Ventilation and the House as a system

Indoor air that is clean, fresh and healthy

V is for Ventilation

A system or means of providing fresh air.

Webster New Collegiate Dictionary

House as a System

The way houses work - **heat, air and moisture** move in and out according to some simple rules. When you build things right, it really works, when it doesn't, you quickly become a case study.

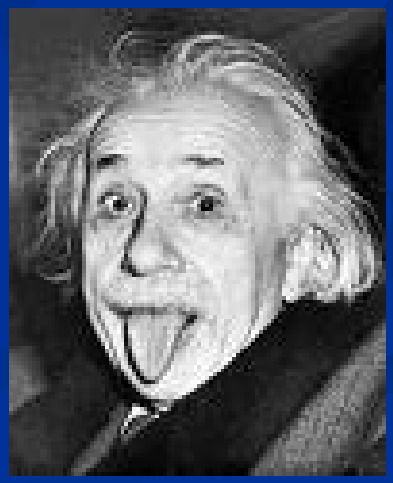
Tex McLeod

Some Common Truths

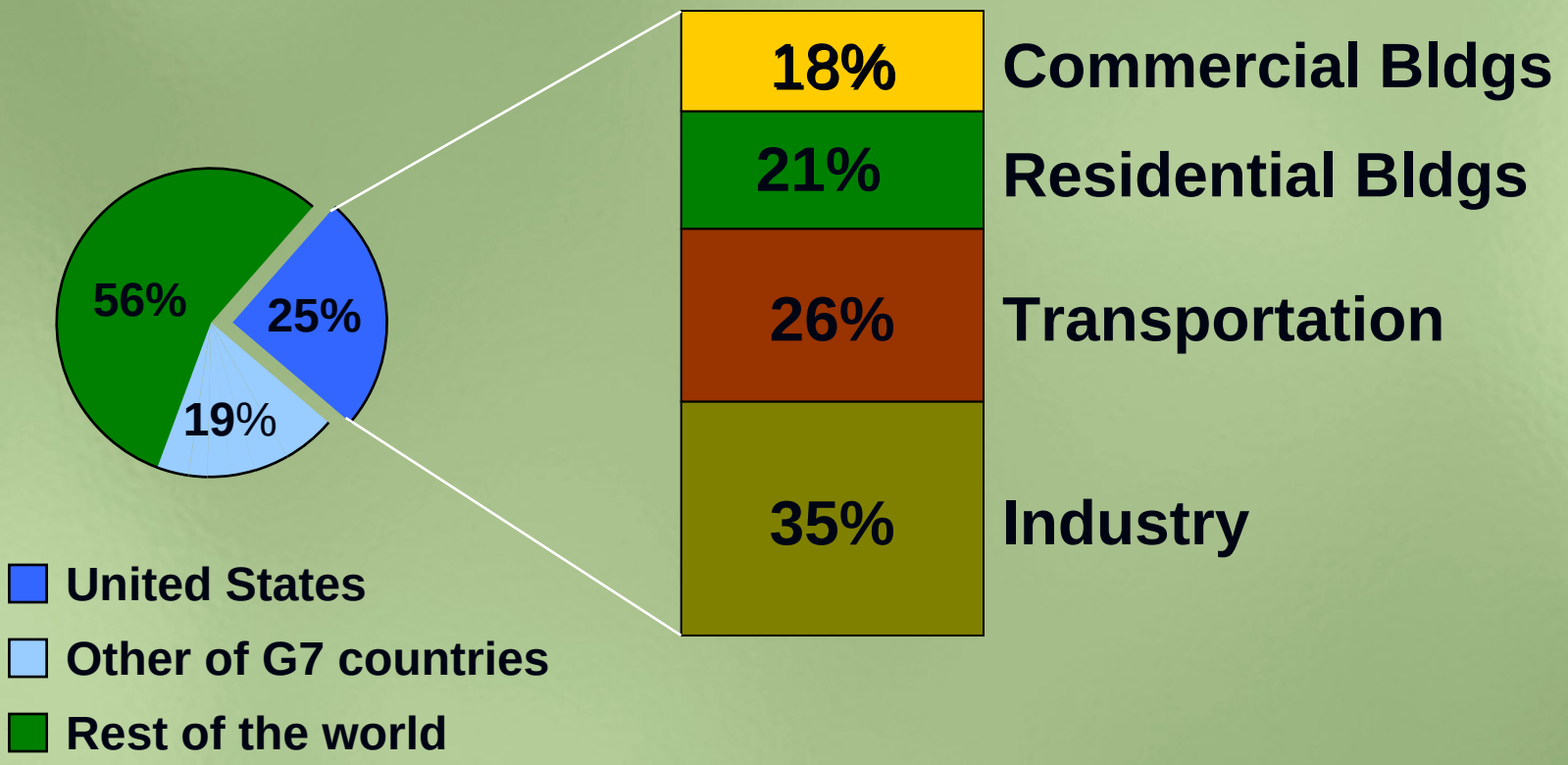
- The housing industry is slumping
- Energy is expensive
- Boomers are getting older
- So am I, in fact…… we resemble that remark

Insanity .....

Continuing to do things the same, and expecting a different outcome

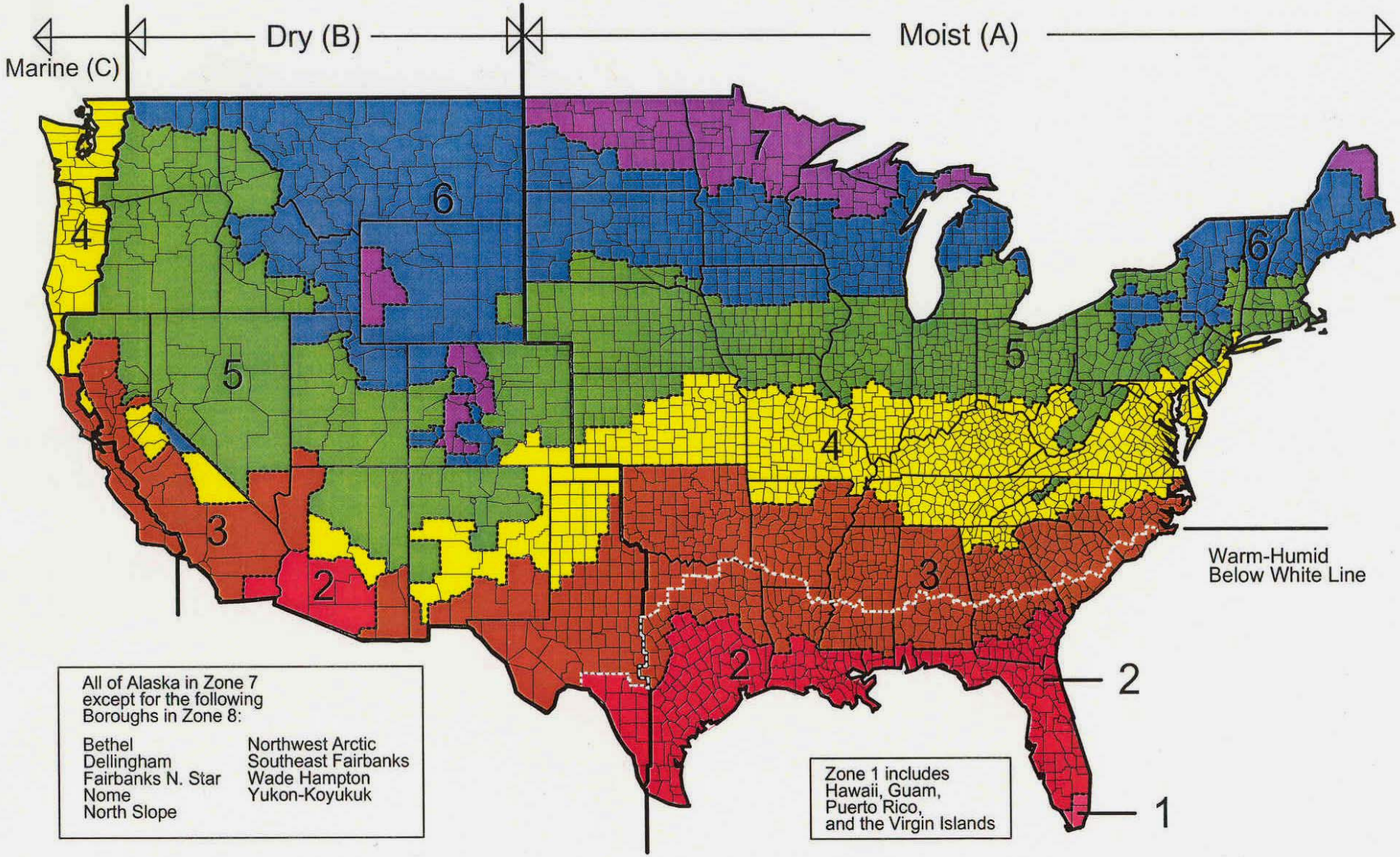


US Energy Demand



US buildings consume roughly 10% of the world's energy, every day!

Map of DOE's Proposed Climate Zones



March 24, 2003

The Better Built House

Everything you need to know but were…..

- **Moisture control**
- **HVAC: heating, cooling, ventilation, filtration**
- **Combustion and garage isolation**
- **Commissioning the building**
- **Radon control**
- Pest barriers
- Healthy building materials

Market Changes

Envelope

- Bigger houses
- Smaller lots
- More and bigger windows
- Tighter envelopes
- More insulation
- More complex roofs

Mechanicals

- High Efficiency HVAC
- More air conditioning
- More plumbing
- More exhaust fans
- More choices - fuels, technologies
- More appliances & lighting

“We face a choice that is starkly simple, we must change or be changed. If we fail to change for the better, we will be changed for the worse”

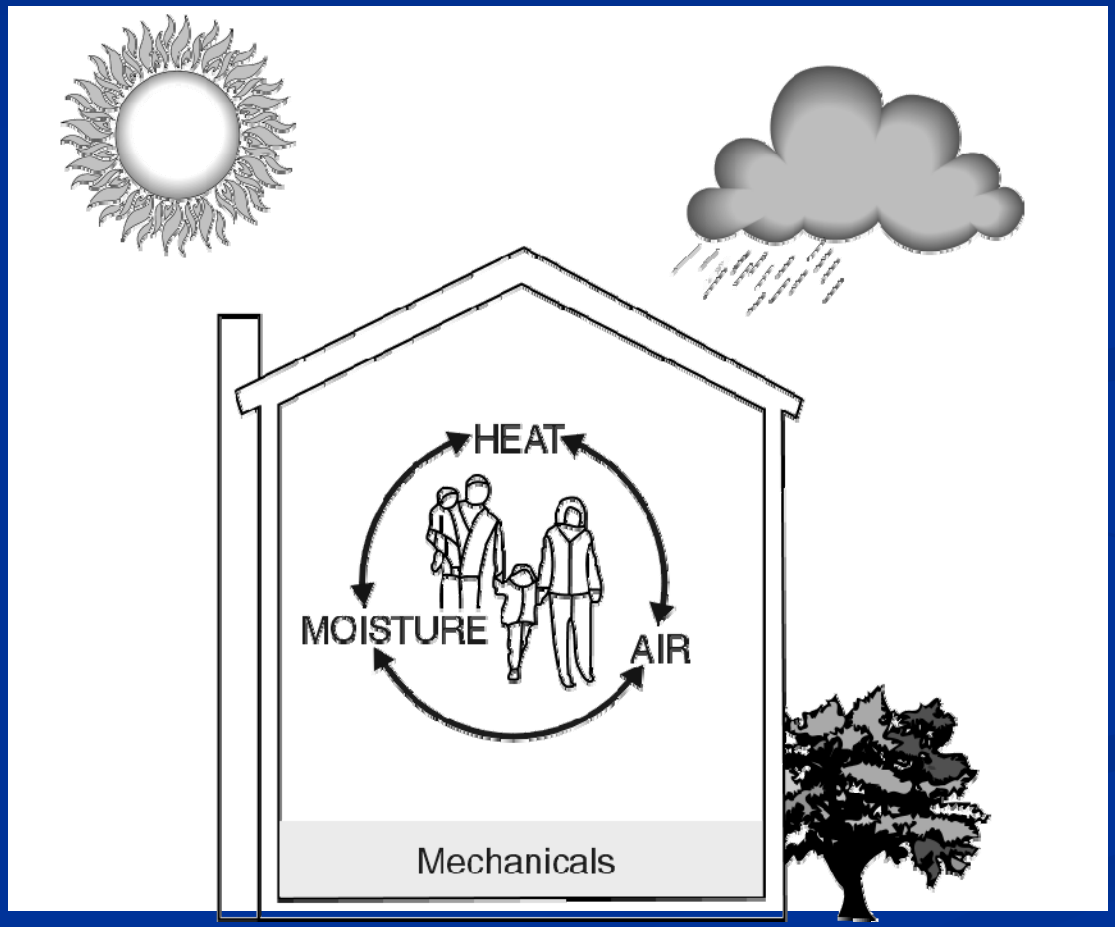
Wendell Berry, philosopher

Houses will .....

be better insulated
be tighter
will need better
ventilation
be low maintenance and
aging friendly

House as a system

Heat, air and moisture flows

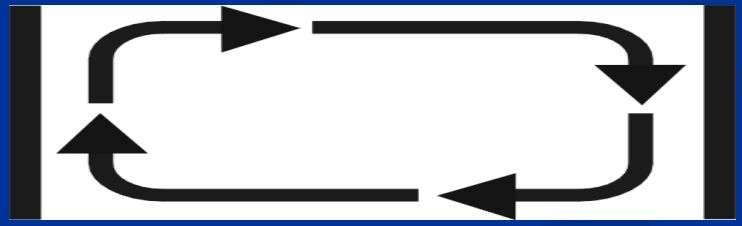


HEAT Flows

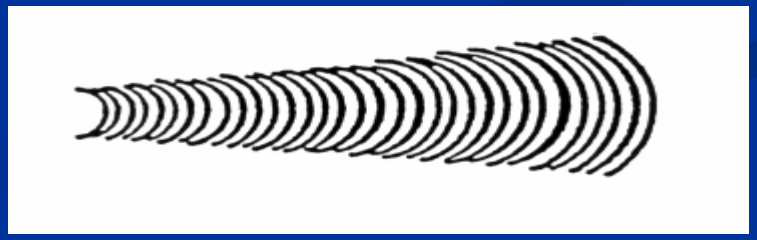
HOT → COLD

a) **Conduction**

b) **Convection**



c) **Radiation**



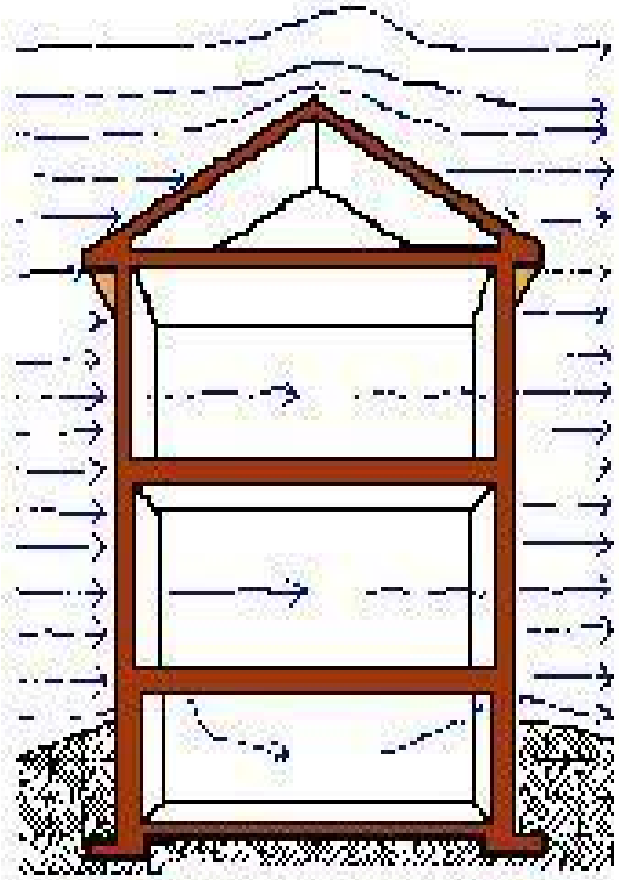
Air Flows

High pressure  **Low**

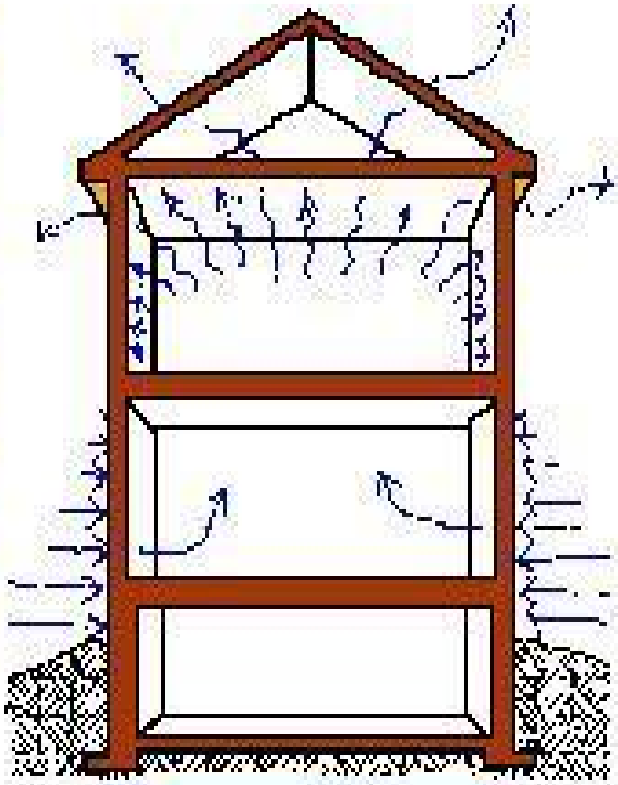
To have air flow you need: a pressure difference and a hole.

Pressure in houses is caused by:

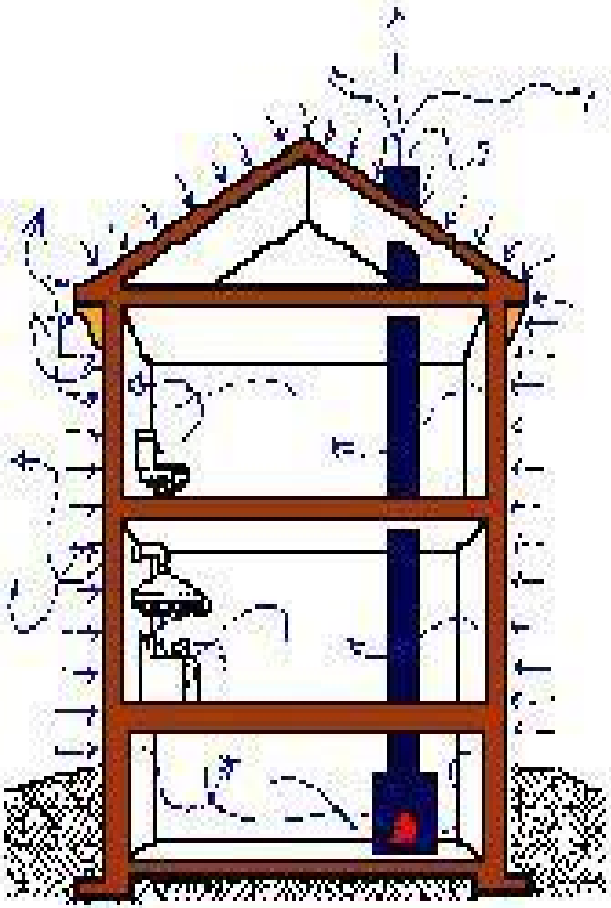
- Wind Effect
- Stack Effect
- Flue or mechanical Effect



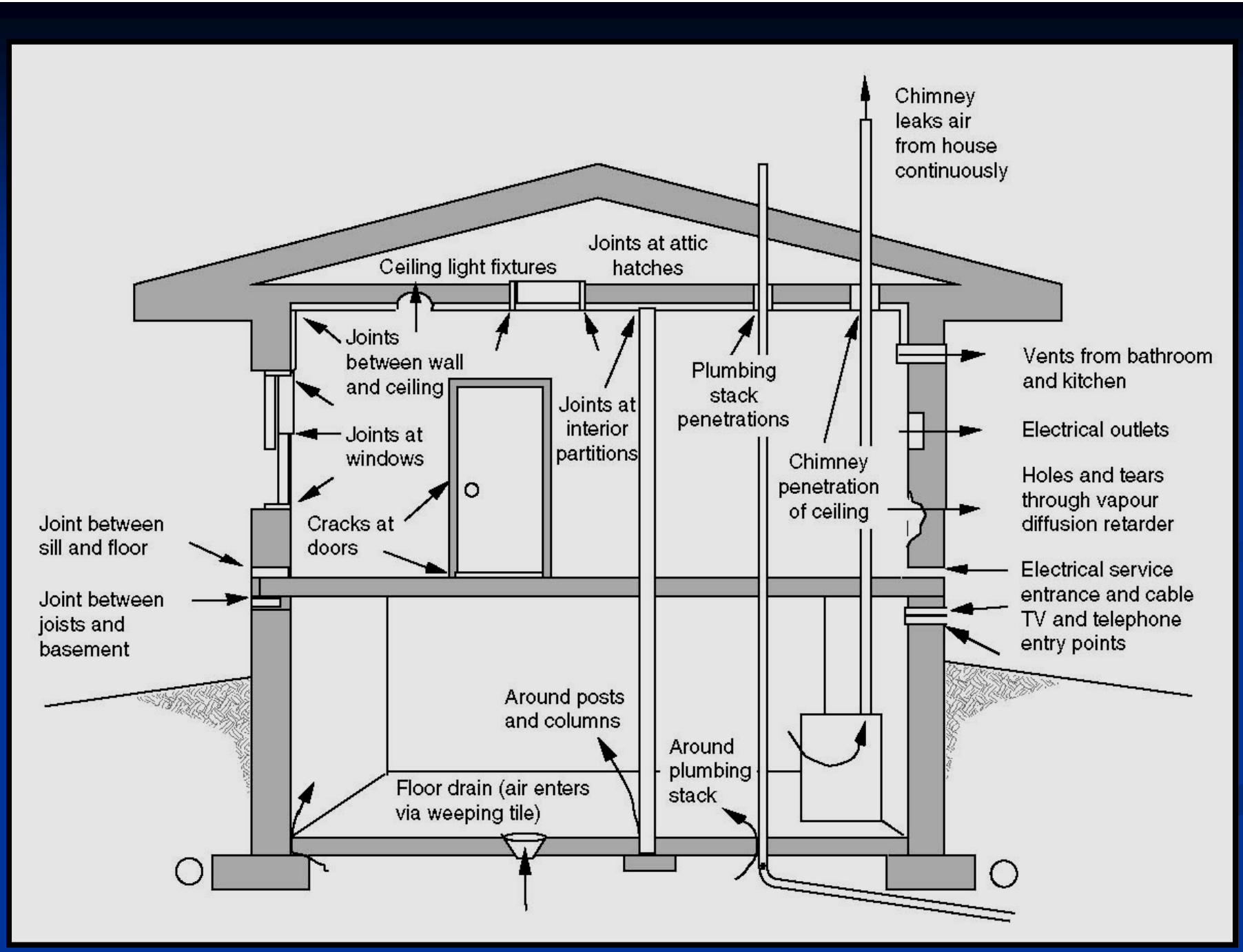
Wind Effect



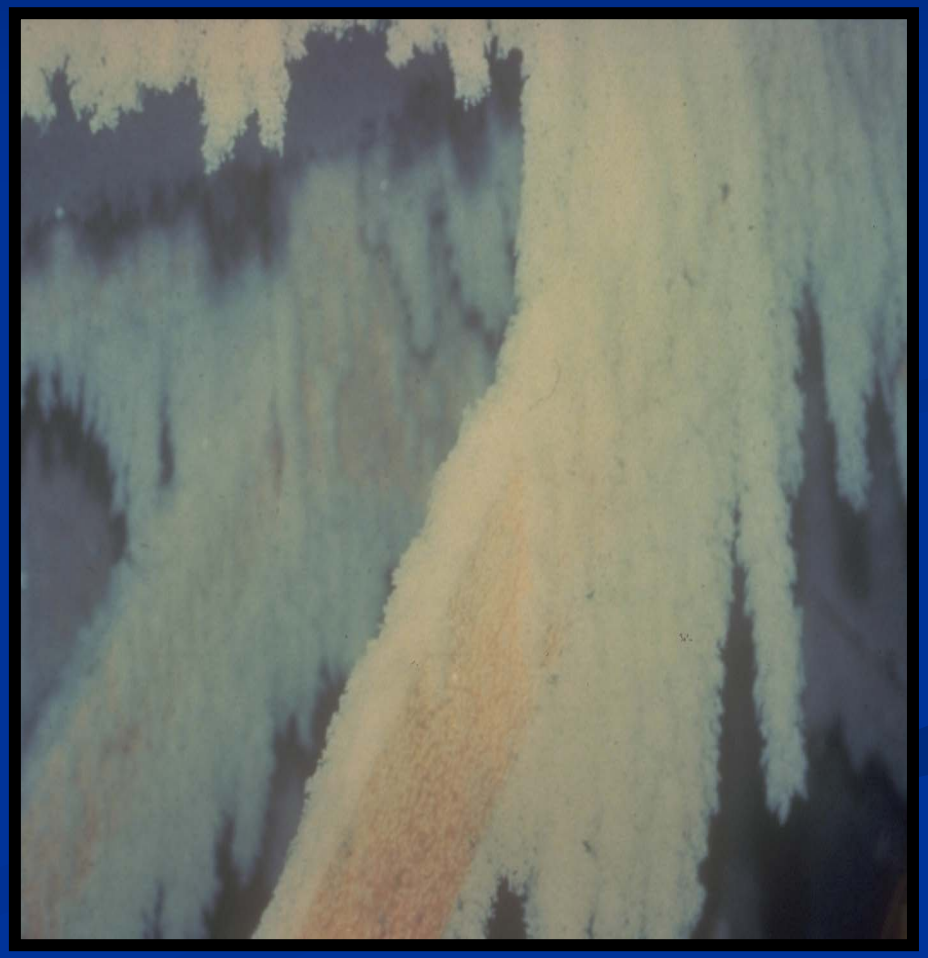
Stack Effect



Flue and Mechanical Effects


Chimney leaks air from house continuously
Joints at attic hatches
Ceiling light fixtures
Joints between wall and ceiling
Joints at windows
Joints at interior partitions
Plumbing stack penetrations
Chimney penetration of ceiling
Vents from bathroom and kitchen
Electrical outlets
Holes and tears through vapour diffusion retarder
Electrical service entrance and cable TV and telephone entry points
Cracks at doors
Joint between sill and floor
Joint between joists and basement
Around posts and columns
Around plumbing stack
Floor drain (air enters via weeping tile)

Uncontrolled air leakage exfiltrating moisture into an insulated wall or roof cavity creates rot & decay



Understanding Moisture

Moisture can be: liquid, vapor or solid

Liquid flow (gravity)

- Rain, leaks, bulk water

Capillary (rising damp)

- Material wicking

Air transport

- Air flows carrying moisture laden air

Diffusion

- Vapor pressure drive

These are in order of priority

HVAC contractor's Opportunity

- Help builders make better choices
- Install equipment that protects and improves IAQ / energy efficiency
- Reduce warranty calls / liabilities
- Understand and incorporate the House is a System into your designs
- Get engaged earlier
- Benefit from "brand" recognition, ie the ENERGY STAR IAQ Package

Size matters

- Size using Manual J
- Get detailed building info from builders on:
  - Air tightness – 30-50% of heating loads
  - Window factors – 30-50% of AC loads
- Match outdoor and indoor cooling coils
- In humid climates, add additional dehumidification
- Ducts need to be properly sized and sealed

Sizing Impacts IAQ

Cooling

Over sizing leads to short cycling

- Short cycling reduces effectiveness of
  - dehumidification
  - filtration
- Over sizing causes pressure differences

Heating

Over sizing can result in

- Comfort problems
- Condensation
- Pressure differences, poor combustion venting

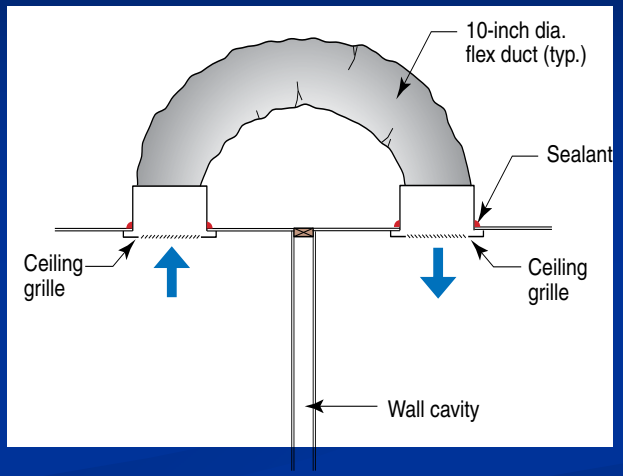
Ducting Impacts IAQ

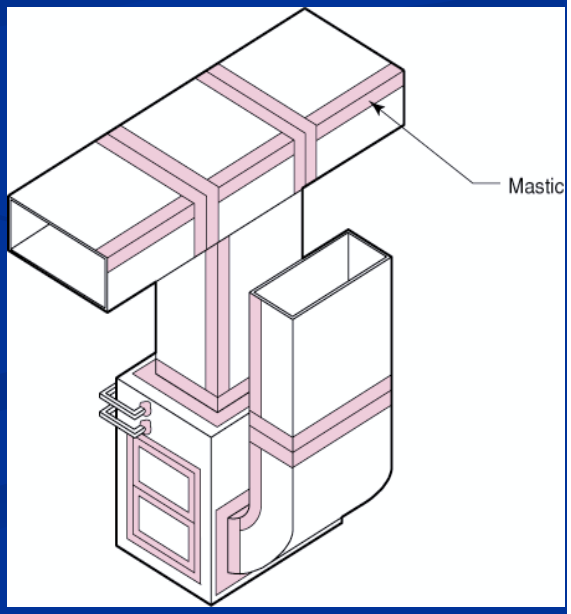
- Construction dust and debris
- Supply air leakage can loose conditioned air into hidden cavities
- Return air leakage can draw pollutants into the ductwork

  – especially when ducts are in the garage or attic

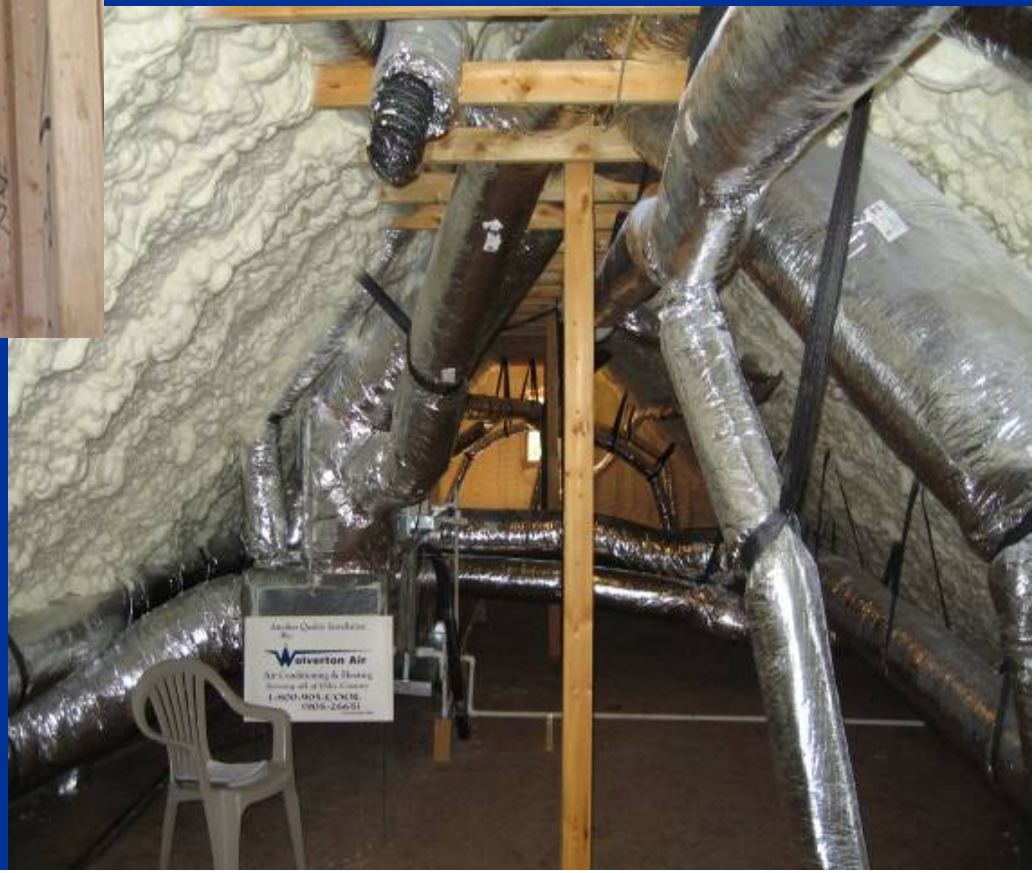
Distribution Systems

- Keep ducts in conditioned spaces
- Work with builder to optimize framing to accommodate ducts
- Provide pressure relief, transfer grills
- Seal ducts for better performance
  - leaky ducts can lose up to 30%

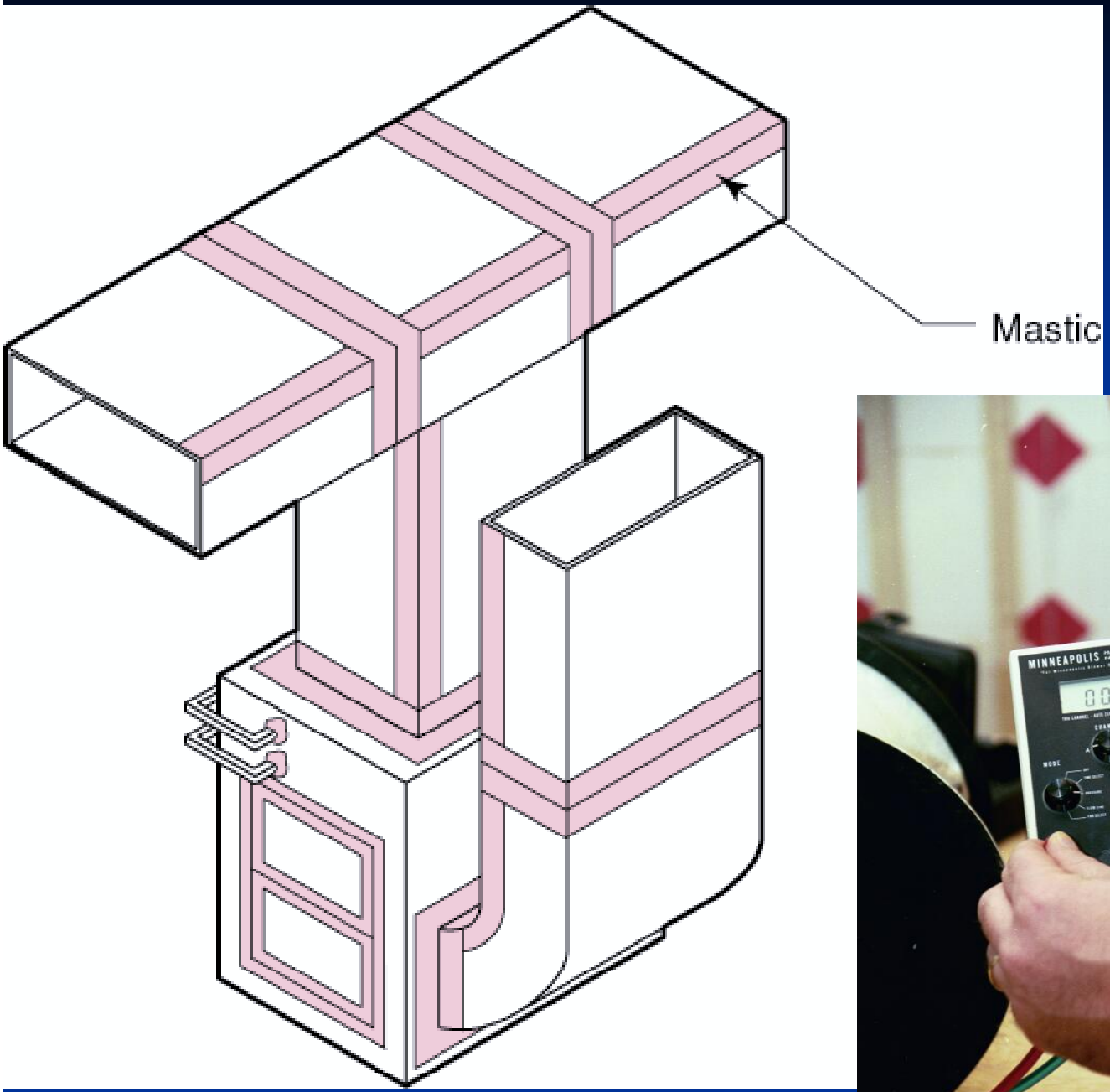




Ducts in Conditioned Space



Return ducts in framing are difficult to seal and may cause IAQ problems


Mastic


MINNEAPOLIS
GAUGE
0000
CHANNEL
MODE
RANGE

Filtration

Filtration is one of 4 IAQ strategies - Remove, Seal, Ventilate, Filter

- Commonly located in the return duct of the air handler
- It works and is cost effective
- Choose a filter with a rating of MERV 8 or better
- Caution – the better the filter, the more it restricts air flow, the more it needs changing / cleaning

Penetrations

- There are more penetrations
- Side wall vented combustion appliances
- Dryer, bath and kitchen fans,
- Plumbing, electrical & security
- More and bigger windows
- Decks

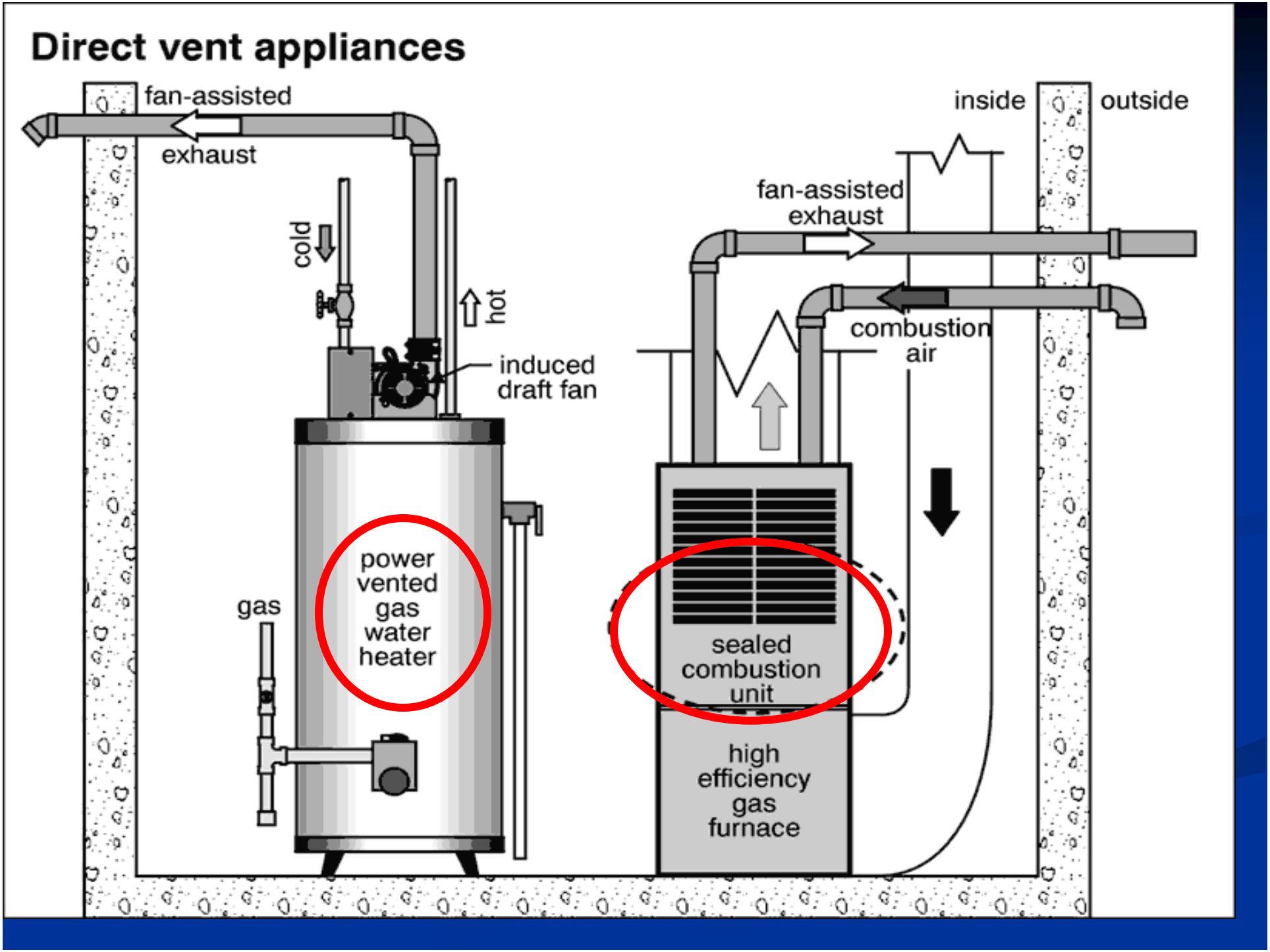
Proper Detailing of Penetrations

Combustion Safety

Rule 1 – don’t kill your customer!

- Sealed combustion equipment
- Power vented water heater
- Direct vent fireplaces – no unvented fireplaces
- Vented gas cooking appliances
- Separating the house from the garage
- Install CO Detectors

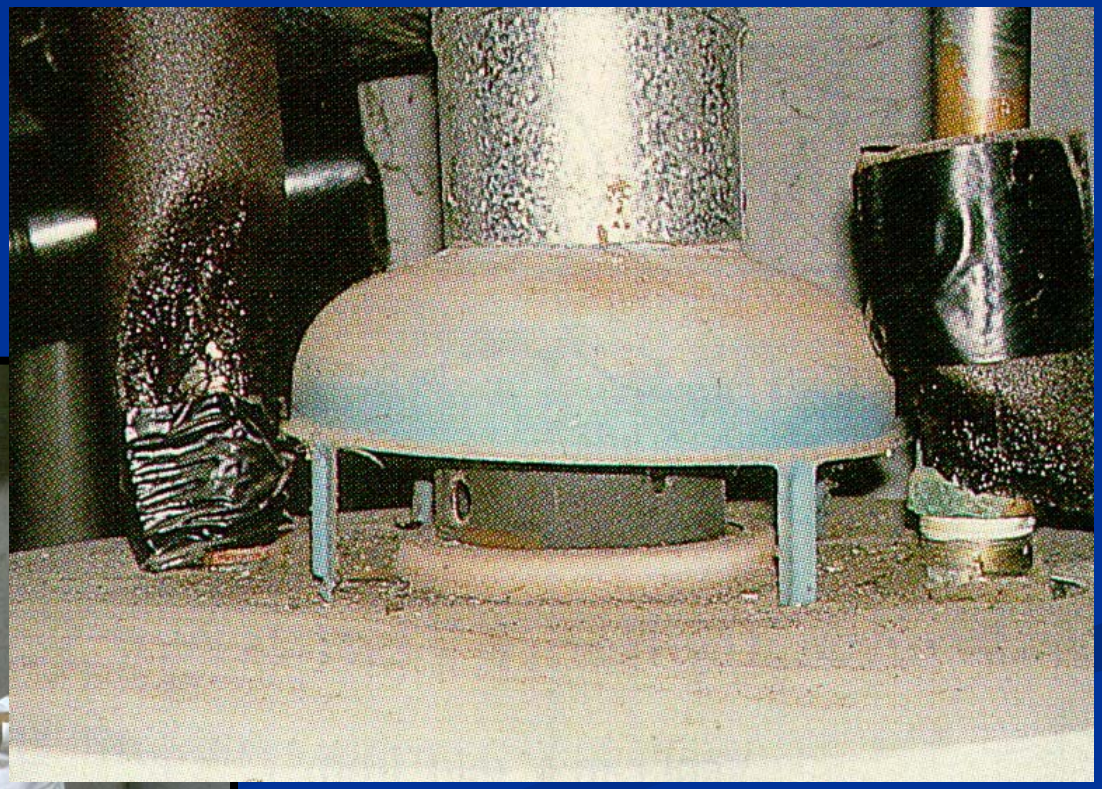
Direct vent appliances



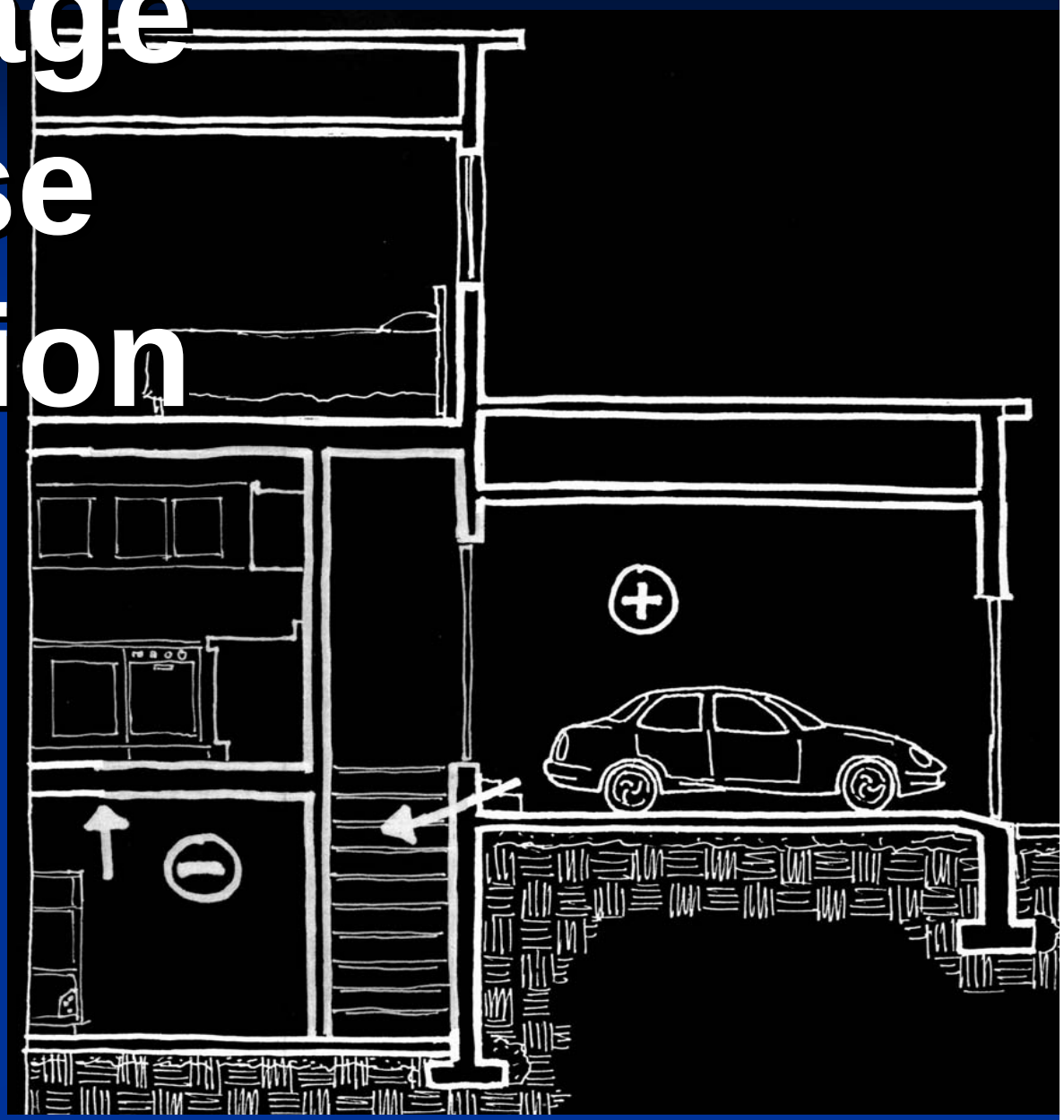
Direct Vent Appliances

- Sealed combustion chamber
- Decouples appliance from house
- You also get high efficiency
- Move to ECM motors

Water heater safety: the good, the bad, and the really ugly



The Garage to house Connection

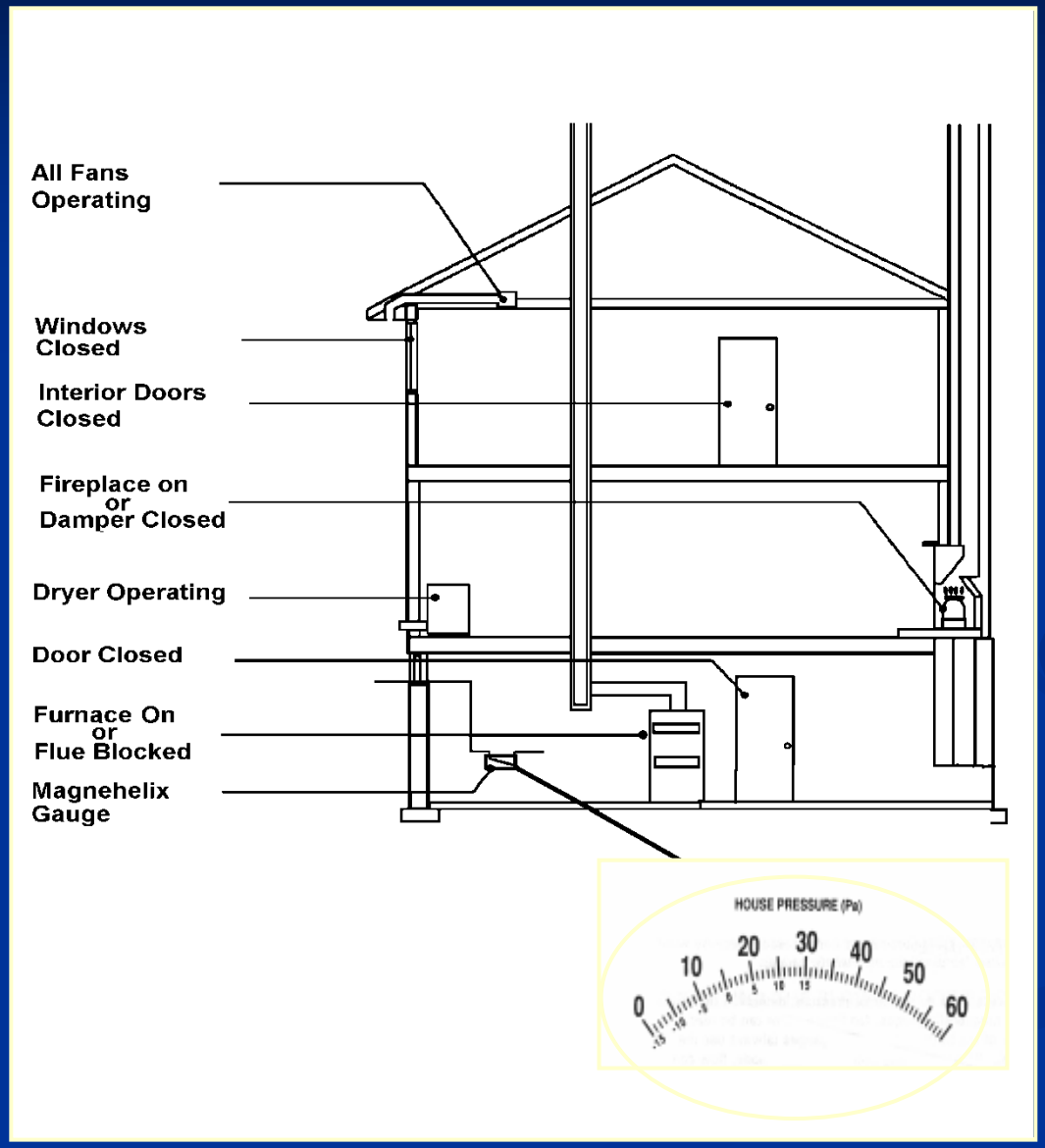


1. Air seal between the garage and the house
2. Weather-strip connecting doors, automatic door closers
3. Install a 100 CFM exhaust that comes on automatically when the garage door closes.

CO detectors

- CO is a product of incomplete combustion
- In all homes with combustion appliances or attached garage
- At a minimum, a certified alarm should be placed outside the sleeping area(s)
- CO is colorless and odorless and it kills
- It doesn’t fall, it doesn’t rise – it just mixes into the air we breath

Depressurization Testing



- Primarily needed if installing natural draft appliances like wood fireplaces
- Measure pressure between outside and inside with exhaust fans running
- If pressure is greater than 5 Pa (0.02”w.g.) provide make-up air

Indoor Air Quality...

Understanding sources and solutions


DECEMBER 3-5, 1999
usaweekend.com
USA WEEKEND
Best of the Web: Holiday gift bargains, p.7
Vote on grandparents' rights, p.18
10 reasons to eat your spinach, p.20
THE MOLD IN YOUR HOME MAY BE DEADLY
Is your home in danger?
Ron Allison suffered memory loss.
His son, Reese, has asthma and scarred lungs.
The cause: simple exposure to household mold.
How you can protect your family.


www.businessweek.com
BusinessWeek
JUNE 5, 2000
A PUBLICATION OF THE McGRAW-HILL COMPANIES
China
Counterfeit goods: A losing battle
Cisco
Does it have a Microsoft problem?
Inside Story
Why 3M banned Scotchgard
Daimler-Chrysler
The fight for control — the untold story
IS YOUR OFFICE KILLING YOU?
The dangers of sick buildings
By Michelle Conlin
PAGE 114
AOL Keyword: BW


U.S.News & WORLD REPORT
MAY 8, 2000
www.usnews.com
The Allergy Explosion
Why you're sneezing—
what
can do
ut it

Fact:

Indoor air has 2-5 times more chemical pollutants than outdoor air

EPA

Fact:

1 in 3 people have an allergy severe enough to seek medical attention

American Lung Association

IAQ – what we know

- Childhood asthma is increasing at an alarming rate
- Dampness and molds increase respiratory problems and affect the immune system
- The Surgeon General estimates more than 21,000 lung cancer deaths per year due to radon.

The Nature of IAQ & Health

Everyone is affected, some more than others

- Age – the very young and the elderly
- General health – the immune system

- Duration of exposure
- Level of pollutant concentration

Indoor air is affected by:

- Outdoor air
- Building materials
- Mechanical equipment
- The foundation (moisture, soil gases)
- Lifestyle - how people live; hobbies, pets, cleaning, home furnishings and personal care products

Pollutant Sources

External

- Outdoor air
- Attached garages
- Soil gases (radon)
- Exterior applied insecticides

Internal

- Building materials
- Combustion equipment
- Occupant Activities
  - cooking
  - cleaning
  - hobbies
- Furnishings
- Mold & other biologicals

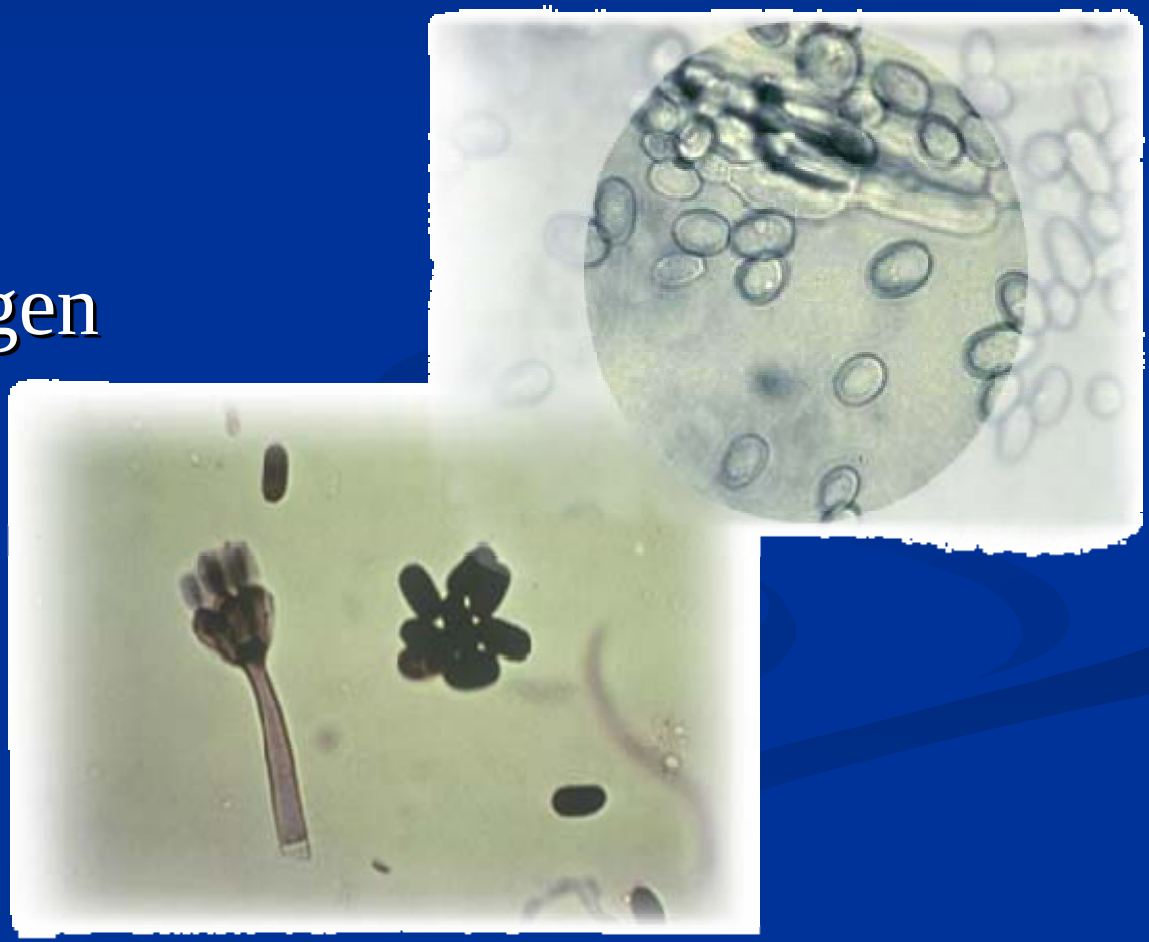
Moisture = Mold

Find the moisture, find the MOLD

Spores (seeds) are everywhere……

Factors that affect the germination and growth of molds are:

- nutrients
- presence of oxygen
- temperature
- **water**



Molds

- Spores (seeds)
- Plant materials (Beta-1,3 glucans)
- Mycotoxins
- Smells (fungal volatiles)

Strategies to Control Moisture

- Manage interior humidity levels
  - Install and operate ventilation system
  - Exhaust from kitchen and baths
  - Vent dryers
- Warm surface temperatures
  - Increase insulation
  - Avoid thermal bridges
  - Wash air over outside walls
  - Use low e, warm edge windows
- No leaks

IAQ Strategies

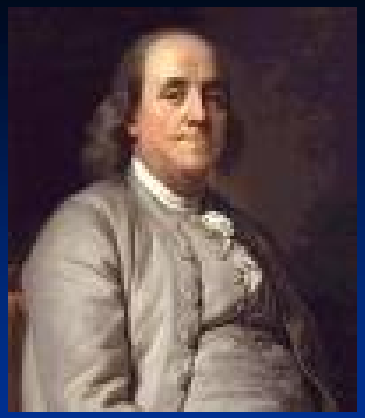
1. Eliminate
2. Seal
3. **Ventilate**
4. Filter

Ventilation...

Methods, amounts & strategies

Why Ventilate?

- To control humidity
- To control pollutants
  - People - respiration (primarily CO_2), perspiration, cooking, hobbies, parties, pets, cleaners
  - Buildings – materials, furnishing, combustion gases, radon, water vapor
- Outdoor air is always better than indoor air



Benjamin Franklin

"I am certain that no air is so unwholesome as air in a closed room that has been often breathed and not changed."

Goals of Mechanical Ventilation

Stale air out, fresh air in

- To control moisture
- To reduce pollutants levels
- To filter incoming air

- Ventilate for people (continuous)
- Capacity for supplementary ventilation when needed (intermittent)

- Distributed, quiet, comfortable, controlled

How Much Ventilation?

- ASHRAE: Standard 62-2
  - So much per person (bedrooms)
  - Additional ventilation based on Floor Area
- Other factors:
  - Moisture generation rates,
  - source strength of pollutant,
  - occupant sensitivity

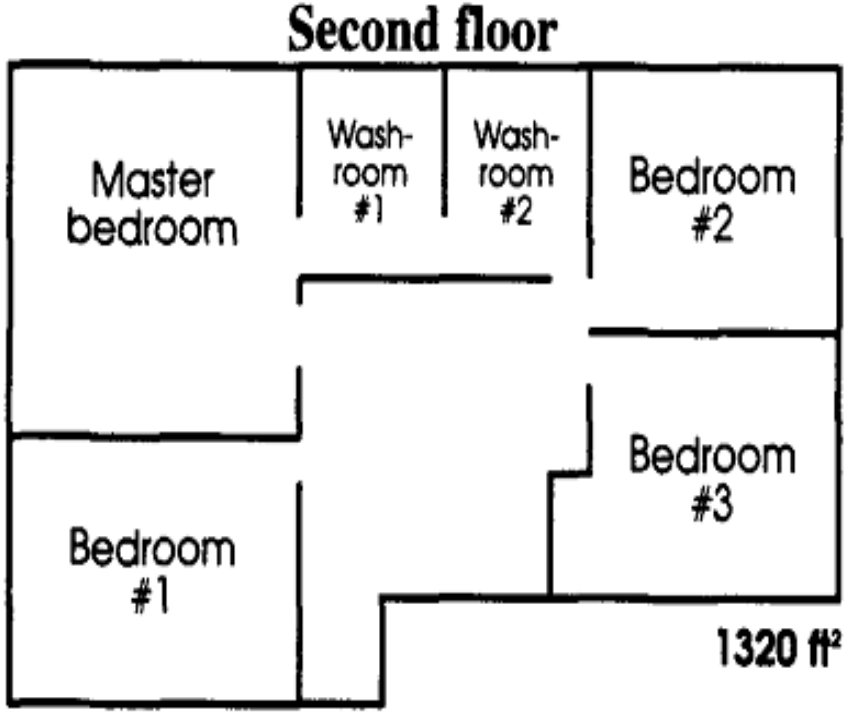
ASHRAE 62.2

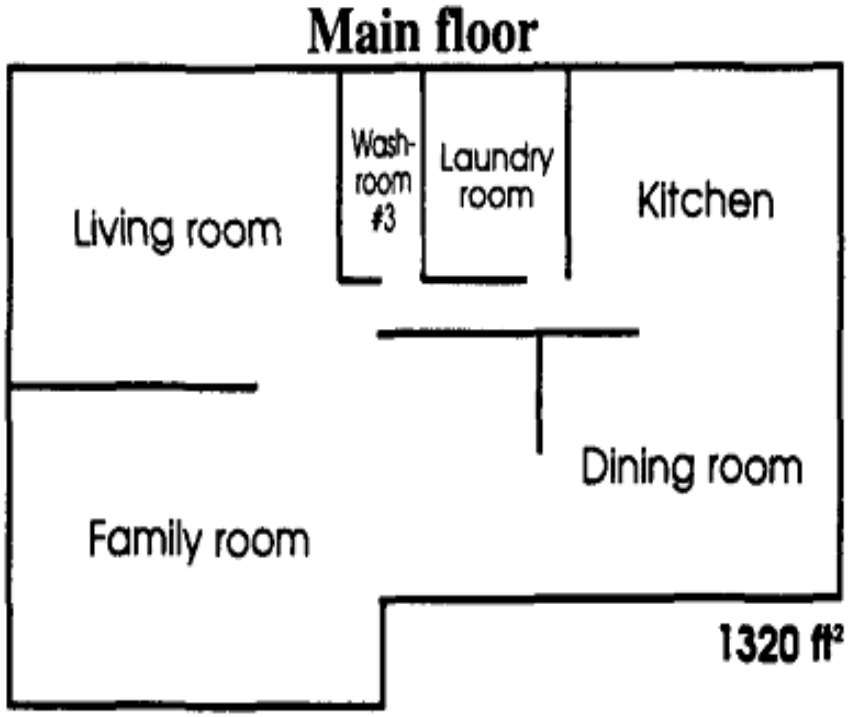
Whole house ventilation

- Every home needs the capacity for mechanical ventilation to manage moisture and dilute pollutants
  - over and above air leakage and opening windows
  - There are exceptions are for warmer climates where windows are expected to be open for extended periods
- 7.5 cfm per bedroom +1extra + 1 cfm / 100ft_2
- More people - more capacity

Ventilation Sizing

The minimum ventilation needed to control moisture, odors and other pollutants





Ventilation Capacity

4 bedrooms + 1 x 7.5 cfm + 26.4 cfm = 63.9 CFM

Types of Mechanical Ventilation

- Balanced System
- Exhaust-Only
- Supply-Only

“Traditional heating and cooling systems have not addressed the fresh air ventilation needs of home occupants.

Homes experience inadequate ventilation because they rely on infiltration and natural ventilation rather than controlled mechanical ventilation systems.”

Program Needs for Indoor Environments Research (PNIER)
US EPA Planning Document

New California study

- 1/3 of the houses didn't open windows in winter
- 75% of houses without mechanical ventilation (80 – 20) had air change rates below code
- All the homes exceeded formaldehyde guidelines

We conclude that new single-family detached homes in Calif. are built relatively tight, and in those homes where the windows/doors are not opened the outdoor air exchange rates are low and concentrations of formaldehyde can be substantial.

Window usage, ventilation, and formaldehyde concentrations in new Calif. homes

New California study

These results suggest that consideration should be given to installing mechanical ventilation systems in new single-family residences to provide a dependable and continuous supply of outdoor air so that indoor sources of formaldehyde are reduced.

The HRV systems performed well in increasing the home air exchange rates and reducing indoor formaldehyde while the DOA systems did not perform well as a result of the low outdoor air flow rates and low fan operation times associated with these systems.

Window usage, ventilation, and formaldehyde concentrations in new Calif. homes

Keep in mind, builders want ventilation solutions

Solutions that work in the home, not in the box - installed.

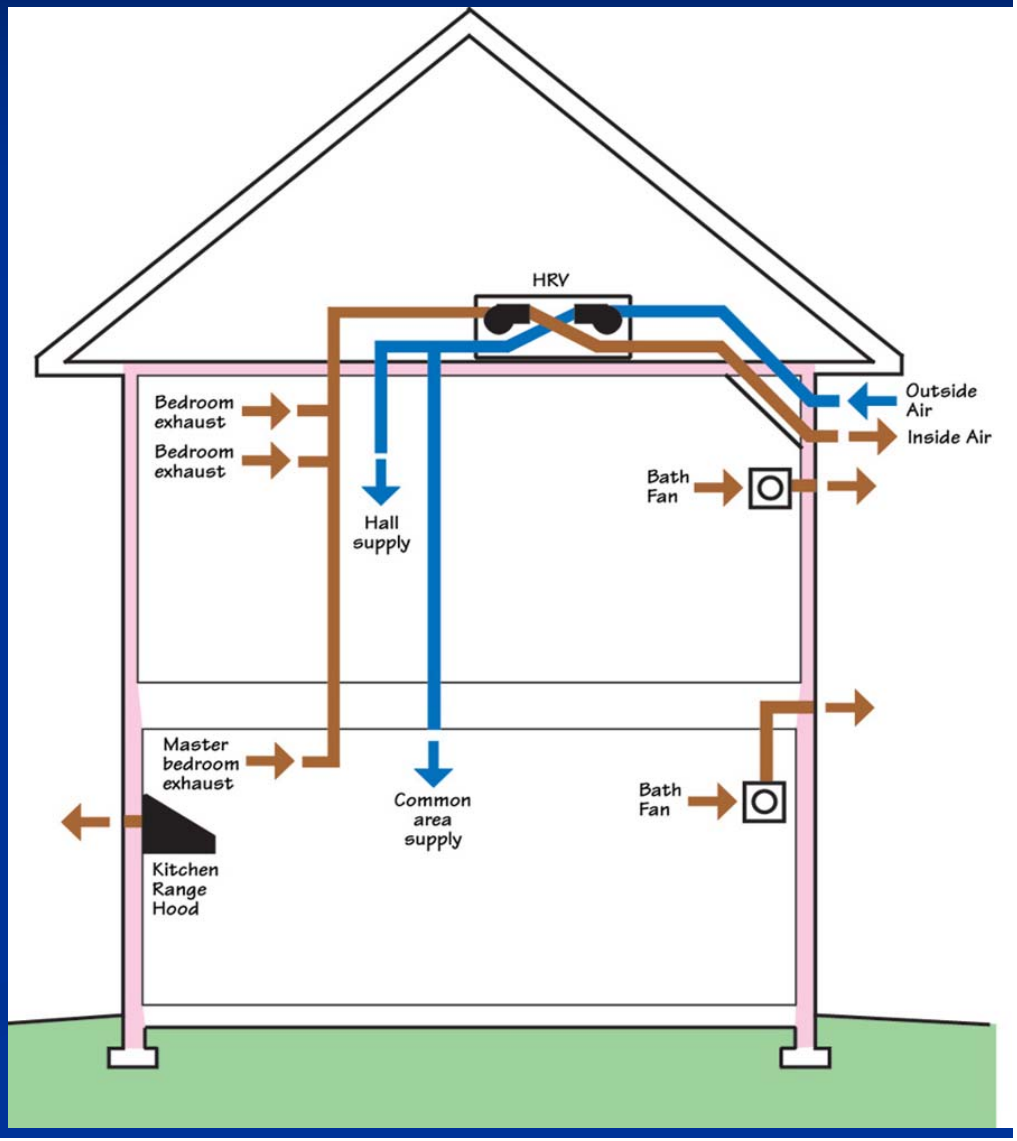
Balanced Ventilation

Balanced Ventilation

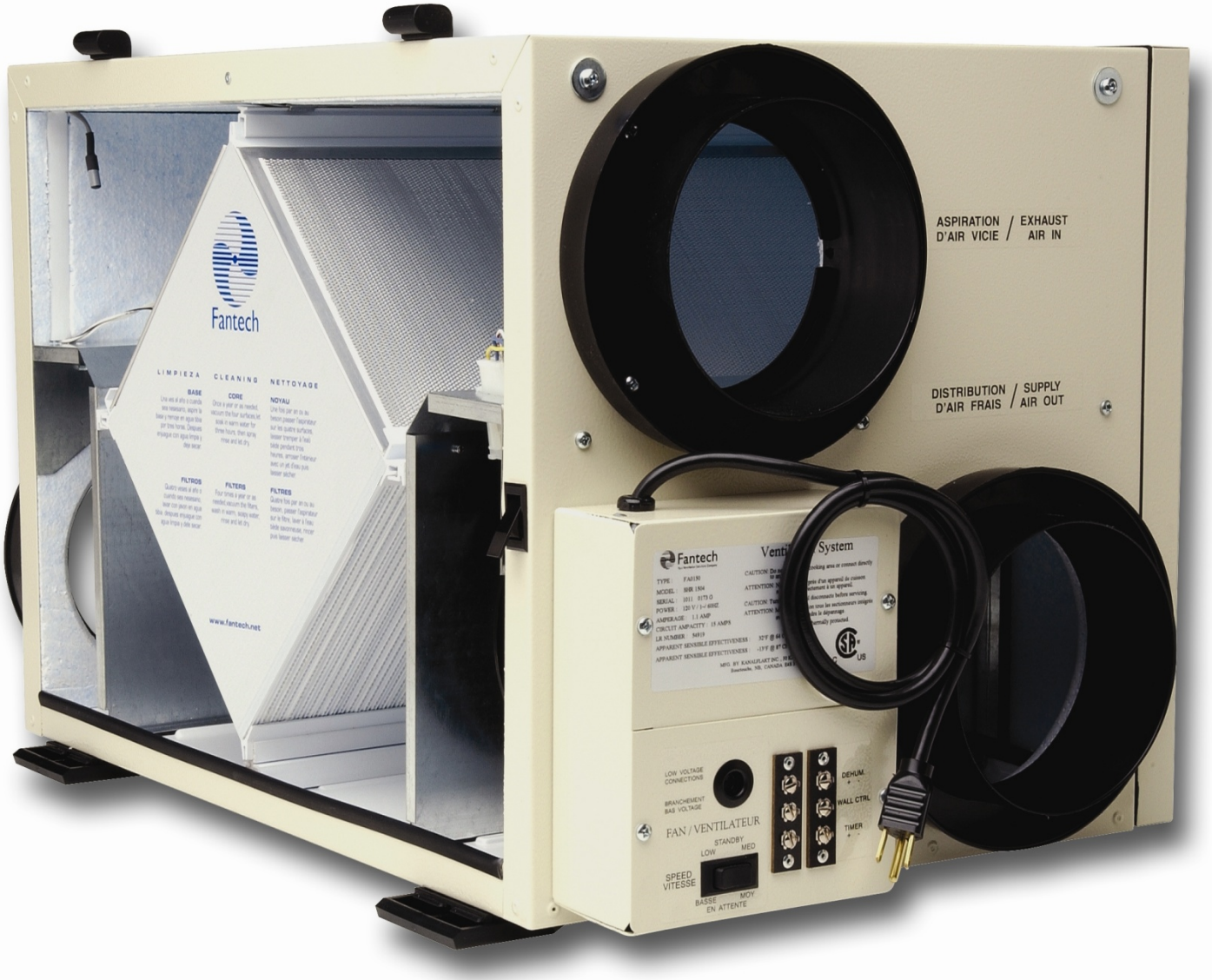
- HRVs / ERVs can be independently ducted or integrated into forced air system
- Choose systems that are rated by the Home Ventilating Institute

2100 HVI CERTIFIED Home Ventilating Institute

- Select units with the
  - right air flow
  - suitable for your climate zone.



Graphics Courtesy of Building Science Corp.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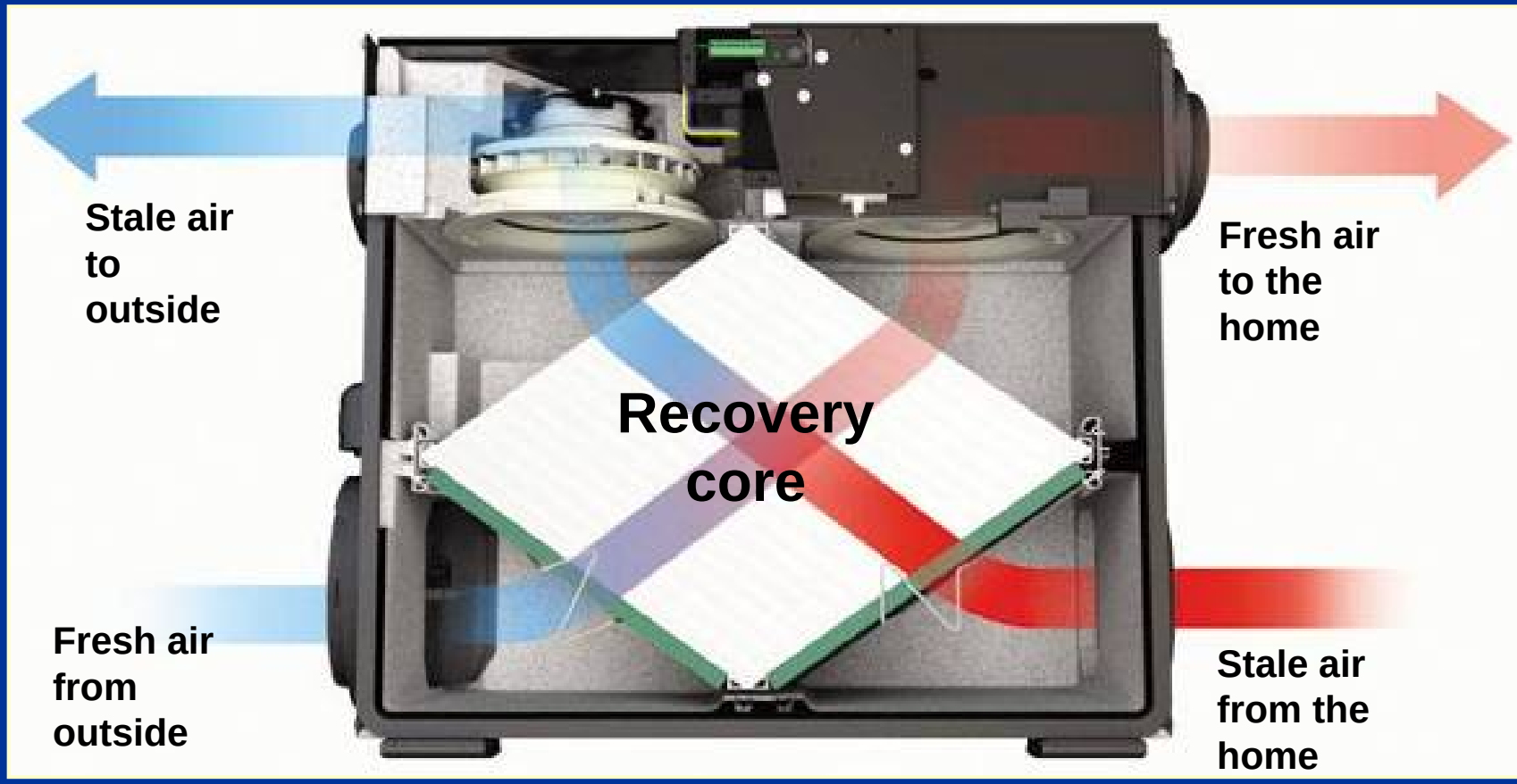
LOW
MED
SPEED
VITESSE
BASSE
MOY
EN ATTENTE
DEHUM.
WALL CTRL
TIMER

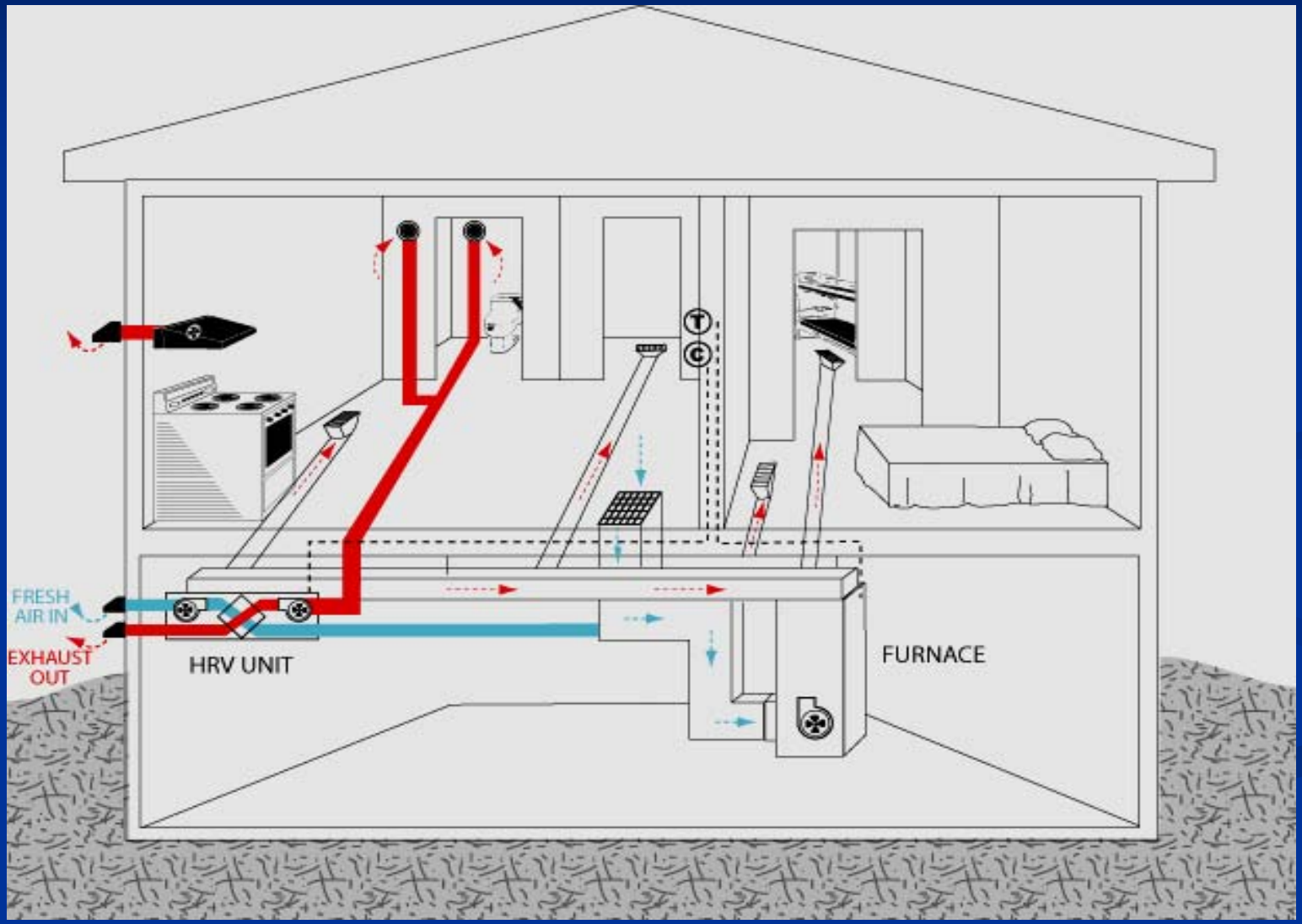
HRV / ERV

the LUNGS of the Home

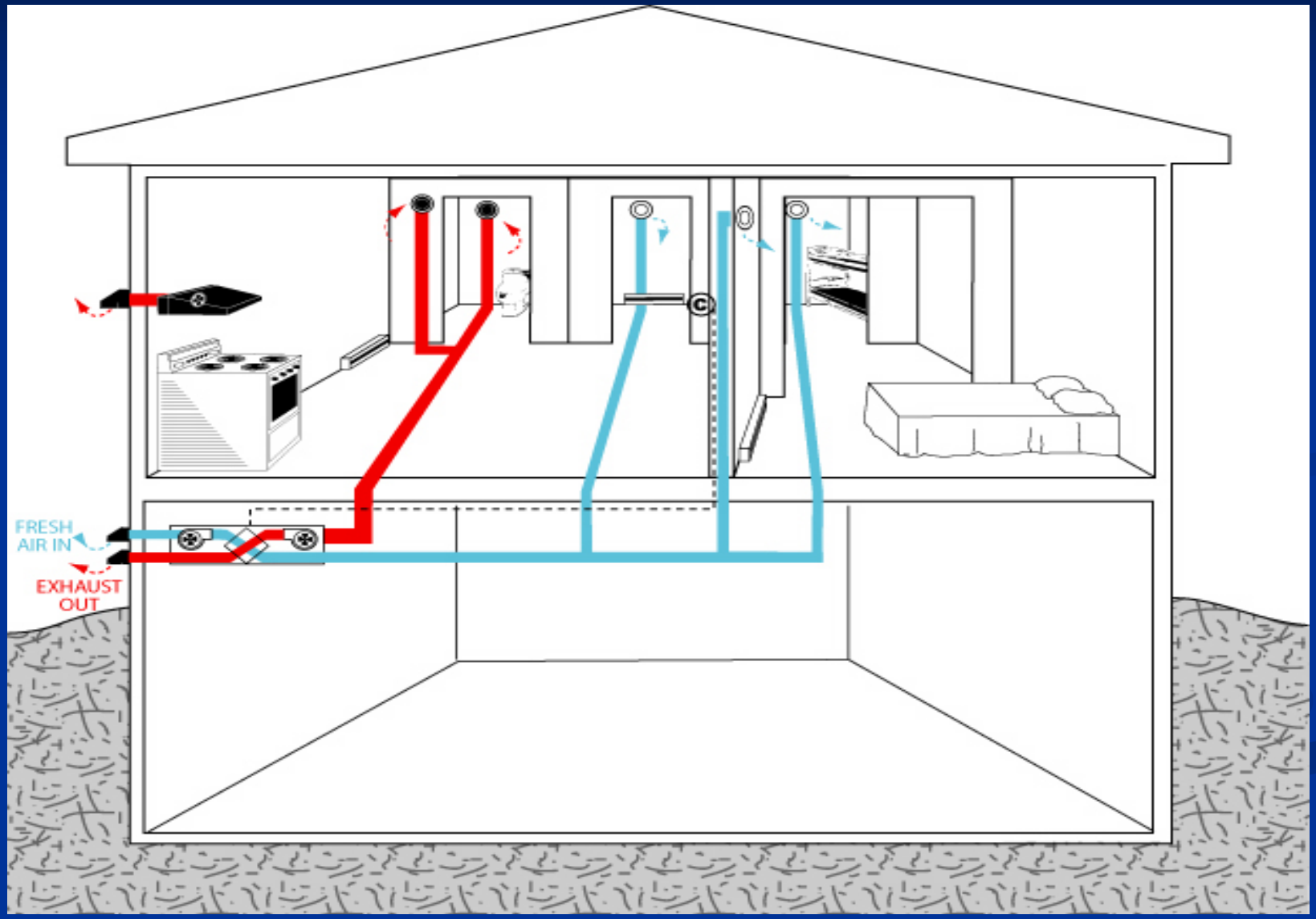
Recover as much as 70% - 80% of the energy from the exhaust air stream



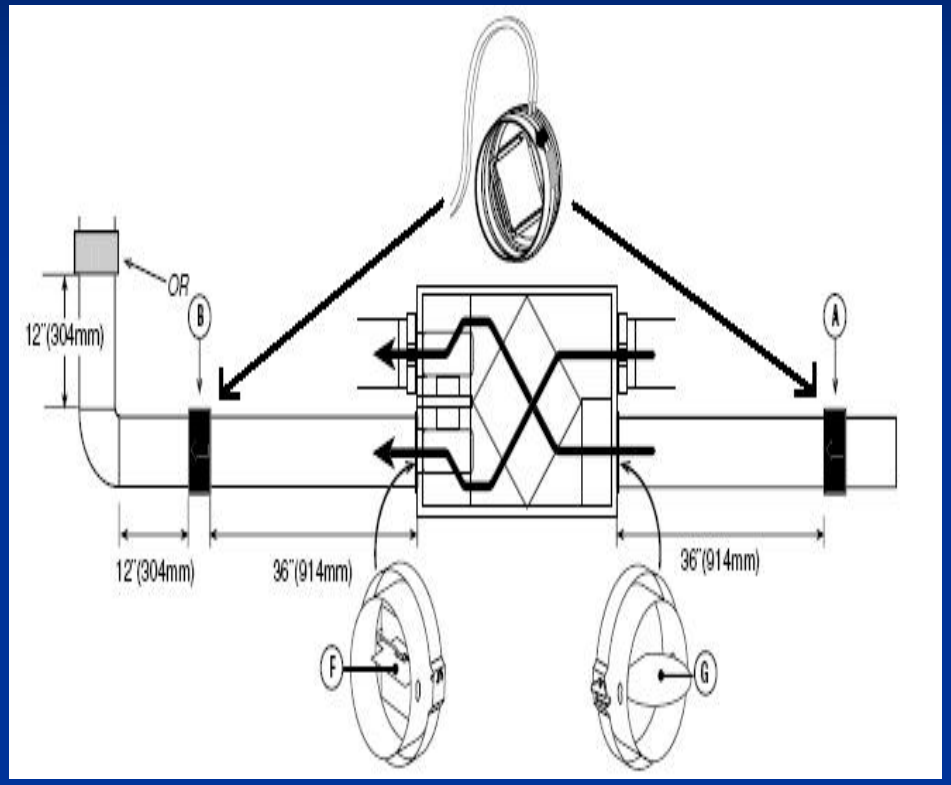
Ducted Exhaust – fresh air distributed by forced-air system



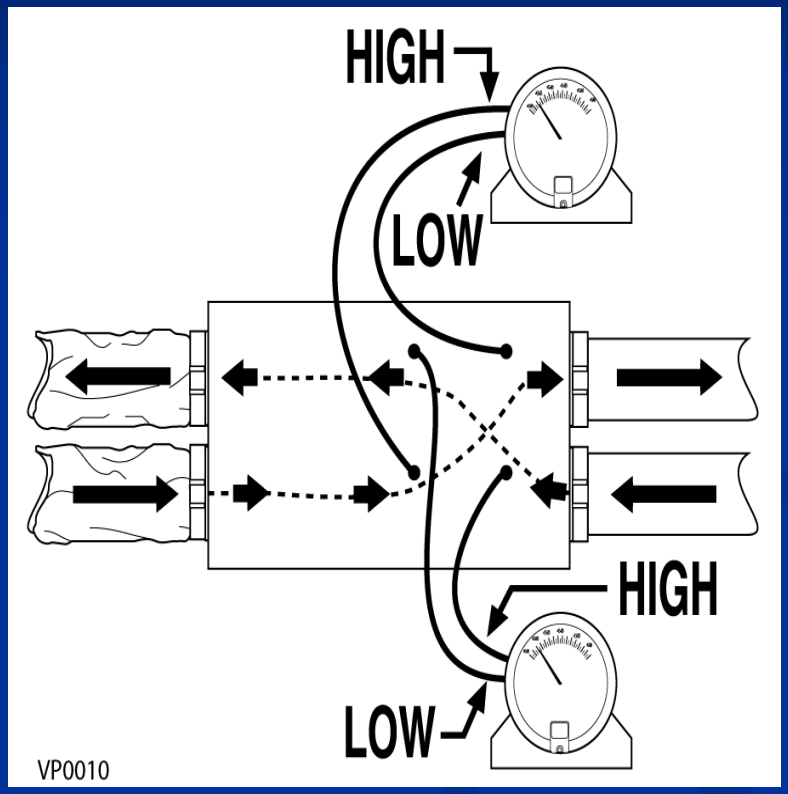
Fully ducted system



Balancing with airflow stations

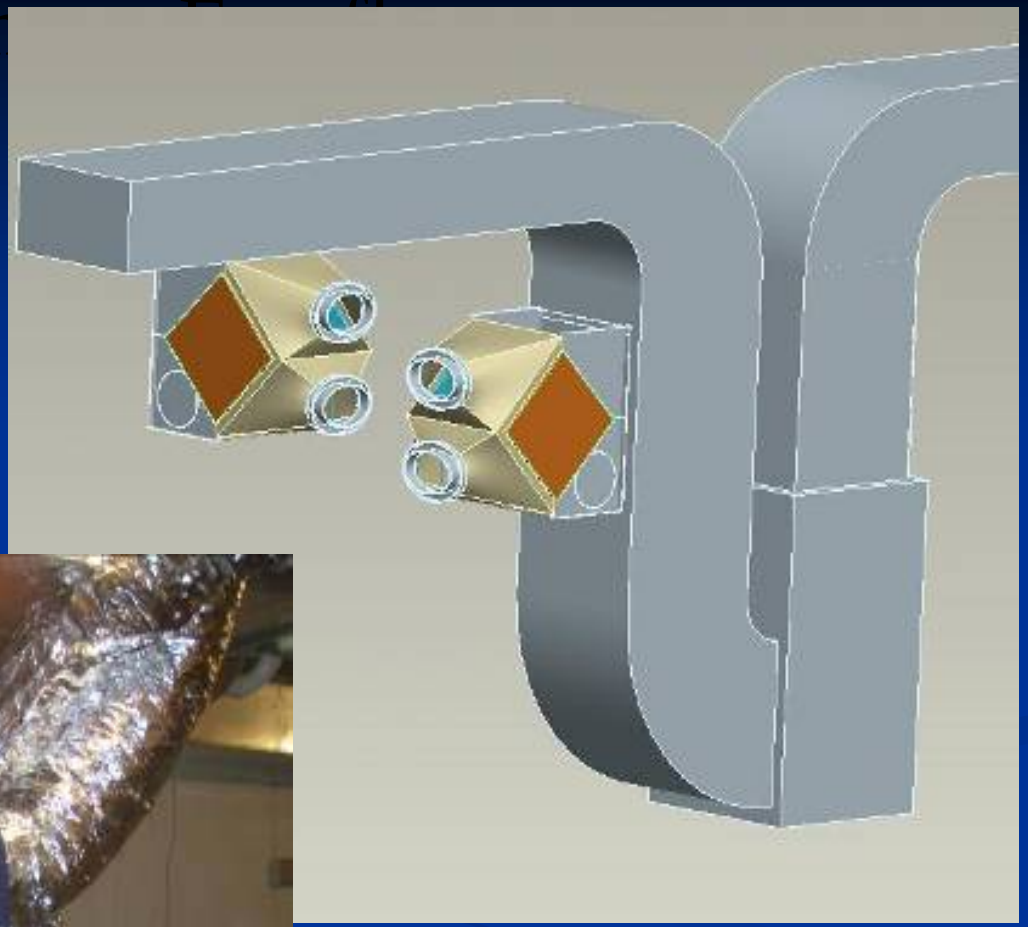


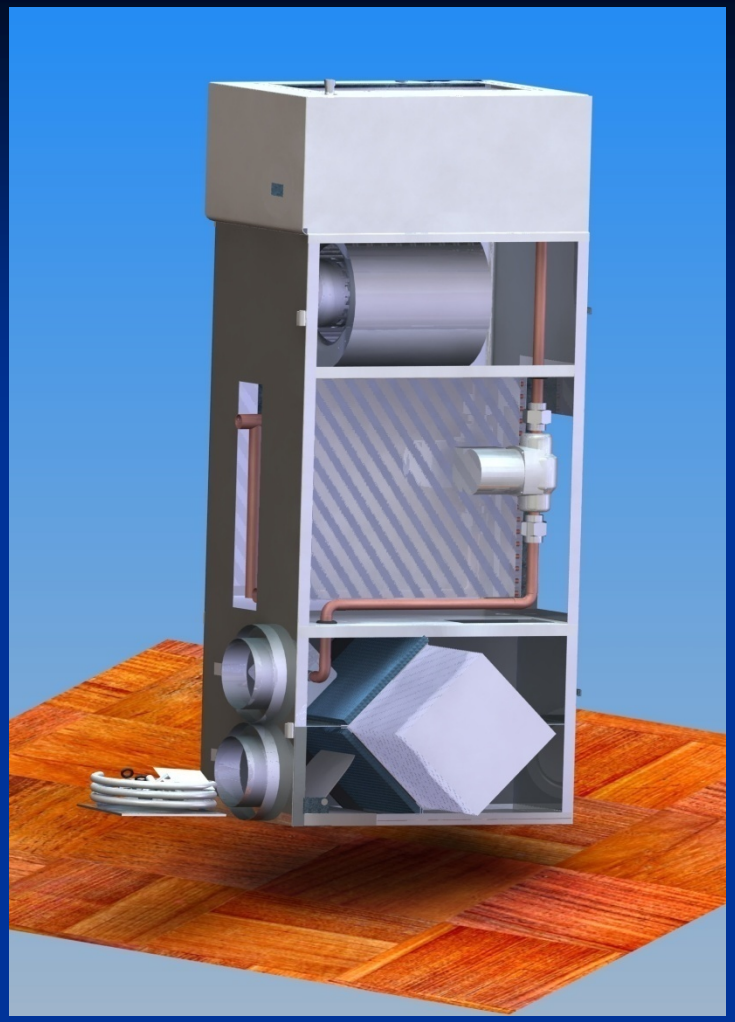
Balancing with door ports



Balance airflows within +/-10% for proper operation

Ver



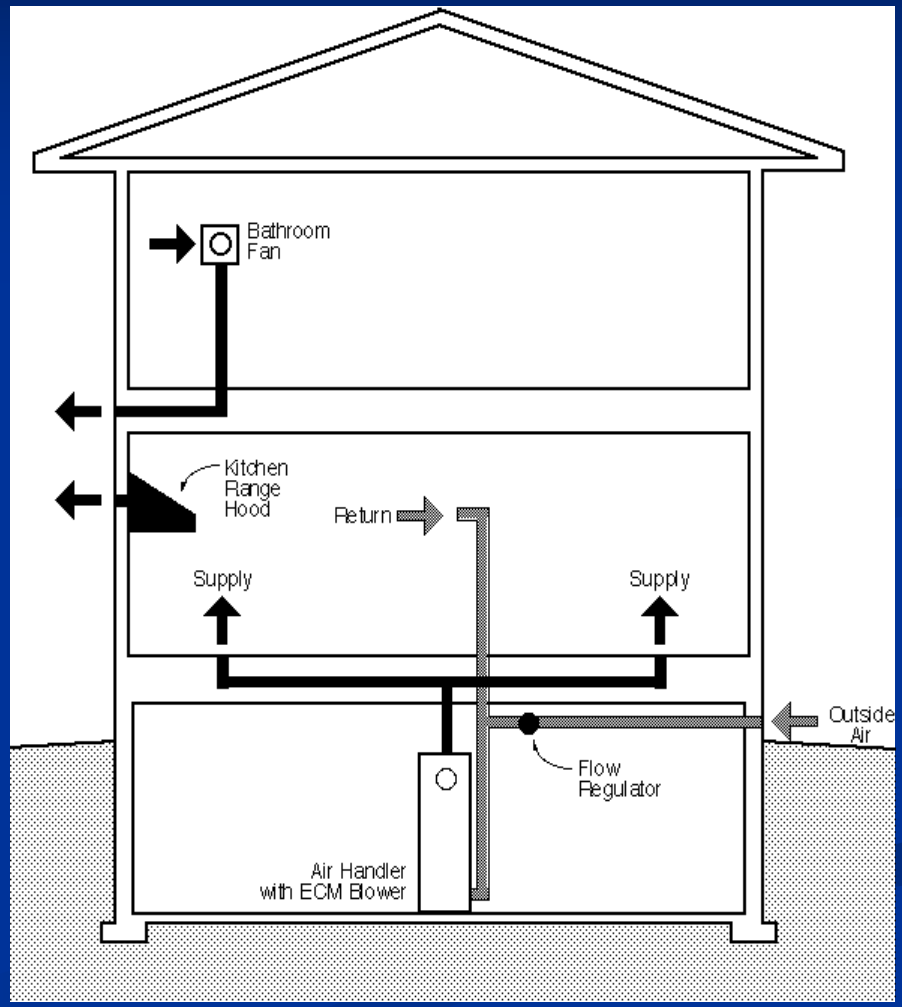


Integrated space, DHW and ventilation systems …

Exhaust Ventilation

Exhaust Ventilation

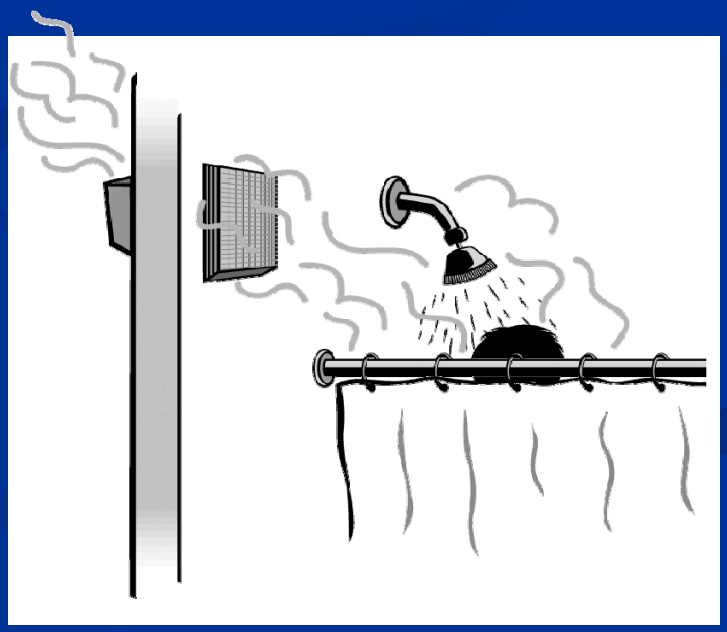
- Exhaust at source
- Use quiet, efficient, “tested” fans
- New controls
- Houses are tighter, be cautious about back-drafting



Minimum bathroom fan specifications

Choose fans that are:

- HVI rated, not less than 50cfm
- Have a sound rating not greater than 3.0 sones
- If intended for continuous use, a sound rating of 1.0 sone is required

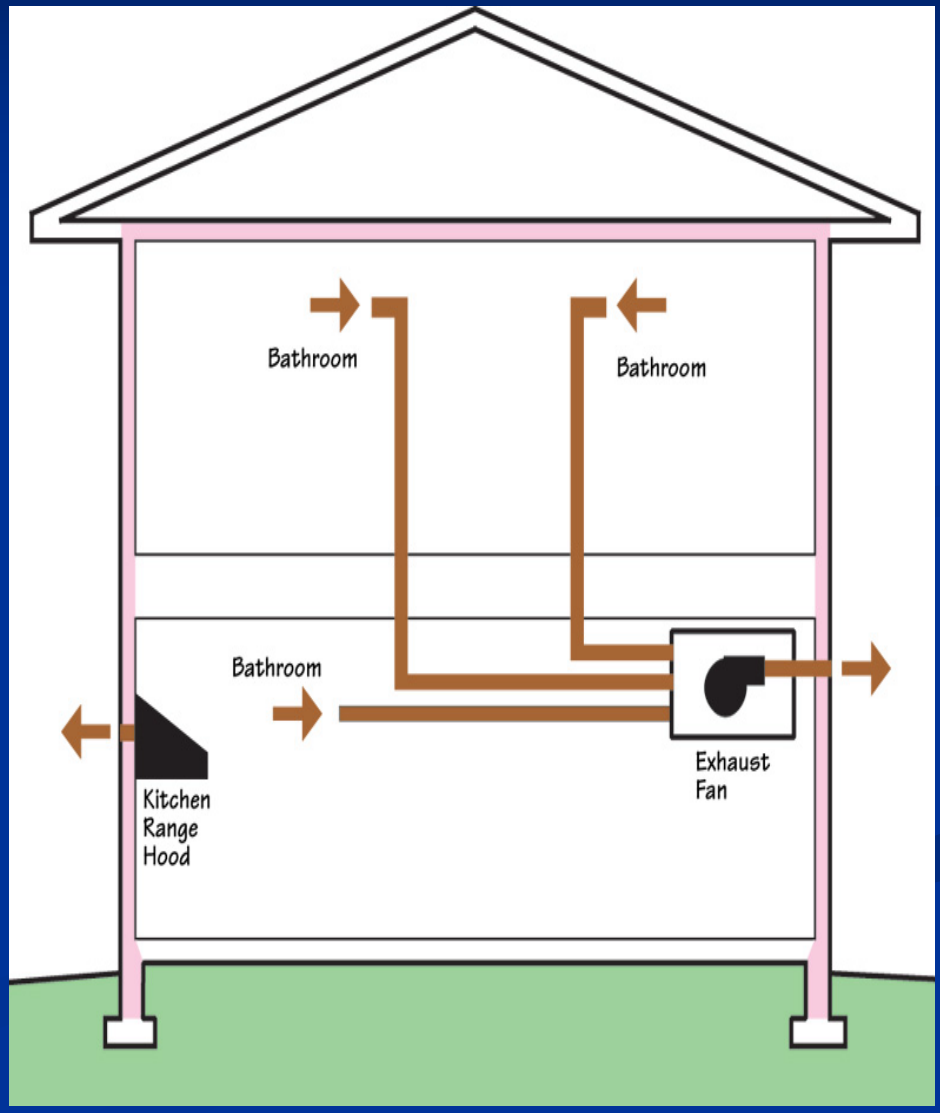



Properly sized fan and duct (5” dia.)
Insulated duct, air tight details

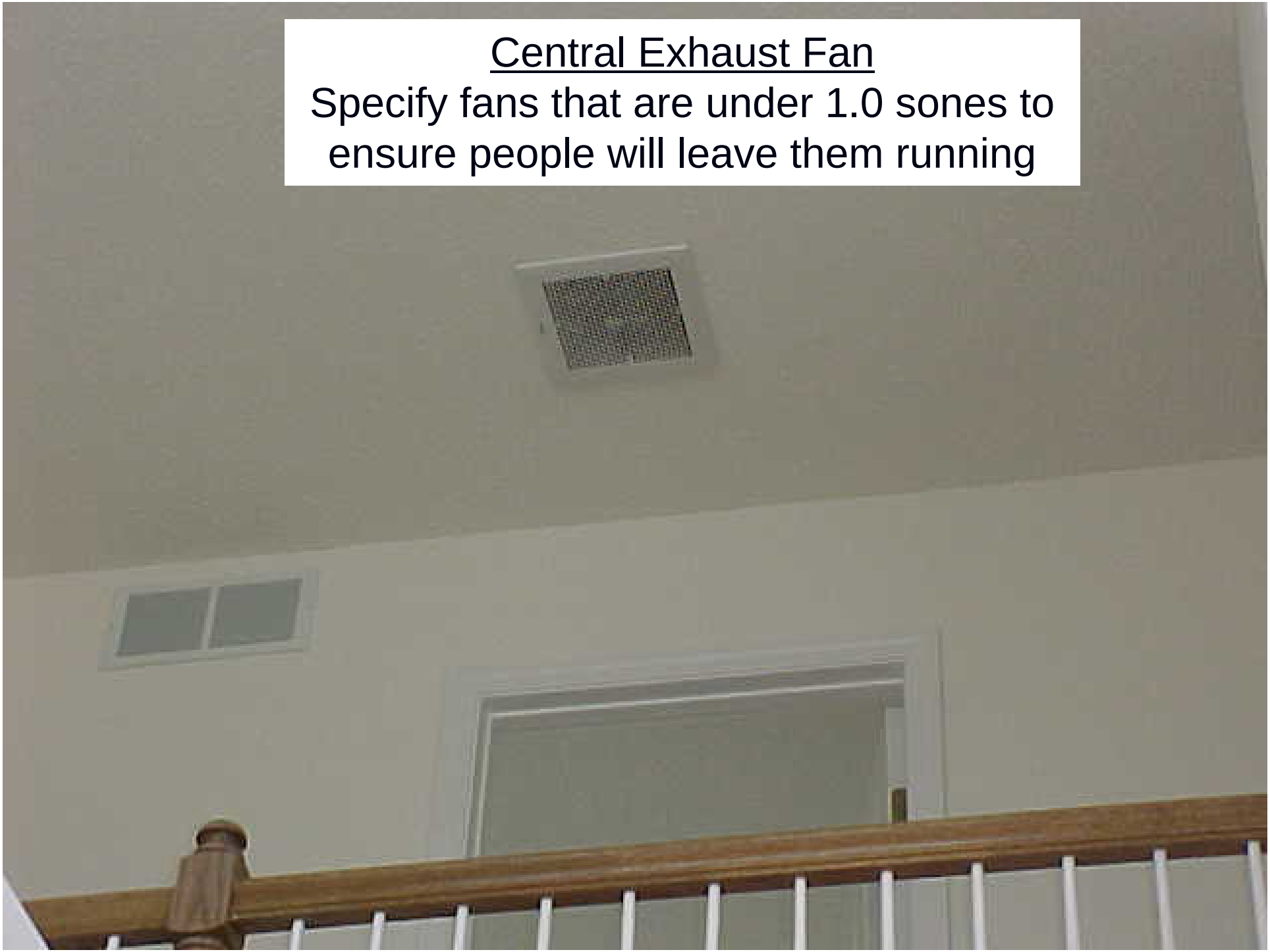
Exhaust Only Ventilation

Central Exhaust Fan

- A central fan can reduce noise levels and encourage extended operation times
- Locate the fan in unoccupied areas, accessible for maintenance
- HRV / ERV ready



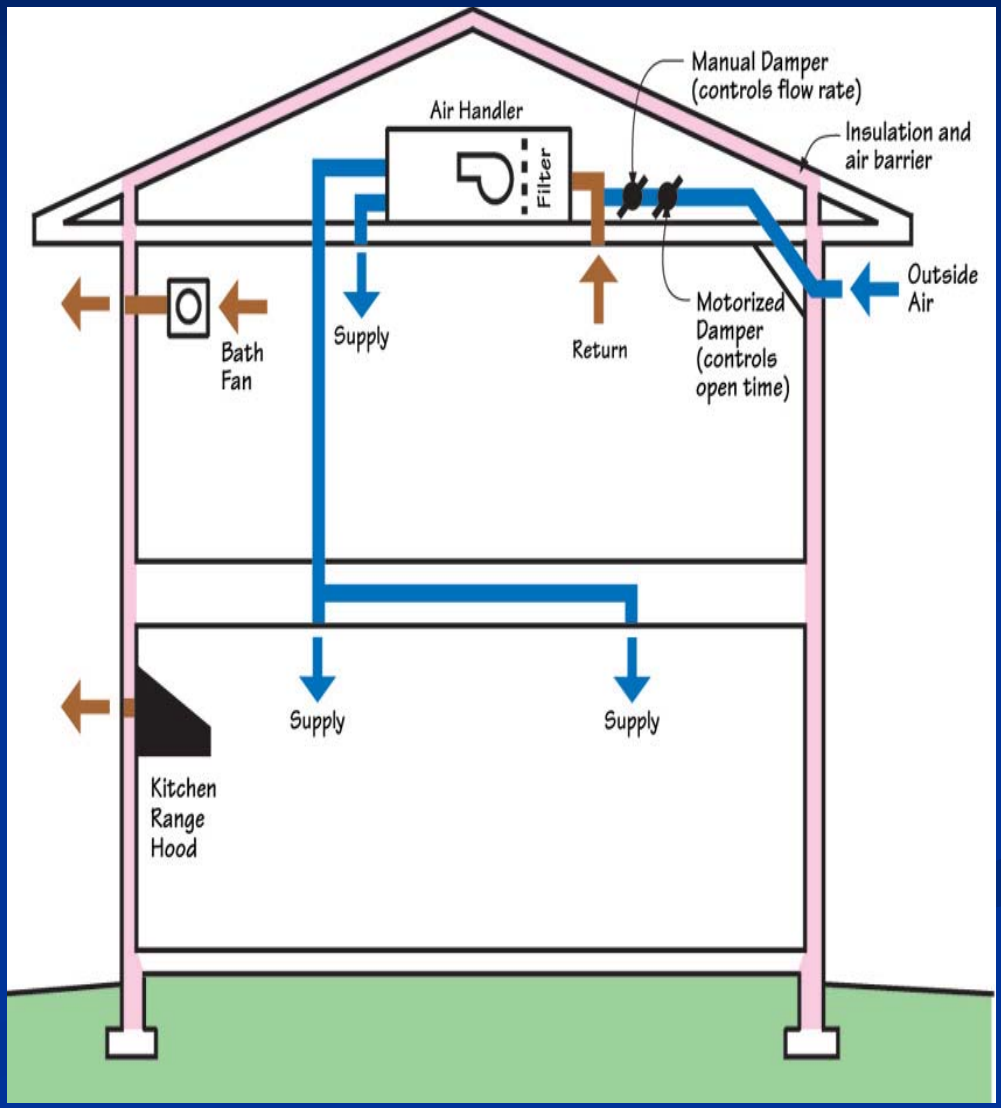
Graphics Courtesy of Building Science Corp.


Central Exhaust Fan
Specify fans that are under 1.0 sones to ensure people will leave them running

Supply Ventilation

Supply Only Ventilation

- A 6” fresh air into the air handler return
- Uses dampers and controls to regulate ventilation (independent of heating & cooling)
- Use ECM motors
- Recognize supply only ventilation will tend to pressurize homes – this is good in cooling zones, bad in heating



Graphics Courtesy of Building Science Corp.

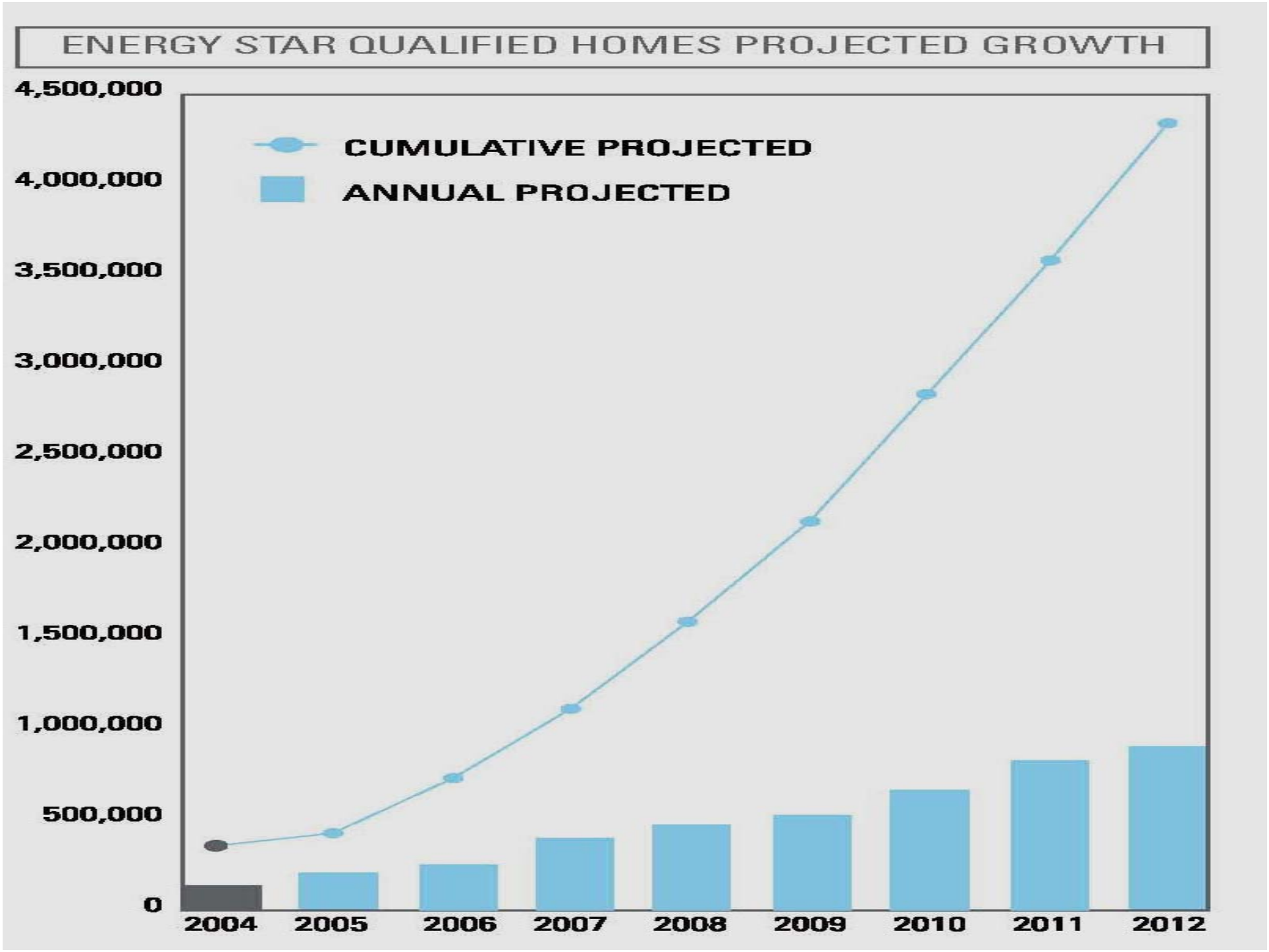
Fresh air distribution is essential for good IAQ with all systems!

the debate continues…
More customers vs more business

- More customers?
- More product to existing customers?

Why not let ventilation help you do more business with your existing customers

Changing the Course of Housing


ENERGY STAR QUALIFIED HOMES PROJECTED GROWTH
4,500,000
4,000,000
3,500,000
3,000,000
2,500,000
2,000,000
1,500,000
1,000,000
500,000
0
CUMULATIVE PROJECTED
ANNUAL PROJECTED
2004
2005
2006
2007
2008
2009
2010
2011
2012

The opportunity

- America needs healthy, energy efficient houses
- Healthy homes need good ventilation
- You're in a great industry, with great products
- You are well placed to take advantage of the opportunities
- There is good work to be done – good money to be made
- **Go get it!**

Put the V back in HVAC


Thank You!
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