

# Ventilation Basics and Beyond

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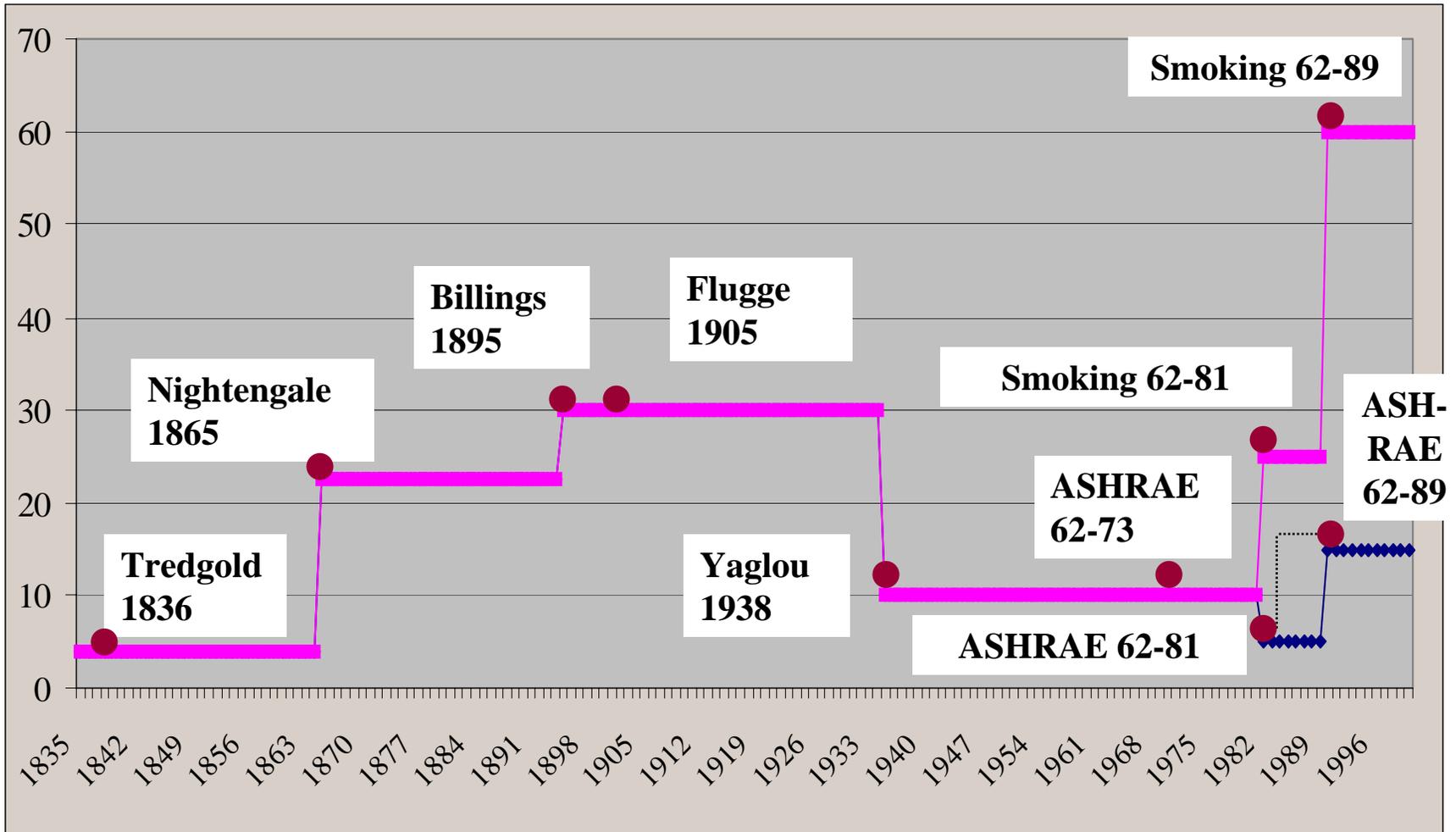
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# Historical Minimum Ventilation Rates (cfm/person)



# Ventilation and IAQ

- ◆ **Outdoor air ventilation addresses most indoor air quality issues**
  - ❖ **Sick building syndrome**
  - ❖ **Moisture and mold problems**
  - ❖ **Second hand tobacco smoke**
  - ❖ **Material outgassing**
  - ❖ **Multiple Chemical Sensitivity**
  
- ◆ **Good ventilation dilutes pollutants!**

# Ventilation

## ◆ Why Ventilate?

### ❖ Humidity control

- Reduce excessive moisture harmful to the building structure
- Reduce excessive moisture that is a source of mold and mildew growth

### ❖ Eliminate odors and pollutants harmful to human health

# Outside Air Ventilation

- ◆ All HVAC systems must be capable of supplying outdoor air ventilation at the minimum rate required by applicable state code
  - ❖ Generally ASHRAE Standard 62-1989 or 1999, Ventilation for Acceptable Indoor Air Quality
- ◆ Provision promotes ventilation
- ◆ No upper limit placed on outdoor air ventilation
- ◆ Ventilation directly impacts load calculations and equipment sizing

# ASHRAE 62

## requirements (both

1989 and 2001)

Example Spaces:	people/ 1,000 sq ft	cfm/ person	cfm/ sq ft
Commercial laundry	10	25	
Commercial dry cleaner	30	30	
Dining rooms	70	20	
Bar, cocktail lounge	100	30	
Kitchen (cooking)	20	15	
Enclosed parking garage			1.5
Hotel lobbies	30	15	
Conference rooms	50	20	
Gambling casinos	120	30	
Offices	7	20	
Smoking lounge	70	60	
Retail stores (street level)	30		0.3
Barber shops	25	15	
Reducing salons	20	15	
Pet shops			1
Darkrooms			0.5
Bank vaults	5	15	
Classrooms	50	15	
Hospital patient rooms	10	25	
Operating rooms	20	30	
Cells in correctional facilities	20	20	
Dining halls in correctional facilities	100	15	

# Ventilation and Lag Time

- ◆ Example: 5,000 ft<sup>2</sup> x 20 ft classroom (ASHRAE 62: 50 occ/ 1,000 ft<sup>2</sup>; 15 cfm/occ)
- ◆ # occupants = 5,000 / 50 = 100
- ◆ volume (ft<sup>3</sup>) = 5,000 \* 20 = 100,000 ft<sup>3</sup>
- ◆ ft<sup>3</sup> / occ = 100,000 / 100 = 1,000 ft<sup>3</sup> / occupant
- ◆ From chart (red line):  
Permissible lag time = 1.1 hours

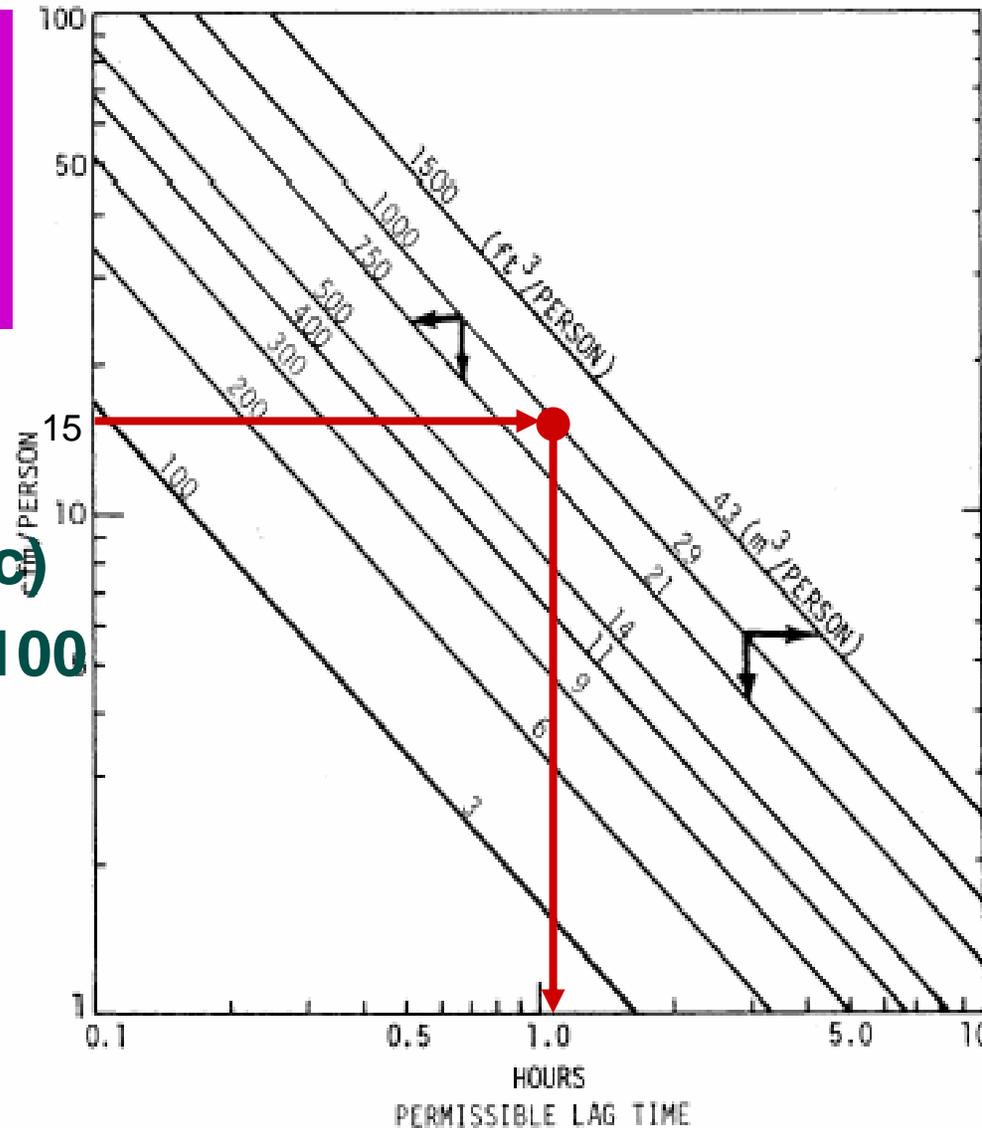


Figure 4 Maximum permissible ventilation lag time.

# Good Ventilation Design

- ◆ Mechanically provide filtered and dehumidified outdoor air to the breathing space.
- ◆ Bring in outdoor air from a clean source.
- ◆ Vary amount of ventilation based on the number of occupants and process loads.
  - ❖ Changes in occupancy can be measured by CO2 sensors
- ◆ Consider designs that provide separate systems for ventilation and space conditioning.
- ◆ Utilize heat recovery systems to reduce system size and ventilation energy costs.

# Recommendations for Ventilation Controls Using CO<sub>2</sub> Sensing System

- ◆ Determine design ventilation rate based on total occupancy
- ◆ Locate CO<sub>2</sub> sensor in conditioned space/return; for systems serving multiple rooms, locate sensor in “critical” area
- ◆ CO<sub>2</sub> concentration setpoint:  $C_R = C_{OA} + 8400 * m / R_p$
- ◆  $C_R$  = concentration in room;  $C_{OA}$  = concentration in outside air;  $m$  = metabolic rate (1.0 for seated, quiet; 1.4 for filing, standing);

$R_p$  = cfm rate per person

# Residential Ventilation Standards

- ◆ ASHRAE 62-1989: 15 cfm per person; 0.35 natural air changes per hour (number of occupants = # bedrooms +1)
- ◆ ASHRAE 62-2001: stays the same, but ASHRAE 62.2 (residential): minimum ventilation cfm =  $7.5 * (\# \text{ bedrms} + 1) + (0.01 * \text{house area in ft}^2)$
- ◆ Bathroom exhaust: 50 cfm

# ASHRAE 62 Residential Standard

$$(7.5 * \# \text{ bedrooms} + 0.01 * \text{area})$$

Outside air ventilation rate in cfm

		Area of Heated Rooms (sq ft)										
		1,000	1,500	2,000	2,500	3,000	3,500	4,000	5,000	6,000	7,500	10,000
Number of Bedrooms	1	25	30	35	40	45	50	55	65	75	90	115
	2	33	38	43	48	53	58	63	73	83	98	123
	3	40	45	50	55	60	65	70	80	90	105	130
	4	48	53	58	63	68	73	78	88	98	113	138
	5	55	60	65	70	75	80	85	95	105	120	145
	6	63	68	73	78	83	88	93	103	113	128	153
	7	70	75	80	85	90	95	100	110	120	135	160
	8	78	83	88	93	98	103	108	118	128	143	168
	9	85	90	95	100	105	110	115	125	135	150	175

# Spot Ventilation

- ◆ Bathroom fans
- ◆ Range Hoods

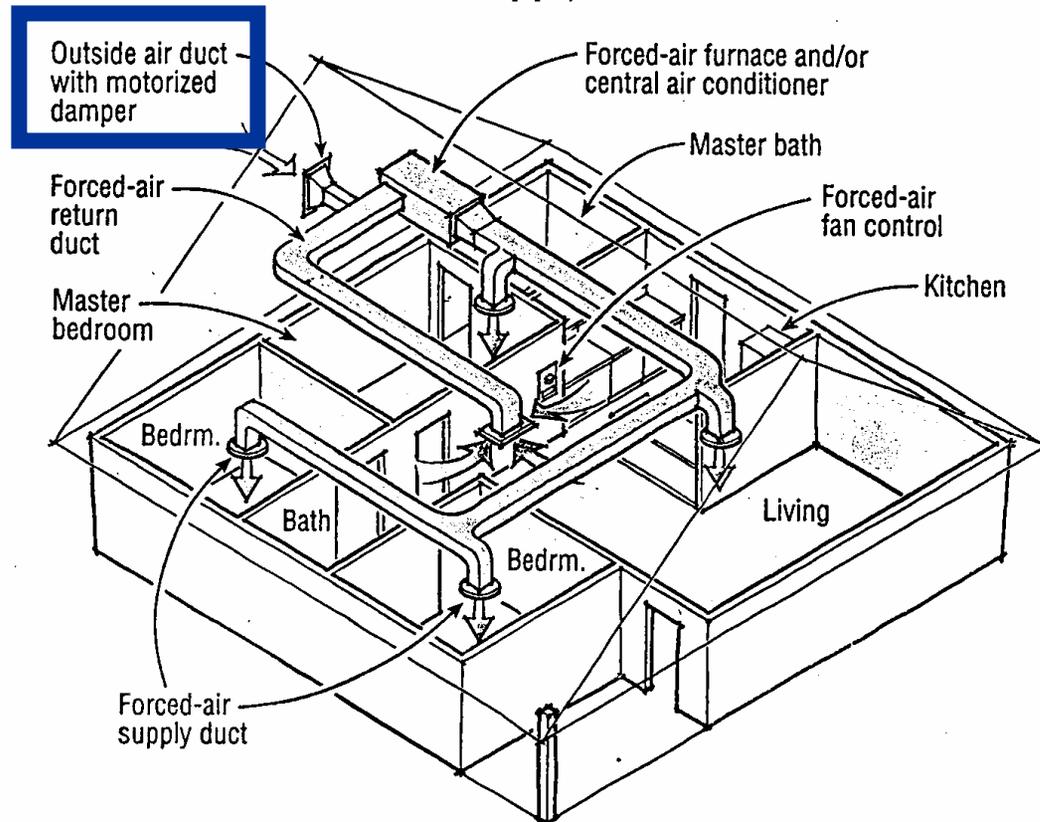


**Almost Is  
Not Good  
Enough**

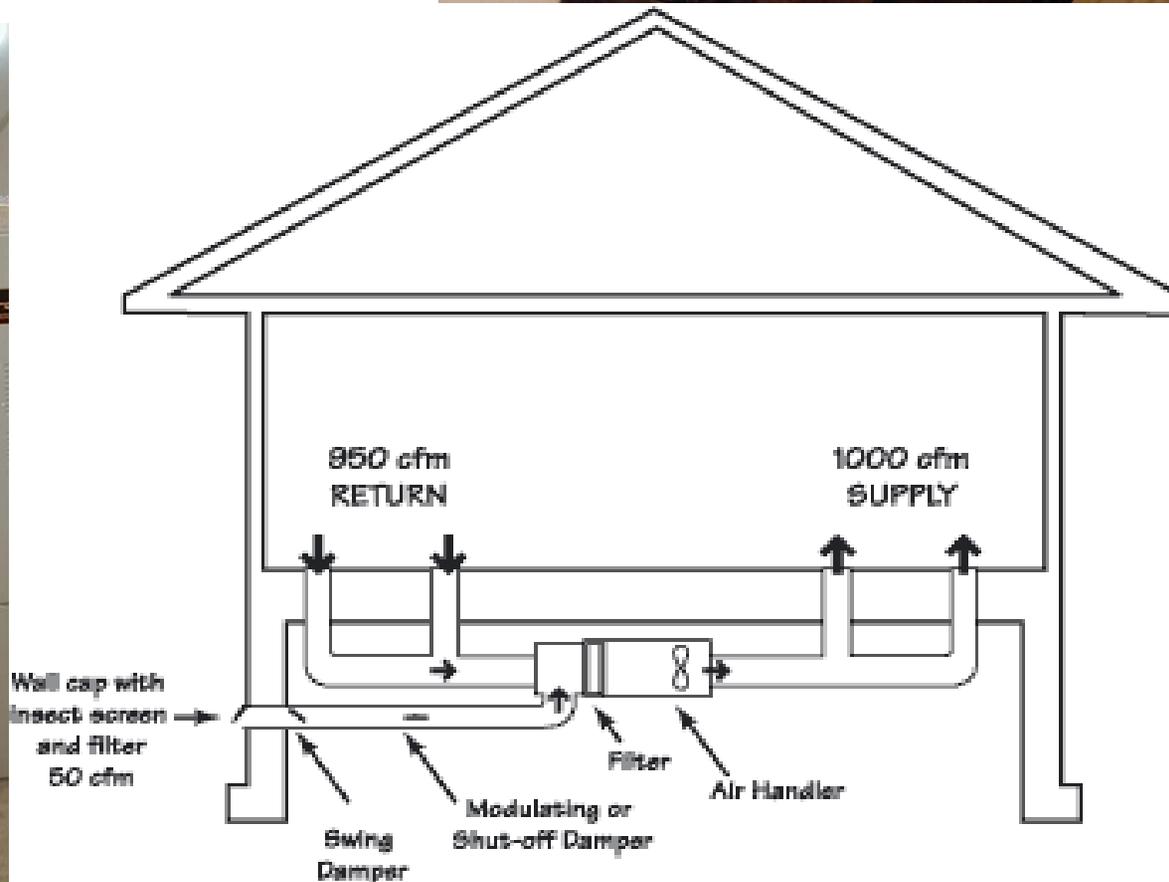


# Simple Ventilation System

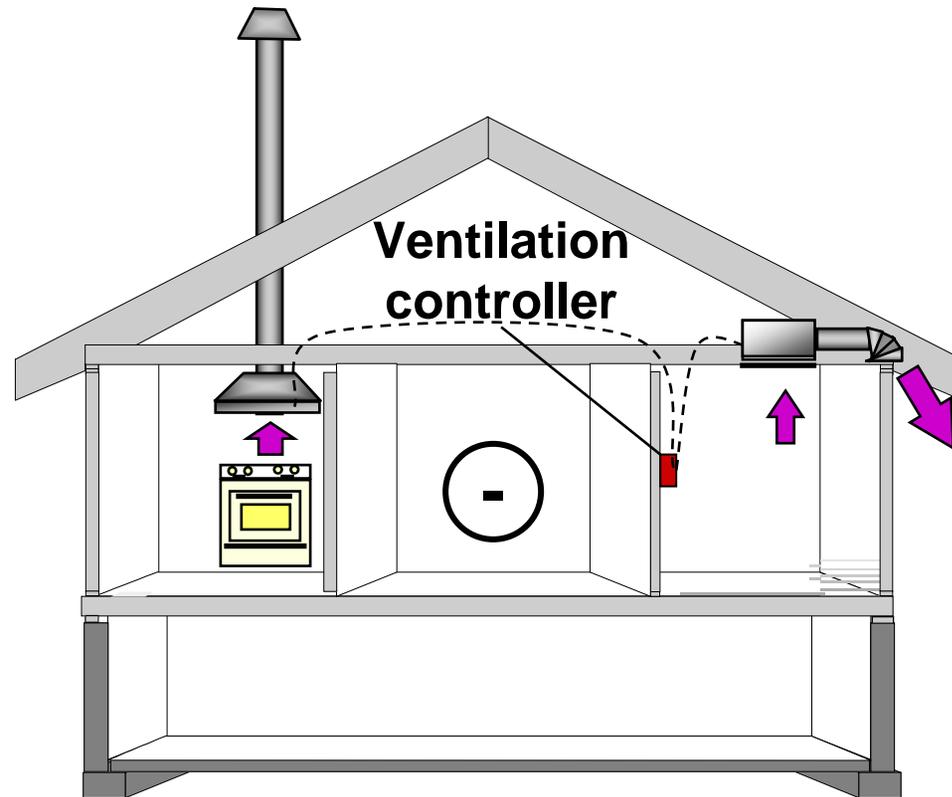
## Forced-Air Supply Ventilation



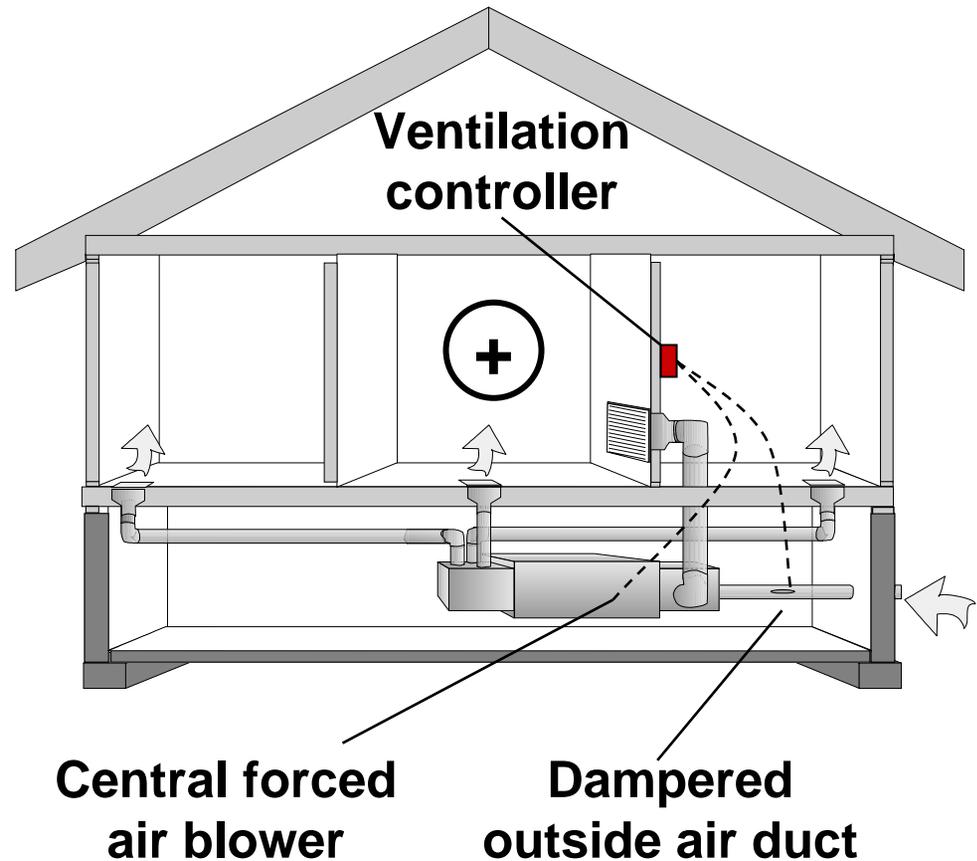
# Fresh, Make-Up Ventilation Air



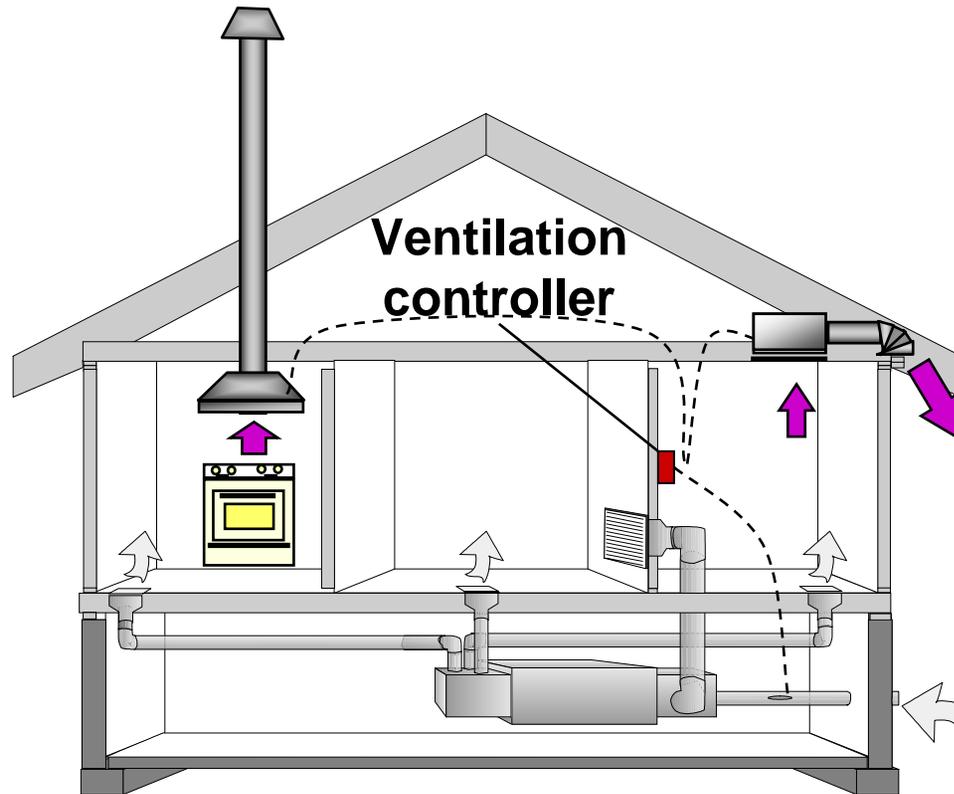
# Exhaust-Only Ventilation Using Spot Fans



# Supply-Only Ventilation



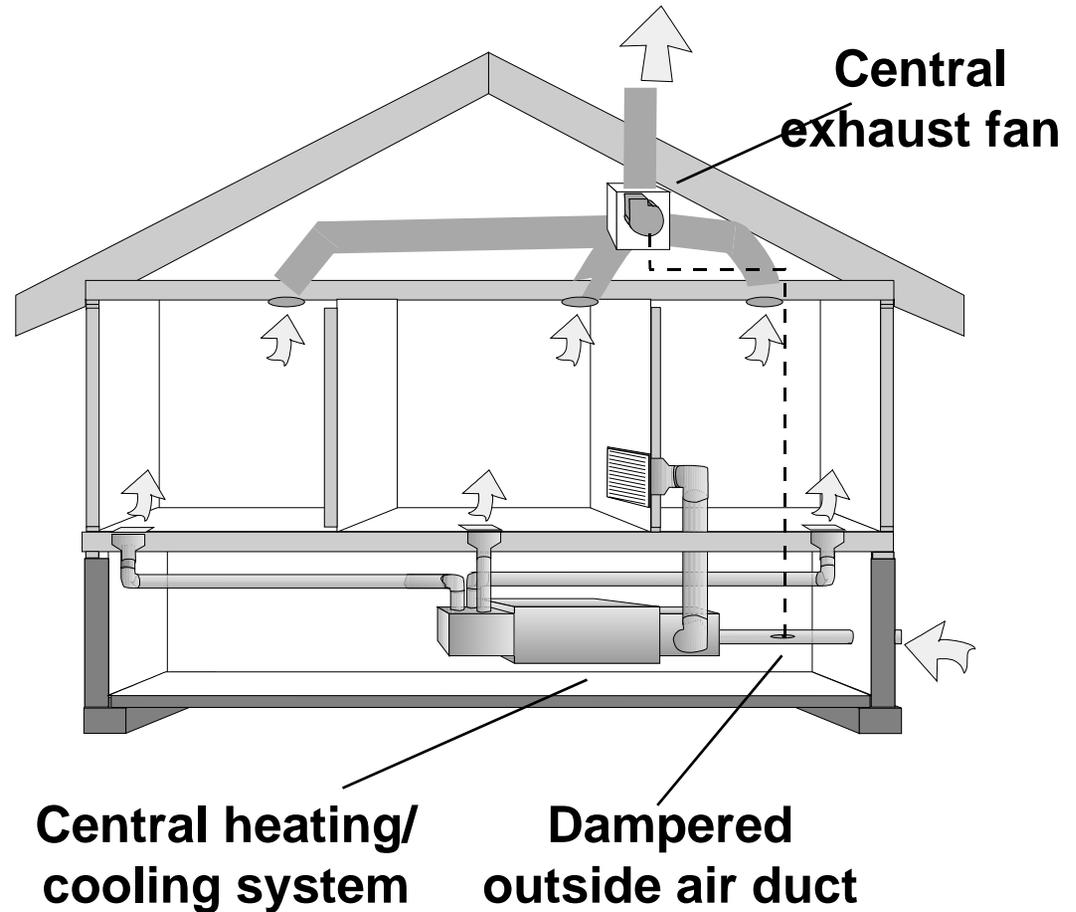
# Spot Fans with Make-Up Air



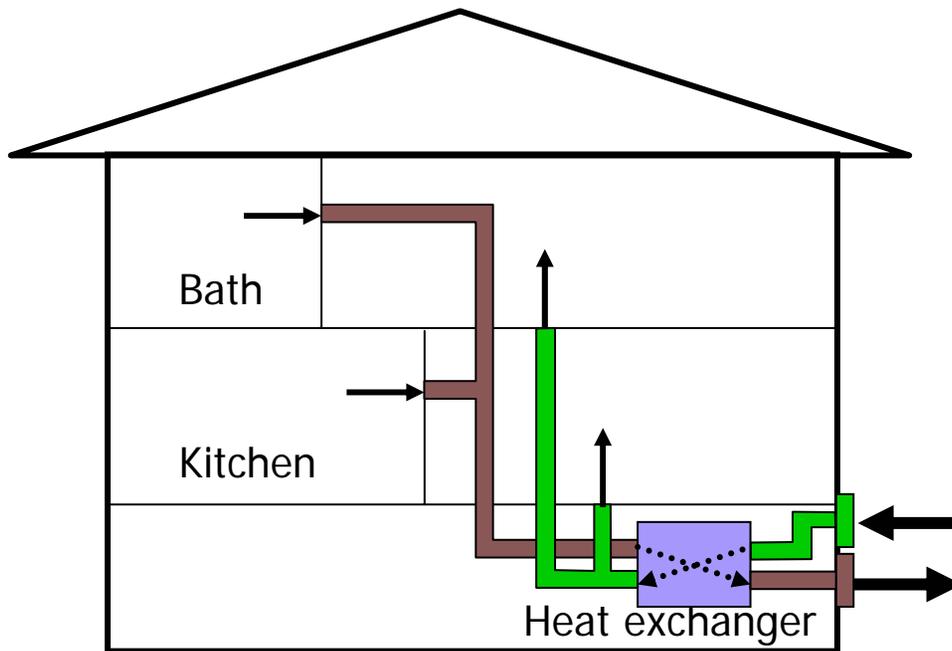
# Central Ventilation System



# Central Exhaust with Make-Up Air



# Heat Recovery Ventilation





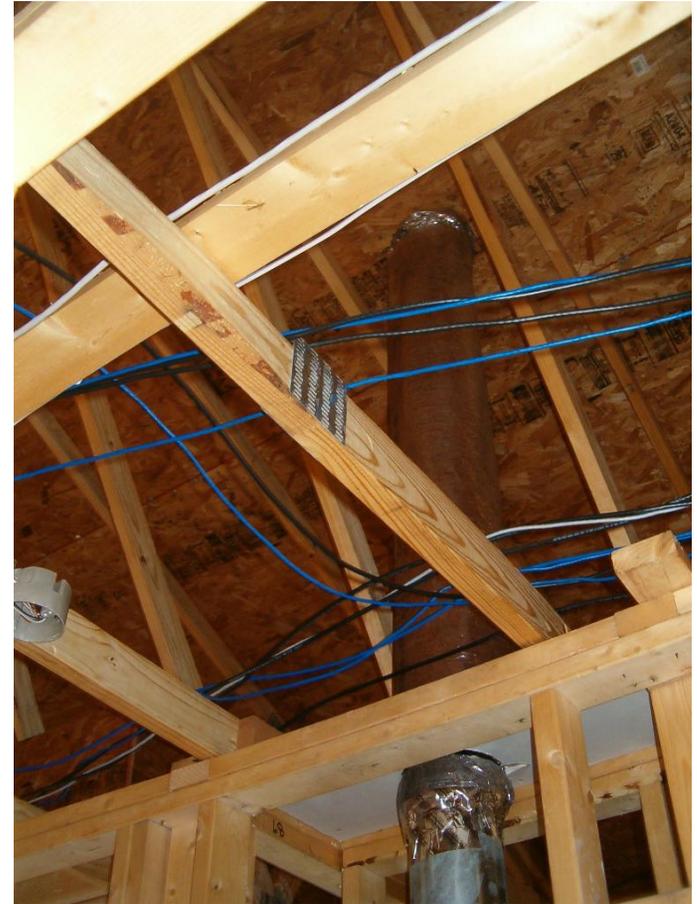
**Heat Recovery  
Ventilation**

**Heat Recovery  
Core**

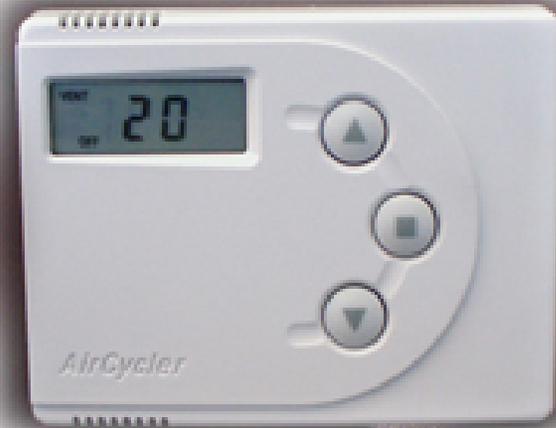
# High Performance Buildings Have Ventilation Systems



# North Carolina High Performance Affordable Homes Ventilation



# HVAC Fan Control



# Impact of Ventilation on Energy Costs (Raleigh --- \$/year)

	cfm of ventilation -- on 12 hours per day					
	no ventilation	25	50	100	150	200
heating	\$ 393	\$ 395	\$ 398	\$ 402	\$ 407	\$ 411
cooling	237	238	241	247	254	260
hot water	366	366	366	366	366	366
appliances	449	449	449	449	449	449
service charge	120	120	120	120	120	120
<b>total</b>	<b>\$ 1,565</b>	<b>\$ 1,568</b>	<b>\$ 1,574</b>	<b>\$ 1,584</b>	<b>\$ 1,596</b>	<b>\$ 1,606</b>
net change from none		\$ 3	\$ 9	\$ 19	\$ 31	\$ 41

## with Residential Ventilation

### Standards

- ◆ Part of State Building Code in a few states
- ◆ Energy Star Home Programs in some states
- ◆ Energy Star - IAQ
- ◆ LEED -- commercial and residential
- ◆ Green Building Programs
- ◆ High Performance Home Programs

# NC Statewide Residential Efficiency Program – A Partnership

- ◆ NC's Electric and Gas Utilities
- ◆ North Carolina Homebuilders Association and North Carolina's builders and contractors
- ◆ Certified Home Energy Raters
- ◆ Building Product Suppliers
- ◆ Advanced Energy Corporation
- ◆ North Carolina Solar Center
- ◆ Southface - North Carolina
- ◆ ASU Energy Center
- ◆ North Carolina State Energy



Greenville  
Utilities



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North Carolina **SolarCenter**



**ELECTRICITIES**



State Energy Office



[www.energync.net](http://www.energync.net) 1-800-662-7131

N.C. Department of Administration "Ensuring a sustainable energy future"



# Test for Results



**Air leakage – blower door**  
**Gauges for pressure problems**  
**Duct leakage – duct testing fan**  
**Ventilation system air flow**  
**You don't know 'til you test**

# Is This a Good Idea?



# Are vents helping?



# What is High Performance?

