Ventilating Single Family Homes
with ASHRAE 62.2-2010

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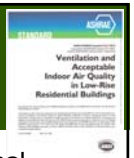
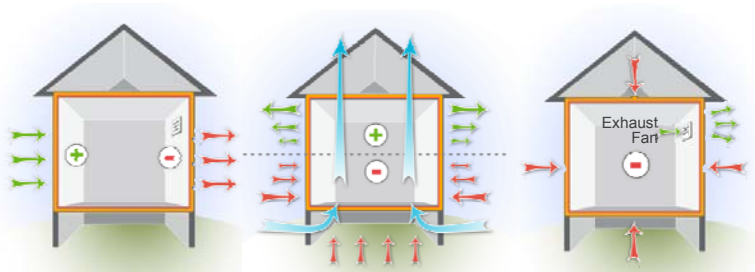
ASHRAE 62.2-2010 Topics
(not simply about cfm's)



- Spot ventilation requirements same as IRC-Mechanical
- Attached garages shall be *adequately* sealed from living spaces to prevent migration of contaminants (IRC-M)
- Clothes driers exhausted to exterior (IRC-M)
- Ducts outside conditioned space must be sealed
  - *IRC-M and IECC-R require all ducts to be sealed*
  - *IECC-R requires leak-testing of ducts if portions of system outside*
- Sone *(sound)* rating requirements must be met (IECC-R)
- Branch duct systems must have back-draft dampers
- Whole-house fan supply/exhaust flows shall be field-verified
- Continuous vs. intermittent fan specifications (IMC-M, IECC-R)
- Max. exhaust threshold for atmospherically vented appliances

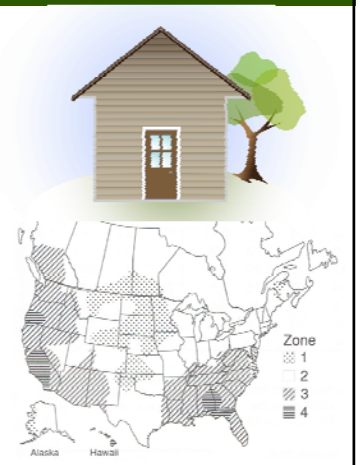
How Air Moves Through Buildings



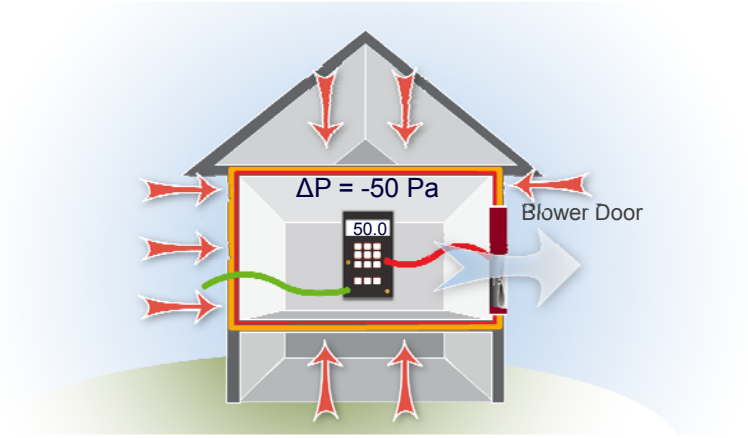
Pressure ***(Wind)*** **Convection** ***(stack effect)*** **Mechanical** ***(fans)***

Historically…How has natural ventilation been calculated?

- ASHRAE 62.1
- ASHRAE 62.2, and
- International Mechanical Code
  - Specify ventilation for acceptable indoor air quality in low-rise residential buildings.
  - Ventilation is acceptable at natural infiltration rates >0.35 ACH_{nat} ($7ACH_{50}$)
- **N-factor variables:**
  - Climate (geography)
  - Building height
  - Building exposure



Blower Door Testing



R402.4.1.1 – Blower Door Testing

(Air Leakage Rate of 3ACH$_{50}$ or 5ACH$_{50}$ Required)

Use of a calibrated fan to quantify/evaluate air leakage…

- **Installation**. Components of the envelope and air barrier are installed in accordance with the thermal- and air-barrier table.
- **Testing**. The building shall be tested/verified with a blower door to quantify rate of air leakage not exceeding 5 ACH50.
- Where required by the AHJ, Blower Door Testing shall be conducted by an ***approved*** third party.

Calculating ACH$_{50}$

ACH$_{50}$=(CFM$_{50}$ X 60 min/hour) ÷ Vol.

- **Blower Door Flow Reading** = 2,550 cfm$_{50}$
- **House Volume** = 27,000 cu/ft
- **ACH$_{50}$** = (2,550 x 60) ÷ 27,000 = 5.7 ACH$_{50}$

(Multiply by 60 to convert from minutes to hours)

Approximate Leakage Area

Divide CFM$_{50}$ by 10

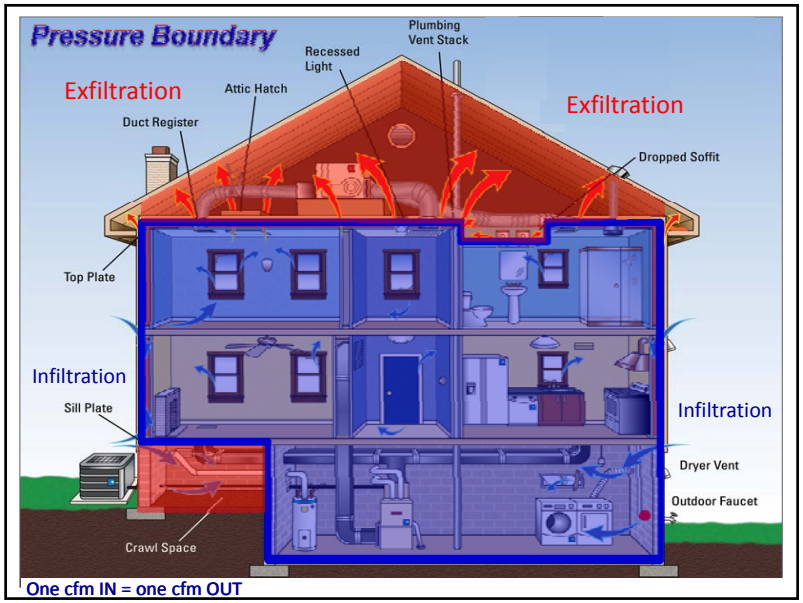
Then take Sq. Root

For example:

2,550 CFM$_{50}$ ÷ 10 = 255 sq”

√ 255 = 16” x 16” hole

It’s like having a window open 24 / 7 / 365



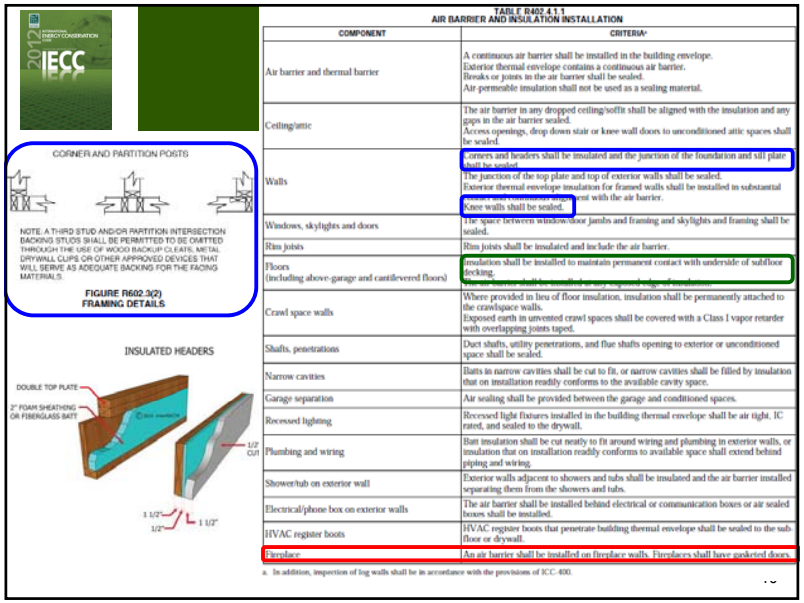
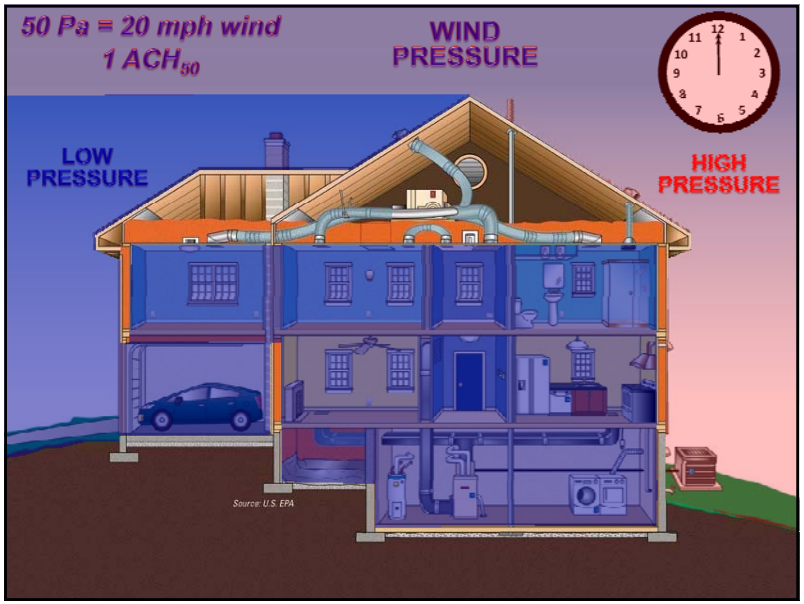
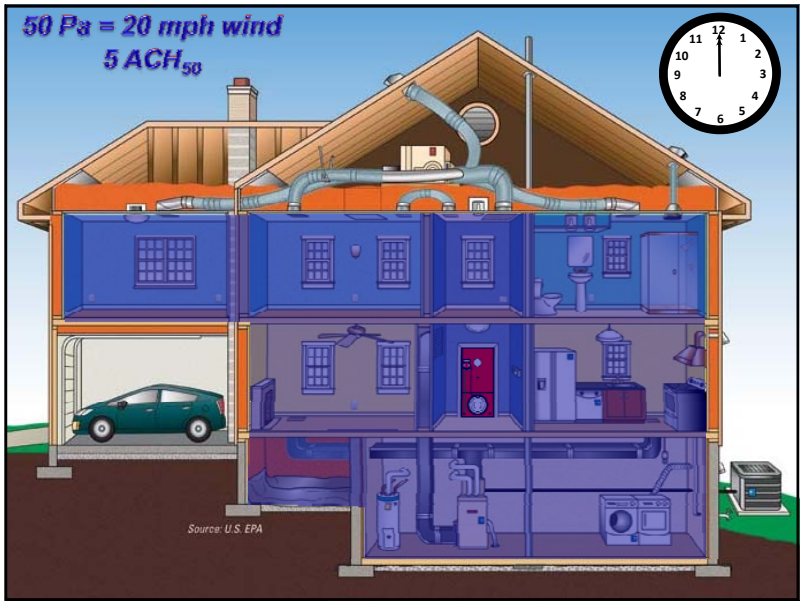


TABLE R402.4.1.1
AIR BARRIER AND INSULATION INSTALLATION

COMPONENT	CRITERIA[a]
Air barrier and thermal barrier	A continuous air barrier shall be installed in the building envelope. Exterior thermal envelope contains a continuous air barrier. Breaks or joints in the air barrier shall be sealed. Air-permeable insulation shall not be used as a sealing material.
Ceiling/attic	The air barrier in any dropped ceiling/soffit shall be aligned with the insulation and any gaps in the air barrier sealed. Access openings, drop down stair or knee wall doors to unconditioned attic spaces shall be sealed.
Walls	Corners and headers shall be insulated and the junction of the foundation and sill plate shall be sealed. The junction of the top plate and top of exterior walls shall be sealed. Exterior thermal envelope insulation for framed walls shall be installed in substantial [illegible] with the air barrier. Knee walls shall be sealed.
Windows, skylights and doors	The space between window/door jambs and framing and skylights and framing shall be sealed.
Rim joists	Rim joists shall be insulated and include the air barrier.
Floors (including above-garage and cantilevered floors)	Insulation shall be installed to maintain permanent contact with underside of subfloor decking. The air barrier shall be installed at any exposed edge of insulation.
Crawl space walls	Where provided in lieu of floor insulation, insulation shall be permanently attached to the crawlspace walls. Exposed earth in unvented crawl spaces shall be covered with a Class 1 vapor retarder with overlapping joints taped.
Shafts, penetrations	Duct shafts, utility penetrations, and flue shafts opening to exterior or unconditioned space shall be sealed.
Narrow cavities	Batts in narrow cavities shall be cut to fit, or narrow cavities shall be filled by insulation that on installation readily conforms to the available cavity space.
Garage separation	Air sealing shall be provided between the garage and conditioned spaces.
Recessed lighting	Recessed light fixtures installed in the building thermal envelope shall be air tight, IC rated, and sealed to the drywall.
Plumbing and wiring	Batt insulation shall be cut neatly to fit around wiring and plumbing in exterior walls, or insulation that on installation readily conforms to available space shall extend behind piping and wiring.
Shower/tub on exterior wall	Exterior walls adjacent to showers and tubs shall be insulated and the air barrier installed separating them from the showers and tubs.
Electrical/phone box on exterior walls	The air barrier shall be installed behind electrical or communication boxes or air sealed boxes shall be installed.
HVAC register boots	HVAC register boots that penetrate building thermal envelope shall be sealed to the sub floor or drywall.
Fireplace	An air barrier shall be installed on fireplace walls. Fireplaces shall have gasketed doors.

a. In addition, inspection of log walls shall be in accordance with the provisions of ICC 400.

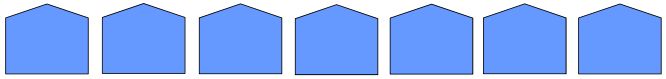




2009 IECC Air Leakage 7ACH$_{50}$

4 mph wind = 0.35 ACH$_{nat}$
(140 cfm or 8,400 cubic/ft of natural ventilation/hr)

20 mph wind = 7.0 ACH$_{50}$
(2,800 cfm or 168,000 cubic/ft of natural ventilation/hr)

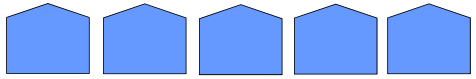


(1,500 sq/ft home w/full basement)

2012 IECC Air Leakage 5ACH$_{50}$

4 mph wind = 0.25 ACH$_{nat}$
(100 cfm or 6,000 cubic/ft of natural ventilation/hr)

20 mph wind = 5.0 ACH$_{50}$
(2,000 cfm or 120,000 cubic/ft of natural ventilation/hr)

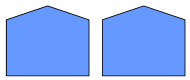


(1,500 sq/ft home w/full basement)

ENERGYSTAR Tighter than Code Air Leakage 2ACH$_{50}$

4 mph wind = 0.1 ACH$_{nat}$
(40 cfm or 2,400 cubic/ft of natural ventilation/hr)

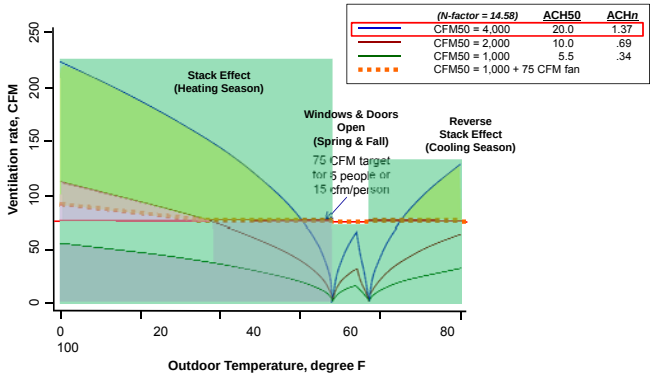
20 mph wind = 2.0 ACH$_{50}$
(800 cfm or 48,000 cubic/ft of natural ventilation/hr)



(1,500 sq/ft home w/full basement)

Mechanical *vs* Natural Ventilation

Based on a single-story 1,500 sq/ft house



Source: University of Illinois – Building Research Council

IRC R303.4 – Mechanical Ventilation
IRC M1507.3 – Whole House Ventilation

R303.4 Mechanical ventilation. Where the air infiltration rate of a dwelling unit is less than 5 air changes per hour when tested with a blower door at a pressure of 0.2 inch w.c (50 Pa) in accordance with Section N1102.4.1.2, the dwelling unit shall be provided with whole-house mechanical ventilation in accordance with Section M1507.3.

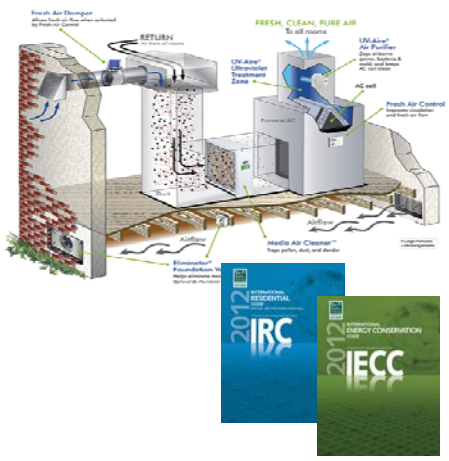
M1507.3 Whole-house mechanical ventilation system. Whole-house mechanical ventilation systems shall be designed in accordance with Sections M1507.3.1 through M1507.3.3.

M1507.3.1 System design. The whole-house ventilation system shall consist of one or more supply or exhaust fans, or a combination of such, and associated ducts and controls. Local exhaust or supply fans are permitted to serve as such a system. Outdoor air ducts connected to the return side of an air handler shall be considered to provide supply ventilation.

M1507.3.2 System controls. The whole-house mechanical ventilation system shall be provided with controls that enable manual override.

M1507.3.3 Mechanical ventilation rate. The whole-house mechanical ventilation system shall provide outdoor air at a continuous rate of not less than that determined in accordance with Table M1507.3.3(1).

Exception: The whole-house mechanical ventilation system is permitted to operate intermittently where the system has controls that enable operation for not less than 25-percent of each 4-hour segment and the ventilation rate prescribed in Table M1507.3.3(1) is multiplied by the factor determined in accordance with Table M1507.3.3(2).



IRC R303.4 – Mechanical Ventilation
IRC M1507.3 – Whole House Ventilation

TABLE M1507.3.3(1)
CONTINUOUS WHOLE-HOUSE MECHANICAL VENTILATION SYSTEM AIRFLOW RATE REQUIREMENTS

DWELLING UNIT FLOOR AREA (square feet)	NUMBER OF BEDROOMS				
	0 – 1	2 – 3	4 – 5	6 – 7	> 7
	Airflow in CFM				
< 1,500	30	45	60	75	90
1,501 – 3,000	45	60	75	90	105
3,001 – 4,500	60	75	90	105	120
4,501 – 6,000	75	90	105	120	135
6,001 – 7,500	90	105	120	135	150
> 7,500	105	120	135	150	165

For SI: 1 square foot = 0.0929 m^2, 1 cubic foot per minute = 0.0004719 m^3/s.

TABLE M1507.3.3(2)
INTERMITTENT WHOLE-HOUSE MECHANICAL VENTILATION RATE FACTORS[a, b]

RUN-TIME PERCENTAGE IN EACH 4-HOUR SEGMENT	25%	33%	50%	66%	75%	100%
Factor[a]	4	3	2	1.5	1.3	1.0

a. For ventilation system run time values between those given, the factors are permitted to be determined by interpolation.
b. Extrapolation beyond the table is prohibited.

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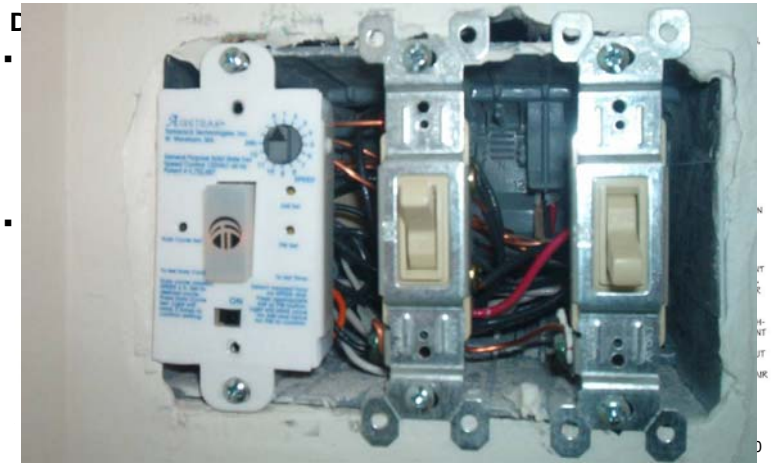
Calculating a 62.2 Ventilation Rate

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

Base formula, step by step:

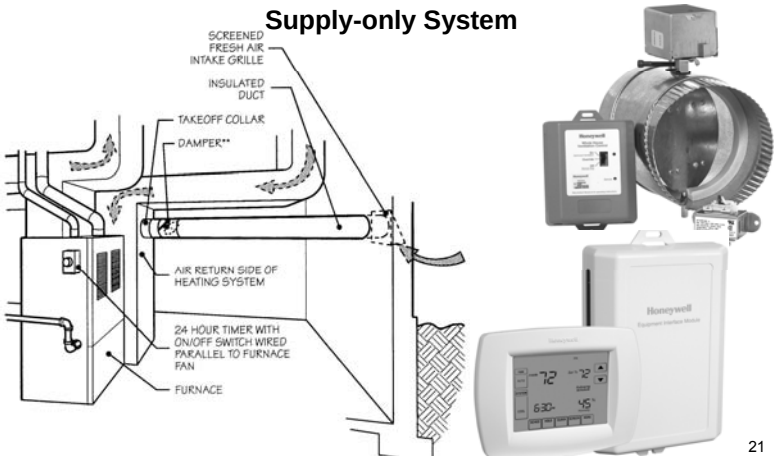
- Multiply the number of bedrooms + 1 or the number of people by 7.5 CFM per person:
  4 people * 7.5 CFM/person = 30 CFM
- Calculate 1 CFM per 100 square feet of floor area:
  1500 ft2/100 ft^2 per required CFM = 15 CFM
- Add them together:
  30 CFM + 15 CFM = 45 CFM continuous

Def'n – WHOLE HOUSE MECHANICAL VENTILATION SYS



Def'n – WHOLE HOUSE MECHANICAL VENTILATION SYS

Supply-only System



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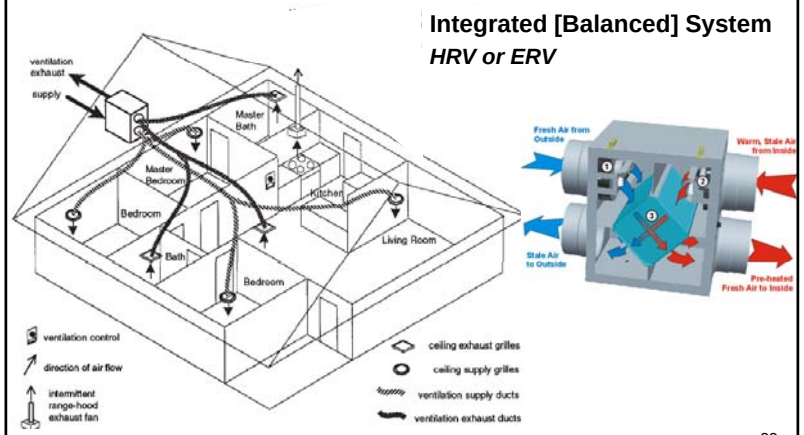
Def'n – WHOLE HOUSE MECHANICAL VENTILATION SYS

Integrated [Balanced] System
HRV or ERV



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System Types, Geography, Climate

Restrictions

- Hot, Humid Climates

  Exhaust-only systems shall not exceed 7.5 cfm/100 ft² of CFA.

- Very Cold Climates

  Mechanical supply systems exceeding 7.5 cfm/100 ft² of CFA, prohibited.

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There is a convergence of thought

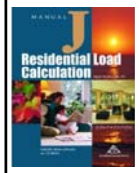
- **ASHRAE 62.2-2010**
  - *Currently required by DOE WAP*
  - *2012 IRC/IECC*
  - *BPI BAS as of January 2013*
- 2006 Wisconsin pilot study found 78% of weatherized units require additional ventilation under 62.2.
- This is from 47% compared to Standard 62.2-2003.
- Average installed cost of exhaust-only system, including controls: $375 (2006 dollars).

Materials & Equipment Costs $

- **Exhaust only $250**
- **Exhaust + Distribution $300**
- **Supply + Distribution $300**
- **Spot + Exh/Sup + Dist $600**
- **Balanced HRV + Dist $950**
- **Balanced ERV + Dist $1,350**

R403.6 – Equipment Sizing ACCA Manual 'J', Manual 'S'

- *Manual J8th* is only used to calculate the heating and cooling loads.
- *Manual J8th* guides HVAC designers to use ACCA *Manual S* to select equipment that is the right size (see § 10-4 of *Manual S*).
- *Manual S* sets equipment sizing limits, as summarized in Table 1.



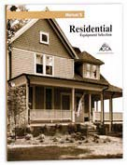
Manual S Equipment Selection Sizing Limitations

Equipment	Sizing Limits	Reference
Furnaces	100% - 140% of total heating load	Section 2-2
Boilers	100% - 140% of total heating load	Section 2-2
Air conditioners	115% of total cooling load*	Section 3-4
Heat pumps	115%[1] or 125%[2] of total cooling load*	Section 4-4
Supplemental heat (heat pumps)		
• Electric	Based on equipment balance point	Section 4-8
• Dual fuel	100% - 140% of total heating load	Section 6-8
Emergency Heat (heat pumps)	Based on local codes	Section 4-9

Manual S Input for Design Air Flow (*Manual D*)

Mode of Operation	Requirement	Reference
• Heating	Temperature rise requirement	Section 2-6
• Cooling	Air flow associated with the selected equipment's capacity	Section 3-11

[1] Heat pumps in a *cooling* dominant climate are allowed to be 115% of the cooling load.
[2] Heat pumps in a *heating* dominant climate are allowed to be 125% of the cooling load.
* The size of the cooling equipment must be based on the same temperature and humidity conditions that were used to calculate the *Manual J* loads.



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Thank you!

Questions?

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