2018 IECC Commercial Scope and Envelope Requirements
-- Energy codes and standards set minimum efficiency requirements for new and renovated buildings, assuring reductions in energy use and emissions over the life of the building. Energy codes are a subset of building codes, which establish baseline requirements and govern building construction.

-- Code buildings are more comfortable and cost-effective to operate, assuring energy, economic and environmental benefits.
Structure of the 2018 IECC

**Commercial Section**
- Ch. 1 Scope and Application / Administrative and Enforcement
- Ch. 2 Definitions
- Ch. 3 General Requirements
- Ch. 4 Commercial Energy Efficiency
- Ch. 5 Existing Buildings
- Ch. 6 Referenced Standards
- Index

**Residential Section**
- Ch. 1 Scope and Application / Administrative and Enforcement
- Ch. 2 Definitions
- Ch. 3 General Requirements
- Ch. 4 Residential Energy Efficiency
- Ch. 5 Existing Buildings
- Ch. 6 Referenced Standards
- Index
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
Scope

Section C101.4.1 – Mixed Residential and Commercial Buildings

Section C101.5 - Compliance

- Treat the residential **building portion** under the applicable residential code
- Treat the commercial **building portion** under the commercial code
- Code Official has final authority
  - Compliance materials, Software, worksheets
The code is not intended to prevent installation of any material or prohibit design of construction that is not specifically prescribed in this code if alternative is approved.

Approved where
- Code official finds proposed design is satisfactory and complies with the intent of the provisions and material, method, or work is for the purpose intended, not less than equivalent prescribed in the code in quality, strength, effectiveness, fire resistance, durability and safety.

Where not approved
- Code official to respond in writing stating the reasons why
Scope/Construction Documents
Section C103

- Documentation shall be prepared by a registered design professional
- Electronic media can be used
- Information required:
  - Insulation materials and R-values
  - Fenestration U-factors, SHGC
  - Area-weighted U-factor and SHGC calculations
  - Mechanical system design criteria
  - Mechanical, SWH, equipment types, sizes, and efficiencies
  - Economizer description
  - Equipment and system controls
  - Duct sealing, duct and pipe insulation and location
  - Lighting fixture schedule with wattage and control narrative
  - Location of daylight zones
  - Air sealing details

The building thermal envelope shall be represented on the construction drawings.
• Examination of documents
• Amended construction documents
• Retention of construction documents
• Building documentation and closeout submittal requirements
Scope
Section C104-C109

✓ Fees, C104
✓ Inspections, C105
  – Work remains visible and accessible for inspection
✓ Code Validity, C106
  – Code deemed to be illegal or void shall not affect the remainder of the code
✓ Referenced standards, C107
  – Provisions take precedence and considered part of the requirements of the code
✓ Stop Work Order, C108
  ✓ Authority of code official
  ✓ Failure to comply
✓ Board of Appeals, C109
• Construction work for which a permit is required is subject to inspection by code official, his or her designated agent or an approved agency

• Required inspections include:
  – Footing and foundation insulation
  – Thermal envelope
  – Plumbing system
  – Mechanical system
  – Electrical system
  – Final
Codes and standards listed in Chapter 6 are considered part of the requirements of this code to the “prescribed extent of each such reference and as further regulated in Sections C107.1.1 and C107.1.2”

- Conflicts, C107.1.1 – where differences occur between this code and the referenced codes and standards, provisions of this code apply
- Provisions in reference codes and standards, C107.1.2 – “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”
Buildings or portions of buildings that are separated from remainder of building by building thermal envelope assemblies complying with C402 are exempt from the Envelope provisions if:

- Peak design rate of energy < 3.4 Btu/h/ft² or 1.0 watt/ft² of floor area for space conditioning purposes, **OR**
- Those portions or building that do not contain conditioned space, **OR**
- Greenhouses
Buildings that comply with the following are exempt from the building thermal envelope provisions:

- Separate building with floor area < 500 ft² (50 m²)
- Intended to house electronic equipment with installed equipment power totaling > 7 watts/ft² (75W/m²)
- Heating system capacity < 17,000 Btu/hr (5 kW) and a heating thermostat set point that is restricted to < 50°F
- Average wall and roof U-factor < 0.200 in Climate Zones 1-5 and < 0.120 in Climate Zones 6-8
- Comply with the roof solar reflectance and thermal emittance provisions for Climate Zone 1
Commercial Compliance Options

1. ASHRAE 90.1-2016

2. 2018 IECC - Prescriptive
   - C402 - Envelope
   - C403 - Mechanical
   - C404 - SWH
   - C405 - Lighting
   AND
   - Pick At Least One C406:
     - C406.2 – Eff. HVAC Performance
     - C406.3 – Reduced Lighting Power
     - C406.4 – Enhanced Lighting Controls
     - C406.5 – On-site Supply of Renewable energy
     - C406.6 – Dedicated Outdoor Air System
     - C406.7 – High Eff. Service Water Heating
     - C406.8 – Enhanced Envelope Performance
     - C406.9 – Reduced Air Infiltration

3. 2018 IECC - Performance
   - C407 – Total Building Performance
   - C402.5 – Air Leakage
   - C403.2 – Provisions applicable to all mechanical systems
   - C404 - SWH
   - Lighting Mandatory Sections
     - C405.2
     - C405.3
     - C405.4
     - C405.6
   - Building energy cost to be ≤ 85% of standard reference design building
• One additional efficiency feature must be selected to comply with the IECC
  – More efficient HVAC performance, OR
  – Reduced lighting power density system, OR
  – Enhanced lighting controls, OR
  – On-site supply of renewable energy
  – Dedicated outdoor air system, OR
  – More efficient SWH
• Efficient HVAC performance per C406.2 OR
  – Per Tables C403.2.3(1) thru C403.2.3(7)
  – Only used when efficiencies in the above tables are greater than 10% in addition to the requirements in C403
  – Where multiple performance requirements are provided, the equipment shall exceed all requirements by 10%
  – Variable refrigerant flow systems exceed energy efficiency provisions of 90.1-2013 by 10%
  – Equipment not listed in tables above shall be limited to 10% of total building system capacity

• Reduced lighting power per C406.3 OR
  – Whole building LPD determined using 90% of values in Table C405.4.2(1) x floor area for the building types OR
  – Using 90% by the space-by-space method in Section C405.4.2
  – Determine total LPD of building using reduced whole building interior lighting power in Table 406.3 x floor area for the building types
Additional Efficiency Package Options
Section C406 – Cont’d.

• Enhanced digital lighting controls per C406.4, controls located and operated in accordance with C405.2.2:
  – Luminaires capable of continuous dimming
  – Luminaires capable of being addressed individually OR a controlled group of ≤ 4 luminaires
  – ≤ 8 luminaires controlled together in a daylight zone
  – Fixtures controlled through digital control system that includes the following function:
    • Control reconfiguration based on digital addressability
    • Load shedding
    • Individual user control of overhead general illumination in open offices
    • Occupancy sensors capable of being reconfigured through the digital control system
  – Construction documents including submittal of Sequence of Operations including specs outlining each function of the fixture requirements above
  – Functional testing of controls comply with C408
Additional Efficiency Package Options
Section C406 – Cont’d.

• On-site renewable energy per C406.5 OR
  – Total minimum ratings to
    • Provide $\geq 1.75$ Btu or $\geq 0.50$ watts per ft$^2$ of conditioned floor area
    OR
    • Provide $\geq 3\%$ of energy used for mechanical and SWH equipment and lighting

• Dedicated outdoor air system per C406.6 OR
  – Be equipped with an independent ventilation system designed to provide $\leq 100\%$ outdoor air to each occupied space
  – Ventilation system capable of total energy recovery
  – HVAC system include supply-air temperature controls that automatically reset the supply-air temp. in response to building loads or outdoor air temperatures
  – Controls reset the supply-air temp. at least 25$\%$ of the difference between design supply-air temp. and design room-air temp.
• Reduced energy use in SWH per C406.7

Buildings with the following types allowed to use this compliance method:

– Group R-1: Boarding houses, hotels, or motels
– Group I-2: Hospitals, psychiatric hospitals, and nursing homes
– Group A-2: Restaurants and banquet halls or buildings containing food preparation areas
– Group F: Laundries
– Group R-2: Buildings with residential occupancies
– Group A-3: Health clubs and spas
– Buildings showing a service hot water load of >10% of total building energy loads as shown with an energy analysis per C407
• Reduced energy use in SWH (cont’d)

Load fraction:

Building SWH system has >1 of the following sized to provide > 60% of hot water requirements or sized to provide 100% of hot water requirements if building complies with C403.4.7

– Waste heat recovery from service hot water, heat recover chillers, building equipment, process, equipment, or combined heat and power system

– Solar water-heating systems

• Enhanced Envelope Performance

– Total UA of building thermal envelope as designed to be not less than 15% below total UA of building thermal envelope per Section C402.1.5
• Reduced Air Infiltration
  – Air infiltration verified by whole-building pressurization test
    • Per ASTM E779 or ASTM E1827
    • By independent third party
  – Measured air-leakage rate not to exceed 0.25 cfm/ft² under pressure differential of 0.3 inches w.c. (75 Pa), with calculated surface area the sum of above- and below-grade building envelope
  – Submit report to code official and building owner
    • Including: tested surface area, floor area, air by volume, stories above grade, and leakage rates

**Exception:** Buildings over 250,000 ft² of conditioned floor area don’t need testing on whole building, can test representative above-grade sections. Tested areas to total not less than 25% of conditioned floor area and tested per C406.9
Determining Your Climate Zone is the First Step in the Process
What is the Building Thermal Envelope?

- Roof/Ceiling Assembly
- Wall Assembly
- Vertical Fenestration and Skylights
- Floor Assembly
- Slab Edge
- Below Grade Wall Assembly
Building thermal envelope to comply with the following:

• Specific insulation requirements of Section C402.2
• Thermal requirements of either:
  – R-value-based method of Section C402.1.3
  – U-, C-, and F-factor-based method of Section C402.1.4 OR
  – Component performance alternative of Section C402.1.5
• Roof solar reflectance and thermal emittance
• Fenestration in building envelope assemblies
• Air Leakage of building envelope assemblies
3 Methods for compliance of building components:

- C402.1.3 – Insulation component R-value based method
- C402.1.4 – Assembly U-factor, C-factor or F-factor based method
- C402.1.5 – Component Performance Alternative
### Table C402.1.3

**Opaque Thermal Envelope Insulation Component Minimum Requirements, R-Value Method**

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<td>Slab-on-grades floors</td>
<td>NR</td>
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<td>Unheated slabs</td>
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<td>Heated slabs*</td>
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</tbody>
</table>

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 4.88 kg/m², 1 pound per cubic foot = 16 kg/m³.

ci = Continuous insulation, NR = No Requirement, LS = Liner System.

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

b. Where using R-value compliance method, a thermal spacer block shall be provided, otherwise use the U-factor compliance method in Table C402.1.4.

c. 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/in·h·F°F.

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

e. “Mass floors” shall be in accordance with Section C402.2.3.

f. Steel floor joist systems shall be insulated to R-38.

g. “Mass walls” shall be in accordance with Section C402.2.2.

h. The first value is for perimeter insulation and the second value is for slab insulation. Perimeter insulation is not required to extend below the bottom of the slab.

i. Not applicable to garage doors. See Table C402.1.4.
## Climate Zones

<table>
<thead>
<tr>
<th>Climate Zone</th>
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### Insulation Entirely Above Deck

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<tr>
<th>Climate Zone</th>
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<td>R-38</td>
<td>R-49</td>
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</tbody>
</table>

### Metal Buildings

- **a**: Where using R-value compliance method, a thermal spacer block shall be provided, otherwise use the U-factor compliance method in Table C402.1.4.
- **b**: R-5.7ci is allowed to be substituted with concrete block walls complying with ASTM C90, angstromed or partially grouted at 32 inches (813 mm) or less on center vertically and 48 inches (1219 mm) or less on center horizontally, with ungrouted cores filled with materials having a maximum thermal conductivity of 0.44 Btu-in·ft·°F/ft²·hr.

### Attic and Other

- **c**: “Mass floors” shall be in accordance with Section C402.2.3.
- **d**: Steel floor joist systems shall be insulated to R-38.
- **e**: “Mass walls” shall be in accordance with Section C402.2.2.
- **f**: The first value is for perimeter insulation and the second value is for slab insulation. Perimeter insulation is not required to extend below the bottom of the slab.

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 4.88 kg/m², 1 pound per cubic foot = 0.016 kg/m³.

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**Notes:**
- **R-25ci**: R-25 continuous insulations.
- **R-30ci**: R-30 continuous insulations.
- **R-35ci**: R-35 continuous insulations.
- **R-11**: R-11 continuous insulations.
- **LS**: Liner System.
### Table C402.1.3

**Opaque Thermal Envelope Insulation Component Minimum Requirements, R-Value Method**

<table>
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<tr>
<th>Climate Zone</th>
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<th>4 Except Marine</th>
<th>5 And Marine 4</th>
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<tr>
<td><strong>Metal building</strong></td>
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<td>R-13+ 6.5ci</td>
<td>R-13+ 6.5ci</td>
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<td><strong>Metal Framed</strong></td>
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<td>R-13+ 7.5ci</td>
</tr>
</tbody>
</table>

- **Walls, Above Grade**

**Chapter 5 Prescriptive Approach Compliance**

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**Notes:**
- e. Where using R-value compliance method, a thermal spacer must be provided, otherwise use the U-factor compliance method in Table C402.1.4.
- f. R-5.7ci is allowed to be substituted with concrete block walls complying with AS TM C90, unplastered or partially glazed at 32 inches or less on center vertically and 48 inches or less on center horizontally.
- g. Where heated slabs are below grade, below-grade walls shall comply with the exterior insulation requirements for heated slabs.
- h. “Mass floors” shall be in accordance with Section C402.2.3.
- i. Steel floor joist systems shall be insulated to R-38.
- j. “Mass walls” shall be in accordance with Section C402.2.2.
- k. The first value is for perimeter insulation and the second value is for slab insulation. Perimeter insulation is not required to extend below the bottom of the slab.

---

**BUILDING ENERGY CODES**

www.energycodes.gov
### Chapter 5 Prescriptive Approach Compliance

#### BUILDING ENERGY CODES

**TABLE C402.1.3**

<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>
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</thead>
<tbody>
<tr>
<td>Metal buildings</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>
<tr>
<td>Attic and other</td>
<td>R-7.5ci</td>
<td>R-7.5ci</td>
<td>R-7.5ci</td>
<td>R-7.5ci</td>
<td>R-13.3ci</td>
<td>R-15.2ci</td>
<td>R-15.2ci</td>
<td>R-15.2ci</td>
</tr>
</tbody>
</table>

#### WALLS, BELOW GRADE

### Climate Zone

<table>
<thead>
<tr>
<th>Below grade wall</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>
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</thead>
<tbody>
<tr>
<td>Mass*</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>
<tr>
<td>Joint/trimming</td>
<td>NR</td>
<td>NR</td>
<td>R-10ci</td>
<td>R-10ci</td>
<td>R-10ci</td>
<td>R-10ci</td>
<td>R-10ci</td>
<td>R-10ci</td>
</tr>
<tr>
<td>Unheated slabs</td>
<td>R-7.5 for 12&quot; below</td>
<td>R-7.5 for 12&quot; below</td>
<td>R-7.5 for 12&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-15 for 24&quot; below</td>
<td>R-15 for 24&quot; below</td>
</tr>
<tr>
<td>Heated slabs</td>
<td>R-7.5 for 12&quot; below + R-5 full slab</td>
<td>R-7.5 for 12&quot; below + R-5 full slab</td>
<td>R-7.5 for 12&quot; below + R-5 full slab</td>
<td>R-10 for 24&quot; below + R-5 full slab</td>
<td>R-10 for 24&quot; below + R-5 full slab</td>
<td>R-10 for 24&quot; below + R-5 full slab</td>
<td>R-15 for 24&quot; below + R-5 full slab</td>
<td>R-15 for 24&quot; below + R-5 full slab</td>
</tr>
</tbody>
</table>

**For Sl: 1 inch = 25.4 mm, 1 pound per square foot = 4.88 kg/m², 1 pound per cubic foot = 16 kg/m³.**

**ci = Continuous insulation, NR = No Requirement, LS = Liner System.**

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

*b. Where using R-value compliance method, a thermal spacer block shall be provided, otherwise use the U-factor compliance method in Table C402.1.4.*

*c. R-5.7ci is allowed to be substituted with concrete block walls complying with ASTM C90, ungrouted or partially grouted at 2 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-in/ft²·°F.*

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

**e. “Mass floors” shall be in accordance with Section C402.2.3.*

**f. Steel floor joist systems shall be insulated to R-30.*

**g. “Mass walls” shall be in accordance with Section C402.2.2.*

**h. The first value is for perimeter insulation and the second value is for slab insulation. Perimeter insulation is not required to extend below the bottom of the slab.*

**i. Not applicable to garage doors. See Table C402.1.4.*
Chapter 5 Prescriptive Approach Compliance

### TABLE C402.1.3

**Opaque Thermal Envelope Insulation Component Minimum Requirements, R-Value Method**

<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>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-49</td>
<td>R-49</td>
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<tr>
<td>Joist/Framing</td>
<td>R-5.7ci</td>
<td>R-5.7ci</td>
<td>R-7.6ci</td>
<td>R-7.6ci</td>
<td>R-13.3ci</td>
<td>R-15.2ci</td>
<td>R-15.2ci</td>
<td>R-2.5ci</td>
</tr>
<tr>
<td>Massa</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-12.5ci</td>
<td>R-12.5ci</td>
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<tr>
<td>Joist/Framing</td>
<td>R-30</td>
<td>R-30</td>
<td>R-30</td>
<td>R-30</td>
<td>R-30</td>
<td>R-30</td>
<td>R-30</td>
<td>R-30</td>
</tr>
<tr>
<td>Heated slabsb</td>
<td>12&quot; below + R-5 full slab</td>
<td>12&quot; below + R-5 full slab</td>
<td>24&quot; below + R-5 full slab</td>
<td>24&quot; below + R-5 full slab</td>
<td>24&quot; below + R-5 full slab</td>
<td>24&quot; below + R-5 full slab</td>
<td>24&quot; below + R-5 full slab</td>
<td>24&quot; below + R-5 full slab</td>
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<tr>
<td>Opaque doors</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, 1 pound per square foot = 4.88 kg/m², 1 pound per cubic foot = 16 kg/m³.

- Continuous insulation, NR = No Requirement, LS = Liner System.
- Assembly descriptions can be found in ANSI/ASHRAE/IESNA Appendix A.
- Where using R-value compliance method, a thermal spacer block shall be provided, otherwise use the U-factor compliance method in Table C402.1.4.
- 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-in/ft²°F.
- Where heated slabs are below grade, below-grade walls shall comply with the exterior insulation requirements for heated slabs.
- “Mass floors” shall be in accordance with Section C402.2.3.
- Steel floor joist systems shall be insulated to R-38.
- “Mass walls” shall be in accordance with Section C402.2.2.
- The first value is for perimeter insulation and the second value is for slab insulation. Perimeter insulation is not required to extend below the bottom of the slab.
- Not applicable to garage doors. See Table C402.1.4.
### Chapter 5 Prescriptive Approach Compliance

#### Table C402.1.3

<table>
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<tr>
<th>Climate Zone</th>
<th>1</th>
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<th>3</th>
<th>4 Except Marine</th>
<th>5 And Marine 4</th>
<th>6</th>
<th>7</th>
<th>8</th>
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</thead>
<tbody>
<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-49</td>
<td>R-49</td>
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<td>Masonry*</td>
<td>R-5.7ci†</td>
<td>R-5.7ci†</td>
<td>R-7.6ci†</td>
<td>R-7.6ci†</td>
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<td>R-10 for 24 in. below</td>
<td>R-15 for 24 in. below</td>
<td>R-15 for 24 in. below</td>
</tr>
<tr>
<td>SLAB-ON GRADE FLOORS</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
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</table>

#### Climate Zones

<table>
<thead>
<tr>
<th>Unheated Slabs</th>
<th>1</th>
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<th>3</th>
<th>4 Except Marine</th>
<th>5 And Marine 4</th>
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<th>8</th>
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</thead>
<tbody>
<tr>
<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>
<td>R-15 for 24 in. below</td>
<td>R-20 for 24 in. below</td>
</tr>
<tr>
<td>R-7.5 for 12 in. below + R-5 full slab</td>
<td>R-7.5 for 12 in. below + R-5 full slab</td>
<td>R-10 for 24 in. below</td>
<td>R-15 for 24 in. below</td>
<td>R-15 for 36 in. below + R-5 full slab</td>
<td>R-15 for 36 in. below + R-5 full slab</td>
<td>R-20 for 48 in. below + R-5 full slab</td>
<td>R-20 for 48 in. below + R-5 full slab</td>
<td></td>
</tr>
</tbody>
</table>

#### Heated Slabs

| NR | R-4.75 | R-4.75 | R-4.75 | R-4.75 | R-4.75 | R-4.75 | R-4.75 | R-4.75 |

#### Opaque Doors

| Nonwarming | R-4.75 | R-4.75 | R-4.75 | R-4.75 | R-4.75 | R-4.75 | R-4.75 | R-4.75 |

---

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 4.88 kg/m², 1 pound per cubic foot = 16 kg/m³.

- b. Where using R-value compliance method, a thermal spacer block shall be provided; otherwise use the U-factor compliance method in Table C402.1.4.
- c. R-5.7ci is allowed to be substituted with concrete block walls complying with ASTM C90. Ungrounded or partially grounded at 32 inches or less on center vertically and 48 inches or less on center horizontally, with ungrounded cores filled with materials having a maximum thermal conductivity of 0.44 Btu-in ft °F/°F.
- d. Where heated slabs are below grade, below-grade walls shall comply with the exterior insulation requirements for heated slabs.
- e. “Mass floors” shall be in accordance with Section C402.2.3.
- f. Steel floor joist systems shall be insulated to R-38.
- g. “Mass walls” shall be in accordance with Section C402.2.2.
- h. The first value is for perimeter insulation and the second value is for slab insulation. Perimeter insulation is not required to extend below the bottom of the slab.
- i. Not applicable to garage doors. See Table C402.1.4.

---

31
Chapter 5 Prescriptive Approach Compliance

<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>
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</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>
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</table>

**Opaque Doors**

<table>
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<tr>
<th>Nonswinging</th>
<th>R-4.75</th>
<th>R-4.75</th>
<th>R-4.75</th>
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<td>NR</td>
<td>NR</td>
<td>R-10 for 24&quot; below</td>
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<td>R-10 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-20 for 24&quot; below</td>
<td>R-20 for 24&quot; below</td>
</tr>
<tr>
<td>Unheated slabs</td>
<td>R-7.5 for 12&quot; below + R-5 full slab</td>
<td>R-7.5 for 12&quot; below + R-5 full slab</td>
<td>R-7.5 for 12&quot; below + R-5 full slab</td>
<td>R-7.5 for 12&quot; below + R-5 full slab</td>
<td>R-10 for 24&quot; below + R-5 full slab</td>
<td>R-10 for 24&quot; below + R-5 full slab</td>
<td>R-15 for 24&quot; below + R-5 full slab</td>
<td>R-15 for 24&quot; below + R-5 full slab</td>
<td>R-20 for 24&quot; below + R-5 full slab</td>
<td>R-20 for 24&quot; below + R-5 full slab</td>
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<td>R-20 for 24&quot; below + R-5 full slab</td>
<td></td>
</tr>
<tr>
<td>Heated slabs</td>
<td>R-7.5 for 12&quot; below + R-5 full slab</td>
<td>R-7.5 for 12&quot; below + R-5 full slab</td>
<td>R-7.5 for 12&quot; below + R-5 full slab</td>
<td>R-7.5 for 12&quot; below + R-5 full slab</td>
<td>R-10 for 24&quot; below + R-5 full slab</td>
<td>R-15 for 24&quot; below + R-5 full slab</td>
<td>R-15 for 24&quot; below + R-5 full slab</td>
<td>R-15 for 24&quot; below + R-5 full slab</td>
<td>R-20 for 24&quot; below + R-5 full slab</td>
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<td>R-20 for 24&quot; below + R-5 full slab</td>
<td>R-20 for 24&quot; below + R-5 full slab</td>
<td></td>
</tr>
</tbody>
</table>

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 4.88 kg/m², 1 pound per cubic foot = 16 kg/m³.

- b. Where using R-value compliance method, a thermal spacer block shall be provided, otherwise use the U-factor compliance method in Table C402.1.4.
- c. R-5.7ci is allowed to be substituted with concrete block walls complying with ASTM C90, ungrouted or partially grouted at 32 inches 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 in·h·F/ft².°F.
- d. Where heated slabs are below grade, below-grade walls shall comply with the exterior insulation requirements for heated slabs.
- e. “Mass floors” shall be in accordance with Section C402.2.3.
- f. Steel floor joist systems shall be insulated to R-38.
- g. “Mass walls” shall be in accordance with Section C402.2.2.
- h. The first value is for perimeter insulation and the second value is for slab insulation. Perimeter insulation is not required to extend below the bottom of the slab.
- i. Not applicable to garage doors. See Table C402.1.4.
Roof Assembly
Section C402.2.1

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

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

Insulation on suspended ceiling with removable ceiling tiles not considered for code compliance.

Continuous insulation board to have > 2 layers and the edge joints between each layer should be staggered.

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 a skylight listed and labeled per NRC 100)
• Continuously insulated roof assemblies where the thickness of insulation varies by \( \leq 1" \) and area-weighted U-factor is equivalent to the same assembly with the R-value specified in Table C402.1.3

• Tapered insulation is used with insulation entirely above deck, the R-value where the insulation thickness varies \( \leq 1" \) from the minimum thickness of tapered insulation must comply with the R-value specified in Table C402.1.3

• Two layers of insulation aren’t required where insulation tapers to the roof deck (e.g., at roof drains)
Roof Solar Reflectance and Thermal Emittance

Section C402.3

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

Comply with one or more options:

1) Minimum three-year aged solar reflectance of 0.55 and minimum three-year aged thermal emittance of 0.75

OR

2) Three-year aged solar reflectance index of 64

Where aged solar reflectance required by Section C402.3 is not available, it should be determined with Equation 4-3

\[ R_{\text{aged}} = [0.2 + 0.7(R_{\text{initial}} - 0.2)] \]
• 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 permanent features of adjacent buildings
• Ballasted roofs with minimum stone ballast of 17 lbs/ft$^2$ or 23 lbs/ft$^2$ pavers
• Roofs, where a minimum of 75% of the roof area meets one or more 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 C402.1.3
Roof Assembly
Insulation Placed on Ceiling with Removable Ceiling Tiles

- Will not count for code compliance
- Not considered part of the minimum thermal resistance of the roof insulation
Thermal spacer block 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

**Liner System includes the following:**

- Continuous vapor barrier liner membrane that is installed below the purlins and that is uninterrupted by framing members
- An uncompressed, unfaced insulation resting on top of the liner membrane and located between purlins
- Multilayer installations, the last rated R-value of insulation is for unfaced insulation draped over purlins and compressed when the metal roof panes are attached
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 5-8 and marine 4 “Group R”
Mass walls must comply with one of the following:

- Walls weigh at least 35 lbs/ft\(^2\) of wall surface area
- 25 lbs/ft\(^2\) of wall surface area if material weight is \(\leq 120\) lb/ft\(^3\)
- Heat capacity > 7 Btu/ft\(^2\)
- Heat capacity > 5 Btu/ft\(^2\) if the material weight is < 120 pcf
Climate Zones 1 and 2 (all other) and Climate Zone 1 (Group R) – 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 C402.1.3

Photo courtesy of Ken Baker, K energy
Below Grade Walls
Table C402.1.3 or Table C402.1.4

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 lowest floor, whichever is less

Heated slabs installed below grade *(footnoted to Tables C402.1.3 and C402.2.14)*

✓ 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
Section C402.2.3

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 ≤ 120 lbs/ft³
✓ Insulation installed continuously

Steel Floor Joist Systems
*(footnoted to Table C402.1.3)*
✓ R-38 in Climate Zones 6 Group R) and 7-8 (Group R and All other)
Floor framing cavity insulation or structural slab insulation should be installed to maintain permanent contact with underside of subfloor decking or structural slabs.

**Exceptions:**

- Framing cavity insulation or structural slab insulation is permitted to be in contact with top side of sheathing or ci installed on the bottom side of floor where combined with insulation that meets or exceeds R-value in Table C402.1.3 for “Metal framed” or “Wood framed and other” values for “Walls, Above Grade” and extends from the bottom to the top of all perimeter floor framing or floor assembly members.
- Insulation applied to underside of concrete floor slabs is permitted an airspace of < 1” where it turns up and is in contact with underside of floor under walls associated with the building thermal envelope.
• Unheated slab – insulation required:
  ✓ Climate Zones 4-8
• Heated slabs – insulation required in all Climate Zones
• **Exception**: where slab-on-grade floor is > 24” below finished exterior grade
Below-grade Walls
Section C402.2.5

• C-factor to be in accordance with Table C402.1.4
• R-value of continuous insulation within or on below-grade exterior walls to be per C402.1.3
• C-factor or R-value required to extend to a depth of not less than 10 feet below outside finished ground level or level of lowest floor in conditioned space enclosed by the below-grade wall, whichever is less
Radiant heating system panels and their associated components:

- Installed in interior or exterior assemblies to be insulated with \( \geq R-3.5 \) on all surfaces not facing the space being heated.
- Installed in the building thermal envelope should be separated from the exterior of the building or unconditioned or exempt spaces by not less than the R-value installed in the opaque assembly in which they are installed or assembly comply with Section C402.1.4.

**Exception**: heated slabs-on-grade insulated in accordance with Section C402.2.4.
### Building Envelope Fenestration Maximum U-Factor and SHGC 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>
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</thead>
<tbody>
<tr>
<td>Vertical fenestration</td>
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<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>
<td>0.37</td>
</tr>
<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>SHGC</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Orientation&lt;sup&gt;a&lt;/sup&gt;</td>
<td>SEW</td>
<td>N</td>
<td>SEW</td>
<td>N</td>
<td>SEW</td>
<td>N</td>
<td>SEW</td>
<td>N</td>
</tr>
<tr>
<td>PF ≤ 0.2</td>
<td>0.25</td>
<td>0.33</td>
<td>0.25</td>
<td>0.33</td>
<td>0.36</td>
<td>0.38</td>
<td>0.51</td>
<td>0.40</td>
</tr>
<tr>
<td>PF ≥ 0.5</td>
<td>0.30</td>
<td>0.37</td>
<td>0.37</td>
<td>0.37</td>
<td>0.43</td>
<td>0.53</td>
<td>0.56</td>
<td>0.48</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>U-factor</td>
<td>0.75</td>
<td>0.65</td>
<td>0.55</td>
<td>0.50</td>
<td>0.50</td>
<td>0.50</td>
<td>0.50</td>
<td>0.50</td>
</tr>
<tr>
<td>SHGC&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.35</td>
<td>0.35</td>
<td>0.35</td>
<td>0.40</td>
<td>0.40</td>
<td>0.40</td>
<td>NR</td>
<td>NR</td>
</tr>
</tbody>
</table>

NR = No Requirement, PF = Projection Factor.

*a.* “N” indicates vertical fenestration oriented within 45 degrees of true north. “SEW” indicates orientations other than “N.” For buildings in the southern hemisphere, reverse south and north. Buildings located at less than 23.5 degrees latitude shall use SEW for all orientations.
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
Section C402.4.1

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
Section C402.4.1 Prescriptive

✓ Limited to ≤ 3% of Roof Area
✓ Up to 6% allowed if automatic daylighting controls installed in toplit zones
Increased Vertical Fenestration with Daylight Responsive Controls
Section C402.4.1.1

✓ 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 in buildings < 2 stories above grade
  – No less than 25% of the net floor area is within a daylight zone in building ≥ 3 stories above grade
  – Daylight responsive controls complying with C405.2.3.1 are installed in daylight zones
  – 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 6% of the roof area provided daylight responsive controls are installed in toplit zones
Minimum Skylight Fenestration Area
Section C402.4.2

- In certain types of enclosed spaces > 2,500 ft² in floor area directly under a roof with > 75% of ceiling area with ceiling height > 15 ft.
  - total toplit daylight zone to not be < ½ the floor area and provide one of the following
    - Minimum of 3% of skylight area to toplit daylight zone where all skylights have a VT not less than 0.40 OR
    - Provide a minimum skylight effective aperture of not less than 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
- Spaces where total area minus area of daylight zones adjacent to vertical fenestration is < 2,500 ft² and lighting is controlled per C405.2.5 (Exterior Lighting Controls)
Daylight responsive controls complying with C405.2.3.1 should be provided to control all lights with toplit zones.
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 and installed to exclude direct sunlight entering the occupied space by use of fixed or automated baffles, or the geometry of skylight and light well
Table C402.4 requirements by these categories:

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

✓ U-factor and SHGC Based
✓ NFRC 100 Rating or ANSI/DASMA 105 for U-factor or Default Table
✓ NFRC 200 Rating for SHGC and VT or Default Table
Fenestration Product Rating
Section C303.1.3

How Do You Meet the Requirement?

✓ Fenestration product rating in accordance to NFRC 100 (Windows, Doors, Skylights)
✓ Labeled and certified by the manufacturer
✓ Non-NFRC 100 rated fenestration
✓ Default Glazed Fenestration U-factor Table C303.1.3(1)
### Default U-Factors

**Tables C303.1.3(1) and (2)**

#### TABLE C303.1.3(1)

**DEFAULT GLAZED WINDOW, GLASS DOOR AND SKYLIGHT U-FACTORs**

<table>
<thead>
<tr>
<th>FRAME TYPE</th>
<th>WINDOW AND GLASS DOOR</th>
<th>SKYLIGHT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Single</td>
<td>Double</td>
</tr>
<tr>
<td>Metal</td>
<td>1.20</td>
<td>0.80</td>
</tr>
<tr>
<td>Metal with Thermal Break</td>
<td>1.10</td>
<td>0.65</td>
</tr>
<tr>
<td>Nonmetal or Metal Clad</td>
<td>0.95</td>
<td>0.55</td>
</tr>
<tr>
<td>Glazed Block</td>
<td></td>
<td>0.60</td>
</tr>
</tbody>
</table>

#### TABLE C303.1.3(2)

**DEFAULT OPAQUE DOOR U-FACTORs**

<table>
<thead>
<tr>
<th>DOOR TYPE</th>
<th>OPAQUE U-FACTOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uninsulated Metal</td>
<td>1.20</td>
</tr>
<tr>
<td>Insulated Metal (Rolling)</td>
<td>0.90</td>
</tr>
<tr>
<td>Insulated Metal (Other)</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 C303.1.3(3)**

<table>
<thead>
<tr>
<th></th>
<th>SINGLE GLAZED</th>
<th>DOUBLE GLAZED</th>
<th>GLAZED BLOCK</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Clear</td>
<td>Tinted</td>
<td>Clear</td>
</tr>
<tr>
<td><strong>SHGC</strong></td>
<td>0.8</td>
<td>0.7</td>
<td>0.7</td>
</tr>
<tr>
<td><strong>VT</strong></td>
<td>0.6</td>
<td>0.3</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
Skylights installed above daylight zones with daylight responsive controls:

- Climate Zones 1-6, permitted maximum SHGC 0.60
- Climate Zones 1-3, permitted maximum U-factor 0.90
- Climate Zones 4-8, permitted maximum U-factor 0.75
Dynamic Glazing
Section C402.4.3.3

✓ SHGC determined using manufacturer’s ratio of the higher to lower labeled SHGC
✓ SHGC ratio ≥ 2.4
✓ Automatically controlled to modulate amount of solar gain into the space in multiple steps
✓ Considered separately from other fenestration
✓ Area-weighted averaging isn’t allowed

✓ **Exception**: not required to comply where both the lower and higher labeled SHGC already comply with Table C402.3
✓ Allowed to meet requirements in Table C402.4
✓ Can’t combine products from different categories when calculating the area-weighted average U-factor
Opaque swinging doors having < 50% glass area
Comply with Table C402.1.4

Opaque nonswinging doors
✓ Comply with Table C402.1.3

All other doors to comply with vertical fenestration requirements (Section C402.4.3)
Mandatory Requirements

- Air Leakage
- Air barriers
- Fenestration air leakage
- Rooms Containing Fuel-burning Appliances
- Air intakes, exhaust openings, stairways and shafts
- Loading dock weatherseals
- Vestibules
- Recessed lighting
Tested in accordance with ASTM E 779 at pressure differential of 0.3 inch water gauge or an equivalent method approved by code official when tested air leakage rate < 0.40 cfm/ft²
• Continuous air barrier required except in:
  Climate Zone 2B

• Air barrier 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 sealed including sealing transitions in places and changes in materials, securely installed in or on the joint for its entire length to not dislodge, loosen or otherwise impair its ability to resist positive and negative pressure from wind, stack effect and mechanical ventilation
Air Barrier Construction
Section C402.5.1.1

- Penetrations of air barrier and air leakage paths to be caulked, gasketed or otherwise sealed in a manner compatible with construction materials and location (sealing to allow for expansion, contraction and mechanical vibration)
- Joints and seals
  - Sealed in same manner or taped
- Sealing of concealed fire sprinklers where required in a manner recommended by manufacturer
  - Caulking or other adhesive sealants should not be used to fill voids between fire sprinkler cover plates and walls, or ceilings
- Recessed lighting to comply with C402.5.8
- Where similar objects are installed that penetrate the air barrier, make provisions to maintain the air barrier’s integrity
Two ways to comply with air barrier requirements:

- Materials – C402.5.1.2.1 OR
- Assemblies – C402.5.1.2.2
Materials with air permeance ≤ 0.004 cfm/ft² 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>
<tr>
<td>Solid or hollow masonry constructed of clay or shale masonry units</td>
<td></td>
</tr>
</tbody>
</table>
OR

Assemblies of materials and components (sealants, tapes, etc.) with average air leakage $\leq 0.04 \text{ cfm/ft}^2$ under pressure differential of 0.3 in. w.g. tested in accordance with ASTM E 2357, 1677 or 283

The following assemblies are deemed to comply provided that joints are sealed and Section C402.5.1.1 (Air Barrier Construction) is met:

- Concrete masonry walls coated with either one application either of block filler or two applications of a paint or sealer coating OR
- Masonry walls constructed of clay or shale masonry units with a nominal width of $> 4''$ OR
- Portland cement/sand parge, stucco or plaster $> \frac{1}{2}''$ thick
### Air Leakage of Fenestration

**Section C402.5.2**

<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 E 283 at 1.57 psf</td>
</tr>
<tr>
<td>Commercial glazed swinging entrance doors</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>Power-operated sliding doors and power operated folding 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 E 283 at 1.57 psf</td>
</tr>
<tr>
<td>Rolling doors</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>High-speed doors</td>
<td>1.30</td>
<td></td>
</tr>
</tbody>
</table>

**Exceptions:**

- Field-fabricated fenestration assemblies
- Fenestration in buildings that meet the building test for air barrier compliance option
• Appliances and combustion air openings to be located outside the building thermal envelope or enclosed in a room isolated from inside the thermal envelope in Climate Zones 3-8, one of the following to comply:
  – Rooms to be sealed and insulated per envelope requirements
  – Doors into the rooms fully gasketed
  – Water lines and ducts insulated
  – Combustion air ducts that pass through conditioned space, insulated to > R-8
Exceptions:

• Fireplaces and stoves complying with 901-905 IMC and Section 2111.14 IBC
Doors and access openings from conditioned space to shafts, chutes, stairways, and elevator lobbies not within the scope of the fenestration assemblies in Section C402.5.2 to be gasketed, weatherstripped, or sealed

Exceptions:
- Door openings required to comply with 716 IBC
- Doors or door openings required to comply with UL 1784 IBC
Air Intakes, Exhaust Openings, Stairways, and Shafts
Section C402.5.5

Openings integral to the building envelope to have dampers per Section C403.7.7 (Shutoff Dampers)
✓ Equip cargo door openings and loading door openings with weatherseals

✓ Goal is to restrict infiltration and provide direct contact with vehicles along top and sides
Vestibules
Section C402.5.7

✔ 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 that have an air curtain with velocity > 6.56 ft/second at the floor tested in accordance with ANSI/AMCA 220 installed in accordance with manufacturer’s instructions. Manual or automatic controls provided that will operate the air curtain with opening and closing. Air curtain and their controls to comply with Section C408.2.3.
All recessed luminaires installed in the building thermal envelope Type IC rated to have all of the following:

- Sealed with gasket or caulk between housing and interior wall or ceiling covering AND
- Labeled in accordance with ASTM E 283 to allow ≤ 2.0 cfm of air movement between conditioned and unconditioned spaces
Existing Buildings Chapter 5  
Section C501 - General

- Additions, alterations, or repairs
- Existing buildings
- Maintenance
- Compliance
- New and replacement materials
- Buildings designated as historic
Any nonconditioned space that is altered to become conditioned space shall be required to be brought into full compliance with this code

**Examples:**

- Converting part of an unconditioned warehouse to office space
- Shell building tenant build-out
Vertical fenestration: new fenestration that results in a total building fenestration area $\leq 30\%$ must comply with C402.4.1.5, C402.4.3 or C407

- If $> 30\%$ for total building or addition alone, must comply with C402.4.1.1 Increased Vertical Fenestration Area with Daylight Responsive Controls for the addition only
- Additions that result in total building vertical fenestration $>40\%$ must comply with C402.1.5 Component Performance Alternative or C407 Total Building Performance

Skylight Area: new skylight area that is $\leq 3\%$ complies with C402.4.1

- If $> 3\%$ for total building or addition alone, must comply with C402.4.1.2 Increased Skylight Area with Daylight Responsive Controls for addition only
- Additions that result in total building skylight area $>6\%$ must comply with C402.1.5 Component Performance Alternative or C407 Total Building Performance
• Mechanical Systems comply with C403
• SWH – C404
• Pools and inground permanently installed spas – C404.10
• Lighting power and systems – C405
  – Interior comply with addition alone or addition plus existing building
  – Exterior comply with addition alone or addition plus existing building
Code applies to any new construction

Unaltered portion(s) do not need to comply

Alterations complying with ASHRAE 90.1-2016 do not need to comply with C402-C405

Vertical Fenestration and Skylight Area similar to requirements for additions

Envelope – where existing building exceeds fenestration area limitations of Section C402.4.1 prior to alteration, building is exempt from C402.4.1 provided there is no increase in fenestration area
Exceptions:

- Storm windows over existing fenestration
- Surface-applied window film installed on existing single pane
- Exposed, existing ceiling, wall or floor cavities if already filled with insulation
- Where existing roof, wall or floor cavity isn’t exposed
- Roof recover
- Reroofing for roofs where neither sheathing nor insulation exposed
  - Insulate above or below the sheathing
    - Roofs without insulation in the cavity
    - Sheathing or insulation is exposed
Change in Space Conditioning
Section C503.2

Any non-conditioned or low energy space that is altered to become conditioned space shall be required to be brought into full compliance with this code.

Exceptions:
  • Where component performance alternative in Section C402.1.5 is used, proposed UA to be not greater than 110% of the target UA.
  • Where total building performance option in Section C407 is used to comply, annual energy cost of proposed design to be not greater than 110% of annual energy cost otherwise permitted by Section C407.3.
• Heating and Cooling
  – New HVAC systems and duct systems that are part of the alteration to comply with Section C403
    • Economizers – new cooling systems that are part of the alteration to comply with Section C403.5

• Service hot water systems
  – New SWH systems that are part of the alteration to comply with C404

• Lighting Systems
  – New Lighting systems that are part of the alteration to comply with C404
    • Exception – alteration that replace <10% of the luminaires in a space provided such alteration does not increase the installed interior lighting power
• Work on nondamaged components necessary for the required repair or damaged components shall be considered to be part of the report and subject to the alterations requirements

• Repairs considered part of the code
  – Glass-only replacements in an existing sash and frame
  – Roof repairs
  – Replacement of existing doors that separate conditioned space from the exterior do not require the installation of a vestibule or revolving door, provided that an existing vestibule that separate a conditioned space from the exterior shall not be removed
  – Repairs where only the bulb and/or ballast within the existing luminaires in a space are replaced provided the replacement does not increase the installed interior lighting power
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 in Tables C405.3.2(1) or C405.3.2(2), the installed lighting wattage shall comply with Section 405.

Where in a building with a fenestration area exceeding C402.4.1, space is exempt from C402.4.1 provided there is no increase in fenestration area.
Exceptions

- Where Section 402.1.5 is used for compliance, proposed UA not to be > 10% of target UA
- Where Section C407 is used for compliance, annual energy cost of proposed design not to be > 110% of that permitted by Section C407.3