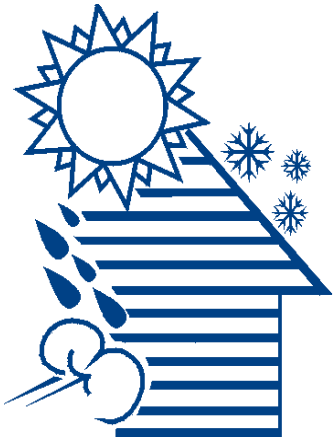


WEATHERIZATION HEALTH AND SAFETY

ASHRAE 62.2

for WAP

Beyond Fan CFM Requirements

ASHRAE 62.2 2010 includes:

- Spot ventilation requirements as mentioned
- Attached garages must be adequately sealed from living space to prevent migration of contaminants
- Clothes driers must be vented to exterior
- All duct joints outside conditioned space must be sealed
- Sone rating requirements must be met
- Branch duct systems must have backdraft dampers
- Whole-home fan flow must be verified
- Continuous vs. intermittent fan specifications

How has natural ventilation been calculated?

N-factor variables:

- Geographic location
- Building height
- Building exposure

The n-factor for the house illustrated at right would be different if it was one story taller, or less shielded. The map shown below is the LBL Climate Zone Map used to determine the geographic variable.

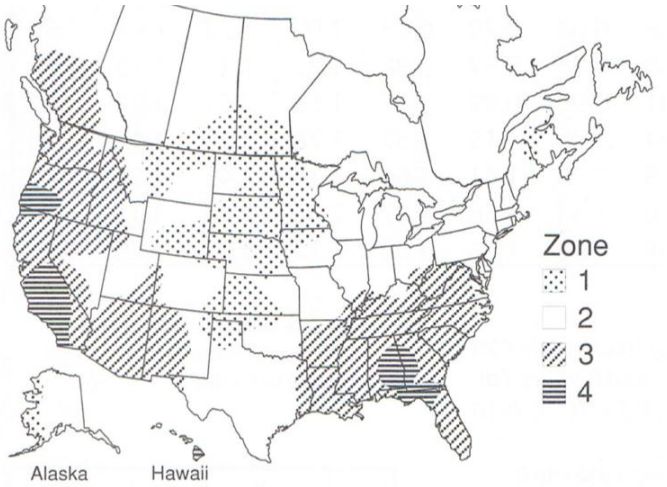


Table 4.1a: Minimum Ventilation Air Requirements, CFM, New Buildings[1]

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*

New or Existing Buildings[2]:

$$CFM_{fan} = 0.01A_{floor} + 7.5(Number_{bedroom} + 1)$$
$$+ \text{(alternative compliance supplement)}$$
$$- \text{(Infiltration credit)}$$

A = 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)

- Assumes two occupants in master bedroom and one each in the other bedrooms. Over this density, increase ventilation by 7.5 cfm/person.
- Whole building, intermittently operating ventilation may be used under some conditions for compliance.
- Ventilation air must come directly from the outdoors.
- Credit is allowed for envelope air leakage in some cases, based on ASHRAE 62.2 and 136.

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

ASHRAE 62.2-2010 Formula Breakdown

$$CFM_{fan} = 0.01A_{floor} + 7.5(Number_{bedroom} + 1) + (\text{alternative compliance supplement}) - (\text{Infiltration credit})$$

Break this down into 3 smaller steps:

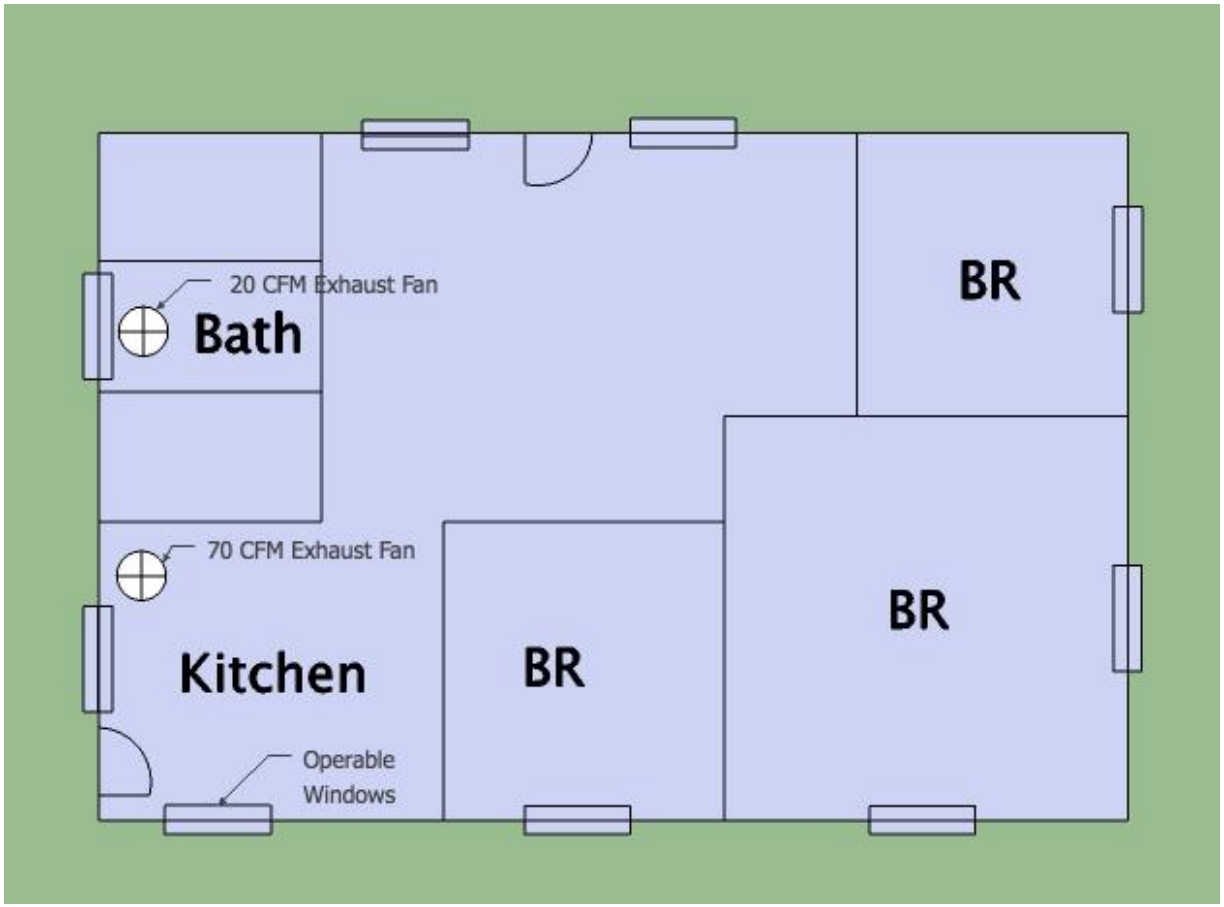
- Use the base formula to determine the whole house continuous requirements = 0.01A + 7.5 * # occupants
- Calculate the local ventilation deficit (alternative compliance supplement)
- Calculate the infiltration credit

Calculating Required Fan CFM #1

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Base formula:

Whole Building Fan CFM = (7.5 * # bedrooms plus 1) + Area/100



Characteristics:

- 1,500 square feet
- 1 story
- 3 bedrooms (4 occupants)
- Norfolk, VA

Calculating Required Fan CFM #2

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Base formula, step by step:

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

*4 people * 7.5 CFM/person = 30 CFM*

Calculate 1 CFM per 100 square feet of floor area:

1500 ft^2/100 ft^2 per required CFM = 15 CFM

Add them together:

30 CFM + 15 CFM = 45 CFM continuous

But what if they don't have adequate local ventilation?

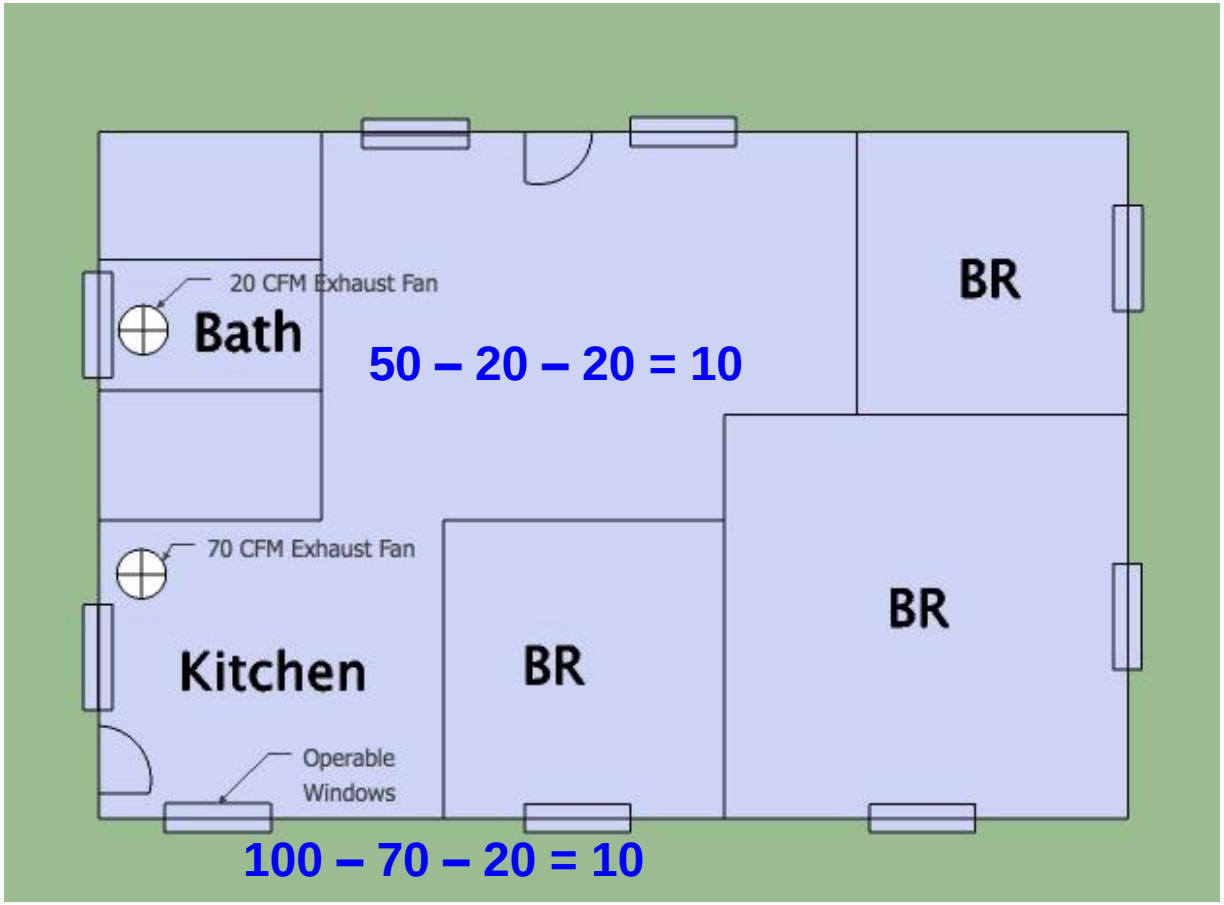
The alternative compliance supplement calculation lets you take the inadequate CFM delivery or total lack of required local ventilation fans into account.

- Kitchen requires 100 CFM on demand or 5 ACH continuous, based on kitchen volume.
- Bathroom requires 50 CFM on demand or 20 CFM continuous. Not required in ½ baths.
- Operable windows in those rooms reduce deficit by 20 CFM. Only one deficit reduction per room.
- Deficit cannot drop below zero.

Sum all deficits and divide by 4. Add the result to the continuous whole building ventilation CFM requirement.

Alternative Compliance Supplement Calculation #1

ASHRAE 62.2 FOR WAP



Bathroom: 50 CFM required

- *Existing fan = 20 CFM*
- *Operable window*
  (reduce deficit by 20 CFM)

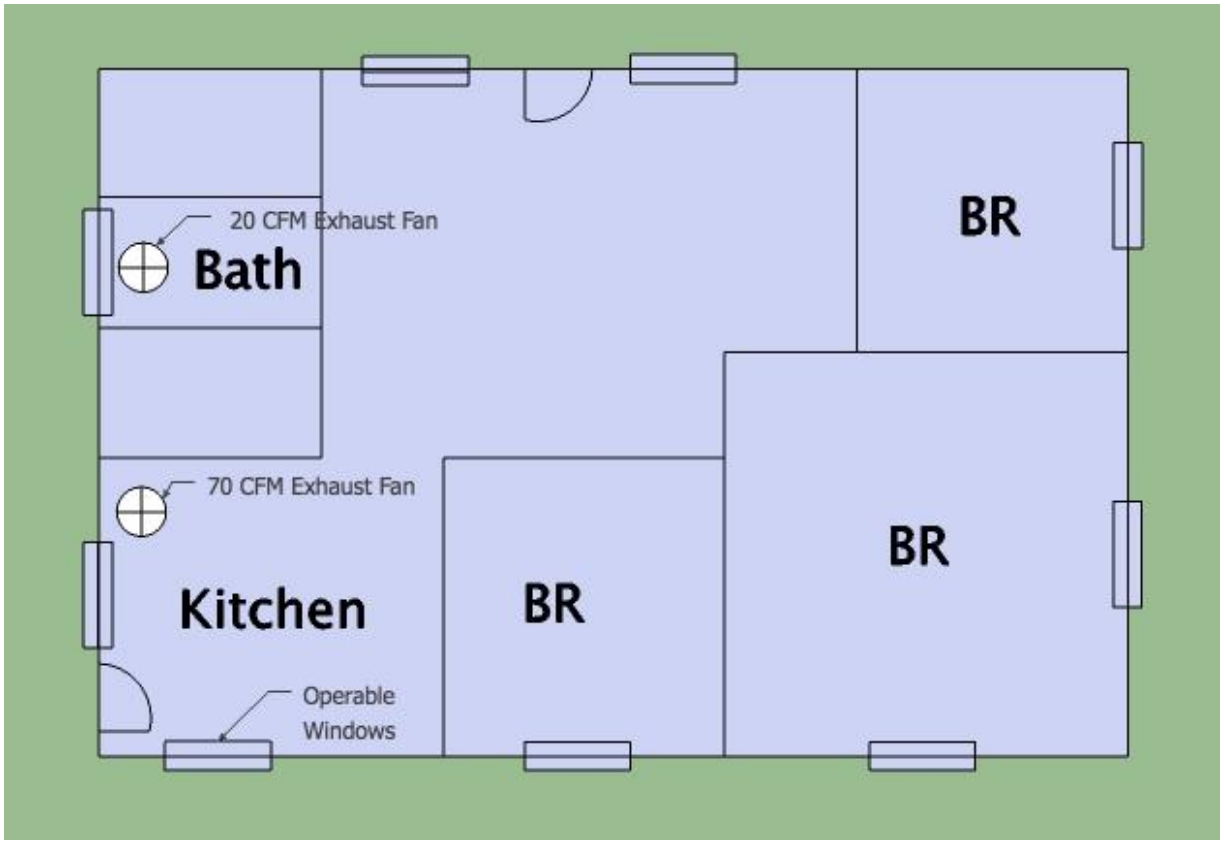
50 CFM req. – 20 CFM existing - 20 CFM (window) = 10 CFM deficit

Kitchen: 100 CFM required

- *Existing fan = 70 CFM*
- *Operable window*

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

Alternative Compliance Supplement Calculation #2



Continuous CFM Req. from Base Formula = 45 CFM

45 CFM + 5 CFM = 50 CFM

Net deficit in home:

- *10 CFM + 10 CFM = 20 CFM*
- *This is based on on-demand requirements.*
- *We will add capacity to the whole home continuous fan, so can reduce deficit.*

Divide deficit by 4 for additional continuous CFM requirement:

- *20 CFM/4 = 5 CFM*

Calculating the Infiltration Credit - Steps

1. Estimate infiltration rate at post-weatherization conditions (I_{CFM}).
2. Calculate default infiltration rate (I_d).
3. If I_{CFM} is greater than the default rate, calculate infiltration credit (I_{cred}).

Inputs needed:

- Weather factor from ASHRAE 136
- S factor accounting for building height (table included)
- CFM_{50} of the home, post-weatherization.
- Area of home, square feet of conditioned space.

Calculating the Infiltration Credit – Step 1

1. Estimate infiltration rate at operating conditions (I_{CFM}).

(I_{CFM}) can be estimated as:

$$I_{CFM} = 0.0508 * w * S * Q_{50}$$

In this equation:

- *S* is a factor accounting for the height of the building, determined from Table X-1 (included).
- Q_{50} is the blower door test result in CFM50 (cubic feet per minute at 50 Pa). Since we are trying to determine the needs of the weatherized home, users must estimate what the CFM50 will be post-weatherization.
- *w* is the weather factor from ASHRAE Standard 136.

S & W Charts

# Stories	1	1.5	2	2.5	3
S factor	1	1.13	1.23	1.32	1.39

Multiply the S factor * 0.0508 * w to get a number you can input into the

If we get a post-Wx BD of 1250 CFM_{50} in our sample 1,500 ft^2, 1-story Norfolk home, the estimated infiltration =

0.0508 * 0.84w * 1s * 1250 CFM_{50}, or

0.043(from the table) * 1250 = 54 CFM

$0.0508 * w * S * Q_{50}$

		Select city (left) and # stories (below)				
City	w	1	1.5	2	2.5	3
Norfolk	0.84	0.043	0.048	0.052	0.056	0.059
Richmond	0.75	0.038	0.043	0.047	0.050	0.053
Roanoke	0.74	0.038	0.042	0.046	0.050	0.052

2. Calculate default infiltration rate (I_d)

- The default infiltration rate is the assumed leakiness, and takes the size of the home into account.

$$\mathbf{I_d = 0.02 * A_{floor}}$$

- A is the conditioned area of the home in square feet. For our sample home $I_d = 0.02 * 1500 = 30$
- This is lower than our estimated infiltration of 54 CFM, so we will continue to step 3…

Calculating the Infiltration Credit – Step 3

3. If I_{CFM} is greater than the default rate (I_d), calculate infiltration credit (I_{cred}).

- This is where we account for the infiltration of the home that is above and beyond the default value.

$$I_{cred} = ½ (I_{CFM} – I_d)$$

$$I_{cred} = ½ (54 – 30)$$

$$I_{cred} = ½ (24)$$

$$I_{cred} = 12$$

Bringing it All Together

CFM_{fan} = (Base formula) + (alternative compliance supplement) - (Infiltration credit)

We broke this down into 3 smaller steps and now have all the pieces to calculate our whole home continuous fan CFM requirement for our sample home in Norfolk:

- Use the base formula to determine the whole house continuous requirements = 0.01A + 7.5 * # occupants
  - $1500ft^2$ /100 + (7.5CFM * # occupants) = 45
- Calculate the spot ventilation deficit = Net deficit/4
  - 20 CFM/4 = 5 CFM deficit
- Calculate the infiltration credit = ½ ($I_{CFM} - I_d$)
  - ½ (54 CFM – 30 CFM) = 12 CFM credit

CFM_{fan} = (45 CFM) + (5 CFM) - (12 CFM)

CFM_{fan} = 38 CFM

Effect of Size

What would change if we had the same home, but 2000 ft^2 instead of 1500?

Characteristics:

- 2000 square feet
- 1 story
- 3 bedrooms
- 1250 CFM_{50}

- The base formula changes = 0.01A + 7.5 * # occupants
  - 2000ft^2 /100 + (7.5CFM * # occupants) = 50
- The spot ventilation deficit is the same = Net deficit/4
  - 20 CFM/4 = 5 CFM deficit
- The infiltration credit will change = ½ ($I_{CFM} – I_d$)
- Remember, $I_{CFM} = 0.0508 * w * S * Q_{50}$, *and* $I_d = 0.02 * A_{FLOOR}$

$$I_{CFM} = 0.0508 * 0.84 * 1 * \ 1250\ CFM_{50} = 54\ CFM$$

$$I_d = 0.02 * 2000\ ft^2 = 40$$

$$I_{Credit} = ½(54 – 40) = 7\ CFM$$

$$CFM_{fan} = \mathbf{(50\ CFM)} + (5\ CFM) – \mathbf{(7\ CFM)}$$

$$CFM_{fan} = \mathbf{48\ CFM}$$

Effect of Climate

What would change if we had the same home, but in Portland, ME?

Characteristics:

- 1,500 square feet
- 1 story
- 3 bedrooms
- Portland, ME (w = 0.91)
- 1250 CFM_{50}

- The base formula is the same= 0.01A + 7.5 * # occupants
  - 1500ft^2 /100 + (7.5CFM * # occupants) = 45
- The spot ventilation deficit is the same = Net deficit/4
  - 20 CFM/4 = 5 CFM deficit
- The infiltration credit will change = ½ ($I_{CFM} - I_d$)
- Remember, $I_{CFM} = 0.0508 * w * S * Q_{50}$, *and* $I_d = 0.02 * A_{FLOOR}$

$$I_{CFM} = 0.0508 * 0.91 * 1 * 1250\ CFM_{50} = 58\ CFM$$

$$I_d = 0.02 * 1500\ ft^2 = 30$$

$$I_{Credit} = ½(58 - 30) = 14\ CFM$$

$$CFM_{fan} = (45\ CFM) + (5\ CFM) - \mathbf{(14\ CFM)}$$

$$CFM_{fan} = \mathbf{38\ CFM}$$

Effect of Deficit

What would change if we had the original Norfolk home, but the kitchen fan delivered only 50 CFM, and the bathroom window didn't open?

Bathroom: 50 CFM required

- *Existing fan = 20 CFM*
- *No window credit*
- *50 – 20 = 30 CFM*

Kitchen: 100 CFM required

- *Existing fan = 50 CFM*
- *Operable window*
- *100 - 50 – 20 = 30 CFM*

Net deficit = 30 + 30 = 60 CFM

- The base formula remains unchanged = 0.01A + 7.5 * # occupants
  - $1500ft^2$ /100 + (7.5CFM * # occupants) = 45
- The local ventilation deficit increases = Net deficit/4
  - 60 CFM/4 = 15 CFM deficit
- The infiltration credit doesn't change = $\frac{1}{2}(I_{CFM} - I_d)$
  - ½ (54 CFM – 30 CFM) = 12 CFM credit

$$CFM_{fan} = (45\ CFM) + \mathbf{(15\ CFM)} - (12\ CFM)$$

$$CFM_{fan} = \mathbf{48\ CFM}$$

Effect of Leakiness

What would change if we got 2,000 CFM_{50} instead of 1250 CFM_{50} on the original Norfolk house?

Characteristics:

- 1,500 square feet
- 1 story
- 3 bedrooms
- Norfolk, VA
- 2,000 CFM_{50}

- The base formula remains unchanged = 0.01A + 7.5 * # occupants
  - $1500ft^2$ /100 + (7.5CFM * # occupants) = 45
- The local ventilation deficit is the same = Net deficit/4
  - 20 CFM/4 = 5 CFM deficit
- The infiltration credit will increase = ½ ($I_{CFM} - I_d$)
- Remember, $I_{CFM} = 0.0508 * w * S * Q_{50}$

  $I_{CFM} = 0.0508 * 0.84 * 1 * 2000\ CFM_{50}$

  $I_{CFM} = 0.0508 * 0.84 * 1 * 2000\ CFM_{50}$

  $I_{CFM} = 85$
- ½ (85 CFM – 30 CFM) = 27.5 CFM infiltration credit

$$CFM_{fan} = (45\ CFM) + (5\ CFM) - \mathbf{(27.5\ CFM)}$$

$$CFM_{fan} = \mathbf{22.5\ CFM}$$

That's complicated!

Three – soon to be four? – 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.

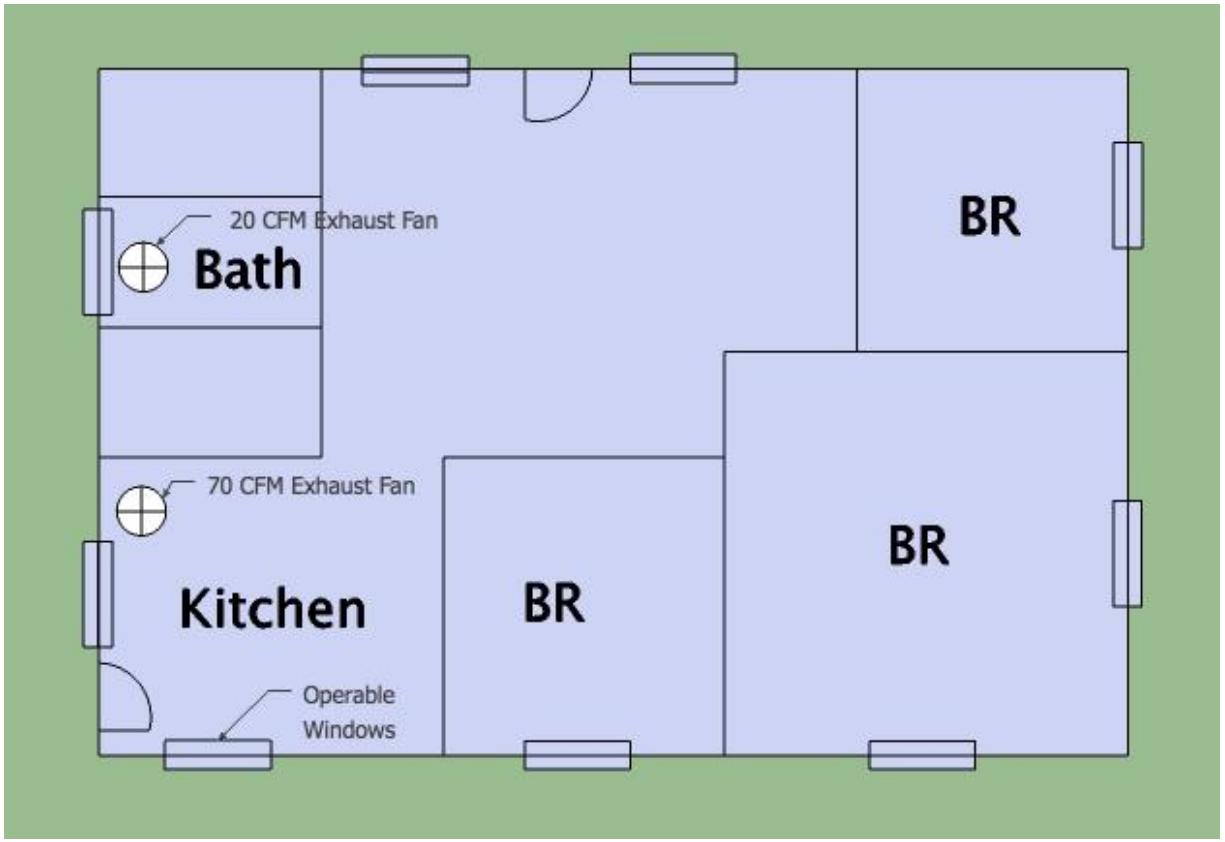
Beyond Fan CFM Requirements Review

Remember, ASHRAE 62.2 2010 also includes:

- Spot ventilation requirements as mentioned
- Attached garages must be adequately sealed from living space to prevent migration of contaminants
- Clothes driers must be vented to exterior
- All duct joints outside conditioned space must be sealed
- Sone rating requirements must be met
- Branch duct systems must have backdraft dampers
- Whole-home fan flow must be verified
- Continuous vs. intermittent fan specifications

Audit Decisions

CFM_{fan} = (7.5 x BR+1) + 0.01A + (2.5 CFM deficit)
- (12 CFM Infil Credit) = 36 CFM_{fan} by replacing bath fan

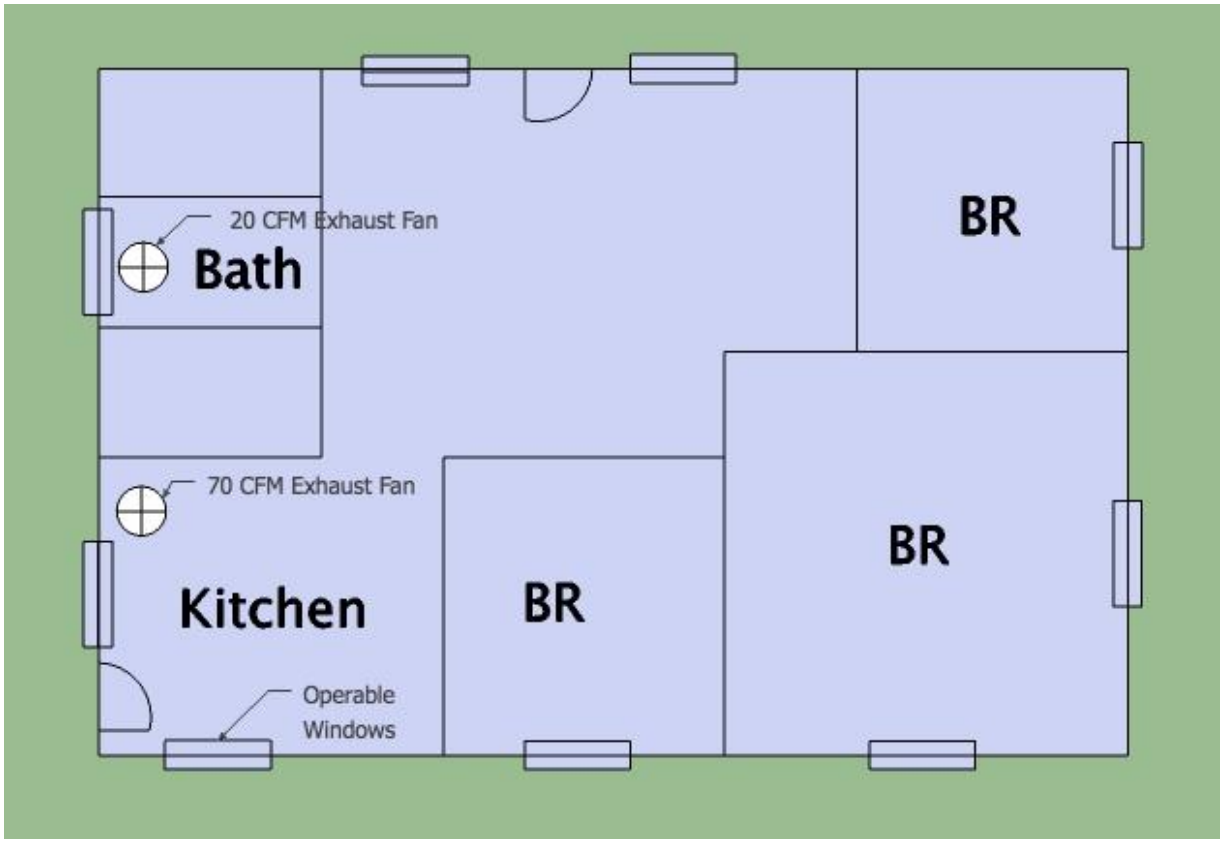


Characteristics:

- 1,500 square feet
- 1 story
- 3 bedrooms (4 occupants)
- Norfolk, VA
- 1,250 CFM50
- 20 CFM bath fan
- 70 CFM kitchen fan

Now lets replace the kitchen fan.

CFM_{fan} = (7.5 x BR+1) + 0.01A -
(9.5 CFM Infil Credit) = 36 CFM_{fan}



Characteristics:

- 1,500 square feet
- 1 story
- 3 bedrooms (4 occupants)
- Norfolk, VA
- 1,250 CFM50
- 20 CFM bath fan
- 70 CFM kitchen fan