ASHRAE 62.2-2016

Residential Ventilation for Acceptable Indoor Air Quality

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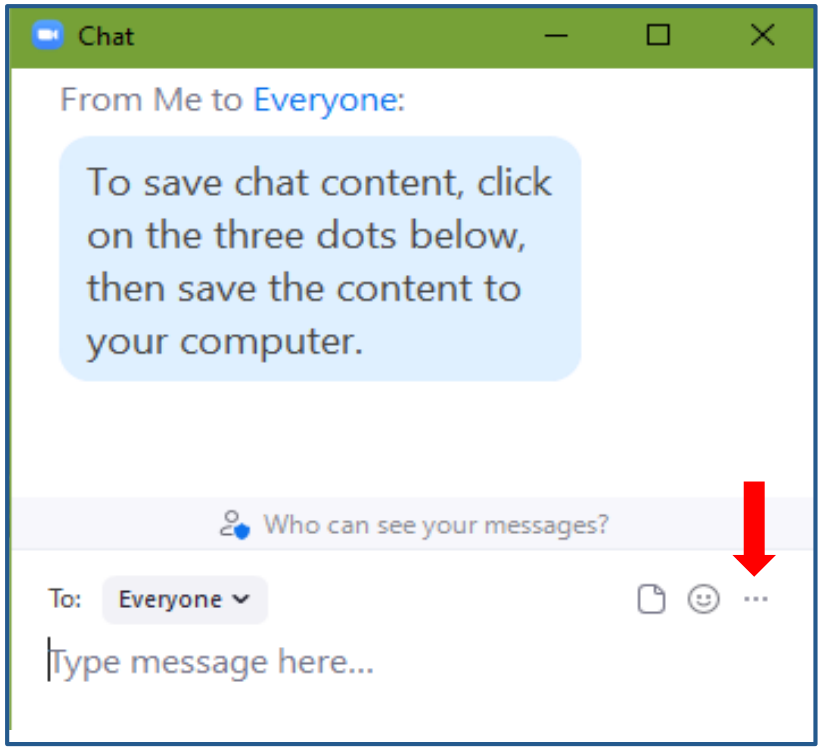
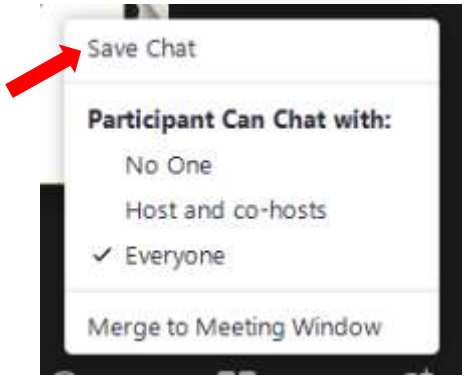
Maine Indoor Air Quality Council

How to get the most from today's program:

1. **Mute your microphone** during the presentation.
2. **Do ask workshop related questions**. Type your questions (to Everyone) into the meeting chat box.
3. **Save the meeting chat** that contains answers to questions, lists of resources, and helpful links to your computer before you leave the program.
4. **Code specific questions** should be directed to the State Fire Marshal's Office Building Codes: https://www.maine.gov/dps/fmo/building-codes.





Additional Energy Code Resources

- **Additional energy code workshops**
  https://www.efficiencymaine.com/professional-training/building-energy-code-workshops/
- **Additional building energy code resources**
  https://www.efficiencymaine.com/building-energy-codes/
- **State Fire Marshal's Building Codes**
  https://www.maine.gov/dps/fmo/building-codes

IAQ & Energy Symposium
www.iaqandenergy.com

Maine Indoor Air Quality Council

www.maineindoorair.org
207-626-8115
Christy@maineindoorair.org

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Instructor, Rick Karg

- Member of ASHRAE 62.2 committee since 2007
- Chair of ASHRAE Residential Buildings Committee
- Primary author of *62.2-2016 User's Manual*
- President of Residential Energy Dynamics (RED)
- Member of MUBEC Board (2008 – 2013)
- Received Phillip C. Hastings award from Efficiency Maine in 2015
- Inducted into the Building Performance Institute (BPI) Hall of Fame in 2016

Workshop Description

This training provides the necessary details of sizing local and dwelling-unit ventilation for new dwellings based on ASHRAE 62.2-2016, Ventilation and Acceptable Indoor Air Quality in Residential Buildings.

The significant requirements of the 62.2 standard are addressed and compliance options are discussed, both for single-family detached dwellings and dwellings in multifamily buildings.

Examples are explained using the free 62.2-2016 web application by Residential Energy Dynamics (RED). An overview of ventilation equipment and control options is included.

Learning Objectives

1. Understand the significant details of the ASHRAE 62.2-2016 standard
2. Be able to size local and dwelling-unit mechanical ventilation for residential buildings
3. Know how to verify ventilation systems for compliance with ASHRAE 62.2-2016
4. Have basic knowledge of mechanical ventilation options and controls

Overview of 62.2-2016 Standard

ASHRAE 62.2 Facts

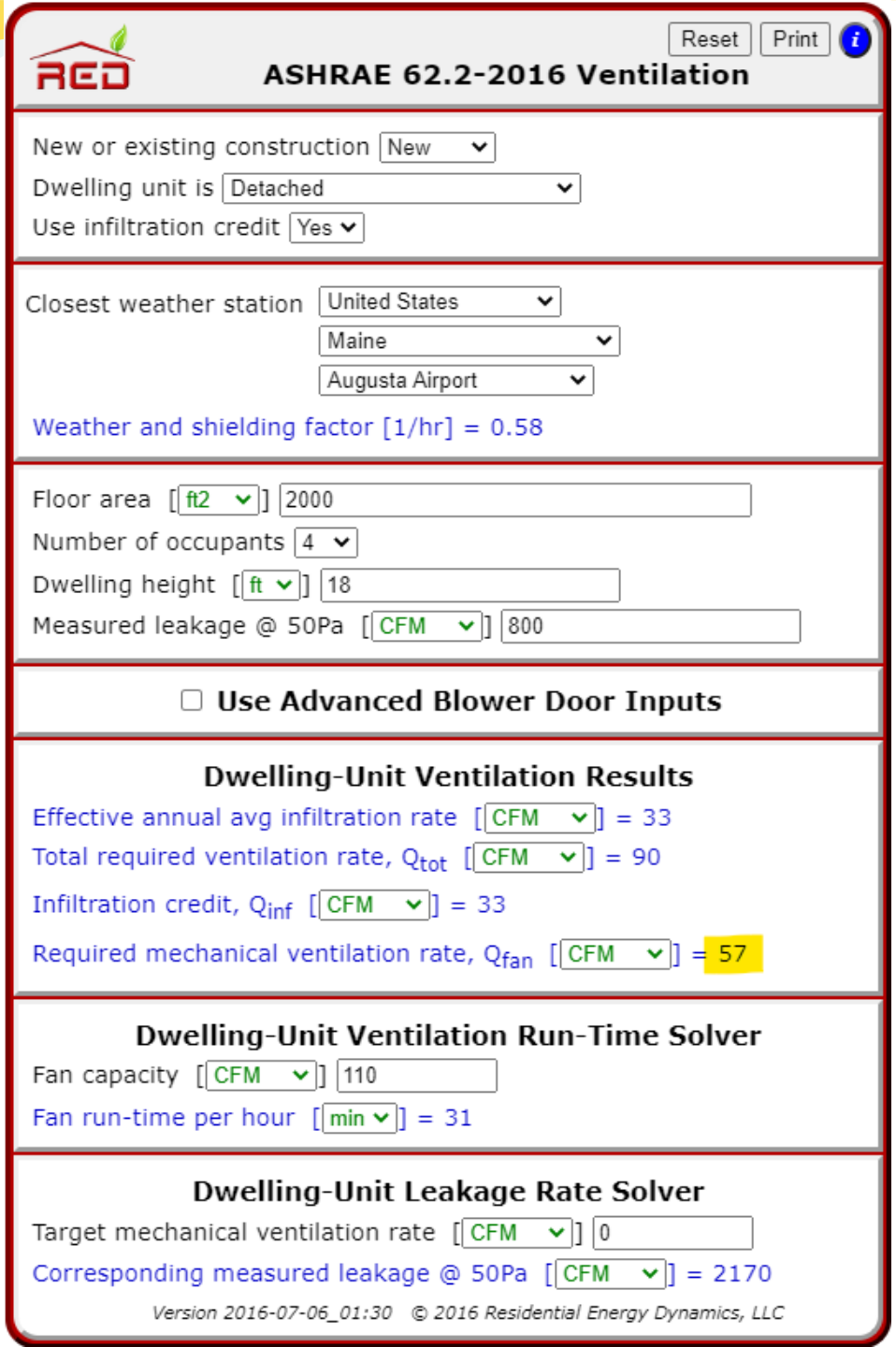
- Minimum standard (code) for all **dwellings**, no matter the height
- First published in 2003
- Continuous maintenance standard
- New edition every three years (next 2022)
- Ventilation sections in I-Codes primarily based on 62.2-2010 (deleted by rule making)

ASHRAE 62.2-2016 Availability

- Available for purchase at www.ashrae.org, $87
- Available for viewing FREE of charge at
  - www.ashrae.org, then
  - “Technical Resources”, then
  - “Standards and Guidelines”, then
  - “Public Review Drafts”, then
  - “Standard 62.2-2016”

Basic Ventilation Requirements

- Local exhaust ventilation
  - Local bathroom ventilation reduces moisture and odors
  - Local kitchen ventilation reduces moisture, odors, and many harmful contaminants
- Dwelling-unit ventilation
  - Reduces general odors and contaminants
  - Usually allows infiltration credit



RED Calc Free web application

www.REDcalc.com
www.redcalc.com/ashrae-62-2-2016

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ASHRAE 62.2-2016 Ventilation

New or existing construction: New

Dwelling unit is: Detached

Use infiltration credit: Yes

Closest weather station: United States / Maine / Augusta Airport

Weather and shielding factor [1/hr] = 0.58

Floor area [ft2] 2000

Number of occupants: 4

Dwelling height [ft] 18

Measured leakage @ 50Pa [CFM] 800

☐ **Use Advanced Blower Door Inputs**

☐ **Use Advanced Blower Door Inputs**

Dwelling-Unit Ventilation Results

Effective annual avg infiltration rate [CFM] = 33

Total required ventilation rate, Q_{tot} [CFM] = 90

Infiltration credit, Q_{inf} [CFM] = 33

Required mechanical ventilation rate, Q_{fan} [CFM] = 57

Dwelling-Unit Ventilation Run-Time Solver

Fan capacity [CFM] 110

Fan run-time per hour [min] = 31

Dwelling-Unit Leakage Rate Solver

Target mechanical ventilation rate [CFM] 0

Corresponding measured leakage @ 50Pa [CFM] = 2170

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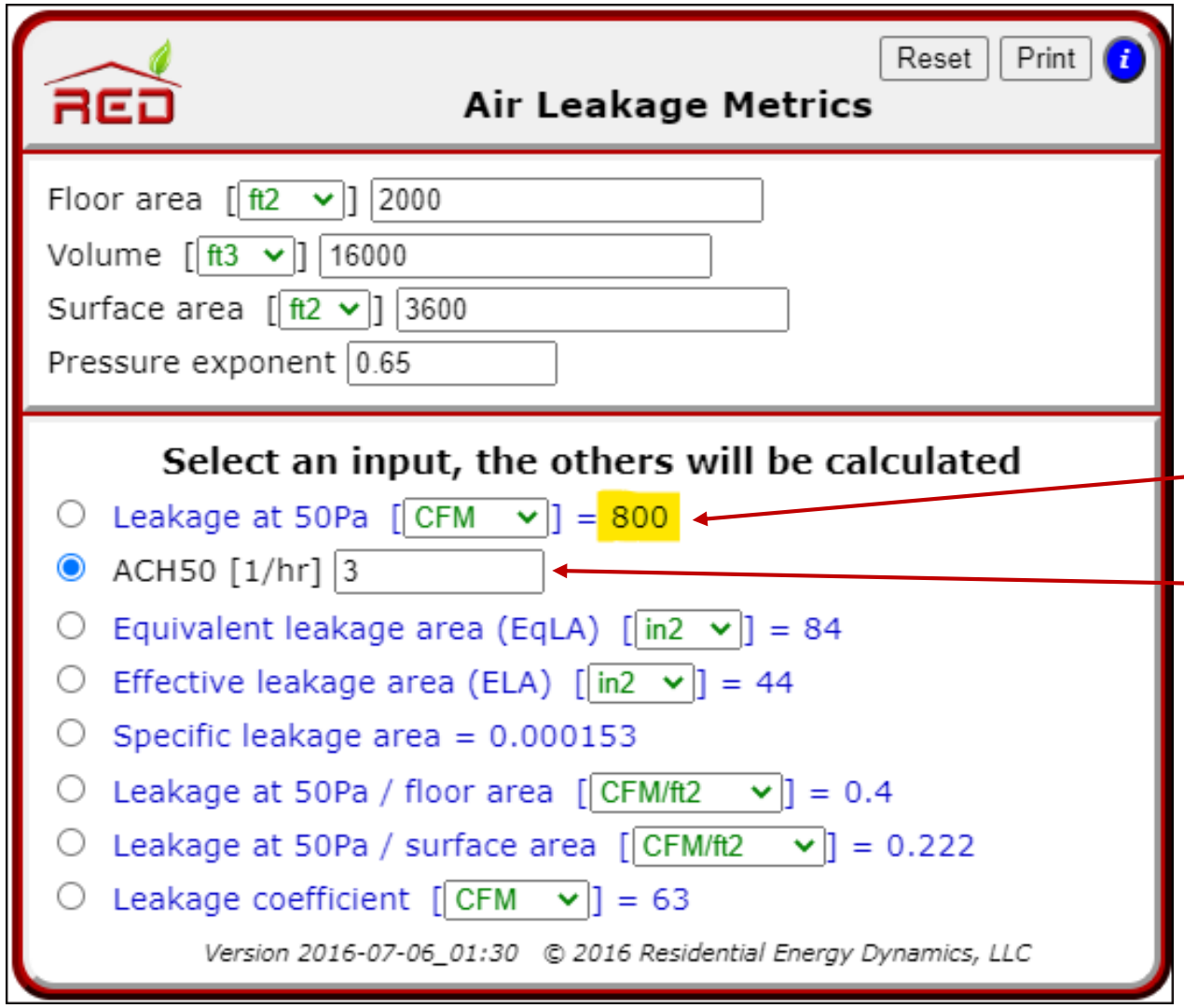
As dwellings become tighter, there is less naturally occurring air leakage, so a controlled supply of fresh air from outdoors becomes more important



Corresponding CFM_{50} tightness level for maximum infiltration allowed

Code requirement

www.redcalc.com/air-leakage-metrics/

Local Ventilation (bathrooms and kitchen)

Exhaust-Only

Local Ventilation

- Exhaust the worst air in the dwelling as quickly as possible
  - Bathrooms
  - Kitchens

Local Ventilation Bathrooms

- Local exhaust fans installed in bathrooms
  - Bathrooms (not half bathrooms)
    - 50 CFM demand-controlled, or
    - 20 CFM continuous

Local Ventilation Kitchen

- Local exhaust fans installed in kitchen.
  - Enclosed kitchen (permanent openings to interior adjacent spaces do not exceed a total of 60 ft^2)
    - 100 CFM if range hood, demand-controlled
    - 300 CFM if other than range hood, or 5 ACH based on kitchen volume
  - Non-enclosed kitchen
    - 100 CFM if range hood, demand-controlled
    - 300 CFM if other than range hood

Sizing Dwelling-Unit Ventilation

Exhaust, Supply, or Balanced

ASHRAE 62.2 Requirement

- Dwelling-unit ventilation
  - “A mechanical exhaust system, supply system, or combination thereof shall be installed for each dwelling unit to provide continuous dwelling-unit ventilation with outdoor air at a rate not less than specified in Section 4.1.1.”

Source: ASHRAE 62.2-2016, Section 4.1

Dwelling-Unit Ventilation

- Assumes two occupants in master bedroom and one in the other bedrooms. Over this density, increase ventilation by 7.5 CFM/person.
- Ventilation air must come directly from the outdoors.
- Infiltration credit is allowed for envelope air leakage in most dwellings.

Dwelling-Unit Ventilation Basic Equation

$$Q_{tot} = 0.03A_{floor} + 7.5(N_{bedroom} + 1)$$

Dwelling-Unit Ventilation Operation

- May operate CONTINUOUSLY or INTERMITTENTLY
- Intermittently:
  - Example
    - HRV rated at 150 CFM capacity.
    - Dwelling-unit requirement is 50 CFM.
    - Operate HRV on a timer for 20 minutes out of every hour* to get 50 CFM average.

* Must operate at least once every 3 hours

Infiltration Credit for New Dwellings

Infiltration Credit

- Acceptable indoor air quality (IAQ) is dependent on outdoor air, Q_{tot}

$$Q_{tot} = 0.03A_{floor} + 7.5(N_{bedroom} + 1)$$

- The two sources of outdoor air are
  - Mechanical ventilation, Q_{fan}
  - Infiltration, Q_{inf}

$$Q_{tot} = Q_{fan} + Q_{inf}$$

ASHRAE 62.2 Requirement

- Infiltration credit, Q_{inf}, for *dwelling-unit ventilation* (local or spot ventilation not relevant)
  - Based on blower door test

  - For single-family detached, infiltration credit limited to 2/3 of Q_{tot}.
  - For horizontally attached dwelling units, multiply Q_{inf} by A_{ext}. A_{ext} = ratio of exterior envelope surface area that is not attached to garages of other dwelling units, to total envelope surface area.
  - For vertically attached dwelling units, no infiltration credit is allowed.

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Dwelling-unit Ventilation: *New Dwellings, Detached*

$$Q_{tot} = 0.03A_{floor} + 7.5(N_{bedroom} + 1)$$

Total Required Ventilation Rate, Q_{tot}
- Infiltration Credit, Q_{inf} *
Required Mechanical Ventilation Rate, Q_{fan}

* Limited to 2/3 of Q_{tot}

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ASHRAE 62.2-2016 Ventilation

New or existing construction: New

Dwelling unit is: Detached

Use infiltration credit: Yes

Closest weather station: United States / Maine / Augusta Airport

Weather and shielding factor [1/hr] = 0.58

Floor area [ft2] 2000

Number of occupants: 4

Dwelling height [ft] 18

Measured leakage @ 50Pa [CFM] 800

☐ **Use Advanced Blower Door Inputs**

☐ **Use Advanced Blower Door Inputs**

Dwelling-Unit Ventilation Results

Effective annual avg infiltration rate [CFM] = 33

Total required ventilation rate, Q_{tot} [CFM] = 90

Infiltration credit, Q_{inf} [CFM] = 33

Required mechanical ventilation rate, Q_{fan} [CFM] = 57

Dwelling-Unit Ventilation Run-Time Solver

Fan capacity [CFM] 110

Fan run-time per hour [min] = 31

Dwelling-Unit Leakage Rate Solver

Target mechanical ventilation rate [CFM] 0

Corresponding measured leakage @ 50Pa [CFM] = 2170

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Dwelling-unit Ventilation
New Dwellings, Horizontally Attached

$$Q_{tot} = 0.03A_{floor} + 7.5(N_{bedroom} + 1)$$

Total Required Ventilation Rate, Q_{tot}
- Infiltration Credit, Q_{inf} x A_{ext}
Required Mechanical Ventilation Rate, Q_{fan}

Multifamily Building Dwelling-Unit Infiltration Credit

- Allows for an infiltration credit to be taken for horizontally-attached multifamily dwellings subject to a reduction factor, A_{ext}

Multifamily Building Dwelling-Unit Infiltration Credit

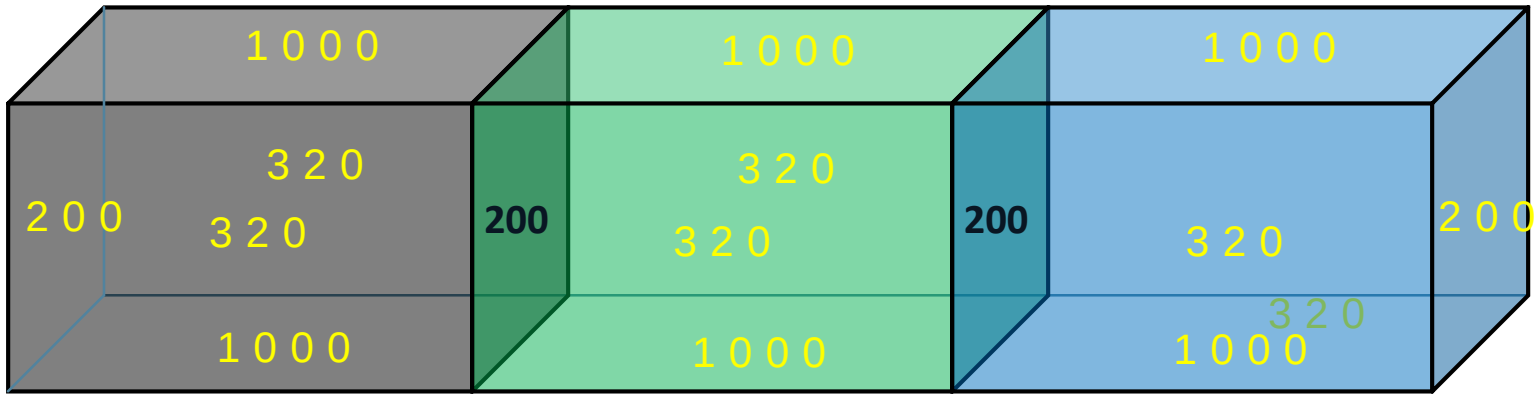
- How it is calculated:
  - Do a blower door test of the unit.
  - Calculate the fraction of enclosure area (6-sides) that is NOT attached to other units or garages.
  - Multiply infiltration estimate from blower door test by this fraction.

$$Q_{fan} = Q_{tot} - (Q_{inf} * A_{ext})$$

$$A_{ext} = \frac{\text{exterior surface}}{\text{total envelope surface}}$$

Multifamily Building Dwelling-Unit Infiltration Credit

Consider a triplex, each unit is 40’ x 25’ with 8’ ceilings



Total surface area per unit is 1000 x 2 + 320 x 2 + 200 x 2 = 3040 sq. ft.

Infiltration credit (as a percentage of single-family calculation):

End units get (3040-200)/3040 = 2840/3040 = 93.4%

Middle unit gets (3040-400)/3040 = 2640/3040 = 86.8%

Horizontally-attached dwelling

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ASHRAE 62.2-2016 Ventilation

New or existing construction: New
Dwelling unit is: Attached to other dwelling unit(s)
Only walls are in common with other dwelling units: Yes
Use infiltration credit: Yes

Closest weather station: United States / Maine / Augusta Airport

Weather and shielding factor [1/hr] = 0.58

Floor area [ft2] 1000
Number of occupants: 3
Dwelling height [ft] 8

Area of common walls [ft2] 400
Envelope area adjoining garage [ft2] 0
Remaining envelope area [ft2] 2640
Total envelope area [ft2] = 3040

Measured leakage @ 50Pa [CFM] 400

Measured leakage @ 50Pa [CFM] 400

☐ **Use Advanced Blower Door Inputs**

Dwelling-Unit Ventilation Results

Effective annual avg infiltration rate [CFM] = 12
Total required ventilation rate, Q_{tot} [CFM] = 52.5
Infiltration credit, Q_{inf} [CFM] = 10.4
Required mechanical ventilation rate, Q_{fan} [CFM] = 42.1

Dwelling-Unit Ventilation Run-Time Solver

Fan capacity [CFM] 110
Fan run-time per hour [min] = 22.9

Dwelling-Unit Leakage Rate Solver

Target mechanical ventilation rate [CFM] 0
Corresponding measured leakage @ 50Pa [CFM] = 2010

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Dwelling-unit Ventilation
New Dwellings, Vertically Attached

$$Q_{tot} = 0.03A_{floor} + 7.5(N_{bedroom} + 1)$$

Total Required Ventilation Rate, Q_{tot}

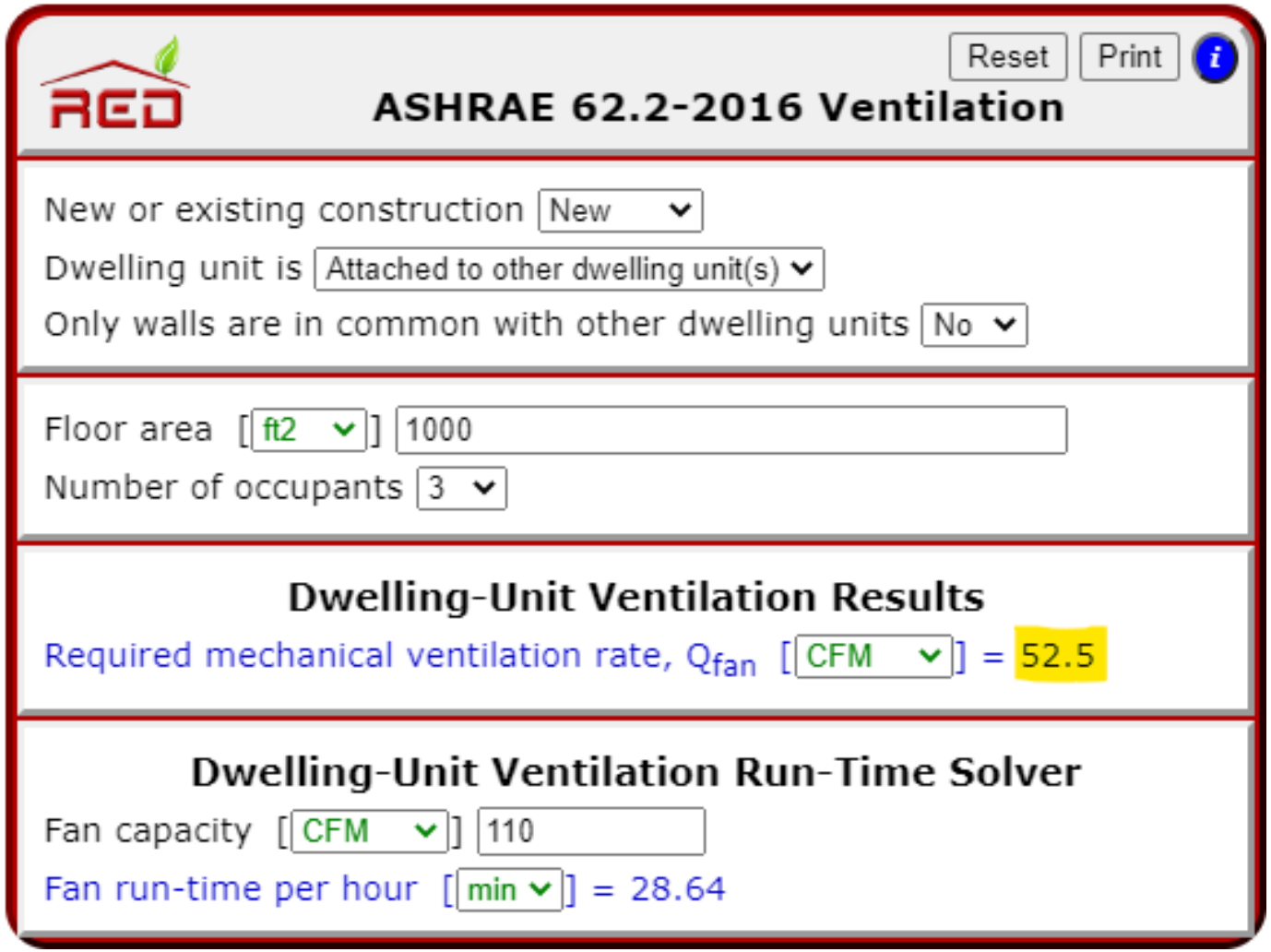
~~- Infiltration Credit, Q_{inf}~~

Required Mechanical Ventilation Rate, Q_{fan}

Thus, $Q_{fan} = Q_{tot}$

Dwelling-unit Ventilation

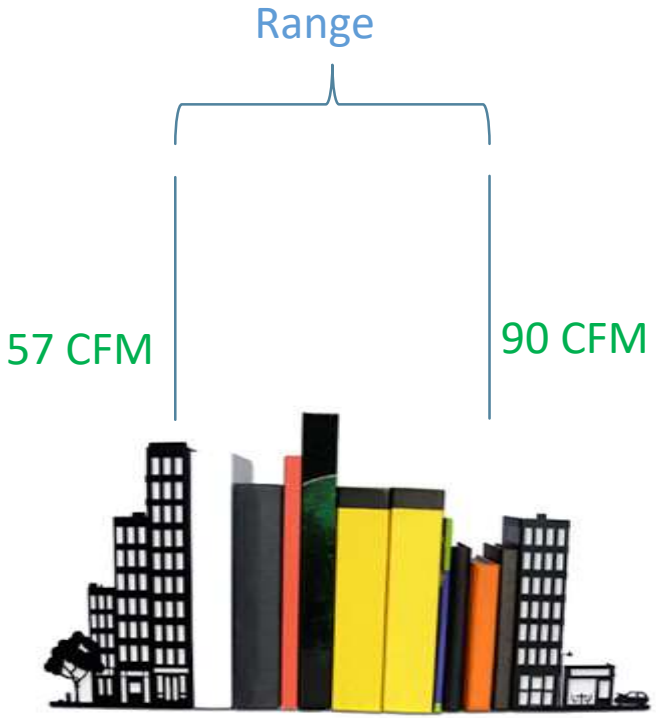
New Dwellings, Vertically Attached



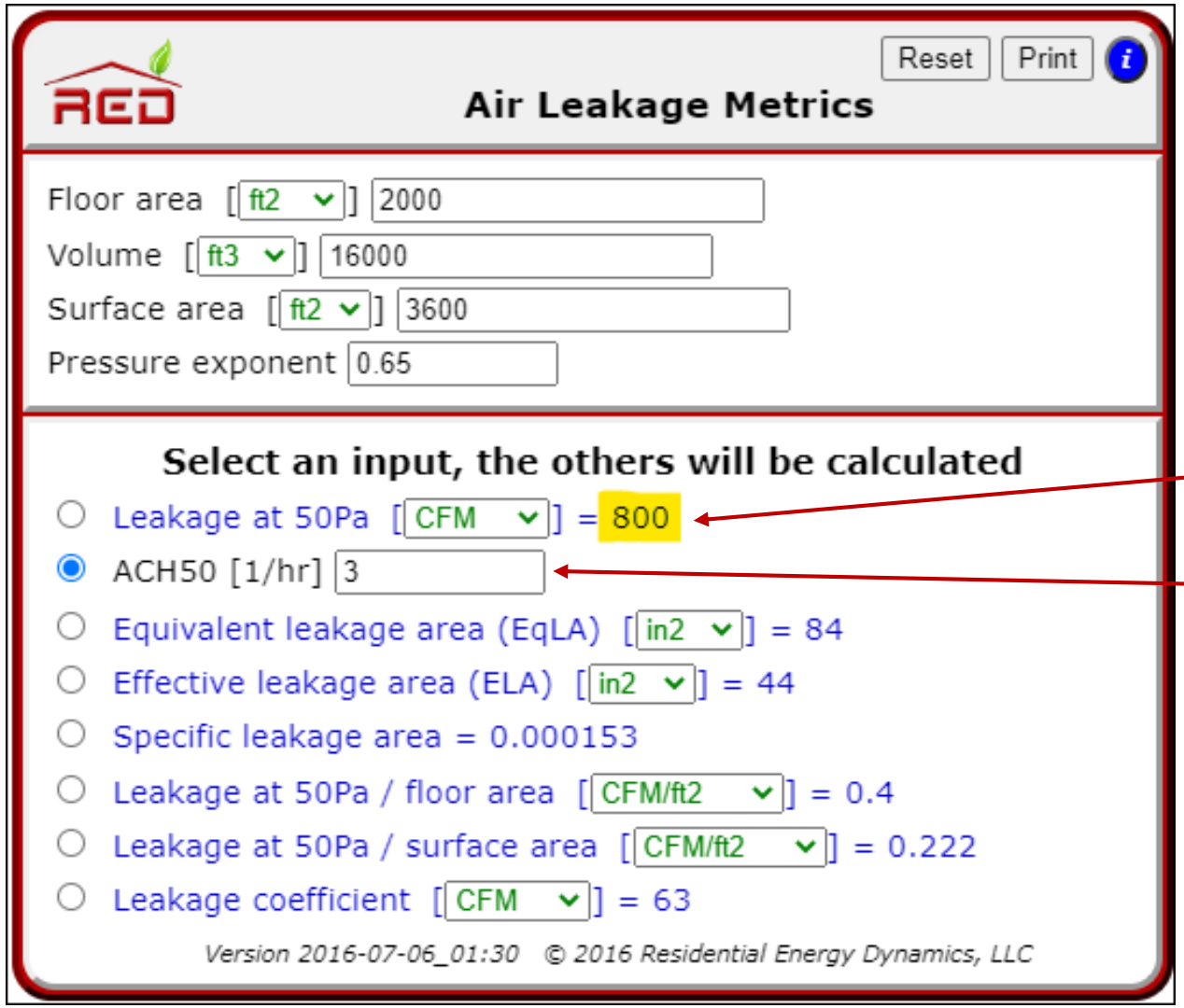
Sizing Dwelling-Unit Ventilation (DUV) BEFORE Dwelling is Built

“Bookend” the Final Air Flow Rate

- Minimum DUV complies with an infiltration rate of 3 ACH_{50}
  - Enter “Measured leakage @ 50Pa” in RED tool that corresponds with 3 ACH_{50}, for example “800” [57 CFM]
- Maximum DUV corresponds to zero infiltration rate
  1. Enter “Measured leakage @ 50Pa” in RED tool that corresponds with no air leakage, for example “1” [90 CFM]
  2. Or, select “No” for “Use infiltration credit” in top section of RED tool



Low “Bookend”



Corresponding CFM_{50} tightness level for maximum infiltration allowed

Code requirement

www.redcalc.com/air-leakage-metrics/

Low “Bookend”

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ASHRAE 62.2-2016 Ventilation

New or existing construction: New

Dwelling unit is: Detached

Use infiltration credit: Yes

Closest weather station: United States / Maine / Augusta Airport

Weather and shielding factor [1/hr] = 0.58

Floor area [ft2] 2000

Number of occupants: 4

Dwelling height [ft] 18

Measured leakage @ 50Pa [CFM] 800

☐ **Use Advanced Blower Door Inputs**

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Dwelling-Unit Ventilation Results

Effective annual avg infiltration rate [CFM] = 33

Total required ventilation rate, Q_{tot} [CFM] = 90

Infiltration credit, Q_{inf} [CFM] = 33

Required mechanical ventilation rate, Q_{fan} [CFM] = 57

Dwelling-Unit Ventilation Run-Time Solver

Fan capacity [CFM] 110

Fan run-time per hour [min] = 31

Dwelling-Unit Leakage Rate Solver

Target mechanical ventilation rate [CFM] 0

Corresponding measured leakage @ 50Pa [CFM] = 2170

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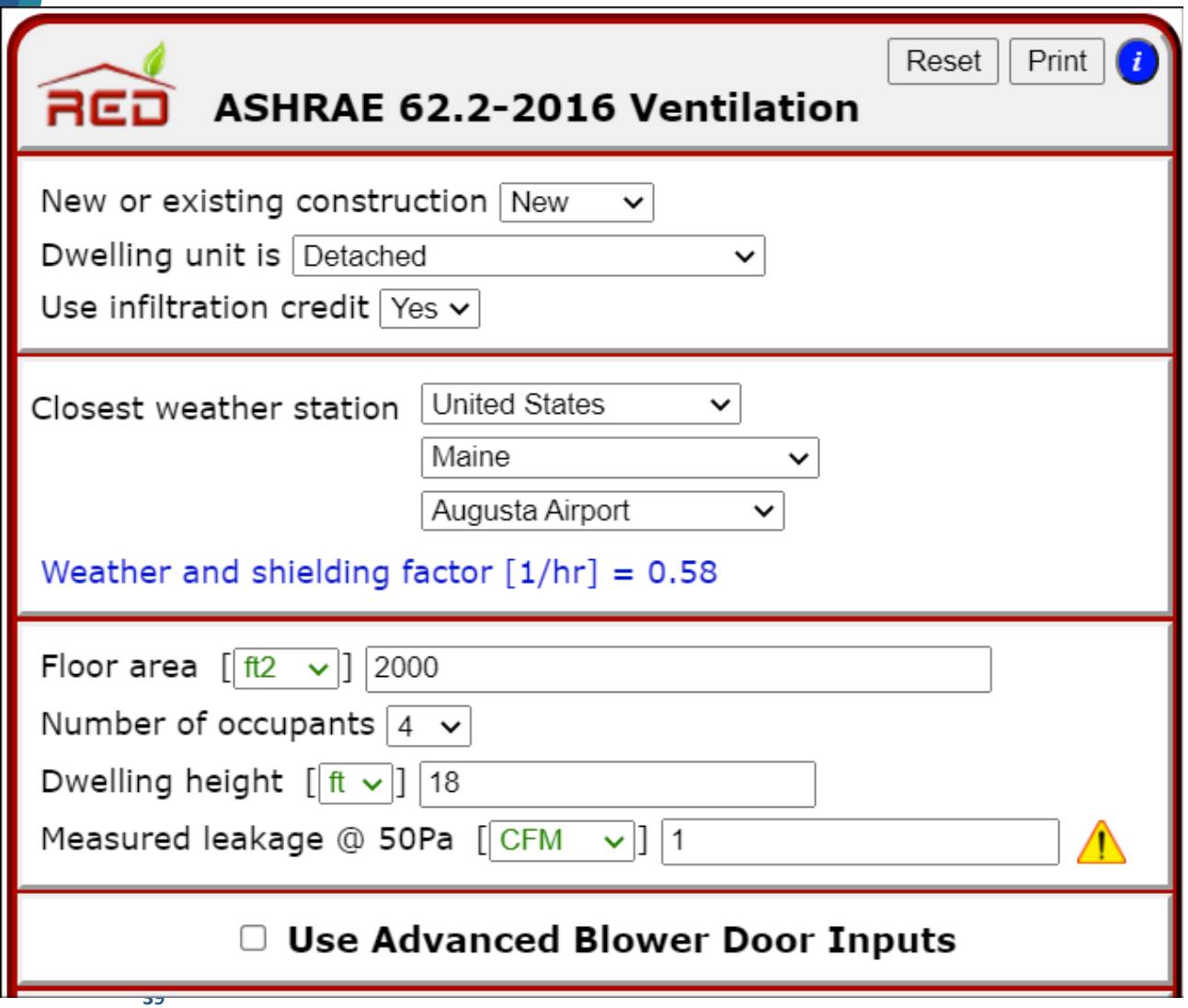
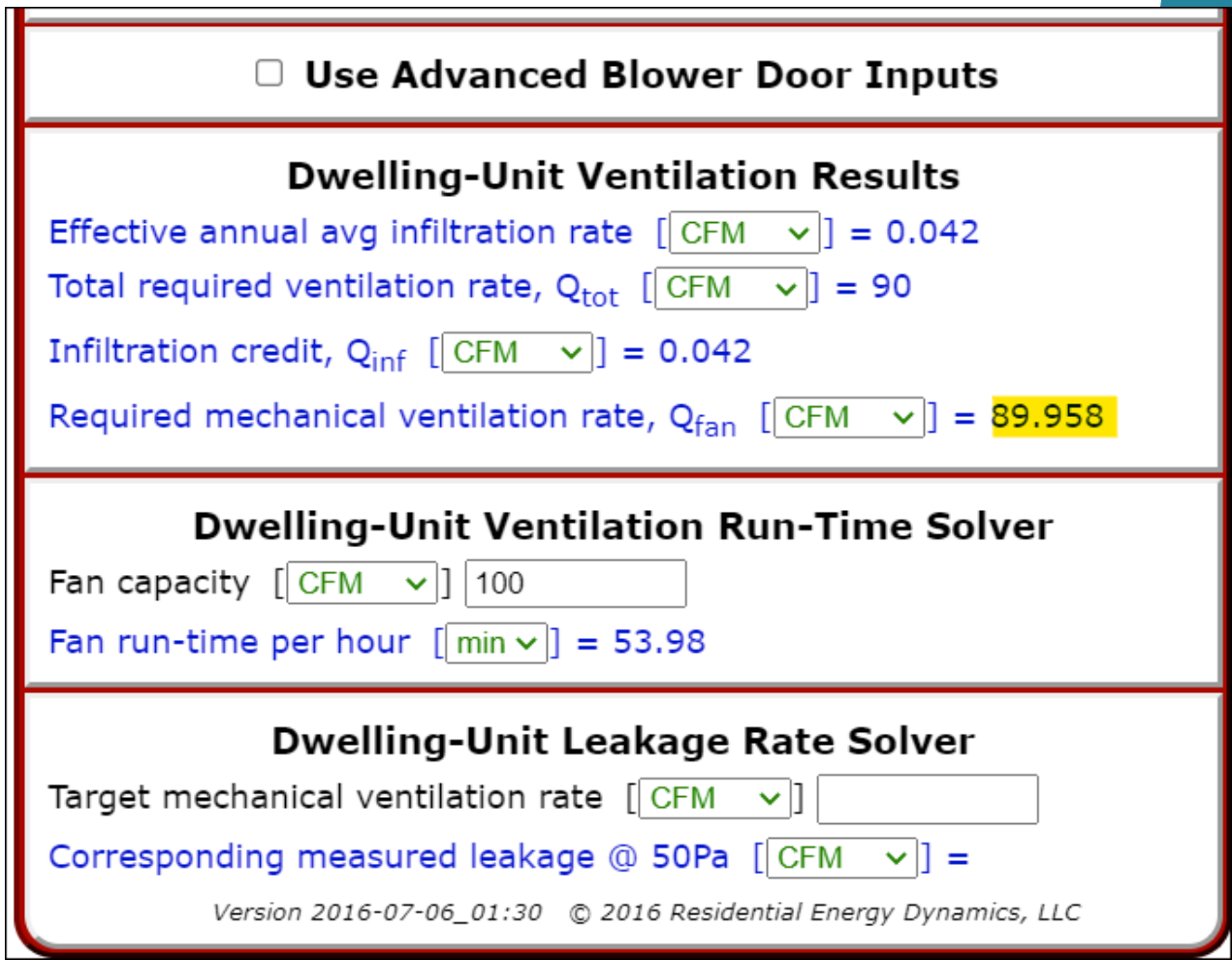
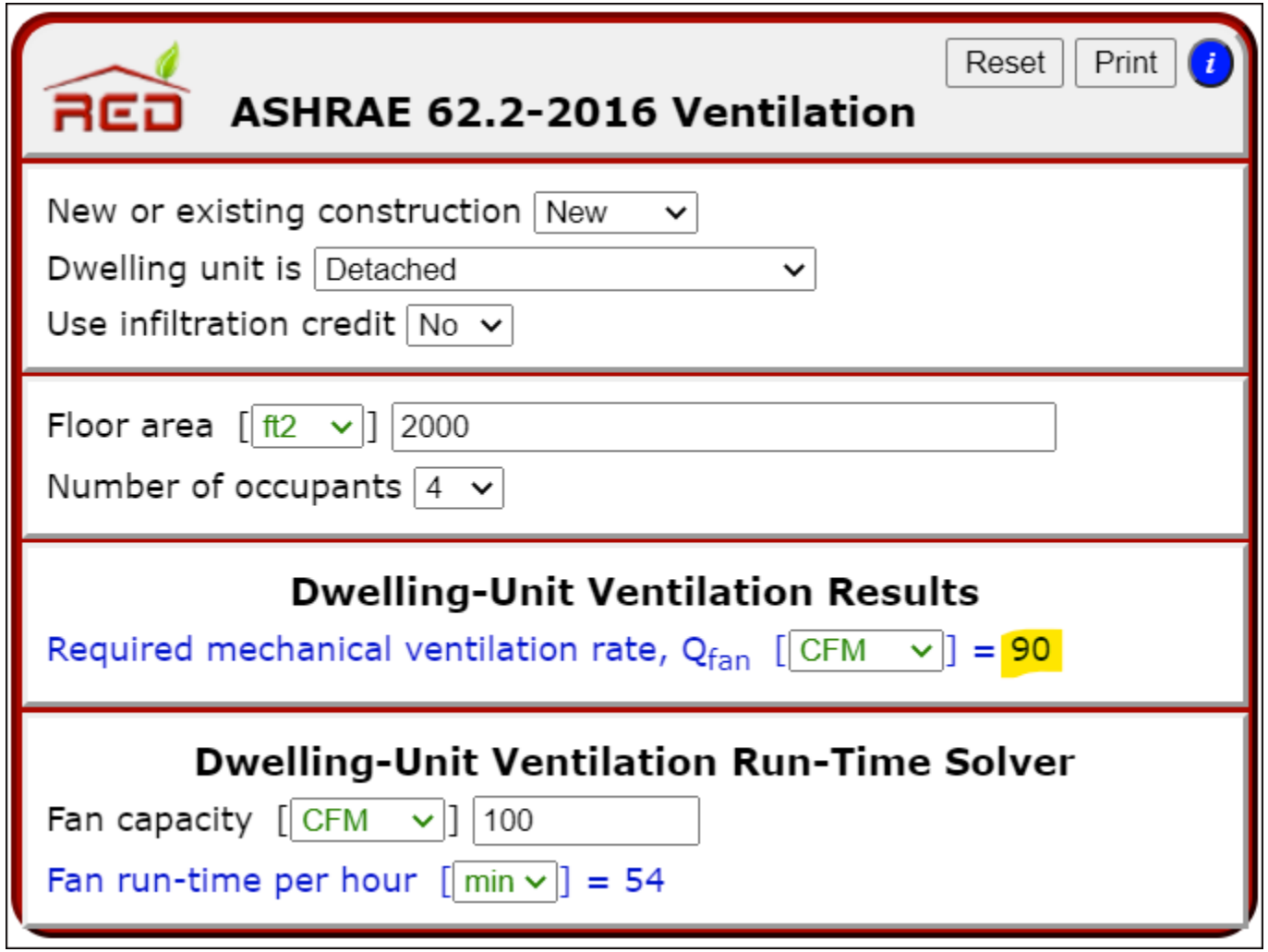
High “Bookend” (1)



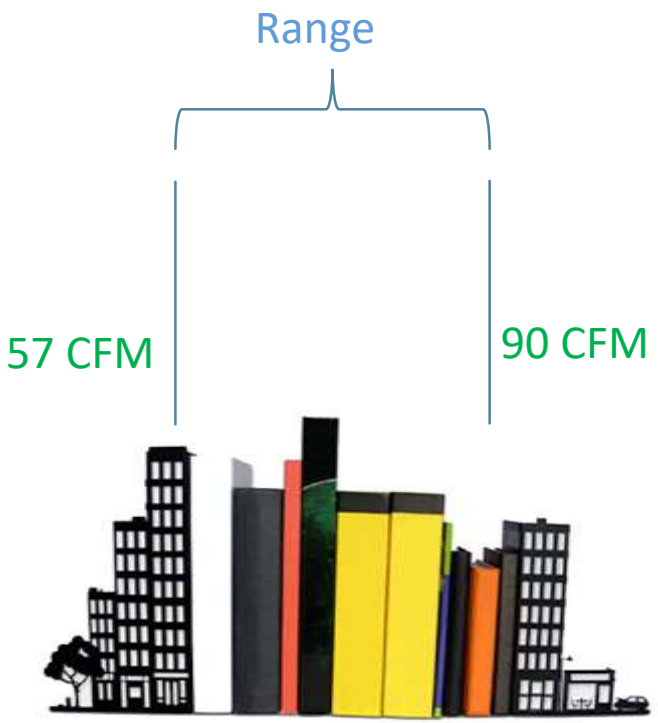


High “Bookend” (2)



“Bookend” the Final Air Flow Rate

- Install DUV with capacity of highest CFM requirement, AND control with variable speed [90CFM]
- Once final tightness of dwelling is measured, “tune-in” the required Air Flow Rate for 62.2-2016 compliance with:
  a. Variable-speed control [65 CFM]
  b. Programmed timer [35.5 min/hr]



ASHRAE 62.2-2016 Ventilation

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New or existing construction: New

Dwelling unit is: Detached

Use infiltration credit: Yes

Closest weather station: United States / Maine / Augusta Airport

Weather and shielding factor [1/hr] = 0.58

Floor area [ft2] 2000

Number of occupants: 4

Dwelling height [ft] 18

Measured leakage @ 50Pa [CFM] 600

☐ **Use Advanced Blower Door Inputs**

☐ **Use Advanced Blower Door Inputs**

Dwelling-Unit Ventilation Results

Effective annual avg infiltration rate [CFM] = 25

Total required ventilation rate, Q_{tot} [CFM] = 90

Infiltration credit, Q_{inf} [CFM] = 25

Required mechanical ventilation rate, Q_{fan} [CFM] = 65

Dwelling-Unit Ventilation Run-Time Solver

Fan capacity [CFM] 110

Fan run-time per hour [min] = 35.5

Dwelling-Unit Leakage Rate Solver

Target mechanical ventilation rate [CFM]

Corresponding measured leakage @ 50Pa [CFM] =

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Additional Selected Requirements of Standard 62.2-2016

Carbon Monoxide Alarm

- Install carbon monoxide alarm

Dryer Venting

- Vent clothes dryer to outdoors unless the dryer is a condensing unit

Instructions and Labeling

- Provide to owner or occupant of dwelling unit
  - Information on ventilation systems installed, including instruction manual
  - Instructions on proper operation, and
  - Instructions on proper maintenance
- Controls shall be labeled as to their function

Sound Ratings for Fans

- 1 sone maximum for continuously operating fans, including dwelling-unit and continuously operating local fans
  - Exception: HVAC air handlers and remote mounted fans with at least four feet of duct between fan and intake grille (e.g., in-line fan)
- 3 sones at maximum demand -controlled fans
  - Exception: Fans with minimum airflow setting exceeding 400 CFM

Ventilation Ducting

- Rigid ductwork preferred, not required
- Flexible duct specifications
- Support properly
- May use Table 5-3 for prescriptive duct sizing (coming up)

Not good!!

Ventilation Ducting

This table may be used for verification of compliant ducting

TABLE 5.3 Prescriptive Duct Sizing

Duct Type	Flex Duct								Smooth Duct							
Fan Airflow Rating, cfm @ 0.25 in. wc (L/s @ 62.5 Pa)	50 (25)	80 (40)	100 (50)	125 (65)	150 (75)	200 (100)	250 (125)	300 (150)	50 (25)	80 (40)	100 (50)	125 (65)	150 (75)	200 (100)	250 (125)	300 (150)
Diameter [a], in. (mm)	Maximum Length [b,c,d], ft (m)															
3 (75)	×	×	×	×	×	×	×	×	5 (2)	×	×	×	×	×	×	×
4 (100)	56 (17)	4 (1)	×	×	×	×	×	×	114 (35)	31 (9)	10 (3)	×	×	×	×	×
5 (125)	NL	81 (25)	42 (9)	16 (5)	2 (0.6)	×	×	×	NL	152 (46)	91 (28)	51 (16)	28 (9)	4 (1)	×	×
6 (150)	NL	NL	158 (48)	91 (28)	55 (17)	18 (5)	1 (0.3)	×	NL	NL	NL	168 (51)	112 (34)	53 (16)	25 (8)	9 (3)
7 (175)	NL	NL	NL	NL	161 (49)	78 (24)	40 (12)	19 (6)	NL	NL	NL	NL	NL	148 (45)	88 (27)	54 (16)
8 (200) and above	NL	NL	NL	NL	NL	189 (58)	111 (34)	69 (21)	NL	NL	NL	NL	NL	NL	198 (60)	133 (41)

a. For noncircular ducts, calculate the diameter as four times the cross-sectional area divided by the perimeter.
b. This table assumes no elbows. Deduct 15 ft (5 m) of allowable duct length for each elbow.
c. NL = no limit on duct length of this size.
d. X = not allowed; any length of duct of this size with assumed turns and fitting will exceed the rated pressure drop.

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Mechanical Ventilation Types

Mechanical Ventilation

- **Local** ventilation MUST be exhaust
- **Dwelling-unit** ventilation may be:
  - Exhaust (pros and cons?)
  - Supply (pros and cons?)
  - Balanced (pros and cons?)
    - No heat recovery is unusual
    - Heat Recovery Ventilator (HRV)
    - Energy Recovery Ventilator (ERV)

Exhaust Ventilation

Local Ventilation

Dwelling-Unit Ventilation

Selected Exhaust Fan Choices, Ceiling and Wall

Ceiling insert

Bath fans.
Should be certified by HVI
for both air flow and sound

Through wall

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Exhaust Fans – Through-the-Wall

- Must vent to outdoors
  - NO RECIRCULATING HOODS
- If through the wall/ceiling, MUST be rated for use in cooking area – otherwise it is a fire hazard

NO

YES

Local Kitchen Ventilation

This does not help the installer's reputation!

System Choices for Inline Fans

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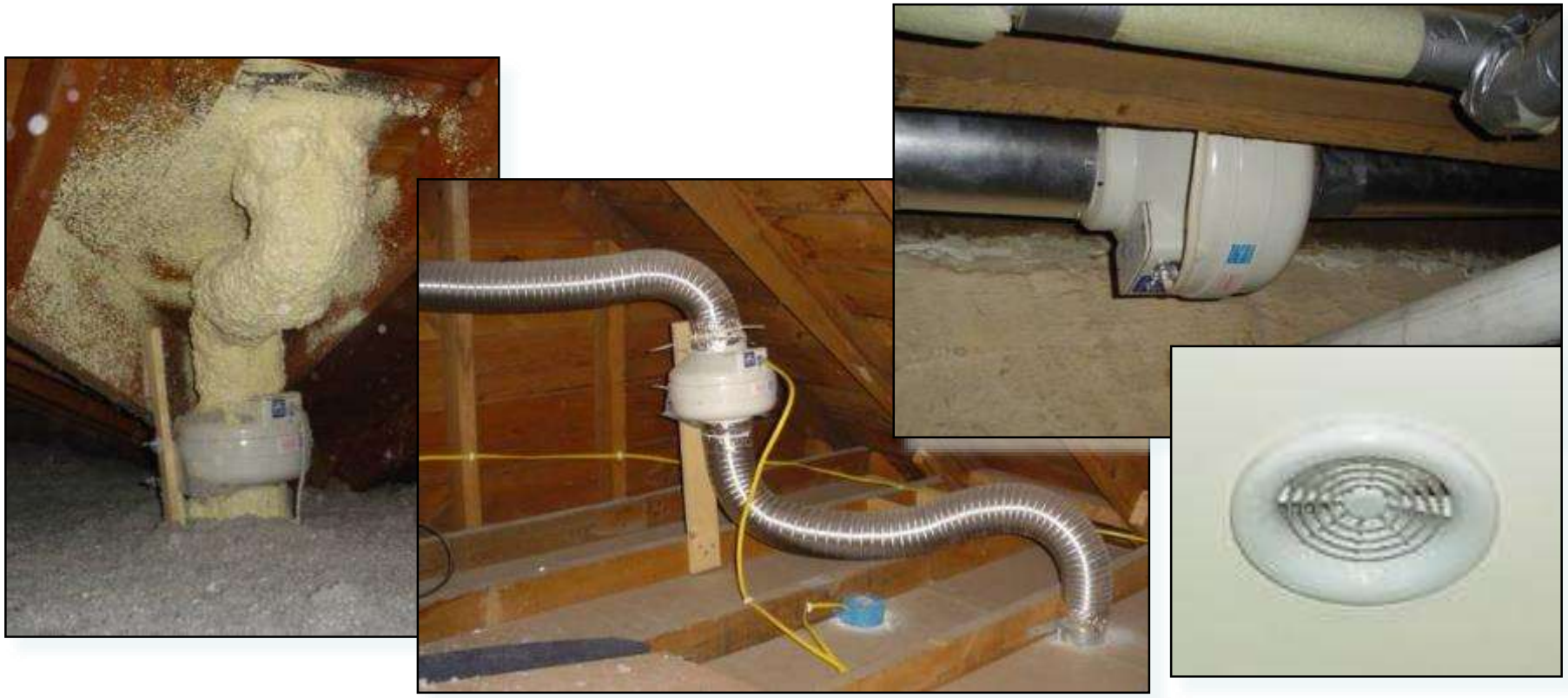
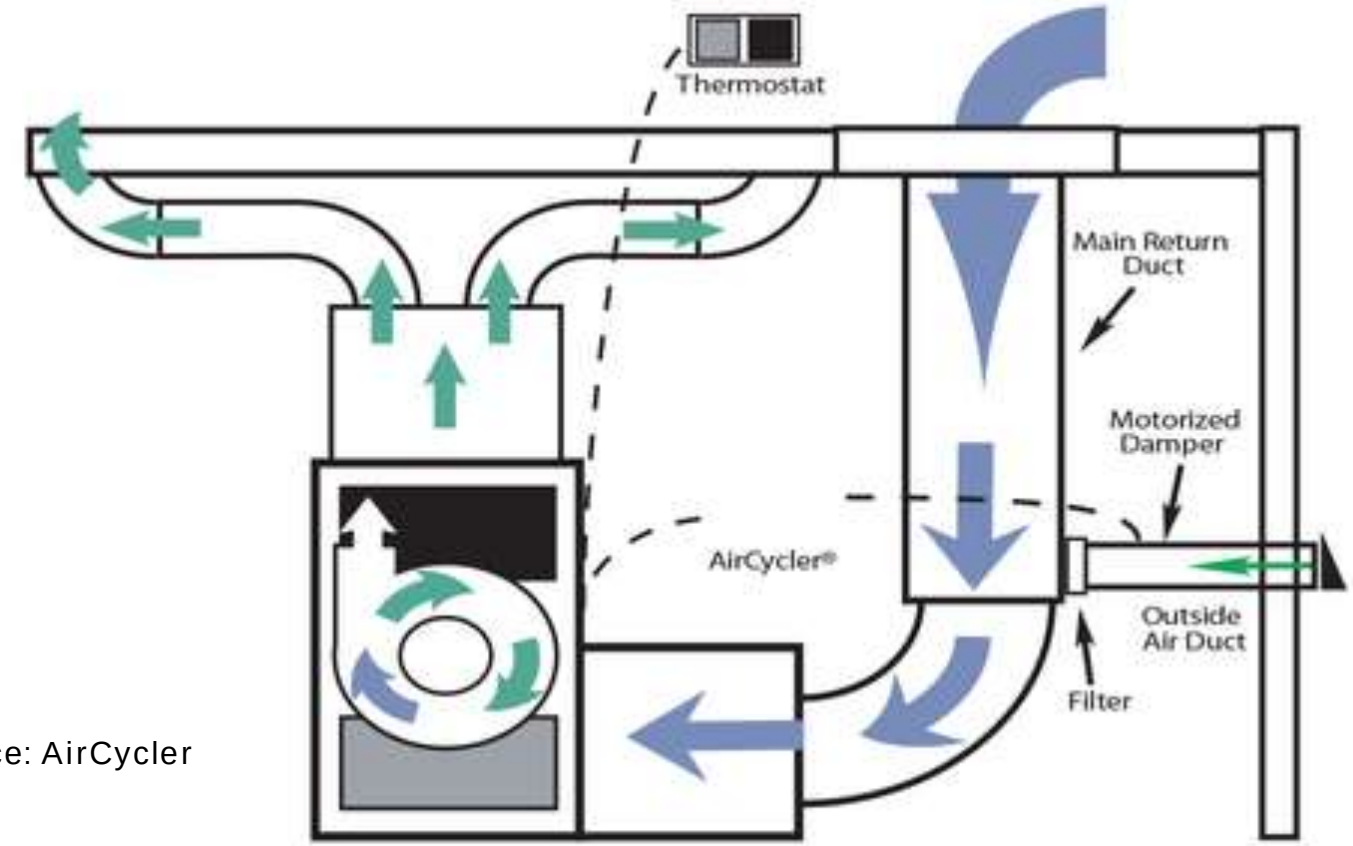
Inline Exhaust Fans



Supply Ventilation

Dwelling-Unit Ventilation Only

Supply Ventilation to Furnace Return Air



Source: AirCycler

Supply Ventilation to Furnace Return-Air Balanced with Bathroom Exhaust Fan

- Ducts must be tight (or they can bring in bad air);
- Should have good motorized damper;
- Should be controlled to run even if no heat is needed;
- Supply ventilation air may be balanced with exhaust that is in within 20% of supply air;
- Furnace fan energy use can be high;
- Intake must be kept clean of yard debris and other outdoor stuff.

Supply Ventilation to Furnace Return Air

Balanced Ventilation

Dwelling-Unit Ventilation Only, but. . .

Balanced Ventilation

- Exhaust and supply ventilation should have equal CFM
  - Balanced without recovery
    - Air handler supply with exhaust fan
  - Heat Recovery Ventilator (HRV)
    - unit transfers sensible heat only with no humidity transfer.
  - Energy Recovery Ventilator (ERV)
    - Unit transfers sensible heat and humidity.

Heat Recovery Ventilators (HRV)

Venmar HRV, inside view

Heat Recovery Ventilators (HRV)

Must be installed in an accessible place for service.
Should be inside the conditioned space for maximum efficiency.

Balanced Ventilation and Bathroom Local Exhaust

- May locate exhaust port for balanced ventilation in bathroom if have 20 CFM or more continuous exhaust from port (register)
- Consider moisture issues if using ERV

Controls for Ventilation

Controls for Dwelling-Unit Ventilation

- ASHRAE 62.2 requires that the occupant have the ability to shut the system off
  - Maintenance
  - Bad outdoor air, such as wildfires
- Intermittent operation requires a automatic control that can be shut down manually

Controls

- For blower door testing, the ventilation system needs to be turned off
- Some controls are multiple speed. Dwelling-unit ventilation is generally set to the lower flow
- Both lower and higher flow rates should be tested

Labeling Dwelling-Unit Fan Control

- Complies with 62.2-2016;
- “appropriately labeled”;
- “readily accessible”.

Control Alternatives

- “appropriately labeled”;
- “readily accessible”.
- Both of these controls require circuit breaker or system override to shut off.

Honeywell will require reprogramming after shut down

AirCycler SmartExhaust

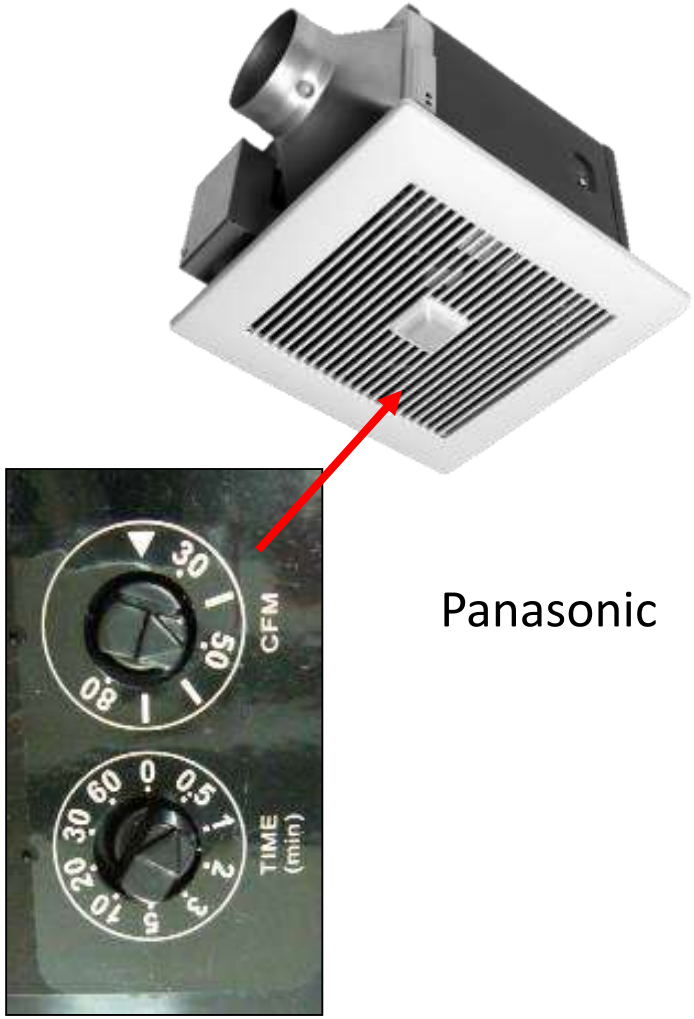
Control

- Circuit breaker?
  - 62.2-2016 makes it clear that circuit breakers are permissible as “readily accessible override”

Controls

Tamarack Technologies, Inc.

Fantech



Panasonic

Terminations

Roof Terminations

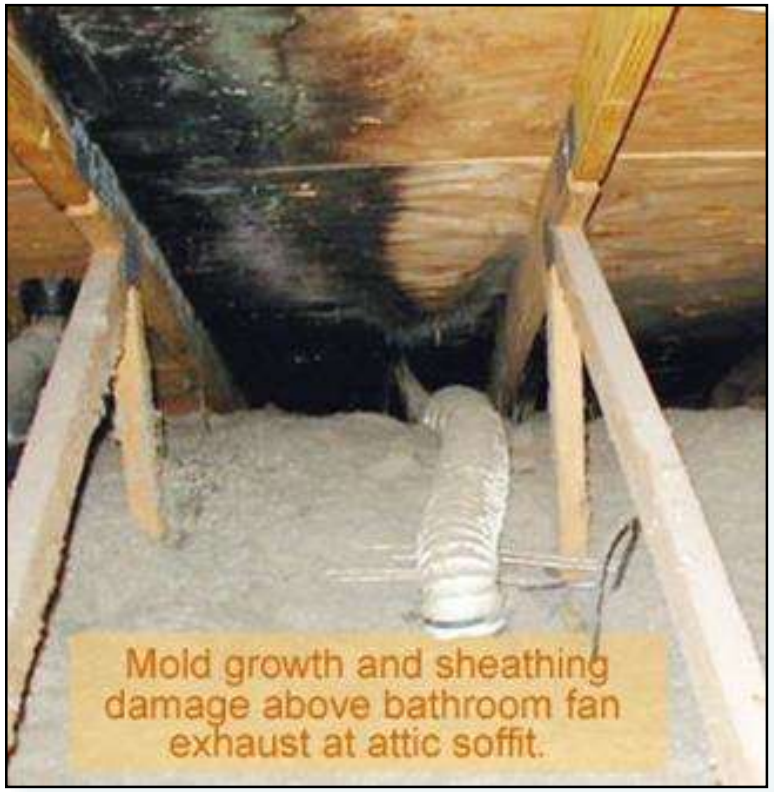
Photo courtesy of Wisconsin Weatherization

Primex brand

Results of Bad Terminations

Different attics

Soffit Terminations



A good solution
EZSoffitVent
www.BathFanSolutions.com

For vents in soffits, no soffit vent holes at least two feet on either side of vent

Terminations

- Always terminate outdoors
- Avoid terminating in soffit
- Terminate in gable end or through roof
- Use bird and insect screen
- Utilize backdraft damper in system

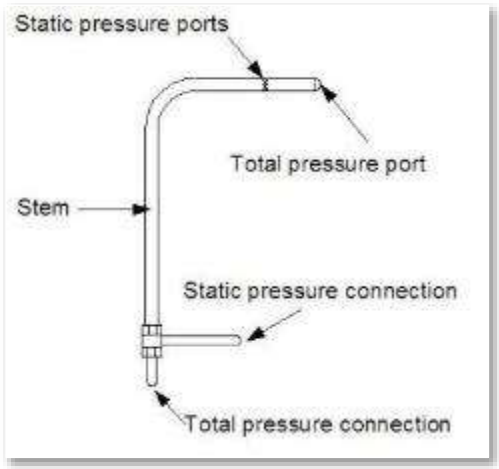
Performance Testing for Quality Control and Verification

Air Flow Measurement

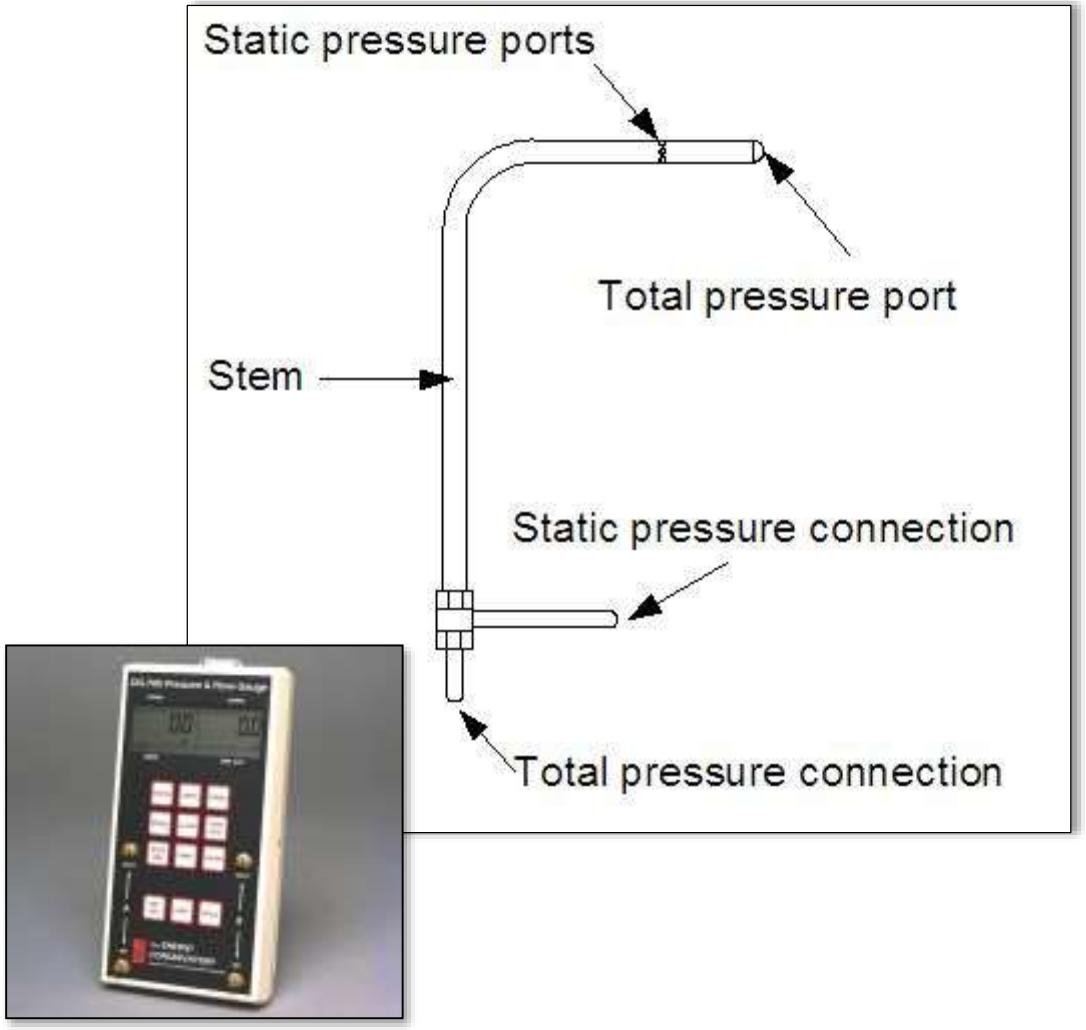
- All fans must have their flow measured after final installation
  - Exhaust Fan Flow Meter for exhaust fans (negative pressure)
  - Supply is harder to measure (positive pressure)

Air Flow Measurement – Exhaust and Supply

Sold by Retrotec



Pitot Tube



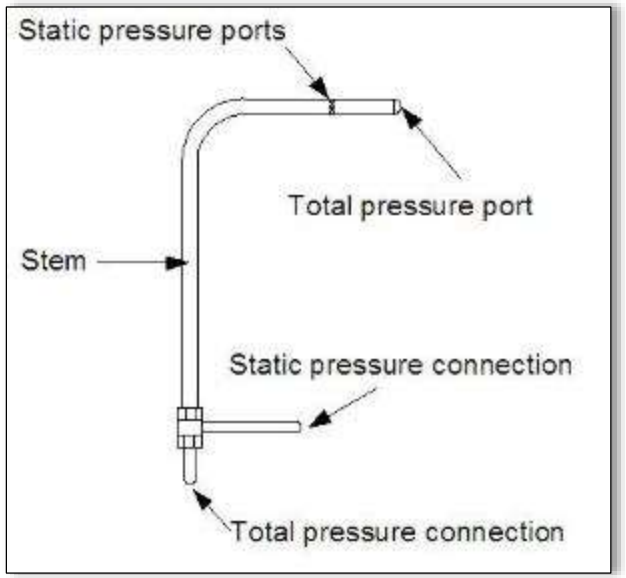
For measuring flow within a duct

Requires manometer and flow chart or calculator.

Good option for inline fan or dryer measurement.

12” length is good.

Pitot Tube



RED

Reset Print

Pitot Tube Airflow

Velocity pressure [Pa ▼] 40

Pitot tube correction (K) factor 1

Duct air temperature [°F ▼] 70

Altitude [ft ▼] 0

Atmospheric pressure [inHg ▼] = 29.9213

Air speed [ft/min ▼] = 1608

Duct cross-section type Round ▼

Diameter [in ▼] 4

Calculated cross-sectional area [in2 ▼] = 12.6

Airflow rate [CFM ▼] = 140

90% Airflow rate [CFM ▼] = 126

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efficiency MAINE

Measuring Exhaust Fan Flow

- Exhaust Fan Flow Meter (The Energy Conservatory).
  - Simple to use, easy, already have digital gauge, accurate.
    - 8 to 124 CFM only.
    - Exhaust flow only.

Process/Verification Issues

Process and Verification Issues

- Consideration of post-construction tightness (assume 3 ACH_{50} maximum; tighter increases Q_{fan})
- Verification of mechanical ventilation airflow (Verification Form?)
- How to use RED tool if builder, Third-Party Inspector (TPI), Code Enforcement Officer (CEO)?

Questions