0.68	0.68	0.69	0.65

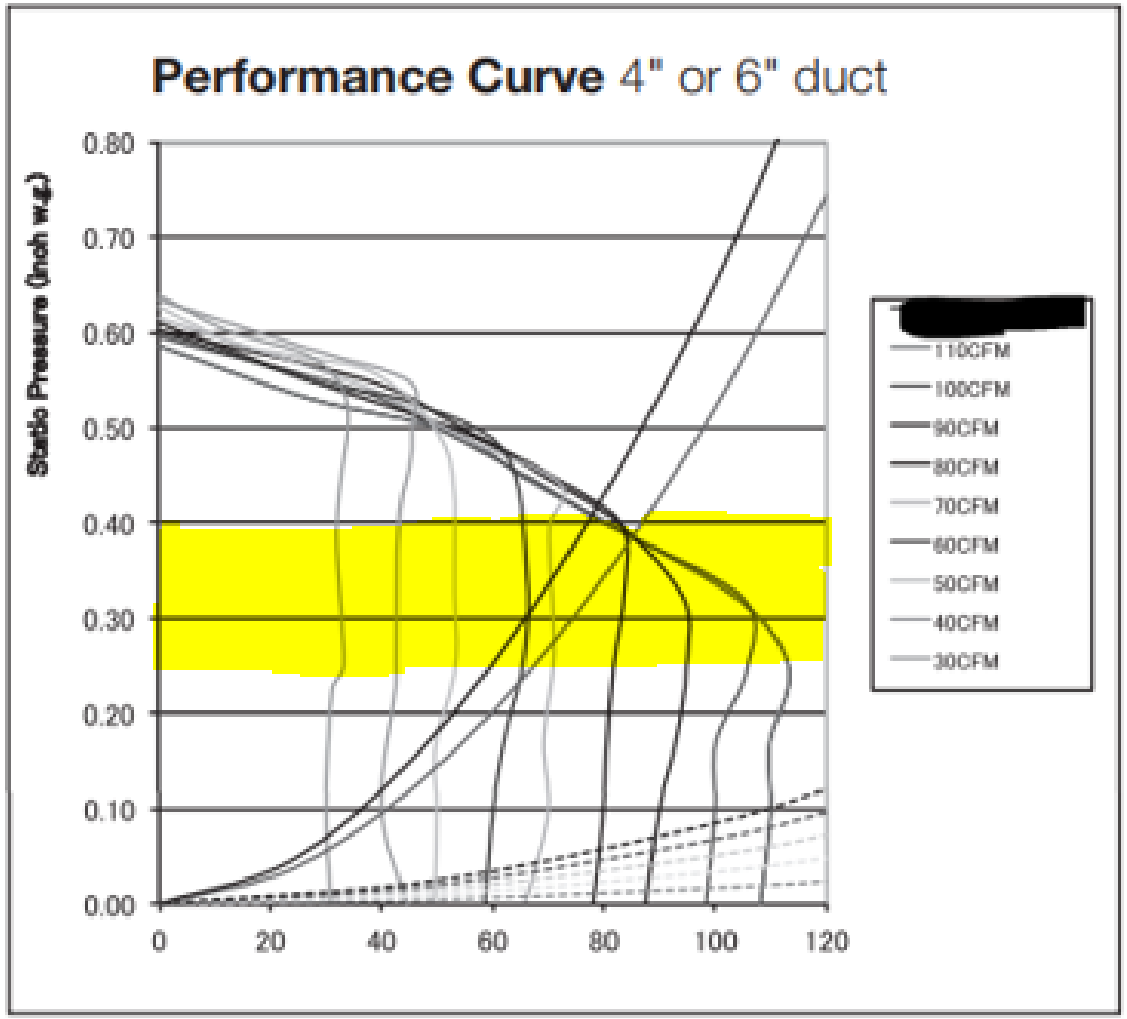
Table 7. Statistical Indicators for 4-inch Roof Jack Vent Caps.

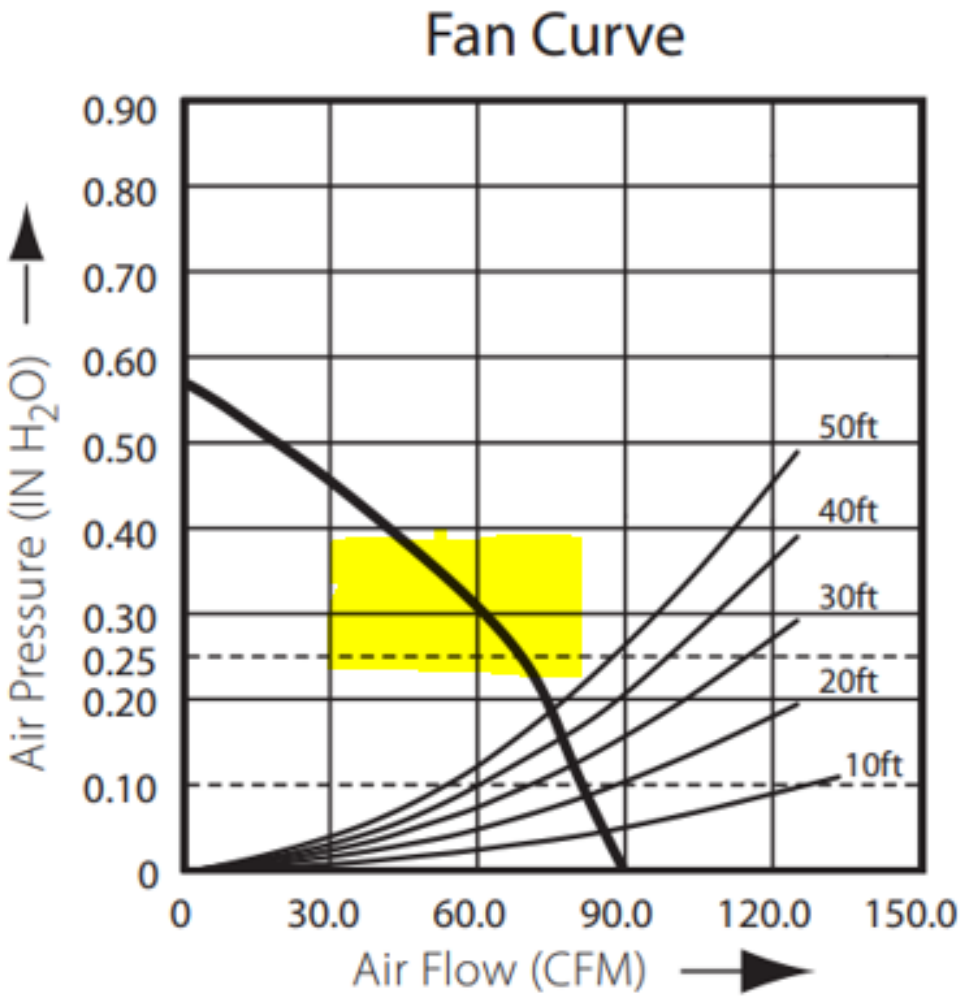
Average Air Flow Rate (CFM)	20.6	40.4	60.5	80.4	100.4	120.3	140.3	160.5	180.5	200.7
Average Pressure Drop (in. w.c.)	0.070	0.087	0.119	0.166	0.227	0.297	0.376	0.470	0.565	0.670
Average Loss Coefficient	19.83	6.48	3.96	3.14	2.74	2.50	2.33	2.22	2.11	2.03
St. Dev. Pressure Drop (in. w.c.)	0.041	0.038	0.034	0.037	0.046	0.054	0.061	0.076	0.078	0.092
St. Dev. Loss Coefficient	11.31	2.91	1.12	0.68	0.56	0.46	0.38	0.36	0.29	0.28
Coefficient of Variance	0.59	0.43	0.28	0.22	0.20	0.18	0.16	0.16	0.14	0.14

What is the realistic "Power Zone" of common installations?



What is the realistic "Power Zone"?

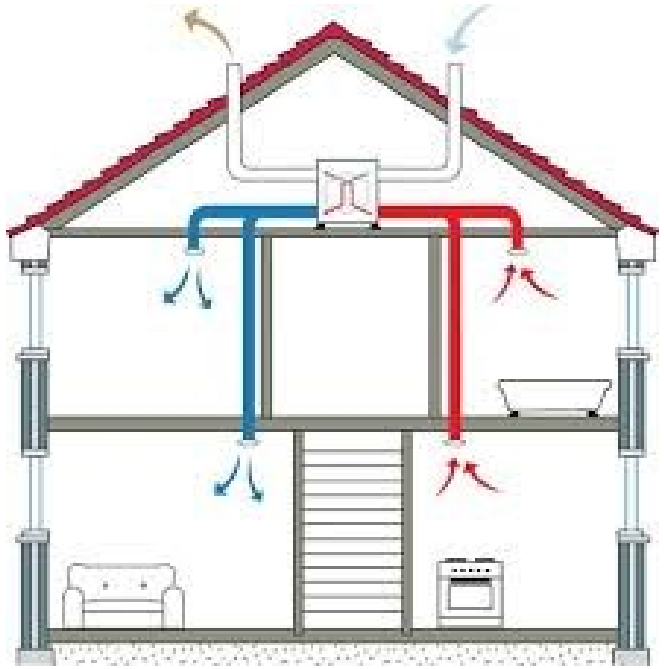




At 0.375” w.g. Static Pressure, some products will fail the 50 CFM code minimum requirement, so it is imperative to work closely with your HVAC contractor and select the appropriate HVI-Certified product.

More Duct Termination Products need to be HVI-Certified

Balanced Ventilation
HRV / ERV



Balanced ventilation with source control exhaust from kitchens and bathrooms is becoming the common recommendation from building scientists.

Because homes are built more tightly, assuring that the system is balanced helps maintain IAQ and assists with moisture management across climate zones.

VENTILATION PERFORMANCE TERMS

Heating Season Performance: This is a mandatory test for HVI Certification at 0°C (+32°F) and 75% relative humidity for the outdoor air and at 22°C (71.6°F) and 40% relative humidity for the indoor air. This test represents the typical steady-state energy performance of the HRV/ERV. Performance is more comparable using this Heating Season Performance data due to the absence of frost formation.

Very Low Temperature Test: This is an optional test for HVI Certification. The Very Low Temperature Test is typically conducted at -25°C (-13°F) and at 22°C (71.6°F) and 40% relative humidity for the indoor air, although the manufacturer may chose to conduct this test at any outdoor temperature below freezing. The test duration is 72 hours. The Net Supply Airflow and all other energy performance values are calculated by using the averages of the last 60 hours of the test.

Cooling Season Performance: This is an optional test for HVI Certification. Outdoor air conditions are 35°C (95°F) at 50% relative humidity, indoor air conditions are 24°C (75°F) at 50% relative humidity. Total Recovery Efficiency (see below) is reported in place of Sensible Recovery Efficiency (see below) as the latter value is less relevant for cooling load applications.

Sensible Recovery Efficiency (SRE): The net sensible energy recovered by the supply airstream as adjusted by electric consumption, case heat loss or heat gain, air leakage, airflow mass imbalance between the two airstreams and the energy used for defrost (when running the Very Low Temperature Test), as a percent of the potential sensible energy that could be recovered plus the exhaust fan energy. This value is used to predict and compare Heating Season Performance of the HRV/ERV unit.

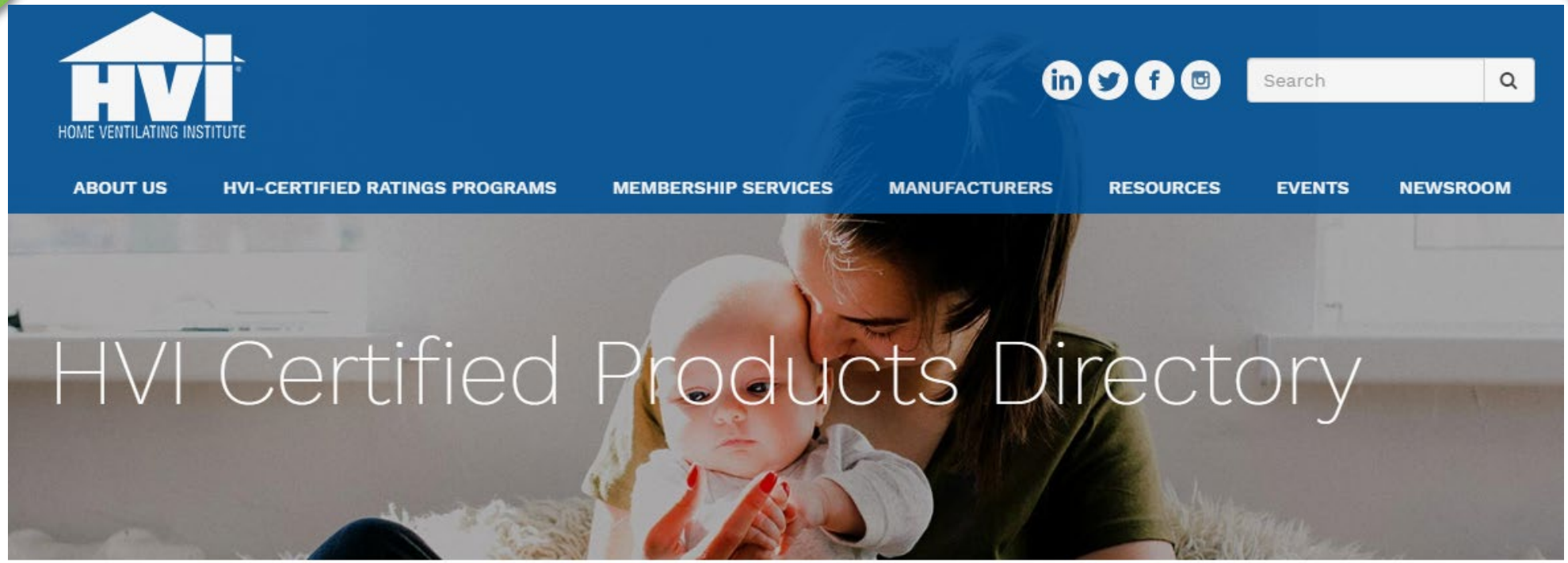
Adjusted Sensible Recovery Efficiency (ASRE): The net sensible energy recovered by the supply airstream as adjusted by case heat loss or heat gain, air leakage, airflow mass imbalance between the two airstreams and the energy used for defrost (when running the Very Low Temperature Test), as a percent of the potential sensible energy that could be recovered. This value should be used for energy modeling when wattage for air movement is separately accounted for in the energy model.

Total Recovery Efficiency (TRE): The net total energy (sensible plus latent, also called enthalpy) recovered by the supply airstream adjusted by electric consumption, case heat loss or heat gain, air leakage and airflow mass imbalance between the two airstreams, as a percent of the potential total energy that could be recovered plus the exhaust fan energy. This value is used to predict and compare Cooling Season Performance for the HRV/ERV unit.

Adjusted Total Recovery Efficiency (ATRE): The net total energy (sensible plus latent, also called enthalpy) recovered by the supply airstream adjusted by case heat loss or heat gain, air leakage and airflow mass imbalance between the two airstreams, as a percent of the potential total energy that could be recovered. This value is used to predict and compare Cooling Season Performance for the HRV/ERV unit. This value should be used for energy modeling when wattage for air movement is separately accounted for in the energy model.

Latent Recovery/Moisture Transfer (LRMT): Moisture recovered divided by moisture exhausted and corrected for the effects of cross-leakage. LRMT = 0 indicates that moisture was not transferred (net of cross-leakage) from the exhaust airstream to the supply airstream. LRMT = 1 would indicate complete transfer of moisture. LRMT is provided for the Heating Season Performance and the Very Low Temperature Test as an indication of moisture handling characteristics, and may be used to evaluate the moisture transfer ability of the equipment in order to assess the humidification or dehumidification performance of the product at the specified test condition.

Selecting the Right Energy Recovery Product(s) with Performance Assurance through HVI



HVI-Certified Products Directory

The HVI Publication 911: Certified Home Ventilating Products Directory© (CPD) is updated monthly and includes more than 3,600 residential ventilation products, providing builders and consumers with a wide range of ventilation options suitable for the varying climates and housing throughout North America. All models listed in the HVI-Certified Products Directory have been tested according to HVI procedures and have been found to qualify based on the requirements of HVI Publication 920©.

Section III - HRV/ERV Directory Listing

HVI Publication 911: Certified Home Ventilating Products Directory ©

Section III - HRV/ERV Directory Listing

Filters

Brand Name

Product Category

201 to 300 (376) 100

Current as of January 24, 2020

Save HVI HRV/ERV Directory as a spreadsheet
Save detailed Airflow Ratings as a spreadsheet
Save detailed Energy Ratings as a spreadsheet

Product Category	Brand Owner	Brand Name	Model	Net Supply at 100 Pa (L/s)	Net Supply at 0.4" w.g. (cfm)	Model Details	Max Rated Sensible Recovery Efficiency at 0 deg C	Net Airflow @ Max Rated SRE (L/s)	Net Airflow @ Max Rated SRE (cfm)	Power Consumed @ Max Rated SRE (watts)	ENERGY STAR (Canada ONLY)
HRVs	Resideo Technologies, Inc.	Honeywell	VNT5200H1000	95	201	Model Details	75	29	61	62	No
ERVs	Johnson Controls Inc.	Johnson Controls	TERV030	147	311	Model Details	67	139	295	315	No
ERVs	Lennox International	Lennox	ERV3150	59	125	Model Details	69	30	64	70	No
HRVs	Lennox International	Lennox	HRV3095	28	59	Model Details	75	28	59	59	Yes

Section III - HRV/ERV Directory Listing

HVI Publication 911: Certified Home Ventilating Products Directory ©

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ERVs	Johnson Controls Inc.	Johnson Controls	TERV030	147	311	Model Details	67	139	295	315	No
ERVs	Lennox International	Lennox	ERV3150	59	125	Model Details	69	30	64	70	No
HRVs	Lennox	Lennox	HRV3095	28	59	Model Details	75	28	59	59	Yes

Model Detail

Brand Owner | Brand Name | Model

Product Category: ERVs

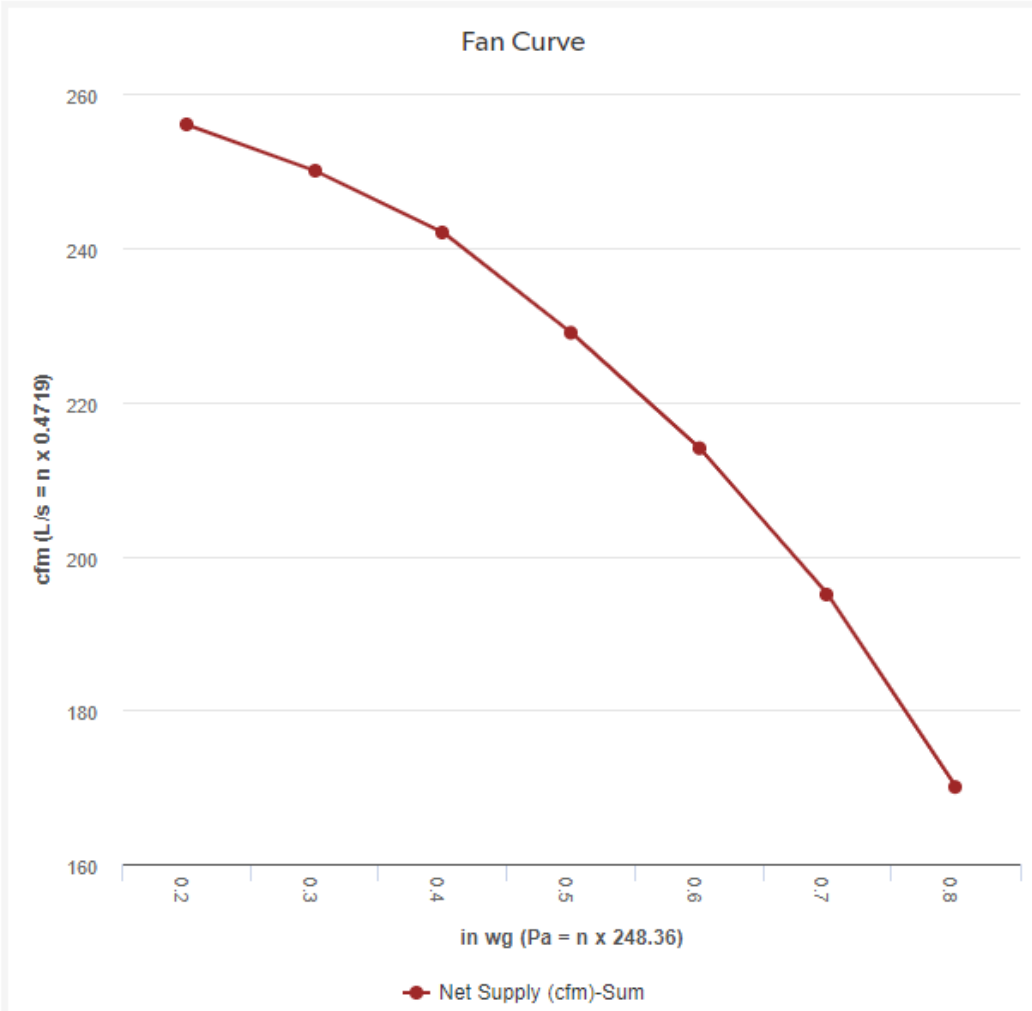
Volts	Amps	EAT 50	EAT 100
120	3.3	2.4	2.3

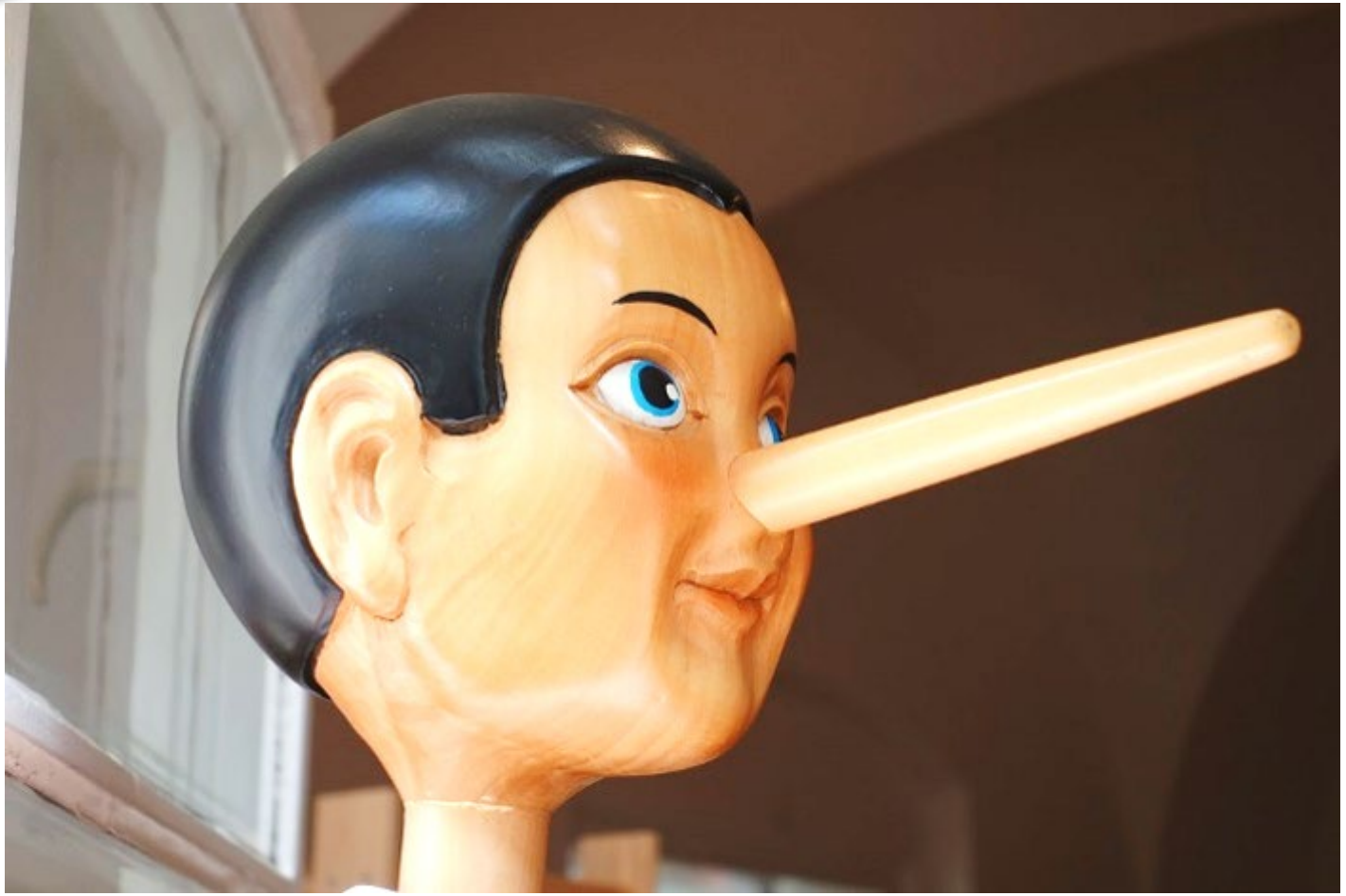
Airflow Ratings

Ext. Static Pressure (Pa)	Ext. Static Pressure (in. wg)	Net Supply Airflow (L/s)	Net Supply Airflow (cfm)	Gross Airflow Supply (L/s)	Gross Airflow Supply (cfm)	Gross Airflow Exhaust (L/s)	Gross Airflow Exhaust (cfm)
25	0.1	125	265	129	273	132	280
50	0.2	121	256	124	263	126	267
75	0.3	118	250	120	254	121	256
100	0.4	114	242	116	246	117	248
125	0.5	108	229	111	235	110	233
150	0.6	101	214	103	218	102	216
175	0.7	92	195	94	199	93	197
200	0.8	80	170	82	174	79	167

Energy Ratings

Brand Name	Model	Temp Mode	°C	°F	Net Airflow (L/s)	Net Airflow (cfm)	Power Consumed (Watts)	SRE	ASRE	Latent Recovery / Moisture Transfer	TRE	ATRE	VLTVRF Supply (%)	VLTVRF Exhaust (%)	Very Low Temp Airflow Imbalance (%)
[redacted]	[redacted]	HEATING	0	32	111	235	216	75	80	0.57					
[redacted]	[redacted]	COOLING	35	95	108	229	213			0.51	53	56			

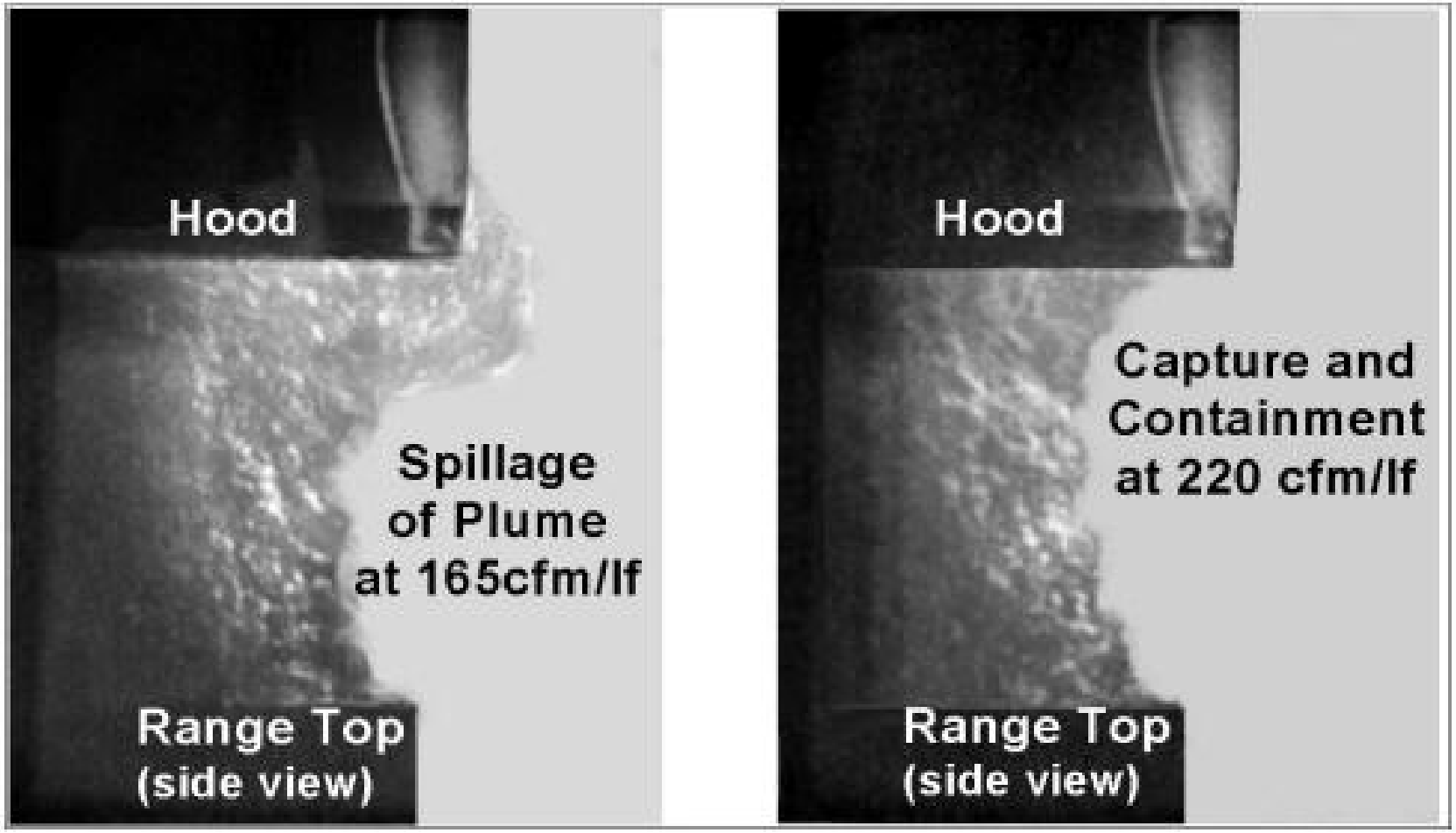




Have your compliance group verify that you are receiving products that are properly certified. Trademark violations may not be apparent with potentially underperforming or unsafe products that may expose you to liability.

Moving Forward with New Metrics

Range Hood Capture Efficiency – THE NEW METRIC



Range Hood Capture Efficiency – THE NEW METRIC

Designation: E3087 – 17

Standard Test Method for Measuring Capture Efficiency of Domestic Range Hoods[1]

This standard is issued under the fixed designation E3087; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

IAQ Measurement

WHAT'S AVAILABLE TO MEASURE IAQ?

Device	Price	Temp	RH	CO_2	VOC	$PM_{2.5}$	PM_{10}	CO	Ozone	NO_2
Birdi (NA)		●	●	●	●	●				
Koto Air Cubes		●	●	●						
Netatmo		●	●	●						
Speck		●				●				
Airmentor		●	●	●	●	●	●	●		
Awair		●	●	●	●	●	●			
BlueAir-Aware		●	●	●	●	●	●			
Foobot		●	●	●	●	●		●		
Air Quality Egg		●	●			●	●	●	●	
Dylos-DC 1100						●	●			
uHoo (NA)		●	●	●	●	●		●	●	

Southface

Brett Singer, LBNL 2016

Thank you for joining us today.

Let’s move forward together,

Making Indoor Air Healthier!