What Does Air Barrier Mean?

1. Rim board to subfloor
2. Rim board to sill plate
3. Sill plate to foundation
Rim Joist / Box Sill
Rim joists shall be insulated, batts need to be installed well (no crescent fitting)

Insulated rim joist

Uninsulated concrete wall

Rim Joist Insulation
Consider other materials at the rim
Table 402.4.1.1
Component – Floors (including above garage & cantilever floors)

**Air Barrier Criteria**
- The air barrier shall be installed at any exposed edge of insulation.

**Insulation Installation Criteria**
- Floor framing cavity insulation shall be installed to maintain permanent contact with underside of subfloor decking.
- 2015 IECC introduction
  - or floor framing cavity insulation shall be permitted to be in contact with the topside of sheathing or continuous insulation installed on the bottom side of floor framing and extends from the bottom to the top of all perimeter floor framing members.

---

The Air Barrier Shall Be Installed at Any Exposed Edge of Insulation

Garage/home interface:
- No gaps at ends
Continuous Air Barrier

Floor Insulation

Permanent contact with sub-floor above, proper density with firm packing
R402.2.8 Exception
Joseph Lstiburek exception and details

1. Complete & tight air barrier system, and
2. R-30 insulation on the bottom sheathing of the assembly, or
3. Continuous R-20 bathtub insulation including floor rim joist insulation, or
4. Continuous insulation below framing with cavity insulation ≥ R-20

Floor Over Garage

22" Cavity

R-38 Batt Insulation

Closed-Cell Spray Foam Insulation
Ducts in Garage Soffits

- Ductwork in garage soffit, adjacent conditioned space, living space above - Solution 1
- Ductwork in garage soffit, adjacent conditioned space, living space above - Solution 2

NOTE: This approach is only approved if BLOWN insulation is used to completely fill the soffit.

It Can Be Done
Details: Cantilever Floor

Bad Cantilevers
Poor detailing
**Cantilevers:**
Just say **no** to heat runs in cantilevers

Heat loss from heat run in cantilever

Cantilever boundary

---

**Cantilevered Floor**

**Solution:**
- Align insulation
- Add air barriers

Cantilever

Thermal bypass

Thermal bypass
**Cantilevers**

**Effective detailing**

1. Framed cavity
2. Air barrier to inside
3. Fully insulated cavity
4. Soffit board

---

**Making the Floor Work**

Permanent contact with sub-floor above, no gaps, voids or compression

Batt Insulation

Air barrier

Wall laid flat still needs six-sided air barrier
**Table 402.4.1.1**
Component – Crawl Space Walls

<table>
<thead>
<tr>
<th>Air Barrier Criteria</th>
<th>Insulation Installation Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exposed earth in unvented crawl spaces shall be covered with a Class I vapor retarder with overlapping joints taped.</td>
<td>Where provided in lieu of floor insulation, insulation shall be permanently attached to the crawlspace walls.</td>
</tr>
</tbody>
</table>

*Perforated Vinyl Drape is ideal.*

| Crawl space walls | Exposed earth in unvented crawl spaces shall be covered with a Class I vapor retarder with overlapping joints taped. | Where provided instead of floor insulation, insulation shall be permanently attached to the crawlspace walls. |

---

**Conditioned Air Supply to Sealed Crawl Space**
2015 IECC table 402.4.1.1
Crawl – Insulation is permanently attached to walls, earth covered and sealed with Class I vapor barrier
Table 402.4.1.1
Component – Shafts, Penetrations

Air Barrier Criteria

• Duct shafts, utility penetrations, fireplace chases and flue shafts opening to exterior or unconditioned space shall be sealed.

Insulation Installation Criteria

• In the 2015 IECC the Fireplace section was consolidated into this section.

| Shafts, penetrations | Duct shafts, utility penetrations, and flue shafts, opening to exterior or unconditioned space shall be sealed. |

Duct/Flue Shafts & Utility Penetrations

Duct shafts, utility penetrations, and flue shafts opening to exterior or unconditioned space shall be sealed.
Sequencing
### Table 402.4.1.1
Component - Narrow Cavities

#### Air Barrier Criteria

**Question:**
Can you insulate narrow cavity walls?

#### Insulation Installation Criteria

Batts in narrow cavities shall be cut to fit, or narrow cavities shall be filled by insulation that on installation readily conforms to the available cavity space. Batts in narrow cavities shall be cut to fit, or narrow cavities shall be filled by insulation that on installation readily conforms to the available cavity space.

<table>
<thead>
<tr>
<th>Component</th>
<th>Narrow cavities</th>
<th>Insulation Installation Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Batts in narrow cavities shall be cut to fit, or narrow cavities shall be filled by insulation that on installation readily conforms to the available cavity space.</td>
<td>Batts in narrow cavities shall be cut to fit, or narrow cavities shall be filled by insulation that on installation readily conforms to the available cavity space.</td>
<td></td>
</tr>
</tbody>
</table>

### Table 402.4.1.1
Component - Garage Separation

#### Air Barrier Criteria

- Air sealing shall be provided between the garage and conditioned spaces.

#### Insulation Installation Criteria

Garage separation

<table>
<thead>
<tr>
<th>Component</th>
<th>Insulation Installation Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Garage separation</td>
<td>Air sealing shall be provided between the garage and conditioned spaces.</td>
</tr>
</tbody>
</table>
Garage Separation
What does this mean?

Table 402.4.1.1
Component - Recessed lighting

Air Barrier Criteria

- Recessed light fixtures installed in the building thermal envelope shall be sealed to the finished surface.

Insulation Installation Criteria

- Recessed light fixtures installed in the building thermal envelope shall be air tight, IC rated.
**Recessed Lighting Fixtures**
Air tight IC rated and sealed to drywall

---

**Table 402.4.1.1**
Component – Plumbing and Wiring

<table>
<thead>
<tr>
<th>Air Barrier Criteria</th>
<th>Insulation Installation Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Batt insulation shall be cut neatly to fit around wiring and plumbing in exterior walls, or insulation that on installation readily conforms to available space shall extend behind piping and wiring.</td>
<td></td>
</tr>
</tbody>
</table>
Plumbing and Wiring
Table 402.4.1.1
Component – Shower/Tub on Exterior Wall

Air Barrier Criteria

• The air barrier installed at exterior walls adjacent to showers and tubs shall separate the wall from the shower or tub.

<table>
<thead>
<tr>
<th>Component</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shower/tub on wall</td>
<td>The air barrier installed at exterior walls adjacent to showers and tubs shall separate the wall from the shower or tub.</td>
</tr>
</tbody>
</table>

Insulation Installation Criteria

• Exterior walls adjacent to showers and tubs shall be insulated.

Tubs and Showers Sequencing

Sealants, adhesive or grout
Corner bead/edge support or trim profile structural sheathing
Continuous bead of sealant or adhesive
Continuous bead of mortar or adhesive
Sealant, adhesive or grout
Continuous bead of mortar or adhesive
Sealant, adhesive or grout
Continuous bead of mortar or adhesive
Sealant, adhesive or grout
Continuous bead of mortar or adhesive
### Table 402.4.1.1
Component – Electrical/Phone Box on Exterior Walls

**Air Barrier Criteria**
- The air barrier shall be installed behind electrical or communication boxes or air sealed boxes shall be installed.

<table>
<thead>
<tr>
<th>Electrical/phone box on exterior walls</th>
<th>Insulation Installation Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>The air barrier shall be installed behind electrical or communication boxes or air-sealed boxes shall be installed.</td>
</tr>
</tbody>
</table>
Table 402.4.1.1
Component – HVAC Register Boots

Air Barrier Criteria (2018 IECC)

• 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.

| HVAC register boots | HVAC register boots that penetrate building thermal envelope shall be sealed to the subfloor or drywall |

A Portion of the Supply Air Hits the Register Cover and Bounces Back into the Cavity

Register cover

Boot
Table 402.4.1.1  
Component – Fireplace

Air barrier criteria
• This section was moved in the 2015 IECC
• An air barrier shall be installed on fireplace walls
• Fireplaces shall have gasketed doors
Sequencing Is the Issue
Air barrier 1st, then over framing

Other Potential Problem Areas
Traps: Seal Them!

Table 402.4.1.1
Component – Concealed Sprinklers

Air Barrier Criteria
- When required to be sealed, concealed fire sprinklers shall only be sealed in a manner that is recommended by the manufacturer. Caulking or other adhesive sealants shall not be used to fill voids between fire sprinkler cover plates and walls or ceilings.

<table>
<thead>
<tr>
<th>Insulation Installation Criteria</th>
</tr>
</thead>
</table>

Concealed sprinklers

When required to be sealed, concealed fire sprinklers shall only be sealed in a manner that is recommended by the manufacturer. Caulking or other adhesive sealants shall not be used to fill voids between fire sprinkler cover plates and walls or ceilings.
Fire Sprinklers and Air Leakage?

Fire Sprinklers and Insulation
Fire Code and Energy Code
Not on the same page

• 2009 IECC
  • Common wall: Air barrier is installed in common wall between dwelling units

• 2012, 2015, & 2018 IECC
  • Not mentioned in the table

Single Family vs. Attached Housing
Other Mandatory Items

- HVAC controls
  - Programmable thermostat
- Building cavities shall not be used as ducts or plenums
- Hot water circulation and pipe insulation
  - If installed
- CFL or LED lighting
  - 2015 IECC 75%
  - 2018 IECC 90%
Ventilation & HVAC Design
R403.6 Mechanical Ventilation

(Mandatory)

- The building shall be provided with ventilation that meets the requirements of the International Residential Code or International Mechanical Code.
- Outdoor air intakes and exhausts shall have automatic or gravity dampers that close when the ventilation system is not operating.

R403.6.1 Whole-house mechanical ventilation system fan efficacy

- Mechanical ventilation system fans shall meet the efficacy requirements of Table R403.5.1. *(efficient fans needed).*
- Exception: Where mechanical ventilation fans are integral to tested and listed HVAC equipment, they shall be powered by an *electronically commutated motor.*
**Local Exhaust Ventilation Sometimes referred to as “Spot Ventilation”**
Removes pollutants, moisture, to the odors at the source

**M1501.1 Outdoor discharge**
- The air removed by every mechanical exhaust system shall be discharged to the outdoors in accordance with Section M1506.2
- Air shall not be exhausted into an attic, soffit, ridge vent or crawl space

- Appliance
  - Dryer
  - Range hoods
  - Bath fans

---

**TABLE M1507.4**
- Kitchens:
  - 100 CFM intermittent
  - 25 CFM continuous
  - Ducted to outside
- Baths:
  - 50 CFM intermittent
  - 20 CFM continuous
M1507.3 Whole-House Mechanical Ventilation System

• M1507.3.1 System design: The whole-house ventilation system shall consist of: Supply Side, Exhaust Side, Balanced systems, or combination there of.

• M1507.3.2 System controls: The whole-house mechanical ventilation system shall be provided with controls that enable manual override.

• M1507.3.3 Mechanical ventilation rate: The whole house mechanical ventilation system shall provide outdoor air at a continuous rate of not less than that determined in accordance with Table M1507.3.3(1).

• Exception:
  • Permitted to operate intermittently where the system has controls that enable operation for not less than 25-percent of each 4-hour segment and the ventilation rate prescribed is multiplied by the factor determined in accordance with Table M1507.3.3(2).
There Must Be a Control

Adjustable fan control highly recommended

Dedicated breaker for whole house ventilation system

Thermal Envelope vs. HVAC

• Is it there and does it work?
**HVAC Design**

The HVAC design process has three major steps:

- **Step 1**: Calculate the heating and cooling loads (Manual J).
- **Step 2**: Select equipment with capacity to meet those loads (Manual S).
- **Step 3**: Design a duct system that can get air from the equipment to the rooms and back (Manual D).

---

**R403.3.2 Sealing**

*(Mandatory)*

- Ducts, air handlers, AC coil, and filter boxes shall be sealed.
- Joints and seams shall comply with either the *International Mechanical Code* or *International Residential Code*, as applicable.
R403.3.5 Building
(Mandatory)

Building framing cavities shall not be used as ducts or plenums.

R101.4 Applicability

• Where, in any specific case, different sections of this code specify different materials, methods of construction or other requirements, the most restrictive shall govern.

• Where there is a conflict between a general requirement and a specific requirement, the specific requirement shall govern.
R403.3.3 Duct Testing
(Mandatory)

Duct tightness shall be verified by either of the following:

Rough In Test
- \( \leq 4 \text{ CFM per 100 sqft of conditioned floor area} \)
- \( \leq 4 \text{ CFM per 100 sqft of conditioned floor area} \) for 2000 sqft house
- \( \leq 3 \text{ CFM per 100 sqft of conditioned floor area} \) if air handler has not been installed
  - \( \leq 3 \text{ CFM per 100 sqft of conditioned floor area} \) for 2000 sqft house

Post Construction
- \( \leq 4 \text{ CFM per 100 sqft of conditioned floor area} \)
  - \( \leq 4 \text{ CFM per 100 sqft of conditioned floor area} \) for 2000 sqft house

Exception: if the air handler and all ducts are entirely within the building thermal envelope.

R403.3.3 Duct testing
(Mandatory)

Leakage testing required when any portion of ductwork is in unconditioned space

- Attic
- Unconditioned crawl space
- Isolated mechanical room
  - with natural draft appliance
- Floor over garage?
- Exterior wall?
Duct Leakage to Outside
Not included in the 2012, 2015, 2018 IECC / Kinda??

Must be tested when using the performance paths of code.
R402.4.4 Rooms Containing Fuel-Burning Appliances

• In climate zones 3 through 8, where open combustion air ducts provide combustion air to open combustion fuel-burning appliances, the appliances and combustion air opening shall be located outside the building thermal envelope or enclosed in a room, isolated from inside the thermal envelope.

• Such rooms shall be sealed and insulated in accordance with the envelope requirements of Table N1102.1.2, where the walls, floors and ceilings shall meet a minimum of the basement wall $R$-value requirement.

• The door into the room shall be fully gasketed and any water lines and ducts in the room insulated in accordance with Section N1103.

• The combustion air duct shall be insulated where it passes through conditioned space to a minimum of R-8.

Conclusion

• The Energy code offers great flexibility
  • R405 Simulated Performance is the most flexible path

• Building science is embedded in Code
  • Air flow
  • Thermal flow
  • Moisture flow
  • Build tight / ventilate right

• HVAC design requires a sound thermal envelope
• The code ensures a sound thermal envelope
• Opportunity cost and consumer satisfaction to meet their core expectations