Workshop Description and Outline:

Title: “High Performance HVAC”

Brief highlights of the presentation:
Recent changes in the International Energy Conservation Code 2012 and in energy efficiency and green building programs such as ENERGY STAR for Homes strongly encourage high performance HVAC best practices. We will discuss the changing requirements and how that will change the way you design, install and test HVAC systems. This seminar will help HVAC contractors identify and implement proven techniques and products that would make homes more energy efficient and incorporate green building elements through a high performance residential HVAC system.

An important element of the workshop will be to introduce the EPA Energy Star HVAC Quality Installation Program.

Relevance to Attendees:
The workshop could be targeted to at least the following groups:
- New home builders and remodelers, their site supervision staff, estimators and contract managers
- Designers and architects
- HVAC contractors
- Building Code Officials
- Utility and housing program officials who promote energy efficiency programs
- Designers and architects

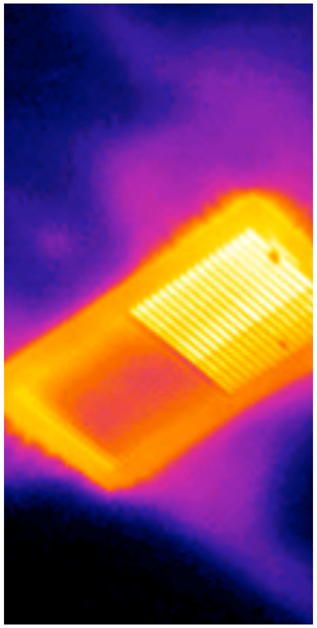
Learning Objectives:
- Learn about the challenges and opportunities presented by new building codes and energy efficient programs
- Identify High Performance HVAC concepts
- Learn essential strategies for High Performance HVAC systems
- Learn about the Energy Star HVAC Quality Installation Program
- Know where to go for additional resources and support

Workshop Format:
Length of presentation: The workshop is designed for a 90 minute format
Overview of presentation structure: The facilitator will use presentation software that will rely heavily on the use of graphics and pictures to tell the story.

Workshop General Agenda:

10 Min.	Introductions and Overview
20 Min.	Key HVAC Design Concepts
20 Min.	Key HVAC Installation and Testing Concepts
10 Min.	Implementing High Performance HVAC strategies
20 Min.	Review Energy Star HVAC Quality Installation Program
10 Min.	Summary and Wrap-up

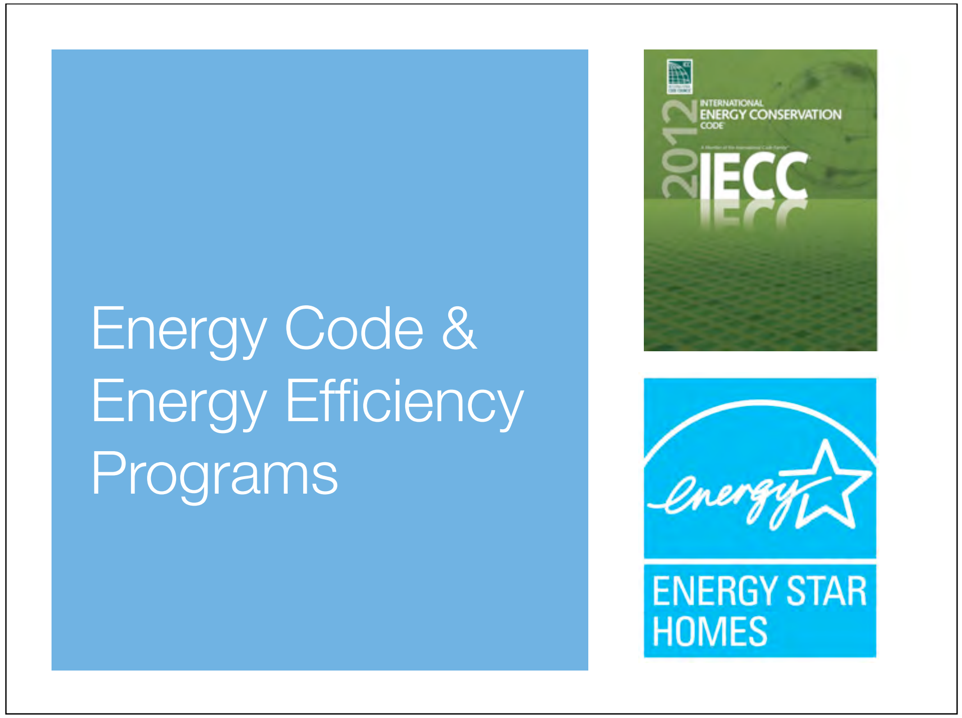
High Performance HVAC



BUILDING KNOWLEDGE

We are a leading training and consulting firm that uses a building science based systems approach to help our clients improve their businesses by Building Better Homes™.

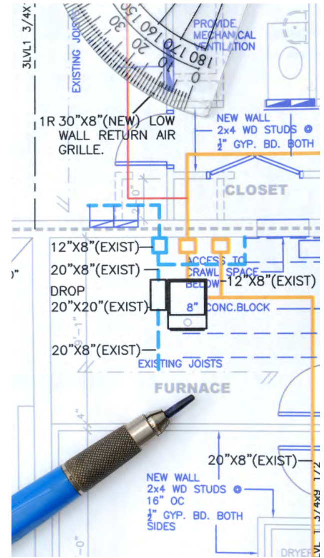
We serve as a resource for the nation's leading energy efficient and green certification programs providing technical, marketing and verification support to developers, builders, contractors, architects and industry professionals.



Overview of today's session:

We will review the IECC code and Energy Programs like Energy Star for Homes

High Performance HVAC Design



High performance home building and remodeling requires a different approach than the traditional, established way of building. Building a high performance home must be a systematic approach and done as a team. The project must be looked at as a system, in which each component is connected to and depends on the other components. Teamwork is required to make it all come together. Addressing and optimizing key factors up front with the whole team will result in a smoother construction process, lower costs and a much better home.

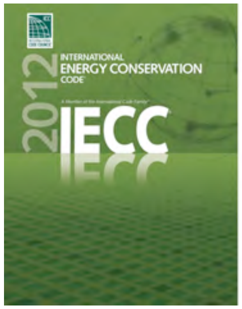
High Performance HVAC Installation and Testing

Based on our experience with certification programs we will review the key best practices for HVAC installations and the available performance tests

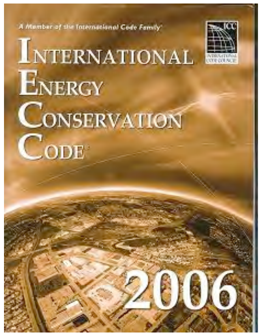
We will discuss strategies for improving you business through High Performance HVAC

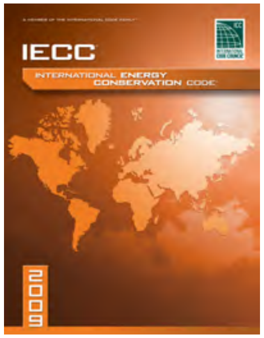
Finally we will review the Energy Star HVAC Quality Installation Program

Energy Code & Energy Efficiency Programs

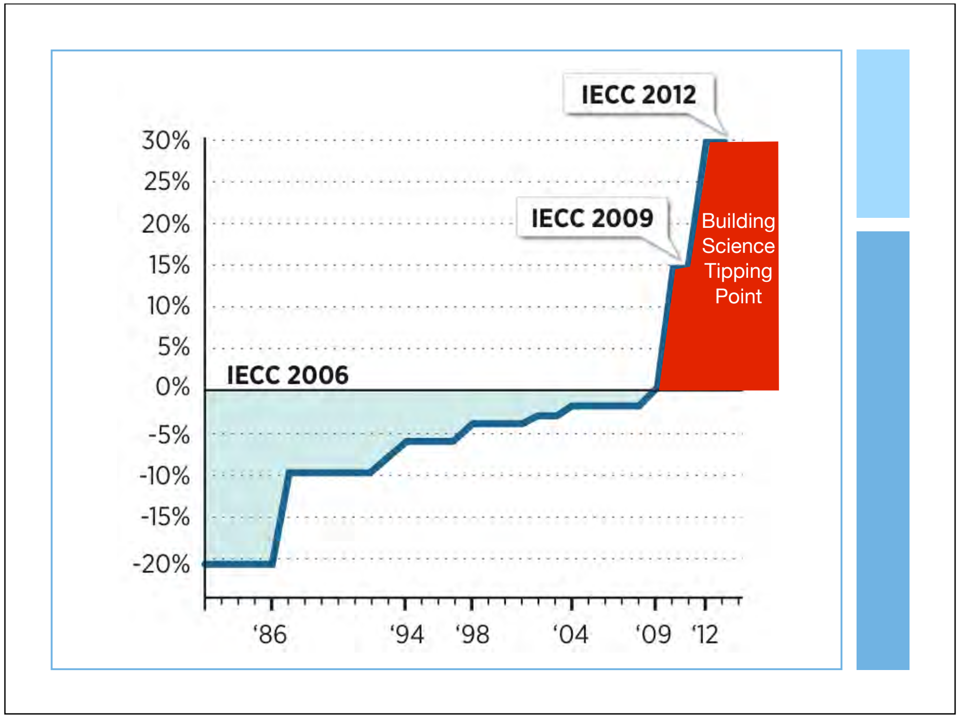


ENERGY STAR HOMES

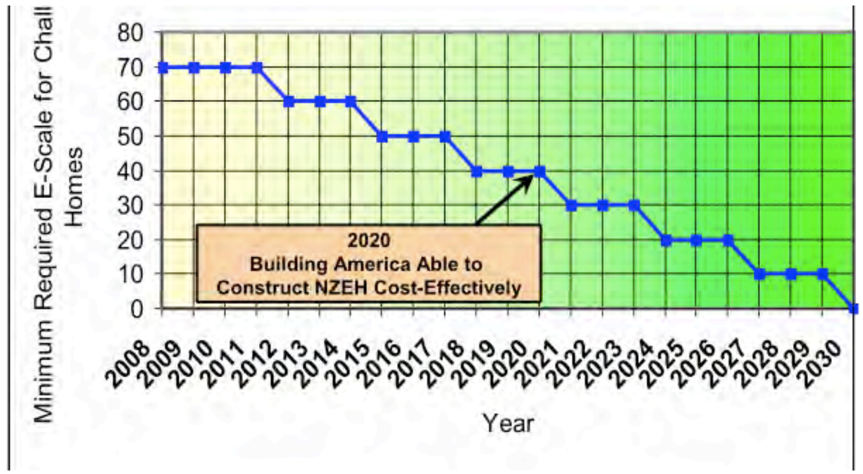

INTERNATIONAL
ENERGY
CONSERVATION
CODE
2006


IECC
INTERNATIONAL ENERGY
CONSERVATION CODE
2009

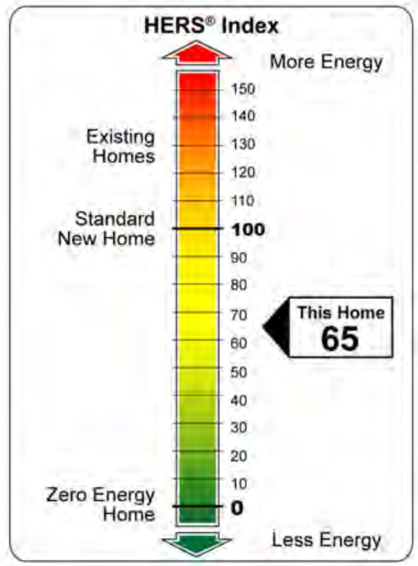

INTERNATIONAL
ENERGY CONSERVATION
CODE
2012
IECC



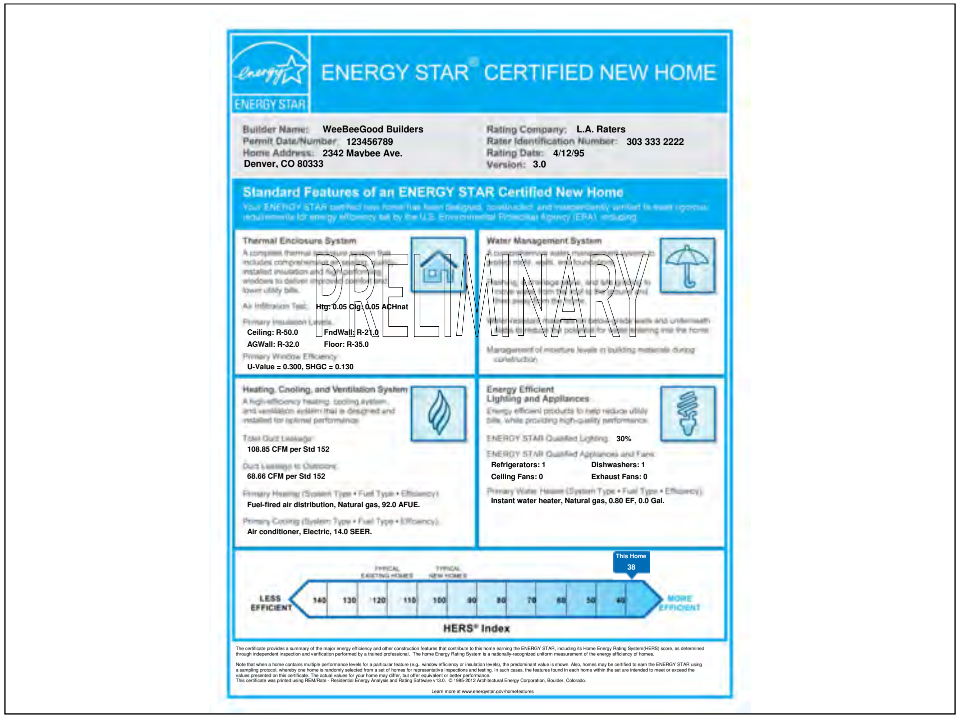
Building Science Tipping Point –
Can't dry out if they get wet
Can't assure adequate IAQ
Greater combustion safety risks



Where are we headed?



HERS Index – Now included as a field in the MLS listings (as well as Green Certified field), allowing us to track the sales prices and length of time on market for energy efficient homes



Energy Star Label for homes

Exclusive. DOE Challenge Home requirements are so rigorous, homebuyers can feel great knowing they chose a home offered only by a select group of leading edge builders.

Tech-Savvy. Starting with comprehensive building science requirements from ENERGY STAR® for Homes, all DOE Challenge Homes include the most effective and proven innovations developed under Building America's world-class research program.

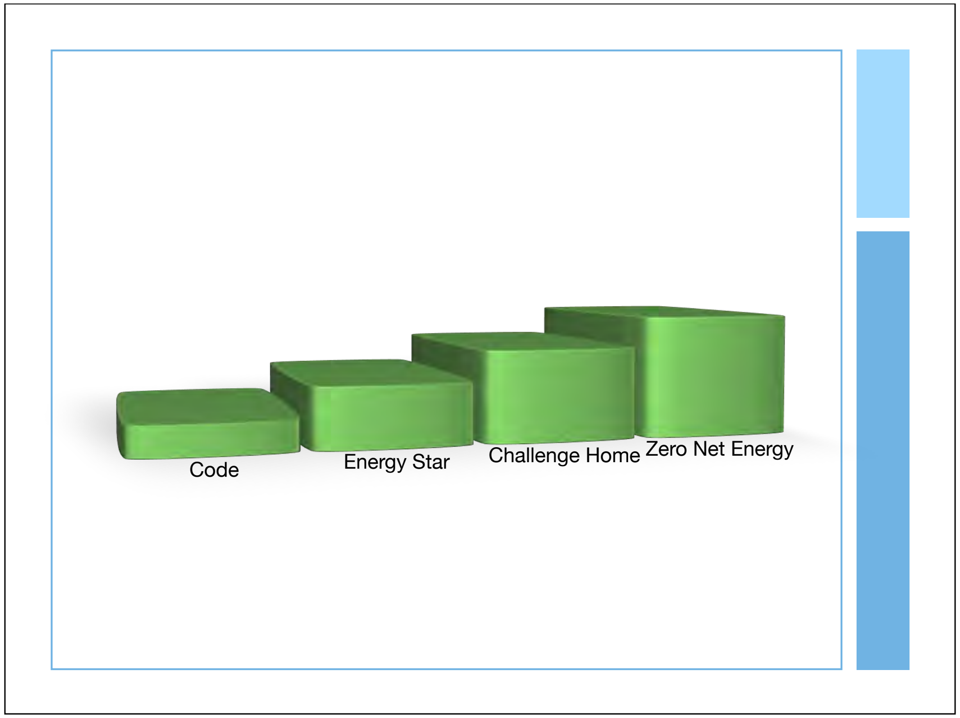
Advanced. All DOE Challenge Homes are constructed to meet forthcoming code requirements to lock in future value. It's great peace-of-mind knowing the largest investment of a lifetime won't be obsolete in a few years.

Challenge Home Builder featured in this Fall Parade and in the Spring Preview

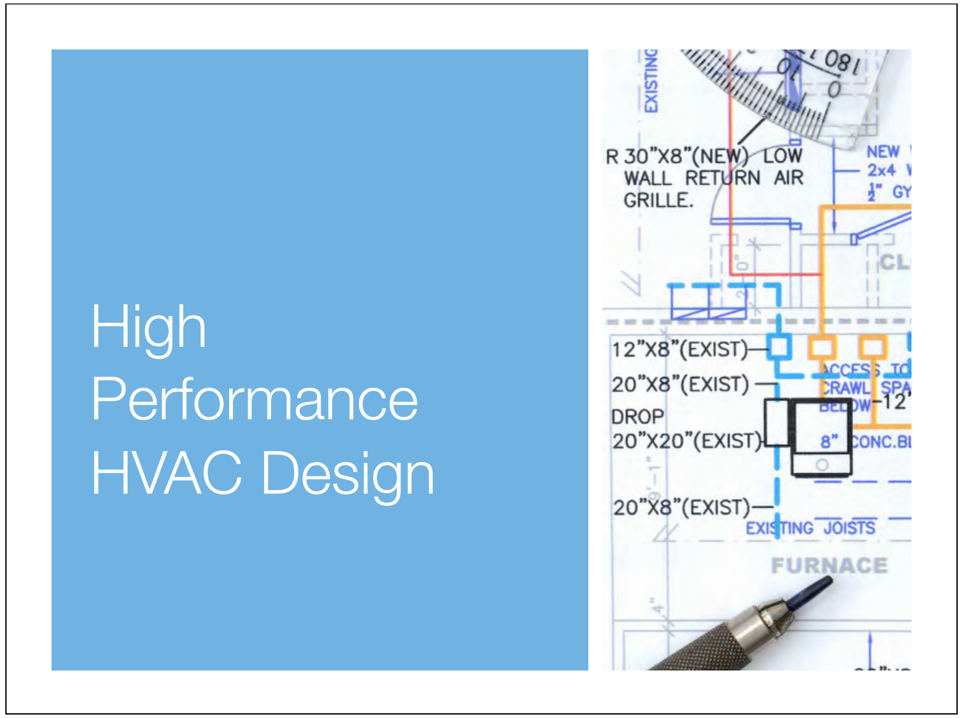
$2000 per home

2013
Energy
Tax Credit

Program Certification



Home Performance Stair Step



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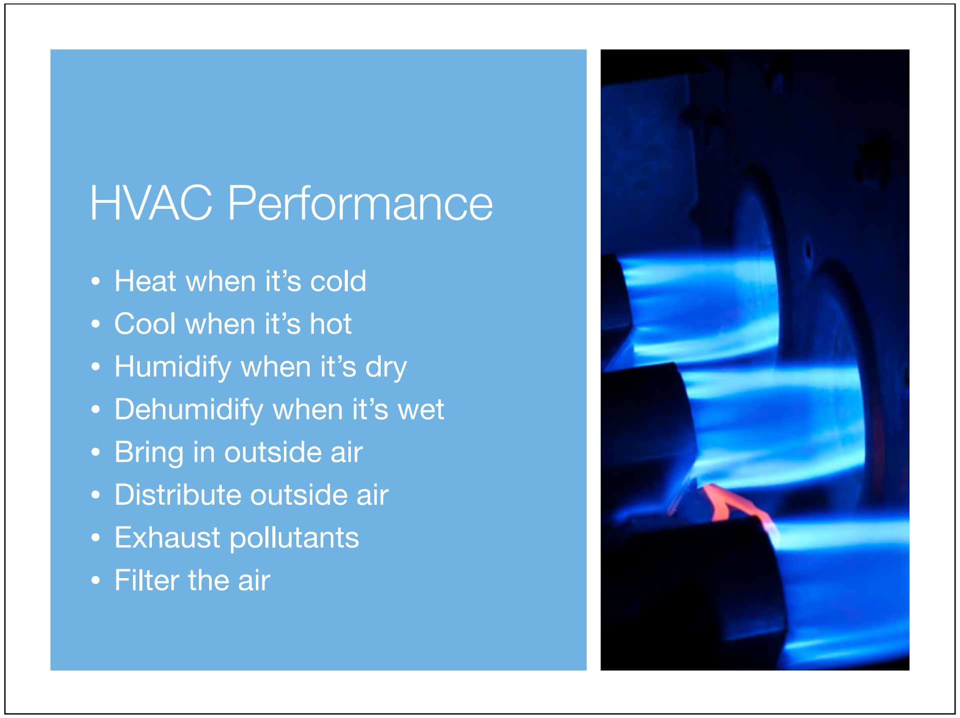
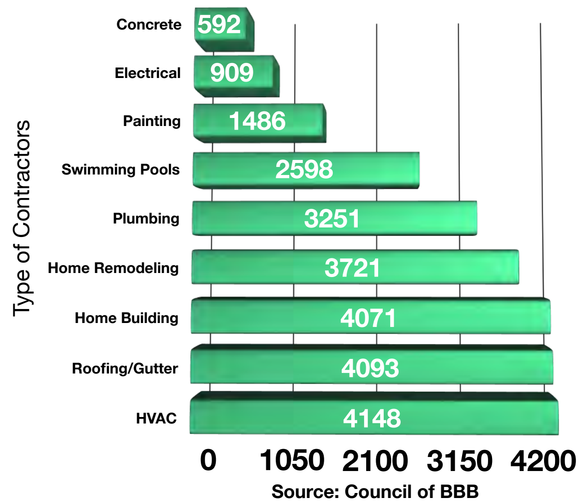
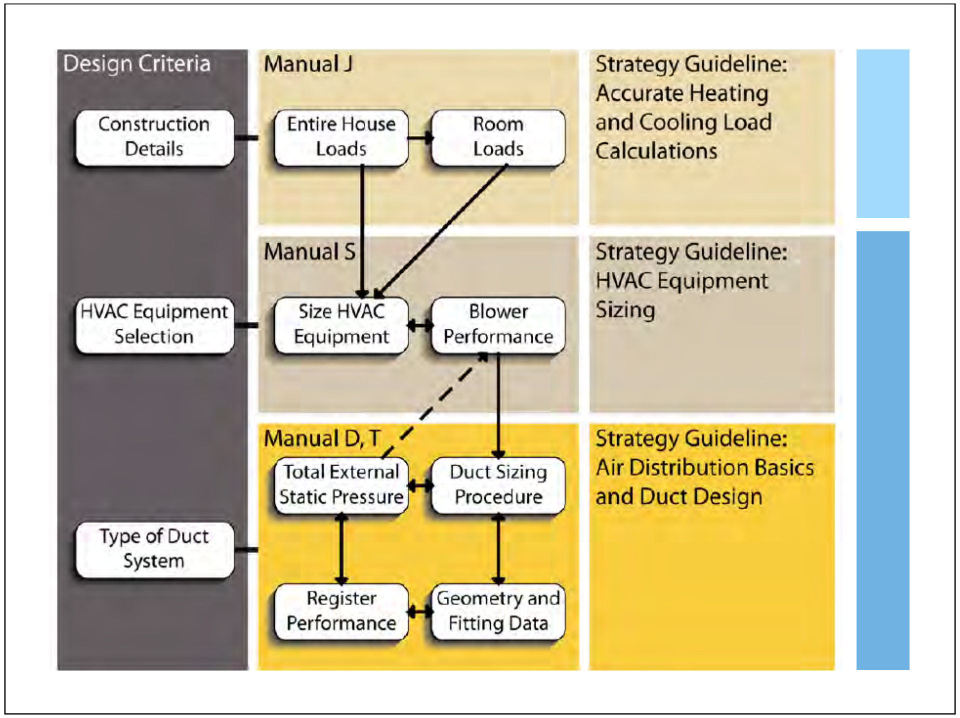


What we require from our HVAC systems

Building-Related Complaints



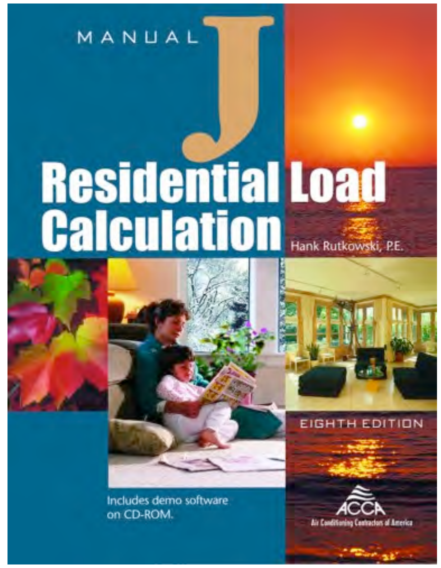
- 60-80% of defect litigation cases are stimulated by failures of the building envelope. (Builder Magazine)
- $9 billion is spent annually on construction defects. (ASHRAE) Water leakage is the #1 consequence of construction defects.
- The average callback costs contractors between $500-$1,500 per home.



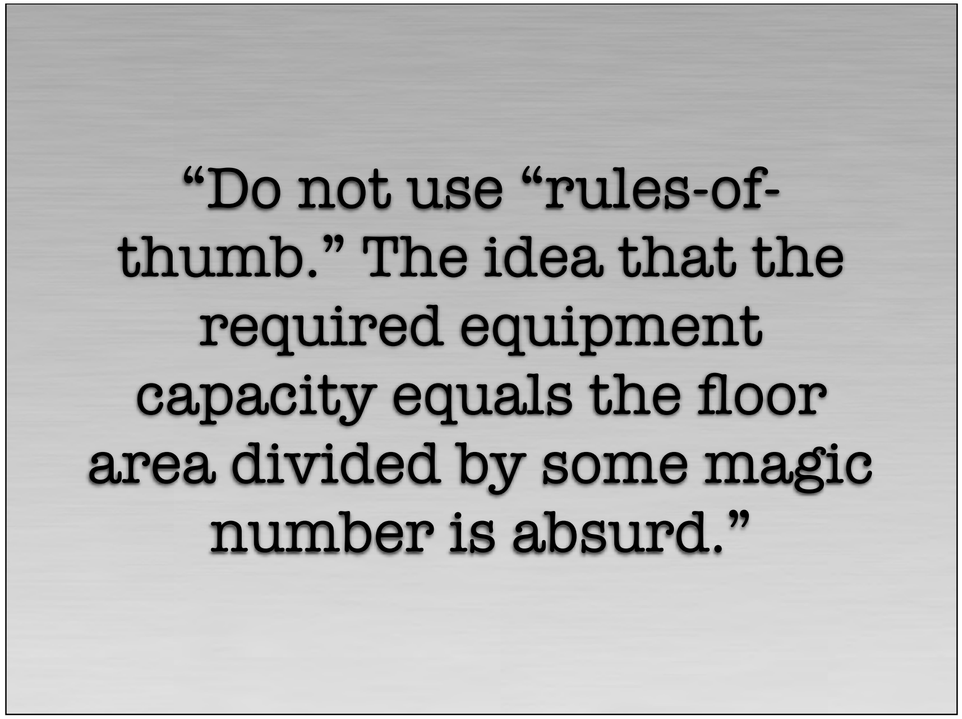
Design Criteria
Construction Details
HVAC Equipment Selection
Type of Duct System
Manual J
Entire House Loads
Room Loads
Manual S
Size HVAC Equipment
Blower Performance
Manual D, T
Total External Static Pressure
Duct Sizing Procedure
Register Performance
Geometry and Fitting Data
Strategy Guideline: Accurate Heating and Cooling Load Calculations
Strategy Guideline: HVAC Equipment Sizing
Strategy Guideline: Air Distribution Basics and Duct Design

Load sizing

Garbage-in, Garbage-out



Check a home’s approximate heating and cooling load and select equipment that match a buildings heating and cooling load



HVAC System Criteria: Do's and Don'ts for Manual J calcs

Do not use "rules-of-thumb." The idea that the required equipment capacity equals the floor area divided by some magic number is absurd.

"Efforts to adjust the load
to provide a "safety factor"
or to produce a solution
that is compatible with the
"I have been doing it this
way for 30 years"
syndrome are forbidden."

HVAC System Criteria: ACCA Do's and Don'ts for Manual J calcs

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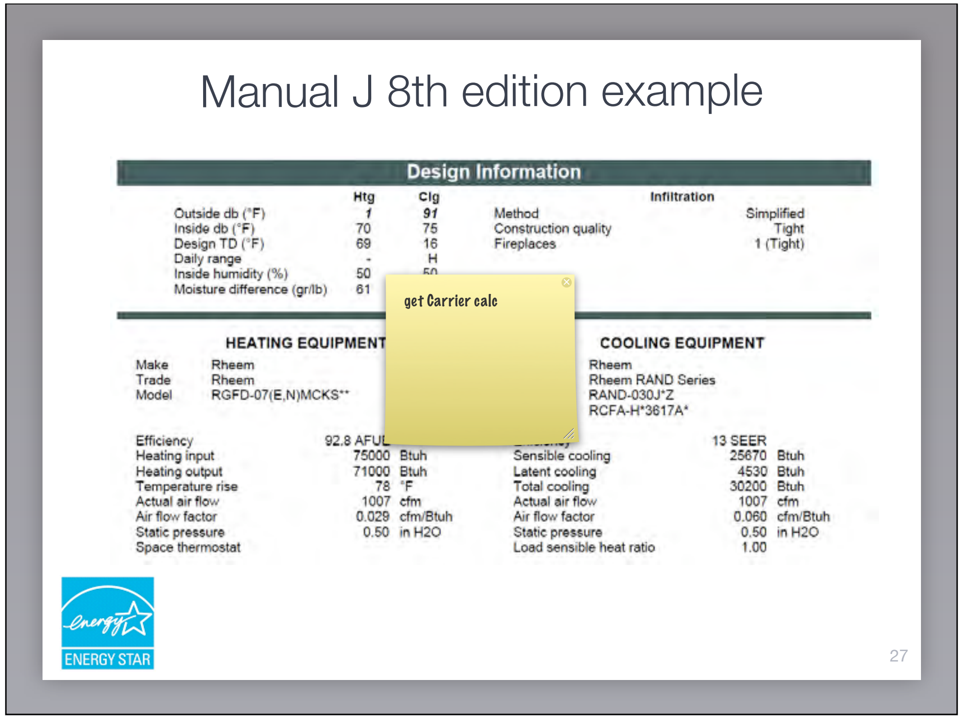


Design Information

	Htg	Clg
Outside db (°F)	*1*	*91*
Inside db (°F)	70	75
Design TD (°F)	69	16
Daily range	-	H
Inside humidity (%)	50	50
Moisture difference (gr/lb)	61	

Infiltration	
Method	Simplified
Construction quality	Tight
Fireplaces	1 (Tight)

HEATING EQUIPMENT

Make	Rheem	
Trade	Rheem	
Model	RGFD-07(E,N)MCKS**	
Efficiency	92.8 AFU	
Heating input	75000	Btuh
Heating output	71000	Btuh
Temperature rise	78	°F
Actual air flow	1007	cfm
Air flow factor	0.029	cfm/Btuh
Static pressure	0.50	in H2O
Space thermostat		

COOLING EQUIPMENT

	Rheem	
	Rheem RAND Series	
	RAND-030J*Z	
	RCFA-H*3617A*	
	13 SEER	
Sensible cooling	25670	Btuh
Latent cooling	4530	Btuh
Total cooling	30200	Btuh
Actual air flow	1007	cfm
Air flow factor	0.060	cfm/Btuh
Static pressure	0.50	in H2O
Load sensible heat ratio	1.00	

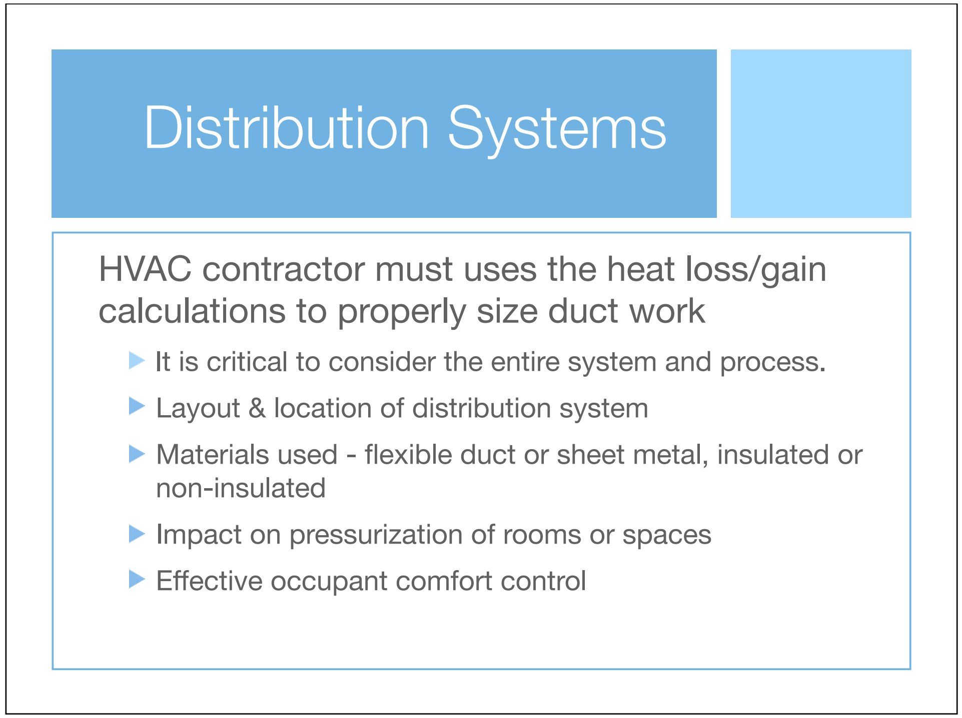
HVAC System Criteria:

Use ACCA Manual J, ASHRAE Handbook of fundamentals to determine heating and cooling loads. This is a sample Manual J report.

Accurately size ducts to match required air flow of a room and the fan's capacity

67 percent of homes in the U.S. have a room that’s too hot in the summer or too cold in the winter.
The kids room is freezing!!!!

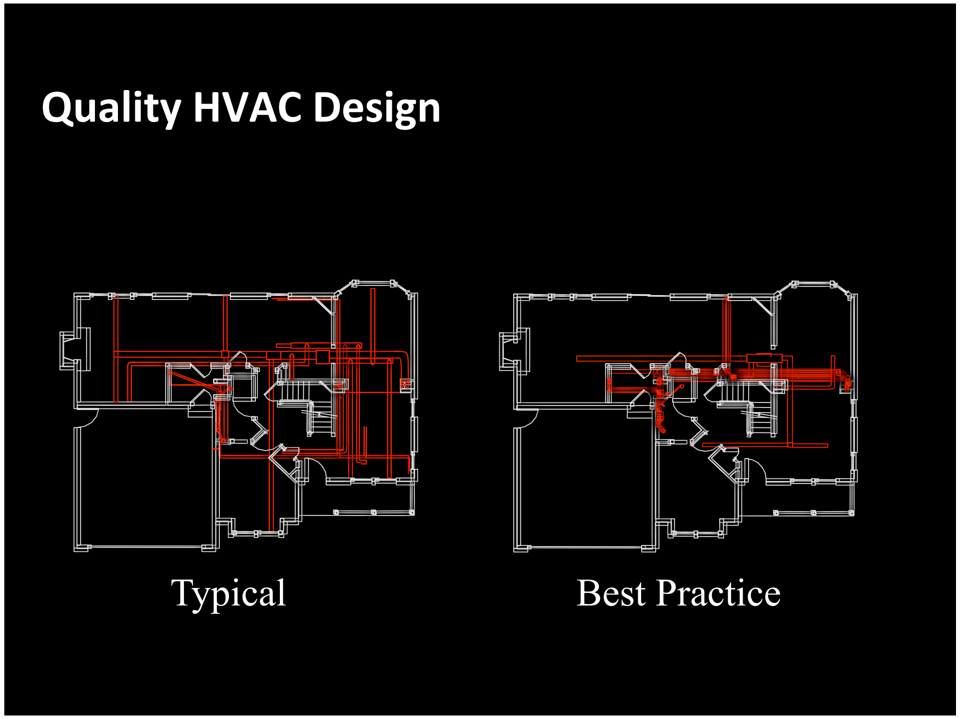
"Research clearly demonstrates that duct system efficiency/ effectiveness is the single biggest issue as far as energy use is concerned (as well as health and comfort!)"



Air Distribution Systems:

HVAC contractor must uses the heat loss/gain calculations to properly size duct work

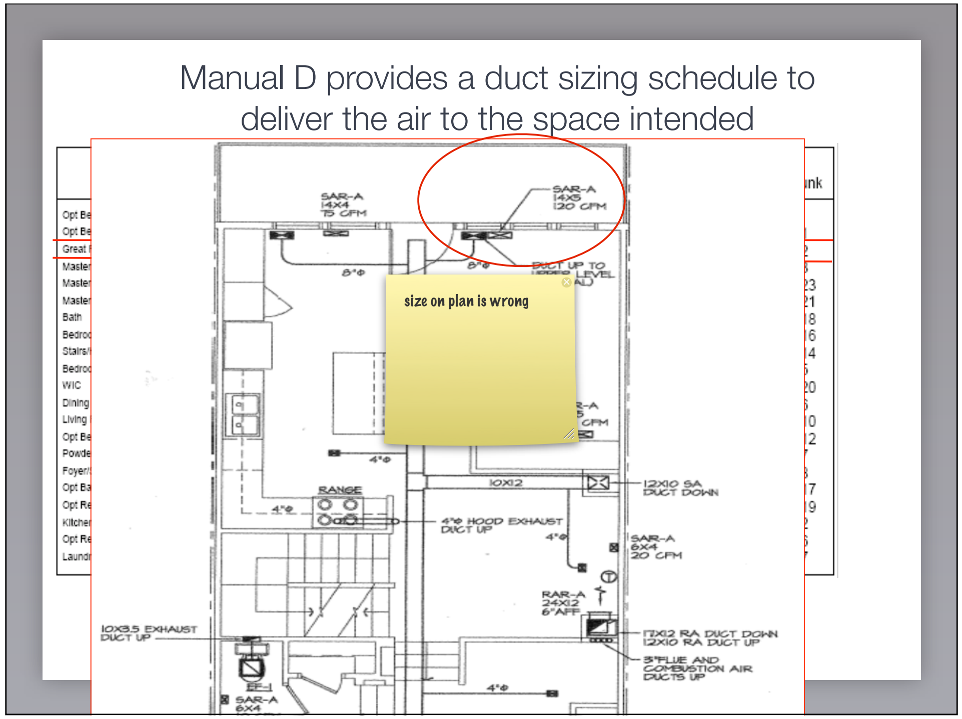
- *It is critical to consider the entire system and process.*
- *Layout & location of distribution system*
- *Materials used - flexible duct or sheet metal, insulated or non-insulated*
- *Impact on pressurization of rooms or spaces*
- *Effective occupant comfort control*



Air Distribution Systems:

Properly sized system with optimized duct layout

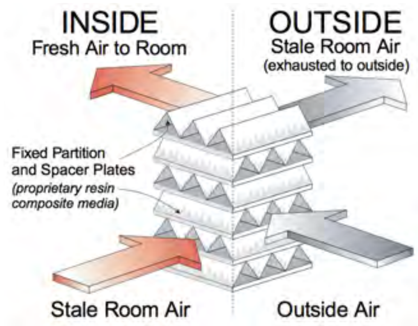
Note reduction of materials and compactness of system

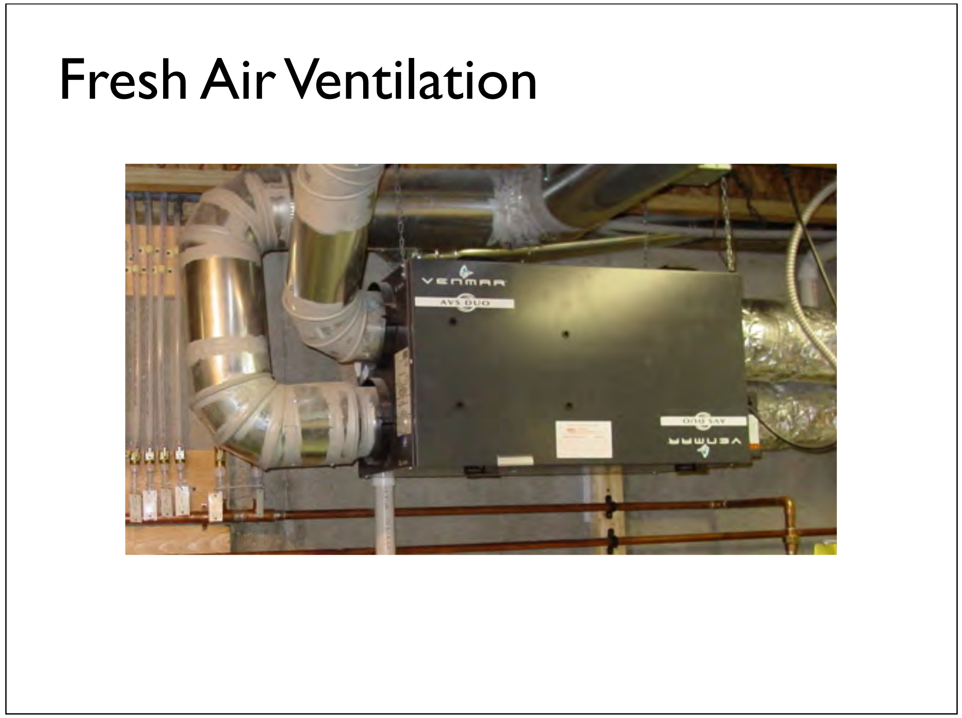


Air Distribution Systems:

Ducts sized and installed in accordance with room-by-room loads calculations for sizing ductwork using ACCA Manual D.

Mechanical Ventilation





Fresh Air Ventilation:

Homes with insufficient outdoor air have problems with humidity, odors and pollutants that can lead to discomfort and increased health risks. Designed ventilation systems help reduce occupants' exposure to indoor pollutants and improve comfort.

ASHRAE 62.2

Conditioned floor area	Bedrooms				
	0, 1	2, 3	4, 5	6, 7	> 7
<= 1,500	30	45	60	75	90
1,501 - 3,000	45	60	75	90	105
3,001 - 4,500	60	75	90	105	120
4,501 - 6,000	75	90	105	120	135
6,001 - 7,500	90	105	120	135	150
> 7,500	105	120	135	150	165

Outdoor Air Ventilation:
2013 version does not allow for infiltration in calculation.

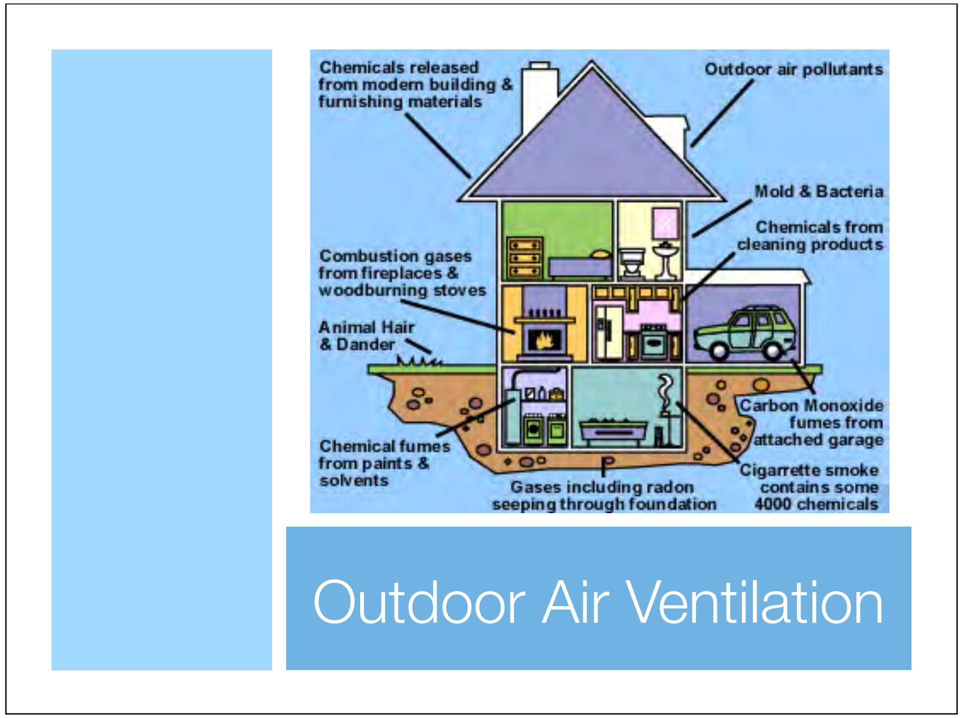
Minimum air flow requirements for continuos ventilation systems, in cfm
Note for typical homes we are only talking about 75 cfm or less

MN Code

Conditioned floor area	Bedrooms [Total/Continuous Ventilation]					
	1	2	3	4	5	6
<= 1,500	60/40	75/40	90/45	105/53	120/60	135/68
1,501-2,000	70/40	85/43	100/50	115/58	130/65	145/73
2,001-2,500	80/40	95/48	110/55	125/63	140/70	155/78
2,501-3,000	90/45	105/53	120/60	135/68	150/75	165/83
3,001-3,500	100/50	115/58	130/65	145/73	160/80	175/88
3,500-4000	110/55	125/63	140/70	155/78	170/85	185/93

Outdoor Air Ventilation:
Minnesota State Energy Code Minimum air flow requirements for Total & Continuous ventilation systems, in cfm

Note the continuos ventilation rate for typical homes is less than 75 cfm



Outdoor Air Ventilation:

This is compounded by changes in lifestyle - people today spend more times indoors with windows and doors closed - and increased awareness of the risks associated with poor indoor air quality

“ACCA has found that code fresh air requirements (such as 0.35 ACH) are being incorrectly used as default infiltration rates without considering the actual tightness of the construction.”

Differentiate in your load calcs between fresh air and infiltration

"Exhaust only ventilation = asking your building to be the filter"

Joe Lstibuerk 2013 Summer Camp

Based on our experience with certification programs we will review the key best practices for HVAC installations and the available performance tests

Duct Installation

"Poor installation practices common with HVAC system installations across the country can decrease rated efficiency levels up to 35 percent or more."

HVAC System Criteria:

Poor installation practices common with HVAC system installations across the county can decrease rated efficiency levels up to 35 percent or more.

Key quality installation practices include proper duct design, terminal design, air flow, pressure balancing, and refrigerant charge.

Chris Nieme, John Proctor, and Steven Nadel, "Energy Savings from Addressing Residential Air Conditioner and Heat Pump Installation Problems," ACEEE, February 1999

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Introduction:

Proper installation is key - The best equipment cannot overcome poor installation practices

Air Distribution System:

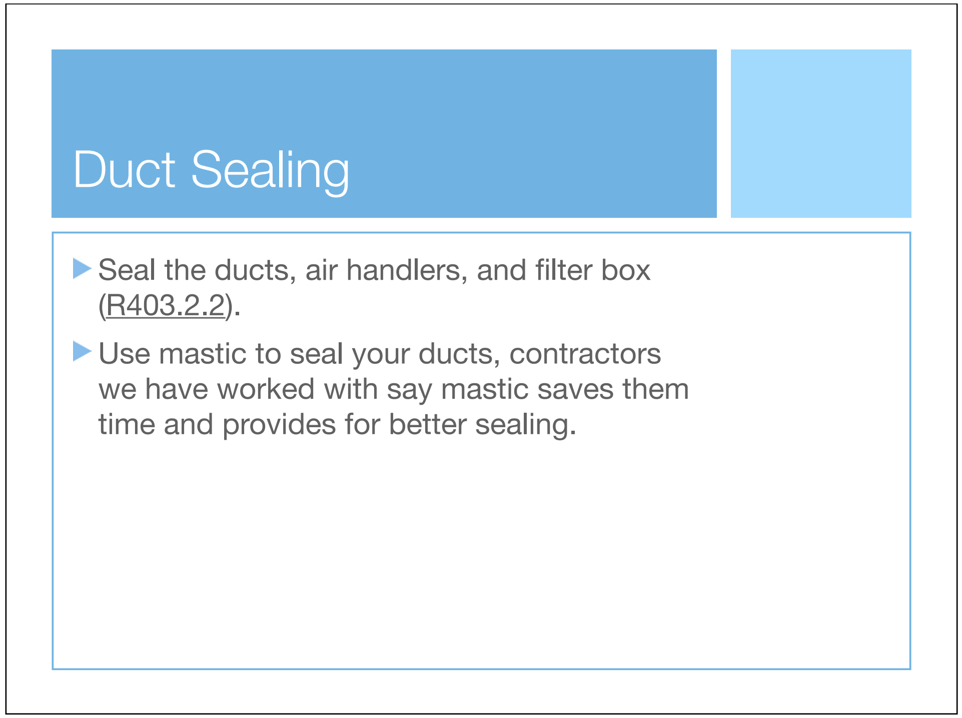
Poorly planned and installed duct work

Air Distribution System:

Poorly planned and installed duct work

Air Distribution System:

Poorly planned and installed duct work



Reemphasize this slide from the previous section on the code

Mastic should be applied "nickel thick"

Images are repeated from code section for emphasis

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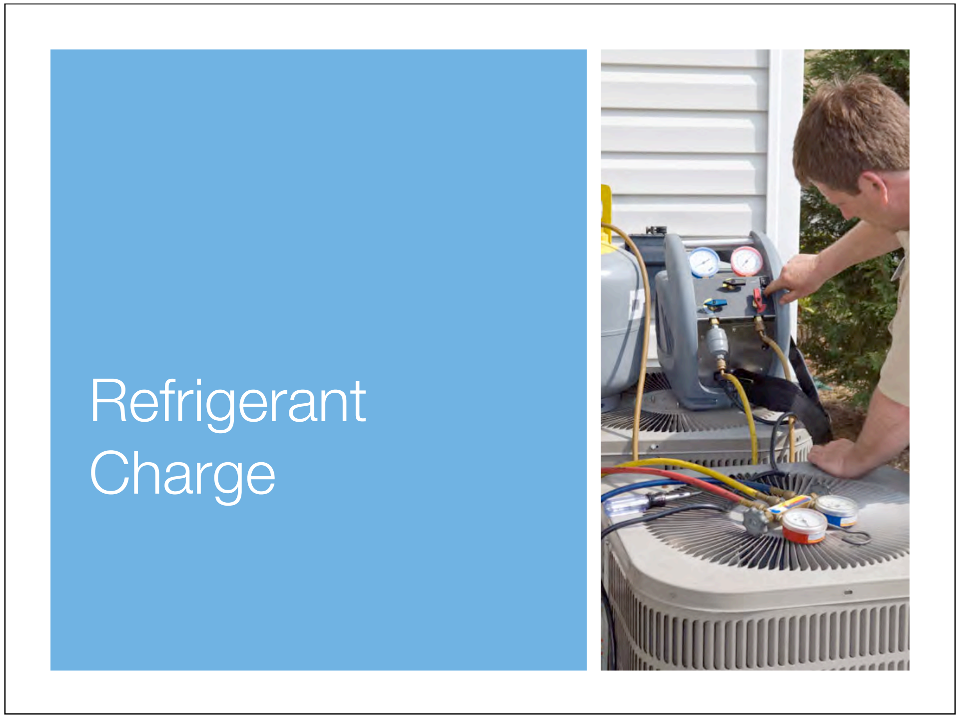
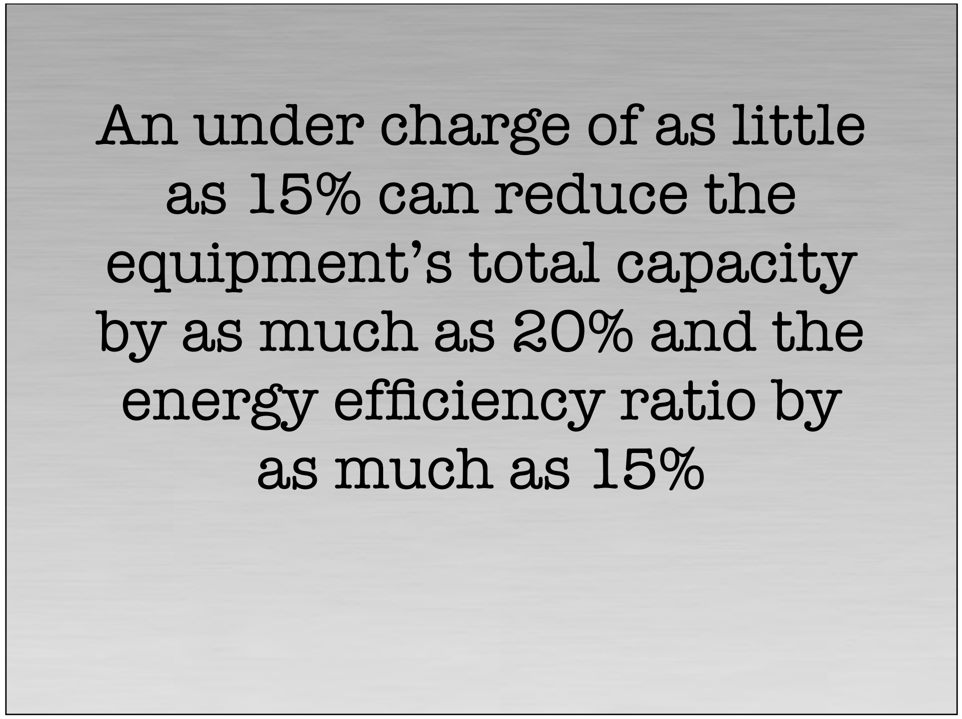


Refrigerant Management:
Both undercharge and overcharge can reduce cooling equipment longevity, capacity and efficiency

Refrigerant Management:

Story of AC tech not using gauges for refrigerant charge and relying on the charge to be beer can cold to tell him when it was charged sufficiently.



Refrigerant Management:
An under charge of as little as 15% can reduce the equipment's total capacity by as much as 20% and the energy efficiency ratio by as much as 15%

Performance Verification

Air leakage testing- blower door

A Blower Door test can be used to quantify air leakage and potential air quality, durability & other issues.

How do we typically measure air flow – We hold our hand over the register, yup its blowing air!
We must be OK!

- exhaust fans
- supply and return flows based on comfort complaints

Duct leakage testing

HVAC Airflow **Address:**

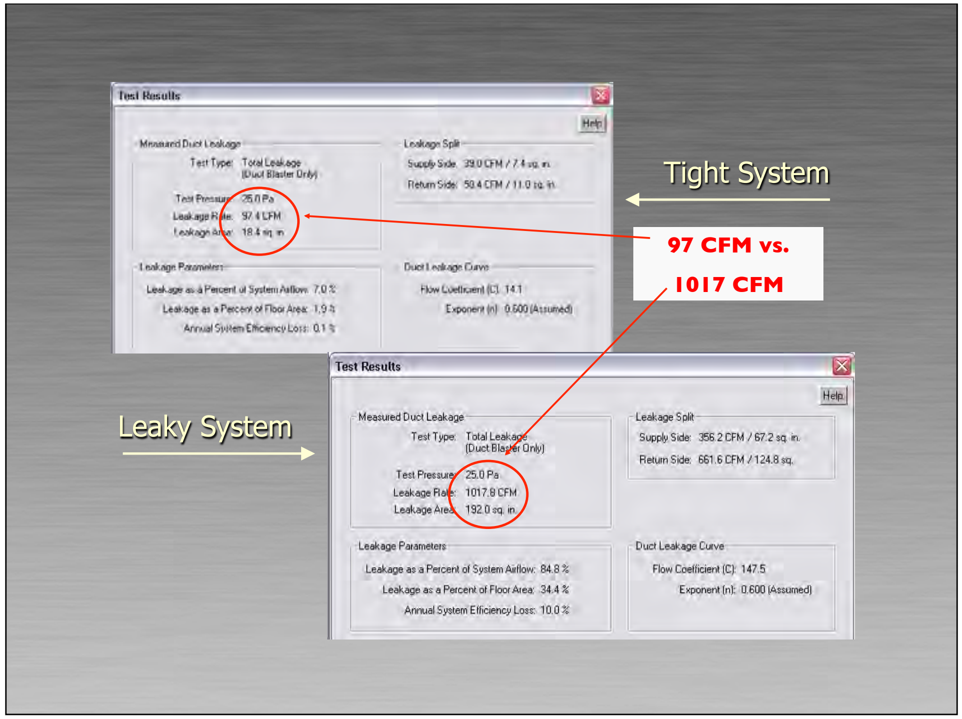
A/C Size	2.5 tons	
Design Air Handler Flow	1,000 CFM @ 400 CFM/ton	

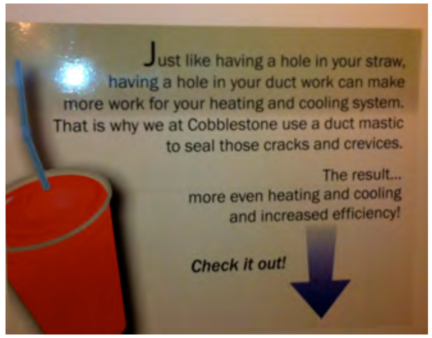
	Design		Actual		
	Branch Size	**Airflow (CFM)**	**Branch Size**	**Airflow (CFM)**	**Pressure**
Main Floor Supplies					
Living A	6"	93	6"	50	
Living B	6"	93	6"	47	
Living C	6"	93	6"	42	
Family/Den A	6"	92	6"	37	
Family/Den B	6"	92	6"	46	
Master BR A	6"	85	6"	66	+4.5 pa
Master BR B	6"	85	6"	68	
Master Closet	4"	40	6"	85	
Master Bath	5"	65	6"	79	
BR #2	6"	95	6"	65	+0.4 pa
BR #3	6"	95	6"	79	+1.2 pa
Main Bath	5"	62	6"	77	
Total Supply Flow:		**990**		**741**	
Returns					
Living		175		110	
Family/Den		175		102	

Performance Testing:

Sample report of measured duct air flow compared to design

Note the differences in the Powder Room and Family Room


Tight System
97 CFM vs.
1017 CFM
Leaky System
Test Results
Help
Measured Duct Leakage
Test Type: Total Leakage (Duct Blaster Only)
Test Pressure: 25.0 Pa
Leakage Rate: 97.4 CFM
Leakage Area: 18.4 sq. in.
Leakage Split
Supply Side: 39.0 CFM / 7.4 sq. in.
Return Side: 58.4 CFM / 11.0 sq. in.
Leakage Parameters
Leakage as a Percent of System Airflow: 7.0 %
Leakage as a Percent of Floor Area: 1.9 %
Annual System Efficiency Loss: 0.1 %
Duct Leakage Curve
Flow Coefficient (C): 14.1
Exponent (n): 0.600 (Assumed)
Test Results
Help
Measured Duct Leakage
Test Type: Total Leakage (Duct Blaster Only)
Test Pressure: 25.0 Pa
Leakage Rate: 1017.9 CFM
Leakage Area: 192.0 sq. in.
Leakage Split
Supply Side: 356.2 CFM / 67.2 sq. in.
Return Side: 661.6 CFM / 124.8 sq.
Leakage Parameters
Leakage as a Percent of System Airflow: 84.8 %
Leakage as a Percent of Floor Area: 34.4 %
Annual System Efficiency Loss: 10.0 %
Duct Leakage Curve
Flow Coefficient (C): 147.5
Exponent (n): 0.600 (Assumed)



Hole in a straw

Have you ever sucked on a straw that had a hole in it?

Implementing High Performance HVAC Strategies

Education

- Hands on Training
- Seminars & Workshops
- Latest Research
- Best Practices

what else do they need to do?

Create your own checklist:
Healthy:
MERV 8 filters or better

Comfort:

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

Home Address: ______________________ City: ______________ State: ______ Zip Code: ________

System Description [2] ______________________ Cooling system for temporary occupant load? [3] Yes ☐ No ☐

1. Whole-Building Mechanical Ventilation Design [4]	Builder Verified [5]	Cont. Verified [6]	N/A
1.1 Ventilation system installed that has been designed to meet ASHRAE 62.2-2010 requirements including, but not limited to, requirements in Items 1.2-1.5. [7]	☐	☐	-
1.2 Ventilation system does not utilize an intake duct to the return side of the HVAC system unless the system is designed to operate intermittently and automatically based on a timer and to restrict outdoor air intake when not in use (e.g., motorized damper).	☐	☐	-
1.3 Documentation is attached with ventilation system type, location, design rate, and frequency and duration of each ventilation cycle.	☐	☐	-
1.4 If present, continuously-operating vent. & exhaust fans designed to operate during all occupiable hours.	☐	☐	☐
1.5 If present, intermittently-operating whole-house ventilation system designed to automatically operate at least once per day and at least 10% of every 24 hours.	☐	☐	☐
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]	☐	☐	-
3. Selected Cooling Equipment, If Cooling Equipment to be Installed			
3.1 Condenser Manufacturer & Model: ______________________	☐	☐	☐
3.2 Evaporator / Fan Coil Manufacturer & Model: ______________________	☐	☐	☐
3.3 AHRI Reference #: [16] ______________________	☐	☐	☐
3.4 Listed Efficiency: ______ EER _______ SEER	☐	☐	☐
3.5 Metering Device Type: ☐ TXV ☐ Fixed orifice ☐ Other: _____	☐	☐	☐
3.6 Refrigerant Type: ☐ R-410a ☐ Other: _____	☐	☐	☐
3.7 Fan Speed Type: [17] ☐ Fixed ☐ Variable (ECM / ICM) ☐ Other: _____	☐	☐	☐
3.8 Listed Sys. Latent Capacity at Design Cond.: [18] ______________________ BTUh	☐	☐	☐
3.9 Listed Sys. Sensible Capacity at Design Cond.: [18] ______________________ BTUh	☐	☐	☐
3.10 Listed Sys. Total Capacity at Design Cond.: [18] ______________________ BTUh	☐	☐	☐
3.11 If Listed Sys. Latent Capacity (Value 3.8) $\leq$ Design Latent Heat Gain (Value 2.12), ENERGY STAR certified dehumidifier installed	☐	☐	☐
3.12 Listed Sys. Total Capacity (Value 3.10) is 95-115% of Design Total Heat Gain (Value 2.14) or next nominal size [8, 19]	☐	☐	☐
3.13 AHRI Certificate Attached [16]	☐	☐	☐
4. Selected Heat Pump Equipment, If Heatpump to be Installed			
4.1 AHRI Listed Efficiency: _______ HSPF or Ground-Source: _______ COP	☐	☐	☐
4.2 Performance at 17°F: Capacity _______ BTUh Efficiency: ______ COP [20]	☐	☐	☐
4.3 Performance at 47°F: Capacity _______ BTUh Efficiency: ______ COP [20]	☐	☐	☐

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

5. Selected Furnace, If Furnace to be Installed	Builder Verified [5]	Cont. Verified [6]	N/A
5.1 Furnace Manufacturer & Model: ______________________________	☐	☐	☐
5.2 Listed Efficiency: ______________________ AFUE	☐	☐	☐
5.3 Listed Output Heating Capacity: ______________________ BTUh	☐	☐	☐
5.4 Listed Output Heat. Cap. (Value 5.3) is 100-140% of Design Total Heat Loss (Value 2.15) or next nominal size [8,21]	☐	☐	☐
6. Refrigerant Tests - *Run system for 15 minutes before testing* Note: If outdoor ambient temperature at the condenser is ≤ 55°F or, if known, below the manufacturer-recommended minimum operating temperature for the cooling cycle, then the system shall include a TXV, and the contractor shall mark "N/A" on the Checklist for Section 6 & 7. [22]			
6.1 Outdoor ambient temperature at condenser: ____ °F DB		☐	☐
6.2 Return-side air temperature inside duct near evaporator, during cooling mode: ____ °F WB		☐	☐
6.3 Liquid line pressure: ____ psig		☐	☐
6.4 Liquid line temperature: ____ °F DB		☐	☐
6.5 Suction line pressure: ____ psig		☐	☐
6.6 Suction line temperature: ____ °F DB		☐	☐
7. Refrigerant Calculations			
For System with Thermal Expansion Valve (TXV):			
7.1 Condenser saturation temperature: ______ °F DB (Using Value 6.3)		☐	☐
7.2 Subcooling value: ______ °F DB (Value 7.1 - Value 6.4)		☐	☐
7.3 OEM subcooling goal: ______ °F DB		☐	☐
7.4 Subcooling deviation: ______ °F DB (Value 7.2 – Value 7.3)		☐	☐
For System with Fixed Orifice:			
7.5 Evaporator saturation temperature: ______ °F DB (Using Value 6.5)		☐	☐
7.6 Superheat value: ______ °F DB (Value 6.6 – Value 7.5)		☐	☐
7.7 OEM superheat goal: ______ °F DB (Using superheat tables and Values 6.1 & 6.2)		☐	☐
7.8 Superheat deviation: ______ °F DB (Value 7.6 – Value 7.7)		☐	☐
7.9 Value 7.4 is ± 3°F or Value 7.8 is ± 5°F		☐	☐
7.10 An OEM test procedure (e.g., as defined for a ground-source heat pump) has been used in place of sub-cooling or super-heat process and documentation has been attached that defines this procedure		☐	☐
8. Electrical Measurements – *Taken at electrical disconnect while component is in operation*			
8.1 Evaporator or furnace air handler fan: ____ amperage _______line voltage		☐	☐
8.2 Condenser unit: ____ amperage _______line voltage		☐	☐
8.3 Electrical measurements within OEM-specified tolerance of nameplate value		☐	☐
9. Air Flow Tests			
9.1 Air volume at evaporator: _______ CFM		☐	☐
9.2 Test performed in which mode? ☐ Heating ☐ Cooling		☐	☐
9.3 Return duct static pressure: ______ IWC Test Hole Location: [23] ________________		☐	☐
9.4 Supply duct static pressure: ______ IWC Test Hole Location: [23] ________________		☐	☐
9.5 Test hole locations are well-marked and accessible [23]		☐	☐
9.6 Airflow volume at evaporator (Value 9.1), at fan design speed and full operating load, ± 15% of the airflow required per system design (Value 2.16) or within range recommended by OEM		☐	☐
10. Air Balance			
10.1 Balancing report prepared and attached indicating the room name and design airflow for each supply and return register. In addition, final individual room airflows measured and documented through one of the following options:			
10.1.1 Measured by contractor using ANSI / ACCA 5 QI-2007 protocol, documented by contractor on the balancing report, & verified by contractor to be within the greater of ± 20% or 25 CFM of design airflow [24], OR;		☐	☐
10.1.2 To be measured, documented, and verified by a Rater per Item 1.4.2 of the HVAC System QI Rater Checklist		☐	☐
11. System Controls			
11.1 Operating and safety controls meet OEM requirements		☐	☐
12. Drain pan			
12.1 Corrosion-resistant drain pan, properly sloped to drainage system, included with each HVAC component that produces condensate [25]		☐	☐

HVAC Company Name:____ Credentialing Organization: ACCA / AE / Other

HVAC Contractor Name:____________________ HVAC Contractor Signature: ________________________ Date: ________

Builder Name: [5] ___________________________ Builder Signature: [5] ____________________________ Date: ________

Integrated Design:
Integrated Project Planning -
When the parts fit together, the house is better. The regular way to build is a linear approach that moves neatly from one step to the next. The only problem is that it's not guaranteed to produce the best result. How come?
Key players may not share common objectives for the project, may not understand how their work affects the work of others, and aren't looking for ways to make the house more efficient and less costly to build and operate.
A successful sustainable green home project begins with a common understanding of the project goals.

When everyone involved in the project can gather before construction begins to discuss the products and systems that will be installed, it helps to ensure that the entire construction team knows their role and plays their part in the process.

One or two advanced planning meetings with the project team early in the design & building process makes installation easier and more efficient.

Hold a pre-construction meeting with all subcontractors present to talk about the schedule and trade interactions, especially any changes from the typical routine to accommodate new methods
or technologies.

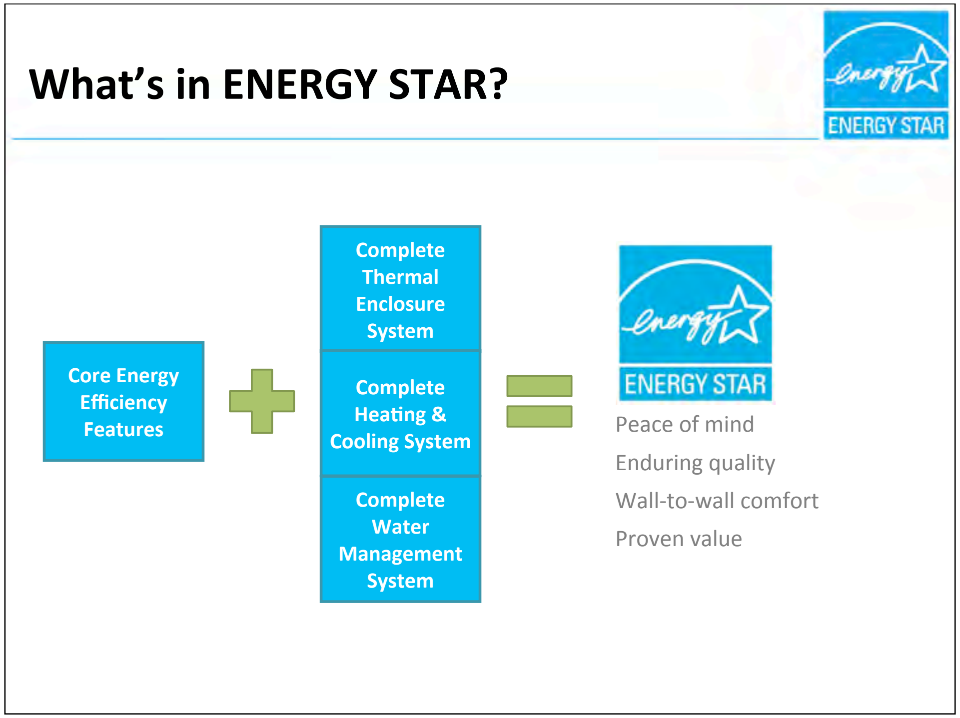
Energy Star HVAC Quality Installation Program

ENERGY STAR HOMES

Purpose: EPA is looking for contractors who want grow their new construction business Benefits

- Work with ENERGY STAR's 4,500 builder partners
- These select builders who can consistently deliver high-quality homes ▪ Contractors get a marketing tool to differentiate themselves

Result: fewer callbacks and complaints, more premium sales



Features

- Money-saving energy efficiency
- Market-leading comfort and durability features

- Home Energy Rater verification

Benefits

- Peace of mind
- Enduring quality
- Wall-to-wall comfort

- Proven value

Animation

HVAC is critical to delivering promised value
HVAC must be designed and installed to best-practice standards by expert contractors Historically, two obstacles:

Quality HVAC Performance

Solution: ENERGY STAR = complete thermal envelopes

- High-quality insulation
- Reduced thermal bridging
- Effective air barriers and air sealing.
- Inspection by a Home Energy Rater ensures consistency

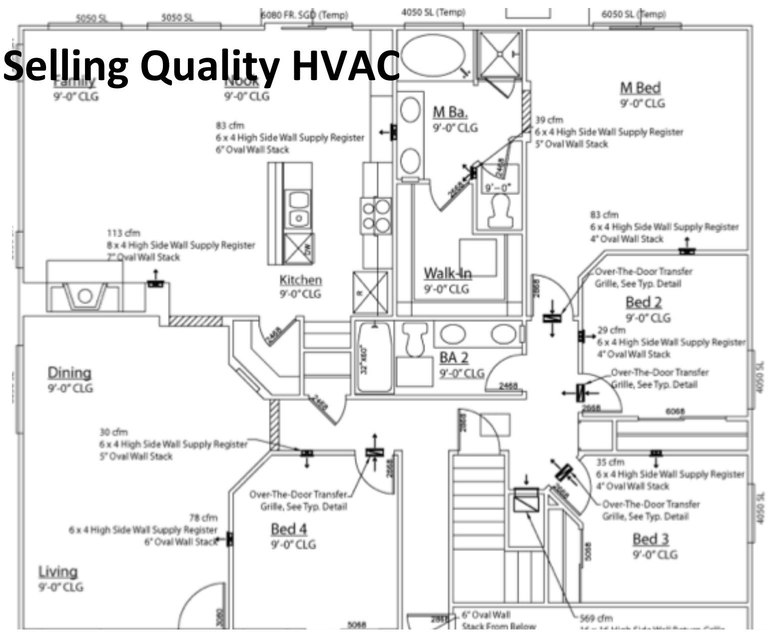
Now HVAC system & home can work together. Example

- Large production builder joined ENERGY STAR a few years ago
- Comfort complaints decreased by 90% in year 1, 90% again in year 2

Example

- HVAC contractor using ENERGY STAR to focus on premium services
- Moved into a new office
- For the first time, engineering staff took up more space than warranty staff
- Instead of competing on price and managing problems later → Focus on highly-engineered services up front

Selling Quality HVAC



Obstacle: Selling best-practice HVAC design and installation to builders

- Many builders don't know difference between typical & best-practice install
- HVAC looks like a commodity

The credential makes it easy for builders to know which contractors can perform this work

Opportunity:
- ENERGY STAR builder partners are looking for credentialed HVAC contractors right now

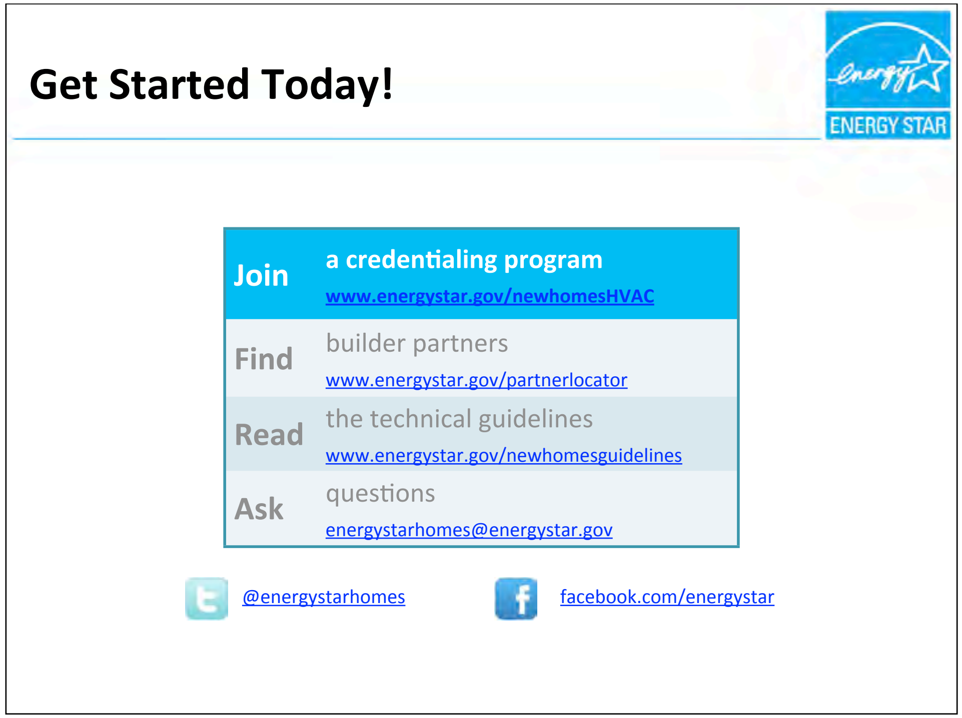
- Builders use proven ENERGY STAR guidelines + Rater verification to consistently deliver homes that perform

- Credentials help contractors stand out from the crowd & get access to ENERGY STAR builders

Credentials are offered by independent, third-party oversight organizations whose programs have been recognized by EPA, including ACCA's Quality Assured Contractor program and Advanced Energy's Quality- Assured Professional program

Now HVAC contractors can:

- Reduce complaints and service calls
- Focus on higher-value services
- Build their reputation as market leaders



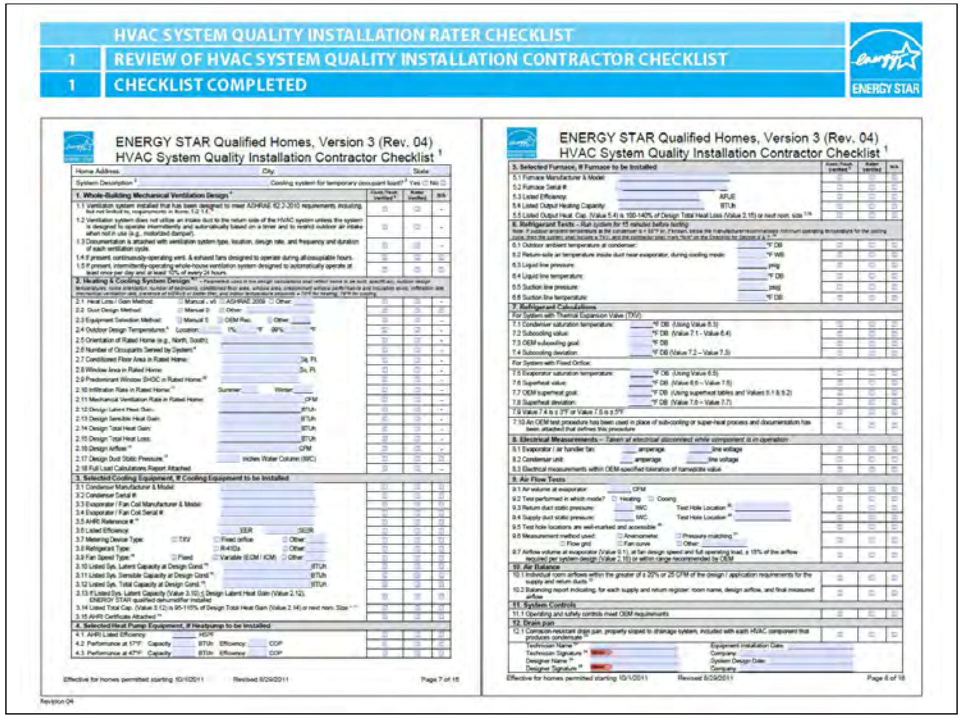
Getting started is easy

- Go to www.energystar.gov/newhomesHVAC
- Click on “Become a Credentialed HVAC Contractor” for links to recognized programs ▪ Each program has its own application process
- Typically, there’s a short online orientation to familiarize you with their program

ENERGY STAR builder and Rater partners are looking for credentialed HVAC contractors now So get started today!

Footnotes:

1. The HVAC System Quality Installation Rater Checklist is designed to align with the requirements of ASHRAE 62.2-2010 and published addenda and ANSI / ACCA's 5 QI-2010 protocol, thereby improving the performance of HVAC equipment in new homes when compared to homes built to minimum code. However, these features alone cannot prevent all ventilation, indoor air quality, and HVAC problems, for instance those caused by a lack of occupant maintenance. Therefore, this checklist is not a guarantee of proper ventilation, indoor air quality, or HVAC performance. This checklist with supporting documents may also be used to demonstrate compliance with Indoor airPLUS specifications 4.1, 4.2, 4.5, 4.6, and 7.1.



HVAC SYSTEM QUALITY INSTALLATION RATER CHECKLIST

1 REVIEW OF HVAC SYSTEM QUALITY INSTALLATION CONTRACTOR CHECKLIST

1 CHECKLIST COMPLETED

ENERGY STAR Qualified Homes, Version 3 (Rev. 04)
HVAC System Quality Installation Contractor Checklist [1]

ENERGY STAR Qualified Homes, Version 3 (Rev. 04)
HVAC System Quality Installation Contractor Checklist [1]

Critical Point:

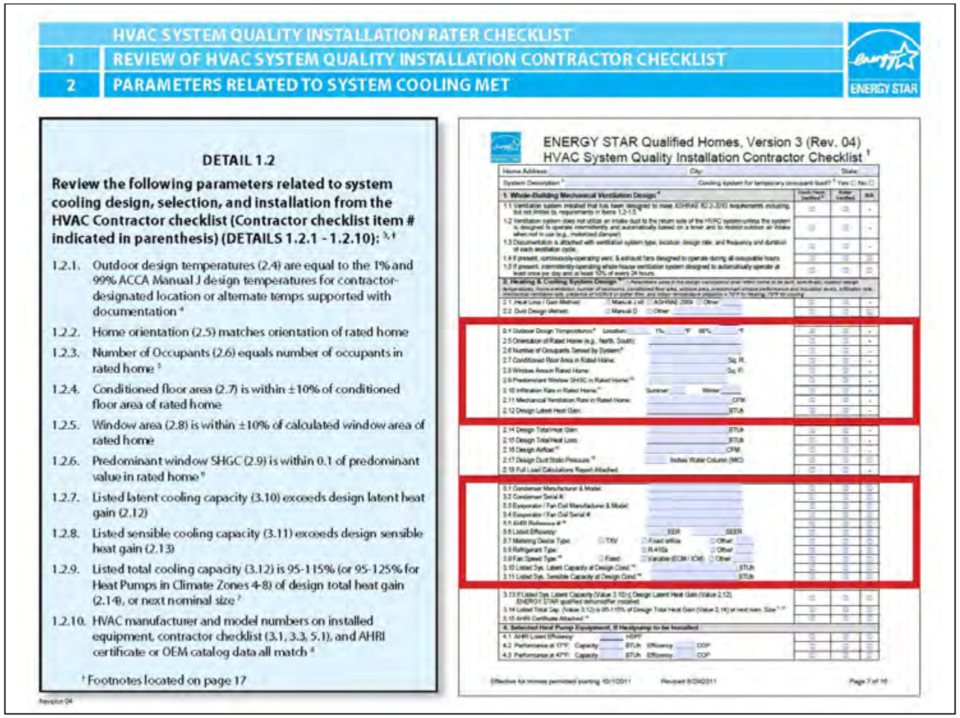
Summary:

Construction Phase:

Inspection:

Footnotes:

2. The Rater is only responsible for ensuring that the Contractor has completed the Contractor checklist in its entirety and verifying the discrete objective parameters referenced in Section 1 of this checklist, not for assessing the accuracy of the load calculations or field verifications included or to verify the accuracy of every input on the Contractor checklist.



Critical Point:

Summary:

Construction Phase:

Inspection:

Important to emphasize rater is not liable for the HVAC contractor work, sizing, and equipment selection. They just will be verifying the checklist was completed as required by EPA. The items in this group are asking the rater to objectively verify the HVAC contractor used appropriate inputs in their sizing calculations and equipment installed has nameplate specifications consistent with those specified from the calculations.

Footnotes:

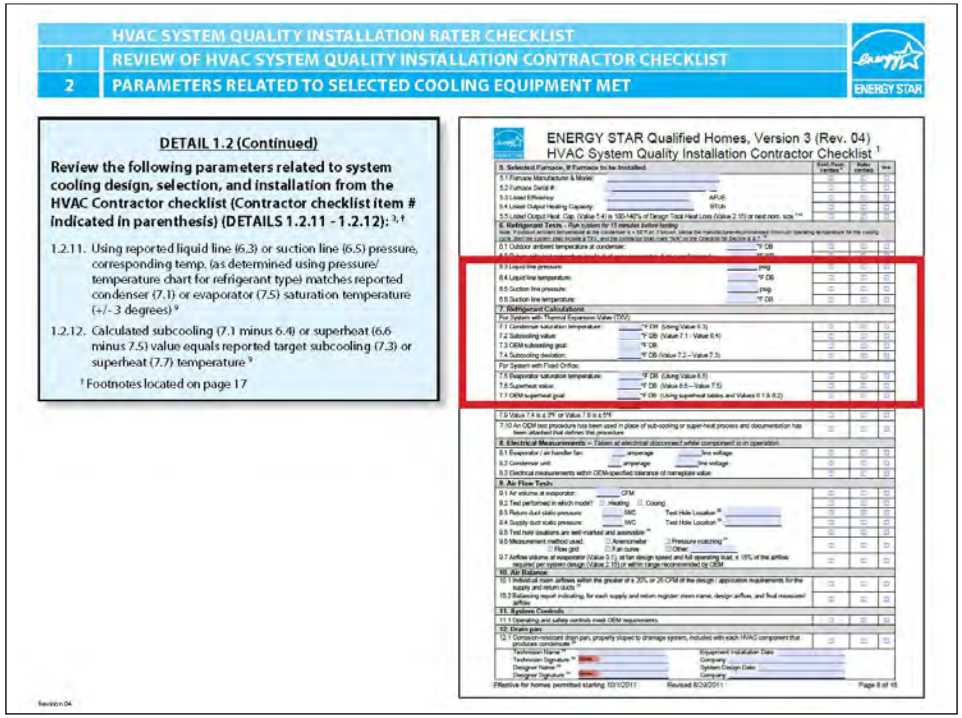
4. The number of occupants among all HVAC systems in the home shall be equal to the number of RESNET-defined bedrooms plus one. Occupants listed for systems for which the header of the contractor checklist indicates that it is designed to handle temporary occupant loads, as defined in footnote 3 of the HVAC System Quality Installation Contractor Checklist, shall be permitted to exceed this limit.

5. "Predominant" is defined as the SHGC value used in the greatest amount of window area in the home.

6. For cooling systems, the next largest nominal piece of equipment may be used that is available to satisfy the latent and sensible requirements. Single-speed systems generally have OEM nominal size increments of ½ ton. Multi-speed or multi-stage equipment may have OEM nominal size increments of one ton. Therefore, the use of these advanced system types can provide extra flexibility to meet the equipment sizing requirements.

7. In cases where the condenser unit is installed after the time of inspection by the Rater, the HVAC manufacturer and model numbers on installed equipment can be documented through the use of photographs provided by the HVAC Contractor after installation is complete.

8. If contractor has indicated that an OEM test procedure has been used in place of a sub-cooling or super-heat process and documentation has been attached that defines this procedure, then the box for "n/a" shall be checked for this item.



HVAC SYSTEM QUALITY INSTALLATION RATER CHECKLIST

1 REVIEW OF HVAC SYSTEM QUALITY INSTALLATION CONTRACTOR CHECKLIST

2 PARAMETERS RELATED TO SELECTED COOLING EQUIPMENT MET

DETAIL 1.2 (Continued)

Review the following parameters related to system cooling design, selection, and installation from the HVAC Contractor checklist (Contractor checklist item # indicated in parenthesis) (DETAILS 1.2.11 - 1.2.12): [3,†]

1.2.11. Using reported liquid line (6.3) or suction line (6.5) pressure, corresponding temp. (as determined using pressure/temperature chart for refrigerant type) matches reported condenser (7.1) or evaporator (7.5) saturation temperature (+/- 3 degrees) [9]

1.2.12. Calculated subcooling (7.1 minus 6.4) or superheat (6.6 minus 7.5) value equals reported target subcooling (7.3) or superheat (7.7) temperature [9]

† Footnotes located on page 17

ENERGY STAR Qualified Homes, Version 3 (Rev. 04)
HVAC System Quality Installation Contractor Checklist [1]

Critical Point:

Summary:

Construction Phase:

Inspection:

From Sam: Important to emphasize rater is not liable for the HVAC contractor work, sizing, and equipment selection. They just will be verifying the checklist was completed as required by EPA. The items in this group are asking the rater to objectively verify the HVAC contractor used appropriate inputs in their sizing calculations and equipment installed has nameplate specifications consistent with those specified from the calculations.

Footnotes:

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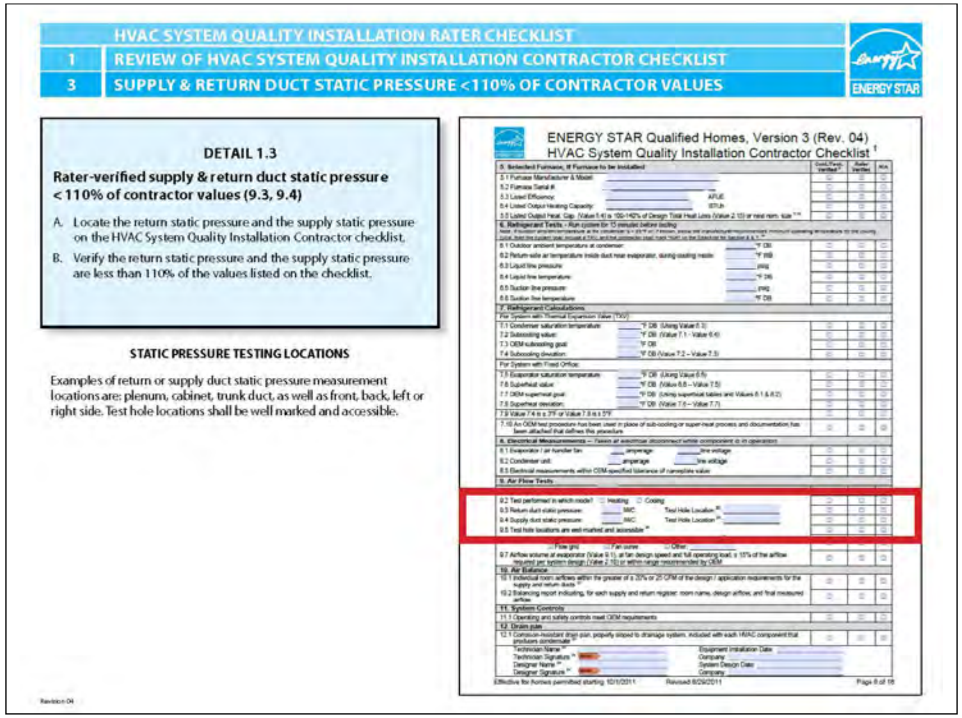
8. If contractor has indicated that an OEM test procedure has been used in place of a sub-cooling or super-heat process and documentation has been attached that defines this procedure, then the box for "n/a" shall be checked for this item.


HVAC SYSTEM QUALITY INSTALLATION RATER CHECKLIST

1 REVIEW OF HVAC SYSTEM QUALITY INSTALLATION CONTRACTOR CHECKLIST

3 SUPPLY & RETURN DUCT STATIC PRESSURE <110% OF CONTRACTOR VALUES

DETAIL 1.3

Rater-verified supply & return duct static pressure <110% of contractor values (9.3, 9.4)

A. Locate the return static pressure and the supply static pressure on the HVAC System Quality Installation Contractor checklist.

B. Verify the return static pressure and the supply static pressure are less than 110% of the values listed on the checklist.

STATIC PRESSURE TESTING LOCATIONS

Examples of return or supply duct static pressure measurement locations are: plenum, cabinet, trunk duct, as well as front, back, left or right side. Test hole locations shall be well marked and accessible.

ENERGY STAR Qualified Homes, Version 3 (Rev. 04)
HVAC System Quality Installation Contractor Checklist [1]

Critical Point:

Air Flow, Heat Flow

Summary:

Follow directions based on how your pressure gauge manual specifies

Construction Phase:

Final

Inspection:

Final

4.1-2

Total Rater-measured duct leakage ≤ 6 CFM25 per 100 sq. ft. of conditioned floor area[15,16]
Rater -measured duct leakage to outdoors ≤ 4 CFM25 per 100 sq. ft. of conditioned floor area.[15, 16, 17]

ENERGY STAR

Connection in place but not sealed.

A

Mechanically fastened and sealed.

EPA

HVAC System Quality Installation Rater Checklist

Critical Point:

Air Flow, Heat Flow

Picture Description:

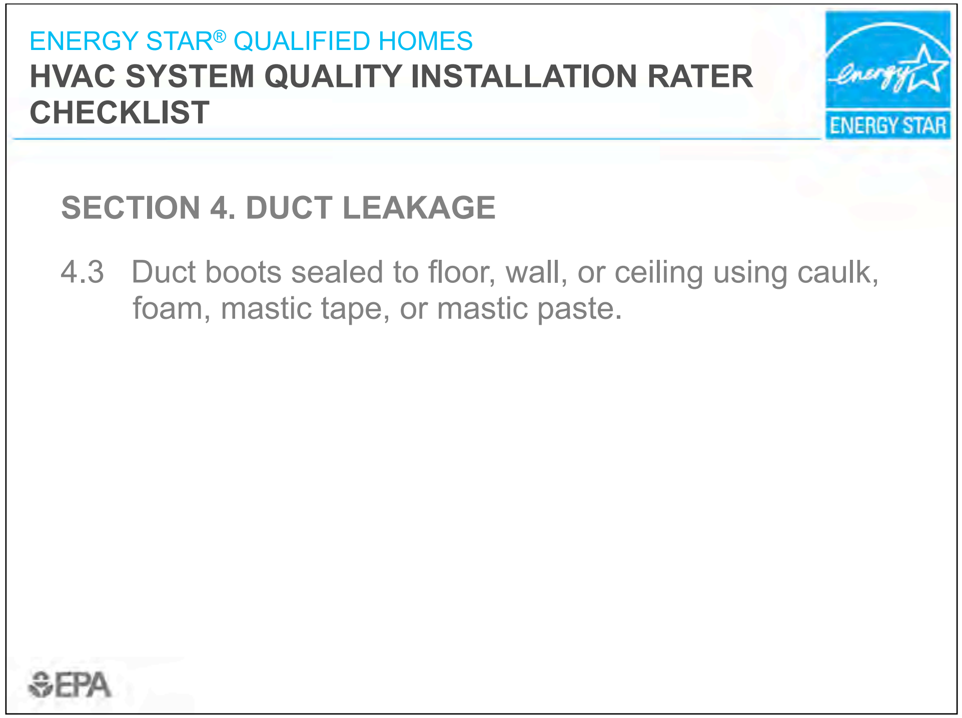
These recommendations will aid the HVAC contractor in meeting the targets for duct leakage. It will be difficult to meet the requirements if these steps aren't followed.

The bad picture shows a duct that is not sealed to the take off. Eventually the duct could fall off because it is only held in place by a metal strap. This sealing should be done before insulation is installed around the duct.

The good picture shows sealing around the inner liner complete.

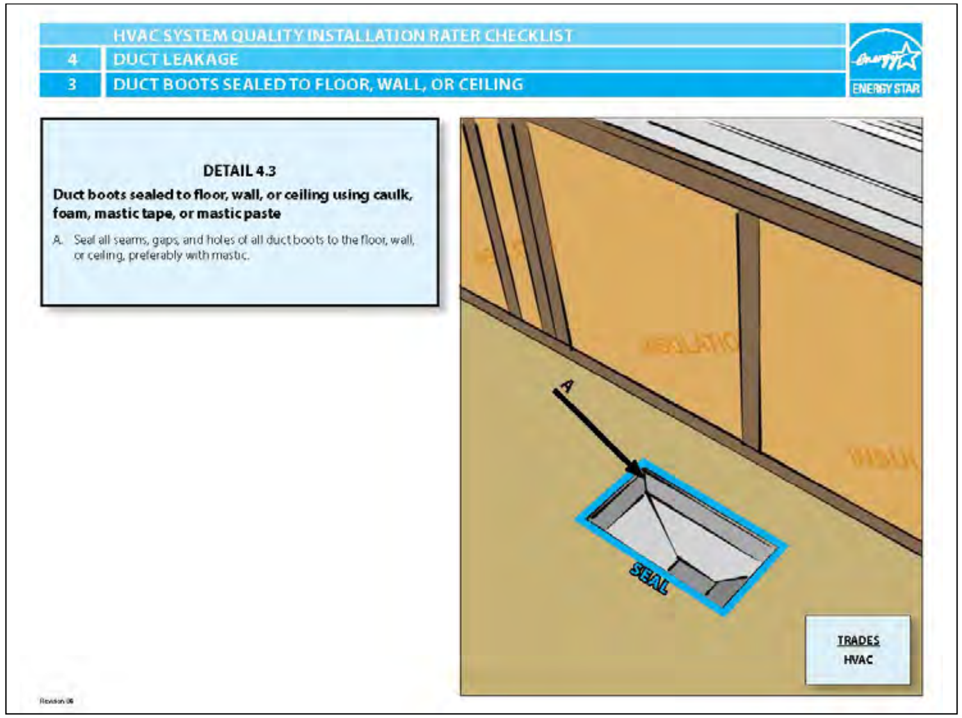
Construction Phase: Rough in

Inspection: Rough in



Critical Point:

Summary:



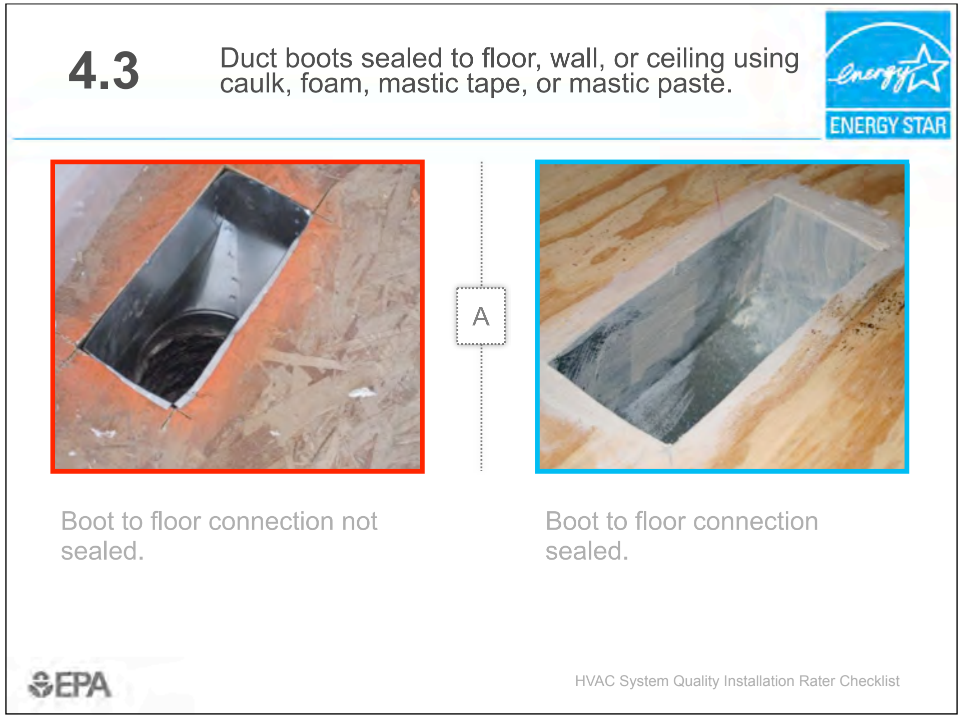
Critical Point:

Air Flow —

Picture Description:

Construction Phase:

Inspection:



Critical Point:

Air Flow, Heat Flow

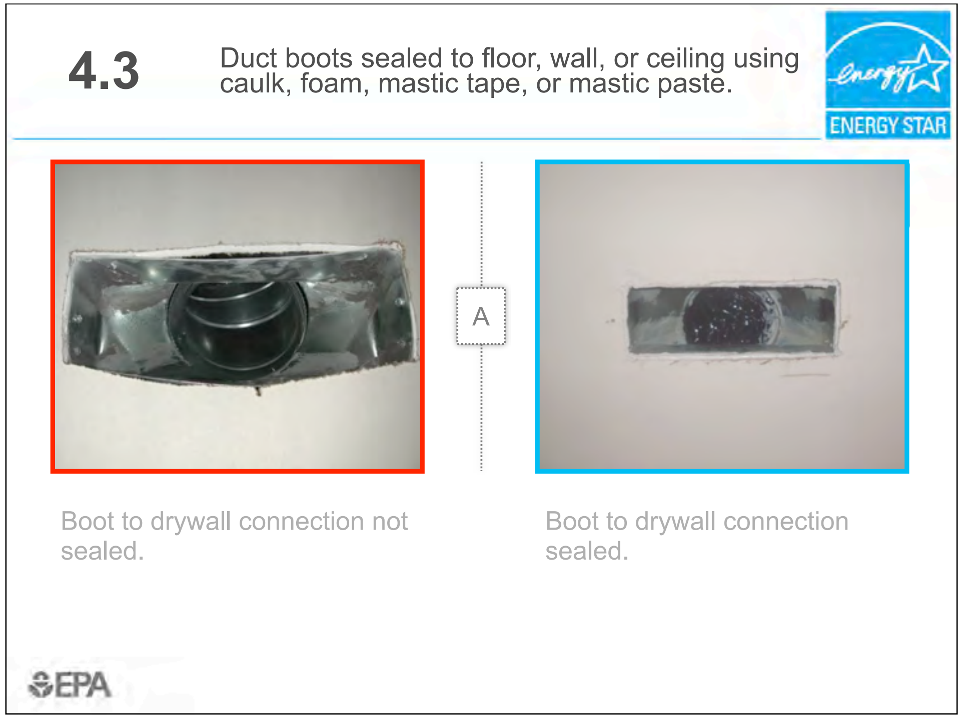
Picture Description:

The bad picture shows a boot not sealed to the floor. Conditioned air could leak into the unconditioned space creating energy loss and comfort complaints.

The good picture shows a duct sealed to the floor with mastic. Caulk, foam or mastic shall be used to seal penetrations to exterior or to unconditioned space (i.e. chases/shafts that terminate in the attic). Penetrations include any ducts, pipes, wires, refrigerant or condensate lines, etc. It is the responsibility of whoever created the hole to verify it is sealable. You make the hole, you own the hole. Caulk, foam or mastic should be used because other materials commonly used, such as fiberglass insulation, are not effective at stopping air flow.

Construction Phase: Insulation

Inspection: Insulation



Critical Point:

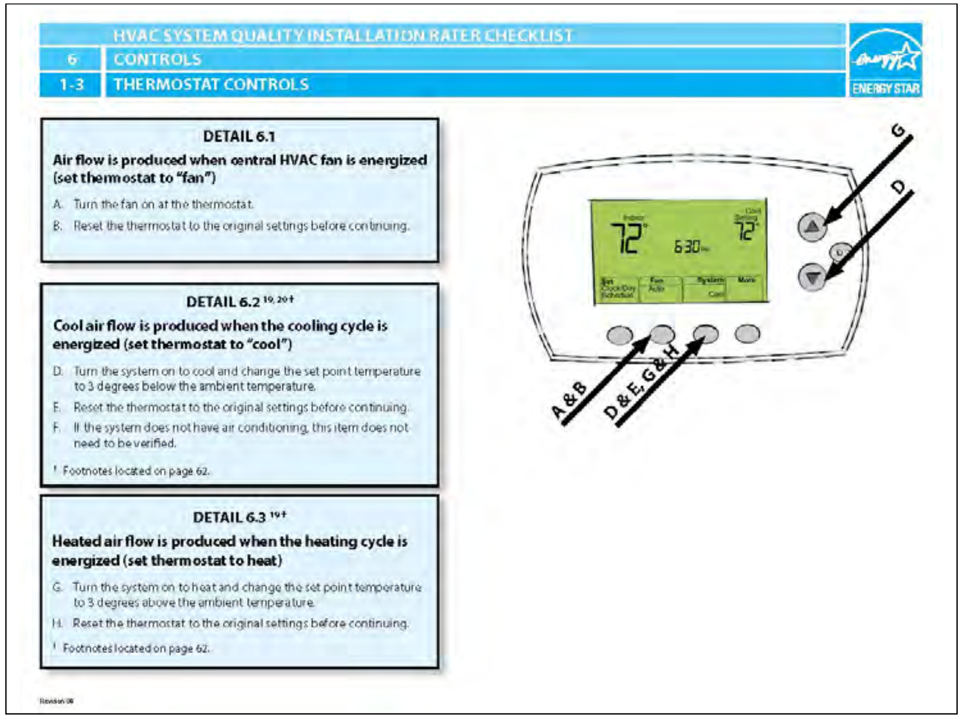
Air Flow, Heat Flow

Picture Description:

The bad picture shows a boot installed in the ceiling and it is not sealed to the drywall. This gap can provide a lot of leakage.

Construction Phase: Final for attics

Inspection: Final for attics



HVAC SYSTEM QUALITY INSTALLATION RATER CHECKLIST

6 CONTROLS

1-3 THERMOSTAT CONTROLS

ENERGY STAR

DETAIL 6.1

Air flow is produced when central HVAC fan is energized (set thermostat to "fan")

A. Turn the fan on at the thermostat.

B. Reset the thermostat to the original settings before continuing.

DETAIL 6.2 [19, 20†]

Cool air flow is produced when the cooling cycle is energized (set thermostat to "cool")

D. Turn the system on to cool and change the set point temperature to 3 degrees below the ambient temperature.

E. Reset the thermostat to the original settings before continuing.

F. If the system does not have air conditioning, this item does not need to be verified.

† Footnotes located on page 62.

DETAIL 6.3 [19†]

Heated air flow is produced when the heating cycle is energized (set thermostat to heat)

G. Turn the system on to heat and change the set point temperature to 3 degrees above the ambient temperature.

H. Reset the thermostat to the original settings before continuing.

† Footnotes located on page 62.

Critical Point:

Air Flow —

Picture Description:

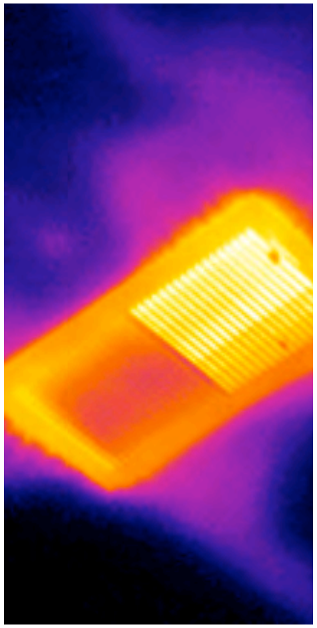
Construction Phase:

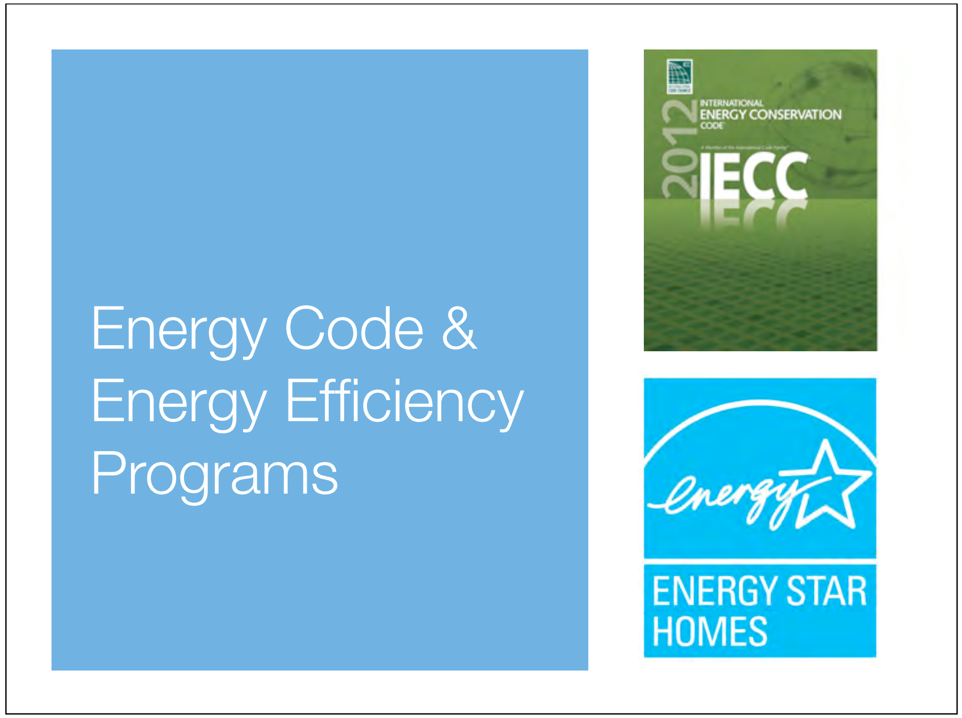
Inspection:

Footnotes:

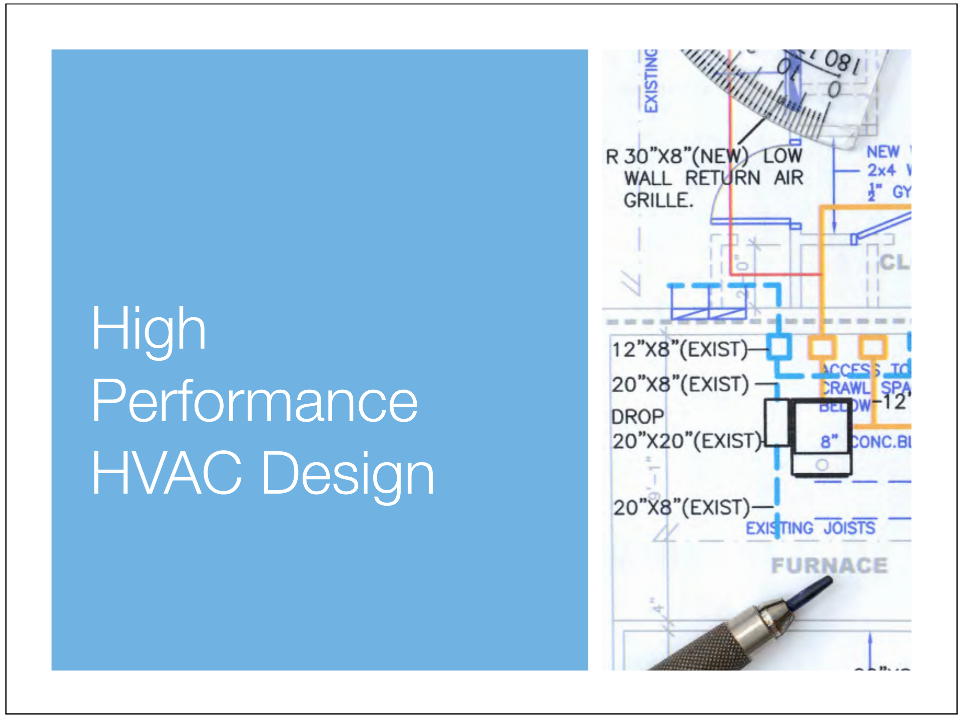
17. In cases where the condenser unit is installed after the time of inspection by the Rater, the Rater is exempt from verifying item 6.2 when the condenser is for an AC unit and also item 6.3 when the condenser is for a heat pump unit.

Takeaways





We talked about the IECC code and the Energy Star for Homes program and the potential market opportunities

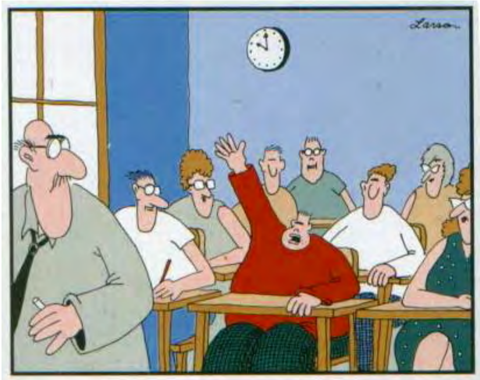


We reviewed how high performance home building and remodeling requires a different approach than the traditional, established way of building. Building a high performance home must be a systematic approach and done as a team. The project must be looked at as a system, in which each component is connected to and depends on the other components. Teamwork is required to make it all come together. Addressing and optimizing key factors up front with the whole team will result in a smoother construction process, lower costs and a much better home.

We talked about the key best practices for HVAC installations and the available performance tests

We talked about strategies for improving you business through High Performance HVAC

We talked about the Energy Star HVAC Quality Installation Program



"Mr. Osborne, may I be excused? My brain is full."

Q&A

BUILDING KNOWLEDGE

Thank You!