Mechanical Ventilation for Kansas Weatherization Programs

ASHRAE 62.2-10

Learning Objectives

By participating in this training, participants will:

- Understand what ASHRAE 62.2 requires, and how it supersedes the old Building Tightness Limit (BTL).
- Understand the importance of Indoor Air Quality (IAQ) and the role of mechanical ventilation.
- Understand how to calculate an ASHRAE 62.2-10 continuous fan rate in CFM, and then select a fan capacity and control for an intermittent rate that satisfies the standard.
- Become familiar with different IAQ ventilation strategies.
- Learn to measure exhaust fan flow in CFM.
- Understand how to size fans and install ducts.

Today's Agenda

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ASHRAE 62.2-10

This morning:
- Very brief review
- Calculating ASHRAE 62.2-10 continuous CFM
- Further requirements of 62.2 for IAQ

After lunch:
- Ventilation strategies
- Fans and controls
- Measuring ventilation rates
- Hands-on (measuring ventilation rates)
- Equivalent intermittent fan rates
- Installation of controls, ducts, and hardware

Scope of 62.2-10

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ASHRAE 62.2-10

Purpose:

62.2-10 defines the minimum requirements for natural and mechanical ventilation systems to provide acceptable indoor air quality (IAQ) in low-rise residential buildings.

ASHRAE 62.2-10 applies to:

- Single and multi-family residential structures 3 stories or fewer above grade, including modular and manufactured housing.
- It does NOT address unvented combustion space heaters.

ASHRAE Standards and Guidelines

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ASHRAE 62.2-10

Read the entire ASHRAE 62.2-10 Standard

http://www.ashrae.org/standards-research--technology/standards--guidelines

Preview Popular ASHRAE Standards

You may preview the following Standards by clicking the links below.

Standard 62.1-2010
Standard 62.2-2010
Standard 90.1-2010
Standard 90.2-2007
Standard 189.1-2011

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Ventilation Standards

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ASHRAE 62.2-10

The obsolete standard “BTL” or “MVR”

ASHRAE 62.1 Greater of:

- 15 CFM/Person
- or 0.35 ACH (based on Volume)

Occupants or volume

The modern standard:

ASHRAE 62.2

- 7.5 CFM/Person + 1 CFM/100 ft^2 floor area
- Includes an infiltration credit calculated from CFM@50
- & has spot ventilation requirements

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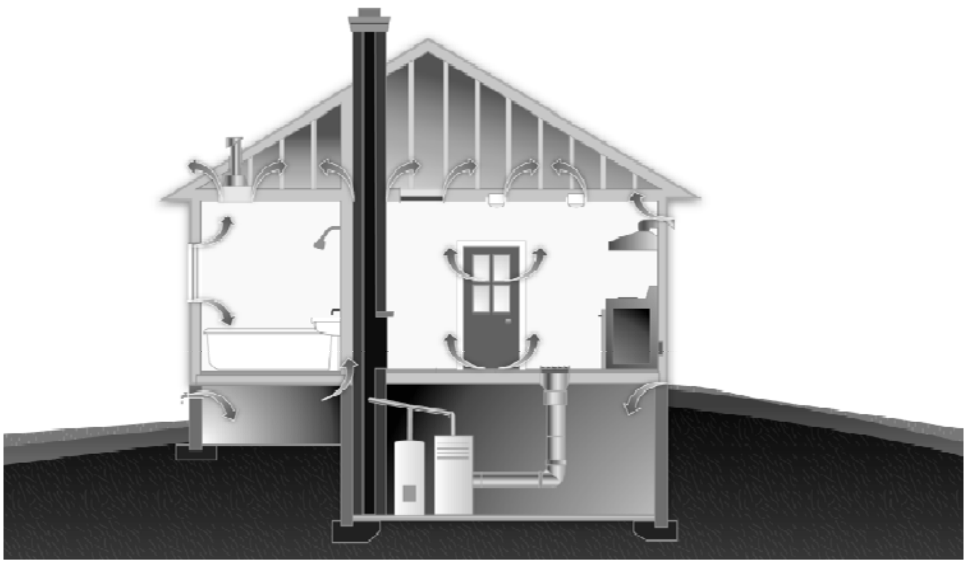
Natural ventilation: Why Seal the Leaks at All?

ASHRAE 62.2-10



Does "uncontrolled infiltration" count?

ASHRAE 62.2-10

$CFM_{nat} = Q_{50}$ / N-factor depending on:

- Geographic location
- Building height (increases stack effect)
- Building exposure (to wind)

ASHRAE 62.2-10 uses a "weather factor" for each location. An infiltration credit is allowed for ½ of the post-weatherization CFM_{NAT} when greater than a "default" rate of 2 CFM per 100ft^2

The equivalent "N_{136}-factors" for KS locations

# of Stories:	1	1.5	2	2.5	3
Dodge City	17.7	15.7	14.4	13.4	12.8
Goodland	18.1	16.0	14.7	13.7	13.0
Wichita*	20.5	18.1	16.7	15.5	14.8
Topeka	22.6	20.0	18.4	17.1	16.3
Kansas City*	23.2	20.5	18.8	17.5	16.7

From: ASHRAE 136

ASHRAE 62.2-10

Table X-1					
# Stories	1	1.5	2	2.5	3
S	1	1.13	1.23	1.32	1.39

Combine these two tables with the 0.0508 factor from **ASHRAE 136** to create a single table for Kansas locations.

Weather factor	Dodge City	Goodland	Wichita (estimated)	Topeka	Kansas City, MO
W	1.11	1.09	0.96	0.87	0.85

"N-factors" for KS locations

# of Stories:	1	1.5	2	2.5	3
Dodge City	17.7	15.7	14.4	13.4	12.8
Goodland	18.1	16.0	14.7	13.7	13.0
Wichita*	20.5	18.1	16.7	15.5	14.8
Topeka	22.6	20.0	18.4	17.1	16.3
Kansas City*	23.2	20.5	18.8	17.5	16.7

What is acceptable IAQ?

ASHRAE 62.2-10

Definition of "acceptable indoor air quality":

Air quality is acceptable when a substantial majority of occupants express no dissatisfaction with respect to odor and sensory irritation, and in which there are not likely to be contaminants at concentrations that are known to pose a health risk

Definition of "contaminant":

A constituent of air that may reduce acceptability of that air

Basic Building Science Review – What drives air-exchange?

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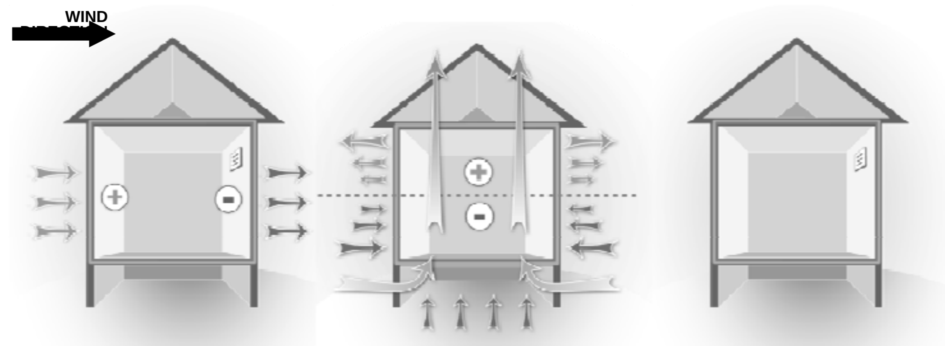
ASHRAE 62.2-10

What creates ∆P to move air through boundaries?



Wind
Dynamic pressure creates static pressure differences

Stack-Buoyancy
Stack effect - warm air rising cold air replacing exfiltration

What else?

Review – What drive air-exchange?

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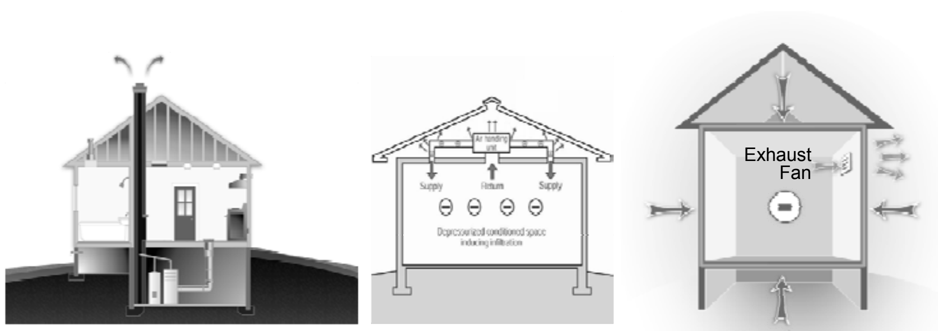
ASHRAE 62.2-10

What else drives pressure differences?



Flue (combustion appliance exhaust)

Forced air system fans
Via duct-to-outside leakage or room pressurization/depressurization

Mechanical Fans

What is the DOE requirement now?

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ASHRAE 62.2-10

ASHRAE 62.2-2010

ASHRAE 62.2-10
Requires ventilation in all new and the majority of existing homes

Requires local, exhaust ventilation in bathrooms and kitchens in all homes

- Provides fan and duct sizing procedures
- Requires installed system testing

Average installed cost, including controls: $525 (2004-2005 prices).

www.ashrae.org

ASHRAE 62.2-2010 Complete Formula

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ASHRAE 62.2-10

Requirement for New or Existing Buildings[2]:

$$CFM_{required} = 7.5\times(Number_{bedrooms} + 1) + (A_{floor} \div 100)$$
$$- \text{(infiltration credit)}$$
$$+ \text{(kitchen/bath spot deficit)}$$

$\mathbf{A_{floor}}$ = conditioned floor area; “the part of the building that is capable of being thermally conditioned for the comfort of occupants.” (ASHRAE 62.2, p.3)

- Include two occupants in master bedroom and one each in the other bedrooms. Increase ventilation by 7.5 cfm/actual person as needed.
- Credit is allowed for envelope air leakage measured with a blower door.
- Local mechanical exhaust shall be installed in each kitchen and bathroom.

[2] *Slide content from ASHRAE 62.2-2010*

ASHRAE 62.2-2010 requirement Formula Breakdown:

ASHRAE 62.2-10

Break the complete formula into 3 steps:

1. Use the base formula below (or use table) to determine the whole house continuous ventilation requirement : $CFM_{fan} = 7.5 \times (Number_{bedrooms} + 1) + (A_{floor} \div 100)$
2. Subtract the infiltration credit (a post-weatherization Q_{50} will be needed from a blower door test)
3. Add the kitchen and bath spot ventilation deficit. (Need to measure existing spot ventilation rates)

Base formula for building and occupants

ASHRAE 62.2-10

Table 4.1a: Minimum Continuous Ventilation Requirement, CFM, New Buildings[1]

Floor Area (ft^2)	BEDROOMS				
	0 - 1	2 - 3	4 - 5	6 - 7	>7
≤ 1500	30	45	60	75	90
1501 – 3000	45	60	75	90	105
3001 – 4500	60	75	90	105	120
4501 – 6000	75	90	105	120	135
6001 – 7500	90	105	120	135	150
> 7500	105	120	135	150	165

[1] ASHRAE 62.2-2010, p 4

Step 2: infiltration credit

ASHRAE 62.2-10

Check to see if an infiltration credit applies

Define Q50 as the Post-weatherization CFM@50

Operating infiltration CFM_{nat} = Q50 ÷ N-factor

Default infiltration: $I_{default}$ = A_{floor} ÷ 50

- If Operating infiltration > Default infiltration, then ½ of this difference, ½ (CFM_{nat} – I_d), is the infiltration credit.
- If the Default infiltration ≥ Operating infiltration, then there is no infiltration credit. (If I_d > CFM_{nat}, no credit)
- The infiltration credit reduces the whole house requirement.

Sum kitchen and bath requirements

ASHRAE 62.2-10

Vent requirement	Intermittent	Continuous	Intermittent with window*
Kitchen	100 CFM	5 ACH	80 CFM
Bath	50 CFM	20 CFM	30 CFM
Noise	≤ 3 sone	≤ 1 sone	≤ 3 sone

- 20 CFM *intermittent* credit given for at least one operable window in kitchen, and 20 CFM intermittent credit is allowed for an operable window in each full bath
- Half baths have no vent requirements
- "Operable" windows are NOT "continuous" ventilation

Kitchen ACH ≥ 5 continuous means that

$CFM_{continuous}$ = 5 × Volume (ft^3) ÷ 60 (minimum)

Step 3: Calculate the spot deficit

ASHRAE 62.2-10

Vent requirement	Intermittent	Continuous
Kitchen	100 CFM	5 ACH
Bath	50 CFM	20 CFM

- Sum the kitchen and all bath spot ventilation deficits and then divide by 4. Add the result to the continuous whole building ventilation CFM requirement.

  Sum of kitchen and bath deficits ÷ 4 = Spot deficit

- Any local exhaust fan with automated control can serve as part or all of the ASHRAE 62.2 ventilation requirement.

Putting it all together

ASHRAE 62.2-10

3 steps:

1. Use the base formula below (or use table) to determine the whole house continuous ventilation requirement : $CFM_{base} = 7.5\times(Number_{bedrooms} + 1) + (A_{floor} \div 100)$
2. Subtract the infiltration credit

   $- ½ (CFM_{nat} – I_{default})$, *only if* $CFM_{nat} > I_d$
3. Add the kitchen and bath spot ventilation deficit.

   \+ (sum of kitchen & bath deficits) ÷ 4

ASHRAE 62.2-10 requires:

ASHRAE 62.2-10

Put it together

$$CFM_{required} = 7.5 \times (Number_{bedrooms} + 1) + (A_{floor} \div 100)$$
$$- (CFM_{nat} - I_{default}) \div 2 \quad \textit{(0nly if } CFM_{nat} > I_d\textit{)}$$
$$+ \text{ (sum of kitchen \& bath deficits)} \div 4$$

Lets do an example!

Example: Calculating the Required Ventilation in CFM

ASHRAE 62.2-10

Example # 1:

Characteristics:

- 1,500 square feet
- 1.5 stories (basement with windows)
- 3 bedrooms (4 occupants)
- Topeka, KS
- One bath & window
- Post WX Q50 = 1250 CFM_{50}

Example #1 Calculating Base Formula Ventilation in CFM

ASHRAE 62.2-10

Base formula:

CFM_{base} = 7.5 × (# bedrooms + 1) + (A_{floor} ÷100)

Multiply 7.5 CFM per person by the number bedrooms + 1 or by the actual number of people :

CFM_{people} = (7.5 × # bedrooms + 1)

= (7.5 CFM × 4 people) = 30 CFM

Calculate 1 CFM per 100 square feet, or Floor Area/100:

CFM_{area} = Conditioned Area ÷100 = 1500/100 = 15 CFM

Add them together; this is the base formula requirement:

30 CFM + 15 CFM = 45 CFM

Base formula from the 62.2 table:

ASHRAE 62.2-10

Table 4.1a: Minimum Continuous Ventilation Requirement, CFM, New Buildings[1]

Floor Area (ft^2)	BEDROOMS 0 - 1	2 - 3	4 - 5	6 - 7	>7
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6001 – 7500	90	105	120	135	150
> 7500	105	120	135	150	165

[1] *ASHRAE 62.2-2010, p 4*

Example 1: Infiltration Credit

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ASHRAE 62.2-10

If Q_{50} ÷ N-factor > A_{floor} ÷ 50,

means CFM_{nat} > $I_{default}$

and infiltration credit is ½ (CFM_{nat} – I_d)

½[(1250 ÷ 20) - (1500 ÷ 50)] = ½(62 - 30) = 16 CFM

Location Table	Equivalent N-factor values shown below				
# of Stories:	1	1.5	2	2.5	3
Dodge City	17.7	15.7	14.4	13.4	12.8
Goodland	18.1	16.0	14.7	13.7	13.0
Wichita	20.5	18.1	16.7	15.5	14.8
Topeka	22.6	20.0	18.4	17.1	16.3
Kansas City	23.2	20.5	18.8	17.5	16.7

Kitchen/bath Compliance
Spot deficit calculation for example #1

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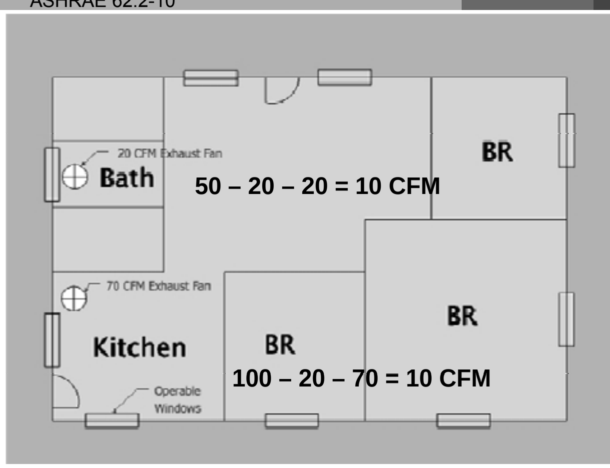
ASHRAE 62.2-10



Total Kitchen and bath deficit s = 10 + 10 = 20 CFM

Spot deficit = (kitchen + bath) ÷ 4 = 20/4 = 5 CFM

Bathroom: 50 CFM required

- *Existing fan = 20 CFM*
- *Operable window (reduces requirement by 20 CFM)*

50 CFM req. – 20 CFM (window) – 20 CFM (existing fan) = 10 CFM bath deficit

Kitchen: 100 CFM required

- *Existing fan = 70 CFM*
- *Operable window (reduces requirement by 20 CFM)*

100 CFM req. – 20 CFM (window) – 70 CFM existing fan = 10 CFM kitchen deficit

Putting it all together

ASHRAE 62.2-10

Put it together

$CFM_{required}$ = $7.5\times(Number_{bedrooms} + 1) + (A_{floor} \div 100)$

= 45 CFM

– $(CFM_{nat} – I_{default}) \div 2$ *(0nly if $CFM_{nat} > I_d$)*

– 16 CFM

+ (sum of kitchen & bath deficits) ÷ 4

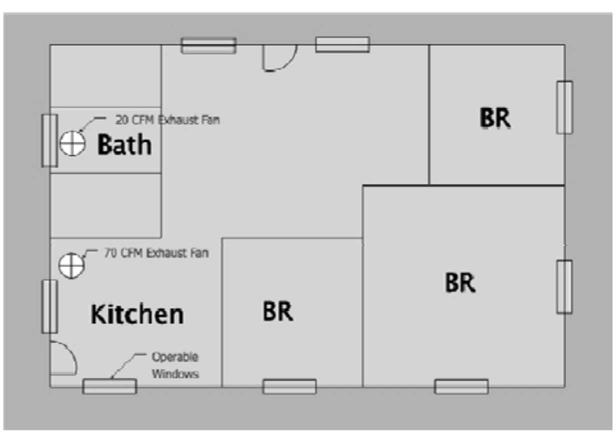
+ 5 CFM

= 45 – 16 + 5 = 34 CFM Required

Audit Decisions

ASHRAE 62.2-10

Need to add the equivalent of 34 CFM continuous!
Replace Kitchen exhaust, or replace Bathroom exhaust fan?



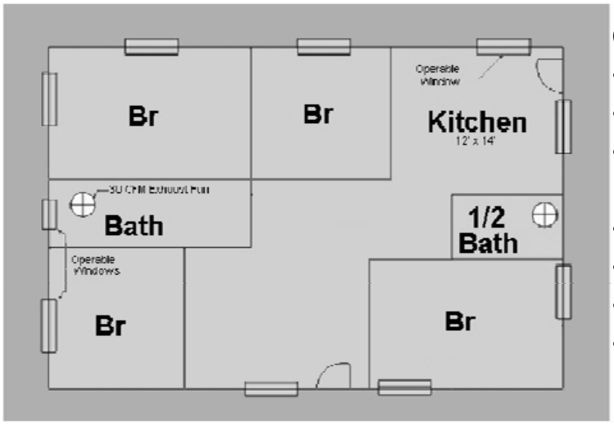
More Options:
Replace both,
Duct a fresh-air intake into the return of the air-handler,
Install an HRV or an ERV

What are the implications?

Now lets work a 2nd example

ASHRAE 62.2-10

Example # 2: Lets work it



Characteristics:
- 1800 square feet
- 2 story
- 4 bedrooms (and 4 occupants)
- Goodland, KS
- 2,200 CFM@50
- 30 CFM bath fans
- No kitchen exhaust

Example #2 Calculating Base Formula Ventilation in CFM

ASHRAE 62.2-10

Base formula:

CFM_{base} = 7.5 × (# bedrooms + 1) + (A_{floor}÷100)

CFM_{people} = (7.5 × # bedrooms + 1)

= (7.5 CFM × 5) = 37.5 CFM

+ A_{floor} ÷100 = 1800/100 = 18 CFM

Add them together; this is the base formula requirement:

37.5 CFM + 18 CFM = 55.5 CFM
Should we round up to 56?

Base formula from the 62.2 table:

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ASHRAE 62.2-10

Table 4.1a: Minimum Continuous Ventilation Requirement, CFM, New Buildings[1]

Floor Area (ft²)	BEDROOMS 0 - 1	2 - 3	4 - 5	6 - 7	>7
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3001 – 4500	60	75	90	105	120
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6001 – 7500	90	105	120	135	150
> 7500	105	120	135	150	165

[1] ASHRAE 62.2-2010, p 4

Example 2: Infiltration Credit

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ASHRAE 62.2-10

If Q_{50} ÷ N-factor > A_{floor} ÷ 50,

Then, infiltration credit is ½ ($CFM_{nat} - I_{default}$)

½[(2200 ÷ 14.7) - (1800 ÷ 50)] = ½(150 - 36) = 57 CFM

Location Table	Equivalent N-factor values shown below				
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Goodland	18.1	16.0	14.7	13.7	13.0
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Topeka	22.6	20.0	18.4	17.1	16.3
Kansas City	23.2	20.5	18.8	17.5	16.7

Example 2: Spot deficit

ASHRAE 62.2-10

Vent requirement	Intermittent	Continuous
Kitchen	100 CFM	5 ACH
Bath	50 CFM	20 CFM

Spot deficit = Sum of kitchen and bath deficits ÷ 4
Kitchen and bath deficits:
No kitchen exhaust fan!
100 CFM – 20 (window) + _?_ (bath deficit)

= 80 CFM

Spot deficit = 80 CFM ÷ 4 = 20 CFM

Example 2: Bringing it All Together

ASHRAE 62.2-10

CFM_{fan} = (Base formula) - (Infiltration credit) + (Spot ventilation deficit)

- Calculate the Base formula =
  7.5 × (# bedrooms plus 1) + (A_{floor}÷100)
  - (7.5CFM × 5) + 1800ft^2/100 = 55.5 = 56 CFM
- Calculate the infiltration credit = ½ (CFM_{nat} – I_d)
  - ½ (149.7 CFM – 36 CFM) = 56.8 = 57 CFM credit
- Calculate the Spot ventilation deficit = (Kitchen + bath deficit) / 4
  - 80 CFM/4 = 20 CFM deficit
- Put these together

CFM_{fan} = (56 CFM) - (57 CFM) + (20 CFM)

***CFM* = 19 CFM continuous whole house requirement**

Audit Decisions

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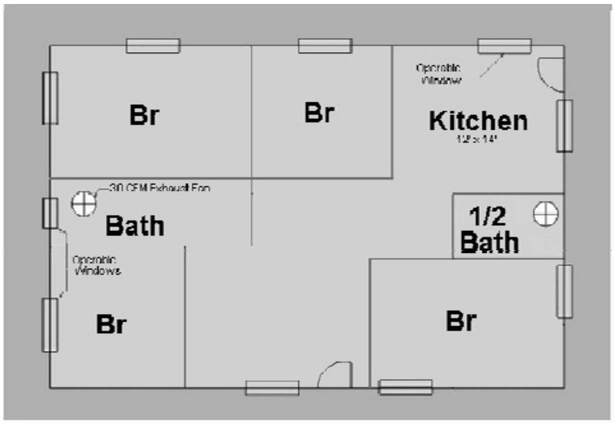
ASHRAE 62.2-10

Install the equivalent of 19 CFM continuous ventilation?
Just install a 100 CFM Kitchen exhaust on a switch?



Another option is to install a continuous vent to provide 5 ACH for the kitchen

How many CFM is 5 ACH?

Is ASHRAE 62.2 complicated?

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ASHRAE 62.2-10

CFM calculation options:

- Appendix B of Ventilation Chapter in *Workforce Guidelines for Home Energy Upgrades*, DOE/NREL, 2011(details of the required math).
- ZipTest Pro^3 for the Texas Instruments TI-89 calculator (R.J. Karg Associates).
- ResVent 62.2 for the iPhone, iPad, and iPod touch (R.J. Karg Associates).
- TECTITE from the Energy Conservatory, updated end of 2011.

- 62.2 for KS-WX Spreadsheet provided by KBSI

Beyond Whole House CFM Ventilation Requirements

ASHRAE 62.2-10

Remember, ASHRAE 62.2 2010 includes:

- Spot ventilation requirements
- Attached garages must be adequately sealed from living space to prevent migration of contaminants
- Clothes driers and all exhaust vents must exit directly outside
- All duct joints outside conditioned space must be sealed
- Air filtration with a accessible MERV 6 or better in all ducted systems
- Fan SONE rating requirements must be met
- Exhaust fans and branch duct systems must have back-draft dampers
- Fan flow rates must be measured / verified

ASHRAE 62.2-10

Mechanical Ventilation for Kansas Weatherization Programs - Part 2

ASHRAE 62.2-10

What is acceptable IAQ?

ASHRAE 62.2-10

Summary of "acceptable indoor air quality":

Air quality is acceptable when a majority of occupants express no dissatisfaction from odors and contaminants are not likely to pose a health risk.

Examples of "contaminants":

Odors – Chemicals, off-gassing of paint, furniture, carpet

Sensory irritation – Pollen, dust, pet dander

Health impact – Carbon monoxide, excess moisture (mold dust mites etc), asthma triggers

Basic Strategies for good IAQ

ASHRAE 62.2-10

Do any occupants have respiratory/asthma, or air quality related health problems?

Yes ☐ **No**☐

The best ventilation strategy for IAQ depends upon the client, the house, and site-specific detail.

Three basic strategies:

1. Eliminate sources of contaminants
2. Exhaust and/or dilute contaminants in the house
3. Filter contaminants in the house

Basic Strategies and Auditor responsibilities

ASHRAE 62.2-10

1. Eliminate sources of contaminants

   Auditors can help to eliminate sources with appropriate recommendations

2. Exhaust and/or dilute contaminants in the house

   Installed ventilation can dilute and/or exhaust contaminants

3. Filter contaminants within the air in the house

   Occupants need to be educated on ventilation controls and filters

Ventilation Options

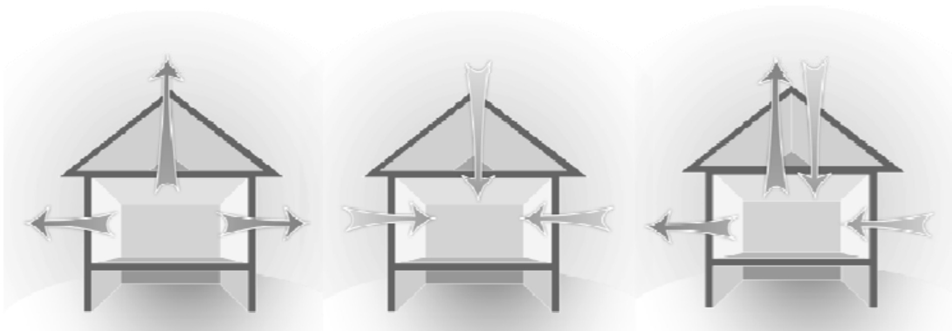
ASHRAE 62.2-10

Once we've determined required CFM, how do we get it?

- Exhaust only
  - Multiple spot ventilation fans
  - Balanced multiple intake - single fan, single exhaust system
- Supply only
  - Into return side of HVAC system
  - Direct through the wall fan
- Balanced
  - Fan driven air in / air out
  - Heat Recovery (HRV)
  - Energy Recovery (ERV)

Ventilation Strategies

ASHRAE 62.2-10



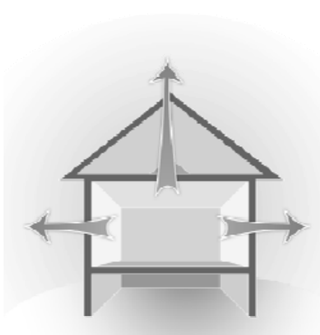
Exhaust only
Stale Air Out

Supply only
Fresh Air In

Balanced
exhaust
and supply

Ventilation Strategies

ASHRAE 62.2-10



Exhaust only
Stale Air Out

How does this affect house pressure?

How are “naturally drafted” combustion appliance affected?

How would a house sitting above a wet crawl space be affected”

How would a house with radon around the foundation be affected?

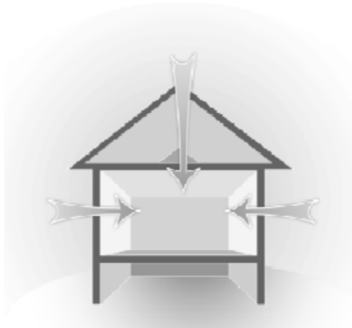
Is this a good strategy for a hot-humid climate, or for a cold mixed climate?

Ventilation Strategies

ASHRAE 62.2-10

Advantages:

____
____
____
____
____
____
____



Supply only
Fresh Air In

Disadvantages:

____
____
____
____
____
____

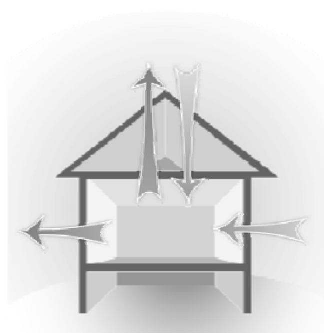
Ventilation Strategies

ASHRAE 62.2-10

Advantages:
1) neutral effect on house pressure
2) Incoming air from known location can be properly filtered
3) Other advantages?

Disadvantages:
1) More expensive
2) Installation expertise required
3) More disadvantages?

Which system is right?



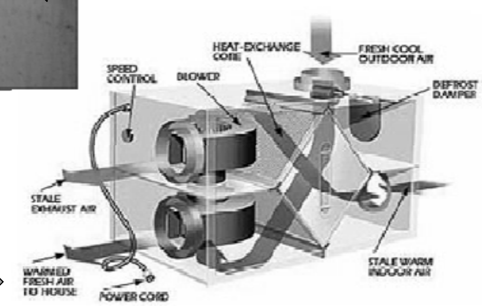
Balanced exhaust and supply

HRV/ERV

ASHRAE 62.2-10

HRV

ERV

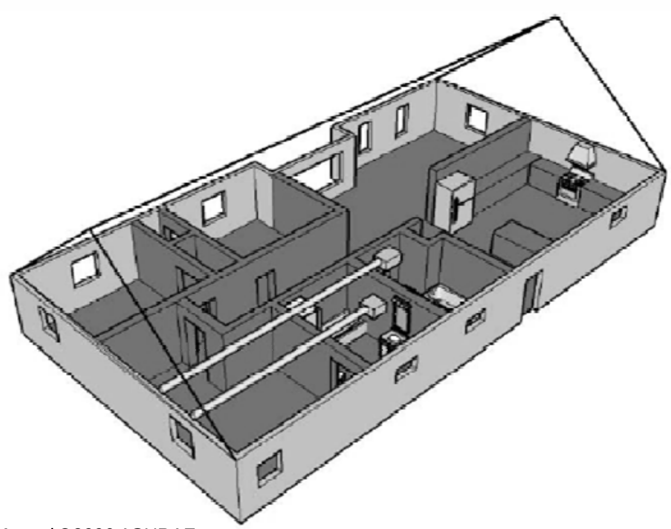


Graphic courtesy of Popular Mechanics

Photo courtesy of the US Department of Energy

Exhaust Only – Multiple Spot Ventilation Fans

ASHRAE 62.2-10



Source: 62.2 User's Manual ©2006 ASHRAE

Exhaust Only – Single System, Multiple Intakes

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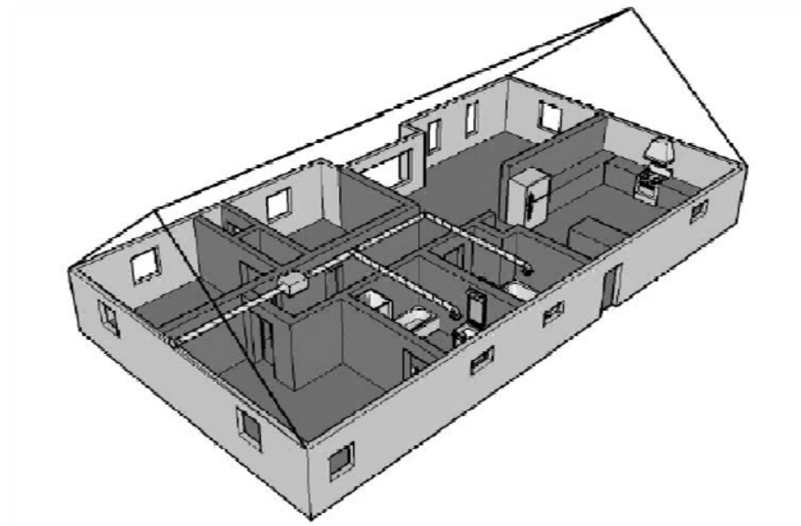

Source: 62.2 User's Manual ©2006 ASHRAE

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Supply Only

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Supply only could also be a direct through the wall fan.

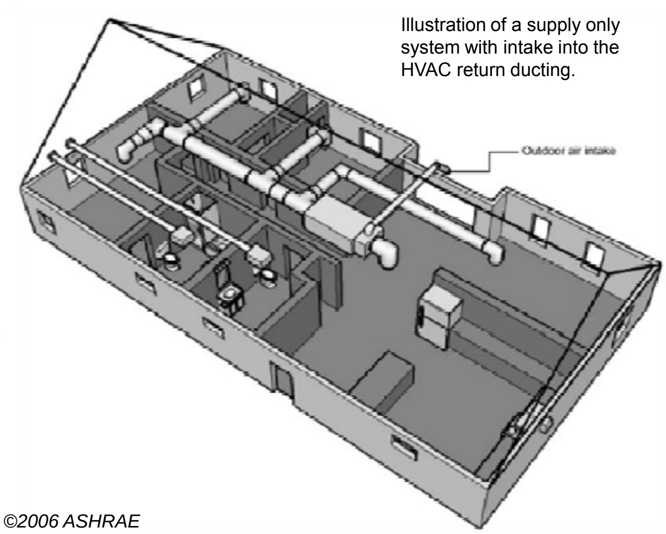

Illustration of a supply only system with intake into the HVAC return ducting.

Source: 62.2 User's Manual ©2006 ASHRAE

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Balanced Ventilation System

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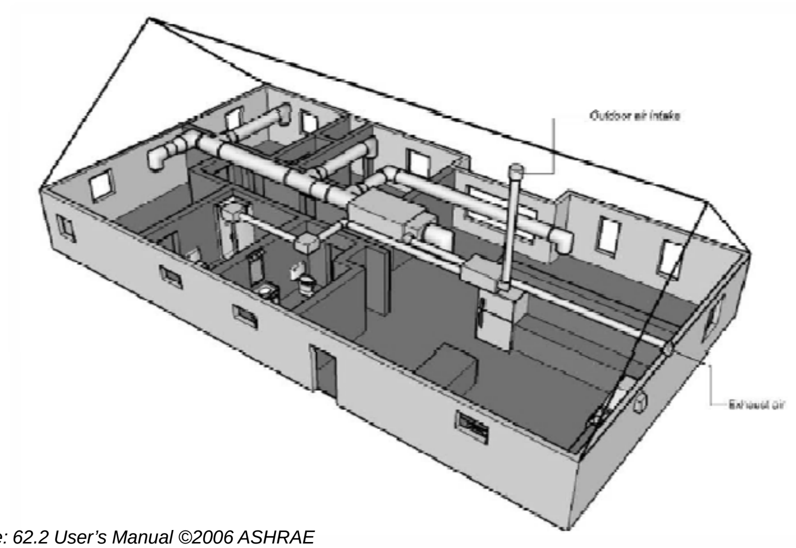

Source: 62.2 User's Manual ©2006 ASHRAE

Other Possibilities

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- Exhaust or supply systems with passive make-up air inlets or outlets.
- Exhaust or supply systems with active (fan powered, hopefully balanced) make-up air inlets or outlets.
- Supply or exhaust fans tied to HVAC systems

Passive air inlets come in many shapes and sizes. The one shown here is from Panasonic.

Cost-effectiveness

ASHRAE 62.2-10

Compare cost-effectiveness of exhaust only vs. HRV in a cold climate.

Annualized cost = Installed cost/lifetime + annual operational costs + annual heating (or cooling) penalty.

Fan Type	Installed Cost	Lifetime (yrs)	Operational cost/yr	Heating penalty/yr [1]	Total annualized cost
Exhaust only, 20 CFM	$400	10	$30	$110	$ 180 (Client pays $140)
HRV, 20 CFM	$1,500	10	$60	$55	$ 265 (Client pays $115)

[1]Based on electric heat at $0.11/kWh in a 6,500 HDD climate.
HRV assumed to reduce heat loss through fan by 50%.

Designing a mechanical ventilation system:

ASHRAE 62.2-10

1. Select a fan with a capacity sufficient to meet the ASHRAE 62.2-10 requirement, and operate at ≤ 1 sone continuous or ≤ 3 sone intermittent.
2. Choose a controller that will establish a duty schedule (if not running continuously).
3. Confirm that the capacity, cycle, and fraction on-time combine to meet the ventilation CFM required.
4. Design duct routes, size the ducts, select inlet/outlet hardware.
5. After installation, measure the CFM rates and verify the system meets the ventilation requirement.

Hardware: Vent Fans

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There are a few good resources for selecting equipment and controls.

- For ventilation fans: HVI http://www.hvi.org (all types including HRV's and ERV's)
- For controls: Tamarack Technologies http://www.tamtech.com/

Hardware: Dual purpose fan

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One bathroom or kitchen exhaust fan can serve a dual purpose:

– Meet the local mechanical exhaust requirement, and,

– Serve as the whole-house ventilation system

A single fan would:

– Be used by the occupants when they desire, and,

– either run on low speed continuously, or cycle on automatically, without occupant intervention.

Hardware: Controls

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Tamarack Technologies, Inc.
Ventilation Solutions
www.tamtech.com

Airetrak 62.2 Matrix

Fan results for low cfm were tested @ 0.1 static pressure w.g.

622M_1

MFGR/ Model	Actual cfm	Red cfm	Blue cfm	Brown cfm	Yellow cfm	Green cfm	White cfm	Violet cfm	Orange cfm	Black cfm
Panasonic										
FV-08VF2	80	N/A	28	36	45	63	70	N/A	N/A	N/A
FV-08VFL2	80	N/A	26	38	46	59	75	N/A	N/A	N/A
FV-08VK1	80	32	42	55	60	N/A	N/A	N/A	N/A	N/A
FV-08VK3*	80	N/A	N/A	24-30	30-35	N/A	N/A	N/A	N/A	N/A
FV-08VQ3	80	N/A	28	33	38	62	70	N/A	N/A	N/A
FV-08VQ5	80	36	58	75	N/A	N/A	N/A	N/A	N/A	N/A
FV-08VQL4	80	N/A	23	44	50	54	65	N/A	N/A	N/A
FV-08VS1	80	N/A	31	N/A	48	56	N/A	75	N/A	N/A
FV-08WQ1	70	N/A	30	42	49	53	N/A	N/A	N/A	N/A
FV-10VS1	100	N/A	27	N/A	56	63	N/A	91	N/A	N/A
FV-11VFL2(3")	110	N/A	N/A	29	37	45	56	N/A	N/A	N/A
FV-11VFL2(4")	110	N/A	23	38	45	52	67	82	N/A	N/A
FV-11VQ3	110	N/A	N/A	36	40	52	65	77	N/A	N/A
FV-15VQL4	150	N/A	20	40	48	55	80	90	105	115
RenewAire										
V150	150	N/A	38	43	68	72	75	78	N/A	N/A
V80	80	25	32	48	50	52	68	N/A	N/A	N/A

Hardware: Controls

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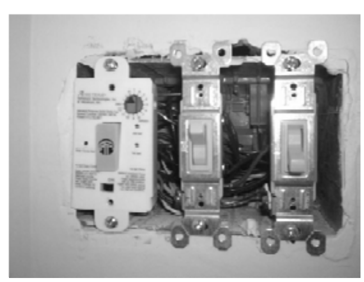
Select a control that:
1) Is readily available.
2) Is simple to install.
3) Allows setting both runtime and fan speed (as needed).
4) Has a long life and low to no maintenance requirements.
5) Has a memory (in case of power failure).
6) Is easily programmable by the installer.



Shown: Tamarack Technologies, Inc and Airetrac™

Verification: measuring flow rates

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Exhaust:

– ENERGY CONSERVATORY

Exhaust flow meter with DG-700

FlowBlaster™

Supply:

– FlowBlaster™

– LoFlo Balometer

Exhaust flow meter

(on the outside inlet)

Ready for some Hands-on?

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Lets demonstrate a DG-700 connected to an exhaust fan flow meter. (please remain seated!)

(pass out the KBSI diagnostics field guide and turn to the exhaust fan flow metering)

Next we will all get up and measure exhaust flow rates of a couple of fans attached to different sizes of ducts.

(a worksheet is provided for recording your results)

Hardware, technical details!

ASHRAE 62.2-10

What you've measured can depends upon the fan and ventilation control installed.

Some control/fan combinations use a continuous or cycled low speed to satisfy the ventilation requirement, then kick up to high speed when the occupant switch is activated.

Install equipment that meets your CFM criteria, only after you understand the technical detail of how it operates. The control should be labeled, accessible, and explained to the homeowner/occupant.

Determining the "Effective CFM" of an intermittent fan

ASHRAE 62.2-10

TABLE 4.2 Mechanical Ventilation Effectiveness for Intermittent Fans

Fractional On-Time, f	Cycle Time, T_{cyc} (h)			
	0 to 4	8	12	24
0.1	1.00	0.79	*	*
0.2	1.00	0.84	0.56	*
0.3	1.00	0.89	0.71	*
0.4	1.00	0.92	0.81	0.20
0.5	1.00	0.94	0.87	0.52
0.6	1.00	0.97	0.92	0.73
0.7	1.00	0.98	0.96	0.86
0.8	1.00	0.99	0.98	0.94
0.9	1.00	1.00	1.00	0.99
1.0	1.00	1.00	1.00	1.00

*Condition not allowed since no amount of intermittent ventilation will provide equivalent ventilation.

This table provides the "Effectiveness factors" to calculate an equivalent continuous ventilation rate from an intermittent fan running on a duty cycle.

Multiply a fan's continuous capacity by the "effectiveness factor" to get the effective CFM rate for a cycled fan.

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Selecting a fan and choosing an intermittent control

ASHRAE 62.2-10

Step 1: Select Cycle Time

Step 2: Select On-time During Cycle

Step 3: Calculate Fractional On-Time

Step 4: Apply Table 4.2 to calculate the intermittent flow rate that satisfies the whole house continuous ASHRAE 62.2-10 compliant ventilation rate.

Step 5: Multiply the fan capacity by the effectiveness factor to get the effective CFM provided.

(in reality It's easier than this because the controls manufacturers have done most of this work)

Calculating the "effective" Intermittent CFM an Example:

ASHRAE 62.2-10

Intermittent Whole House Ventilation

Example:

Step 1: Selected Cycle Time ***8 hours***

Vent fan starts every 8 hours

Step 2: Selected On-time during cycle:

2 hours on 6 hours off

Step 3: Calculate the fraction on-time

2 hours / 6 hours = 0.33 fraction on-time

Step 4: Determine the effectiveness factor from Table 4.2 to get the effective CFM rate.

↓ 8 hours, → 0.3 on time ⇒ 0.89 effectiveness

Calculating the "effective" Intermittent CFM an Example:

ASHRAE 62.2-10

Intermittent Whole House Ventilation

Example continued:

Step 4: Multiply the fan capacity by the effectiveness factor to get the effective CFM rate.

↓ 8 hours, → 0.3 on time ⇒ 0.89 effectiveness

Step 5: Multiply the fan rated capacity by the effectiveness factor to get the effective CFM rate provided.

$CFM_{effective} = CFM_{rated}$ x Effectiveness factor

For example if we selected an 80 CFM fan, the effective rate provided will be 80 x 0.89 = 71 CFM

Designing ducts, guidelines and recommendations

ASHRAE 62.2-10

1) Exhaust flow must exit directly outside.
2) Use short, straight, well-sealed ducts.
3) Use large diameter duct.
4) Use insulated ducts when the route goes outside the thermal boundary.
5) Use 2 to 3 feet of straight pipe before and after elbows.
6) Use hard duct elbows for sharp bends
7) Use low-friction supply diffusers and return grilles.
8) Terminations must keep animals out.
9) Follow manufacturer specs and installation instructions.

Designing ducts, prescriptive sizing

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ASHRAE 62.2-10

Prescriptive duct sizing from ASHRAE 62.2-2007 Table 7.1

Duct Type:	Flex duct				Smooth duct			
Fan rating (CFM)	50	80	100	125	50	80	100	125
Diameter (inches)	Maximum duct length (ft)							
3"	DNU	DNU	DNU	DNU	5'	DNU	DNU	DNU
4"	70'	3'	DNU	DNU	105'	35'	5'	DNU
5"	NL	70'	35'	20'	NL	135'	85'	55'
6"	NL	NL	125'	95'	NL	NL	NL	145'
7"	NL	NL	NL	NL	NL	NL	NL	NL
DNU = Do Not Use	This table assumes no elbows, diffusers, or grilles.							
NL = No Limit	Fan rating in CFM at 0.25 inches of Water Column							

Designing ducts, equivalent length

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Equivalent Duct Length (EDL)

		DUCT DIAMETER	
		4”	6”
Duct Material	Flex Aluminum	1.25 x duct length	1.5 x duct length
Terminal	Wall Cap	30 feet	40 feet
Device	Roof Cap	30 feet	40 feet
Elbow	Adjustable	15 feet	20 feet

Work Flow - Auditor

ASHRAE 62.2-10

Work Flow - Installer

ASHRAE 62.2-10

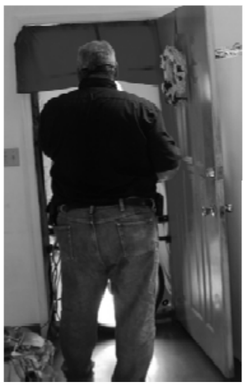
Necessary ducting for existing fans must be properly installed to bring air into or out of the dwelling.

Fan controls, like the one shown at right, must be installed to insure proper run times.

Work Flow - Inspector

ASHRAE 62.2-10




Setting the control

ASHRAE 62.2-10


Summary

ASHRAE 62.2-10

- The natural ventilation calculation we've used for years is flawed when dealing with weatherized homes
- ASHRAE 62.2 is a performance standard – fan flow must be measured.
- The math to compute the required fan flow is really a series of simple steps.
- The chosen ventilation method should be customized for the location and site conditions.
- Choosing a fan, control, and duct to install is a design process. Shoot for simplicity, durability, and ease of maintenance/replacement.