2012 IECC Commercial Scope and 
Envelope Requirements 

July 2011
Does My Project Need to Comply with the Commercial Provisions in the IECC?

All Buildings Other Than:

- One- and two-family residential
- R-2, R-3, R-4 three stories or less in height
Spaces undergoing a change in occupancy that would result in an increase in demand for either fossil fuel or electrical energy shall comply with this code.

Where the use in a space changes from one to another, the installed lighting wattage shall comply with Section 505.5.
Any non-conditioned space that is altered to become conditioned space shall be required to be brought into full compliance with this code.
Mixed Occupancy
C101.4.6

✓ Treat the residential occupancy under the applicable residential code
✓ Treat the commercial occupancy under the commercial code
✓ The residential and commercial occupancies fall under two different scopes. Thus, two compliance submittals must be prepared using the appropriate calculations and forms from the respective codes for each.
Codes and standards listed in Chapter are considered part of the requirements of this code to the “prescribed extent of each such reference and as further regulated in Sections C106.1.1 and C106.1.2”

- Conflicts, C106.1.1 – where differences occur between this code and the referenced codes and standards, provisions of this code apply
- Provisions in reference codes and standards, C106.1.2 – “where the extent of the reference to a referenced code or standard includes subject matter that is within the scope of this code, the provisions of this code, as applicable, shall take precedence over the provisions in the referenced code or standard”
What is the Building Thermal Envelope?

- Roof/Ceiling Assembly
- Wall Assembly
- Vertical Fenestration and Skylights
- Floor Assembly
- Slab Edge
- Below Grade Wall Assembly
Commercial Compliance Options

1. 90.1-2010

2. 2012 IECC
   - C402 - Envelope
   - C403 - Mechanical
   - C404 - SWH
   - C405 - Lighting
   AND
   - Pick One:
     - C406.2 – Eff. HVAC Performance
     - OR
     - C406.3 – Eff. Lighting Systems
     - OR
     - C406.4 – On-site Renewable Energy

3. 2012 IECC
   - C407 – Total Building Performance
   - C402.4 – Air Leakage
   - C403.2 – Provisions applicable to all mechanical systems
   - C404 - SWH
   - Lighting Mandatory Sections
     - C405.2
     - C405.3
     - C405.4
     - C405.6
     - C405.7
   - Building energy cost to be ≤ 85% of standard reference design building
Additional Efficiency Package Options

C406

- One additional efficiency feature must be selected to comply with the IECC
  - More efficient lighting system (consistent with 90.1-2010), OR
  - More efficient HVAC system, OR
  - Installation of onsite renewables
    - 3% of the regulated energy
Additional Efficiency Package Options

C406

• Efficient HVAC performance per C406.2 OR
  – Per Tables C406.2(1) thru C406.2(7)
  – Only used when efficiencies in the above tables are greater than those in the efficiency tables in C403

• Efficient lighting system per C406.3 OR
  – Whole building LPD complies with C406.3.1
  – Determine total LPD of building using reduced whole building interior lighting power in Table 406.3 x floor area for the building types

• On-site supply of renewable energy per C406.4
  – Total minimum ratings to comply with
    • Provide ≥ 1.75 Btu or ≥ 0.50 watts per ft² of conditioned floor area OR
    • Provide ≥ 3% of energy used for mechanical and SWH equipment and lighting

Individual tenant spaces to comply with either C406.2 or C406.3 unless documentation is provided that demonstrates compliance with C406.4 for the entire building
Climate Zones
2012 IECC - Chapter 3

Determining Your Climate Zone is the First Step in the Process
### Chapter 5 Prescriptive Approach Compliance

#### Table C402.2: Opaque Thermal Envelope Requirements

<table>
<thead>
<tr>
<th>CLIMATE ZONE</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4 EXCEPT Marine</th>
<th>5 AND Marine</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Other</td>
<td>R-20ci</td>
<td>R-20ci</td>
<td>R-20ci</td>
<td>R-20ci</td>
<td>R-20ci</td>
<td>R-20ci</td>
<td>R-20ci</td>
<td>R-20ci</td>
</tr>
<tr>
<td>Group R</td>
<td>R-20ci</td>
<td>R-20ci</td>
<td>R-20ci</td>
<td>R-20ci</td>
<td>R-20ci</td>
<td>R-20ci</td>
<td>R-20ci</td>
<td>R-20ci</td>
</tr>
<tr>
<td>All Other</td>
<td>R-20ci</td>
<td>R-20ci</td>
<td>R-20ci</td>
<td>R-20ci</td>
<td>R-20ci</td>
<td>R-20ci</td>
<td>R-20ci</td>
<td>R-20ci</td>
</tr>
<tr>
<td>Group R</td>
<td>R-20ci</td>
<td>R-20ci</td>
<td>R-20ci</td>
<td>R-20ci</td>
<td>R-20ci</td>
<td>R-20ci</td>
<td>R-20ci</td>
<td>R-20ci</td>
</tr>
</tbody>
</table>

#### Walls, Above Grade

<table>
<thead>
<tr>
<th>CLIMATE ZONE</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4 EXCEPT Marine</th>
<th>5 AND Marine</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Other</td>
<td>R-5.7ci</td>
<td>R-5.7ci</td>
<td>R-5.7ci</td>
<td>R-5.7ci</td>
<td>R-5.7ci</td>
<td>R-5.7ci</td>
<td>R-5.7ci</td>
<td>R-5.7ci</td>
</tr>
<tr>
<td>Group R</td>
<td>R-5.7ci</td>
<td>R-5.7ci</td>
<td>R-5.7ci</td>
<td>R-5.7ci</td>
<td>R-5.7ci</td>
<td>R-5.7ci</td>
<td>R-5.7ci</td>
<td>R-5.7ci</td>
</tr>
<tr>
<td>All Other</td>
<td>R-9ci</td>
<td>R-9ci</td>
<td>R-9ci</td>
<td>R-9ci</td>
<td>R-9ci</td>
<td>R-9ci</td>
<td>R-9ci</td>
<td>R-9ci</td>
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<tr>
<td>Group R</td>
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<td>R-9ci</td>
<td>R-9ci</td>
<td>R-9ci</td>
<td>R-9ci</td>
<td>R-9ci</td>
<td>R-9ci</td>
<td>R-9ci</td>
</tr>
</tbody>
</table>

#### Walls, Below Grade

<table>
<thead>
<tr>
<th>CLIMATE ZONE</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4 EXCEPT Marine</th>
<th>5 AND Marine</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Below-grade wall</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
</tr>
<tr>
<td>Floors</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
</tr>
</tbody>
</table>

#### Slab-on-Grade Floors

<table>
<thead>
<tr>
<th>CLIMATE ZONE</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4 EXCEPT Marine</th>
<th>5 AND Marine</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unheated slabs</td>
<td>R-7.5 for 12&quot; below</td>
<td>R-7.5 for 24&quot; below</td>
<td>R-7.5 for 24&quot; below</td>
<td>R-7.5 for 24&quot; below</td>
<td>R-7.5 for 24&quot; below</td>
<td>R-7.5 for 24&quot; below</td>
<td>R-7.5 for 24&quot; below</td>
<td>R-7.5 for 24&quot; below</td>
</tr>
<tr>
<td>Heated slabs</td>
<td>R-10 for 24&quot; below</td>
<td>R-10 for 24&quot; below</td>
<td>R-10 for 24&quot; below</td>
<td>R-10 for 24&quot; below</td>
<td>R-10 for 24&quot; below</td>
<td>R-10 for 24&quot; below</td>
<td>R-10 for 24&quot; below</td>
<td>R-10 for 24&quot; below</td>
</tr>
</tbody>
</table>

#### Opaque Doors

<table>
<thead>
<tr>
<th>CLIMATE ZONE</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4 EXCEPT Marine</th>
<th>5 AND Marine</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Swing</td>
<td>U-0.61</td>
<td>U-0.61</td>
<td>U-0.61</td>
<td>U-0.61</td>
<td>U-0.61</td>
<td>U-0.61</td>
<td>U-0.61</td>
<td>U-0.61</td>
</tr>
<tr>
<td>Roll-up or sliding</td>
<td>U-4.75</td>
<td>U-4.75</td>
<td>U-4.75</td>
<td>U-4.75</td>
<td>U-4.75</td>
<td>U-4.75</td>
<td>U-4.75</td>
<td>U-4.75</td>
</tr>
</tbody>
</table>

For SI 1 inch = 25.4 mm. d = Continuous insulation. NR = No requirement.

- LS = Liner System — A continuous membrane installed below the purlins and uninterrupted by framing members. Unexpanded, unfurred insulation rests on top of the membrane between the purlins.
- a. Assembly descriptions can be found in ANSI/ASHRAE/IESNA Appendix A.
- b. Where using R-value compliance method, a thermal gap block shall be provided, otherwise use the U-factor compliance method.
- c. R-5.7ci is allowed to be substituted with concrete block walls, complying with ASTM C 90, ungrouted or partially grouted at 32 inches or less on center vertically and 48 inches or less on center horizontally, with ungrouted cores filled with materials having a maximum thermal conductivity of 0.44 Btu/h-ft°F.
- d. Where heated slabs are below grade, below grade walls shall comply with the exterior insulation requirements for heated slabs.
- e. Steel floor joist systems shall be insulated to R-38.
Chapter 5 Prescriptive Approach Compliance

### TABLE C402.2

#### OPAQUE THERMAL ENVELOPE REQUIREMENTS

<table>
<thead>
<tr>
<th>Climate Zone</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4 Except Marine</th>
<th>5 And Marine 4</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insulation entirely above deck</td>
<td>R-20ci</td>
<td>R-20ci</td>
<td>R-20ci</td>
<td>R-20ci</td>
<td>R-20ci</td>
<td>R-20ci</td>
<td>R-20ci</td>
<td>R-20ci</td>
</tr>
<tr>
<td>Attic and other</td>
<td>R-38</td>
<td>R-38</td>
<td>R-38</td>
<td>R-38</td>
<td>R-38</td>
<td>R-38</td>
<td>R-38</td>
<td>R-38</td>
</tr>
</tbody>
</table>

**Attic and Other Insulations**

- **Metal buildings (with R-5 thermal blocks)**: R-19+ R-11 LS
- **Attic and other**: R-38

**Roofs**

- **Insulation entirely above deck**: R-20ci
- **Metal buildings (with R-5 thermal blocks)**: R-19+ R-11 LS
- **Attic and other**: R-38

**Additional Requirements**

- Heated slabs: U-0.61 U-0.61 U-0.61 U-0.61 U-0.61 U-0.61 U-0.61 U-0.61 U-0.61 U-0.61 U-0.61 U-0.61 U-0.61 U-0.61 U-0.61 U-0.61 U-0.61 U-0.61 U-0.61 U-0.61 U-0.61 U-0.61 U-0.61 U-0.61
- Roll-up or sliding: R-4.35 R-4.35 R-4.35 R-4.35 R-4.35 R-4.35 R-4.35 R-4.35 R-4.35 R-4.35 R-4.35 R-4.35 R-4.35 R-4.35 R-4.35 R-4.35 R-4.35 R-4.35 R-4.35 R-4.35 R-4.35 R-4.35 R-4.35 R-4.35
## Chapter 5 Prescriptive Approach Compliance

### Opaque Thermal Envelope Requirements

#### Walls, Above Grade

<table>
<thead>
<tr>
<th>Climate Zone</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4 Except Marine</th>
<th>5 And Marine 4</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wood Framed &amp; Other</td>
<td>R-13+R-3.8ci or R-20</td>
<td>R-13+R-3.8ci or R-20</td>
<td>R-13+R-3.8ci or R-20</td>
<td>R-13+R-3.8ci or R-20</td>
<td>R-13+R-3.8ci or R-20</td>
<td>R-13+R-3.8ci or R-20</td>
<td>R-13+R-3.8ci or R-20</td>
<td>R-13+R-3.8ci or R-20</td>
</tr>
</tbody>
</table>

*Assembly descriptions can be found in ANSI/ASHRAE/IESNA Appendix.*

*When using R-value compliance method, a thermal break shall be provided, otherwise use the 6-factor compliance method in Table C402.1.*

*R-5.7ci is allowed to be substituted with concrete block walls complying with ASTM C90, ungrouted or partially grouted at 32 inches or less on center vertically and 48 inches or less on center horizontally, with ungrouted cores filled with materials having a maximum thermal conductivity of 0.44 Btu hr ft °F.*

*Where heated slabs are below grade, below grade walls shall comply with the exterior insulation requirements for heated slabs.*

*Steel floor joist systems shall be insulated in R-30.*
### Chapter 5 Prescriptive Approach Compliance

**TABLE C402.2**

**Opaque Thermal Envelope Requirements**

<table>
<thead>
<tr>
<th>Climate Zone</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4 Except Marine</th>
<th>5 And Marine 4</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Below grade wall</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
<td>R-7.5ci</td>
<td>R-7.5ci</td>
</tr>
</tbody>
</table>

**WALLS, BELOW GRADE**

- **Floors**
  - Masonry: NR, NR, NR, R-6.5ci, R-8.5ci, R-9ci, R-10ci, R-10ci, R-15ci, R-15ci, R-16.5ci
  - Wood framing: NR, NR, NR, R-9ci, R-10ci, R-10ci, R-12.5ci, R-12.5ci, R-15ci, R-15ci, R-16.5ci

- **Slab-on-Grade Floors**
  - Unheated slabs: R-7.5 for 12" below, R-7.5 for 12" below, R-7.5 for 24" below, R-10 for 24" below, R-10 for 24" below, R-15 for 60" below, R-15 for 60" below, R-15 for 60" below, R-20 for 60" below, R-20 for 60" below, R-20 for 60" below
  - Heated slabs: R-3.5 for 12" below, R-3.5 for 12" below, R-3.5 for 24" below, R-10 for 24" below, R-10 for 24" below, R-15 for 60" below, R-15 for 60" below, R-15 for 60" below, R-20 for 60" below, R-20 for 60" below, R-20 for 60" below

- **Opaque Doors**
  - Swinging: R-0.65, R-0.65, R-0.65, R-0.65, R-0.65, R-0.65, R-0.65, R-0.65, U-0.35, U-0.35, U-0.35, U-0.35, U-0.35, U-0.35

For SI: 1 inch = 25.4 mm
- a. Continuous insulation. NR = No requirement.
- b. Where using R-value compliance method, a thermal air barrier shall be provided, otherwise use the 6-factor compliance method in Table C402.1.2.
- c. R-5.2ci is allowed to be substituted with concrete block wall complying with ASTM C90, ungrouted or partially grouted at 32 inches or less on center vertically and 48 inches or less on center horizontally, with ungrouted cores filled with materials having a minimum thermal conductivity of 0.44 Btu/h ft°F.
- d. Where heated slabs are below grade, below grade walls shall comply with the exterior insulation requirements for heated slabs.
- e. Steel floor joist systems shall be insulated to R-38.
### Chapter 5 Prescriptive Approach

#### Compliance

**TABLE C402.2 OPAQUE THERMAL ENVELOPE REQUIREMENTS**

<table>
<thead>
<tr>
<th>CLIMATE ZONE</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>All Other</td>
<td>Group R</td>
<td>All Other</td>
<td>Group R</td>
<td>All Other</td>
<td>Group R</td>
<td>All Other</td>
<td>Group R</td>
</tr>
</tbody>
</table>

**Mass**

<table>
<thead>
<tr>
<th>Climate Zone</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NR</td>
<td>NR</td>
<td>R-6.3ci</td>
<td>R-8.3ci</td>
<td>R-10ci</td>
<td>R-10ci</td>
<td>R-10.4ci</td>
<td>R-10ci</td>
</tr>
</tbody>
</table>

**Unheated slabs**

<table>
<thead>
<tr>
<th>Climate Zone</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NR</td>
<td>NR</td>
<td>R-3 for 12&quot; below</td>
<td>R-3 for 12&quot; below</td>
<td>R-3 for 12&quot; below</td>
<td>R-4 for 24&quot; below</td>
<td>R-4 for 24&quot; below</td>
<td>R-4 for 24&quot; below</td>
</tr>
<tr>
<td>Heated slabs</td>
<td>R-3.5 for 12&quot; below</td>
<td>R-3.5 for 12&quot; below</td>
<td>R-3.5 for 12&quot; below</td>
<td>R-3.5 for 24&quot; below</td>
<td>R-15 for 24&quot; below</td>
<td>R-15 for 24&quot; below</td>
<td>R-15 for 24&quot; below</td>
<td>R-15 for 48&quot; below</td>
</tr>
</tbody>
</table>

**Wooden Doors**

<table>
<thead>
<tr>
<th>Climate Zone</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>R-4.35</td>
<td>R-4.35</td>
<td>R-4.35</td>
<td>R-4.35</td>
<td>R-4.35</td>
<td>R-4.35</td>
<td>R-4.35</td>
<td>R-4.35</td>
</tr>
</tbody>
</table>

For 1 inch = 25.4 mm. "ci" = Continuous insulation. "NR" = No requirement.

a. Assembly descriptions can be found in ANSI/ASHRAE/IESNA Appendix A.
b. Where using R-value compliance method, a thermal air space block shall be provided, otherwise use the 16" Gf Method in Table C402.1.2.
c. R-5.2 is allowed to be subtracted with concrete block walls complying with ASTM C 90, ungrouted or partially grouted at 32 inches or less on center horizontally, with ungrouted cores filled with materials having a maximum thermal conductivity of 0.44 Btu/h ft² °F.
d. Where heated slab is below grade, below grade walls shall comply with the exterior insulation requirement for heated slabs.
e. Steel door joint systems shall be insulated to R-38.
## Chapter 5 Prescriptive Approach Compliance

### TABLE C402.2

#### Opaque Thermal Envelope Requirements

<table>
<thead>
<tr>
<th>Climate Zone</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4 (Except Marine)</th>
<th>5 (And Marine)</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>All Other</td>
<td>Group R</td>
<td>All Other</td>
<td>Group R</td>
<td>All Other</td>
<td>Group R</td>
<td>All Other</td>
<td>Group R</td>
</tr>
<tr>
<td>Floor Ins.</td>
<td>R-20</td>
<td>R-20a</td>
<td>R-20c</td>
<td>R-20d</td>
<td>R-20e</td>
<td>R-20f</td>
<td>R-20g</td>
<td>R-20h</td>
</tr>
<tr>
<td>Metal buildings, with R-thermal block</td>
<td>R-19</td>
<td>R-19a</td>
<td>R-19b</td>
<td>R-19c</td>
<td>R-19d</td>
<td>R-19e</td>
<td>R-19f</td>
<td>R-25</td>
</tr>
<tr>
<td>Artic and other</td>
<td>R-18</td>
<td>R-18a</td>
<td>R-18b</td>
<td>R-18c</td>
<td>R-18d</td>
<td>R-18e</td>
<td>R-18f</td>
<td>R-18g</td>
</tr>
</tbody>
</table>

#### SLAB-ON GRADE FLOORS

<table>
<thead>
<tr>
<th>Climate Zone</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4 (Except Marine)</th>
<th>5 (And Marine)</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unheated Slabs</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
<td>R-10 for 24 in. below</td>
<td>R-10 for 24 in. below</td>
</tr>
<tr>
<td>Heated Slabs</td>
<td>R-7.5 for 12 in. below</td>
<td>R-7.5 for 12 in. below</td>
<td>R-7.5 for 12 in. below</td>
<td>R-10 for 24 in. below</td>
<td>R-10 for 24 in. below</td>
<td>R-15 for 24 in. below</td>
<td>R-15 for 24 in. below</td>
<td>R-15 for 24 in. below</td>
</tr>
</tbody>
</table>

---

**Notes:**
- *NR* = No requirement.
- *Continuous insulation* is required on tops of the membrane between the slabs.
- *Unheated Slabs* are below grade, while *Heated Slabs* are below grade and below 12 in. below grade.
- *Slab-on-Grade Floors* are below grade and below 24 in. below grade.
- *Opaque Doors* require insulation as specified in Table C402.1.2.
- *For 1 inch = 25.4 mm = Continuous insulation. NR = No requirement.*
# Chapter 5 Prescriptive Approach Compliance

## Opaque Doors

<table>
<thead>
<tr>
<th>Climate Zone</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4 Except Marine</th>
<th>5 And Marine 4</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Swinging</td>
<td>U-0.61</td>
<td>U-0.61</td>
<td>U-0.61</td>
<td>U-0.61</td>
<td>U-0.61</td>
<td>U-0.37</td>
<td>U-0.37</td>
<td>U-0.37</td>
</tr>
<tr>
<td>Roll-Up Or Sliding</td>
<td>R-4.75</td>
<td>R-4.75</td>
<td>R-4.75</td>
<td>R-4.75</td>
<td>R-4.75</td>
<td>R-4.75</td>
<td>R-4.75</td>
<td>R-4.75</td>
</tr>
</tbody>
</table>

For SI 1 inch = 25.4 mm, -d = Continuous insulation, NR = No requirement.

a. Assemblies described in ANSI/ASHRAE/IESNA Appendix A.

b. For U-value compliance method, a thermal barrier shall be provided; see the U-value compliance method in Table C402.1.2.

c. R-5.2 is allowed to be substituted with concrete block walls complying with ASTM C90, ungrouted or partially grouted at 32 inches or less on center vertically and 48 inches or less on center horizontally, with ungrouted cores filled with materials having a minimum thermal conductivity of 0.44 Btu hr ft °F.

d. Where heated slabs are below grade, below grade walls shall comply with the exterior insulation requirements for heated slabs.

e. Steel door joint systems shall be insulated to R-38.
Roof R-Value (C402.2.1) U-Factor (C402.1.2)

Roof R-values and U-factor requirements are based on assembly type / insulation placement

✓ Insulation entirely above deck
✓ Metal buildings
✓ Attic and other

Skylight curbs to be insulated to the level of roofs with insulation entirely above deck or R-5, whichever is less

✓ **Exception**: unit skylight curbs included as a component of an NFRC 100 rated assembly
Roof Solar Reflectance
C402.2.1.1

Required in Climate Zones 1-3 for low-sloped roofs (less than 2 units vertical in 12 horizontal), directly above cooled conditioned spaces

Requirements:
Minimum three-year aged solar reflectance of 0.55 and minimum three-year aged thermal emittance of 0.75

OR

Initial solar reflectance of 0.70 and initial thermal emittance of 0.75

OR

Three-year aged solar reflectance index of 64

OR

Initial solar reflectance index of 82
High Albedo Roofs – Exceptions
C402.2.1.1 (cont’d)

• Portions of roofs that include or are covered by:
  – PV systems or components
  – Solar air or water heating systems or components
  – Roof gardens or landscaped roofs
  – Above-roof decks or walkways
  – Skylights
  – HVAC systems, components, and other opaque objects mounted above the roof
• Portions of roofs shaded during peak sun angle on June 21 by permanent features of the building or adjacent buildings
• Ballasted roofs with minimum stone ballast of 17 lbs/ft² or 23 lbs/ft² pavers
• Roofs, where a minimum of 75% of the roof area meets one of the above exceptions
High Albedo Roof - Example
Roof R-Value
Insulation Completely Above Deck

- Insulation considered continuous (CI)
- Insulation thickness can vary ≤ 1” and area weighted U-factor meets the requirements of Table C402.2
Roof R-Value
Insulation Placed on Suspended Ceiling with Removable Ceiling Tiles

✓ Will not count for code compliance
✓ Not considered part of the minimum thermal resistance of the roof insulation
R-5 thermal blocks required on all metal buildings or must use U-factor Compliance Method

Two layers of insulation required

- CZ 1-5 and marine 4: R-19+R-11 LS
- CZ 6: R-25+R-11 LS
- CZ 7-8: R-30+R-11 LS
Metal Building Roofs

Photos courtesy of MBMA
Metal Building Roofs

Photos courtesy of MBMA
Roof R-Value
Ceilings with Attic Spaces

- Install insulation between framing
- R-38 in Climate Zones 1-5 and marine 4 “All Other”
- R-49 in Climate Zones 5 and marine 4 “Group R”-8
Walls weighing at least 35 lbs/ft² of wall surface area

OR

25 lbs/ft² of wall surface area if material weight is \( \leq 120 \) lb/ft³
Climate Zones 1 and 2 (all other) – Can use integral insulation instead of R-5.7 ci

- Concrete block walls must comply with ASTM C 90, and
- Ungrouted or partially grouted @ 32 inch. o.c. or less vertically or 48 inch. o.c. or less horizontally, and
- Ungrouted cells must be filled with insulation material ≤ of 0.44 Btu-in./h-ft² F
Cavity insulation or cavity plus continuous (ci)
Continuous insulation not broken up by framing members e.g., rigid board insulation
Metal Building Walls

Table C402.2

Photo courtesy of Ken Baker, K energy
Below Grade Walls
C402.2.4

What is a below grade wall?
✓ Basement or first-story walls ≥ 85% below grade

Insulation must extend down 10 ft from the outside finished grade level or to the level of the floor, whichever is less

Heated slabs installed below grade (footnoted to Tables C401.2.2 and C402.2)
✓ Below grade walls must meet exterior insulation requirements for heated slabs
Below-Grade Wall Insulation

Photo courtesy of Dow Building Solutions
Floors Over Outdoor Air or Unconditioned Space

C402.2.5

Joist/Framing (Steel/Wood)
- Insulation installed between framing

Mass Floors
- Materials weighing (of floor surface area)
  - 35 lbs/ft², or
  - 25 lbs/ft² if material weight is ≤ 12 lbs/ft³
- Insulation installed continuously

Steel Floor Joist Systems
(footnoted to Table C402.2)
- R-38 in Climate Zones 6-8
Unheated slab – insulation required:
✓ Climate Zones 4-8

Heated slabs – insulation required in all Climate Zones
Opaque Doors
C402.2.7

Doors having < 50% glass area

Swinging doors
✓ Meet U-factor requirement

Roll-up or sliding doors
✓ R-4.75 in all climate zones
Radiant panels and associated U-bends and headers to be insulated with a minimum of R-3.5
## Compliance

### Chapter 5 Prescriptive Approach

<table>
<thead>
<tr>
<th>CLIMATE ZONE</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4 EXCEPT MARINE</th>
<th>5 AND MARINE</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>U-factor</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fixed fenestration</td>
<td>0.50</td>
<td>0.50</td>
<td>0.46</td>
<td>0.38</td>
<td>0.38</td>
<td>0.36</td>
<td>0.29</td>
<td>0.29</td>
</tr>
<tr>
<td>Operable fenestration</td>
<td>0.65</td>
<td>0.65</td>
<td>0.60</td>
<td>0.45</td>
<td>0.45</td>
<td>0.43</td>
<td>0.37</td>
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<tr>
<td>Entrance doors</td>
<td>1.10</td>
<td>0.83</td>
<td>0.77</td>
<td>0.77</td>
<td>0.77</td>
<td>0.77</td>
<td>0.77</td>
<td>0.77</td>
</tr>
<tr>
<td><strong>SHGC</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SHGC</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
<td>0.40</td>
<td>0.40</td>
<td>0.40</td>
<td>0.45</td>
<td>0.45</td>
</tr>
<tr>
<td><strong>U-factor</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Skylights</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>SHGC</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

NR = No requirement.
Vertical Fenestration Requirement
C402.3.1 – Prescriptive (Max area)

Percentage of Vertical Fenestration Area to Gross Wall Area

- Allowed up to 30% maximum of above grade wall
- In Climate Zones 1-6, up to 40% maximum of above grade wall with daylighting controls
Vertical Fenestration Requirement
C402.3.1

Based on above-grade wall area \((gross)\)

- Includes walls between conditioned space and unconditioned space or the great outdoors
  - Includes walls that are > 15% above grade

Total fenestration area \((includes frame and glazing)\)

- Does not include opaque door area
Skylight Minimum Fenestration Area

**C402.3.1** Prescriptive

- Limited to ≤ 3% of Roof Area
- Up to 5% allowed if automatic daylighting controls installed in daylight zones under skylights
Increased Vertical Fenestration with Daylighting Controls
C402.3.1.1

✓ Up to 40% vertical fenestration area allowed in Climate Zones 1-6, provided
  – No less than 50% of the conditioned floor area is within a daylight zone
  – Automatic daylighting controls are installed in daylight zones; and
  – VT of vertical fenestration is ≥ 1.1 times SHGC

Exception:
Fenestration that is outside the scope of NFRC 200 isn’t required to comply with VT
✓ Up to 5% provided automatic daylighting controls are installed in daylight zones under skylights.
Minimum Skylight Fenestration Area
C402.3.2

• In certain types of enclosed spaces > 10,000 ft² directly under a roof with ceiling heights > 15 ft
  – total daylight zone under skylights to not be < ½ the floor area and to provide a minimum skylight area to daylight zone of either
    • Minimum of 3% of roof area with a skylight VLT at least 0.40 OR
    • Provide a minimum skylight effective aperture of at least 1%

Exceptions
• Climate Zones 6-8
• Spaces with LPDs < 0.5 W/ft²
• Documented shaded spaces
• Daylight area under rooftop monitors is > 50% of floor area
• All lighting in daylight zones to have multilevel lighting controls and meet C405.2.2.3.3

Exceptions
• Climate Zones 6-8
• Spaces with LPDs < 0.5 W/ft²
• Documented shaded spaces
• Daylight area under rooftop monitors is > 50% of floor area
• Skylights in certain space types to have a glazing material or diffuser with a measured haze factor > 90% per ASTM D 1003
  – Office, storage, automotive service, manufacturing, nonrefrigerated warehouse, retail store, and distribution/sorting area

• **Exception**
  – Skylights designed to exclude direct sunlight entering the occupied space by use of fixed or automated baffles, or the geometry of skylight and light well
Table C402.3 requirements by these categories:

- Fixed fenestration
- Operable fenestration
- Entrance doors
Skylight U-Factor / SHGC

☑️ U-factor and SHGC Based
☑️ NFRC 100 Rating for U-factor or Default Table
☑️ NFRC 200 Rating for SHGC and VT or Default Table
☑️ No SHGC requirements in Climate Zones 7-8
Fenestration U-Factor
303.1.3

How Do You Meet the Requirement?

✓ Fenestration product rating in accordance to NFRC 100
✓ Labeled and certified by the manufacturer
✓ Non-NFRC 100 rated fenestration
✓ Default Glazed Fenestration U-factor Table C303.1.3(1)
### TABLE C303.1.3(1)
**DEFAULT GLAZED FENESTRATION U-FACTOR**

<table>
<thead>
<tr>
<th>FRAME TYPE</th>
<th>SINGLE PANE</th>
<th>DOUBLE PANE</th>
<th>SKYLIGHT</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Single</td>
<td>Double</td>
<td></td>
</tr>
<tr>
<td>Metal</td>
<td>1.20</td>
<td>0.80</td>
<td>2.00</td>
<td>1.30</td>
<td></td>
</tr>
<tr>
<td>Metal with Thermal Break</td>
<td>1.10</td>
<td>0.65</td>
<td>1.90</td>
<td>1.10</td>
<td></td>
</tr>
<tr>
<td>Nonmetal or Metal Clad</td>
<td>0.95</td>
<td>0.55</td>
<td>1.75</td>
<td>1.05</td>
<td></td>
</tr>
<tr>
<td>Glazed Block</td>
<td></td>
<td>0.60</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### TABLE C303.1.3(2)
**DEFAULT DOOR U-FACTOR**

<table>
<thead>
<tr>
<th>DOOR TYPE</th>
<th>U-FACTOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uninsulated Metal</td>
<td>1.20</td>
</tr>
<tr>
<td>Insulated Metal</td>
<td>0.60</td>
</tr>
<tr>
<td>Wood</td>
<td>0.50</td>
</tr>
<tr>
<td>Insulated, nonmetal edge, max 45% glazing, any glazing double pane</td>
<td>0.35</td>
</tr>
</tbody>
</table>
What is Solar Heat Gain Coefficient?

✓ “The ratio of the solar heat gain entering the space through the fenestration assembly to the incident solar radiation.”
Two Options for Meeting the SHGC and VT Requirements

- Fenestration product rated and labeled to NFRC 200, or
- Select default from Table C303.1.3(3)

<table>
<thead>
<tr>
<th>TABLE C303.1.3(3)</th>
<th>DEFAULT GLAZED FENESTRATION SHGC AND VT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SINGLE GLAZED</td>
</tr>
<tr>
<td></td>
<td>Clear</td>
</tr>
<tr>
<td>SHGC</td>
<td>0.8</td>
</tr>
<tr>
<td>VT</td>
<td>0.6</td>
</tr>
</tbody>
</table>
The Effect of Overhangs on Fenestration SHGC

- Overhangs allow a higher SHGC product to be installed
- Projection factor must be calculated
- When different windows or glass doors have different PFs
  - Evaluate separately
When $PF \geq 0.2$, the required maximum SHGC in Table C402.3 must be adjusted by multiplying the required maximum SHGC by the multiplier in Table C402.3.3.1.

<table>
<thead>
<tr>
<th>PROJECTION FACTOR</th>
<th>ORIENTED WITHIN 45 DEGREES OF TRUE NORTH</th>
<th>ALL OTHER ORIENTATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>$0.2 \leq PF &lt; 0.5$</td>
<td>1.1</td>
<td>1.2</td>
</tr>
<tr>
<td>$PF \leq 0.5$</td>
<td>1.2</td>
<td>1.6</td>
</tr>
</tbody>
</table>
✓ In Climate Zones 1-3, vertical fenestration entirely located not less than 6 ft above the finished floor is permitted a maximum SHGC of 0.40
✓ In Climate Zones 1-6, skylights above daylight zones with automated daylight controls are permitted a maximum SHGC of 0.60
Skylights above daylight zones with automated daylight controls are permitted a maximum U-factor of

- 0.9 in Climate Zones 1-3
- 0.75 in Climate Zones 4-8
✓ SHGC determined using manufacturer’s lowest-rated SHGC
✓ VT/SHGC ratio determined using maximum VT and maximum SHGC
✓ Considered separately from other fenestration
✓ Area-weighted averaging isn’t allowed
Allowed to meet requirements in Table C402.3
Can’t combine products from different categories when calculating the area-weighted average U-factor
Mandatory Requirements

- Air barriers
- Fenestration air leakage
- Air intakes, exhaust openings, stairways and shafts
- Loading dock weatherseals
- Vestibules
- Recessed lighting
Continuous air barrier required except in:

- **Climate Zones 1-3**

**Air barrier requirements:**

- **Placement allowed**
  - Inside of building envelope
  - Outside of building envelope
  - Located within assemblies composing envelope **OR**
  - Any combination thereof
- **Continuous for all assemblies part of the thermal envelope and across joints and assemblies**
- **Joints and seams to be sealed per C402.4.2**
- **Recessed lighting to comply with C404.2.8**
- Where similar objects are installed that penetrate the air barrier, make provisions to maintain the air barrier’s integrity
Three ways to comply with air barrier requirements

- Materials
- Assemblies
- Building
Materials with air permeance $\leq 0.004 \text{ cfm/ft}^2$ under pressure differential of 0.3 in. w.g. tested in accordance with ASTM E 2178

These materials meet this requirement:

<table>
<thead>
<tr>
<th>Material</th>
<th>Thickness (minimum)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plywood</td>
<td>3/8 in.</td>
</tr>
<tr>
<td>Oriented strand board</td>
<td>3/8 in.</td>
</tr>
<tr>
<td>Extruded polystyrene insulation board</td>
<td>½ in.</td>
</tr>
<tr>
<td>Foil-faced urethane insulation board</td>
<td>½ in.</td>
</tr>
<tr>
<td>Closed cell spray foam minimum density of 1.5 pcf</td>
<td>1-1/2 in.</td>
</tr>
<tr>
<td>Open cell spray foam density between 0.4 and 1.5 pcf</td>
<td>4.5 in.</td>
</tr>
<tr>
<td>Exterior gypsum sheathing or interior gypsum board</td>
<td>½ in.</td>
</tr>
<tr>
<td>Cement board</td>
<td>½ in.</td>
</tr>
<tr>
<td>Built up roofing membrane</td>
<td></td>
</tr>
<tr>
<td>Modified bituminous roof membrane</td>
<td></td>
</tr>
<tr>
<td>Fully adhered single-ply roof membrane</td>
<td></td>
</tr>
<tr>
<td>A Portland cement/sand parge, stucco, or gypsum plaster</td>
<td>5/8 in.</td>
</tr>
<tr>
<td>Cast-in-place and precast concrete</td>
<td></td>
</tr>
<tr>
<td>Sheet metal or aluminum</td>
<td></td>
</tr>
</tbody>
</table>
OR

Assemblies of materials and components (sealants, tapes, etc.) with average air leakage ≤ 0.04 cfm/ft² under pressure differential of 0.3 in. w.g. tested in accordance with ASTM E 2357, 1677 or 283

These assemblies meet this requirement:

- Concrete masonry walls coated with one application either of block filler and two applications of a paint or sealer coating OR
- Portland cement/sand parge, stucco or plaster minimum ½ thick
Air leakage rate of completed building tested and confirmed to not exceed 0.40 cfm/ft$^2$ at a pressure differential of 0.3 inches water gauge per ASTM E779 or equivalent method approved by code official
Air Barrier Penetrations
C402.4.2

• Penetrations of air barrier and air leakage paths to be caulked, gasketed, or otherwise sealed

• Joints and seals
  – Sealed in same manner or taped or covered with a moisture vapor-permeable wrapping material
  – Securely installed in or on the joint for the entire length
    • To resist positive and negative pressure from wind, stack effect and mechanical ventilation
  – Sealing materials appropriate to construction materials
## Air Leakage of Fenestration

### C402.4.3

<table>
<thead>
<tr>
<th>Fenestration Assembly</th>
<th>cfm/ft²</th>
<th>Test Procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Windows, sliding glass doors, and swinging doors</td>
<td>0.20</td>
<td>AAMA/WDMA/CSA 101/I.S.2/A440 or NFRC 400</td>
</tr>
<tr>
<td>Skylights - with condensation weepage openings</td>
<td>0.30</td>
<td></td>
</tr>
<tr>
<td>Skylights – all other</td>
<td>0.20</td>
<td></td>
</tr>
<tr>
<td>Curtain walls and storefront glazing</td>
<td>0.06</td>
<td>NFRC 400 or ASTM E283 at 1.57 psf</td>
</tr>
<tr>
<td>Commercial glazed swinging entrance doors</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>Revolving doors</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>Garage doors</td>
<td>0.4</td>
<td>ANSI/DASMA 105, NFRC 400, or ASTM E283 at 1.57 psf</td>
</tr>
<tr>
<td>Rolling doors</td>
<td>1.00</td>
<td></td>
</tr>
</tbody>
</table>

### Exceptions
- Field-fabricated fenestration assemblies
- Fenestration in buildings that meet the building test for air barrier compliance option
Mandatory Requirements
C402.4.5.1 Stairway and Shaft Vents

• To have Class I motorized dampers with maximum leakage rate of 4 cfm/ft² at 1.0 inch water gauge

• Dampers to be installed with controls to be able to open automatically upon
  – Activation of any fire alarm initiating device of building’s fire alarm system or
  – Interruption of power to the damper
Mandatory Requirements
C402.4.5.2 Outdoor Air Intakes and Exhausts

Buildings ≥ 3 stories in height above grade

✓ Class IA motorized leakage-rated damper
  - Maximum leakage rate ≤ 4cfm /ft² @ 1.0 inch w.g.

Buildings < 3 stories in height

✓ Gravity (nonmotorized) with maximum leakage rate of 20 cfm/ft² at 1.0 inch water gauge allowed
  ✓ For exhaust and relief dampers
  ✓ For ventilation air intakes and exhaust and relief dampers in buildings of any height in CZ 1-3
  ✓ Where design outdoor air intake or exhaust capacity is < 300 cfm

✓ Dampers < 24 inches in either dimension may have a leakage of 40 cfm/ft² at 1.0 inch water gauge
Mandatory Requirements

C402.4.6 Loading Dock Weatherseals

- Equip cargo doors and loading dock doors with weatherseals
- Goal is to restrict infiltration
Mandatory Requirements

C402.4.7 Vestibules

- Required to reduce infiltration into spaces
- Required on entrance doors leading into spaces ≥ 3,000 ft²
- Doors must have self-closing devices
- Exceptions
  - Buildings in Climate Zones 1 and 2
  - Doors from a sleeping unit or dwelling unit
  - Revolving doors
  - Doors not intended for public use or intended solely for employee use
All recessed luminaires installed in the building envelope

- Type IC rated and sealed with gasket or caulk between housing and interior wall or ceiling covering

- Type IC rated and labeled in accordance with ASTM E 283 to allow ≤ 2.0 cfm of air movement between conditioned and unconditioned spaces