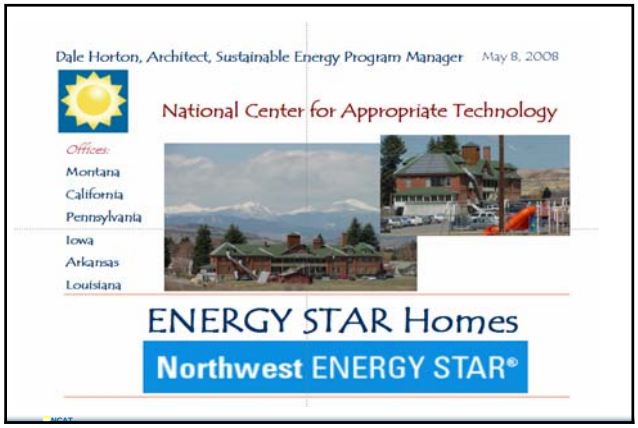
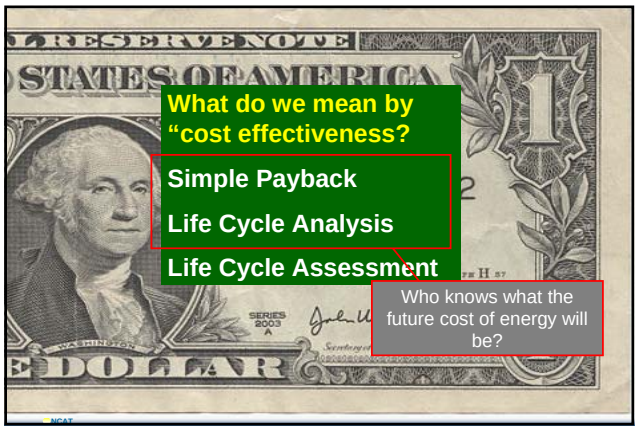
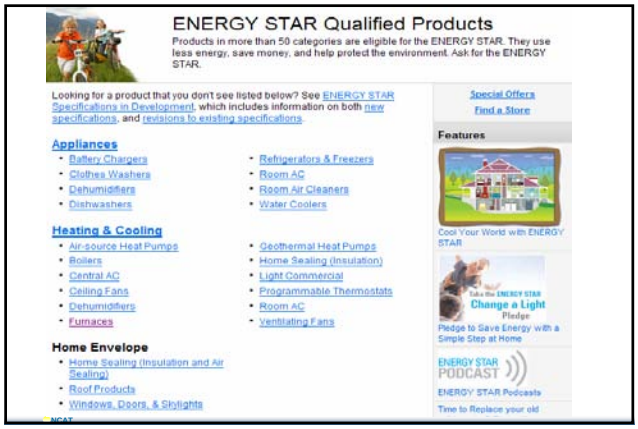
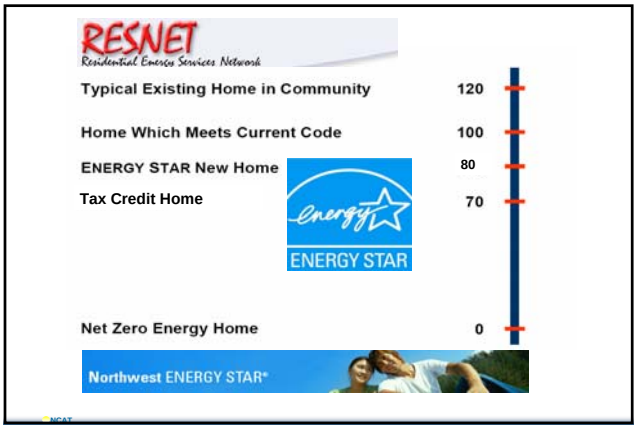
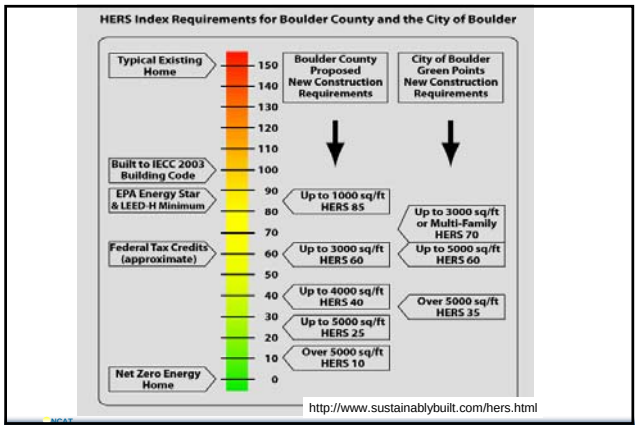


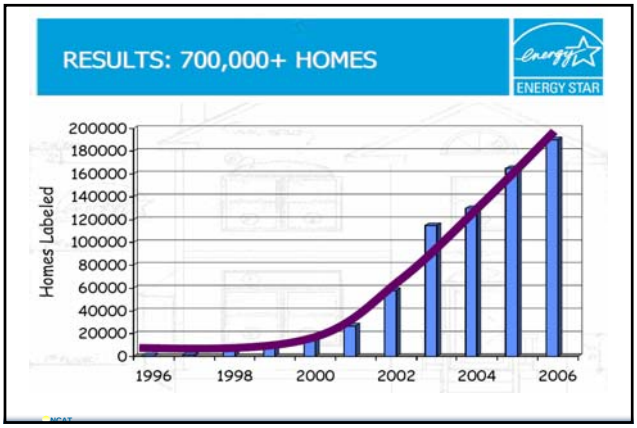
Green Design = Sustainable Design = Ecological Design = Climate Responsive Design = Energy Efficient = High Performance Building = Good Design

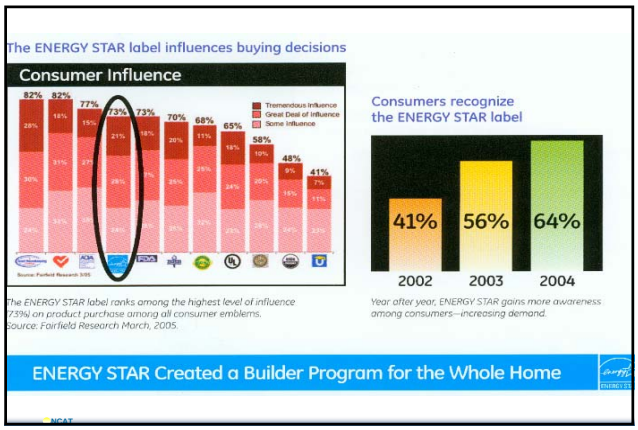


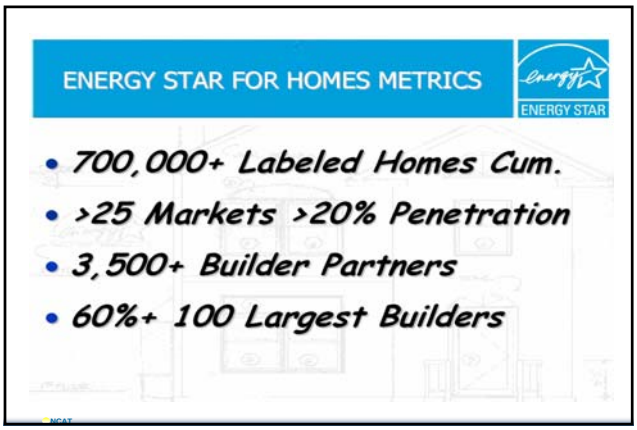




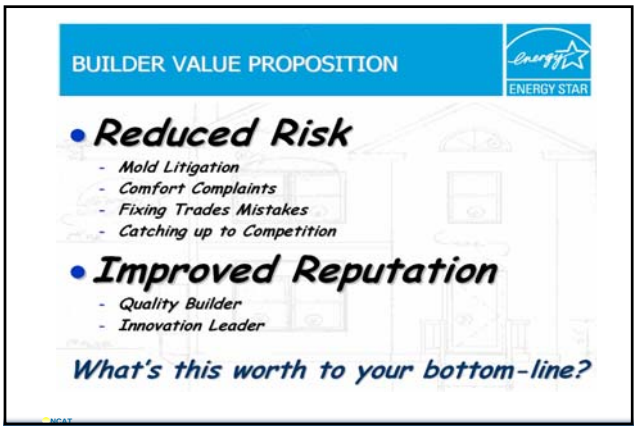

HERS Index Requirements for Boulder County and the City of Boulder
Typical Existing Home
Built to IECC 2003 Building Code
EPA Energy Star & LEED-H Minimum
Federal Tax Credits (approximate)
Net Zero Energy Home
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
Boulder County Proposed New Construction Requirements
City of Boulder Green Points New Construction Requirements
Up to 1000 sq/ft HERS 85
Up to 3000 sq/ft HERS 60
Up to 4000 sq/ft HERS 40
Up to 5000 sq/ft HERS 25
Over 5000 sq/ft HERS 10
Up to 3000 sq/ft or Multi-Family HERS 70
Up to 5000 sq/ft HERS 60
Over 5000 sq/ft HERS 35
http://www.sustainablybuilt.com/hers.html


RESULTS: 700,000+ HOMES
ENERGY STAR
Homes Labeled
200000
180000
160000
140000
120000
100000
80000
60000
40000
20000
0
1996
1998
2000
2002
2004
2006


The ENERGY STAR label influences buying decisions
Consumer Influence
Tremendous Influence
Great Deal of Influence
Some Influence
The ENERGY STAR label ranks among the highest level of influence (73%) on product purchase among all consumer emblems.
Source: Fairfield Research March, 2005.
Consumers recognize the ENERGY STAR label
41%
56%
64%
2002
2003
2004
Year after year, ENERGY STAR gains more awareness among consumers—increasing demand.
ENERGY STAR Created a Builder Program for the Whole Home


ENERGY STAR FOR HOMES METRICS
ENERGY STAR
700,000+ Labeled Homes Cum.
>25 Markets >20% Penetration
3,500+ Builder Partners
60%+ 100 Largest Builders


ASSURING BETTER PERFORMANCE
ENERGY STAR
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
ENERGY STAR
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

ENERGY STAR

air leakage in envelope

air leakage in ducts

air leakage and air barriers in envelope

CHANGING WORLD:
BUILDER LIABILITY: NEW STORM

ENERGY STAR

Defects no longer hidden…

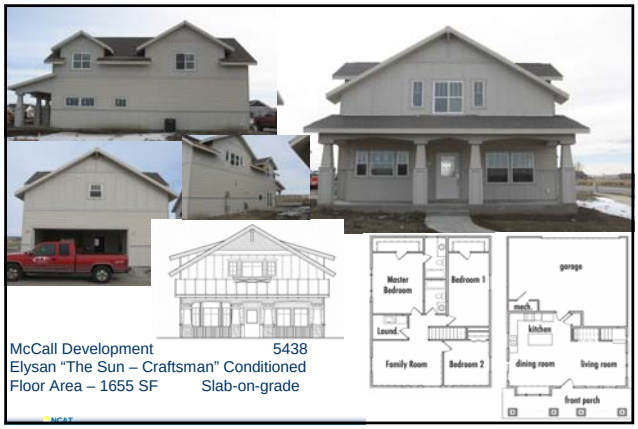
END GAME: CARBON NEUTRAL HOME

ENERGY STAR

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
Total	$4,000

	Stony Meadow			Elysan		
Weather Site	Helena			Helena		
Utility	NWE			NWE		
Conditioned Floor Area	3019			1655		
Foundation Type	Basement			Slab-on-grade		
	Code	NWESH		Code	NWESH	
HERS Index	85	61		83	69	
ENERGY STAR	Fails	Passes		Fails	Passes	
Tax Credit	Fails	Passes		Fails	Fails	
Ann. MMBtu/Yr	172.8	120.7	70%	113.1	93.8	83%
Ann. Energy Cost	$2,652	$2,005	76%	$1,671	$1,413	85%
Ann. Cost Savings		$647			$258	
Added Cost		$4,000			$2,500	
Simple Payback		6.5			9.7	
30 Year Savings (Energy Cost Escalation Rate)						
30Y Savings (1%)		$21,254			$8,975	
30Y Savings (3%)		$29,069			$12,274	
30Y Savings (5%)		$40,594			$17,141	
30Y Savings (10%)		$100,506			$42,439	
30 Year NPV Savings, 8% Discount Rate (Energy Cost Escalation Rate)						
30Y NPV Sav (1%)		$7,559			$3,192	
30Y NPV Sav (3%)		$9,272			$3,915	
30Y NPV Sav (5%)		$11,619			$4,906	
30Y NPV Sav (10%)		$22,426			$9,470	

Montana Energy Star Verifiers

Last Name	First Name	Company	Address	City	State	Zip	Office Phone	E-mail
McPherson	Mike	Comfort Engineering	2635 Turkey Red Lane	Bozeman	MT	59715	406.585.8912	comforteng@yahoo.com
Hellem	Russ	Energetechs	615 Oak St, Suite 101	Missoula	MT	59801	406.721.2741	russ@energetechs.com
Wagenman	Neal	Billings Insulation Service	PO Box 31634	Billings	MT	59107	406.861.3640	neal@billingsinsulation.com
Dolezal	Les	Leading Educational Services LLC	3428 Fife Circle	Billings	MT	59101	406.256.9393	info@bcaneemt.com
Jones	Margaret	NW MT Human Resources Inc.	PO Box 8300	Kalispell	MT	59904-1300	406.758.5447	margie@kalhrdc.mt.gov
Diem	John	Advanced Energy Solutions	255 Heligate Drive	Missoula	MT	59802	406.258.6146	johndiemmmt@yahoo.com
Robeson	Mike	CC Insulation & Urethane	1300 Lockwood Rd	Billings	MT	59101	406.245.3636	kadinsdad@hotmail.com
Klinefelter	John	Klinefelter's Insulation	3208 19th Ave. S.	Great Falls	MT	59405	406.788.2056	jwklinefelter@bresnan.net
O'Leary	Paul	O'Leary Builders	4609 12th Street NE	Great Falls	MT	59404	406.899.6027	
Brown	Steve	EMT West	PO Box 5780	Helena	MT	59604	406.444.8714	steve.brown@bmcwest.com
Schwahn	William	BV Inspections Birthday 10/10/56	PO Box 440	Belgrade	MT	59714	406.388.9890	bvinspections@qwest.net
Sparhawk	Erica		907 N. 25th Street	Billings	MT	59101	406.670.6552	ericafuller@gmail.com
Palm	John	Baker Creek Log Homes	3010 Linney Road	Bozeman	MT	59718	406.580.6068	info@bakercreekloghomes.com
Gress	Tim	GPM Heating & Cooling	1935 McDonald Avenue	Missoula	MT	59801	406.880.1265	ut1gress@hotmail.com
Hall	Sam		1110 Phillips St.	Missoula	MT	59802	406.396.7832	shallonius@earthlink.net

Federal Tax Credit for New Homes

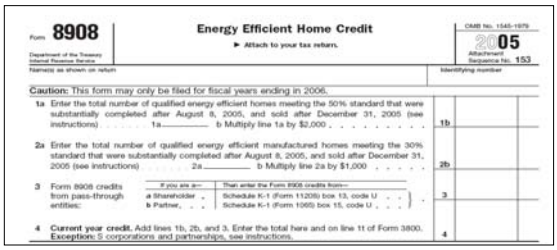
➔$2000 to home builders (site-built and manufactured homes) 50% of the heating and cooling energy of the 2004 IECC and uses a SEER 13 air conditioner plus …… building envelope improvements must account for at least 1/5 of the 50% energy savings.

➔$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



Form **8908** — **Energy Efficient Home Credit** — ► Attach to your tax return. — 2005

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 _____ b Multiply line 1a by $2,000 . . . 1b

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 _____ b Multiply line 2a by $1,000 . . . 2b

3 Form 8908 credits from pass-through entities: If you are a— / Then enter the Form 8908 credits from— a Shareholder . . Schedule K-1 (Form 1120S) box 13, code U . . . b Partner, . . Schedule K-1 (Form 1065) box 15, code U . . . 3

4 **Current year credit.** Add lines 1b, 2b, and 3. Enter the total here and on line 11 of Form 3800. **Exception:** S corporations and partnerships, see instructions. 4

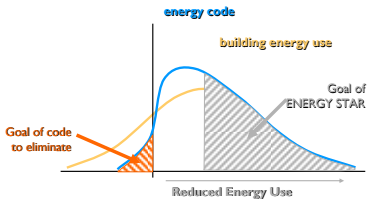
What Rater Does:

➔**Perform Analysis (Projected Rating)**

➔**Provide appropriate information to enable builder to reach the 50% reduction**

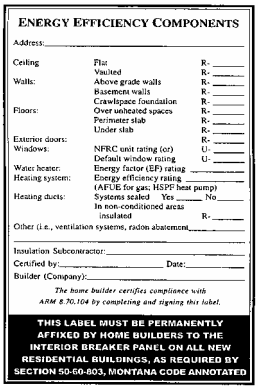
➔**Certify with inspection confirmation of projected rating**

ENERGY STAR Moves Energy Efficiency Beyond Current Code



Adapted from a Better Bricks presentation prepared by Paladino & Assoc.

Montana State Energy Efficiency Components Label



ENERGY EFFICIENCY COMPONENTS

Address:_____

Ceiling	Flat	R-_____
	Vaulted	R-_____
Walls:	Above grade walls	R-_____
	Basement walls	R-_____
	Crawlspace foundation	R-_____
Floors:	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 heat pump)	_____
Heating ducts:	Systems sealed Yes _____ No_____	
	In non-conditioned areas insulated	R-_____

Other (i.e., ventilation systems, radon abatement)_____

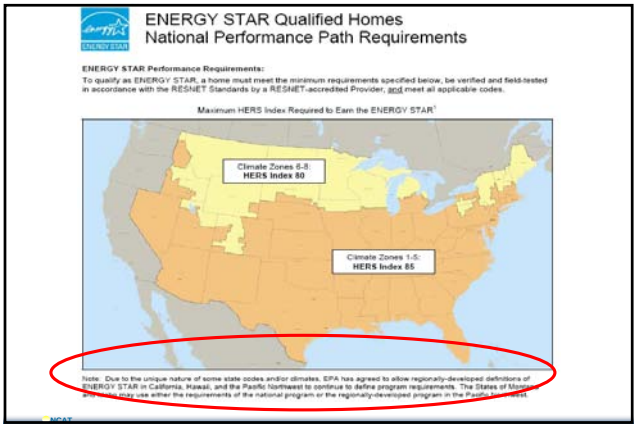
Insulation Subcontractor:_____

Certified by:_____ Date:_____

Builder (Company):_____

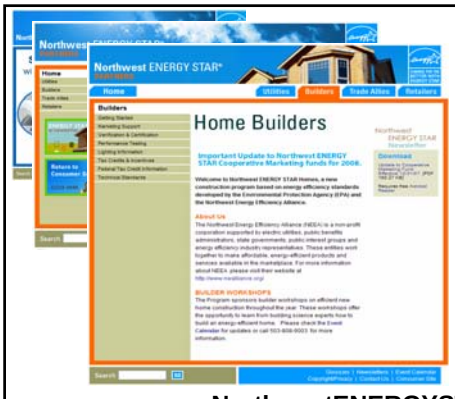
The home builder certifies compliance with ARM 8.70.104 by completing and signing this label.

THIS LABEL MUST BE PERMANENTLY AFFIXED BY HOME BUILDERS TO THE INTERIOR BREAKER PANEL ON ALL NEW RESIDENTIAL BUILDINGS, AS REQUIRED BY SECTION 50-60-803, MONTANA CODE ANNOTATED



www.NorthwestENERGYSTAR.com

www.NorthwestENERGYSTAR.com



www.NorthwestENERGYSTAR.com

www.NorthwestENERGYSTAR.com

Northwest ENERGY STAR Homes Program

- Builder Agreement
- Builder Contracts with Verifier
- Project Initiation by Verifier
- Builder/Subcontractor Education
- Design and Construction of Home
- Site Inspection and Performance Testing
- Verification Database Entry
- ENERGY STAR Label

Quality Assurance Inspection


ENERGY STAR® Homes Northwest

BUILDER PARTNERSHIP AGREEMENT

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® Homes Northwest Certification Requirements

NWBOP 1

Single Family Homes

NWBOP 2

Single Family Homes

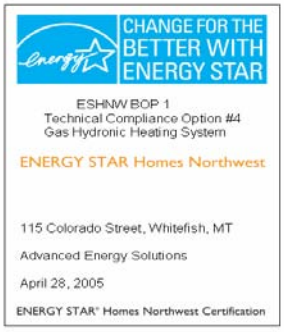
ENERGY STAR and MT Energy Code in Brief

	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* When finished.	R-19
Slab Floors	R-13: 4'	R-10: 2'
Air Distribution Design	Yes Not Enforced	Yes

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 Testing Required.
Construction Cavity Chases	Yes	No
Ventilation	Code	Code
Envelope Tightness	Not Specified	7 ACH50 Testing Required.
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



LEED for Homes & Northwest ENERGY STAR Homes

Dark border indicates mutually exclusive credits.
LTO = Total duct leakage to o.utside
The credits shown in blue will accomplish NWESH certification.
* - NWESH has specific insulation requirements for particular components.

Pts	EA	LEED for Homes	Northwest ENERGY STAR Homes BOP #1	Min.	Typ	Code
Pre	2.1*	Basic Insulation & TBC	Insulation Yes, No TBC	Yes	Yes	Yes
2	2.2	Enhanced Insulation	Probably			
Pre	3.1	Reduced Envelope Leakage (<=5 ACH50)	Probably	Yes	Yes	No
2	3.2	Greatly Reduced Envelope Leakage (<=3.5 ACH50)	Maybe		2	
3	3.3	Minumum Evelope Leakage (<=2 ACH50)	Maybe			
Pre	4.1	Good Windows (<=U0.35)	Yes	Yes	Yes	Yes
2	4.2	Enhanced Windows(<=U0.31)	No			
3	4.3	Exceptional Windows (<=U0.28)	No			
Pre	5.1	Reduced Duct Distribution Losses (LTO<=0.04 cfm25, fully ducted, R-6)	Probably	Yes	Yes	No
2	5.2	Greatly Reduced Duct Distribution Losses (LTO<=0.03 cfm25)	Maybe		2	
3	5.3	Minimal Duct Distribution Losses (LTO <=0.03 cfm25, ducts inside, <=2 ACH50)	Maybe			
Pre	6.1	Good HVAC Design & Installation (ACCA Manual J, 90% AFUE)	Yes	Yes	Yes	Yes
2	6.2	High Efficiency HVAC (92% AFUE)	No		2	
3	6.3	Very High Efficiency HVAC (94% AFUE)	No			
2	7.1	Efficient Hot Water Distribution	No			
1	7.2	Pipe Insulation (All R-4)	No			
3	7.3	Efficient DHW Equipment (40 Gal Gas EF>=0.61, 50 Gal El EF>=0.92)	Yes	3	3	
Pre	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	ES Advanced Lighting Package (with fixtures)	Probably		3	
2	9.1	High Efficiency Appliances (Refr=1, Clg Fan=.5, Dishwasher=.5, Clothes Washer=.1)	Dishwasher Only	0.5	0.5	
1	9.2	Water Efficiency Clothes Washer	No			
26.5 Maximum				5	14	0

26.5

14

0

NAHB Model Green Home Building Guidelines & NWESH

Dark border indicates mutually exclusive credits.
LTO = Total duct leakage to o.utside

Pts	EE	NAHB Model Green Home Building Guidelines	NWESH BOP #1	Code
Req	3.1.1	Meets 2003 IECC	Yes	Yes
Req	3.1.2	ACCA Manual J	Yes	Yes
Req	3.1.3	Third Party Verification	Yes	Yes
		EE 37 points minimum		
8	3.3.1 A	SIPS		
8	3.3.1 A	ICFs		
6	3.3.1 A	Exterior Wall Advanced Framing		
2	3.3.1 A	Raised Heal Trusses		
4	3.3.1 A	Continuous Insulated Sheathing Exterior Walls		
10	3.3.1 B	Air Sealing	10	10
8	3.3.2 C	ENERGY STAR Windows (No. Zone U-0.35)	8	8
8	3.3.2 A	ACCA Manual D for Ducts	8	8
8	3.3.2 B	Radiant/Hydronic Design Standards		
8	3.3.2 C	ACCA Manual S for Htg. & Clg. Selection		
8	3.3.2 D	Htg & Clg System Commissioning		
6	3.3.2 E	HVAC Installer Certification		
4	3.3.2 E	Gas Furnace AFUE >=81% AFUE		
6	3.3.2 E	Gas Furnace AFUE >=88% AFUE	6	
8	3.3.2 E	Gas Furnace AFUE >=94% AFUE		
6	3.3.2 K	Seal Ducts with Tapes or Mastic	6	6
8	3.3.2 L	Fully Ducted, No Building Cavities	8	
6	3.3.2 M	Pressure Relief in Every Room	6	
1	3.3.2 N	ENERGY STAR Ceiling Fans (points per fan)		
4	3.3.2 O	Whole House Fan		
8	3.3.2 P	ES Bathroom Exhaust to Outside		
4	3.3.3 A	Gas DWH 40 Gal EF>=.62		
4	3.3.3 A	Electric DWH 50 Gal EF>=.92	4	
4	3.3.3 B	Whole House Tankless DWH		
4	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 within 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	
5	3.3.4 E	ENERGY STAR Clothes Washer		
8	3.3.6 .1	Third Party Verification	8	
8	3.3.6 .2	Blower Door Test	8	
8	3.3.6 .2	Duct Leakage Test	8	
8	3.3.6 .2	Duct System Balancing		
205			83	32

205

83

32

Performance Testing Requirements

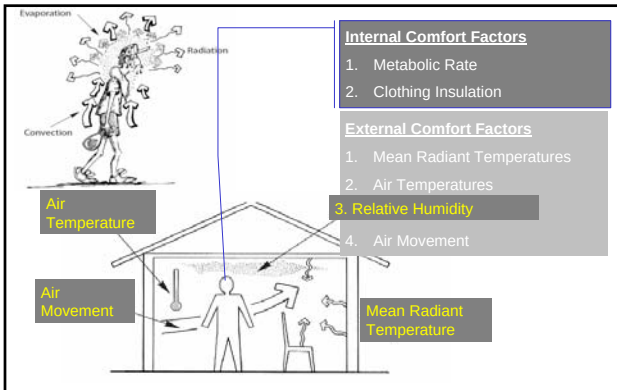
- ➔Duct Leakage Testing (if outside the thermal envelope)
- ➔Blower Door Testing **all** Homes in Montana (only BOP 2 Homes in OR & WA)
- ➔Combustion Appliance Zone Test if unsealed combustion appliance in house with forced air system
- ➔Refrigerant Testing and Commissioning for Heat Pumps

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

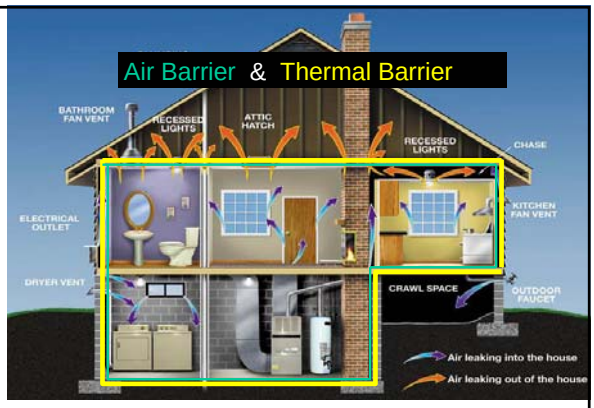
R-values are additive, U-values are not additive

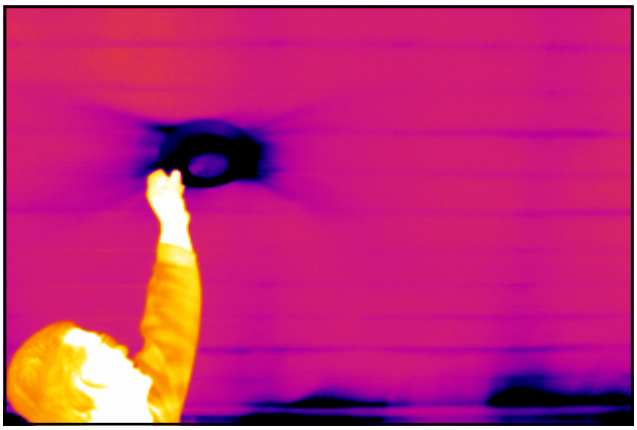
R-values of a series of components can be added; the inverse of this sum will be the

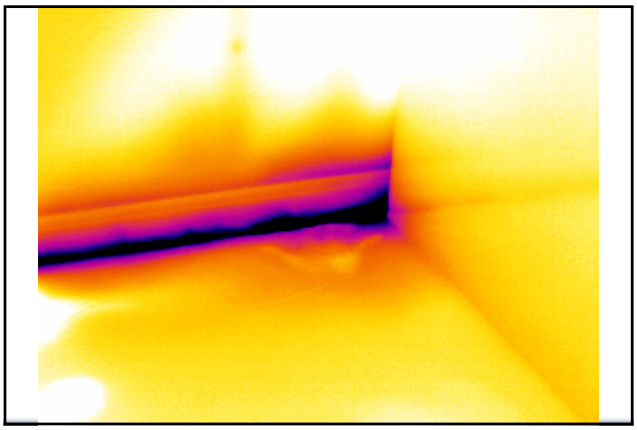
➔R1 + R2 = R total

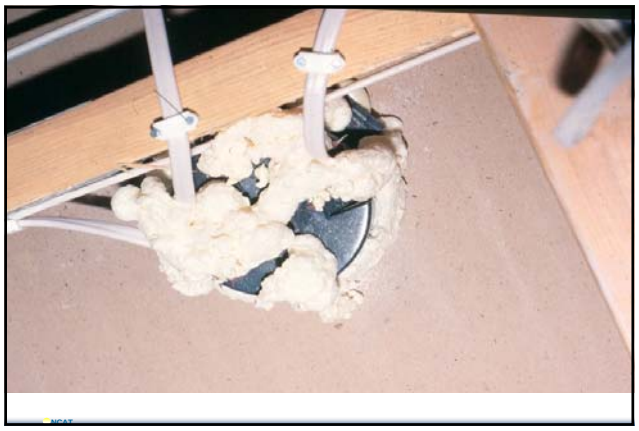
➔U1 + U2 = Garbage

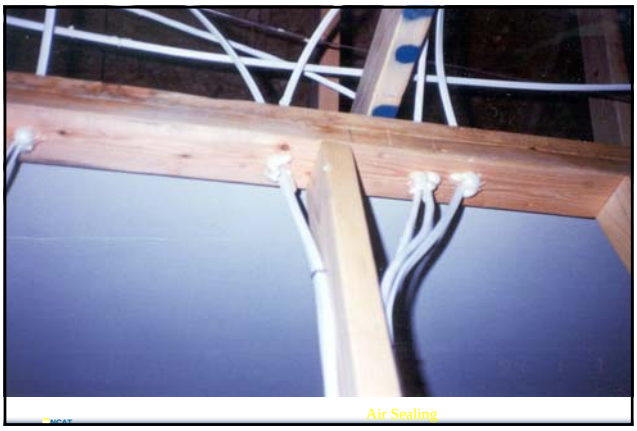
➔R= 1/U and U= 1/R

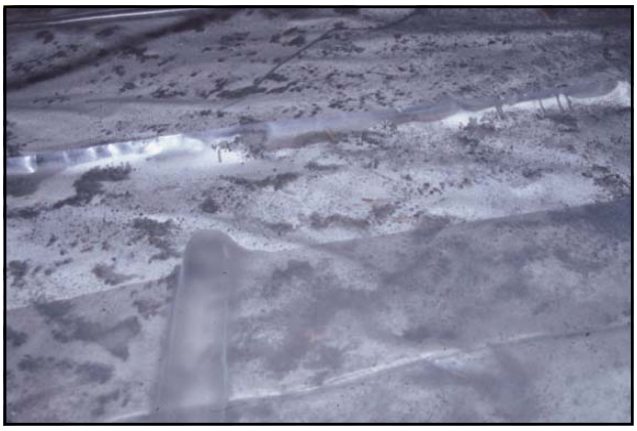






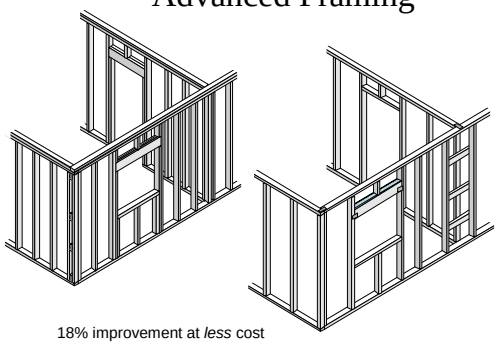



Air Sealing



Interior Basement Insulation

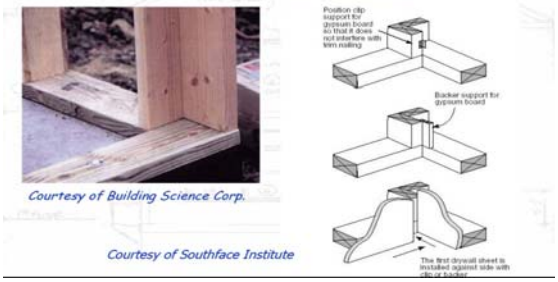
Advanced Framing



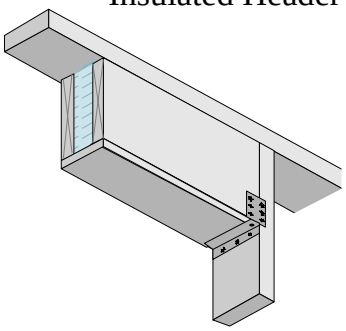
18% improvement at *less* cost

© Conservation Services Group

CORNER FRAMING



Insulated Header



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

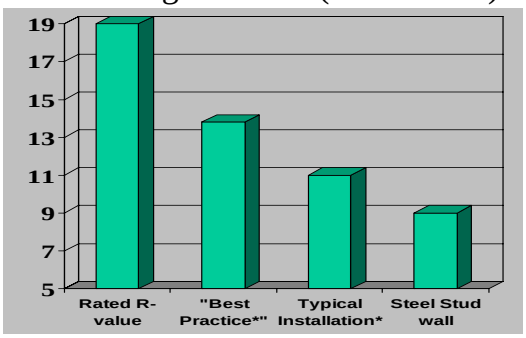
Rigid Insulation = **Air Barrier + Insulation + Thermal Break**

Where code acceptable, consider using at:

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

- 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

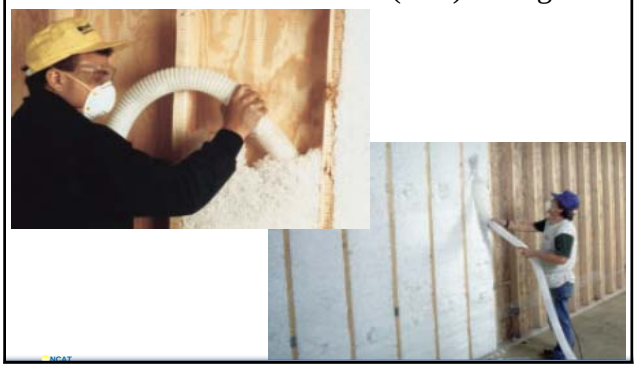
Fiberglass Batts (Real World)



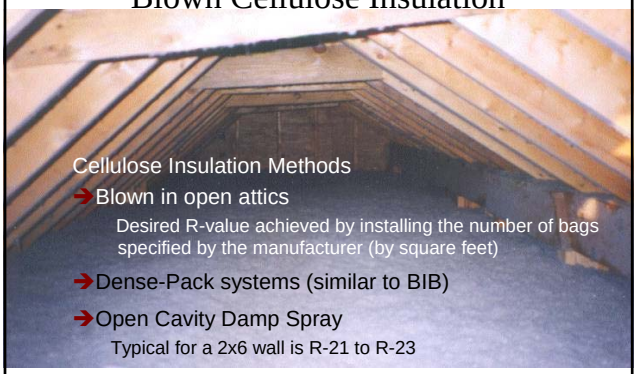
Typical installations…

Correct Installation

Blown-in Blanket (BIB) Fiberglass



Blown Cellulose Insulation



Insulation Quick Comparison (A work in progress.)

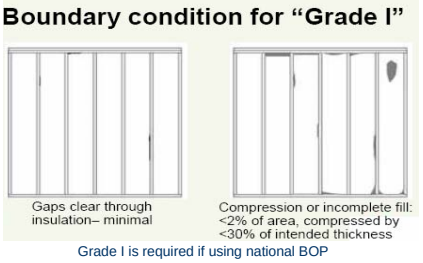
Material	Type	R-Value	Ozone Depleting Blowing Agent	Density	Vapor Retarder Perm Rating	Recycled Content	Common or Brand Name
Fiberglass	batts	3.6	No	3 pcf	Permeable	Doubtful	
	loose fill	3.2	No	2-3 pcf	Permeable	Doubtful	
Cellulose	Loose Dry	3.4	No	1.5-2.0 pcf	Permeable	Yes	
	Wet Blown	4.0	No		Permeable	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, Sealection 500
Low Density	Spray Foam	3.7-3.6	No, soy	low 0.5 pcf	Permeable	Doubtful	Biobase 501, Healthy Seal
High Density	Spray Foam	5.5	No, soy	high 1.7 pcf	Semi-impermeable	Doubtful	Biobase 1701
	Spray Foam	6.0 - 8.0	Yes	high 2 pcf	Semi-impermeable	Doubtful	

Remarks:
1. Fiberglass is susceptable to convective currents and poor installation and may contain formaldehyde.
2. Styrene and urethane insulations may give off toxic gases when if burned.
3. In general, low density foams are open cell and high density foams are closed cell.
4. 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"

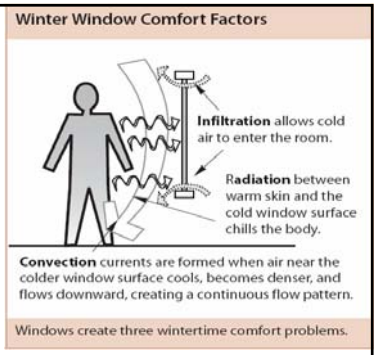
Gaps clear through insulation: <2%

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

Window Surface Temperature

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

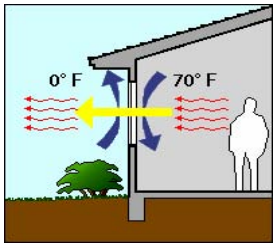
- ➔Single glass 52 °F
- ➔Double glass 59 °F
- ➔Low E + Argon 62 °F
- ➔High Performance 64 °F
  (Heat mirror films)



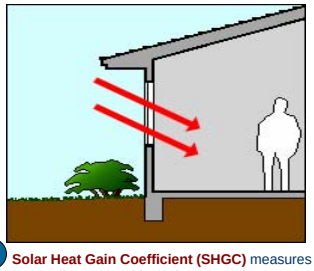
Source - **Residential Energy**

www.nfrc.org

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.

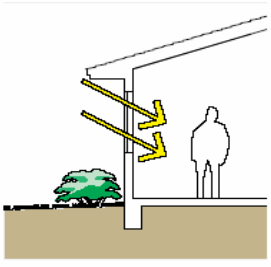


www.nfrc.org

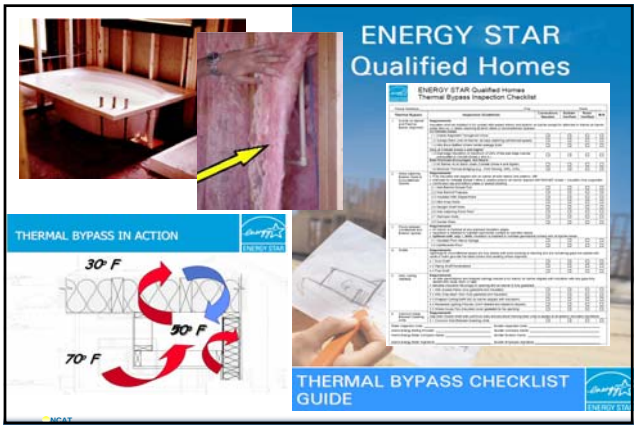


B **Solar Heat Gain Coefficient (SHGC)** measures how well a product blocks heat from the sun. SHGC is expressed as a number between 0 and 1. The lower the SHGC, the better a product is at blocking unwanted heat gain. Assumes the sun strikes the glass at 90 degrees.

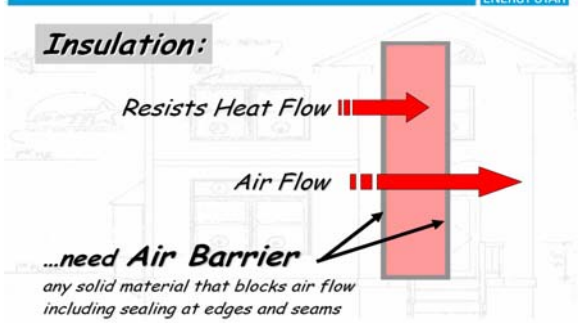
www.nfrc.org



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.



THERMAL BYPASS PRINCIPLE



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

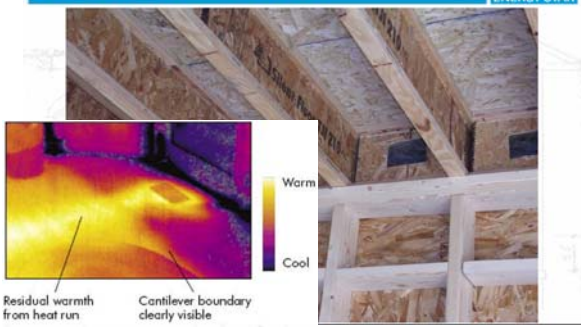
THERMAL BYPASS CHECKLIST:
4. ATTIC KNEE WALLS

Hot Wall

Courtesy of Building Science Corp.

THERMAL BYPASS CHECKLIST:
5. ATTIC ACCESS STAIRS

THERMAL BYPASS CHECKLIST:
6. CANTILEVERED FLOOR



THERMAL BYPASS CHECKLIST:
7. DUCT/PIPING PENETRATIONS

Airtight foam on pervious rock wool will not work.

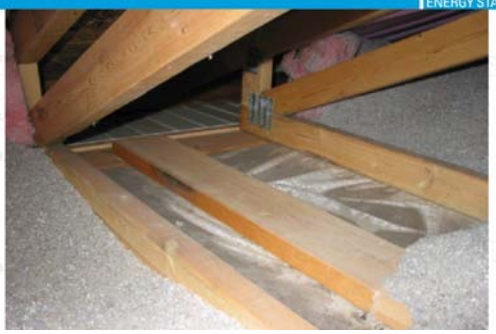
Courtesy of Advanced Energy Corporation

THERMAL BYPASS CHECKLIST:
8. FLUE SHAFT

Courtesy of Building Science Corp.

Image courtesy of EnergyLogic

THERMAL BYPASS CHECKLIST:
9. ATTIC EAVES



THERMAL BYPASS CHECKLIST:
9. ATTIC EAVES

Image courtesy of MaGrann Associates

THERMAL BYPASS CHECKLIST:
10. DROPPED CEILINGS

Courtesy of Building Science Corp.

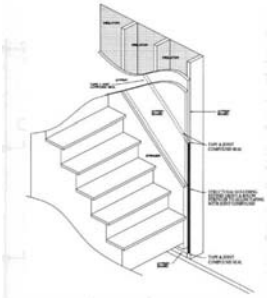
THERMAL BYPASS CHECKLIST:
10. DROPPED CEILINGS

Courtesy of Building Science Corp.

THERMAL BYPASS CHECKLIST:
11. FIREPLACE SHAFT WALL

Courtesy of Building Science Corp.

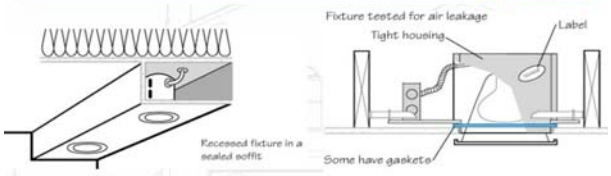
THERMAL BYPASS CHECKLIST:
12. STAIRCASE FRAMING



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.

THERMAL BYPASS CHECKLIST: 14. PORCH ROOF

Courtesy of Energy Services Group

"Build it tight, ventilate it right."

IAQ RISK REDUCTION PRINCIPLES

1. **Source Control**
   eliminate, substitute, or modify pollutant sources
2. **Dilution**
   ventilate to dilute unavoidable pollutants
3. **Filtration**
   remove targeted pollutants,
   last resort after source control & dilution

Volatile Organic Compounds (VOCs)

Infiltration versus Mechanical Ventilation

	Infiltration	Mechanical Ventilation
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 cfm x (3+1)) + (2400/100) = 54 cfm

* - Mech exhaust system may include local exhaust fans.

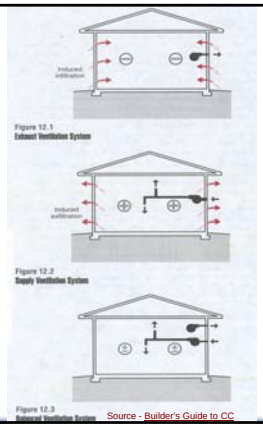
Residential Energy's BTL is out-of-date

Mechanical Ventilation System Types

1. Exhaust Only
2. Supply Only

Balanced:

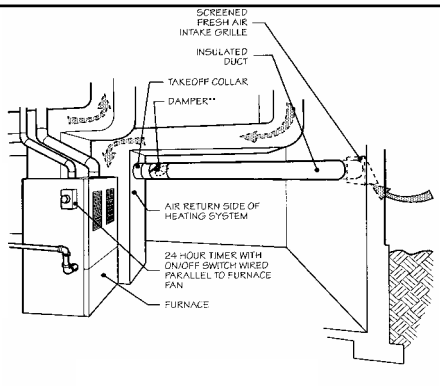
3. Spot exhaust w/ make-up air
4. Central exhaust without heat recovery
5 Central exhaust with Heat Recovery



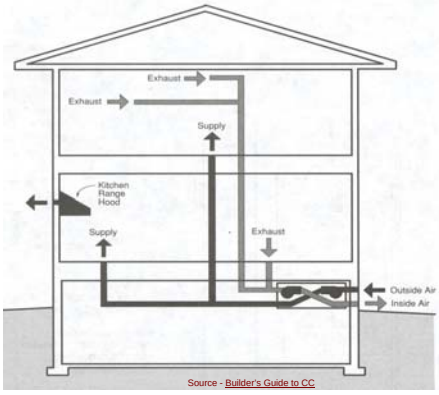
Source - Builder's Guide to CC

Quiet Exhaust Fan <= 1 sone

Balanced Ventilation without Heat Recovery



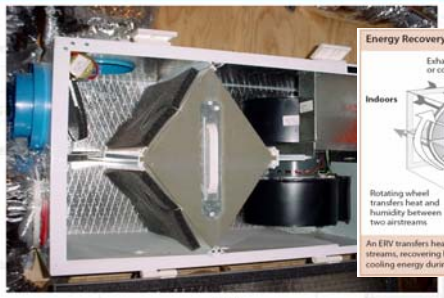
Central Exhaust with Heat Recovery



Source - Builder's Guide to CC

HVAC SYSTEM HIGHLIGHTS: WHOLE-HOUSE VENTILATION

ENERGY STAR



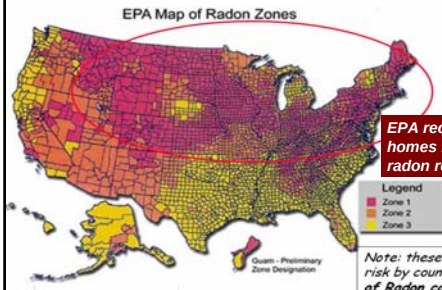
ERV

Ventilation Controls

RADON CONTROL HIGHLIGHTS: RADON RESISTANT CONSTRUCTION

ENERGY STAR

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.

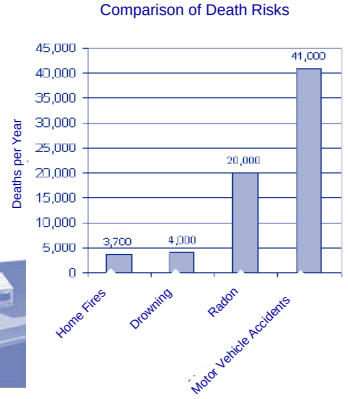
EPA recommends that all homes built in Zone 1 have radon reduction systems.

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

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

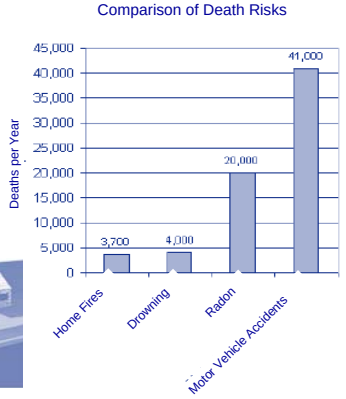
Is there a safe level of radon?

Can you test for radon before construction?



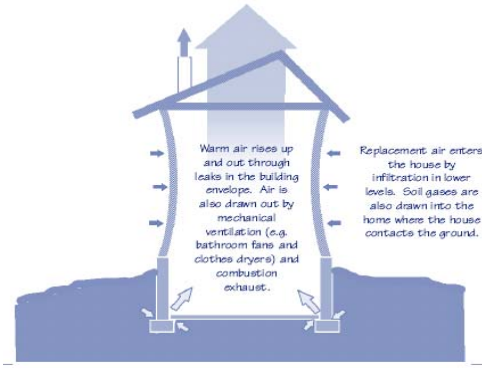
Is there a safe level of radon? **No.**

Can you test for radon before construction? **No.**



How Does Radon Enter A House?

Common Radon Entry Points



RADON CONTROL HIGHLIGHTS: RADON RESISTANT CONSTRUCTION

ENERGY STAR

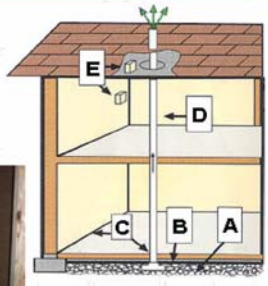
A. Gas Permeable Layer
(4" clean gravel)

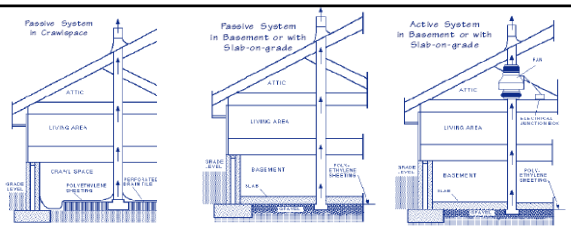
B. Plastic Sheeting
(under slab or over crawl space)

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)



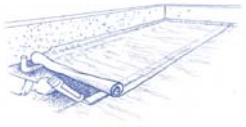


How much perforated pipe is needed?
(12" from footing, 1" below slab)

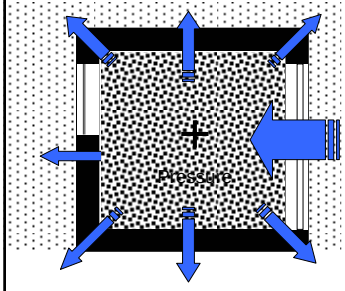
3" Pipe up to 2,000 SF of slab

4" Pipe if 2,000 SF to 4,000 SF slab

Separate Loop for each 2,000 Additional SF of slab



CFM air in = CFM air out



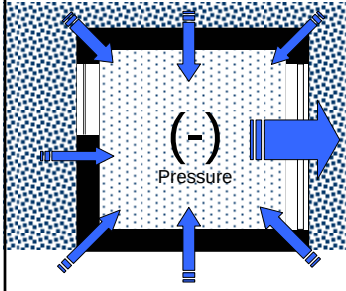
House Pressurization

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

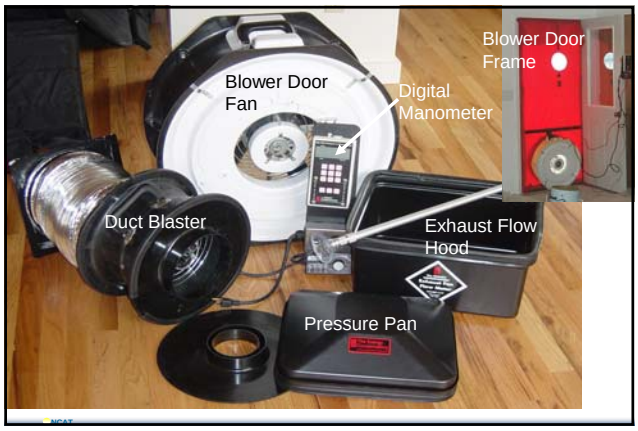


House Depressurization

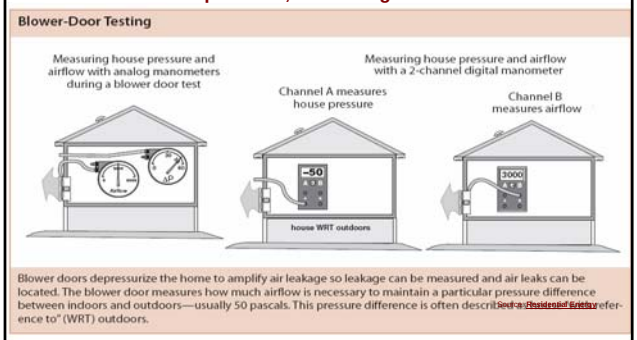
Pressure outside is greater than pressure inside, house is under negative pressure

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

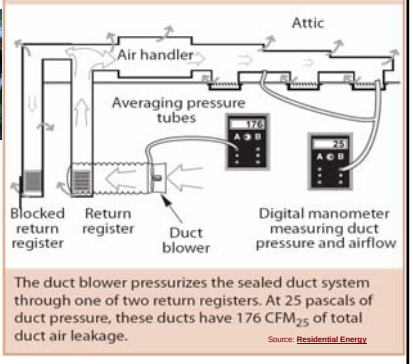
Result: Outdoor air drawn into house.



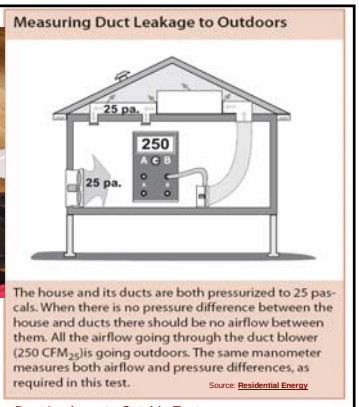
Building tightness testing is an estimator, not a "true" predictor, of building infiltration.



Blower Door Test



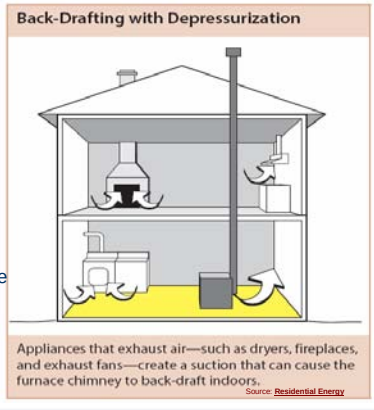
Total Duct Leakage Test



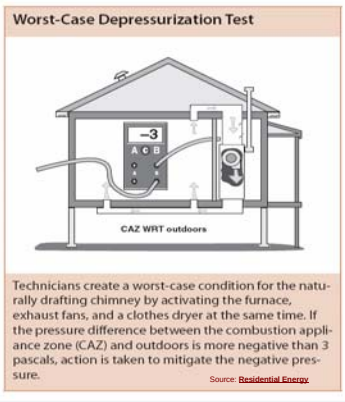
Duct Leakage to Outside Test

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

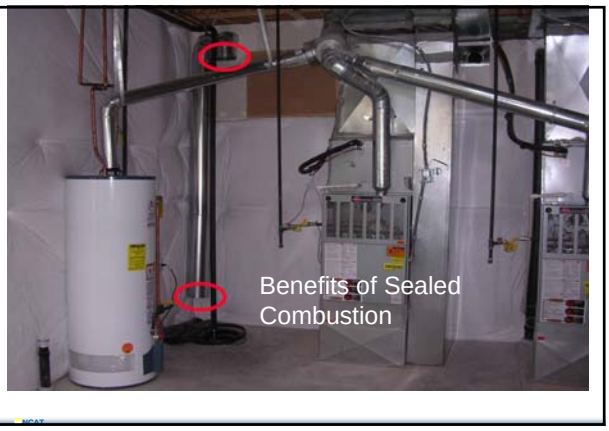


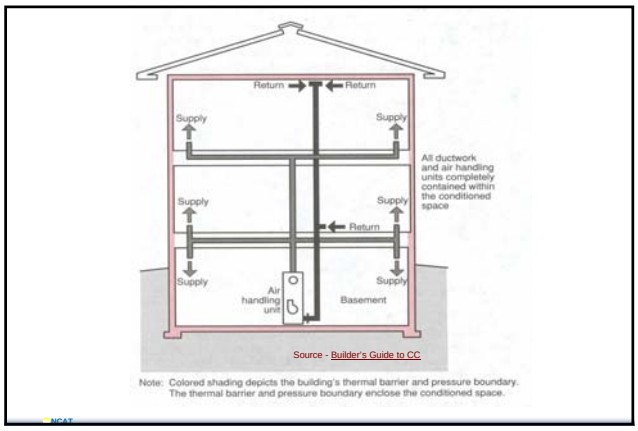
CAZ Test

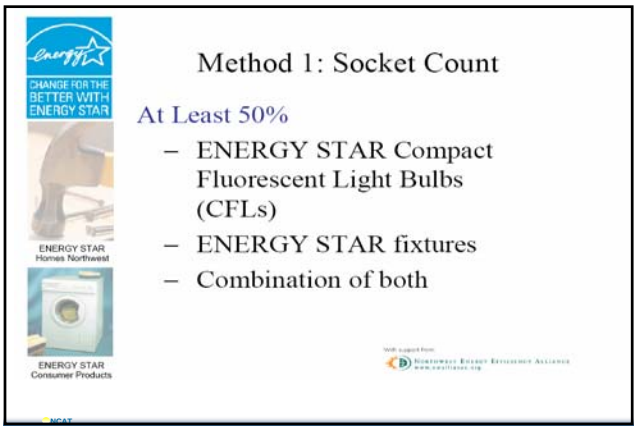


CAZ Test

Exhaust Fan Flow Test







Method 2: Fixture Count (ALP)

CHANGE FOR THE BETTER WITH ENERGY STAR

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ENERGY STAR Consumer Products

High Use Rooms –50%

-Living Room, Kitchen, Dining Room, Family Room, Bathrooms, Hallways, Stairways

Med-Low Use Rooms – 25%

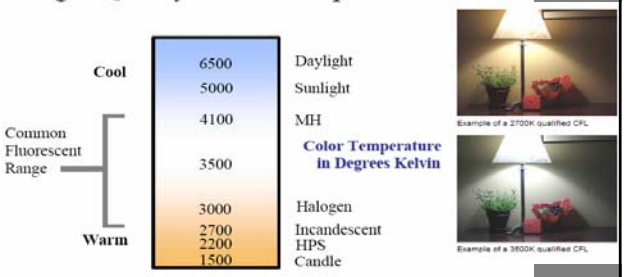
-Bedroom, Den, Office, Basement, Laundry Room, Garage, Closet(s), and all other rooms

Outdoor – 50%

-Outdoor Lighting Affixed to the Home or Free-Standing Pole(s)

(% based on category total, not individual rooms)

Light Quality: Color Temperature



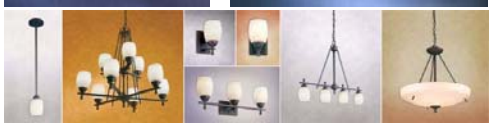
Example of a 2700K qualified CFL

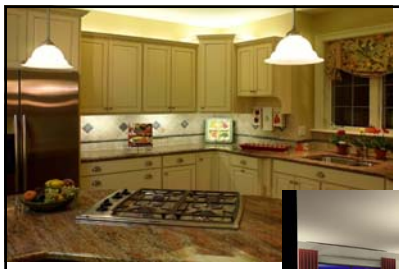
Example of a 3500K qualified CFL

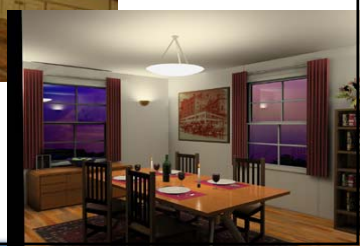
CFL Sizes and Shapes

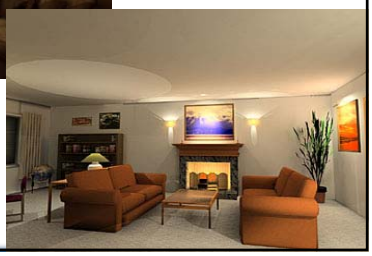
CFLs come in a variety of shapes and sizes. The majority of CFLs are designed to look identical to the incandescent light bulb version. The table below identifies the most popular CFL shapes that are available at retail:

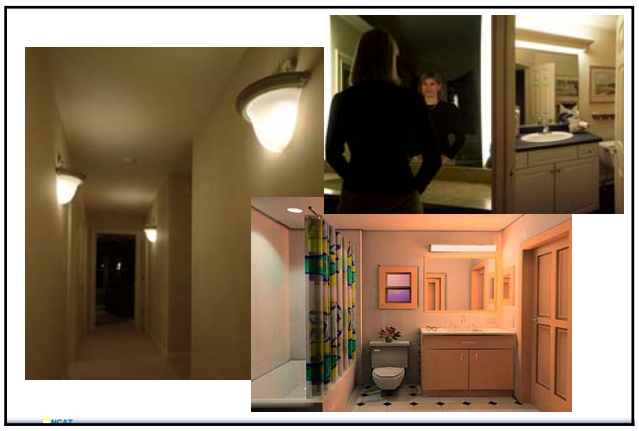
Bare Products		Covered Products			Reflector Products
Mini-Spiral or Twist	Tube or Universal	Incandescent/ A-line	Globe G25, G30, G40	Candelabra, Post or Bullet Shape	Indoor and Outdoor R20, R30, R40, PAR38
					

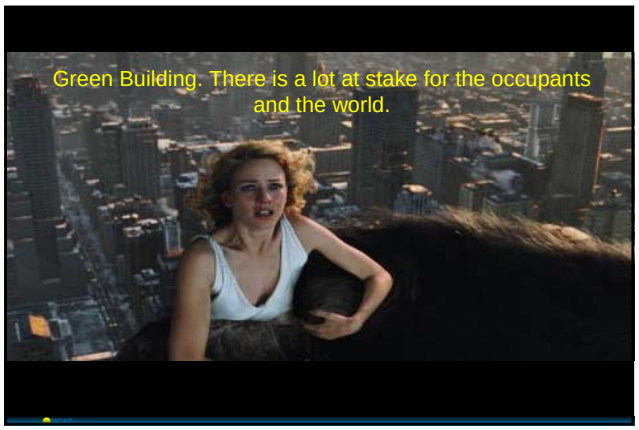












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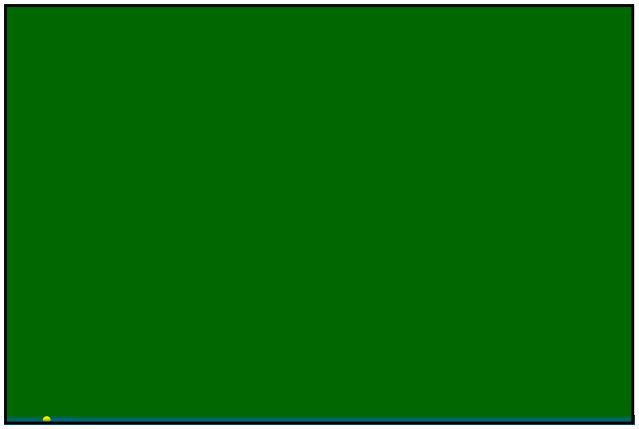

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Technical Compliance Options

TCO #001(a)– Perimeter Insulated (Conditioned) Crawlspace

BOP 1 **Gas/Heat Pump**

Description:

Mechanically ventilated, perimeter insulated crawlspace.

R30 Crawl Space Wall with continuous exhaust ventilation from CS

Fine Print:

All requirements not specified in this additional BOP shall be those already specified in NWBOP 1.

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.

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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.

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Technical Compliance Options

TCO #001(b)– Perimeter Insulated (Conditioned) Crawlspace Pending

BOP 1 **Gas/Heat Pump**

Description:

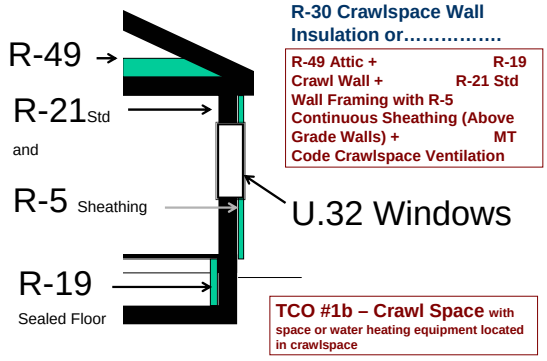
Mechanically ventilated, perimeter insulated crawlspace.

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.



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Technical Compliance Options

BOP 1 **Gas/Heat Pump**

TCO #003 – Advanced Lighting Package

BOP 2 **Electric/Propane**

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.

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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.

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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.

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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.**

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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.**

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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.**

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Technical Compliance Options

BOP 1 **Gas/Heat Pump**

TCO #009 – Hybrid Gas Unit Heaters & Zoned Electric

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 (NFRC 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 BTUh/sf
   - Intermountain Regions – 13 BTUh/sf
   - Mountain Zones – 16 BTUh/sf
5. Zonal electric heaters shall provide up to 60% of the gas unit heaters or fireplaces. Separate thermostats shall be in each room.

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Technical Compliance Options

BOP 1 **Gas/Heat Pump**

TCO #010 – Ductless-Split Heat Pump/Zonal Electric

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 (NFRC 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.**

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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.**

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Technical Compliance Option

TCO #012 – HSPF 8.3 Heap Pump Coupled with a 90 AFUE Gas Furnace Backup

BOP 1 **Gas/Heat Pump**

Description: **Allow a HSPF 8.3 Heap 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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Technical Compliance Option

TCO #013 – Cathedral Attic

BOP 1 **Gas/Heat Pump**

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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