Are you Getting Your Fan Flows Right?

Eurihea Speciale,

Building Efficiency Resources (The BER)

Agenda

- *To discuss HERS rater specific methods for identifying and determining correct ventilation test methodology and data collection for HERS ratings and EEPs*

Ventilation Strategies

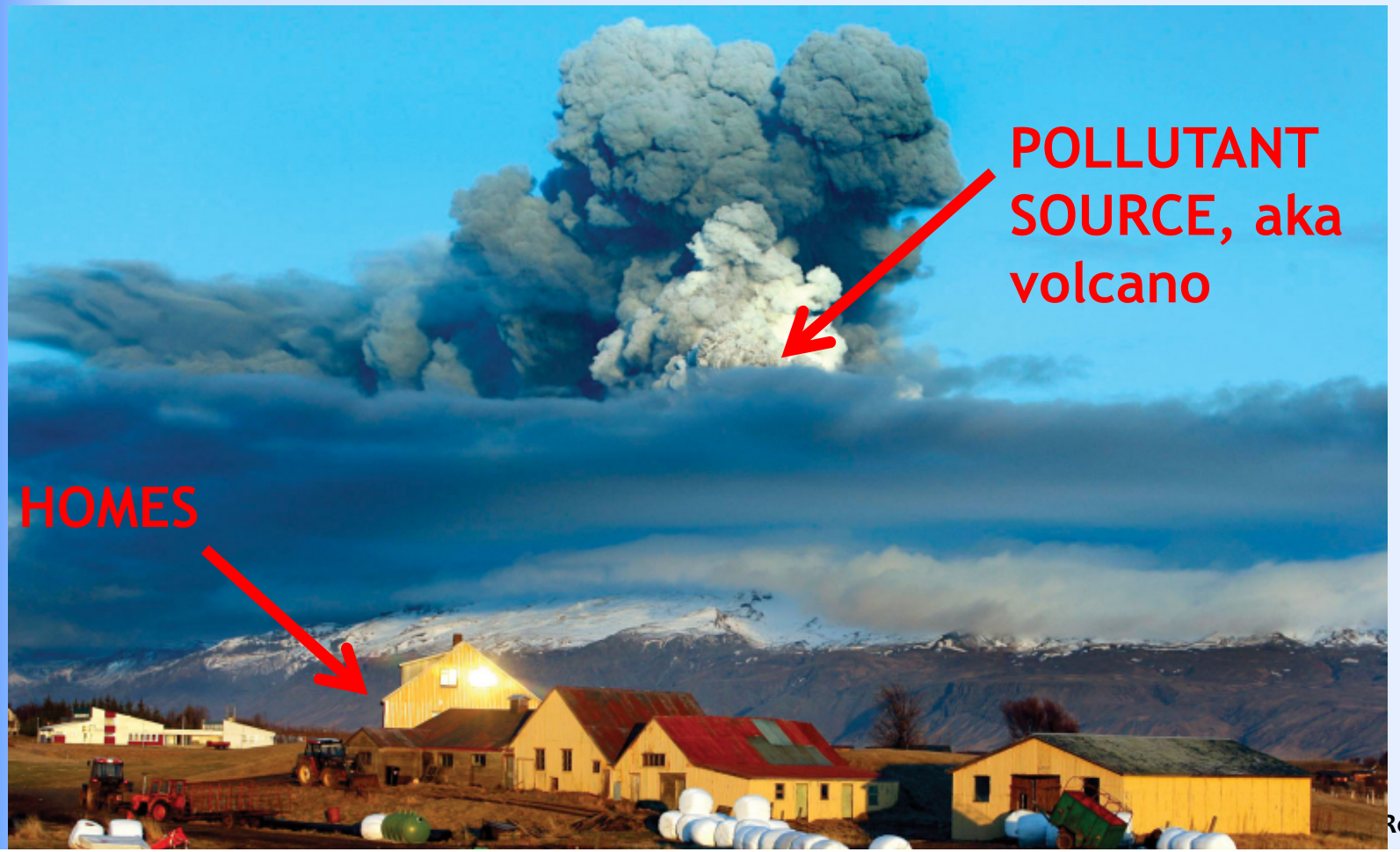
- **Natural ventilation – *uncontrolled air movement into a building through cracks and small holes (infiltration) and through vents such as windows and doors***

Ventilation Strategies

- **Whole house fresh air ventilation – *used to mix fresh outdoor air with not so fresh indoor air***

Ventilation Strategies

- **Source control (aka, spot) ventilation – *used to remove pollutants and moisture from the home***



Ventilation Systems

- **Exhaust Only –** ***One or more fans that remove air from the building, causing outdoor air to enter by ventilation inlets or normal leakage paths through the building envelope.***

Ventilation Systems

- **Supply Only – *one or more fans that supply outdoor air to the building, causing indoor air to leave by normal leakage paths through the building envelope***

Ventilation Systems

- **Balanced** - *One or more fans that supply outdoor air and exhaust building air at substantially equal rates from the space. This makes heat recovery possible via an air to air heat exchanger.*

RESNET DEFINITIONS

- **Mechanical Ventilation** – ***The active process of supplying or removing air to or from an indoor space by powered equipment such as motor-driven fans and blowers but not by devices such as wind-driven turbine ventilators and mechanically operated windows.***

RESNET DEFINITIONS

- **Mechanical Ventilation System** – ***A fan designed to exchange the air in the house with outside air, sized to provide whole-house service per ASHRAE 62.2, and controlled automatically (i.e. not requiring human intervention to turn on and off).***

Ventilation & HERS Ratings

- **Ventilation:** ***to test or not to test?***
  - **HERS ratings:** ***when system meets definition of mechanical ventilation, must be tested to achieve an accurate rating and to claim credit for reduced infiltration below 0.35ACHn***
  - **ENERGY STAR:** ***mechanical and source ventilation testing is always required***

Ventilation & HERS Ratings

Table 303.4.1(1) Specifications for the HERS Reference and Rated Homes

Air exchange rate	Specific Leakage Area (SLA) [d] = 0.00048 (assuming no energy recovery)	For residences that are not tested, the same as the HERS Reference Home For residences without mechanical ventilation systems that are tested in accordance with ASHRAE Standard 119, Section 5.1, the measured air exchange rate [e] but not less than 0.35 ach For residences with mechanical ventilation systems that are tested in accordance with ASHRAE Standard 119, Section 5.1, the measured air exchange rate [e] combined with the mechanical ventilation rate,[f] which shall not be less than 0.01 x CFA + 7.5 x (Nbr+1) cfm

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Ventilation & HERS Ratings

- ***Wattage and fan run time must also be measured and verified in order to achieve an accurate rating***

Table 303.4.1(1) Specifications for the HERS Reference and Rated Homes

Mechanical ventilation:	None, except where a mechanical ventilation system is specified by the Rated Home, in which case:	Same as Rated Home
	Annual vent fan energy use: kWh/yr = 0.03942*CFA + 29.565*(N_{br}+1) (per dwelling unit) where: CFA = conditioned floor area N_{br} = number of bedrooms	Same as Rated Home

Ventilation & HERS Ratings

- *Mechanical ventilation - is a minimum rated feature that significantly impacts the HERS Index*
- *Untested and unverified mechanical ventilation = inaccurate HERS rating*

303.8 Minimum Rated Features

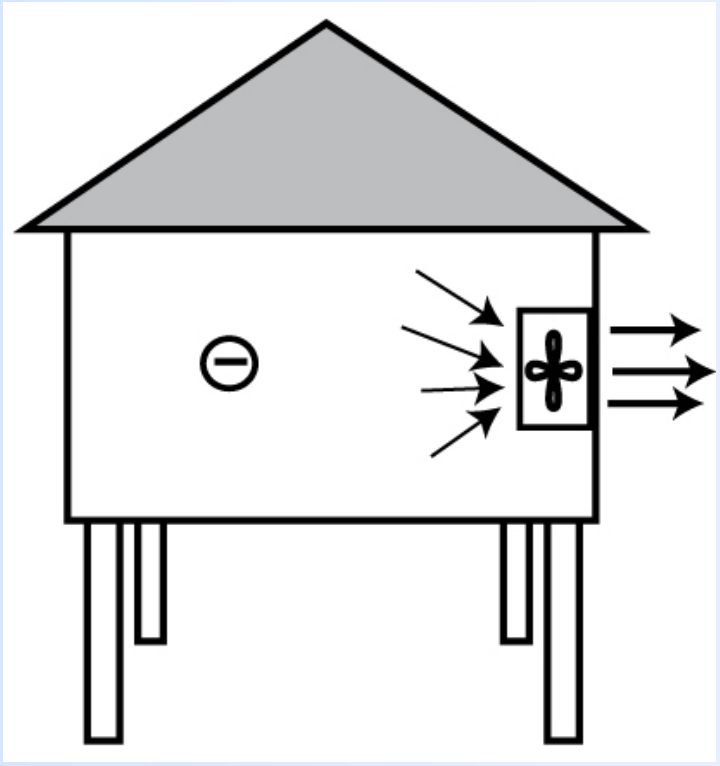
303.8.1 All HERS providers shall calculate the estimated annual purchased energy consumption for heating, cooling, water heating and lighting and appliances set forth in Section 303.1 of this Standard using the energy loss and gain associated with the minimum rated features as set forth in Table 303.8.1(1),

Table 303.8.1(1) Minimum Rated Features

Building element	Minimum Rated Feature
20. Mechanical Ventilation System(s)	Equipment type, daily run hours, and wattage (may be listed in the Certified Home Ventilating Products Directory available from the Heating and Ventilation Institute (HVI).

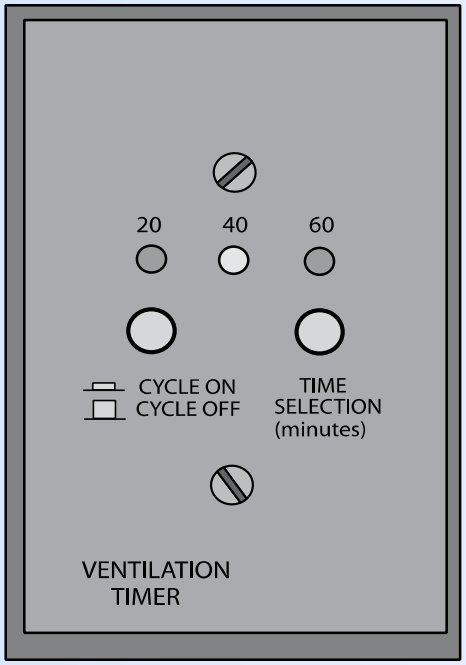
Determining Ventilation Types

- **Exhaust: spot/source vs. mechanical**
  - Timer (just a switch – spot/source) vs. controlled (mechanical system - automatic)
  - Continuously operating - OK



Exhaust Ventilation

Determining Ventilation Types

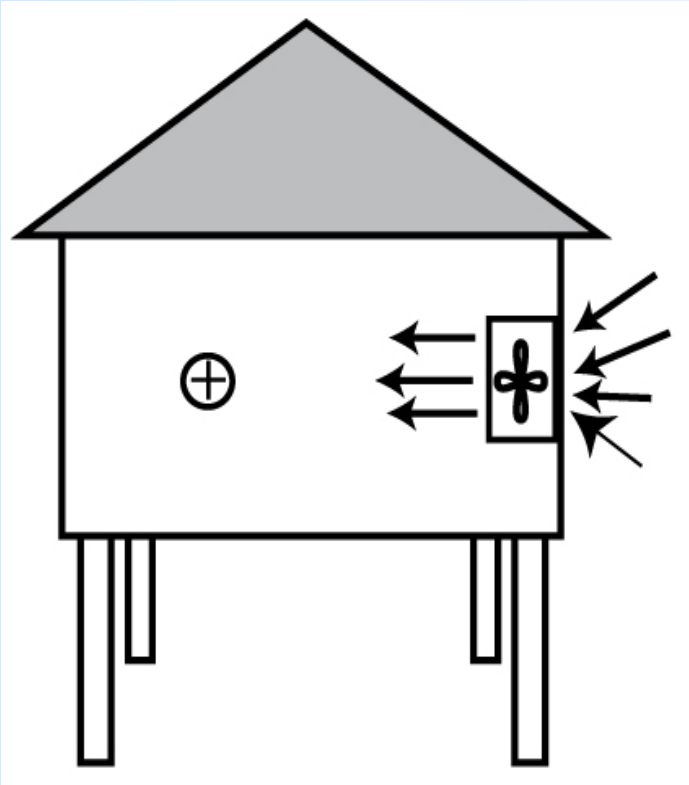


A "manual" ventilation timer either runs continuously or cycles on/off in 20, 40, or 60-minute intervals.

Determining Ventilation Types

Determining Ventilation Types

- **Supply only:**
  - Open duct w/ barometric damper or no damper – not mechanical ventilation, duct leakage
  - "Air cycler" – mechanical ventilation

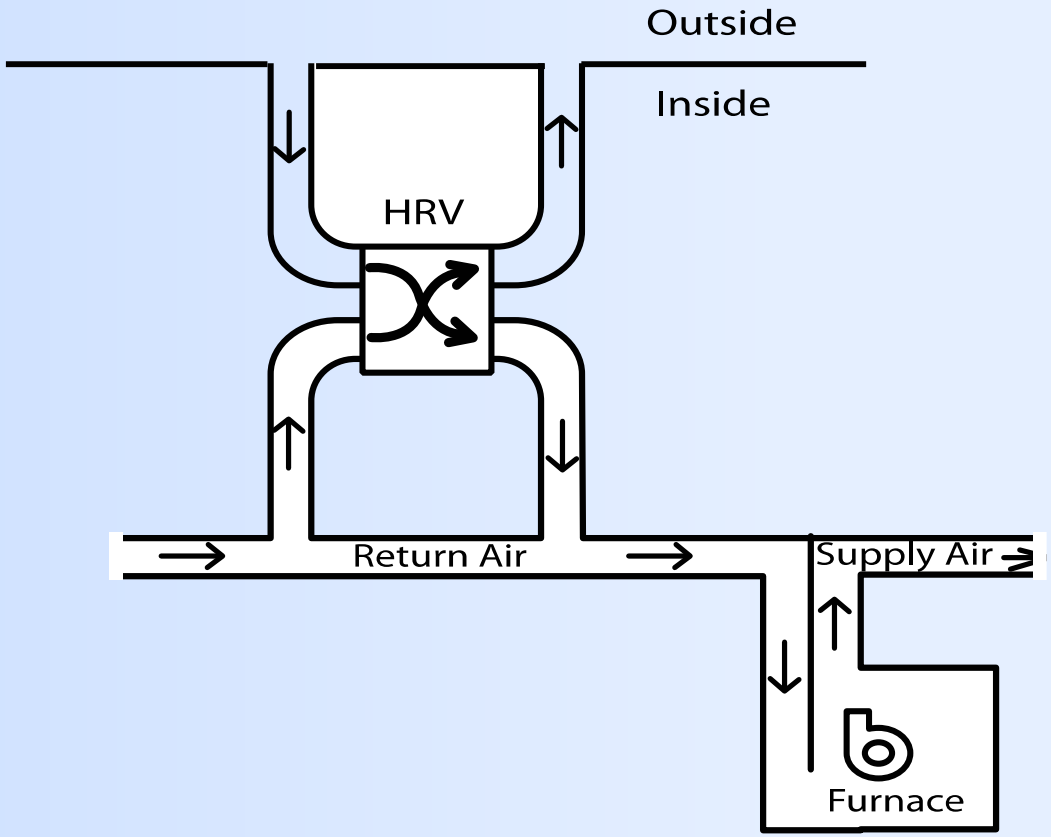


Supply Only Ventilation

Determining Ventilation Types

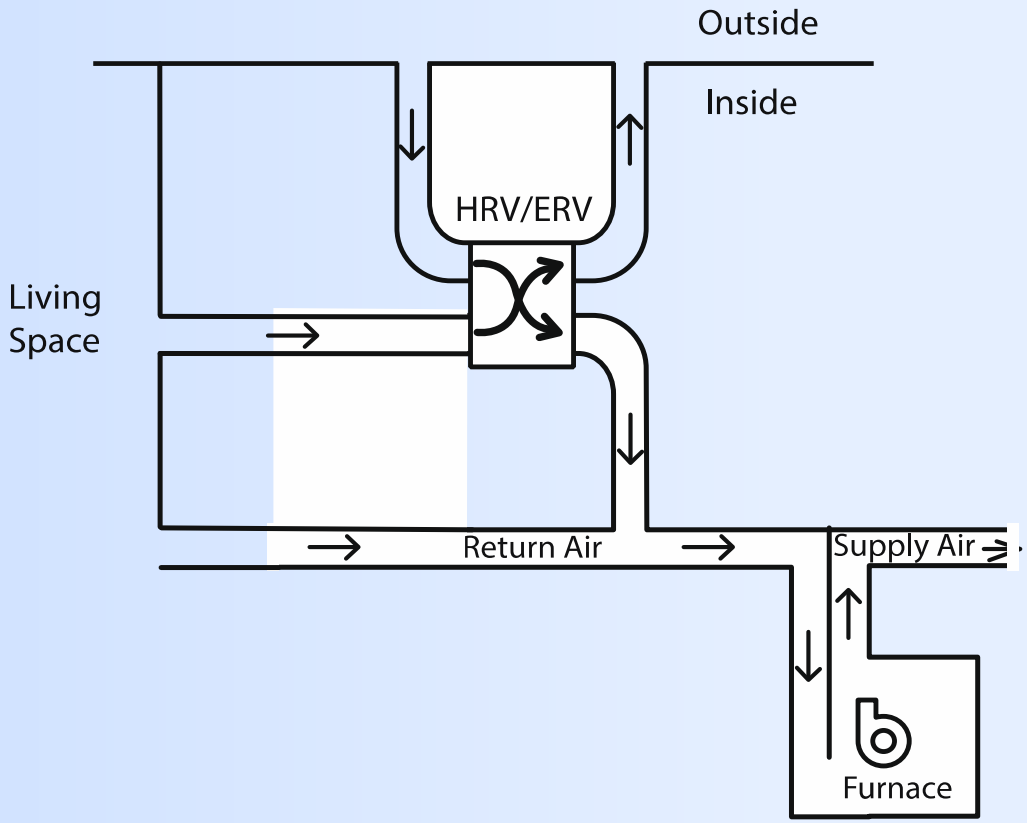
Air Cycler control – Supply Only

Determining Ventilation Types



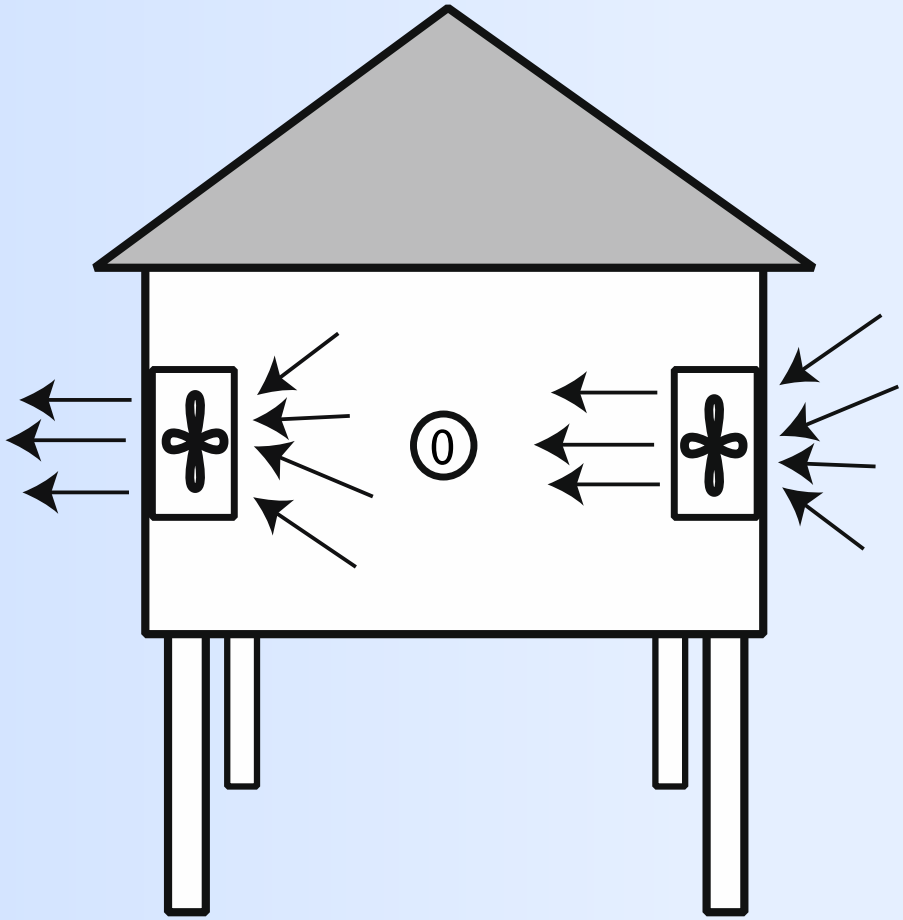
Balanced Ventilation – Short Circuited?

Determining Ventilation Types



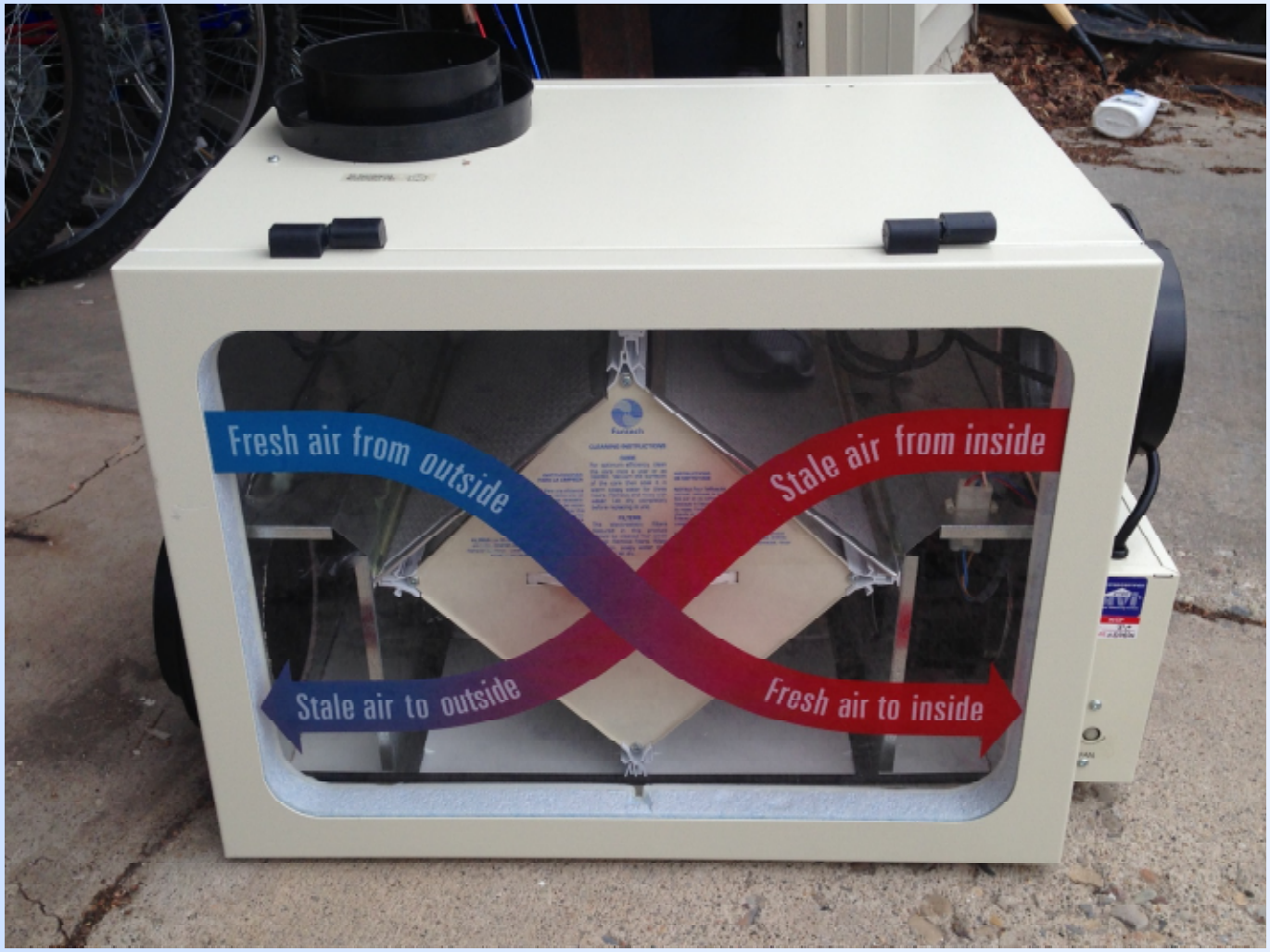
Balanced Ventilation Without Short Circuit

Determining Ventilation Types



Balanced Ventilation Without Heat Recovery

Determining Ventilation Types



Balanced

Ventilation Air Flow Testing

- **RESNET Standards, Chapter 8, Section 804**
  - *Provides on-site inspection procedures for ventilation air flow testing for whole house ventilation systems and local exhausts*
- **Somewhat limited in scope**
  - *Only 3 ventilation testing methods discussed*

Section 804

On-site Inspection Procedures for ventilation air flow Testing

- **Purpose**
  - *To measure the air flows through whole house ventilation systems and local exhausts*

Section 804

On-site Inspection Procedures for ventilation air flow Testing

- Test procedures treat the measurement of air flows into and out of the grille separately
- Airflow into grille (return/exhaust)
  - Only powered flow hoods and air resistance devices discussed
- Airflow out of grille (supply)
  - Only powered flow hoods and bag inflation discussed
- Use of a manometer with manufacturer-installed calibrated ports (common on ERV/HRV equipment) acceptable method
  - Follow manufacturer's instructions

Section 804

On-site Inspection Procedures for ventilation air flow Testing

- 804.1 Air Flows into Grilles
- 804.1.1 Powered Flow Hood

  - A flow capture device that is placed over grille to be measured
    - Flow capture element must be large enough to cover the whole grille and be airtight.
  - Must have:
    - Pressure measuring system to measure static pressure inside flow capture element
    - Manometer to measure pressure difference between inside of flow capture element and the room.
    - Air flow meter to measure air flow through air flow capture element
      - Shall measure airflow with an accuracy of +/-5%.
    - Variable-speed fan to move air through flow capture element and flow meter

Section 804

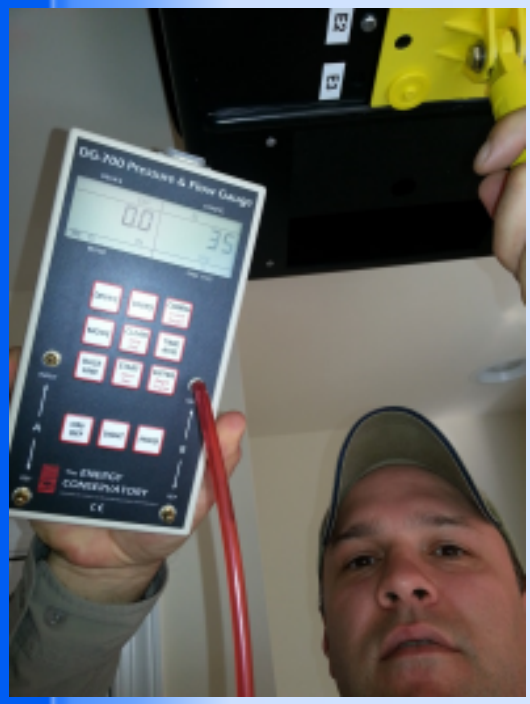
On-site Inspection Procedures for ventilation air flow Testing

- 804.1 Air Flows into Grilles
  - 804.1.1.1 Place flow capture element over grille
  - 804.1.1.2 Turn on air flow assisting fan and adjust airflow until zero pressure difference is measured between flow capture element and the room
    - Similar to duct blaster pressure matching
  - 804.1.1.3 Record air flow through the air flow meter.

Section 804

On-site Inspection Procedures for ventilation air flow Testing

- 804.1.2 Air Flow Resistance
  - The Air Flow Resistance method measures pressure difference across a flow capture element with a known air flow resistance.
  - May only be used on systems that do not have multiple branches in ventilation air duct system
  - Examples:
    - Energy Conservatory Exhaust Fan Flow Meter
    - Rectangular user-fabricated box where:
      - Size of the hole is not greater than half the size of box in each direction
      - Distance from hole to grill is at least as large the larger dimension of hole
      - Approved by provider prior to use.



Section 804

On-site Inspection Procedures for ventilation air flow Testing

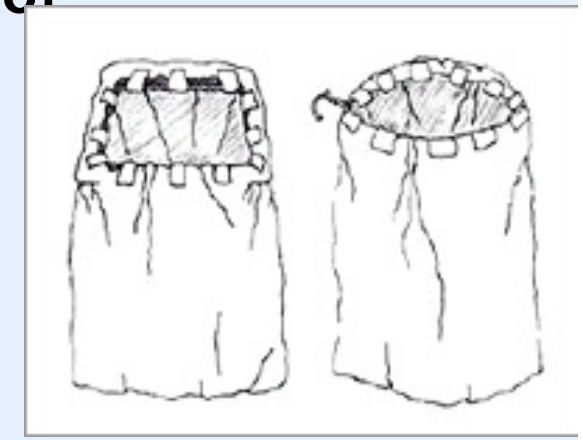
- 804.1.2.1 Place flow capture element over grille.
  - Ensure there is air tight seal around the grille and the flow device so that all of the air entering the grill goes through the device.
- 804.1.2.2 Measure pressure difference (ΔP) between flow capture element and room at a corner of inlet side of box.
  - The hole in flow capture device should be sized so that the (ΔP) is between 1 and 5 Pa.
- 804.1.2.3 Calculate airflow using MNF calibration of device
- User fabricated devices, use calculation below:

Air Flow (cfm) = Open Area×1.07×(ΔP)0.5; for Area in in2, ΔP in Pa

Section 804

On-site Inspection Procedures for ventilation air flow Testing

- 804.2 Air Flows Out of Grilles
  - 804.2.1 Powered Flow Hood
    - Same procedure as for air flow into grilles (Section 804.1.1) but with fan and flowmeter arranged to have flow out of the grille.

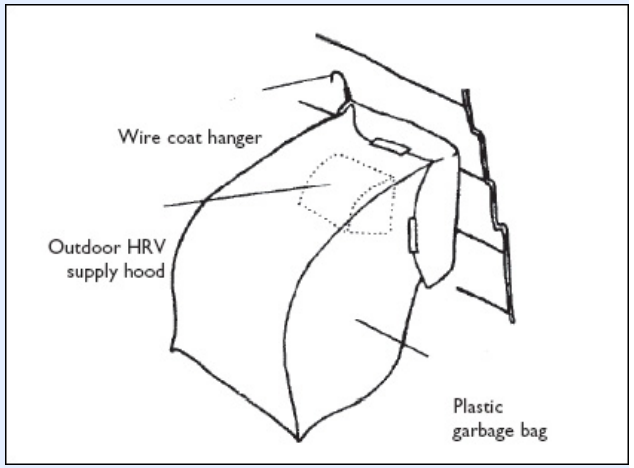


  - 804.2.2 Bag Inflation
    - The Bag Inflation method requires:
      - A bag of a known volume
      - A method to hold the bag open (typically a lightweight frame of wood, plastic or metal wire)
      - A shutter to start the air flow
      - A stopwatch

Section 804

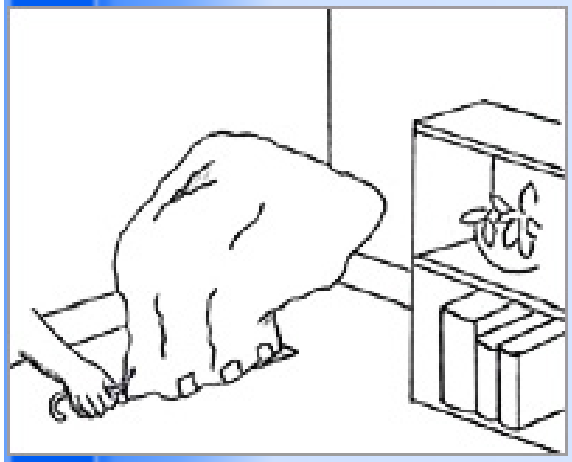
On-site Inspection Procedures for ventilation air flow Testing

- 804.2.2.1 Completely empty bag of air and place a shutter over its opening.
- 804.2.2.2 Rapidly withdraw shutter and start stopwatch.
- 804.2.2.3 When the bag is completely full stop stopwatch.
- 804.2.2.4 Calculate airflow by dividing bag volume by elapsed time.
  - Calculate the air flow in cfm as 8 X bag volume in gallons/number of seconds
- 804.2.2.5 Repeat measurement one or more times and average the results.



Section 804

On-site Inspection Procedures for ventilation air flow Testing



- 804.2.2.6 How to Choose a Bag
  - Plastic thickness.
    - Bags made from thinner material often do not fill uniformly because the air flow from the register blows them about too much.
    - If the bag sides flap a lot and measuring the same register twice gives results that differ by more than 20%, then try a bag with thicker material.
  - Use the right sized bags.
    - Bags that fill in < 2 seconds have increased errors
    - Bags that are too large for a given register flow have increased leakage around edges of bag before its filled
    - Aim for a fill time of 2 to 20 seconds for complete fill

Ventilation Testing Methods

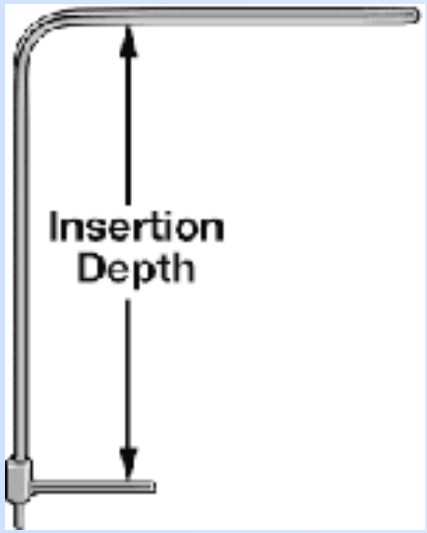
Wet weather pallet cover bag – 100 cu ft

Ventilation Testing Methods

- Do Chapter 8 testing procedures provide methods for testing of all ventilation types?
- No, therefore alternative test methods must be employed
- All ventilation can be tested with high degree of accuracy
- Key is to have the right tools

Ventilation Testing Methods

Neither Approved nor Disapproved by RESNET



Ventilation Testing Methods

- Exhaust: Bath & Kitchen
  - Air flow resistance (flow meter)
    - Bath exhaust fans
  - Large vane anemometer
    - Small kitchen exhaust hoods
  - Hot wire/small vane
    - Large kitchen exhaust hoods (test in duct pipe)

Ventilation Testing Methods

Range Hood Flow Video

Ventilation Testing Methods

- Air cycler:
  - Hot wire anemometer
  - Small vane anemometer
  - Pitot tube
    - readings can be challenging to get consistency, need to be adjusted based on temperature/barometric pressure, and need to consider length of run/bends etc to get accurate number.
  - From outside using flow hood or flow meter
    - Challenging due to varied surface of siding, brick, wind
    - Not recommended, inaccurate

Ventilation Testing Methods

- Hot Wire Anemometer
  - Very accurate readings
  - Requires drilling holes in pipe if not present
  - Can be used for all ventilation types when ducts are used
  - Can be used to determine top speed of HERS rater if held in hand while running down the block

Ventilation Testing Methods

Duct Flow Video

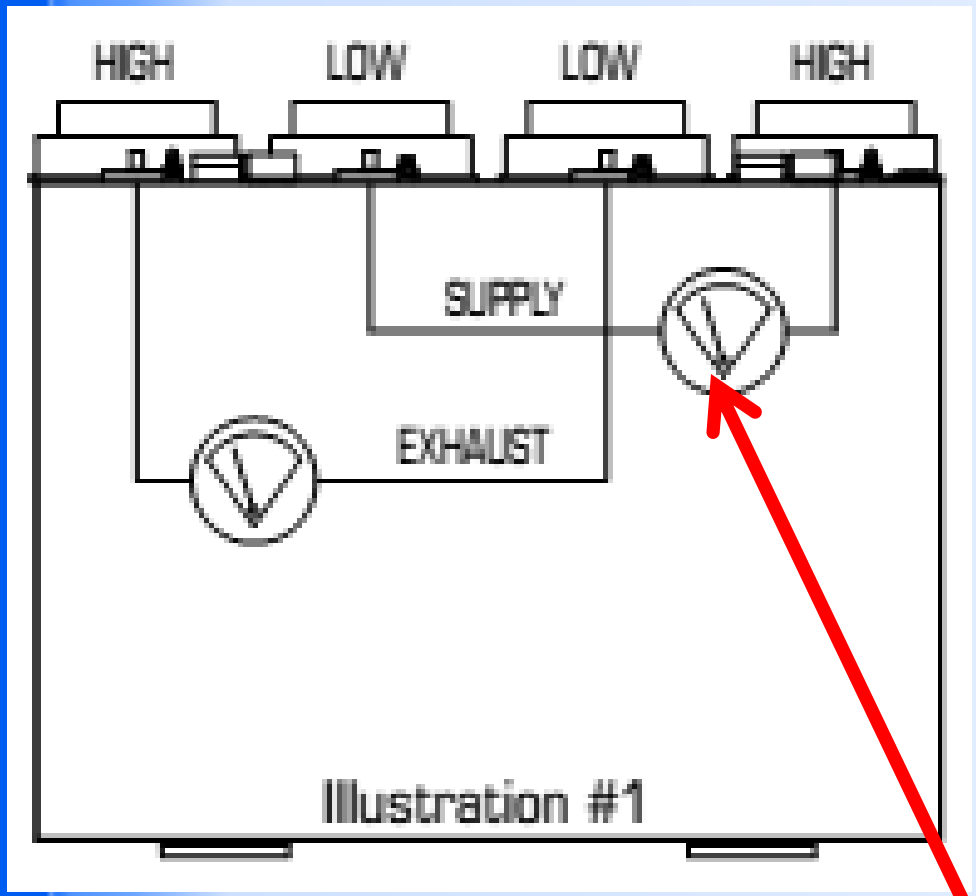
Ventilation Testing Methods

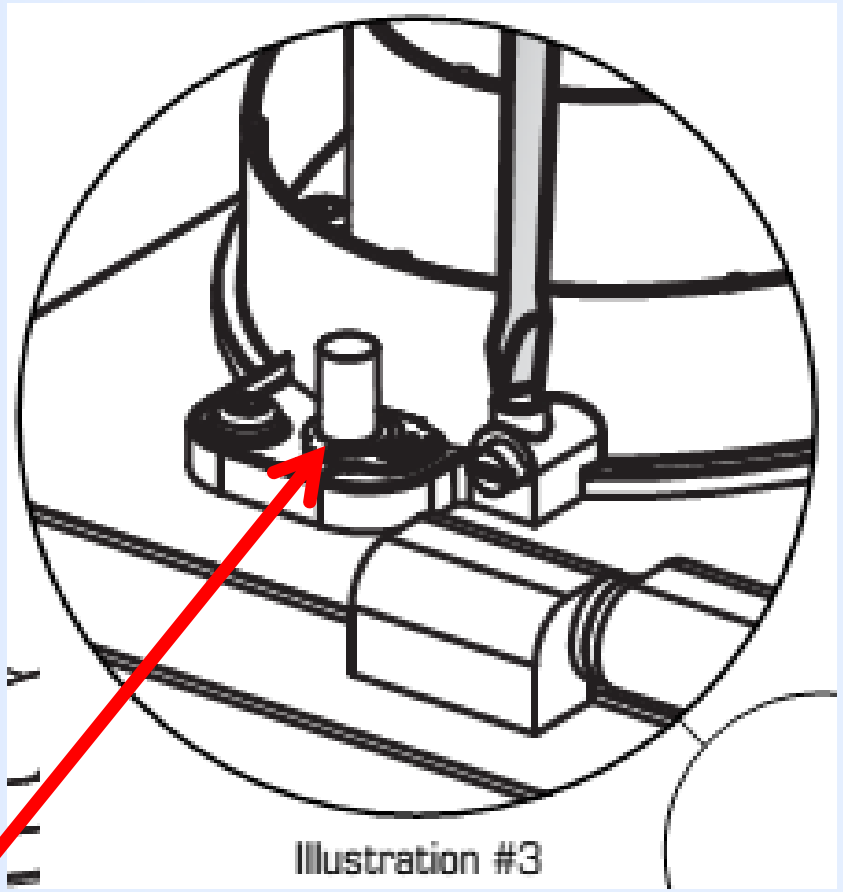
- HRV/ERV
  - Manufacturer calibrated ports (available on select models, follow manufacturer instructions)
  - Hot wire anemometer traverse
  - Airflow Station (GRID) method
  - Pitot tube – not recommended, ok for balancing

Ventilation Testing Methods

- HRV/ERV
  - Important to measure both supply and exhaust
    - If unbalanced, use the higher of the 2 numbers for flow
    - Unbalanced systems affect efficiency of system
  - Air flow resistance possible for independently ducted systems

Ventilation Testing Methods



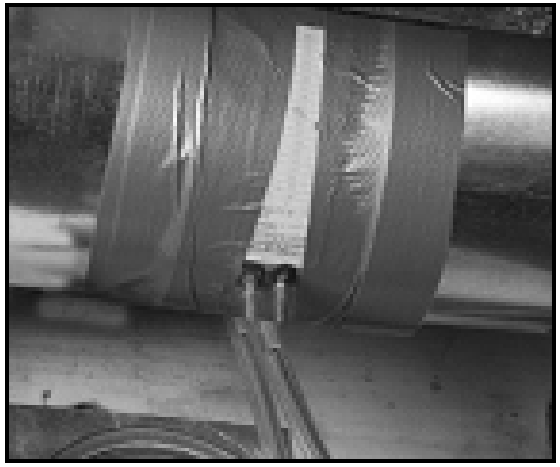


- Using manometer, follow mfg. instructions to measure the supply and exhaust sides

Ventilation Testing Methods

- HRV/ERV

AIRFLOW STATION (GRID) METHOD

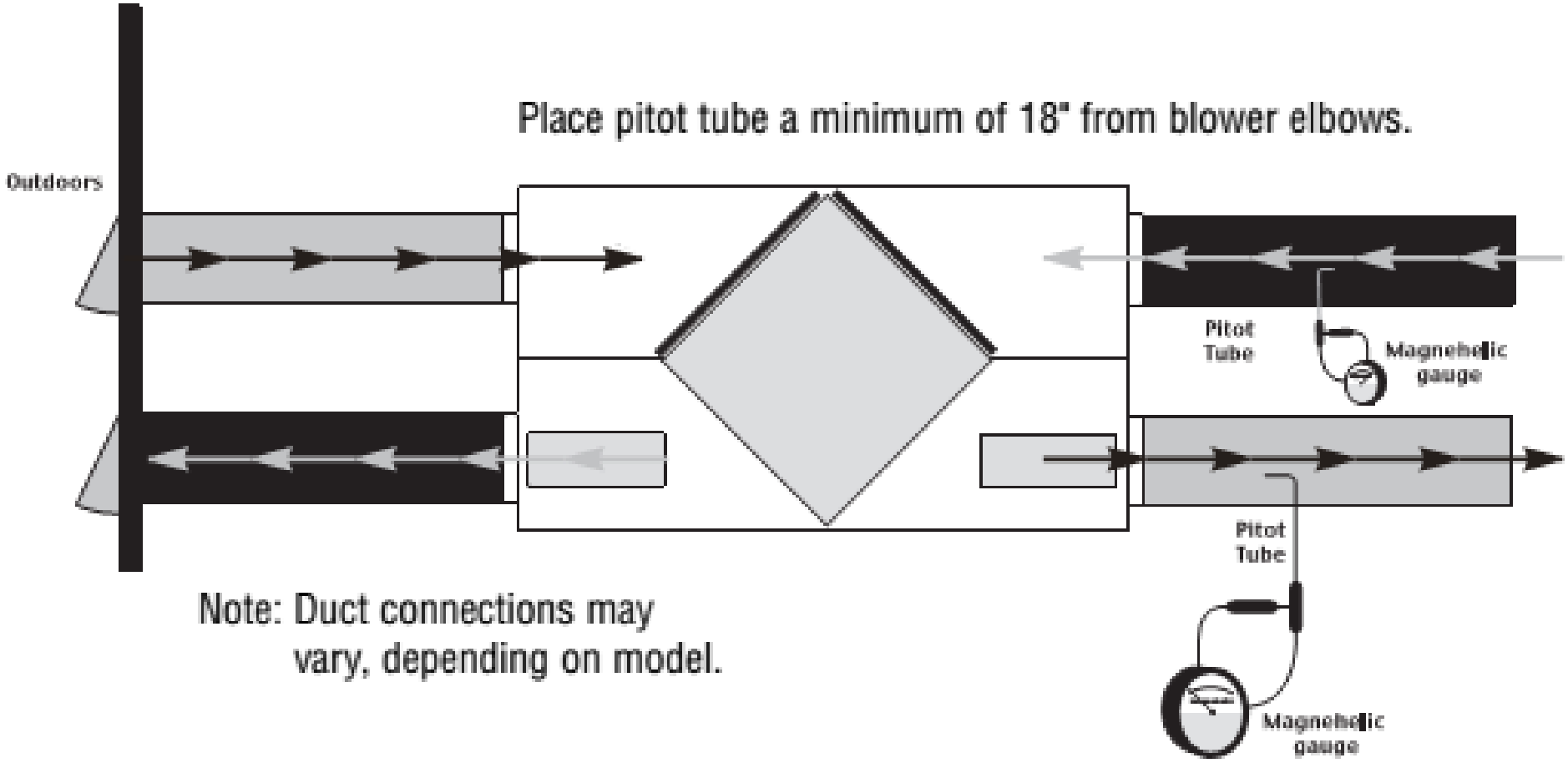


1 For this flow measuring station, cut the duct and place the flow measuring station between each station. Make sure that the flow measuring station's air direction arrow points in the direction of the airflow. Secure the flow measuring station with duct tape.

2 Before taking the reading, make sure that the magnehelic gauge is level and at 0. Refer to the flow measuring station's chart to determine your unit's airflow velocity.

Ventilation Testing Methods

- Pitot Tube – used to take a velocity pressure reading



Ventilation Testing Methods

- Other methods/tools BER is less favorable towards
  - Garbage Bag
  - Duct blaster pressure matching
    - Complex and cumbersome
  - Non-powered flow hoods
  - Large vanes for supply side measurement
    - Need K-factor from manufacturer

Ventilation Testing Methods

- Dos and don'ts
  - Not recommended to use air flow resistance outside the building
  - Don't use air flow resistance on popcorn ceiling, siding or any other varied surface
  - Don't include any ventilation in energy modeling software that is not RESNET defined as mechanical ventilation system
    - Example: supply side duct into central HVAC system that does not automatically turn on AHU to provide ventilation if HVAC system is not running

Run Time & Wattage

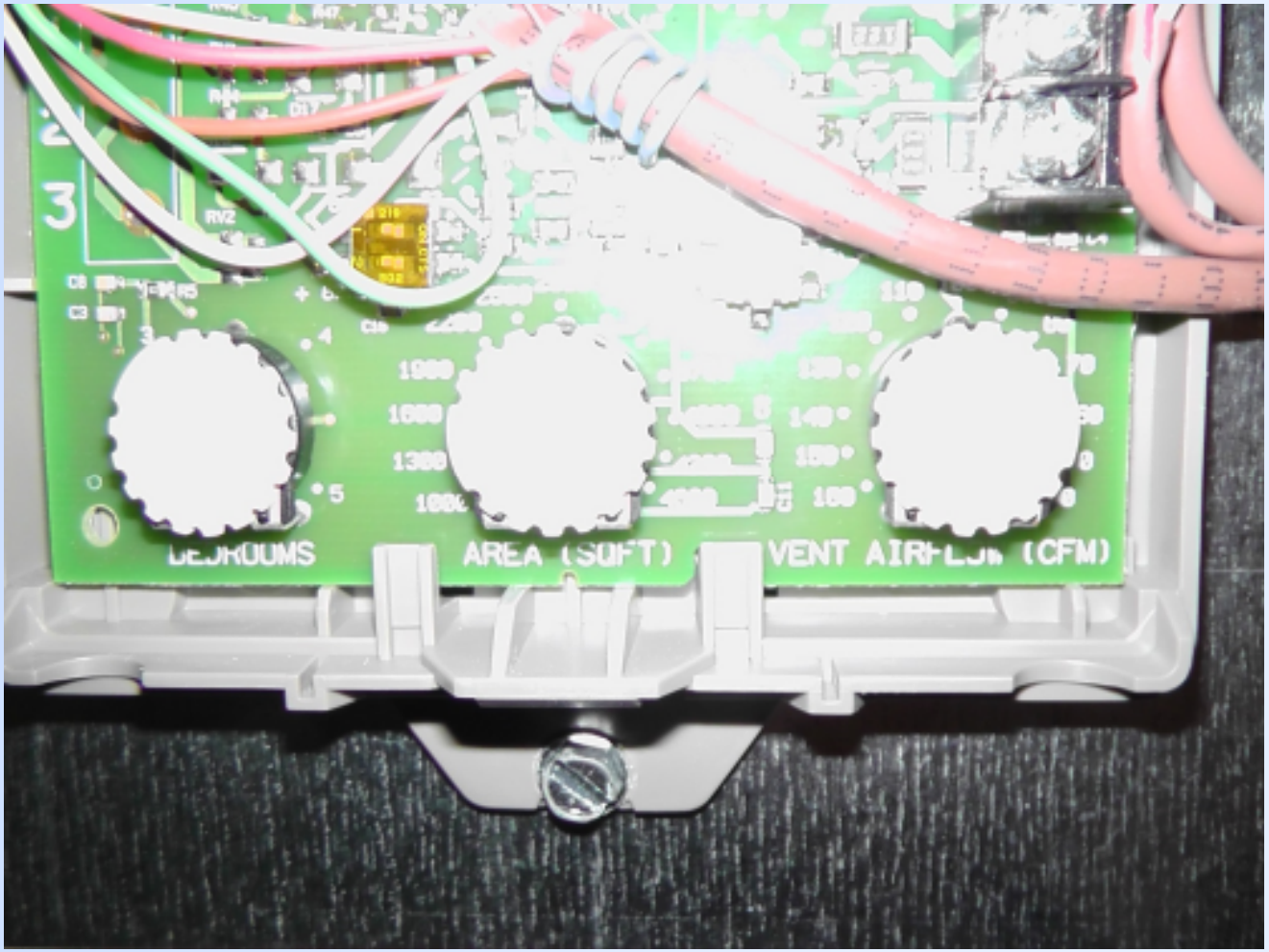
Delay dial (spot)

Flow Rate

Run Time & Wattage

– Automatic spot & continuous mechanical

Run Time & Wattage



Run Time & Wattage

Run Time & Wattage

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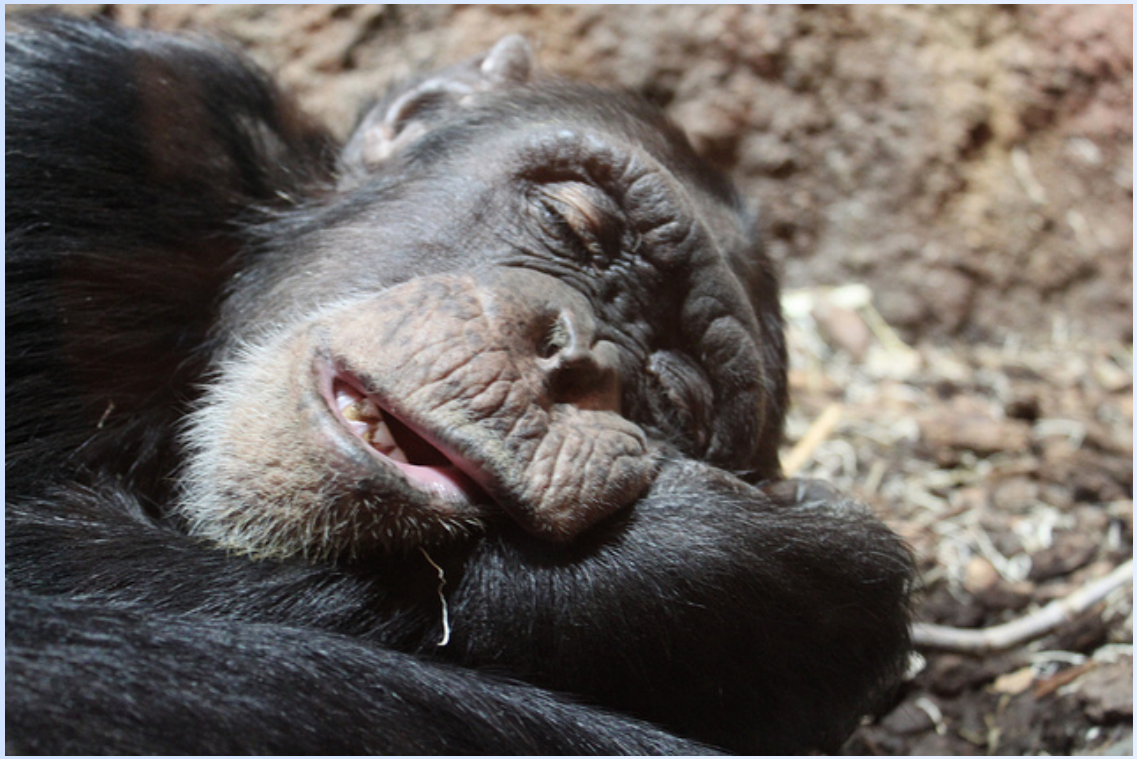

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