

# Energy Code Compliance in Wood-Frame Buildings

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In terms of meeting energy code requirements, wood-frame buildings are extremely versatile. One of the key regulated areas within any energy code is the building thermal envelope. Due to the unique thermal resistance of wood and the ease of accommodating cavity insulation between wood studs, options exist for wood-frame construction that are not available for other construction types. Mandatory requirements for lighting systems or mechanical systems do not change based on the building construction material; however, wood provides versatility in the building envelope configuration that can allow designers to achieve desired building features more easily.

This paper provides an overview of how to meet energy code requirements with a specific focus on wood-frame buildings and compliance with the *2012 International Energy Conservation Code* (IECC).

Within the IECC, there are several paths of compliance that can be chosen when designing a building. The choice of design path depends on the systems, components and features of the design. Another consideration is the level of stakeholder effort that can be committed to compliance documentation. This paper covers the fundamentals of compliance with the 2012 IECC and emphasizes the design flexibilities that exist for wood-frame buildings in non-residential and multi-family construction.

As in all discussions of a model code, it is imperative that the designer be aware of state or local amendments to or interpretation rulings of the model codes by the local jurisdiction.

## **Purpose of the IECC**

The IECC sets minimum efficiency requirements for new and renovated buildings. It is one of a number of model codes developed by the International Code Council (ICC)—a private, nonprofit organization that is independent of jurisdictions responsible for enacting and enforcing adopted codes. Local governments choose to adopt a model building code primarily





because it promotes greater regulatory uniformity between jurisdictions across the U.S. It also saves time, expense and expertise that would otherwise be required to develop a comparable code. The IECC is updated on a three-year cycle through a consensus process whereby any member of the public can submit a code change proposal for consideration. Buildings that comply with the energy-efficiency requirements of the IECC

are generally more comfortable and cost-effective to operate, assuring economic and environmental benefits for the life of the building.

As of December 2014, forty-seven states, the District of Columbia, Puerto Rico and the U.S. Virgin Islands have adopted the IECC. The exceptions are California, Minnesota, and Indiana, though these states have similar requirements for many building systems.

International Code Council

# **Code Adoption Process**

When states or, in some cases, jurisdictions adopt a model code as their own, they have the choice of adopting the entire code verbatim or making local amendments. Amendments may delete, modify or add requirements at the state or local level where the code is enforced. With the IECC, a common amendment is deleting the bulk of Section C301, which defines Climate Zones for the entire country. For a statewide code, this section can usually be accomplished in a few lines, depending on whether areas of the state fall into more than one Climate Zone.

# **Scope of Buildings Covered in IECC**

The 2012 IECC is split into two sections: residential and commercial.

The residential section applies to detached one- and two-family dwellings, multiple single-family dwellings (townhouses), and Groups R-1, R-2 and R-3 buildings that are three or fewer stories in height above grade plane. (Note: The energy efficiency requirements of the *International Residential Code* are extracted from and identical to the 2012 IECC– Residential Provisions.)

The commercial section applies to all other buildings, and also contains some requirements applicable to Group R occupancies. Group R occupancy requirements apply to



The residential portion of this mixed-use infill project includes five stories of Type IIIA wood-frame construction. Multi-residential buildings are covered under the commercial section of the IECC.

Cityville Cityplace Dallas, TX JHP Architecture/Urban Design

Photo: Charles Davis Smith, AIA

buildings which contain residential occupancies but do not fit within the scope of the residential section. This includes multifamily buildings over three stories and mixed-use buildings containing Group R occupancies. IECC Section C402 specifies more stringent building envelope requirements for buildings or sections of buildings with Group R than for commercial buildings of other occupancies. In mixed-use buildings, the building envelope of Group R areas must independently meet the residential requirements in Section C402, and the rest of the building may independently meet the non-residential requirements.

The IECC is written to apply to new construction. While elements of building additions, alterations, renovations and repairs are also required to conform to specific provisions, unaltered portions of a project are exempt. With certain exceptions, additions are deemed to comply if either the addition alone or the entire, newly altered building complies. A change in occupancy or use that increases the use of fossil fuels and the addition of space conditioning to a non-conditioned space also require full compliance with the IECC. Most changes in occupancy or use require compliance with the lighting wattage requirements of Section C405.5. Historic buildings, as defined by C101.4.2, are exempt.

Major components regulated by the IECC are the building envelope, lighting systems and mechanical systems, which include space conditioning and service water heating. The building envelope and other selected requirements are dependent on the Climate Zone in which the building is located. IECC Section C301 assigns the entire United States, plus its territories, different Climate Zones based on historical heating and cooling climate patterns and amount of precipitation. As a general rule, lower numbered Climate Zones are in the southern latitudes, and higher numbered Zones are in the Northern latitudes. Examples of requirements that are dependent on Climate Zone are the air barrier requirement around the building envelope, which is waived in Climate Zones 1-3, and the economizer requirement on cooling systems greater than or equal to 33,000 Btu/h, which is waived in Climate Zones 1A and 1B (See IECC Table C403.3.1(1)).

# **Paths of Compliance**

When designing a building, architects have three main paths for obtaining compliance with the 2012 IECC:

- IECC Prescriptive Path
- IECC Performance Path
- ASHRAE 90.1 Path

For either IECC path, certain sections of the IECC are mandatory. These include requirements specific to air leakage in the thermal envelope (Section C402.4), space conditioning and ventilation (Section C403.2), service water heating (Section C404), and electrical power and lighting systems (five subsections of Section C405). The path outlined in the ASHRAE Standard 90.1-2010 (ASHRAE 90.1), developed jointly by the American National Standards Institute (ANSI), American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) and Illuminating Engineering Society of North America (IESNA), is not required to comply with the mandatory sections of the IECC; however, ASHRAE 90.1 has its own mandatory sections.



An above-code program, when deemed to meet or exceed code requirements by the Building Official, is a fourth compliance path. All mandatory section of the IECC are still required to be met.

# **IECC Prescriptive Path**

The prescriptive path is a simple compliance option, well-suited for small-to-moderately sized buildings. All components of the building envelope (Section C402), building mechanical systems (Section C403), service water heating (Section C404), and electrical power and lighting systems (Section C405) must meet the prescribed set of requirements stated in the code on an individual basis for compliance. The downside to this method is lack of flexibility in optimizing the economies of component costs and selection. Under the prescriptive path, walls, floors and roofs have specific insulation requirements based on the framing type and the Climate Zone in which the building is located. For example, in IECC Table C402.2, above-grade metal-framed walls in Climate Zones 3 and 4 (Except Marine) are required to have R-13 cavity insulation and R-7.5 continuous insulation applied to one face of the wall. The wood-framed walls at the same location are required to have R-13 cavity insulation and R-3.8 continuous insulation or have R-20 cavity insulation with no additional continuous insulation requirements. The option to forego continuous insulation requirements on wood-framed walls with R-20 cavity insulation is acknowledgement that the

metal studs have a significantly higher thermal conductance than wood studs. The R-20 cavity insulation option allows wood wall frames with 6-inch deep studs to meet the prescriptive wall requirements with no continuous insulation in Climates Zones 1–5, except Group R occupancies in Marine Climate Zone 4. The R-20 wood-framed wall is the only option available in the IECC prescriptive wall path using prescribed R values that does not require continuous insulation for above-grade walls.

Many designers use the ComCheck and ResCheck energy modeling packages, which are free to download through the U.S. Department of Energy website, to verify that their designs meet the IECC prescriptive thermal envelope requirements. Designers are advised to seek prior approval from their local jurisdiction to ensure that local policy allows their application. Some jurisdictions may have local requirements that are not incorporated into either software.

# **R-Value of Common Wall Materials**



Though compliance with this path limits certain features that a building owner could desire, such as the maximum percentage of fenestration area (windows, doors) in the exterior walls, it is often more than sufficient for the average building.

## **IECC Performance Path**

The total building performance path involves designing a building that, when evaluated against a comparable building of a standard reference design, has energy costs at least 15% lower (C401.2(3)). This path allows greater flexibility but requires more effort and expertise during design. The flexibility arises from trade-offs that can be made between the building envelope and mechanical systems as long as the building as a whole is compliant based on relative energy costs. Compliance software tools, of which there are both commercial and no-cost options, are utilized to generate reports that document the annual energy costs of the proposed design versus that of the standard reference design. The tools generate a checklist documenting each building component characteristic for the proposed and standard reference design. Mandatory sections of the IECC must still be met.

## **ASHRAE 90.1 Alternative**

ASHRAE 90.1 also provides designers with a prescriptive and a performance-based compliance path. Similar to the IECC, there are sections within ASHRAE 90.1 that provide the designer with options even when utilizing the prescriptive path. An example is the R-value and U-factor building envelope compliance options, a choice that exists both in the IECC and ASHRAE 90.1. Unlike the IECC, ASHRAE 90.1 does not contain the option to reduce or forego continuous insulation in wood-frame walls with the use of R-20 cavity insulation under the prescriptive path.

## **Above Code Programs**

IECC Section C102.1.1 permits the Building Official to deem a national, state or local energy-efficiency program, such as the U.S. Green Building Council's (USGBC's) Leadership in Energy and Environmental Design (LEED) program, to exceed the energy-efficiency requirements of the 2012 IECC. If this path is chosen and approved by the Building Official, the designer is still required to comply with mandatory sections of the IECC in addition to achieving full compliance and accreditation with the chosen program.

## **Significant Differences Between Paths**

The choice of which compliance path to follow is dependent on the building features desired and the professional resources that can be dedicated to compliant design. Both the IECC and ASHRAE 90.1 allow a performance-based compliance path, and each has mandatory requirements that must also be met in addition to the computer modeling results. Above-code programs can vary significantly, and it is always up to the Building Official of a particular jurisdiction whether or not to allow the equivalency. This is not to say that an above-code program cannot be achieved without acceptance by the Building Official; however, the building will have to meet applicable requirements of the IECC as well.

Prescriptive paths of the IECC and ASHRAE 90.1 are similar but not identical, and there may be exceptions to requirements in one that are not found in the other. Designers should check both to see if one set of requirements allows a building to be built more efficiently or less expensively than the other. The specific differences between the respective code and standard occur in the areas of building envelope, mechanical systems and lighting systems.

#### FIGURE 2

# Wood-Frame vs Steel-Frame Wall Assembly Effective Insulation R-Values



Note: A conservative insulation value of R-3.8 per inch was assumed for expanded polystyrene (EPS), based on various manufacturers' thermal conductivity data; ci = continuous insulation

References: ASHRAE 90.1-2010, Table A3.3 – Assembly U-Factors for Steel-Frame Walls ASHRAE 90.1-2010, Table A3.4 – Assembly U-Factors for Wood-Frame Walls

As an alternative to using the prescribed R-values, the areaweighted thermal resistance (U-factor) of the entire wall assembly can be calculated to comply with IECC Table C402.1.2. Similar R-value or U-factor requirements are defined for floors and roofs within the two tables. Under the prescriptive path, one of three additional efficiency package options (Section C406) must also be chosen, which tightens the requirements of the HVAC performance (Section C406.2) or the lighting system efficiency (Section C406.3), or which requires an on-site supply of renewable energy (Section C406.4). See the last row in Table 1.

#### TABLE 1

### 2012 IECC Prescriptive Compliance Paths

Section	Option 1	Option 2	Option 3	
C402 – Building Envelope	C402.1.1 – R-Value	C402.1.2 – U-Factor Alternative		
C403 – Building Mechanical Systems	C403.3 – Simple Systems	C403.3 – Complex Systems		
C404 – Service Water Heating	Mandatory Provisions			
C405 – Electrical Power & Lighting	Mandatory Provisions + Building Area Method	Mandatory Provisions + Space-by-Space Method		
C406 – Additional Energy Package	C406.2 – Efficient HVAC Performance	C406.3 –Efficient Lighting System	C406.4 – On-Site Supply of Renewable Energy	

#### TABLE 2

## **ASHRAE 90.1 Prescriptive Compliance Paths**

Chapter	Option 1	Option 2	
5 – Building Envelope	5.5 – Prescriptive Building Envelope	5.5 – Building Envelope Trade-Off	
6 – Heating, Ventilation and A/C	6.3 – Simplified Approach	6.4 & 6.5 – Mandatory Provisions & Prescriptive	
7 – Service Water Heating	Mandatory Provisions & Prescriptive		
8 – Power	Mandatory Provisions		
9 – Lighting	9.5 – Building Area method	9.6 – Space-by-Space method	

#### FIGURE 3



**Significant Differences Between Paths** 

The calculation procedure for determining the allowable window wall area is different in the 2012 IECC and ASHRAE 90.1. More window area is permitted with the ASHRAE 90.1 approach because of the way the outside wall is defined.

The thermal requirements for opaque and non-opaque assemblies are not always identical within the IECC and ASHRAE 90.1. Additionally, ASHRAE 90.1 allows a window-to-wall ratio up to 40% and a 5% skylight roof area. The 2012 IECC allows 30% and 3% (with certain exceptions), respectively. The definition of a wall within each code is also of significant consequence. For the purpose of determining the percentage of wall that is vertical fenestration, ASHRAE 90.1 uses both aboveand below-grade walls as the denominator, whereas the 2012 IECC considers only above-grade walls. This further limits the percent of allowable window area in buildings designed to the IECC. On the other hand, ASHRAE 90.1 limits the fenestration area on the east and west facades by requiring that the south façade have a greater fenestration area than the east or west.

The 2012 IECC contains more stringent requirements for mechanical systems and requires the choice of an additional energy-efficiency package option, whereas ASHRAE 90.1 contains more stringent lighting density limits. These facts should be considered along with the primary energy-consuming features of the building during the design phase.

# **Common Design Considerations**

When designing a building, all systems and components are integrated for occupant comfort, safety, aesthetics and overall energy performance. Each of these features must be designed with consideration of the building as a whole. A strong understanding of the IECC is a fundamental advantage to building energy performance and will simplify the compliance process throughout design and construction. The following discussions deal with specific energy code-related issues that may be encountered during building design.

## **Building Envelope Thermal Trade-offs**

The prescriptive requirements for a building's thermal envelope are dependent on the Climate Zone in which the building is located. Tables C402.1.2, C402.2 and C402.3 in the 2012 IECC summarize the main requirements for a building envelope's thermal performance while allowing two prescriptive compliance paths.

Utilizing Table C402.2 is the most commonly followed path. For each component of the building envelope (i.e., roofs, walls, floors and opaque doors), a minimum R-factor is specified. Wood-frame walls are unique in that they're the only component where a choice can be made between two insulation requirements based on the level of continuous insulation desired. Continuous insulation is comprised of rigid boards placed end-to-end over an entire wall to provide a contiguous layer of insulating material. The purpose is to minimize condensing surfaces in walls and provide an insulation layer in which little to no thermal bridging occurs. Wood framing has sufficient thermal insulation that cavity-only insulation is allowed by the IECC for some applications and Climate Zones.

If areas of an assembly cannot meet the prescriptive R-values specified in Table C402.2, then the U-factor alternative path can be followed. This path allows the designer to have portions of each component of the building envelope exceed the maximum U-factor that's specified in Table C402.1.2 as long as the area-weighted U-factor for each component does not. The thermal

performance of opaque door assemblies (doors having less than 50% glass area) are not differentiated from walls in this path. Table C402.1.2 is an alternative to Table C402.2.

The thermal performance requirements of fenestration other than opaque doors are tabulated in Table C402.3. Area-weighted average U-factors are permitted to satisfy the requirements of each product category listed (i.e., fixed fenestration, operable fenestration, entrance doors and skylights). Entrance doors are allowed a higher maximum U-factor than other operable fenestration or swinging opaque doors.

When the performance path is chosen, none of the prescriptive building envelope thermal requirements are required to be individually satisfied.



Credit: KC Kim, GB Construction

## Building Envelope Air Leakage Design Requirements

Measuring the amount of air leakage through a building envelope is accomplished with a full building test, where a series of fans is set up in an exterior doorway and the necessary flow rate of air is measured in order to maintain a specified pressure differential between the interior and exterior of the building. While full building blower door tests are not commonly performed on commercial structures, such testing is increasing as a way to achieve and validate low air leakage rates.



Full building tests are a compliance option with building air leakage requirements if using non-traditional air barrier materials that do not meet the prescriptive requirements of the code.

redit: Retrotec



IECC Section C402.4.1.2.1 lists specific materials that are deemed to comply with air barrier requirements. Examples include plywood or oriented strand board having a thickness of not less than 3/8 inch.

University of Washington Student Housing Seattle, WA Ankrom Moisan Architects

Credit: W.G. Clark Construction

Section C402.4 in the 2012 IECC specifies the mandatory requirements regarding building air leakage through the thermal envelope. Except for in Climate Zones 1, 2 and 3, a continuous air barrier is required for all assemblies that comprise the thermal barrier of the building. Air barriers can be materials or assemblies of materials of a specified permeability or can be constructed of specific materials listed in IECC Section C402.4.1.2, Air Barrier Compliance Options. In all Climate Zones, fenestration assemblies are required to meet the air infiltration rates specified in IECC Table C402.4.3. Recessed lights installed in the building envelope are required to have an air leakage rating of not more than 2.0 cubic feet per minute (cfm) when tested in accordance with ASTM E 283. Though a full building test will allow a designer to use materials that do not comply with these prescriptive requirements, the completed building must have an air leakage rate less than or equal to 0.40 cfm/ ft<sup>2</sup>. With the exception of Climate Zones 1 and 2, all building public entrances that open into a space greater than 3,000 ft<sup>2</sup> are required to be provided with an enclosed vestibule equipped with self-closing doors.

ASHRAE 90.1 has similar mandatory requirements for air leakage in Section 5.4.3, Air Leakage. There are slight differences in the maximum allowable leakage for sliding opaque doors and rolling doors, as they are categorized differently in ASHRAE 90.1 as non-swinging opaque doors.

## Maximum Air Leakage Rates for Fenestration Assemblies in the IEC

Fenestration Assembly	Maximum Rate (cfm/ft2)	Test Procedure		
Windows	0.20			
Sliding doors	0.20			
Swinging doors	0.20	AAMA/WDMA/ CSA101/I.S.2/A440 or NFRC 400*		
Skylights – with condensation weepage openings	0.30			
Skylights – all others	0.20			
Curtain walls	0.06			
Storefront glazing	0.06	NFRC 400		
Glazed swinging entrance doors	1.00	or ASTM E 283 at 1.57 psf		
Revolving doors	1.00			
Garage doors	0.40	ANSI/DASMA 105,		
Rolling doors	1.00	ASTM E 283 at 1.57 psf		

\*National Fenestration Rating Council 400:

Procedure for Determining Fenestration Product Air Leakage

# **Semi-heated Spaces**

Buildings with large areas used for storage, warehousing and other ancillary purposes that do not require space conditioning for occupant comfort, but do require heating for the protection of building systems and contents, may be better accommodated utilizing ASHRAE 90.1. ASHRAE 90.1 has a specific designation of semi-heated space and comparable thermal envelope provisions for assemblies associated with such spaces (Tables 5.5-1 through 5.5-8) that are less rigorous than those for conditioned spaces. The 2012 IECC does not distinguish between semi-heated spaces and conditioned spaces, but treats them identically. The result is that spaces that would be semi-heated under ASHRAE 90.1 have the full thermal envelope requirements under the 2012 IECC. See Table 4 for space categorizations in both the 2012 IECC and ASHRAE 90.1.

# **On-Site Renewable Energy**

Incorporating on-site renewable energy into a project can pay dividends whether a design is pursued from a prescriptive or performance path. When following the prescriptive path in the 2012 IECC, Section C406 requires that one additional efficiency package option be chosen. One of the three options is on-site renewable energy (Section C406.4), which specifies the total minimum ratings of on-site renewable energy systems as the lesser of:

- 1. 1850 watts
- 2. 0.5 watts per ft<sup>2</sup> of conditioned floor area or
- 3. 3% of the energy used within the building for building mechanical and service water heating and lighting regulated in Chapter 4 of the IECC.

In a building with tenant spaces, supplying on-site renewable energy for the entire building that is compliant with IECC Section C406.4 allows individual tenant spaces to automatically be compliant with Section C406, an additional selling point for the initial tenants and new tenants who require an occupancy change.

Performance paths in both the IECC and ASHRAE 90.1 allow energy from non-depletable sources collected on site to be omitted from the annual energy cost of the proposed design. Although mandatory sections of the code still need to be followed, omission of the market price of on-site renewable energy generated creates considerable options when designing the building envelope and specifying fenestration or mechanical systems. An example is the ability to use higher framing factors in walls without the need for continuous insulation, making wood-framed construction feasible for higher structural loading.

Many above-code programs also award credit for on-site renewable energy. LEED, for example, assigns as many as 8 points toward certification. Examples of on-site renewable energy include solar photovoltaic and thermal, wind, geothermal heating and electric, biomass, biogas, low-impact hydroelectric, and wave/tidal power.

TABLE 4

Space Categorizations in the 2012 IECC and ASHRAE 90.1 based on Heating System Output Capacity

Space	2012 IECC	ASHRAE 90.1					
	All Climate Zones	Climate Zones 1 & 2	Climate Zone 3	Climate Zones 4 & 5	Climate Zones 6 & 7	Climate Zone 8	
Unconditioned <sup>a</sup>	< 3.4 Btu/h • ft <sup>2</sup>						
Semi-heated	n/a	≥ 3.4 Btu/h • ft <sup>2</sup> < 5.0 Btu/h • ft <sup>2</sup>	≥ 3.4 Btu/h • ft <sup>2</sup> < 10 Btu/h • ft <sup>2</sup>	≥ 3.4 Btu/h • ft² < 15 Btu/h • ft²	≥ 3.4 Btu/h • ft² < 20 Btu/h • ft²	≥ 3.4 Btu/h • ft² < 25 Btu/h • ft²	
Conditioned	≥ 3.4 Btu/h • ft²	≥ 5.0 Btu/h • ft²	≥ 10 Btu/h • ft <sup>2</sup>	≥ 15 Btu/h • ft²	≥ 20 Btu/h • ft²	≥ 25 Btu/h • ft²	

<sup>a</sup> ASHRAE 90.1 refers to these enclosed spaces within a building as *unconditioned*. The 2012 IECC uses the nomenclature, *Low-Energy* as *unconditioned* spaces refers to non-enclosed areas such as garages, attics and crawlspaces, which are exempt from building envelope requirements in both ASHRAE 90.1 and the 2012 IECC.

# Daylighting

Minimum daylighting areas and automatic controls can play a role in permitting increased fenestration and skylight area (IECC Sections C402.3.1.1/2) and increased skylight solar heat gain coefficients (SHGC) and U-factors (IECC Sections C402.3.3.3/4). The greater thermal resistance of non-metal fenestration framing, including wood, eases compliance with the U-factor requirements and overall thermal resistance requirements of the building envelope.

The IECC Defines a daylight zone as the following:

## DAYLIGHT ZONE.

- Under skylights. The area under skylights whose horizontal dimension, in each direction, is equal to the skylight dimension in that direction plus either the floor-to-ceiling height or the dimension to a ceiling height opaque partition, or one-half the distance to adjacent skylights or vertical fenestration, whichever is least.
- 2. Adjacent to vertical fenestration. The area adjacent to vertical fenestration which receives daylight through the fenestration.

For purposes of this definition and unless more detailed analysis is provided, the daylight zone depth is assumed to extend into the space a distance of 15 feet (4572 mm) or to the nearest ceiling height opaque partition, whichever is less. The daylight zone width is assumed to be the width of the window plus 2 feet (610 mm) on each side, or the window width plus the distance to an opaque partition, or the window width plus one-half the distance to adjacent skylight or vertical fenestration, whichever is least.

## FIGURE 4

# Daylight Zone Adjacent to Fenestration in a Wall



This diagram shows the daylight zones within a room next to vertical fenestration. Daylight zones have unique requirements for lighting controls.

There are lighting control requirements that must be met in any daylight zone, and the designer usually has the option to use manual or automatic controls. When minimum daylighting areas are required in some enclosed spaces greater than 10,000 ft<sup>2</sup> directly under a roof, as detailed in the next section, automatic daylighting controls are required.



Duke School Durham, NC DTW Architects & Planners and Fielding Nair International Photo: Jerry Markatos



# Skylights

Skylights are defined in the IECC as any glazing material installed at less than 60 degrees from horizontal. When following the prescriptive path in the IECC, skylight area is limited to 5% of the gross roof area when automatic daylighting controls are installed in the daylight zones under the skylights. When manual daylighting controls are used, the skylight area is limited to 3%. If a designer wants the gross roof area to be more than 5% skylights, then the performance path of compliance needs to be pursued.

Default U-factors and SHGCs for skylights are specified in Section C303.1.3, and the maximum values permitted by Climate Zone are specified in Table C402.3. The default glazed fenestration U-factors are differentiated by metal and nonmetal framing type. Double-paned nonmetal framed skylights are assigned a default U-factor of 0.55, making them prescriptively compliant in Climate Zones 1-3 without any need for formal product testing. Enclosed spaces of certain occupancies located directly under a roof, greater than 10,000 ft<sup>2</sup>, and having ceiling heights over 15 feet are required to have at least 50% of the floor area of the space as a daylight zone. Wood-framed roofs allow for the easy and inexpensive field fabrication of skylights, and with the installation of double-paned glazing, the fenestration automatically meets the U-factor requirements in Climate Zones 1–3. For buildings located in Climate Zones other than 6–8, which are not subject to this requirement, designers should familiarize themselves with the details of IECC Section C402.3.2 including additional details and exceptions.

# Conclusion

Wood construction offers advantages in terms of cost, design versatility and sustainability, and it easily meets the rigorous requirements of the 2012 IECC. With a little foresight and consideration of code requirements early in the design phase, the choice of pursuing wood construction provides a number of options that may be appreciated as the design matures. The proper design and construction of the building envelope is only one piece of a code-compliant and energy-efficient building. On a larger scale, it sets the stage for the efficient performance of the building over its entire lifetime.

## **Additional Information:**

International Energy Conservation Code, 2012, International Code Council, http://shop.iccsafe.org/codes/2012-international-codes/2012-international-energy-conservation-code/2012-international-energy-conservation-code/2012-international-energy-conservation-code.

Standard 90.1 – Energy Standard for Buildings Except Low-Rise Residential Buildings, 2010, American Society of Heating, Refrigerating and Air-Conditioning Engineers, https://www.ashrae.org/resources--publications/bookstore/standard-90-1

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Design for Code Acceptance 7: Meeting Residential Energy Requirements with Wood-Frame Construction, 2014, American Wood Council, http://www.awc.org/publications/DCA/DCA7.pdf

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