Conducting Plan Reviews for the 2018 IECC

Part 2

Dale Horton
406-239-4196
horton@montana.com

Horton Associates

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6 Thermal Envelope
Air Leakage
Vapor Retarder and Air Barrier [R402.4] Code Summary

Continuous Air Barrier in Building Envelope

Class I or II Vapor Retarder – Above Grade Walls
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.
Thermal envelope must comply with both:

**Testing (402.4.1.2)**

**Air Barrier and Insulation Installation (Table R402.4.1)**

- **Component**
  - **Air Barrier Criteria**
  - **Insulation Installation Criteria**

<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 or barrier.</td>
<td>Air-permeable insulations shall not be used as a sealing material.</td>
</tr>
<tr>
<td>Ceiling/Jatial</td>
<td>The air barrier is any dropped ceiling/soffits shall be aligned with the insulation and any gaps in the air barrier sealed. Access openings, drop down stair or loose wall doors to unconditioned attic spaces shall be sealed.</td>
<td>The insulation in any dropped ceiling/soffits 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>Walls, exterior walls, and headers of eave walls shall be insulated by completely filling the cavity with a material having a thermal resistivity of R1 per inch.</td>
</tr>
<tr>
<td>Windows, skylights and doors</td>
<td>The spaces between windows, doors and framing and skylights and framing shall be sealed.</td>
<td>Exterior thermal envelope insulation be installed in sudden vertical and continuous depressions with the air barrier.</td>
</tr>
</tbody>
</table>

“Where required by the code official, testing shall be conducted by an approved third party.”

Past MT Amendment
The rate at which indoor air is exchanged with outdoor air. If a building has an **air change rate** of 1 ACH50, this equates to all of the air within the building being replaced in one hour at the test pressure of 50 Pa.
### Building Envelope Air Tightness (R402.4.1.2)

<table>
<thead>
<tr>
<th>Year</th>
<th>IECC</th>
<th>Montana</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009</td>
<td>7 ACH50</td>
<td>4 ACH50</td>
</tr>
<tr>
<td>2012</td>
<td>3 ACH50</td>
<td>4 ACH50</td>
</tr>
<tr>
<td>2015</td>
<td>3 ACH50</td>
<td>4 ACH50</td>
</tr>
<tr>
<td>2018</td>
<td>3 ACH50</td>
<td>4 ACH50</td>
</tr>
<tr>
<td>Component</td>
<td>Air Barrier Criteria</td>
<td>Insulation Installation Criteria</td>
</tr>
<tr>
<td>------------------------</td>
<td>----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------------------------------</td>
</tr>
<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)
Air Barrier Installation: General Requirements

- Continuous air barrier installed.
- Breaks or joints in the air barrier shall be sealed.

Continuous Sealed Air Barrier on the Warm Side of the Building Envelope Assembly

Thermal Envelope
Air Barrier Installation – General Requirements

Interior Air Barrier Approaches

Interior Air Barrier Using Gypsum Board and Framing

Source - Builder’s Guide to CC
In any dropped ceiling/soffit, aligned with the insulation, gaps sealed.
Sealed access openings, drop down stairs, or knee wall doors.
Air Barrier Installation: Walls

- Top plate and top of exterior walls sealed.
- Junction of the foundation and sill plate sealed.
- Knee walls sealed.

Source: USDOE Building America
Air Barrier Installation: Windows, Skylights and Doors

The space between window/door jambs and framing and skylights and framing sealed.
Rim joists include air barrier.
Air barrier installed at any exposed edge of insulation. (including cantilevered floors and floors above garages)
Air Barrier Installation: Crawl Space Walls

Class I vapor retarder at exposed earth, overlapping joints.
(sealed 6” overlap, up walls 6” and attached per 402.2.11)
Air Barrier Installation: Shafts and Penetrations

Duct shafts, utility penetrations, and flue shafts opening to exterior or unconditioned space sealed.
Air Barrier Installation: Garage Separation

Air sealing provided between the garage and conditioned spaces.

Source: ENERGY STAR New Homes
Air Barrier Installation: Recessed Lighting

Recessed light fixtures installed in the building thermal envelope sealed to the finished surface.
The air barrier installed at exterior walls adjacent to showers and tubs shall separate the wall from the shower or tub.
The air barrier installed behind electrical and communication boxes. Alternatively, air-sealed boxes installed.

Source: ENERGY STAR New Homes
Air Barrier Installation: HVAC Register Boots

HVAC supply and return register boots that penetrate building thermal envelope shall be sealed to the subfloor, wall covering, or ceiling penetrated by the boot.
Air Barrier Installation: Concealed Sprinklers

- Where required to be sealed, only be sealed per manufacturer’s recommendations. Sealants not used to fill voids between fire sprinkler cover plates and walls or ceilings.
Air-permeable insulation shall not be used as a sealing material.
The insulation in any dropped ceiling/soffit aligned with the air barrier..
Insulation Installation: Walls

- Cavities within corners and headers insulated (not less than R-3 per inch), completely filling the cavity.
- Installed in substantial contact and continuous alignment with the air barrier.

Source: USDOE Building America
Rim joists shall be insulated.
Installed to maintain permanent contact with the underside of subfloor decking. (Includes cantilevered floors and floors above garages.)
Crawl space insulation, where provided instead of floor insulation, shall be permanently attached to the walls.
Insulation Installation: Narrow Cavities

Batts to be installed in narrow cavities cut to fit or narrow cavities filled with insulation that on installation readily conforms to the available cavity space.
Insulation Installation: Recessed Lighting

Recessed light fixtures installed in the building thermal envelope shall be air tight and IC-rated.

Source: ENERGY STAR

Source: NorthWest ENERGY STAR Homes
Batt insulation cut neatly to fit around wiring and plumbing, or insulation, that on installation readily conforms to available space, shall extend behind piping and wiring.
Exterior walls adjacent to showers and tubs shall be insulated.
Fireplaces shall have tight fitting flue dampers or doors and outdoor combustion air.

Source: ENERGY STAR and Building Science Corp

Source: ENERGY STAR New Homes
2012 IECC
Bare bones procedure.

2015 IECC
Required either ASTM E 779 or ASTM E 1827.

2018 IECC – Added
RESNET/ICC 380-2016 Standard to acceptable procedures.
Building Tightness Testing (Blower Door) [402.4.1.2]

Air In = Air Out  \[\leq 4 \text{ ACH50}\]
Open combustion fuel burning appliances and combustion air opening shall:

Enclosed in a room isolated from inside the thermal envelope
- Sealed and insulated per Table R402.1.2
- Door gasketed and sealed
- Any ducts or water lines insulated per R403
- Combustion air duct insulated to $> R-8$ where it passes through conditioned space

Exceptions:
- Direct vent appliances with both intake and exhaust pipes installed continuous to outside
- Fireplaces and stoves complying with R402.4.2 and Section R1006-IRC
IC-rated recessed lighting fixtures sealed at housing/interior finish and labeled to indicate \( \leq 2.0 \text{ cfm leakage at 75 \text{ Pa}}. \)
7 Mechanical Systems & Service Hot Water
Programmable Thermostats [R403.1.1]

Programmable thermostats installed for control of primary heating and cooling systems and initially set by manufacturer to code specifications (70º/78º).

Heat Pump Controls [R403.1.2]

Electric supplemental heat controlled to prevent operation when compressor can meet load.
Hot water boilers supplying heat through one- or two-pipe heating systems have **outdoor setback control** to lower boiler water temperature based on outdoor temperature.
# Ducts Insulation (R403.3.1)

## Duct Diameter

<table>
<thead>
<tr>
<th>Location</th>
<th>≥3-inch</th>
<th>&lt;3 inch</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conditioned Space</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Vented Attic</td>
<td>R-8</td>
<td>R-6</td>
</tr>
<tr>
<td>Vented Crawlspace</td>
<td>R-6</td>
<td>R-4.2</td>
</tr>
<tr>
<td>Conditioned Crawlspace</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Conditioned Basement</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Unconditioned Basement</td>
<td>R-6</td>
<td>R-4.2</td>
</tr>
<tr>
<td>Exterior Walls</td>
<td>R-6</td>
<td>R-4.2</td>
</tr>
</tbody>
</table>

IECC 2018
Ducts, air handlers and filter boxes are sealed with joints/seams compliant with International Mechanical Code or International Residential Code, as applicable.
Duct Tightness Testing[(R403.3.3 & R403.3.4] Postconstruction Test
Total Leakage Test or Leakage to the Outside Test <= 4 cfm/100 SF (at 25 PA)

Rough-in Test
Total Leakage Test
With Air Handler Installed <= 4 cfm/100 SF (at 25 PA)
Without Air Handler Installed <= 3 cfm/100 SF (at 25 PA)

Testing not required if ducts and air handler entirely within building thermal envelope.
Total Duct Leakage Test

Duct Tightness Testing [R403.3.3 & R403.3.4]
Duct Tightness Testing [R403.3.3 & R403.3.4]

Duct Leakage to the Outside Test

Digital Manometers
Supply Registers
Return Registers
Duct Tester Fan

Blower
Door
Fan

Supply and Return Registers Must be Sealed

Air Handler

Source: NCAT
Duct Tightness Testing Report
A written report of results of test signed by the party conducting test must be provided to code official.

HRV & ERV Ducts Exception
Testing not required for ducts serving ERVs and HRVs.
- 2012 through 2018 IECC prohibits using cavities as supply or return ducts.
- Montana amended 2012 IECC to allow cavities as returns.
Ducts Buried Within Ceiling Insulation [R403.3.6]

Total R-19 Above and Below Duct

R-8 Duct Insulation
Ducts Located in Conditioned Space [R403.3.7]

1. Air Handler and Ducts entirely within Air Barrier and Thermal Envelope; or
2. Ducts Buried Per R403.3.6; and

A. Air Handler within Air Barrier and Thermal Envelope; and
B. Rough-In Total Leakage or Final Leakage to Outside \( \leq 1.5 \) CFM/100Ft²; and
C. R-Value of Duct Insulation and Ceiling Insulation Must Equal Proposed Total Ceiling R-Value
HVAC piping conveying fluids above 105 °F or chilled fluids below 55 °F are insulated to ≥ R-3.
Hot water pipes are insulated to ≥ R-3.
Drain water heat recovery units tested in accordance with CSA B55.1.
Clarifying Language...but no major changes.

1. Exhaust air must be to outside and *not through another dwelling*.

2. Does not prohibit ductless range hoods (but ductless range hoods do not count as ventilation).

3. Dwelling unit exhaust equipment labeled as providing minimum airflow per ANSI/AMCA 210 or AMSI/ASHRAE 51.
Mechanical Ventilation Requirement

- Part 1. Whole House Ventilation
- Part 2. Local Ventilation
<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.
## 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>
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<td>75</td>
<td>90</td>
<td>105</td>
<td>120</td>
</tr>
</tbody>
</table>

**Airflow in CFM**
Minimum ventilation values table not changed but formula added:

$$CFM = (0.01 \times \text{total house Ft}^2) + [7.5 \times (\text{number of bedrooms} + 1)]$$
### TABLE M1507.3.3(2)

<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>

Intermittent Whole-House Mechanical Ventilation Rate Factors
All mechanical ventilation system fans not part of tested and listed HVAC equipment must meet efficacy and air flow limits per Table R403.6.1.

### Mechanical Ventilation Fan Efficacy (Table R403.6.1)

<table>
<thead>
<tr>
<th>Fan Location</th>
<th>Minimum Airflow Rate (CFM)</th>
<th>Minimum Efficacy (CFM/Watt)</th>
<th>Maximum Airflow Rate (CFM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HRV or ERV</td>
<td>Any</td>
<td>1.2 CFM/Watt</td>
<td>Any</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>
### 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>
Example #1: 2,000 ft² House, 3 bedroom, 1 Bath

- **60 cfm Continuous Exhaust**
  - From the Bath
- **100 cfm Intermittent Exhaust Fan**
  - From the Kitchen
Mechanical Ventilation

Example #3: 3,600 ft², 4 bedroom, 2 bath

- 90 cfm Continuous Central Exhaust
- 20 cfm from Master Bedroom
- 20 cfm from Bath
- 50 cfm from Kitchen
Automatic or gravity dampers are installed on all outdoor air intakes and exhausts.
Heating and Cooling Equipment

- Sized according to **ACCA Manual S**
- Based on loads calculated per **ACCA Manual J**
  (or other approved calculation methodology)
Plan Review Process – Submittal of Calculations?
Verify that for all HVAC and Service Water Heating (SWH) equipment schedules the following are clearly documented:

• Equipment efficiency or performance rating
• Type
• Size
• Capacity
• Fuel type

Where the validity of such values is in question, copied of calculations should be requested.
Systems serving multiple dwelling units shall comply with Sections C403 and C404 in lieu of Section R403
Snow- and ice-melting system controls installed. Shut off system when pavement is >50°F.

- Electric on/off controls
- Gas pilot lights
- Timer controls for heater and pump
- Vapor retardant cover
Lighting
High Efficacy Lamps in 90% of Permanently Installed Fixtures.
Simulated Performance
1. Annual Energy Cost of Proposed Building must be Less Than the Standard Reference House
2. Complies with Mandatory Provisions

Tool(s)
Residential tools such as REM/Rate™ and REM/Design™ help users show compliance by the performance approach. REScheck has limited performance option.
Simulated Performance Alternative [R404]

Standard Reference Design

Proposed Design

“Geometric Twins”
10 Energy Rating Index
Energy Rating Index (R406)

Prescriptive

Prescriptive Simulation Performance

Simulated Performance

Energy Rating Index

R-Value (No Tradeoffs)

U-Factor (component tradeoffs)

Total UA (tradeoffs between components)

Simulated Performance Approach R405

ERI Compliance Alternative R406
ANSI/RESNET/ICC

301-2014

Basis of ERI approach

Energy Rating Index (R406)
Completed by an approved third party with documentation, including compliance reports, that must be reviewed by the code official.

ERI Raters may be required to be ICC Certified as Residential Energy Inspectors by Code Official.
Energy Rating Index (R406)

ANSI/RESNET Standard 301

HERS® Index

Zero Energy Home
Reference Home
Existing Homes

Less Energy

More Energy

©2013 RESNET

ERI 61
2018 IECC

70 2012 IECC
85 2009 IECC
100 2006 IECC
• Minimum Score 2015 IECC is 54.
• Minimum Score 2018 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 System
• House must also all of the mandatory code provisions.
Renewable Energy May Now Be Included

- **Without renewables backstop** is 2009 IECC for thermal envelope.
- **With renewables backstop** is 2015 IECC for thermal envelope.
Boundary condition for “Grade I”

- Gaps clear through insulation—minimal
- Compression or incomplete fill: <2% of area, compressed by <30% of intended thickness
Boundary condition for “Grade II”

Gaps clear through insulation: <2%

Compression or incomplete fill: <10% of area, compressed by <30% of intended thickness
11 Existing Buildings Chapter
Additions
Alterations
Repairs
Change of Occupancy
Residential to Commercial – C505
Commercial to Residential – R505 or 110%

Unaltered Portions of Building Need Not Comply
Additions – Compliance Options

- Addition Complies as Single Building
- Addition & Existing as Single Building
- Addition + Existing Energy Use < Existing Envelope, HVAC, Hot Water Systems, & Lighting - Must Comply with Chapter 4

- Building and Duct Leakage Testing Required.

Unaltered Portions of Building Need Not Comply
Alterations

Building Envelope - Must Comply with Chapter 4

Exceptions:

1. Storm windows
2. Exposed, existing ceiling, wall or floor cavities if already filled with insulation
3. Where existing roof, wall or floor cavity isn’t exposed
4. Roof recover (adding a new roofing layer)
5. [Applies to above or below deck insulation situations] Roofs without insulation in cavity and where sheathing or insulation is exposed during the reroofing - Insulate per R402 either above or below the sheathing
6. Surface-applied window film installed on existing single pane
Alterations - Must Comply with Chapter 4

- Heating & Cooling Systems
  When less than 40’ of new duct is added duct testing is not required.

- Service Hot Water Systems

- Lighting must comply with R404 of 50% or more luminaries in a space are replaced

- Change to Conditioned Space – Full Code Compliance or 110% Simulated Performance
Repairs

Work on nondamaged components necessary for the required repair of damaged components shall be considered part of the repair and are not subject to the alterations requirements.

Considered repairs and not alterations

- Glass-only replacements
- Roof repairs
- Only the bulb and/or ballast within the existing luminaires are replaced if installed interior lighting power does not increase
12 Solar Ready Appendix
Homes designed so that solar technologies can be easily applied in the future.
• Identify **Solar-Ready Zone** on roof
  (at least 600 Ft², between 110° and 270° of true North)
• No obstructions
• Roof load documentation
• Interconnection pathway
• Reserve electrical service space (in main panel)
• Documentation posted near electric panel
• Exception if shaded >70% of annual daylight hours
Energy Codes – Recommended Sites
www.energycodes.gov

//deq.mt.gov/Energy/EnergizeMT/energycode