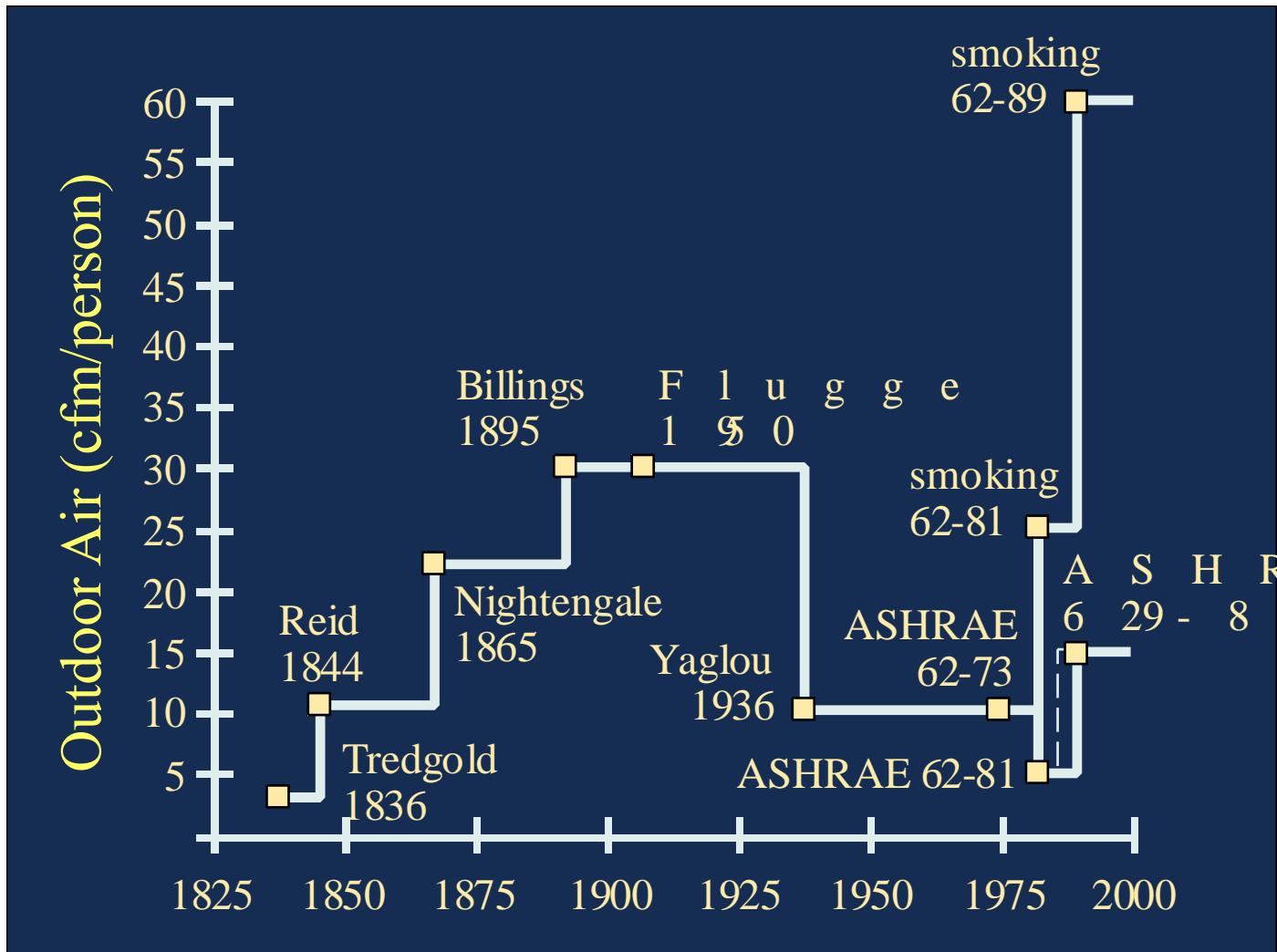


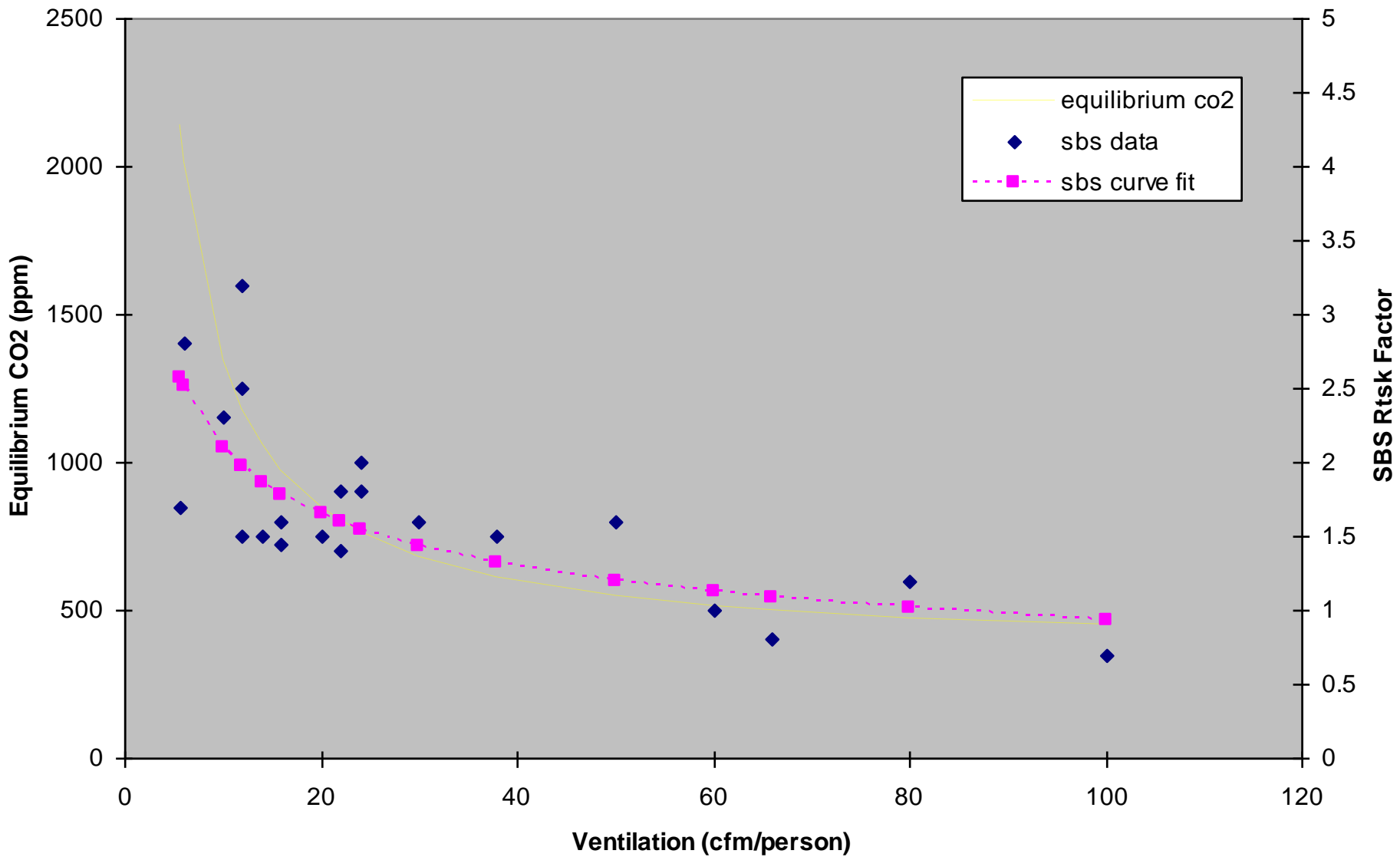


# Why ventilate?

- Dilute contaminants
- Control or aggravate humidity
- Comfort or lack of cooling
- Odors
- Provide oxygen

# History of Minimum Ventilation Recommendations

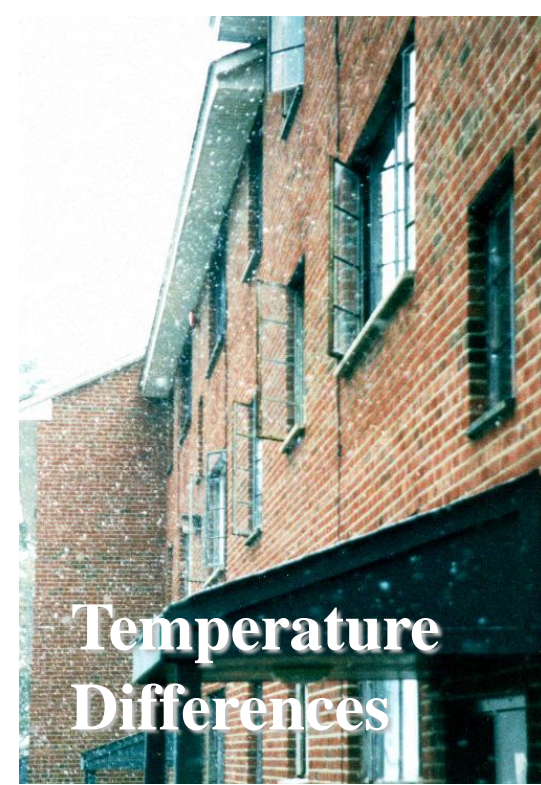




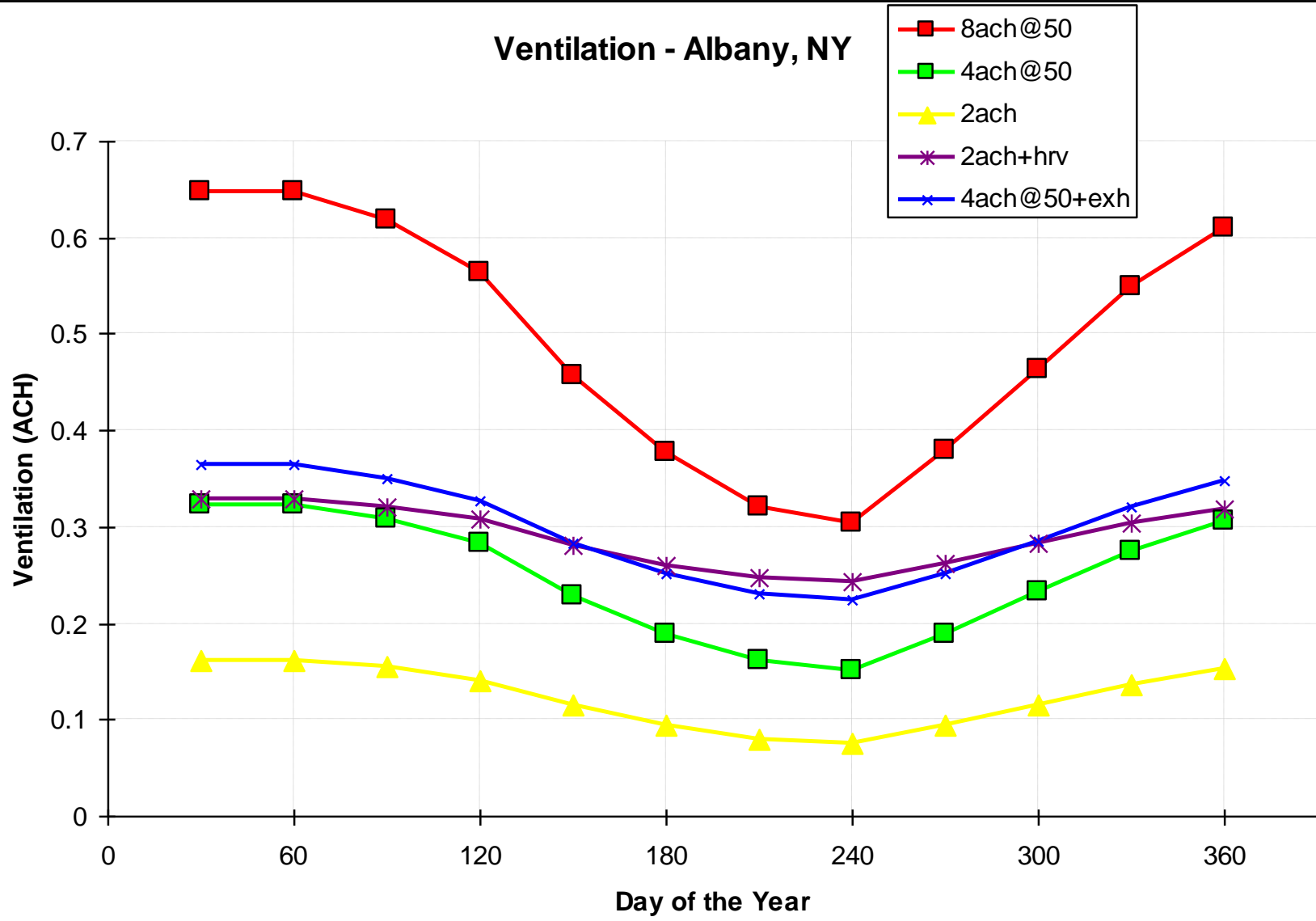
Sick Building Syndrome data from Jan Sundell Swedish Office Building Study



# What Powers air flows?



### Ventilation - Albany, NY



# Does it all work?

- Dilution ventilation system:
  - Central exhaust
  - OA to return of AHU
  - HRV/ERV
- Local exhaust:
  - Bathrooms
  - kitchen
- Combustion devices
- Clothes dryers

# Does It Work? Local exhaust and dilution ventilation

- What speed?
- Fan flows
- Sound levels
- Pressure drop across the fan
- Watts
- Pressure map house?
  - Indoors-outdoors for each mode?
  - CAZ





# More than a Fan

- Exhaust vent point sources to the outside
  - Kitchen, bathroom, dryers (except condensing dryers), combustion devices, laundries
- Provide dilution ventilation
  - Exhaust, supply, both
- Effective distribution
  - Central air handlers?
  - Baseboard or radiant heat?
- Air seal enclosure
  - 1.25 in<sup>2</sup> per 100 ft<sup>2</sup> enclosure
- Multi-family issues

# Getting a good ventilation system

- Design
  - Spot exhaust
  - Dilution ventilation and distribution
  - Airtightness of enclosure and ductwork
  - Filtration – recirc/outdoor air
- Construction
  - Kickoff meeting
  - inspections
- Verification
  - Duct leakage test and blower door test
  - TAB

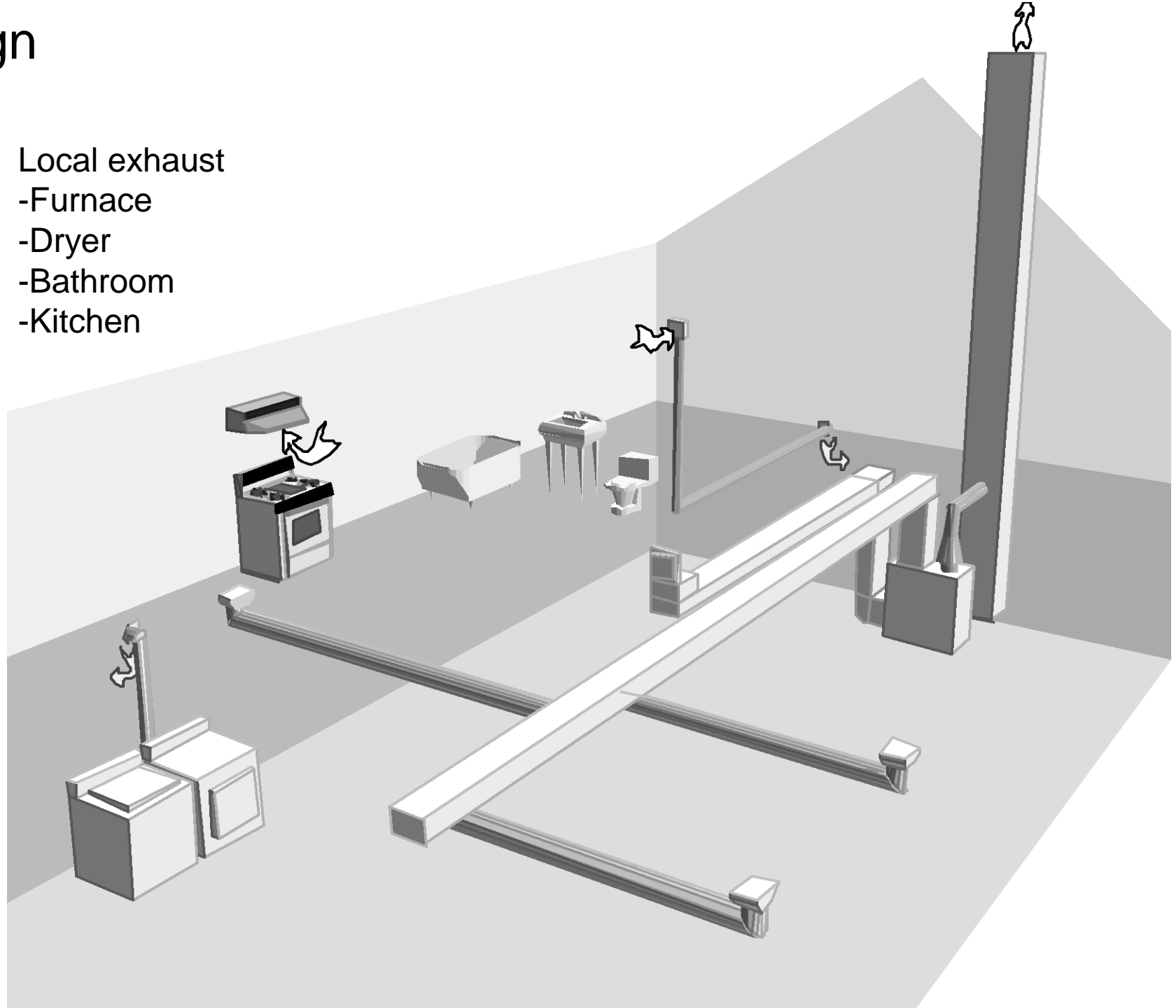
## Ventilation Standards and Codes?

- IRC, IMC 2003
  - 4 ft<sup>2</sup> window/100ft<sup>2</sup> or 0.35 ach (not less than 15 cfm/person) mechanical
  - Bath 1.5 ft<sup>2</sup> window(1/2 operable) or 50 cfm intermittent or 20 cfm continuous exhaust to outside
  - Kitchens 100 cfm intermittent, 25cfm continuous
  - Dryer must exhaust
- ASHRAE 62.2 2003 Residential Buildings
  - 7.5 cfm/person+1cfm/100sq.ft. fan powered
    - assumes additional 2cfm/100ft<sup>2</sup> infiltration
    - <4500 infiltration degree day exclusion
  - Exhaust: Intermittent 100cfm kitchen, 50 cfm bath, or continuous 5 ach kitchen , 20 cfm bath (continuous exhaust fans can be used to meet the dilution requirement)
  - Dryer must exhaust; range hood required if flow less than 5 ach
  - Some noise and installation requirements

# Design

Local exhaust

- Furnace
- Dryer
- Bathroom
- Kitchen



# Design

**Furnaces, boilers, solid fuel stoves, gas and oil hot water heaters all are exhaust vented to prevent combustion products from spreading throughout the house.**





Design



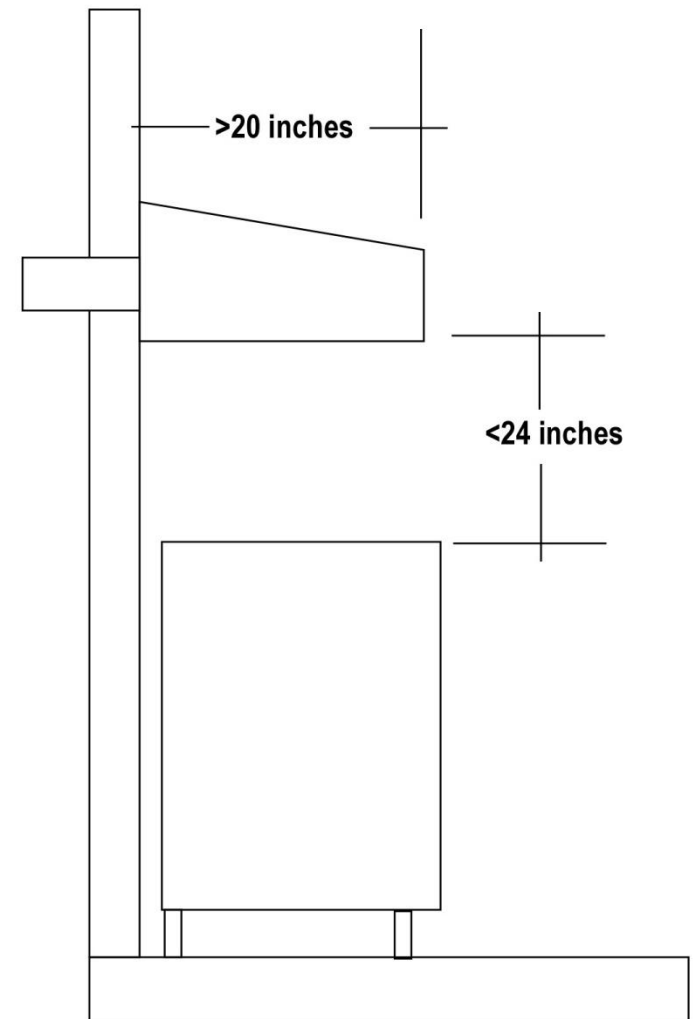
# Design



# Design



40 - 100 cfm per foot of range top





# Design



## Recommendations for Bathroom Exhaust

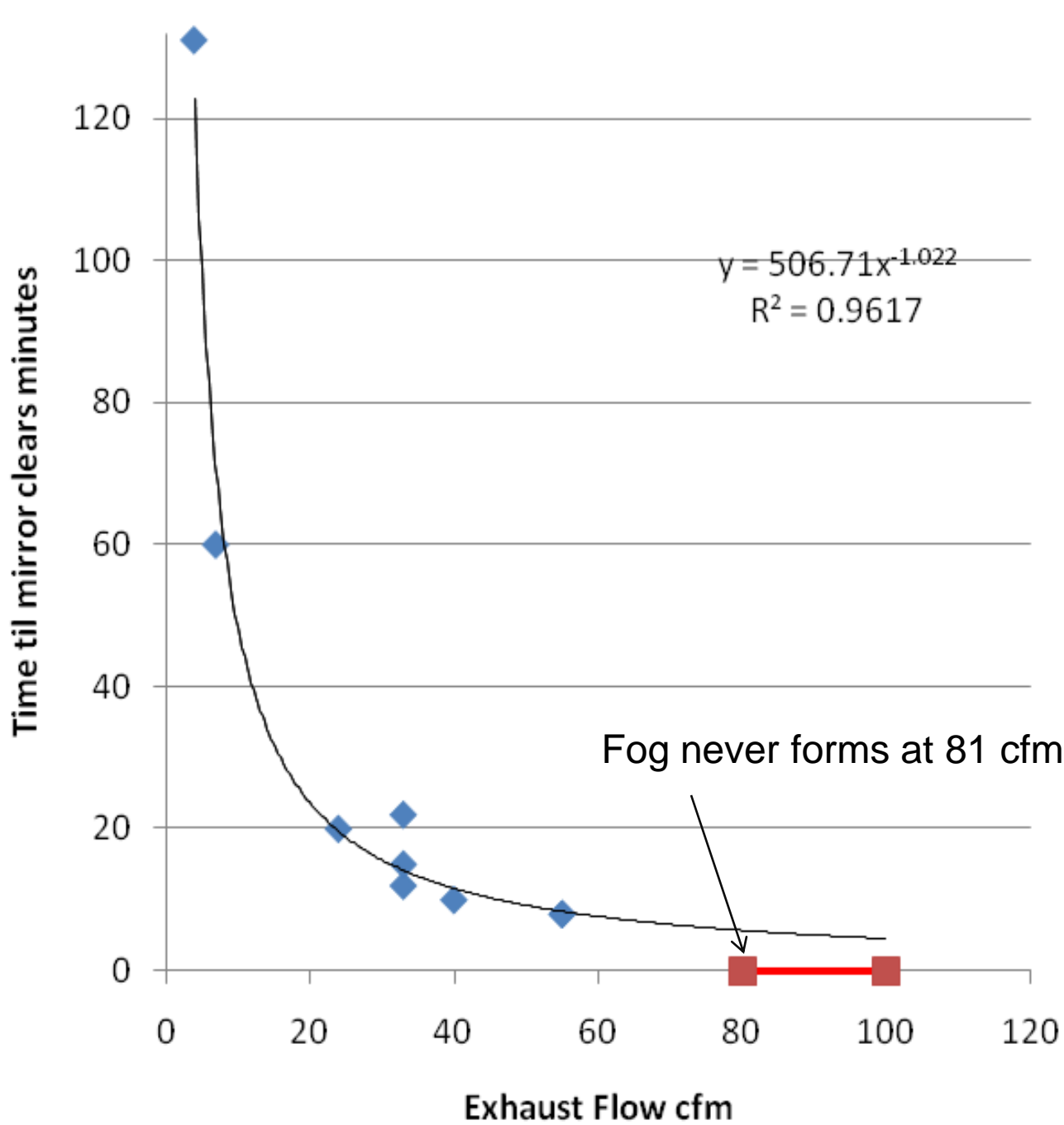
- Grille within 6 inches of ceiling
- 20 cfm continuous
- 80 cfm boost controlled by motion sensor  
(light switch or timer switch ok)



Design



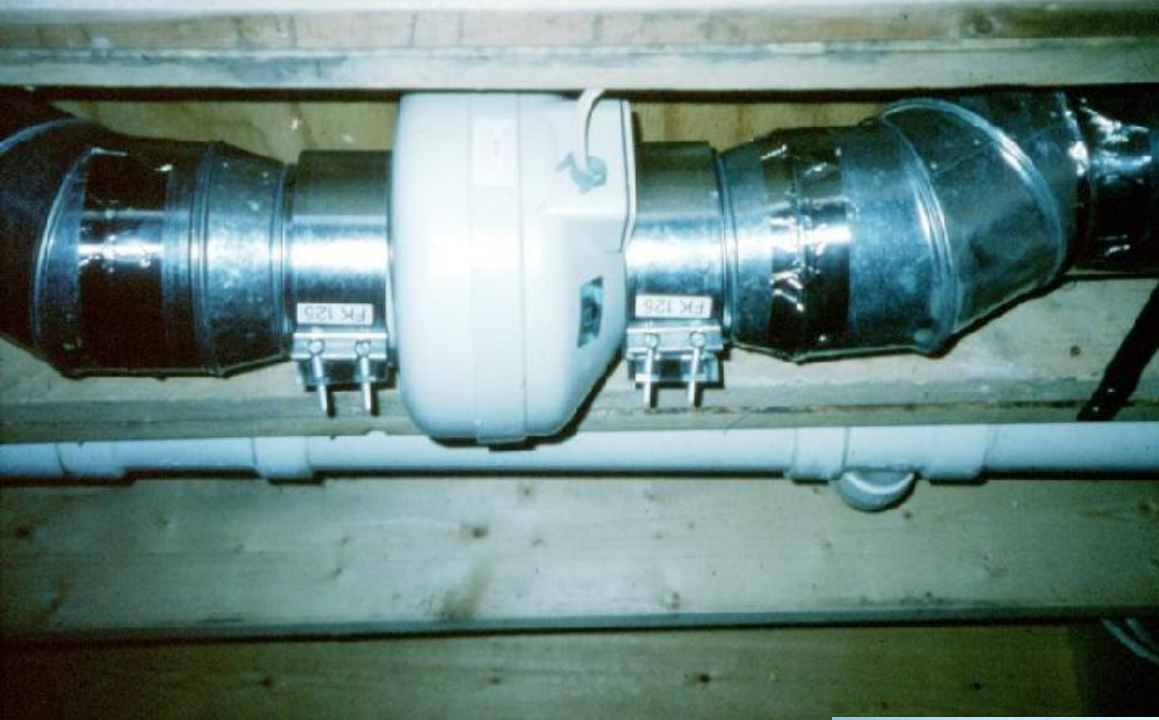
# Design





Design



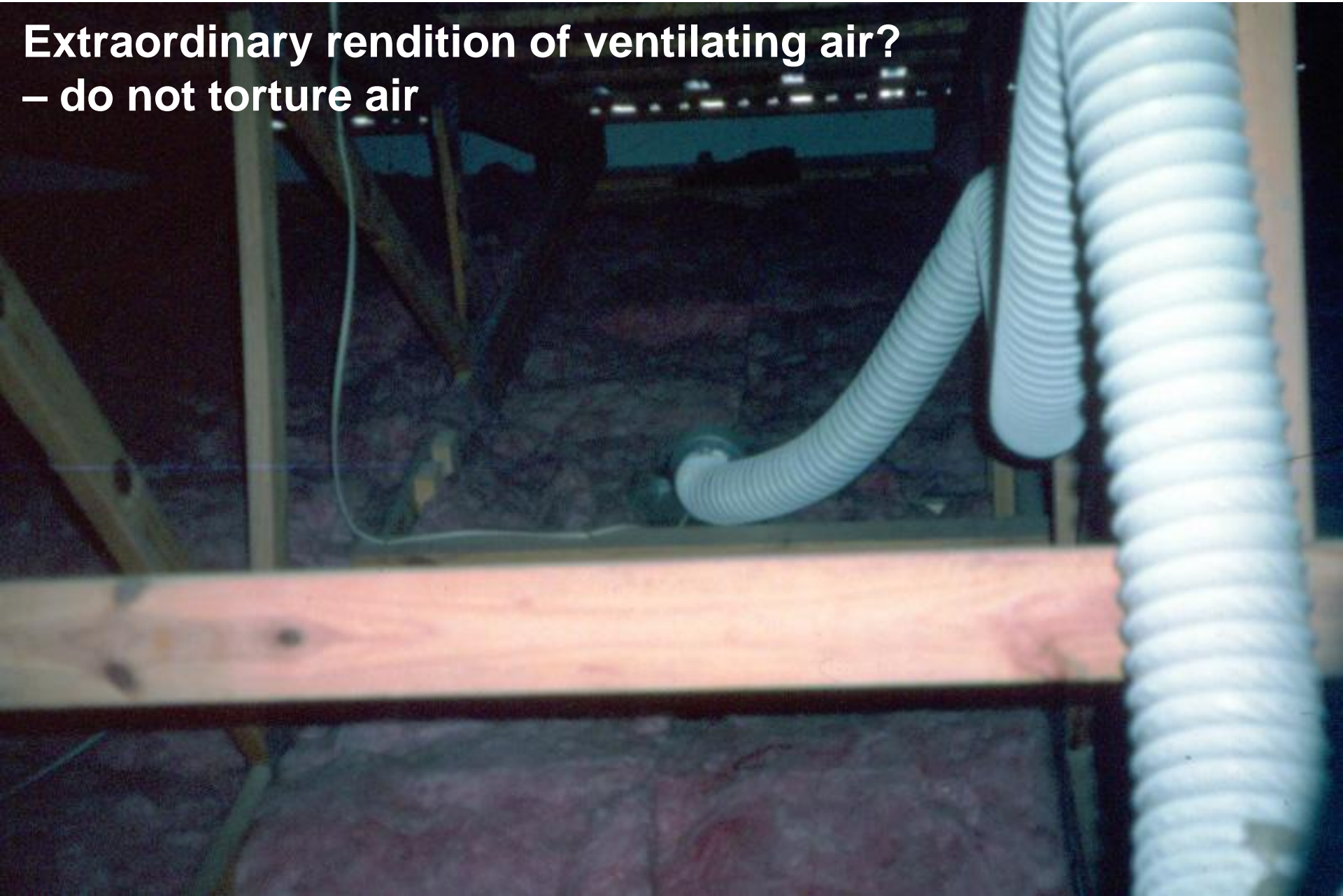


**Exhaust fan in  
basement,  
vented through  
rim joist fitting**





**Extraordinary rendition of ventilating air?  
– do not torture air**





Paul & Emily King  
PAID







**Worse installation**





**Is it working?**



**Is it the right amount?**

# CHECKING EXHAUST AIR VOLUMES

- Flowhood
  - Must be capable of measuring air volumes below 50 cfm
- Anemometer
  - Find the average air velocity in FPM
  - Multiple by the free-vent area of grille in sq. ft.
  - Gives volume in cubic feet per minute



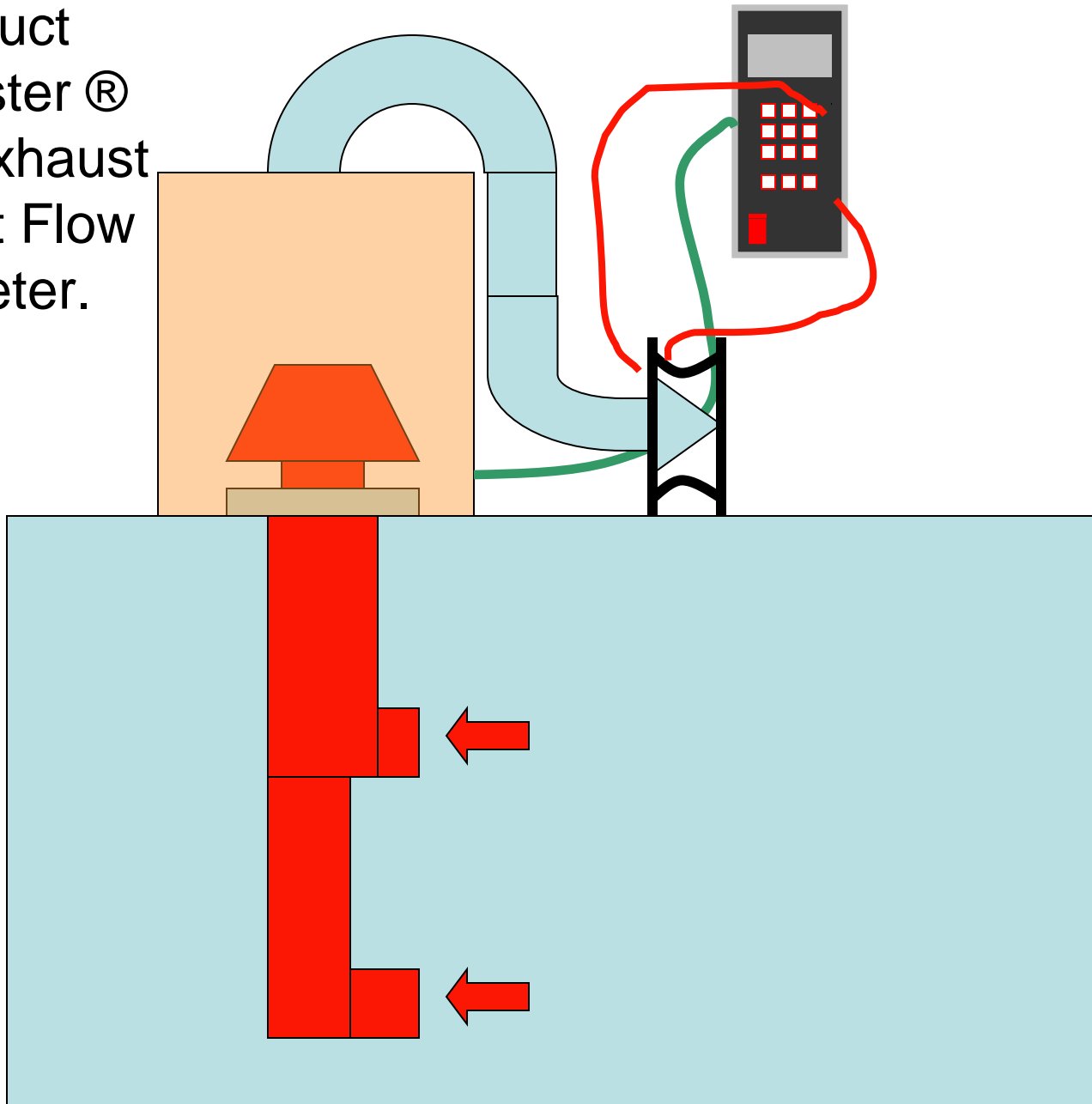




IRIS 100

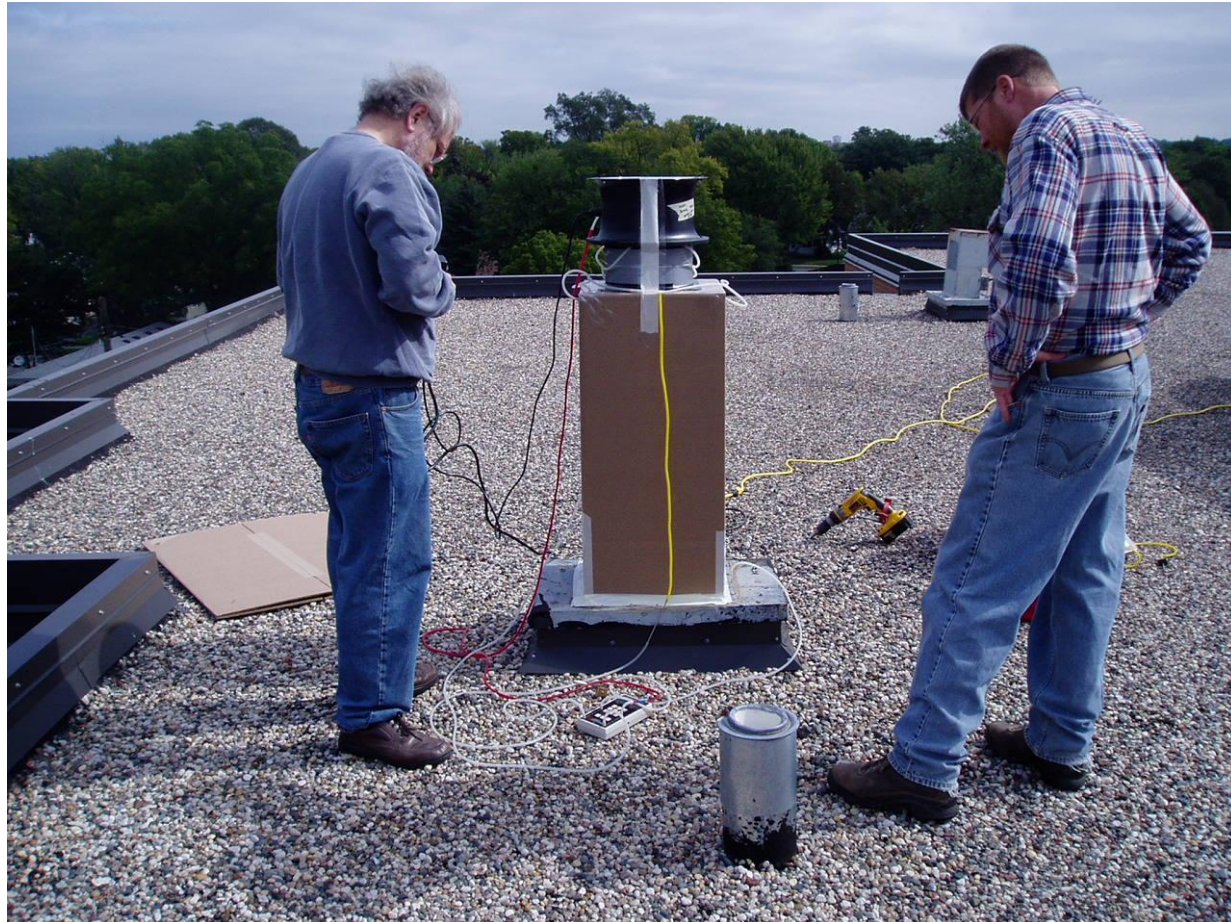


Duct  
Blaster<sup>®</sup>  
as Exhaust  
Vent Flow  
Meter.





# Duct Blaster ® as Exhaust Vent Flow Meter.



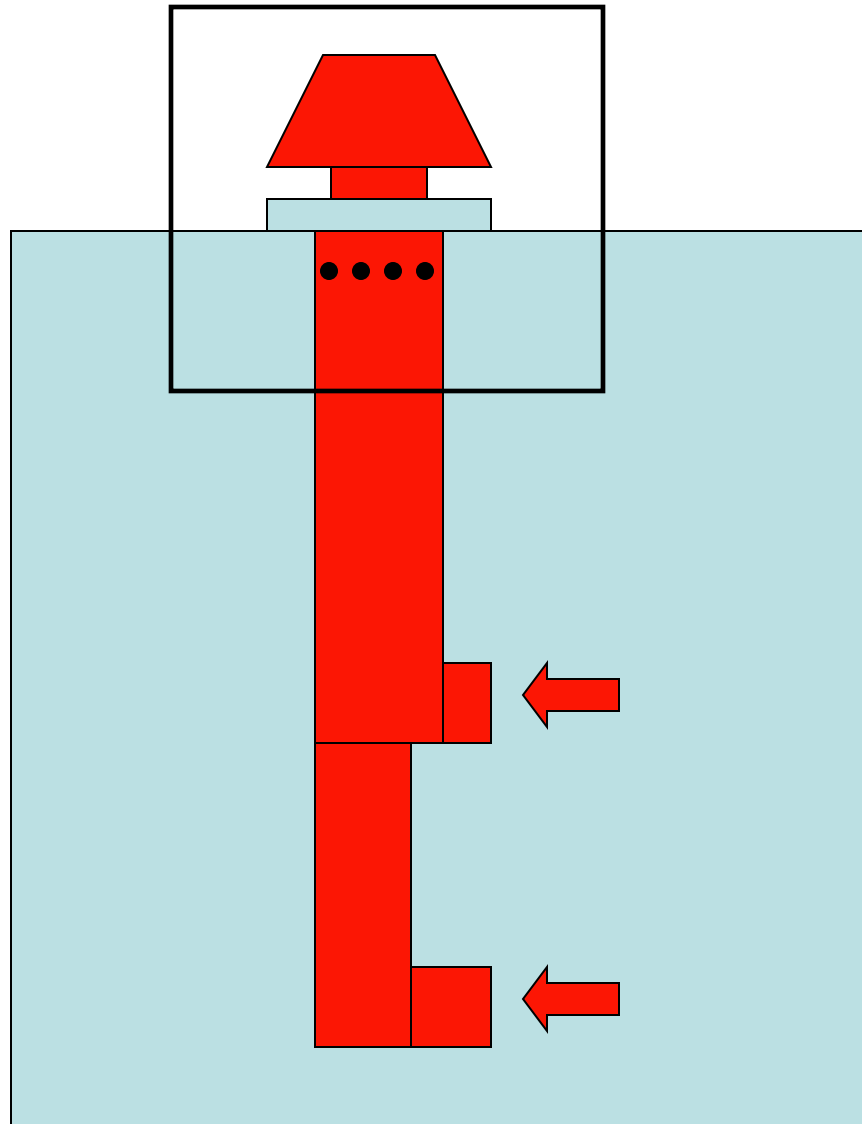


# Duct Blaster ® as Exhaust Vent Flow Meter.

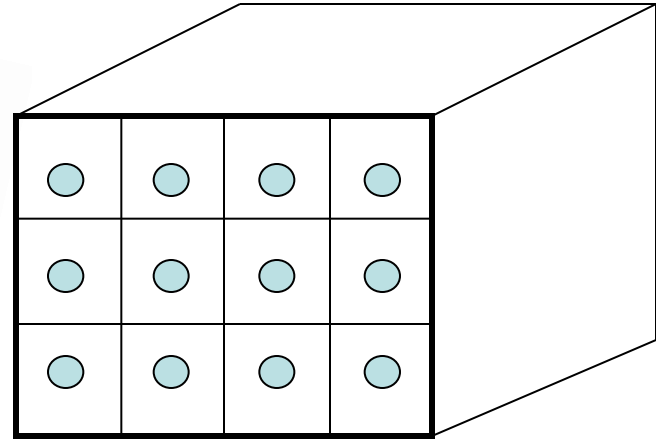
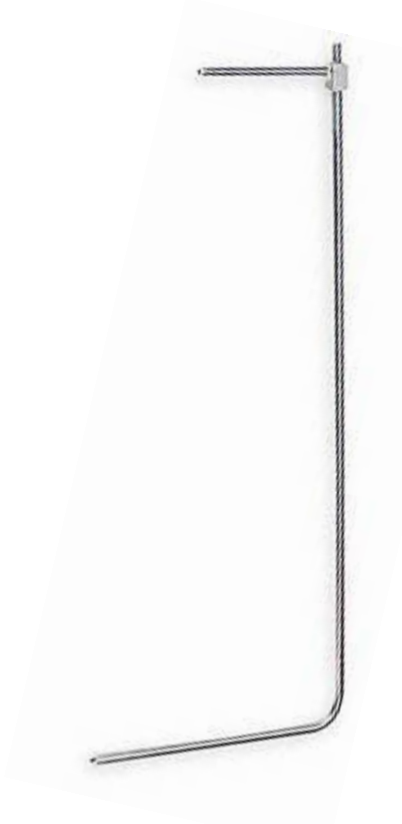
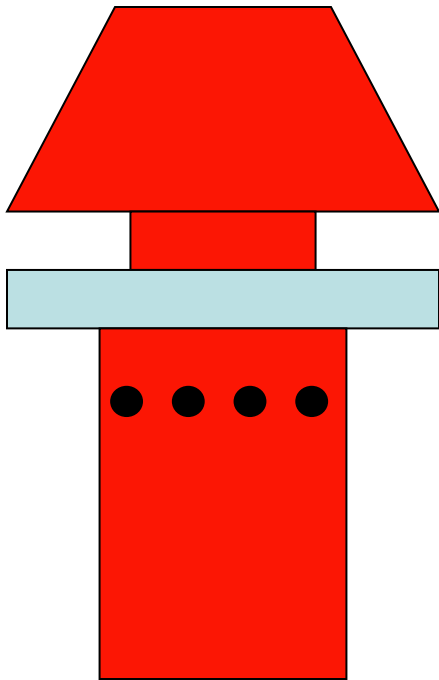




# Traverse velocity measurements.



# Traverse velocity measurements.



Velocity less at edges

No more than 6 inches o.c. at points of equal area.

8 duct dia. down stream

2 duct dia. up stream from elbow or transition/

[http://www.bnl.gov/esh/shsd/SOP/pdf/IH\\_SOPS/IH62470.pdf](http://www.bnl.gov/esh/shsd/SOP/pdf/IH_SOPS/IH62470.pdf)

# More than a Fan



- Exhaust vent point sources to the outside
  - Kitchen, bathroom, dryers (except condensing dryers), combustion devices, laundries
- Provide dilution ventilation
  - Exhaust, supply, both
- Effective distribution
  - Central air handlers?
  - Baseboard or radiant heat?
- Air seal enclosure
  - 1.25 in<sup>2</sup> per 100 ft<sup>2</sup> enclosure
- Multi-family issues

# Distribution

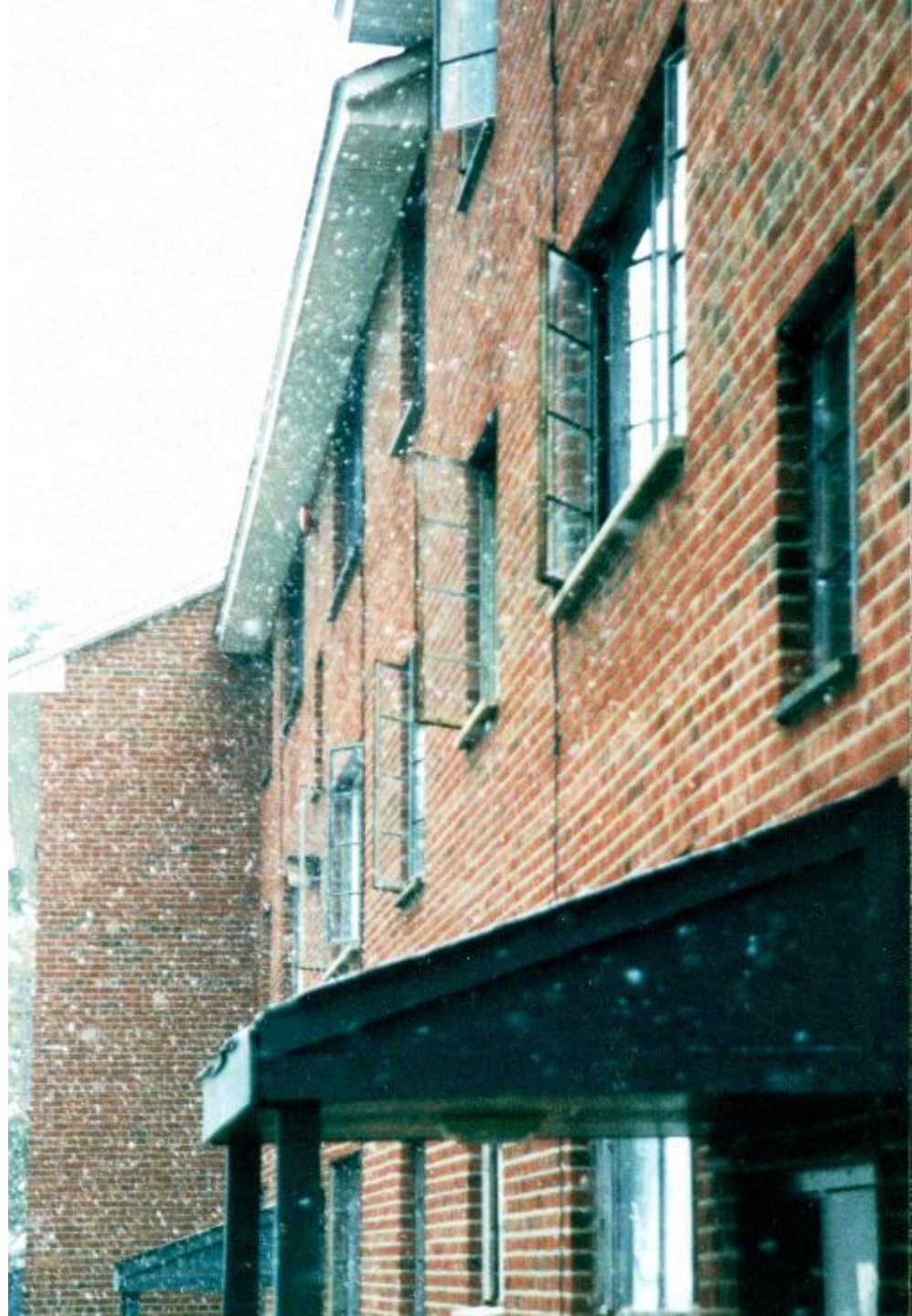
- If ventilation was ducted to our mouths we'd only need  $\frac{1}{4}$  cfm per person (the amount of air a person breathes)
- But ventilation air must keep all the air in a home fit to breath
- Features that produce good distribution:
  - Outdoor air ducted to many rooms
  - House air exhausted from many rooms
  - A central air handler that runs 10 minutes in each hour in combination with a ventilation system
  - Be certain bedrooms get good ventilation



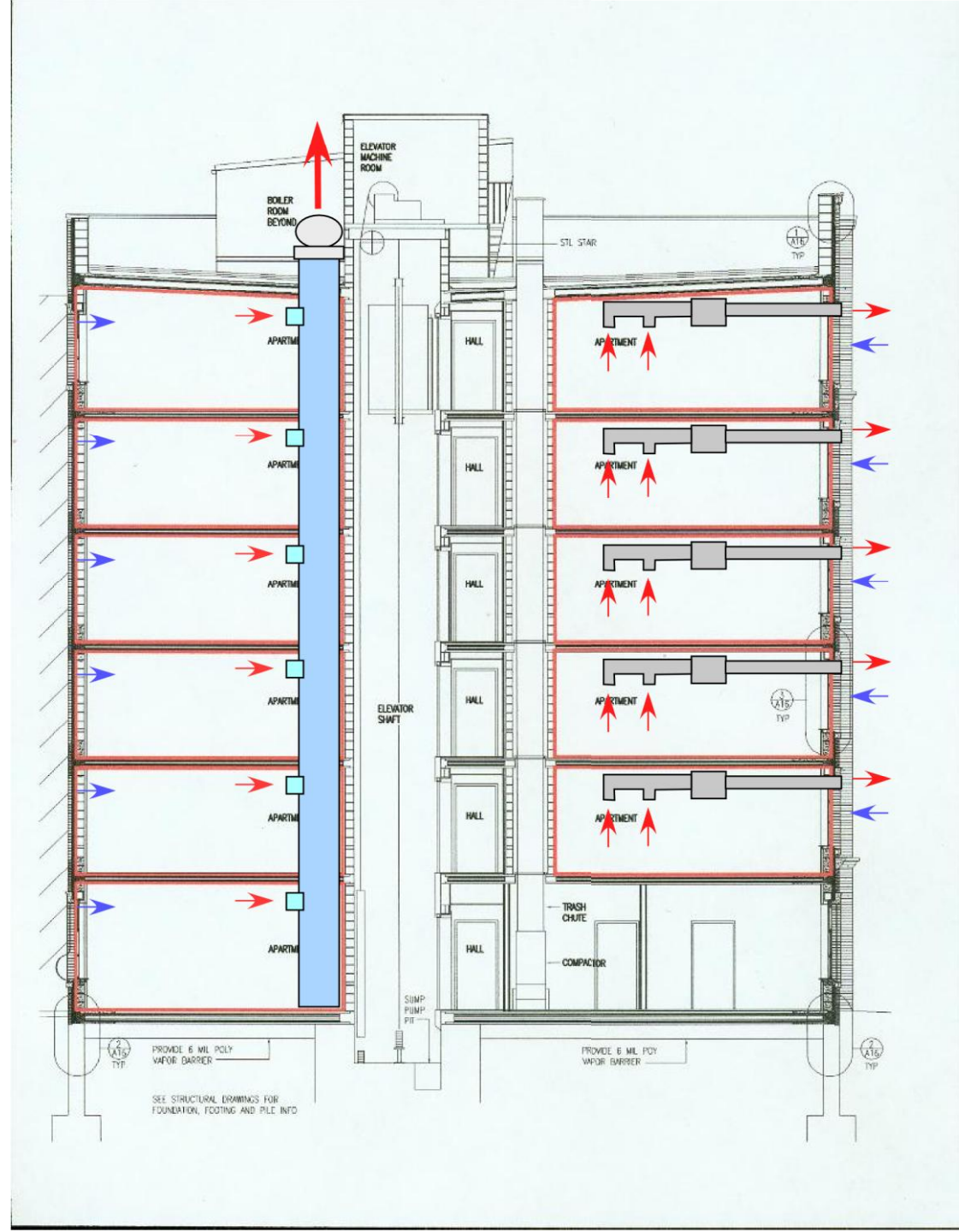
# Distributed exhaust







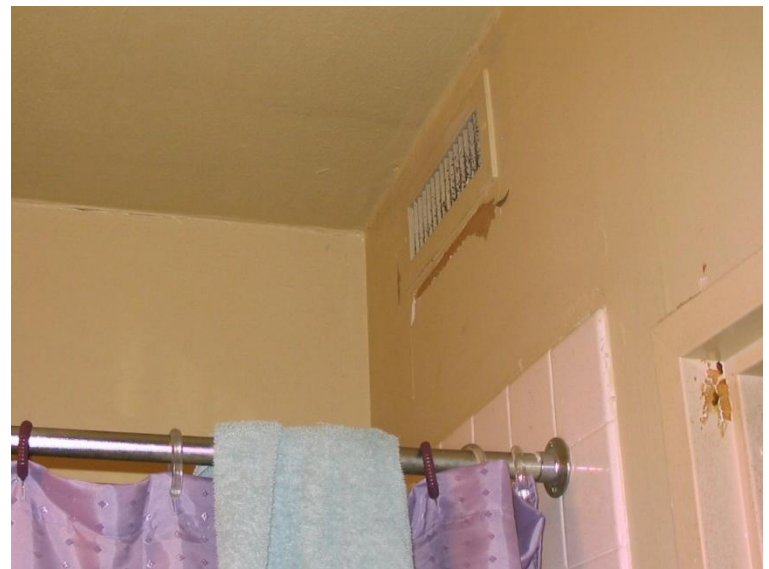
- **Compartmentalize**
- **Provide exhaust** for baths and kitchens
- **Stack effect** in cold climates





# Exhaust System Components

- Grilles in apartments or corridors
  - Bathrooms
  - Kitchens
- Mushroom fans on roofs









# Leakage at Sheetrock Connection



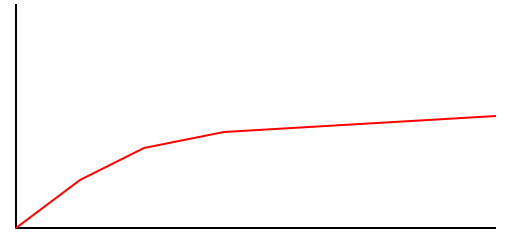
# Leakage at Roof Curb



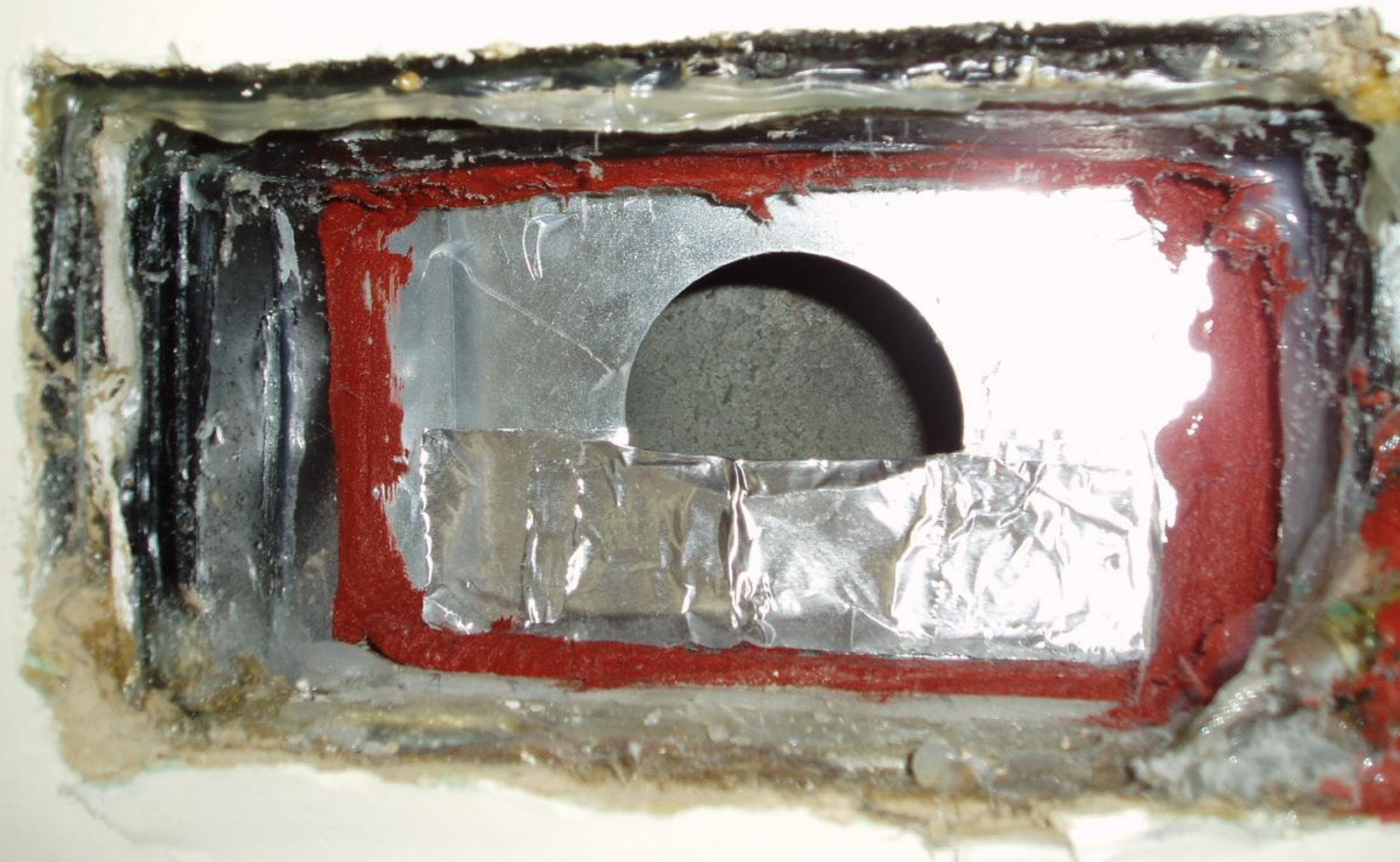


flow

pressure



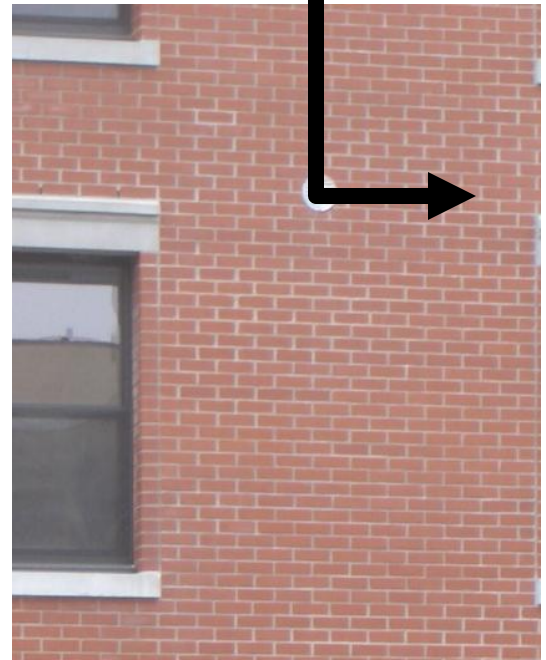






Multi-family ventilation issues

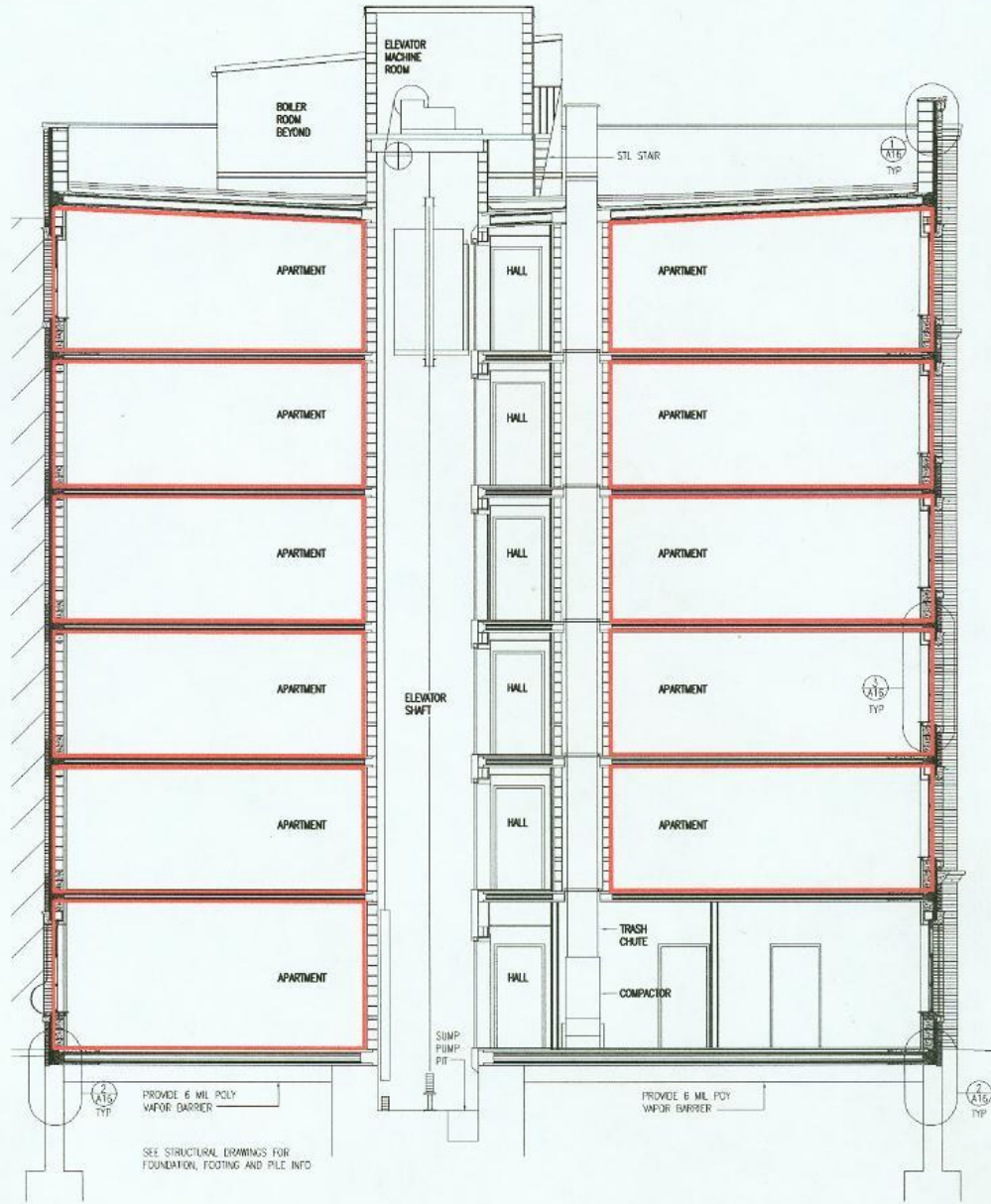




- Each unit airsealed to 1.25 in<sup>2</sup> per 100 ft<sup>2</sup> enclosure
- No transfer to neighbors when system's on
- 4% transfer when one unit turned off
- 1-3% exhaust re-enters through trickle vents worst case







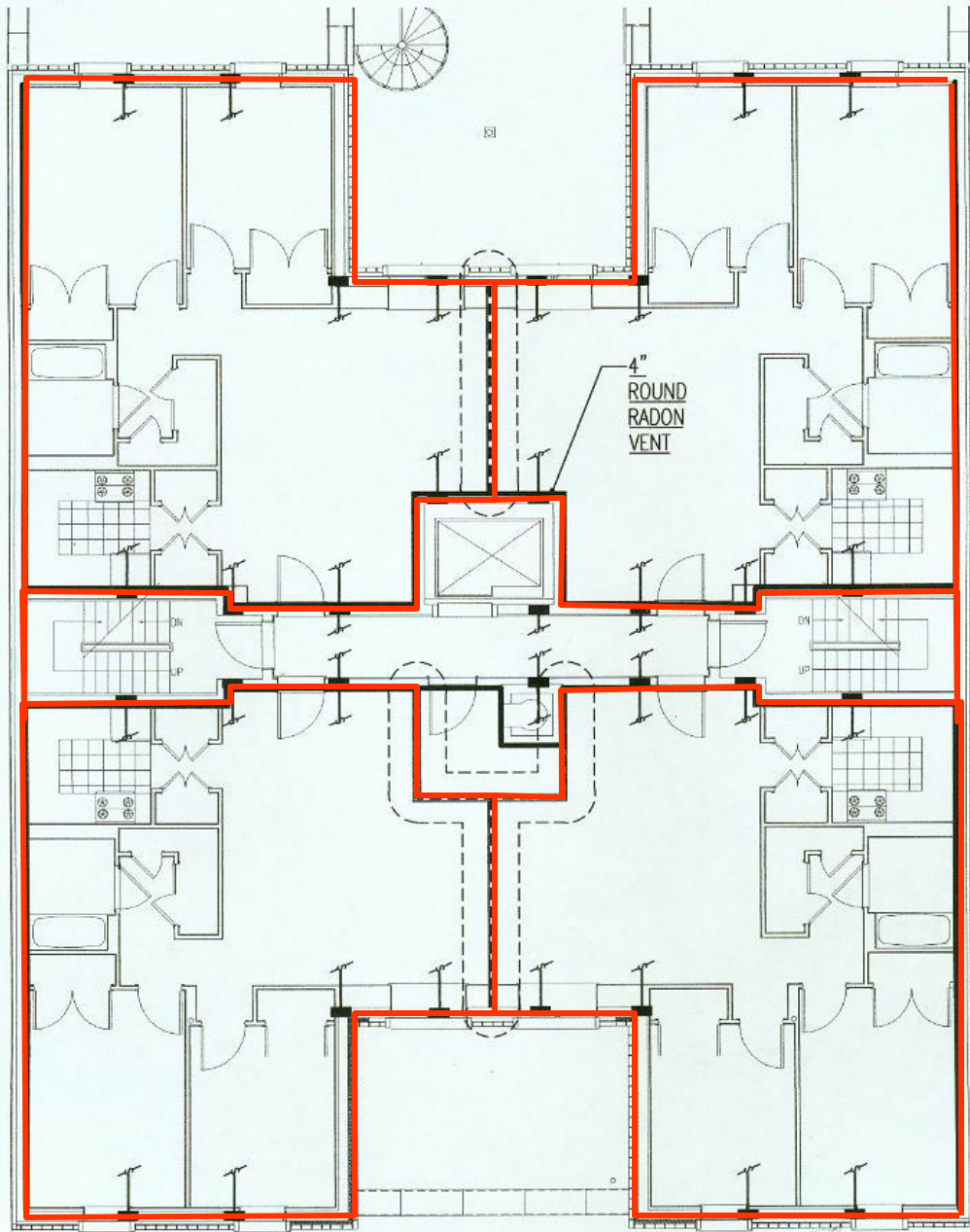
$\frac{1}{4}$ " = 1'-0"  
 TYP

PROVIDE 6 MIL POLY VAPOUR BARRIER

SEE STRUCTURAL DRAWINGS FOR FOUNDATION, FOOTING AND PILE INFO

PROVIDE 6 MIL POLY VAPOUR BARRIER

$\frac{1}{4}$ " = 1'-0"  
 TYP



② SECOND THROUGH SIXTH FLOOR PLAN

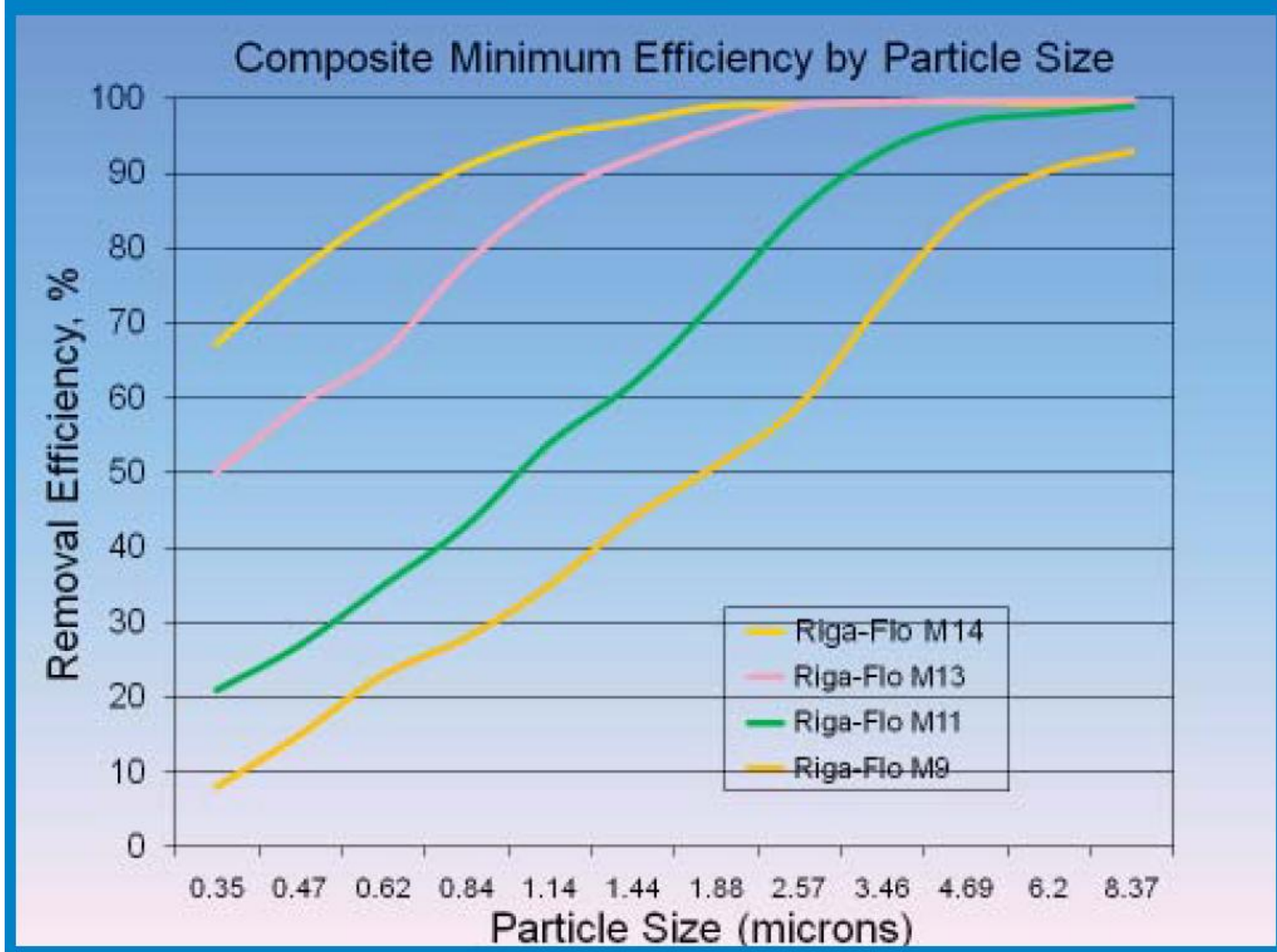




# Tightness Specifications

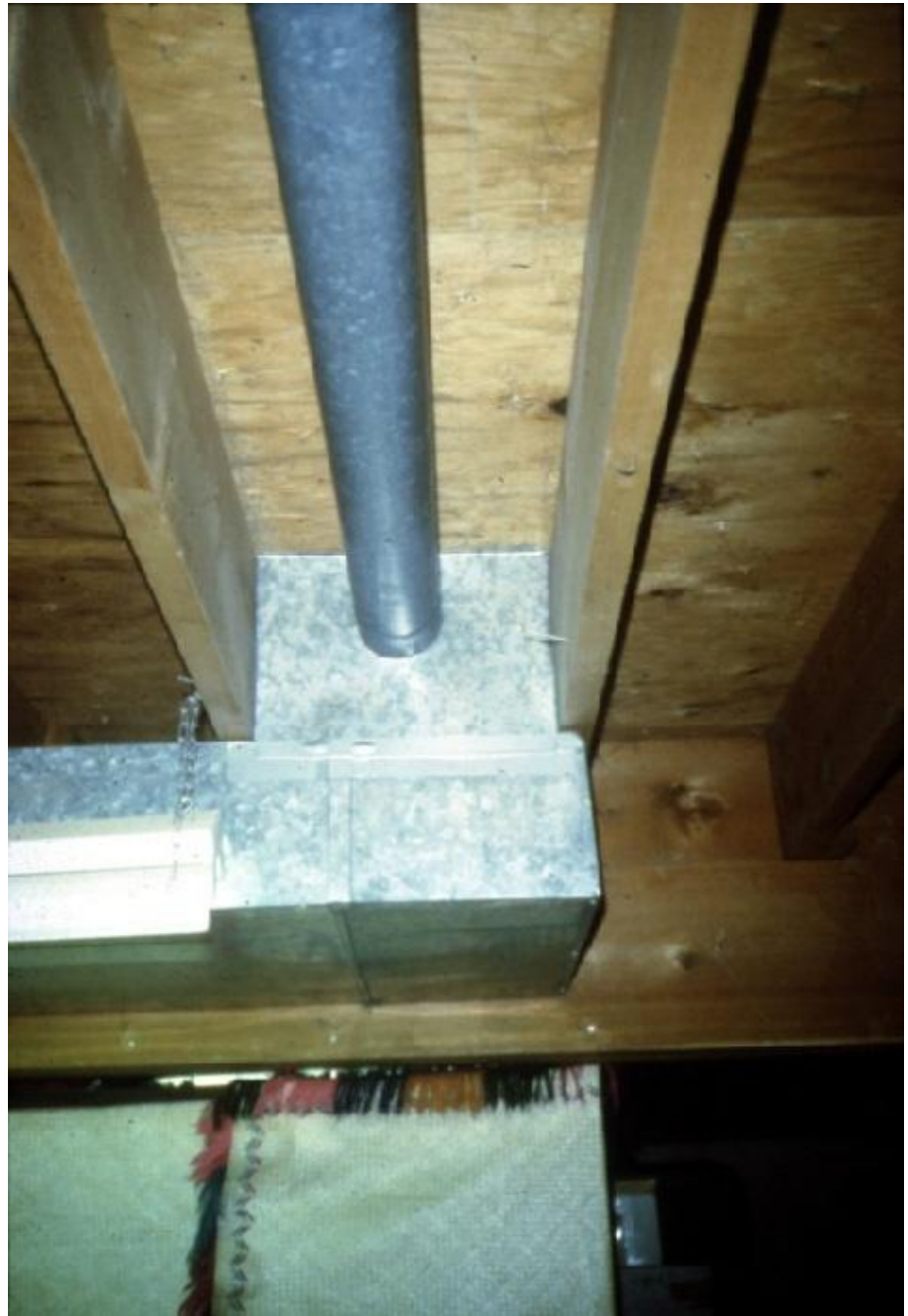
- 0.3 cfm50/ft<sup>2</sup> enclosure – Energystar High Rise Multi & ASHRAE
- 0.1 cfm50/ft<sup>2</sup> to be certain about tobacco smoke transport





Values are Minimum Efficiency Reporting Values (MERV) when evaluated per ASHRAE Standard 52.2.







Outdoor air ducted to the return side of an air handler provides good distribution







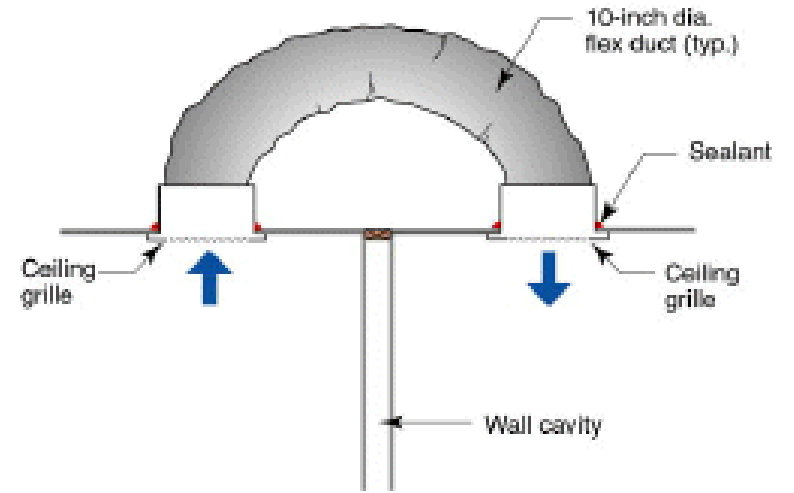








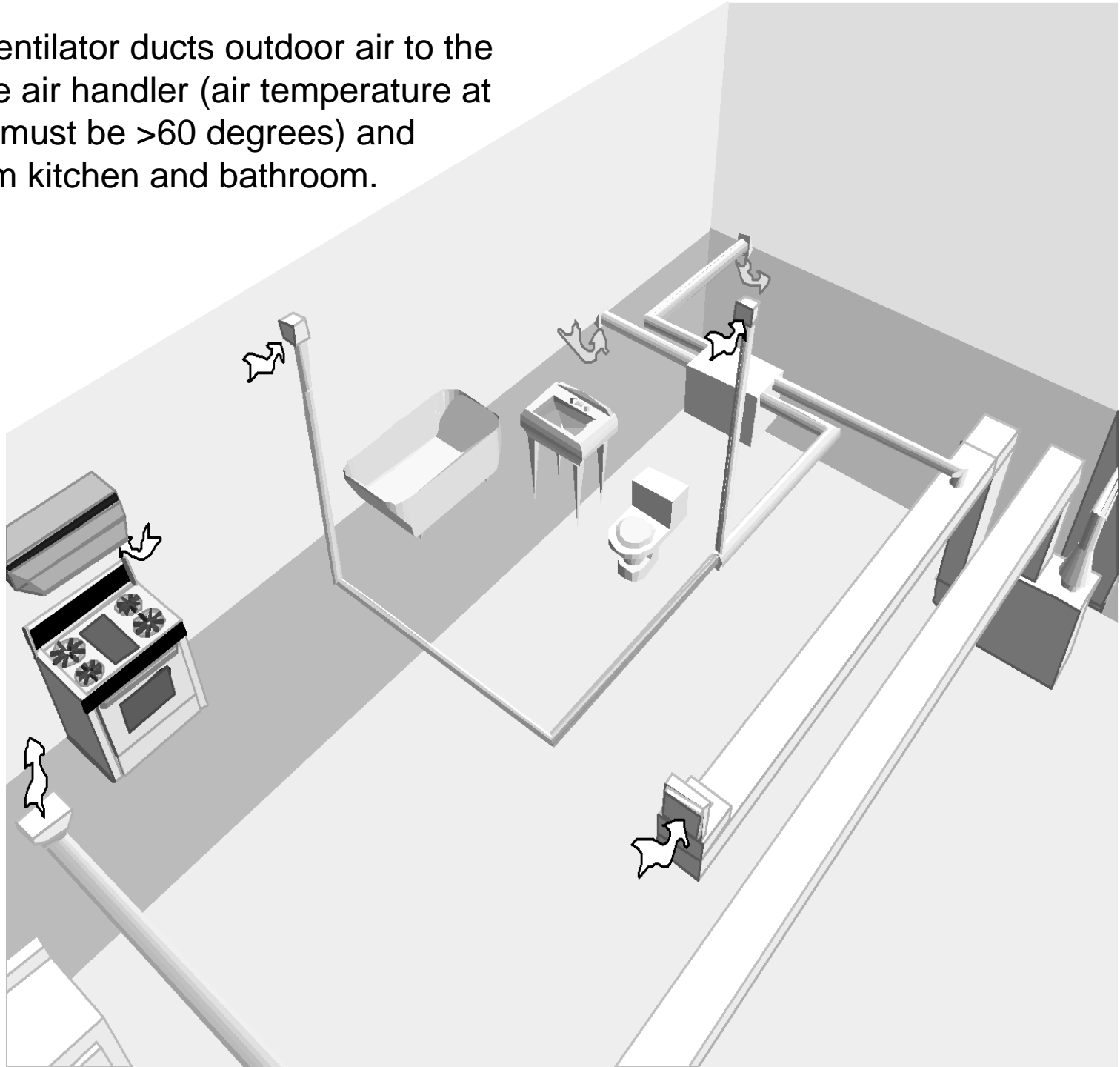




Transfer across  
closed doors



Heat recovery ventilator ducts outdoor air to the return side of the air handler (air temperature at heat exchanger must be  $>60$  degrees) and exhausts air from kitchen and bathroom.







**Balanced ventilation systems provide good distribution (unless the exhaust and outdoor air are both ducted to a furnace distribution system)**





BOTTOM OF UNIT  
BAS DE L'UNITÉ



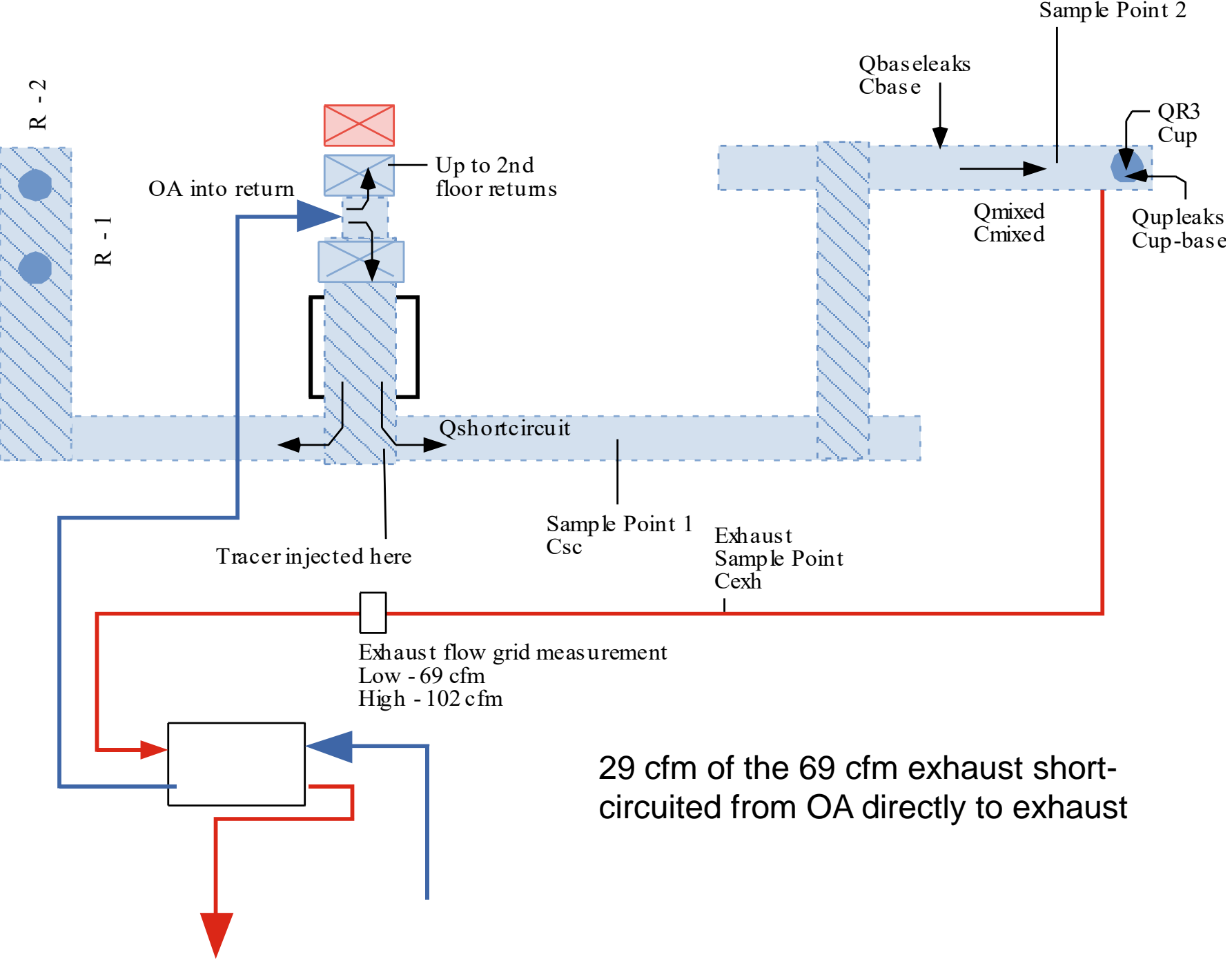


**Integrated space heating, heat recovery ventilation and hot water heating**



# Effective HRV/ERV Layout

- Locate supplies where they won't blow on someone (e.g. bedroom closets, across ceiling)
- Locate exhausts in bathrooms, laundries and general kitchen area (strongest moisture and contaminant sources)
- Use dedicated ductwork for at least the supply or exhaust (don't use furnace or AC ducts for both supply and exhaust – no matter how far apart you put them)

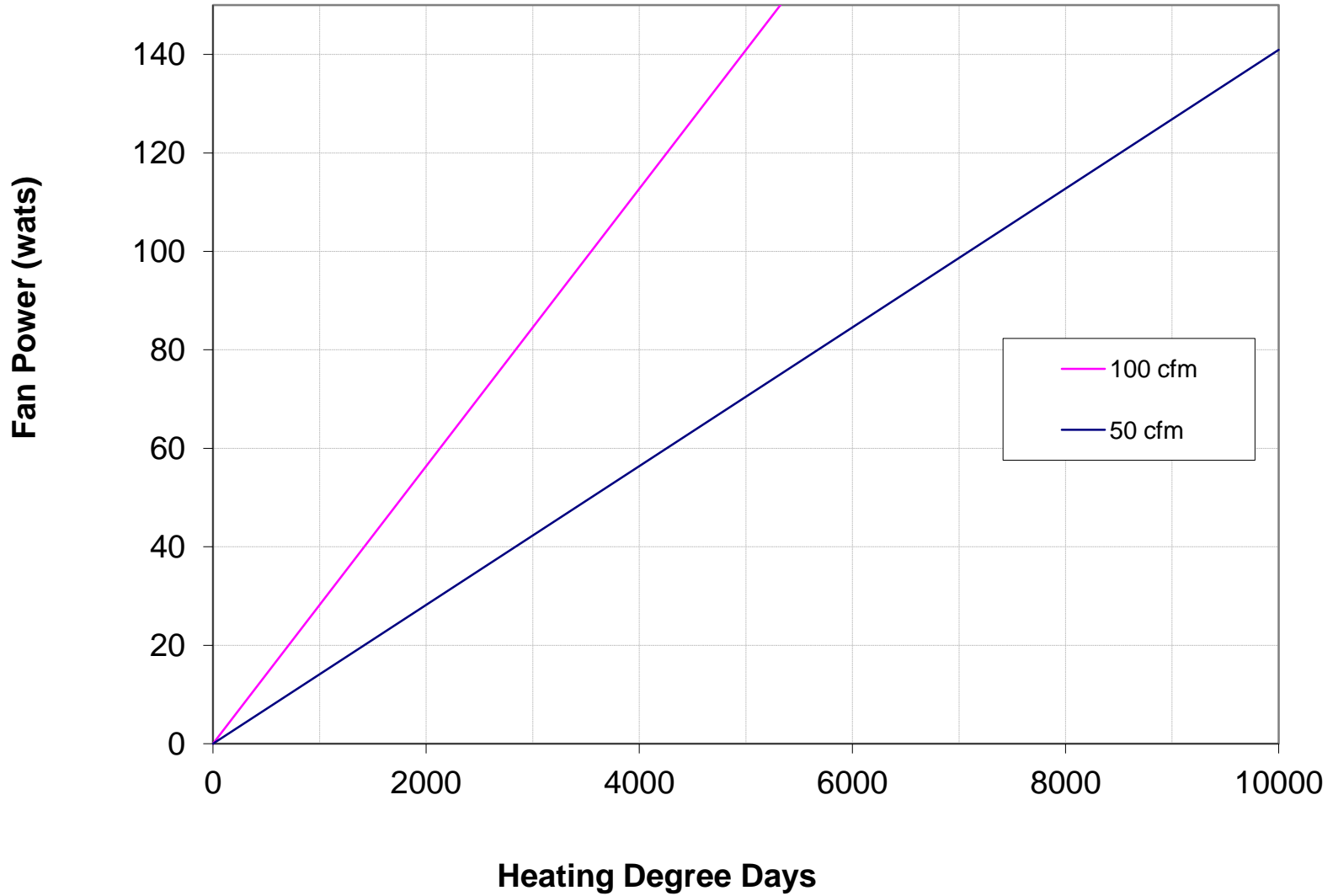




# HRV/ERV system tips

- Put filters where exhaust and outdoor air ducts enter the HRV (MERV 8)
- Locate intake where it gets good air
- Best – hard duct (flex only for short run on inlet and exhaust)
- Ok – hard elbows-stretched flex
- Low noise, low wattage fans

**Fan Power is Important  
Energy Saved = Fan Use**









1	2	3	4h	4j	5	6	7k	7l	8	9	10m	10n	11	12	13p	13r	14	15	16m	16n	17	18	19k	19l	20	21	22h	22j	23	24	25f	25g	26
0	0	0	0	0	92	0	50	99	94	109	100	105	96	108	110	99	92	101	98	94	107	96	109	102	95	95	0	0	0	0	0	0	0
0	0	0	0	92	94	60	94	93	91	92	97	94	104	94	98	90	107	77	99	96	95	105	50	103	90	0	0	66	0	0	0	0	0
101	94	103	95	92	99	60	75	106	100	89	105	80	131	183	110	96	96	93	102	101	91	246	103	106	98	94	99	97	101	91	0	101	0
99	100	92	0	91	92	92	92	97	94	103	106	101	98	100	96	110	97	98	99	97	99	102	106	105	177	95	92	96	97	75	97	74	65
107	101	108	101	0	118	94	103	103	103	105	101	97	107	91	99	91	96	124	102	93	99	92	99	93	96	40	93	94	104	56	0	0	0
110	0	105	106	98	94	100	94	99	101	101	99	91	105	90	98	152	98	101	97	97	102	99	101	97	106	93	104	102	98	92	50	44	20
93	109	105	101	95	107	105	105	92	110	80	100	90	100	106	97	92	101	91	92	106	101	99	97	103	97	95	90	101	92	92	50	38	20
109	91	0	109	171	114	107	101	100	101	109	92	97	100	109	101	0	94	0	102	97	98	98	95	97	103	0	96	0	108	101	50	97	20
																		100	92	103	96	108	95	25	61	0	109	0	107	101	50	110	20

48	47
0	0
0	0
67	102
90	103
92	101
0	0
102	97
101	107
92	109

46	45
107	98
79	80
100	107
97	104
97	108
109	107
99	153
47	100
96	103

44	43	42	41
102	101	107	99
92	33	96	105
91	101	149	109
94	99	96	91
151	94	103	103
107	94	270	96
106	101	97	100
99	102	91	107
	0		108

40	39	38
98	115	95
105	98	115
98	110	109
90	92	97
102	95	101
99	0	95
100	95	97
94	168	0

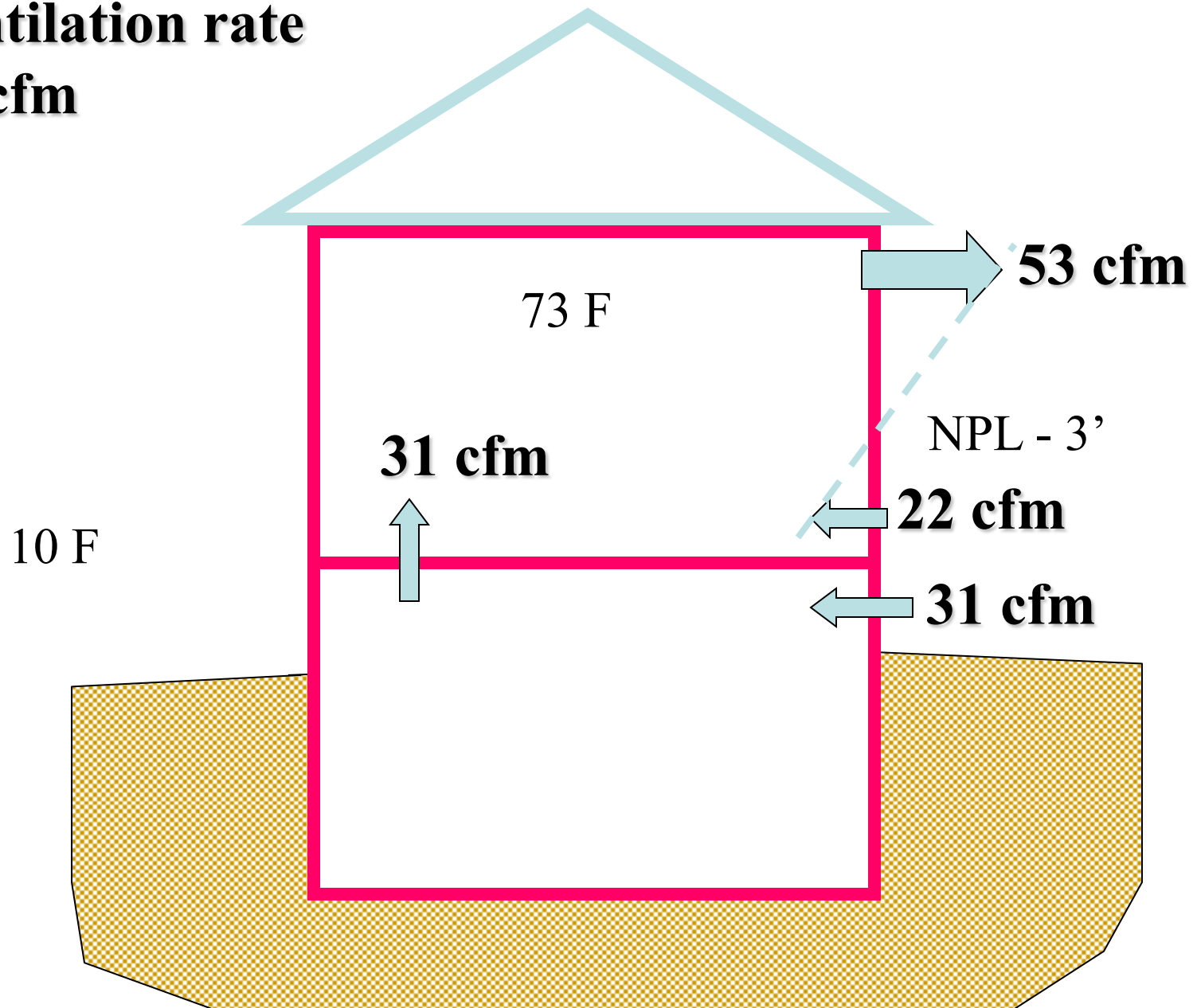
37	36	35
0	107	104
105	104	98
106	95	102
94	97	98
103	94	381
103	109	109
101	0	105
96	0	102
	96	103

34	33	32
101	104	0
92	92	90
123	110	103
101	103	101
100	73	85
92	101	100
97	109	100
97	194	95
100	107	91

31	30	29
93	0	0
91	94	52
98	92	92
109	105	96
90	94	98
103	97	98
108	0	102
16	83	90
94	110	105

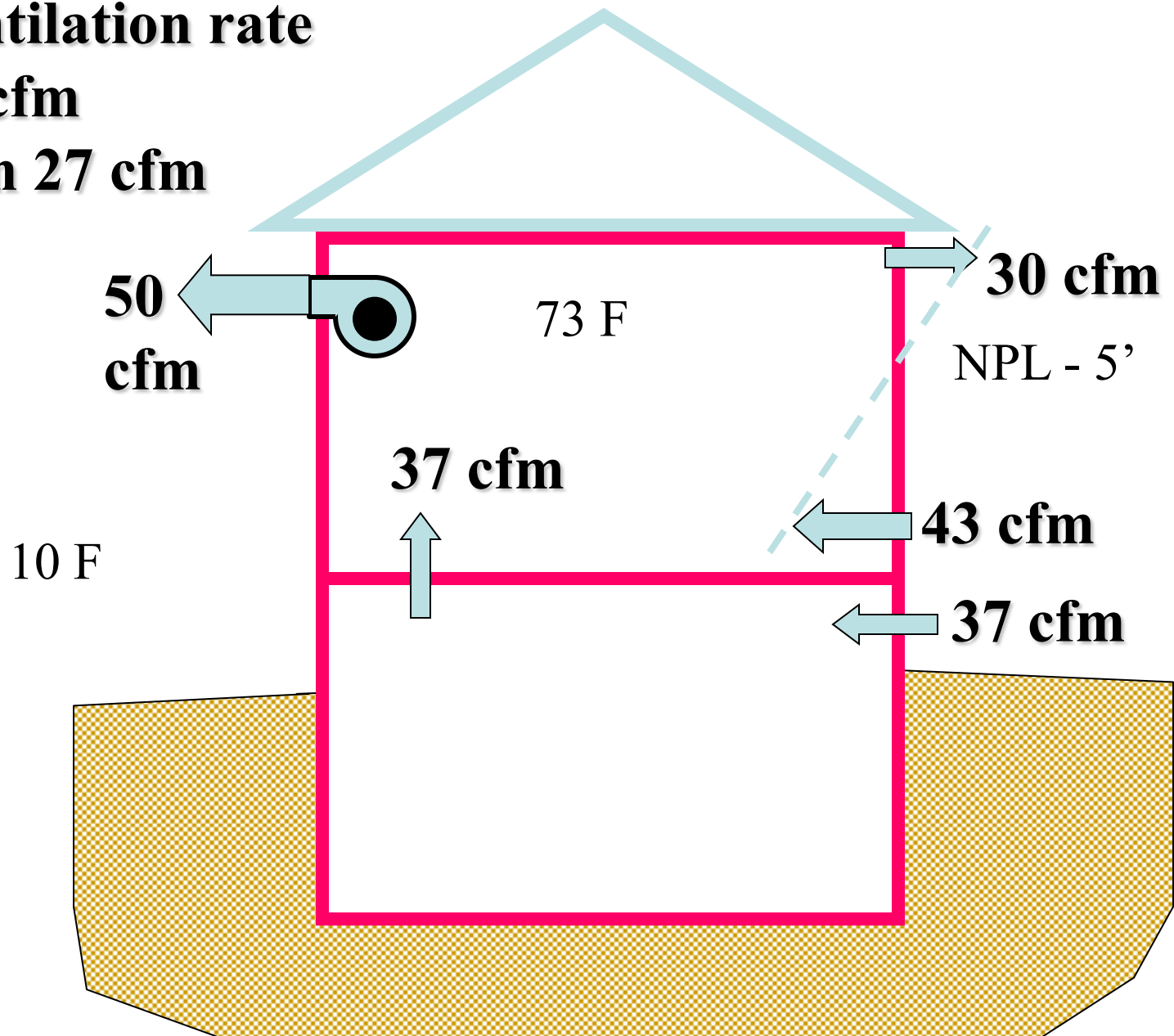
28	27
0	0
0	0
95	59
46	110
109	93
96	102
102	107
101	98
106	108

**Ventilation rate**  
**53 cfm**

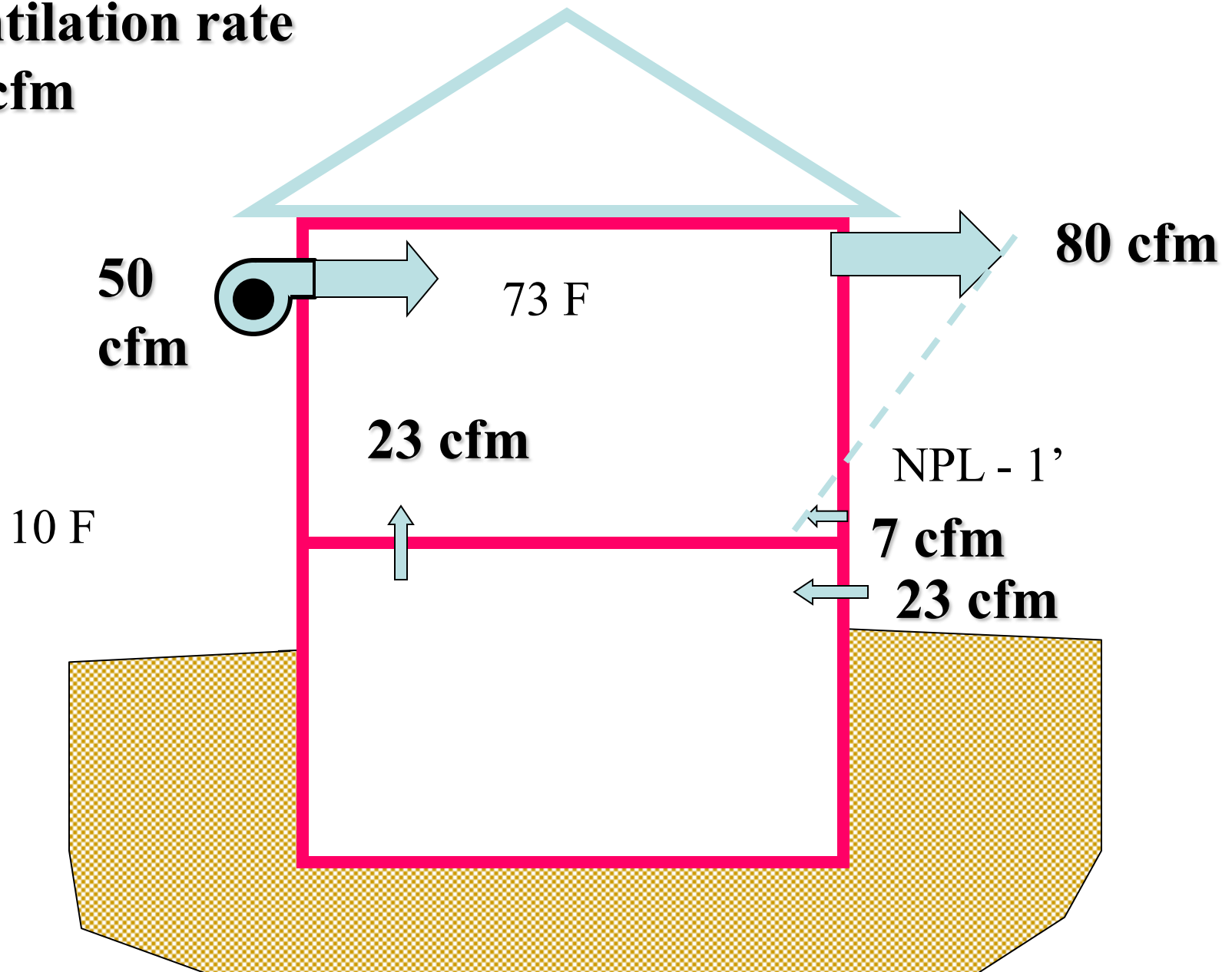




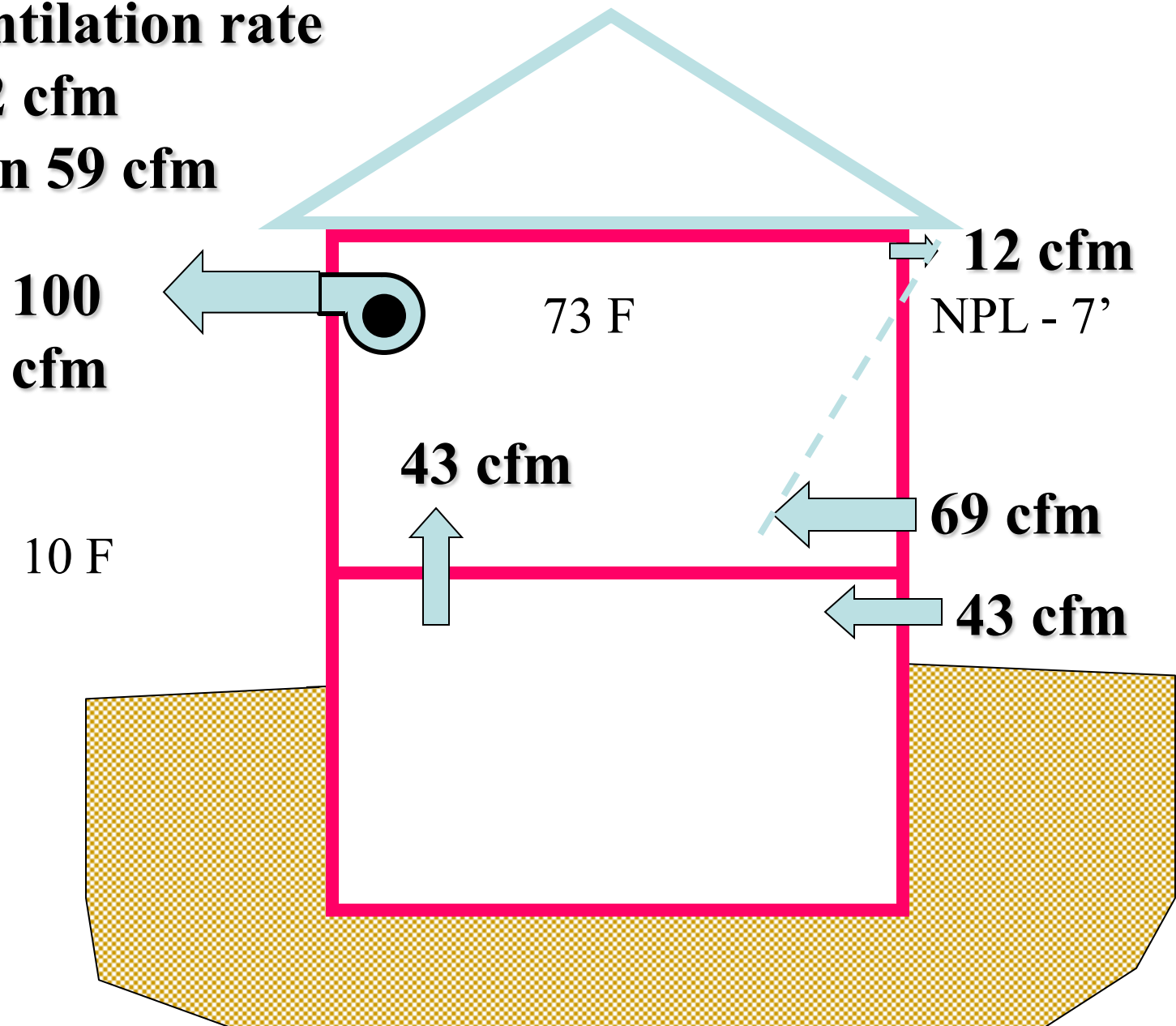
**Ventilation rate**  
**80 cfm**  
**gain 27 cfm**



**Ventilation rate**  
**80 cfm**



**Ventilation rate**  
**112 cfm**  
**gain 59 cfm**





**Ventilation rate**  
**103 cfm**  
**gain 50 cfm**

