

## **Study Session**

# **3**

### **2012 IECC Sections C401 and C402 (partial) Commercial Energy Efficiency—Part I**

**OBJECTIVE:** To obtain an understanding of the specific insulation requirements (prescriptive) for the building thermal envelope of commercial buildings.

**REFERENCE:** Sections C401 and C402 (partial), 2012 *International Energy Conservation Code*

- KEY POINTS:**
- Which compliance options are available for demonstrating compliance with the IECC for commercial buildings? When should one be utilized instead of the other for the building envelope?
  - Which parts of the building envelope are covered under Chapter 4 [CE]?
  - What two parameters must be determined before the thermal requirements for the building envelope can be selected?
  - What are the different wall types addressed in Chapter 4 [CE]?
  - Where can roof insulation be installed to meet the envelope requirements? What are the requirements for metal roof systems?
  - How does the IECC apply to metal wall systems?
  - Which options are available for insulated framed wall systems? Which options are available for insulated concrete or concrete masonry unit wall systems?
  - Which options are available when the design includes more than 3 percent of the roof area in skylights?
  - How should slab edge insulation be installed to meet the code requirements? Below grade walls?

**Topic:** Application

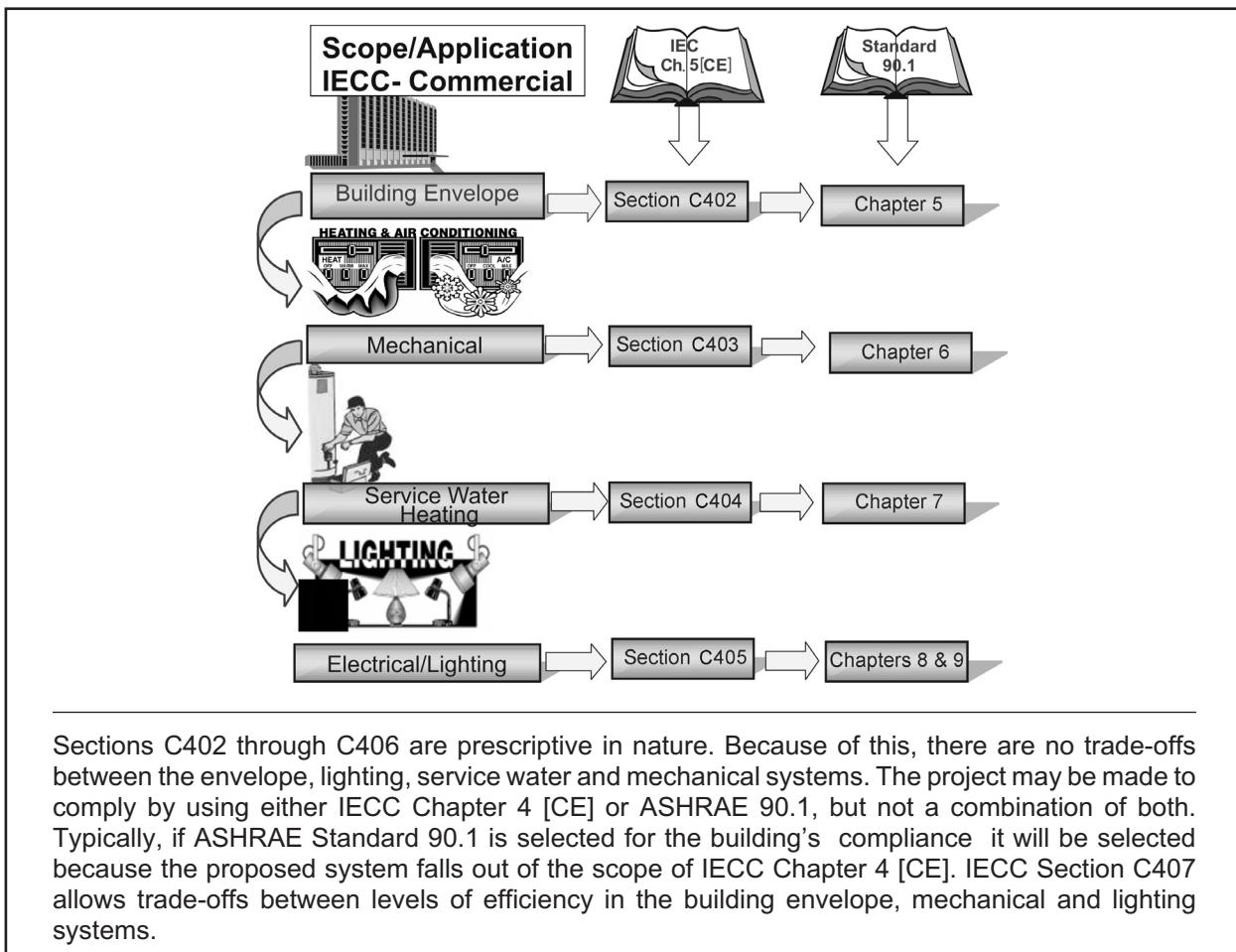
**Category:** Commercial Energy Efficiency

**Reference:** IECC C401.2

**Subject:** General

**Code Text:** *The commercial building project shall comply with 1) the requirements in ANSI/ASHRAE/IESNA 90.1; or 2) the requirements of Sections C402 (Building Envelope Requirements), C403 (Building Mechanical Systems), C404 (Service Water Heating) and C405 (Electrical Power and Lighting Systems). In addition, commercial buildings shall comply with either Section C406.2 (Efficient HVAC Performance), C406.3 (Efficient Lighting System) or C406.4 (On-Site Renewable Energy); or 3) the requirements of Section C407 (Total Building Performance), C402.4 (Air Leakage), C403.2 (Provisions Applicable to All Mechanical Systems), C404 (Service Water Heating), C405.2 (Lighting Controls), C405.3 (Tandem Wiring), C405.4 (Exit Signs), C405.6 (Exterior Lighting) and C405.7 (Electrical Energy Consumption). The building energy cost shall be equal to or less than 85 percent of the standard reference design building.*

**Discussion and Commentary:** Compliance for a commercial building shall be demonstrated by using Chapter 4 [CE] to individually evaluate the building envelope, mechanical, service water heating and lighting systems. As an alternative to Chapter 4 [CE] of the IECC, ASHRAE/IESNA Standard 90.1 can be used to demonstrate compliance with the IECC. ASHRAE/IESNA 90.1 is also to be used when the building system is not covered under Chapter 4 [CE].



**Topic:** General

**Reference:** IECC C402.1.1

**Category:** Commercial Energy Efficiency

**Subject:** Building Envelope Compliance

**Code Text:** *The building thermal envelope shall meet the requirements of Tables C402.2 and C402.3 based on the climate zone specified in Chapter 3. Buildings with a vertical fenestration area or skylight area that exceeds that allowed in Table C402.3 shall comply with the building envelope provisions of ASHRAE/IESNA 90.1.*

**Discussion and Commentary:** The opaque envelope provisions contain specific requirements addressing two types of buildings: (1) those Group R buildings defined as commercial buildings by Chapter 2, and (2) all other commercial buildings. Typically, the insulation requirements for Group R occupancies defined as *commercial* are more stringent than for other commercial buildings so as to be more consistent with the insulation requirements for Group R buildings defined as *residential*. Typically, if the building is going to be semiconditioned, the designer will choose to use ASHRAE Standard 90.1, which has specific provisions to address semiconditioned buildings.

TABLE C402.2  
OPAQUE THERMAL ENVELOPE REQUIREMENTS<sup>a</sup>

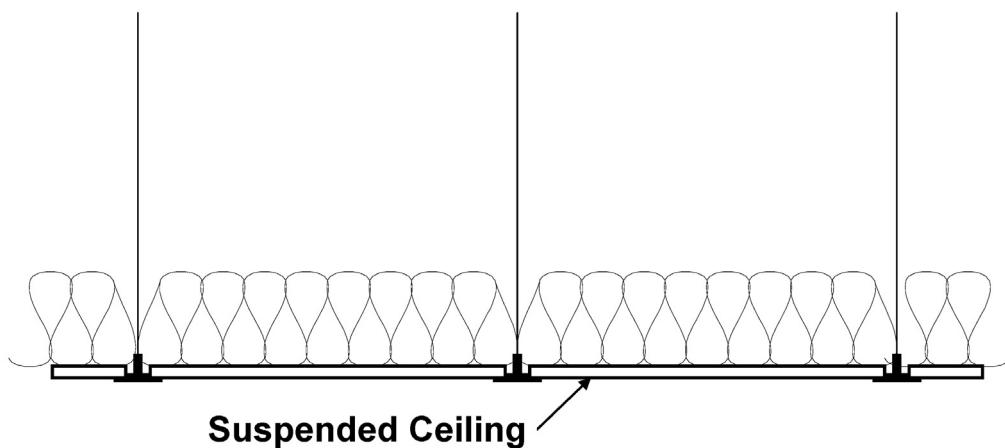
CLIMATE ZONE	1		2		3		4 EXCEPT MARINE		5 AND MARINE 4		6		7		8	
	All Other	Group R	All Other	Group R	All Other	Group R	All Other	Group R								
Roofs																
Insulation entirely above deck	R-20ci	R-20ci	R-20ci	R-20ci	R-20ci	R-20ci	R-25ci	R-25ci	R-25ci	R-25ci	R-30ci	R-30ci	R-35ci	R-35ci	R-35ci	R-35ci
Metal buildings (with R-5 thermal blocks) <sup>b</sup>	R-19 + R-11 LS	R-25 + R-11 LS	R-25 + R-11 LS	R-30 + R-11 LS												
Attic and other	R-38	R-49	R-49	R-49	R-49	R-49	R-49	R-49								
Walls, Above Grade																
Mass	R-5.7ci	R-5.7ci	R-5.7ci	R-7.6ci	R-7.6ci	R-9.5ci	R-9.5ci	R-11.4ci	R-11.4ci	R-13.3ci	R-13.3ci	R-15.2ci	R-15.2ci	R-25ci	R-25ci	
Metal building	R-13+ R-6.5ci	R-13+ R-6.5ci	R-13+ R-13ci	R-13+ R-6.5ci	R-13+ R-13ci	R-13+ R-13ci	R-13+ R-13ci	R-13+ R-19.5ci	R-13+ R-13ci	R-13+ R-19.5ci						
Metal framed	R-13 + R-5ci	R-13 + R-5ci	R-13 + R-7.5ci	R-13 + R-7.5ci	R-13 + R-7.5ci	R-13 + R-7.5ci	R-13 + R-7.5ci	R-13 + R-17.5ci								
Wood framed and other	R-13 + R-3.8ci or R-20	R-13 + R-7.5ci or R-20 + R-3.8ci	R-13 + R-15.6ci or R-20 + R-10ci	R-13 + R-15.6ci or R-20 + R-10ci												
Walls, Below Grade																
Below-grade wall <sup>d</sup>	NR	NR	NR	NR	NR	NR	R-7.5ci	R-7.5ci	R-7.5ci	R-7.5ci	R-7.5ci	R-7.5ci	R-7.5ci	R-10ci	R-10ci	R-12.5ci
Floors																
Mass	NR	NR	R-6.3ci	R-8.3ci	R-10ci	R-10ci	R-10ci	R-10.4ci	R-10ci	R-12.5ci	R-12.5ci	R-12.5ci	R-15ci	R-16.7ci	R-15ci	R-16.7ci
Joist/framing	NR	NR	R-30	R-30	R-30	R-30	R-30 <sup>e</sup>	R-30 <sup>e</sup>	R-30 <sup>e</sup>							
Slab-on-Grade Floors																

(continued)

Typically, insulation requirements for metal-framed walls are more stringent than for wood-framed wall systems because of the increased heat transfer in metal. For example, in Climate Zone 3, metal wall systems must be provided with continuous insulation in addition to the required insulation installed between the framing members. A wood-framed wall in the same Climate Zone is only required to have insulation installed between the framing members.

**Code Text:** *The minimum thermal resistance (R-value) of the insulating material installed either between the roof framing or continuously on the roof assembly shall be as specified in Table C402.2, based on construction materials used in the roof assembly. Skylight curbs shall be insulated to the level of roofs with insulation entirely above deck or R-5, whichever is less. See exceptions for 1) continuously insulated roof assemblies where the insulation thickness varies by no more than 1 inch and the area-weighted U-factor is equivalent to the same assembly, with the R-value specified in Table C402.2, and 2) unit skylight curbs included as a component of an NFRC 100 rated assembly. Insulation installed on a suspended ceiling with removable ceiling tiles shall not be considered part of the minimum thermal resistance of the roof insulation.*

**Discussion and Commentary:** The insulation requirements for a roof/ceiling assembly will vary depending on how the roof is constructed and where the insulation is placed. Three different roof assemblies are addressed in Table C402.2. Based on the roof type, insulation is required to be placed between framing or be continuous. For example, in most Climate Zones a vented attic space will be required to have a minimum R-38 insulation installed between framing. A skylight curb is not required to be insulated where the total glazed assembly, including the curb, has already been rated per NFRC 100 and assigned a U-factor.



Insulation installed on top of a suspended ceiling system cannot contribute toward the ceiling insulation requirement. Insulation must be installed at the same location as the air barrier. A suspended ceiling cannot be considered an air barrier, unless each ceiling tile is individually sealed.

**Code Text:** *Low-slope roofs, with a slope less than 2 units vertical in 12 horizontal, directly above cooled conditioned spaces in Climate Zones 1, 2 and 3 shall comply with one or more of the options in Table C402.2.1.1 (Minimum Roof Reflectance And Emittance Options). See exceptions for roofs and portions of roofs that are covered by photovoltaic systems, solar air or water heating systems, roof gardens, landscaped roofs, above-roof decks, walkways, skylights, HVAC, ballasted roofs, and other opaque objects; as well as roofs that are adequately shaded or ballasted.*

**Discussion and Commentary:** The provisions in Section C402.2.1.1 only apply to roofs in Climate Zones 1, 2 and 3 with slopes less than 2 in 12. These structures are to comply with at least one of the four options noted in the table related to solar reflectance, or the accompanying footnotes, unless they are specifically exempted. Those exemptions address photovoltaic systems, roof gardens, deck, walkways, HVAC and ballasted roofs.

**TABLE C402.2.1.1  
MINIMUM ROOF REFLECTANCE AND EMITTANCE OPTIONS<sup>a</sup>**

Three-year aged solar reflectance <sup>b</sup> of 0.55 and three-year aged thermal emittance <sup>c</sup> of 0.75
Initial solar reflectance <sup>b</sup> of 0.70 and initial thermal emittance <sup>c</sup> of 0.75
Three-year-aged solar reflectance index <sup>d</sup> of 64
Initial solar reflectance index <sup>d</sup> of 82

- a. The use of area-weighted averages to meet these requirements shall be permitted. Materials lacking initial tested values for either solar reflectance or thermal emittance, shall be assigned both an initial solar reflectance of 0.10 and an initial thermal emittance of 0.90. Materials lacking three-year aged tested values for either solar reflectance or thermal emittance shall be assigned both a three-year aged solar reflectance of 0.10 and a three-year aged thermal emittance of 0.90.
- b. Solar reflectance tested in accordance with ASTM C 1549, ASTM E 903 or ASTM E 1918.
- c. Thermal emittance tested in accordance with ASTM C 1371 or ASTM E 408.
- d. Solar reflectance index (SRI) shall be determined in accordance with ASTM E 1980 using a convection coefficient of  $2.1 \text{ Btu/h} \times \text{ft}^2 \times {}^\circ\text{F}$  ( $12\text{W/m}^2 \times \text{K}$ ). Calculation of aged SRI shall be based on aged tested values of solar reflectance and thermal emittance. Calculation of initial SRI shall be based on initial tested values of solar reflectance and thermal emittance.

Roof Reflectance, also known as Solar Reflectance and as Albedo, is a measure of the ability of a surface material to reflect sunlight. Solar Reflectance Index (SRI) is a single value that incorporates both solar reflectance and infrared emittance to represent a material's temperature in the sun. This value affects energy savings and the overall heat island contribution of the building.