Montana

Residential Energy Code

Looking Under the Hood

Funding for this presentation has been provided by the NorthWestern Energy and the Northwest Energy Efficiency Alliance.
Presentation Available at:
https://www.ncat.org/energy-code-trainings/
Residential
Energy Code Evolution

Source - BECP
Q1. Does the Montana Energy Code apply to houses built outside local code jurisdictions?

A. Yes
B. No
Q1. Does the Montana Energy Code apply to houses built outside local code jurisdictions?

A. Yes
B. No
R402
Building Thermal Envelope

- What’s an R-Value? Really.
- The Shape of Things.
- Tight is Right. Isn’t it?
- Testing Today & Tomorrow.
Q2. Heat we feel from a campfire is heat transfer by:

A. Conduction
B. Convection
C. Radiation
Q2. Heat we feel from a campfire is heat transfer by:

A. Conduction
B. Convection
C. Radiation
<table>
<thead>
<tr>
<th>CLIMATE ZONE</th>
<th>FENESTRATION U-FACTOR&lt;sup&gt;b&lt;/sup&gt;</th>
<th>SKYLIGHT&lt;sup&gt;b&lt;/sup&gt; U-FACTOR</th>
<th>GLAZED FENESTRATION SHGC&lt;sup&gt;b, e&lt;/sup&gt;</th>
<th>CEILING R-VALUE</th>
<th>WOOD FRAME WALL R-VALUE</th>
<th>MASS WALL R-VALUE</th>
<th>FLOOR R-VALUE</th>
<th>BASEMENT&lt;sup&gt;c&lt;/sup&gt; WALL R-VALUE</th>
<th>SLAB&lt;sup&gt;d&lt;/sup&gt; R-VALUE &amp; DEPTH</th>
<th>CRAWL SPACE&lt;sup&gt;c&lt;/sup&gt; WALL R-VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>2009 IECC</strong>&lt;sup&gt;*&lt;/sup&gt;</td>
<td>6</td>
<td>0.33</td>
<td>0.60</td>
<td>NR</td>
<td>49</td>
<td>21 or 13+5&lt;sup&gt;h&lt;/sup&gt;</td>
<td>15/19</td>
<td>30&lt;sup&gt;g&lt;/sup&gt;</td>
<td>15/19</td>
<td>10, 4 ft</td>
</tr>
<tr>
<td><strong>2012 IECC</strong>&lt;sup&gt;*&lt;/sup&gt;</td>
<td>6</td>
<td>0.32</td>
<td>0.55</td>
<td>NR</td>
<td>49</td>
<td>21 or 13+5&lt;sup&gt;h&lt;/sup&gt;</td>
<td>15/20</td>
<td>30&lt;sup&gt;g&lt;/sup&gt;</td>
<td>15/19</td>
<td>10, 4 ft</td>
</tr>
<tr>
<td><strong>2012 IECC</strong></td>
<td>6</td>
<td>0.32</td>
<td>0.55</td>
<td>NR</td>
<td>49</td>
<td>20+5 or 13+10&lt;sup&gt;h&lt;/sup&gt;</td>
<td>15/20</td>
<td>30&lt;sup&gt;g&lt;/sup&gt;</td>
<td>15/19</td>
<td>10, 4 ft</td>
</tr>
</tbody>
</table>

* - With Montana Amendments
Q3. U-factors are a measure thermal resistance while R-values are a measure of heat transfer.

A. True
B. False

R-Values are additive \((R-1 + R-1 = R-2)\)

\[ R = 1/U \text{ and } U = 1/R \]
Q3. U-factors are a measure of thermal resistance while R-values are a measure of heat transfer.

A. True

B. False

R-Values are additive \((R-1 + R-1 = R-2)\)

\[ R = \frac{1}{U} \text{ and } U = \frac{1}{R} \]
Q4. The higher the U-factor the better the insulator.

A. True

B. False
Q4. The higher the U-factor the better the insulator.

A. True

B. False
Q5. Do the characteristics shown comply with the energy code? A. Yes  B. No

U = 0.33
R = 21

U = 0.55
R = 38

R = 21

Crawl Space

R = 10
Q5. Do the characteristics shown comply with the energy code? A. Yes  B. No

- U = 0.55
- R = 38
- R = 21
- R = 21
- R = 10

Crawl Space
Q6. Do the characteristics shown comply with the energy code?  

A. Yes  
B. No

- \( R = 49 \)  
- Windows  
  100 SF U-0.33  
  100 SF U-0.30  
- \( R = 21 \)  
- \( R = 15 \)  
  Continuous

Basement
Q6. Do the characteristics shown comply with the energy code?  

- Windows:
  - 100 SF U-0.33
  - 100 SF U-0.30
- R = 49
- R = 21
- Continuous
- R = 15

- Basement

A. Yes  B. No
Q7. Installing eave baffles for air permeable insulation is good practice but not required by code.

A. True
B. False
Q7. Installing eave baffles for air permeable insulation is good practice but not required by code.

A. True

B. False
Eave Baffles Required

R402.2.3

New: Required for air permeable insulations in vented attics

Source: USDOE Building Technologies Program, Introduction to Building Systems Performance: Houses That Work II
Calculating Assembly U-Factors

<table>
<thead>
<tr>
<th>Material</th>
<th>R-Value Cavity</th>
<th>R-Value Framing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inside air film</td>
<td>0.68</td>
<td>0.68</td>
</tr>
<tr>
<td>Gypsum board</td>
<td>0.45</td>
<td>0.45</td>
</tr>
<tr>
<td>Cavity insulation</td>
<td>21.00</td>
<td>......</td>
</tr>
<tr>
<td>5.5” Stud</td>
<td>......</td>
<td>6.80</td>
</tr>
<tr>
<td>Exterior sheathing</td>
<td>0.50</td>
<td>0.50</td>
</tr>
<tr>
<td>Exterior siding</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Outside Air Film</td>
<td>0.17</td>
<td>0.17</td>
</tr>
<tr>
<td><strong>Total R-value</strong></td>
<td><strong>23.80</strong></td>
<td><strong>9.60</strong></td>
</tr>
<tr>
<td><strong>U-Value</strong></td>
<td><strong>0.042</strong></td>
<td><strong>0.104</strong></td>
</tr>
<tr>
<td><strong>Area Fraction</strong></td>
<td><strong>0.80</strong></td>
<td><strong>0.20</strong></td>
</tr>
</tbody>
</table>

Area Weighted U-Factor = (Area\(_1\) \_Frac \times U1) + (Area\(_2\) \_Frac + Area2)

Area Weighted U-Factor = (0.8 \times 0.042) + (0.2 \times 0.104) = 0.054

Area Weighted R-Value = (1/0.054) = 18.38
Using REScheck Software

Download  http://www.energycodes.gov/rescheck
Q8. The maximum Solar Heat Gain Coefficient according to the Montana energy code is:

A. 0.25
B. 0.40
C. None of the above.
Q8. The maximum Solar Heat Gain Coefficient according to the Montana energy code is:

A. 0.25
B. 0.40
C. None of the above.
Window U-Factor

from 0.32  U-Factor  to 0.33

Lower means less heat loss.

Source: www.nfrc.org
Q9. Exterior wall insulation works just like beverage can insulation to prevent condensation within walls?
A. True
B. False
Q9. Exterior wall insulation works just like beverage can insulation to prevent condensation within walls?

A. True
B. False
Exterior Insulated Sheathing & Condensation Resistance

- 33 F
- 40 F
- 44 F

70 F
32 F
Unvented Attic (IRC R806.5.5.1)
Air Impermeable Insulation Only

Air Impermeable Insulation in Direct Contact with Sheathing

Air Impermeable Insulation must be Class II Vapor Retarder or Have a Class III Vapor Retarder on the Underside

Class I Vapor Retarder Not Allowed
Unvented Enclosed Rafter Assembly  
(R806.5.5.1)  
Air Impermeable Insulation Only

- Air Impermeable Insulation in Direct Contact with Sheathing
- Air Impermeable Insulation must be Class II Vapor Retarder or Have a Class III Vapor Retarder on the Underside
- Class I Vapor Retarder Not Allowed
Unvented Attic (IRC R806.5.5.2)
Air Impermeable & Permeable Insulation

Air-impermeable Insulation
Above Sheathing $\geq$ R-25

Air Permeable Insulation in Direct Contact with Sheathing
($R_{49} - R_{25} = R_{24}$)

Class I Vapor Retarder
Not Allowed
Unvented Attic (IRC R806.5.5.3)
Air-Impermeable and
Air-Permeable Insulation

Air-Impermeable Insulation in Direct Contact with Sheathing Min. R-25

Air-Permeable Insulation in Direct Contact with Air-Impermeable Insulation

Class I Vapor Retarder Not Allowed
What’s an R-Value? Really.
Wall Effective R-Value Based on % of Window

- **R-21 Wall U-0.32 Window**
- **R-21 Wall U-0.28 Window**
- **R-21 Wall U-0.21 Window**

**Y-axis:** Effective R-Value

**X-axis:** Window-to-Floor Ratio

- 5% to 50% increments
Effective R-Value of Wall Types
Based on % Framing and Insulation Grade

<table>
<thead>
<tr>
<th>Wall Type</th>
<th>Annual Consumption MMBtu/Yr</th>
</tr>
</thead>
<tbody>
<tr>
<td>2x6, 24&quot;, R21+5 (15%)</td>
<td>Grade III: 54</td>
</tr>
<tr>
<td>2x6, 16&quot;, R21+5 (23%)</td>
<td>Grade III: 53</td>
</tr>
<tr>
<td>2x4, 24&quot;, R13+10 (15%)</td>
<td>Grade III: 55</td>
</tr>
<tr>
<td>2x4, 16&quot;, R13+10 (23%)</td>
<td>Grade III: 54</td>
</tr>
<tr>
<td>2x6, 24&quot;, R21 (15%)</td>
<td>Grade III: 58</td>
</tr>
<tr>
<td>2x6, 16&quot;, R21 (23%)</td>
<td>Grade III: 61</td>
</tr>
</tbody>
</table>
Q10. Which photo complies with the code?
Q10. Which photo complies with the code?
Solar Electric Price and Installations

- **Blended Average Solar PV Price ($/watt)**
  - 2005: $9.00
  - 2006: $8.00
  - 2007: $8.00
  - 2008: $7.00
  - 2009: $7.00
  - 2010: $6.00
  - 2011: $5.00
  - 2012: $4.00
  - 2013: $3.00
  - 2014: $2.00

- **Solar PV Installations (MWdc)**
  - 2005: 0
  - 2006: 1,000
  - 2007: 2,000
  - 2008: 3,000
  - 2009: 4,000
  - 2010: 5,000
  - 2011: 6,000
  - 2012: 7,000

**Legend**
- **Solar PV Installations**
- **Solar PV Prices**
Climate Responsive Orientation

Window Orientation and Solar Heat Gain
Q11. The critical solar window is:
A. 10 AM until 2 PM
B. 8 AM until 4 PM
C. 9 AM until 3 PM
Q11. The critical solar window is:
A. 10 AM until 2 PM
B. 8 AM until 4 PM
C. 9 AM until 3 PM

The diagram shows that the critical solar window is from 9 AM to 3 PM.
Climate Responsive Orientation

Plan Room Functions to Coincide with the Sun’s Movement
The Shape of Things

Climate Responsive Design

Subdivision with predominantly north- and south-facing sites for higher solar panel exposure to sun

Source: Volume 12 USDOE Building America: 40% Whole-House Energy Savings, 2011
Climate Responsive Overhangs

**L = H / Overhang Factor**

<table>
<thead>
<tr>
<th>Latitude</th>
<th>June 21</th>
<th>August 1</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>45</td>
<td>2.58</td>
<td>1.93</td>
<td>Dillon, Red Lodge</td>
</tr>
<tr>
<td>46</td>
<td>2.45</td>
<td>1.85</td>
<td>Butte, Bozeman, Billings</td>
</tr>
<tr>
<td>47</td>
<td>2.33</td>
<td>1.78</td>
<td>Helena, Missoula</td>
</tr>
<tr>
<td>48</td>
<td>2.20</td>
<td>1.70</td>
<td>Kalispell, Great Falls</td>
</tr>
<tr>
<td>49</td>
<td>2.10</td>
<td>1.65</td>
<td>Cut Bank, Havre</td>
</tr>
</tbody>
</table>
Q12. The energy code requires that a house comply with air tightness by a blower door test or by compliance with the Insulation and Air Barrier Installation Table.

A. True
B. False
Q12. The energy code requires that a house comply with air tightness by a blower door test \textit{or} by compliance with the \textit{Insulation and Air Barrier Installation Table}.

A. True

B. False
Q13. Which water vapor transport mechanism is more significant for building cavities?

A. Diffusion
B. Air Transport
C. Capillary
Q13. Which water vapor transport mechanism is more significant for building cavities?
A. Diffusion
B. Air Transport
C. Capillary
Q14. Which of the following must be installed on the warm side of the wall according to Montana code?
A. Vapor Retarder
B. Air Barrier
C. Both
Q14. Which of the following must be installed on the warm side of the wall according to Montana code?
A. Vapor Retarder
B. Air Barrier
C. Both
**Air Barrier**: Material(s) assembled and joined together to provide a barrier to air leakage through **and** **into** the building envelope. An air barrier may be a single material or a combination of materials.
Vapor Retarders

Class I or II vapor retarder at warm side of wall required.
Exception: Basement Walls and any portion of below grade walls.

Class III is allowed for:
- Vented cladding
- Continuous Insulation
  - R-7.5 for 2x4 wall
  - R11.25 for 2x6 wall

Source - NCAT
## Vapor Retarders

<table>
<thead>
<tr>
<th>Class</th>
<th>Definition</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>0.1 perm or less</td>
<td>Sheet polyethylene, sheet metal, non-perforated aluminum foil</td>
</tr>
<tr>
<td>II</td>
<td>Greater than 0.1 perm to less than 1.0 perm</td>
<td>Kraft-faced fiberglass batts or low-perm paint</td>
</tr>
<tr>
<td>III</td>
<td>Greater than 1.0 perm to less than 10 perm</td>
<td>Latex or enamel paint</td>
</tr>
</tbody>
</table>

**Impermeable (vapor barrier)**

**Semi-impermeable**

**Semi-permeable**

---

Source: USDOE Building Technologies Program, Whole-House Energy Savings in Cold and Very Cold Climates
Vapor Retarder and Air Barrier Code Summary

Continuous Air Barrier in Building Envelope

Class I or II Vapor Retarder – Above Grade Walls
Unvented Attic (IRC R806.5.5.1)
Air Impermeable Insulation Only

Air Impermeable Insulation in Direct Contact with Sheathing

Air Impermeable Insulation must be Class II Vapor Retarder or Have a Class III Vapor Retarder on the Underside

Class I Vapor Retarder Not Allowed
Q15. The Montana code allows humidistat control of unvented crawlspace exhaust fan.

A. True
B. False
Q15. The Montana code allows humidistat control of unvented crawlspace exhaust fan.

A. True  
B. False

**Continuous Exhaust to Exterior**
- 1 CFM/50 SF Crawlspace Area
- Air Pathway to Common Area

**Conditioned Air Supply**
- 1 CFM/50 SF Crawlspace Area
- Air Pathway to Common Area
Q16. Lapped poly satisfies the energy code requirement for a continuous air barrier?

A. True      B. False
Q16. Lapped poly satisfies the energy code requirement for a continuous air barrier?

A. True      B. False
Q17. According to building science, should a polyethylene vapor retarder be installed on a furred out frame wall in the basement?

A. Yes

B. No
Q17. According to building science, should a polyethylene vapor retarder be installed on a furred out frame wall in the basement?

A. Yes
B. No
Q18. What is this photo?
A. Aliens communicating with humans.
B. Infrared image of wall air leaks.
Q18. What is this photo?
A. Aliens communicating with humans.
B. Infrared image of wall air leaks.
Q19. In this infrared photo is it hot or cold outside?
A. Hot     B. Cold
Q19. In this infrared photo is it hot or cold outside?

A. Hot  B. Cold
Q20. Recessed can light fixtures rated “air tight” are really air tight.

A. True

B. False
Q20. Recessed can light fixtures rated “air tight” are really air tight.

A. True

B. False
Q21. What is the best strategy for preventing mold?

A. Eliminate mold spores

B. Control nutrient source

C. Control moisture
Q21. What is the best strategy for preventing mold?

A. Eliminate mold spores

B. Control nutrient source

C. Control moisture
Q22. The typical blower door test depressurizes the house.
A. True      B. False
Q22. The typical blower door test depressurizes the house.

A. True  B. False

Air In = Air Out
Q23. A blower door test is conducted at what house pressure with reference to outdoors?

A. +25 Pa
B. +50 Pa
C. -50 Pa
Q23. A blower door test is conducted at what house pressure with reference to outdoors?

A. +25 Pa  
B. +50 Pa  
C. -50 Pa
Q24. The maximum envelope leakage allowed by the Montana energy code is:

A. 3 ACH50

B. 4 ACH50

C. 5 ACH50
Q24. The maximum envelope leakage allowed by the Montana energy code is:

A. 3 ACH50
B. 4 ACH50
C. 5 ACH50
Q25. A blower door test may be done before the sheet rock has been installed.
A. True      B. False
Q25. A blower door test may be done before the sheet rock has been installed.  

A. True  
B. False
Q26. How is relative humidity in a house affected by a tighter building envelope?  
A. Decreasing  
B. Increases
Q26. How is relative humidity in a house affected by a tighter building envelope?
A. Decreasing  B. Increases
Building Tightness Testing (Blower Door)

Air In = Air Out

≤ 4 ACH50
Blower Door Skirt Configurations

Mini-Fan Blower Door System

Minneapolis Blower Door™ System

Minneapolis Blower Door™ System: 2-Fan System

Minneapolis Blower Door™ System: 3-Fan System

Source: The Energy Conservatory
Multifamily Tightness Testing

Compartmentalization Test

RESNET Guidelines for Multifamily Energy Ratings

These Guidelines were developed by the Residential Energy Services Network (RESNET) and adopted by the RESNET Board of Directors on August 29, 2014

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Multifamily Tightness Testing

Full Building Single Zone Test

Source: The Energy Conservatory
Multifamily Tightness Testing

Full Building Multi-Zone Test

Source: The Energy Conservatory
Multifamily Tightness Testing

Full Building Plus Target Unit Test

Source: The Energy Conservatory
Multifamily Tightness Testing

Apartment Test Option

Source: The Energy Conservatory
R403 Systems

• Build it Tight. Ventilate it Right.
• Ventilation, Now and Then.
• Ductless and Proud of It.
Key Findings New Green Construction:

- Four studies documented reductions in healthcare utilization.
- Multiple studies found reductions in:
  - Indoor air pollutants,
  - Asthma triggers such as pests and mold
  - Asthma symptoms

Key Findings Enhanced Ventilation Strategies:

- Documented reduced indoor air quality contaminants that have been linked with chronic illnesses or respiratory risks
- Fewer respiratory risks among people with asthma Reduced allergens.
## Continuous Mechanical Ventilation

### IRC M1507.3.3

**TABLE M1507.3.3(1)**

CONTINUOUS WHOLE-HOUSE MECHANICAL VENTILATION SYSTEM

AIRFLOW RATE REQUIREMENTS

<table>
<thead>
<tr>
<th>DWELLING UNIT FLOOR AREA (square feet)</th>
<th>0-1</th>
<th>2-3</th>
<th>4-5</th>
<th>6-7</th>
<th>&gt; 7</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 1,500</td>
<td>30</td>
<td>45</td>
<td>60</td>
<td>75</td>
<td>90</td>
</tr>
<tr>
<td>1,501 - 3,000</td>
<td>45</td>
<td>60</td>
<td>75</td>
<td>90</td>
<td>105</td>
</tr>
<tr>
<td>3,001 - 4,500</td>
<td>60</td>
<td>75</td>
<td>90</td>
<td>105</td>
<td>120</td>
</tr>
<tr>
<td>4,501 - 6,000</td>
<td>75</td>
<td>90</td>
<td>105</td>
<td>120</td>
<td>135</td>
</tr>
<tr>
<td>6,001 - 7,500</td>
<td>90</td>
<td>105</td>
<td>120</td>
<td>135</td>
<td>150</td>
</tr>
<tr>
<td>&gt; 7,500</td>
<td>105</td>
<td>120</td>
<td>135</td>
<td>150</td>
<td>165</td>
</tr>
</tbody>
</table>

Note: Manual override required.
<table>
<thead>
<tr>
<th>NUMBER OF BEDROOMS</th>
<th>0-1</th>
<th>2-3</th>
<th>4-5</th>
<th>6-7</th>
<th>&gt; 7</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 1,500</td>
<td>30</td>
<td>45</td>
<td>60</td>
<td>75</td>
<td>90</td>
</tr>
<tr>
<td>1,501 - 3,000</td>
<td>45</td>
<td>60</td>
<td>75</td>
<td>90</td>
<td>105</td>
</tr>
<tr>
<td>3,001 - 4,500</td>
<td>60</td>
<td>75</td>
<td>90</td>
<td>105</td>
<td>120</td>
</tr>
</tbody>
</table>
TABLE M1507.3.3(2)
Intermittent Whole-House Mechanical Ventilation Rate Factors

<table>
<thead>
<tr>
<th>Run-Time Percent in Each 4-Hour Segment</th>
<th>25%</th>
<th>33%</th>
<th>50%</th>
<th>66%</th>
<th>75%</th>
<th>100%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Factor</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1.5</td>
<td>1.3</td>
<td>1.0</td>
</tr>
</tbody>
</table>

**Exhaust Ventilation**
- Central exhaust fan
- Exhaust air outlet
- Air flow
- Positive air pressure
- Air infiltration
- Negative air pressure

**Balanced Ventilation**
- Room air exhaust ducts
- Exhaust fan
- Fresh air inlet
- Supply fan
- Air flow
- Positive air pressure
- Air infiltration
- Negative air pressure
### Table M1507.4
Minimum Required Local Exhaust Rates for One- and Two-Family Dwellings

<table>
<thead>
<tr>
<th>Area to Be Exhausted</th>
<th>Exhaust Rates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kitchens</td>
<td>100 cfm intermittent or 25 cfm continuous</td>
</tr>
<tr>
<td>Bathrooms-Toilet Rooms</td>
<td>Mechanical exhaust capacity of 50 cfm intermittent or 20 cfm continuous</td>
</tr>
</tbody>
</table>
Whole House Ventilation Example

3 BR, 2000 SF House = 60 CFM

60 CFM Continuous Exhaust Fan

100 CFM Manual Exhaust Fan
Whole House Ventilation Example

4BR, 3600 SF House = 90 CFM
Whole-house mechanical ventilation system fans to meet efficacy in Table R403.5.1

**Exception** When fans are integral to tested and listed HVAC equipment, powered by electronically commutated motor

<table>
<thead>
<tr>
<th>FAN LOCATION</th>
<th>AIR FLOW RATE MINIMUM</th>
<th>MINIMUM EFFICACY</th>
<th>AIR FLOW RATE MAXIMUM</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(CFM)</td>
<td>(CFM/WATT)</td>
<td>(CFM)</td>
</tr>
<tr>
<td>Range hoods</td>
<td>Any</td>
<td>2.8 cfm/watt</td>
<td>Any</td>
</tr>
<tr>
<td>In-line fan</td>
<td>Any</td>
<td>2.8 cfm/watt</td>
<td>Any</td>
</tr>
<tr>
<td>Bathroom, utility room</td>
<td>10</td>
<td>1.4 cfm/watt</td>
<td>&lt; 90</td>
</tr>
<tr>
<td>Bathroom, utility room</td>
<td>90</td>
<td>2.8 cfm/watt</td>
<td>Any</td>
</tr>
</tbody>
</table>
Q27. The Montana codes require new homes to have radon mitigation systems.

A. True
B. False
Q27. The Montana codes require new homes to have radon mitigation systems.

A. True

B. False
Q28. Can you accurately test for radon before construction?

A. Yes

B. NO
Q28. Can you accurately test for radon before construction?

A. Yes

B. NO
Q29. Mechanical ventilation systems must be tested for airflow.
A. True   B. False
Q29. Mechanical ventilation systems must be tested for airflow.

A. True    B. False
### Kitchen Exhaust Use in CA IAQ Study

<table>
<thead>
<tr>
<th>Reasons for NOT using exhaust system</th>
<th>Number</th>
<th>% of 193 using &lt;50% of time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not needed</td>
<td>92</td>
<td>48%</td>
</tr>
<tr>
<td>Too noisy</td>
<td>40</td>
<td>21%</td>
</tr>
<tr>
<td>Don’t think about it</td>
<td>31</td>
<td>16%</td>
</tr>
<tr>
<td>Doesn’t work</td>
<td>19</td>
<td>10%</td>
</tr>
<tr>
<td>Open window instead</td>
<td>17</td>
<td>9%</td>
</tr>
<tr>
<td>Other reasons</td>
<td>7</td>
<td>&lt;4%</td>
</tr>
<tr>
<td>Wastes energy</td>
<td>3</td>
<td>&lt;2%</td>
</tr>
<tr>
<td>No reason selected or don’t know</td>
<td>23</td>
<td>12%</td>
</tr>
</tbody>
</table>

*Mullen et al. LBNL-5970E*

#### Continuous Exhaust

<table>
<thead>
<tr>
<th></th>
<th>2012 IRC</th>
<th>ASHRAE 62.2-2016</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ventilation Rate</td>
<td>$0.01A_{floor} + 7.5 (N_{BR} = 1)$</td>
<td>$0.03A_{floor} + 7.5 (N_{BR} = 1)$</td>
</tr>
</tbody>
</table>

#### Local Exhaust

<table>
<thead>
<tr>
<th></th>
<th>Continuous (cfm)</th>
<th>Demand Controlled (cfm)</th>
<th>Continuous (cfm)</th>
<th>Demand Controlled (cfm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bathroom</td>
<td>20</td>
<td>50</td>
<td>20</td>
<td>50</td>
</tr>
<tr>
<td>Kitchen Enclosed</td>
<td>25</td>
<td>100</td>
<td>100 cfm Hood or 300 cfm Non-hood or 5 ACH</td>
<td>100</td>
</tr>
<tr>
<td>Kitchen Nonenclosed</td>
<td>25</td>
<td>100</td>
<td>NA</td>
<td>100 cfm Hood or 300 cfm Non-hood</td>
</tr>
<tr>
<td>Air Flow Measurement</td>
<td>Not Required</td>
<td></td>
<td>Required</td>
<td></td>
</tr>
</tbody>
</table>

“Enclosed” - Permanent openings to the interior adjacent spaces $\leq 60$ ft$^2$. 
### Ventilation Rates

**2012 IRC**

<table>
<thead>
<tr>
<th>Dwelling Unit Floor Area (ft²)</th>
<th>0-1</th>
<th>2-3</th>
<th>4-5</th>
<th>6-7</th>
<th>&gt; 7</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;1,500</td>
<td>30</td>
<td>45</td>
<td>60</td>
<td>75</td>
<td>90</td>
</tr>
<tr>
<td>1,501-3,000</td>
<td>45</td>
<td>60</td>
<td>75</td>
<td>90</td>
<td>105</td>
</tr>
<tr>
<td>3,001-4,500</td>
<td>60</td>
<td>75</td>
<td>90</td>
<td>105</td>
<td>120</td>
</tr>
<tr>
<td>4,501-6,000</td>
<td>75</td>
<td>90</td>
<td>105</td>
<td>120</td>
<td>135</td>
</tr>
<tr>
<td>6,001-7,500</td>
<td>90</td>
<td>105</td>
<td>120</td>
<td>135</td>
<td>150</td>
</tr>
<tr>
<td>&gt;7,500</td>
<td>105</td>
<td>120</td>
<td>135</td>
<td>150</td>
<td>165</td>
</tr>
</tbody>
</table>

Example: **1,200 ft² - 2 Bedrooms**

**ASHRAE 62.2 2016**

<table>
<thead>
<tr>
<th>Dwelling Unit Floor Area (ft²)</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;500</td>
<td>30</td>
<td>38</td>
<td>45</td>
<td>53</td>
<td>60</td>
</tr>
<tr>
<td>501-1000</td>
<td>45</td>
<td>53</td>
<td>60</td>
<td>68</td>
<td>75</td>
</tr>
<tr>
<td>1001-1500</td>
<td>60</td>
<td>68</td>
<td>75</td>
<td>83</td>
<td>90</td>
</tr>
<tr>
<td>1501-2000</td>
<td>75</td>
<td>83</td>
<td>90</td>
<td>98</td>
<td>105</td>
</tr>
<tr>
<td>2001-2500</td>
<td>90</td>
<td>98</td>
<td>105</td>
<td>113</td>
<td>120</td>
</tr>
<tr>
<td>2501-3000</td>
<td>105</td>
<td>113</td>
<td>120</td>
<td>128</td>
<td>135</td>
</tr>
<tr>
<td>3001-3500</td>
<td>120</td>
<td>128</td>
<td>135</td>
<td>143</td>
<td>150</td>
</tr>
<tr>
<td>3501-4000</td>
<td>135</td>
<td>143</td>
<td>150</td>
<td>158</td>
<td>165</td>
</tr>
<tr>
<td>4001-4500</td>
<td>150</td>
<td>158</td>
<td>165</td>
<td>173</td>
<td>180</td>
</tr>
<tr>
<td>4501-5000</td>
<td>165</td>
<td>173</td>
<td>180</td>
<td>188</td>
<td>195</td>
</tr>
</tbody>
</table>

Example: **1,200 ft² - 2 Bedrooms**

**2012 IRC**

45 cfm

**ASHRAE 62.2 2016**

68 cfm
### Ventilation Rates

#### 2012 IRC

<table>
<thead>
<tr>
<th>DWELLING UNIT FLOOR AREA (square feet)</th>
<th>0-1</th>
<th>2-3</th>
<th>4-5</th>
<th>6-7</th>
<th>&gt; 7</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 1,500</td>
<td>30</td>
<td>45</td>
<td>60</td>
<td>75</td>
<td>90</td>
</tr>
<tr>
<td>1,501 - 3,000</td>
<td>45</td>
<td>60</td>
<td>75</td>
<td>90</td>
<td>105</td>
</tr>
<tr>
<td>3,001 - 4,500</td>
<td>60</td>
<td>75</td>
<td>90</td>
<td>105</td>
<td>120</td>
</tr>
<tr>
<td>4,501 - 6,000</td>
<td>75</td>
<td>90</td>
<td>105</td>
<td>120</td>
<td>135</td>
</tr>
<tr>
<td>6,001 - 7,500</td>
<td>90</td>
<td>105</td>
<td>120</td>
<td>135</td>
<td>150</td>
</tr>
<tr>
<td>&gt; 7,500</td>
<td>105</td>
<td>120</td>
<td>135</td>
<td>150</td>
<td>165</td>
</tr>
</tbody>
</table>

**Example:** 3,000 ft\(^2\) - 4 Bedrooms  
2012 IRC  
75 cfm

#### ASHRAE 62.2 2016

<table>
<thead>
<tr>
<th>Dwelling Unit Floor Area (ft(^2))</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 500</td>
<td>30</td>
<td>38</td>
<td>45</td>
<td>53</td>
<td>60</td>
</tr>
<tr>
<td>501-1000</td>
<td>45</td>
<td>53</td>
<td>60</td>
<td>68</td>
<td>75</td>
</tr>
<tr>
<td>1001-1500</td>
<td>60</td>
<td>68</td>
<td>75</td>
<td>83</td>
<td>90</td>
</tr>
<tr>
<td>1501-2000</td>
<td>75</td>
<td>83</td>
<td>90</td>
<td>98</td>
<td>105</td>
</tr>
<tr>
<td>2001-2500</td>
<td>90</td>
<td>98</td>
<td>105</td>
<td>113</td>
<td>120</td>
</tr>
<tr>
<td>2501-3000</td>
<td>105</td>
<td>113</td>
<td>120</td>
<td>128</td>
<td>135</td>
</tr>
<tr>
<td>3001-3500</td>
<td>120</td>
<td>128</td>
<td>135</td>
<td>143</td>
<td>150</td>
</tr>
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<td>143</td>
<td>150</td>
<td>158</td>
<td>165</td>
</tr>
<tr>
<td>4001-4500</td>
<td>150</td>
<td>158</td>
<td>165</td>
<td>173</td>
<td>180</td>
</tr>
<tr>
<td>4501-5000</td>
<td>165</td>
<td>173</td>
<td>180</td>
<td>188</td>
<td>195</td>
</tr>
</tbody>
</table>

**Example:** 3,000 ft\(^2\) - 4 Bedrooms  
ASHRAE 62.2 2016  
128 cfm
Mechanical Ventilation Control Options

- Demand Control (Intermittent)
- Humidity Sensors
- Shutoff Timers
- Occupancy Motion Sensors
- Multiple-speed Fans
- IAQ Sensors

Humidity Control (P/N 611224)
Multifunction Control (P/N 611227)
20/40/60 Timer (P/N 611228)
Speed Control (P/N 611229)
Home Ventilation

A classic balancing act

Ventilation is essential to remove and/or dilute indoor pollutants

Energy is required to condition ventilation air and operate fans

More air flow = better IAQ
More air flow = more energy

Smart Ventilation aims to minimize the energy penalty for ventilating
Source Control – Combustion & Cooking Emissions

- Moisture & CO₂
- NO₂ and formaldehyde
- Ultrafine particles & CO

- Ultrafine particle
- VOCs including acrolein
- Moisture and odors

Source: LBNL
Coming Soon

How can you tell if a hood works well?

The effectiveness of range hoods at capturing cooking pollutants is called capture efficiency.

New ASTM test method.

Source: LBNL
Range Hood Standard Development

Front and rear capture different: but most cooking on the front:
Should we test front and back or front only???

Source: LBNL
Capture Efficiency – Lab Results

Reference Flows:
100 cfm
60% back
30% oven, front

200 cfm
~80% back
40-80% oven
25-80% front

Source: LBNL
Formaldehyde Emitting Materials and IAQ

Homes Built With Low-Emitting Materials Have Lower Formaldehyde Concentrations (Hult et al., 2014)

- Conventional Materials
  - 54 CA homes from California New Home Survey (2-5 years old) (Offermann, 2009)

- Low-Emitting Materials (LBNL Study)
  - 11 New Mexico LEED/Indoor airPLUS homes
  - CARB compliant wood products

REL = Reference Exposure Levels

Source: LBNL
New Calculations - Variable Mechanical Ventilation

Enables Smart Time Shifted Ventilation

Short-Term Average Ventilation
• 3-Hour Time Averaged Flow Rate for Non-continuous Fans.

Scheduled Ventilation
• Calculate Relative Exposures Over Year

Annual Average Schedule
• Based on Average
• Controls commonly used to operate demand-controlled fans *may not* be used to operate continuous exhaust fans.

• Specifies duct diameter based on flow rate.
Q30. Are ducts allowed in exterior walls?
A. Yes
B. No
Q30. Are ducts allowed in exterior walls?

A. Yes
B. No
Q31. The Total Duct Tightness test is the only test allowed by the 2012 IECC.

A. True
B. False

---

**Postconstruction Test**

Total Leakage or Leakage to the Outside

\[ \leq 4 \text{ cfm/100 SF (at 25 PA)} \]

Former leakage to outside limit was 8 cfm/100 SF

Former total leakage limit was 12 cfm/100 SF

---

**Rough-in Test**

Total Leakage

\[ \leq 4 \text{ cfm/100 SF (at 25 PA)} \]

Former total leakage limit was 6 cfm/100 SF
Q31. The Total Duct Tightness test is the only test allowed by the 2012 IECC.

A. True

B. False

Postconstruction Test
Total Leakage or Leakage to the Outside
$\leq 4 \text{ cfm/100 SF (at 25 PA)}$

Former leakage to outside limit was 8 cfm/100 SF
Former total leakage limit was 12 cfm/100 SF

Rough-in Test
Total Leakage
$\leq 4 \text{ cfm/100 SF (at 25 PA)}$

Former total leakage limit was 6 cfm/100 SF
Q32. Leaky return ducts can cause backdrafting of atmospherically vented appliances.

A. True
B. False
Q32. Leaky return ducts can cause backdrafting of atmospherically vented appliances.

A. True  
B. False

Source: USDOE Building Energy Codes University
Ductless and Proud of It

Ductless heat pumps:

- Reliable
- Efficient
- Energy saving
- Aesthetics matter
- Give homeowners high levels of satisfaction

Originally recognized for greater efficiency compared to electric resistance heat.

Source: NEEA/Clear Result
Sec 407.3.1  All detached one and two family dwellings and multiple single-family dwellings (townhouses) up to three stories in height above grade plane using **electric zonal heating** as the primary heat source **shall install an inverter-driven ductless mini-split heat pump to provide heating to the largest zone in the dwelling.** Building permit drawings shall specify the heating equipment type and location. **Exception:** Total installed heating capacity of 2 kW/dwelling or less.
What Has Been Learned?

- Sizing and selection is **REALLY** important!
- Placement is **REALLY** important!
- Homeowner education is **REALLY** important!
- There are **BIG** differences between models with same nominal size.

Heating Cooling Loads Must Be Calculated

Source: NEEA/Clear Result
SIZING DUCTLESS HEAT PUMPS

Comparison of Nominal 1-ton DHP Models

"Rated" Capacity

Manufacturer's Stated Heating Capacity at 47 deg F (Btu/hr)

Source: NEEA/Clear Result
Comparison of Nominal 2-ton DHP Models

Manufacturer's Stated Heating Capacity at 47 deg F (Btu/hr)

"Rated" Capacity

Source: NEEA/Clear Result
SIZING DUCTLESS HEAT PUMPS

Cycling off and on every 3 to 5 minutes.
SIZING DUCTLESS HEAT PUMPS

Source: NEEA/Clear Result
Check out the turn down ratios at 47°F, 30°F, and 15°F. It's over 4:1 at 47°F.
Considerations:

- How to heat and cool remote rooms
- Home geometry and floor plan influence heat distribution
- Backup heat in bedrooms may be a good idea

Source: NEEA/Clear Result
Effective Air Throw & Temperature Distribution for Larger Rooms

6ft
3ft
2 Inches
3ft  6ft  9ft  13ft  16ft  19ft  23ft  26ft  30ft  33ft
Distance (ft)

<Test conditions>
Outdoor temp.: 35°F  R/C setting: 73°F, "Powerful" 30 min. later the operation is started. Test room : 350ft² Test model :

30ft @ 2" above the floor = 76°F
33ft @ 2" above the floor = 75°F

Source: NEEA/Clear Result
DHP SYSTEM DESIGN

- Appropriate number of indoor heads
  - One head per floor is usually enough

- An optimal system:
  - 1 DHP main living area, +1 smaller unit master suite
  - 1 DHP main living area, +1 ducted mini-split serving bedrooms
  - 1 DHP main living area, plus small electric resistance heaters in the bedrooms
  - If using ER heaters, use smaller units (750w), control with digital wall T-stats
Ductless Heat Pumps

IRC R303.9 Required Heating
...every dwelling unit shall be provided with heating facilities capable of maintaining a minimum room temperature of 68° at a point 3 feet above the floor and 2 feet from exterior walls in all habitable rooms at design temperature.

Source: NEEA/Clear Result
IT’S NOT A DUCTLESS PURITY TEST. IT’S OK TO TRANSFER AIR BY OTHER MEANS.

Source: NEEA/Clear Result
How DHP Hybrid Displacement Works

- Ideal alternative to electric resistance zonal heated homes
- Reduces heating bills by displacing a large share of zonal electric heat
- DHP installed in the main living area

Source: NEEA/Clear Result
Homeowner Education

- Leave interior doors open
- Clean filters
- Don’t make big changes in the set points
- The best system in the world does nothing if it isn’t used properly—
  
  *Homeowners must be educated on the operation of systems in their homes*

Source: NEEA/Clear Result
Q33. What does ACCA stand for?

A. American Construction Codes Association

B. Air Conditioning Contractors of America
Q33. What does ACCA stand for?
A. American Construction Codes Association
B. Air Conditioning Contractors of America
Q34. What does ACCA Manual J deal with?

A. Load Calculations

B. Equipment Sizing
Q34. What does ACCA Manual J deal with?

A. Load Calculations

B. Equipment Sizing
R403

Electrical & Lighting Systems

- % High Efficacy
- LEDs
Q35. What does the mandatory 75% high efficacy lighting requirement apply to?

A. Fixtures

B. Lamps

C. Either
Q35. What does the mandatory 75% high efficacy lighting requirement apply to?

A. Fixtures
B. Lamps
C. Either
Q36. Do low-voltage lamps count toward the mandatory 75% high efficacy lighting requirement?

A. Yes

B. No
Q36. Do low-voltage lamps count toward the mandatory 75% high efficacy lighting requirement?

A. Yes

B. No
Where are Energy Codes Headed?

Residential

Presenter  Dale Horton Architect  NCAT Energy Program Manager
Why do energy codes change?

1. Increase Stringency
2. Clarify Language to Increase Compliance
3. Decrease Stringency
Energy Code Evolution

Energy Use Index (1975 use = 100)

- Standard 90-75
- MEC 1983/86
- MEC 1992/93
- MEC 1995
- IECC 1998
- IECC 2004/06
- IECC 2009
- IECC 2012
- IECC 2018

Savings
- 2%
- 1%
- 2%

- 2010
- 2015
- 2018

Source - BECP
1. Insulation Materials & R-values
2. Fenestration U-Factors
3. Area Weighted U-Factor Calculations
4. Mechanical Systems Design Criteria
5. Mech/DHW Types, Sizes, Efficiencies
6. Equipment Systems and Controls
7. Duct Sealing, Duct & Pipe Insulation
8. Air Sealing Details
Required Inspections (2015)

Lists and Describes Required Inspections

- Footing and foundation
- Framing and Rough-in
- Plumbing Rough-in
- Mechanical rough-in.
## Envelope Glazing U-Factors

<table>
<thead>
<tr>
<th>Climate Zone</th>
<th>2015 Glazing U-factor</th>
<th>2018 Glazing U-factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>NR</td>
<td>NR</td>
</tr>
<tr>
<td>2</td>
<td>0.40</td>
<td>0.40</td>
</tr>
<tr>
<td>3</td>
<td>0.35</td>
<td>0.32</td>
</tr>
<tr>
<td>4</td>
<td>0.32</td>
<td>0.32</td>
</tr>
<tr>
<td>5</td>
<td>0.32</td>
<td>0.30</td>
</tr>
<tr>
<td>6</td>
<td>0.32</td>
<td>0.30</td>
</tr>
<tr>
<td>7</td>
<td>0.32</td>
<td>0.30</td>
</tr>
<tr>
<td>8</td>
<td>0.32</td>
<td>0.30</td>
</tr>
</tbody>
</table>
Air Sealing and Insulation Installation Table

- Separate columns for the insulation versus air tightness requirements.
- Recessed lights sealed to the finished surface
- Insulation behind electrical and phone boxes.
<table>
<thead>
<tr>
<th>Component</th>
<th>Air Barrier Criteria</th>
<th>Insulation Installation Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>General requirements</td>
<td>A continuous air barrier shall be installed in the building envelope. The exterior thermal envelope contains a continuous air barrier. Breaks or joints in the air barrier shall be sealed.</td>
<td>Air-permeable insulation shall not be used as a sealing material.</td>
</tr>
<tr>
<td>Ceiling/attic</td>
<td>The air barrier in any dropped ceiling/soffit shall be aligned with the insulation and any gaps in the air barrier sealed. Access openings, drop down stair or knee wall doors to unconditioned attic spaces shall be sealed.</td>
<td>The insulation in any dropped ceiling/soffit shall be aligned with the air barrier.</td>
</tr>
<tr>
<td>Walls</td>
<td>The junction of the foundation and sill plate shall be sealed. The junction of the top plate and the top of exterior walls shall be sealed. Knee walls shall be sealed.</td>
<td>Cavities within corners and headers of frame walls shall be insulated by completely filling the cavity with a material having a thermal resistance of R-3 per inch minimum. Exterior thermal envelope insulation for framed walls shall be installed in substantial contact and continuous alignment with the air barrier.</td>
</tr>
<tr>
<td>Windows, skylights and doors</td>
<td>The space between window/door jambs and framing and skylights and framing shall be sealed.</td>
<td></td>
</tr>
</tbody>
</table>

(partial table)
Envelope Air Leakage Testing

2015 IECC Required either ASTM E 779 or ASTM E 1827.
• ASTM E 1827 is easier
• More detailed reporting requirements

2018 IECC – RESNET/ICC 380-2016 Std
Allows single point test in addition to the ASTM E 779 multipoint test.

Allows vertical doors that provide access from conditioned to unconditioned spaces to meet the fenestration requirements.
ICC 400 Log Home Standard

Deemed equal to the IECC for Thermal Envelope Requirements
Combustion Closets (2015)

“Rooms containing fuel burning appliances.”
(i.e., atmospherically vented gas furnaces, boilers, and water heaters)

- Combustion air opening located outside the building thermal envelope or enclosed in a room, isolated from inside the thermal envelope.
- Closet to be air sealed and the door must be fully gasketed.
- Combustion closets to be insulated to levels not less than the basement wall R-value requirements.
# Duct Insulation

<table>
<thead>
<tr>
<th>All Supply and Return Ducts</th>
<th>Duct Diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>≥ 3-inch</td>
</tr>
<tr>
<td>Attic</td>
<td>R-8</td>
</tr>
<tr>
<td>Outside Conditioned Space</td>
<td>R-6</td>
</tr>
</tbody>
</table>
Lighting Equipment

90% High Efficacy Lamps
Energy Rating Index (ERI) Compliance Path

- Minimum Score 2015 IECC is 54.
- Minimum Score 2016 IECC is 61.
- Score of 100 equates to the levels prescribed in the 2006 IECC
- Score of Zero is equivalent to a net-zero-energy home
- Like RESNET’s Home Energy Rating System (HERS) rating
- House must also meet the minimum envelope requirements of the 2009 IECC and all of the mandatory code provisions.
It’s official: ANSI/RESNET Standard 301-2014
Over 16,000 More Homes HERS Rated in 2016

1,942,252

TOTAL Number of HERS-rated Homes to Date

206,583

Number of homes HERS-rated in 2016
States that Allow the ERI Compliance Option in the International Energy Conservation Code® (IECC®)

The map indicates the states that allow the ERI Compliance Option in the IECC (Section R 406).

- **Green States**: Allow the ERI Compliance Option in the IECC (Section R 406)
- **Gray States**: Do not allow the ERI Compliance Option in the IECC (Section R 406)

The states that allow the ERI Compliance Option include:
- Nevada
- Utah
- Texas
- Alabama
- Florida

The states that do not allow the ERI Compliance Option include:
- All other states on the map (gray states)

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Note: This map is a general representation and may not include all states or be updated to reflect current regulations.
Builders use it ...
Renewables in the ERI Compliance Path

<table>
<thead>
<tr>
<th>Climate Zone</th>
<th>2018 ERI Score</th>
<th>2015 ERI Scores</th>
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<tr>
<td>1 – 2</td>
<td>57</td>
<td>52</td>
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</tr>
<tr>
<td>7-8</td>
<td>58</td>
<td>53</td>
</tr>
</tbody>
</table>

Renewable Energy May Be Included

- Without renewables backstop is 2009 IECC for thermal envelope.
- With renewables backstop is 2015 IECC for thermal envelope.
Attic Ducts Considered in Conditioned Space

1. Leakage rate $\leq 1.5$ cfm/100 ft$^2$
2. Insulation around duct is equal to the required duct insulation plus the required attic insulation

Building America research shows encapsulating the ducts in spray foam before covering with loose-fill insulation provides adequate protection against condensation making this low-cost, high-performance method appropriate for every climate zone.
ANSI/RESNET/ICC 301-2014

Becomes basis of ERI approach
Existing Buildings Chapter

A new chapter has been added to deal specifically with existing buildings.
Presentation Available at:
https://www.ncat.org/energy-code-trainings/

Energize Montana at:
deq.mt.gov/energy

energycodes.gov
The End