Welcome

Houses That Work - Module 3

Module Three

- Heating, Ventilation and Air Conditioning Systems (HVAC) that work in high performance homes
- Then a final summary, including a discussion of process changes you will want to undertake to implement all that you have learned.

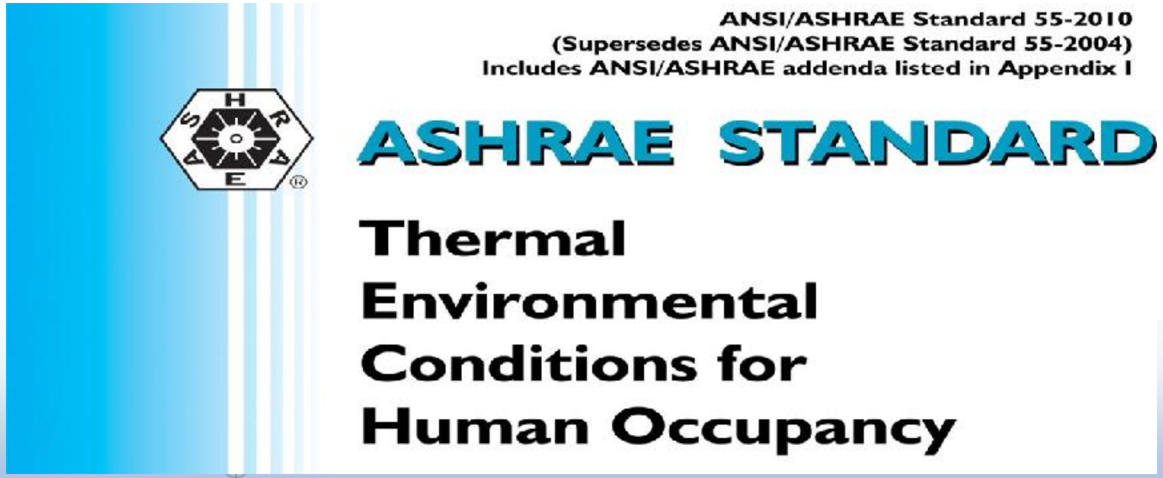
Conditioning the Indoors

- Heating,
- Cooling,
- Ventilation and
- Indoor air quality
- Hot water

Are we ready for the changes?

Let’s Start with Defining Comfort

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

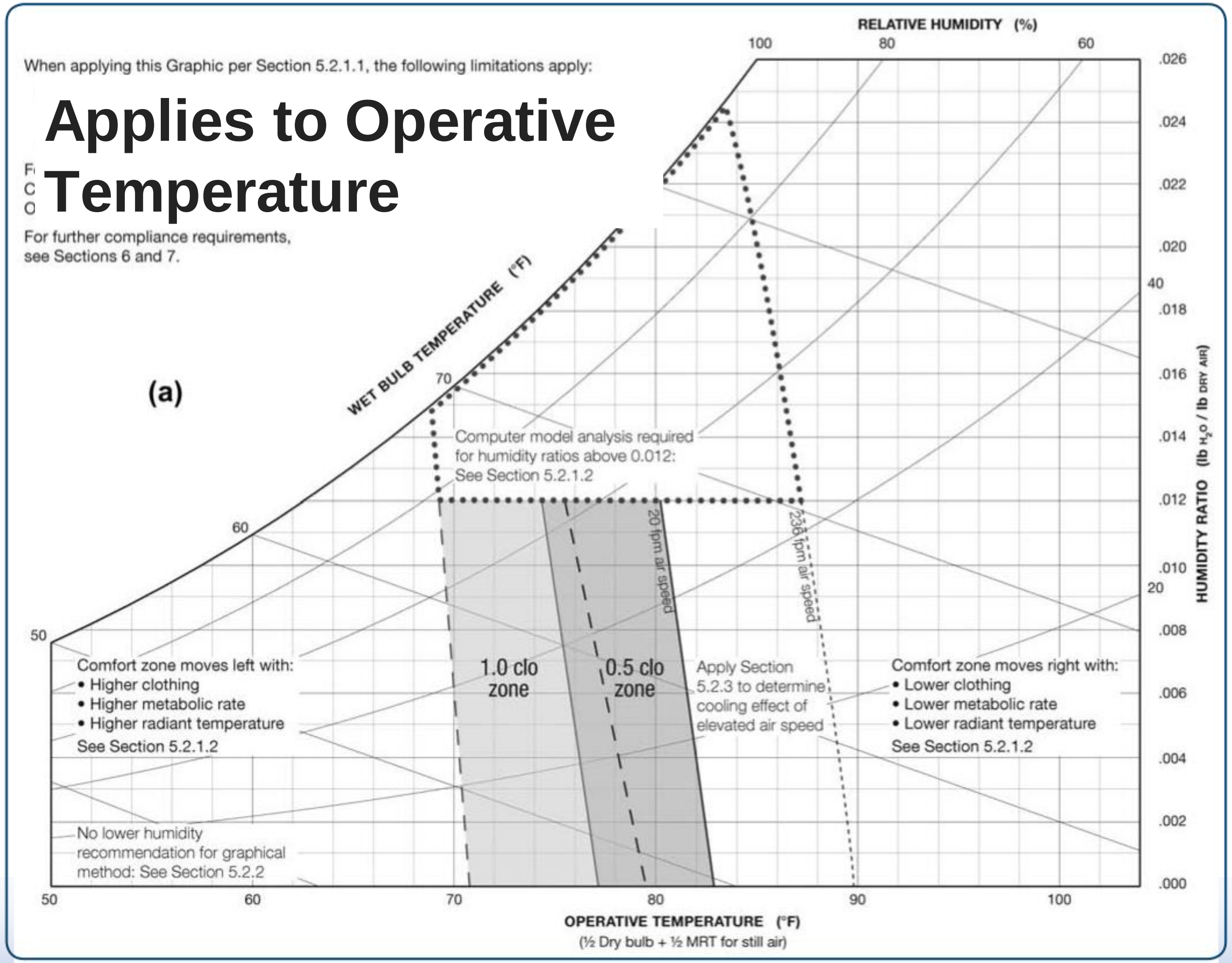

ANSI/ASHRAE Standard 55-2010
(Supersedes ANSI/ASHRAE Standard 55-2004)
Includes ANSI/ASHRAE addenda listed in Appendix I

ASHRAE STANDARD

Thermal Environmental Conditions for Human Occupancy

Operative Temperature
or “real feel temp”

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

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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

Can we meet the expectations of our customers?

ACCA Comfort Guidelines

Comfort – A starting point

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

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1) Get heating & cooling capacity right

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

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	110 BTUs / sq.ft

Raleigh, NC
- design conditions

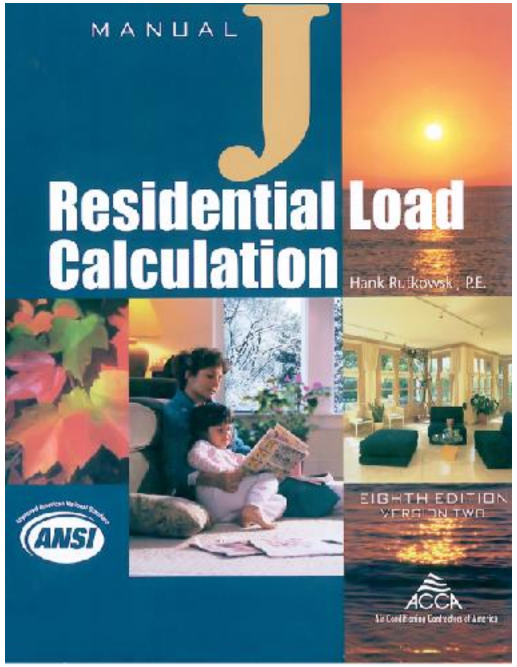
Condition	ASHRAE 99% / 1%
Winter, design dry bulb (F)	23.1°F
Summer, design dry bulb (F)	91.7°F
Summer, design wet bulb (F)	75.6°F
Degree days-heating	3322
Degree days-cooling	1579
Precipitation	46”
Solar incidence - South, Aug	100 btu/hr/ft2
Solar incidence - West, Aug	160 btu/hr/ft2

Proper Manual J Calculations

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

Common Errors:

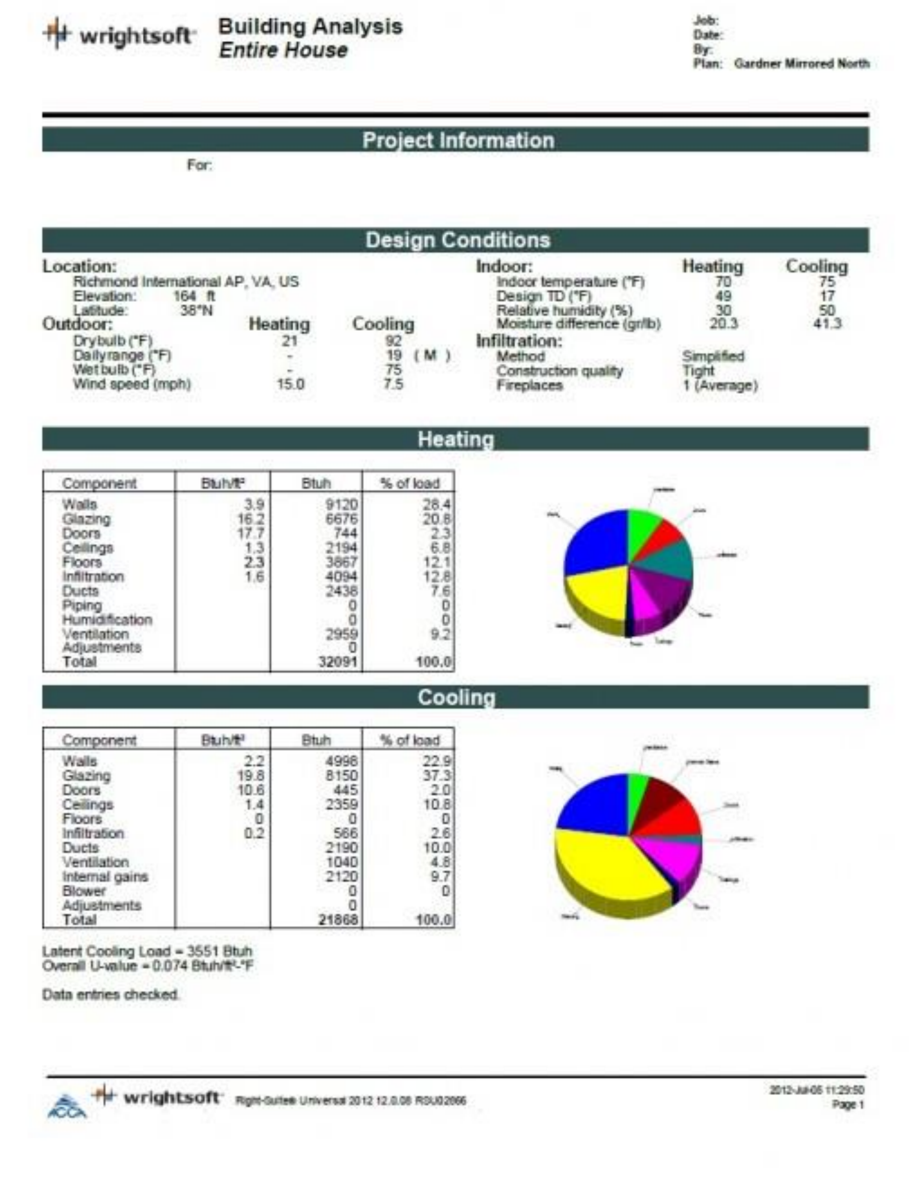
- Fudging design day conditions
- Using default values for air tightness, windows, insulation
- Using improper ventilation rates



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**
Drybulb (°F)	21	92
Dailyrange (°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.

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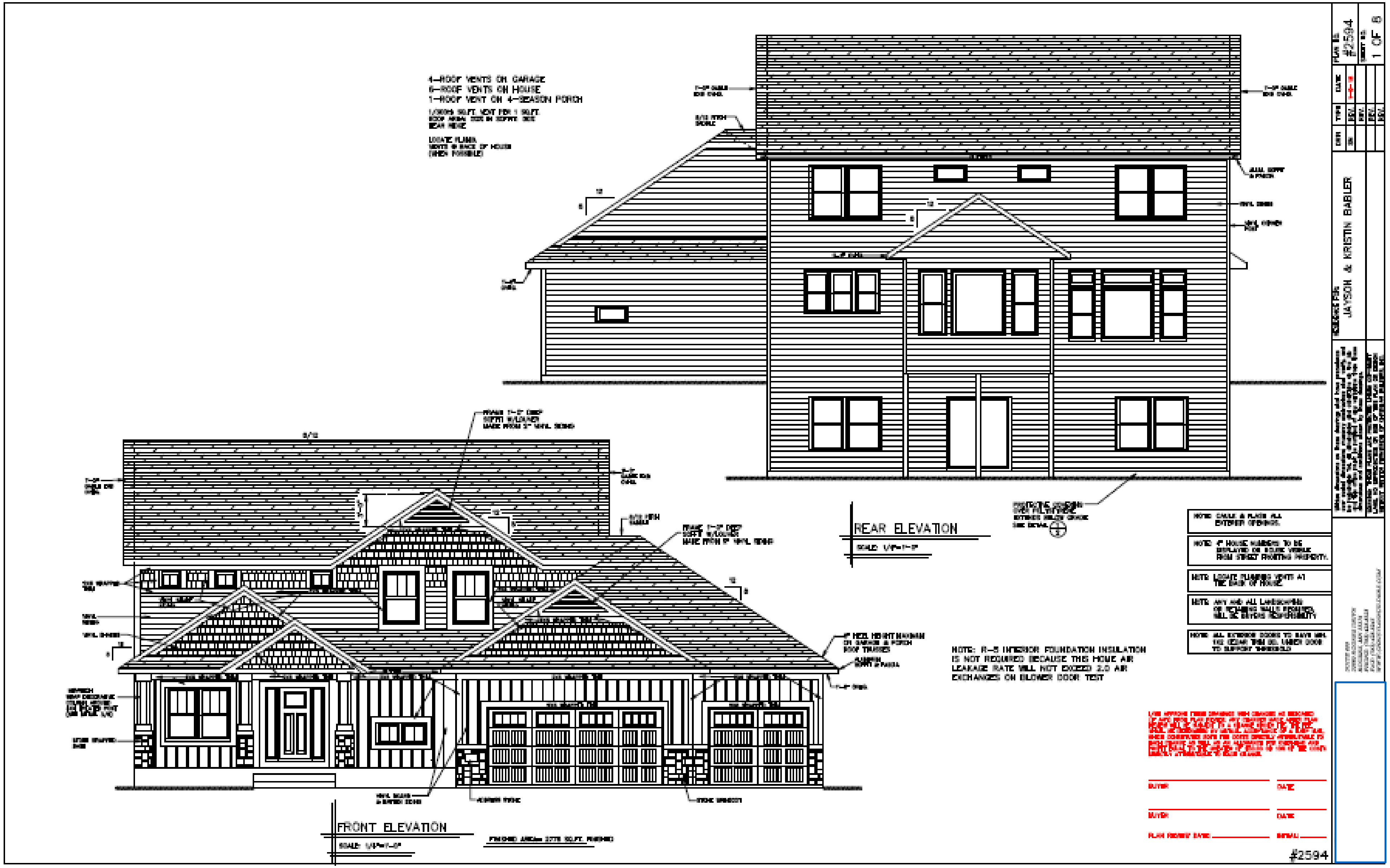
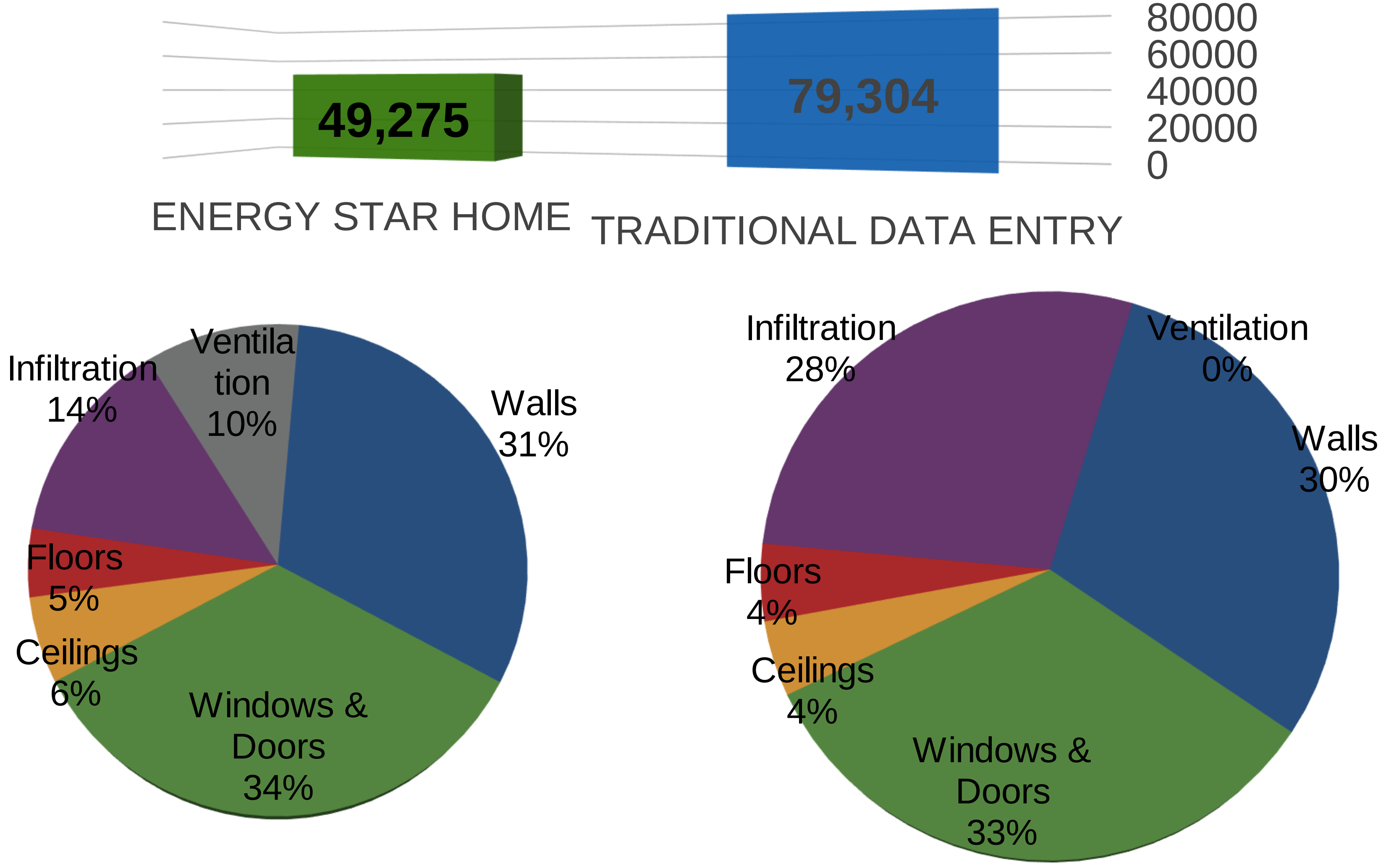
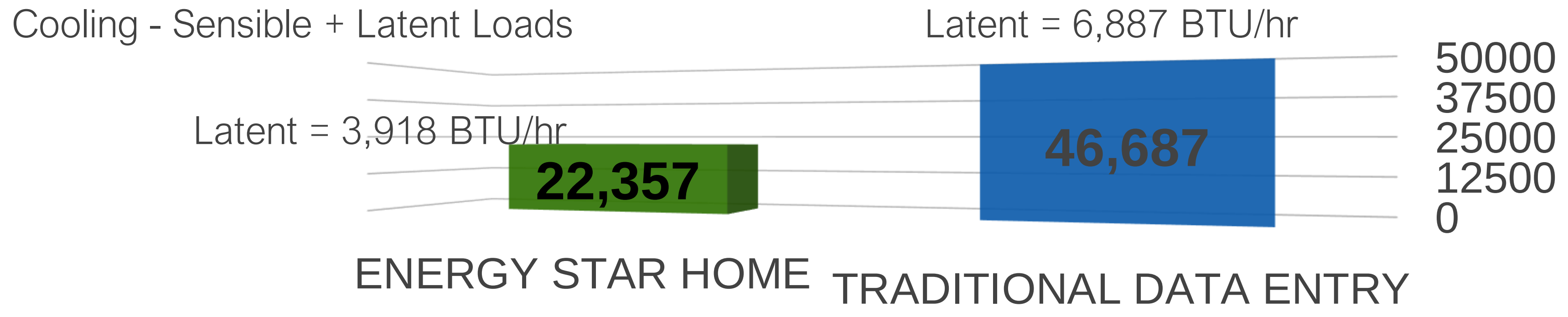

4-ROOF VENTS ON GARAGE
6-ROOF VENTS ON HOUSE
1-ROOF VENT ON 4-SEASON PORCH
REAR ELEVATION
FRONT ELEVATION
NOTE: R-5 INTERIOR FOUNDATION INSULATION IS NOT REQUIRED BECAUSE THIS HOME AIR LEAKAGE RATE WILL NOT EXCEED 2.0 AIR EXCHANGES ON BLOWER DOOR TEST
JAYSON & KRISTIN BABLER
#2594
1 OF 8
#2594

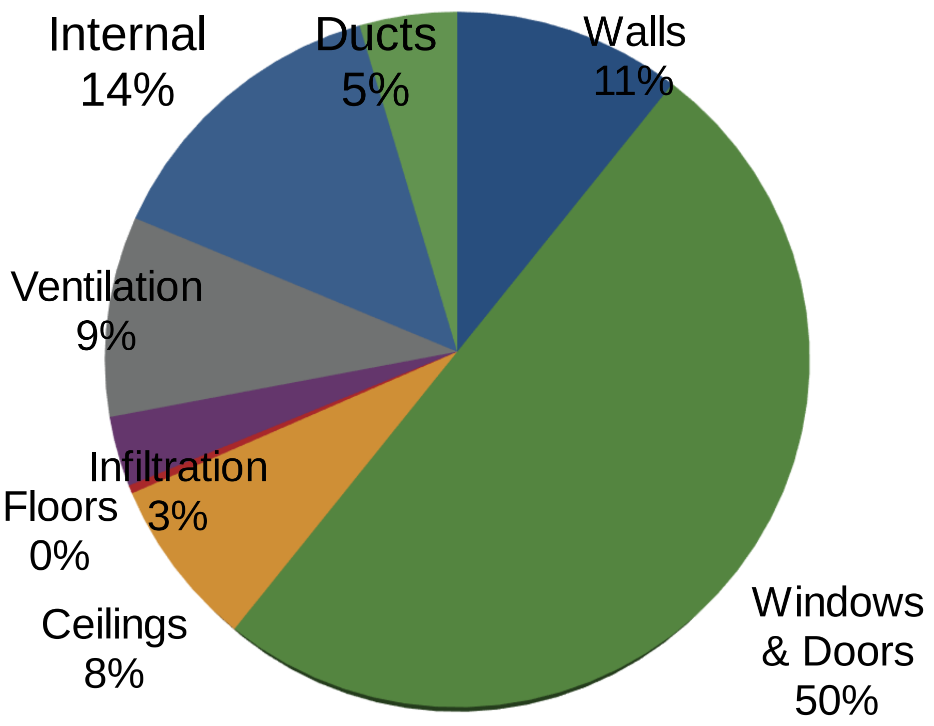
Parameter	Actual	Traditional
Design Temp (W) Design Temp (S)	-15 ^{0}F 91 ^{0}F	Its cold here: -22 ^{0}F Its getting hotter: 97 ^{0}F
Indoor Design (W) Indoor Design (S)	70 ^{0}F 75 ^{0}F	People are picky: 72 ^{0}F 72 ^{0}F
Orientation	North Front	Worst Case - East Front
Windows	From NFRC label U=0.28, SHGC=0.28 Overhangs used	Default U=0.41, SHGC=0.32 Overhangs not used
Air tightness	Actual 2.0 ACH50	Default 7.0 ACH50
Insulation	R50 ceilings R25 walls R 15 foundation	R44 ceilings R19 walls R 10 foundation
Ventilation	ERV - 75 CFM	Exhaust fans - 75 CFM

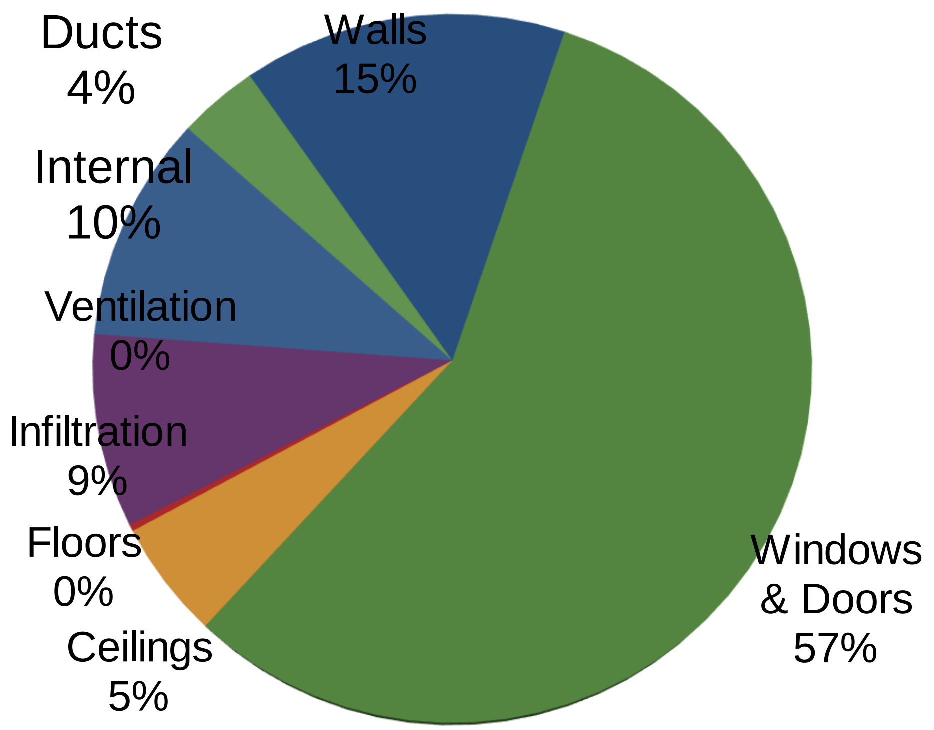
Design Day Heat Loss - BTUs/hr



Design Day Heat Gain - BTUs/hr





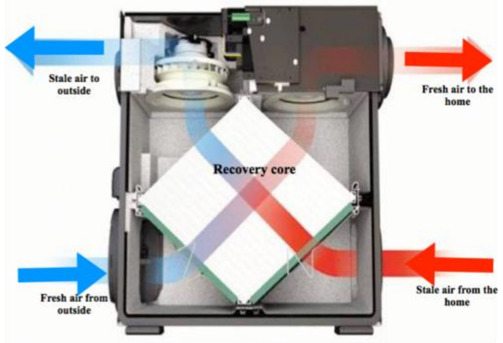


HVAC Sizing: 2 more important load factors

INFILTRATION Heat Loss/Gain

- Standard Default 4 ACH50….or even 7ACH50

DO WE KNOW WHAT THE REAL ACH50 NUMBERS ARE IN THE FIELD?



INFILTRATION AND VENTILATION HEAT LOSS CAN MAKE UP TO 30-40% OF A HOMES ENTIRE HEATING LOAD

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

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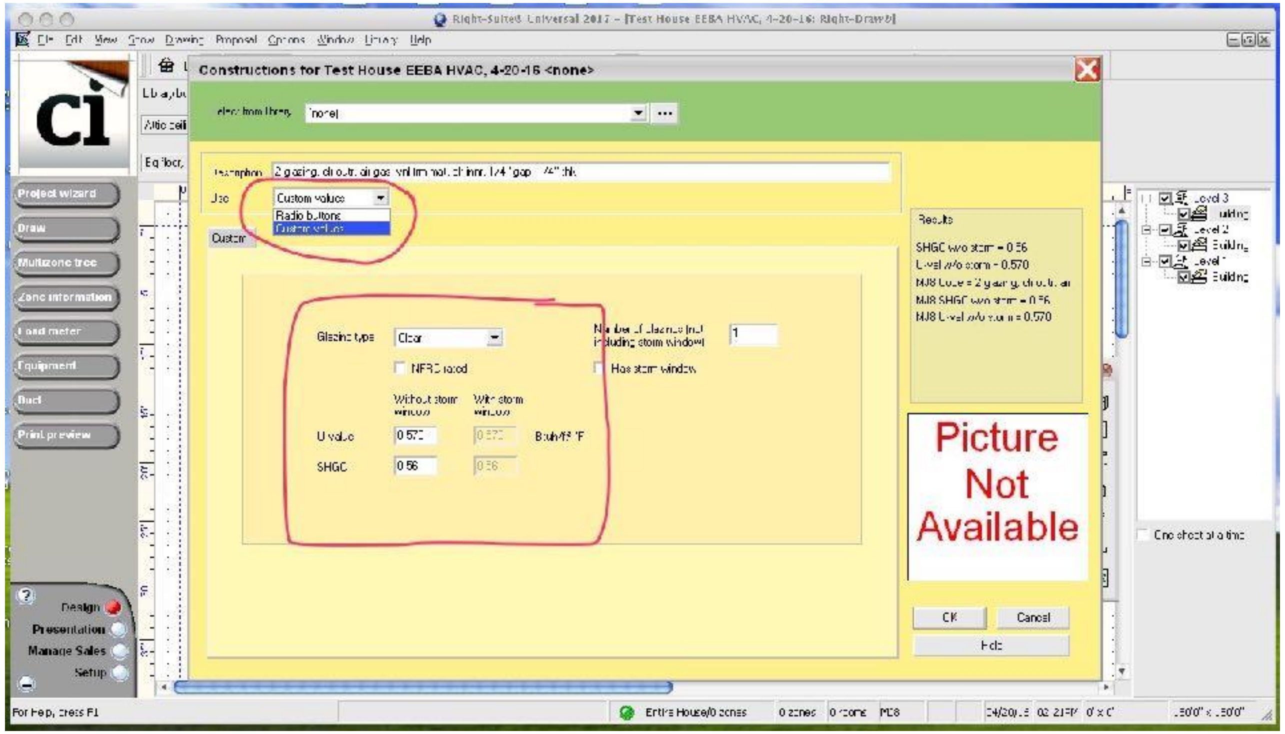


2) Select the right equipment

ACCA Equipment Selection

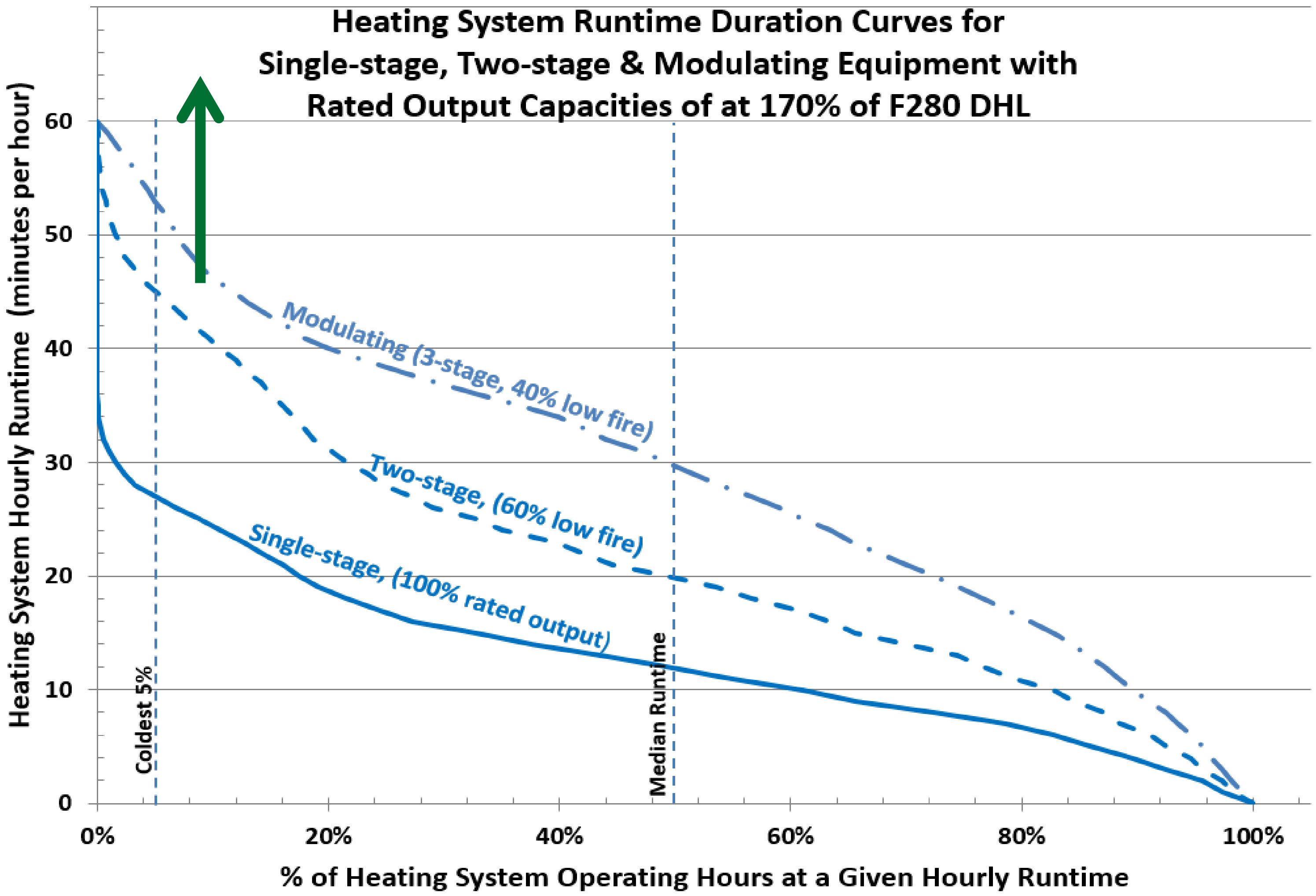
Good System Selection

Heating and cooling systems come in specific sizes

(2, 2.5, 3 ton, or 45, 70, 90 Thousand BTUs for example)

- For heating it is acceptable to select a system that is within 110% -125% of the design load - slightly oversized
- For cooling choose a system that is between 90% - 110% of design load
- Other issues:
  - Equipment location (garage, attic, crawl…)
  - Blower type (ECM, PSC, HV…)
  - Filtration needs

A STUDY IN EQUIPMENT SELECTION FOR LOW LOAD ZERO ENERGY READY HOMES



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

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Combustion Safety

- Easy Stuff!!
- Switch to closed combustion equipment or heat pumps
- Furnaces, water heaters, fireplaces
- Even if the equipment is located in the garage or attic
- Properly vent gas cooking appliances
- These better choices have the added benefit of improving efficiency and effectiveness

Preferred AC choices

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

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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"

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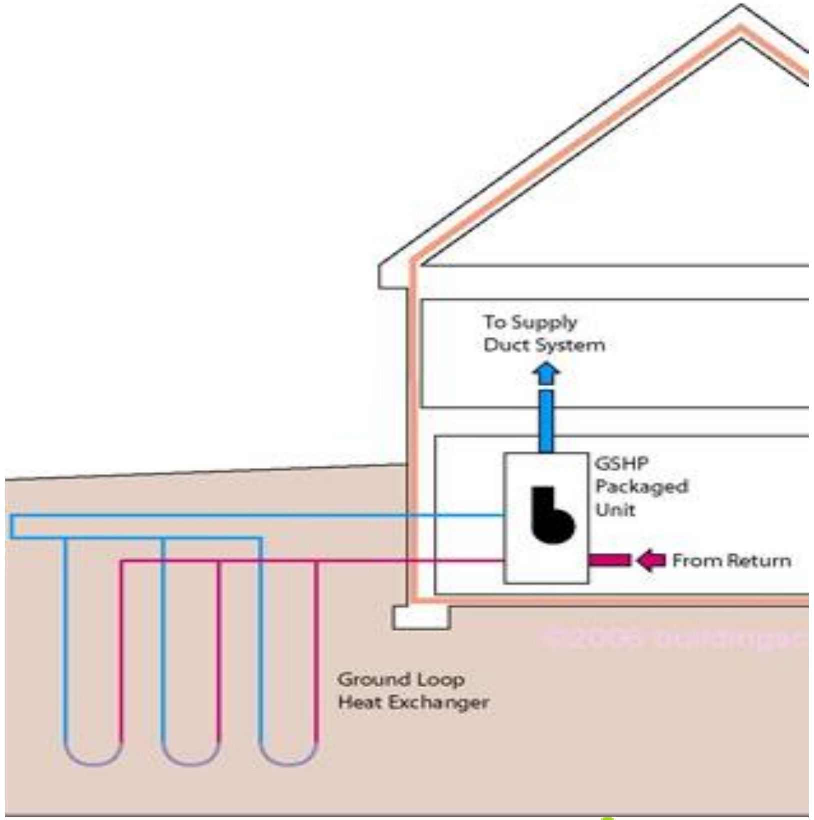
What about Heat Pumps?

- Is it the first thing to do?
- Reliance on electric grid
- Can do water or air
- High Performance homes help reduce capital cost
- “250% to 400%” efficiency



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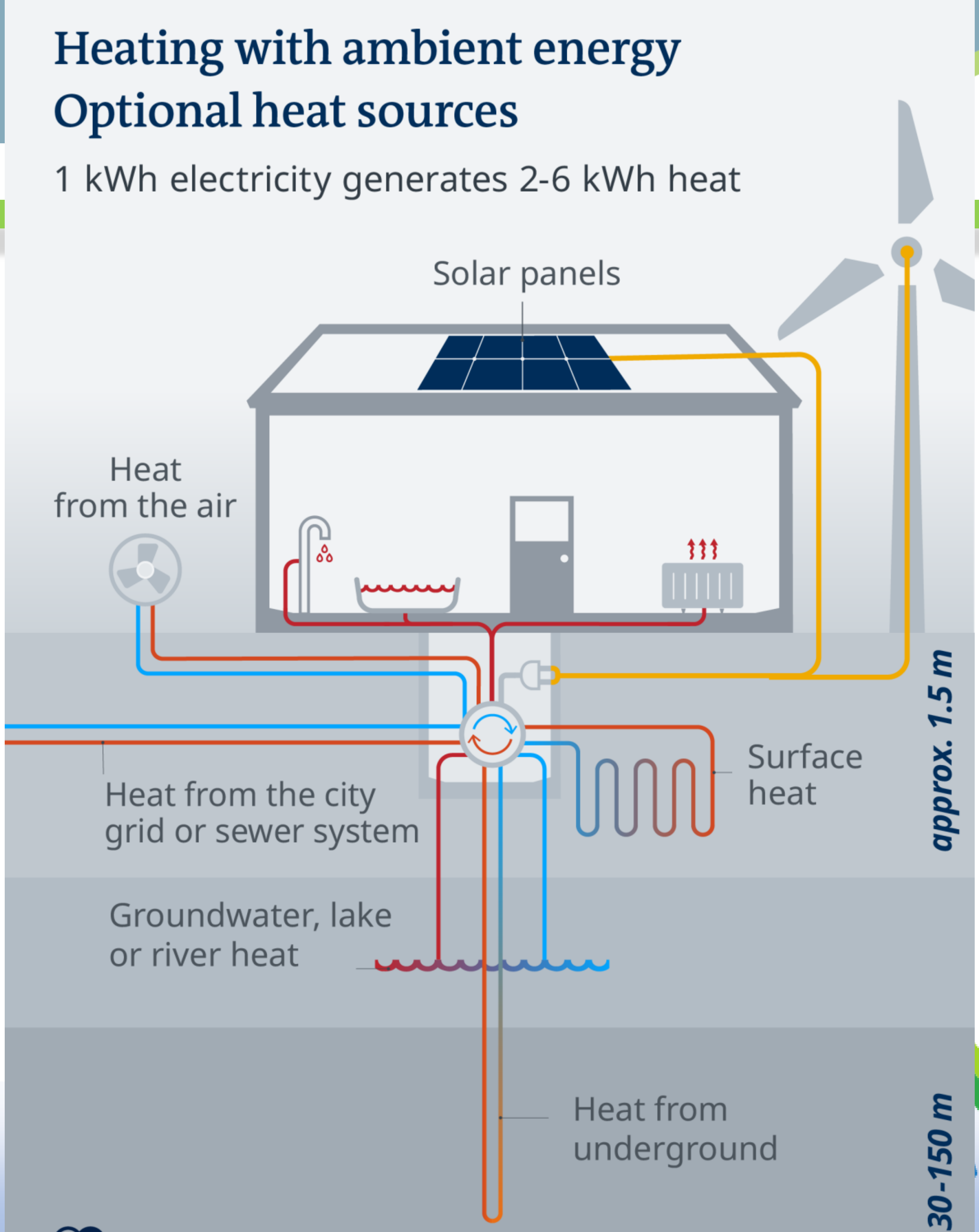
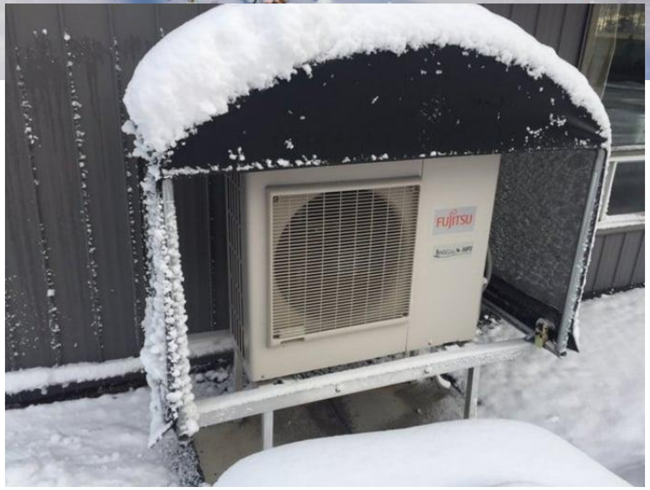
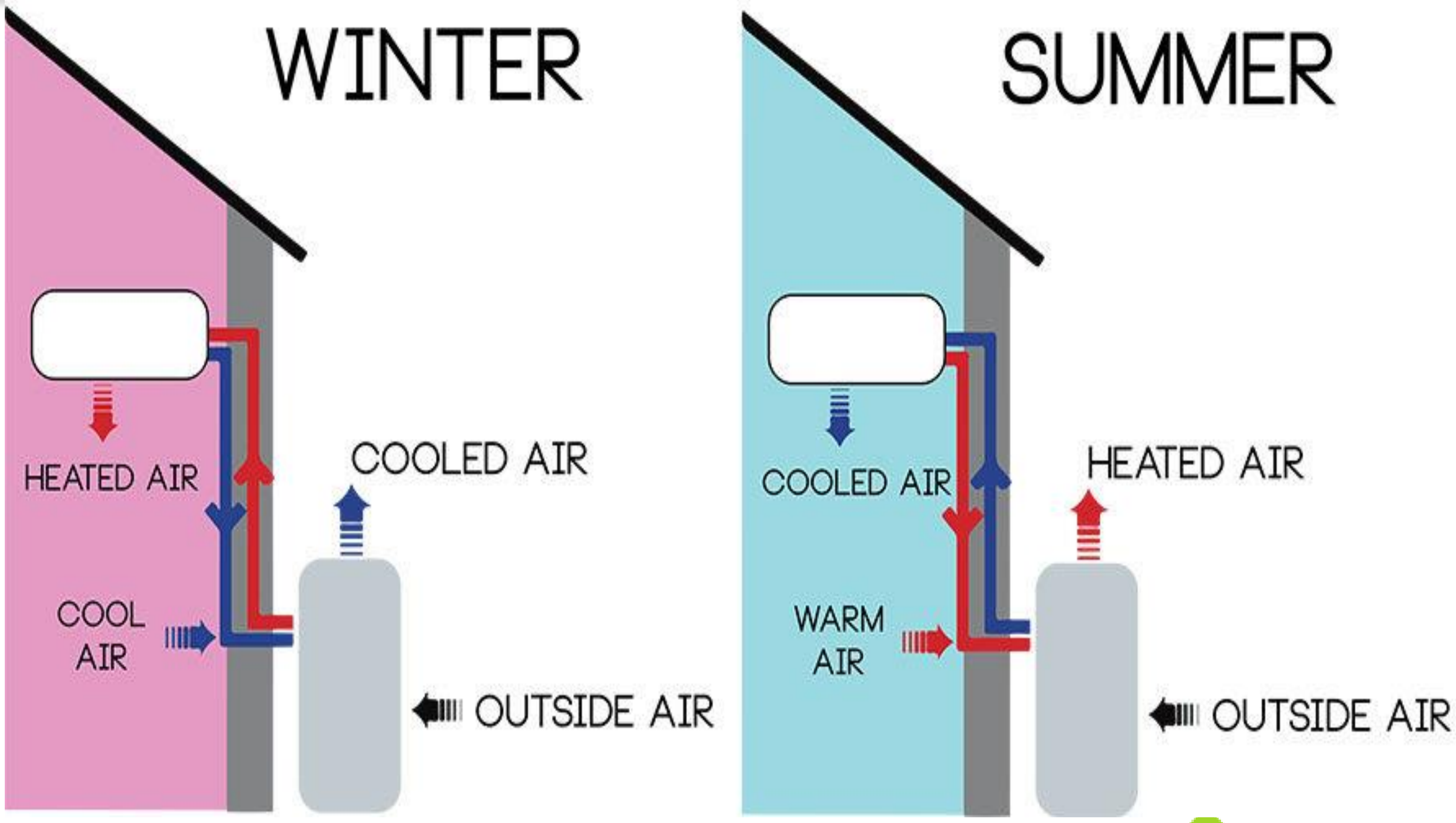
Heat Pumps Everywhere…

Air, Ground(deep or shallow) , Water.

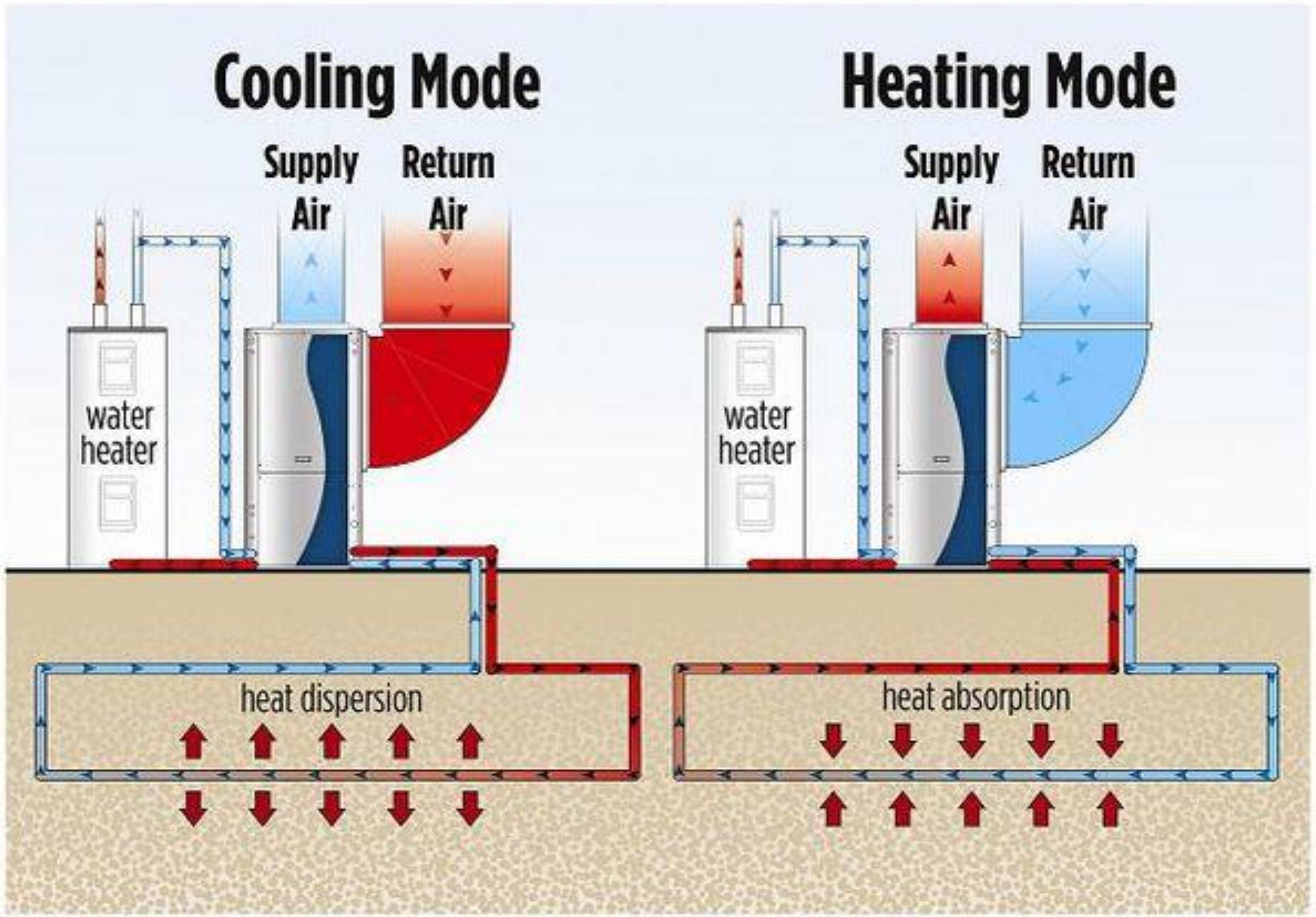


How Air Source Heat Pumps Work





How Ground Source Heat Pumps Work



New High Performance choices

- Air Source Heat Pumps
- SEER ratings of 14+ and HSPF of 8.6+
- MULTI stage heating/cooling
- Dehumidification cycles

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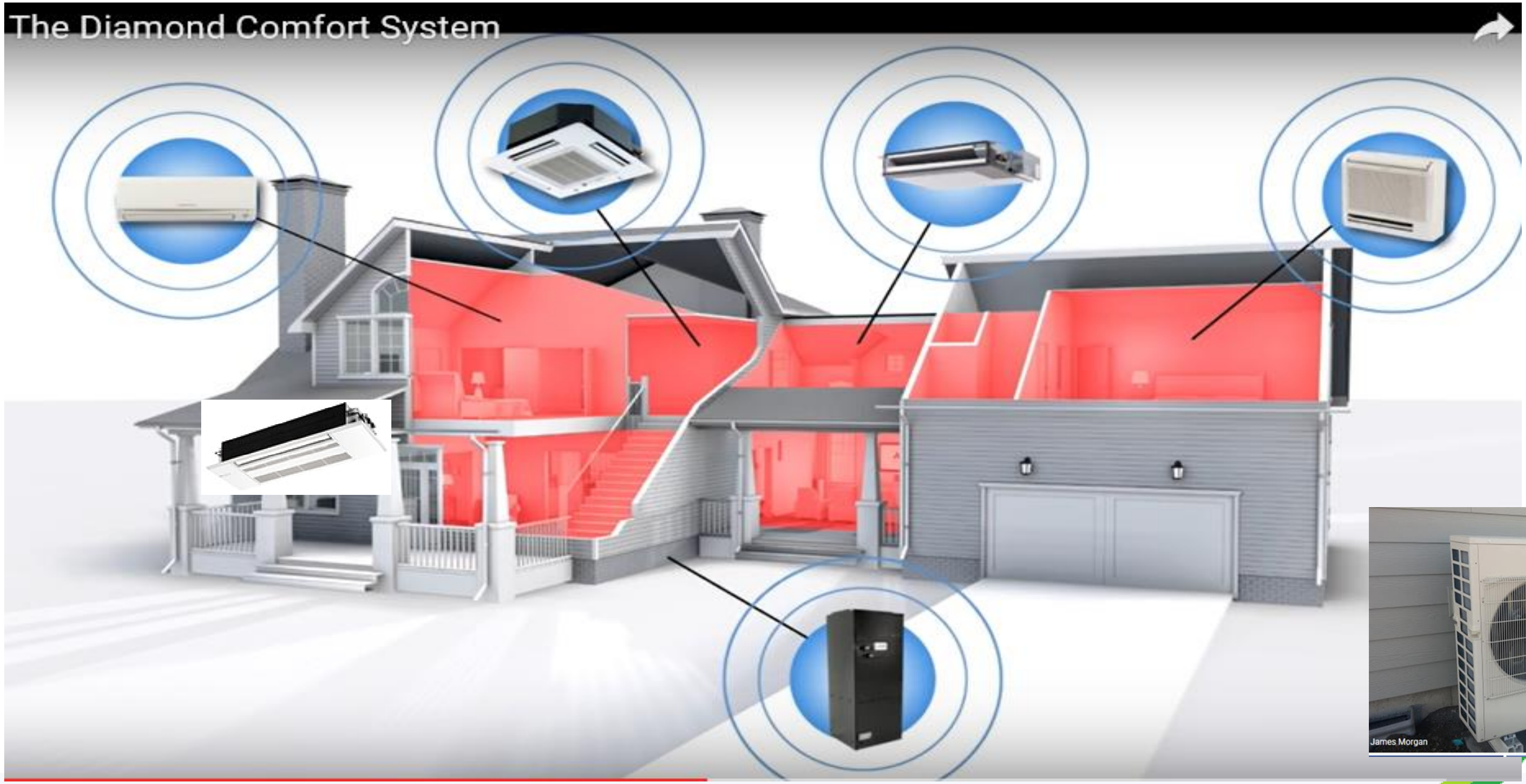
Distribution Design w/ ASHP

Distribution is getting easier

Small air handlers, small ducted mini split/multi split



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Energy Efficiency: Zero Energy Lessons learned

Low loads change the game.

Low ambient heat pump study CZ 6 / 2014

	Manufacturer	EnerGuide	Test	Season
ASHP				
Seasonal Energy Efficiency Ratio (SEER)	16	>=14	18	Cooling
Coefficient of Performance (COP)	2.75	2.05	3.23	Heating
GSHP				
Seasonal Energy Efficiency Ratio (SEER)	12.9	>=14.1	19.7	Cooling
Coefficient of Performance (COP)	3.0	>=3.3	3.44	Heating

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Energy Efficiency: Zero Energy Lessons learned

Zero Energy Homes can be fuel agnostic…

Dual Fuel /Hybrid Solutions work

- Enables "smart" use of Electrical or Gas
- Balance point can be either Operational OR Economic

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3) Design the ducts correctly

ACCA Duct Design

Distribution Design

High performance homes require good distribution design.

HVAC contractor must use the heat loss/gain calculations to properly size duct work. It is critical to consider the entire system and process.

- Layout & location of distribution system
- Materials used - flexible duct or sheet metal, insulated or non-insulated
- Impact on pressurization of rooms or spaces
- Effective occupant comfort control

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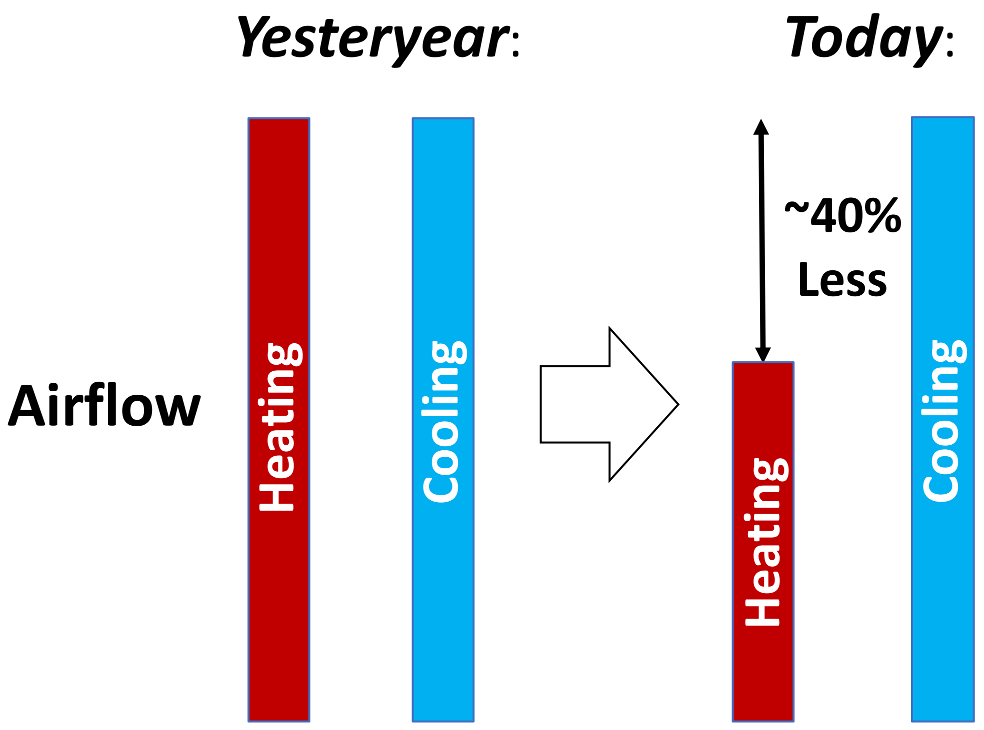
ZERO ENERGY READY HOMES: LESSONS LEARNED
DISTRIBUTION SIZING AND SELECTION

Example of Calculations

- Typical 2275 sq.ft. house-

	1990 Code	IECC 2012	ZERH
Load	70,000 BTUs 3.0 tons	36,000 BTUs 2.0 tons	26,000 BTUs 1.5 tons
Air Flow	1200 CFM	750 CFM	600 CFM
Duct sizes • Mains • Branch	 8”x28” 5” – 6”	 8” x 18” 5”	 8” x 12” 3”- 4”

Air Distribution: Size on heating or cooling?



Design Cooling Loads

- No change in window Solar Heat Gain Coefficient (SHGC).
- Sometimes more glazing and more concentrated glazing.

Duct Sizing

- Often based on cooling airflow requirements – even where cooling is not installed.

Average COOLING = 300 CFM< per ton

Average HEATING = 120 CFM per ton

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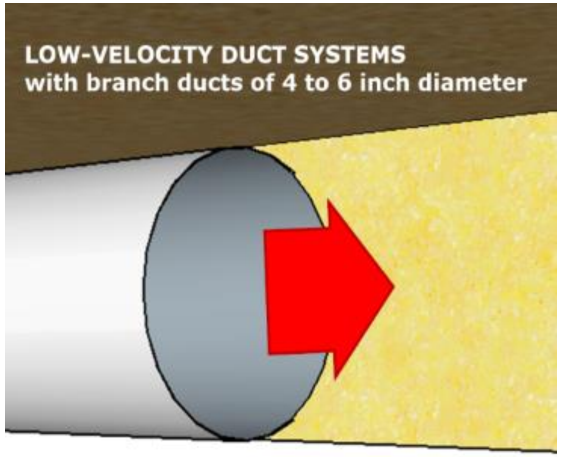
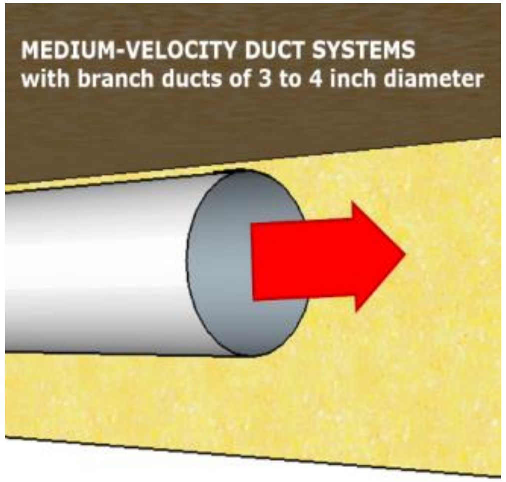
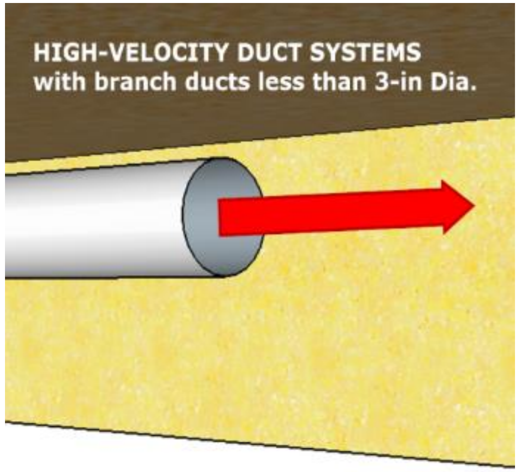
Air Distribution Design: A Few Options

Option A: Low | **Option B:** Medium | **Option C:** High

- smaller branch ducts will be easier to install in joist and wall cavities;
- Trunks will be fabricated from round ducts which are easier to seal, resulting in lower leakage rates.







Parameter	Option A: Low	Option B: Medium	Option C: High
Total External Static Pressure (ESP)	Less than or equal to 0.5 in. WC	Between 0.5 and 1.0 in. WC	Greater than 1.0 in. WC
Typical Supply branch diameter	4 to 6 inch	3 to 4 inch	Less than 3 inch

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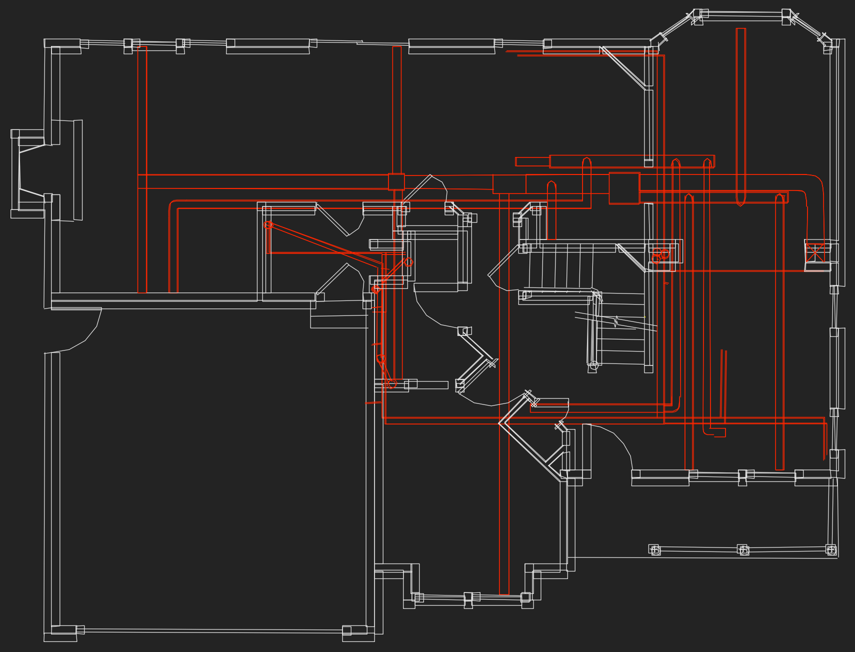
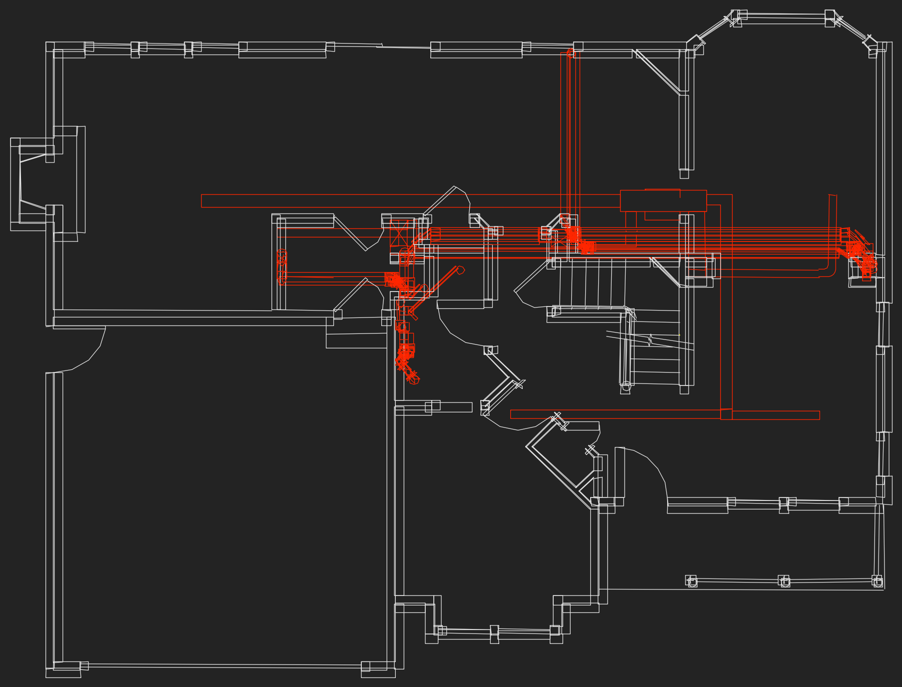
HVAC by Design

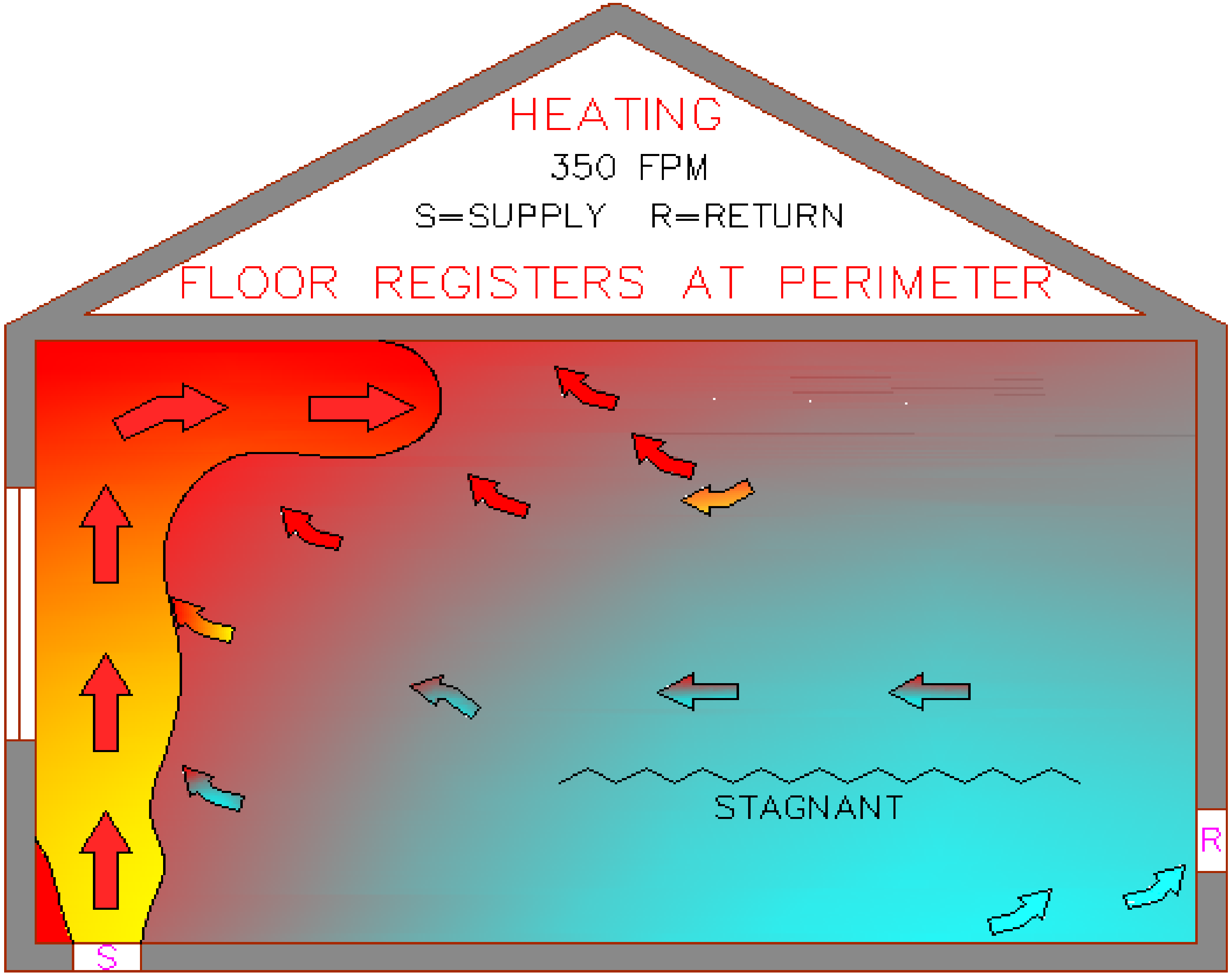
- Properly size system
- Optimize duct layout

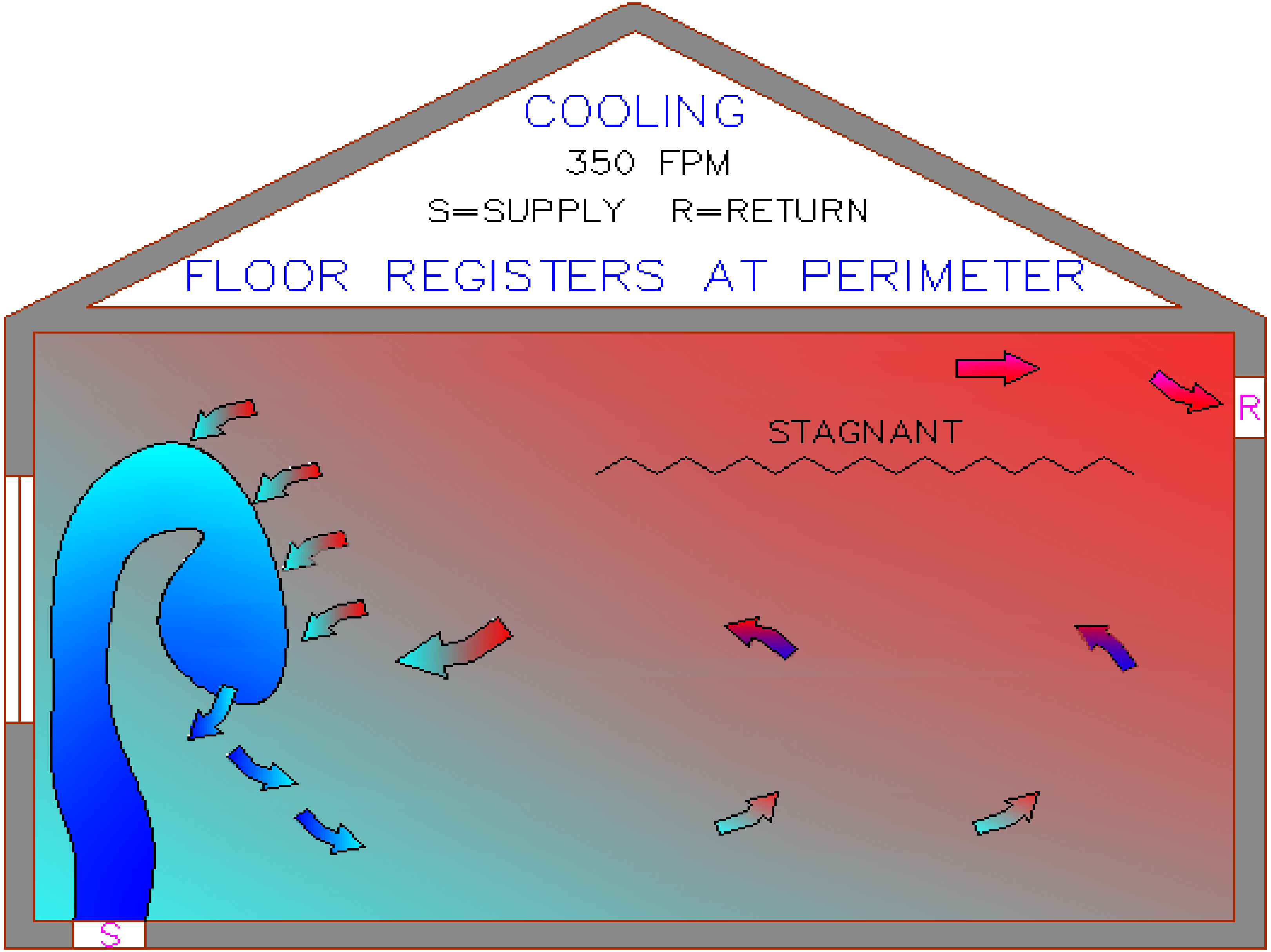


Traditional



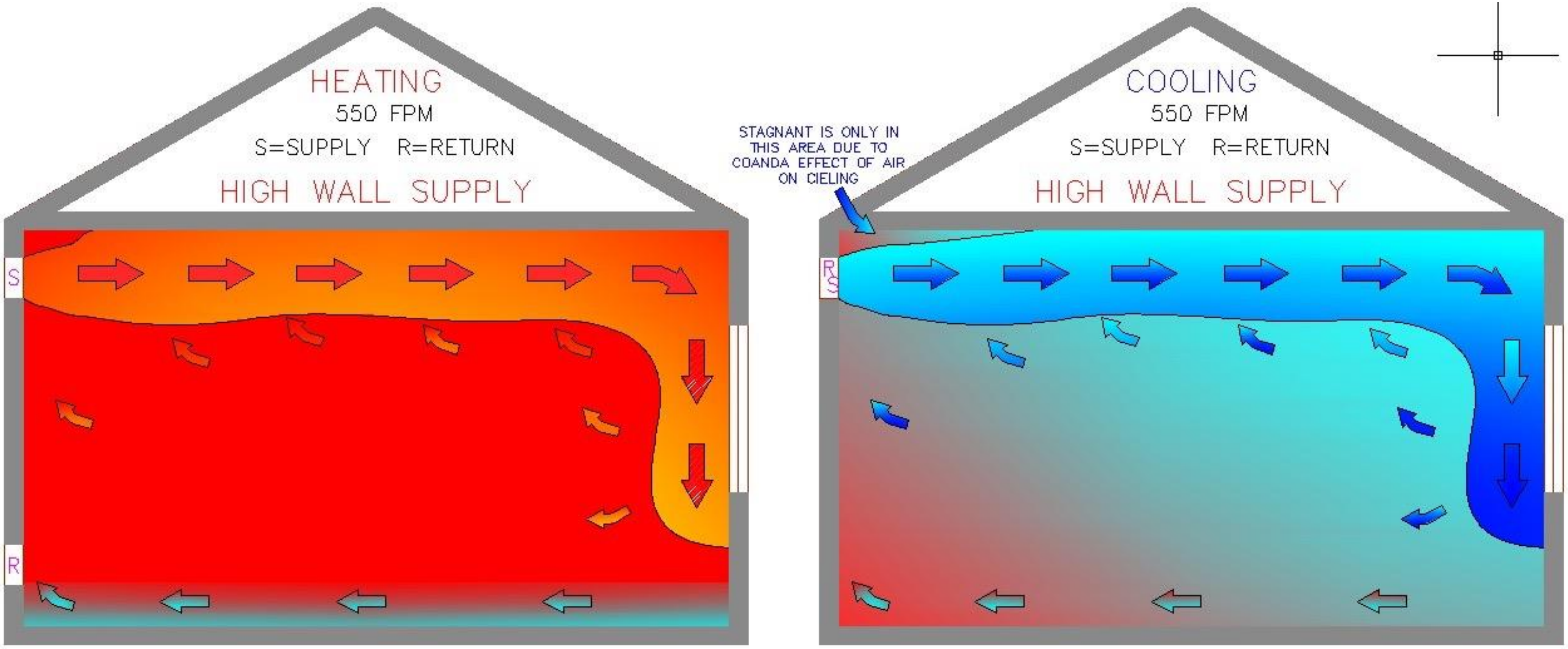
Advanced


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



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

Ducts in Conditioned Space
4 options
attics are an option

It can raise the value of a home

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

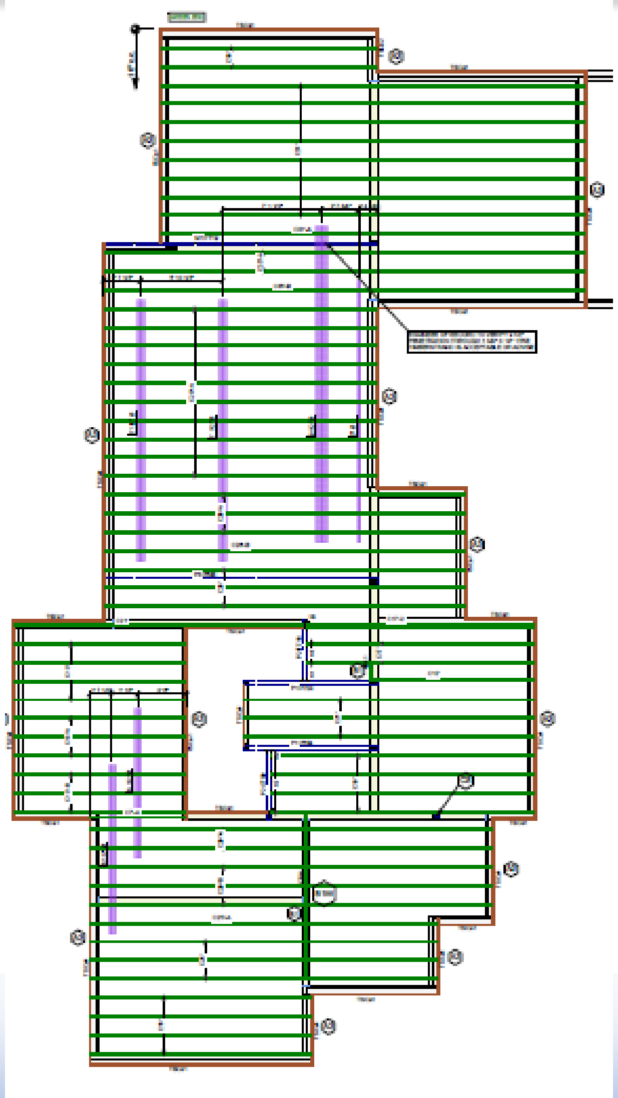
Ducts are now properly insulated and any duct leakage is to the interior

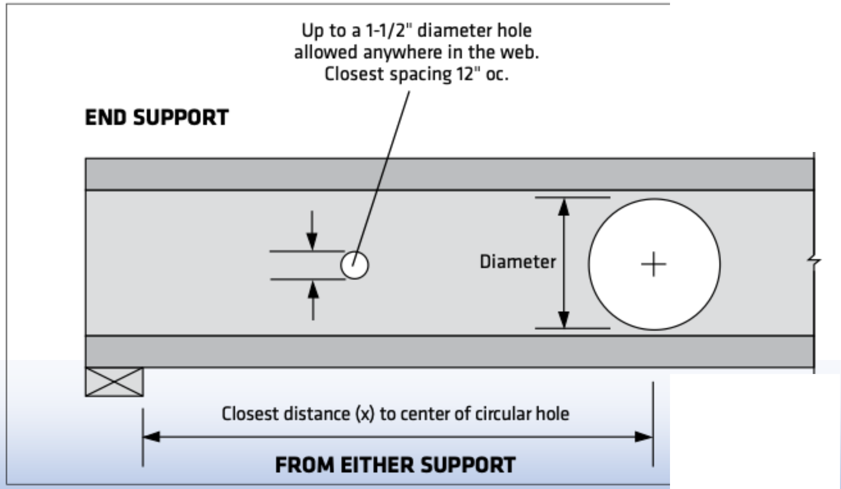
Using floor cavities is an option

It can raise the value of a home

Open web floor joist systems

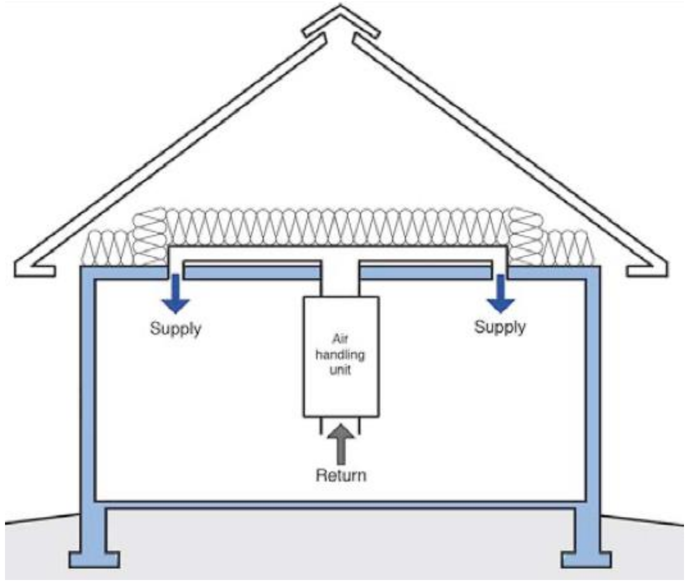
Layout your floors to accommodate duct work





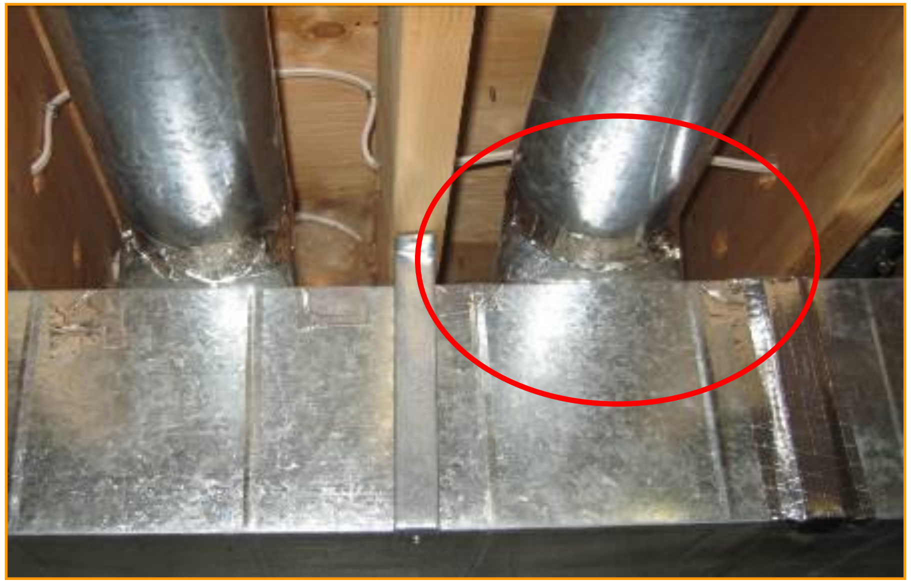
Buried Ducts are an Option

- Mastic with a brush is quickest & best



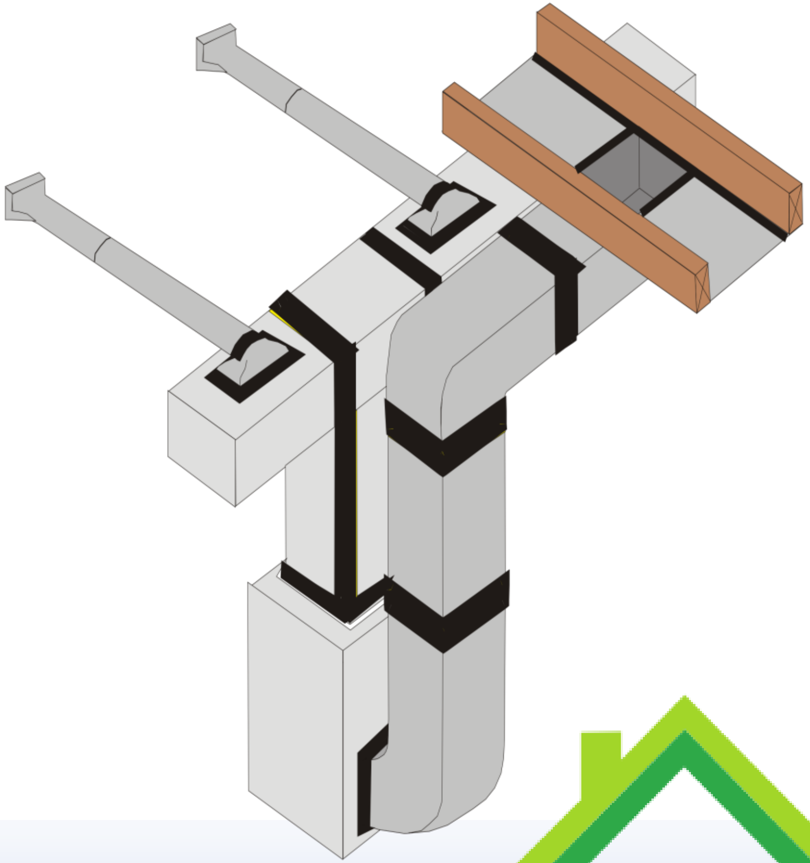
Seal Ducts

- Mastic with a brush is quickest & best

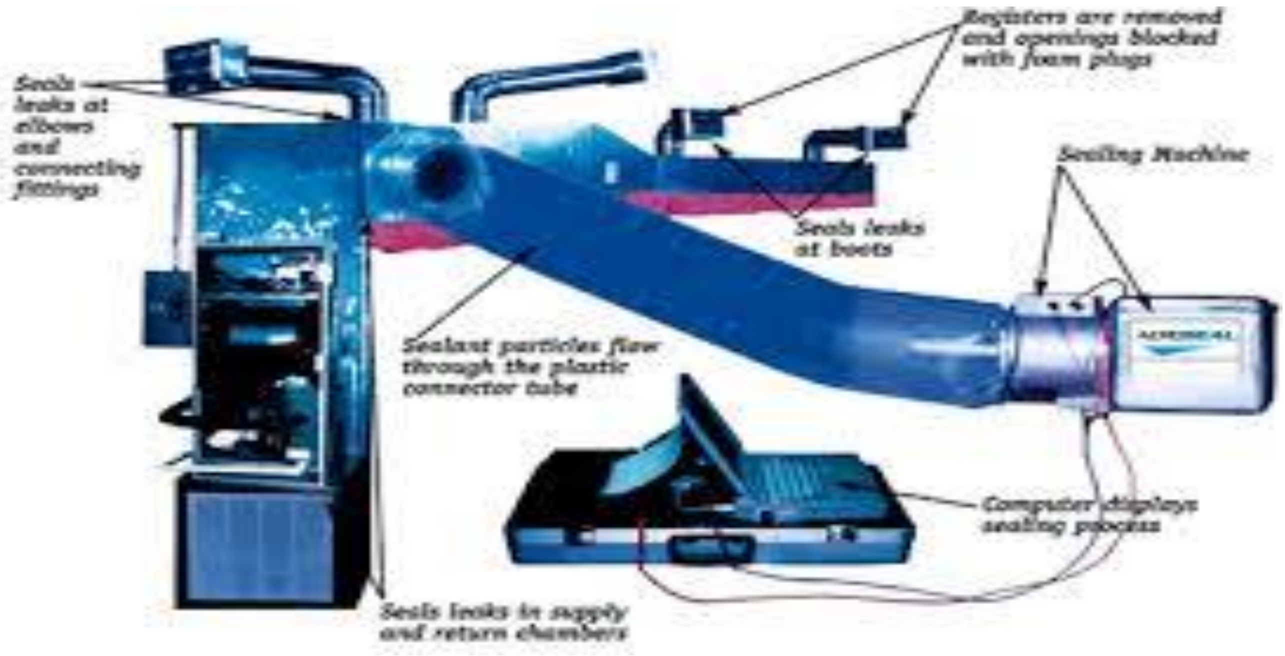


Sealing Ducts Matters!!!

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



Duct Sealing Technology



Duct Sealing Technology

AEROSEAL GTA

www.aerosealgta.com
647-367-6111

Certificate of Completion

Duct Sealing Performed for:
RICK VEENHUIZEN
6 WYCHWOOD PARK
Toronto,ON M6G2V5
(416)999-9999

Overall Sealing Results

When we arrived,
YOUR DUCTS HAD:

494 CFM of Leakage, equivalent to a
94 Square Inch Hole

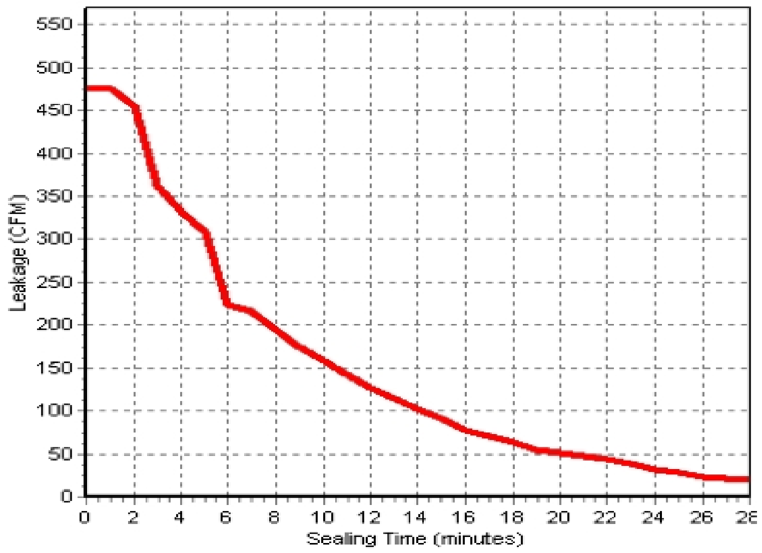
After we finished,
YOUR DUCTS HAVE:

25 CFM of Leakage, equivalent to a
5 Square Inch Hole

This corresponds to a **95% Reduction** in Duct Leakage

Note: Duct leakage results are calculated in cubic feet per minute (CFM) measured at a standard OPERATING PRESSURE of 25 Pa (0.10 in. water).

Aerosol Sealing Profile



Your Heating and Cooling Capacity Improvement for Duct Sealing is
29%
based upon measured leakage reduction and original register flow

AEROSEAL. Certified Duct Diagnostics & Sealing

Aeroseal Technician: TIBO, JOE, BRAD
Aeroseal Equipment Serial #: 2163
Wednesday, April 29, 2015

Duct Sealing Results – Gord Cooke's 1990 HERS 50 Home Reno house

Room	Airflow Before CFM	Airflow After CFM
Master Bed	45	59
Master Bed	28	35
Master Bath	36	34
Bed 3	32	46
Bed 3	16	24
Bed 2	37	37
Main Bath	21	25
Bed1	35	42
Bed1	43	50
Family	32	46
Family	37	31
Family	10	15
Living	51	66
Dining	13	18
Kitchen	53	64
Office	36	49
Mudroom	13	13
Basement	42	48
Basement	39	48
Total	**619**	**750**

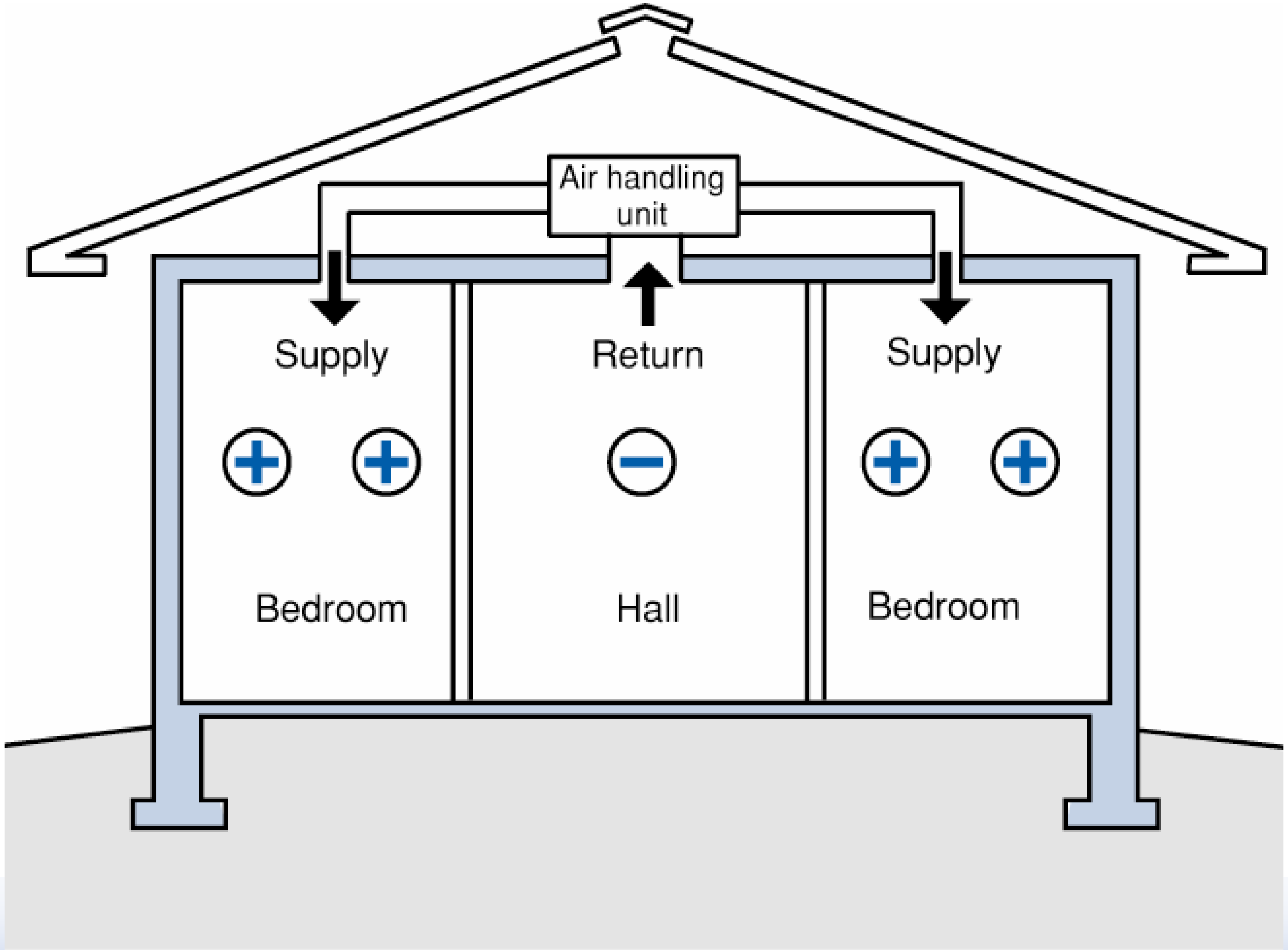
Zoning will become more important

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

Ducted Returns
will become expected

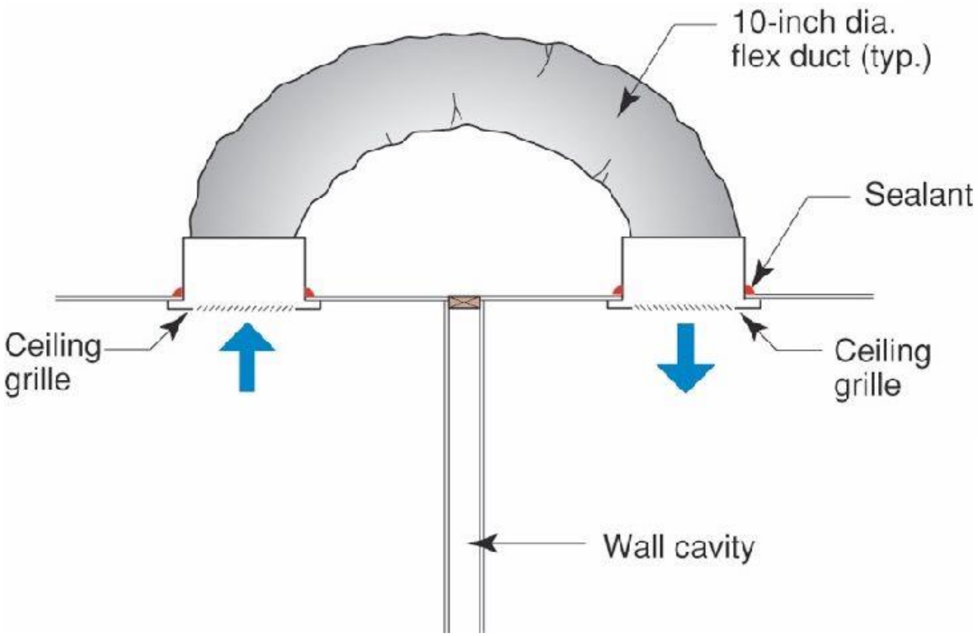
- A good choice is to hard duct returns…strategically to a centralized location

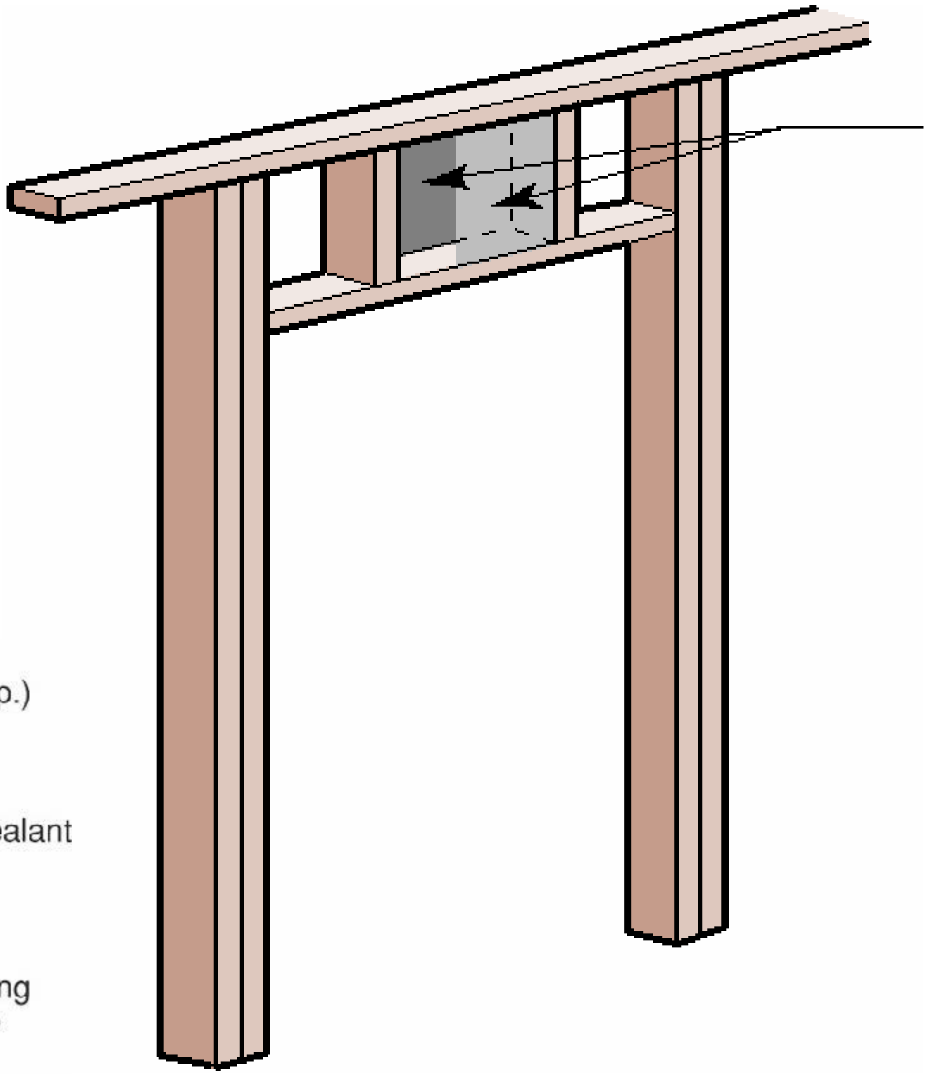
Return Air Paths



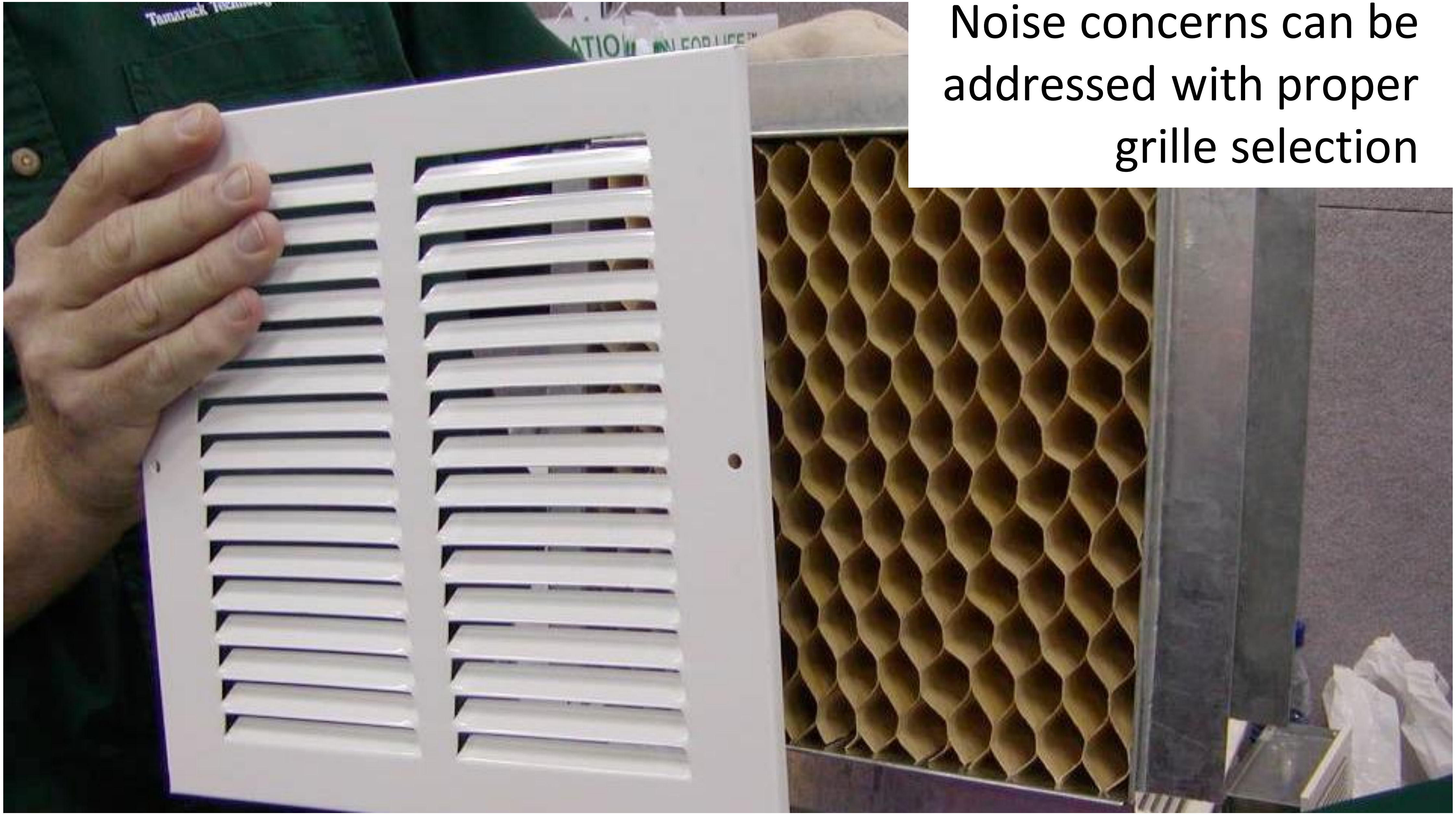
Graphics Courtesy of Building Science Corp.


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




TG



Noise concerns can be addressed with proper grille selection

Radiant in-Floor Heat

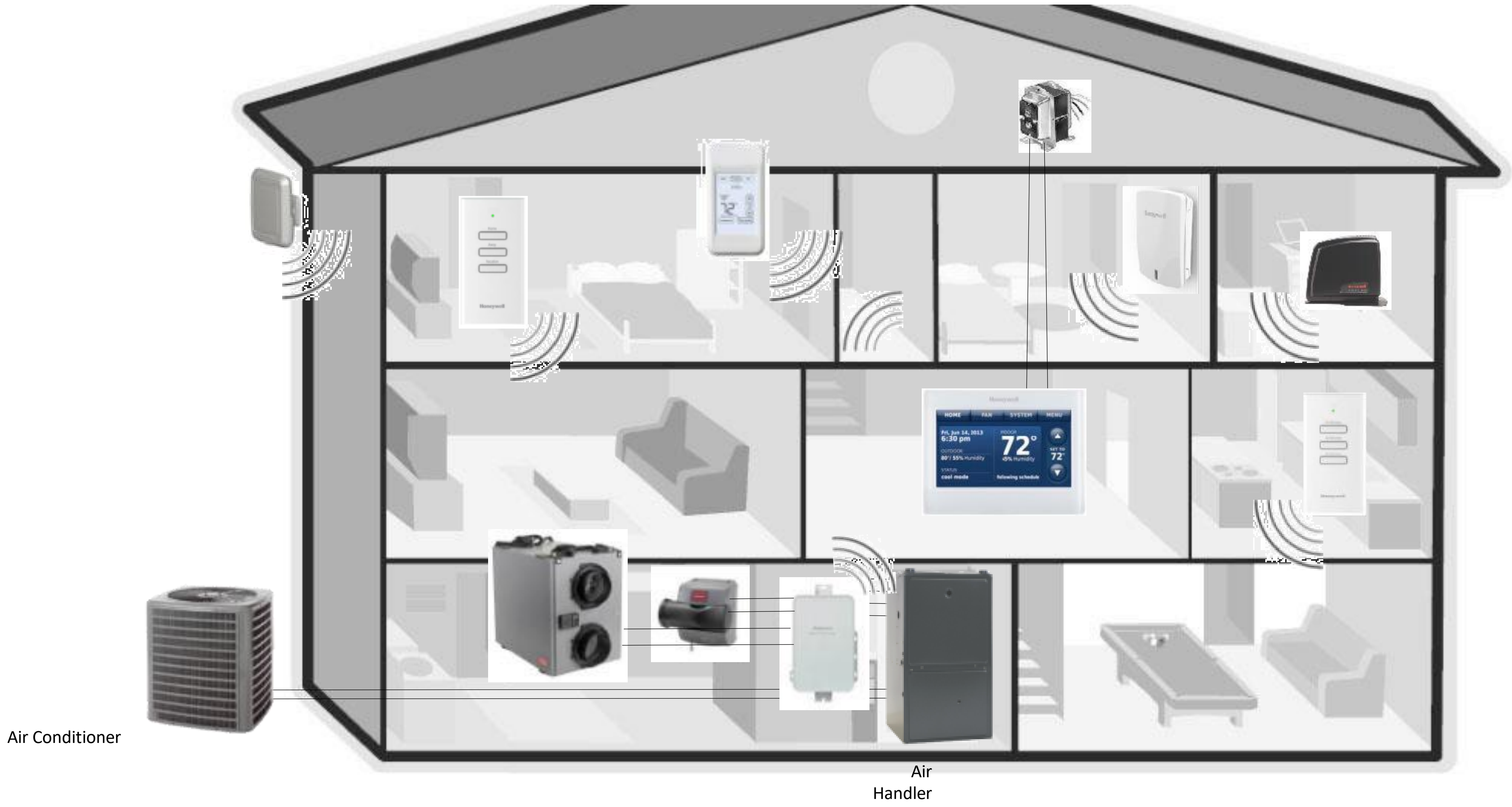
- Heat surfaces, not air
- Lower noise
- Comfort on concrete floors
- Ideal for basements & "floor warming"
- Requires additional systems for AC, humidity control and filtration

Controls

Smarter Controls

- Anticipating change
- Outdoor reset
- Time of use rate decisions
- Programming & integrating functions
- Fan cycles
- Humidification
- Dehumidification
- Ventilation
- Real time diagnostics


UV Treatment
Zoning
Humidification
Dehumidification
Filtration
Ventilation


Air Conditioner
Air Handler

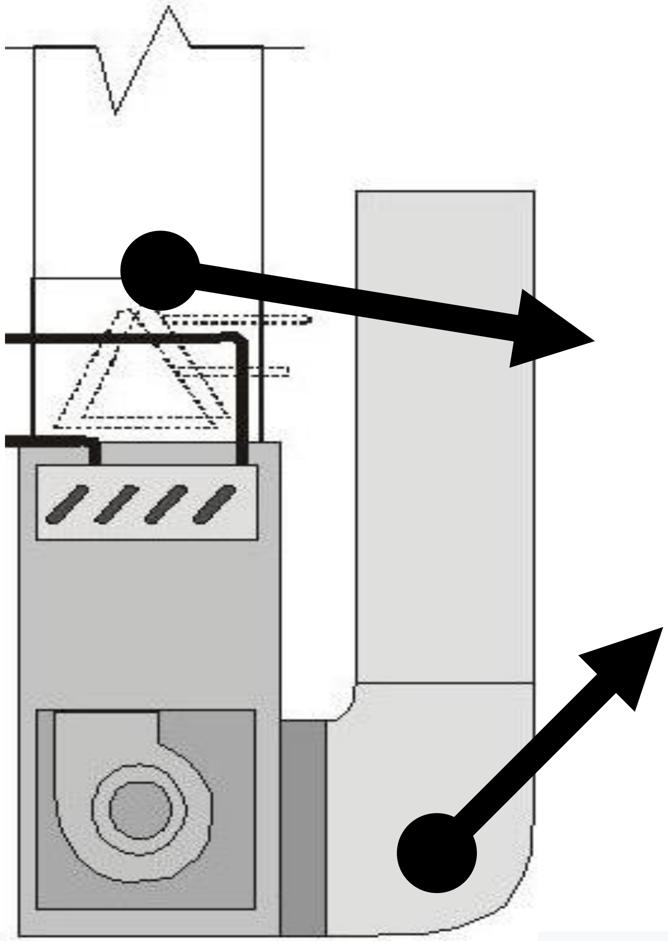
Verification / Commissioning

5 key tests

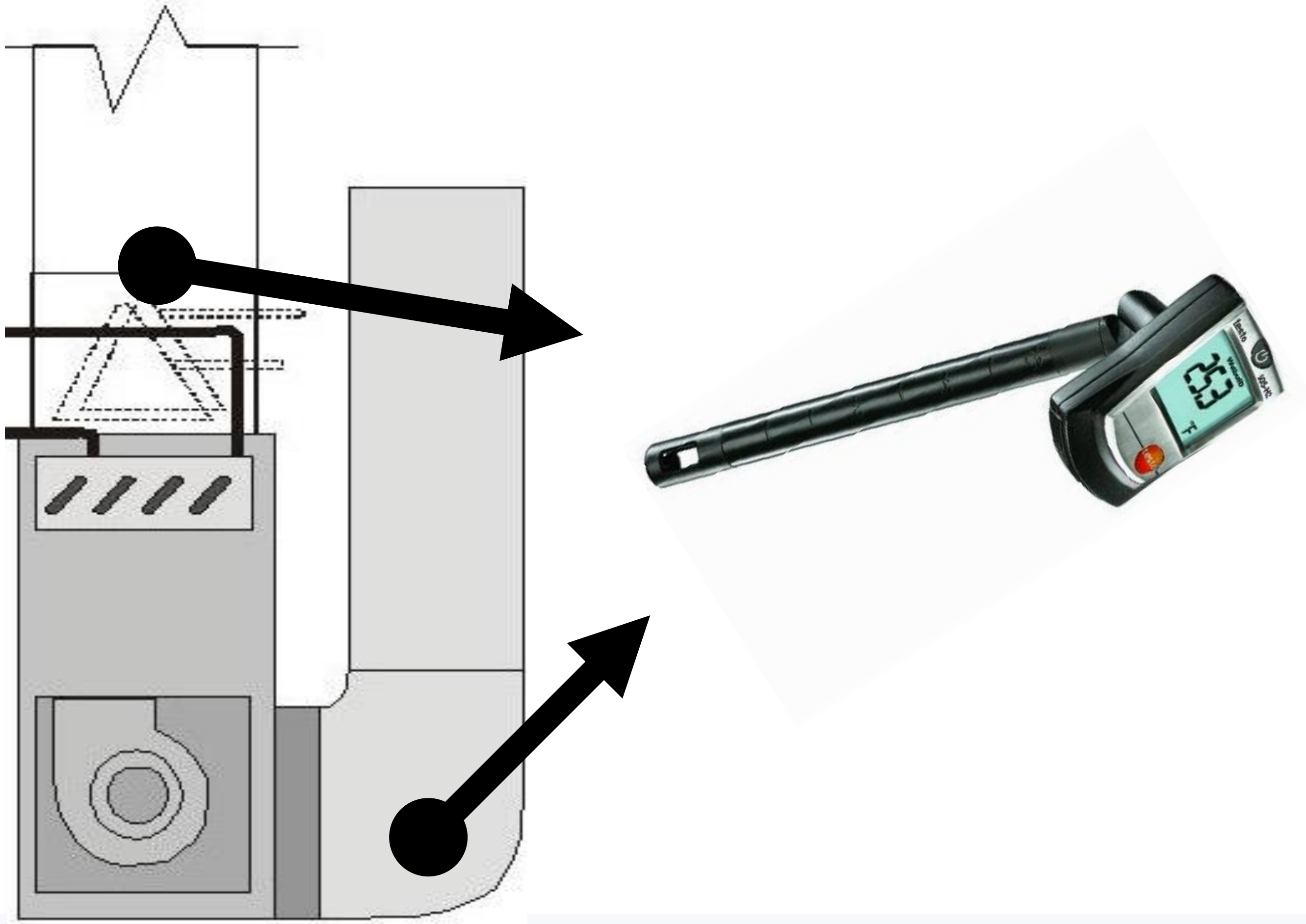
Testing for performance - 1) Flow at the air handler

2) Air flow at grilles or registers

3) Pressures at the air handler



4) Temperature rise / fall across the air handler



5) Refrigerate Verification

EPA's Indoor air PLUS Program

An excellent opportunity for builders & HVAC contractors

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

look for EPA Indoor airPLUS QUALIFIED HOMES

ENERGY STAR

EEBA

Valuable Resources

ENERGY STAR

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

ENERGY STAR

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]	☐	☐	-

EEBA

Lets think about water heating

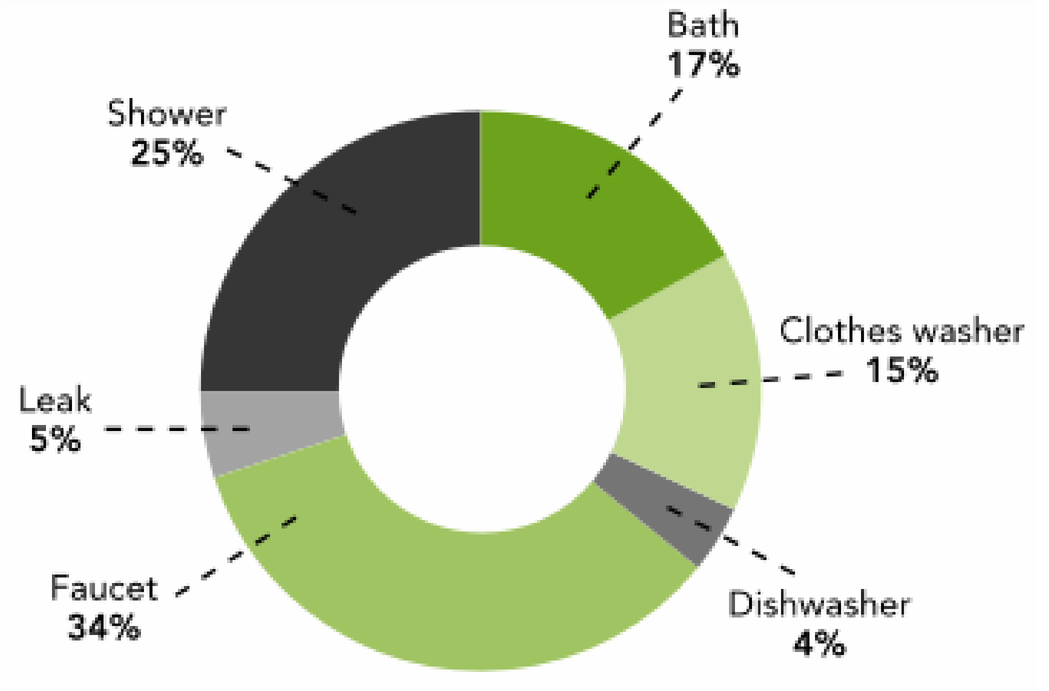
5 key tests


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

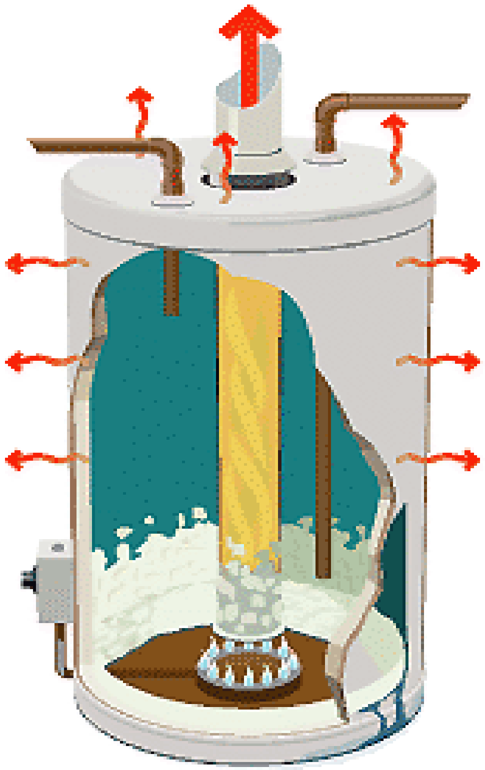


Source: Canadian Building Energy End-Use Data and Analysis Centre

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?



Traditional Tank
EF < 0.60

Tankless = +0.80

Condensing
water heater =0.86

Domestic Hot Water

The new large load in high performance homes

- Hot Water Use: pretty consistent load regardless of house size
- Tied with space heating as the 2nd largest load in a Net Zero ready homes
- Wide variety of options

150 years

Domestic Hot Water

Sealed combustion is a must

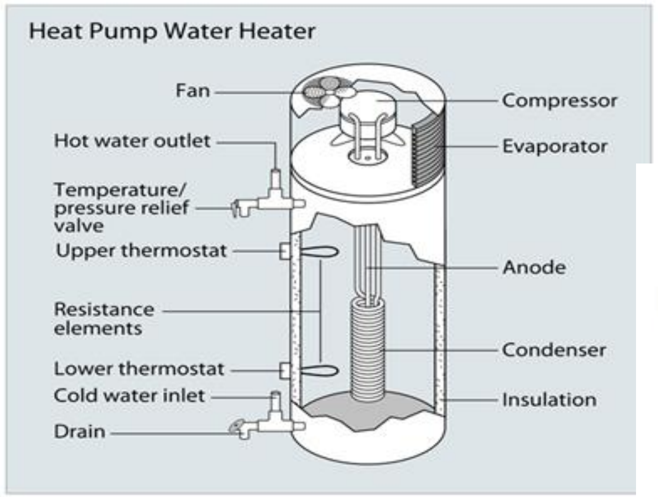
- No conditioned air loss
- Minimal off-cycle losses
- Potential for significant efficiency improvement when no use of conditioned space included
- Uses two pipe system or coaxial venting
- No spillage issues
- Non-fan-assisted sealed water heaters have much lower efficiencies than fan-equipped models

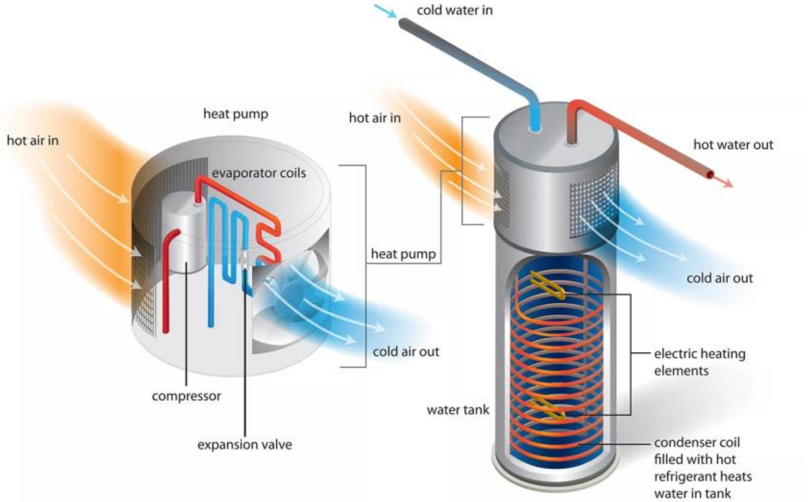
EEBA

Domestic Hot Water

Air Source Heat Pump Water Heaters

- Packaged or split condensing units
- Recovery rate boosted with electrical Hybrid OR with DWHR
- Rejection of cool air into utility rooms? (free cooling)
- Noise concerns?
- Unit height (5’ to 6’+)
- COP 2.0 to 2.5+
- Geothermal htg/cooling with DHW DE-SUPER HEATER storage tank





Domestic Hot Water: Optimizing Performance

Drain Water Heat Recovery

- Installation as per CSA Standard
- Unit Size
- Efficiency Rating
- 1 or 2 showers?
- Model Properly (New inputs for DWHR in HOT2000 v11)

Domestic Hot Water: Optimizing Performance

Optimized Plumbing System Design

Good Design =
Energy Savings =
Occupant Satisfaction

- The water/energy matrix is key
- Right sizing PIPE
- Plumbing design prepared ahead of time
- Re-circulation pump

Vol. in Pipe (OZ)	*Min. time-to-tap (secs) at selected flow rates*					
	0.25 gpm	*0.5 gpm*	*1.0 gpm*	*1.5 gpm*	*2.0 gpm*	*2.5 gpm*
24	45	23	11	8	6	5
64	120	60	30	20	15	12
75	141	70	35	23	18	14
300	563	281	141	94	70	56

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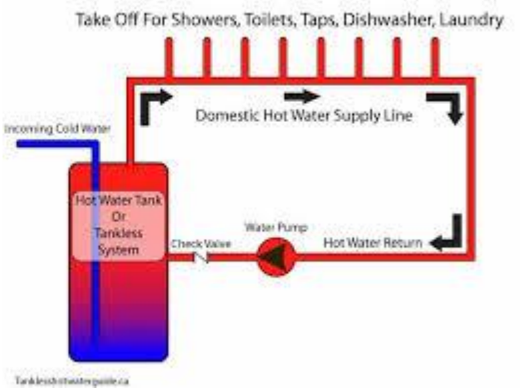
Domestic Hot Water: Optimizing Performance

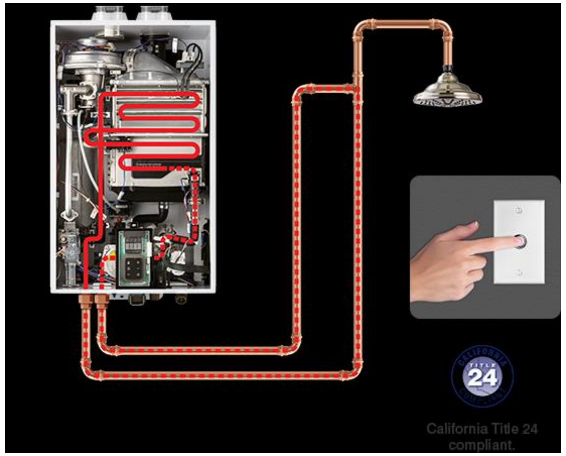
Domestic Hot Water Re-circulation Pump

Table 1. Water and Energy Savings in Existing Homes

Number of Hot Water Use Points	Daily Water Savings (Gal)	Annual Water Savings (Gal)	Annual Energy Savings (kWh)
1	2.5–8.2	900–3,000	200–400
4	10–32.8	3,600–12,000	800–1,600

Courtesy Oakridge National Laboratories: Gary Klein





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