



Clearing the Air: Ventilation

RESNET Building Performance Conference
San Diego, CA
February 17th, 2015

Learn more at energystar.gov

Agenda

- Value of mechanical ventilation and indoor air quality.
- Three major components:
 - Local mechanical exhaust.
 - Whole-house ventilation.
 - Filtration.
- Measuring ventilation airflow:
 - RESNET Standard 380.
 - Live demo!
- Ventilation: The year ahead.
- Questions & answers.

The Value of Mechanical Ventilation

Value of mechanical ventilation & indoor air quality



- Consumers place value on indoor air quality.



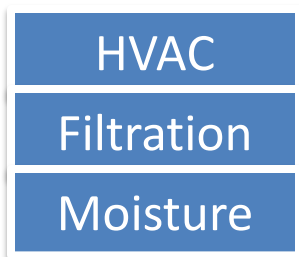
What is indoor air quality?

- Homeowner is satisfied (e.g., no odors or irritants).
 - Low levels of contaminants known to pose health risks.
- 
- A photograph of a young girl with blonde hair tied back, wearing a white shirt. She is covering her mouth with her right hand, looking directly at the camera. This image is used to illustrate the concept of indoor air quality and its impact on health.
- This is the basic definition of indoor air quality in the industry standard, ASHRAE 62.2-2010/2013.
 - Don't sacrifice indoor air quality in exchange for efficiency.

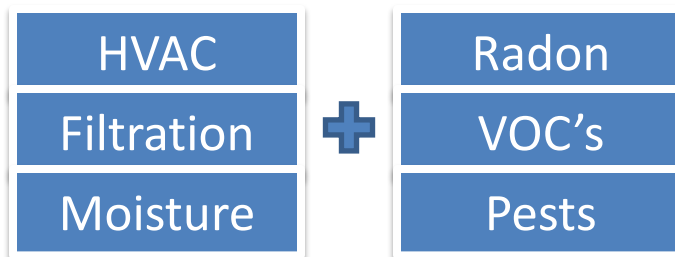
How are the ENERGY STAR & Indoor airPLUS programs related?



- Both are voluntary labeling programs run by EPA.
- ENERGY STAR is better than standard practice, while Indoor airPLUS offers a complete indoor air quality package.
- For more information, visit www.epa.gov/indoorairplus/



IAQ Improvement



Complete IAQ Protection

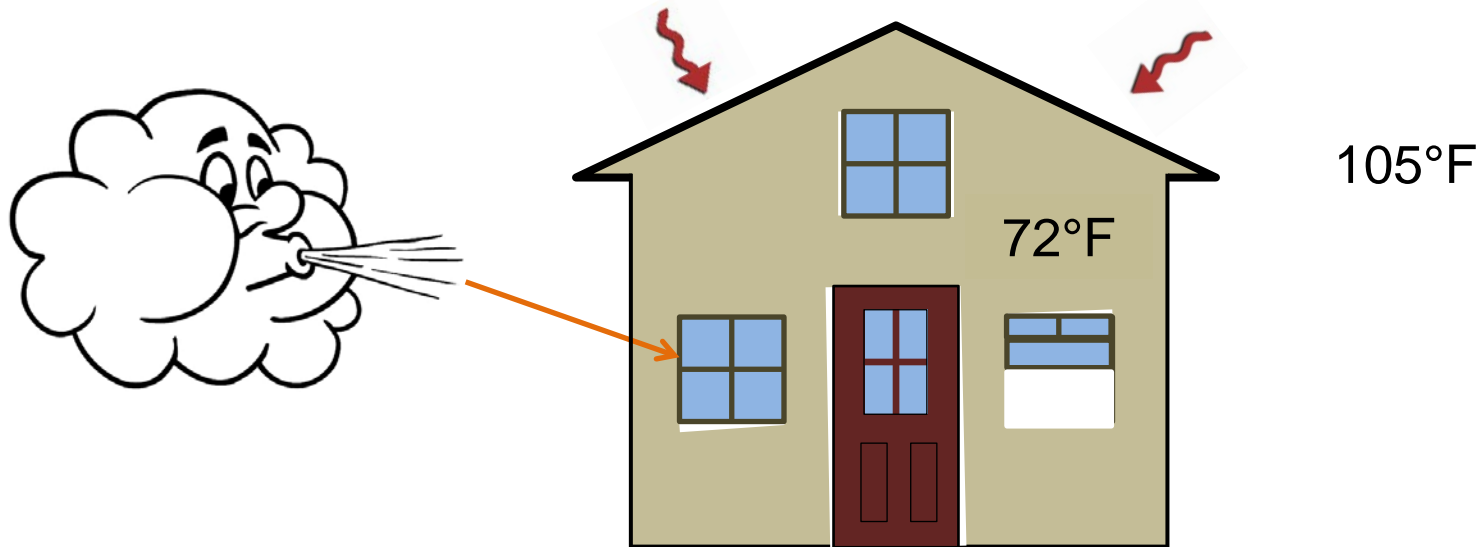
Non-ENERGY STAR approach

- Some advantages, but mostly disadvantages.
- Advantages of leaky homes:
 - Dilution of contaminants in home.
 - Drying of building components that become wet.



Non-ENERGY STAR approach

- Disadvantages of leaky homes:
 - Rate of outdoor air is not controlled.
 - Source and path of outdoor air is unknown.
 - Outdoor air may cause discomfort if not first conditioned.
 - Excess outdoor air increases energy use.



ENERGY STAR approach



1. Build the home tight to improve efficiency & comfort.
2. Remove contaminants using occupant-controlled exhaust fan in kitchens & bathrooms and a filter in HVAC system.
3. Bring in outdoor air in a controlled way to dilute contaminants.
4. Include key durability details relating to water management.



Consumer features

- Better options for venting their kitchens & baths.
- An automated system to bring outdoor air into the house.



Summary of value

- Indoor air quality is valued by consumers.
- ENERGY STAR addresses efficiency without sacrificing indoor air quality or durability through:
 - Tight homes.
 - Removal of contaminants.
 - Dilution of contaminants with outdoor air.
 - Durability details related to moisture.

A small inset image in the top left corner shows a person in a blue shirt looking up and using a long-handled tool to inspect or work on a ceiling area.

Concepts of Local Mechanical Exhaust

Local mechanical exhaust: Overview of requirements



- Include an exhaust fan in each kitchen.
 - Achieve a minimum ***measured*** air flow rate or use a prescriptive duct design.
- Include an exhaust fan in most bathrooms.
 - Achieve a minimum measured air flow rate.
 - Achieve a maximum rated sound limit.

Local mechanical exhaust:

Bath fans



- Only bathrooms with a bathtub, shower, spa, or similar source of moisture must have an exhaust fan.

Does this bathroom need a fan?



Local mechanical exhaust: Bath fans



- Two requirements for bath fans:
 - Achieve a minimum measured air flow rate.
 - Achieve a maximum rated sound limit.

Summary of Airflow Requirements for Bath Fans		
Fan Type	Measured Airflow	Rated Sound
Intermittent	≥ 50 CFM	≤ 3 sones

Local mechanical exhaust: Bath fans



- Installation quality impacts the airflow.

HVI PERFORMANCE

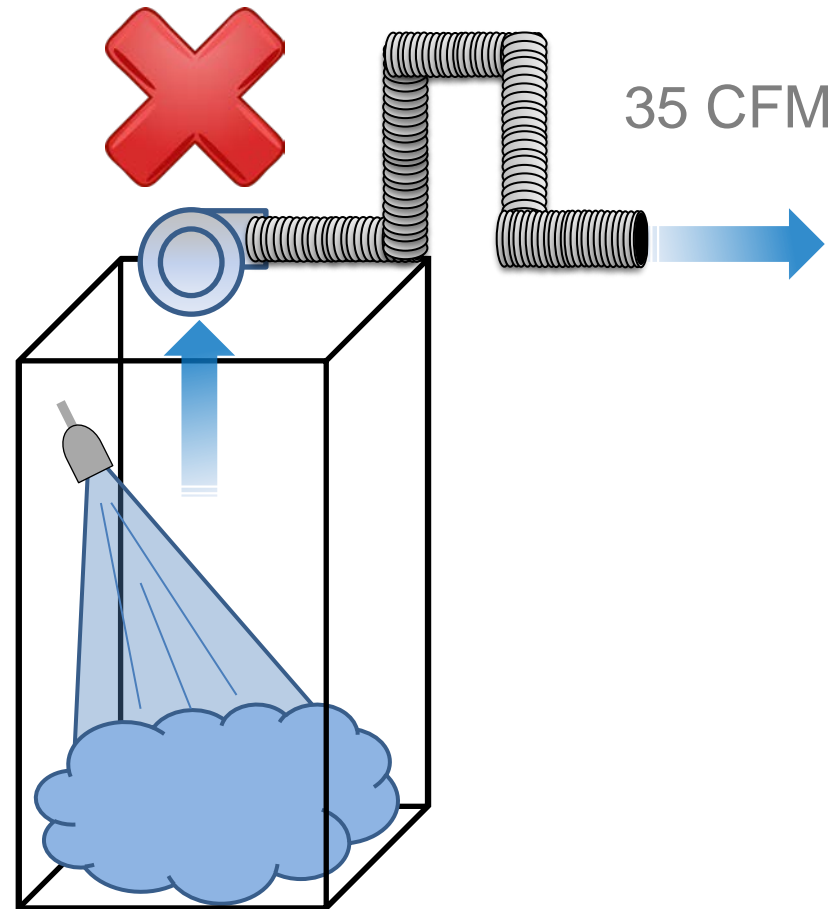
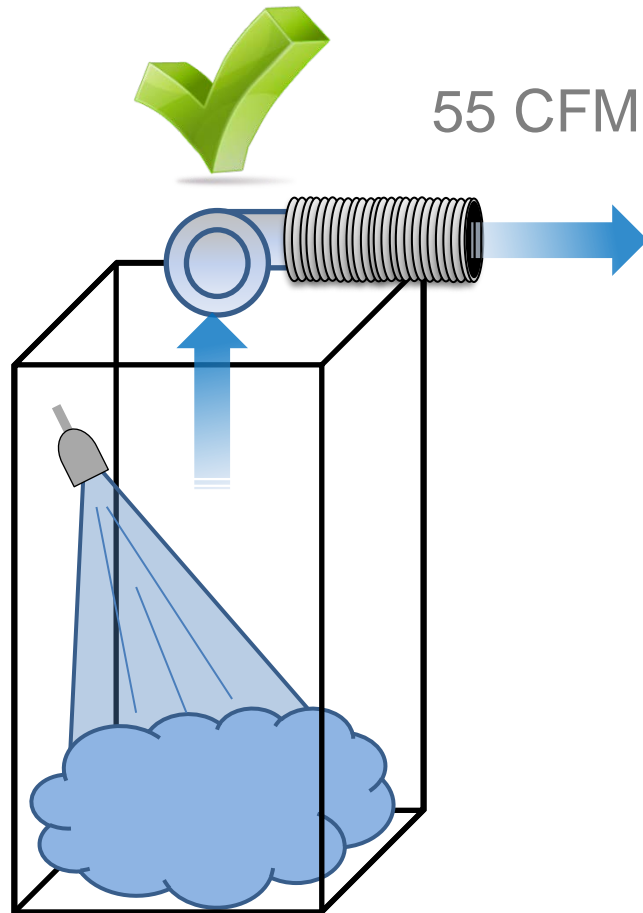
4" Duct			3" Duct				
0.1 Ps	Static Pressure (inH ₂ O)		0.25 Ps	0.1 Ps	Static Pressure (inH ₂ O)		0.25 Ps
Airflow (CFM)	Sound (Sones)	Power (Watts)	Airflow (CFM)	Airflow (CFM)	Sound (Sones)	Power (Watts)	Airflow (CFM)
80	1.1	25.7	61	70	1.3	25.7	55.3



HVI-2100 CERTIFIED RATINGS comply with new testing technologies and procedures prescribed by the Home Ventilating Institute, for off-the-shelf products, as they are available to consumers. Product performance is rated at 0.1 in. static pressure, based on tests conducted in a state-of-the-art test laboratory. Sones are a measure of humanly-perceived loudness, based on laboratory measurements.

Local mechanical exhaust: Bath fans

- Measured airflow is usually less than rated airflow.




Local mechanical exhaust: Bath fans



- Sound levels, in sones, quantify how much sound a fan will make.
- Sones don't have to be measured in the field. Instead use the rated value from the product label or documentation.

HVI PERFORMANCE							
4" Duct				3" Duct			
0.1 Ps - Static Pressure (inH ₂ O)		0.25 Ps		0.1 Ps - Static Pressure (inH ₂ O)		0.25 Ps	
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Local mechanical exhaust:

Bath fans



- Continuous bath fans have different airflow and sound targets.

Summary of Airflow Requirements for Bath Fans		
Fan Type	Measured Airflow	Rated Sound
Intermittent	≥ 50 CFM	≤ 3 sones
Continuous	≥ 20 CFM	≤ 1 sones

- Revision 08 (coming May/June): Intermittent bath fan sound rating is a recommendation.

Local mechanical exhaust:

Kitchen fans



- Like bath fans, kitchen fans must meet a minimum airflow and should meet maximum sound rating.
- Requirements depend on whether the fan is intermittent or continuous, and whether it's integrated with the range.

Summary of Airflow Requirements for Kitchen Fans			
Fan Type	Integrated with Range?	Measured Airflow	Recommend. Rated Sound
Intermittent	Yes	≥ 100 CFM	≤ 3 sones
Intermittent	No	Greater of ≥ 100 CFM or 5 ACH	≤ 3 sones
Continuous	n/a	≥ 5 ACH	≤ 1 sone

Local mechanical exhaust: Kitchen fans



- Prescriptive duct sizing option for fans with a rated airflow that's hard to measure.
- Maximum length for smooth ductwork:

Diameter (inches)	Fan Rating (CFM @ 0.25 IWC)				
	50	80	100	125	>125
3	5	X	X	X	x
4	105	35	5	X	x
5	NL	135	85	55	x
6	NL	NL	NL	145	145
7	NL	NL	NL	NL	NL

Note: X = combination not possible NL = no length limit

- Include 15ft per turn or elbow in the duct.

Local mechanical exhaust: Summary



- An exhaust fan is required for each kitchen and most bathrooms.
- Each fan must meet a minimum airflow rate.
- Bath fans must meet a maximum rated sound level. Kitchen fans are recommended, but not required, to meet a maximum rated sound level.
- This helps homeowner maintain indoor air quality.

A small inset image in the top left corner shows a person in a blue shirt looking up into an attic space, holding a flashlight to inspect the ceiling or roof structure.

Options for Whole-House Mechanical Ventilation

Whole-house mechanical ventilation: Overview



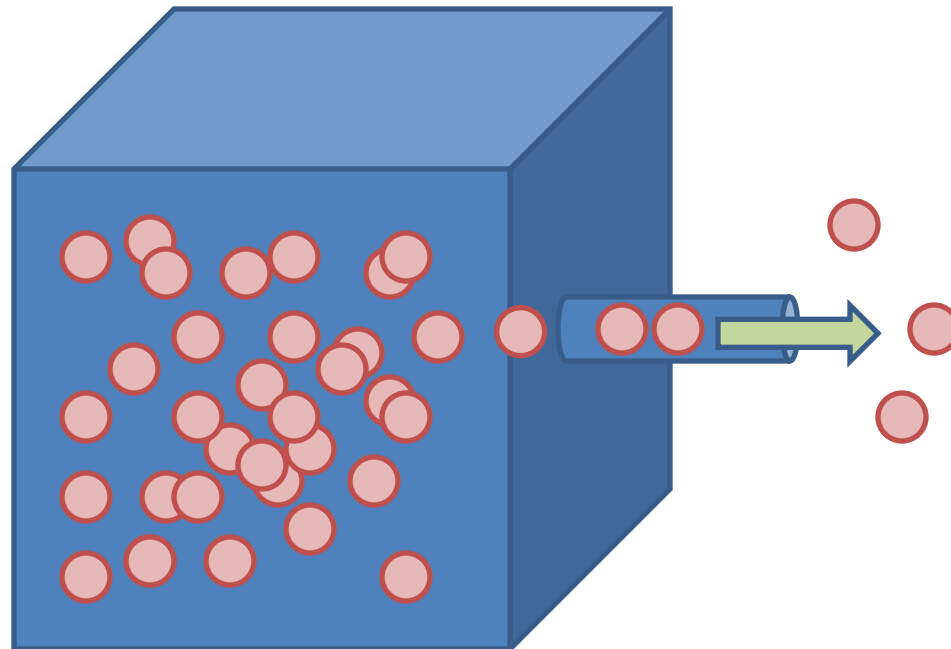
- Goal is to bring outdoor air into the house in a controlled, automatic, way.
- Three ventilation strategies:
 - Exhaust-only ventilation.
 - Supply-only ventilation.
 - Balanced ventilation.

Whole-house mechanical ventilation:

Strategy 1: Exhaust-only ventilation



- Use a fan (typically a bath fan) to remove air from the home.
- Draws outdoor air into the home through cracks in the building envelope or a fresh air intake.
- Frequently used in colder climates.

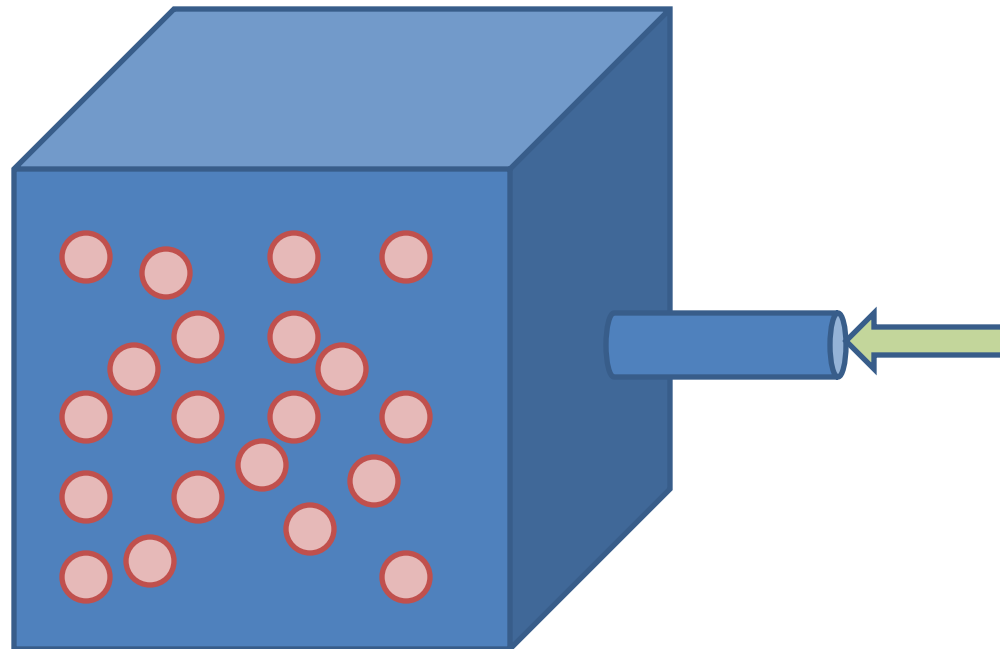


Whole-house mechanical ventilation:

Strategy 2: Supply-only ventilation



- Draw in outdoor air on the return side of the air handler.
- Indoor air is forced out through leaks in the building shell.
- Frequently used in warmer climates.

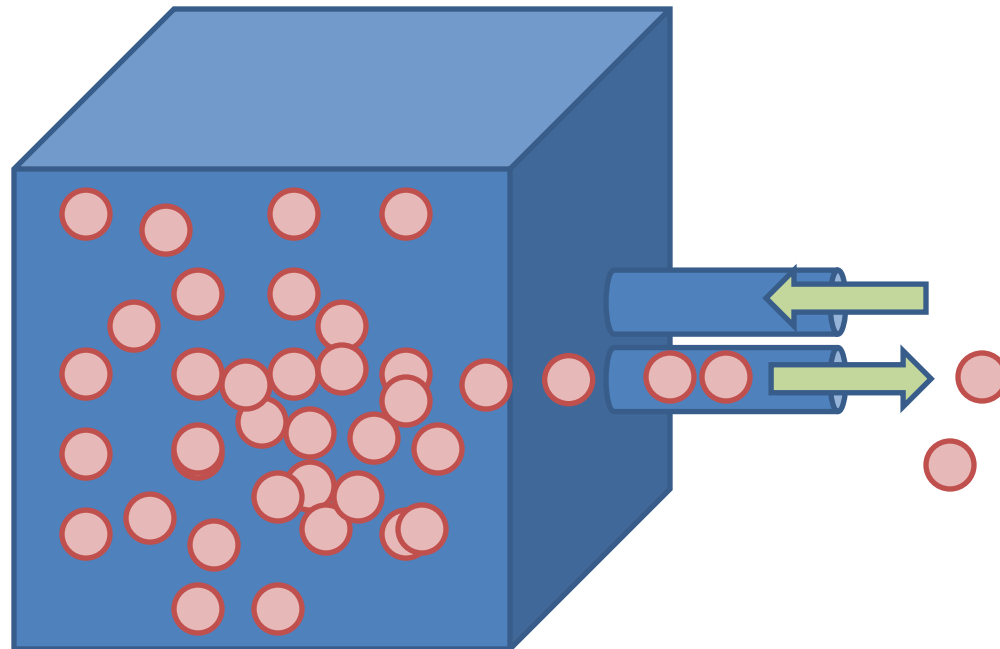


Whole-house mechanical ventilation:

Strategy 3: Balanced ventilation




- Draw in outdoor air, while exhausting air from indoors.
- An equal amount of air is exhausted and supplied to the home, so air is not forced through cracks in the home.
- Used in both warm and cold climates.



Whole-house mechanical ventilation: Summary



- Three ventilation strategies:
 - Exhaust-only.
 - Supply-only.
 - Balanced.
- Purpose is to bring outdoor air into the house in a controlled, automatic way.

A small inset image in the top left corner shows a person in a blue shirt looking up into an attic space, possibly inspecting for ventilation issues.

Calculating Whole-House Mechanical Ventilation Air Flow Rate

Whole-house mechanical ventilation:

Air flow rate



- Required airflow depends on type of whole-house mechanical ventilation system:
 - Continuous, or,
 - Cycled

Whole-house mechanical ventilation:

Continuous air flow rate



- Conditioned floor area = 2,000 ft²
- Number of bedrooms = 3

Whole-house mechanical ventilation:

Continuous air flow rate



ASHRAE 62.2-2010 Equation 4.1

Airflow = $0.01 * \text{Floor Area} + 7.5 * (\text{Bedrooms} + 1)$

Airflow = $0.01 * 2,000 + 7.5 * (3 + 1)$

Airflow = $20 + 30$

Airflow = **50 CFM**

Whole-house mechanical ventilation:

Cycled air flow rate

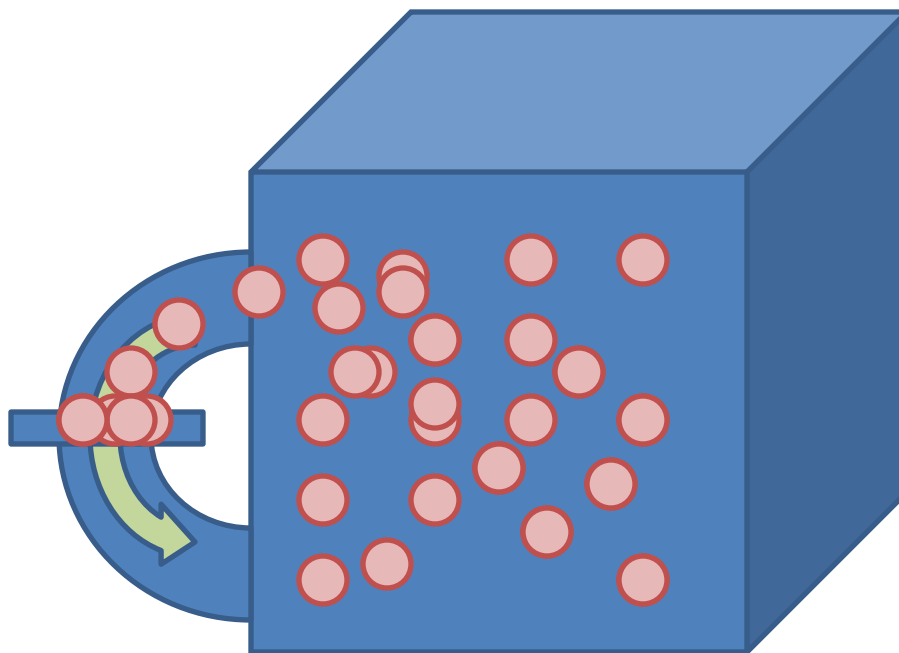


- Cycled systems turns on and off automatically to provide outdoor air in cycles.
- The designer chooses the frequency and length of the ventilation cycles, which dictates the airflow rate.
- Cycled systems can be used to avoid running the system during a fixed period of time (e.g., hottest or coldest hours of the day).
- The ventilation system must run $\geq 10\%$ every 24 hours.

Filtration

Filtration

- Purpose is to remove contaminants from the air and protect the HVAC equipment.



Filtration



- Four basic filtration requirements:
 1. Provide a MERV 6 or better filter in each ducted mechanical system.
 2. All return air and mechanically supplied outdoor air must pass through filter prior to conditioning.
 3. Filter must be accessible to occupants and able to be serviced.
 4. Filter must be gasketed to prevent bypass.



Summary

- Don't sacrifice indoor air quality in exchange for efficiency.
- Three major concepts:
 1. Bath and kitchen fans remove contaminants.
 - Generally, turned on and off by occupants.
 - Must meet airflow and sound requirements.
 2. Whole-house mechanical ventilation removes contaminants and/or dilutes them with outdoor air.
 - System operates automatically.
 - System types: exhaust-only, supply-only, & balanced.
 - Must meet airflow and sound requirements.
 3. Filters trap contaminants.

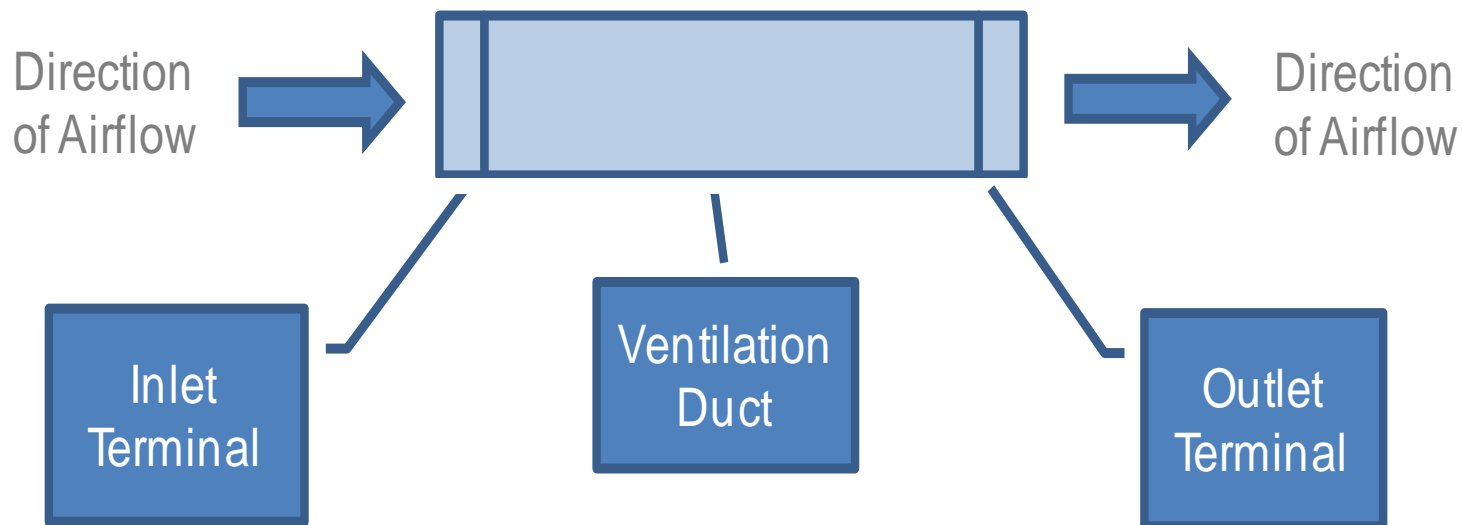
Measuring Ventilation Airflow

RESNET Standard 380

- “Standard For Testing Air Leakage Of Building Enclosures, Air Leakage Of Heating And Cooling Air Distribution Systems, And Airflow Of Mechanical Ventilation Systems”.
- STALBEALHCADSAMVS, for short.
- Brings together diagnostic tests related to building air flow:
 - Envelope leakage
 - Duct leakage
 - Mechanical ventilation

RESNET Standard 380

- Ventilation airflow can be measured at three places:

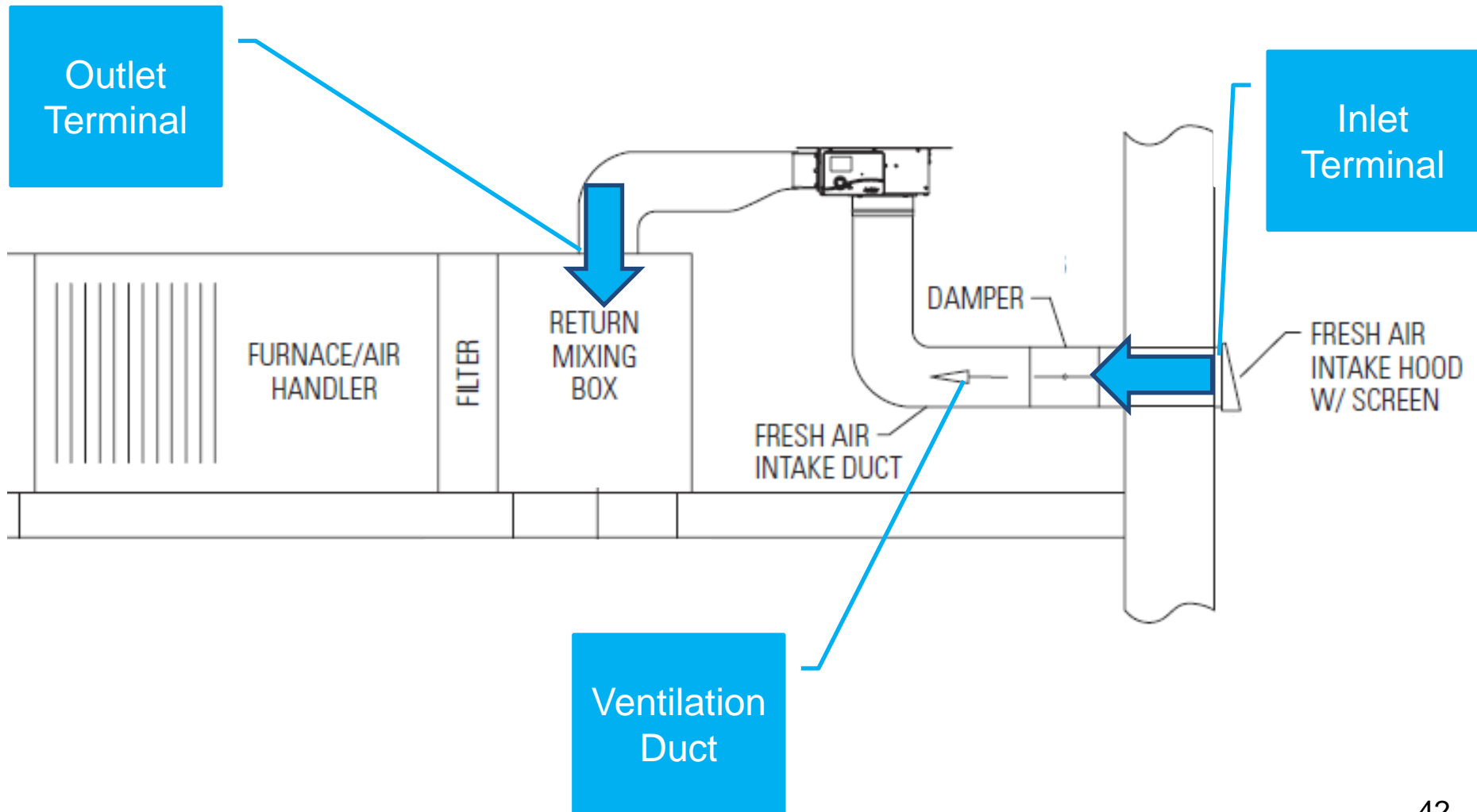


RESNET Standard 380: Measurement locations for exhaust fan



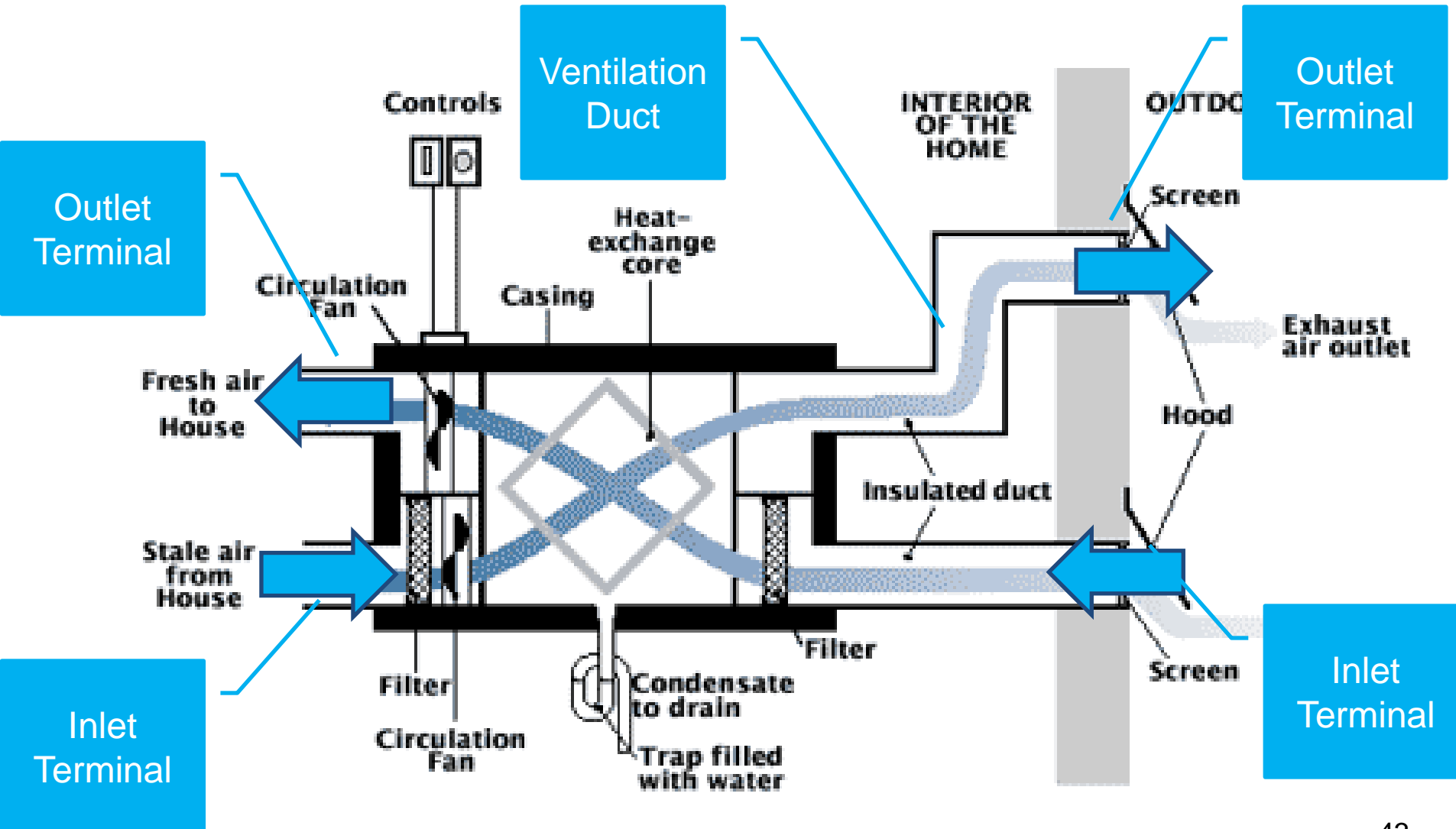
RESNET Standard 380:

Measurement locations for return-side system



RESNET Standard 380:

Measurement locations for balanced system

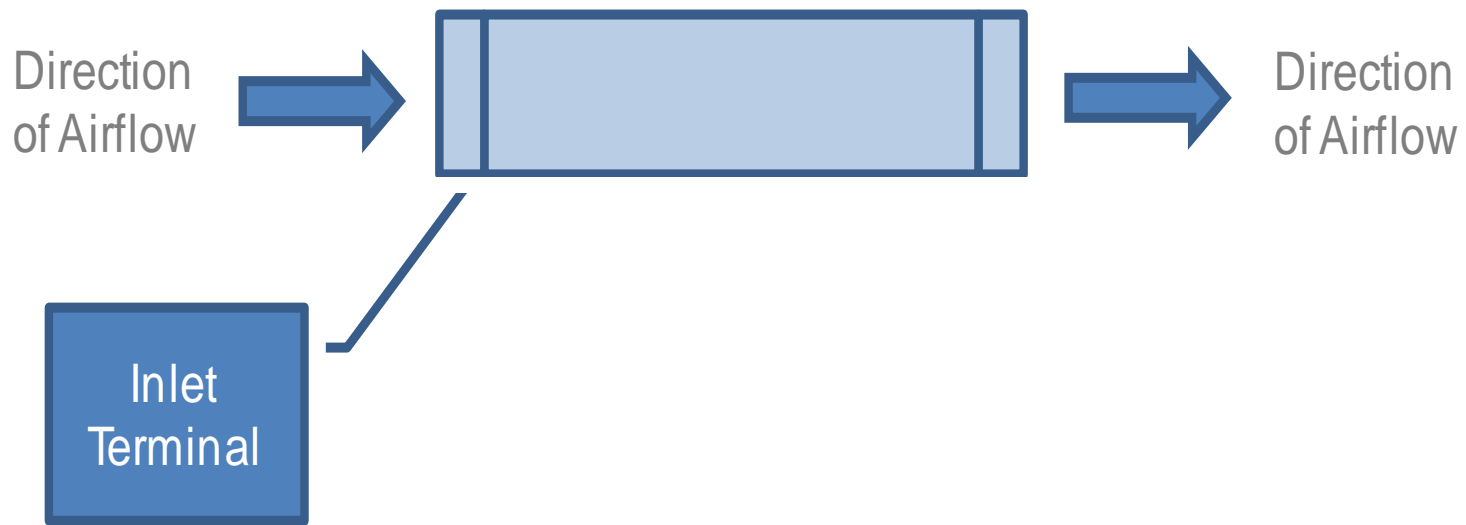


RESNET Standard 380:

Test options at inlet terminal



- Ventilation airflow can be measured at three places:



Options at Inlet Terminal:

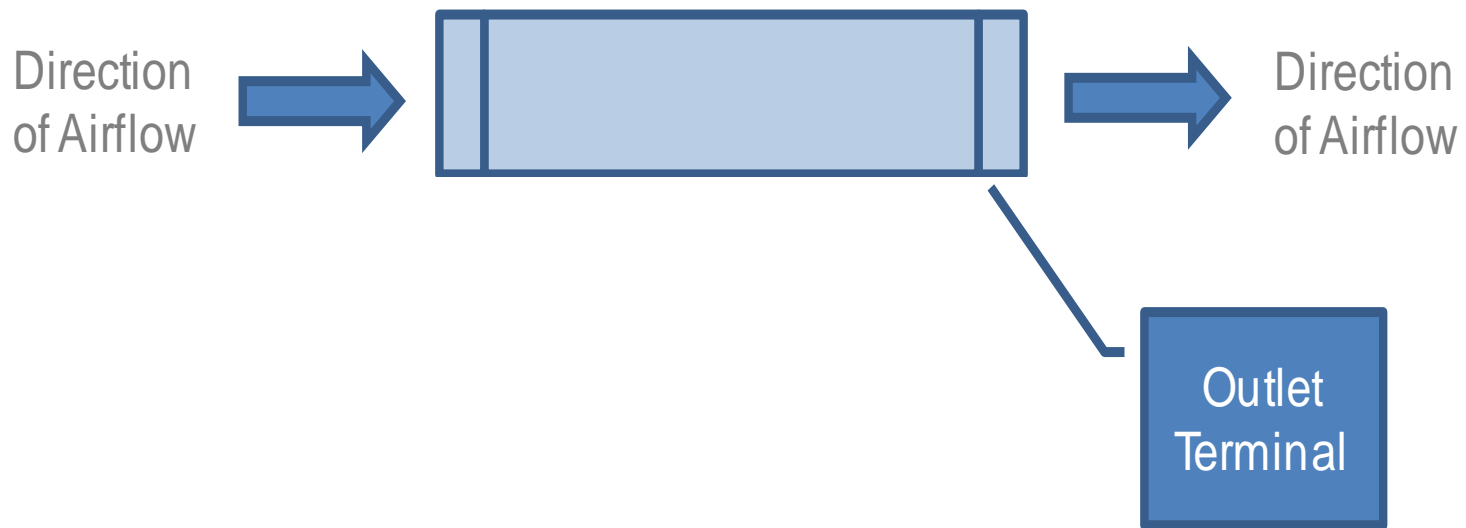
1. Powered flow hood
2. Passive flow hood
3. Airflow resistance device

RESNET Standard 380:

Test options at inlet terminal



- Ventilation airflow can be measured at three places:



Options at Outlet Terminal:

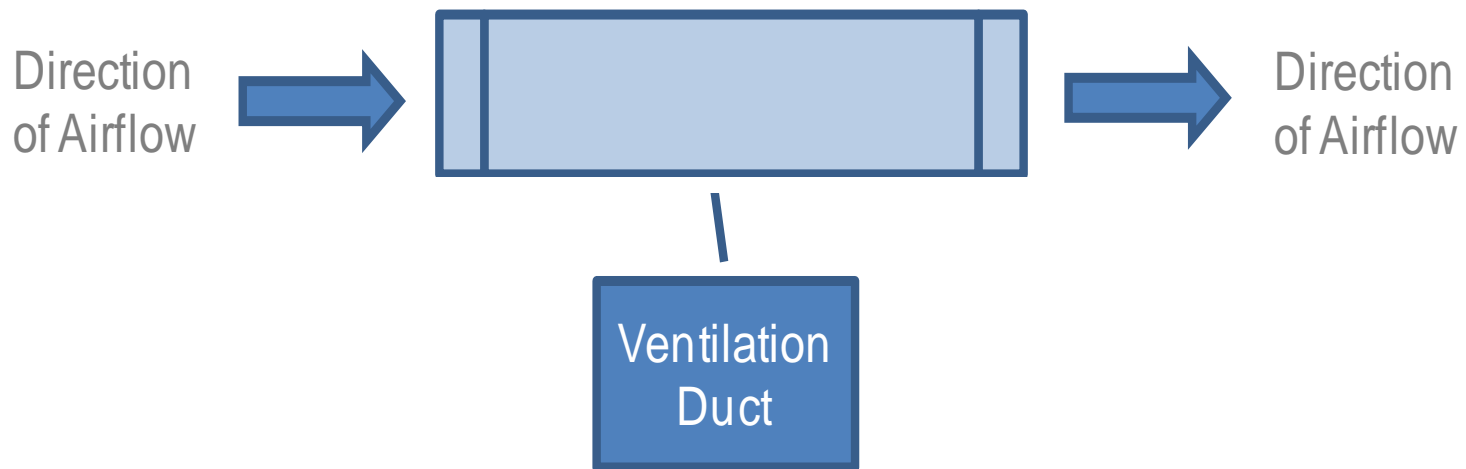
1. Powered flow hood
2. Bag inflation device

RESNET Standard 380:

Test options at inlet terminal



- Ventilation airflow can be measured at three places:



Options Mid-stream in Ventilation Duct:

1. Airflow test station
2. Integrated diagnostic tool

Live Demo!

A small inset photo in the top left corner shows a person in a blue shirt looking up into an attic space, holding a flashlight to inspect the ceiling or roof structure.

Ventilation: The Year Ahead

Ventilation: The year ahead

1. Publication of Standard 380.




Standard BSR/RESNET 380-20xx PDS-1

Standard for Testing Air Leakage of Building Enclosures, Air Leakage of Heating and Cooling Air Distribution Systems, and Airflow of Mechanical Ventilation Systems

Ventilation: The year ahead

2. More, and better, training resources.

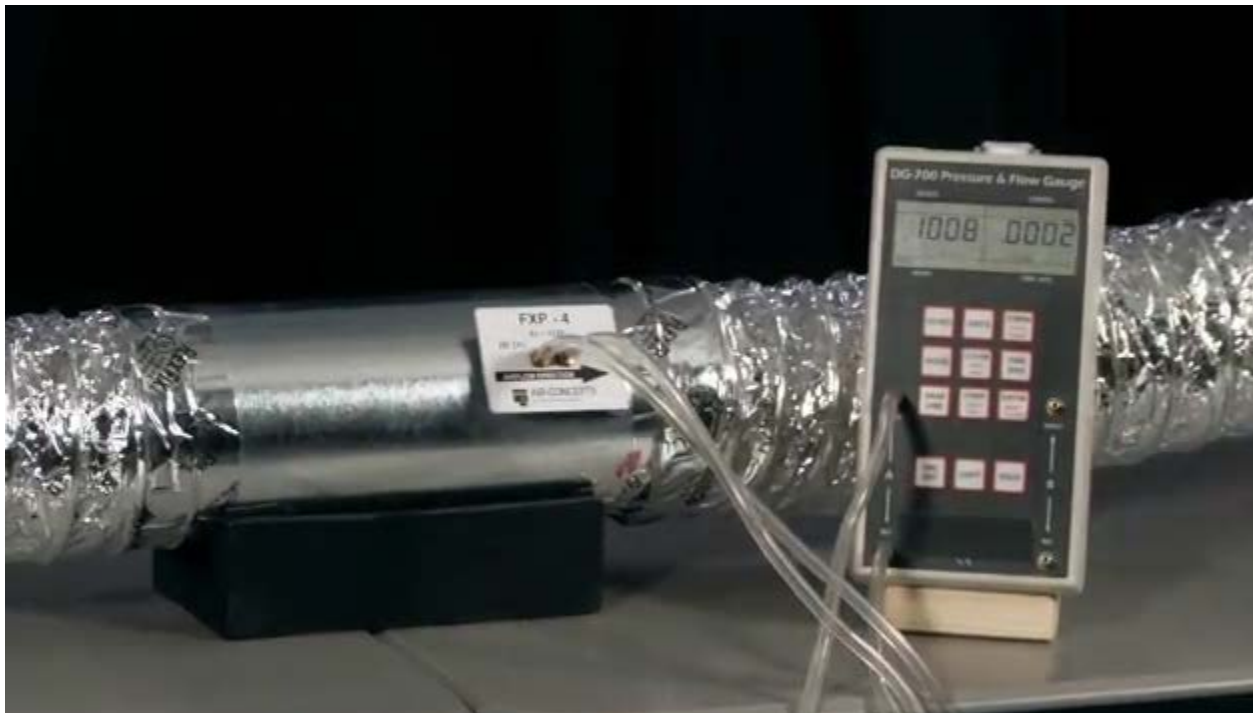
ENERGY STAR Certified Homes:
How to Measure Whole-House Ventilation Airflow

 Video 3 of 4 – Outlet Terminal



Ventilation: The year ahead

3. Rise of the airflow test station.



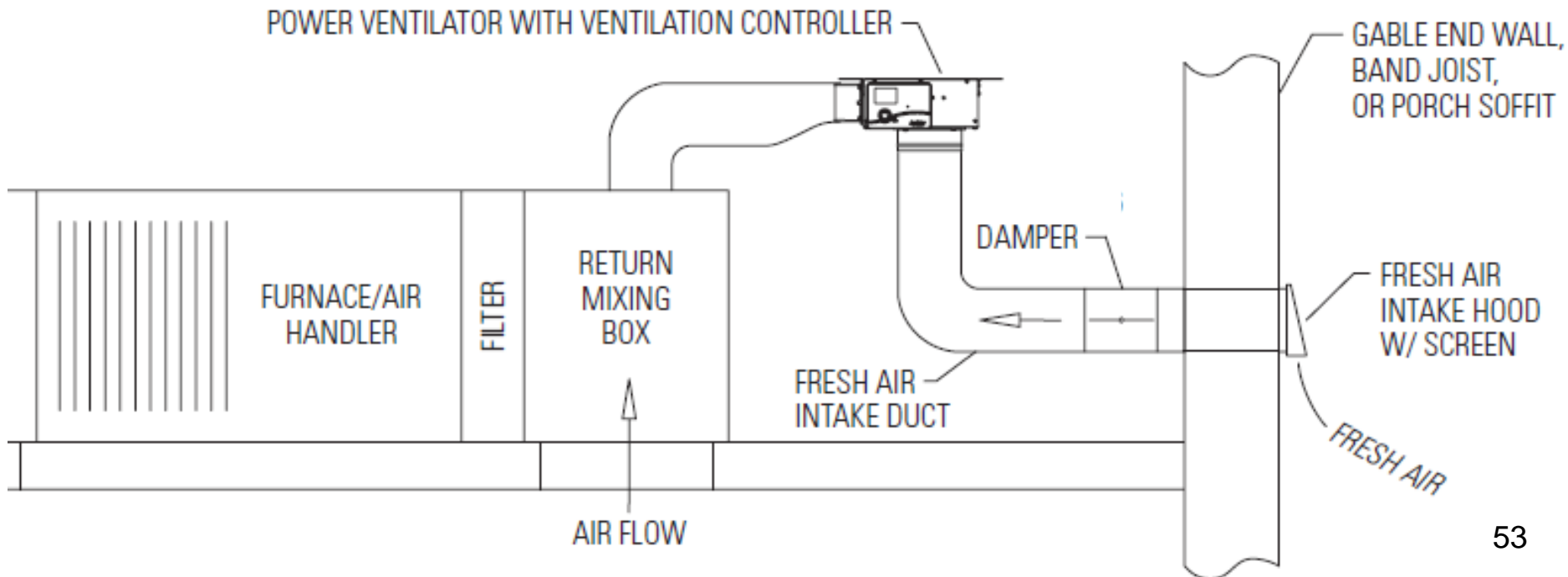
Ventilation: The year ahead

4. More sophisticated ventilation controls:
 - Additional control options than just % run-time per hour.
 - Integration with outdoor sensors.

If the ventilation air temperature is outside of the set range, then no additional ventilation will occur for another hour, and the cycle will automatically adjust to four hours. If the air temperature is still out of range, the control will automatically switch to an 8-hour cycle period, then a 12-hour cycle period and finally a 24-hour cycle period. During 8, 12, and 24 hour cycle periods, the total ventilation time increases to compensate for ventilation effectiveness as defined in ASHRAE Standard 62.2-2010.

Ventilation: The year ahead

5. More ventilation products that include their own fan:
- Improved efficiency relative to HVAC fan.
 - Greater consistency of airflow rate.
 - Potentially easier commissioning.





ENERGY STAR Certified Homes

Web:

Main: www.energystar.gov/newhomespartners
Technical: www.energystar.gov/newhomesguidelines
Training: www.energystar.gov/newhomestraining
HVAC: www.energystar.gov/newhomesHVAC

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