

# Compliance Guide



## 2012 International Energy Conservation Code for Simple Commercial Buildings

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The Institute for Market Transformation (IMT), founded in 1996, is a Washington, DC-based nonprofit organization promoting energy efficiency, green building, and environmental protection in the United States and abroad. IMT's work addresses market failures that inhibit investment in energy efficiency and sustainability in the building sector. For more information, visit [imt.org](http://imt.org).

Britt/Makela Group (BMG) has participated in the model code development process since 2001 and is recognized and respected for its objective efforts with code reform, interpretation, and education. This guide has been developed based on its experience providing technical support to designers and enforcers of the IECC, and its work in code development.

The National Fenestration Rating Council (NFRC) is a nonprofit organization that administers the only uniform, independent rating and labeling system for the energy performance of windows, doors, skylights, and attachment products.

IMT, NFRC, and BMG wish to thank the International Code Council (ICC) for permission to print portions of the International Energy Conservation Code (IECC). We recognize our responsibility to educate and inform and welcome feedback and comments.

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# Simple Buildings:

## A Compliance Guide to Energy Code Compliance for Simple Commercial Buildings



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This compliance guide was developed to help those with Simple Buildings comply with the 2012 International Energy Conservation Code (IECC). Though the goal of the guide is to make the energy code more accessible for anyone who is interested, the target audience is designers, engineers, and building officials.

### What is a simple system?

The term "Simple" is not an indicator of building size, but of building components. The four components to evaluate are; the building envelope, mechanical systems, service hot water heating, and electrical power and lighting systems. A Simple Building can range from a 3,000 square feet (sq ft) dentist office to a strip mall, or a 100,000 sq ft warehouse. The sidebar on the right of this page lists the criteria for Simple Buildings and the systems to which this guide applies. If your building does not meet these criteria,

you will need to refer directly to the complete text of the 2012 IECC for guidance.

The guide is intended to give helpful information on the code provisions applicable to your building and is organized by components:

- ✓ Building Envelope
- ✓ Mechanical Systems
- ✓ Service Hot Water Heating
- ✓ Electrical Power and Lighting Systems

### How to use the Guide:

Follow the steps outlined in the blue margins for each component or read the complete text and refer to the illustrations for more information. Code citations are provided for easy reference to the complete code.

## SIMPLE BUILDING QUALIFIERS

### BUILDING ENVELOPE

- ✓ No more than two wall types in the building.
- ✓ Only one roof type
- ✓ Only one floor type
- ✓ Glass levels below 40 percent window-to-wall ratio.

### MECHANICAL

- ✓ Single zone unitary systems
- ✓ 5 horsepower or less
- ✓ Low or medium pressure duct systems.
- ✓ No snow melt systems

### SERVICE HOT WATER SYSTEMS

- ✓ Standard water heater
- ✓ Recirculation

### LIGHTING

- ✓ All types and systems

## Simple Buildings: 2012 IECC, Quick Reference Table

Primary Component	Secondary Component	Steps to Ensure Compliance	2012 IECC
	1. Determine Applicable Requirements	<b>Step BE1a.</b> Determine which parts of the building are "Group R" or "Other" <b>Step BE1b.</b> Refer to Table C402.2 for minimum R-Values and U-factors for each component of the building envelope.	C402.1.1
	2. Roof Insulation	<b>Step BE2a.</b> Ensure insulation is the proper R-Value for the roof type, per Table C402.2. <b>Step BE2b.</b> Verify that the building specifications meet the requirements for roof solar reflectance and thermal emittance.	C402.2.1
	3. Wall Insulation	<b>Step BE3a.</b> Determine wall type according to code definitions <b>Step BE3b.</b> Determine cavity or continuous insulation requirements, per Table C402.2, for the appropriate assembly type.	C402.2.2
	4. Floor Insulation	<b>Step BE4a.</b> Determine floor type according to code definition <b>Step BE4b.</b> Determine insulation requirements for floors over unconditioned spaces per Table C402.2. <b>Step BE4c.</b> Determine insulation requirements for slabs on grade per Table C402.2.	C402.2.5, C402.2.6
	5. Opaque Doors	<b>Step BE5.</b> Ensure the opaque doors meet the U-factor requirements of Table C402.2.	C402.2.7
Building Envelope	6. Fenestration	<b>Step BE6a.</b> Select fenestration rated in accordance with NFRC 100 and 200 <b>Step BE6b.</b> Verify glazing is no more than 30 percent of gross above-grade wall area and skylights are no more than 3 percent of gross roof area. <b>Step BE6c.</b> If fenestration exceeds 30 percent of gross above-grade wall area or skylights exceed 5 percent of gross roof area, ensure that appropriate daylighting controls are installed (only applicable in Climate Zones 1-6. Climate Zones 7 and 8 are limited to 30 percent). <b>Step BE6d.</b> Verify that the required spaces over 10,000 sq ft contain the minimum skylight area. <b>Step BE6e.</b> Verify all daylight zones under skylights required by section C402.3.2 are controlled by multilevel lighting controls <b>Step BE6f.</b> Verify that skylights over specified spaces have a haze factor greater than 90 percent when tested in accordance with ASTM D 1003. <b>Step BE6g.</b> Verify that glazed fenestration U-factor and SHGC values comply with Table C402.3. <b>Step BE6h.</b> If SHGC values are higher than allowed in Table C402.3, verify that the projection factor allows for an increase in the SHGC. <b>Step BE6i.</b> If skylight U-factor or SHGC do not comply with Table C402.3, verify that automated daylighting controls are specified and installed. <b>Step BE6j.</b> Where dynamic glazing is installed, verify that it complies with the SHGC requirements.	C402.3

## Simple Buildings: 2012 IECC, Quick Reference Table

Primary Component	Secondary Component	Steps to Ensure Compliance	2012 IECC
	7. Air Leakage	<p><b>Step BE7a.</b> Verify that a continuous air barrier is appropriately specified and constructed.</p> <p><b>Step BE7b.</b> Verify that one of the three air barrier compliance options has been specified.</p> <p><b>Step BE7c.</b> Verify that fenestration meets the appropriate air leakage requirements or qualifies for one of the two exceptions.</p> <p><b>Step BE7d.</b> Verify access openings meet air leakage requirements</p> <p><b>Step BE7e.</b> Verify air intakes and exhaust openings have appropriate dampers</p> <p><b>Step BE7f.</b> Verify weather seals on all cargo doors and loading dock doors</p> <p><b>Step BE7g.</b> Verify a vestibule is designed and properly constructed for entrance doors into spaces greater than 3,000 ft<sup>2</sup>, unless otherwise exempt</p> <p><b>Step BE7h.</b> Specify and install IC rated recessed lights and ensure they are sealed</p> <ul style="list-style-type: none"> <li>• Between housing and interior wall or ceiling covering</li> <li>• Between conditioned and unconditioned spaces (as applicable)</li> </ul>	C402.4
<b>Mechanical</b>	1. Calculating Heating and Cooling Loads	<b>Step M1.</b> Calculate heating and cooling loads in accordance with ASHRAE 183	C403.2.1
	2. HVAC Equipment Efficiencies	<b>Step M2.</b> Ensure efficiencies comply with the IECC Table C403.2.3 (1)-(4)	C403.2.3
	3. HVAC Controls	<p><b>Step M3a.</b> Ensure temperature controls are specified and installed with all required features.</p> <p><b>Step M3b.</b> Ensure heat pumps have controls to prevent supplementary operation when the heat pump can handle the load.</p> <p><b>Step M3c.</b> Ensure gravity dampers automatically shut when system is not in use.</p>	C403.2.4
	4. Demand Control Ventilation	<b>Step M4.</b> Ensure demand control ventilation is specified and installed for any spaces larger than 500 sq ft if occupancy loads are greater than or equal to 25 persons per 1,000 sq ft.	C403.2.5.1
	5. Energy Recovery Ventilation	<b>Step M5.</b> Ensure energy recovery ventilation systems are installed	C403.2.6
	6. Duct and Plenum Insulation and Sealing	<b>Step M6.</b> Specify and install duct and plenum insulation and sealing	C403.2.7
	7. Piping Insulation	<b>Step M7.</b> Specify and install piping insulation	C403.2.8
	8. Economizers	<b>Step M8.</b> Ensure economizers are specified and installed on single and aggregate (when serving a single space) systems greater than 33,000 Btu/h unless an exception applies.	C403.3.1
	9. Mechanical systems commissioning and completion requirements	<b>Step M9.</b> Verify that all system commissioning requirements have been properly specified on construction plans and completed after construction.	C408

## Simple Buildings: 2012 IECC, Quick Reference Table

Primary Component	Secondary Component	Steps to Ensure Compliance	2012 IECC
Service Hot Water Systems	1. Equipment Efficiencies	<b>Step SW1.</b> Ensure the system complies with the efficiencies in accordance with Section C404.2 and Table C404.2. in the IECC.	C404.2
	2. Controls	<b>Step SW2.</b> Ensure equipment includes: <ul style="list-style-type: none"> <li>✓ Automatic and manual off switch for recirculation pumps</li> <li>✓ Temperatures that are set to 110°F in public restrooms and dwelling units, 90°F for other occupancies.</li> </ul>	C404.3, C404.6
	3. Heat Traps	<b>Step SW3.</b> Ensure heat traps are installed on systems without circulation loops	C404.4
	4. Piping Insulation	<b>Step SW4.</b> Ensure appropriate insulation is specified and installed on circulating and non-circulating pipe.	C404.5
Electrical Power and Lighting Systems	1. Maximum Interior Lighting Power	<b>Step L1a.</b> Calculate maximum interior lighting power allowance <b>Step L1b.</b> Calculate actual installed interior lighting power loads based on allowances and exemptions. <b>Step L1c.</b> Ensure wattages used for calculations are consistent with Section C405.5.2.	C405.5.2
	2. Interior Lighting Controls	<b>Step L2a.</b> Ensure manual controls are specified and installed in appropriate spaces <b>Step L2b.</b> Ensure appropriate spaces have light reduction controls <b>Step L2c.</b> Ensure automatic time switch control devices are specified and installed <b>Step L2d.</b> Ensure occupancy sensors are specified and installed <b>Step L2e.</b> Ensure manual or automatic controls are specified and installed in all daylight zones. <b>Step L2f.</b> Ensure multi-level lighting controls are specified and installed for daylight zones under skylights per C402.3.1.2 and C402.3.2. <b>Step L2g.</b> Ensure appropriate, dedicated controls are specified and installed for display, accent, and supplemental task lighting. <b>Step L2h.</b> Ensure exit signs don't exceed 5 watts/side	C405.2
	3. Exterior Lighting Power	<b>Step L3a.</b> Determine tradable and non-tradable lighting areas <b>Step L3b.</b> Determine in which zone the building is located <b>Step L3c.</b> Calculate exterior lighting allowance	C405.6.2
	4. Exterior Lighting Controls	<b>Step L4.</b> Ensure appropriate exterior lighting controls are specified and installed	C405.2.4
Additional Efficiency Package Options	1. Efficient HVAC Performance	<b>Step EO1.</b> Ensure the HVAC system meets the efficiency requirements in Tables C406.2(1)–(4) if the HVAC performance option is selected.	C406.2
	2. Efficient Lighting System	<b>Step EO2.</b> If the efficient lighting system option is selected, the lighting calculations should be done as described in Steps L1a-L1c in the Electrical Power and Lighting Systems Section of this Guide with a maximum interior lighting allowance as determined in Table C406.3.	C406.3
	3. On-Site Supply of Renewable Energy	<b>Step EO3.</b> Ensure renewable energy system rating is greater than or equal to those specified in section C406.4.	C406.4

# Building Envelope



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"Group R" Buildings: Apartments and condos more than three stories in height.



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"All Other" commercial construction

## 1. Determine Applicable Requirements,

### C402.1.1

#### a. Group "R" or "All other"

The code requirements for insulation and fenestration are based on occupancy type, "Group R," or "All other," and measured in "R-Value."

- ✓ "Group R" includes R-2, R-3, and R-4 buildings.
- ✓ "All Other" is for any other type of commercial building, regardless of height.

#### b. Insulation Requirements

For each component of the building envelope—roofs, walls, floors, slab on grade, and opaque doors—a minimum insulation R-Value and U-factor (for doors) is listed in Table C402.2. The IECC specifies what can and cannot be counted as the R-Value for both "Group R" and "All Other," (Note: R-Values are for insulation only).

Table C402.2 shows minimum R-Value requirements for each of these assemblies.

#### Step BE1a.

Determine whether the building is "Group R" or "Other."

#### Step BE1b.

Refer to Table C402.2 for minimum R-Values and U-Factors (for doors) for each component of the building envelope.

#### Climate Zones

The 2012 IECC identifies eight climate zones nationwide. Building energy use is related to the environment, and the code recognizes the differences. Be mindful of which climate zone the building is in. Many requirements are contingent on the climate zone.

For more information, visit the energycodes.gov website.

#### Simple Building criteria for the building envelope:

- ✓ No more than two wall types in the building.
- ✓ Only one roof type
- ✓ Only one floor type
- ✓ Glass levels below 40 percent window-to-wall ratio.



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**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	All other	Group R						
<b>Roofs</b>																
Insulation entirely above	R-20ci	R-20ci	R-20ci	R-20ci	R-20ci	R-20ci	R-25ci	R-25ci	R-25ci	R-30ci	R-30ci	R-35ci	R-35ci	R-35ci	R-35ci	R-35ci
Metal buildings (with R-5 thermal blocks) <sup>a,b</sup>	R-19 + R-11 LS	R-25 + R-11 LS	R-30 + R-11 LS	R-30 + 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	R-49							
<b>Walls, Above Grade</b>																
Mass <sup>c</sup>	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	R-25ci
Metal building <sup>d</sup>	R-13+ R-6.5ci	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-13ci	R-13+ R-13ci	R-13+ R-13ci	R-13+ R-13ci	R-13+ R-19.5ci	R-13+ R-13ci	R-13+ R-	R-13+ R-
Metal framed	R-13+ R-5ci	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-15.6ci	R-13 + R-7.5ci	R-13 + R-	R-13 + R-					
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-7.5ci or R-20 + R-10ci	R-13 + R-15.6ci or R-20 + R-	R-13 + R-15.6ci or R-20 + R-										
<b>Walls, Below Grade</b>																
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-10ci	R-10ci	R-10ci	R-12.5ci
<b>Floors</b>																
Mass	NR	NR	R-6.3ci	R-8.3ci	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 <sup>e</sup>	R-30 <sup>e</sup>	R-30 <sup>e</sup>	R-30 <sup>e</sup>	R-30 <sup>e</sup>						
<b>Slab-on-Grade Floors</b>																
Unheated slabs	NR	NR	NR	NR	NR	NR	R-10 for 24" below	R-10 for 24" below	R-10 for 24" below	R-10 for 24" below	R-10 for 24" below	R-15 for 24" below	R-15 for 24" below	R-15 for 24" below	R-15 for 24" below	R-20 for 24" below
Heated slabs <sup>d</sup>	R-7.5 for 12" below	R-10 for 24" below	R-10 for 24" below	R-15 for 24" below	R-15 for 24" below	R-15 for 36" below	R-15 for 36" below	R-20 for 48" below	R-20 for 48" below	R-20 for 48" below						
<b>Opaque doors</b>																
Swinging	U-0.61	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37							
Roll-up or	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. ci = Continuous insulation. NR = No requirement. LS= Liner System-A continuous membrane installed below the purlins and uninterrupted by framing members. Uncompressed, unfaced 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 spacer block shall be provided, otherwise use the U-factor compliance method in Table C402.1.2.

c. R-5.7 ci 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 material having a maximum thermal conductivity of 0.44 Btu-in/hr · ft<sup>2</sup> · °F.

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

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

**R-Value (Thermal Resistance):** The inverse of the time rate of heat flow through a body from one of its bounding surfaces to the other surface for a unit temperature difference between the two surfaces, under steady state conditions.

**F-Factor:** The perimeter heat loss factor for slab-on-grade floors.

**U-Factor (Thermal Transmittance):** The coefficient of heat transmission (air to air) through a building component or assembly, equal to time rate of heat flow per unit area and unit temperature difference between the warm side and cold side air films. This is used for above grade assemblies and fenestration.

**Note:** As a reminder, the U-Factor and the R-Value are similar equations and use the

same data. The main distinction is that R-Value shows how much heat the assembly type is retaining and is generally used in reference to insulation. U-Factor shows how much heat the assembly type is letting out and is generally used in the context of fenestration. In other words, an assembly that has a high R-Value will have a low U-Factor. It's the difference between dividing 1 by 4 or 4 by 1.

## 2a. Roof Assembly C402.2.1

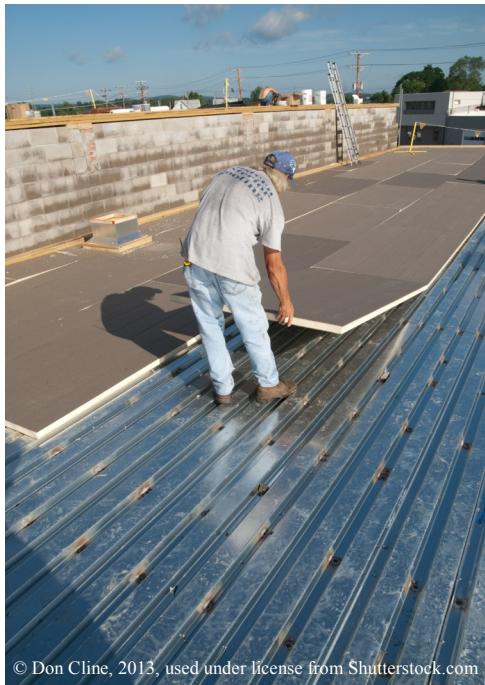
The IECC covers three different roof insulation options:

- ✓ Insulation installed entirely above the roof deck.
- ✓ Insulation installed in metal building roofs
- ✓ Insulation installed in attic assemblies, which can include insulation installed directly below the roof deck.

Additionally, the IECC calls for roof solar reflectance and thermal emittance requirements for climate zones 1-3, as discussed in sub-section "b."

### Insulation Installed Entirely Above the Roof Deck

To comply with the R-Value requirement for installing insulation directly above the roof deck, the continuous insulation must meet the minimum R-Value requirements in Table C402.2. The IECC recognizes that there will be penetrations in the insulation for mechanical equipment, skylights, etc., but as long as the remainder of the roof deck is covered by the correct R-Value of insulation, the roof complies with the code.



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### Insulation Installed in Attic Assemblies or Other Assemblies

A common practice is to install insulation between roof framing systems directly under the roof deck.

Insulation can also be installed on the floor of the attic assembly using either batts or blown insulation. It must meet the minimum R-value requirement in the IECC.



### Step BE2a.

Ensure insulation is the proper R-Value for the roof type, per Table C402.2.

### Exceptions

For roofs that fall under the category "continuously insulated," if the thickness varies 1 inch or less (to provide for drainage, for instance) and the area-weighted U-Factor is equivalent to the same assembly with the R-Value specified, then you can use the U-Factor alternative table.

In other words, if you can continuously insulate your roof with an assembly that utilizes U-Factors, and if the U-Factor is equivalent to the stipulated R-Value, the project complies.

### What Cannot be Counted as R-Value?

If you have a suspended ceiling with removable tiles, the insulation there cannot be counted toward the overall roof insulation. The insulation must be in contact with an air barrier that prevents air from passing through the insulation, such as would occur if installing the insulation directly under the roof deck or on top of a drywall ceiling. Ceilings with removable tile will not prevent air movement and are not considered air barriers.

**Step BE2b.** Verify that the building specifications meet the requirements for roof solar reflectance and thermal emittance.

**Step BE3a.**

Determine wall type according to code definitions.



### Insulation Installed in Metal Roof Buildings

Insulation for metal building roofs must comply with Table C402.2. All metal building roofs are required to have the appropriate level of cavity insulation plus an R-11 liner system. A footnote to

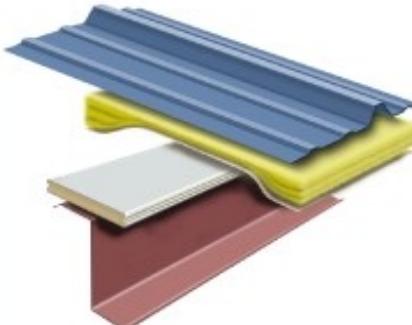


Photo Credit: Metal Building Outlet Corp.

Table C402.2 describes a liner system as a continuous membrane installed below the purlins and uninterrupted by framing members. Uncompressed, unfaced insulation rests on top of the membrane between the purlins. One critical aspect of compliance is installing a thermal block between the purlin and the metal roof deck to limit heat transfer. The IECC requires that this thermal block be at least R-5.

#### b. Roof Solar reflectance and thermal emittance.

Section C402.2.1.1 requires that low-sloped roofs, with slope less than two units vertical in 12 horizontal, directly above cooled conditioned spaces in Climate Zones 1–3 comply with one or more options in Table C402.2.1.1.

TABLE C402.2.1.1

#### MINIMUM ROOF REFLECTANCE AND EMMITTANCE

##### OPTIONS

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 three-year aged thermal emittance of 0.90.

b. Solar reflectance tested in accordance with ASTM C1549, ASTM E903 or ASTM E1918.

c. Thermal emittance tested in accordance with ASTM C1371 or ASTM E408.

d. Solar reflectance index (SRI) shall be determined in accordance with ASTM E1980 using a convection coefficient of 2.1 Btu/h x ft<sup>2</sup> x °F. 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.

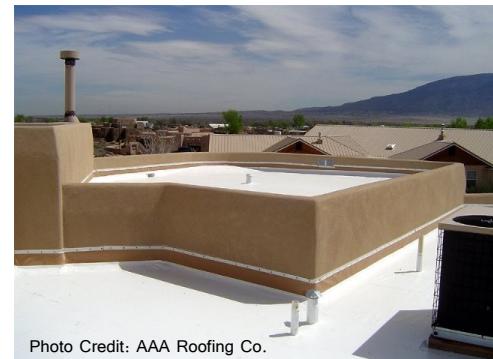


Photo Credit: AAA Roofing Co.

### 3. Wall Insulation

#### a. What type of wall are you using?

There are two options for walls: above grade and below grade, which refer specifically to external walls. Walls are categorized as above grade when they are either entirely above the grade (ground level) or are more than 15 percent above the grade.

With below grade walls, the IECC is generally referring to basement walls or first floor walls. At

least 85 percent of the wall must be located below grade (below ground level) to satisfy this label.

### b. Determine Insulation Requirements

#### How are you insulating the walls?

The options are continuous or cavity. If you're continuously insulating the walls, you'll be adding layers of insulation externally and covering the face of the studs. If you are using cavity insulation, the space between the studs must be filled to the required R-Value. Generally, builders use a combination of both types of insulation based on the type of exterior cladding selected for the building (e.g., EIS).



#### Above Grade Walls

Included in the R-Value total:

- ✓ Cavity insulation in the walls
- ✓ Continuous insulation

NOT included in the R-Value total:

- ✓ Integral insulation in Concrete Masonry Units (CMUs), unless you are building in Climate Zone 1 or 2, in which case you can eliminate the need to install any insulation on the exterior of the wall (see Footnote "C" of Table C402.2).

#### Below Grade Walls

Basement walls are typically just mass walls that are built below grade. These can be insulated using the techniques discussed in the above grade wall section. In many cases and depending

on the climate zone, they will not need to be insulated.

Included in the R-Value total:

- ✓ The insulating material installed continuously or between framing in furred out walls.
- ✓ The continuous insulation either needs to extend 10 feet below the outside finished grade level, OR to the floor level of the first floor down from the finished grade, whichever is less.



Photo Credit: Insulfoam

#### What About Mass Walls?

"Mass Walls" refers to walls weighing at least:

35 pounds per square foot of wall surface area

OR

25 pounds per square foot of wall surface area if the material weight is not more than 120 pounds per cubic foot

Mass wall assemblies include tilt-up concrete, CMU block, brick, and insulated concrete forms.

You have two options for insulating these walls: You can install continuous insulation and meet the mass wall requirements, or you can fur out the wall and meet the wood or metal framed wall insulation requirements.

### Step BE3b.

Determine cavity or continuous insulation requirements, per Table C402.2, for the appropriate assembly type.

#### Cavity Insulation

Cavity insulation is blown-in or batt insulation, filling the stud cavities with the required R-Value of insulation.



#### Continuous Insulation

Continuous insulation covers the face of the structural material.



**Step BE4a.**

Determine floor type according to code definitions.

**Step BE4b.**

Determine insulation requirements for floors over unconditioned spaces per Table C402.2.

**Step BE4c.**

Determine insulation requirements for slabs on grade per Table C402.2.



#### 4. Floor Insulation

##### a. What type of floor are you using?

This section refers to floors over an unconditioned space (e.g., a crawl space that isn't insulated or has exposed ground) and slabs on grade.

##### b. Determine Insulation Requirements for Floors Over Unconditioned Space per Table C402.2

The options for insulating these types of surfaces are to either install continuous insulation or to insulate between the floor joists. For concrete floors (considered mass floors) over a crawl space or other unconditioned space, continuous insulation will generally be used and attached to the underside of the floor system. Cavity insulation will generally be used on a framed floor over an unconditioned crawl space.

Included in the R-Value total:

- ✓ Cavity insulation between floor framing.
- ✓ Continuous insulation on the surface of the floor assembly.

##### c. Determine Insulation Requirements for Slab-on-Grade per Table C402.2

With the insulation of a slab on grade, there are a few options, as illustrated below.

The insulation must begin at the top of the slab and cover the face of the slab and extend down-



Photo Credit: buildipedia

ward, or downward and then horizontally, either under the slab or to the exterior of the slab, the total distance shown in Table C402.2.

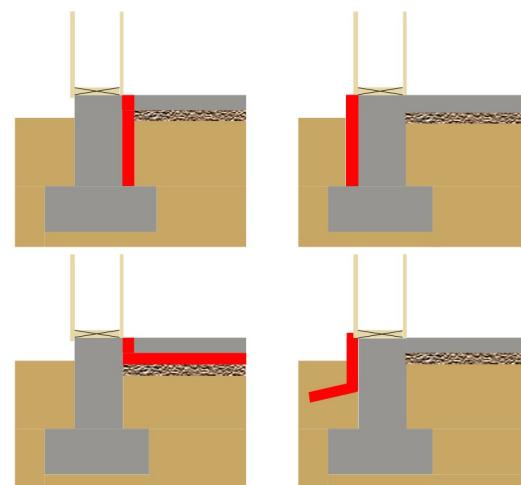
In addition to meeting the minimum R-Value requirements in the table, the insulation needs to extend downward or downward and horizontally, according the predetermined length listed in the table.

There are two options:

- ✓ Install insulation either on the inside of the foundation wall      OR
- ✓ Insulate the outside of the foundation wall. If the insulation extends away from the building it shall be protected by pavement or at least 10 inches of soil.

Where the slab-on-grade floor is greater than 24 inches below the finished exterior grade, perimeter insulation is not required.

Potential Locations for Slab on Grade Insulation





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## 5. Opaque Doors C402.2.7

Opaque doors, or doors that have less than 50 percent glass area, are commonly used. As they are either solid or have a minimum amount of glass, the rate of heat loss is less than it is with the average window or all-glass door. Because of this, the code has a separate U-Factor requirement (see Table C402.2) for opaque doors and they are not counted as part of the maximum fenestration area.

## 6. Fenestration C402.3

### a. Selecting fenestration

All fenestration must meet two standards: the U-Factor and the Solar Heat Gain Coefficient (SHGC) listed in Table C402.3. The U-Factor for fenestration is for the glazing and frame combined and must be rated in accordance with the National Fenestration Rating Council (NFRC) 100. In addition, the SHGC for the glass and frame combined must be rated according to NFRC 200.

### Factory and Site-Built Windows

For windows that are assembled at the factory and brought out to the job site (manufactured windows), the NFRC rating will be on a label attached to the window. For site-built windows, a NFRC Label Certificate must be provided for all windows on a given project. NFRC's commercial window energy rating process (called the compo-

ment modeling approach) enables manufacturers to combine frame, spacer, and glass components into project specific, final window products—listing U-factor and SHGC per NFRC 100 and NFRC 200 as section C303.1.3 requires. Visit [www.nfrc.org](http://www.nfrc.org) and click on “verify ratings, commercial” to access the label certificates or ask the manufacturer (usually the frame manufacturer) to provide the label certificate. Projects lacking these certificates must use the IECC default tables for U-factor and SHGC values (tables C303.1.3-1, 2 & 3). A typical NFRC Label Certificate is shown below:

### b. Maximum Fenestration Area

No more than 30 percent of the gross wall area may be glass. The gross wall area includes opaque walls and doors; and glazing.

NATIONAL FENESTRATION RATING COUNCIL LABEL CERTIFICATE																																							
PRODUCT LISTING FOR CODE COMPLIANCE																																							
LABEL CERTIFICATE ID: PJ-NFC-2410				Issuance Date: 10/30/2013																																			
NFRC CERTIFIED PRODUCT RATING INFORMATION: *																																							
<i>This is to be completed by an NFRC Approved Calculation Entity (ACE), based on information provided by the Specifying Authority and calculated in accordance with NFRC procedures.</i>																																							
PRODUCT LISTING:																																							
<table border="1"> <thead> <tr> <th colspan="8">CERTIFIED Performance Rating at NFRC Standard Size</th> </tr> <tr> <th>CPD ID</th> <th>Product Name</th> <th>Framing Ref</th> <th>Glazing Ref</th> <th>Spacer Ref</th> <th>Total Area</th> <th>U-factor**</th> <th>SHGC**</th> </tr> </thead> <tbody> <tr> <td></td> <td></td> <td></td> <td></td> <td></td> <td>ft<sup>2</sup></td> <td>Btu/ hr·ft<sup>2</sup>·F</td> <td>-</td> </tr> <tr> <td>PJ-WAU-21937</td> <td>Label Certificate Changes #8:</td> <td>FA-NAU-25213</td> <td>GA-CBG-8154</td> <td>SA-NFC-3874</td> <td>12379.17</td> <td>0.71</td> <td>0.50</td> </tr> </tbody> </table>								CERTIFIED Performance Rating at NFRC Standard Size								CPD ID	Product Name	Framing Ref	Glazing Ref	Spacer Ref	Total Area	U-factor**	SHGC**						ft <sup>2</sup>	Btu/ hr·ft <sup>2</sup> ·F	-	PJ-WAU-21937	Label Certificate Changes #8:	FA-NAU-25213	GA-CBG-8154	SA-NFC-3874	12379.17	0.71	0.50
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### c. Increased Vertical Fenestration and Skylight Area with Daylighting Controls

In order to exceed the maximum vertical fenestration area of 30 percent, daylighting controls must be used. Any building exceeding 30 percent without using daylighting controls must use the performance path (Section C407). In Climate Zones 1–6, a maximum of 40 percent of the gross above-grade wall area shall be permitted

### Step BE5.

Verify that opaque doors meet the requirements of Table C402.2.

### Step BE6a.

Select fenestration rated in accordance with NFRC 100 and 200.

### Step BE6b.

Verify glazing is no more than 30 percent gross wall area and skylights are no more than 3 percent of gross roof area.

### Gross Wall Area

The gross above-grade wall surrounds the space that you are heating and cooling (conditioned space) and is the wall between conditioned space and unconditioned space or the outdoors.

### Fenestration

Skylights, roof windows, vertical windows (fixed or moveable), opaque doors, glazed doors, glazed block and combination opaque/glazed doors. Fenestration includes products with glass and non-glass glazing materials.

### **Step BE6c.**

If fenestration exceeds 30 percent of gross wall area or skylights exceed 5 percent of gross roof area, ensure that appropriate daylighting controls are installed.

### **Step BE6d.**

Verify that the required spaces contain the minimum skylight area.

### **Step BE6e.**

Verify all daylight zones under skylights required by section C402.3.2 are controlled by multilevel lighting controls.

### **Step BE6f.**

Verify that skylights over specified spaces have a haze factor greater than 90 percent when tested in accordance with ASTM D 1003.

to be vertical fenestration, provided the following are met:

- ✓ No less than 50 percent of the conditioned floor area is within a daylight zone.
- ✓ Automatic daylighting controls are installed in daylight zones and
- ✓ Visible transmittance (VT) of vertical fenestration is greater than or equal to 1.1 times SHGC. Where fenestration is outside the scope of NFRC 200 it is not required to comply with the VT.

To increase the skylight area to a maximum of five percent of the roof area, automatic daylight controls must be installed in daylight zones under the skylights.

For specific requirements for daylighting controls, refer to the "Electrical Power and Lighting Systems" section of this guide.

#### **d. Minimum Skylight Fenestration Area**

Where an enclosed space is greater than 10,000 square feet directly under a roof with ceiling heights greater than 15 feet, and used as an office, lobby, atrium, concourse, corridor, storage, gymnasium/exercise center, convention center, automotive service, manufacturing, non-

- ✓ Not less than 3 percent with a skylight VT of at least 0.40; or
- ✓ Provide a minimum skylight effective aperture of at least 1 percent determined in accordance with Equation 4-1.

**Equation 4-1**

<b>Skylight Effective Aperture =</b>	<b>0.85 x Skylight Area x Skylight VT x WF</b>
	<b>Daylight zone under skylight</b>

In the following instances skylights above daylight zones of enclosed spaces are not required:

- ✓ Buildings in Climate Zones 6–8
- ✓ Spaces where the designed general lighting power densities are less than 0.5 W/sq ft.
- ✓ Areas where it is documented that existing structures or natural objects block direct beam sunlight on at least half of the roof over the enclosed area for more than 1,500 daytime hours per year between 8 AM and 4 PM.
- ✓ Spaces where the daylight zone is under rooftop monitors is greater than 50 percent of the enclosed space floor area.

#### **e. Lighting Controls in Daylight Zones Under Skylights**

All lighting in daylight zones under skylights required by section C402.3.2.1 shall be controlled by multilevel lighting controls that comply with IECC Section C405.2.2.3.3. Specific requirements are discussed in the "Electrical Power and Lighting Systems" section of this guide.



refrigerated warehouse, retail store, distribution/sorting area, transportation center, or workshop, the total daylight zone under skylights shall be no less than half the floor area and shall provide a minimum skylight area to daylight zone under the skylights of either:

Skylights in office, storage, automotive service, manufacturing, non-refrigerated warehouse, retail store, and distribution/sorting area spaces shall have a glazing material or diffuser with a measured haze factor greater than 90 percent when tested in accordance with ASTM D 1003.

#### **Exception:**

Skylights designed to exclude direct sunlight entering the occupied space by the use of fixed or automated baffles, or the geometry of skylight and light well do not need to comply with this requirement.

#### **g. Maximum U-factor and SHGC**

The U-factor and SHGC requirements are in Table C402.3, based on Climate Zone.

The SHGC is a measurement of the amount of solar heat gain that is allowed to pass through the window. The lower the value, the lower the amount of solar gain allowed to pass through. This will directly affect the cooling load of the space or building because solar gain brings heat to a space.

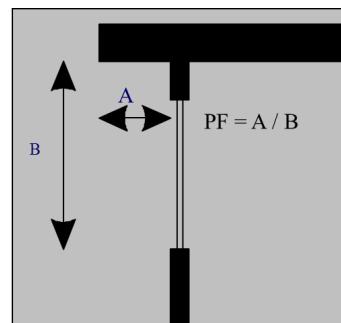
Select a fenestration product that has a maximum U-factor and SHGC less than or equal to that required in the table. This will be rated by NFRC 200 and the window product will either have a label (manufactured window products) or a certificate that accompanies the window (site-built).

For U-factors, an area weighted average shall be permitted to satisfy the requirements within each individual product category.

#### **h. Vertical Fenestration SHGC Adjustment**

Windows with SHGC values higher than those allowed in Table C402.3 may be allowed where the windows are shaded by an overhang, eave, or permanently attached shading device. To determine the adjustment attributable to a shading device, the projection factor (PF) must first be calculated. Where different windows or glass doors have different PF values, each must be evaluated separately. Adjustments to the SHGC must be done in accordance with Section C402.3.3.1 and Table C402.3.3.1.

The PF is determined by dividing the distance from the glazing to the edge of the projection (A) by the distance from the bottom of the projection to the bottom of the glazing (B). Equation 4-2 in the IECC is  $PF = A / B$ .



After determining the PF, use Table C402.3.3.1 to determine the adjustment multiplier that is multiplied by the SHGC in Table C402.3 to get the new allowable SHGC.

**TABLE C402.3 BUILDING ENVELOPE REQUIREMENTS: FENESTRATION**

Climate Zone	1	2	3	4 Except Marine	5 And Marine 4	6	7	8
<b>Vertical fenestration</b>								
<b>U-factor</b>								
Fixed fenestration	0.50	0.50	0.46	0.38	0.38	0.36	0.29	0.29
Operable fenestration	0.65	0.65	0.60	0.45	0.45	0.43	0.37	0.37
Entrance doors	1.10	0.83	0.77	0.77	0.77	0.77	0.77	0.77
<b>SHGC</b>								
SHGC	0.25	0.25	0.25	0.40	0.40	0.40	0.45	0.45
<b>Skylights</b>								
U-factor	0.75	0.75	0.55	0.50	0.50	0.50	0.50	0.50
SHGC	0.35	0.35	0.35	0.40	0.40	0.40	NR	NR

#### **Step BE6g.**

Verify that fenestration U-factor and SHGC values comply with Table C402.3.

#### **Step BE6h.**

If SHGC values are higher than allowed in Table C402.3, verify that the projection factor allows for an increase in the SHGC.

#### **Projection Factor**

Equation 4-2:  $PF = A / B$

Where:

A = distance measured horizontally from the furthest continuous extremity of any overhang, eave, or permanently-attached shading device to the vertical surface of the glazing.

B = distance measured vertically from the bottom of the glazing to the underside of the overhang, eave, or permanently attached shading device.

### **Step BE6i.**

If skylight U-factor or SHGC do not comply with Table C402.3, verify that automated daylighting controls are specified and installed.

### **Step BE6j.**

Where dynamic glazing is installed, verify that it complies with the SHGC requirements.

#### ***Dynamic Glazing***

Any fenestration product that has the fully reversible ability to change its performance properties, including U-factor, SHGC, or VT.

Additionally, in Climate Zones 1, 2, and 3 vertical fenestration entirely located not less than 6 feet above the finished floor shall be permitted a maximum SHGC of 0.40.

#### **i. Increased Skylight SHGC and U-factor**

In Climate Zones 1-6, skylights shall be permitted a maximum SHGC of 0.60 where located above daylight zones with automated daylighting controls. For those same skylights, the U-factor may be a maximum of 0.90 in Climate Zones 1-3 and 0.75 in Climate Zones 4-8.

**Table C402.3.3.1**  
**SHGC ADJUSTMENT MULTIPLIERS**

Projection Factor	Oriented within 45 degrees of True North	All Other Orientation
$0.2 \leq PF < 0.5$	1.1	1.2
$PF \leq 0.5$	1.2	1.6

#### **j. Dynamic Glazing**

To demonstrate compliance with the maximum SHGC requirements, dynamic glazing SHGC shall be determined using the manufacturer's lowest rated SHGC and the VT/SHGC ratio shall be determined using the maximum VT and maximum SHGC. Dynamic glazing shall be considered separately from other fenestration and may

not be considered in an area weighted average with other fenestration.



## 7. Air Leakage C402.4

Section C402.4 is a mandatory section and applies to all projects regardless of the compliance path chosen.

### a. Air Barriers

A continuous air barrier shall be provided throughout the building thermal envelope. The air barrier may be located on the inside, outside, or within the assemblies composing the building envelope or any combination thereof.

#### Exception:

Air barriers are not required in buildings located in Climate Zones 1, 2, and 3.

#### Air Barrier Construction:

The continuous air barrier shall be constructed to comply with the following:

- ✓ It must be continuous across all joints and assemblies that are part of the building thermal envelope.
- ✓ Joints and seams in the air barrier must be sealed, including sealing transitions and changes in materials.
- ✓ Materials used for sealing must be securely installed so as to be able to resist positive and negative pressure on the building.
- ✓ All penetrations through the air barrier must be caulked, gasketed, or otherwise

appropriately sealed for the type of construction material.

### b. Air Barrier Compliance Options

Compliance with the continuous air barrier requirements can be demonstrated in one of three ways:

- ✓ By specifying and using the appropriate materials
- ✓ By specifying and using the appropriate assemblies; or
- ✓ By conducting and passing a whole building air leakage test.

### Materials:

Materials with an air permeability can be no greater than 0.004 cfm/sq ft under a pressure differential of 0.3 inch water gauge, when tested in accordance with ASTM E2178. The 15 items listed below shall be deemed to comply with this section, provided joints are sealed and materials are installed as air barriers in accordance with the manufacturer's instructions.

### Assemblies:

Assemblies of materials and components with an average air leakage not to exceed 0.04 cfm/ft<sup>2</sup> under a pressure differential of 0.3 inches of water gauge when tested in accordance with ASTM E 2357, ASTM E 1677 or ASTM E 283 shall comply with the assembly compliance method. The following assemblies shall be

### Step BE7a.

Verify that a continuous air barrier is appropriately specified and constructed.

### Step BE7b.

Verify that one of the three air barrier compliance options has been specified.

### Infiltration

The uncontrolled inward air leakage into a building caused by the pressure effects of wind or the effect of differences in the indoor and outdoor air density or both.

### Continuous Air Barrier

A combination of materials and assemblies that restrict or prevent the passage of air through the building thermal envelope.

#### Materials deemed to comply as air barriers:

1. Plywood with a thickness of not less than 3/8 inch.
2. OSB having thickness not less than 3/8 inch.
3. Extruded polystyrene insulation board having a thickness of not less than 1/2 inch.
4. Foil-back polyisocyanurate insulation board having thickness not less than 1/2 inch.

5. Closed cell spray foam with minimum density of 1.5 pcf having thickness not less than 1-1/2 inches.

6. Open cell spray foam with a density between 0.4 and 1.5 pcf and having thickness of not less than 4.5 inches.

7. Exterior or interior gypsum board having a thickness of not less than 1/2 inch.

8. Cement board having a thickness of not less than 1/2 inch.

9. Built up roofing membrane

10. Modified bituminous roof membrane

11. Fully adhered single-ply roof membrane

12. A Portland cement/sand parge, or gypsum plaster having a thickness of not less than 5/8 inch.

13. Cast-in-place and precast concrete

14. Fully grouted concrete block masonry

15. Sheet steel or aluminum

**Step BE7c.**

Verify fenestration meets the appropriate air leakage requirements or qualifies for one of the two exceptions.

**Step BE7d.**

Verify access openings meet air leakage requirements.

**Step BE7e.**

Verify air intakes and exhaust openings have appropriate dampers.

deemed to comply provided the "air barrier construction" requirements are met:

- ✓ Concrete masonry walls coated with one application either of block filler and two applications of a paint or sealer coating;
- ✓ A Portland cement/sand parge, stucco, or plaster minimum of 1/2 inch in thickness.

**Building Test:**

Photo Credit: NREL

The completed building shall be deemed to comply with the air barrier requirements when the building is tested and achieves an air leakage rate of the building envelope not to exceed 0.40 cfm/sq ft at a pressure differential of 0.3 inches water gauge in accordance with ASTM E 779 or an equivalent method approved by the code official.

**c. Air Leakage of Fenestration**

The air leakage rate of fenestration assemblies are required to meet the provisions set forth in Table C402.4.3 of the IECC. Testing shall be done in accordance with the applicable test standard listed in the table by an accredited, independent testing laboratory and labeled by the manufacturer.

**Exceptions:**

✓ Field-fabricated fenestration assemblies that are sealed in accordance with Section C402.4.1 ("air barrier construction" requirements).

- ✓ Fenestration in buildings that comply with the whole building air leakage test requirements.

**d. Doors and Access Openings to Shafts, Chutes, Stairways and Elevator Lobbies**

Doors and access openings from conditioned space to shafts, chutes, stairways, and elevator lobbies shall either meet the requirements for "Air Leakage of Fenestration" or shall be gasketed, weatherstripped or sealed.

**Exception:**

- ✓ Door openings required to comply with Section 715 or 715.4 of the International Building Code (IBC); or
- ✓ Doors and door openings required by the IBC to comply with UL 1784.

**e. Air Intakes, Exhaust Openings, Stairways, and Shafts****Stairway and Shaft Vents**

Stairway and shaft vents must be provided with Class 1 motorized dampers with maximum leakage rate of 4 cfm/sq ft at 1 inch water gauge, when tested in accordance with AMCA 500D. These vents must be capable of automatically opening upon:

- ✓ Activation of any fire alarm initiating device of the building's fire alarm system; or
- ✓ Interruption of power to the damper.

**Outdoor Air Intakes and Exhausts**

Outdoor air supply and exhaust openings shall be provided with Class IA motorized dampers with a maximum leakage rate of 4 cfm/sq ft at 1 inch water gauge, when tested in accordance with AMCA 500D.

**Exceptions:**

Gravity dampers having a maximum leakage rate of 20 cfm/sq ft when tested in accordance with AMCA 500D and protected from direct wind exposure are permitted as follows:

- ✓ For exhaust and relief dampers
- ✓ Buildings less than three stories in height above grade.
- ✓ For ventilation air intakes and exhaust relief dampers in buildings of any height located in Climate Zones 1, 2, and 3.
- ✓ Where the design outdoor air intake or exhaust capacity does not exceed 300 cfm.

Dampers smaller than 24 inches in either dimension shall be permitted to have a leakage rate of 40 cfm/sq ft when tested in accordance with AMCA 500D.

#### f. Loading Dock Weatherseals

Cargo doors and loading dock doors must be equipped with weatherseals to restrict infiltration when vehicles are parked in the doorway.



#### g. Vestibules

All buildings shall be provided with an enclosed vestibule. The installation of revolving doors in the building entrance shall not eliminate the requirement that a vestibule be provided on any doors adjacent to the revolving doors.

Design requirements for vestibules include:

- ✓ All doors opening into and out of the vestibule equipped with self-closing devices.



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#### Step BE7f.

Verify weatherseals on all cargo doors and loading dock doors.

#### Step BE7g.

Verify a vestibule is designed and properly constructed for entrance doors into spaces greater than 3,000 sq ft, unless otherwise exempt.

#### Step BE7h.

Specify and install IC rated recessed lights and ensure they are sealed:

- ✓ Between housing and interior wall or ceiling covering.
- ✓ Between conditioned and unconditioned spaces (as applicable).



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#### h. Recessed Lighting

The code includes two requirements for recessed lighting:

- ✓ All recessed luminaires must be IC rated and labeled as having an air leakage rate of not more than 2.0 cfm when tested in accordance with ASTM E 283. This labeling can be found on the product packaging or on the product itself.
- ✓ All recessed luminaires must be sealed with a gasket or caulk between the housing and interior wall or ceiling covering.

**Simple Building criteria  
for the Mechanical  
System:**

- ✓ Single zone unitary system.
- ✓ Fan system of 5 horse power or less.
- ✓ Low or medium pressure duct system.
- ✓ No snow melt systems

# Mechanical Systems



## Basic Requirements

For this Guide, HVAC systems are limited to unitary single zone systems with the maximum fan horsepower (HP) per each system of no more than 5 HP. The following provisions must be complied with, if applicable, for all mechanical systems covered under this guide:

- ✓ HVAC load calculations must be performed for use in the sizing of the HVAC system.
- ✓ HVAC equipment must meet minimum equipment efficiency requirements.
- ✓ HVAC systems must be controlled by a programmable thermostat that allows for night setback/setup and is programmable 24 hours a day/seven days a week.
- ✓ High occupancy spaces will be required to have demand control ventilation.
- ✓ Spaces requiring significant quantities of outdoor air may require an energy recovery ventilation system.

- ✓ Economizers may be required in each system based on the size of the system.
- ✓ Duct and plenum systems must be insulated and sealed.
- ✓ Refrigeration pipes must be insulated and protected.
- ✓ Systems must be balanced
- ✓ Information must be provided to the building owner on how to properly operate and maintain the HVAC system in addition to providing dampers on the system that can be used for air balancing.
- ✓ Automatic start controls for each HVAC system.
- ✓ Mechanical systems commissioning and completion.

## 1. Calculating Heating and Cooling Loads

### C403.2.1

When calculating heating and cooling loads, there are two things to keep in mind:

- ✓ The design loads need to comply with ASHRAE 183 or be approved by an equivalent computation procedure, using the design parameters specified in IECC Chapter Three.
- ✓ The design loads must be adjusted to account for load reductions that are achieved when energy recovery systems are utilized in the HVAC system in accordance with the ASHRAE "HVAC Systems and Equipment Handbook."

## 2. HVAC Equipment Efficiencies C403.2.3

Heating and cooling systems must meet the minimum efficiency requirements for the type of system that is being installed. The equipment efficiencies that are used for Simple Buildings are located in IECC Table C403.2.3(1)-(4).

Typically air-cooled air conditioners, including through-the-wall systems less than 65,000 Btu/h and gas furnaces less than 225,000 Btu/h are covered under the National Appliance Energy Conservation Act and automatically comply with the equipment efficiency requirements, so no additional verification is needed.



Photo Credit: Daikin Applied

## 3. HVAC Controls C403.2.4

Each HVAC system that falls under this guide must have specific thermostatic, heat pump supplementary heating, and shut-off damper controls.



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### a. Thermostats

Simple Building must have a thermostat that controls the amount of heating and cooling energy delivered to the zone, based on the temperature requirements of the zone. The following capabilities are required:

- ✓ Setback controls that can set back or temporarily operate the system to maintain zone temperatures down to 55°F or up to 85°F.
- ✓ Capability of starting and stopping the system for seven different daily schedules per week.
- ✓ Capability to retain the programming during a power loss for up to at least 10 hours.
- ✓ A manual override that allows temporary operation for 2 hours, or manually operated timer that can be adjusted to, or operate the system for up to 2 hours, or an occupancy sensor.

Additional requirements include:

#### Set point overlap restriction

When using a thermostat to control the temperature of a zone handling both heating and

### Step M1.

Calculate heating and cooling loads in accordance with ASHRAE 183.

### Step M2.

Ensure efficiencies comply with the IECC Table C403.2.3 (1)-(4).

### Step M3a.

Ensure temperature controls are specified and installed with all required features.

### **Step M3b.**

Ensure heat pumps have controls to prevent supplementary operation when the heat pump can handle the load.

### **Step M3c.**

Ensure gravity dampers automatically shut when system is not in use.

### **Step M4.**

Ensure demand control ventilation is specified and installed for any spaces larger than 500 sq ft if occupancy loads are greater than 24 persons per 1,000 sq ft.

### **Step M5.**

Ensure energy recovery ventilation systems are installed on qualifying systems.

### ***Exceptions to energy recovery ventilation requirements***

- As prohibited by the IMC
- Systems serving spaces that are heated to less than 60°F and are not cooled.
- Where more than 60% of the outdoor heating energy is provided from site-recovered or site-solar energy.
- Heating energy recovery in Climate Zones 1 and 2.

cooling, the controls for the thermostat must have a range of at least 5°F. In addition to supplying this range, the thermostat must have the capacity to either turn off the supply of heating and cooling energy to the zone or reduce it to a minimum.

#### **Off-hour controls**

Each zone that's being controlled by a thermostat must be provided with off-hour setback and shutdown capabilities that run on either a time clock or a programmable control system.

Exceptions:

- ✓ Continuously operating zones
- ✓ A full HVAC load demand that does not exceed 6,800 Btu/h and has a readily accessible manual shutoff switch.

#### **Automatic Start Capabilities**

Each HVAC system shall be provided with controls capable of automatically adjusting the daily start time of the HVAC system in order to bring each space to the desired occupied temperature immediately prior to scheduled occupancy.

#### **b. Heat pump supplementary heating**

Heat pumps that have supplementary electric resistance heat must have controls that, except during defrost, prevent supplementary heat operation when the heat pump can meet the heating load.

#### **c. Shut-off damper controls**

Simple buildings are required to have gravity dampers for outdoor air and exhaust that will automatically shut with the system or spaces served when they are not in use.

### **4. Demand Control Ventilation C403.2.5.1**

The IECC has ventilation control requirements for spaces with high occupancy rates and systems that serve spaces that require large amounts of outside air and large fan systems.

Demand control ventilation is required for spaces larger than 500 sq ft with an occupancy load of 25 people per 1000 sq ft of floor area and served by systems with one or more of the following:

- ✓ An air-side economizer,
- ✓ Automatic modulation control of the outdoor air damper, or
- ✓ A design outdoor airflow greater than 3,000 cfm.

Exceptions to this requirement include:

- ✓ Systems using an energy recovery ventilation system.
- ✓ Systems with a design outdoor airflow less than 1,200 cfm.
- ✓ Multiple-zone systems without direct digital control of individual zones communicating with a central control point.
- ✓ Spaces where the supply airflow rate, minus any makeup or outgoing transfer air requirement, is less than 1,200 cfm.
- ✓ Ventilation provided for process loads only



### **5. Energy Recovery Ventilation C403.2.6**

Simple Buildings may also require high amounts of outside air to meet the ventilation needs of the building. Energy recovery ventilation systems are required where the supply airflow rate of a fan

**TABLE C403.2.6. ENERGY RECOVERY REQUIREMENT**

CLIMATE ZONE	PERCENT (%) OUTDOOR AIR AT FULL DESIGN AIRFLOW RATE					
	≥ 30% and < 40%	≥ 40% and < 50%	≥ 50% and < 60%	≥ 60% and < 70%	≥ 70% and < 80%	≥ 80%
<b>DESIGN SUPPLY FAN AIRFLOW RATE (cfm)</b>						
3B, 3C, 4B, 4C, 5B	NR	NR	NR	NR	≥ 5000	≥ 5000
1B, 2B, 5C	NR	NR	≥ 26000	≥ 12000	≥ 5000	≥ 4000
6B	≥ 11000	≥ 5500	≥ 4500	≥ 3500	≥ 2500	≥ 1500
1A–6A	≥ 5500	≥ 4500	≥ 3500	≥ 2000	≥ 1000	> 0
7, 8	≥ 2500	≥ 1000	> 0	> 0	> 0	> 0

system exceeds the values specified in Table C403.2.6.

The system must be capable of providing a change in the enthalpy of the outdoor air supplied by 50 percent or more of the difference between the outdoor and return air at design conditions.

Additionally, when an economizer is required there must be a bypass or control installed for the energy recovery system to permit the operation of the economizer in accordance with Section C403.4.

There are several exceptions to the energy recovery ventilation system requirements in Section C403.2.6 of the IECC (see sidebar on page 22 and 23).

## 6. Duct and Plenum Insulation and Sealing C403.2.7

There are several requirements for duct and plenum systems:

- ✓ Ducts and plenums in unconditioned spaces must have a minimum of R-6 insulation.
- ✓ Ducts located outside the building require a minimum of R-8 insulation.
- ✓ Any duct or plenum located within an exterior wall or unconditioned space must have at least R-8 insulation between it and the exterior wall or unconditioned space.

- ✓ All duct systems must be sealed with welds, gaskets, mastics, mastic-plus-embedded-fabric systems, or tapes installed in accordance with the manufacturer's installation instructions.
- ✓ Continuously welded and locking-type longitudinal joints and seams in ducts are exempted as long as the static pressure is less than 2 inches w.g.
- ✓ Duct sealant must be UL 181 listed and labeled and approved for the application.

### Exception:

- ✓ Systems with design temperature difference between the interior/exterior of the duct/plenum less than 15°F do not require insulation.

## 7. Piping Insulation C403.2.8

Piping insulation for Simple Buildings is limited to piping carrying refrigerant. Line sets in split systems are required to be insulated to 1.5 inches of piping insulation having an R-Value no less than 3.7/inch thickness.

The following do not need to comply:

- ✓ Factory-installed piping that is part of your HVAC equipment and that HVAC equipment complies with the performance requirements shown in the previous section.

### Exceptions to energy recovery ventilation requirements cont.

- Cooling energy recovery systems in Climate Zones 3C, 4C, 5B, 6B, 7, and 8.
- Systems requiring dehumidification that employ energy recovery in series with the cooling coil.
- Where the largest source of air exhausted at a single location at the building exterior is less than 75% of the design outdoor air flow rate.
- Systems expected to operate less than 20 hours per week at the outdoor air percentage covered by Table 403.2.6.

### Step M6.

Specify and install duct and plenum insulation and sealing.

### Step M7.

Specify and install insulation on appropriate mechanical piping.

**Duct.** A tube or conduit utilized for conveying air. The air passages of self-contained systems are not to be construed as air ducts.

## Step M8.

Ensure economizers are specified and installed, where required.

- ✓ Conveys fluid whose design operating temperature range is between 60°F and 105°F.
- ✓ Strainers, control valves, and balancing valves associated with piping 1 inch or less in diameter.
- ✓ Direct buried piping that conveys fluids at or below 60°F.
- ✓ System expected to operate less than 20 hours per week.
- ✓ Where the use of outdoor air for cooling will affect supermarket open refrigerated case-work systems.
- ✓ Where the cooling efficiency meets or exceeds the efficiency requirements in Table C403.3.1(2).

### Protection of Piping Insulation:

Piping insulation exposed to weather shall be protected from damage, including that due to sunlight, moisture, equipment maintenance, and wind, and shall provide shielding from solar radiation that can cause degradation of the material. Adhesive tape shall not be permitted.

## 8. Economizers C403.3.1

Economizers are required on each cooling system  $\geq 33,000 \text{ Btu/h}$  that has a fan in climate zone 2-8.

Economizers are not required on the following systems:

- ✓ Where more than 25 percent of the air designed to be supplied by the system is to spaces that are designed to be humidified above 35°F dew-point temperature to satisfy process needs.
- ✓ Systems that serve residential spaces where the system capacity is less than 165,000 Btu/h in Climate Zones 2-8; with no requirement for Climate Zone 1.

*Note: The total capacity of all systems without economizers in Climate Zones 2-8 shall not exceed 300,000 Btu/h per building, or 20% of its air economizer capacity, whichever is greater.*

**Table C403.3.1(2)**

Climate Zones	Cooling equipment performance improvement (EER or IPLV)
2B	10% Efficiency Improvement
3B	15% Efficiency Improvement
4B	20% Efficiency Improvement

*air economizer capacity, whichever is greater.*

### Requirements for Air Economizers

#### Design Capacity:

Air economizer systems shall be capable of modulating outdoor air and return air dampers to provide up to 100 percent of the design supply air quantity as outdoor air for cooling.

#### Control Signal:

Economizer dampers shall be capable of being sequenced with the mechanical cooling equipment and shall not be controlled by only mixed



Photo credit: Ryan Meres

air temperature; except where the use of mixed air temperature limit controls are used on systems controlled from space temperature (i.e., single zone systems).

#### **High-limit Shutoff:**

Air economizers shall be capable of automatically reducing outdoor air intake to the design minimum outdoor air quantity when outdoor air intake will no longer reduce cooling energy usage. High-limit shutoff control types for specific climates shall be chosen from Table C403.3.1.1.3(1). High-limit shutoff control settings for these control types shall be those specified in Table C403.3.1.1.3(2).

#### **Relief of Excess Outdoor Air:**

To avoid over-pressurizing the building, systems shall be capable of relieving excess outdoor air during economizer operation. The relief air outlet shall be located to avoid recirculation into the building.

### **9. System Commissioning C408**

System commissioning and completion requirements represent one of the most significant changes from the 2009 to the 2012 versions of the IECC.

Unless your Simple Building meets one of the following two exceptions, the mechanical system commissioning and completion requirements must be met:

- ✓ Mechanical systems in buildings where the total mechanical equipment capacity is less than 480,000 Btu/h cooling capacity and 600,000 Btu/h heating capacity.
- ✓ Systems included in Section C403.3 that serve dwelling units and sleeping units in hotels, motels, boarding houses, or similar units.

#### **Documentation:**

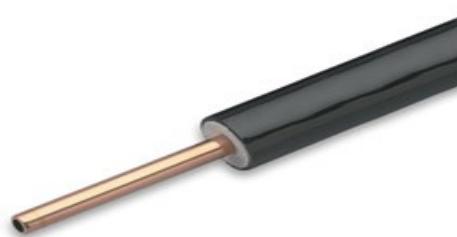
Construction document notes shall clearly indicate provisions for commissioning and completion and are permitted to refer to specifications for more detailed information. Copies of all documentation shall be given to the owner and made available to the code official upon request.

Prior to signing off on the final mechanical inspection, a registered design professional shall provide evidence that the following mechanical systems commissioning and completion requirements have been met:

#### **Commissioning Plan:**

A commissioning plan shall be developed by a registered design professional or approved agency and shall include the following items:

- ✓ Narrative description of the activities that will be accomplished during each phase of commissioning, including the personnel intended to accomplish each of the activities.
- ✓ A listing of the specific equipment, appliances, or systems to be tested and a description of the tests to be performed.
- ✓ Functions to be tested, including, but not limited to calibrations and economizer controls.
- ✓ Conditions under which the test will be performed. At a minimum, testing shall affirm winter and summer design conditions and full outside air conditions.
- ✓ Measurable criteria for performance.



### **Step M9.**

Verify that all system commissioning requirements have been properly specified on construction plans and completed after construction.

**Building Commissioning.** A process that verifies and documents that the selected building systems have been designed, installed, and function according to the owner's project requirements and construction documents, and to minimum code requirements.

**Systems Adjusting and Balancing:**

HVAC systems shall be balanced in accordance with generally accepted engineering standards. Air flow rates shall be measured and adjusted to deliver final flow rates within tolerances provided in the product specifications. Each supply air outlet and zone terminal device shall be equipped with means for air balancing in accordance with the requirements of Chapter 6 of the International Mechanical Code. Air systems shall be balanced in a manner to first minimize throttling losses then, for fans with system power of greater than 1 hp fan speed shall be adjusted to meet design flow conditions.

- ✓ Exception: Fans with fan motors of 1 hp or less.

**Functional Performance Testing:**

**Equipment:**

Functional performance testing for equipment shall demonstrate the installation and operation of components, systems, and system-to-system interfacing relationships in accordance with approved plans and specifications such that operation, function, and maintenance serviceability for each of the commissioned systems is confirmed. Testing shall include all modes and sequence of operation, including under full-load, part-load and the following emergency conditions:

- ✓ All modes as described in the sequence of operation;
- ✓ Redundant or automatic back-up mode;
- ✓ Performance of alarms; and
- ✓ Mode of operation upon a loss of power and restoration of power.

Exception: Unitary or packaged HVAC equipment listed in IECC Tables C403.2.3(1) through C403.2.3(3) that do not require supply air economizers.

**Controls:**

HVAC control systems shall be tested to document that control devices, components, equipment, and systems are calibrated, adjusted and operate in accordance with approved plans and specifications, sequences of operation shall be functionally tested to document they operate in accordance with approved plans and specifications.

**Economizers:**

Air economizers shall undergo a functional test to determine that they operate in accordance with manufacturer's specifications.

**Preliminary Commissioning Report:**

A preliminary report of commissioning test procedures and results shall be completed and certified by the registered design professional or approved agency and provided to the building owner. The report shall identify:

- ✓ Deficiencies found during testing required by this section that have not been corrected at the time of the report preparation.
- ✓ Deferred tests that cannot be performed at the time of report preparation because of climatic conditions.
- ✓ Climatic conditions required for performance of the deferred tests.



**Acceptance of Report:**

The building shall not pass the final mechanical inspection until the code official has received a letter of transmittal from the building owner acknowledging that the building owner has received the Preliminary Commissioning Report.

**Copy of Report:**

The code official shall be permitted to request that a copy of the Preliminary Commissioning Report be made available for review.

**Documentation Requirements:**

Construction documents shall specify that the documents described in this section be provided to the building owner within 90 days of the date of receipt of the certificate of occupancy.

**Drawings:**

Construction documents shall include the location and performance data on each piece of equipment.

**Manuals:**

In order to ensure that the building mechanical systems are properly run and maintained, an operating and maintenance manual shall be provided and include all of the following:

- ✓ Equipment size and selected options for each piece of equipment requiring maintenance.
- ✓ Manufacturer's operation manuals and maintenance manuals for each piece of equipment requiring maintenance, except equipment not furnished as part of the project.

Required routine maintenance actions shall be clearly identified.

- ✓ Name and address of at least one service agency.
- ✓ HVAC controls system maintenance and calibration information, including wiring diagrams, schematics, and control sequence descriptions. Desired or field-determined set-points shall be permanently recorded on control drawings at control devices or, for digital control systems, in system programming instructions.
- ✓ A narrative of how each system is intended to operate, including recommended set-points.
- ✓ A written report describing the activities and measurements completed in accordance with the section on System Adjusting and Balancing.

**Final Commissioning Report:**

A final report of test procedures and results shall be delivered to the building owner and include:

- ✓ Results of functional performance tests
- ✓ Disposition of deficiencies found during testing, including details of corrective measures used or proposed.
- ✓ Functional performance test procedures used during the commissioning process including measurable criteria for test acceptance, provided herein for repeatability.

Exception: Deferred tests which cannot be performed at the time of report preparation due to climatic conditions.

**Simple Building criteria  
for service hot water  
systems.**

- ✓ Storage gas,
- ✓ Electric and oil, including air source heat pump, and
- ✓ Instantaneous gas and oil.

**Step SW1.**

Ensure the system complies with the efficiencies in accordance with Section C404.2 and Table C404.2. in the IECC.

**Step SW2.**

Ensure equipment includes:

- ✓ Automatic and manual off switch.
- ✓ Temperatures that are set to 110°F in public restrooms and dwelling units, 90°F for other occupancies.

# Service Water Heating



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**Simple Buildings must take into account  
four elements of service hot water systems:**

- ✓ Minimum efficiency of service water heating equipment.
- ✓ Controls used for the equipment
- ✓ Heat traps
- ✓ Insulation of service hot water piping

## 1. Equipment Efficiencies C404.2

Simple Buildings with the following systems need not provide documentation showing they meet the efficiency standards of Table C404.2 as they meet the requirements of the National Appliance Energy Conservation Act (NAECA):

- ✓ Storage tank (electric) water heaters that use less than 12 KW.
- ✓ Storage tank (gas) water heaters that use less than 75,000 Btu/h.

- ✓ Heat pumps that use less than 24 amps and 250 volts.
- ✓ Instantaneous gas that use between 50,000 Btu/h and 200,000 Btu/h.

The efficiency of other hot water equipment is addressed in Table C404.2.

## 2. Controls C404.3, C404.6

The IECC has several requirements for controls on service water heating equipment including:

- ✓ Temperature controls allow a set-point of 110°F for equipment serving dwelling units and 90° F for equipment for other occupancies.
- ✓ Outlet temperature for lavatories in public facility restrooms limited to 110°F.
- ✓ Automatic or manual off switches installed for pumps and heat trace.
- ✓ Automatic circulating hot water system pumps or heat trace must be arranged to be conveniently turned off automatically or manually when the hot water system is not in operation. This can be complied with by installing an on/off switch in an accessible location.



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An automatic control will save more energy. Installing a time clock or an on-demand control will meet the intent of the code.

### 3. Heat Traps C404.4

Heat traps must be installed on the supply and discharge piping associated with water-heating equipment when the equipment is not supplied with integral heat traps and serves noncirculating systems. Some water heaters come with integral heat traps already installed so no additional plumbing will be required. For all other water heaters, an external heat trap will need to be installed.



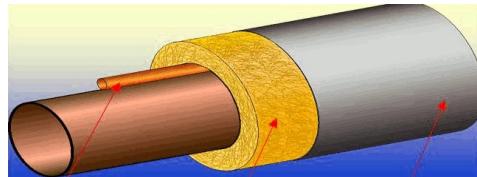
Photo credit: U.S. Dept. of Energy

inch/H x sq ft x °F. This is equal to an R-3.7 per inch thickness.

The first 8 feet of piping in non-temperature maintenance systems served by equipment without integral heat traps should be insulated with 0.5 inches of material having a conductivity not exceeding 0.27 Btu per inch/H x ft<sup>2</sup> x °F.

#### Exception:

Heat-traced piping systems shall meet the insulation requirements of the manufacturer's installation instructions. Untraced piping within a heat traced system shall be insulated with not less than 1 inch of insulation having a conductivity of not exceeding 0.27 Btu per inch/H x sq ft x °F.



### 4. Piping Insulation C404.5

The piping insulation provision accounts for two different piping configurations—automatic circulating hot water or heat-traced systems and non-temperature maintenance systems.

For automatic circulating hot water systems, piping shall be insulated with 1 inch of insulation having a conductivity not exceeding 0.27 Btu per



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#### Step SW3.

Ensure heat traps are installed on systems without circulation loops.

#### Step SW4.

Ensure appropriate insulation is specified and installed on circulating and non-circulating pipe.

## Simple Building criteria for lighting systems.

- ✓ All types and systems

**Simple Buildings follow the same lighting requirements as all other commercial buildings.**

### General Exemption

This section does not apply to dwelling units within commercial buildings when 75% or more of the permanently-installed light fixtures are fitted for and contain only high efficacy lamps.

The efficacy of lamps is determined by how much light is emitted, in lumens per watts (W) or lumens/W. Check the manufacturer's specifications to see if the ratio listed fits IECC's requirements.

- ✓ 60 lumens/W for lamps over 40W
- ✓ 50 lumens/W for lamps over 15W to 40W
- ✓ 40 lumens/W for lamps 15W or less

# Electrical Power and Lighting Systems—Interior Lighting



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**There are four key requirements for interior electrical power and lighting in the 2012 IECC that all apply to Simple Buildings:**

- ✓ Maximum interior lighting power
- ✓ Interior lighting controls
- ✓ Exterior Lighting Power
- ✓ Exterior Lighting Controls

### 1. Maximum Interior Lighting Power

#### C405.5.2

The 2012 IECC allows two methods for determining the interior lighting power allowance, or lighting power density, of a building. In addition to the Building Area Method of previous IECC versions, the 2012 IECC now recognizes the Space-by-Space Method as an acceptable compliance option. The Space-by-Space Method is based

largely on the Space-by-Space Method in ASHRAE Standard 90.1-2010.

#### Building Area Method

For the Building Area Method, the interior lighting power allowance (watts) is determined by multiplying the total floor area for each building area type by the lighting power density (W/sq ft) value for that particular area. "Area" is defined as all contiguous spaces that accommodate or are associated with a single building area type as per Table C405.5.2(1). When calculating the interior lighting power allowance for an entire building, each building area type identified in Table C405.5.2(1) must be treated as a separate area. The sum of the proposed interior lighting power (in watts) must be less than or equal to the interior lighting power allowance for each building area type.

#### Space-by-Space Method

For the space-by-space method, the interior lighting power allowance is determined by multiplying the floor area of each space type by the lighting power density for the space type in Table C405.5.2(2) that most closely represents the proposed use of the space. The sum of the lighting power densities of each space determines the lighting power allowance for the entire building.

Tradeoffs among spaces are permitted provided the sum of all spaces is less than or equal to the lighting power allowance of the building. As such, the Space-by-Space Method offers greater design flexibility than the Building Area Method.

In the 2012 IECC, the installed lighting power must not exceed the interior lighting power allowance, as calculated for the building.

- ✓ Calculate the interior lighting power allowance.
- ✓ Calculate actual installed loads based on exemptions.

To do this, look at Table C405.5.2(1). After you calculate your allowance, go through and follow the calculation rules and identify the exempted lighting. The requirement is to have your actual calculated installed wattage be less than or equal to the wattage allowance.

#### a. Calculating Allowance

First, choose an appropriate “Building Area Type” from the allowance table (C405.5.2(1)).

“Building Area” includes all spaces that are associated with that business or function type. For example an office building may include the following uses:

- ✓ Corridors
- ✓ Restrooms
- ✓ Lobby
- ✓ Office space

Then, multiply the lighting power density (W/sq ft) by the total building floor area to calculate the allowed watts for compliance.

#### Question:

How is an allowance determined if the building has more than one Building Area Type?

#### Answer:

Use the most accurate building area type when more than one area type exists in the building.

Use the sum the individual (lighting power density X floor area) values for Total Power Allowance.

**Table C405.5.2(1)**

Lighting Power Density	
Building Area Type <sup>a</sup>	(W/ft <sup>2</sup> )
Automotive Facility	0.9
Convention Center	1.2
Courthouse	1.2
Dining: Bar Lounge/Leisure	1.3
Dining: Cafeteria/Fast Food	1.4
Dining: Family	1.6
Dormitory	1.0
Exercise Center	1.0
Fire Station	0.8
Gymnasium	1.1
Healthcare-clinic	1.0
Hospital	1.2
Hotel	1.0
Library	1.3
Manufacturing Facility	1.3
Motel	1.0
Motion Picture Theater	1.2
Multifamily	0.7
Museum	1.1
Office	0.9
Parking Garage	0.3
Penitentiary	1.0
Performing Arts Theater	1.6
Police/Fire Station	1.0
Post Office	1.1
Religious Building	1.3
Retail <sup>b</sup>	1.4
School/University	1.2
Sports Arena	1.1
Town Hall	1.1
Transportation	1.0
Warehouse	0.6
Workshop	1.4

\*Refer to IECC for footnotes a and b.

#### Step L1a.

Calculate maximum interior lighting power allowance.

#### Step L1b.

Calculate actual installed interior lighting power loads based on allowances and exemptions.

## Step L1c.

Ensure wattages used for calculations are consistent with Section C405.5.2.

### b. Calculating Installed Load

After calculating the allowance, the next step is to calculate the Installed load. Not all lighting must be included when calculating the installed lighting load. See Section C405.5.1 for a complete list of exempted lighting.

This total wattage allowed does not include: professional sports arena playing field lighting; sleeping unit lighting in hotels or similar buildings; emergency lighting; lighting designed for occupants with special lighting needs including the visually impaired; lighting in registered interior historic landmarks; casino gaming areas.

### c. Calculating Installed Lighting Wattage

Installed lighting wattage must be calculated in accordance with Section C405.5.1. Wattage numbers for the installed lighting calculations come from the following sources:

- ✓ Screw lamp holders: maximum labeled wattage of the luminaire.
- ✓ Low voltage lighting: transformer wattage
- ✓ Line voltage track as specified wattage with minimum of 30 W/linear ft **OR** wattage limit of system's circuit breaker **OR** wattage limit of other permanent current limiting devices.
- ✓ Manufacturer's rated wattage of lamp and associated ballast.

#### Calculation Example:

The following illustrates the two compliance options in the 2012 IECC for calculating the lighting power allowance of a building: Building Area Method and Space-by-Space Method.

Office-Enclosed (2,000 ft <sup>2</sup> )	Lobby (1,000 ft <sup>2</sup> )
Fine Material Storage (2,000 ft <sup>2</sup> )	
Bulky Storage (3,000 ft <sup>2</sup> )	Fine Material Storage (2,000 ft <sup>2</sup> )
Warehouse (10,000 ft <sup>2</sup> )	

**Building Type:** Warehouse

**Total floor area:** 10,000 sq ft

**Space Types:** Fine Material Storage (2 areas)  
Office-Enclosed, Bulky Storage and Lobby.

#### Building Area Method Example:

To determine the interior lighting power allowance of the building using the Building Area Method, the building area type, Warehouse, is selected from Table C405.5.2 (1), on the previous page.

The total square footage of the Warehouse is multiplied by the lighting power density (LPD W/

Building Type	Area	LPD W/ ft <sup>2</sup>	Total Watts
Ware-house	10,000 ft <sup>2</sup>	0.6	6,000
<b>Total Watts Allowed:</b> 6,000			

sq ft) provided for the Warehouse building type in Table C405.5.2(1). The product is the total lighting power allowance of the building. In this example, the total watts allowed for the Warehouse using the Building Area Method is 6,000.

#### Space-by-Space Method Example:

To determine the interior lighting power allowance of the building using the Space-by-Space Method, the space type for each of the five spaces is selected from Table C405.5.2 (2).

The square footage of each space type is multiplied by the lighting power density (LPD W/sq ft) provided for that space type in Table C405.5.2 (2). The product for each calculation is added

Space Type	Area	LPD W/ft <sup>2</sup>	Total Watts
Fine Storage	2,000+2,000 ft <sup>2</sup>	1.4	5,600
Office- Enclosed	2,000 ft <sup>2</sup>	1.1	2,200
Bulky Storage	3,000 ft <sup>2</sup>	0.6	1,800
Lobby	1,000 ft <sup>2</sup>	1.10	1,100
<b>Total Watts Allowed: 10,700</b>			

together to determine the total lighting power allowance of the building. In this example, the total watts allowed for the Warehouse using the Space-by-Space Method is 10,700.

## 2. Interior Lighting Controls C405.2

The 2012 IECC includes specific control requirements for lighting:

- ✓ Interior manual controls
- ✓ Light reduction controls
- ✓ Automatic time switch controls



- ✓ Occupancy sensors
- ✓ Daylight zone controls

### a. Interior manual controls

Any lighted space that is enclosed by walls, or floor to ceiling partitions, must have a manual control for that lighting system to turn the lights on and off. The control must either be located within the space or remotely, as long as that switch is labeled and indicates which space it is controlling and whether the lights are on or off. (See C405.2.1.1)

Exceptions include:

- ✓ Spaces designated as a security or an emergency area that must be constantly lit.
- ✓ Lighting in stairways or corridors that are elements of the means of egress.

### b. Interior Light Reduction Controls

In any area required to have manual control, occupants must have the ability to reduce the space lighting level uniformly by 50 percent. The code offers several means to accomplish this:

- ✓ Install a single control for all of the lights that, in addition to switching the loads on and off, can dim the lights at least 50 percent.
- ✓ Provide switching for alternating lights or rows of lights providing control over 50 percent of lighting from each switch.
- ✓ Provide ability to switch the center lamp independently of the outer lamps.

**Exceptions:** Light reduction controls are not required in the following areas:

- ✓ Areas that have only one luminaire, with rated power less than 100 watts.
- ✓ Areas controlled by an occupancy sensor.
- ✓ Corridors, equipment rooms, storerooms, restrooms, public lobbies, electrical or mechanical rooms.
- ✓ Sleeping units (see C405.2.3)
- ✓ Spaces that use less than 0.6 W/sq ft
- ✓ Daylight spaces complying with Section C405.2.2.3.2.



**Illustrated Lighting Reduction Control**

### Options:

### Step L2a.

Ensure manual controls are specified and installed in appropriate spaces.

### Step L2b.

Ensure appropriate spaces have light reduction controls.

### Sleeping Unit Controls

Sleeping units are a common exception for automatic lighting shutoffs and light reduction controls. They are defined as a room or space in which people sleep, which can also include permanent provisions for living, eating, and *either* sanitation or kitchen facilities **but not both**.

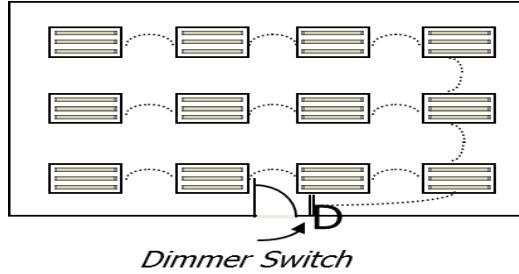
A master switch must be installed at the main entry door that controls all permanently wired lighting systems and switched receptacles except those in bathrooms. Suites must have a control meeting these requirements at the entry to each room or the primary entry to the suite.

### Step L2c.

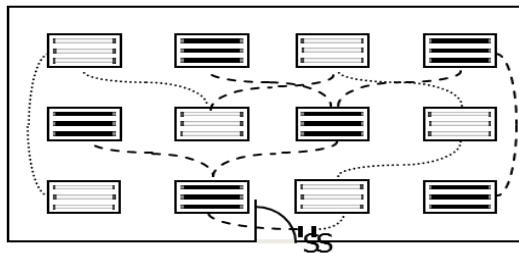
Ensure automatic time switch controls are specified and installed.

**Automatic.** Self-acting, operating by its own mechanism when actuated by some impersonal influence, as, for example, a change in current strength, pressure, temperature or mechanical configuration.

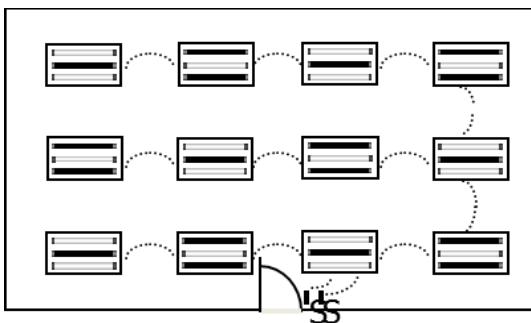
*Option 1:* A single control for all of the lights that, in addition to switching the loads on and off, can dim the lights at least 50%.



*Option 2:* If you have several rows of lights in a given area, have switching that turns off every other row or every other fixture to decrease overall lighting load uniformly by 50%.



*Option 3:* Switch the center lamp independently of the outer lamps in each luminaire.



#### Additional Lighting Controls

Each area required to have manual control must also comply with the following:

- ✓ Automatic time switch control
- ✓ Occupancy sensors
- ✓ Daylight zone control

**Exceptions:** Additional lighting controls are not required in the following spaces:

- ✓ Sleeping units
- ✓ Spaces where patient care is directly provided.
- ✓ Spaces where an automatic shutoff would endanger occupant safety or security.
- ✓ Lighting intended for continuous operation

#### c. Automatic Time Switch Control Devices

##### C405.2.2.1

Automatic time switch controls shall control lighting in all areas of the building, except emergency egress lighting and lighting controlled by occupancy sensors.

The time switch control device shall include an override switching device that complies with the following:

- ✓ Switch shall be readily accessible
- ✓ Switch shall be located where the lights controlled by the device are visible; or the switch shall provide a mechanism which announces the area controlled by the switch.
- ✓ Switch shall permit manual operation
- ✓ The switch, when initiated, shall permit the controlled lighting to remain on for a maximum of 2 hours; and

- ✓ Any individual switch shall control the lighting for a maximum of 5,000 sq ft.

**Exceptions:** Within malls, arcades, auditoriums, single tenant retail spaces, industrial facilities, and arenas:

- ✓ The time limit shall be permitted to exceed two hours provided the override switch is a captive key device; and
- ✓ The area controlled by the override switch is permitted to exceed 5,000 sq ft, but shall not exceed 20,000 sq ft.

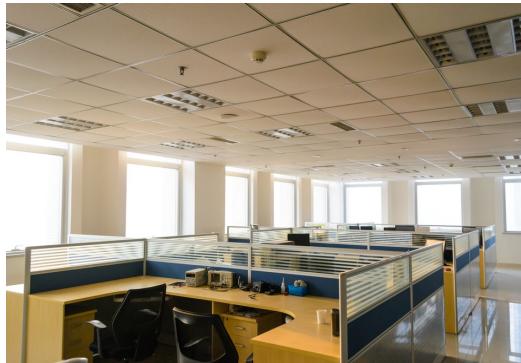
#### d. Occupancy Sensors C405.2.2.2

The 2012 IECC requires occupancy sensors to be installed in the following:

- ✓ Classrooms
- ✓ Conference/meeting rooms
- ✓ Employee lunch and break rooms
- ✓ Private offices
- ✓ Restrooms
- ✓ Storage rooms
- ✓ Janitorial closets
- ✓ Other spaces 300 sq ft or less enclosed by floor-to-ceiling height partitions.

In these spaces, occupancy sensors shall automatically turn off lights within 30 minutes of all occupants leaving the space, and shall either be manual on or shall be controlled to automatically turn the lighting on to not more than 50% power.

**Exception:** In areas such as public corridors, stairways, restrooms, and lobbies where manual-on operation would endanger the safety or secu-



Where contiguous daylight zones face in two adjacent orientations, artificial lights can be controlled on one switch.

rity of the room or building occupants, full automatic-on controls shall be permitted.

#### Step L2d.

Ensure occupancy sensors are specified and installed.

#### Step L2e.

Ensure manual or automatic controls are specified and installed in all daylight zones

#### e. Daylight Zone Controls C405.2.2.3

Daylight zones shall be controlled with either manual or automatic controls. The lights in daylight zones shall be designed such that they are controlled independently of general area lighting. Each daylight control zone shall not exceed 2,500 sq ft. Contiguous daylight zones adjacent to vertical fenestration are allowed to be controlled by a single controlling device provided they do not include zones facing more than two adjacent cardinal orientations (i.e., north, south, east, west). Where a daylight zone under a skylight is more than 15 feet from the perimeter it shall be controlled separately from daylight zones adjacent to vertical fenestration.

**Exception:** Daylight zones enclosed by walls or ceiling height partitions and containing two or fewer light fixtures are not required to have a separate switch for general area lighting.

##### Manual Daylighting Controls C405.2.2.3.1

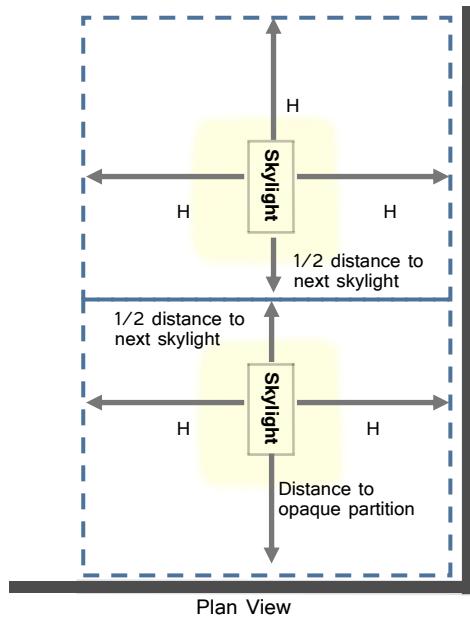
Manual controls must be installed unless automatic controls are installed.

Note: Automatic controls may be required in Climate Zones 1–6 where a building exceeds the maximum 30% window to wall ratio and is demonstrating compliance with the prescriptive provi-

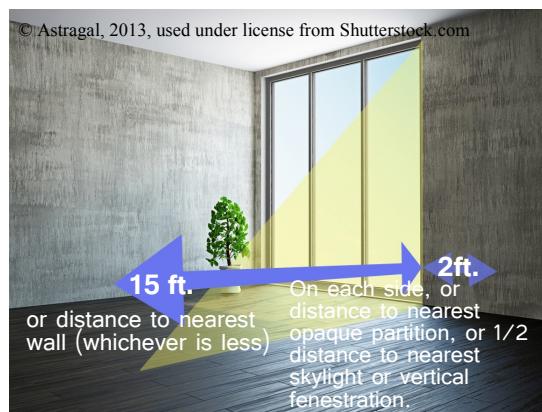
## Step L2f.

Ensure multi-level lighting controls are specified and installed for daylight zones under skylights.

### Example: Daylight Under Skylights



### Example: Daylight Adjacent to Vertical Fenestration



sions of the code. (See IECC Section C402.3.1.1 or Step BE5c of this guide)

### Automatic Daylighting Controls C405.2.2.3.2

Automatic controls are not required except as mentioned in the note above. Set-point and other controls for calibrating the lighting control device shall be readily accessible.

The daylighting control device shall be capable of automatically reducing the lighting power in response to available daylight by either one of the following two methods:

- ✓ Continuous dimming using dimming ballasts and daylight-sensing automatic controls that are capable of reducing the lighting power of the general lighting in the daylit zone continuously to less than 35 percent of rated power at maximum light output.
- ✓ Stepped dimming using multi-level switching and daylight-sensing controls that are capable of reducing lighting power automatically. The system shall provide a minimum of two control channels per zone and be installed in a manner such that at least one control step is between 50–70 percent of design lighting power and another control step is no greater than 35 percent of design power.

### f. Multi-level Lighting Controls C405.2.2.3.3

The 2012 IECC requires multi-level lighting controls in all daylight zones under skylights. (See Section C402.3.2.1). In these zones, the general lighting shall be separately controlled by at least one multi-level lighting control that reduces the lighting power in response to daylight available in the space. Where the daylight illuminance in the space is greater than the rated illuminance of the general lighting of daylight zones, the general lighting shall be automatically controlled so that its power draw is no greater than 35 percent of its rated power. The multi-level lighting control shall be located so that calibration and set point adjustment controls are readily accessible and separate from the light sensor.

### g. Specific Application Controls C405.2.3

### **Step L2g.**

Ensure appropriate, dedicated controls are specified and installed for display, accent and supplemental task lighting.



### **Step L2h.**

Ensure exit signs are specified and installed not to exceed 5 W/side.

In addition to all of the regulations regarding lighting controls, Section C405.2.3 requires dedicated controls for display and accent lighting, supplemental task lighting and other similar specific applications.

- Display and accent lighting must be controlled by a dedicated control which is independent of the controls for other lighting within the room or space.
- Lighting in cases used for display purposes must be controlled by a dedicated control which is independent of the controls for other lighting within the room or space.
- Hotel and motel sleeping units and guest suites must have a master control device at the main room entry that controls all permanently installed luminaires and switched receptacles.
- Supplemental task lighting, including permanently installed under-shelf or under-cabinet lighting, must have a control device integral to the luminaires or be controlled by a wall-mounted control device provided the control device is readily accessible.
- Lighting for non-visual applications, such as plant growth and food warming, must be controlled by a dedicated control which is independent of the controls for other lighting within the room or space.
- Lighting equipment that is for sale or for

demonstrations in lighting education must be controlled by a dedicated control which is independent of the controls for other lighting within the room or space.

### **h. Exit Signs C405.4**

Internally illuminated exit signs shall not exceed 5 watts per side.



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# Electrical Power and Lighting

## Systems—Exterior Lighting



### 3. Exterior Lighting Power C405.6.2

In the 2012 IECC, the installed exterior lighting power must not exceed the Exterior Lighting Power Allowance, as calculated for the building. Two pieces of information are needed to determine the exterior lighting allowance:

- ✓ **Tradable** and **non-tradable** lighting areas
- ✓ The zone in which the building is located

#### a. Tradable and Non-Tradable Lighting Allowances

Tradable lighting can be installed anywhere on the exterior as long as the lighting level satisfies the specified health and life safety requirements.

Typically, the most common surfaces are included as tradable (example: parking lot lighting). If you don't install the allotted wattage of lighting in a certain area you can use the remaining lighting in other areas of the project.

Tradable lighting includes:

- ✓ Uncovered parking lots and areas
- ✓ Walkways (under and over 10 feet wide)
- ✓ Stairways

- ✓ Pedestrian tunnels
- ✓ Main building entrances and exits
- ✓ Other doors
- ✓ Entry canopies
- ✓ Free-standing and attached sales canopies
- ✓ Open sales areas
- ✓ Street frontage sales areas

However, non-tradable lighting allowances must be used only within the specified area and for the specified use. Non-tradable typically relates to specific security requirements (for example, lighting located next to automated teller machines). Other non-tradable uses include:

- ✓ Building facades
- ✓ Automated teller machines and night depositories.
- ✓ Entrances and gatehouse inspection stations at guarded facilities.
- ✓ Loading areas for law enforcement, fire, ambulance, and other emergency vehicles.



Main building entrances are tradable areas.

### Step L3a.

Determine tradable and non-tradable lighting areas

**Building Entrance.** Any door, set of doors, doorway, or other form of portal that is used to gain access to the building from the outside by the public.

**Step L3b.**

Determine in which zone the building is located.

**Step L3c.**

Calculate exterior lighting allowance.

**Step L4.**

Ensure appropriate exterior lighting controls are specified and installed.



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ATM areas are non-tradable.

- ✓ Drive-up windows/doors
- ✓ Parking near 24-hour retail entrances

**b. Determine the Lighting Zone**

To determine the lighting zone, find the predetermined zone from Table C405.6.2(1) that best describes the area where the project will be located. Table C405.6.2(1) is shown below.

**c. Calculate Exterior Lighting Allowance**

Once you have determined the lighting zone, use it to determine the lighting power allowances for the building exteriors based on the information in Table C405.6.2(2).

**4. Exterior Lighting Controls C405.2.4**

Requirements for exterior lighting controls on Simple Buildings are straightforward:

- ✓ All lighting for dusk-to-dawn operation must be equipped with an astronomical clock or a photo sensor.

- ✓ All other exterior lighting must be equipped with either a photo sensor and a time switch or an astronomical clock.

**Example**

A bank building located in a neighborhood business district is proposed, which will include the following exterior areas:

- ✓ Parking lot: 15,000 ft<sup>2</sup>
- ✓ Walkways less than 10 feet wide: 100 ft
- ✓ Main entries: 2 at 8 ft. wide each
- ✓ Automated Teller Machines: 2 at a single location

**Tradable Surfaces**

Lighting Zone 2

600 W +

Parking lot: 15,000 ft<sup>2</sup> @ 0.06 W/ft<sup>2</sup> = 900 W

Walkways less than 10 ft. wide: 100 ft @ 0.7

W/linear foot = 70 W

Main entries: 2 at 8 ft. wide each @ 20 W/linear foot = 320 W

**Total Tradable Surfaces: 1,890 W**

**Non-Tradable Surfaces**

Automated teller machines:

2 at one location = 270 W + 90 W = 360 W

**Total Non-Tradable Surfaces: 360 W**

**Table C405.6.2(1) Exterior Lighting Zones**

Lighting Zone	Description
1	Developed areas of national parks, state parks, forest land, and rural areas
2	Areas predominantly consisting of residential zoning, neighborhood business districts, light industrial with limited nighttime use and residential mixed use areas
3	All other areas
4	High-activity commercial districts in major metropolitan areas as designated by the local land use planning authority

# Additional Efficiency Package Options

Only one of the three steps in this section needs to be complied with.

## Section C406 Additional Efficiency Package Options

Section C406 provides three efficiency package options for commercial buildings to choose from for compliance with the prescriptive provisions of the 2012 IECC. The three sets of provisions provide equal energy efficiency and allow for flexibility in selecting which option to apply to the design of a commercial building.

The options listed in C406 include:

- Efficient HVAC Performance (C406.2)
- Efficient Lighting System (C406.3)
- On-Site Supply of Renewable Energy (C406.4)

Each building must select one of the three efficiency features provided in C406 to demonstrate compliance. For commercial buildings with tenant spaces, tenant spaces must individually comply with either the HVAC performance (C406.2) or lighting system (C406.3) option unless documentation can be provided that shows the building as a whole complies with the renewable energy option (C406.4).

### 1. Efficient HVAC Performance C406.2

Option one, Efficient HVAC Performance, requires the addition of high-efficiency HVAC equipment. The efficiencies included in option one are based on the Consortium for Energy Efficiency. A building that is being constructed to comply with a green building code or certification may find it advantageous to comply with option one as high-efficiency equipment is often required to meet the green building code or fulfill sustainability certification requirements.

often required to meet the green building code or fulfill sustainability certification requirements.

Option one, however, is not applicable to all HVAC system types. Electrically operated condensing units, heat rejection units and heat transfer units, for example, are not listed under C406.2. A building that is designed using one of the excluded HVAC systems should not select to comply with option one as it would require a change in system type.

If a building is designed to comply with option one, Tables C406.2 (1) through C406.2 (7) provide the additional efficiency requirements. These tables are similar in structure and organization to the mandatory minimum efficiency requirement tables included in section C403.2.3.

### 2. Efficient Lighting System C406.3

Option two, Efficient Lighting System, requires a building to comply with a lower lighting power density allowance. The whole-building lighting power densities included in option two are based on the requirements of the Building Area Method and are consistent with those listed in ASHRAE Standard 90.1-2010.

The following table provides an example of the difference between the mandatory lighting power allowances required for all buildings in Table C405.5.2 (1) using the Building Area Method and the reduced interior lighting power allowance required in Table C406.3 as part of the additional efficiency option.

### Step EO1.

Ensure the HVAC system meets the efficiency requirements in Tables C406.2(1)-(4) if the HVAC performance option is selected.

### Step EO2.

If the efficient lighting system option is selected, the lighting calculations should be done as described in Steps L1a-L1c in the Electrical Power and Lighting Systems Section of this Guide.

### Step EO3.

Ensure renewable energy system rating is greater than or equal to those specified in section C406.4

Retail and office spaces have an additional option for complying with the Efficient Lighting System requirements. Per Table C406.3, the builder can either:

- ✓ Choose a lower wattage allowance with no additional daylighting requirements

OR

- ✓ Choose a higher wattage allowance with the provision of keeping a minimum of 30 percent of the conditioned floor area in a daylight zone.

**EXAMPLE: Interior Lighting Power Density Comparison**

Building Area Type	Building Area Method LPD (w/ft <sup>2</sup> ) in C405.5.2	Reduced LPD (w/ft <sup>2</sup> ) in C406.3
Automotive Facility	0.9	0.82
Convention Center	1.2	1.08
Courthouse	1.2	1.05

### 3. On-Site Supply of Renewable Energy

#### C406.4

The third option, On-Site Supply of Renewable Energy, requires a building to comply with one of the following minimum ratings:

- ✓ Provide not less than three percent of the energy used within the building for

mechanical and service water heating equipment and lighting regulated in Chapter 4.

- ✓ Provide not less than 1.75 Btu (1850W) or not less than 0.50 watts per square foot (5.4 W/m<sup>2</sup>) of conditioned floor area.

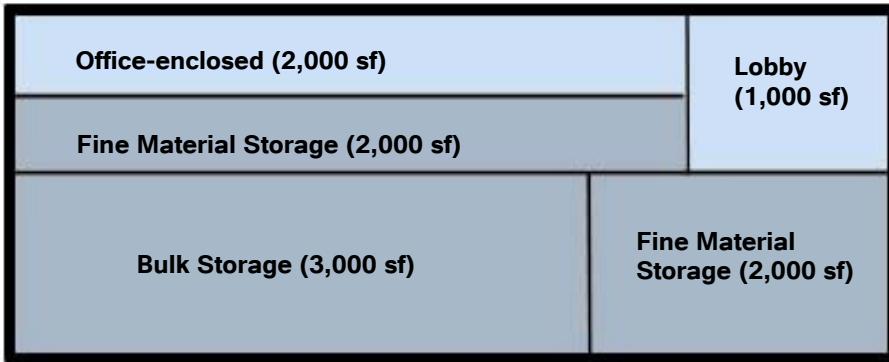
#### Limitations

The minimum ratings required of renewable energy systems can be achieved through a variety of design options that do not require modification of the building envelope, HVAC or lighting systems. Instead, the 2012 IECC lists “energy derived from solar radiation, wind, waves, tides, landfill gas, biomass, or the internal heat of the earth” as renewable energy options for buildings as long as the renewable system is installed on-site. Because the system must be installed on-site, C406.4 may not be a suitable option for all building sites. For example, inadequate wind, limited space for solar radiation systems or no access to waves and tides may hinder a building from achieving compliance with the minimum rating requirements. The use of renewable energy credits (RECS) to meet this option is not allowed as the intent of the code is that the renewable system is a permanent part of the building.



### **Renewable Energy Requirement Calculation Examples:**

The following illustration depicts a standard warehouse with both conditioned (light blue) and unconditioned space (dark blue), and onsite renewable energy.



**Example A.** If you are using photovoltaics (PVs) to satisfy the renewable energy provision with the warehouse above, the calculation will be in watts.

Conditioned Space	Square Footage		Total Square Footage Multiplied by 0.5 Watts
Office Enclosed	2,000 ft <sup>2</sup>	Summed Total = 3,000 ft <sup>2</sup>	3,000 x 0.5
Lobby	1,000 ft <sup>2</sup>		= Minimum of 1,500 Watts of Renewables

**Example B.** If you are using solar water heating to satisfy the renewable energy provision with the warehouse above, the calculation will be in Btu.

Conditioned Space	Square Footage		Total Square Footage Multiplied by 1.75 Btu
Office Enclosed	2,000 ft <sup>2</sup>	Summed Total = 3,000 ft <sup>2</sup>	3,000 x 1.75
Lobby	1,000 ft <sup>2</sup>		= Minimum of 5,250 Btu of Renewables

### **On-Site Renewable**

**Energy.** Energy derived from solar radiation, wind, waves, tides, landfill gas, bio mass, or the internal heat of the hearth. The energy system providing on-site renewable energy shall be located on the project site.

**Alteration** is any construction or **renovation** to an existing structure, other than repair or addition, that requires a permit. Also a change in a mechanical system that involves an extension, addition, or change to the arrangement, type, or purpose of the original installation and that requires a permit.

**Conditioned Space** is an area or space within a building being heated or cooled, containing uninsulated ducts, or with a fixed opening directly into an adjacent conditioned space.

**Building Thermal Envelope** is the basement walls, exterior walls, floor, roof, and any other building elements that enclose conditioned space. This boundary also includes the boundary between conditioned space and any exempt or unconditioned space.

# Alterations and Renovations

Additions, alterations, and renovations to simple commercial buildings need to comply with the provisions of the 2012 IECC. The following provides the key provisions where the IECC applies to alterations and renovations.

## **Conditioned Space.**

Any garage, warehouse, or other non-conditioned space that is altered to become conditioned space shall be brought into full compliance with the IECC.



## **Fenestration.**

When replacing a whole window, it must comply with the IECC requirements for U-factor, SHGC and air leakage. When only replacing the glass in an existing sash and frame, the glass is not required to comply with the IECC.



Photo credit: OregonDOT



Photo credit: OregonDOT

## **HVAC Equipment.**

The replacement of an HVAC unit is required to comply with the IECC including minimum equipment efficiency requirements and equipment and system sizing.

## **Cavity Insulation.**

If a cavity within the building thermal envelope is exposed and contains no insulation, or the insulation does not completely fill the cavity, the exposed cavity is required to be "filled" with insulation. Insulation installed on a suspended ceiling with removable tiles is not considered part of the minimum thermal resistance of the roof insulation.



# Alterations and Renovations

## **Roofing:**

Roof recovers over insulation above deck or roofs without insulation in the cavity and where the sheathing or insulation is exposed during re-roofing shall be insulated either above or below the sheathing.

Otherwise, roof recovers are exempt from the provisions of the IECC.



## **Lighting:**

Alterations/repairs that replace only the bulb and ballast within the existing luminaires in a space are exempt provided the alteration does not increase the installed interior lighting power.



Alterations that replace less than 50 percent of the luminaires in a space are exempt from the IECC lighting and power requirements provided such alterations do not increase the installed interior lighting power.

Where the use in a space changes from one use to another in the "Interior Lighting Power Allowances" tables, the installed lighting power shall comply with the IECC "Interior Lighting

Power Requirements" section for the new use.

## **Historic buildings:**

Historic buildings are exempt from the requirements of the 2012 IECC.



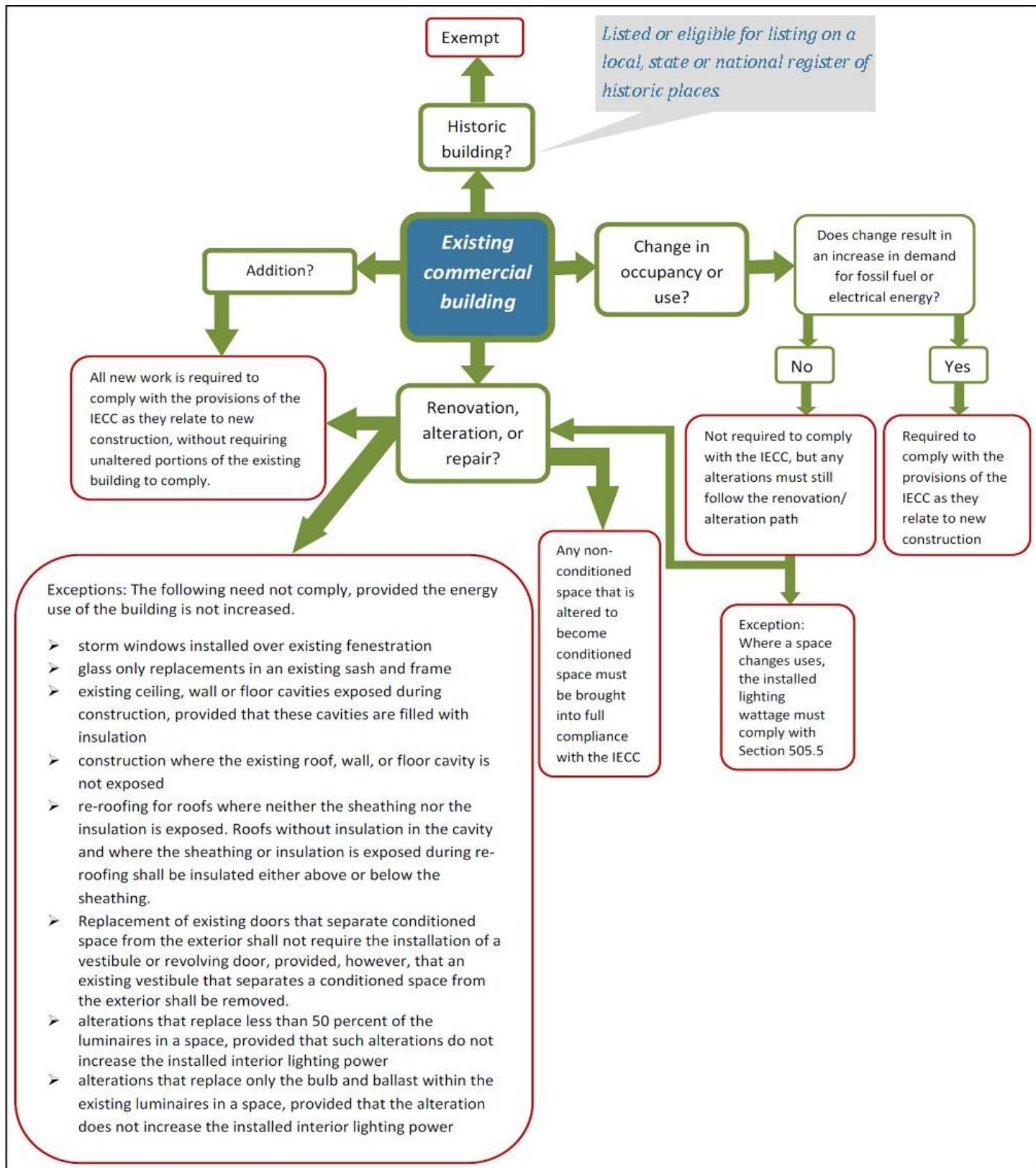
## ***Roof Assembly.***

A system designed to provide weather protection and resistance to design loads. The system consists of a roof covering and roof deck or a single component serving as both the roof covering and roof deck. A roof assembly includes the roof covering, underlayment, roof deck, insulation, vapor retarder and interior finish.

## ***General Lighting.***

Lighting that provides a substantial uniform level of illumination throughout an area. General lighting shall not include decorative lighting or lighting that provides a dissimilar level of illumination to serve a specialized application or feature within such area.

The following graphic is a flow chart that should be used as a guide when determining how an addition, alteration or renovation project needs to comply with the IECC.





Small commercial buildings (less than 50,000 sq ft) make up more than 90 percent of the U.S. commercial building stock. Of those small buildings, most are considered “simple commercial buildings.” Many of the complex requirements in the International Energy Conservation Code (IECC) do not apply to simple commercial buildings. As such, this Compliance Guide was created to parse out only the requirements needed for simple buildings. It is a step-by-step guide on how simple commercial buildings can comply with the 2012 IECC. It provides detailed guidance and many illustrations for the four main energy-related elements in simple commercial buildings: building envelope, mechanical systems, service hot water heating and electrical power and lighting systems. This guide is ideal for designers, contractors and code officials. This guide is not intended to be a substitute for the IECC. Designers and builders should always consult the IECC and any local amendments to the IECC when determining compliance.