Poor Spray foam installation


14 1/2

Insulating is a system

More choices offer better performance

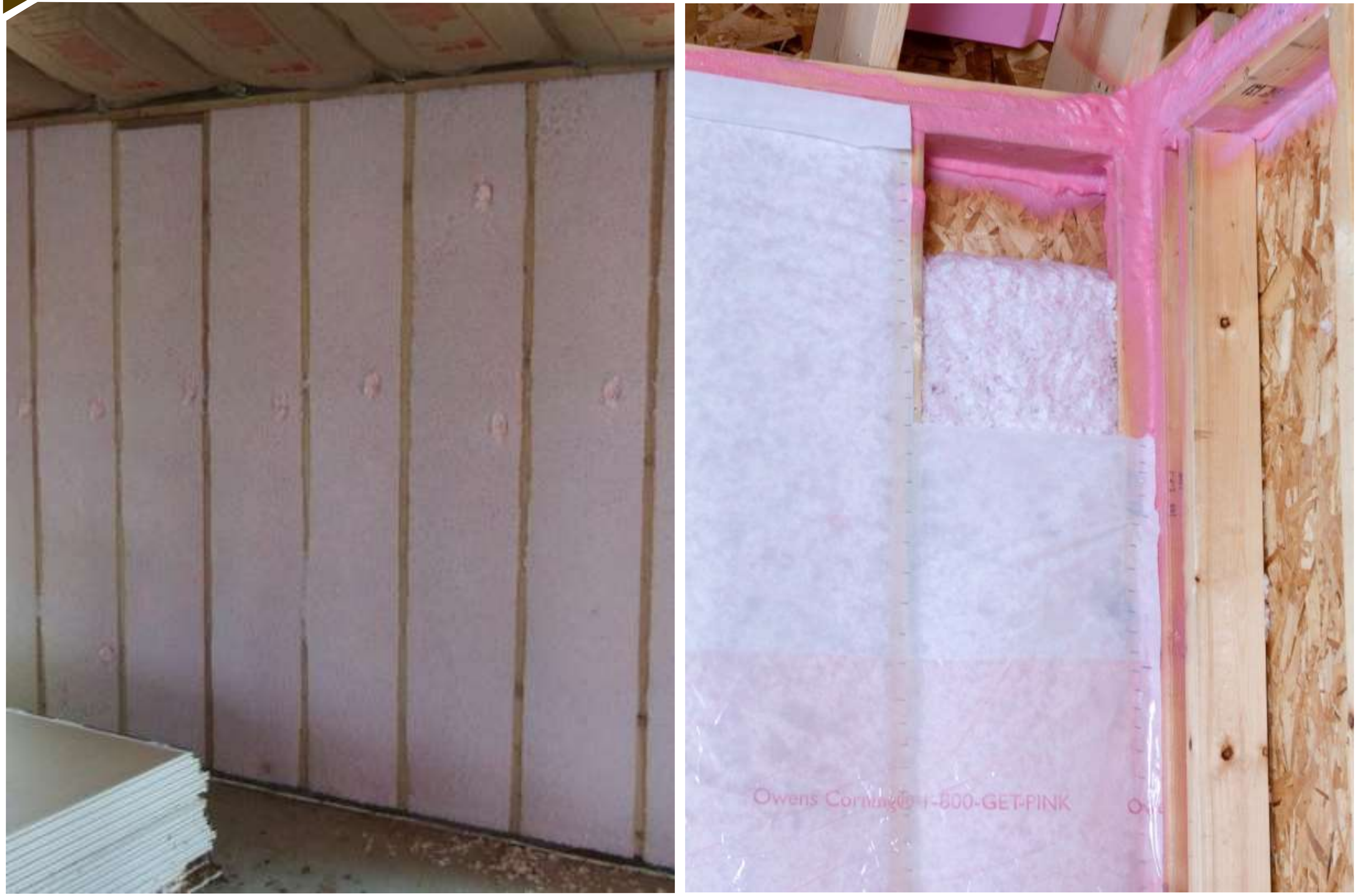
INSULATING
GUIDE

By
R. Christopher Mathis

Careful installation of all insulating systems are essential for good performance

Blown cellulose insulation

High density blown fiberglass



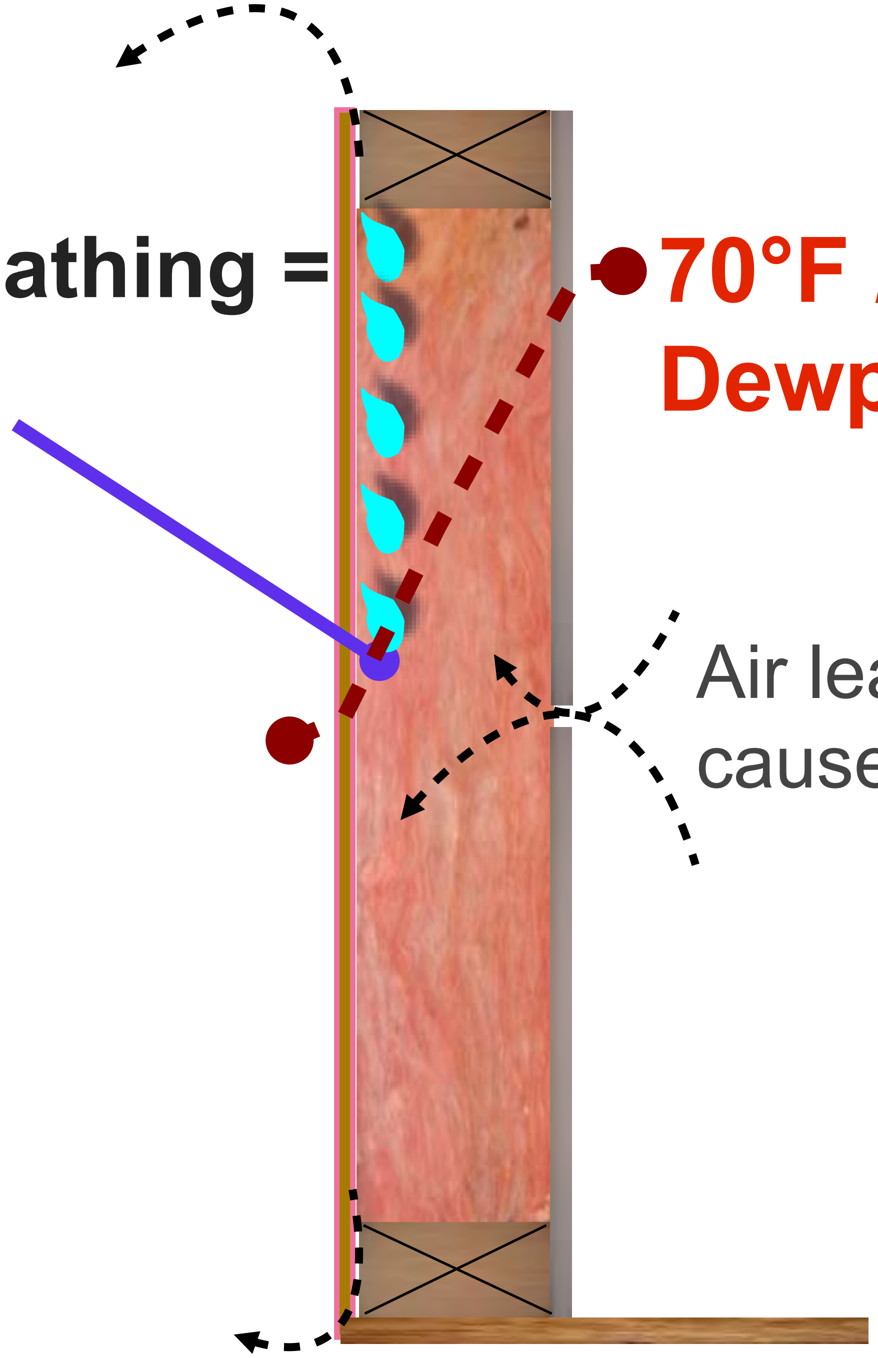
SPF- spray polyurethane foam

SPF- spray polyurethane foam

Again....benefits of exterior insulation

New products and techniques

Surface temperature calculation - 2 x 6 walls, w/ R-19 insulation



Temp. @ sheathing =

17.1°F

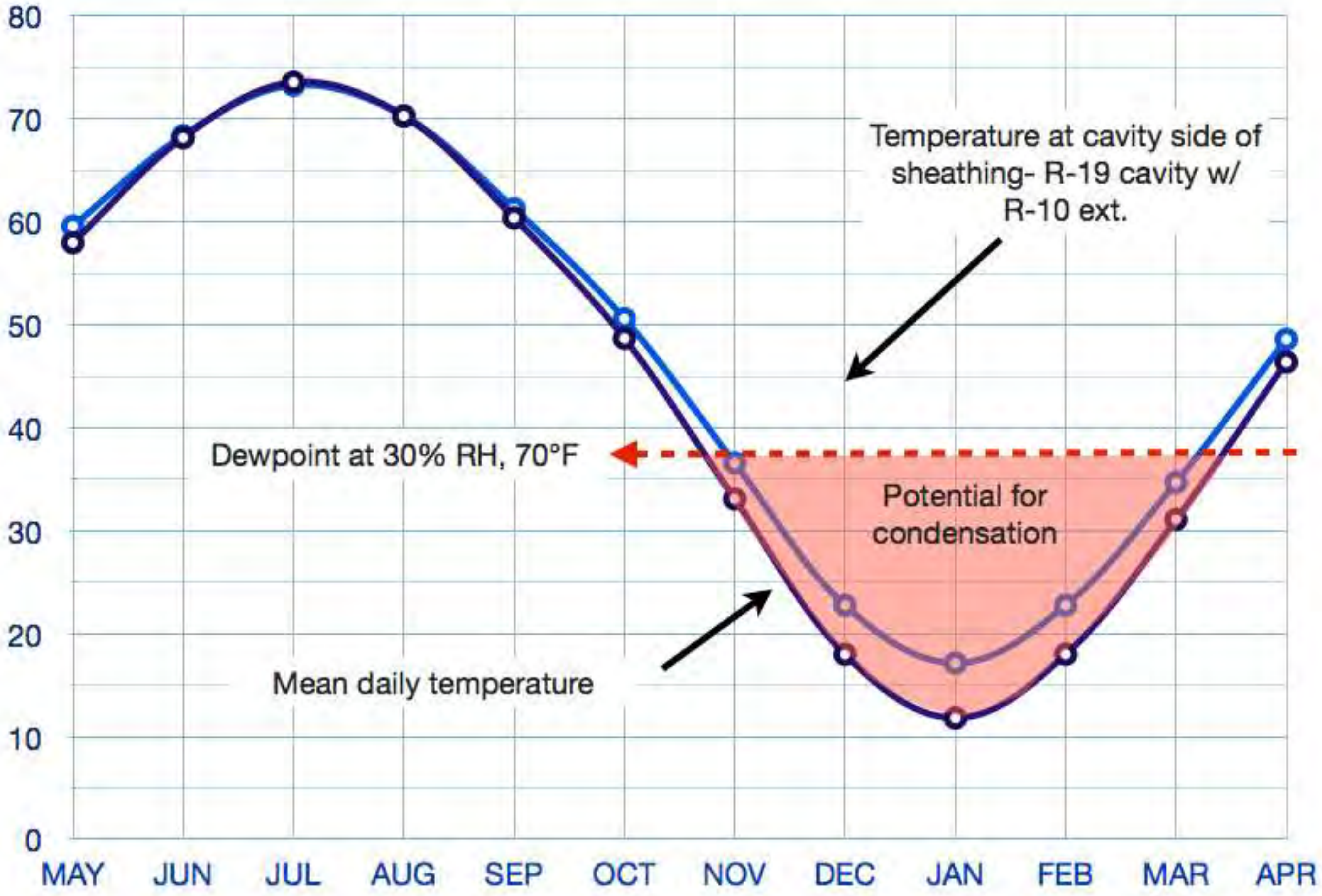
70°F / 30% RH,
Dewpoint = 37.2°F

Air leakage can
cause condensation

12°F

4% of total thermal resistance is outside (only OSB)

Climate Zone 6 - 2 x 6 wall , R-19 cavity Insulation



Temperature at cavity side of sheathing- R-19 cavity w/ R-10 ext.

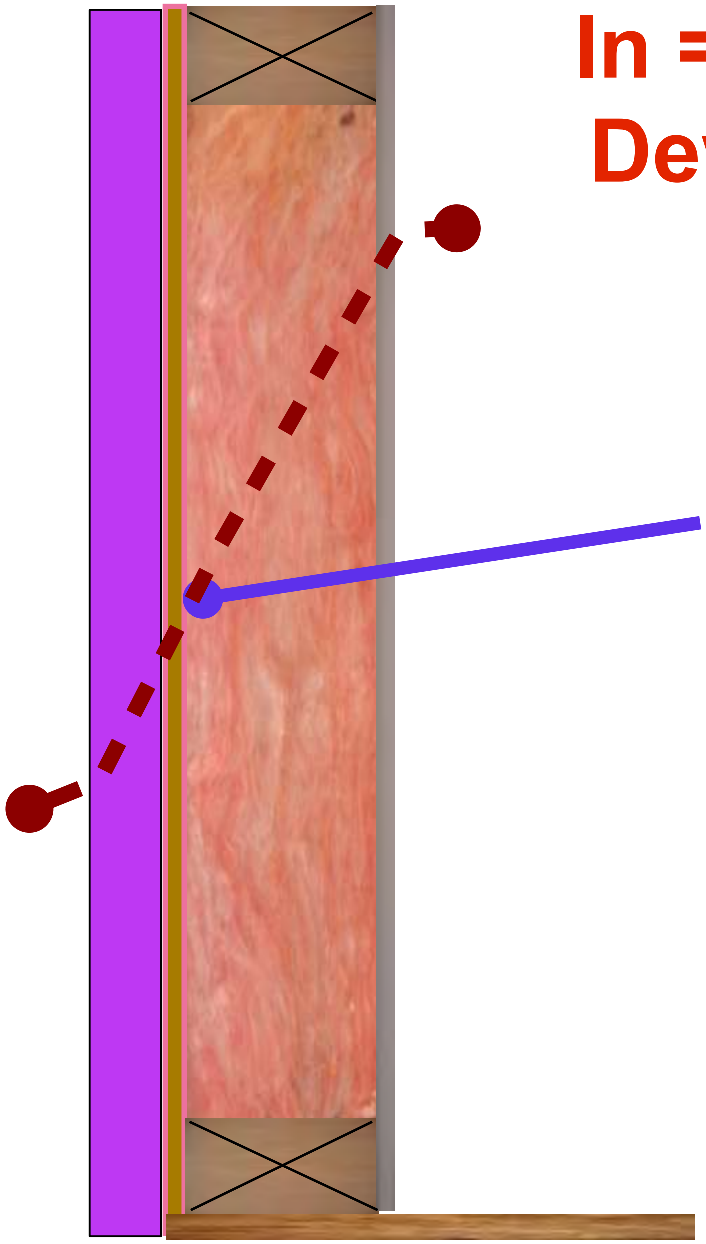
Dewpoint at 30% RH, 70°F

Potential for condensation

Mean daily temperature

Surface temperature calculation - 2 x 6 walls, w/ R-19 insulation + R 10 ext.

Temp. @ sheathing



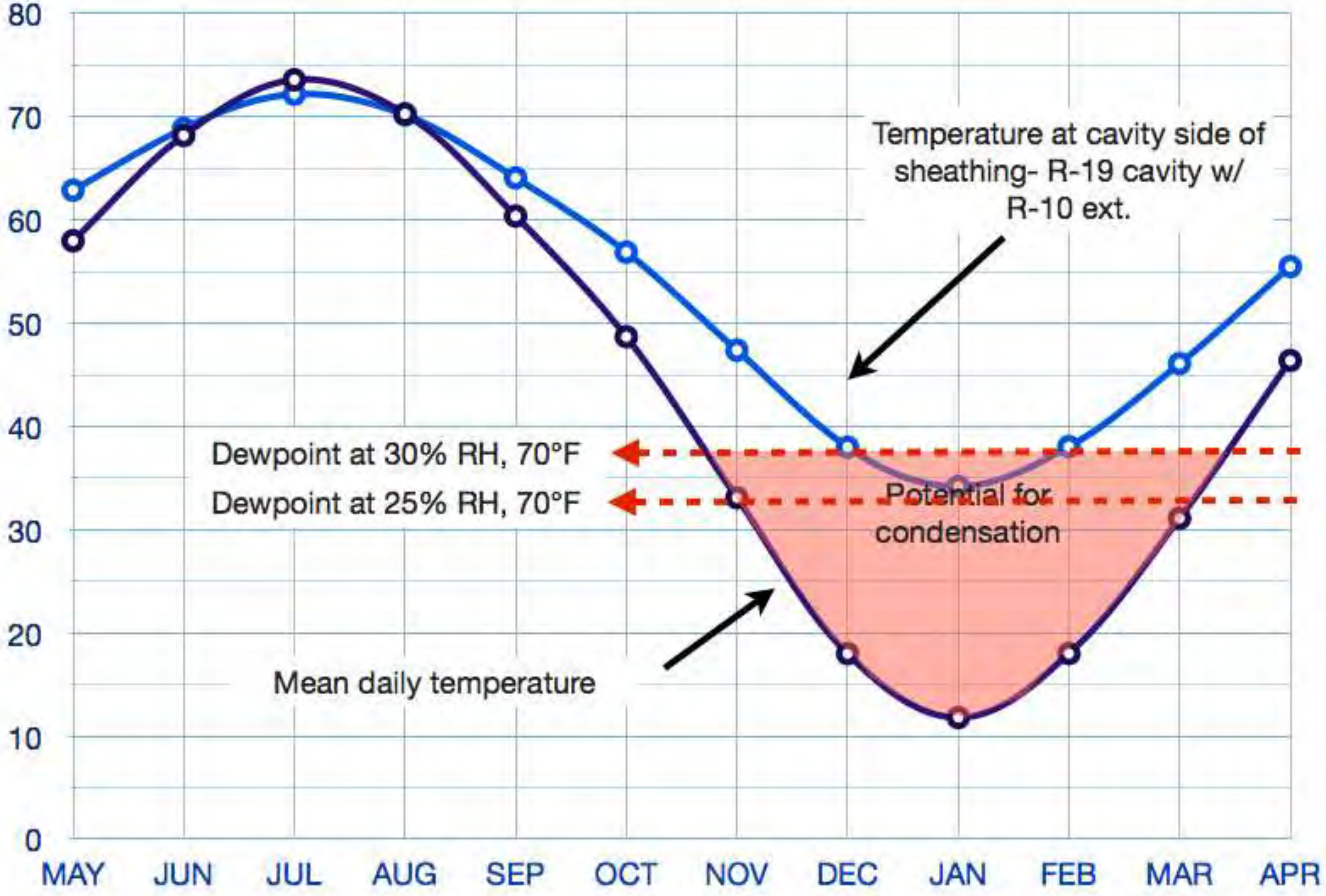
In = 70°F / 30% RH
DewPoint temp. = 37.2°F

34.4°F

Out = 12°F

41% of the total wall R-value is outside sheathing plane (OSB)

Minneapolis, MN - 2 x 6 wall w/ R-10 foam sheathing



Class III Vapor retarders (semi-permeable) are permitted if:

Permeance of < 10 or >1.0

Climate Zone	Minimum Cont. Insulation R-Value	
	2 x 4 walls	2 x 6 walls
Marine & Zone 4	R-2.5	R-3.75
Zone 5	R-5	R-7.5
Zone 6	R-7.5	R-11.25
Zones 7 & 8	R-10	R-15

Summary of Proper Insulation

- R-Value is assured
- Reduce thermal bridging
- Calculation for load & equipment match
- Thermal comfort is provided
- Sound reduction occurs
- Energy savings

Innovative wall systems

- Alternate methods can provide benefits

Wood Frame Construction

- Wood dominated industry
- Wood constitutes 84% of residential construction
- 1.3 million single family detached built annually

What constitutes the other 16%?

Structurally insulated panels provide high R-Value assemblies

ICF Subdivision

Window Systems

Windows

- Provided natural light and ventilation
- Passive solar heat
- Architectural element
- 1/3 to 2/3 thirds of total AC loads

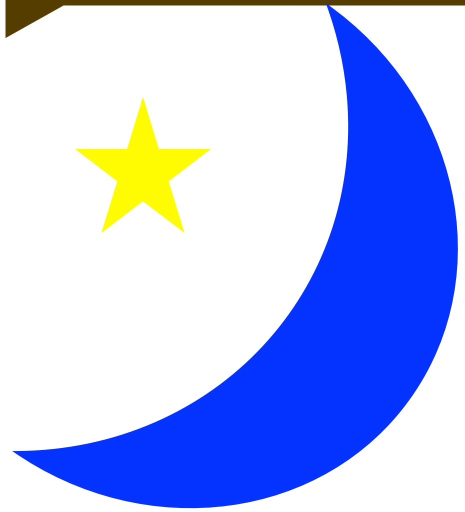
What defines high performance windows?

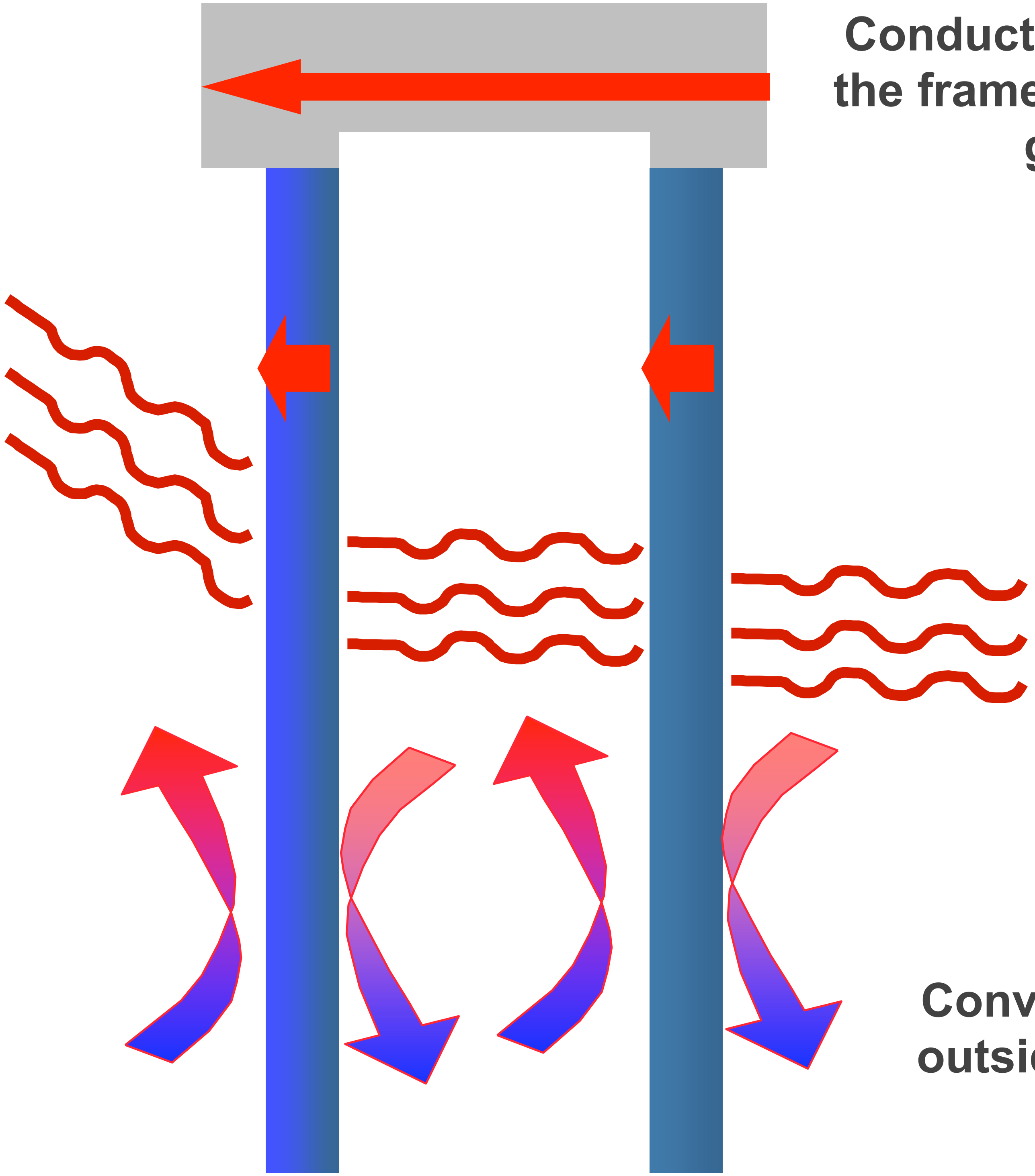
- Heat gain & heat loss reduction
- Energy efficiency
- UV light reduction
- Durability
- Wind and rain resistance

Four technologies are common:

1. Low emissivity coatings
2. Insulated spacers
3. Gas filled
4. Insulated frame tech.

Wintertime Heat Loss





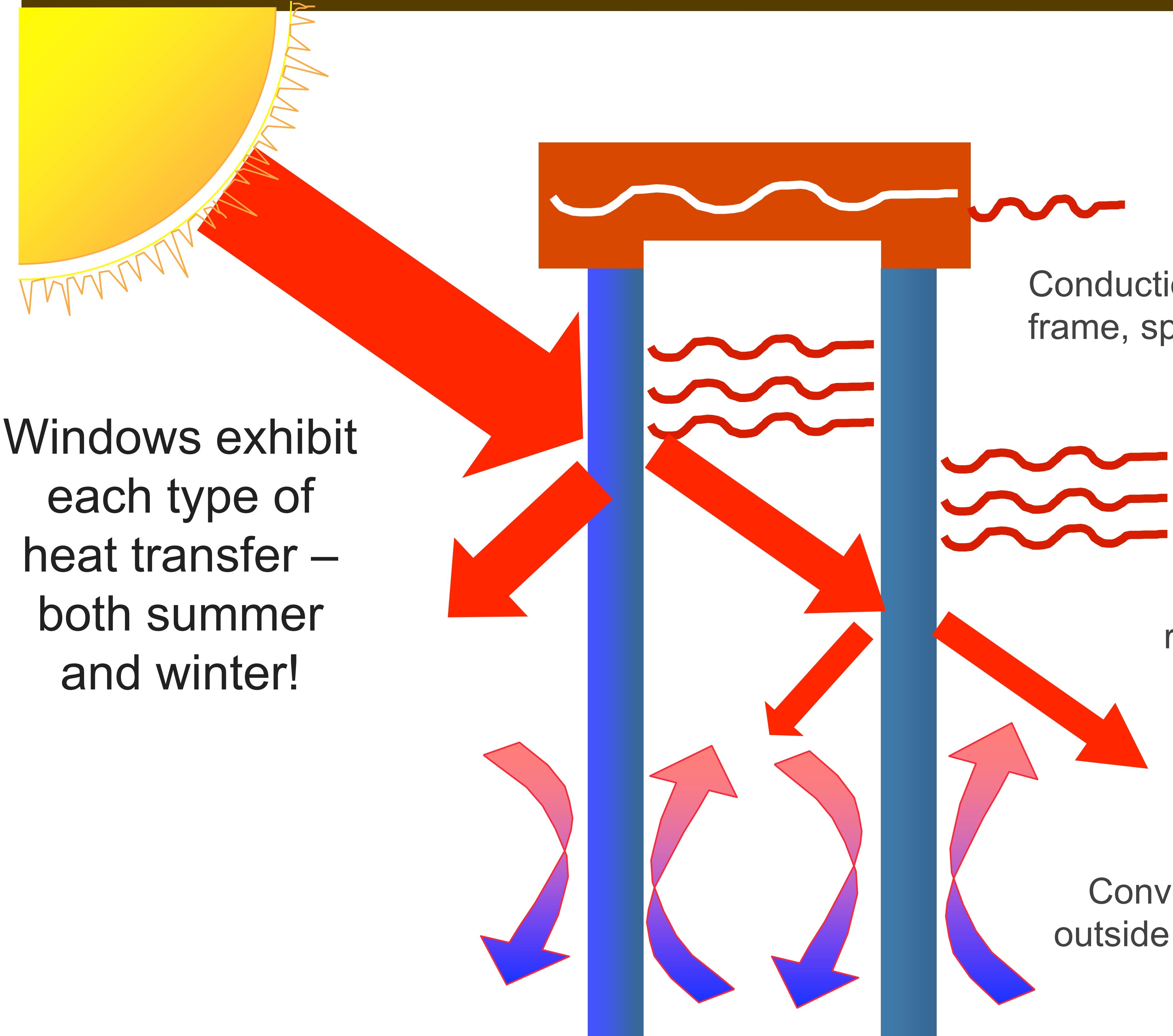
Conduction –through the frame, spacer, and glass

Radiation – direct, re-radiated, inside, outside and between the glass

Convection – inside, outside and between the glass

Windows exhibit each type of heat transfer – both summer and winter!

Summertime Heat Gain



Windows exhibit each type of heat transfer – both summer and winter!

Conduction –through the frame, spacer, and glass

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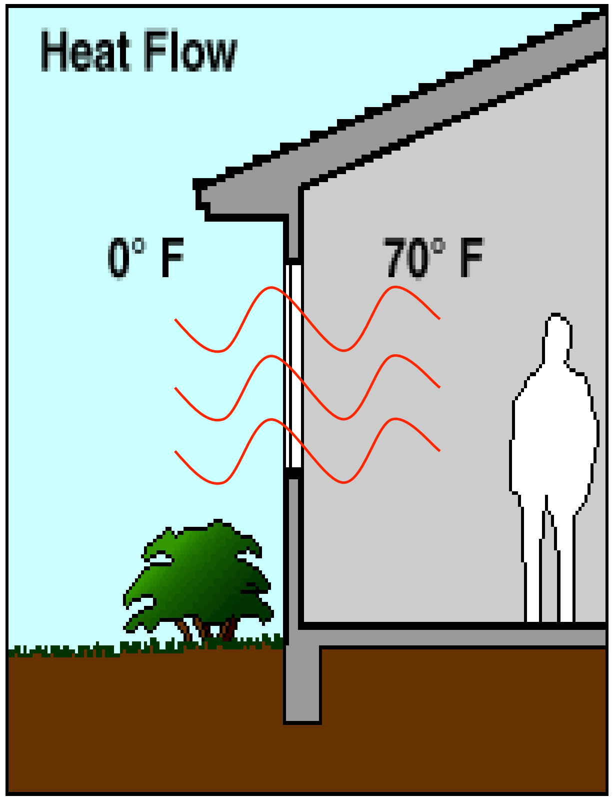
Convection – inside, outside and between the glass



National Fenestration Rating Council CERTIFIED

ENERGY PERFORMANCE RATINGS

U-Factor (U.S./I-P)	Solar Heat Gain Coefficient
0.30	0.36

ADDITIONAL PERFORMANCE RATINGS

Visible Transmittance	
0.59	—

Manufacturer stipulates that these ratings conform to applicable NFRC procedures for determining whole product performance. NFRC ratings are determined for a fixed set of environmental conditions and a specific product size. Consult manufacturer's literature for other product performance information.
www.nfrc.org

ENERGY STAR® Qualified
in All 50 States

Design Pressure (PSF)

DP 30

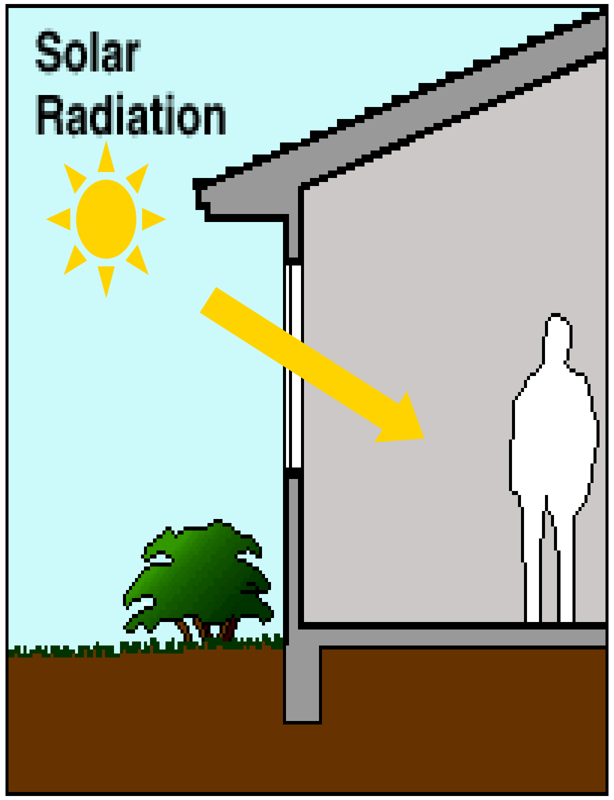
WDMA HALLMARK WINDOW AND DOOR MANUFACTURERS ASSOCIATION CERTIFIED

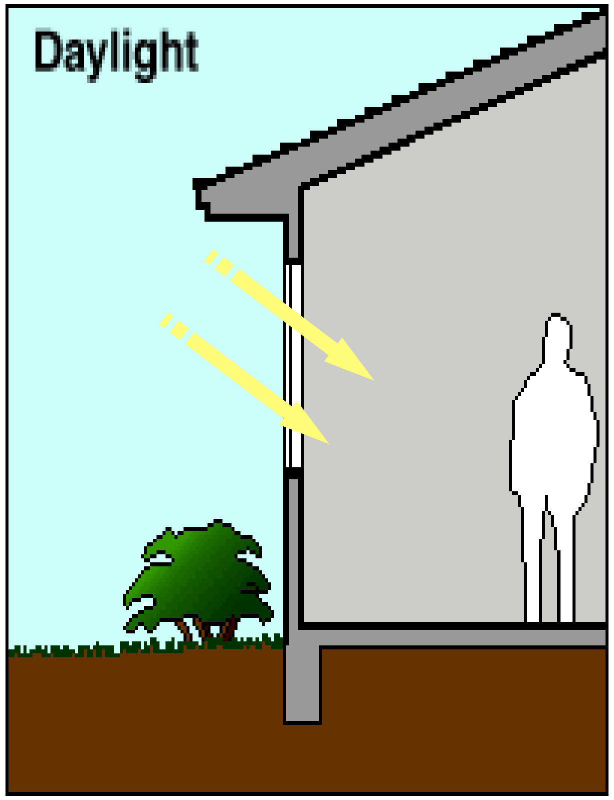
F-C50 60" x 72"

Tested to ANSI/AAMA/NWWDA 101/I.S.2-97 or NAFS-1

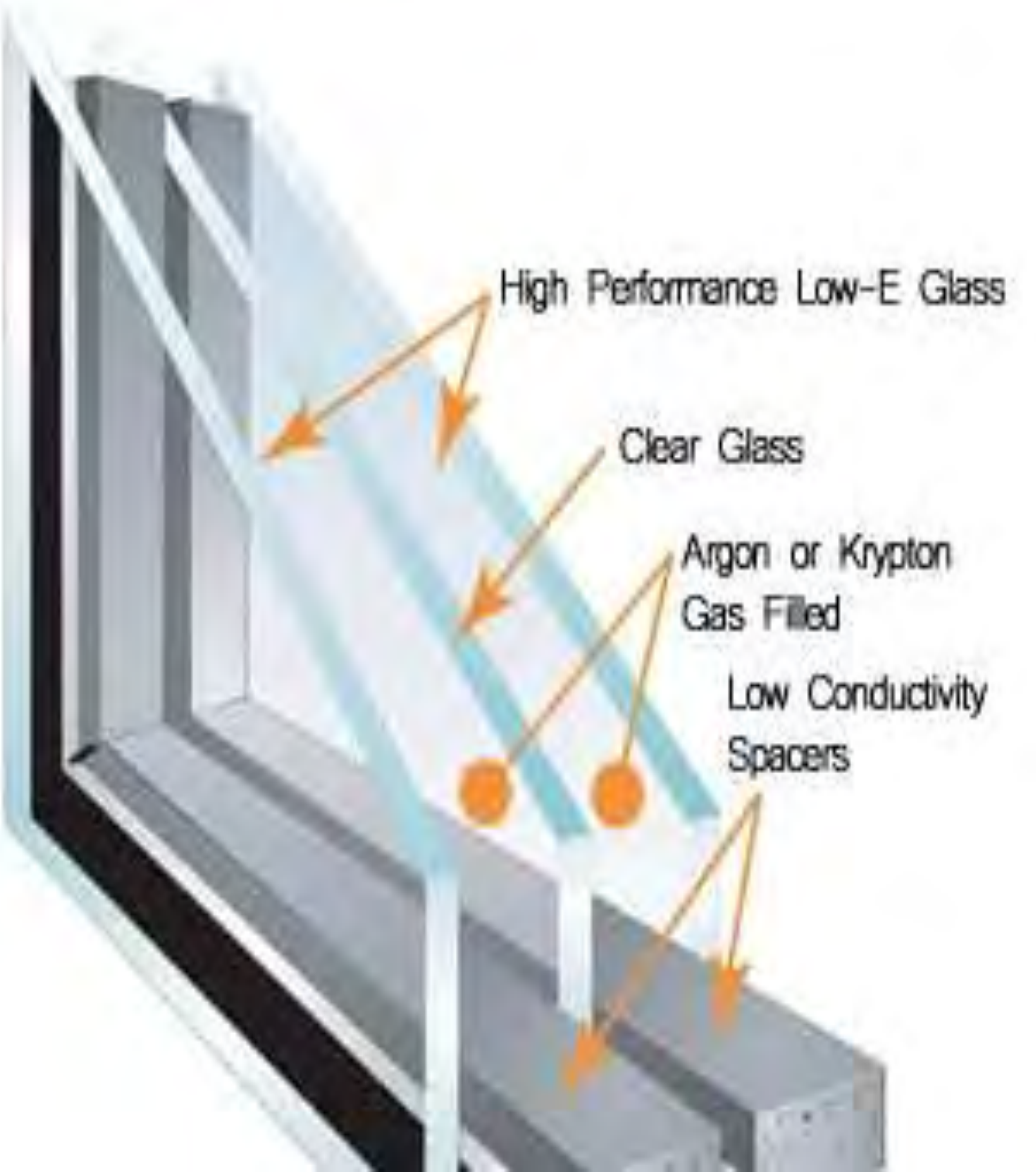
Meets or exceeds M.E.C., C.E.C., & I.E.C.C. Air Infiltration Requirements WDMA Hallmark Certification Program

Rev. 1/04 Part # [illegible]





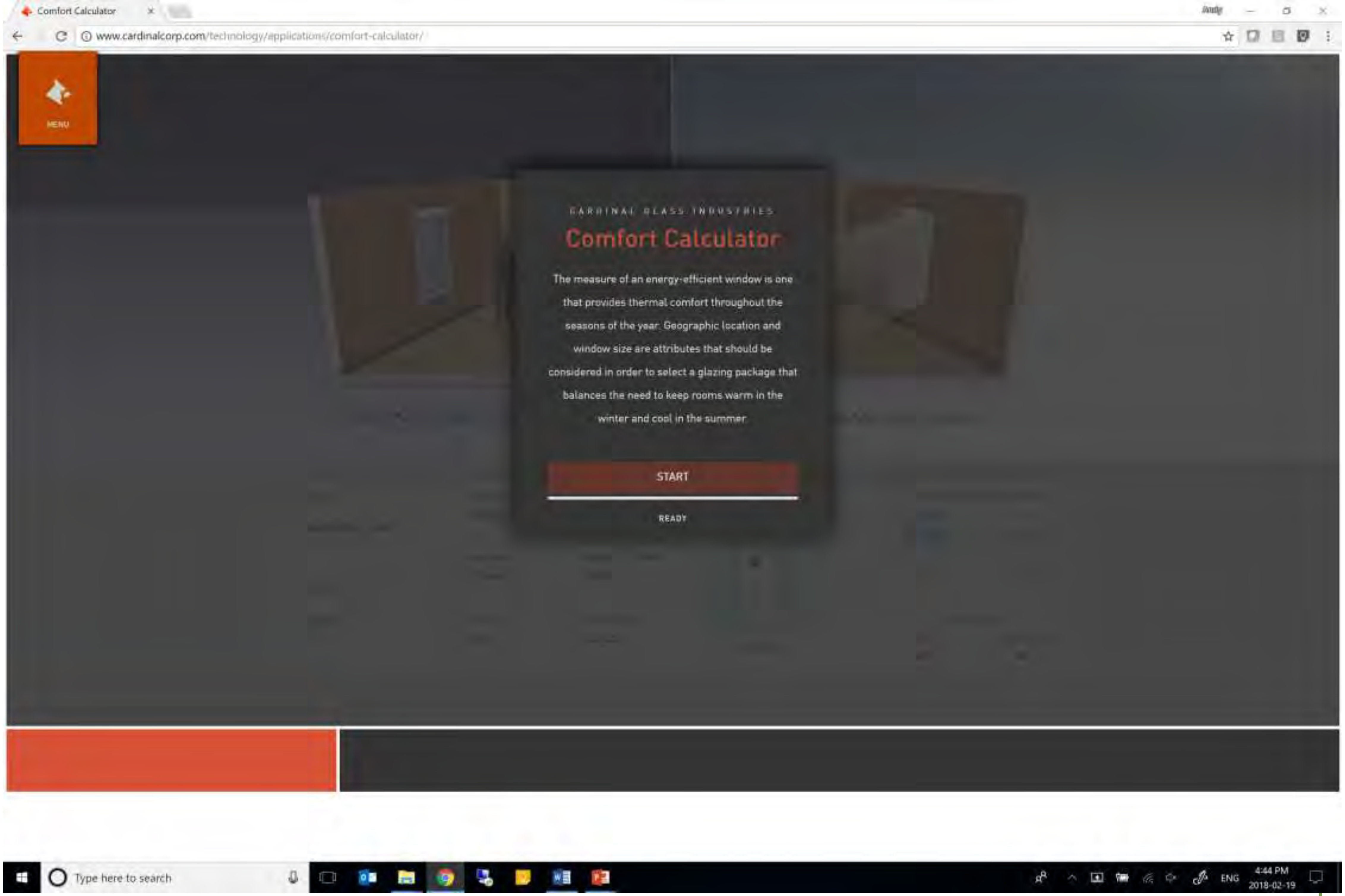
HIGH PERFORMANCE HOMES AND KEY WINDOW CONSIDERATIONS YOU DON'T GENERALLY THINK OF…



- Solar energy gain
- AC loads
- Comfort
- Condensation
- Installation
- COST

Windows and Thermal Comfort

http://www.cardinalcorp.com/technology/applications/comfort-calculator/

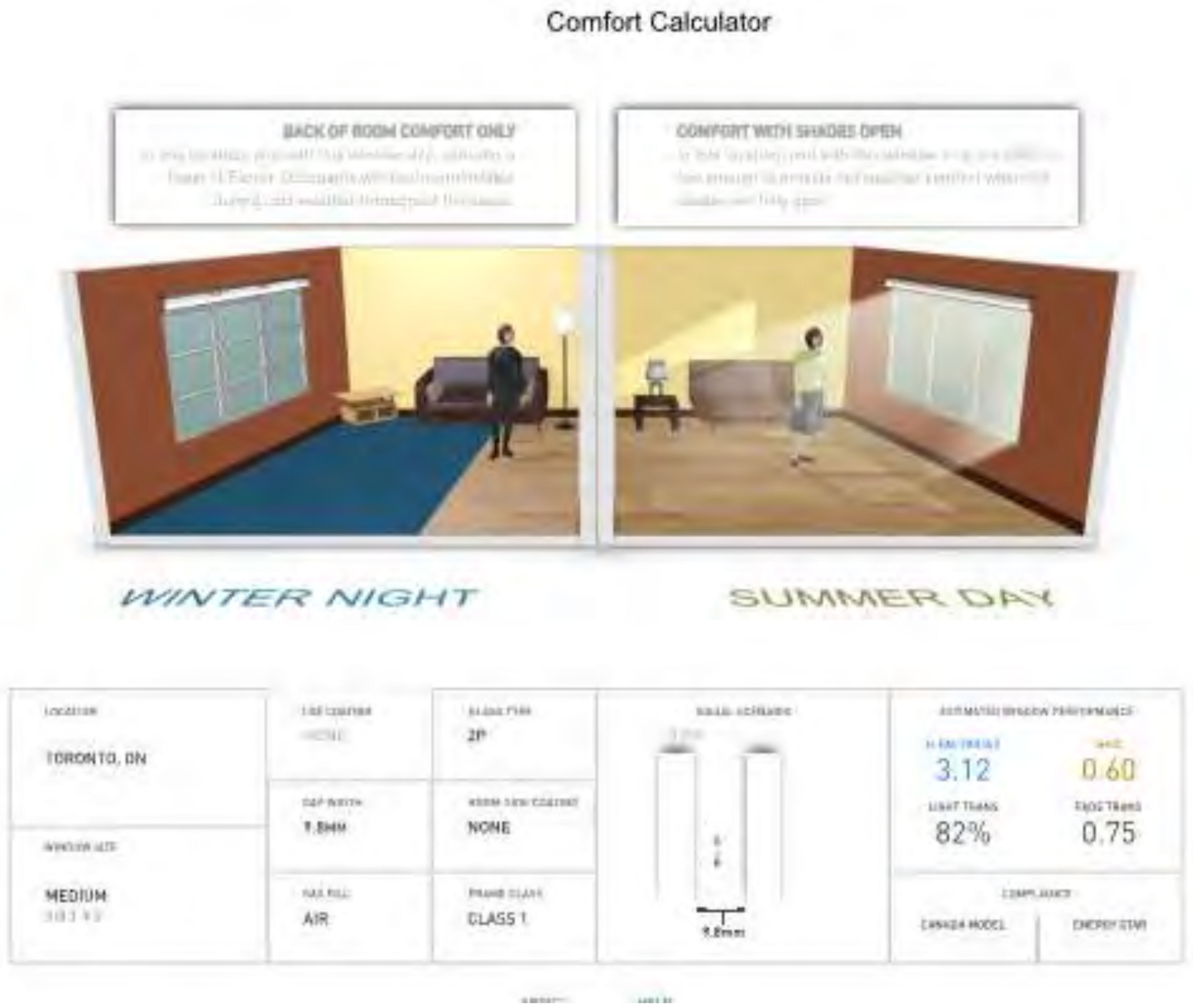


CARDINAL GLASS INDUSTRIES

Comfort Calculator

The measure of an energy-efficient window is one that provides thermal comfort throughout the seasons of the year. Geographic location and window size are attributes that should be considered in order to select a glazing package that balances the need to keep rooms warm in the winter and cool in the summer.

Windows and Thermal Comfort



Comfort Calculator

BACK OF ROOM COMFORT ONLY

COMFORT WITH SHADES OPEN

WINTER NIGHT

SUMMER DAY

TORONTO, ON

MEDIUM

2P

9.8MM

NONE

AIR

CLASS 1

ESTIMATED WINDOW PERFORMANCE

3.12

0.60

LIGHT TRANS

82%

0.75

COMPLIANCE

CANADA MODEL

ENERGY STAR

Windows and Thermal Comfort
Does Triple Pane really make a difference?

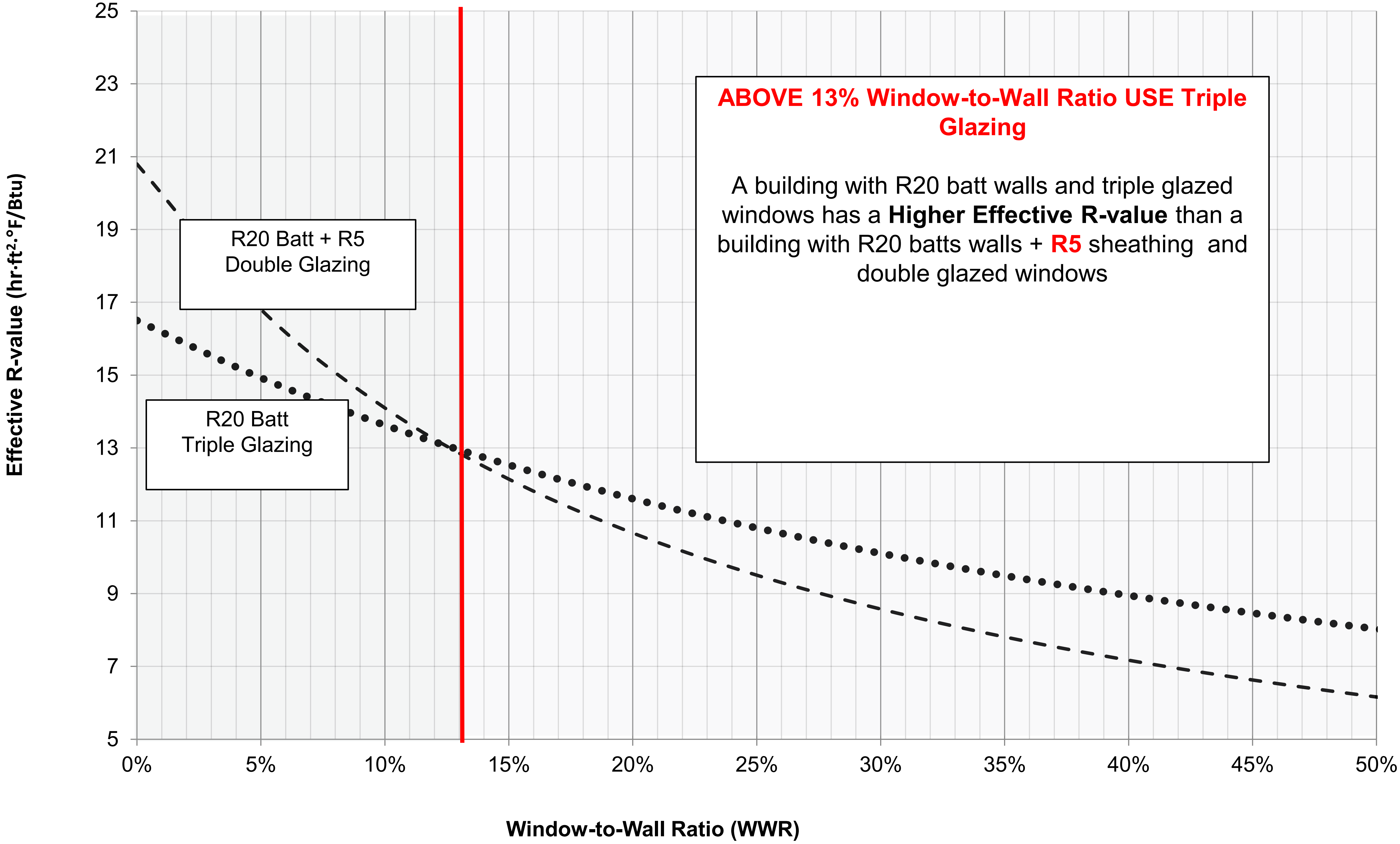
ASHRAE 55 and Windows: Zone 5-6:

  - 1m from glass, patio door
  - Winter: Acceptable room side glass threshold temp= 57F or 14C
  - Summer: Discomfort comes from any hour/elevation with solar gain greater than 70 btu/hr·ft²·°F

- Single, metal frame:
  - Winter: 3000+ hrs of discomfort
  - Summer: 300+ hrs of discomfort
- Double , insulated, SHGC 0.55
  - Winter: 500+ hrs of discomfort
  - Summer: 75+ hrs of discomfort
- Triple: insulated, SHGC 0.22
  - Winter: negligible
  - Summer: negligible

WHY PICK BETTER THAN MINIMUM GLASS ?

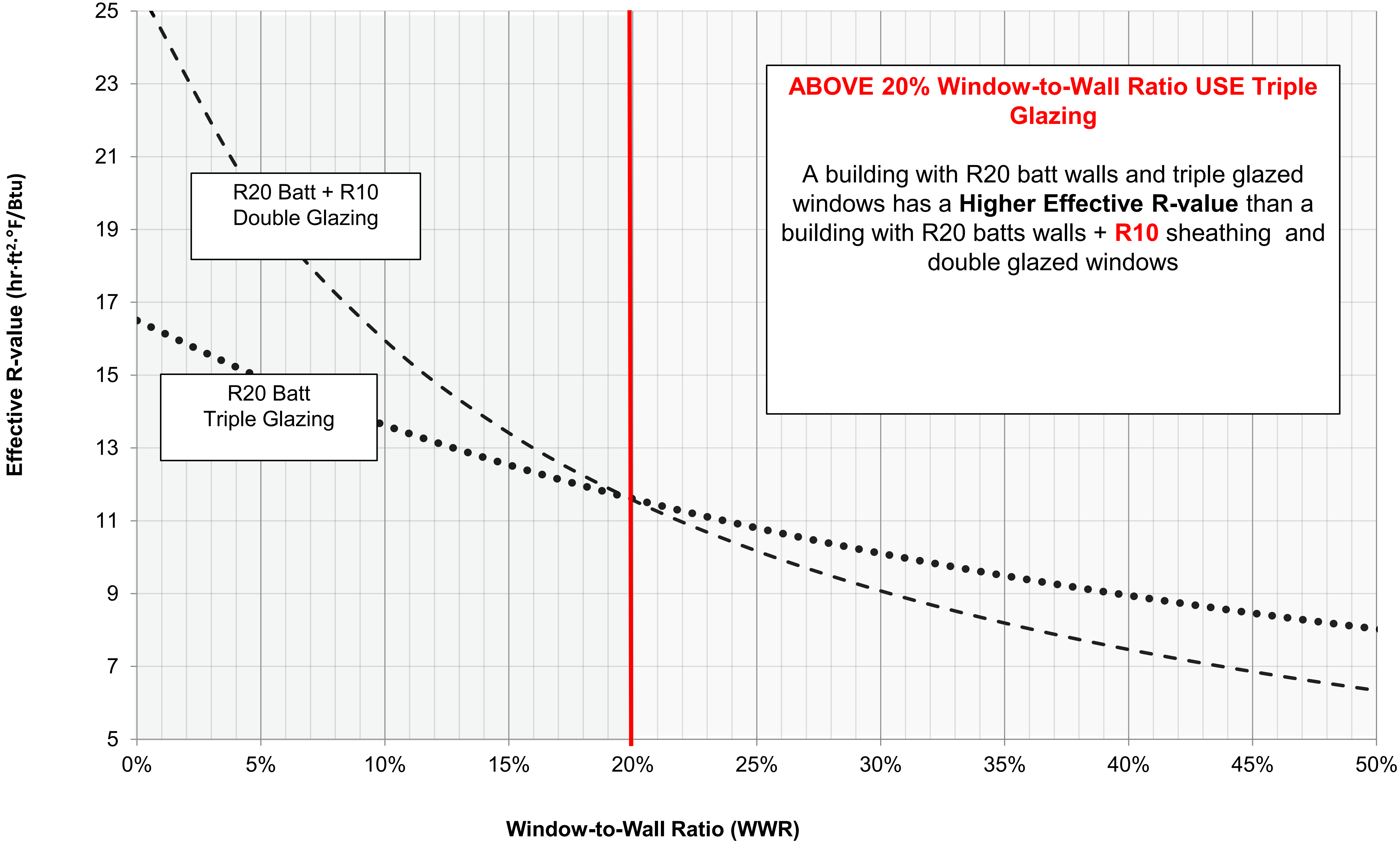
Effective R-value
Triple Glazing vs. R5 Sheathing



ABOVE 13% Window-to-Wall Ratio USE Triple Glazing

A building with R20 batt walls and triple glazed windows has a **Higher Effective R-value** than a building with R20 batts walls + **R5** sheathing and double glazed windows

Effective R-value
Triple Glazing vs. R10 Sheathing



ABOVE 20% Window-to-Wall Ratio USE Triple Glazing

A building with R20 batt walls and triple glazed windows has a **Higher Effective R-value** than a building with R20 batts walls + **R10** sheathing and double glazed windows

A Tale of Two Houses

House before & after improvements

Standard Clear Double Glazed

U = .65

SHGC = .68

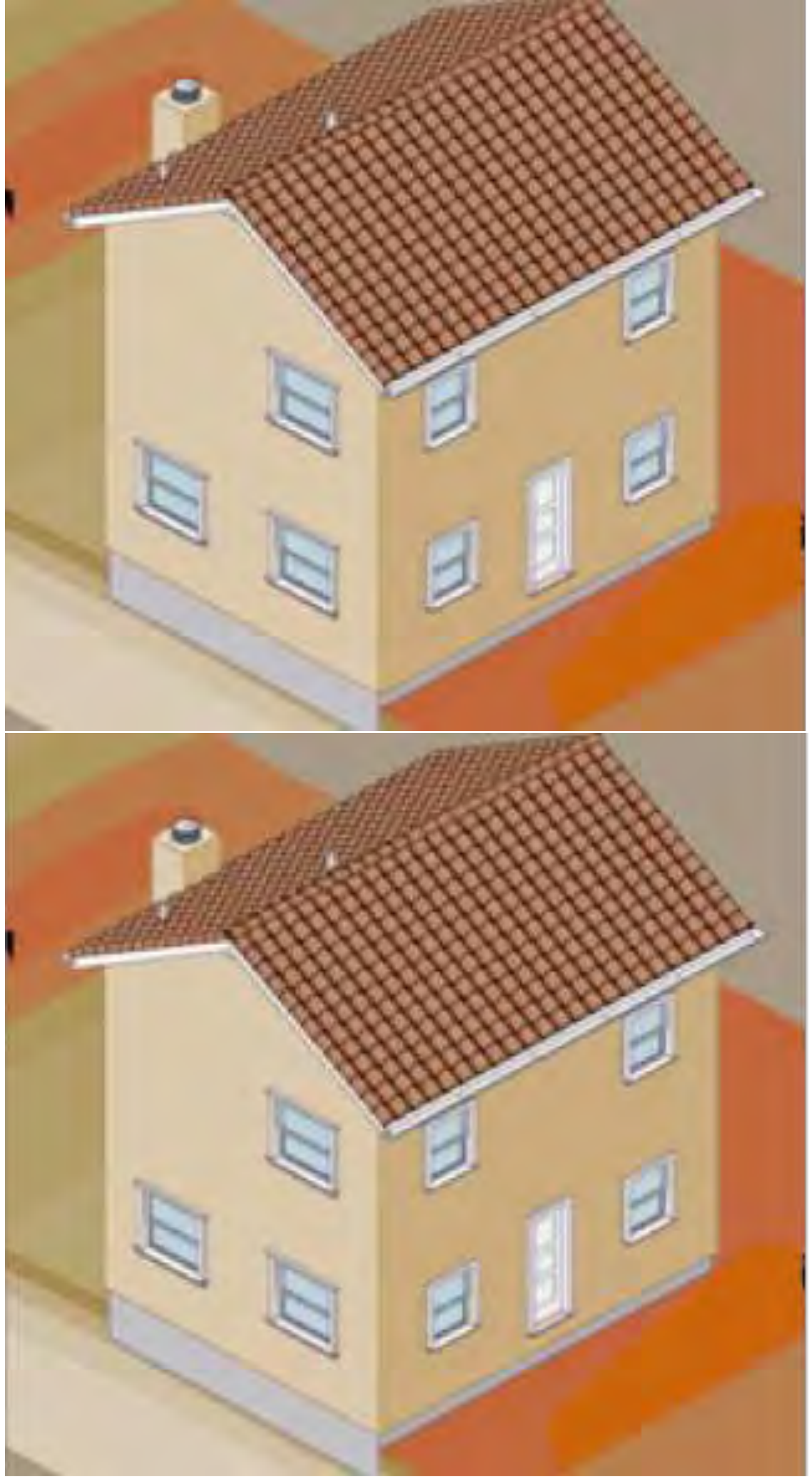
4.0 Ton AC Unit

Double Glazed Low-e, Low SHGC

U = .32

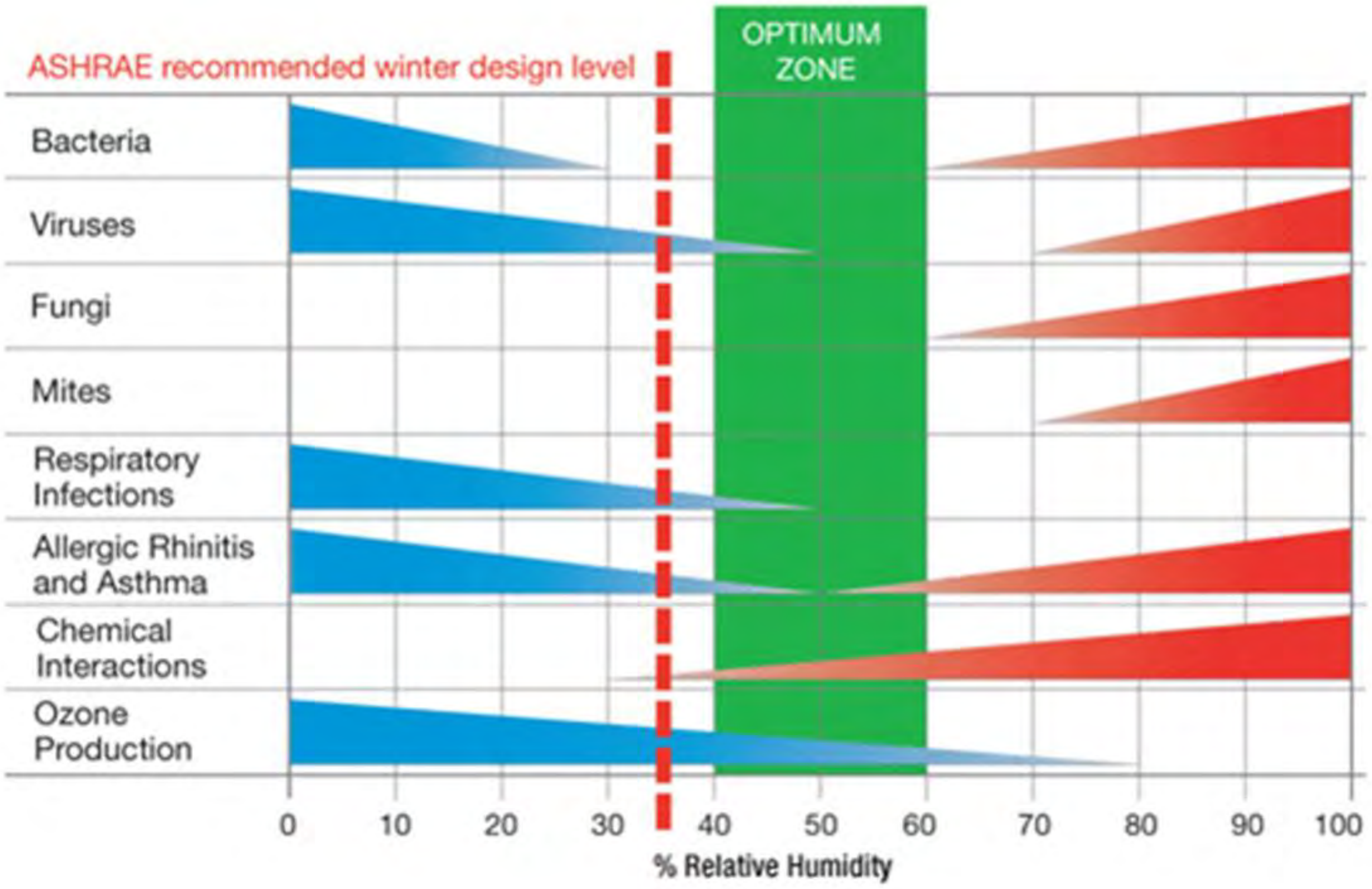
SHGC = .32

2.5 Ton AC Unit



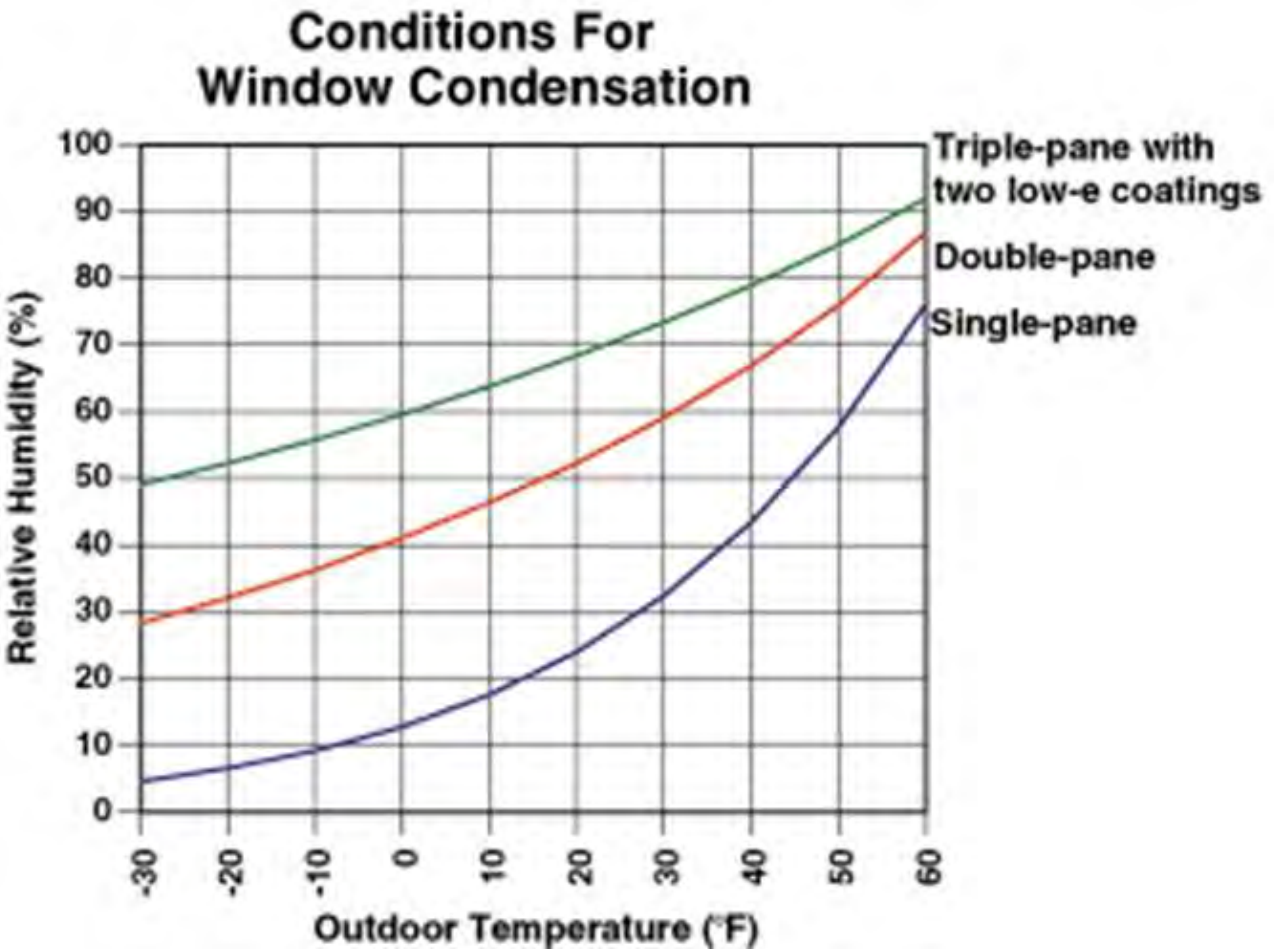
Condensation Resistance

Healthy Relative Humidity and Windows.



Condensation Resistance

Healthy Relative Humidity and Windows.



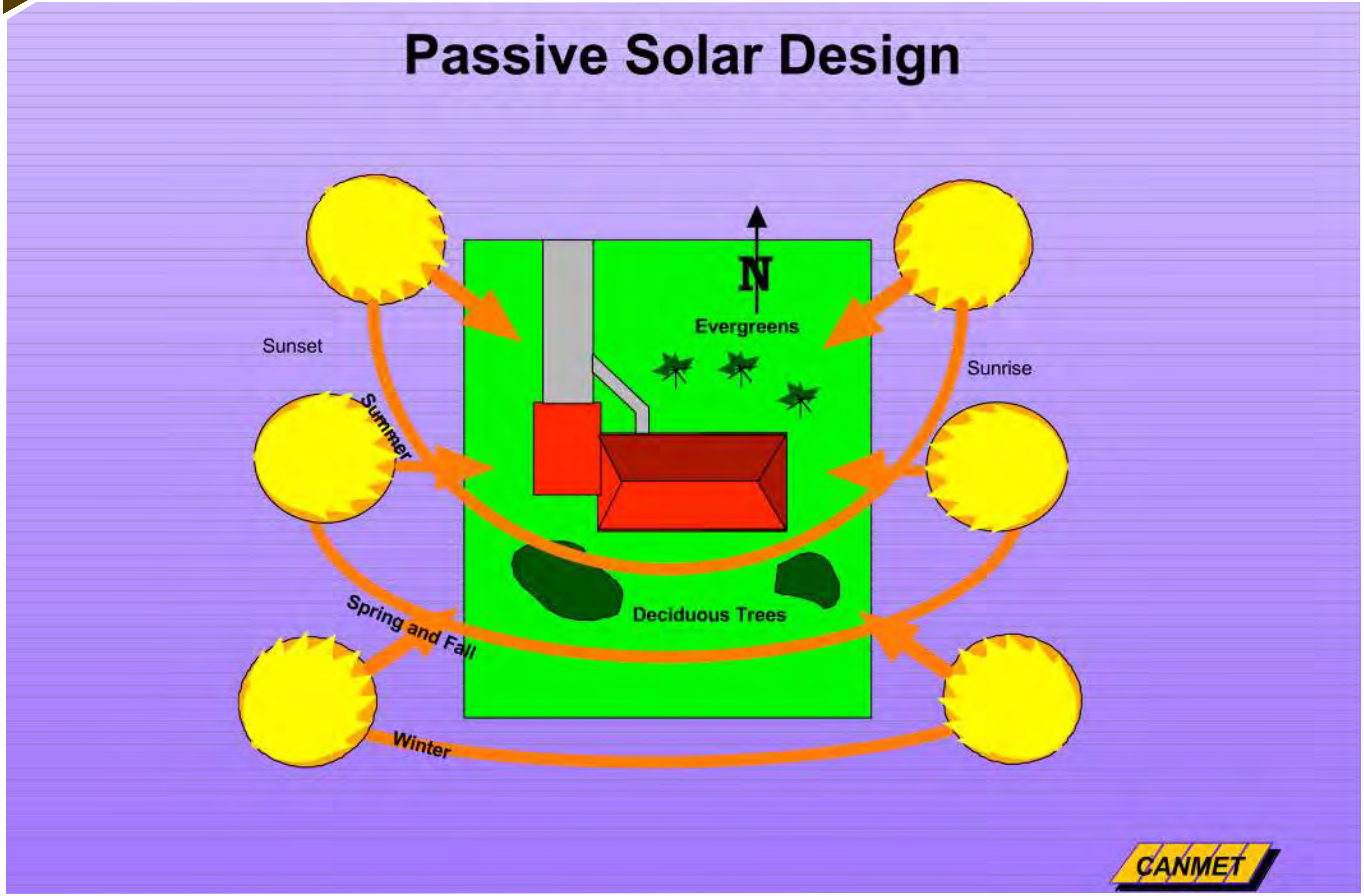
A Deeper Look:

Why better windows are suddenly a no-brainer

OR

- Overall effective R value at 12.5% WWR : Triple Pane (U 1.1>) is equivalent to adding more continuous insulation (R5) to a 2x6 wall.
- No learning curve for framer and trades
- Increased condensation resistance for owner(higher interior RH)
- Potential decrease in AC or ASHP tonnage cost
- Annual operating expense decreased by approx. $200 annually(with both heating and cooling combined)
- Occupant more comfortable in the living room easy chair….

In your experience how much control do you have on orientation, site-scaping & house design?



Roof Systems

What does a roof system need?

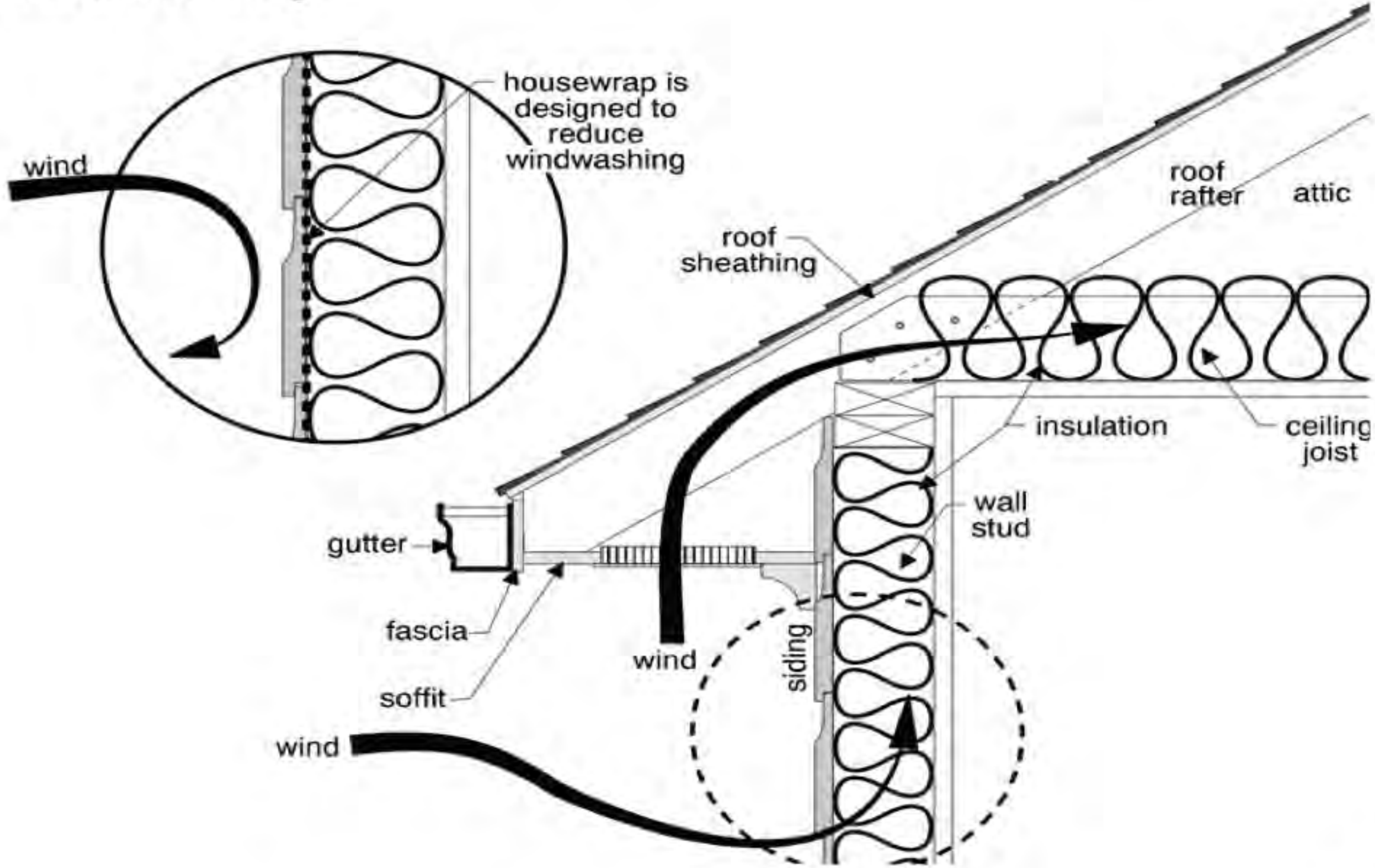
- Protection from rain penetration
- Drainage
- Flashing
- Durability
- Ventilation (always needed?)
- Proper insulation levels

Sound like our wall systems?

Courtesy of Construction Instruction. All rights reserved

Hipped roof details make insulating difficult

Wind washing

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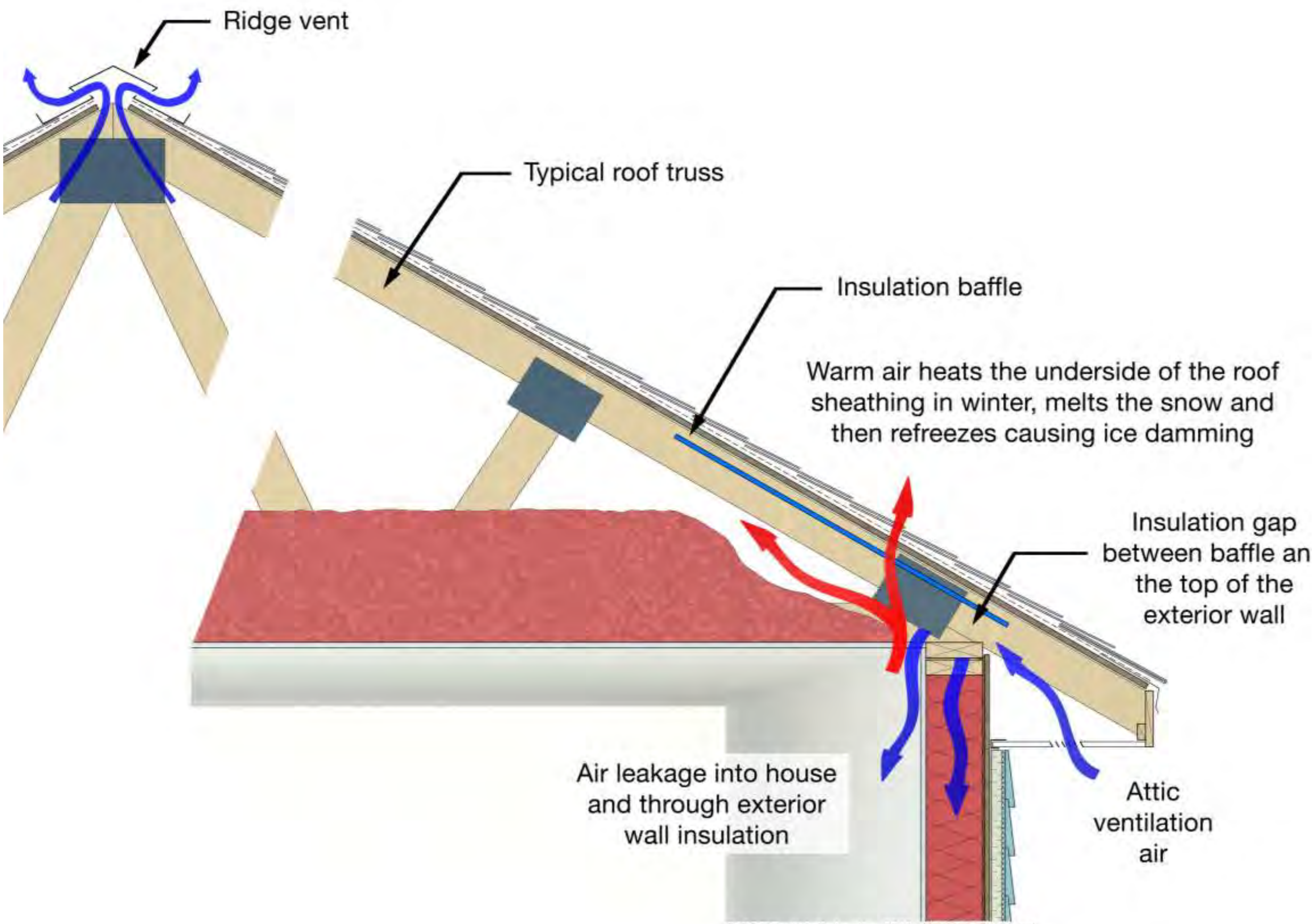
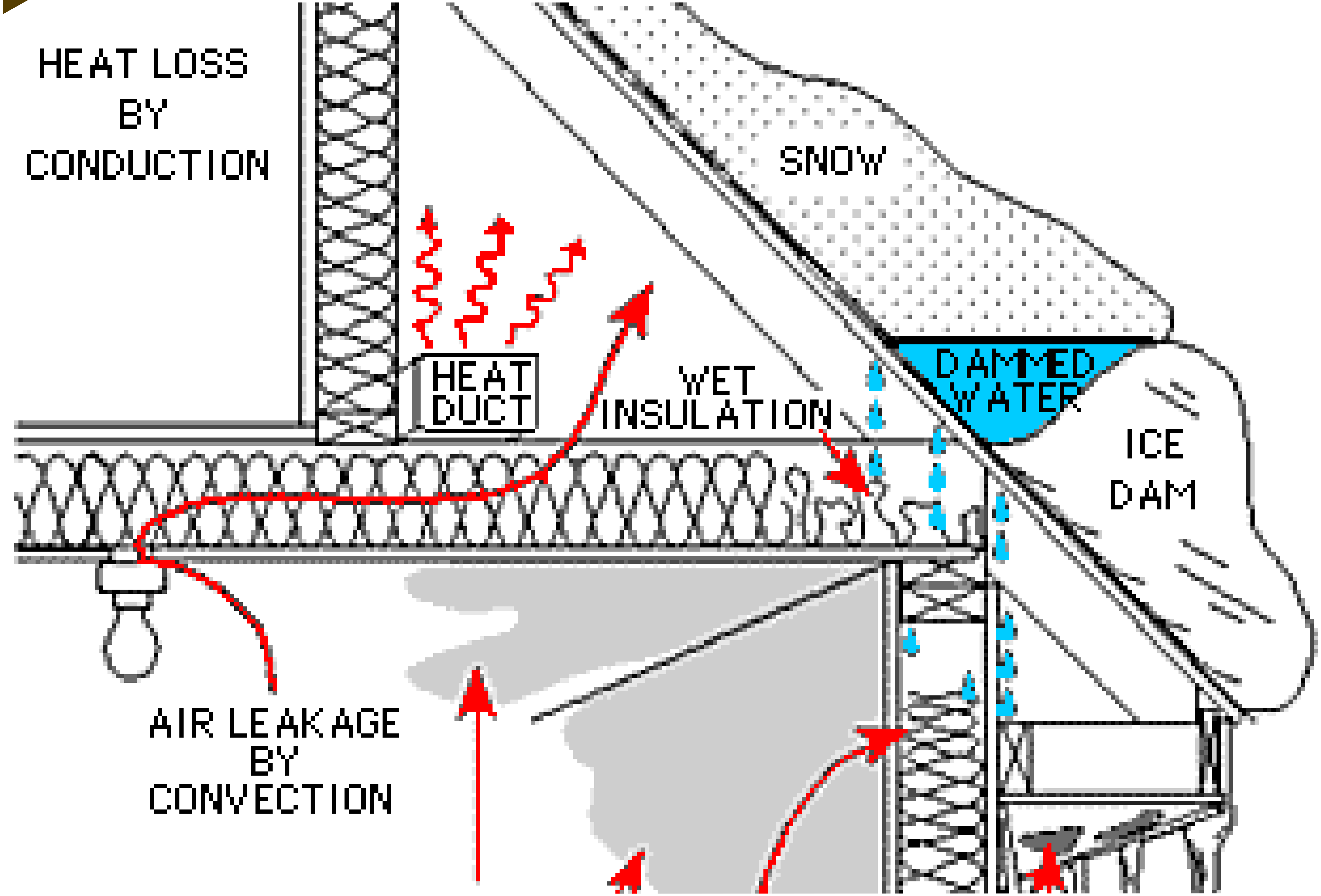
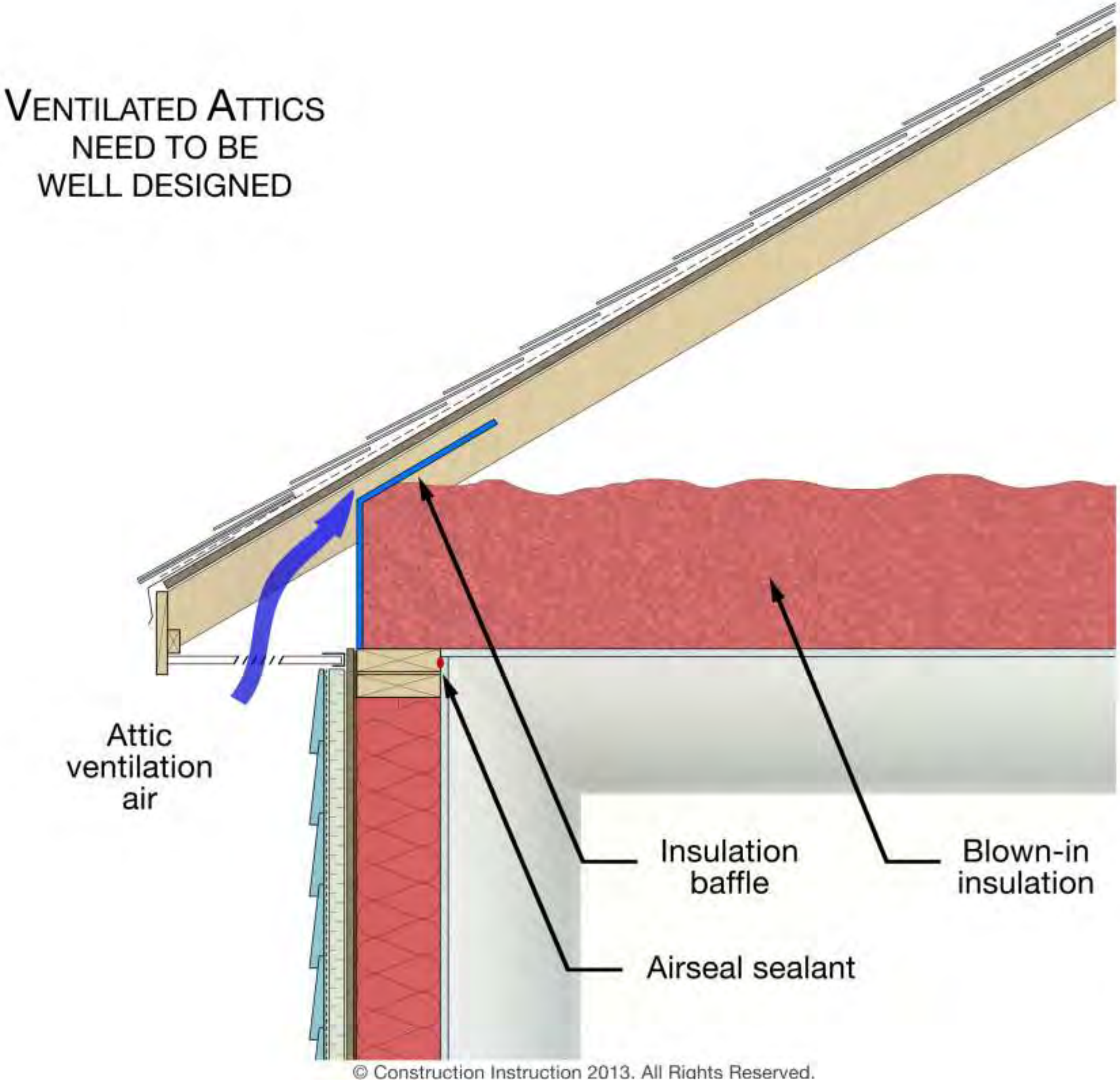

Ridge vent
Typical roof truss
Insulation baffle
Warm air heats the underside of the roof sheathing in winter, melts the snow and then refreezes causing ice damming
Insulation gap between baffle an the top of the exterior wall
Air leakage into house and through exterior wall insulation
Attic ventilation air

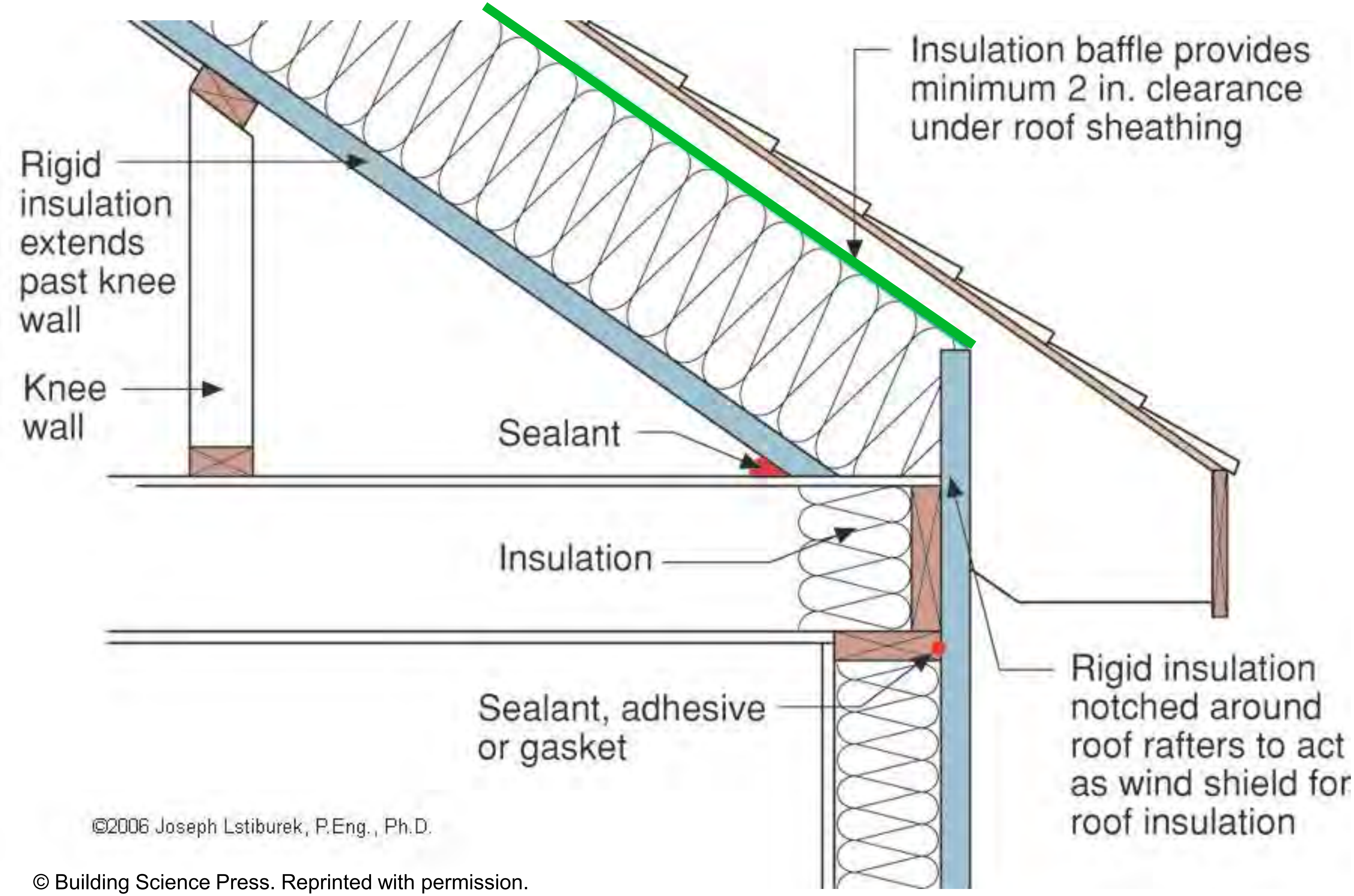
Ice Damn formation



Ventilated attics need good design



Vaulted Roofs: With ventilation & rigid insulation



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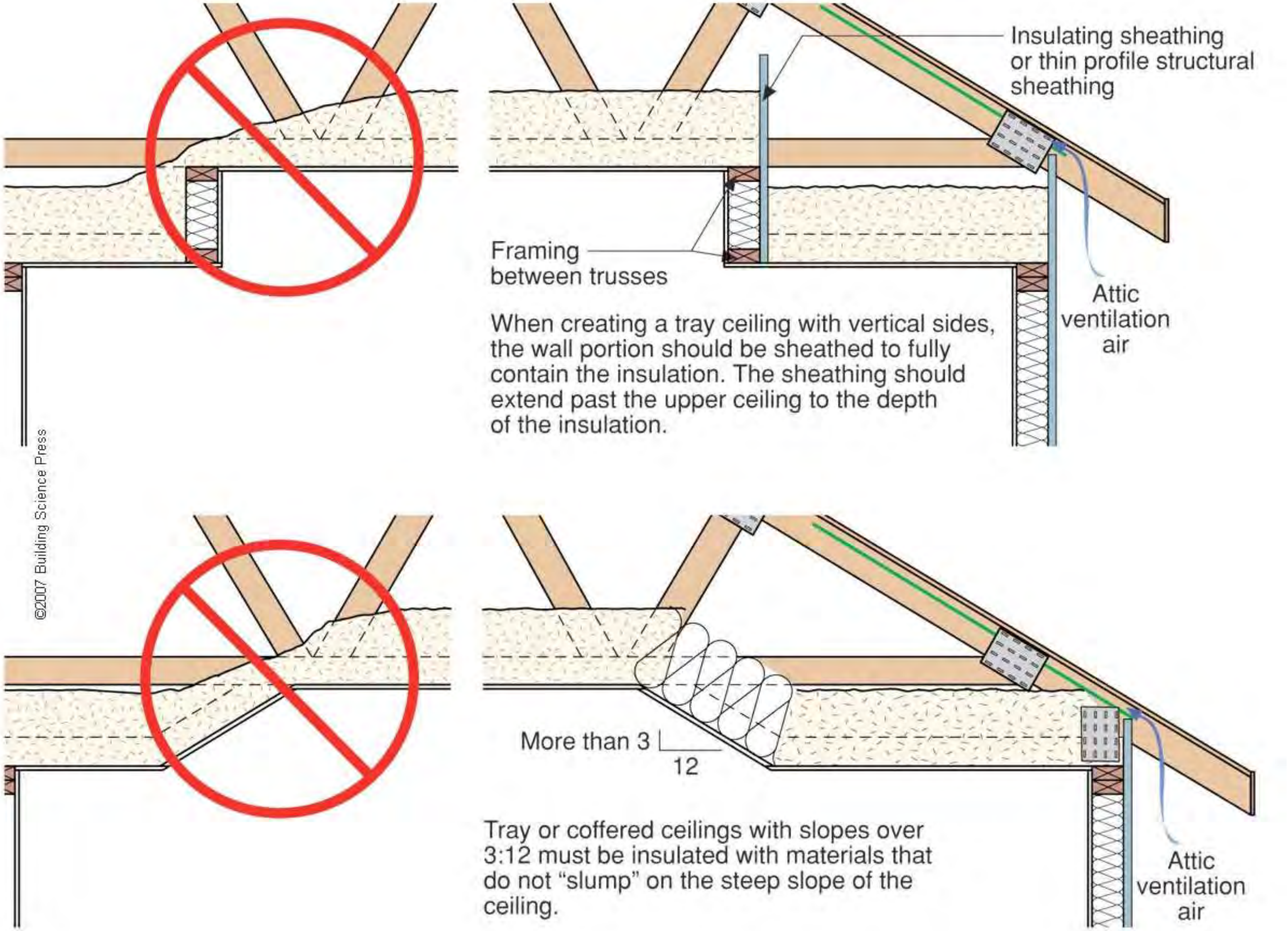
Attic Ventilation Strategies

Ceiling height changes



When creating a tray ceiling with vertical sides, the wall portion should be sheathed to fully contain the insulation. The sheathing should extend past the upper ceiling to the depth of the insulation.

Tray or coffered ceilings with slopes over 3:12 must be insulated with materials that do not "slump" on the steep slope of the ceiling.

Airsealing at wall to roof interface

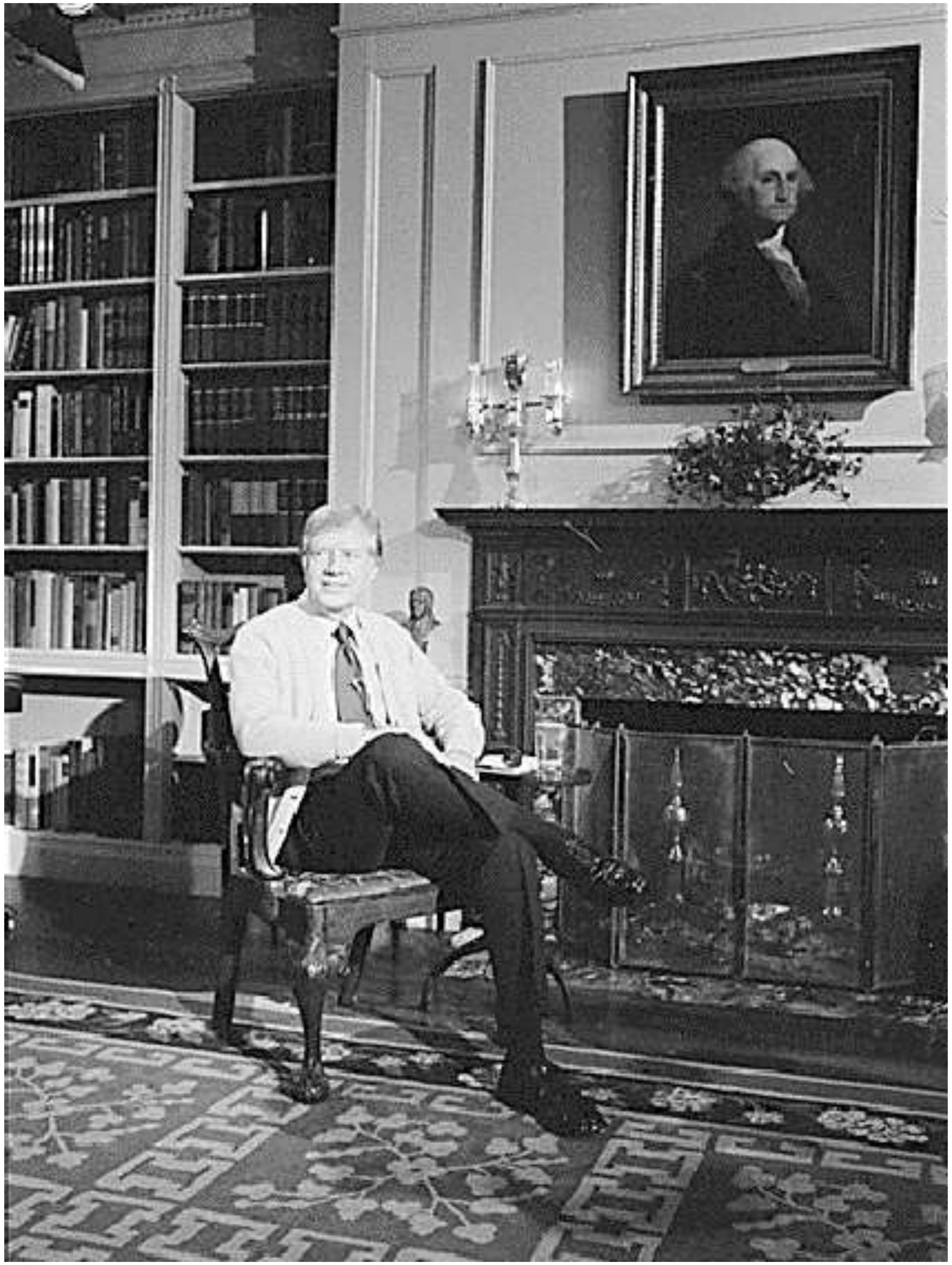
Conditioning the Indoors

- Heating, cooling, ventilation and indoor air quality

Are we ready for the changes?

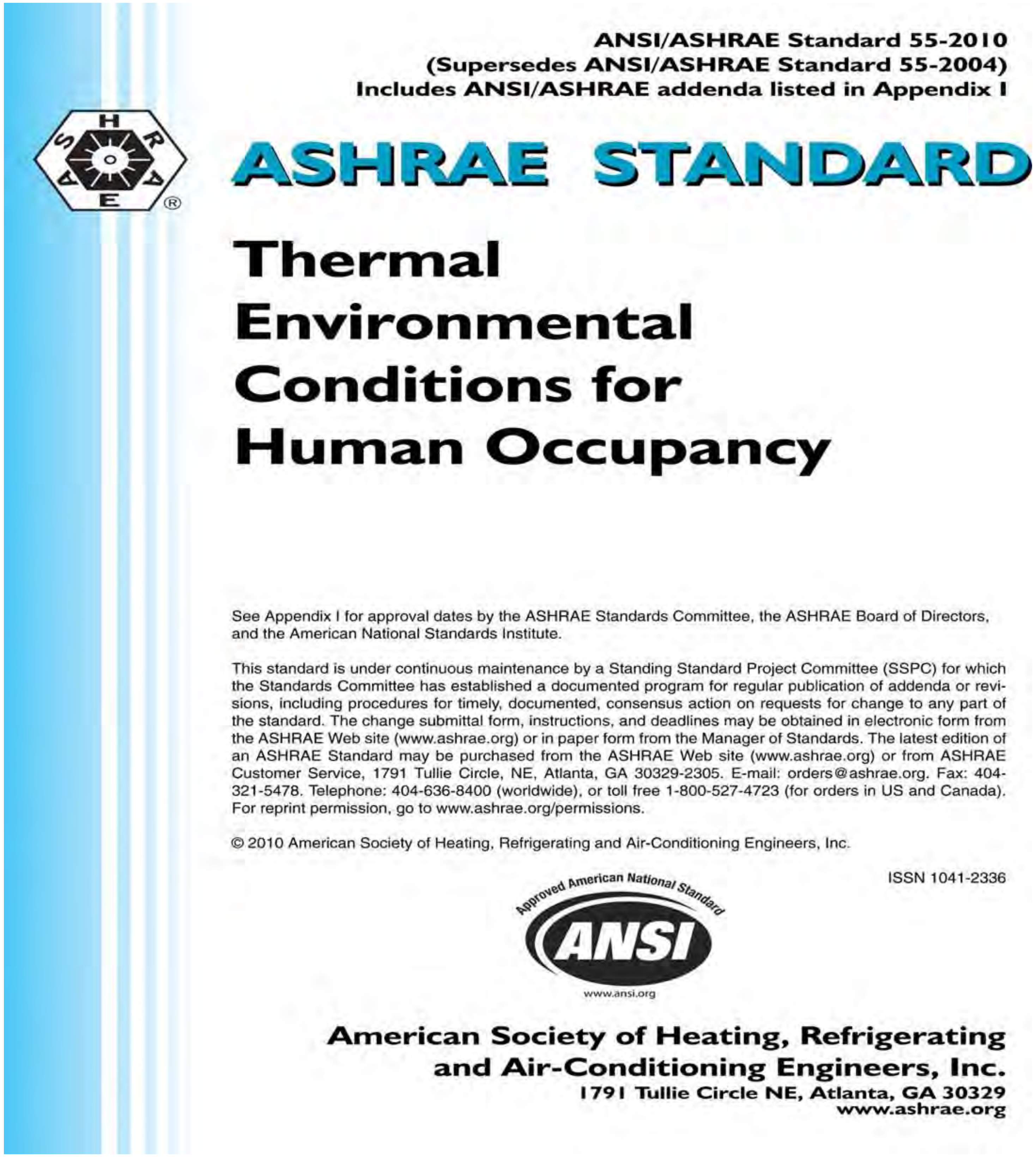
Be Aware…

- Energy Efficiency ≠ Comfort
- Builders typically have more comfort complaints than high bill complaints
- If you can't provide comfort, energy efficiency could be set back 20 years
- Need to remember comfort fundamentals



Let’s Start with Defining Comfort

- Air temperature
- Humidity
- Air speed - drafts
- Surrounding surface temperatures
- Gender, age, activities of occupants
- Metabolic rate & clothing



ANSI/ASHRAE Standard 55-2010
(Supersedes ANSI/ASHRAE Standard 55-2004)
Includes ANSI/ASHRAE addenda listed in Appendix I

ASHRAE STANDARD

Thermal Environmental Conditions for Human Occupancy

See Appendix I for approval dates by the ASHRAE Standards Committee, the ASHRAE Board of Directors, and the American National Standards Institute.

This standard is under continuous maintenance by a Standing Standard Project Committee (SSPC) for which the Standards Committee has established a documented program for regular publication of addenda or revisions, including procedures for timely, documented, consensus action on requests for change to any part of the standard. The change submittal form, instructions, and deadlines may be obtained in electronic form from the ASHRAE Web site (www.ashrae.org) or in paper form from the Manager of Standards. The latest edition of an ASHRAE Standard may be purchased from the ASHRAE Web site (www.ashrae.org) or from ASHRAE Customer Service, 1791 Tullie Circle, NE, Atlanta, GA 30329-2305. E-mail: orders@ashrae.org. Fax: 404-321-5478. Telephone: 404-636-8400 (worldwide), or toll free 1-800-527-4723 (for orders in US and Canada). For reprint permission, go to www.ashrae.org/permissions.

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Comfort – Finding the sweet spot

Applies to Operative Temperature

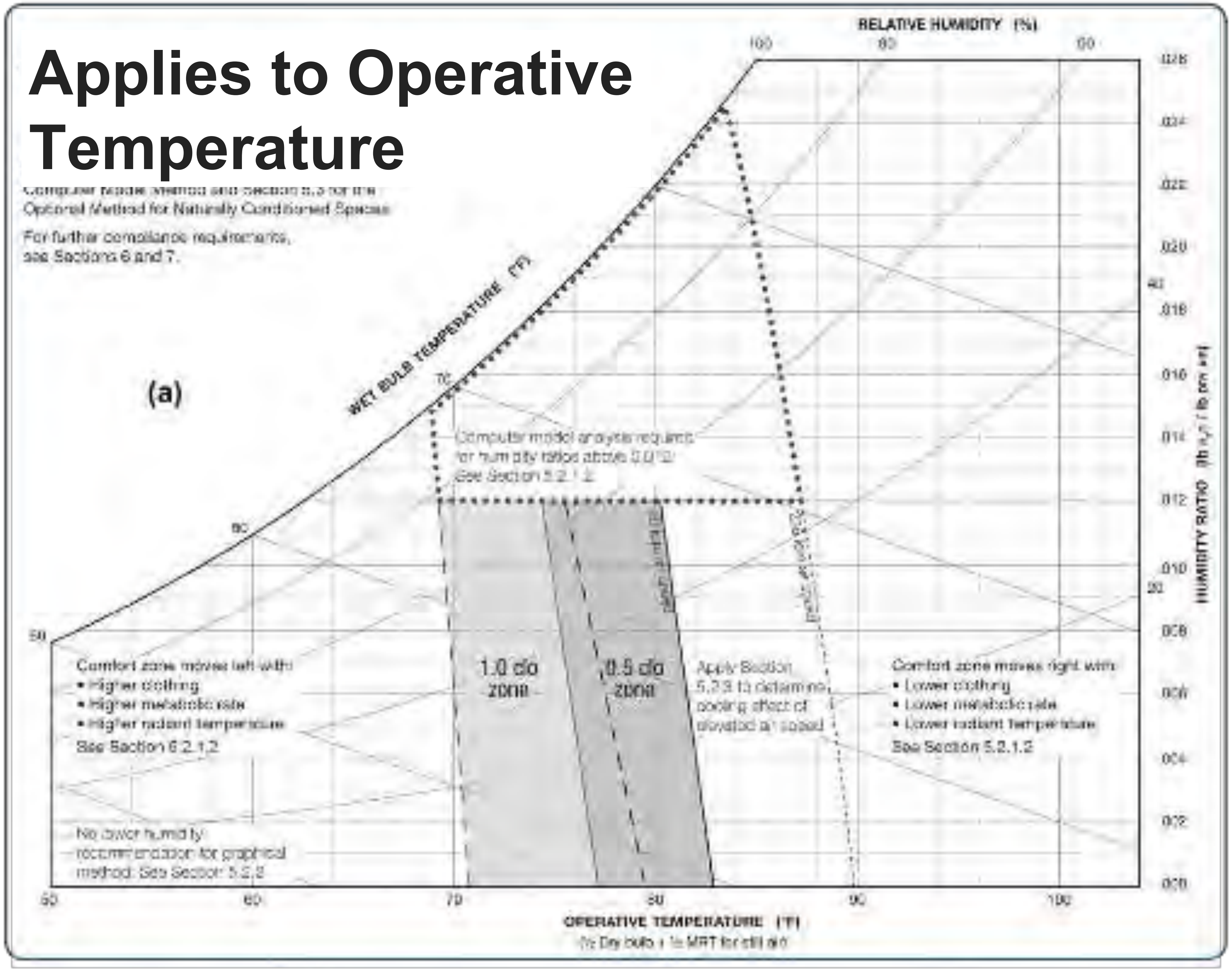


Figure 2: The new Graphic Comfort Zone Method, Figure 5.2.1.1 in Standard 55-2010 (IP version shown).

Operative Temperature

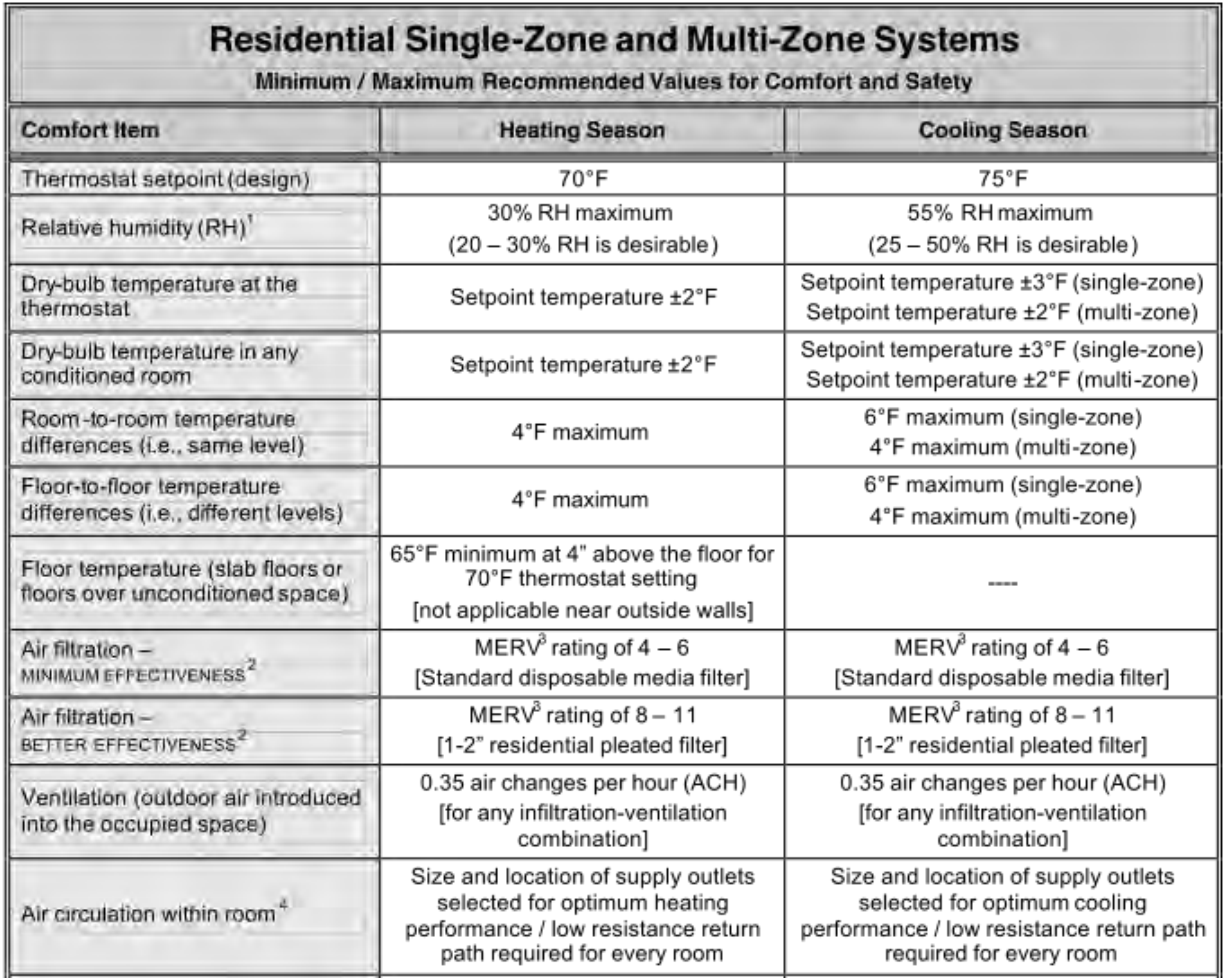
Operative temperature:

- The average of the **mean radiant** and ambient air temperatures, weighted by their respective heat transfer coefficients.

- Thermostats respond to air temperature

- Human **thermal comfort** responds to operative temperature

Can we meet the expectations of our customers?



Residential Single-Zone and Multi-Zone Systems

Minimum / Maximum Recommended Values for Comfort and Safety

Comfort Item	Heating Season	Cooling Season
Thermostat setpoint (design)	70°F	75°F
Relative humidity (RH)[1]	30% RH maximum (20 – 30% RH is desirable)	55% RH maximum (25 – 50% RH is desirable)
Dry-bulb temperature at the thermostat	Setpoint temperature ±2°F	Setpoint temperature ±3°F (single-zone) Setpoint temperature ±2°F (multi-zone)
Dry-bulb temperature in any conditioned room	Setpoint temperature ±2°F	Setpoint temperature ±3°F (single-zone) Setpoint temperature ±2°F (multi-zone)
Room-to-room temperature differences (i.e., same level)	4°F maximum	6°F maximum (single-zone) 4°F maximum (multi-zone)
Floor-to-floor temperature differences (i.e., different levels)	4°F maximum	6°F maximum (single-zone) 4°F maximum (multi-zone)
Floor temperature (slab floors or floors over unconditioned space)	65°F minimum at 4" above the floor for 70°F thermostat setting [not applicable near outside walls]	----
Air filtration – MINIMUM EFFECTIVENESS[2]	MERV[3] rating of 4 – 6 [Standard disposable media filter]	MERV[3] rating of 4 – 6 [Standard disposable media filter]
Air filtration – BETTER EFFECTIVENESS[2]	MERV[3] rating of 8 – 11 [1-2" residential pleated filter]	MERV[3] rating of 8 – 11 [1-2" residential pleated filter]
Ventilation (outdoor air introduced into the occupied space)	0.35 air changes per hour (ACH) [for any infiltration-ventilation combination]	0.35 air changes per hour (ACH) [for any infiltration-ventilation combination]
Air circulation within room[4]	Size and location of supply outlets selected for optimum heating performance / low resistance return path required for every room	Size and location of supply outlets selected for optimum cooling performance / low resistance return path required for every room

ACCA Comfort Guidelines

Comfort – A starting point

Parameter	**Setting**	**Range**
Temperature		
Summer	75 ^{0}F	+/- 3 ^{0}F
Winter	72 ^{0}F	+/- 3 ^{0}F
Humidity		
Summer	50%	+/- 5%
Winter	35%	+/- 5%
Foot Comfort	63 ^{0}F	+/- 3 ^{0}F

Heating & Cooling Systems

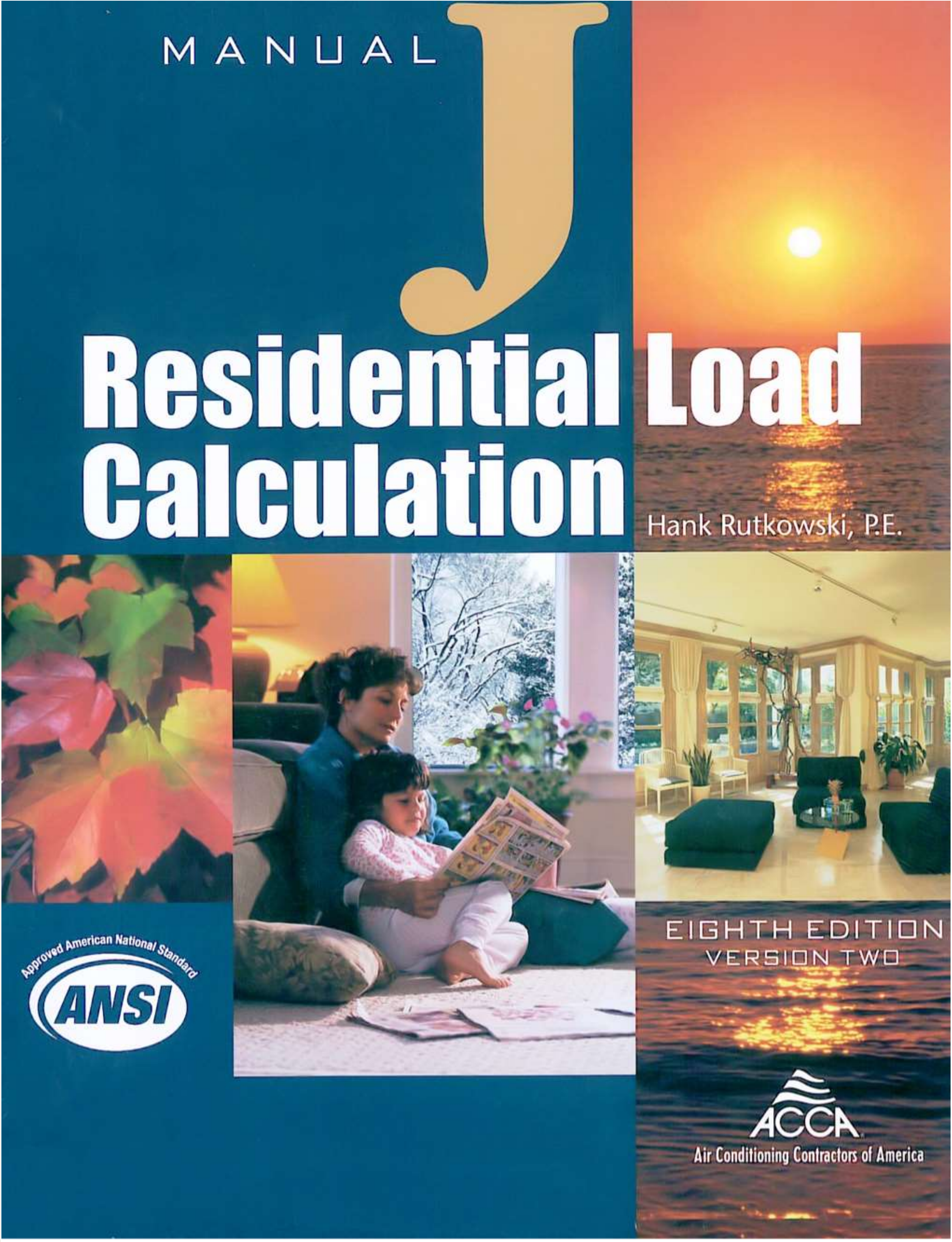
Fuel choices

- Electric
- Gas
- Oil
- Wood
- Solar
- Combinations

Distribution choices

- Central Forced air
- Radiant
  - In-floor
  - Baseboard
- Ductless
- Space heaters

1) Get heating & cooling capacity right



MANUAL J

Residential Load Calculation

Hank Rutkowski, P.E.

Approved American National Standard

ANSI

EIGHTH EDITION
VERSION TWO

ACCA
Air Conditioning Contractors of America

ACCA Sizing Standards

Heat Flow Formulas

Conduction heat flow (through walls, ceilings, floors)

= (Surface Area x Temp. Diff.) / R-value

Radiant flow (through glass)

= Surface area x Solar incidence x **S**olar **H**eat **G**ain **C**oefficient

Heat flow by air (via air leakage or ventilation)

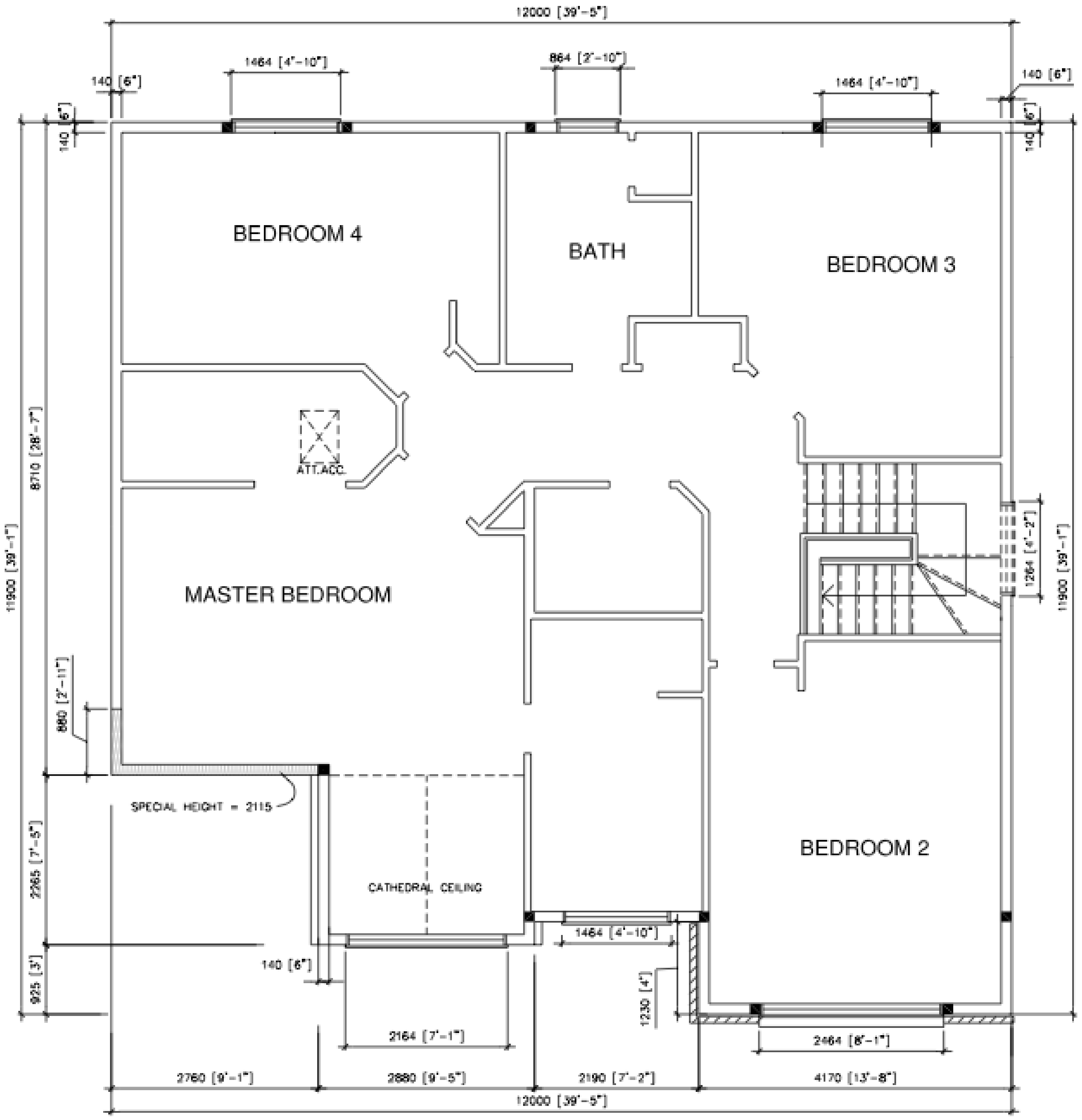
= Volume of air (CFM) x Temp. Diff. x 1.1

HEATING – Get the Size Right

- Do Room-by-Room heat loss & gain calculation

Based on:

- Design Day - Winter
- Conduction losses through enclosure
- Air leakage through enclosure
- Heat losses through ducts in unconditioned space



SECOND FLOOR PLAN

Minneapolis, MN
- design conditions

Condition	ASHRAE 99% / 1%
Winter, design dry bulb (F)	-15°F
Summer, design dry bulb (F)	91°F
Summer, design wet bulb (F)	71.6°F
Degree days-heating	7981
Degree days-cooling	682
Precipitation	28”
Solar incidence - South, July	

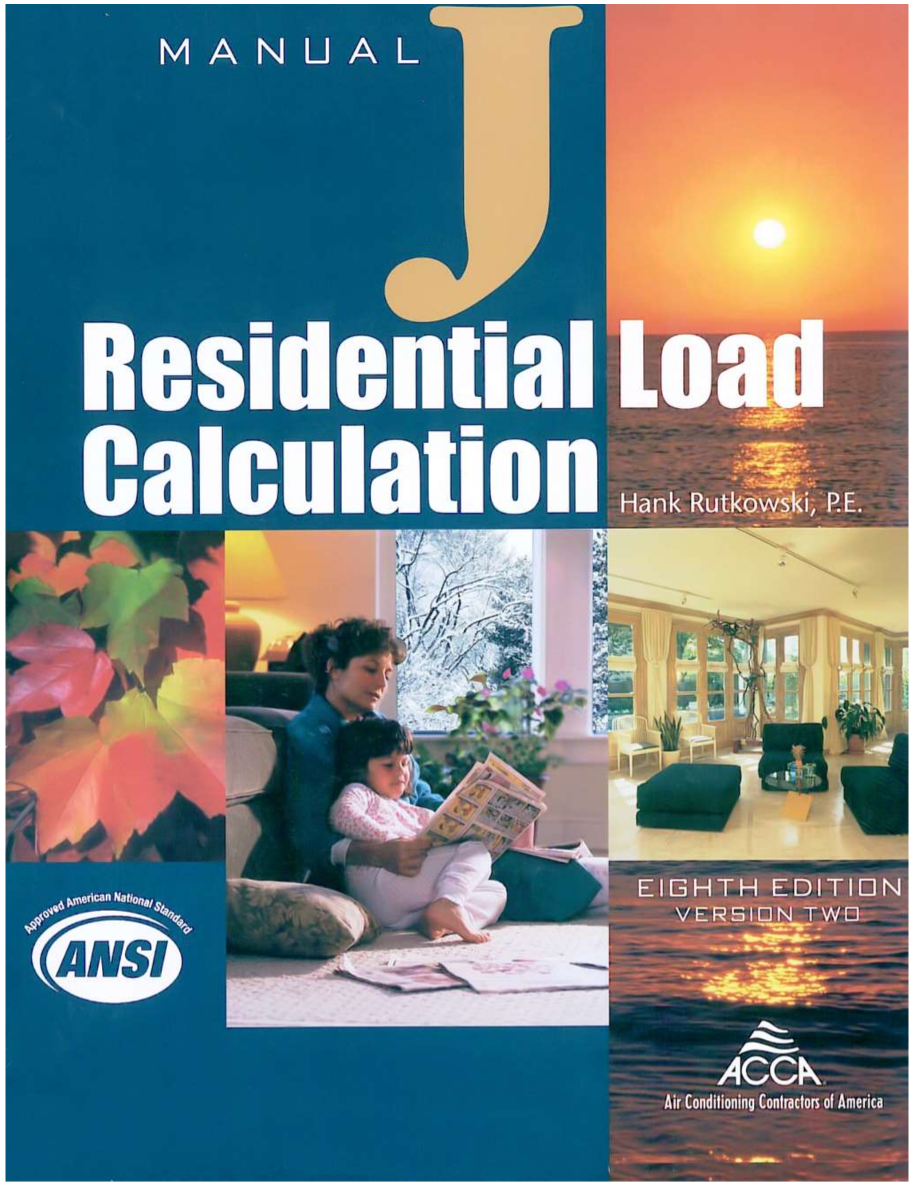
Proper Manual J Calculations

- Numerous software packages exist
- All rely on proper data input and appropriate assumptions

Common Errors:

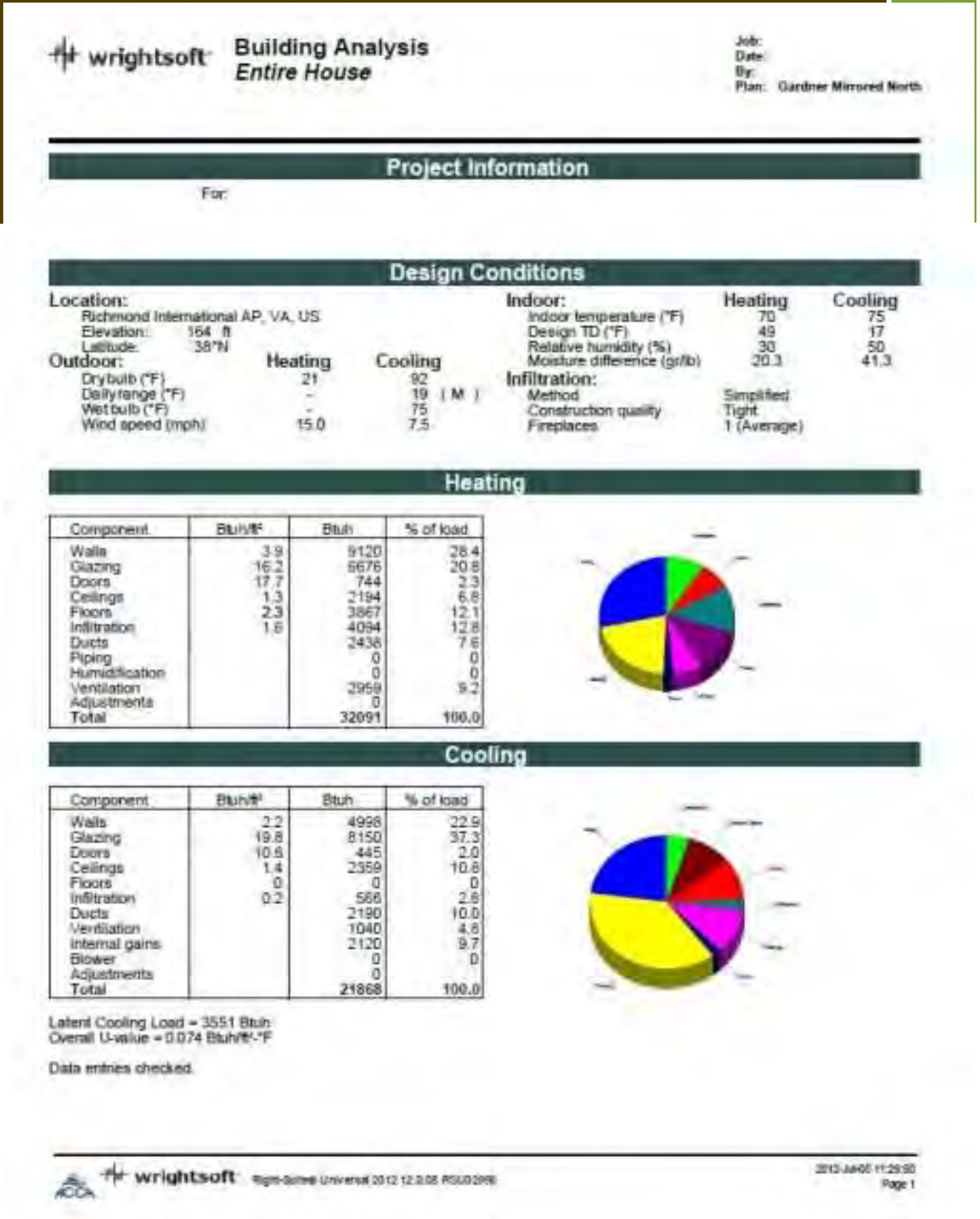
- Fudging design day conditions
- Using default values for air tightness, windows, insulation
- Using improper ventilation rates

Don't tolerate oversizing, Manual J compliant programs have safety factors built in already



Impact of Improper Sizing

- Short cycling
- Poor humidity control
- Poor temperature control
- Noise
- Extra cost for equipment & duct work
- Possibly higher energy bills



wrightsoft

Building Analysis
Entire House

Job:
Date:
By:
Plan: Gardner Mirrored North

Project Information

For:

Design Conditions

Location:
Richmond International AP, VA, US
Elevation: 164 ft
Latitude: 38°N

Outdoor:	**Heating**	**Cooling**
Dry bulb (°F)	21	92
Daily range (°F)	-	19 (M)
Wet bulb (°F)	-	75
Wind speed (mph)	15.0	7.5

Indoor:	**Heating**	**Cooling**
Indoor temperature (°F)	70	75
Design TD (°F)	49	17
Relative humidity (%)	30	50
Moisture difference (gr/lb)	20.3	41.3

Infiltration:
Method: Simplified
Construction quality: Tight
Fireplaces: 1 (Average)

Heating

Component	Btuh/ft²	Btuh	% of load
Walls	3.9	9120	28.4
Glazing	16.2	6676	20.8
Doors	17.7	744	2.3
Ceilings	1.3	2194	6.8
Floors	2.3	3867	12.1
Infiltration	1.6	4094	12.8
Ducts		2438	7.6
Piping		0	0
Humidification		0	0
Ventilation		2959	9.2
Adjustments		0	
Total		32091	100.0

Cooling

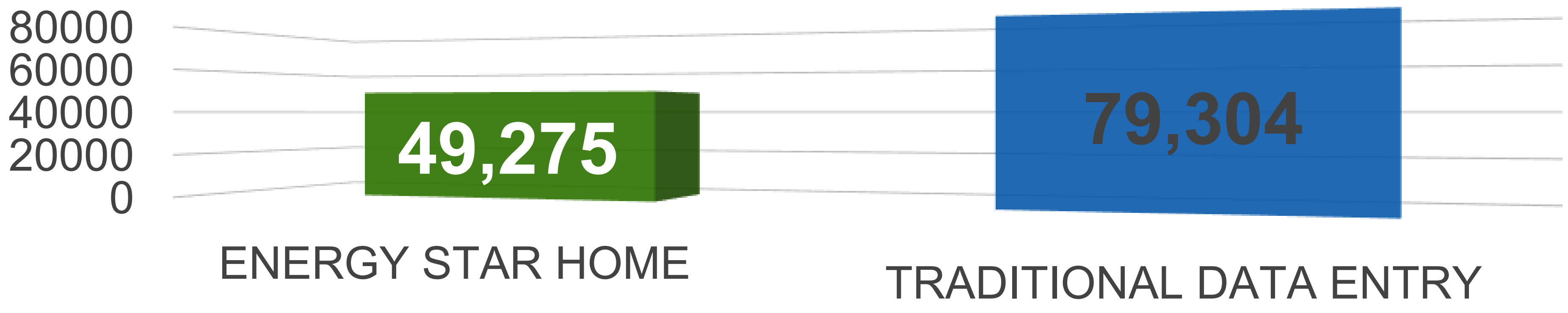
Component	Btuh/ft²	Btuh	% of load
Walls	2.2	4998	22.9
Glazing	19.8	8150	37.3
Doors	10.6	445	2.0
Ceilings	1.4	2359	10.8
Floors	0	0	0
Infiltration	0.2	566	2.6
Ducts		2190	10.0
Ventilation		1040	4.8
Internal gains		2120	9.7
Blower		0	0
Adjustments		0	
Total		21868	100.0

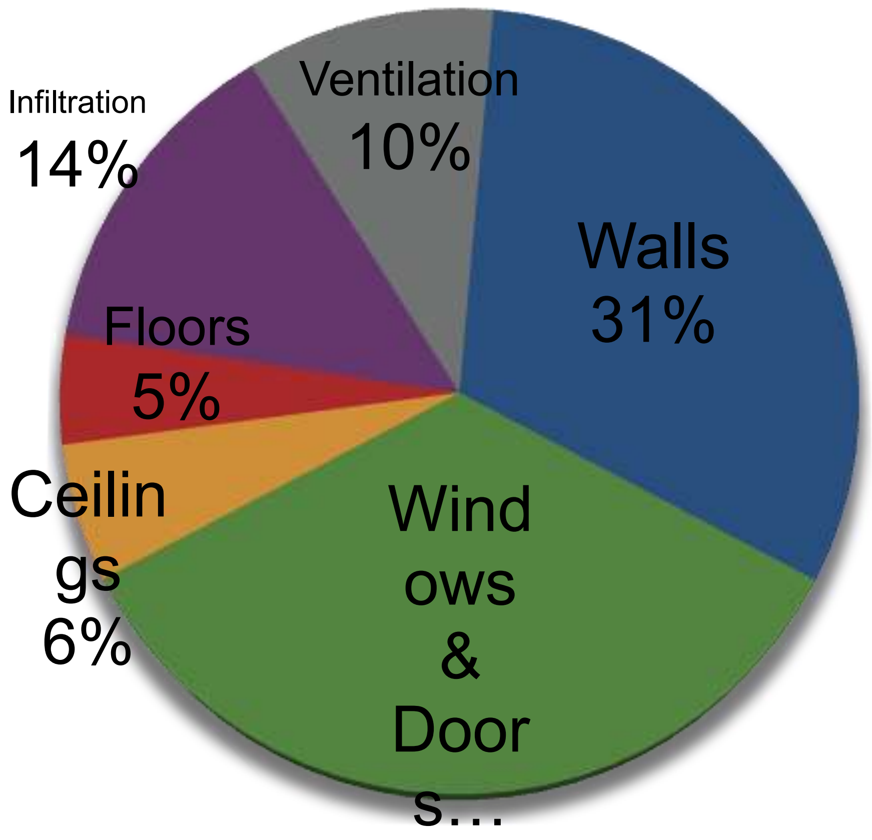
Latent Cooling Load = 3551 Btuh
Overall U-value = 0.074 Btuh/ft²-°F

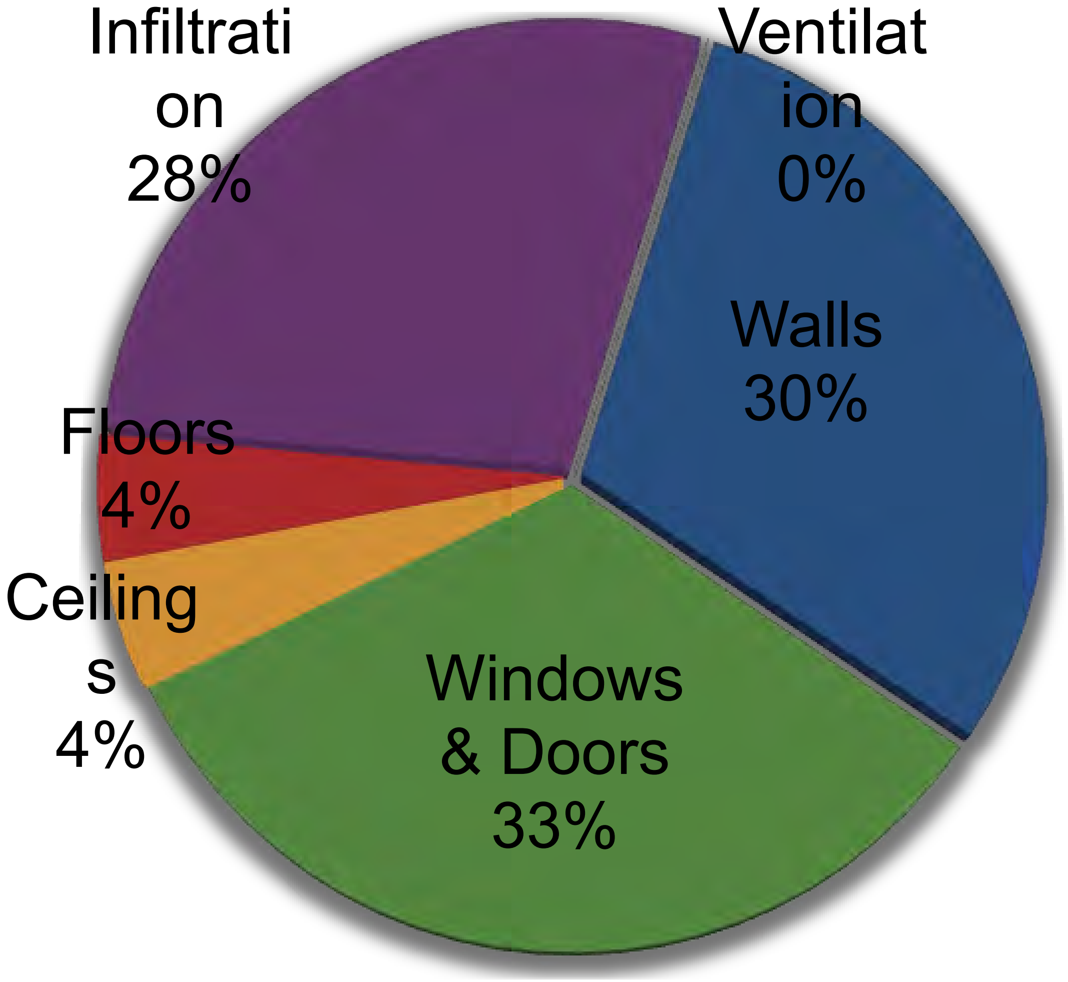
Data entries checked.

wrightsoft Right-Suite® Universal 2012 12.0.08 [illegible]
2013-Jul-05 11:29:50
Page 1

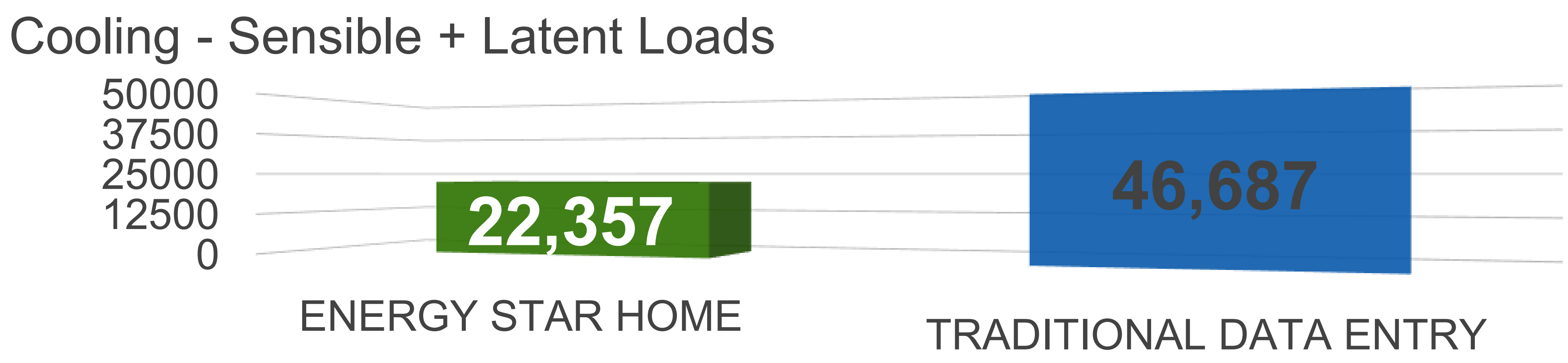
Heading Loads- HP Home Versus Standard

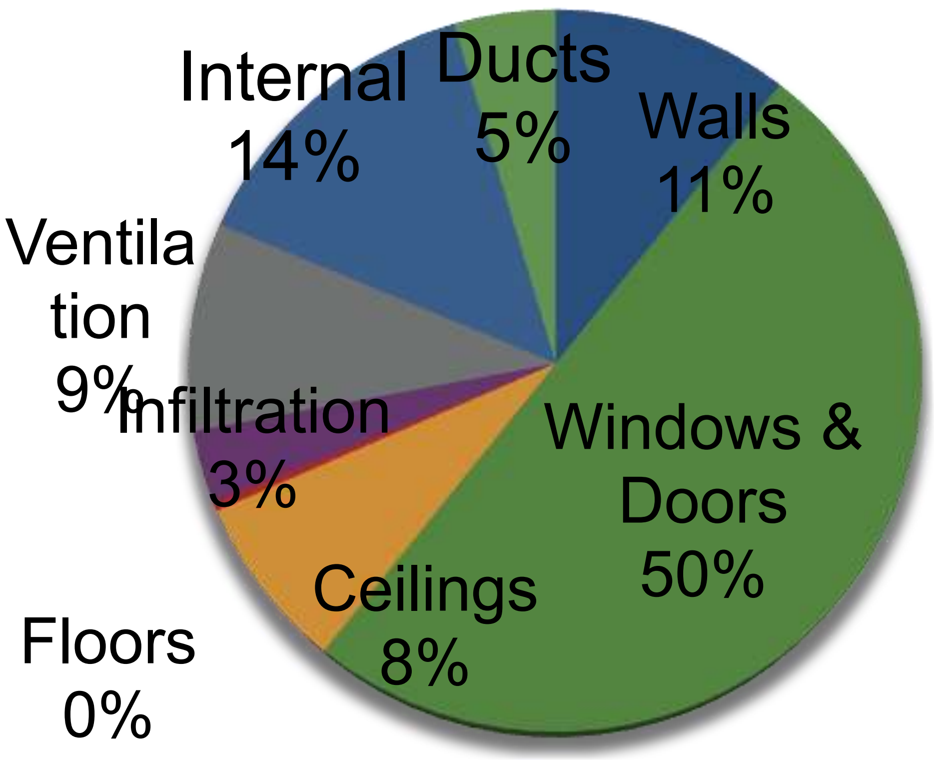


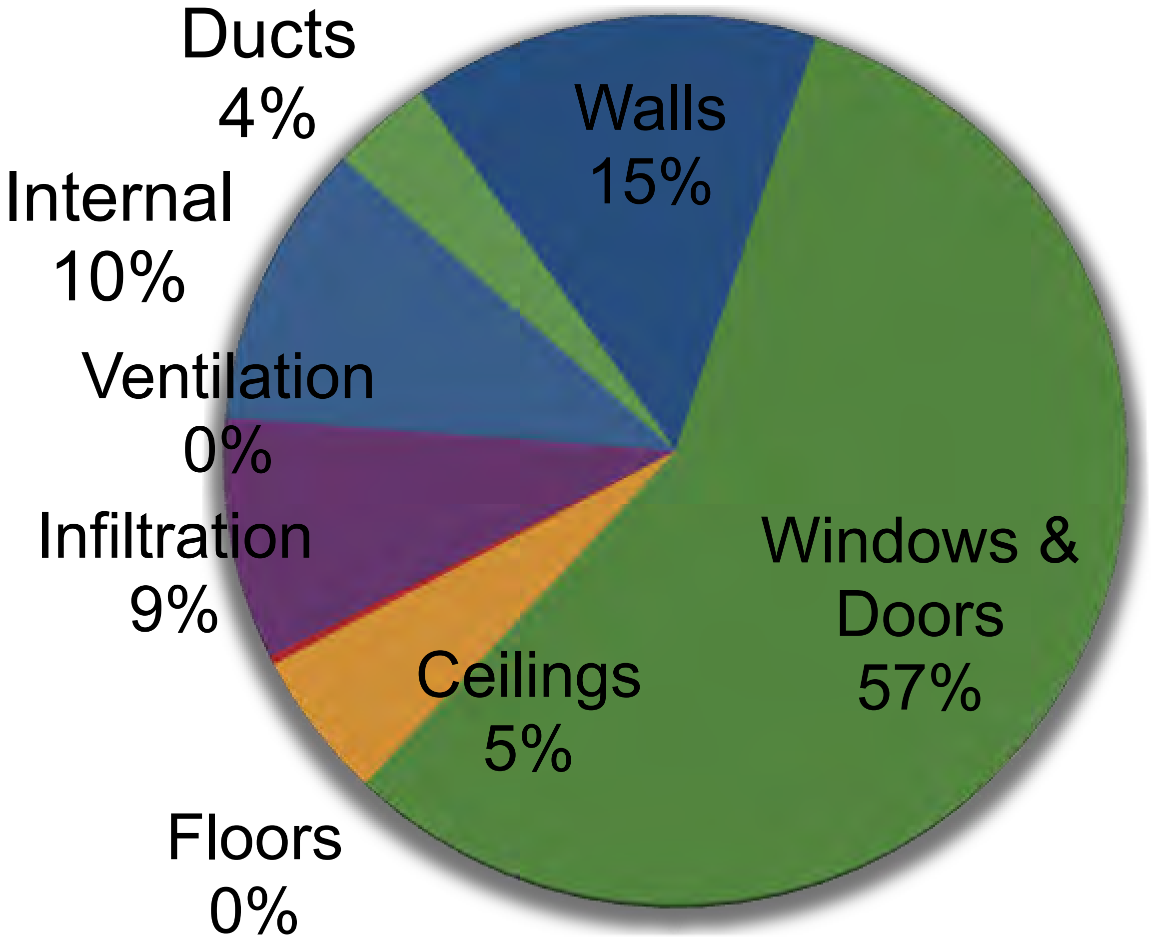




Cooling Loads- HP Home Versus Standard



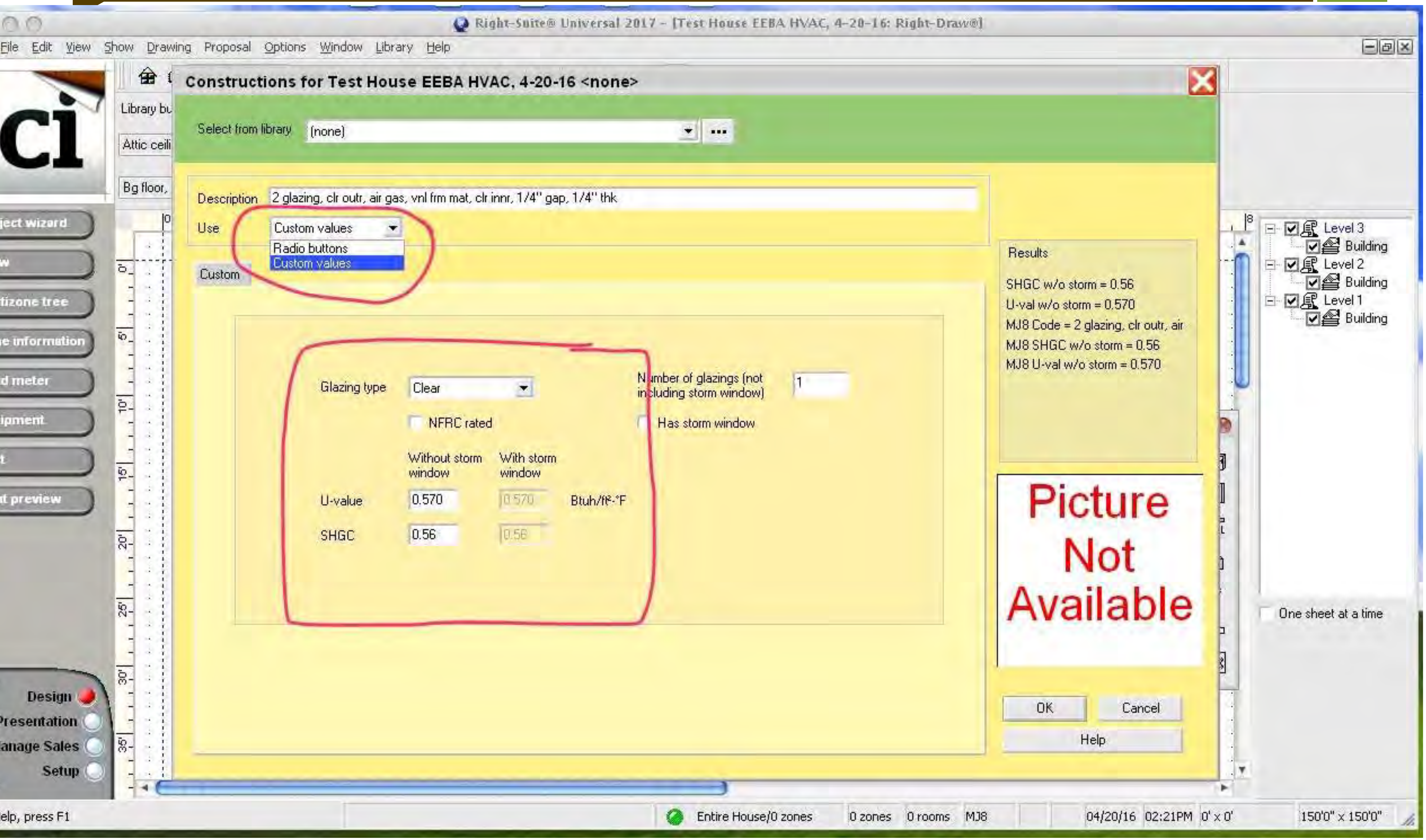




Provide your Contractor with Good Information

- Insulation levels
  - Wall and attic insulation levels
  - Foundation insulation
- Window data - use NFRC ratings
  - Solar heat gain coefficients
  - U values
- House Air leakage - (this is often the single biggest variable)
  - Provide blower door test values

Approved Software Guides Better Inputs



Constructions for Test House EEBA HVAC, 4-20-16 <none>

Select from library: (none)

Description: 2 glazing, clr outr, air gas, vnl frm mat, clr innr, 1/4" gap, 1/4" thk

Use: Custom values

Glazing type: Clear

☐ NFRC rated

Number of glazings (not including storm window): 1

☐ Has storm window

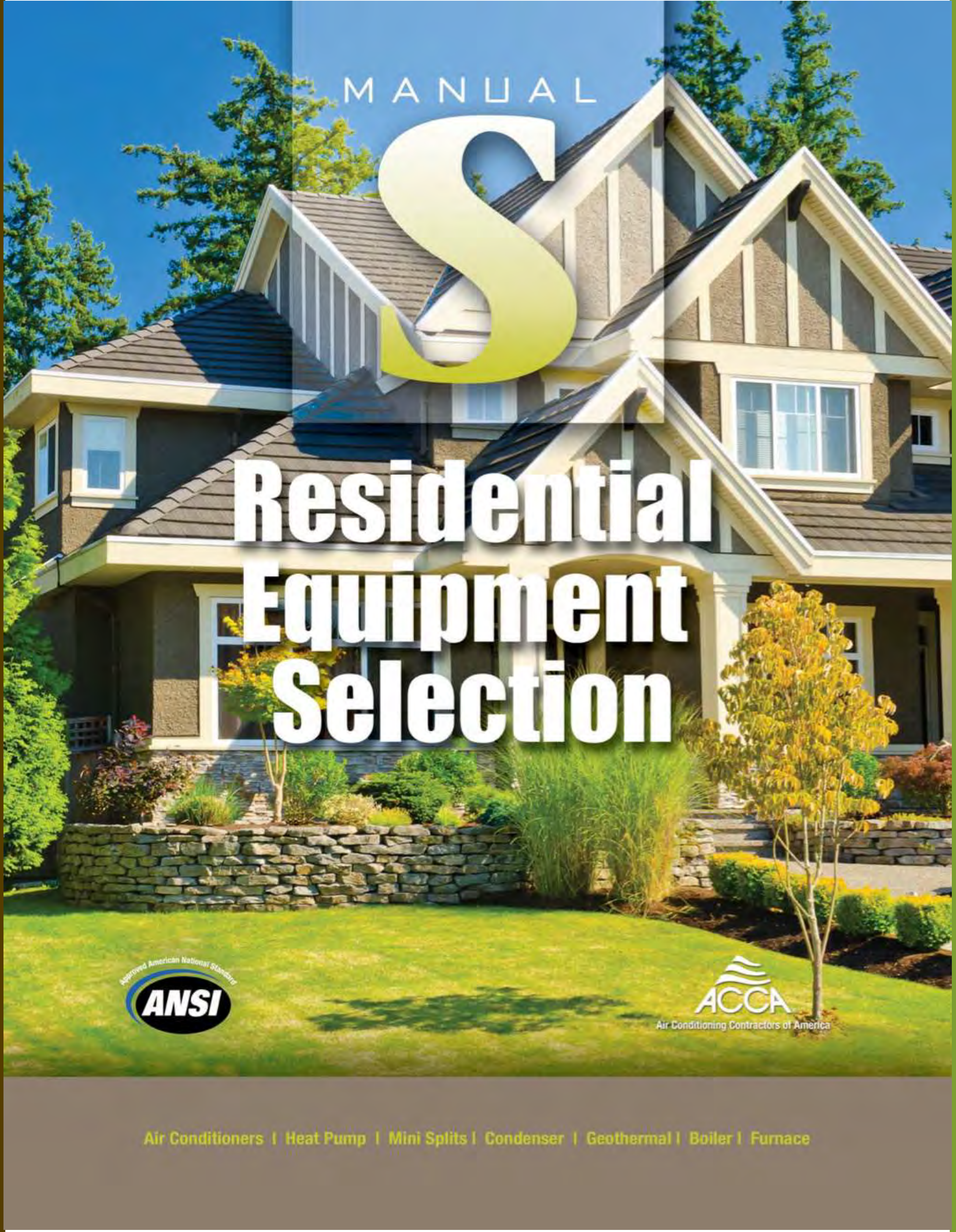
	Without storm window	With storm window	
U-value	0.570	0.570	Btuh/ft²·°F
SHGC	0.56	0.56	

Results

SHGC w/o storm = 0.56
U-val w/o storm = 0.570
MJ8 Code = 2 glazing, clr outr, air
MJ8 SHGC w/o storm = 0.56
MJ8 U-val w/o storm = 0.570

Entire House/0 zones | 0 zones | 0 rooms | MJ8 | 04/20/16 02:21PM | 0' x 0' | 150'0" x 150'0"

2) Select the right equipment



MANUAL

S

Residential Equipment Selection

Approved American National Standard

ANSI

ACCA

Air Conditioning Contractors of America

Air Conditioners | Heat Pump | Mini Splits | Condenser | Geothermal | Boiler | Furnace

ACCA Equipment Selection

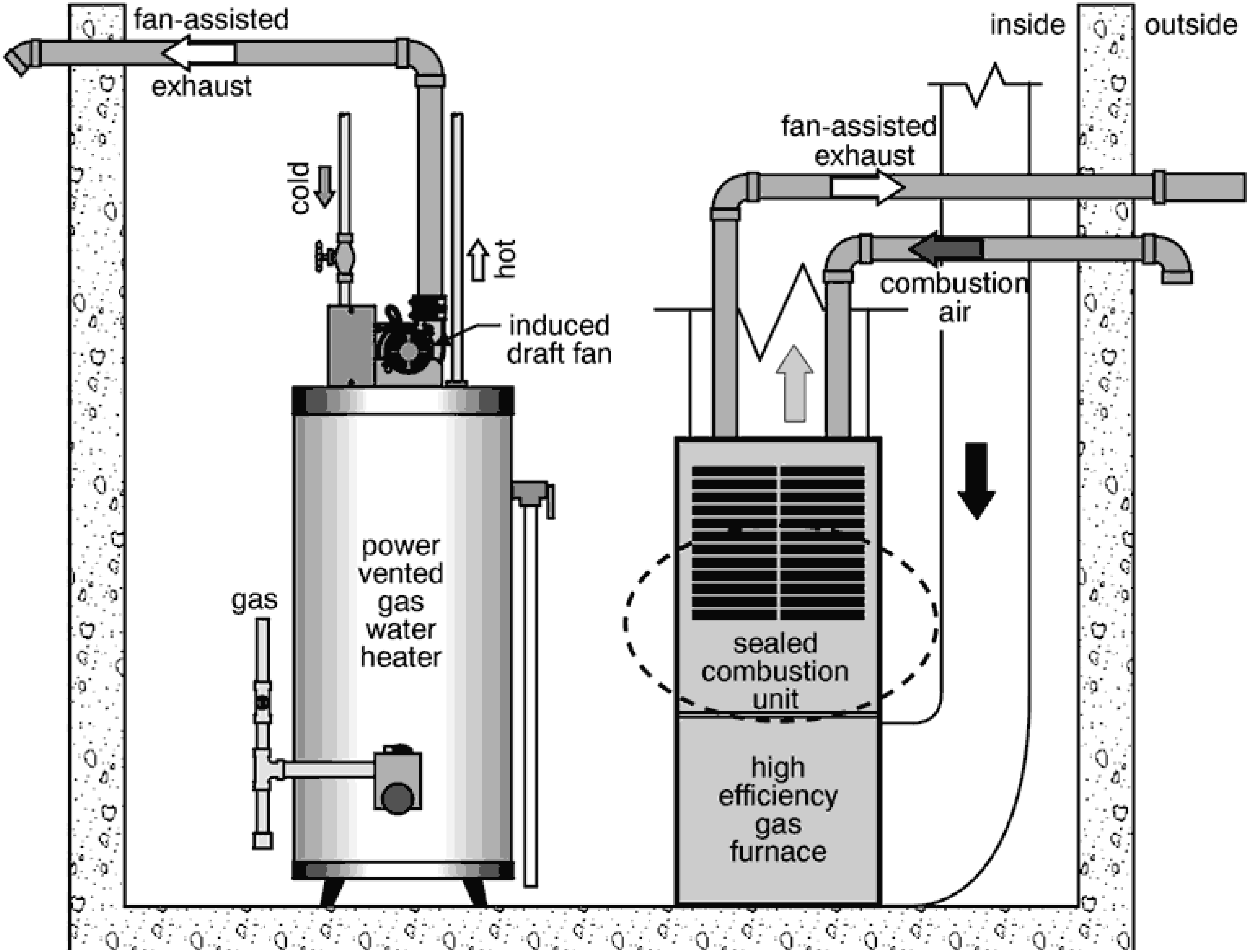
Good System Selection

- Use manufacturer’s technical manuals to match:
  - Required heat output
  - Required cooling output
    - Sensible & latent (moisture) loads
  - Fan / airflow delivery capacity and static pressure

Preferred furnace choices

- Sealed combustion chamber
- Venting system decoupled from house pressures
- Efficiencies of 90%+
- High efficiency blower motors - ECM
- Two/multi stage heating

Direct vent appliances



Preferred AC choices

- Outdoor condenser matched to indoor coil
- SEER ratings of 14+
- High efficiency blower motors - ECM
- Two - stage cooling
- Dehumidification cycles
- Inverter for simple connection to solar

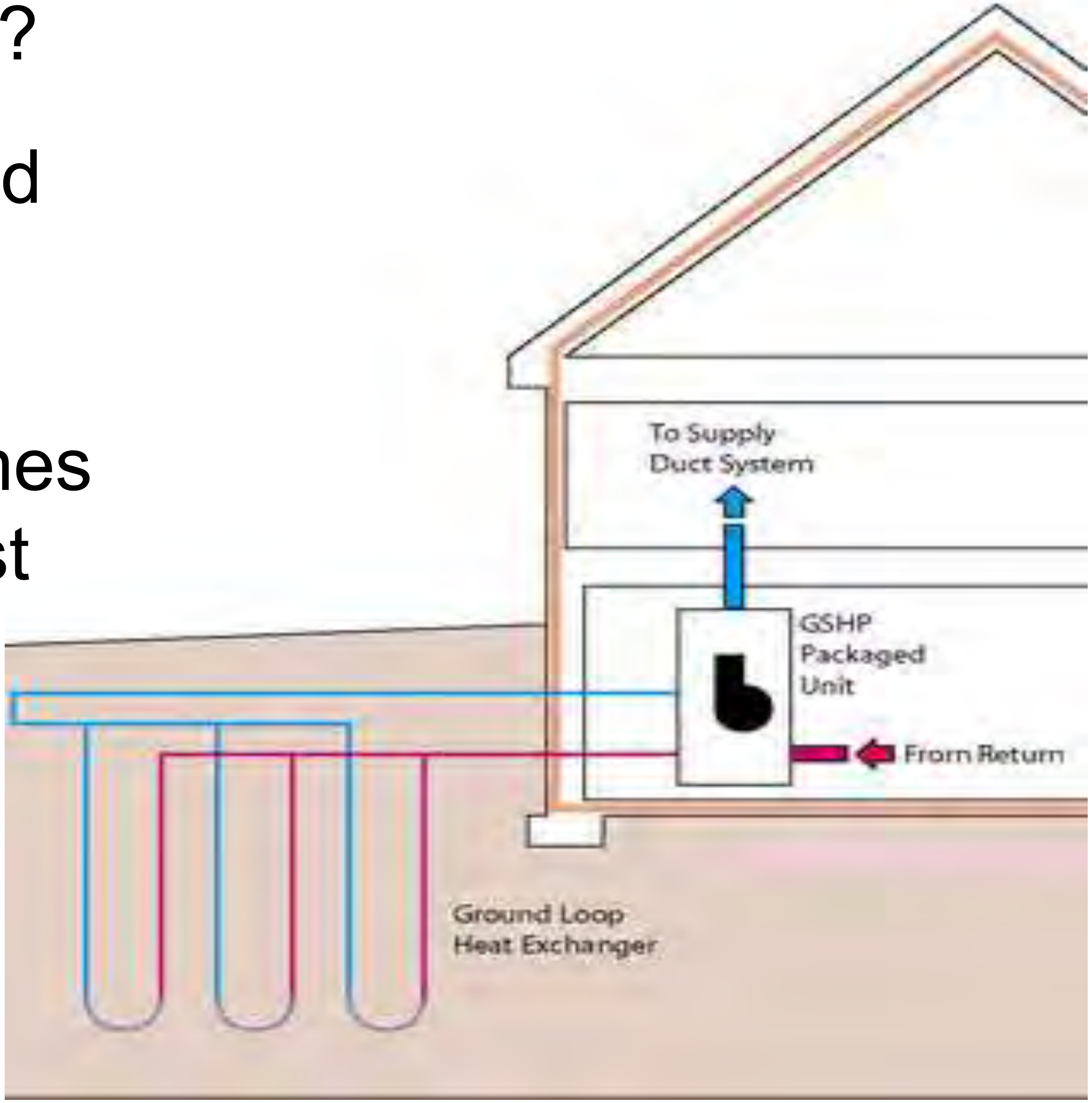
New Realities in HVAC Design & Performance

High Performance homes need more efficient motors!

- Capable of meeting small loads, part loads and full loads!
- Use1/5 of original PSC motor types.
- Run efficiently at a variety of speeds (Modulation)
- Equipment lasts longer
- Enables balanced temperatures throughout home
- Enhances Ventilation “Effectiveness”

What about Heat Pumps?

- Is it the first thing to do?
- Reliance on electric grid
- Can do water or air
- High Performance homes help reduce capital cost



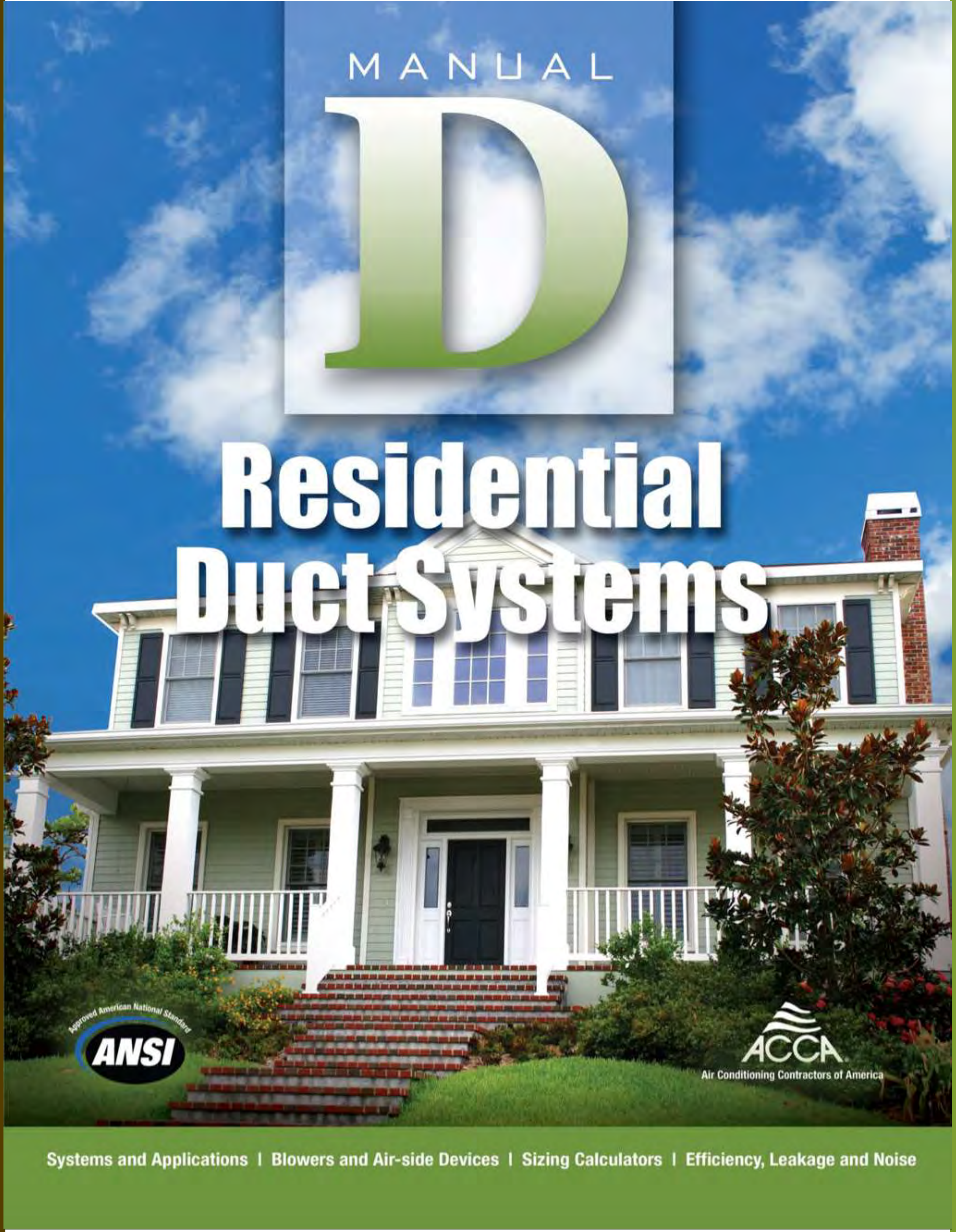
Energy Efficiency

- Heat pumps are hard to overlook
- Low ambient temperature units: COPs of 2 to 4
- Be mindful of HSPF rating points and operating conditions – cold weather:
- Zone 5+ + 8.6 HSPF+
- Dual Fuel /Auxillary back up as gas vs electric.

Example of a different strategy
- Ductless opportunities

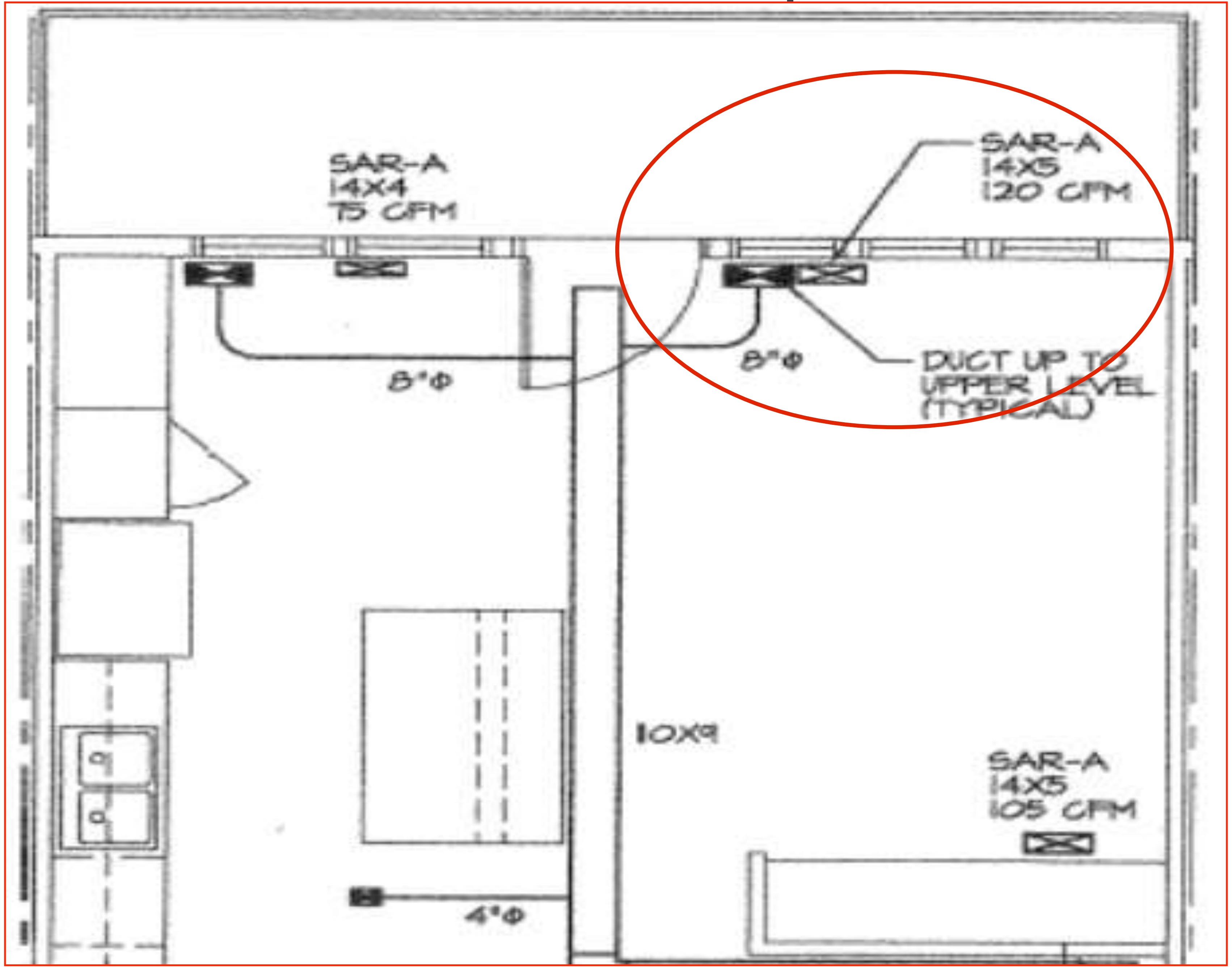
- Provides zoning
- Can target specific high load areas
- In very high performance homes, it could provide all heating & cooling needs

3) Design the ducts correctly



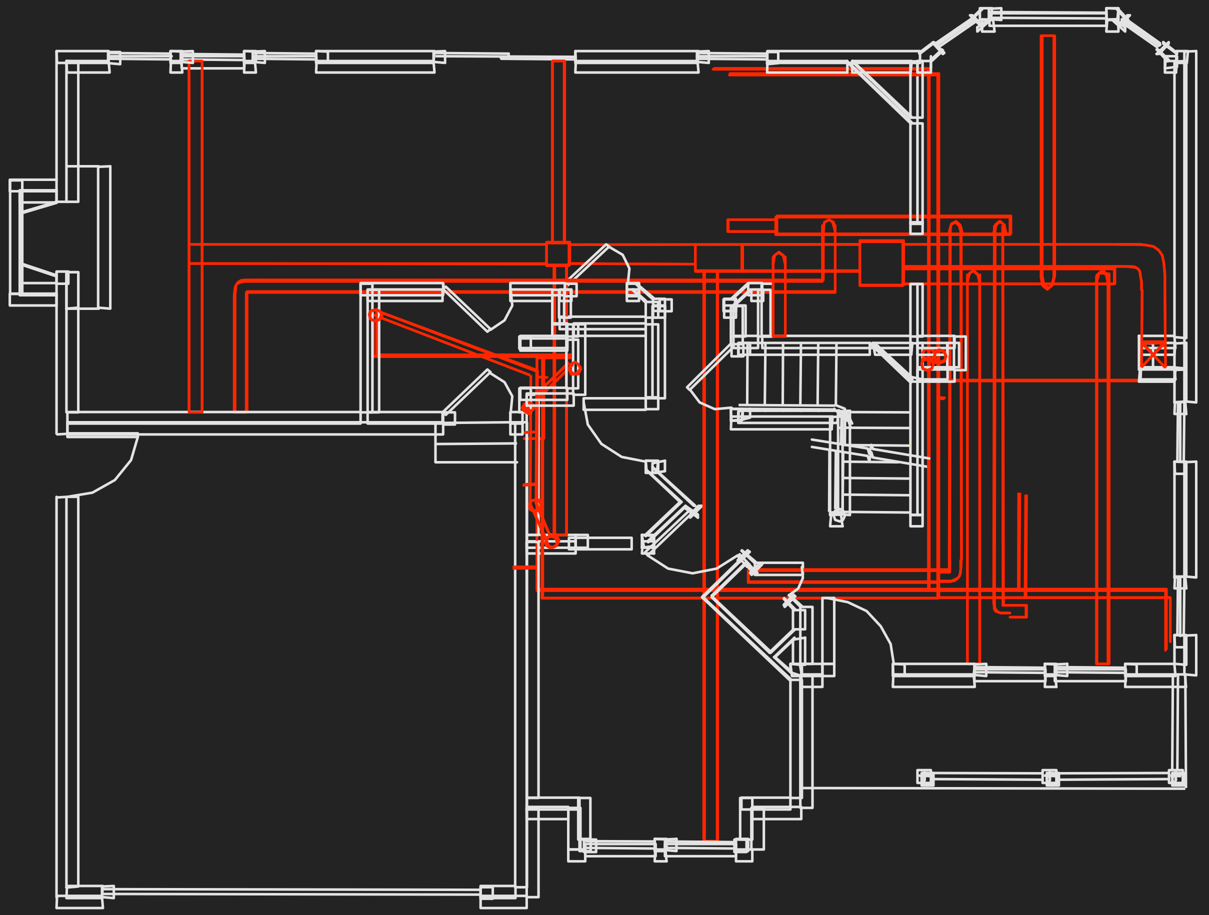
ACCA Duct Design

Manual D provides a duct sizing schedule to deliver the air to the space intended

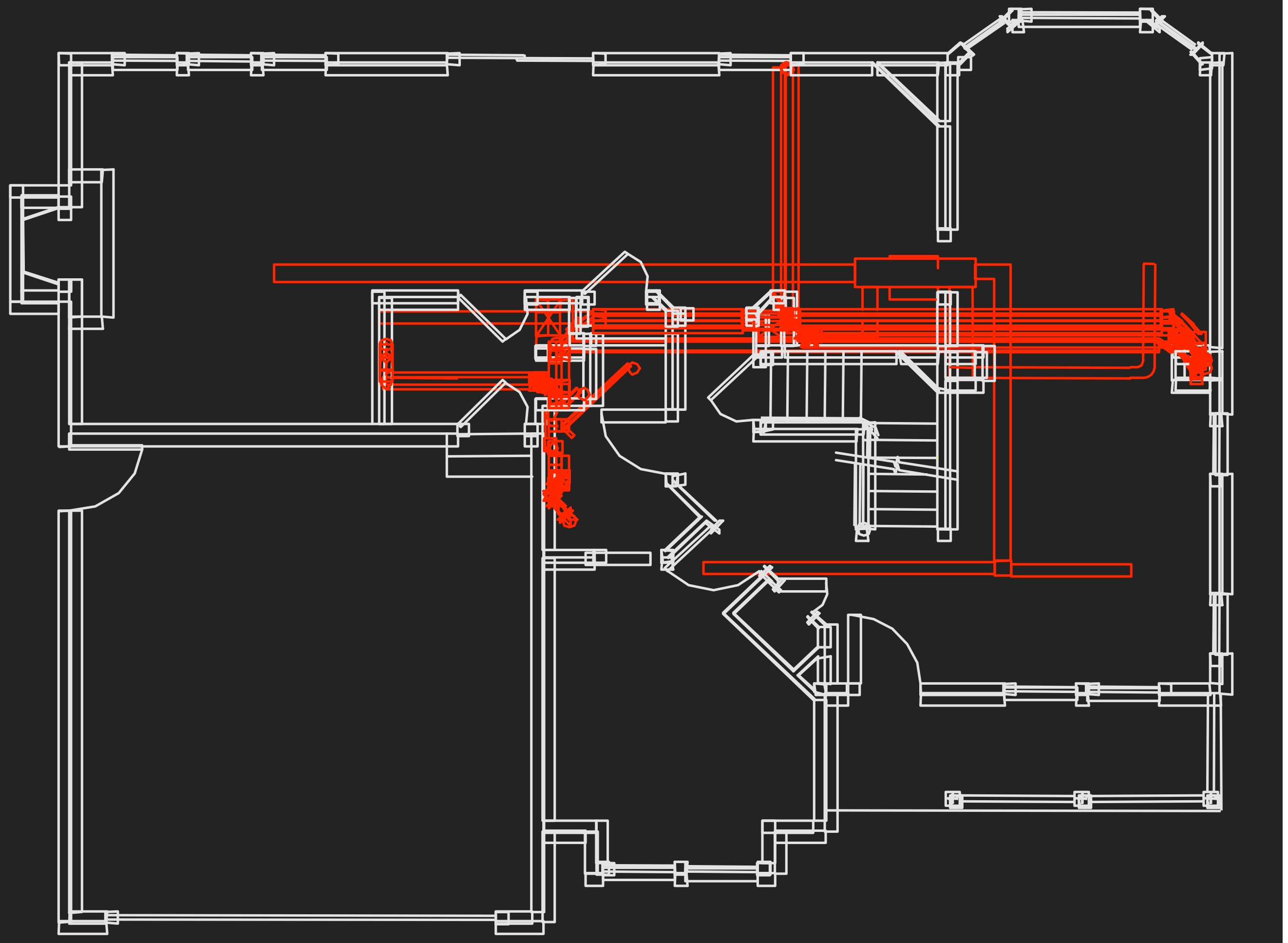


HVAC by Design

- Properly size system
- Optimize duct layout



Traditional



Advanced

Ducts & equipment in conditioned space

A closet & dropped ceiling

Use direct vent equipment

Ducts in conditioned space will be cooler in summer, warmer in winter

Place the ducts in conditioned space

A dropped ceiling in the hallway can be effective

Ducts are now properly insulated and any duct leakage is to the interior

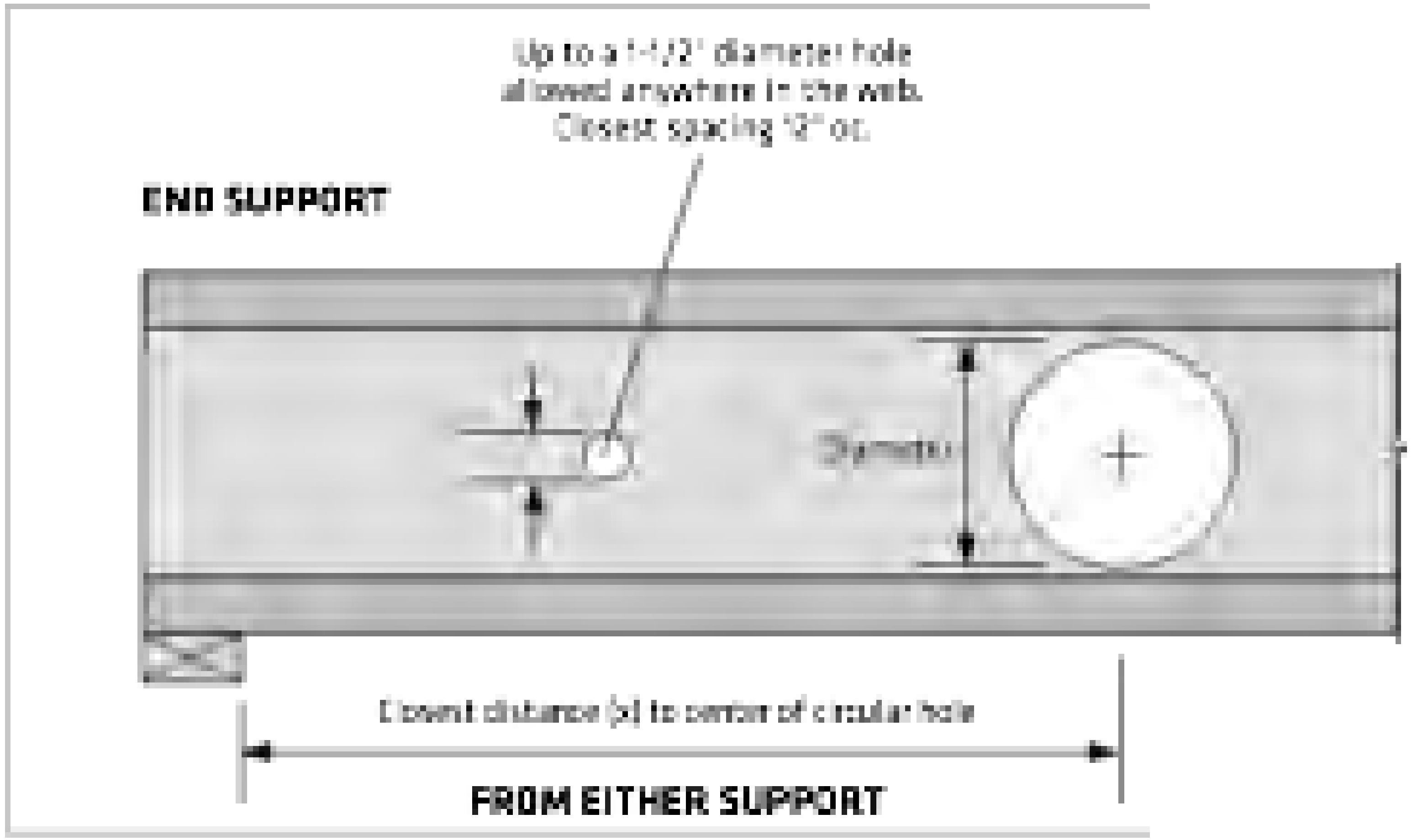
Properly sized and located grilles “throw” air to the perimeter windows and walls

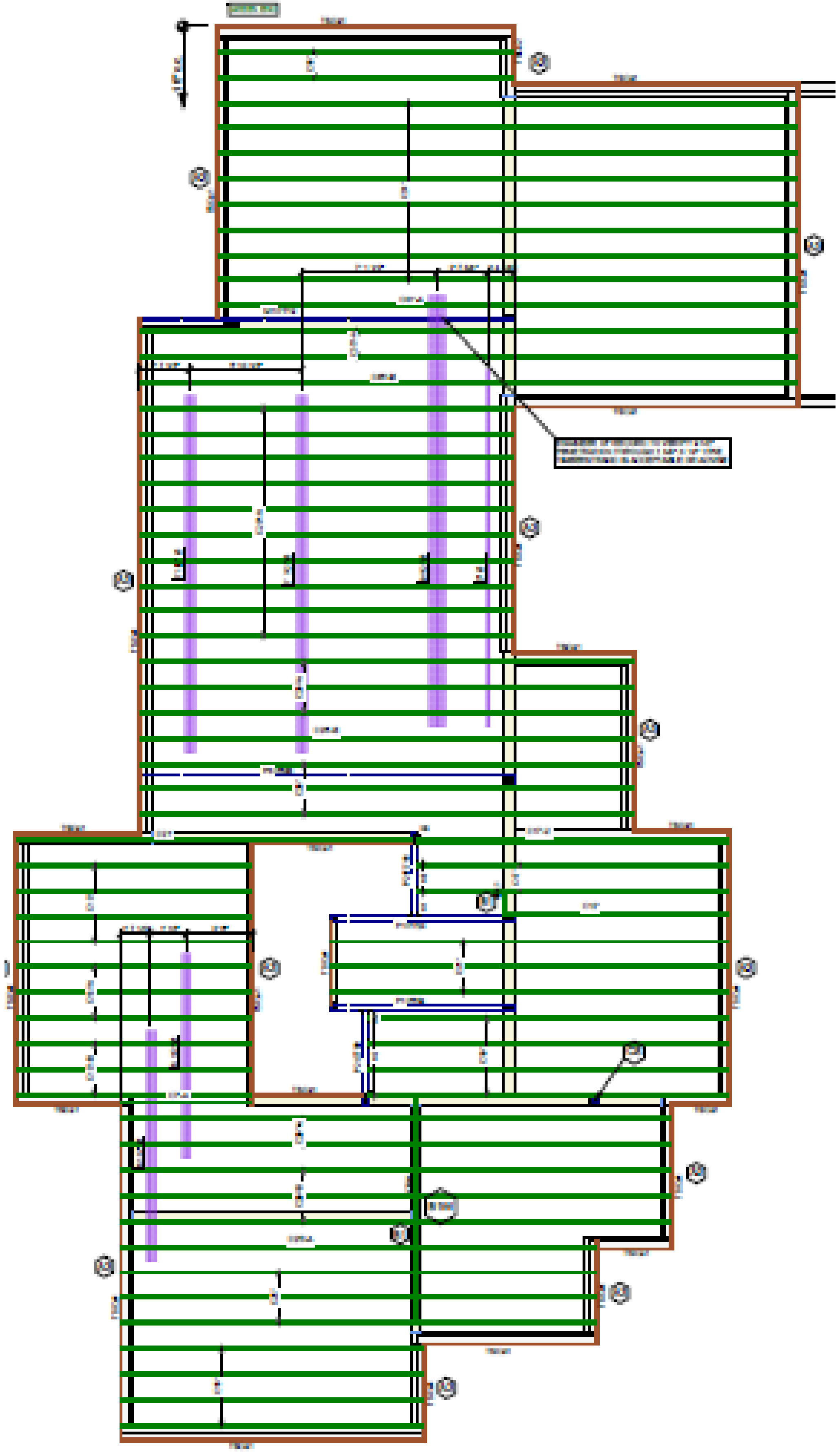
Conditioned attics are an option

It can raise the value of a home

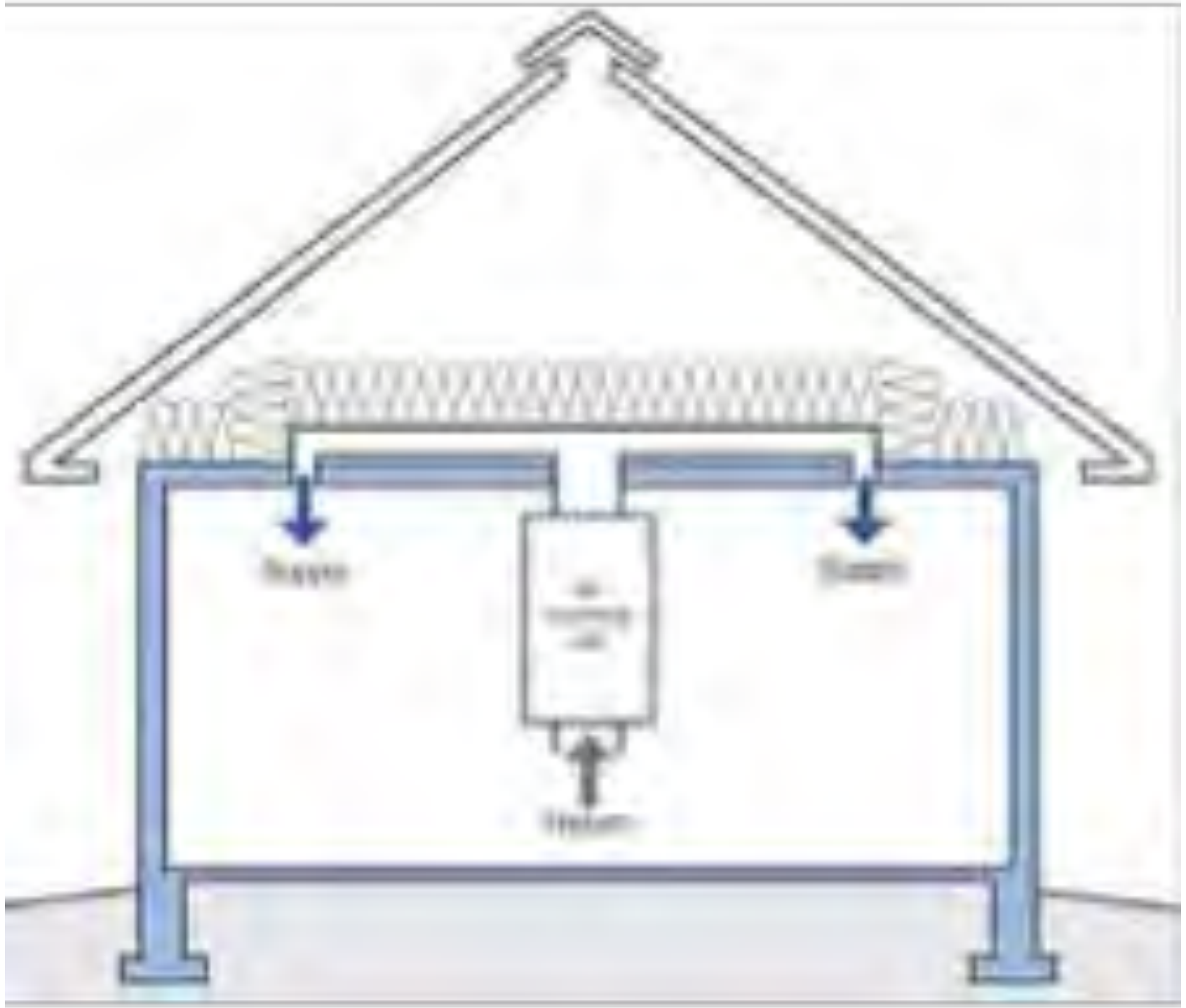
Open web floor joist systems

Layout your floors to accommodate duct



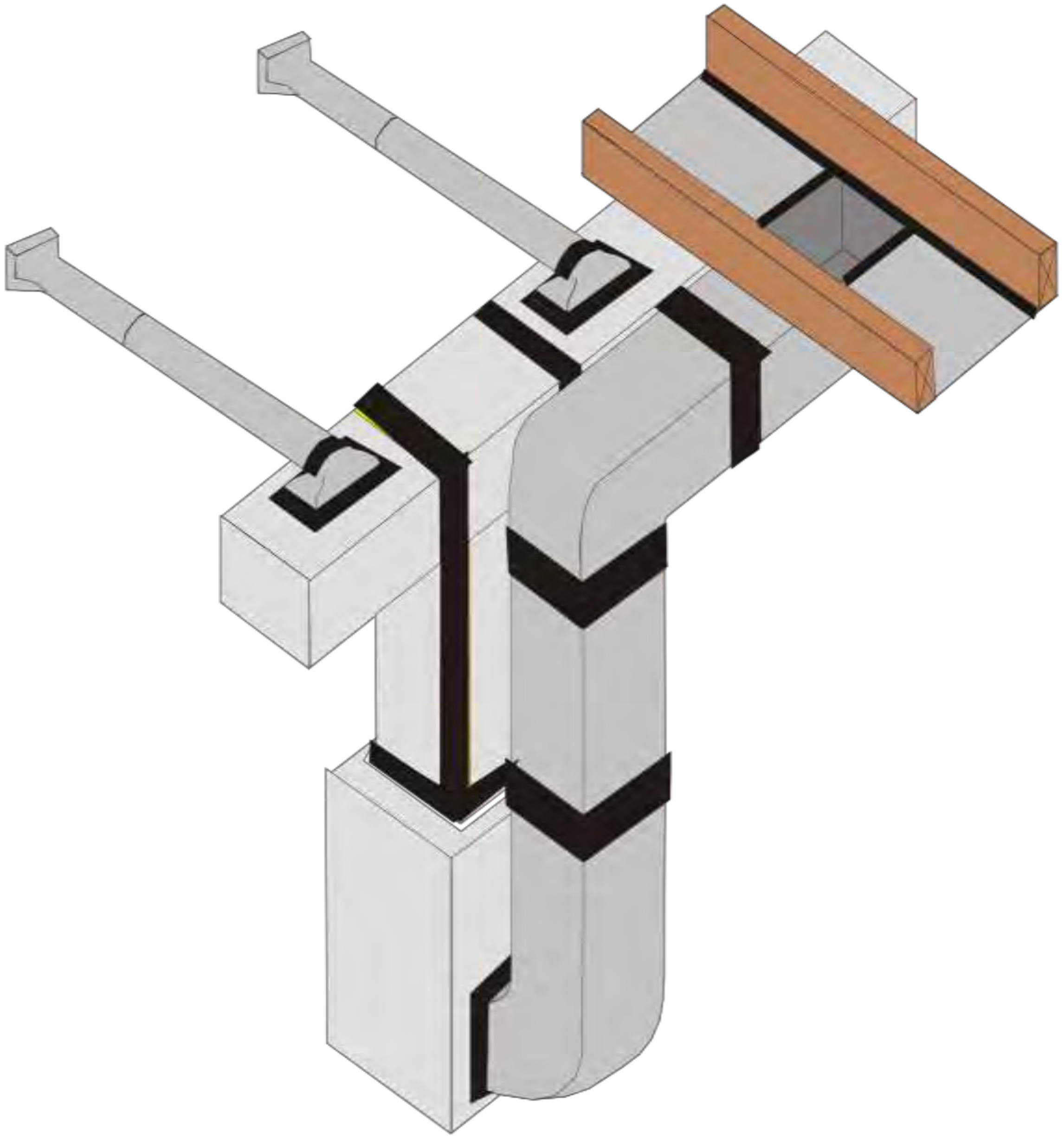


Buried Ducts are an Option



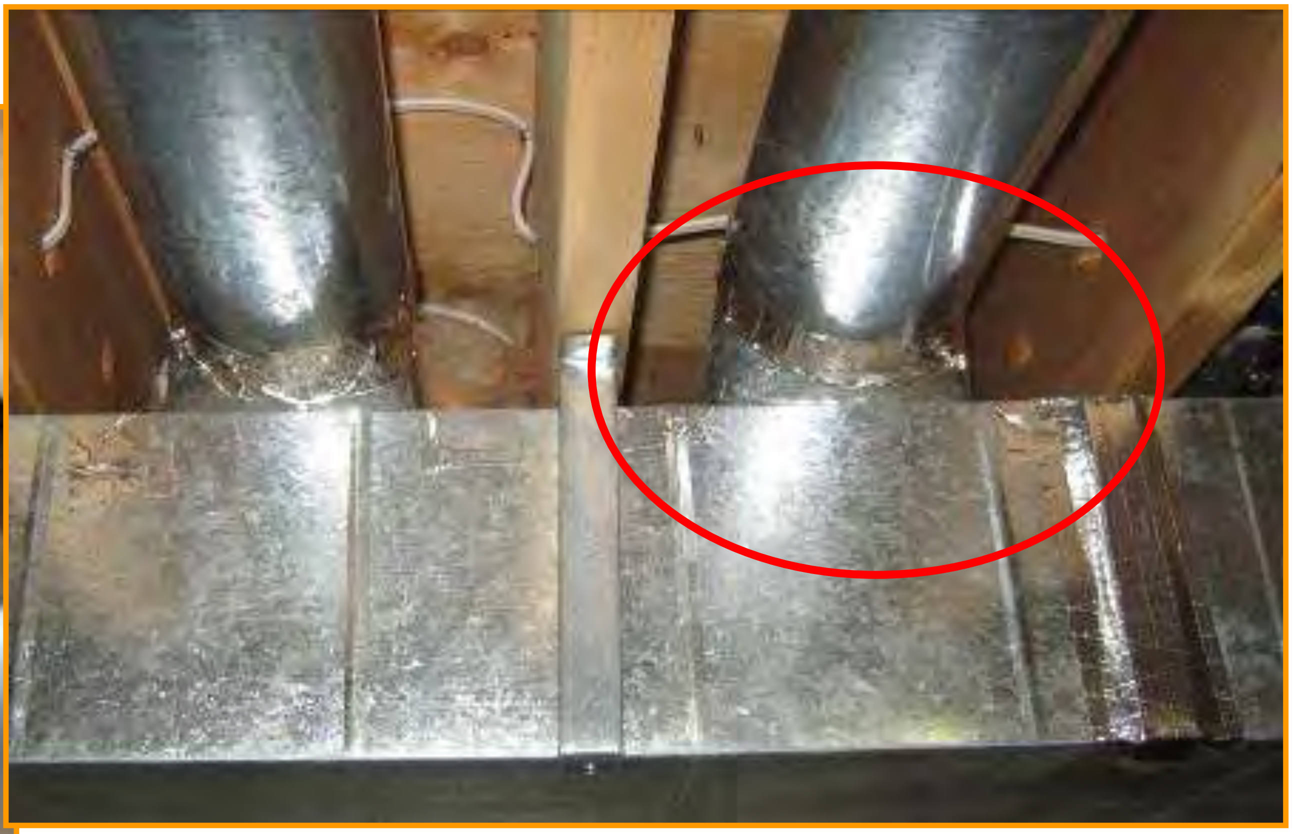
Sealing Ducts Matters!!!

- Getting air where you need it
- Allowing balancing & seasonal adjustment to work
- Empowers zoning to work

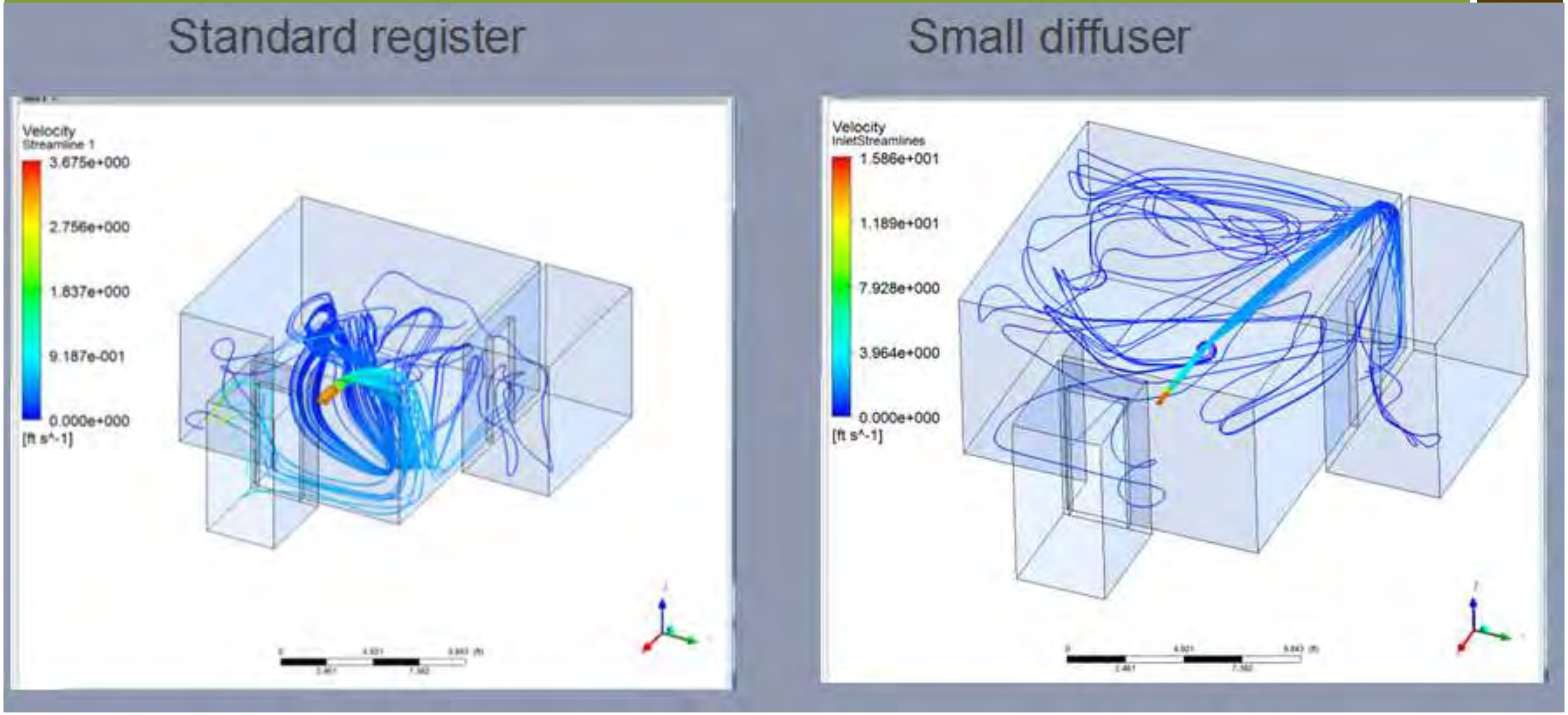


Seal Ducts

Mastic with a brush is quickest & best

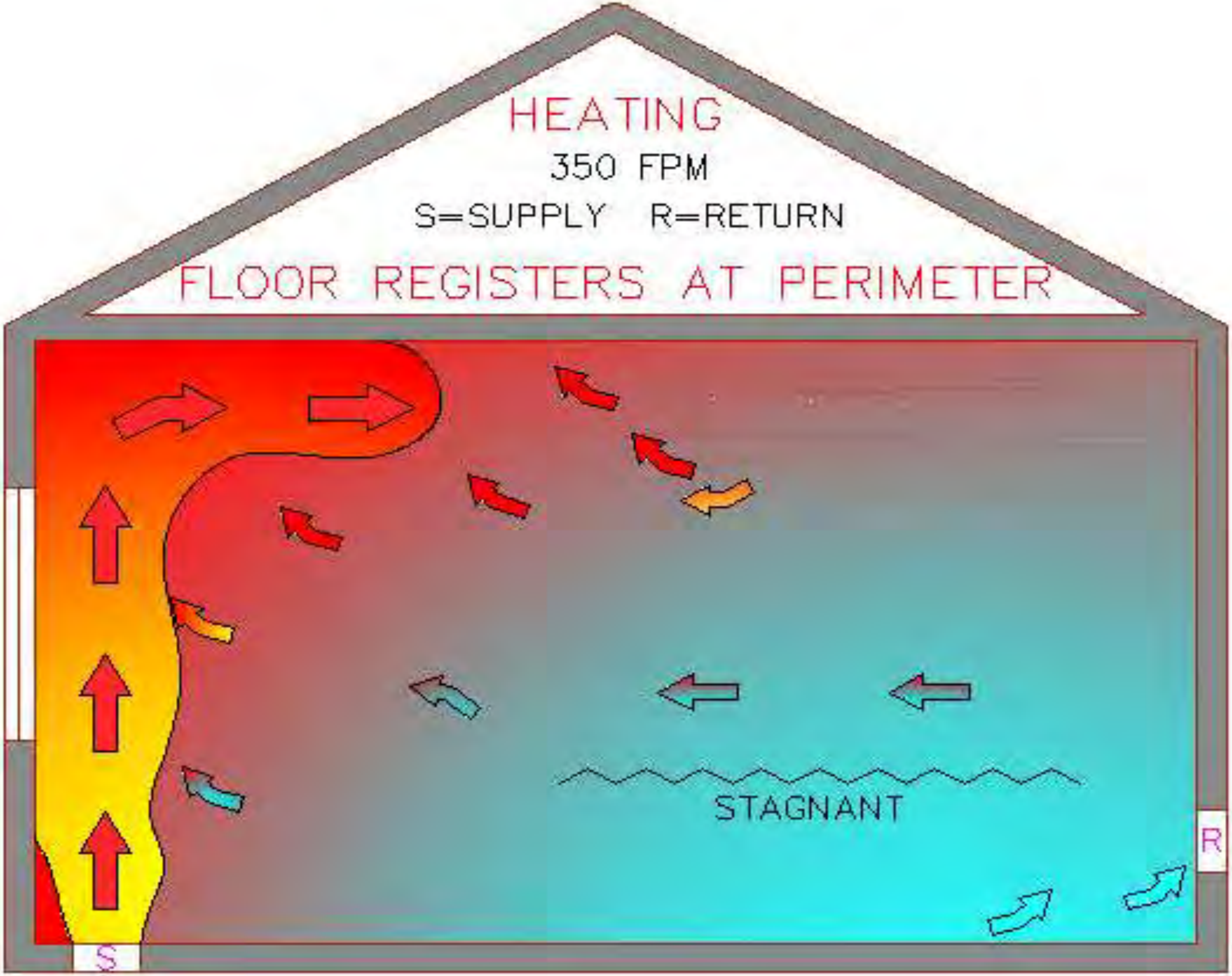


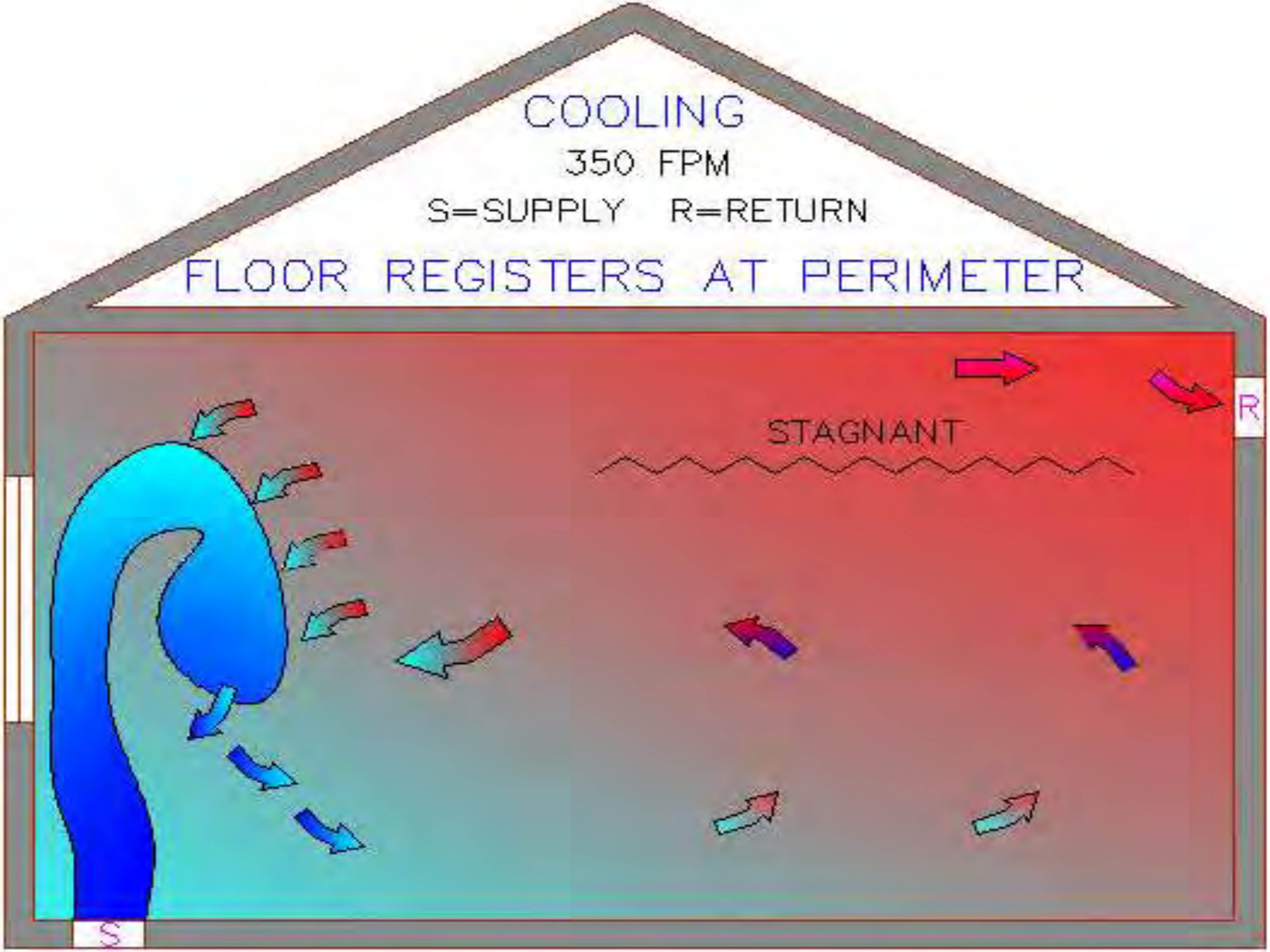
Low Load Homes suffer from lack of air flow-THROW and MIXING!
(Not lack of Returns)



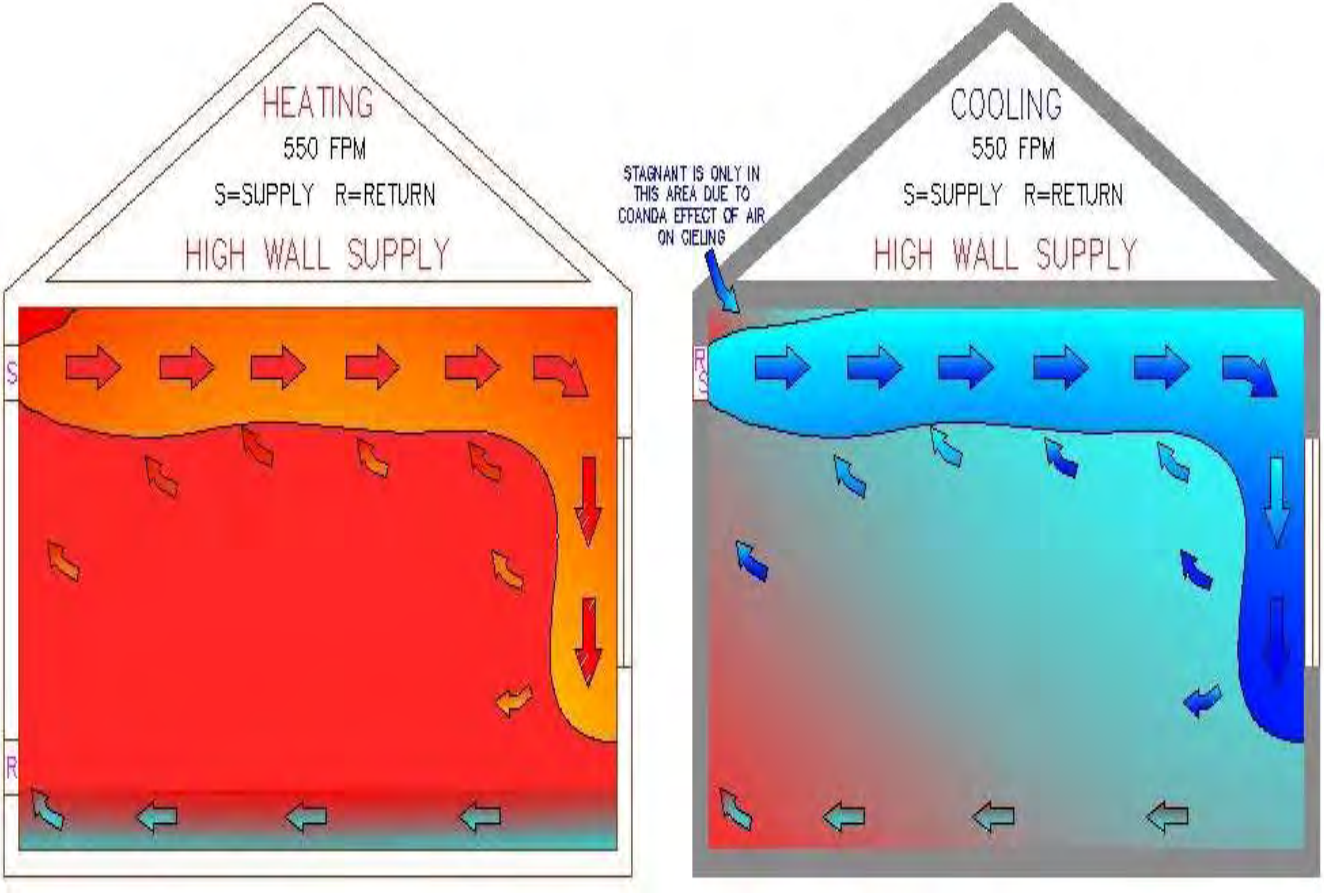
Standard register

Small diffuser


HEATING
350 FPM
S=SUPPLY R=RETURN
FLOOR REGISTERS AT PERIMETER
STAGNANT
R
S

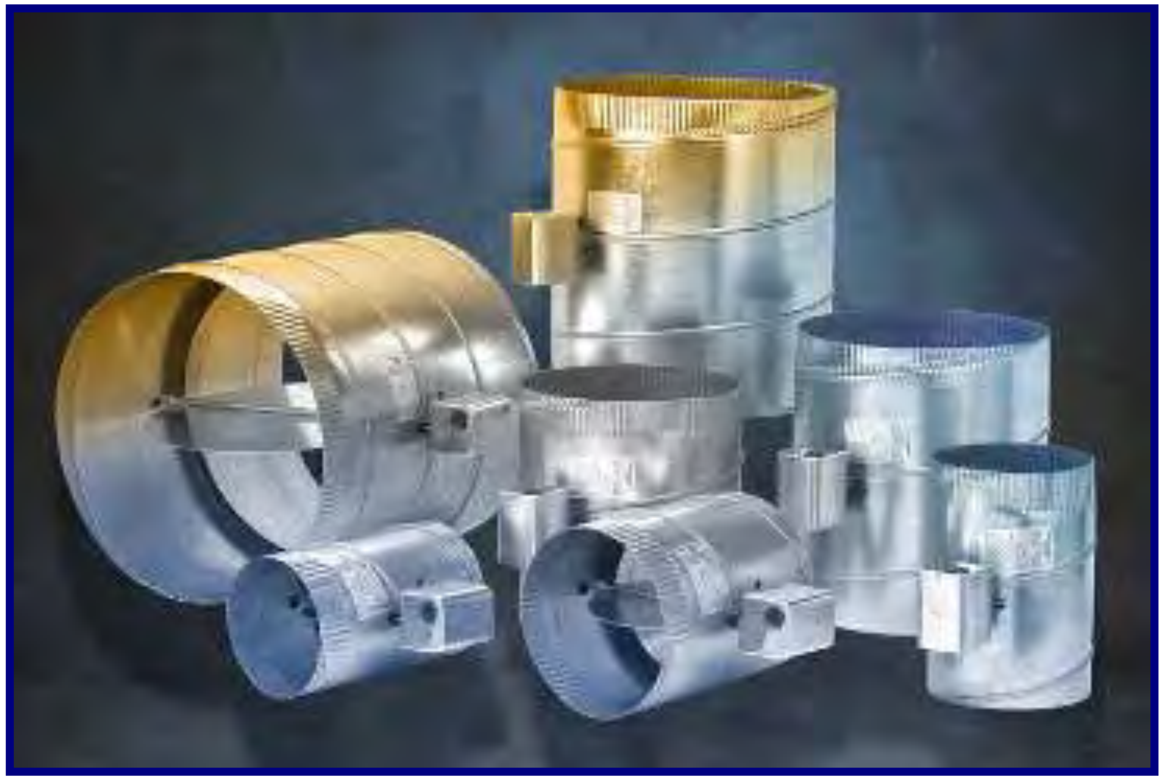

COOLING
350 FPM
S=SUPPLY R=RETURN
FLOOR REGISTERS AT PERIMETER
STAGNANT
R
S

Choose Proper Diffusers with Velocity and “Throw” in Mind



Zoning will become more important

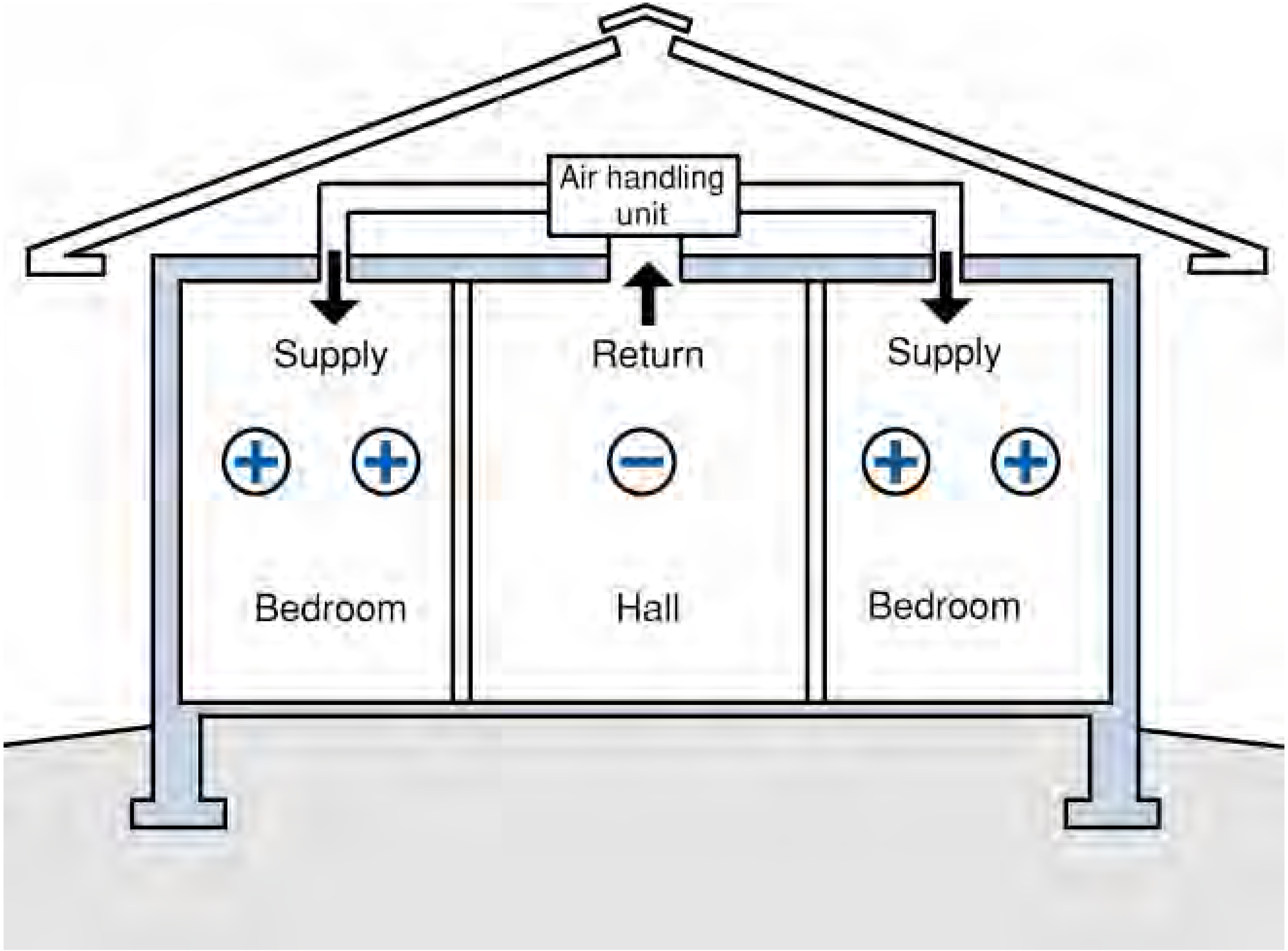
- Matching seasonal load adjustments
- Example – basements
- Accurate delivery of part loads
- Making best use of equipment capacity



Ducted Returns will become expected

- A good choice is to hard duct returns...strategically to a centralized location

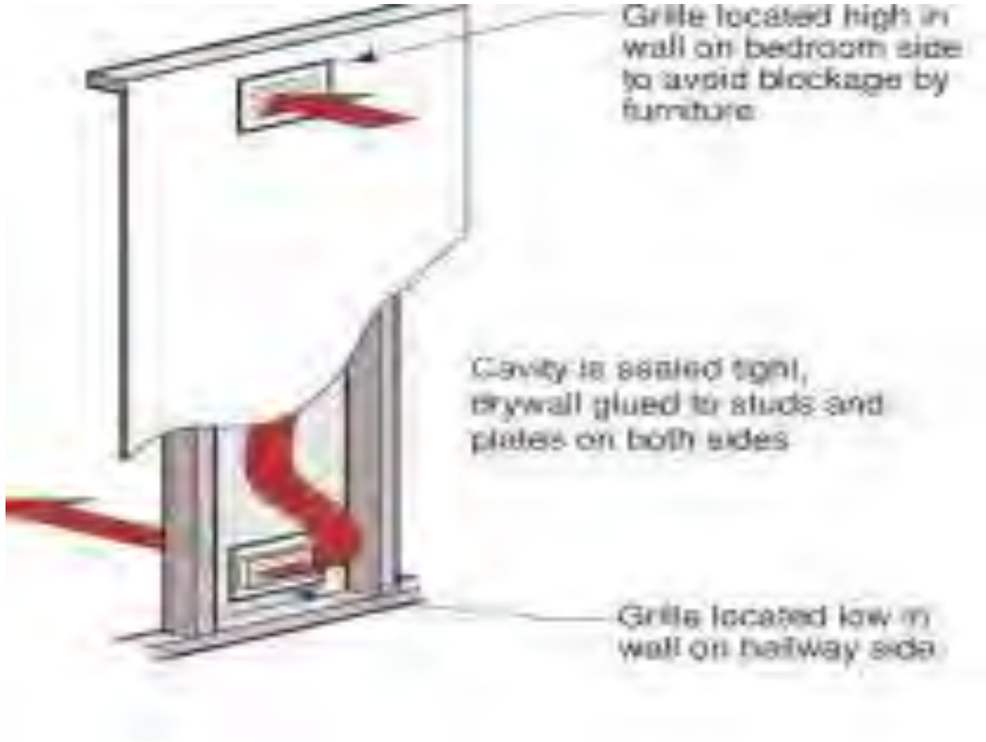
Return Air Paths

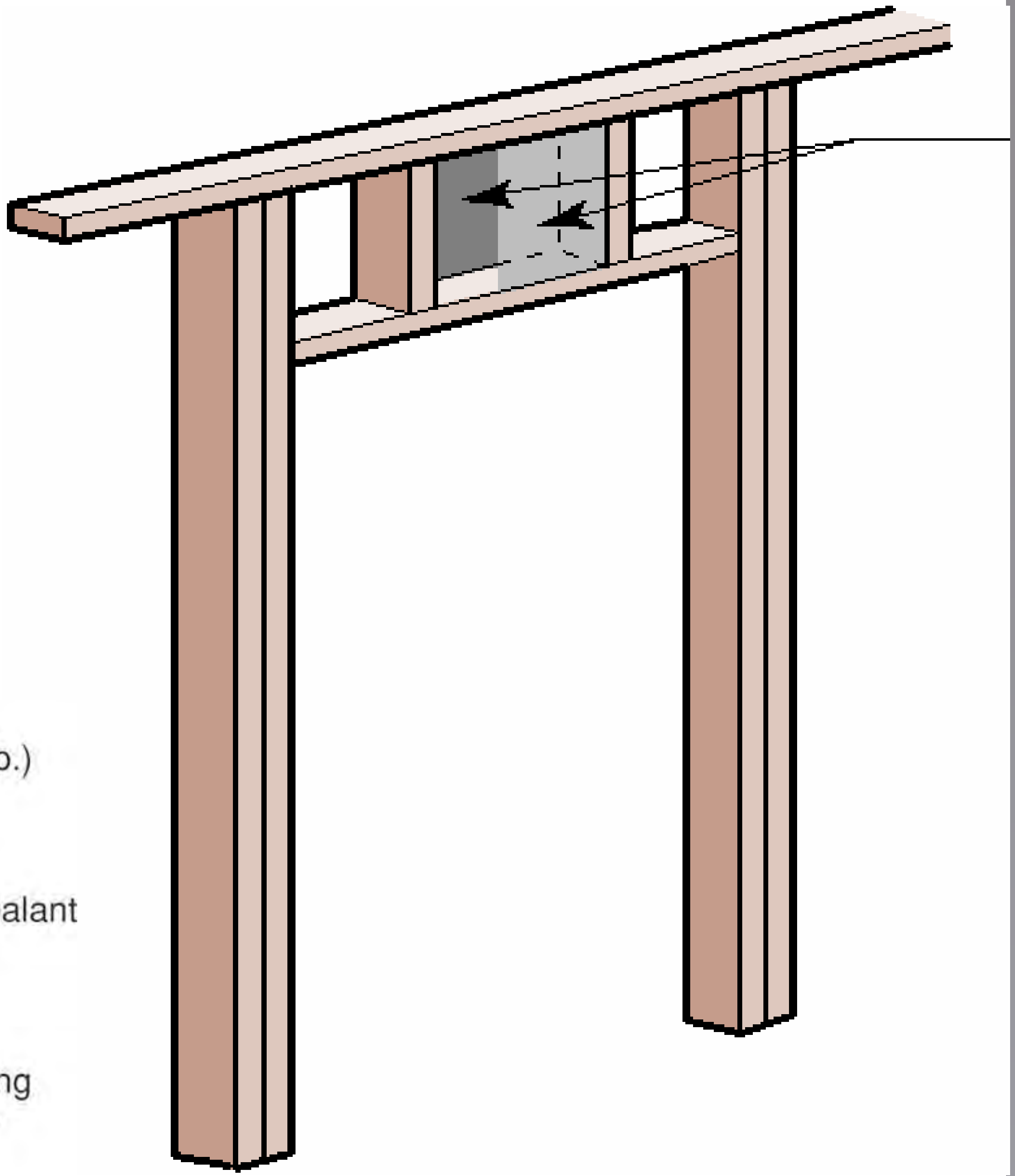


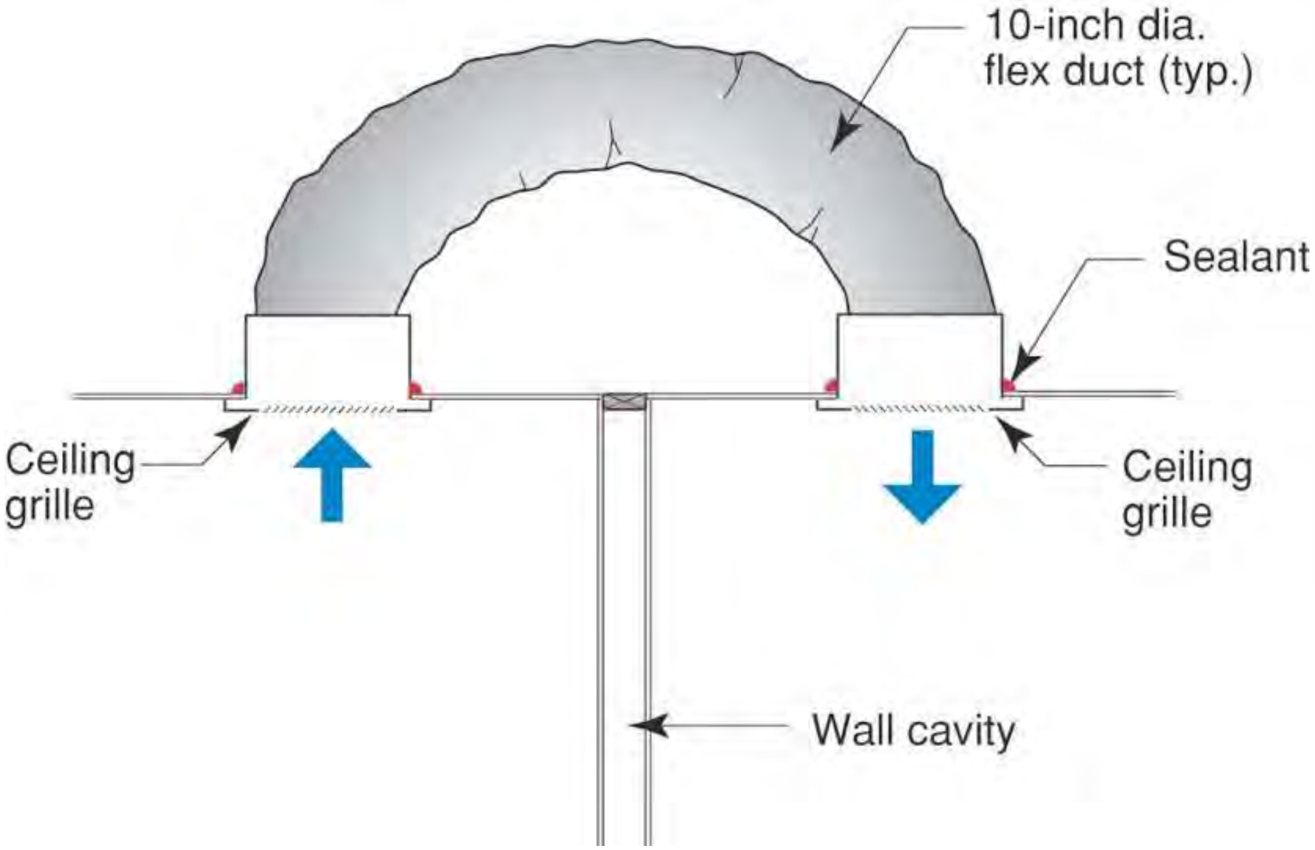
Graphics Courtesy of Building Science Corp.

A single return requires transfer grilles to provide a return path, and avoid pressurizing bedrooms

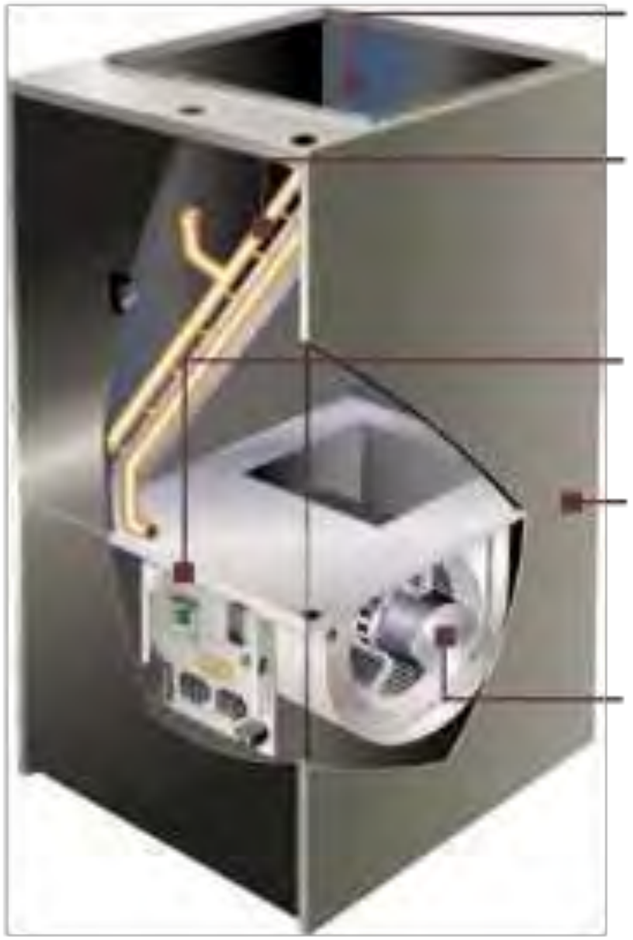
Note: not an IECC requirement


Grille located high in wall on bedroom side to avoid blockage by furniture
Cavity is sealed tight, drywall glued to studs and plates on both sides
Grille located low in wall on hallway side




10-inch dia. flex duct (typ.)
Sealant
Ceiling grille
Ceiling grille
Wall cavity

Combination Systems



Fully Insulated Cabinet – Lowers operating sound.

High-Efficiency Hot Water Coil – Provides exceptional heat transfer and efficient operation.

Electronic Control – Automatically controls unit's operation.

Heavy-Gauge Steel Cabinet – Offers long-lasting reliability with a durable, baked-on enamel finish.

Variable Speed Blower Motor – Designed for comfort and efficiency while minimizing sound.

Multi-Position Design – Allows greater installation flexibility.

Hot water air handler

Condensing Water Heater

Controls

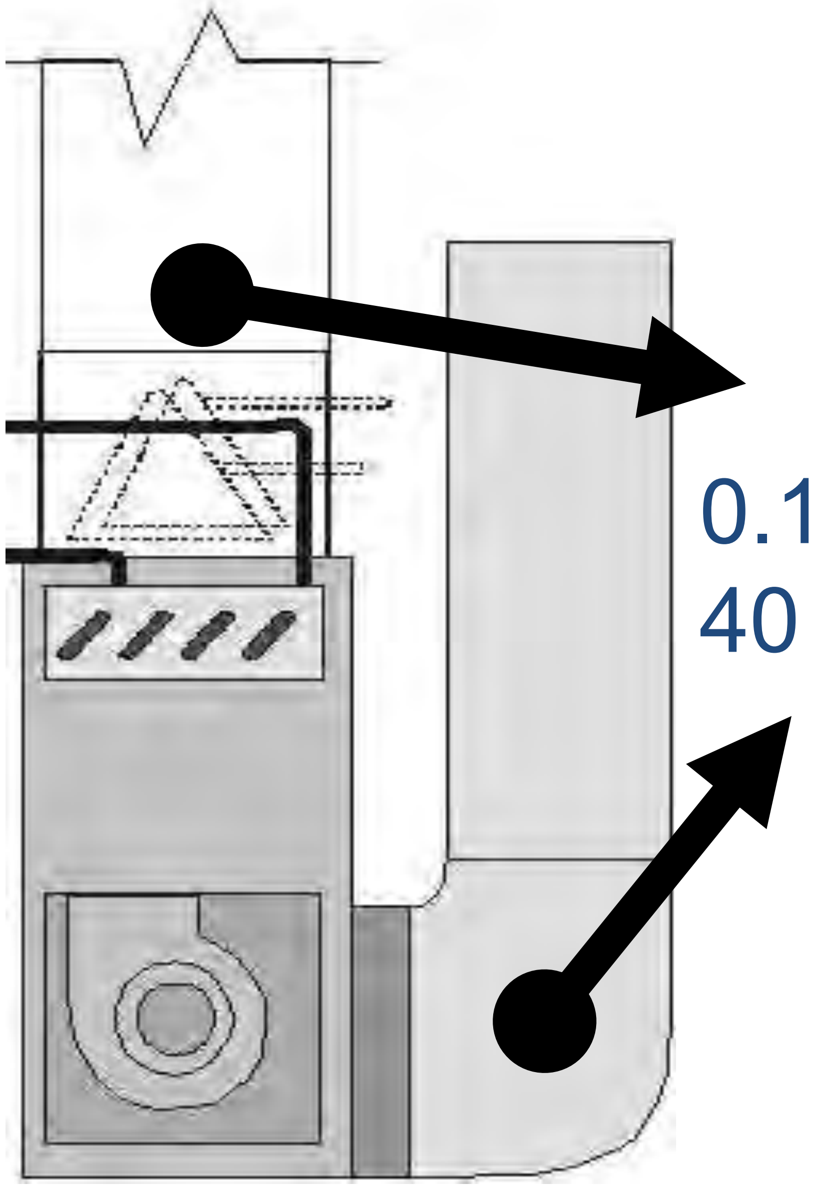
Verification / Commissioning

Testing for performance

Simple Testing Can Help

- Verify performance before the Design Day
- 3-4 measurements
- Matched to the design
- Matched to manufacturer’s specifications

1) Duct pressures



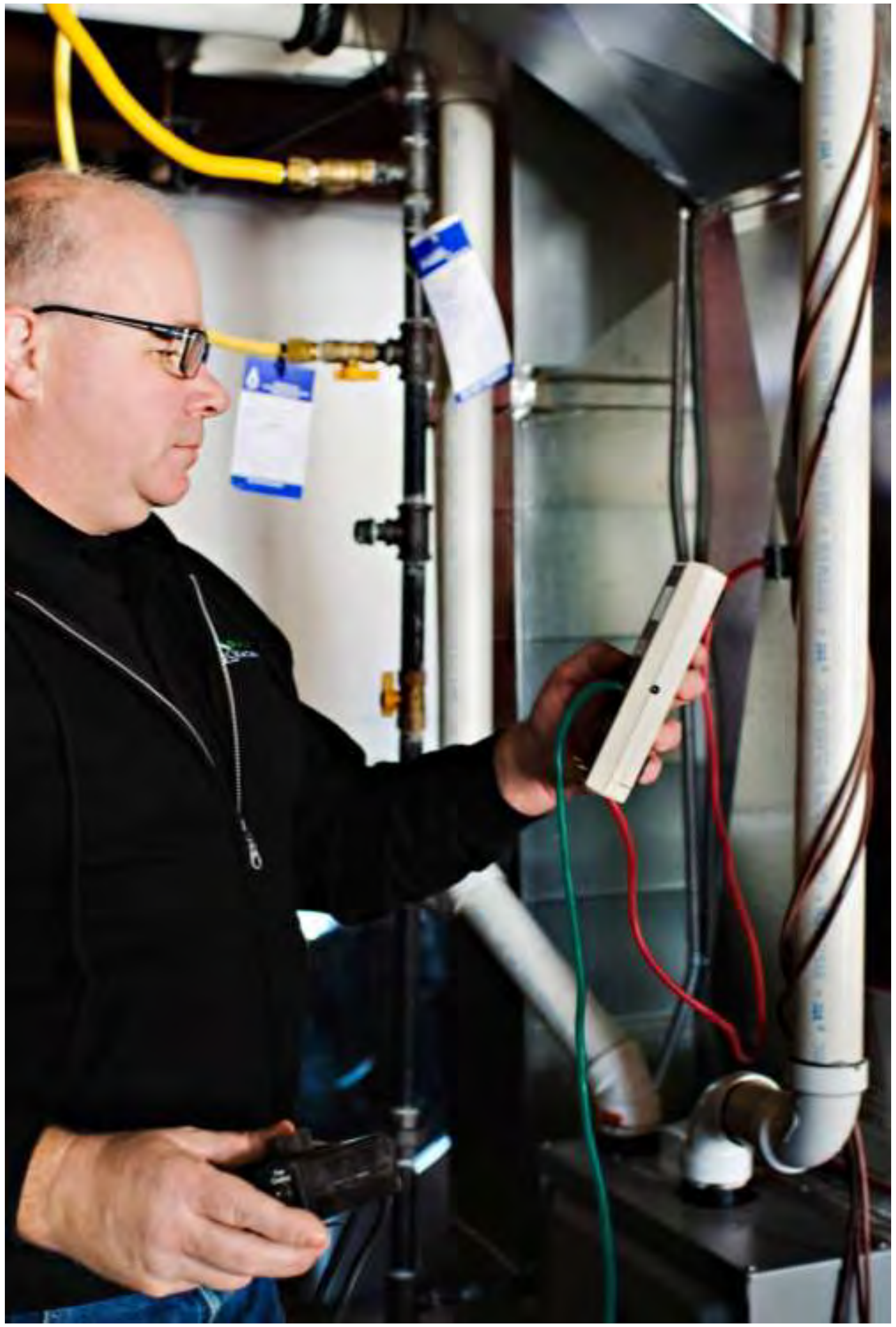
0.15” to 0.25”
40 – 60 Pa

2) Airflow at Air Handler

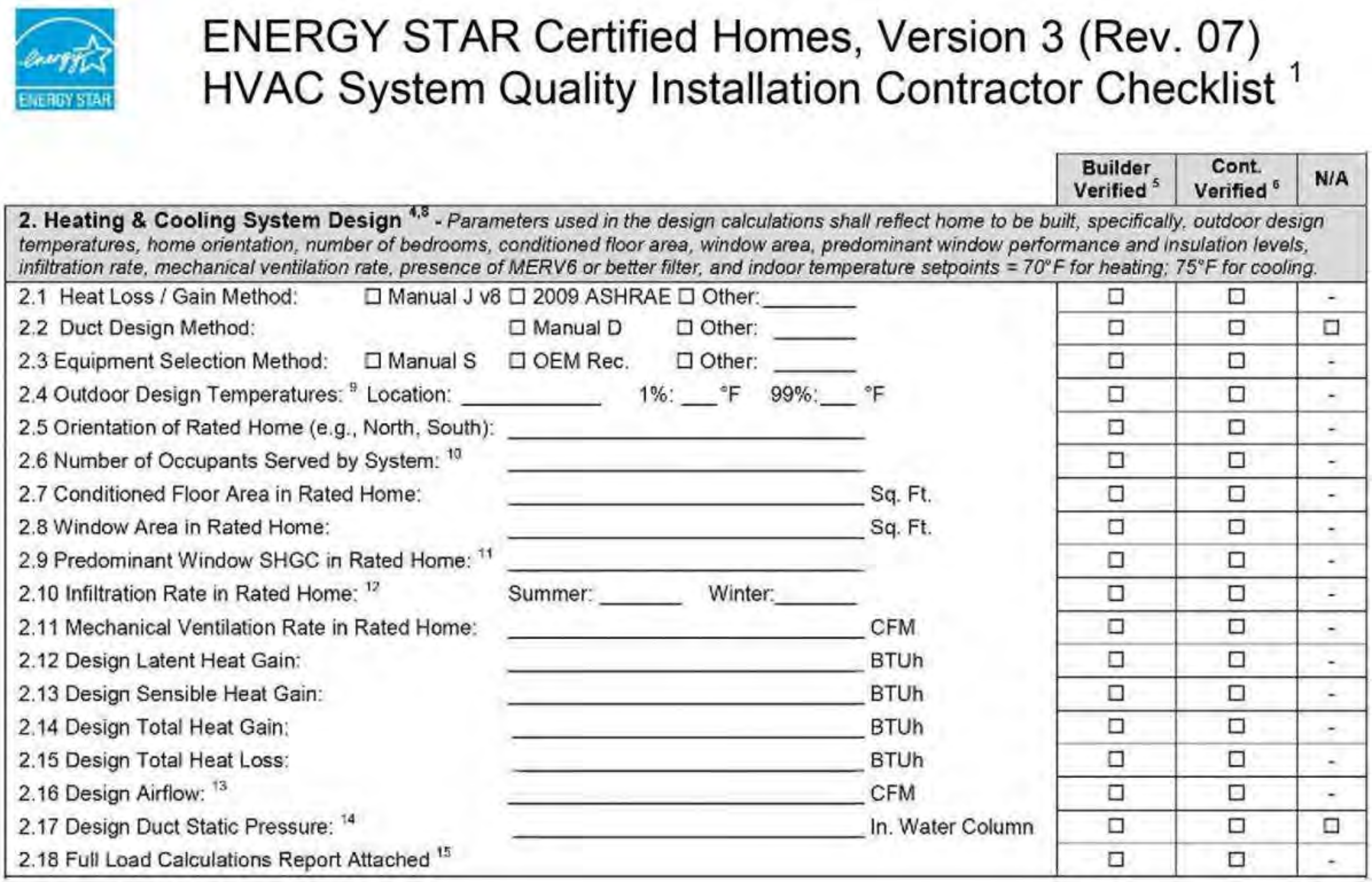
3) Airflow at Registers

4) Refrigerate Verification

5) Temperature rises



Valuable Resources



ENERGY STAR Certified Homes, Version 3 (Rev. 07)
HVAC System Quality Installation Contractor Checklist [1]

	Builder Verified [5]	Cont. Verified [6]	N/A
2. Heating & Cooling System Design [4,8] - *Parameters used in the design calculations shall reflect home to be built, specifically, outdoor design temperatures, home orientation, number of bedrooms, conditioned floor area, window area, predominant window performance and insulation levels, infiltration rate, mechanical ventilation rate, presence of MERV6 or better filter, and indoor temperature setpoints = 70°F for heating; 75°F for cooling.*			
2.1 Heat Loss / Gain Method: ☐ Manual J v8 ☐ 2009 ASHRAE ☐ Other:________	☐	☐	-
2.2 Duct Design Method: ☐ Manual D ☐ Other: _______	☐	☐	☐
2.3 Equipment Selection Method: ☐ Manual S ☐ OEM Rec. ☐ Other: _______	☐	☐	-
2.4 Outdoor Design Temperatures: [9] Location: ____________ 1%: ___°F 99%:___ °F	☐	☐	-
2.5 Orientation of Rated Home (e.g., North, South): ______________________________	☐	☐	-
2.6 Number of Occupants Served by System: [10] ______________________________	☐	☐	-
2.7 Conditioned Floor Area in Rated Home: ______________________________ Sq. Ft.	☐	☐	-
2.8 Window Area in Rated Home: ______________________________ Sq. Ft.	☐	☐	-
2.9 Predominant Window SHGC in Rated Home: [11] ______________________________	☐	☐	-
2.10 Infiltration Rate in Rated Home: [12] Summer: _______ Winter:_______	☐	☐	-
2.11 Mechanical Ventilation Rate in Rated Home: ______________________________ CFM	☐	☐	-
2.12 Design Latent Heat Gain: ______________________________ BTUh	☐	☐	-
2.13 Design Sensible Heat Gain: ______________________________ BTUh	☐	☐	-
2.14 Design Total Heat Gain: ______________________________ BTUh	☐	☐	-
2.15 Design Total Heat Loss: ______________________________ BTUh	☐	☐	-
2.16 Design Airflow: [13] ______________________________ CFM	☐	☐	-
2.17 Design Duct Static Pressure: [14] ______________________________ In. Water Column	☐	☐	☐
2.18 Full Load Calculations Report Attached [15]	☐	☐	-

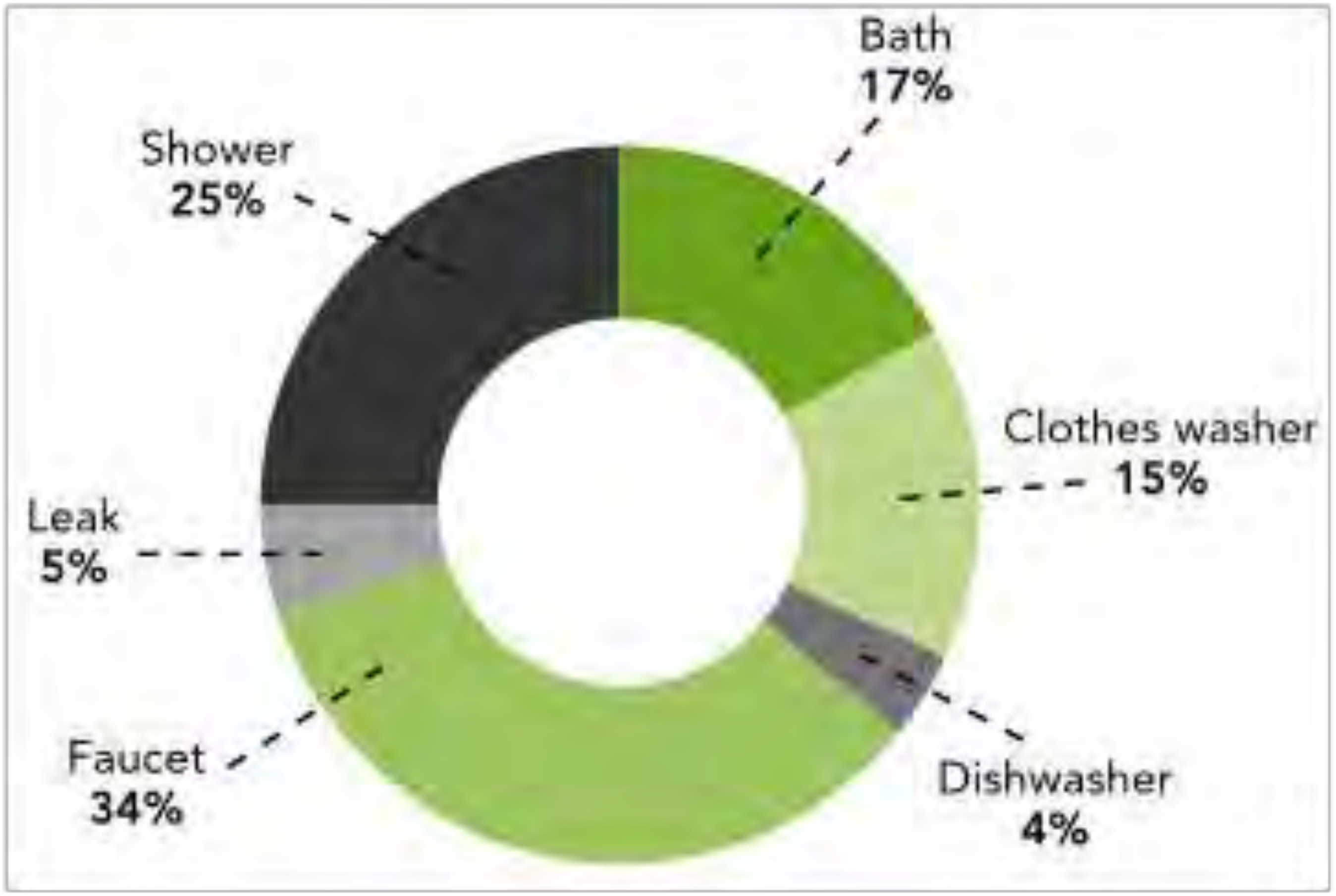
Hot Water


TEMPERED

Hot Water Usage Relevance

- Hot water use is still on its way up
- Wait times are an issue
    - Waste of water
    - Perception of energy waste

Main uses for household hot water

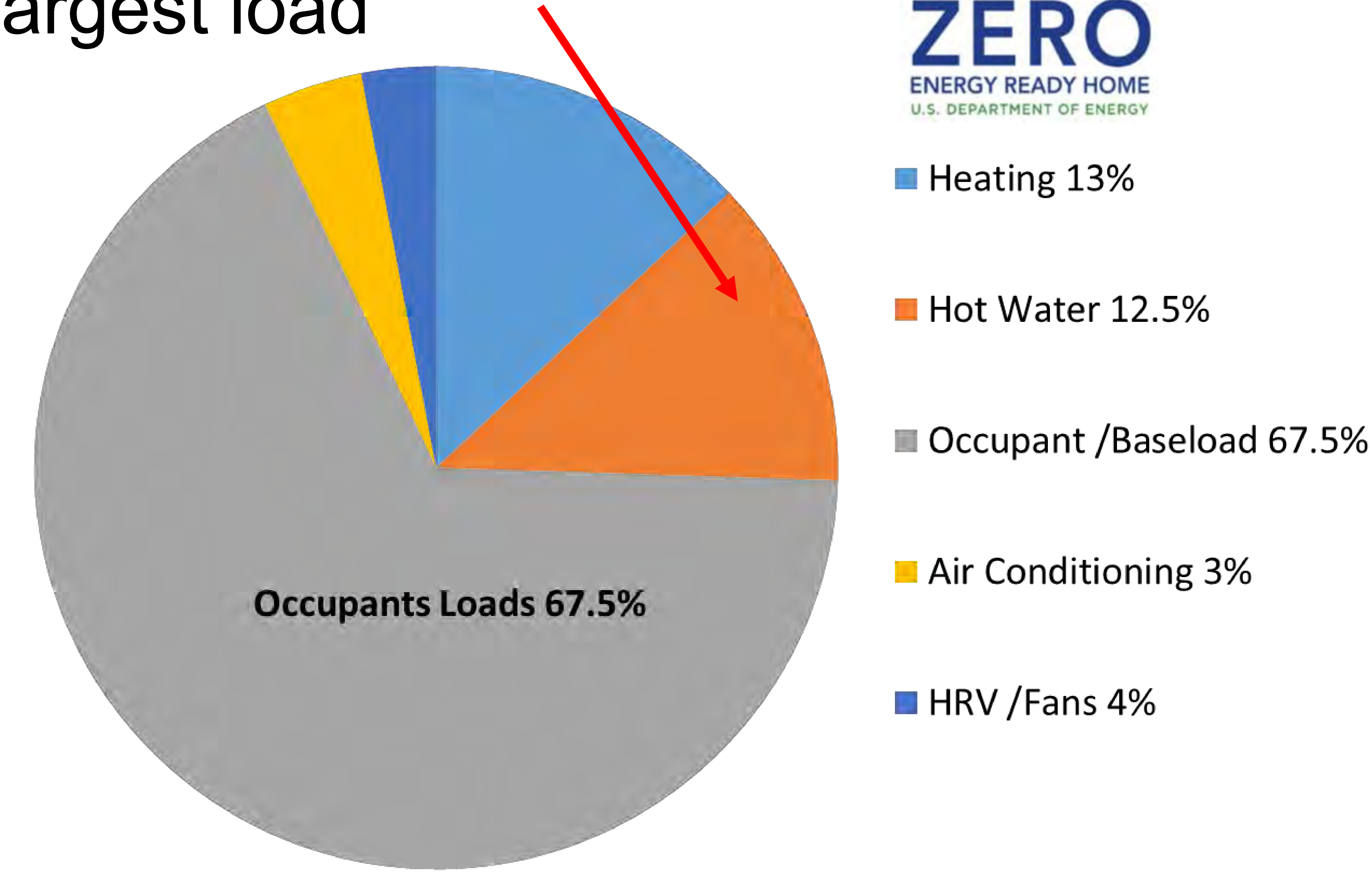


Source: Canadian Building Energy End-Use Data and Analysis Centre

ZERH
DOMESTIC HOT WATER IS A BIG DEAL

- In ZERH’S DHW is tied with space heating as the 2nd largest load

ZERO
ENERGY READY HOME
U.S. DEPARTMENT OF ENERGY



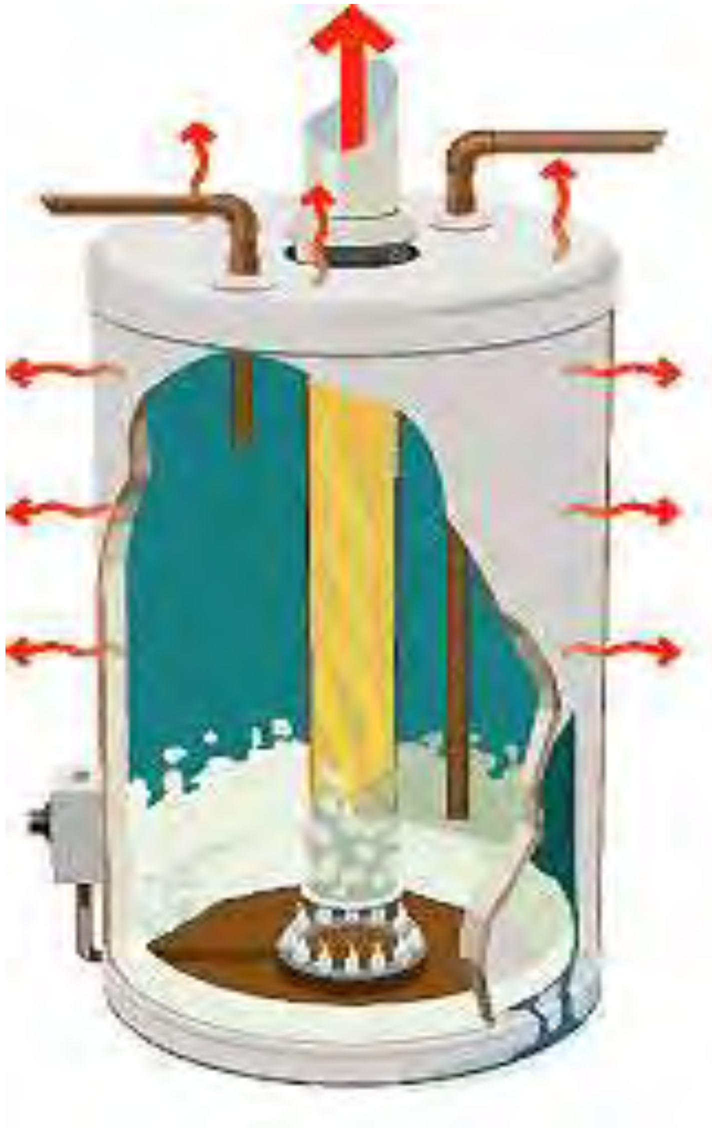
Regulations have changed

Minimum 2016 Requirements		**Example EF**
Gas	**Storage:** <55 US gal. EF = 0.675 – (gal x 0.0015) >55 US gal. EF = 0.8012 – (gal x 0.00078) **Tankless:** EF = 0.82−(gal x 0.0019)	40 US gal = 0.62 60 US gal = 0.75 Typical = 0.80
Oil	EF = 0.68−(gal. x 0.0019)	50 gal = 0.585
Electric	<55 gal. EF = 0.960−(gal x 0.0003) >55 gal. EF = 2.057−(gal x 0.00113)	40 gal = 0.95 60 gal = 1.98

What’s the Right Choice?

- Fuel access?
- Number of people?
- Patterns of use?
- Space / location limits
- Climate zone?
- Efficiency of the home?
- Other mechanicals?
- Expectations of clients?
- Other?

Water Heaters



Traditional Tank
EF < 0.60

Tankless = +0.80

Condensing
water heater =0.86

Tankless Water Heaters

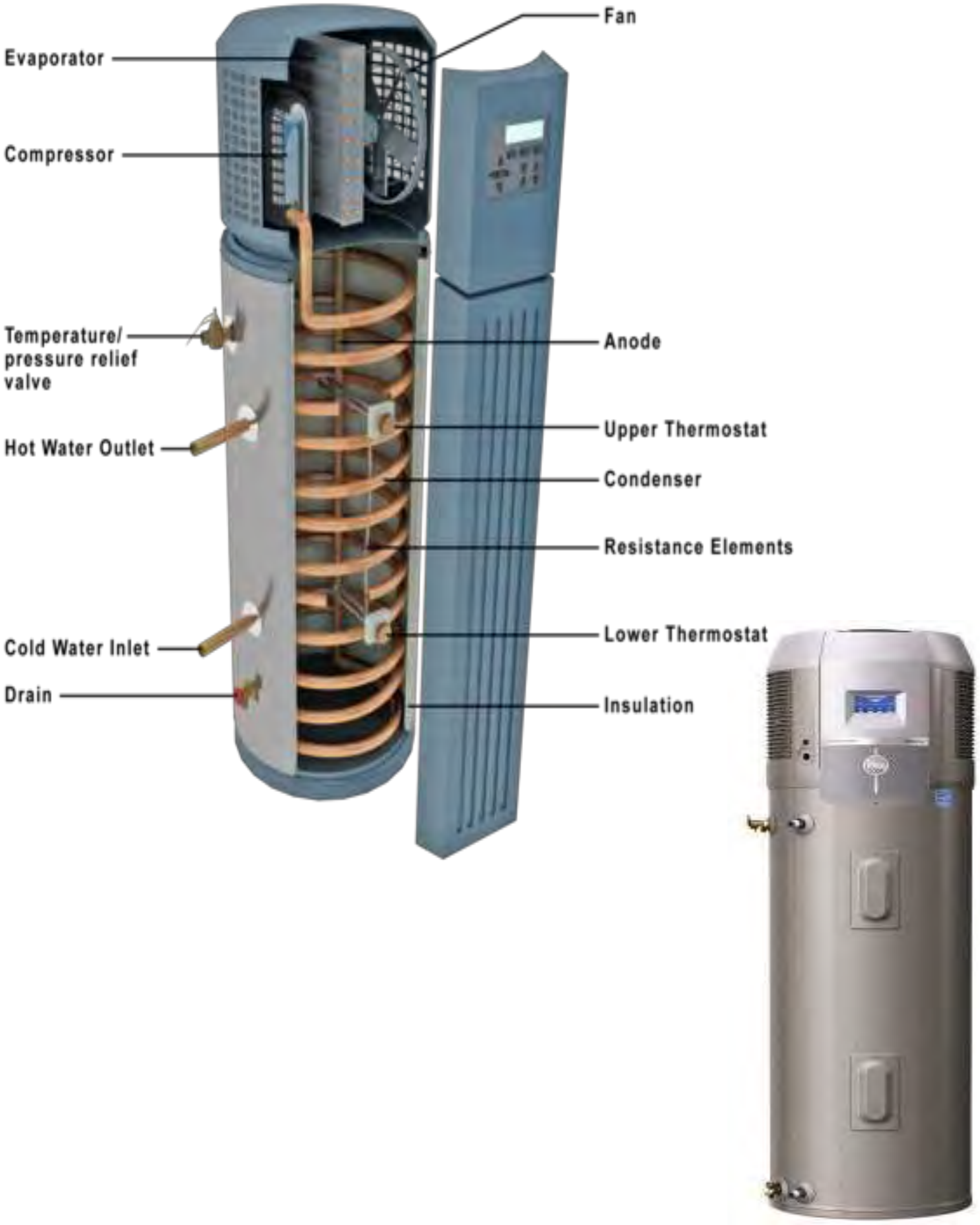
Strengths

- Low stand-by losses
- EFs from 0.80 to high 0.90's possible
- Wall installation frees up floor space
- Continuous supply of hot water
- Great flexibility
  - Point of use temperature controls
  - Locate supplementary units near point of use
  - Combo space & water heating capabilities
- Safe operation with direct venting
- New technologies reduce wait times - recirc. and internal storage tanks

Heat Pump Water Heaters

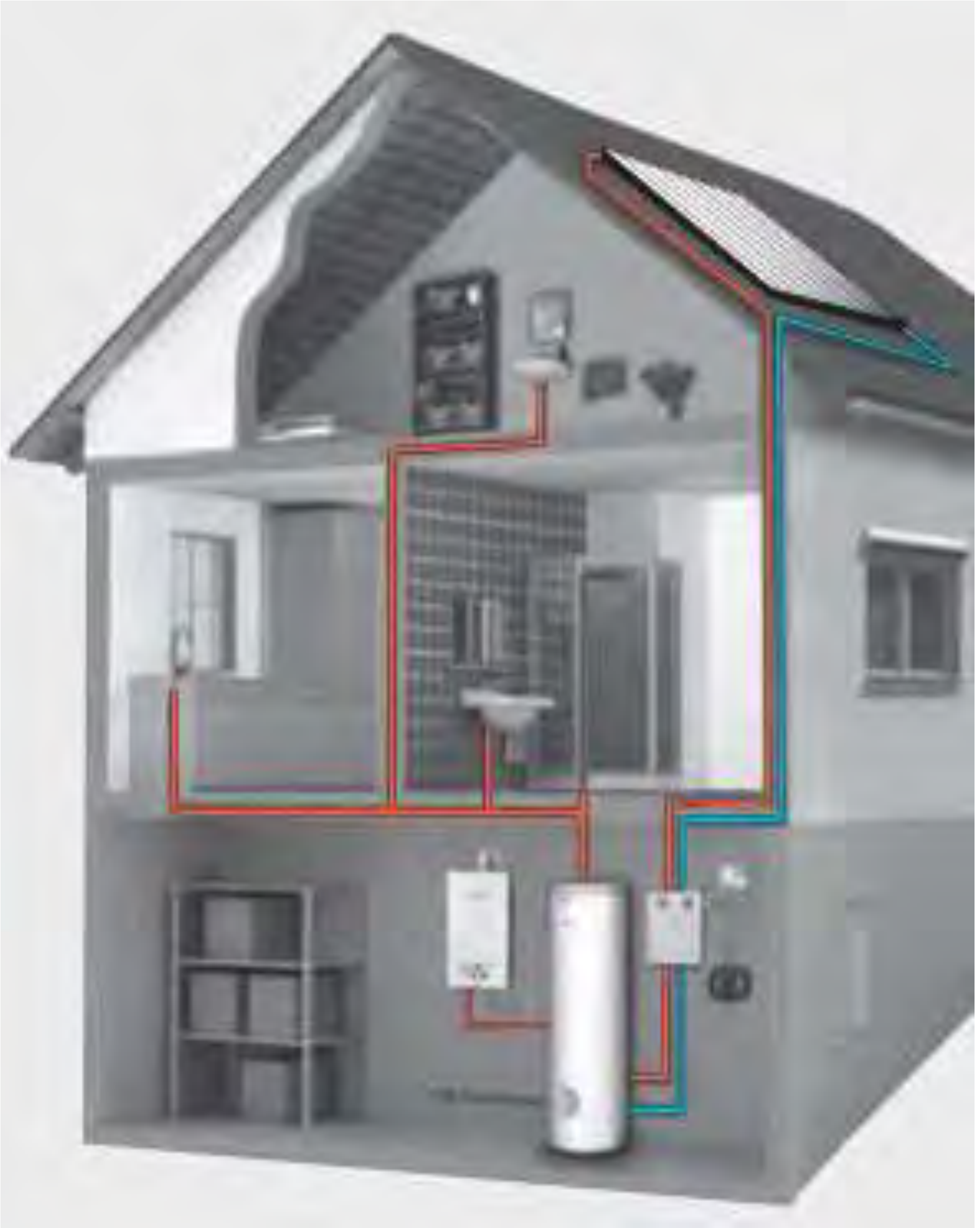
Strengths

- Very high EFs – 2.30+ possible
- Similar foot print as existing storage
- Provides cooling & dehumidification to the space
- Electric back-up
- Particularly useful in “Net zero-energy” homes to complement solar thermal & solar PV.



Solar Thermal Water Heaters

- A great preheat strategy for tankless, storage water heaters & HPWHs – increases their capacity
- 50-60% of annual hot water needs are easily provided
- Excess hot water can be used to heat swimming pools
- Requires freeze protection & annual maintenance



IAQ & Ventilation

Indoor Air Quality is Important to our Clients

20% of households have someone with asthma, allergies or respiratory problems

…poor IAQ may cost 10's of billions annually in lost productivity

EPA

Air cleaners are a $1.2 Billion industry

BusinessWeek

UNE 5, 2000

A PUBLICATION OF THE McGRAW-HILL COMPANIES

hina
ounterfeit
oods:
losing battle

isco
oes it have
Microsoft
oblem?

nside
tory
hy 3M banned
otchgard

aimler-
hrysler
he fight for
ntrol—
e untold
ory

IS YOUR OFFICE KILLING YOU?

The dangers of sick buildings

By Michelle Conlin

IAQ…Why is it a bigger issue than ever?

Change in the
way we build

-Tighter
-More chemicals
-Air conditioning

Change in the
way we live

-90% of time indoors
-Don't open windows
-More moisture

Change in
products we use

-Carpets &furnishings
-Cleaners & hygiene
-More "stuff" inside

IAQ Control Strategies

1. **Remove Pollutants**
2. **Source control**
   - “Seal” or Isolate
   - If you can’t remove it find a way to isolate or seal it
3. **Ventilate**
   - Dilute pollutants with “fresh” outdoor air
   - Point source removal
4. **Filter**

Ventilation

Ventilation - a system or means of providing fresh air.

Webster New Collegiate Dictionary

We used to ventilate with windows, now we don't

All homes need Capacity for Mechanical Ventilation

- To control moisture
- To remove common pollutants
- To ensure good indoor air quality for occupants

How Much Ventilation?

ASHRAE 62.2 - 2013

Whole House - Continuous "Capacity"

Based on # of occupants & size of home

CFM = (# of bedrooms + 1) x 7.5 + (0.03 x cond. ft^2)

OR USE THE TABLE

Floor Area Sq. ft	# of Bedrooms		
	1	2-3	4-5
<1500	60	75	90
1501 - 2500	90	105	120
2501 - 3500	120	135	150
3501 - 5000	165	180	195

Controls moisture and common occupant pollutants

Local Exhaust Ventilation

ASHRAE 62.2 Minimum Exhaust Flow Rate

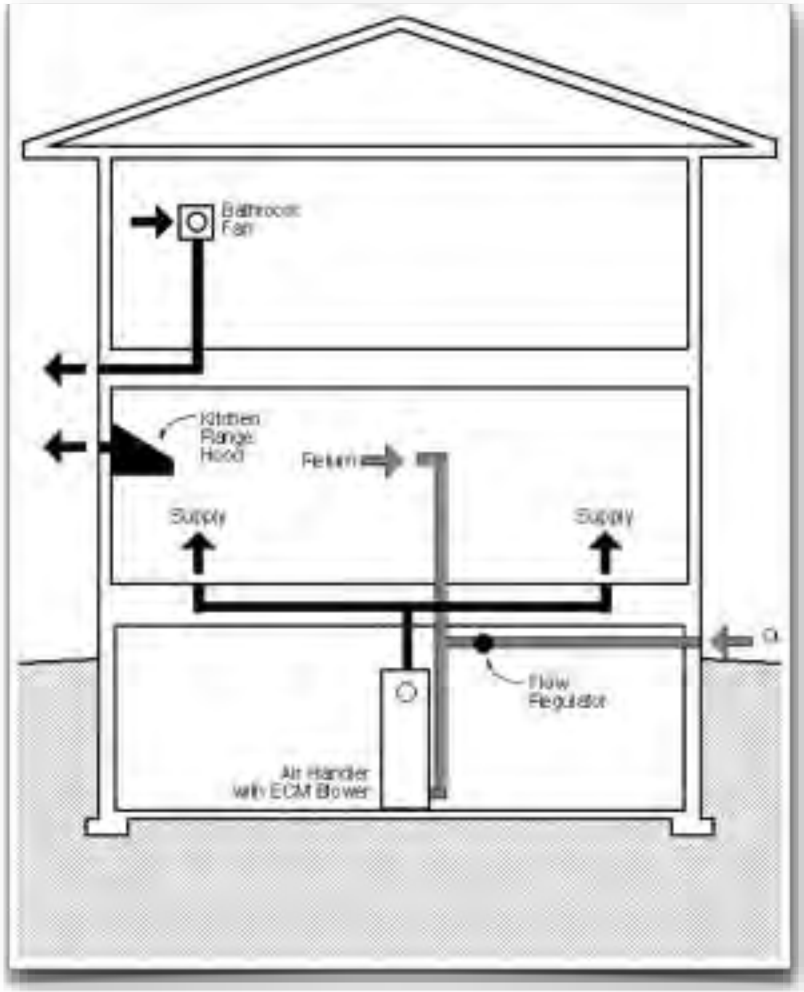
	Continuous	**Intermittent**
Kitchen	60 CFM	100 CFM
Bathroom	20 CFM	50 CFM

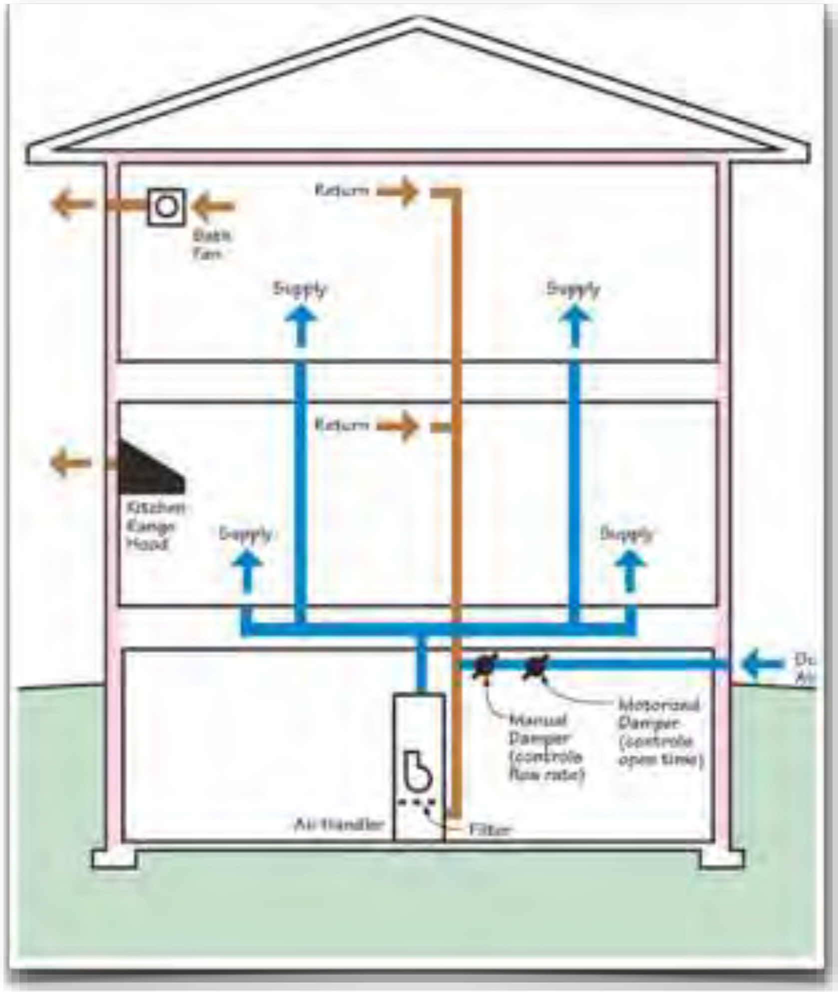
HVI Kitchen Range Exhaust Flow Rate

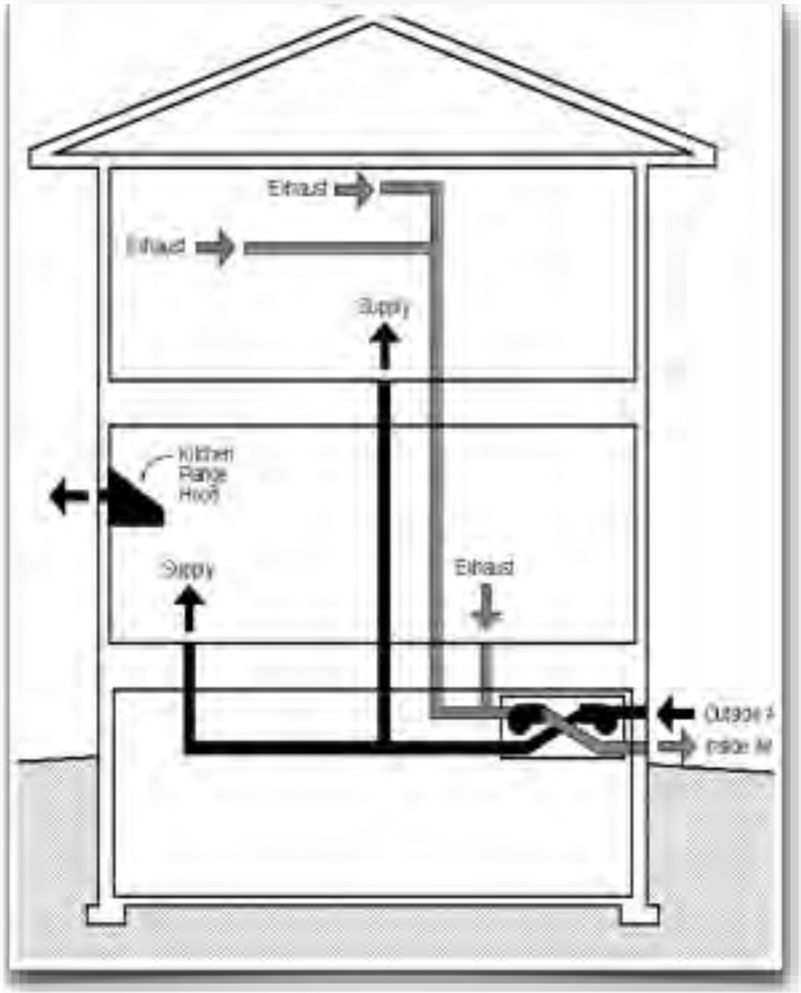
Location of Range	**Recommended per Linear Ft of Range**	**Minimum per Linear Ft of Range**
Against a Wall	100 CFM	40 CFM
In an Island	150 CFM	50 CFM

For Gas Ranges recommend 100 CFM / 10,000 BTUs of burner capacity

Types of Mechanical Ventilation







Graphic courtesy of Building Science Corporation

Exhaust

Supply

Balanced

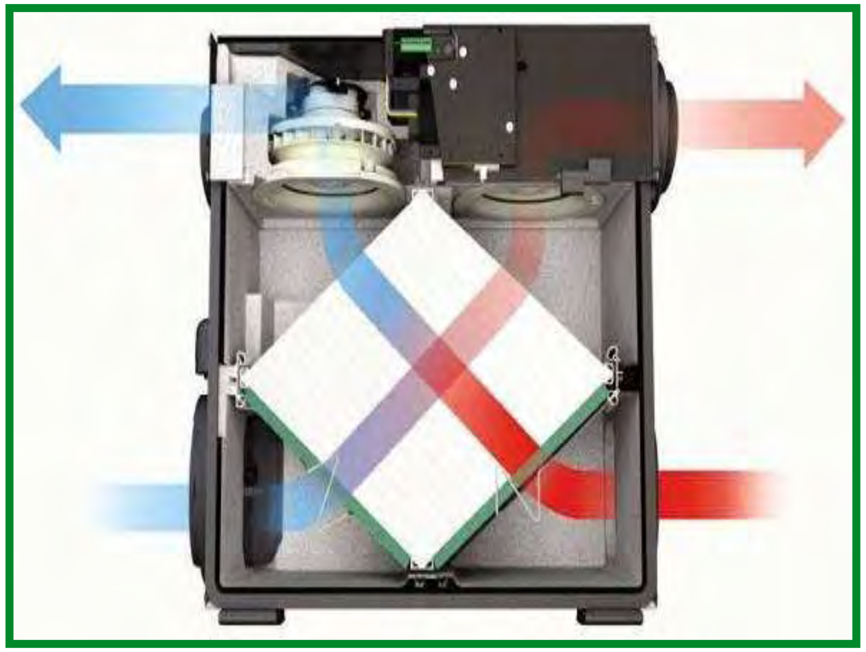
Ventilation Opportunities

Rated, Tested, Labeled Product

- Always use HVI Certified fans
- Choose ENERGY STAR Qualified Fan and HRVs

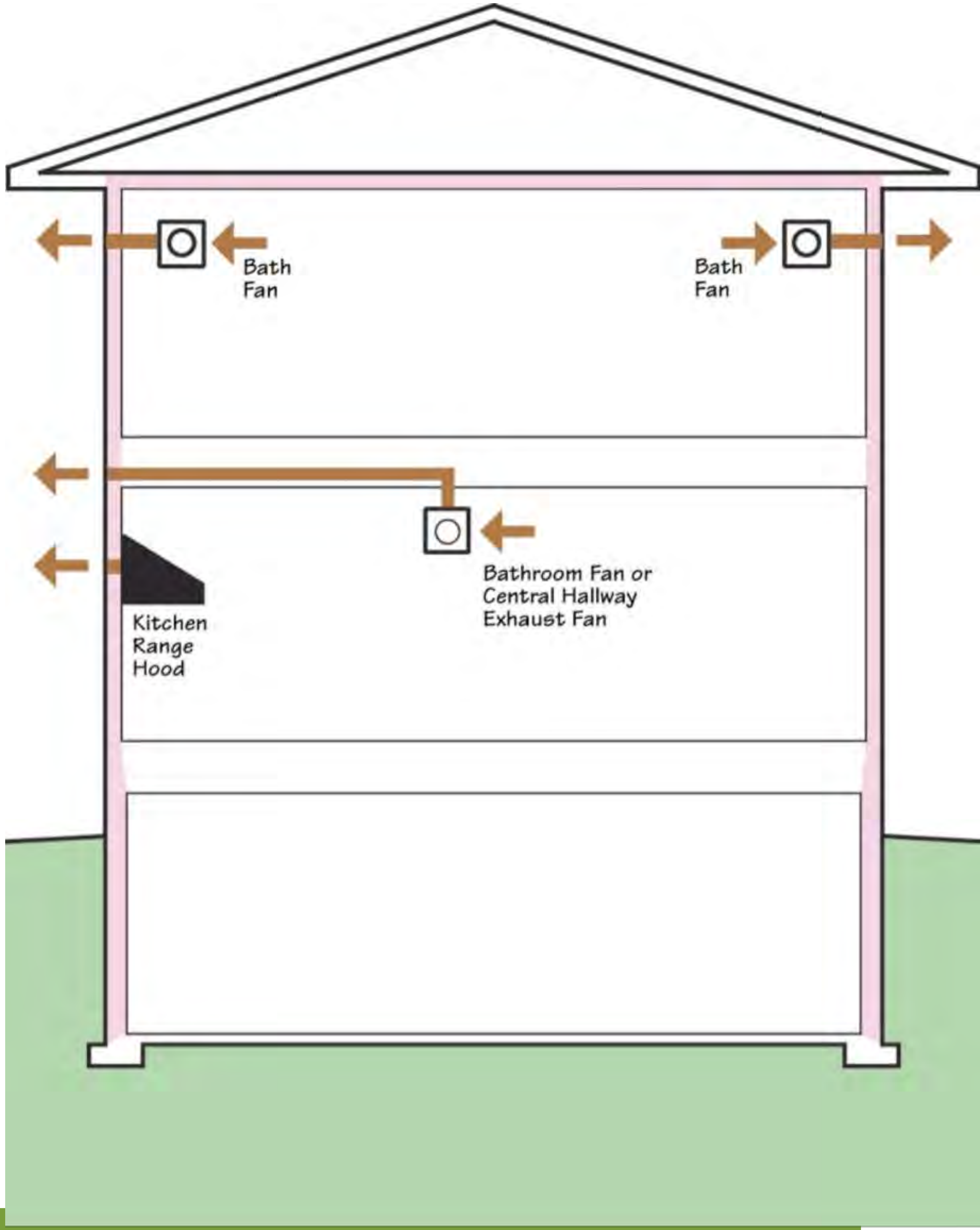
TESTED/CERTIFIED
2100
HVI
Home Ventilating Institute

ENERGY STAR



Exhaust Only Ventilation

- Specify good quiet fans in bathrooms and kitchen
- Bath fans with sound ratings under 1.5 sones
- Can be used for point source control or general ventilation
- Use timers or other controls to extend usage
- Recall that large exhaust fans can cause negative pressure



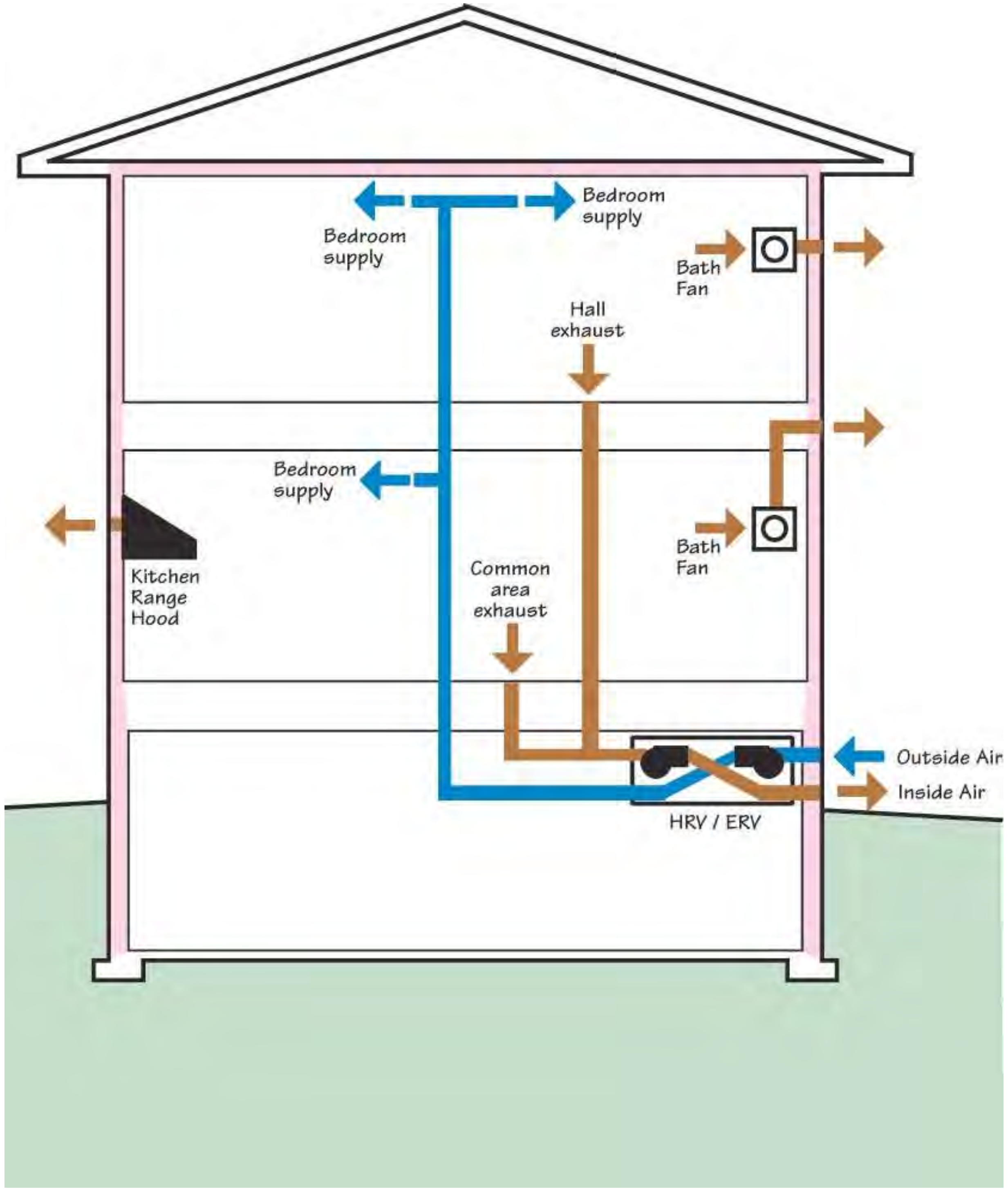
Control Strategies for “Continuous” Exhaust

Fan manufacturers have many new, helpful control strategies

- Continuous Low
- High speed occupancy
- Cycle timed

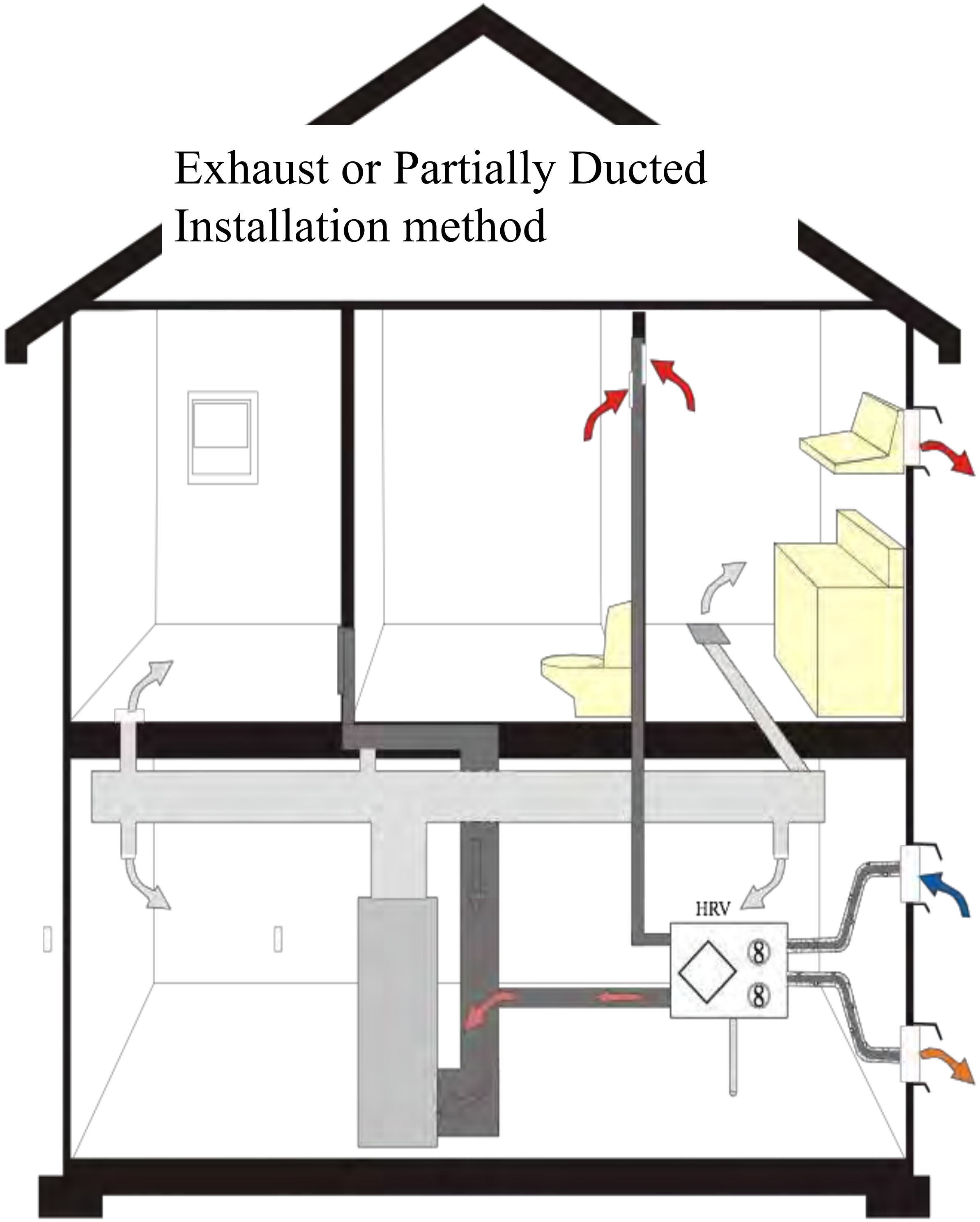
Balanced ventilation with heat or energy recovery

- Remote mounted multiple room pick-up and delivery
- Draw from the common area and supply to all bedrooms
- Central fan integration is also used



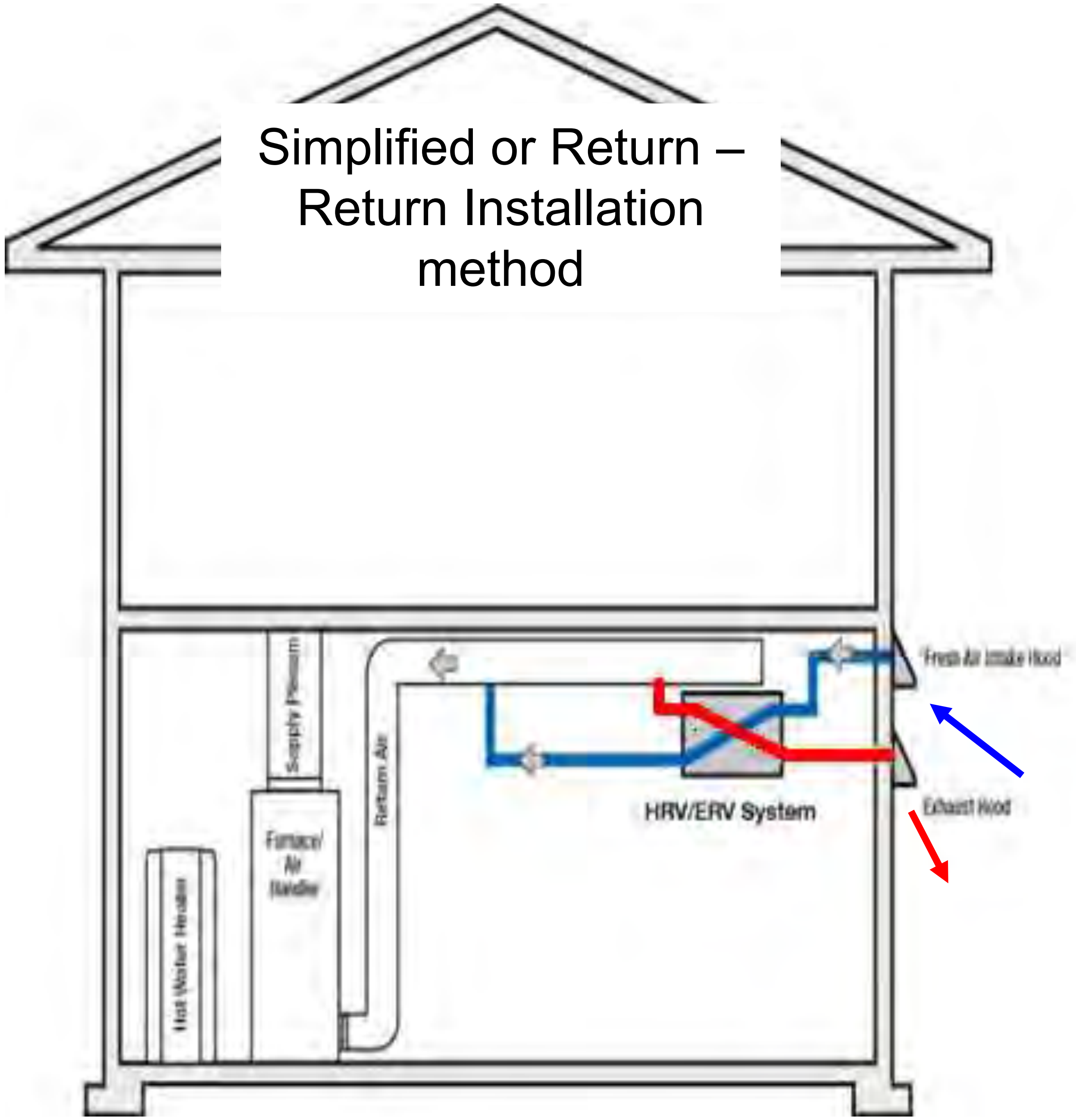
Installation Options

- There are different options for installation depending on application needs
- Often the furnace duct system is used to distribute fresh air
- When possible, run exhaust ducts from bathrooms & kitchens


Exhaust or Partially Ducted Installation method

Balanced Ventilation with Heat Recovery

- HRVs / ERVs for continuous ventilation
- Choose Home Ventilating Institute (HVI) certified
- Select units with the right air flow.



Simplified or Return – Return Installation method

HOME VENTILATING INSTITUTE

Ventilation & High Performance Homes

Ventilation is an important part of the House as a System

- Allows for houses to be built tighter
- Provides interior moisture and pollutant control

Ventilation will impact other HVAC systems

- Impact on HVAC load calculations
- Impact on moisture balance
- Impact on house pressures
- Impact on control strategies

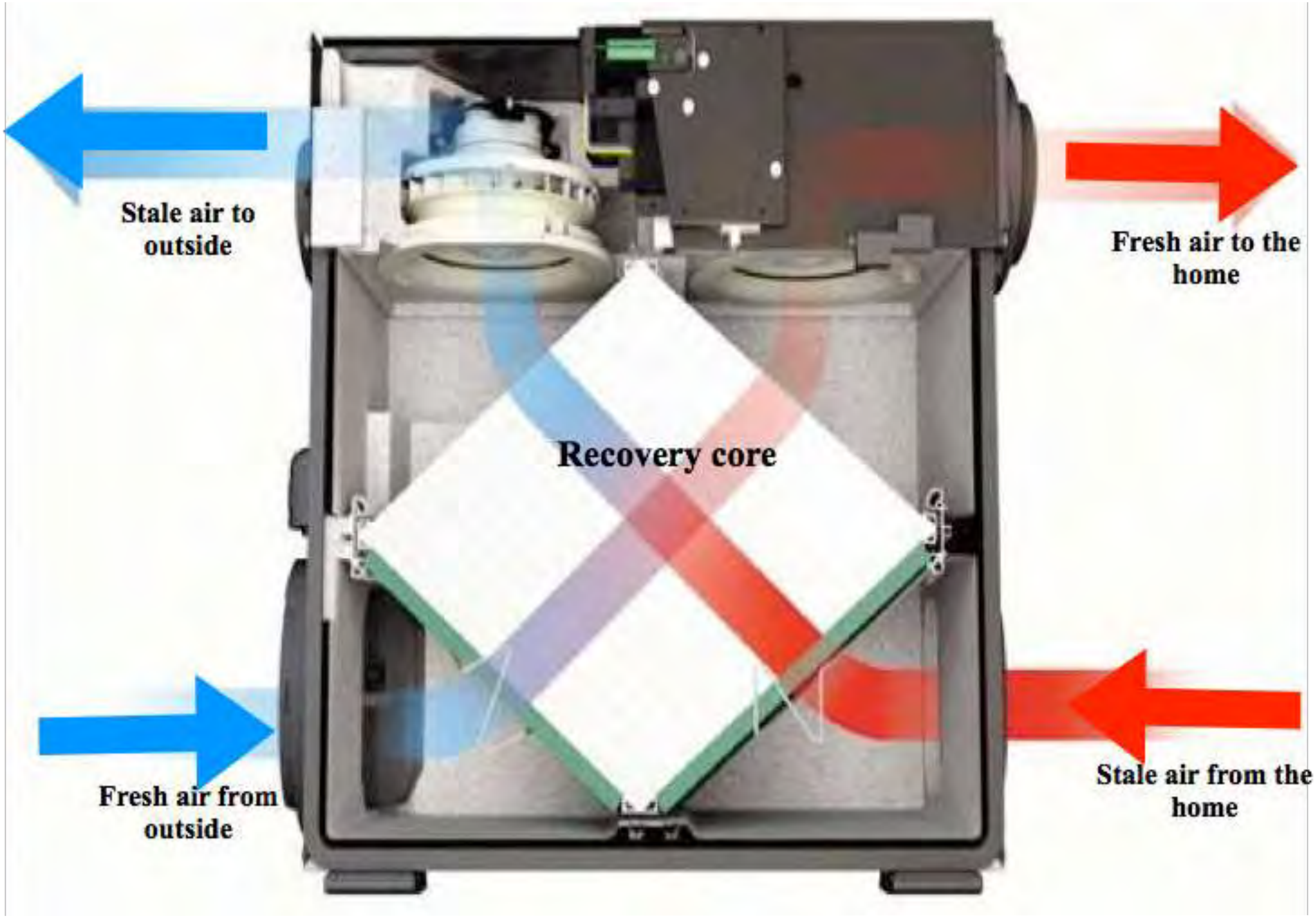
HVAC Sizing

Air leakage / ventilation heat loss

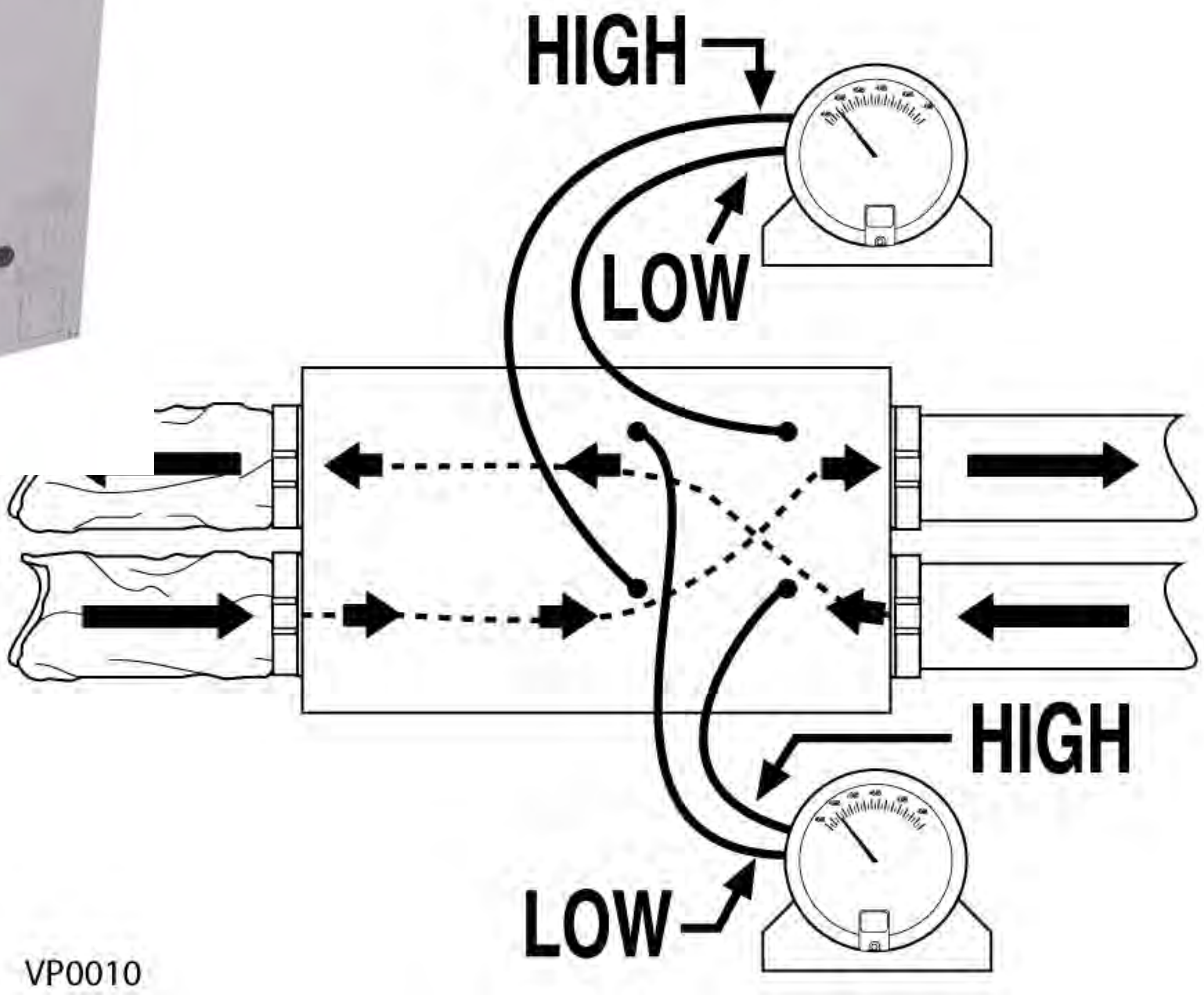
= CFM x temp. difference x 1.1

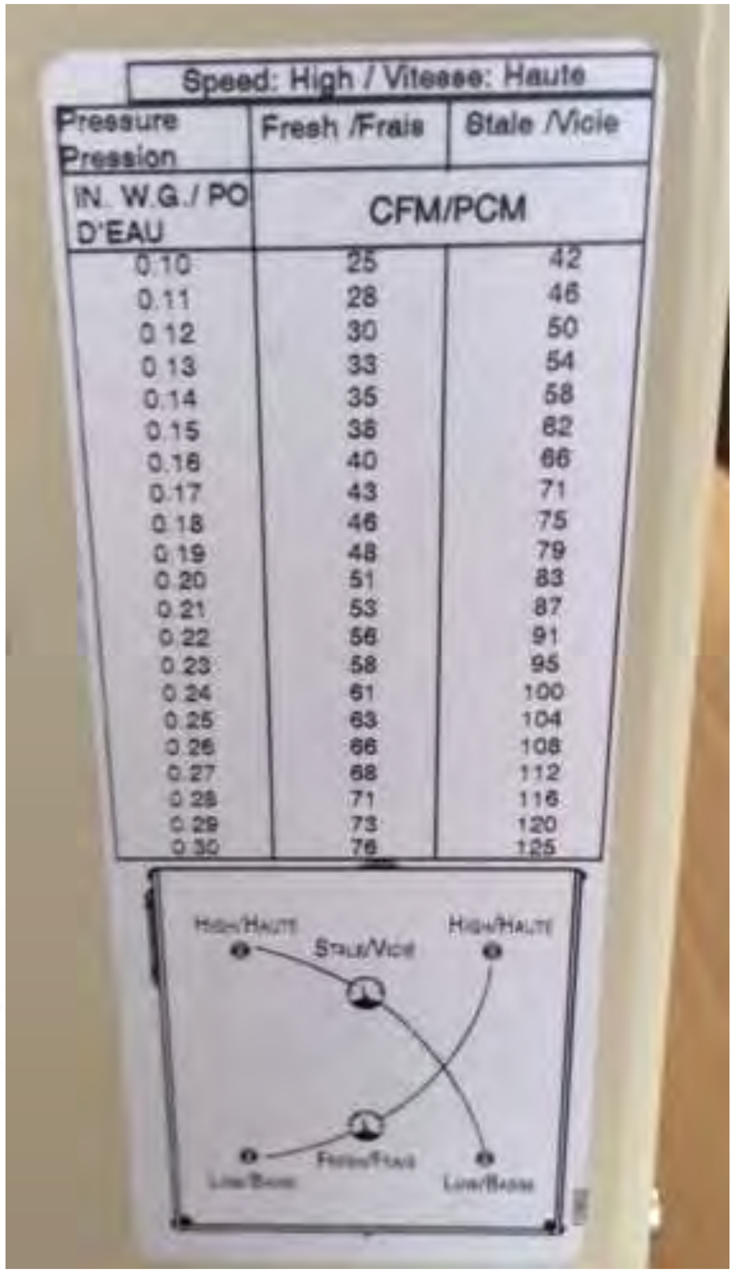
= 60 x 100 x 1.1= 6600 BTUs/hr

The Lungs of the Home



HRVs / ERVs - Balancing Flows





Speed: High / Vitesse: Haute		
Pressure Pression	Fresh /Frais	Stale /Vicie
IN. W.G./ PO D'EAU	CFM/PCM	
0.10	25	42
0.11	28	46
0.12	30	50
0.13	33	54
0.14	35	58
0.15	38	62
0.16	40	66
0.17	43	71
0.18	46	75
0.19	48	79
0.20	51	83
0.21	53	87
0.22	56	91
0.23	58	95
0.24	61	100
0.25	63	104
0.26	66	108
0.27	68	112
0.28	71	116
0.29	73	120
0.30	76	125

HRV's - ERV's what's the difference?

Heat Recovery Ventilation

- Allows transfer of sensible heat or temperature difference

Poly or Aluminum Core

Energy Recovery Ventilation

- Allows both sensible and latent transfer
- Moisture transfer
  - Reduces cooling loads in humid climates
  - Avoids over-drying in winter

Permeable Core

The Cost of Ventilation – 75 CFM continuous

Electric costs Gas heat costs	$0.06 / kW $1.20 / Therm	$0.12 / kW $1.20 / Therm	$0.18 / kW $1.20 / Therm
North (Duluth, MN)	$225/yr	$260/yr	$290/yr
Mixed (Louisville, KY)	$145/yr	$195/y	$240/yr
Hot, Humid (Miami, Fl)	$ 125/yr	$195/yr	$285/yr

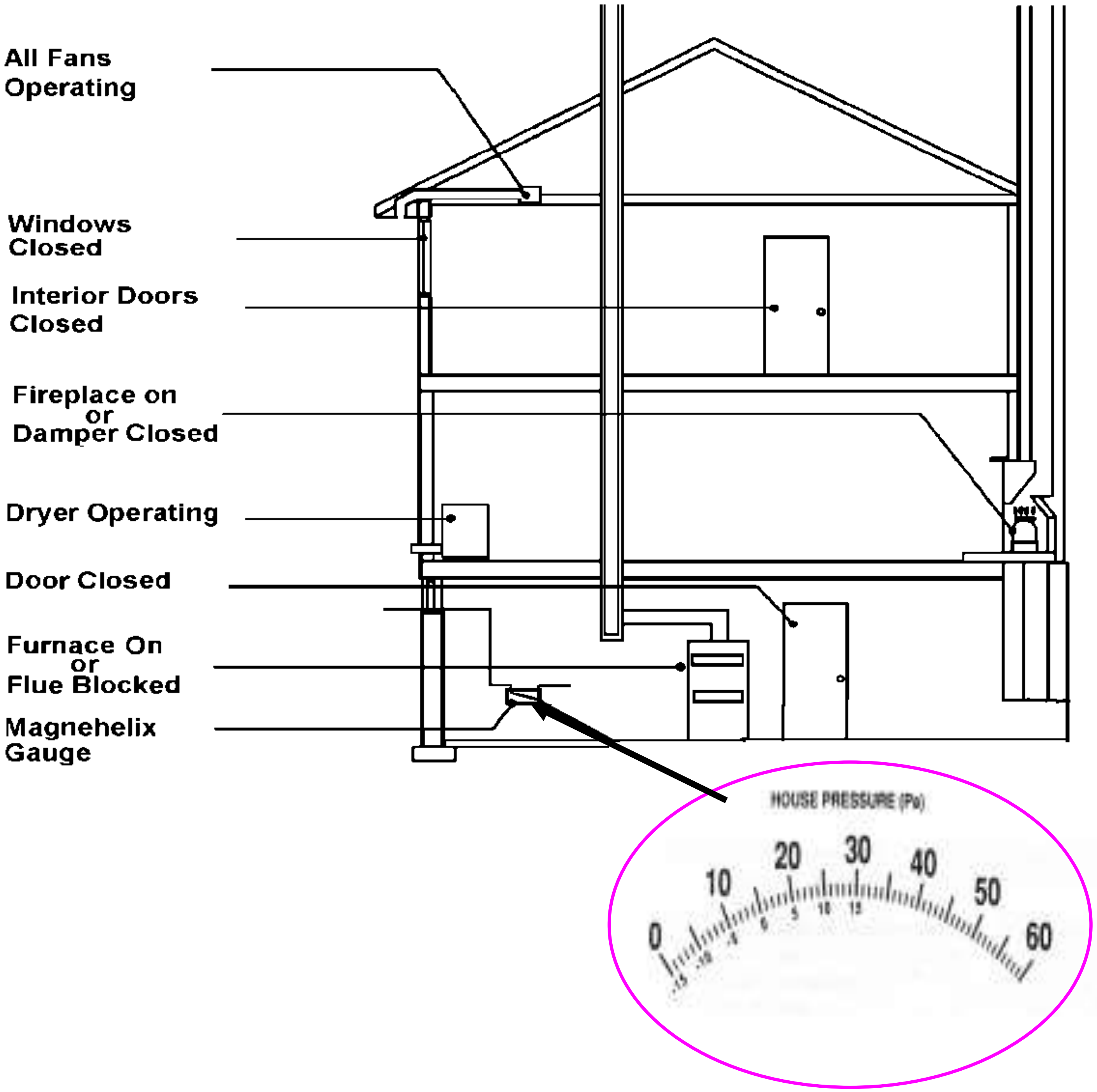
The Savings of Balanced Heat Recovery Ventilation

Proper ventilation enables tighter homes

This can save:

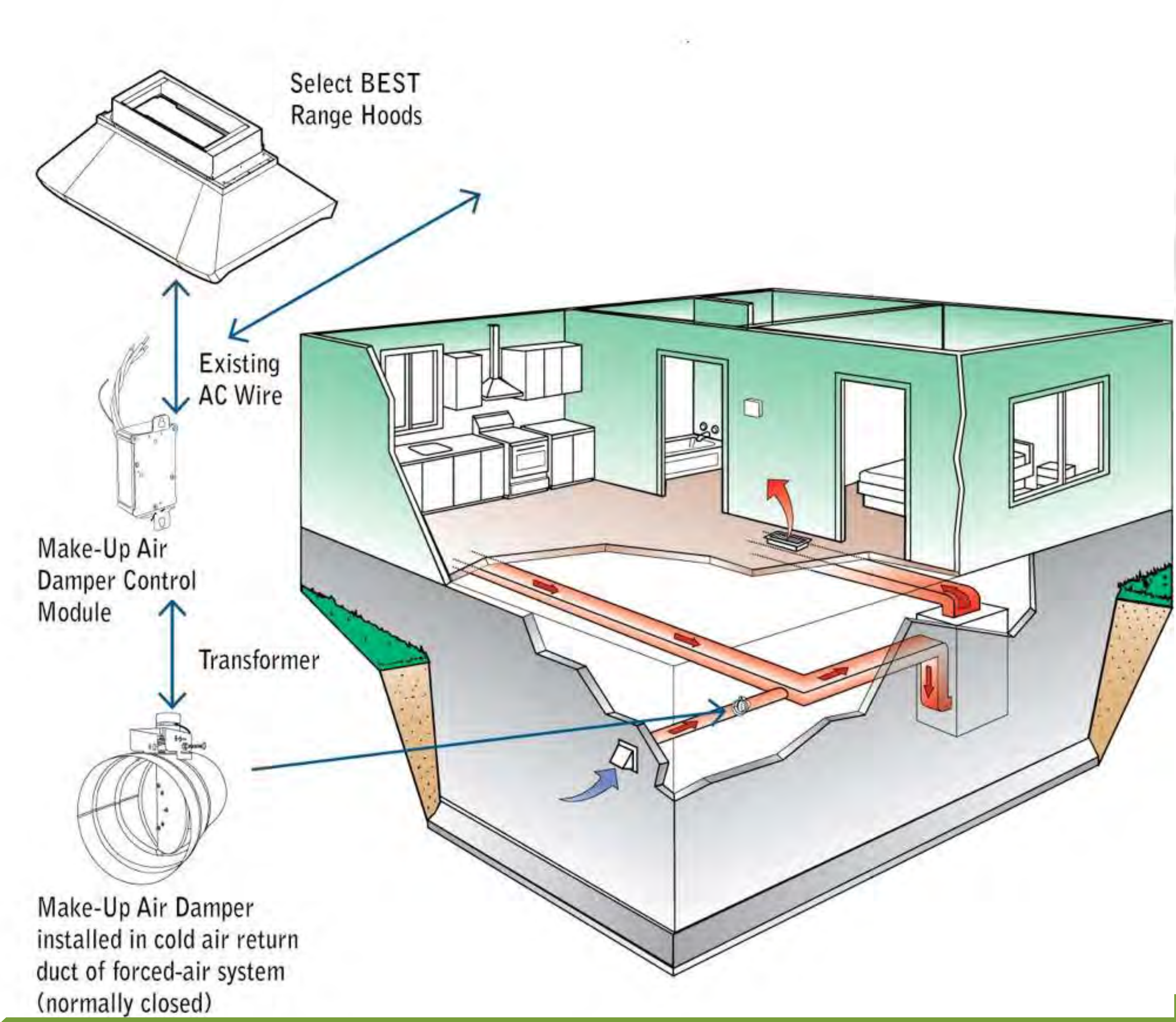
- $200 - $250 /yr in the north
- $125 - $175 /yr in mixed climates
- $ 75 - $125 /yr in southern climates
- ECM motors on air handlers, fans and ERVs can help save even more

Ventilation Impact on combustion appliances
Testing for depressurization



- Specific concern with natural draft appliances; wood burning fireplaces, gas log sets
- Tight houses with large exhausts can cause negative pressure
- Chimneys can overcome -5 Pa (-0.02"w.g.) pressure
- Test and provide make-up air if required

What about make-up air?



Over 400 CFM ??

The importance of Dehumidification

Sensible loads are down:

- Better windows
- Better walls
- Better ceilings

Latent loads are up:

- More time indoors
- More plumbing
- More consistent ventilation

HVAC design must include dehumidification, to supplement air conditioning

Humidification Applications

- Winter in cold climates
- Large homes with low occupancy levels

Sizing:

- **Required capacity is a function of:**
  - Air tightness of the home
  - Ventilation strategies
  - Occupancy generation

Filtration

Filtration

Filtration is the 4th of IAQ strategies: Remove, Seal, Ventilate, then Filter

- Filtration at the furnace works and is cost effective
- Commonly located in the return duct of the air handler
- Choose a filter with a rating of MERV 10 or better
- The better the filter, the more it restricts air flow, understand the appliance needs

Filtration Options

HEPA Filters

- Work to eliminate pollutant sources before spending money on HEPA
- MERV 16-20
- Very restrictive on airflow, they need their own fan system
- Available in ducted o units

Mechanical Systems

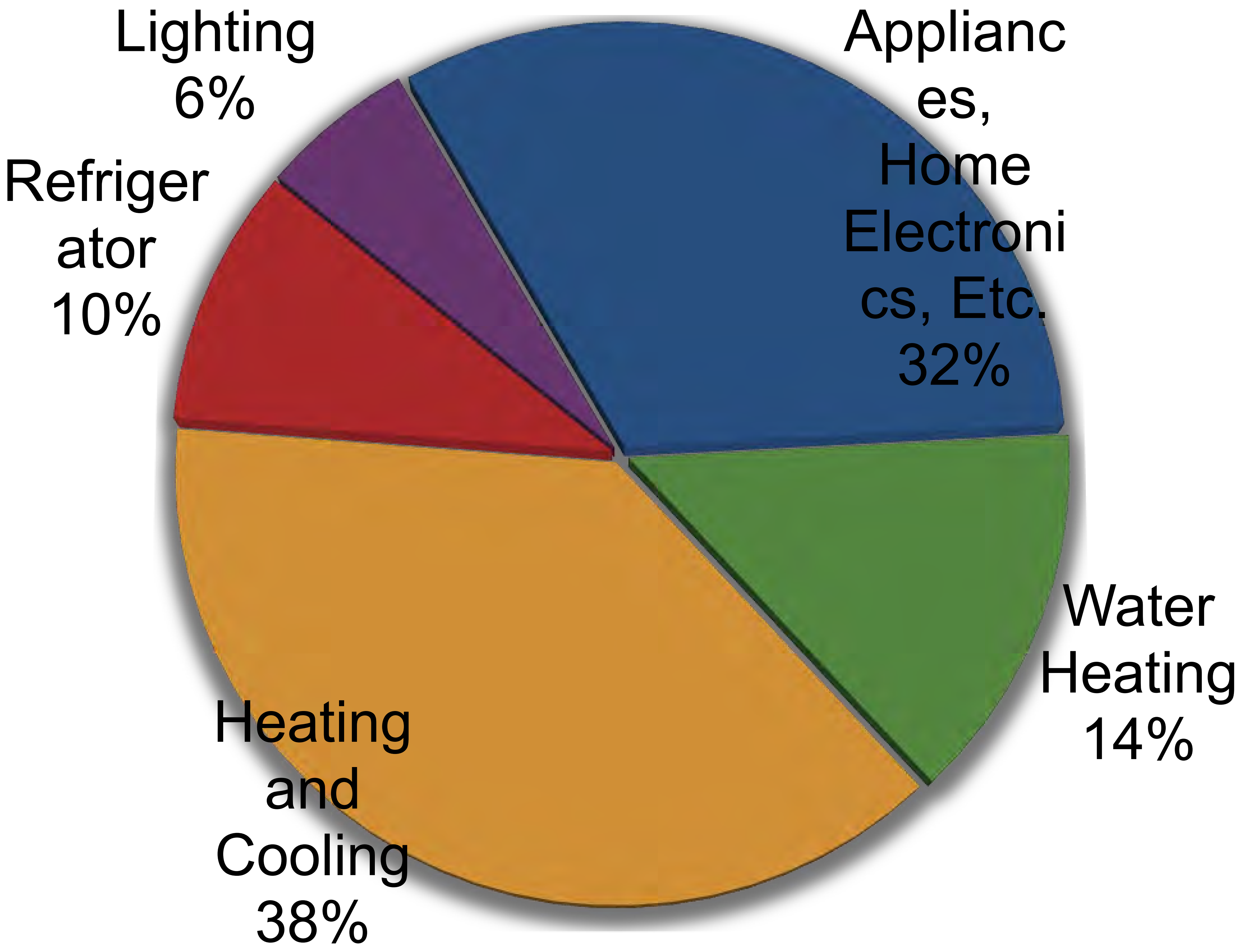
- HVAC
- Heating
- Ventilation (something new?)
- Part of the indoor Air Quality Conversation
- Air Conditioning
- Fireplaces
- Lighting and Appliances
- Humidification & Dehumidification

Heating & Cooling Systems Summary

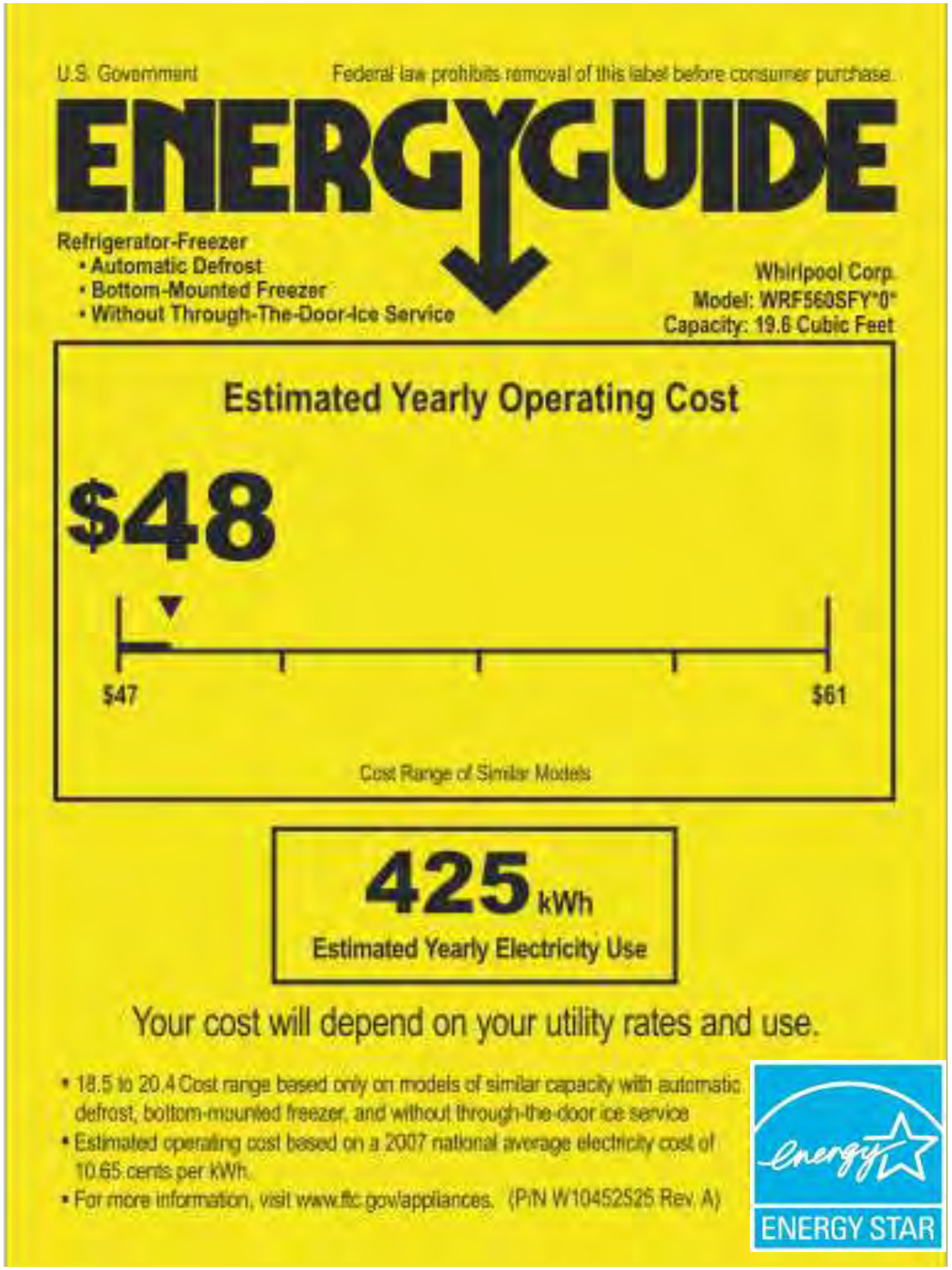
- Ensure combustion safety
- Get equipment and duct sizes right
- Make good equipment choices
- Get ducts into conditioned spaces
- Get ducts sealed
- **Test** the performance

Appliances Make a Difference!

Appliance energy use and water use is growing



Appliances, Lights & Plug Loads



U.S. Government

Federal law prohibits removal of this label before consumer purchase.

ENERGYGUIDE

Refrigerator-Freezer
- **Automatic Defrost**
- **Bottom-Mounted Freezer**
- **Without Through-The-Door-Ice Service**

Whirlpool Corp.
Model: WRF560SFY*0*
Capacity: 19.6 Cubic Feet

Estimated Yearly Operating Cost

$48

Cost Range of Similar Models

425 kWh

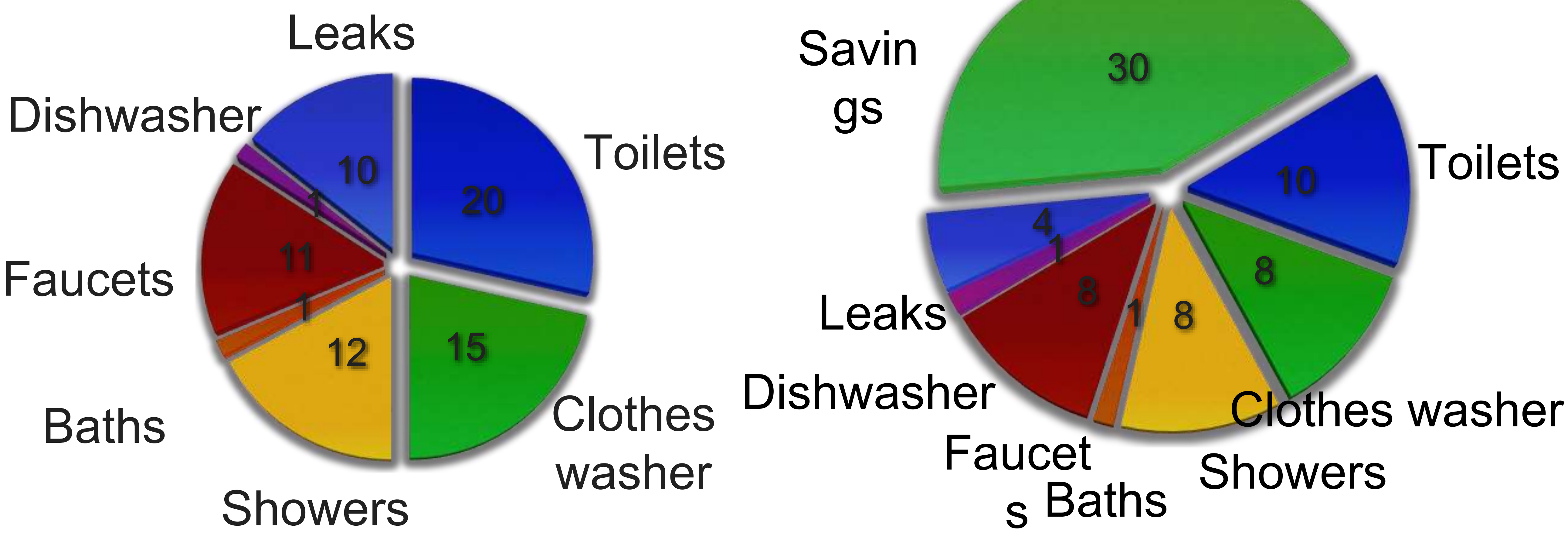
Estimated Yearly Electricity Use

Your cost will depend on your utility rates and use.

- 18.5 to 20.4 Cost range based only on models of similar capacity with automatic defrost, bottom-mounted freezer, and without through-the-door ice service
- Estimated operating cost based on a 2007 national average electricity cost of 10.65 cents per KWh.
- For more information, visit www.ftc.gov/appliances. (P/N W10452525 Rev. A)

ENERGY STAR

Typical US Home = 70 gallons per person/day



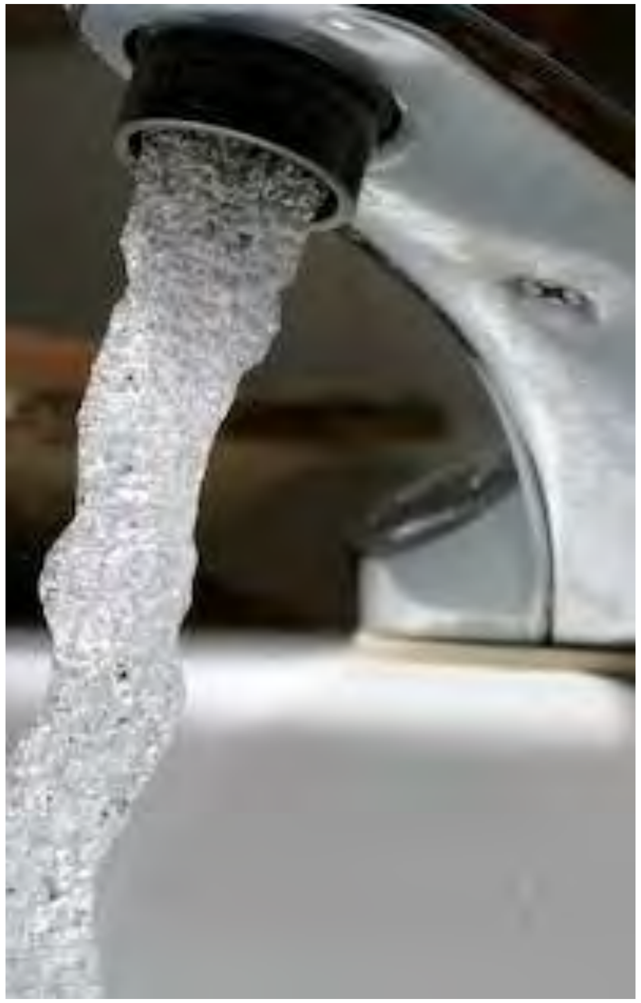
Gallons per person per day

An EPA water efficiency retrofit study indicated the total water use was reduced to 40 gallons per person per day - 39% reduction

Source: Aquacraft, Boulder, CO

Lighting Efficiency

Water Efficient Fixtures



Faucets < 1.8 GPM

Shower heads < 2.0 GPM

Front load washers save 60%

Toilet with < 1.3 Gallons

Renewable Energy Systems


For Sale
GREEN

Summary

- Creating better envelopes
- Include ventilation on every project, performance and rationalize costs
- Choose effective, efficient, quiet fans and appliances
- Challenge your mechanical contractor to participate in your quest improving total system performance

Green Building Programs

BUILT GREEN
BUILT BETTER

U.S. GREEN BUILDING COUNCIL

LEED for HOMES

Buildings, Benchmarks & Beyond
The State of Minnesota Sustainable Building Guidelines
Version 2.0
Admin Minnesota

SENSIBLY BUILT FOR THE ENVIRONMENT
EARTH CRAFT HOUSE

BUILD GREEN UTAH

BUILT GREEN
"imagine if everyone did"

AUSTIN
CITY CONNECTION

NAHB
NAHB RESEARCH CENTER
Green Home Building Guidelines

BuiltGreen
ALBERTA

Changing your process
Where does actual change begin?

Image courtesy of: Seth Godin

Who will be responsible for change?

- Select key people
  - Top management
  - Top field staff
  - Key sub-contractors
  - Testing professionals
  - Architects & designers
  - Sales management staff

Creating a plan to move forward

- Define the concerns, plan for the solution and set a timeframe

What Now?

Tomorrow

- Evaluate flashing
- Review insulation quality
- Review duct installations
- Test a few homes to establish your basis

Two Weeks

- Review bids for change
- Create internal teams responsible for change
- Set goals for future direction

Create goals and prioritize them by both complexity and risk

Short Term Goals **Timeframe: 1 to 6 months**

Construction Detail	Best Practice	Complexity (1-Basic, 5-Complex)
Combustion safety		
Atmospherically vented furnace	Sealed combustion furnace	1
Return plenum connected to garage	Seal duct with water-based mastic, like RCD-6	3
"Fresh" air intake connected to garage	Seal all duct seams with water-based mastic and	2
	protect duct with dropped soffit	2
Leaky house/garage wall connection	Continuous air sealing	2
Water Management		
Flashing at Roof/Wall Connections	Kick-out flashing, proper lapping of Tyvek and step flashing	2
	raw wood attached to Hardie w/o priming,	2
Window flashing	Pan flashing, proper installation sequence and integration with Tyvek	4
Penetration flashing	Correct hole sizes, Tyvek Flex Wrap patches, Tyvek lapping detail	2
Flashing attention to detail	Taping seams & tears, proper lapping, ensuring full-coverage	1
Thermal Shell Improvements		
Walls	Ensure insulation is installed properly - must be fulldepth,	2
	no gaps, or compression	2
Attics	Insulation must be installed to consistent depth,	2
	proper sequencing of Framing and Mechanical trades	3
Air Sealing		
Bypasses	Seal large air leaks with combination of proper blocking and gun foam	2
Key leaks	Seal house to garage connection	2

Marketing for Performance

- Selling the benefits of health, safety,
  - durability & performance

Innovations in Home Building

Innovation is at the foundation of the Ideal Homes approach. As a national leader in energy efficient homes, Ideal Home utilizes the latest construction technology, the newest approaches to building and partners with national experts in building science. This site is devoted to the innovative practices and projects that Ideal executes. Visit one of our 16 Oklahoma City communities to see why our thousands customers tell us that "Anything Else is Less Than Ideal".

Featured Innovation:

» Zero Energy Home «

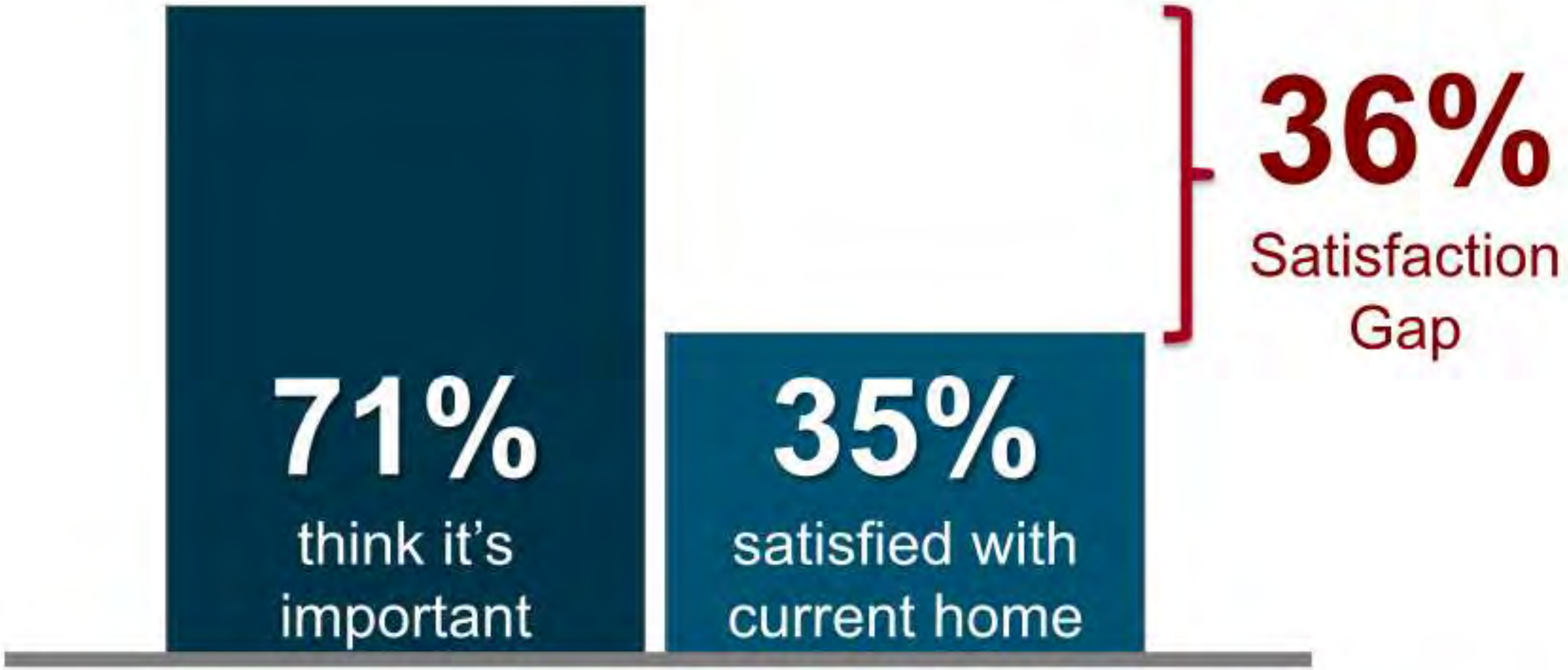
Ideal Homes is proud to announce the nation's first Zero Energy Home under $200,000.

Click Here to Learn More

Other Innovation Links:

» Past Innovations «

THE CONSUMER: ARE THEY REALLY SATISFIED?



“very energy efficient with low monthly utility costs.”

Source: *The Housing Satisfaction Gap: What People Want but Don't Have*, Demand Institute, 2014

THE CONSUMER: THEY KNOW MOST HOUSING IS LESS EFFICIENT

- High Utility Bills
- Poor Comfort
- Health Concerns
- Moisture Issues
- Excessive Bugs/Pests
- Durability Problems
- Obsolete Technology

Meet
85%
of Your
Competition

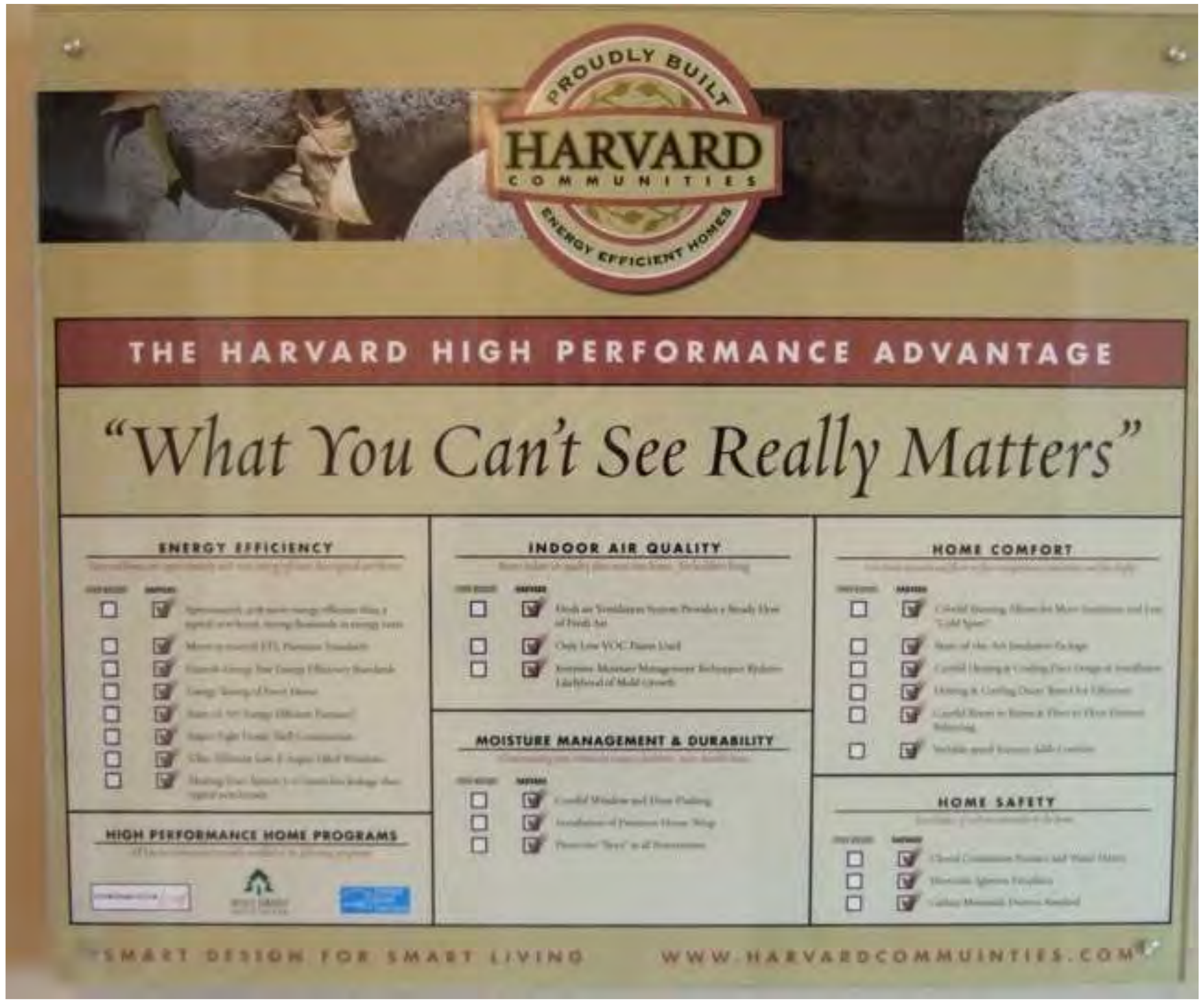
Marketing and communicating


SPRAY FOAM INSULATION
HIGH PERFORMANCE INSULATOR & AIR BARRIER
ICYNENE
TIGHT BUILDING ENVELOPE
WHY YOU WANT ONE?


24
20
18
16
14
12


Our homes are
30%
more efficient
than homes built to
state code standards
McSTAIN
NEIGHBORHOODS

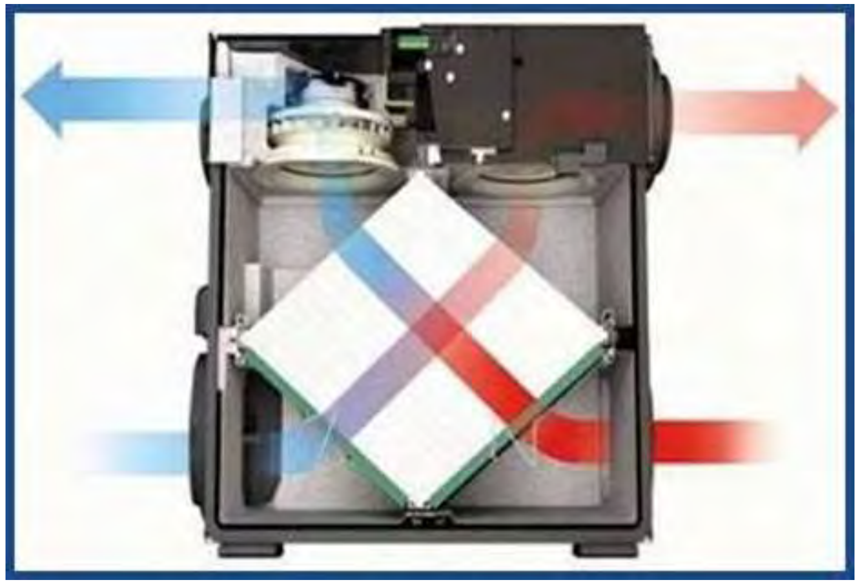
Communicating to buyers



THE CONSUMER AND HIGH PERFROMANCE HOMES

HOW TO TALK LIKE A NORMAL PERSON

?



Fresh Air Machine!

New Town Builders

Lives Better: **Healthful Environment**

- Fresh Air:
  - Supply Fresh Air System
  - Odor and Moisture Control Fans
  - High-Capture Filtration Technology
- Quiet:
  - Quiet Window Technology
  - Quiet Wall Technology
- Moisture Control:
  - Dry-by-Design Construction
  - Moisture Control System – Whole House
  - Moisture Controlled Comfort System
  - Moisture Controlled Windows
  - Moisture Controlled Lower Level
- Pest Control:
  - Bug Control Barrier
  - Pest Screened Home
- Outdoor Contaminant Control:
  - Contaminant Sealed Construction
  - Contaminant Sealed Comfort Delivery
  - Dust and Pollen Barrier
  - Radon Controlled Home
- Chemical Control:
  - Formaldehyde Controlled Home
  - VOC Controlled Home
- Fume Control:
  - Carbon Monoxide Controlled Equipment
  - Carbon Monoxide Controlled Fireplace
  - Fume Controlled Garage

THE CONSUMER AND HIGH PERFROMANCE HOMES

HOW TO TALK LIKE A NORMAL PERSON

How consumers feel about the term

"low-VOC"

no

Few knew which products actually emit VOCs.

no

Only 21% said they understand the term.

no

A majority (54%) actually found this term undesirable.

THE CONSUMER AND HIGH PERFORMANCE HOMES

ZERO
ENERGY READY HOME
U.S. DEPARTMENT OF ENERGY

Lives Better
- Engineered Comfort
- Healthier Living

Exclusivity

Works Better
- Ultra-Low Utility Bills
- Advanced Technology

Visionary

Lasts Better
- Quality Construction
- More Durability

Smart

The right words make the purchaser feel...

Matching High Performance Features to **Emotion**

Translate Technical Features into **Benefits**

DOE Building Science Translator

ZERO
ENERGY READY HOME
U.S. DEPARTMENT OF ENERGY

Tool for Sales and Marketing Professions

www.basc.energy.gov

Tools for improving your business

constructioninstruction.com

Get Started !!

- Develop new standards for performance
- Train your crews and subcontractors
- Reward new ideas to improve a technique
- Demonstrate new features in models
- Market your leadership position
- Document performance improvements
- Solicit customer testimonials

“A small group of thoughtful people could change the world...

...Indeed it is the only thing that ever has”

Margaret Mead

“When we build let us think that we build

forever. Let it not be for present delight nor

present use alone. Let it be such work as our

descendants will thank us for…”

John Ruskin (1819 to 1901)

Thank You

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