

High Performance Homes



Design Features

- ❑ **Envelope Performance First**

- ❑ **Systems Approach**

Health

Safety

Affordability

Comfort

Durability

- ❑ **Lowest Cost Greatest Benefit**

Air Flow

Moisture Flow

Heat Flow

Pressure Management

Design Features

- ❑ **Maximize Dollars Already Spent**

Framing

Windows

Air Sealing

Insulation

HVAC

Duct Systems

- ❑ **Further Improve Performance**

Pressure Management

Moisture Management

- ❑ **Additional Cost to Builder**

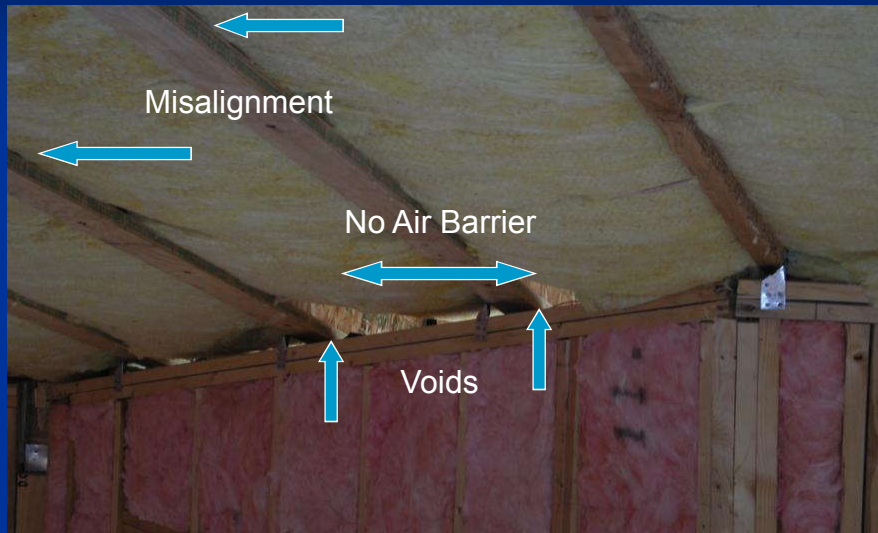
Design Features

□ Inspect and Test

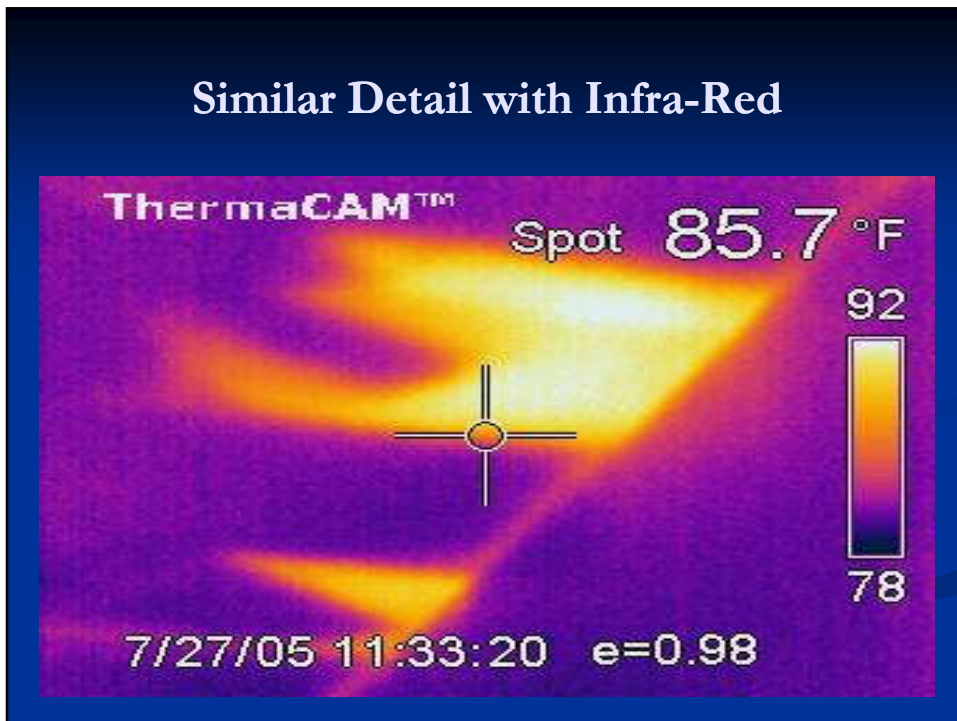
Framing Inspection
Duct Leakage Test
Insulation Inspection
Pressure Test
Air Leakage Test



Inspect



Similar Detail with Infra-Red



Inspect



Pressure Management

□ Extremely Important

Health and Safety

Energy Use

Comfort

□ 3 Primary Reasons

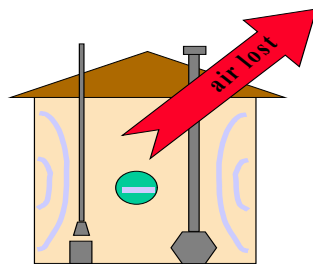
Duct Leakage

Door Closures

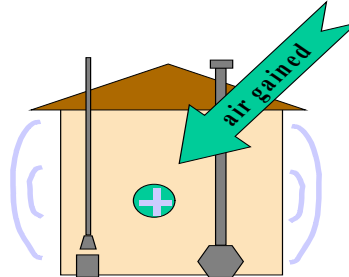
Exhaust Devices

Manage Pressures – Duct Leakage

Impact of Duct Leakage On House Pressures



Supply Leaks



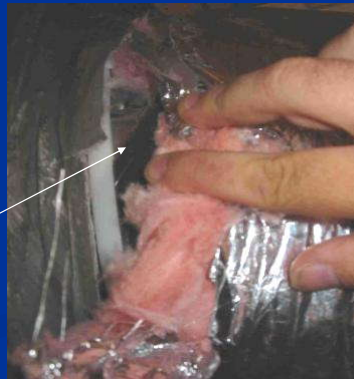
Return Leaks

Eliminate Duct Leaks

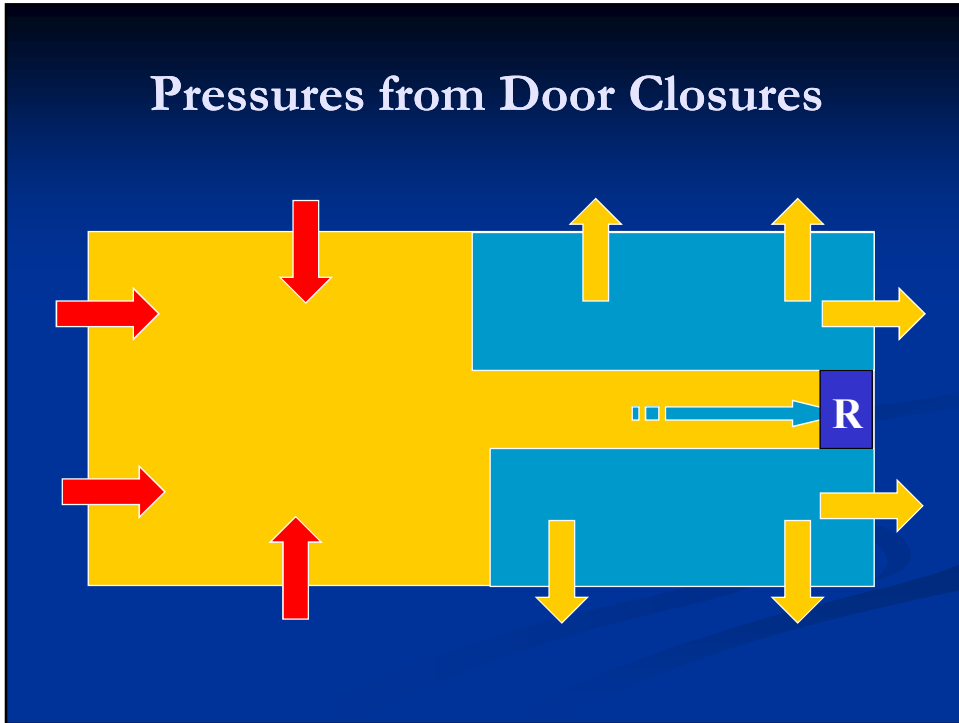


No mastic between the sheet metal collar and the flex duct beneath the strap.

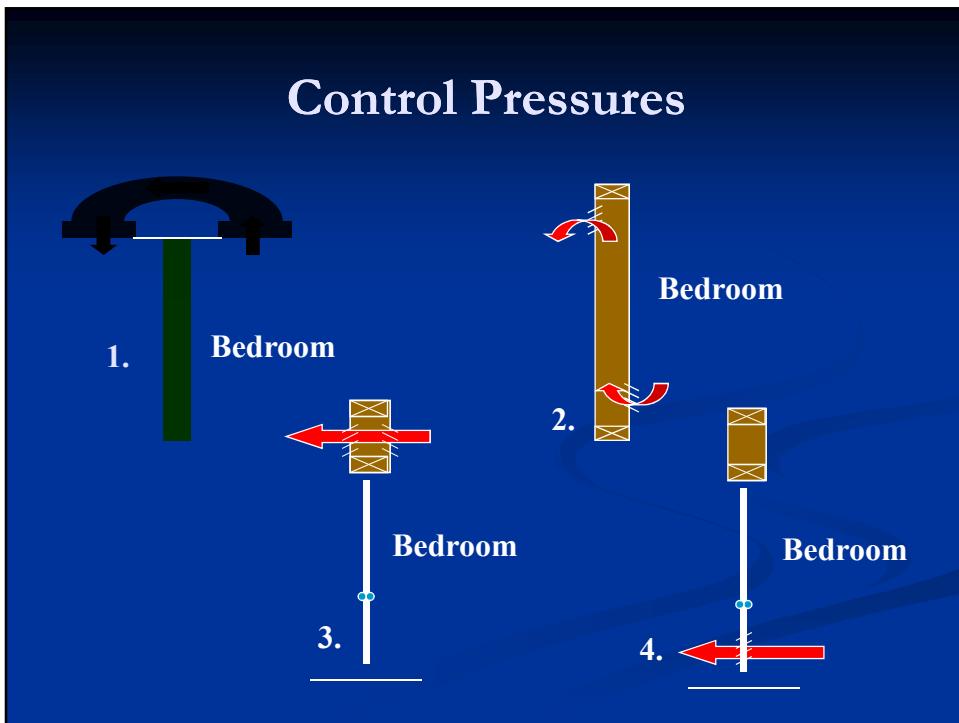
The return duct to plenum is not sealed at all. The strap did not catch the interior flex duct.



Pressures from Door Closures



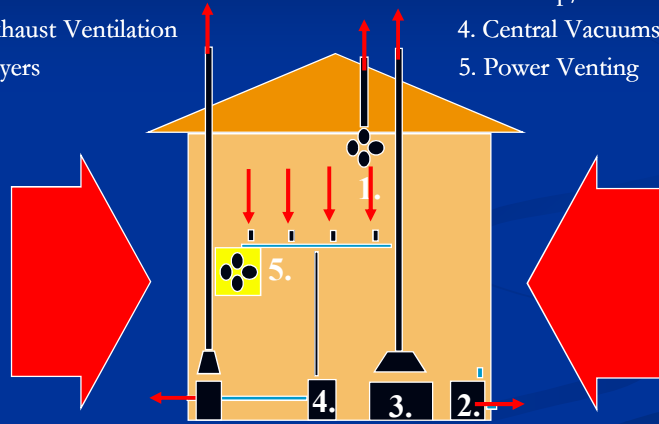
Control Pressures



Exhaust Devices

1. Exhaust Fans and Exhaust Ventilation
2. Dryers

3. Cooktop/Stove Exhaust
4. Central Vacuums
5. Power Venting



Install and Filter Fresh Air



Test During Construction



Test When Complete



Financial & Technical

□ **Builder – Financial Assistance**

- Average \$400.00 per home cash incentive
- Print, Radio, TV Advertising
- On-site promotional items

□ **Builder – Technical Assistance**

- HVAC Load Calculations
- Inspections and Testing
- Training for Sub-contractors, Sales Agents, Etc.

Marketing and Selling



Guaranteed Comfort
Specially Designed Electric Rate
Personal Attention on problems

Distributed Generation

Guarantee with PV@ Armory Park



NearNet Zero



Long Term Goal - Near NetZero



They

Work

Together

ldouglas@tep.com

www.tep.com

Financial Assistance - Distributed Generation

- Distributed Generation (2008)
 - \$3.00 per DC watt up-front incentive
 - \$2,000 maximum Federal Tax Credit
 - \$1,000 maximum State Tax Credit

Financial Assistance 2008 Residential Solar Hot Water

- Solar Water Heating (with 10 year warranty)
 - \$750 plus
 - 25¢ per kWh based on 1st year kWh (max \$1750)
- Solar Water Heating (with 5-10 year warranty)
 - PBI at 5.7¢/kWh for 10 Years
 - PBI at 5.2¢/kWh for 15 Years
 - PBI at 5.1¢/kWh for 20 Years

Financial Risk of Guarantee?

- Average Dollars Exceeding Guarantee:
\$5,800.00/Year (10 year average)
- Percentage Exceeding Guarantee:
10% (10 year average)

Average air change & duct leaks

The baseline Guarantee Home DOE-2 model was developed using test data, specification and program standards, provided by TEP. Table 2.0 provides a summary description of the baseline Guarantee Home DOE-2 model that was validated against TEP provided utility data. Some of the parameters in Table 2.0 are slightly superior to the Guarantee Home specification, such as infiltration rates and duct leakage. Each Guarantee Home is tested for infiltration and duct leakage using a blower door test method and with a Duct Buster®, respectively. The test data provided by TEP shows that on average the infiltration rate for an approximate 1850-square-foot Guarantee Home is 0.22 air-changes per hour (ACH), and the average duct leakage is about 2%. These numbers were used in the DOE-2 model inputs. Infiltration was modeled only when the HVAC

Enovity Analysis

Table 4.0
Model Home DOE-2 Annual Simulation Results

DOE-2 Model Home	HVAC		Total Energy			Peak	Total Utility Costs			
	Heating (therms) (kWh)	Cooling (kWh)	Total (therms)	Total (kWh)	Summer (kW)		Gas: OWG* (\$)	Electric: TEP R-201** (\$)	TEP R-01*** (\$)	Total (\$)
Guarantee Home: Electric Heat & DHW	N/A	794	4,003	N/A	13,634	4.7	NA	\$1,041	NA	\$1,041
IECC Standards: Electric Heat & DHW	N/A	1,570	4,077	N/A	14,484	4.9	NA	NA	\$1,516	\$1,516
Guarantee Home Savings	-	776	-1,074	-	1,350	1.2	-	-	-	\$475
IECC Standards: Gas Heat & DHW	234	N/A	5,077	450	10,345	5.7	\$737	NA	\$1,058	\$1,844
Guarantee Home Savings	234	-794	-1,074	450	-3,389	1.0	\$737	-	-	\$573
Energy Star Homes: Electric Heat & DHW	N/A	583	4,140	N/A	13,959	5.0	NA	NA	\$1,373	\$1,373
Guarantee Home Savings	-	181	-137	-	325	0.3	-	-	-	\$131
Energy Star Homes: Gas Heat & DHW	153	N/A	4,140	349	9,408	4.7	\$541	NA	\$561	\$1,606
Guarantee Home Savings	153	-794	-137	349	-4,226	0.0	\$541	-	-	\$565

Footnote:
 *Based on SW Gas rate after March 2005 rate case and includes purchased gas adjustment using from data from Mar to Oct 2006
 **TEP R-201 = TOU Rate for all electric Guarantee Homes
 ***TEP 1 = standard residential rate
 Natural gas and electric utility costs include monthly customer charges and 6.24% tax

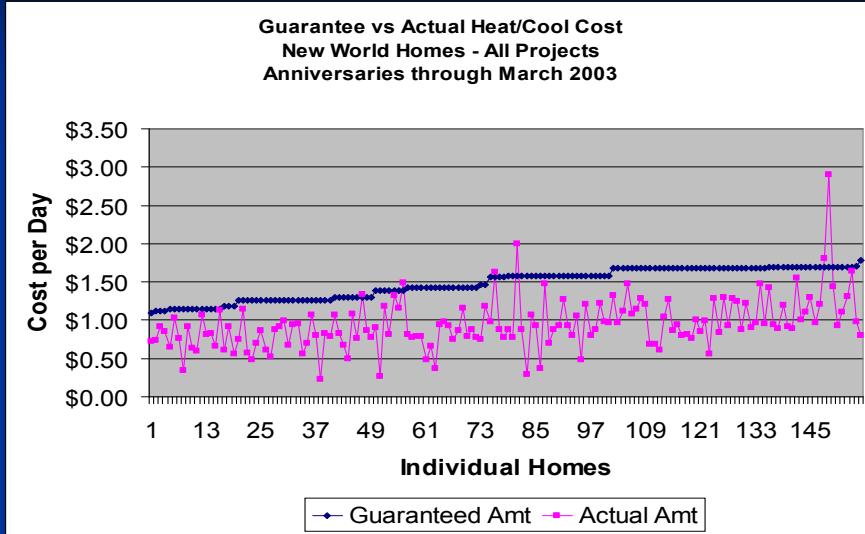
High-Efficiency Options

Table 4.1
Additional DOE-2 Annual Simulation Results:
Guarantee Home with Higher Efficiency (SEER) Heat Pumps

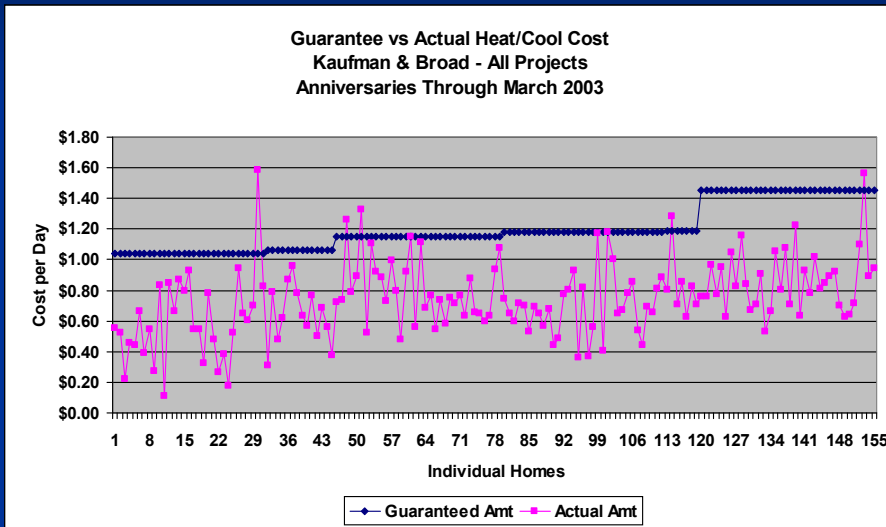
Model Home	HVAC		Total Energy			Peak	Total Utility Costs			
	Heating (therms) (kWh)	Cooling (kWh)	Total (therms)	Total (kWh)	Summer (kW)		Gas: OWG* (\$)	Electric: TEP R-201** (\$)	TEP R-01*** (\$)	Total (\$)
IECC Standards 10 SEER: Electric Heat & DHW	N/A	1,571	6,213	N/A	16,620	6.9	NA	NA	\$1,629	\$1,629
Guarantee Home 13 SEER: Electric Heat & DHW	N/A	794	4,003	N/A	13,634	4.7	NA	\$1,041	NA	\$1,041
Guarantee Home 14 SEER: Electric Heat & DHW	N/A	786	3,526	N/A	13,142	4.4	NA	\$1,002	NA	\$1,002
Guarantee Home 15 SEER: Electric Heat & DHW	N/A	779	3,353	N/A	12,958	4.3	NA	\$988	NA	\$988
Guarantee Home 16 SEER: Electric Heat & DHW	N/A	779	3,305	N/A	12,921	4.3	NA	\$955	NA	\$955

Footnote:
 *Based on SW Gas rate after March 2005 rate case and includes purchased gas adjustment using from data from Mar to Oct 2006
 **TEP R-201 = TOU Rate for all electric Guarantee Homes
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 Natural gas and electric utility costs include monthly customer charges and 6.24% tax

Does The Guarantee Work



Does The Guarantee Work



House Facts

- 1860 ft²
- All Electric
- 12 SEER, 3-ton heat pump
- Solar water heating with electric back-up
- Heydon Building System

Energy Costs - Year 1

- Total Energy Cost = \$652
- \$54.30 per month

- Heating & Cooling = \$198
- \$16.50 per month

- 56¢ per day avg. (356 days)

Energy Costs - Year 2

- Total Energy Cost = \$799
- \$66.57 per month

- Heating & Cooling = \$244
- \$20.32 per month

- 67¢ per day avg. (364 days)

Energy Costs - Year 3

- Total Energy Cost = \$768
- \$64.00 per month

- Heating & Cooling = \$221
- \$18.39 per month

- 61¢ per day avg. (364 days)

Pressure Balance

- Master Bedroom to Main Body of house = +2.8 pa.
- Bedroom 2 to Main Body = +0.8 pa.
- Bedroom 3 to Main Body = +1.8 pa.

Pressure Balance

- House to Outdoor with heat pump on = +0.6 pa.
- Master Bedroom closed with heat pump on = +0.3 pa.
- All doors closed with heat pump on = 0.0 pa.

Duct Leak Test

- 26 CFM25 - This Guarantee House
- 411 CFM25 – Average Code Built House

Blower Door Test Average Code Built Home

- 2162 ft²
- 2623 CFM50
- 7.4 ACH50
- 0.34 ACH

Blower Door Test This Guarantee Home

- 1860 ft²
- 1540 CFM50
- 5.0 ACH50
- 0.23 ACH