Compliance Guide

2009 International Energy Conservation Code for Simple Commercial Buildings

Britt/Makela Group

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The Institute for Market Transformation (IMT), with the assistance of the Britt/Makela Group, Inc. (BMG), has published this visual interpretation of the 2009 International Energy Conservation Code (IECC), as it applies to Simple Buildings, to aid in the understanding of the written text.

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

IMT and BMG wish to thank the ICC for permission to print portions of the IECC. We recognize our responsibility to educate and inform and welcome your feedback and comments.

Simple Buildings:

A Compliance Guide to Energy Code Compliance for Simple Commercial Buildings


Photo credit: Ryan Meres, 2013

The illustrated guide to Simple Buildings was developed to help those with Simple Buildings comply with the 2009 International Energy Conservation Code (IECC). Though the goal of this guide is making 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 building components. The four components to evaluate are building envelope, mechanical systems, service hot water heating, and electrical power and lighting systems. A Simple Building can be anything from a 3,000 ft^2 dentist office, a strip mall or a 100,000 ft^2 warehouse. The sidebar on the right of this page lists the criteria for Simple Buildings, and the systems to which this book applies. If your building does not meet these criteria, you will need to refer directly to the complete text of the 2009 IECC for guidance.

The book is intended to be a quick illustrated guide to 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 if needed.

SIMPLE BUILDING QUALIFIERS

BUILDING ENVELOPE

- ✓ No more than 2 wall types in the building
- ✓ Only 1 roof type
- ✓ Only 1 floor type
- ✓ Glass levels below 40% 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: 2009 IECC, Quick Reference Table

Primary Component	Secondary Component	Steps to Ensure Compliance	2009 IECC
Building Envelope	1. Insulation R—Values and Fenestration U-Factors	**Step BE1a.** Determine whether the building is "Group R" or "Other" **Step BE1b.** Refer to Table 502.2 for minimum R-Values for each component of the building envelope	502.1.1
	2. Roof Insulation	**Step BE2.** Ensure insulation is the proper R-Value for the roof type, per Table	502.2.1
	3. Wall and Floor Insulation	**Step BE3a.** Determine wall and floor type, according to code definitions **Step BE3b.** Determine cavity or continuous insulation requirements, per Table 502.2 (1), for the appropriate assembly type	502.2.2
	4. Opaque Doors	**Step BE4.** Ensure the opaque doors meet the requirements of Table 502.2(1)	502.2.7
	5. Fenestration	**Step BE5a.** Select fenestration with or without projection factor (shading) **Step BE5b.** Calculate projection factor of shading **Step BE5c.** Ensure fenestration meets both the U-Factor and SHGC requirement of Table 502.3 **Step BE 5d.** Ensure there is no more than 40% glass wall area	502.3
	6. Air Leakage	**Step BE6a.** Ensure site-built fenestration products and all openings, penetration, joints and seams are sealed in accordance with Section 502.4.3 **Step BE6b.** Ensure gravity dampers with automatic closure are installed **Step BE6c.** Ensure a vestibule is designed and properly constructed for entrance doors into spaces greater than 3,000 ft^2, unless otherwise exempt. **Step BE6d.** Specify and install weatherseals on all cargo doors and loading dock doors. **Step BE6e.** Specify and install IC rated recessed lights and ensure they are sealed.	502.4
Mechanical	1. Calculating Heating and Cooling Loads	**Step M1.** Calculate heating and cooling loads in accordance with ASHRAE 183	503.2.1
	2. HVAC Equipment	**Step M2.** Ensure efficiencies comply with the IECC Table 503.2.3(1)-(4)	503.2.3
	3. HVAC Controls	**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 have automatic closure controls.	503.2.4
	4. Demand Control Ventilation	**Step M4.** Ensure demand control ventilation is specified and installed for any spaces larger than 500ft^2 if occupancy loads are greater than 40 persons per 1,000 ft^2	503.2.5.1

Simple Buildings: 2009 IECC, Quick Reference Table

Primary Component	Secondary Component	Steps to Ensure Compliance	2009 IECC
Mechanical	5. Energy Recovery Ventilation	**Step M5.** Ensure energy recovery ventilation systems are installed on qualifying systems	503.2.6
	6. Economizers	**Step M6.** Ensure economizers are specified and installed on single and aggregate (when serving a single space) systems greater than 54,000 Btu/h	503.3.1
	7. Duct and Plenum Insulation and Sealing	**Step M7.** Specify and install duct and plenum insulation and sealing	503.2.7
	8. Piping Insulation	**Step M8.** Specify and install piping insulation	503.2.8
	9. Air System Balancing	**Step M9.** Conduct air balancing	503.2.9.1
	10. Manuals	**Step M10.** Provide manuals	503.2.9.3
Service Hot Water Systems	1. Equipment Efficiencies	**Step SHW1.** Ensure the system complies with the efficiencies in Table 504.2 if it includes storage tank (electric) that use greater than 12KW, storage tank (gas) that use greater than 75,000 Btu/h, instantaneous gas that use greater than or equal to 200,000 Btu/h, storage tank (oil) that uses greater than 105,000 Btu/h, or instantaneous oil that uses greater than or equal to 10,000 Btu/h	504.2
	2. Controls	**Step SHW2.** Ensure equipment includes: controls for 110°F setback, automatic and manual off switch, temperatures are set to 110°F in public restrooms and dwelling units, 90°F for other occupancies.	504.3, 504.6
	3. Heat Traps	**Step SHW3.** Ensure heat traps are installed	504.4
	4. Piping Insulation	**Step SHW4.** Ensure appropriate insulation is specified and installed on circulating and non-circulating pipe	504.5
Electrical Power and Lighting Systems	1. Maximum Lighting Power	**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 505.5.1	505.5
	2. Interior Lighting Controls	**Step L2a.** Ensure manual controls are specified and installed in appropriate spaces **Step L2b.** Ensure controls are specified and installed to reduce lighting load by 50% **Step L2c.** Ensure lighting shutoff controls are specified and installed	505.2.1
	3. Daylight Zone Controls	**Step L3a.** Identify whether the project has daylight zones either under skylights or adjacent to vertical windows **Step L3b.** Determine your lighting control requirements **Step L3c.** Ensure exit signs don't exceed 5 watts/side	
	4. Exterior Lighting Power	**Step L4a.** Determine tradable and non-tradable lighting areas **Step L4b.** Determine in which zone the building is located **Step L4c.** Calculate exterior lighting allowance	505.6.2
	5. Exterior Lighting Controls	**Step L5.** Ensure appropriate exterior lighting controls are specified and installed	505.2.4

Building Envelope

Step BE1a.

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

Step BE1b.

Refer to Table 502.2 for minimum R-Values for each component of the building envelope.

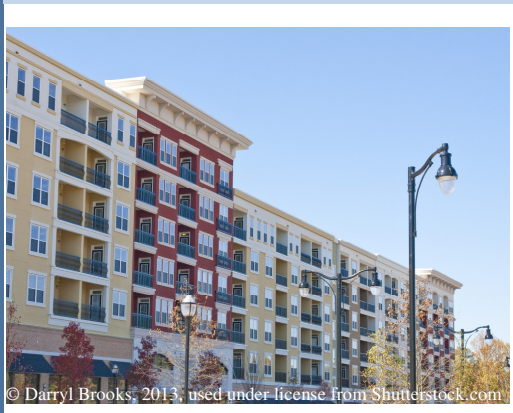
Climate Zones

The 2009 IECC identifies 8 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.

Visit the energycodes.gov website or http:energycode.pnl.gov/EnergyCodeReqs/

Simple Building criteria for the building envelope:

- ✓ No more than 2 wall types in the building
- ✓ Only 1 roof type
- ✓ Only 1 floor type
- ✓ Glass levels below 40% window-to-wall ratio



"Group R" Buildings: Apartments, condos and townhouses three stories or more

"All Other" commercial construction

1. Insulation R—Values and Fenestration U-Factors, 502.1.1

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" is for apartment buildings, condos, and townhomes (R-2, R-3, and R-4) more than three stories in height.
- ✓ "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 is listed in Table 502.2(1). 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 502.2(1) shows minimum R-Value requirements for each of these assemblies.

Table 502.2(1) BUILDING ENVELOPE REQUIREMENTS - OPAQUE ASSEMBLIES

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	All other	Group R	All other	Group R	All other	Group R
Roofs																
Insulation entirely above deck	R-15ci	R-20ci	R-20ci	R-20ci	R-20ci	R-20ci	R-20ci	R-20ci	R-20ci	R-20ci	R-20ci	R-20ci	R-25ci	R-25ci	R-25ci	R-25ci
Metal buildings (with R-5 thermal blocks[a,b])	R-19	R-19	R-13 + R-13	R-13 + R-13	R-13 + R-13	R-19	R-13 + R-13	R-19	R-13 + R-13	R-19	R-13 + R-19	R-19	R-13 + R-19	R-19 + R-10	R-11 + R-19	R-19 + R-10
Attic and other	R-30	R-38	R-38	R-38	R-38	R-38	R-38	R-38	R-38	R-38	R-38	R-38	R-38	R-38	R-49	R-49
Walls, Above Grade																
Mass	NR	R-5.7ci[c]	R-5.7ci[c]	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-15.2ci	R-25ci	R-25ci
Metal building[b]	R-16	R-16	R-16	R-16	R-19	R-19	R-19	R-19	R-13 + R-5.6ci	R-13 + R-5.6ci	R-13 + R-5.6ci	R-13 + R-5.6ci	R-19 + R-5.6ci	R-19 + R-5.6ci	R-19 + R-5.6ci	R-19 + R-5.6ci
Metal framed	R-13	R-13	R-13	R-13 + R-7.5ci	R-13 + R-3.8ci	R-13 + R-7.5ci	R-13 + R-7.5ci	R-13 + R-7.5ci	R-13 + R-7.5ci	R-13 + R-7.5ci	R-13 + R-7.5ci	R-13 + R-7.5ci	R-13 + R-7.5ci	R-13 + R15.6ci	R-13 + R7.5ci	R-13 + R18.8ci
Wood framed and other	R-13	R-13	R-13	R-13	R-13	R-13	R-13	R-13 + R-3.8ci	R-13 + R-3.8ci	R-13 + R-3.8ci	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-15.6ci
Walls, Below Grade																
Below grade wall[d]	NR	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-7.5ci	R-12.5ci
Floors																
Mass	NR	NR	R-6.3ci	R-8.3ci	R-6.3ci	R-8.3ci	R-10ci	R-10.4ci	R-10ci	R-12.5ci	R-12.5ci	R-14.6ci	R-15ci	R-16.7ci	R-15c R-30i	R-16.7ci
Joist/Framing (steel/wood)	NR	NR	R-19	R-30	R-19	R-30	R-30	R-30	R-30	R-30	R-30	R-30[e]	R-30	R-30[e]	R-30[e]	R-30[e]
Slab-on-Grade Floors																
Unheated slabs	NR	NR	NR	NR	NR	NR	NR	R-10 for 24 in. below	NR	R-10 for 24 in. below	R-10 for 24 in. below	R-15 for 24 in. below	R-15 for 24 in. below	R-15 for 24 in. below	R-15 for 24 in. below	R-20 for 24 in. below
Heated slabs	R-7.5 for 12 in. below	R-7.5 for 12 in. below	R-7.5 for 12 in. below	R-7.5 for 12 in. below	R-10 for 24 in. below	R-10 for 24 in. below	R-15 for 24 in. below	R-15 for 24 in. below	R-15 for 24 in. below	R-15 for 24 in. below	R-15 for 24 in. below	R-20 for 48 in. below	R-20 for 24 in. below	R-20 for 48 in. below	R-20 for 48 in. below	R-20 for 48 in. below
Opaque doors																
Swinging	U-0.70	U-0.70	U-0.70	U-0.70	U-0.70	U-0.70	U-0.70	U-0.70	U-0.70	U-0.70	U-0.70	U-0.50	U-0.50	U-0.50	U-0.50	U-0.50
Roll-up or sliding	U-1.45	U-1.45	U-1.45	U-1.45	U-1.45	U-1.45	U-0.50	U-0.50	U-0.50	U-0.50	U-0.50	U-0.50	U-0.50	U-0.50	U-0.50	U-0.50

For SI: 1 inch = 25.4 mm.
ci = Continuous insulation. NR = No requirement
a. When using *R*-value compliance method, a thermal spacer block is required, otherwise use the *U*-factor compliance method. [see Tables 502.1.2 and 502.2(2)].
b. Assembly descriptions can be found in Table 502.2(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^2 · °F.
d. When heated slabs are placed below grade, below-grade walls must meet the exterior insulation requirements for perimeter insulation according to the heated slab-on-grade construction.
e. Steel floor joist systems shall be 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.

Building Envelope

Step BE2.

Ensure insulation is the proper R-Value for the roof type, per Table 502.2 (1).

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, then you'll comply.

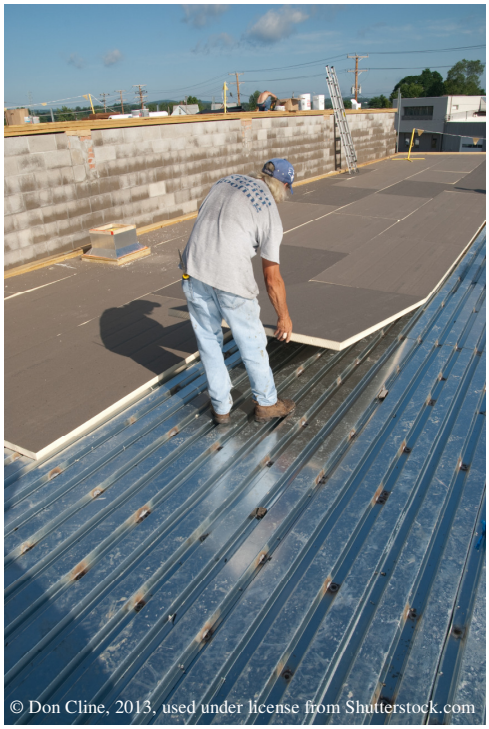
2. Roof Insulation 502.2.1

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

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.



Insulation being installed above the roof deck.

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 installed 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.

Insulation installed on the floor of the attic assembly

Frame of a metal building.

Insulation Installed in Metal Roof Buildings

Metal building can easily comply with the IECC by following the recommended practices included in the Energy Design Guide for Metal Building Systems by the Metal Building Manufacturer's Association (MBMA).

The IECC will typically require the installation of two layers of insulation, with one layer draped over the top of the purlins that is used to support a second layer installed 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. Other methods available to meet this requirement can be found in MBMA publication.

Thermal block on metal beam.

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 sheetrock ceiling. Ceilings with removable tile will not prevent air movement and are not considered air barriers.

K-Factor

The K-Factor is the perimeter heat loss factor for slab-on-grade floors. It is determined by multiplying the energy use times the volume of the floor times the temperature.

Building Envelope

Step BE3a.

Determine wall and floor type, according to code definitions.

Step BE3b.

Determine cavity or continuous insulation requirements, per Table 502.2(1), for the appropriate assembly type.

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.

3. Wall and Floor Insulation 502.2.2

a. What type of wall and floor are you using?

Walls

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% above the grade.

With below grade walls, the IECC is generally referring to basement walls or first floor walls. At least 85% of the wall must be located below grade (below ground level) to satisfy this label.

Floors

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

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. EIFS).

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 502.2(1).

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

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.

Uninsulated below grade walls.

How are you insulating the floors?

Floors Over Unconditioned Space

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

Slab-on-Grade

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

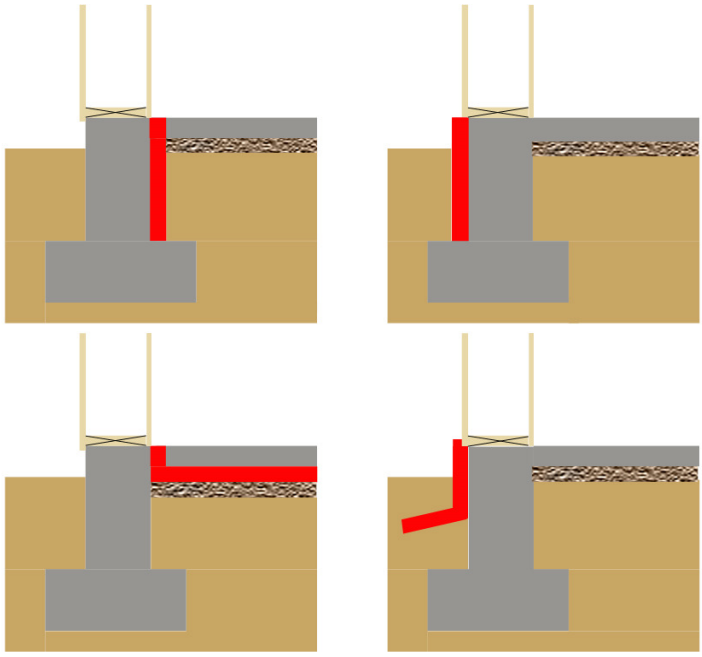
The insulation must begin at the top of the slab and cover the face of the slab and extend downward, or downward and then horizontally, either under the slab or to the exterior of the slab, the total distance shown in Table 502.2(1).

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

There are two options:

- ✓ The insulation can be installed either on the inside of the foundation wall, OR
- ✓ Insulate the outside of the foundation wall. If it is installed on the outside of the wall system it must be protected from potential damage by a rigid, weather-resistant protective cover.

Potential Locations for Slab on Grade Insulation



Cavity Insulation

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

Continuous Insulation

Continuous insulation covers the face of the structural material.

K-Factor

The K-Factor is the perimeter heat loss factor for slab-on-grade floors. It is determined by multiplying the energy use times the volume of the floor times the temperature.

Building Envelope

Step BE4.

Ensure the opaque doors meet the requirements of Table 502.2(1)

Step BE5a.

Select fenestration with or without projection factor (shading)

Step BE5b.

Calculate projection factor of shading.

Step BE5c.

Ensure fenestration meets both the U-Factor and SHGC requirement of Table 502.3.

Step BE5d.

Ensure glazing is no more than 40% gross wall area.

Site-built Windows

See http://www.nfrc.org/SB/default.aspx for information on NFRC and site-built windows.

Refer to Table 502.3 as the baseline for meeting minimum energy standards for fenestration.

4. Opaque Doors 502.2.7

Opaque doors, or doors that have less than 50% 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 502.2(1)] for opaque doors and they are not counted as part of the maximum fenestration area.

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5. Fenestration 502.3

a. Selecting fenestration

All fenestration must meet two standards: the U-Factor and the Solar Heat Gain Coefficient (SHGC) listed in Table 502.3. The U-Factor will be based on whether the window was built on site or factory made. The U-Factor for fenestration is for the glazing and frame combined and must be rated in accordance with NFRC 100.

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 that are assembled out on site, a National Fenestration Rating Council (NFRC) Certificate must accompany the window unit. The glazing provider should be able to provide this information for the product that they are installing. As an alternative to testing, NFRC has a Component Modeling Approach (CMA) program that allows the user to access a database of predefined, NFRC approved glazing frame and spacer options and generate an NFRC certificate for a proposed site-built window. U-Factor ratings for factory built products and some site-built products can be found on the NFRC website.

b. Calculate projection factor (PF)

(See side bar on opposite page) 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 5-1 in the IECC is PF=A/B.

c. Maximum Solar Heat Gain Coefficient

The SHGC is mandated in Table 502.3, based on climate zone and whether projections (shading devices) are used.

The SHGC is a measurement of the amount of solar 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 with it heat. There are two ways to comply with the SHGC requirement in the code:

Select a fenestration product that has a maximum SHGC less than or equal to the required SHGC. 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)

OR

Install an overhang over the window and calculate a projection factor

The overhang will allow you to install a less efficient window, in this case a window with a higher SHGC value. Once you have calculated the PF, you can use Table 502.3 to determine the new SHGC requirement for the window.

d. Maximum Fenestration Area

No more than 40% of the gross wall area may be glass. The gross wall area includes opaque walls and doors; and glazing.

Note: To see if the gross wall area complies with Table 502.3, follow this equation:

$$\text{Value} = \frac{\text{Total Vertical Fenestration Area}}{\text{Gross Above Grade Wall Area}}$$

Table 502.3, Building Envelope Requirements: Fenestration

Climate Zone	1	2	3	4 Except Marine	5 And Marine 4	6	7	8
Vertical fenestration (40% maximum of above-grade wall)								
***U*-factor**								
Framing materials other than metal with or without metal reinforcement cladding								
U-factor	1.20	0.75	0.65	0.40	0.35	0.35	0.35	0.35
Metal framing with or without thermal break								
Curtain wall/storefront *U*-factor	1.20	0.70	0.60	0.50	0.45	0.45	0.40	0.40
Entrance door *U*-factor	1.20	1.10	0.90	0.85	0.80	0.80	0.80	0.80
All other *U*-factor	1.20	0.75	0.65	0.55	0.55	0.55	0.45	0.45
SHGC-all frame types								
SHGC: PF< 0.25	0.25	0.25	0.25	0.40	0.40	0.40	0.45	0.45
SHGC: 0.25 ≤ 0.25 PF < 0.5	0.33	0.33	0.33	NR	NR	NR	NR	NR
SHGC: PF ≥ 0.5	0.40	0.40	0.40	NR	NR	NR	NR	NR
Skylights (3% maximum)								
U-factor	0.75	0.75	0.65	0.60	0.60	0.60	0.60	0.60
SHGC	0.35	0.35	0.35	0.40	0.40	0.40	NR	NR

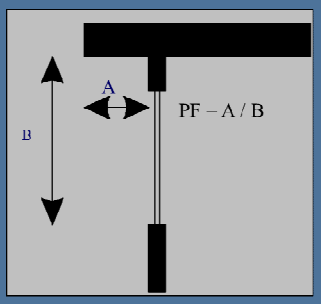
NR= No Requirement

PF= Projection Factor (see Section 502.3.2 of the IECC and sidebar on this page)

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.

Projection Factor



Building Envelope

Step BE6a.

Ensure site-built fenestration products and all:

- ✓ Openings
- ✓ Penetrations
- ✓ Joints
- ✓ Seams

are sealed in accordance with Section 502.4.3:

With caulking materials or closed with gasketing material compatible with the construction material and location.

Joints and seams may be taped or covered with moisture vapor permeable wrapping

Joint and seam sealing materials must allow for expansion and contraction of construction materials

Step BE6b.

Ensure gravity dampers with automatic closure are installed in:

- ✓ Stair and elevator shaft vents
- ✓ Outdoor air intakes
- ✓ Exhaust openings through building envelope

6. Air Leakage 502.4

a. Sealing the Building Envelope, Window, and Door Assemblies

Sealing the building envelope is critical. All penetrations and site-built windows and fenestration must be:

- ✓ Sealed with caulking materials or closed with gasketing material compatible with the construction material and location.
- ✓ Joints and seams need to be sealed the same way, or taped or covered with moisture vapor permeable wrapping material.
- ✓ Sealing materials spanning joints between construction materials need to allow for expansion and contraction of the construction materials.
- ✓ Window and door air leakage is certified at the factory, so products that come to the site should comply with the IECC.

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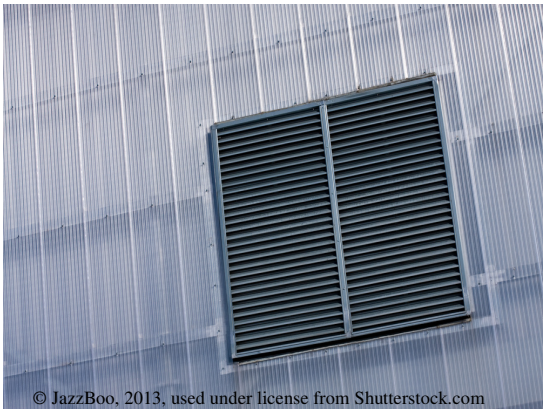
b. Outdoor Air Intakes and Exhaust Openings

For Simple Buildings, stair and elevator shaft vents and other outdoor air intakes and exhaust openings that are installed in the building envelope must have Class I motorized leakage rated dampers with a maximum leakage rate of 4 cfm/ft^2. Buildings two stories or less can have a damper that automatically closes when not needed.



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c. Vestibules

Vestibules are required in Climate Zones 3-8 on entrance doors opening into spaces > 3,000 ft^2.

Design requirements for vestibules include:

- ✓ All doors opening into and out of the vestibule equipped with self-closing devices
- ✓ Both the interior and exterior doors do not open at the same time when passing through the vestibule

Exceptions to the vestibule requirements include:

- ✓ Buildings in Climate Zone 1 and 2 as indicated in Figure 301.1 and Table 301.1

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- ✓ Doors not intended to be used as building entrance doors, such as doors to mechanical or electrical equipment rooms
- ✓ Doors opening directly from a sleeping unit or dwelling unit
- ✓ Doors that open directly from a space less than 3,000 ft^2 in area
- ✓ Revolving doors used primarily to facilitate vehicular movement or material handling and adjacent personal doors

d. Loading Dock Weatherseals

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

Photo credit: Ryan Meres

e. Recessed Lighting

The code includes three requirements for recessed lighting:

- ✓ All recessed luminaires must be IC rated and labeled as meeting 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
- ✓ Recessed luminaires installed in the building thermal envelope must be sealed to limit air leakage between conditioned and unconditioned spaces.

For more information on IC ratings, visit www.capri.info.

Step BE6c.

Ensure a vestibule is designed and properly constructed for entrance doors into spaces greater than 3,000ft^2, unless otherwise exempt.

For more information on vestibules, visit the Code Notes section at energycodes.gov.

Step BE6d.

Specify and install weatherseals on all cargo doors and loading dock doors.

Step BE6e.

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).

Conditioned space: An area or room within a building being heated or cooled, containing un-insulated ducts, or with a fixed opening directly into an adjacent conditioned space.

Mechanical Systems

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

Step M1.

Calculate heating and cooling loads in accordance with ASHRAE 183.

Step M2.

Ensure efficiencies comply with the IECC Table 503.2.3 (1)-(4).

Step M3a.

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

Basic Requirements

For this Guide, HVAC systems are limited to unitary single zone systems with the maximum fan horsepower 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 to be used 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
- ✓ 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

1. Calculating Heating and Cooling Loads

503.2.1

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 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 503.2.3

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 503.2.3(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.

3. HVAC Controls 503.2.4

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

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

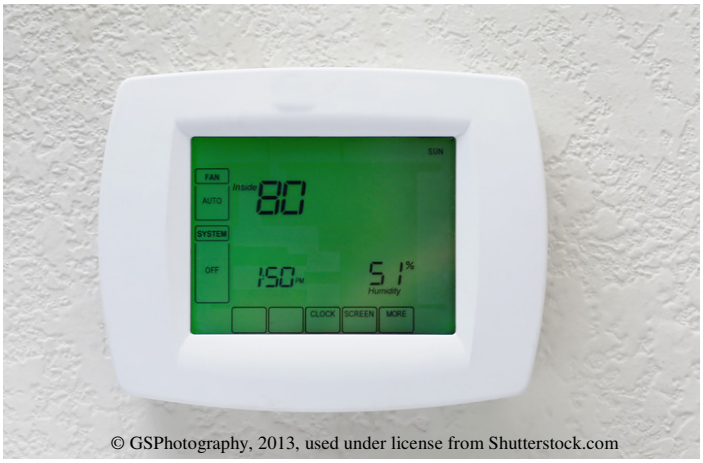
When using a thermostat to control the temperature of a zone handling both heating and cooling, the controls for the thermostat must have a range of at least 5°F. In addition to supplying this range, the thermostat must have the capacity to either turn off the supply of heating and cooling energy to 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



Step M3b.

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

Step M3c.

Ensure gravity dampers have automatic closure controls.

Step M4.

Ensure demand control ventilation is specified and installed for any spaces larger than 500 ft^2 if occupancy loads are greater than 40 persons per 1,000 ft^2.

Step M5.

Ensure energy recovery ventilation systems are installed on qualifying systems.

Step M6.

Ensure economizers are specified and installed on single and aggregate (when serving a single space) systems greater than 54,000 Btu/h.

Step M7.

Specify and install duct and plenum insulation and sealing.

Mechanical Systems

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

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 503.2.5.1

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 Simple Buildings that have spaces larger than 500 ft^2 with an occupancy load of 40 people per 1000 ft^2 that are served by any of the following systems:

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- ✓ 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
- ✓ Spaces where the supply airflow rate, minus any makeup or outgoing transfer air requirement, is less than 1,200 cfm

5. Energy Recovery Ventilation 503.2.6

Simple Buildings may also require high amounts of outside air to meet the ventilation needs of the building. Energy recovery ventilation systems are required for individual systems that have both a design supply air capacity of 5,000 cfm or greater, and a minimum outside air supply of 70% or greater of the design supply air quantity.

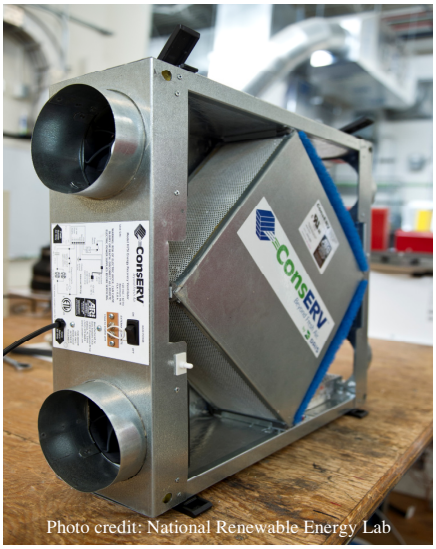

Photo credit: National Renewable Energy Lab

The system must be capable of providing a change in the enthalpy of the outdoor air supplied by 50% 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 cooling with outdoor air.

There are several exceptions to the energy recovery ventilation system requirements in Section 503.2.6 of the IECC (see sidebar, page 19).

6. Economizers 503.3.1

Economizers are generally required on all individual cooling systems and aggregate systems serving a single room or space greater than ≥ 54,000 Btu/h in climate zones 2B through 6B. Requirements for the economizer include capability to provide:

- ✓ 100% outdoor air, even if additional mechanical cooling is required to meet the cooling load of the building
- ✓ A means to relieve excess outdoor air during economizer operation in order to prevent over pressurizing the building. The relief air outlet must be located so as to avoid recirculation into the building

Exceptions

- ✓ High efficiency equipment as defined in Table 503.3.1 (2) below:

Climate Zones	Cooling equipment performance improvement over Tables 503.2.3 (1 and 2)
2B	10% Efficiency Improvement
3B	15% Efficiency Improvement
4B	20% Efficiency Improvement

- ✓ Systems that serve spaces with open case refrigeration or that require filtration equipment in order to meet the minimum ventilation requirements of chapter 4 of the IMC.

7. Duct and Plenum Insulation and Sealing 503.2.7

There are several requirements for duct and plenum systems:

- ✓ Ducts and plenums in unconditioned spaces must have a minimum of R-5 insulation
- ✓ Ducts located outside the building require a minimum of R-8 insulation
- ✓ Any duct or plenum located adjacent to exterior walls 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-

Photo credit: Ryan Meres

Simple Building exceptions to energy recovery ventilation requirements

As prohibited by the IMC

Spaces without cooling that are heated to less than 60°F

No more than 60% of the outdoor heating energy is provided from site-recovered or site-solar energy

Heating systems in climates with less than 3,600 HDD

Cooling systems in climates with a 1% cooling design wet-bulb temperature less than 64°F

Systems requiring dehumidification that employ series-style energy recovery coils wrapped around the cooling coil

Mechanical Systems

Step M8.

Specify and install piping insulation.

Step M9.

Conduct air balancing.

Step M10.

Provide manuals.

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.

8. Piping Insulation 503.2.8

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 piping does not need to comply if it:

- ✓ Is factory installed piping that's part of your HVAC equipment, and that HVAC equipment complies with the performance requirements shown in the previous section.
- ✓ Conveys fluid whose design operating temperature range is between 55°F and 105°F.

- ✓ Utilizes runout piping that does not exceed 4 feet in length and 1 inch in diameter between the control valve and HVAC coil.

HVAC System Completion

Because Simple Buildings focus only on air systems, the following are required:

- ✓ Air system balancing
- ✓ Manuals

9. Air System Balancing 503.2.9.1

Each supply air outlet and zone terminal device must be equipped with means for air balancing (in compliance with Chapter 6 of the IMC).

10. Manuals 503.2.9.3

The IECC requires that construction documents and operating and maintenance manuals be provided to the building owner by the mechanical contractor. The manuals need to include:

- ✓ Equipment capacity (input/output) and required maintenance actions.
- ✓ Equipment operation and maintenance manuals.
- ✓ HVAC system control maintenance and calibration information, including wiring diagrams, schematics, and control sequence descriptions. Desired or field-determined set-points must be permanently recorded on control drawings, at control devices, or, for digital control systems, in programming comments.
- ✓ A complete written narrative of how each system is supposed to work.

Service Hot Water Systems

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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, and
- ✓ Insulation of service hot water piping.

1. Equipment Efficiencies 504.2

Simple Buildings with the following systems need not provide documentation showing they meet the efficiency standards of Table 504.2 as they meet the requirements of the National Appliance Energy Conservation Act (NAECA):

- ✓ Storage tank (electric) water heaters that use less than 12KW
- ✓ Storage tank (gas) that uses >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 502.4.

2. Controls 504.3, 504.6

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, and
- ✓ 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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Simple Building criteria for service hot water systems

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

Step SHW1.

Ensure the system complies with the efficiencies in Table 504.2 if it includes:

- ✓ Storage tank (electric) that use greater than 12KW
- ✓ Storage tank (gas) that use greater than 75,000 Btu/h
- ✓ Instantaneous gas that use greater than or equal to 200,000 Btu/h
- ✓ Storage tank (oil) that uses greater than 105,000 Btu/h
- ✓ Instantaneous oil that uses greater than or equal to 210,000 Btu/h

Step SHW2.

Ensure equipment includes:

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

Service Hot Water Systems

Step SHW3.

Ensure heat traps are installed.

Step SHW4.

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

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 504.4

Heat traps must be installed on the inlet and outlet side of water heaters that use circulation loops to circulate hot water through the building. Some

Photo credit: U.S. Dept. of Energy

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.

4. Piping Insulation 504.5

The piping insulation provision accounts for two different piping configurations—automatic circulating hot water systems and non-circulating systems.

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For automatic circulating hot water systems, piping shall be insulated with 1 inch of insulation having a conductivity not exceeding 0.27 Btu per inch/H x ft^2 x F^o. This is equal to an R-3.7 per inch thickness.

The first 8 feet of piping in noncirculating 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^2 x F^o.

Electrical Power and Lighting Systems–Interior Lighting

There are four key requirements for electrical power and lighting in the 2009 IECC that all apply to Simple Buildings:

- ✓ Maximum interior lighting power,
- ✓ Interior lighting controls,
- ✓ Maximum exterior lighting power, and
- ✓ Exterior lighting controls.

1. Maximum Interior Lighting Power 505.5

In the 2009 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 505.5.2 located to the right. 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 (505.5.2)

"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
- ✓ A lobby
- ✓ Office space

Then, multiply the lighting power density (W/ft^2) 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 more specific building area type where more than one area type exists in the building.

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

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

General Exemption

This section does not apply to dwelling units when 50% or more of the installed interior lighting fixtures are fitted with high efficacy lamps. The efficacy of lamps is determined by how much light is emitted, in lumens per watts 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

For more information on high efficacy lighting, visit energycodes.gov and look through the "Code Notes" publications. There is one specifically for high efficacy lighting.

Step L1a.

Calculate maximum interior lighting power allowance.

Electrical Power and Lighting Systems

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 505.5.1.

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. In the right-hand column is a list of exempted lighting. (See 505.5.1)

This total wattage allowed does not include

- ✓ Emergency lighting,
- ✓ Display lighting,
- ✓ Directional signage, or
- ✓ Any other applicable type of lighting from Table 505.5.2.

c. Calculating Installed Lighting Wattage

Installed lighting wattage must be calculated in accordance with Section 505.5.1. 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

Interior Lighting Allowance Exemptions (Section 505.5.1)

The connected power for the following does not need to be included in calculations:

- ✓ Professional sports arena playing field.
- ✓ Sleeping unit lighting.
- ✓ Emergency lighting automatically off during normal building operation.
- ✓ Lighting in spaces specifically designed for use by occupants with special lighting needs including visual impairment and other medical and age-related issues.
- ✓ Lighting in interior spaces specifically designated as a registered interior historic landmark.
- ✓ Lighting for casino gaming areas.
- ✓ Task lighting for medical and dental procedures.
- ✓ Display lighting for exhibits in galleries, museums, and monuments.
- ✓ Theatrical, stage, film, and video production.
- ✓ Lighting used for photographic processes.
- ✓ Lighting integral to equipment or instrumentation installed by manufacturer.
- ✓ Lighting for plant growth or maintenance.
- ✓ Lighting for advertising or directional signage.
- ✓ Lighting for food warming and food prep equipment (in restaurant buildings and areas).
- ✓ Lighting equipment that is for sale.
- ✓ Lighting demonstration equipment in lighting education facilities.
- ✓ Lighting approved because of safety or emergency considerations, exclusive of exit lights.
- ✓ Lighting integral to both open and glass-enclosed refrigerator and freezer cases.

- ✓ Lighting in retail display windows when the display is enclosed by ceiling-height partitions.
- ✓ Furniture-mounted supplemental task lighting controlled by automatic shutoff.

Calculation Examples

Calculating Interior Lighting,

Single Space Types

Example:

A 200,000 ft^2 office building that contains a corridor, restrooms, break rooms, and a lobby is given 1.0 W/ft^2 for the entire building

Office: 200,000 ft^2

1.0 W/ft^2 = 200,000 W

Total watts allowed = 200,000 W

Calculating Interior Lighting,

Multiple Space Types

Example:

A building contains the following area type

Retail: 5,000 ft^2

Cafeteria: 10,000 ft^2 } at 1.1 W/ft^2

Museum: 40,000 ft^2

= 44,000 W

Cafeteria: 10,000 ft^2

at 1.4 W/ft^2 = 14,000 W

Retail: 5,000 ft^2

at 1.5 W/ft^2 = 7,500 W

Total watts allowed = 65,500 W

Table 505.5.2

Lighting Power Density	
Building Area Type[a]	**(W/ft^2)**
Automotive Facility	0.9
Convention Center	1.2
Court House	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
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	1.0
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[b]	1.5
School/University	1.2
Sports Arena	1.1
Town Hall	1.1
Transportation	1.0
Warehouse	0.8
Workshop	1.4

*Refer to IECC for footnotes a and b.

Electrical Power and Lighting Systems

Step L2a.

Ensure manual controls are specified and installed in appropriate spaces.

Step L2b.

Ensure controls are specified and installed to reduce the lighting load by 50% .

Step L2c.

Ensure lighting shutoff controls are specified and installed, using one of the three methods:

- ✓ Scheduled on/off
- ✓ Occupancy sensors
- ✓ Alarm system activation triggers lights off

2. Interior Lighting Controls 505.2.1

The 2009 IECC includes specific control requirements for lighting:

- ✓ Interior manual controls
- ✓ Lighting reduction controls
- ✓ Automatic lighting shutoffs
- ✓ Daylit zone controls

a. Interior manual controls

Any lit 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 505.2.1)

Exceptions include:

- ✓ Spaces designated as a security or an emergency area that must be constantly lit
- ✓ Spaces used for a corridor is considered a means of egress for the general coming and going of people

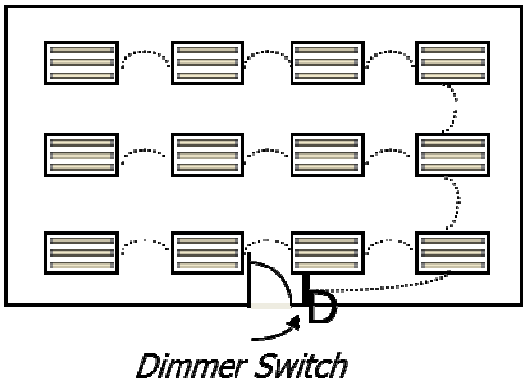
b. Interior Lighting Reduction Controls

Occupants must have the ability to reduce the space lighting level uniformly by 50%. The code offers several alternative means to accomplish this:

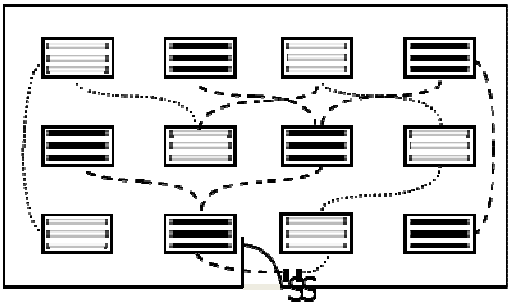
- ✓ Install a single control for all of the lights that, in addition to switching the loads on and off, can dim the lights at least 50%
- ✓ Provide switching for alternating lights or rows of lights providing control over 50% of lighting from each switch.
- ✓ Provide ability to switch the center lamp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

Illustrated Lighting Reduction Control Options:

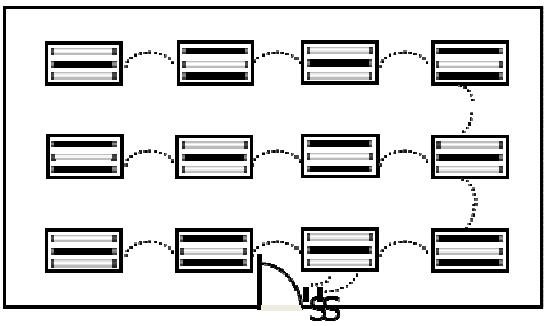
Option 1: A single control for all of the lights that, in addition to switching the loads on and off, can dim the lights at least 50%



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 the overall lighting load uniformly by 50%.



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



c. Automatic Lighting Shutoff

Buildings larger than 5,000 ft^2 need an automatic control device to shut off lighting in the building. This automatic control device can function in a few different ways:

- ✓ Scheduled on/off
- ✓ Occupancy sensors
- ✓ Alarm system activation triggers lights off

Exceptions to this requirement include: *sleeping units,* patient care areas, and places where automatic shutoff would endanger occupant security or safety.

Scheduled on/off

A lighting control system can be installed that turns lights off on a scheduled basis e.g. at 8:00 p.m. daily. Note:

- ✓ Each floor must be independently controlled.
- ✓ Each space > 25,000 ft^2 must be independently controlled.
- ✓ Occupant override capabilities and holiday scheduling functions are required.

Occupant Override

Scheduled on/off occupancy controls must have occupant override controls that meet the following rules and guidelines:

- ✓ Located so that a person using the device can see the lights or the area controlled by that switch
- ✓ Manually operated
- ✓ Allow the lighting to remain on for no more than 2 hours when an override is initiated
- ✓ The area it controls should be no larger than 5,000 ft^2 (see note).

Exceptions:

Where a captive-key override is utilized in arcades, single-tenant retail spaces, and industrial facilities, override time shall be permitted to exceed 2 hours. The spaces controlled may be up to 20,000 ft^2.

Holiday Scheduling

Scheduled on/off occupancy controls must have holiday scheduling capabilities that turn off lighting systems for at least 24 hours, then resume the normal schedule. Certain building uses are exempt from the holiday scheduling requirement:

- ✓ Retail stores and associated malls
- ✓ Restaurants
- ✓ Places of religious worship
- ✓ Theatres
- ✓ Occupancy Sensors

Occupancy sensors must turn lights off within 30 minutes of an occupant leaving that space.

Alarm Trigger

A signal from another control or alarm system which indicates the space is unoccupied and turns off lighting may be used.

Occupancy Override and Space Considerations

It is clear that each occupancy override switch can only govern 5,000 ft^2. But according to the rules for Option 1, the automatic shutoff switch can control up to 25,000 ft^2. In larger buildings it won't be unusual to see multiple occupancy override switches on a given floor.

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.

Electrical Power and Lighting Systems

Step L3a.

Identify whether the project has daylight zones either under skylights or adjacent to vertical windows.

Step L3b.

Determine your lighting control requirements.

Step L3c.

Ensure exit signs don't exceed 5 watts/side.

3. Daylight Zone Controls

The last provision to address for manual lighting controls is daylighting zone controls, which affect areas under skylights adjacent to vertical fenestration.

Complying with the daylighting control requirements in Section 505.2.2.3 includes two steps.

- ✓ Identify whether the project has daylight zones either under skylights or adjacent to vertical windows.
- ✓ Determine your lighting control requirements.

a. Under Skylights or Adjacent to Vertical Fenestration

Under Skylights

This refers to the area under skylights whose horizontal dimension, in each direction, is equal to the skylight dimension plus the smaller of:

- ✓ The floor-to-ceiling height, OR
- ✓ The distance to a ceiling height opaque partition, OR
- ✓ One-half the distance to adjacent skylights or windows

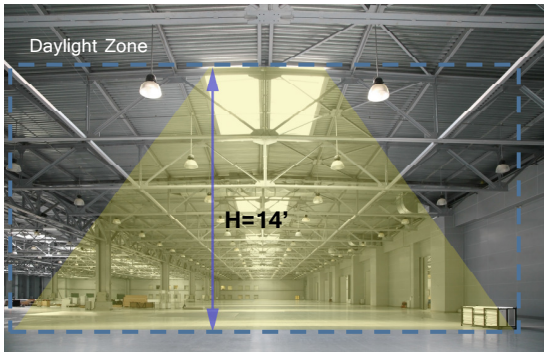
Adjacent to Vertical Fenestration

This refers to the area along the exterior walls, defined as 15 feet into the space or to the nearest wall, whichever is less, and the width of the window plus 2 feet on each side, OR

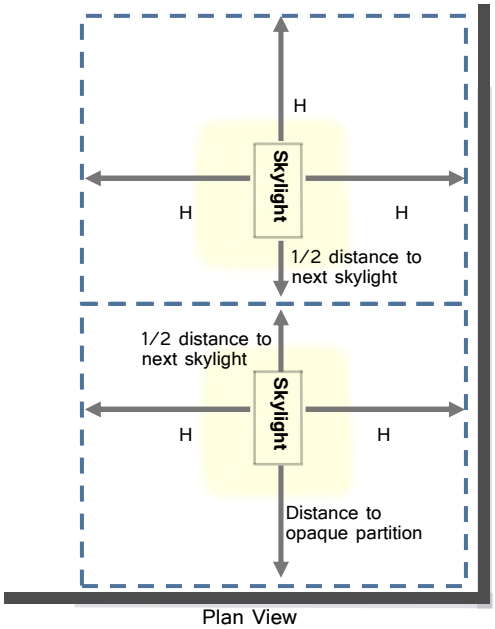
the window width plus the distance to opaque partitions, OR the window width plus one-half

Example: Daylight Under Skylights

Skylights in Warehouse



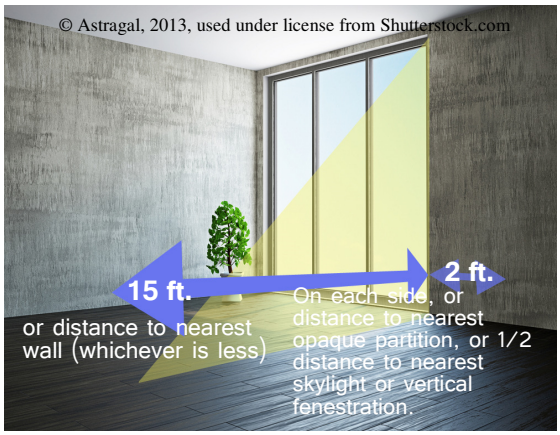
Interior View Showing Daylight Zone



Plan View

the distance to the adjacent skylight or vertical fenestration

Example: Daylight Adjacent to Vertical Fenestration



Exception:

Daylight spaces enclosed by walls or ceiling height partitions that contain two or fewer light fixtures are not required to have a separate switch for general lighting.

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

b. Controls for Daylit Zones

Determine your lighting control requirements. If your space includes a daylit zone, the lights in the daylit zone(s) need to be switched separately from the general lighting. Note that lighting controls in daylit zones are only required to be manual switches.

- ✓ Contiguous daylight zones next to vertical fenestration (e.g. a long wall of windows with lights in those areas) must have one control for that section.
- ✓ Where contiguous daylight zones face in two adjacent orientations (e.g. west and north), the lights can be controlled on one switch.
- ✓ Zones facing three cardinal orientations (e.g. east, south, and west) and lights located in two non-adjacent orientations need two controls.

Daylight zones more than 15 feet from the perimeter (e.g. from a skylight) must be controlled separately from daylight zones adjacent to vertical fenestration.

c. Exit Signs

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

Step L4a.

Determine tradable and non-tradable lighting areas

Step L4b.

Determine in which zone the building is located .

Electrical Power and Lighting Systems-Exterior Lighting

4. Exterior Lighting Power 505.6.2

In the 2009 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
- ✓ Drive-up windows/doors
- ✓ Parking near 24-hour retail entrances

ATM areas are non-tradable.

b. Determine the Lighting Zone

To determine the lighting zone, do the following: find the predetermined zone from Table 505.6.2 (1) that best describes the area where the project will be located.

- ✓ Loading areas for law enforcement, fire, ambulance, and other emergency vehicles
- ✓ Drive-up windows/doors
- ✓ Parking near 24-hour retail entrances

Main building entrances and exits are tradable areas.

Table 505.6.2(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

Step L4c.

Calculate exterior lighting allowance.

Step L5.

Ensure appropriate exterior lighting controls are specified and installed.

Exceptions: Lighting used for the following exterior applications is exempt when equipped with a control device independent of the control of the non-exempt lighting:

1. Specialized signal, directional, and marker lighting associated with transportation
2. Advertising signage or directional signage
3. Integral to equipment or instrumentation and is installed by its manufacturer
4. Theatrical purposes, including performance, stage, film production, and video production
5. Athletic playing areas
6. Temporary lighting
7. Industrial production, material handling, transportation sites, and associated storage areas
8. Theme elements in theme/amusement parks
9. Used to highlight features of public monuments and registered historic landmark structures or buildings

Electrical Power and Lighting Systems-Exterior Lighting

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 505.6.2(2).

Example

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

- ✓ Parking lot: 15,000 ft^2
- ✓ 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^2 @ 0.6 W/ft^2 = 9,000 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: 9,990 W

Non-Tradable Surfaces

Automated teller machines:

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

Total Non-Tradable Surfaces: 360 W

5. Exterior Lighting Controls 505.2.4

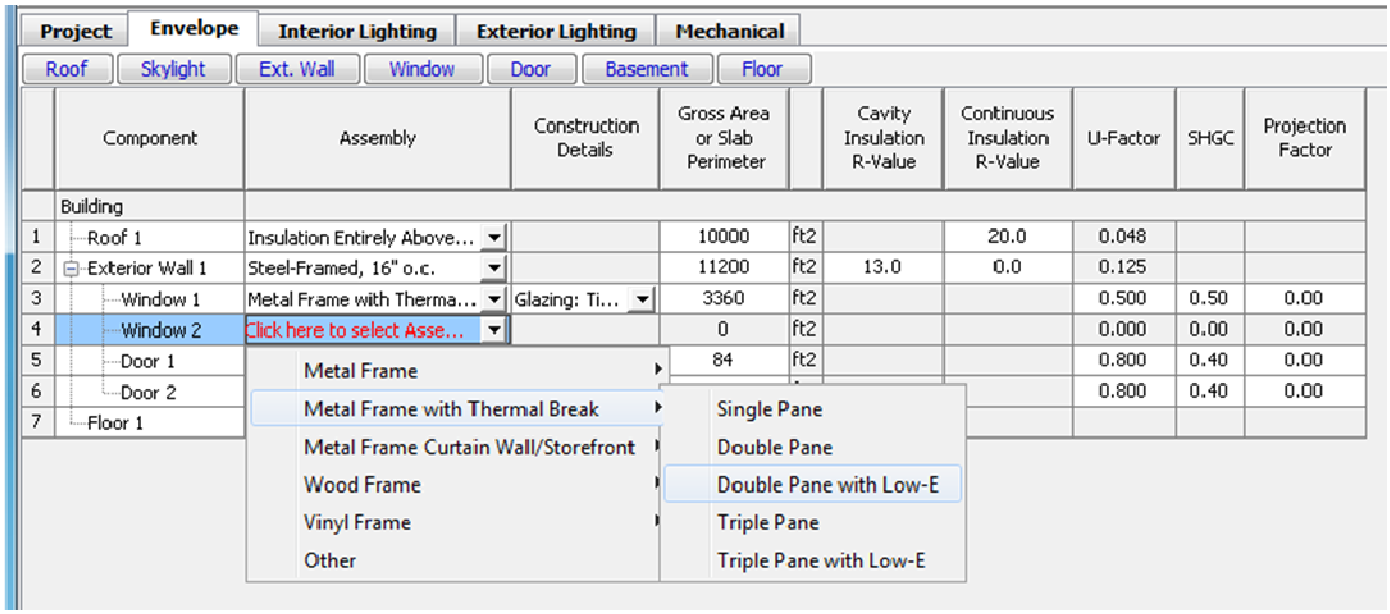
Requirements for exterior lighting controls on Simple Buildings are straightforward:

- ✓ 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.

Compliance

COMcheck

COMcheck is software for energy code compliance. You begin by entering information about the jurisdiction you're complying with. Then, the program walks you through each assembly type (for the most part, you can draw from your building plans) and you insert your given R-Values. At the end of that process, COMcheck computes all of the information and tells you if you passed. This is a great program for several reasons. First, it's free and easily downloadable from the energycodes.gov website. Second, it lets you see all the values that go into the process of complying with the code and gives the opportunity to note needed adjustments.



Small commercial buildings (less than 50,000 ft^2) 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, so this Compliance Guide was created to parse out only the requirements needed for simple buildings. This book is a step-by-step guide on how simple commercial buildings can comply with the 2009 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 book is ideal for designers, contractors and code officials.