



Dale Horton, Architect, Sustainable Energy Program Manager May 8, 2008



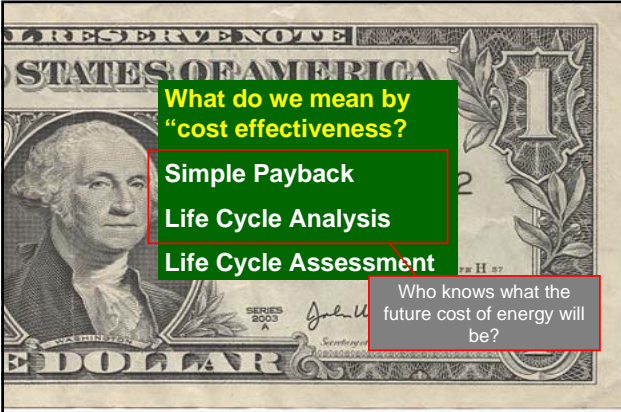
**National Center for Appropriate Technology**

Offices:  
 Montana  
 California  
 Pennsylvania  
 Iowa  
 Arkansas  
 Louisiana



**ENERGY STAR Homes**  
**Northwest ENERGY STAR®**

Green Design = Sustainable Design =  
 Ecological Design =  
 Climate Responsive Design =  
 Energy Efficient = High  
 Performance Building = Good  
 Design



**What do we mean by "cost effectiveness?"**

Simple Payback  
 Life Cycle Analysis  
 Life Cycle Assessment

Who knows what the future cost of energy will be?



PROTECT OUR ENVIRONMENT FOR FUTURE GENERATIONS  
 U.S. Environmental Protection Agency · U.S. Department of Energy

ENERGY STAR About ENERGY STAR · News Room · FAQs

PRODUCTS > HOME IMPROVEMENT >

Stay Warm With ENERGY STAR Home

Explore Home Improvement > Common Home Problems Home Energy Audits Air Seal & Insulate Heat & Cool Efficiently Home Performance with ENERGY STAR For Contractors

BUILDINGS & PLANTS > NEW HOMES >

Take the ENERGY STAR CHALLENGE!

Explore Buildings & Plants > Guidelines for Energy Management Tools & Resources Library Expert Help Commercial Building Design Green Buildings

ENERGY STAR Qualified Homes

Explore Qualified New Homes > Find an ENERGY STAR Builder ENERGY STAR New Home Features Benefits for Homeowners For Residential Professionals

www.energystar.gov

**ENERGY STAR Qualified Products**

Products in more than 50 categories are eligible for the ENERGY STAR. They use less energy, save money, and help protect the environment. Ask for the ENERGY STAR.

Looking for a product that you don't see listed below? See [ENERGY STAR Specifications in Development](#), which includes information on both new specifications, and revisions to existing specifications.

**Appliances**

- Battery Chargers
- Clothes Washers
- Dehumidifiers
- Dishwashers
- Refrigerators & Freezers
- Room AC
- Room Air Cleaners
- Water Coolers

**Heating & Cooling**


- Air-source Heat Pumps
- Boilers
- Central AC
- Ceiling Fans
- Dehumidifiers
- Furnaces
- Geothermal Heat Pumps
- Home Sealing (Insulation)
- Light Commercial
- Programmable Thermostats
- Room AC
- Ventilating Fans

**Home Envelope**


- Home Sealing (Insulation and Air Sealing)
- Roof Products
- Windows, Doors, & Sightsights

Special Offers Find a Store

Features



Cool Your World with ENERGY STAR

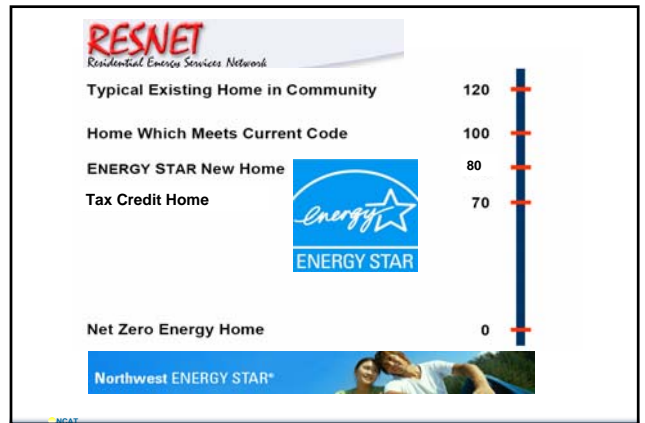


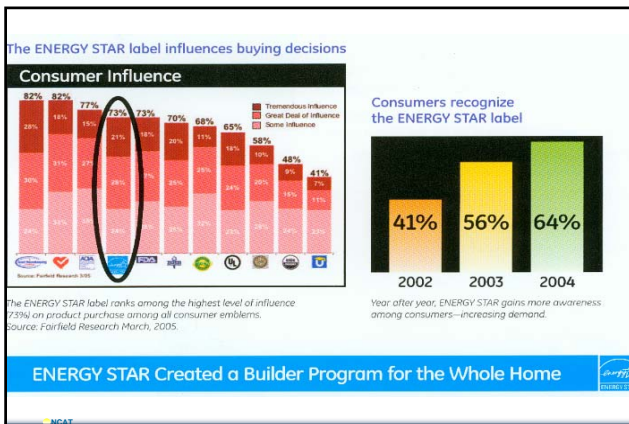
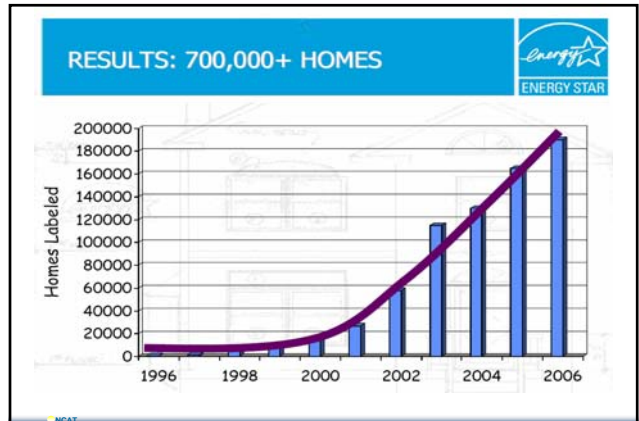
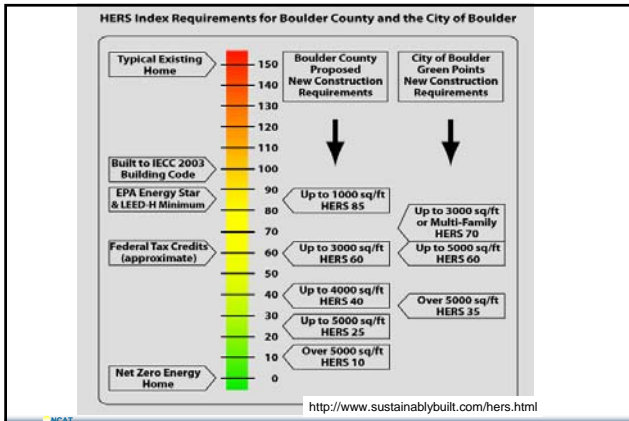
Pledge to Save Energy with a Simple Step at Home

ENERGY STAR PODCAST

ENERGY STAR Podcasts

Time to Replace your old





### ENERGY STAR FOR HOMES METRICS

- 700,000+ Labeled Homes Cum.
- >25 Markets >20% Penetration
- 3,500+ Builder Partners
- 60%+ 100 Largest Builders

### ASSURING BETTER PERFORMANCE

Unless you're prepared to break the laws of physics, energy efficiency delivers:

- Lower Utility **Cost**
- More **Comfort**
- More **Durability**
- Improved **Indoor Air Quality**
- Protect **Environment**

### BUILDER VALUE PROPOSITION

- **Reduced Risk**
  - Mold Litigation
  - Comfort Complaints
  - Fixing Trades Mistakes
  - Catching up to Competition
- **Improved Reputation**
  - Quality Builder
  - Innovation Leader

What's this worth to your bottom-line?

CHANGING WORLD:  
BUILDER LIABILITY: NEW STORM




air leakage  
in envelope

air leakage  
in ducts

air leakage  
and  
air barriers  
in envelope





CHANGING WORLD:  
BUILDER LIABILITY: NEW STORM



*Defects no longer hidden...*




END GAME: CARBON NEUTRAL HOME




*Optimized energy efficiency plus some combination of renewable energy to offset remaining energy loads:*


- Passive Solar
- Solar Hot Water Heating
- Active Solar Heating/Cooling
- Renewable Electric Generation (PV, Wind)
- Green Tags
- Planting Trees



McCall Development 1626  
Stony Meadow "The Gallatin"  
Conditioned floor area – 3019 SF Full  
Basement

McCall Development 5438  
Elysan "The Sun – Craftsman" Conditioned  
Floor Area – 1655 SF Slab-on-grade



McCall Development ENERGY STAR Incremental Costs

Basement Insulation (with framing)	\$1,500
Furnace Upgrade	\$700
Duct Sealing	\$400
Building Tightening	\$600
Water Heater Upgrade	\$200
Verification/Performance Testing	\$400
Lighting Upgrades	\$200
<b>Total</b>	<b>\$4,000</b>



Stony Meadow		Elysian	
Weather Site	Helena	Helena	
Utility	NWE	NWE	
Conditioned Floor Area	3019	1655	
Foundation Type	Basement	Slab-on-grade	
	Code	NWESH	
HERS Index	85	61	
ENERGY STAR	Fails	Passes	
Tax Credit	Fails	Passes	
Ann. MMBtu/Yr	172.8	120.7	70%
Ann. Energy Cost	\$2,652	\$2,005	76%
Ann. Cost Savings		\$647	
Added Cost		\$4,000	
Simple Payback		6.5	
30 Year Savings (Energy Cost Escalation Rate)			
30Y Savings (1%)		\$21,254	
30Y Savings (3%)		\$29,069	
30Y Savings (5%)		\$40,594	
30Y Savings (10%)		\$100,506	
30 Year NPV Savings, 8% Discount Rate (Energy Cost Escalation Rate)			
30Y NPV Sav (1%)		\$7,559	
30Y NPV Sav (3%)		\$9,272	
30Y NPV Sav (5%)		\$11,619	
30Y NPV Sav (10%)		\$22,426	

Montana Energy Star Verifiers							
Last Name	First Name	Company	Address	City	State	Zip	Office Phone / Email
McPherson	Mike	Comfort Engineering	2535 Turkey Red Lane	Bozeman	MT	59715	408.585.8912 comforteng@yahoo.com
Heilem	Russ	Energetechs	615 Oak St, Suite 101	Missoula	MT	59801	408.721.2741 russ@energetechs.com
Wagenman	Neal	Billings Insulation Service	PO Box 31534	Billings	MT	59107	408.861.3640 neal@billingsinsulation.com
Doezal	Les	Leading Educational Services LLC	3428 File Circle	Billings	MT	59101	408.256.9393 lfd@lcsnet.com
Jones	Margaret	NW MT Human Resources Inc.	PO Box 6300	Kalispell	MT	59904-1300	408.758.5447 margie@valhrdc.mt.gov
Diem	John	Advanced Energy Solutions	255 Heligata Drive	Missoula	MT	59802	408.258.8146 john@avmsi.com
Robeson	Mike	CC Insulation & Urethane	1300 Lockwood Rd	Billings	MT	59101	408.245.3636 kalin@ccu@comcast.net
Klinefelter	John	Klinefelter's Insulation	3208 19th Ave. S.	Great Falls	MT	59405	408.788.2056 john@kibers.com
Clabry	Paul	O'Leary Builders	4692 12th Street NE	Great Falls	MT	59404	408.889.8027 paul@olearybuilders.com
Brown	Steve	EMT West	PO Box 5780	Helena	MT	59604	408.444.9714 steve.brown@emtwest.com
Schwahn	William	BV Inspections Bimbyday 10/10/06	PO Box 440	Belgrade	MT	59714	409.358.9690 wbschwahn@comcast.net
Spahrhawk	Erica		907 N. 29th Street	Billings	MT	59101	408.670.6552 ericas@spahrhawk.com
Palm	John	Baker Creek Log Homes	3010 Linney Road	Bozeman	MT	59718	408.580.6266 john@bakercreekloghomes.com
Gress	Tim	GPM Heating & Cooling	1635 McDonald Road	Missoula	MT	59801	408.880.1285 tgress@comcast.net
Hall	Sam		1110 Phillips St.	Missoula	MT	59802	408.398.7832 sballonus@earthlink.net

- Federal Tax Credit for New Homes**
- \$2000 to home builders (site-built and manufactured homes) 50% of the heating and cooling energy of the 2004 IECC and uses a SEER 13 air conditioner plus ..... building envelope improvements must account for at least 1/5 of the 50% energy savings.
  - \$1000 to manufactured home producers of units that are 30% of 2004 IECC or that qualify for Energy Star Homes program
  - These credits are available for homes placed in service (i.e. ready and available for use) from January 1, 2006, through December 31, 2008
  - These credits go to the builder or producer of the home

### IRS Tax Form

**Energy Efficient Home Credit**

Form **8908** (OMB No. 1545-0079) **2005**

Department of the Treasury Internal Revenue Service

Attach to your tax return.

Caution: This form may only be filed for fiscal years ending in 2006.

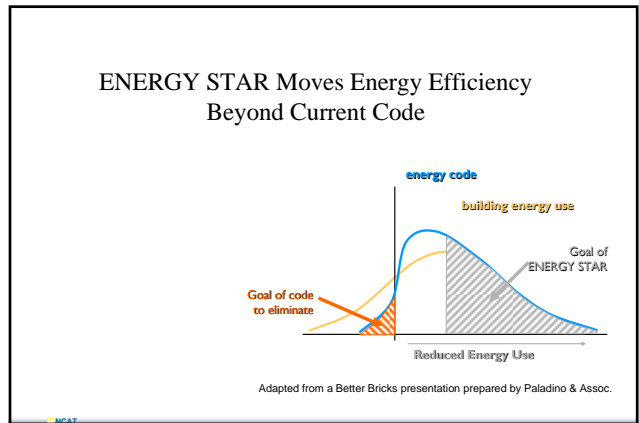
1a Enter the total number of qualified energy efficient homes meeting the 50% standard that were substantially completed after August 8, 2005, and sold after December 31, 2005 (see instructions) 1a

2a Enter the total number of qualified energy efficient manufactured homes meeting the 30% standard that were substantially completed after August 8, 2005, and sold after December 31, 2005 (see instructions) 2a

3 Form 8908 credits from pass-through entities: a Shareholder b Partner

4 Current year credit. Add lines 1b, 2b, and 3. Enter the total here and on line 11 of Form 990. Exceptions: S corporations and partnerships. See instructions.

- What Rater Does:**
- Perform Analysis (Projected Rating)
  - Provide appropriate information to enable builder to reach the 50% reduction
  - Certify with inspection confirmation of projected rating



**ENERGY EFFICIENCY COMPONENTS**

Address: \_\_\_\_\_

Ceiling: Flat \_\_\_\_\_ R- \_\_\_\_\_  
 Vachied \_\_\_\_\_ R- \_\_\_\_\_

Walls: Above grade walls \_\_\_\_\_ R- \_\_\_\_\_  
 Basement walls \_\_\_\_\_ R- \_\_\_\_\_  
 Floors: Crawlspace foundation \_\_\_\_\_ R- \_\_\_\_\_  
 Over unheated spaces \_\_\_\_\_ R- \_\_\_\_\_  
 Perimeter slab \_\_\_\_\_ R- \_\_\_\_\_  
 Under slab \_\_\_\_\_ R- \_\_\_\_\_

Exterior doors: \_\_\_\_\_ R- \_\_\_\_\_

Windows: NFRC unit rating (or) \_\_\_\_\_ U- \_\_\_\_\_  
 Default window rating \_\_\_\_\_ U- \_\_\_\_\_

Water heater: Energy factor (EF) rating \_\_\_\_\_

Heating system: Energy efficiency rating \_\_\_\_\_  
 (AFUE for gas; HSPF for pump) \_\_\_\_\_

Heating ducts: Systems sealed Yes \_\_\_\_\_ No \_\_\_\_\_  
 Insulated \_\_\_\_\_ R- \_\_\_\_\_

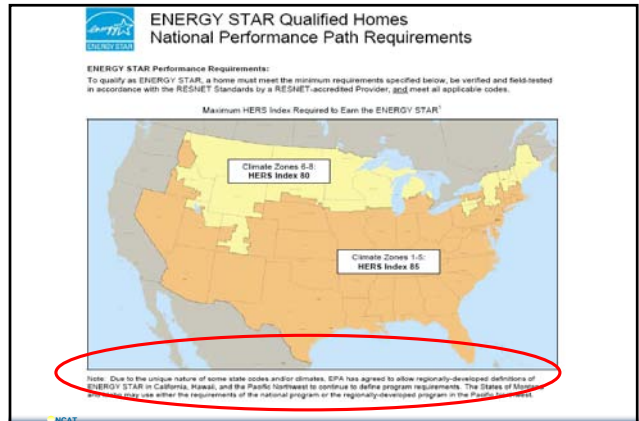
Other (i.e., ventilation systems, radon abatement) \_\_\_\_\_ R- \_\_\_\_\_

Insulation Subcontractor: \_\_\_\_\_  
 Certified by: \_\_\_\_\_ Date: \_\_\_\_\_  
 Builder (Company): \_\_\_\_\_

*The home builder certifies compliance with APM 6.30.004 by completing and signing this label.*

**THIS LABEL MUST BE PERMANENTLY AFFIXED BY HOME BUILDERS TO THE INTERIOR BREAKER PANEL ON ALL NEW RESIDENTIAL BUILDINGS, AS REQUIRED BY SECTION 50-60-603, MONTANA CODE ANNOTATED**

**Montana State Energy Efficiency Components Label**



**Northwest ENERGY STAR®**

**Save Money and Energy with ENERGY STAR Homes & Products**

[Build, Renovate, Trade-In, or Buy a New Home](#)

[www.NorthwestENERGYSTAR.com](http://www.NorthwestENERGYSTAR.com)

**Northwest ENERGY STAR® Partners**

**Home Builders**

**Trade Allies**

**Retailers**

**Return to Consumer Section**

[CLICK HERE](#)

**Partner Resources**

**Utilities**

For partners of the Northwest Energy Efficiency Alliance.

[CLICK HERE](#)

**Builders**

For builders who are ENERGY STAR certified, or who would like more information on how to become certified.

**Trade Allies**

For contractors, vendors, distributors and sales agents supporting ENERGY STAR homes.

**Retailers**

For retailers participating in the ENERGY STAR Consumer Products Program.

[Energy Trust of Oregon Builders and Trade Allies click here](#)

[www.NorthwestENERGYSTAR.com](http://www.NorthwestENERGYSTAR.com)

**Northwest ENERGY STAR®**

**Home Builders**

**Important Update to Northwest ENERGY STAR Cooperative Marketing Funds for 2008.**

Welcome to Northwest ENERGY STAR Homes, a new construction program based on energy efficiency standards developed by the Environmental Protection Agency (EPA) and the Northwest Energy Efficiency Alliance.

**ABOUT US**  
 The Northwest Energy Efficiency Alliance (NWEA) is a non-profit organization supported by private utilities and public benefits administrators, state governments, public interest groups and energy efficiency industry representatives. These utilities and partners have developed energy efficiency standards and incentive programs available in the marketplace. For more information about NWEA please visit our website at [www.nwea.org](http://www.nwea.org)

**BUILDER WORKSHEETS**  
 The Program requires builder worksheets on certified new home construction throughout the year. These worksheets offer the opportunity to learn from building experts how to build an energy-efficient home. Please visit the Trust Center for updates as our 2008-2009 2009 program information.

[www.NorthwestENERGYSTAR.com](http://www.NorthwestENERGYSTAR.com)

**Northwest ENERGY STAR®**

**Home Builders**

- TCO #1 - Alternative Materials Construction (PFI)
- TCO #2 - Advanced Lighting Package (PFI)
- TCO #3 - Insulation Package (PFI)
- TCO #4 - Electric Hot Water Heating System (PFI)
- TCO #5 - Insulated Frame (or) RFI - Certified (or) weather or RFI for more information)
- TCO #6 - Insulated Frame (or) RFI - Certified (or) weather or RFI for more information)
- TCO #7 - Insulated Frame (or) RFI - Certified (or) weather or RFI for more information)
- TCO #8 - Insulated Gas and Heaters with EcoStar Residential (or) Heating (PFI)
- TCO #9 - Insulated Ductless Split (or) Pump with Electric Resistance Zone Heating (PFI)
- TCO #10 - 60 AFUE Package (PFI)
- TCO #11 - 80 AFUE Gas Furnace Package (PFI)
- TCO #12 - Collette (or) The Storm and Windows and (PFI)
- TCO #14 - Lighting Details Package (or) 100% per Report Card

**100% per Report Card**

For a Technical Compliance Option application or details on previously approved trade offs, select from the items below:

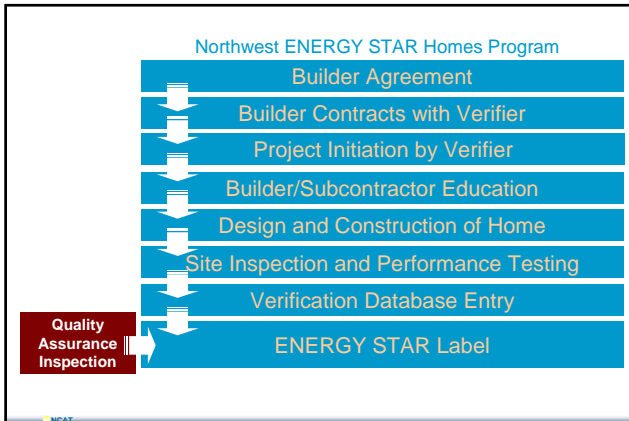
- TCO Application (PFI)
- TCO Application (PFI)

**Technical Compliance Option**  
 The Technical Compliance Option provides a detailed technical checklist to the specifications required by the Northwest ENERGY STAR Homes Certification Requirements.

**GreenSource Heat Pump Supplemental Specifications**  
 The following specifications are for homes utilizing ground source heat pumps for their primary heat source.

**GreenSource Heat Pump Supplemental Specifications (PFI)**

[www.NorthwestENERGYSTAR.com](http://www.NorthwestENERGYSTAR.com)



**ENERGY STAR<sup>®</sup> Homes Northwest**  
**BUILDER PARTNERSHIP AGREEMENT**

This is an Agreement to become a builder partner in the ENERGY STAR Homes Northwest Program, which is administered by the Northwest Energy Efficiency Alliance. The ENERGY STAR Homes Northwest program is offered in the areas of Idaho, Montana, Oregon and Washington to bring ENERGY STAR qualified homes to home buyers throughout the Northwest.

**COMPANY INFORMATION** (see you would like it to appear on the ENERGY STAR website)

Company Name: \_\_\_\_\_  
Address: \_\_\_\_\_  
City: \_\_\_\_\_ State: \_\_\_\_\_ Zip: \_\_\_\_\_  
Phone: \_\_\_\_\_  
E-mail: \_\_\_\_\_

Registered service area: (check all that apply)  
 All Oregon  All Washington / 1 Idaho  
 All Oregon  All Washington  All Idaho  
 All Oregon  All Washington  All Idaho

Please indicate the role of the built home builder you are: (check all that apply)  
 Small Builder (Residential)  Medium (Subcontractor)  Corporate (Professional)  Licensed Homeowner  
 Number of years in business: \_\_\_\_\_ (percentage number of years last year): \_\_\_\_\_

ENERGY Environmental Rights: Builders interested in special recognition can contact building and testing (100% of their homes ENERGY STAR Qualified) and an approved third-party (100% of the homes ENERGY STAR Qualified) partner builder that meets the ENERGY STAR Qualified Home Label has been reported to the U.S. Environmental Protection Agency to make the certification process faster here: \_\_\_\_\_

**CONTACT INFORMATION**  
 Building / Sales Contact (please print): \_\_\_\_\_ Title: \_\_\_\_\_  
 Phone: \_\_\_\_\_ E-mail: \_\_\_\_\_  
 Authorized Company Representative (please print): \_\_\_\_\_ Title: \_\_\_\_\_  
 Phone: \_\_\_\_\_ E-mail: \_\_\_\_\_

By signing this Agreement, I represent that the information provided in this Application is true and I acknowledge that I shall understand and comply with the Program Specific and Requirements outlined on the back of this application, as well as the ENERGY STAR Homes Northwest Certification Requirements. I also acknowledge that by signing this agreement, I will become a partner in the national ENERGY STAR program, managed by the U.S. Environmental Protection Agency.

**CONTACT:**  
 ENERGY STAR Homes Northwest  
 PO Box 4433  
 Portland, OR 97208-4433  
 Phone: (503) 341-1305  
 Fax: (503) 324-1563  
 Email: info@energystarhomes.com

**Builder Partnership Agreement includes:**

- Company address & contact information
- Program benefits and requirements
- Use of ES name & label for promotion
- Disclaimers

Builder Partnership Agreement

**ESHNW Prescriptive Approach**

ENERGY STAR<sup>®</sup> Homes Northwest Certification Requirements Single Family Homes

Residential Package (BOP) is a prescriptive method for verifying and certifying ENERGY STAR qualified homes. All components of the RESIDENTIAL PACKAGE (BOP) must be completed and verified by the Verifier. The BOP is a prescriptive method for verifying and certifying ENERGY STAR qualified homes. All components of the RESIDENTIAL PACKAGE (BOP) must be completed and verified by the Verifier.

Component	Requirement	Verification Method
Attic <td>R-49 <td>Insulation</td> </td>	R-49 <td>Insulation</td>	Insulation
Exterior Wall <td>R-21 <td>Insulation</td> </td>	R-21 <td>Insulation</td>	Insulation
Window <td>U-0.35 <td>Window</td> </td>	U-0.35 <td>Window</td>	Window
Floor (over non-cond. space) <td>R-21 <td>Insulation</td> </td>	R-21 <td>Insulation</td>	Insulation
Crawlspace Wall <td>R-20 <td>Insulation</td> </td>	R-20 <td>Insulation</td>	Insulation
Basement Wall <td>R-11* <td>Insulation</td> </td>	R-11* <td>Insulation</td>	Insulation
Slab Floors <td>R-13: 4' <td>Insulation</td> </td>	R-13: 4' <td>Insulation</td>	Insulation
Air Distribution Design <td>Yes <td>Yes</td> </td>	Yes <td>Yes</td>	Yes

**ENERGY STAR and MT Energy Code in Brief**

	MT Code	NG/HP BOP #1
Attic	R-49	R-49
Exterior Wall	R-21	R-21
Window	U-0.35	U-0.35
Floor (over non-cond. space)	R-21	R-30
Crawlspace Wall	R-20	R-30
Basement Wall	R-11* <small>When finished.</small>	R-19
Slab Floors	R-13: 4'	R-10: 2'
Air Distribution Design	Yes	Yes

Not Enforced

**ENERGY STAR and MT Energy Code in Brief**

	MT Code	NG/HP BOP #1
Duct Sealing	Tape	Mastic
Duct Tightness	NA	0.06 CFM/SF <small>Testing Required.</small>
Construction Cavity Chases	Yes	No
Ventilation	Code	Code
Envelope Tightness	Not Specified	7 ACH50 <small>Testing Required.</small>
Gas Furnace	78% AFUE	90% AFUE
Gas Water Heater	0.62 EF	0.62 EF
Electric Water Heater	0.93 EF	0.93 EF
Lighting	NA	50% ES

**ENERGY STAR Homes Northwest Label**

**CHANGE FOR THE BETTER WITH ENERGY STAR**

ESHNW BOP 1  
Technical Compliance Option #4  
Gas Hydronic Heating System

**ENERGY STAR Homes Northwest**

115 Colorado Street, Whitefish, MT

Advanced Energy Solutions

April 28, 2005

ENERGY STAR<sup>®</sup> Homes Northwest Certification

**CHANGE FOR THE BETTER WITH ENERGY STAR**

ESHNW BOP 1  
Technical Compliance Option #4  
Gas Hydronic Heating System

**ENERGY STAR Homes Northwest**

5187 Forest Hill Lane, Missoula, MT

Energetechs

April 29, 2005

ENERGY STAR<sup>®</sup> Homes Northwest Certification

LEED for Homes & Northwest ENERGY STAR Homes						
Dark border indicates mutually exclusive credits.						
LTO = Total duct leakage to outside						
The credits shown in blue will accomplish NWESH certification.						
- NWESH has specific insulation requirements for particular components.						
Prq	EA	LEED for Homes	Northwest ENERGY STAR Home BOP #1	Min.	Typ	Code
2.1*	2.1*	Basic Insulation & TBC	Insulation Yes, No TBC	Yes	Yes	Yes
2	2.2	Enhanced Insulation	Probably			
3.1	3.1	Reduced Envelope Leakage (<=5 ACH50)	Probably	Yes	Yes	No
3	3.2	Greatly Reduced Envelope Leakage (<=3.5 ACH50)	Maybe		2	
3	3.3	Minimum Envelope Leakage (<=2 ACH50)	Maybe			
4.1	4.1	Good Windows (<=U0.30)	Yes	Yes	Yes	Yes
2	4.2	Enhanced Windows (<=U0.31)	No			
3	4.3	Exceptional Windows (<=U0.20)	No			
Reduced Duct Distribution Losses						
5.1	5.1	LTD<=0.04 cfm25, fully ducted, R-6)	Probably	Yes	Yes	No
5	5.2	Greatly Reduced Duct Distribution Losses (LTD<=0.03 cfm25)	Maybe		2	
5	5.3	Minimal Duct Distribution Losses (LTD<=0.03 cfm25, ducts inside, <=2 ACH50)	Maybe			
6.1	6.1	Good HVAC Design & Installation (ACCA Manual J, 90% AFUE)	Yes	Yes	Yes	Yes
8.2	8.2	High Efficiency HVAC (90% AFUE)	No		2	
8.3	8.3	Very High Efficiency HVAC (94% AFUE)	No			
7	7.1	Efficient Hot Water Distribution	No			
1	7.2	Pipe Insulation (R1 R6)	No			
8.1	8.1	Efficient DHW Equipment (40 Gal Gas EPA=0.01, 50 Gal EI EF=0.52)	Yes	-3	3	
8.1	8.1	ENERGY STAR Lights (4 in high use rooms)	Yes	Yes	Yes	No
1.5	8.2	Improved Lighting (3 additional)	Yes	1.5	1.5	
3	8.3	Advanced Lighting Package (with fixtures)	Probably		3	
9.1	9.1	High Efficiency Appliances (Refr-1, Ctg)	Yes			
1	9.2	Water Efficiency Appliances (Refr-1, Ctg)	Dishwasher Only	0.5	0.5	
26.5	26.5	Maximum		5	14	6

26.5

14

0

NAHB Model Green Home Building Guidelines & NWESH					
Dark border indicates mutually exclusive credits.					
LTO = Total duct leakage to outside					
The credits shown in blue will accomplish NWESH certification.					
- NWESH has specific insulation requirements for particular components.					
Prq	EE	NAHB Model Green Home Building Guidelines	NWESH BOP #1	Code	Yes
Req	3.1.1	Meets 2003 IECC	Yes	Yes	Yes
Req	3.1.2	ACCA Manual J	Yes	Yes	Yes
Req	3.1.3	Third Party Verification	Yes	Yes	Yes
EE 10 points minimum					
8.3.3.1 A SIPS					
8.3.3.1 A ICF					
6.3.3.1 A Exterior Wall Advanced Framing					
2.3.3.1 A Recessed Neck Trusses					
4.3.3.1 A Continuous Insulated Sheathing Exterior Walls					
10.3.3.1 B Air Sealing					
8.3.3.2 C ENERGY STAR Windows (No Zone I+O.35)					
8.3.3.2 A ACCA Manual D for Ducts					
8.3.3.2 B Radiant/Infrared Design Standards					
8.3.3.2 C ACCA Manual S for Htg. & Ctg. Selection					
8.3.3.2 D Htg. & Ctg. System Commissioning					
6.3.3.2 E HVAC Installer Certification					
8.3.3.2 E Gas Furnace AFUE >=81%, AFUE					
8.3.3.2 E Gas Furnace AFUE >=81%, AFUE					
8.3.3.2 E Gas Furnace AFUE >=90%, AFUE					
8.3.3.2 E Seal Ducts with Tapes or Mastic					
8.3.3.2 E Fully Ducted, No Building Cavities					
8.3.3.2 N Pressure Relief in Entry Room					
1.3.3.2 N ENERGY STAR Ceiling Fans (points per fan)					
8.3.3.2 D Whole House Fan					
8.3.3.2 F ES Bedroom Exhaust to Outside					
8.3.3.3 A Gas DHW 40 Gal EF=>62					
8.3.3.3 B Electric DHW 50 Gal EF=>60					
8.3.3.3 B Whole House Tankless DHW					
8.3.3.3 C Insulate Hot Water Lines					
7.3.3.4 A ENERGY STAR Advanced Lighting Package					
7.3.3.4 B Recessed Fixtures with Thermal Envelope					
7.3.3.4 C Motion Sensors on Exterior Lighting					
2.3.3.4 D Tubular Skylights in Room without Windows					
3.3.3.4 E ENERGY STAR Refrigerator					
3.3.3.4 E ENERGY STAR Dishwasher					
3.3.3.4 E ENERGY STAR Clothes Washer					
8.3.3.6 1 Third Party Verification					
8.3.3.6 2 Duct Leakage Test					
8.3.3.6 3 Duct System Balancing					
205			83	32	

205

83



32

### Performance Testing Requirements



- ➔ Duct Leakage Testing (if outside the thermal envelope)
- ➔ Blower Door Testing all Homes in Montana (only BOP 2 Homes in OR & WA)
- ➔ Combustion Appliance Zone Test if unsealed combustion appliance in house with forced air system
- ➔ Refrigerant Testing and Commissioning for Heat Pumps

### Technical Compliance Options (TCOs)

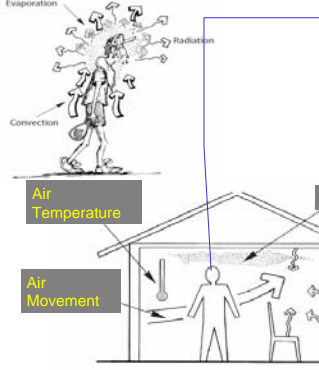
- TCO #1: Perimeter Insulated Crawlspace
- TCO #3: Advanced Lighting Package
- TCO #4: Gas Hydronic Heating System
- TCO #5: Electric Hydronic Heating System
- TCO #6: U-value Tradeoff for BOP 1
- TCO #7: U-value Tradeoff for BOP 2
- TCO #8: DHW Efficiency for Uo Trade off
- TCO #9: Hybrid Gas Unit Heaters with Electric Resistance Zonal Heating
- TCO #10: Hybrid "Ductless Split" Heat Pump with Electric Resistance Zonal Heating
- TCO #11: 90 AFUE Propane Furnace
- TCO #12: Heat Pump HSPF 8.3 with Gas Backup
- TCO #13: Cathedral Attic
- TCO #14: Lighting Density Package
- TCO #15: Conditioned Crawlspace

## Moisture

- Water related to 90% of building and material failures (ASHRAE)
- Estimated \$9 Billion/year in repairs



#### Internal Comfort Factors

1. Metabolic Rate
2. Clothing Insulation

#### External Comfort Factors

1. Mean Radiant Temperatures
2. Air Temperatures
3. Relative Humidity
4. Air Movement

Source - Residential Energy Thermal Comfort Criteria ASHRAE Standard 55



R- values measure thermal resistance

R-value is the inverse of U-value:  $R=1/U$  and  $U=1/R$

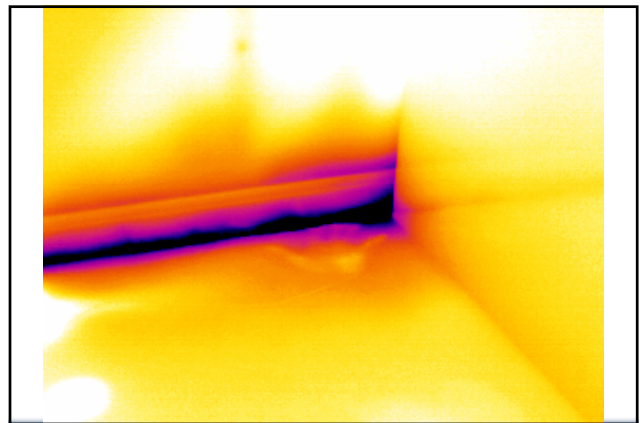
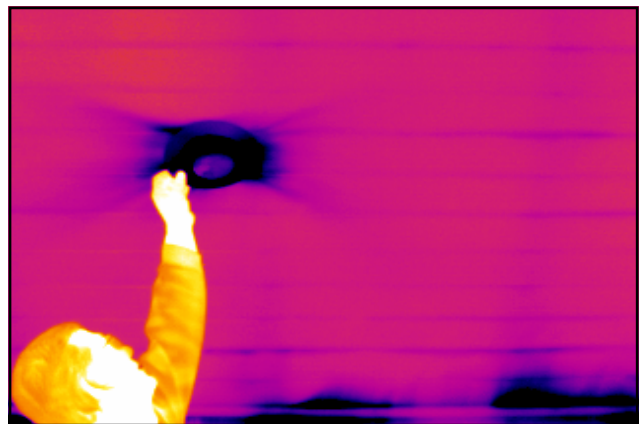
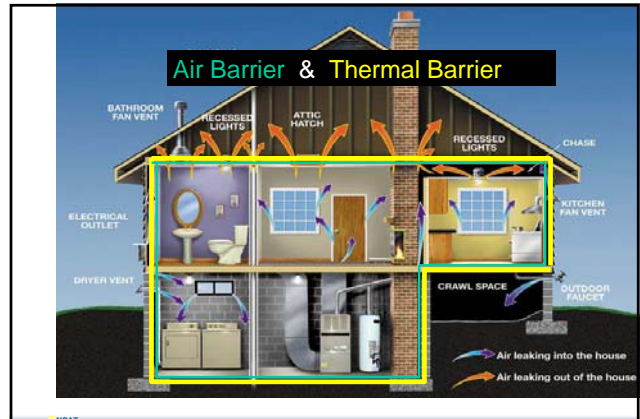
R-values are additive, U-values are not additive

R-values of a series of components can be added; the inverse of this sum will be the

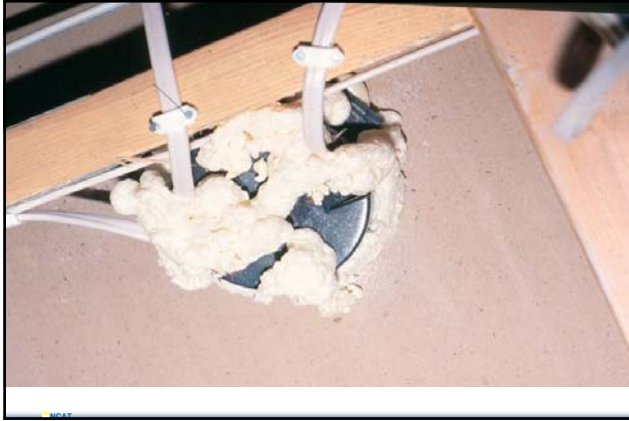
$$\rightarrow R1 + R2 = R \text{ total}$$

$$\rightarrow U1 + U2 = \text{Garbage}$$

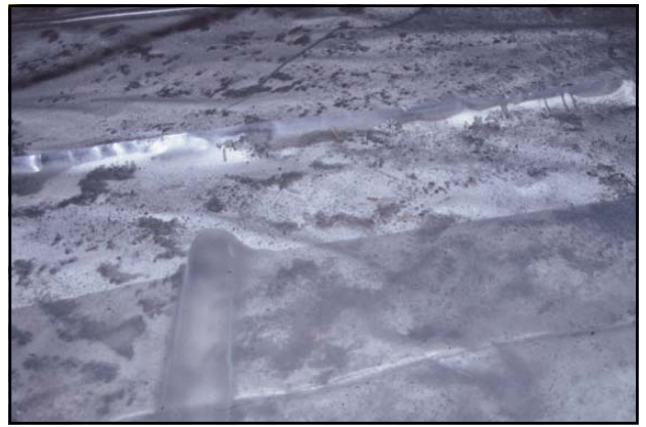
$$\rightarrow R = 1/U \text{ and } U = 1/R$$





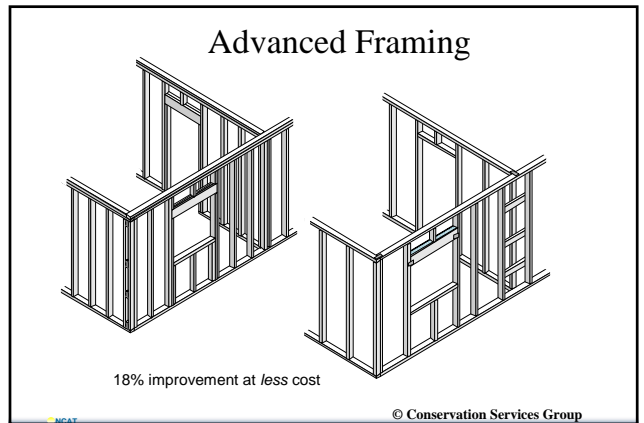


Air Sealing







Interior Basement Insulation



### CORNER FRAMING

Courtesy of Building Science Corp.

Courtesy of Southface Institute

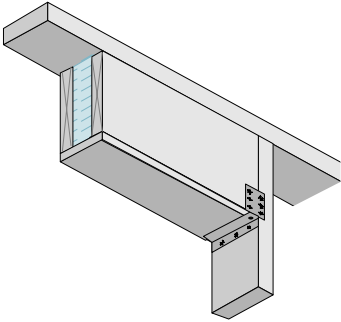
INSIDE "TWO-STUD" CORNERS

Position slip support for gypsum board so that it does not interfere with trim molding

Backer support for gypsum board


The first drywall sheet is installed against side with slip of stud

### Insulated Header



© Conservation Services Group

### WHY SPRAY FOAM




**Closed Cell Foam = Air Barrier + Insulation**

Consider using at:

- Band Joists
- Behind Tubs/Showers
- Cantilevered Floors
- Conditioned Space Above Garage
- Party Walls (must be fire-proof)


### WHY INSULATED SHEATHING




**Rigid Insulation = Air Barrier + Insulation + Thermal Break**

Where code acceptable, consider using at:

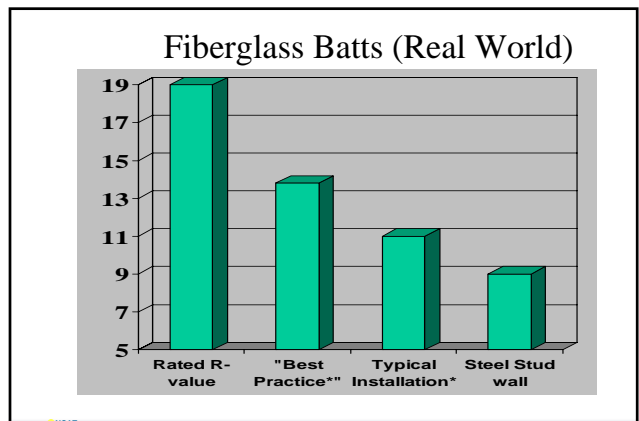
- Exterior Sheathing
- Attic Knee Walls
- Skylight Shafts
- Porch/House Interface



### Why is it So Bad?



- The gaps and spaces dominate the heat loss
- No matter how much insulation you pile up next to a gap, the heat loss through the gap is not reduced at all
- The larger the initial R-value, the greater the effect





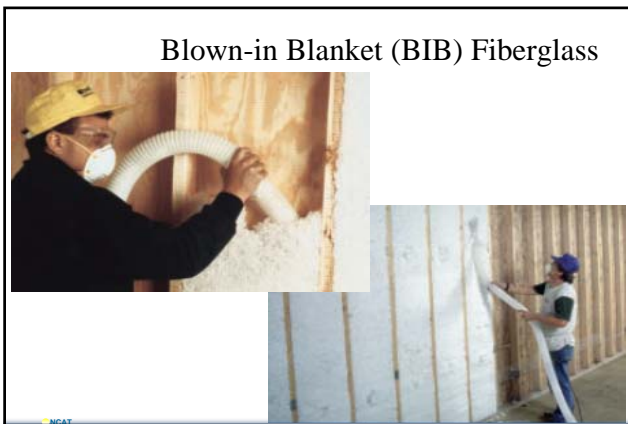
### Typical installations...



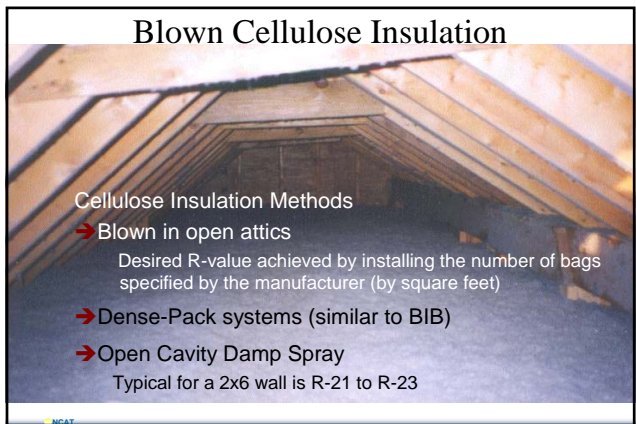
### Correct Installation



### Blown-in Blanket (BIB) Fiberglass



### Blown Cellulose Insulation



#### Cellulose Insulation Methods

- ➔ Blown in open attics  
Desired R-value achieved by installing the number of bags specified by the manufacturer (by square feet)
- ➔ Dense-Pack systems (similar to BIB)
- ➔ Open Cavity Damp Spray  
Typical for a 2x6 wall is R-21 to R-23

### Insulation Quick Comparison (A work in progress.)

Material	Type	R-Value	Ozone Depleting Agent	Density	Vapor Retarder	Recycled Content	Common or Brand Name
Fiberglass	batts	3.6	No	3 pcf	Permeable	Doubtful	
	loose fill	3.2	No	2-3 pcf	Permeable	Doubtful	
Cellulose	Loose Dry	3.4	No	1.5-2.0 pcf	Permeable	Yes	
	Wet Blown	4.0	No		Permeable	Yes	
Expanded Polystyrene	Rigid Board	4.0	No	low 1 pcf	Permeable	Doubtful	beadboard
	Rigid Board	4.0	No	high 2-3 pcf	Semi-impermeable	Doubtful	
Extruded Polystyrene	Rigid Board	5.0	Yes	2 pcf	Semi-impermeable	Doubtful	Styrofoam Blue Board
Polyisocyanurate	Rigid Board	7.0	Yes	3 pcf	Imperm w/ facing	Doubtful	Thermax
Polyurethane	Spray Foam	3.6-3.8	No, water	low 0.5 pcf	Permeable	Doubtful	Icynene, Seallection 500
<b>Low Density</b>	Spray Foam	3.7-3.6	No, soy	low 0.5 pcf	Permeable	Doubtful	Biobase 501, Healthy Seal
	Spray Foam	5.5	No, soy	high 1.7 pcf	Semi-impermeable	Doubtful	Biobase 1701
<b>High Density</b>	Spray Foam	6.0 - 8.0	Yes	high 2 pcf	Semi-impermeable	Doubtful	

Remarks:

- Fiberglass is susceptible to convective currents and poor installation and may contain formaldehyde.
- Styrene and urethane insulations may give off toxic gases when if burned.
- In general, low density foams are open cell and high density foams are closed cell.
- Vapor permeability of depends on thickness, especially with foams.

Perms	Vapor Impermeability
<=0.1	Impermeable
0.1> and <=1.0	Semi-impermeable
1.0> and <=10	Semi-permeable
>10	Permeable

### Grade I Assessment

Installed according to manufacturer's instructions, fills each cavity completely, no substantial gaps or voids, split and fit tightly around wiring and other services

### Boundary condition for "Grade I"




Grade I is required if using national BOP




**Grade II Assessment**

Moderate to frequent defects such as gaps around wiring, electrical outlets, plumbing, and other services; rounded edges or shoulders.

**Boundary condition for "Grade II"**



Gaps clear through insulation: <math>< 2\%</math>



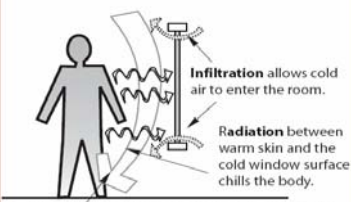
Compression or incomplete fill: <math>< 10\%</math> of area, compressed by <math>< 30\%</math> of intended thickness

**Winter Window Comfort Factors**

**Window Surface Temperature**

Glass surface temperature at 25°F outdoor, 70°F indoor temperature:

- Single glass 52 °F
- Double glass 59 °F
- Low E + Argon 62 °F
- High Performance 64 °F (Heat mirror films)




**Infiltration** allows cold air to enter the room.

**Radiation** between warm skin and the cold window surface chills the body.

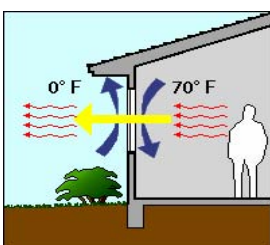
**Convection** currents are formed when air near the colder window surface cools, becomes denser, and flows downward, creating a continuous flow pattern.

Windows create three wintertime comfort problems.


Source - Residential Energy



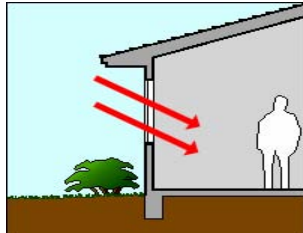
**A** **U-Factor** measures how well a product prevents heat from escaping a home or building. U-Factor ratings generally fall between 0.20 and 1.20. The lower the U-Factor, the better a product is at keeping heat in. U-Factor, takes into account more than conductivity. It also is affected by the airflow around the window.




[www.nfrc.org](http://www.nfrc.org)



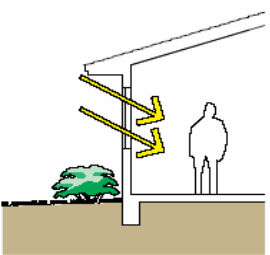
**B** **Solar Heat Gain Coefficient (SHGC)** measures how well a product blocks heat from the sun. SHGC is expressed as a number between 0 and 1. The lower the SHGC, the better a product is at blocking unwanted heat gain. Assumes the sun strikes the glass at 90 degrees.




[www.nfrc.org](http://www.nfrc.org)



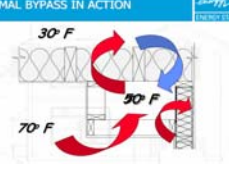
**C** **Visible Transmittance (VT)** measures how much light comes through a glazing. VT is expressed as a number between 0 and 1. The higher the VT, the higher the potential for daylighting.




[www.nfrc.org](http://www.nfrc.org)



**THERMAL BYPASS IN ACTION**



**ENERGY STAR Qualified Homes**



**THERMAL BYPASS CHECKLIST GUIDE**

**THERMAL BYPASS PRINCIPLE**

**Insulation:**

Resists Heat Flow

Air Flow

**...need Air Barrier**

any solid material that blocks air flow including sealing at edges and seams

**THERMAL BYPASS CHECKLIST:**

**1. INSULATION ALIGNMENT**

**THERMAL BYPASS CHECKLIST:**

**1. INSULATION ALIGNMENT**

**THERMAL BYPASS CHECKLIST:**

**2. SHOWER/TUB EXTERIOR WALL**

*Courtesy of Building Science Corp.*

**THERMAL BYPASS CHECKLIST:**


**2. SHOWER/TUB EXTERIOR WALL**

**THERMAL BYPASS CHECKLIST:**

**3. INSULATED FLOOR OVER GARAGE**

**Improper insulation!**  
It must touch the surface it is intended to insulate

THERMAL BYPASS CHECKLIST:  
4. ATTIC KNEE WALLS

**Hot Wall**


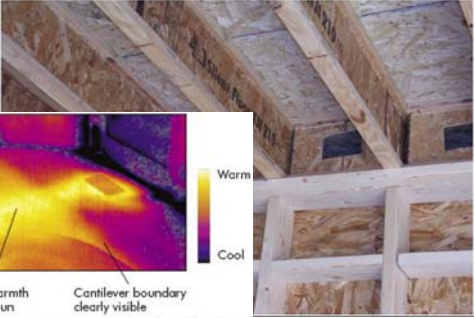
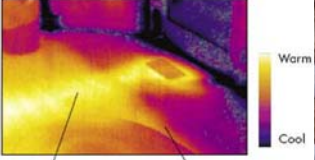
Courtesy of Building Science Corp.

THERMAL BYPASS CHECKLIST:  
5. ATTIC ACCESS STAIRS




**Right**

THERMAL BYPASS CHECKLIST:  
6. CANTILEVERED FLOOR



Residual warmth from heat run

Cantilever boundary clearly visible

Warm

Cool

THERMAL BYPASS CHECKLIST:  
7. DUCT/PIPING PENETRATIONS






Insulation will not stop air flow

**Airtight foam on pervious rock wool will not work.**

Courtesy of Advanced Energy Corporation

THERMAL BYPASS CHECKLIST:  
8. FLUE SHAFT

**TIP:**  
Specially colored fire-rated foam now available for sealing difficult air gaps at flue openings

Courtesy of Building Science Corp.

Image courtesy of EnergyLogic

THERMAL BYPASS CHECKLIST:  
9. ATTIC EAVES







THERMAL BYPASS CHECKLIST:  
9. ATTIC EAVES




*Baffles at every bay*

Image courtesy of MaGrann Associates

THERMAL BYPASS CHECKLIST:  
10. DROPPED CEILINGS




Courtesy of Building Science Corp.

THERMAL BYPASS CHECKLIST:  
10. DROPPED CEILINGS




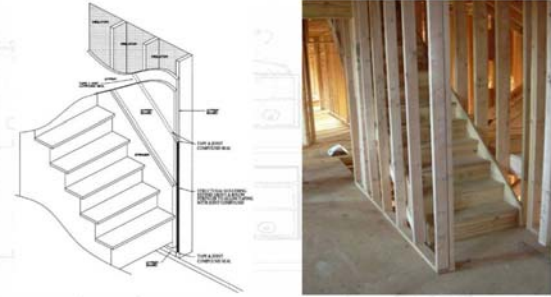

Courtesy of Building Science Corp.

THERMAL BYPASS CHECKLIST:  
11. FIREPLACE SHAFT WALL




Courtesy of Building Science Corp.


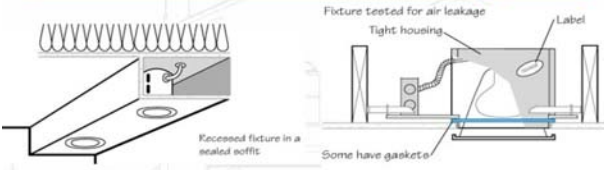
THERMAL BYPASS CHECKLIST:  
12. STAIRCASE FRAMING

Courtesy of MaGrann Associates

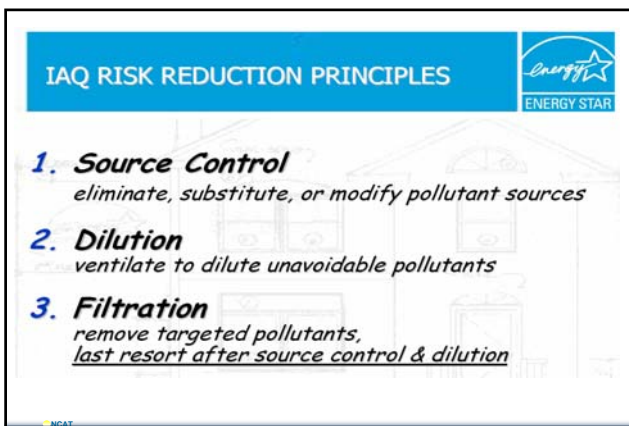
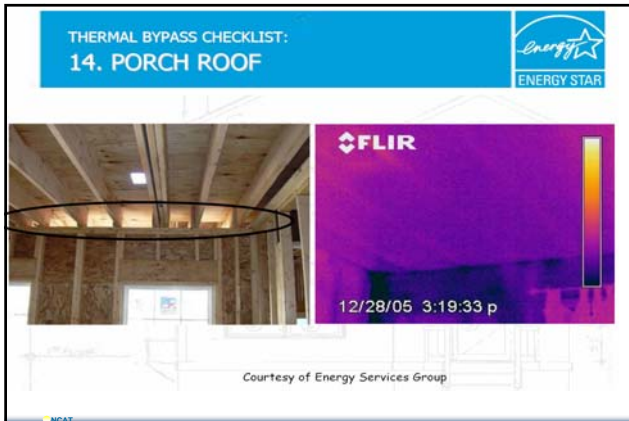
Image courtesy of Energy Services Group

THERMAL BYPASS CHECKLIST:  
13. RECESSED LIGHTING

*Eliminate this air leakage by locating fixtures inside the insulated envelope or using insulated can, air-tight (ICAT) recessed fixtures.*





**Infiltration versus Mechanical Ventilation**

	<u>Infiltration</u>	<u>Mechanical Ventilation</u>
Reliable appropriate quantity of air	NO	Yes
Air delivered to appropriate spaces	NO	Yes
Can be shut off if house is unoccupied	NO	Yes
Quality of air good as outdoor air	NO	Yes

Note: This assumes mechanical system is properly designed.

## Mechanical Ventilation

REM/RATE assumes ASHRAE 62.2-2003

Requires continuous whole-building\* mechanical ventilation based on conditioned floor area and # of bedrooms

7.5 cfm/bedroom +1 plus 1 cfm/100 SF

Example: 3-bedroom 2400 SF house

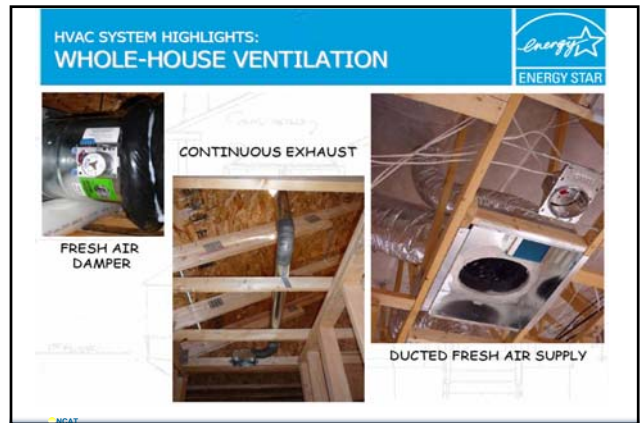
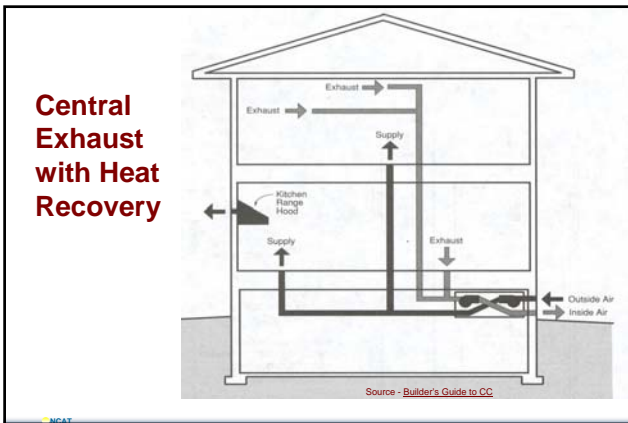
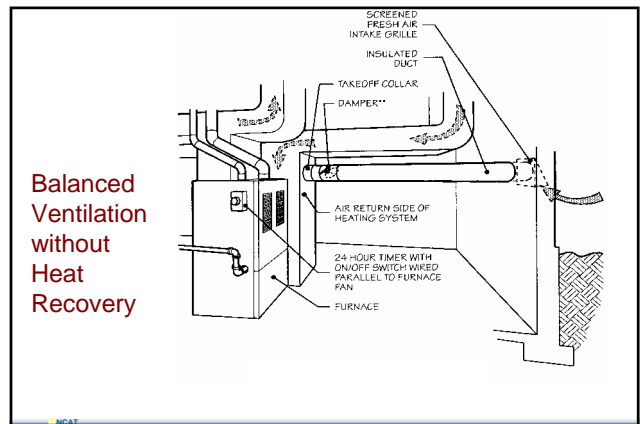
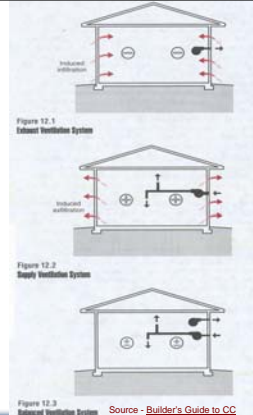
$$(7.5 \text{ cfm} \times (3+1)) + (2400/100) = 54 \text{ cfm}$$

\* - Mech exhaust system may include local exhaust fans.


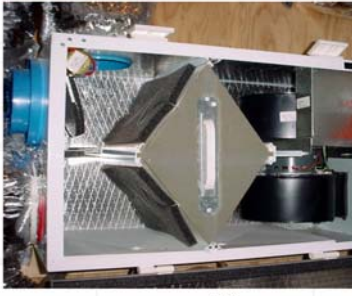
Residential Energy's BTL is out-of-date

## Mechanical Ventilation System Types

1. Exhaust Only
2. Supply Only
- Balanced:**
3. Spot exhaust w/ make-up air
4. Central exhaust without heat recovery
5. Central exhaust with Heat Recovery



### HVAC SYSTEM HIGHLIGHTS: WHOLE-HOUSE VENTILATION

**Energy Recovery Ventilator**  
Exhaust air leaves much of its heat or cooling energy on the wheel

**Indoors**  
Rotating wheel transfers heat and humidity between two airstreams.

**Outdoors**  
Intake air is cooled and dehumidified in summer or heated and humidified in winter.


An ERV transfers heat and humidity between airstreams, recovering heat during winter and recovering cooling energy during summer.

Source: Residential Energy

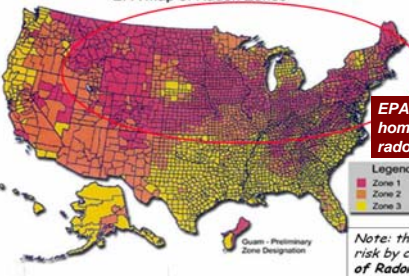
ERV



### RADON CONTROL HIGHLIGHTS: RADON RESISTANT CONSTRUCTION



#### EPA Map of Radon Zones



Radon Risk is High in much of the U.S. Check State & local authorities for more detailed information on Radon risk in your area.

**EPA recommends that all homes built in Zone 1 have radon reduction systems.**

Legend  
 Zone 1  
 Zone 2  
 Zone 3

Note: these maps indicate average risk by county. However, High levels of Radon can be found anywhere, and soil gases may be toxic!



United States Environmental Protection Agency  
 EPA/600/R-01/002  
 April 2001  
 Office of Air and Radiation

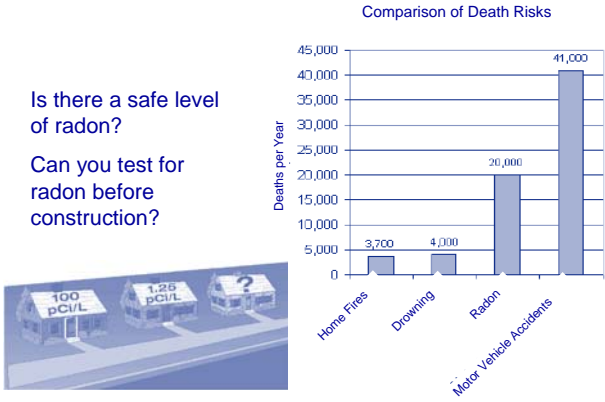
### Building Radon Out

A Step-by-Step Guide On How To Build Radon-Resistant Homes

<http://www.epa.gov/radon/pdfs/buildradonout.pdf>

#### Comparison of Death Risks

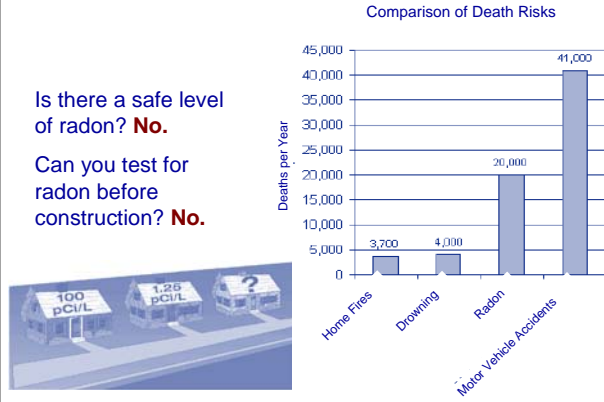
Is there a safe level of radon?  
 Can you test for radon before construction?



Category	Deaths per Year
Home Fires	3,700
Drowning	4,000
Radon	20,000
Motor Vehicle Accidents	41,000

#### Comparison of Death Risks

Is there a safe level of radon? **No.**  
 Can you test for radon before construction? **No.**



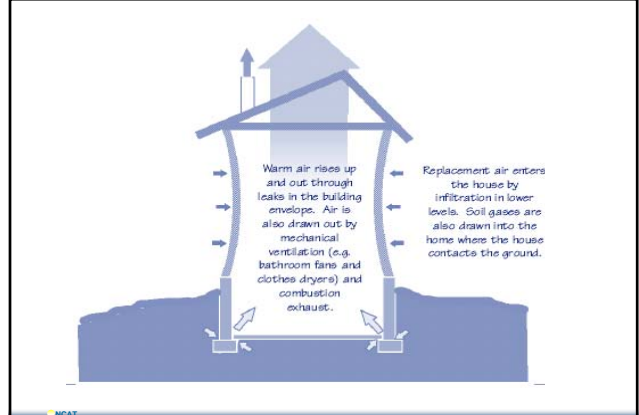
Category	Deaths per Year
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Radon	20,000
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## How Does Radon Enter A House?



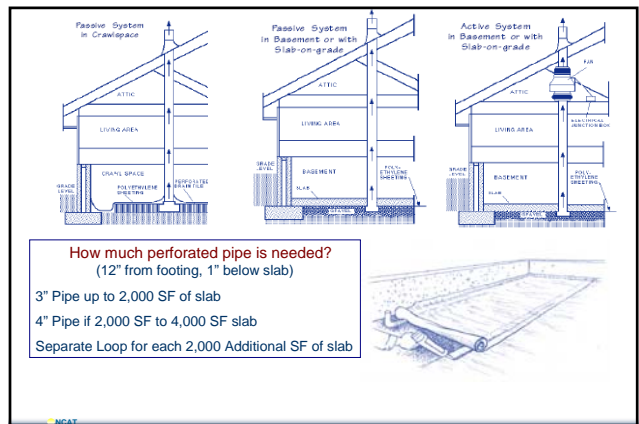
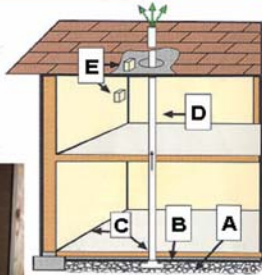
Common Radon Entry Points



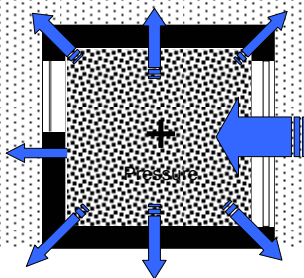
## RADON CONTROL HIGHLIGHTS: RADON RESISTANT CONSTRUCTION



- A. Gas Permeable Layer**  
(4" clean gravel)
- B. Plastic Sheeting**  
(under slab or over crawl space)
- C. Sealing and Caulking**  
(all openings in concrete floor)
- D. Vent Pipe**  
(3 or 4 inch PVC pipe)
- E. Junction Box**  
(if fan needed later)



CFM air in = CFM air out



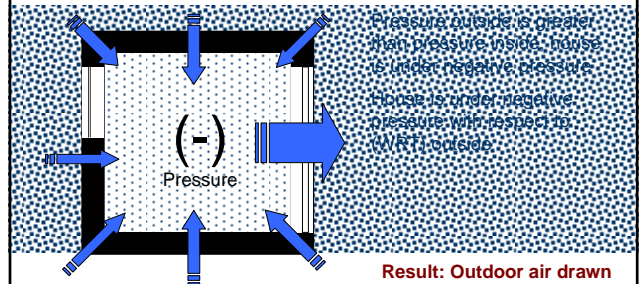
### House Pressurization

Pressure inside is greater than pressure outside. house is under positive pressure.

House is under pressure with respect to (WRT) outside

Result: Indoor conditioned air forced into structure.

CFM air in = CFM air out



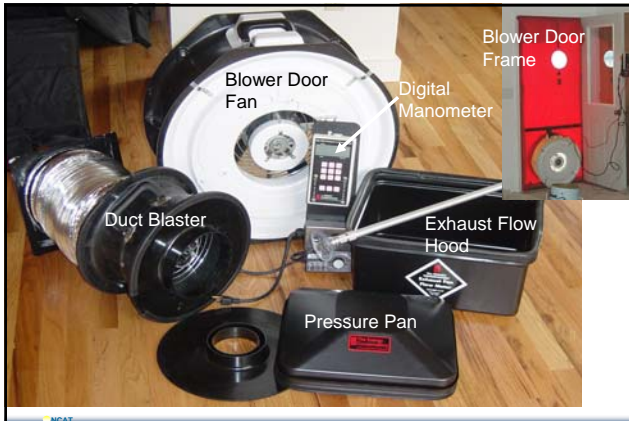
### House Depressurization

Pressure outside is greater than pressure inside. house is under negative pressure.

House is under negative pressure with respect to (WRT) outside

Result: Outdoor air drawn into house.





### Building tightness testing is an estimator, not a "true" predictor, of building infiltration.

#### Blower-Door Testing

Measuring house pressure and airflow with analog manometers during a blower door test

Measuring house pressure and airflow with a 2-channel digital manometer

Channel A measures house pressure

Channel B measures airflow

Blower doors depressurize the home to amplify air leakage so leakage can be measured and air leaks can be located. The blower door measures how much airflow is necessary to maintain a particular pressure difference between indoors and outdoors—usually 50 pascals. This pressure difference is often described as "house WRT outdoors".

Blower Door Test

#### Measuring Total Duct Air Leakage

The duct blower pressurizes the sealed duct system through one of two return registers. At 25 pascals of duct pressure, these ducts have 176 CFM<sub>25</sub> of total duct air leakage.

Source: Residential Energy

Total Duct Leakage Test

#### Measuring Duct Leakage to Outdoors

The house and its ducts are both pressurized to 25 pascals. When there is no pressure difference between the house and ducts there should be no airflow between them. All the airflow going through the duct blower (250 CFM<sub>25</sub>) is going outdoors. The same manometer measures both airflow and pressure differences, as required in this test.

Source: Residential Energy

Duct Leakage to Outside Test

#### Exhaust Flows

- Designer range hoods 500-1200 CFM
- Older clothes dryers 150 CFM
- New clothes dryers 250-300 CFM
- Historically a typical 70 CFM fan will provide 30 CFM delivered air flow

#### Back-Drafting with Depressurization

Appliances that exhaust air—such as dryers, fireplaces, and exhaust fans—create a suction that can cause the furnace chimney to back-draft indoors.

Source: Residential Energy

CAZ Test

#### Worst-Case Depressurization Test

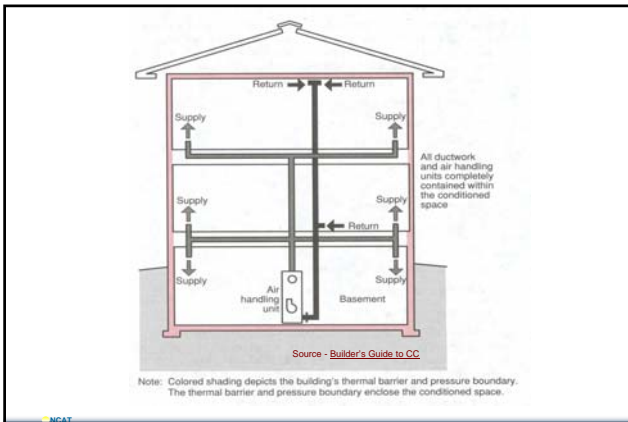
Technicians create a worst-case condition for the naturally drafting chimney by activating the furnace, exhaust fans, and a clothes dryer at the same time. If the pressure difference between the combustion appliance zone (CAZ) and outdoors is more negative than 3 pascals, action is taken to mitigate the negative pressure.

Source: Residential Energy

CAZ Test



Exhaust Fan Flow Test



**Method 1: Socket Count**

At Least 50%

- ENERGY STAR Compact Fluorescent Light Bulbs (CFLs)
- ENERGY STAR fixtures
- Combination of both

ENERGY STAR Homes Northwest

ENERGY STAR Consumer Products

With support from: NORTHWEST ENERGY EFFICIENCY ALLIANCE www.nweea.org


**Method 2: Fixture Count (ALP)**

**High Use Rooms – 50%**  
 -Living Room, Kitchen, Dining Room, Family Room, Bathrooms, Hallways, Stairways

**Med-Low Use Rooms – 25%**  
 -Bedroom, Den, Office, Basement, Laundry Room, Garage, Closets(s), and all other rooms

**Outdoor – 50%**  
 -Outdoor Lighting Affixed to the Home or Free-Standing Pole(s)

*(% based on category total, not individual rooms)*



ENERGY STAR  
Homes Northwest

ENERGY STAR  
Consumer Products

Web Support From:  
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**Light Quality: Color Temperature**

Cool

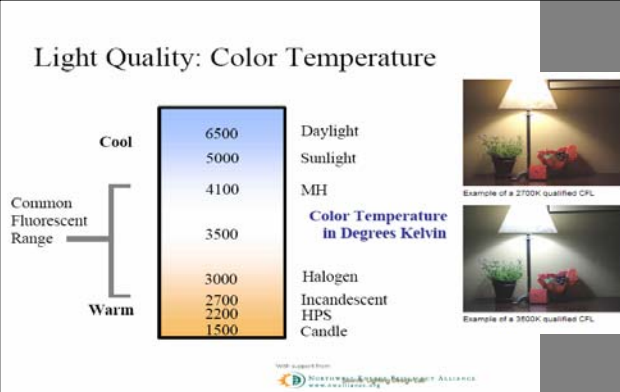
Common Fluorescent Range

Warm

6500	Daylight
5000	Sunlight
4100	MH
3500	Color Temperature in Degrees Kelvin
3000	Halogen
2700	Incandescent
2200	HPS
1500	Candle

Example of a 2700K qualified CFL







Example of a 3500K qualified CFL


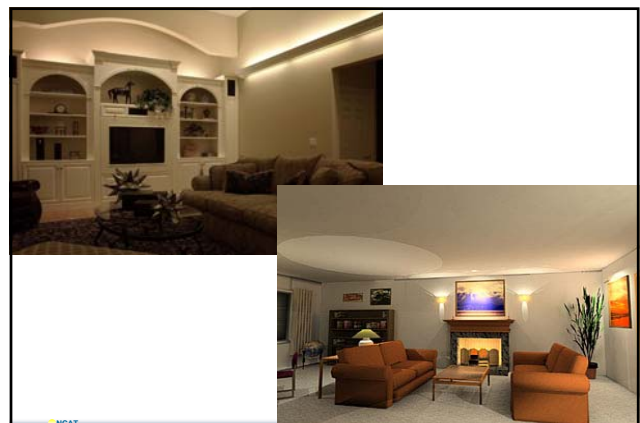
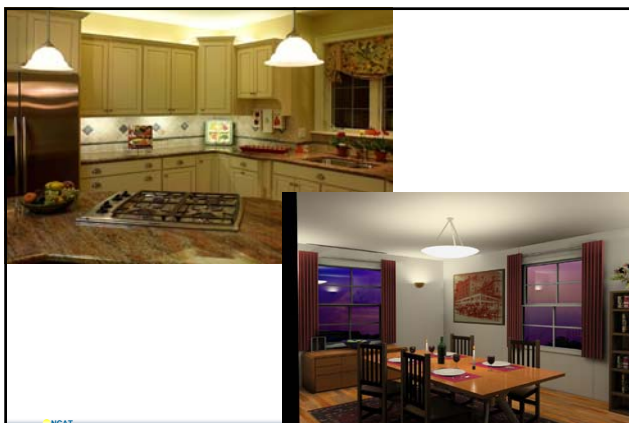
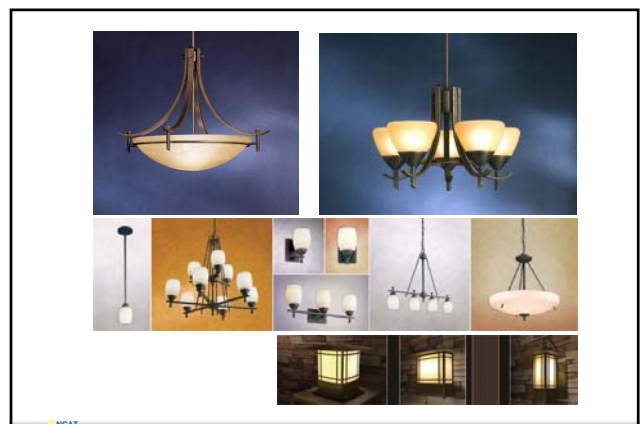


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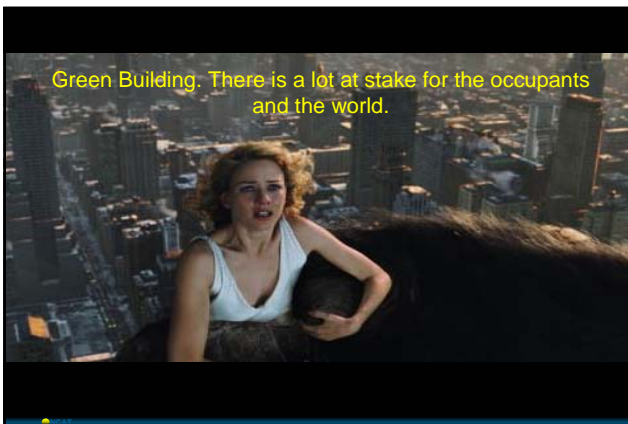
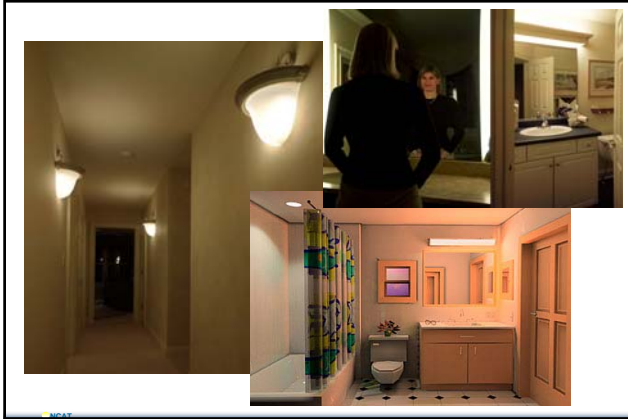
**CFL Sizes and Shapes**

CFLs come in a variety of shapes and sizes. The majority of CFLs are designed to look identical to the incandescent light bulb version. The table below identifies the most popular CFL shapes that are available at retail:

Bare Products		Covered Products			Reflector Products
Mini-Spiral or Twist	Tube or Universal	Incandescent/A-line	Globe G25, G30, G40	Candelabra, Post or Bullet Shape	Indoor and Outdoor R20, R30, R40, PAR38
					





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**Northwest ENERGY STAR®**  
[www.northwestenergystar.com](http://www.northwestenergystar.com)

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[www.energystar.gov](http://www.energystar.gov)

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**RESNET**  
Residential Energy Services Network [www.natresnet.org](http://www.natresnet.org)



ENERGY STAR Homes Northwest		Technical Compliance Options
<b>TCO #001(a)– Perimeter Insulated (Conditioned) Crawlspace</b>	BOP 1 Gas/Heat Pump	
<b>Description:</b>		
<b>Mechanically ventilated, perimeter insulated crawlspace.</b>		
<b>R30</b> Crawl Space Wall with continuous exhaust ventilation from CS		
<b>Fine Print:</b>		
All requirements not specified in this additional BOP shall be those already specified in NWBOP 1.		
<u>Not applicable if water or space heating equipment is located in crawlspace unless in insulated sealed enclosure.</u>		
This TCO #1 requires a continuously operating exhaust fan from the crawl space without air transfer of living space air to crawlspace. Since this approach is not allowed by code, the Montana code requirements for unvented crawlspaces must be met.		

ENERGY STAR Homes Northwest **Technical Compliance Options**

**TCO #001(a)– Perimeter Insulated (Conditioned) Crawlspace** BOP 1 Gas/Heat Pump

**Description:** Mechanically ventilated, perimeter insulated crawlspace. R-19 may be installed in lieu of R-30 in the crawl space wall if one of the following options are substituted for the BOP requirement:

1. R-21 Advanced framing in above grade walls or
2. R-21 Standard framing + R-2.5 Sheathing in above grade walls or
3. R-40 Ceiling + U-0.32 Windows + .92 AFUE Furnace or 8.7 HSPF Heat Pump

**Not applicable if water or space heating equipment is located in crawlspace unless in insulated sealed enclosure.**

This TCO #1 requires a continuously operating exhaust fan from the crawl space without air transfer of living space air to crawlspace. Since this approach is not allowed by code, the Montana code requirements for unvented crawlspaces must be met.

ENERGY STAR Homes Northwest **Technical Compliance Options**

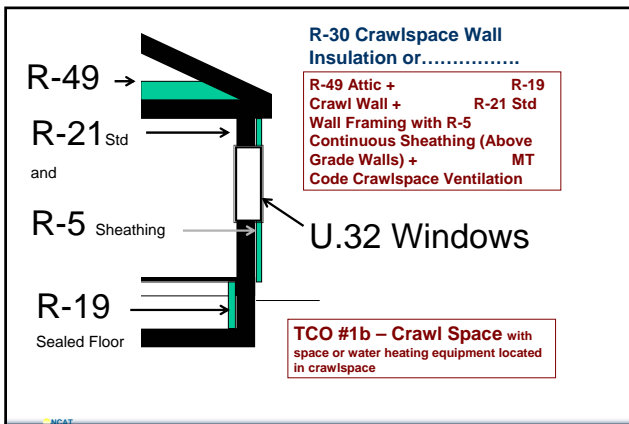
**TCO #001(b)– Perimeter Insulated (Conditioned) Crawlspace Pending** BOP 1 Gas/Heat Pump

**Description:**  
**Mechanically ventilated, perimeter insulated crawlspace.**

**R-19** Crawl Space Wall + Windows **U.32** + **R-5** sheathing at above grade walls + MT Code Crawlspace Venting

**Fine Print:**  
All requirements not specified in this additional BOP shall be those already specified in NWBOP 1. The Montana code requirements for unvented crawlspaces must be met.

**Applicable if water or space heating equipment is located exposed in the crawlspace.**



ENERGY STAR Homes Northwest **Technical Compliance Options**

BOP 1 Gas/Heat Pump BOP 2 Electric/Propane

**TCO #003 – Advanced Lighting Package**

**Description:** Deemed 50% equivalent in NWBOP EPA's Advanced Lighting Package using efficient fixtures in targeted locations is an option to the NWBOP requirement (50% of sockets).

1. 50% of total number of fixtures  
Kitchens, Dining Room, Living Room, Family Room, Bathrooms, Hall(s), Stairway(s)
2. 25% of total number of fixtures  
Bedroom(s), Den, Office, Basement, Laundry Room, Garage, Closet(s), and all other rooms.
3. 50% of total number of fixtures including all flood lighting outdoor lighting affixed to house or free standing pole except for landscape and solar lighting.

ENERGY STAR Homes Northwest **Technical Compliance Options**

**TCO #004 – Natural Gas Fired Hydronic Heating** BOP 1 Gas/Heat Pump

**Description:** Substitute a hot water distribution system based on fan coils or radiators.

1. If the heating system is supplied by a DHW tank the EF rating for "Recovery Efficiency" shall be 79 as rated by GAMA.
2. If the heating system is supplied by an instantaneous water heater the minimum EF shall be .81 minimum.
3. Minimum boiler efficiency shall be .83 AFUE.
4. Pipe insulation shall meet the provisions of the local code for 150 degree hot water delivery temperature.

ENERGY STAR Homes Northwest **Technical Compliance Options**

BOP 2 Electric/Propane

**TCO #005 – Electric Fired Hydronic Heating**

**Description:** Substitute a hot water distribution system based on fan coils or radiators. Heating fuel is electric.

1. If the heating system is supplied by an instantaneous water heater the minimum EF shall be 1.0.
2. Minimum boiler efficiency shall be 1.00.
3. For radiant slab on grade R10 slab insulation continuous and thermal breaks at the exterior wall shall be met.
4. Electric fired hydronic systems can be combined with traditional electric resistance heating system components.

ENERGY STAR® Homes Northwest **Technical Compliance Options**

**TCO #006 – U-Value Equivalency** BOP 1 Gas/Heat Pump

**Description:** Provide a heat loss trade-off calculation procedure for compliance with the NWBOP 1 specifications.

1. Trade-offs are restricted to only those components shown in the attached table.
2. To determine the U-value of a proposed components the attached library must be used.
3. Maximum window U-value .35.
4. Maximum attic/vaulted ceiling U-value not to exceed .30.
5. Whole House Uo not to exceed 0.0623.
6. U-values for basements, slab on grade or perimeter insulated crawlspaces, shall meet NWBOP 1. Trade-offs may be made among the remaining components and the total allowed Uo shall not exceed 0.0759.

ENERGY STAR® Homes Northwest **Technical Compliance Options**

**TCO #007 – U-Value Equivalency** BOP 2 Electric/Propane

**Description:** Provide a heat loss trade-off calculation procedure for compliance with the NWBOP 2 specifications.

1. Trade-offs are restricted to only those components shown in the attached table.
2. To determine the U-value of a proposed components the attached library must be used.
3. Maximum window U-value .35.
4. Maximum attic/vaulted ceiling U-value not to exceed .30.
5. Whole House Uo not to exceed 0.0558.
6. U-values for basements, slab on grade or perimeter insulated crawlspaces, shall meet NWBOP 2. Trade-offs may be made among the remaining components and the total allowed Uo shall not exceed 0.0672.

ENERGY STAR® Homes Northwest **Technical Compliance Options**

**TCO #008 – Natural Gas DHW Efficiency Trade-off** BOP 1 Gas/Heat Pump

**Description:** Substitute a .59 EF DHW tank for the .61 tank with additional insulation components added to the envelope.

1. All requirements specified in NWBOP 1 must be met except for the additional insulation requirements needed to meet the reduction in EF of the DHW tank.
2. Minimum walls insulation level is R-21 w/ insulated headers and ceilings are insulated to at least R-49.
3. All roof trusses to be "raised heel" for pitches < 6:12.
4. This trade-off is allowed only for conventional DHW storage tanks.

ENERGY STAR® Homes Northwest **Technical Compliance Options**

**TCO #009 – Hybrid Gas Unit Heaters & Zoned Electric** BOP 1 Gas/Heat Pump

**Description:** Allow gas unit heaters or fireplaces in combination with electric zonal heaters as the heating source.

1. Gas unit heaters or fireplaces shall have a minimum AFUE of .74.
2. Maximum window U-value .32 (NFRS rated).
3. Remote thermostats are required for unit heaters or fireplaces.
4. Unit heaters or fireplaces shall be sized to meet the following:
  - West of the Cascades – 9 BTU/h/sf
  - Intermountain Regions – 13 BTU/h/sf
  - Mountain Zones – 16 BTU/h/sf
5. Zonal electric heaters shall provide up to 60% of the gas unit heaters or fireplaces. Separate thermostats shall be in each room.

ENERGY STAR® Homes Northwest **Technical Compliance Options**

**TCO #010 – Ductless-Split Heat Pump/Zonal Electric** BOP 1 Gas/Heat Pump

**Description:** Allow gas unit heaters or fireplaces in combination with electric zonal heaters as the heating source.

1. Ductless-Split Heat Pumps shall be a minimum 6.8 HSPF.
2. Maximum window U-value .32 (NFRS rated).
3. Remote thermostats are required in the zones heated by the ductless-split heat pumps.
4. Systems shall be sized to meet the following:
  - West of the Cascades – 1700 sf/ton of rated capacity.
  - Intermountain Regions – 1200 sf/ton of rated capacity.
  - Mountain Zones – 1000 sf/ton of rated capacity.
5. Zonal electric heaters may supplement the output rated capacity of ductless-split heat pump system.

ENERGY STAR® Homes Northwest **Technical Compliance Option**

**TCO #011 – 90 AFUE Propane Furnace** BOP 1 Gas/Heat Pump

**Description:** Substitute a 90 AFUE propane furnace for a 90 AFUE gas furnace.

1. All the requirements for NWBOP 1 must be met.
2. The propane furnace must have a rating of 90 AFUE or better to comply.



ENERGY STAR® Homes Northwest Technical Compliance Option

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**TCO #012 – HSPF 8.3 Heat Pump Coupled with a 90 AFUE Gas Furnace Backup** BOP 1 Gas/Heat Pump

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**Description:** Allow a HSPF 8.3 Heat Pump when coupled with a 90 AFUE gas furnace backup below 40 degrees.

1. All the requirements for NWBOP 1 must be met.

Note: HSPF 8.5 is required by BOP 1.

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ENERGY STAR® Homes Northwest Technical Compliance Option

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**TCO #013 – Cathedral Attic** BOP 1 Gas/Heat Pump

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**Description:** Allows uninsulated ducts in attic if attic ceiling is insulated with R-33 foam in place with a maximum perm rating of 1.

Alternatively attic ceiling may be R-30 foam in place if average window U-value is 0.33 or below.

1. All the requirements for NWBOP 1 must be met.

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