

ENERGY CODE COMPLIANCE FOR POST-FRAME BUILDINGS

BY AARON HALBERG, PE

Many different sections of the building code can affect a building project, depending on the complexity and nature of the building and on the extent of the building codes adopted by the state or local municipality where the building is located. Sections of the building code include fire safety, fuel gas, mechanical systems, existing buildings, energy conservation and plumbing.

This article focuses on the energy code, which, like other sections of the building code, has the effect of law only after it has been adopted by a state or local unit of government. In cases where the building code adopts a model code, such as the International Energy Conservation Code (International Code Council, Inc., 2015; see **Figure 1**), modifications, exemptions and additions are usually made in the legislative process as the model code is adopted. These provisions adopted by the local unit of government may significantly change the model building code language and should always be consulted for your particular project. This article is general: it does not address any local provisions or amendments made to the model building code and should not, therefore, be presumed to apply to a specific building project.

To determine which energy code and which edition apply to your next project, visit www.energycodes.gov and select your state in the “Status of State Energy Codes” section. While there, you can also download free energy code compliance software: COMcheck for commercial buildings and REScheck for residential buildings. Both programs provide assistance in complying with IECC and other model energy codes. The IECC contains efficiency requirements for energy systems within a building, including heating, ventilation and air conditioning; service water heating; electrical

power; lighting; and the building envelope.

This article focuses on building envelope requirements of the 2015 edition of the IECC as they relate to post-frame buildings for commercial use (ICC, 2015), but similar provisions exist for residential buildings. The primary focus for building envelope compliance is ensuring that the building has enough insulation in the proper locations to provide a shell that is energy efficient for heating and cooling based on the climate zone and use of the building. The 2015 IECC requires commercial buildings to demonstrate building envelope compliance through one of three paths:

1. ANSI/ASHRAE/IESNA 90.1-13 (American Society of Heating, Refrigerating and Air-Conditioning Engineers, 2013)
2. IECC prescriptive requirements (Chapter 4)
3. Total Building Performance method.

Most post-frame projects will use the IECC prescriptive requirements, although some builders may want to use the ANSI/ASHRAE/IESNA 90.1 standard, especially if the project contains many insulated garage doors (discussed below). Within the IECC prescriptive requirements compliance path, requirements are given for the opaque building thermal envelope (§C402.2), roof solar reflectance and thermal emittance (§C402.3), fenestration (§C402.4) and air leakage (§C402.5). Again, this article focuses on the requirements for the building envelope (see **Figure 2**), and within that section of the code, three options satisfy the prescriptive envelope requirements:

1. R-value-based method (§C402.1.3)
2. U-/C-/F-factor-based method (§C402.1.4)
3. Component Performance Alternative (§C402.1.5).

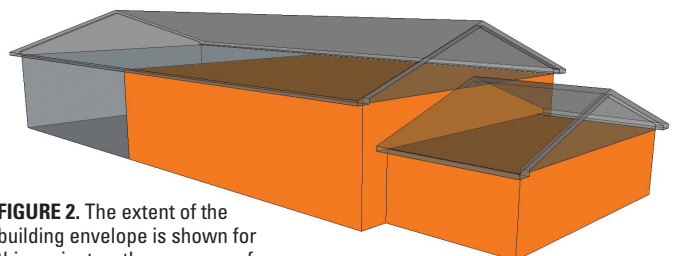


FIGURE 2. The extent of the building envelope is shown for this project as the orange surfaces. The unheated storage area (far end) and the vented attic spaces are not conditioned spaces and are excluded from the building envelope.

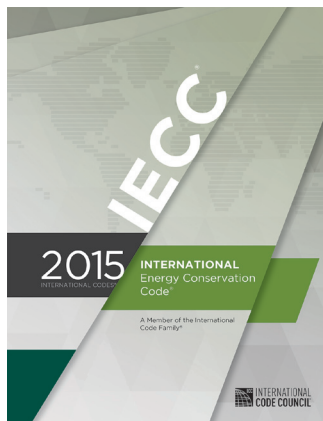


FIGURE 1. The International Energy Conservation Code is a model building code published by the International Code Council and widely adopted throughout the United States

USING COMCHECK

My experience indicates that the Component Performance Alternative will provide the most efficient compliance path for most post-frame projects, although certain subcontractors and manufacturers may have reasons to look at the first two options, especially if they are required to confirm code compliance for their portion of the envelope but do not have responsibility for the entire building envelope.

Using COMcheck to analyze the entire building envelope allows a designer to enter all assemblies and components and their performance criteria into the software. The resulting report produces a summary of the envelope and any requirements that must be satisfied during and after construction. The COMcheck report also gives a convenient score showing the building envelope's performance as a percentage better than (passing) or worse than (failing) the code requirements. One can ensure that if some portions of the building envelope in a given project are not well insulated, other areas are more aggressively insulated. If the total energy use for the building envelope is calculated to be less than the energy use level specified by the code, the COMcheck report (see **Figure 3**) will show a passing result.

AIR LEAKAGE

Some requirements of the energy code are considered mandatory because they still apply when the energy efficiency of the project exceeds the minimum energy code requirements. One mandatory example in the building envelope is resistance to air leakage (§C402.5) because even the most robustly insulated building will not be energy efficient if the envelope allows unconditioned air to enter the building when the wind blows.

Air leakage compliance can be demonstrated through either testing or compliance with IECC sections 402.5.1–402.5.8. The leakage testing is performed according to ASTM E779-10 (ASTM International, 2010) to confirm no more than 0.4 cubic feet per minute of leakage per square foot of building at 0.3-inch water pressure differential. A few requirements within this section of the code will still apply to buildings that pursue the testing option.

CONTINUOUS INSULATION

One item of confusion after the 2012 edition of the IECC was adopted in Minnesota was the enforcement of a continuous insulation (CI) requirement that is listed within the R-value method (§C402.1.3). I was told of at least one situation where the CI was required as if it were mandatory, when in fact it is just one conformance option out of the three listed above, but to refute the claim that CI was going to be required on all buildings under this new code, I had to dig into the code commentary (ICC, 2015).

Supporting comments were found to confirm that not all parts of the prescriptive code are mandatory, specifically where multiple compliance options are available. The commentary text includes this statement (some portions of the text have been omitted): “Clearly for the ... component performance approach ... the use of the R-value (Table C402.1.3) would not be appropriate” (International Code Council, Inc., 2015). Table C402.1.3 lists the required R-value for various building components and assemblies depending on the climate zone. The commentary clarifies that compliance with Table C402.1.3 is required when using the R-value method, but not when using the component performance approach.

ENERGY CODE CONCERNS SPECIFIC TO POST-FRAME BUILDINGS

Post-frame buildings as framing systems do not have unique energy code requirements, but four topics relevant to post-frame designers and builders deserve mention here.

R-Values for Wall and Ceiling Assemblies with Wider Framing Cavities than in Standard Construction

COMcheck software includes drop-down menus that make it easy to select common construction configurations and enter the common variables. For exterior walls, the user can select from a list of assemblies that includes wood-framed, 16” on center and wood-framed, 24” on center. After selecting one of these options, the user simply enters the cavity insulation R-value that will be used (R-19, R-25, etc.), and the software uses this information to calculate an effective U-value for the wall assembly, including the combined effect of the framing type, spacing and cavity insulation.

From the list of wall assemblies, the user can also select “Other (U-Factor Option)” and then select the basic wall framing type (wood-framed wall, steel-framed wall, etc.) and enter a calculated U-value for the entire assembly using accepted design procedures. COMcheck should automatically greet the user with this prompt when this option is selected:

The ‘Other’ option is for assemblies with a known assembly U-factor. Enter an overall assembly U-factor for the assembly in the U-factor field. The U-factor is assumed consistent throughout the entire assembly. Documentation must be submitted verifying the overall U-factor. The U-factor must be developed in accordance with accepted engineering practice.

The same option of providing a cus-

Envelope PASSES: Design 33% better than code

Envelope Compliance Statement
Compliance Statement: The proposed envelope design represented in this document is consistent with the building plans, specifications, and other calculations submitted with this permit application. The proposed envelope systems have been designed to meet the 2015 IECC requirements in COMcheck Version 4.0.2.5 and to comply with the mandatory requirements listed in the Inspection Checklist.

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Name - Title

Signature

Date

FIGURE 3. This example result from a COMcheck compliance report shows the building envelope result passing the minimum code requirements (by 33 percent in this case!).

tom U-factor for an “Other” assembly is offered in the section on roof or ceiling (attic) insulation.

Although this documentation and justification can be developed for post-frame wall and ceiling cavities with common framing spacing of 6’ on center up to 10’ on center or more (compared to 16” on center or 24” on center in standard wood-frame construction), the impact on energy scores seems small, in my opinion, and may not be worth specialized analysis. The overall effect of having fewer columns than studs, but with the post-frame columns being wider than the studs, may be negligible on the calculated U-value for the wall. The actual impact of thermal performance within the constructed post-frame wall may be more significant than predicted in the software because the larger cavities have fewer edges and less chance for thermal leaking between the cavity insulation and the framing members.

In the case where a builder does something innovative with wall construction using blown-in insulation that fills not only the cavity between post-frame columns but also the cavities on the inside and outside faces of the wall between outset (face-nailed) girts, development of an analysis and documentation for a customized U-value would have greater payback. Such a wall assembly (see **Figure 4**) results in significantly less thermal bridging from framing (only where girts and posts cross) than in standard wall insulation.

U-Values for Large Garage Doors

Fenestration products (doors, windows, skylights) must use U-values that include the installed effectiveness of the assembly determined according to NFRC 100 (National Fenestration Rating Council, Inc., 2013) (see ICC 2015, §C303.1.3). Because of the larger size of garage doors, they have a real difficulty meeting the NFRC 100 testing requirements, so garage door U-values can be determined according to ANSI/DASMA 105-2012 (Door and Access Systems Manufacturers Association International, 2014). In my experience, getting a published effective U-value from the garage door manufacturer used to be very rare, but it is important to the energy code compliance efforts for your building.

Most garage door manufacturers do publish their nominal R-value for the door slab (R-12, R-15, etc.), but this cannot be converted directly into an effective U-value for the installed door. If the effective and tested U-value for the installed door is not available, the energy code requires the analysis of the envelope to be based on a conservative default U-value for these doors (Table C303.1.3(2)). Using these default values in buildings with many garage doors can make it difficult or impossible to meet the energy code envelope standards, so look for door manufacturers with published ANSI/DASMA 105-2012 high-performance U-values (the lower value, the better). This is one reason that some users may want to use

the ANSI/ASHRAE/IESNA 90.1 within COMcheck instead of the IECC. ANSI/ASHRAE/IESNA 90.1 allows an insulated metal door to use a default U-value of 0.500, which is better than the IECC-allowed default value of 0.600.

Best Ways to Insulate Foundations and Building Perimeter

In “Below-Grade Insulation for Post-Frame Buildings. Part II: Preventing Heat Transfer,” in the April 2010 issue of *Frame Building News* (Bohnhoff, 2010b), David Bohnhoff discussed the importance of using vertical insulation at the edge of the concrete slab on grade and the disadvantage of using a sand layer between the concrete slab and a below-grade vapor barrier. He then presented three viable construction details for effectively insulating the building foundation for embedded-post projects.

The building perimeter and under-slab insulation details are very important for several reasons. As Part I (Bohnhoff, 2010a) in Bohnhoff’s insulation series in *Frame Building News* pointed out, foundation insulation is important for preventing frost heave. In heated buildings in cold environments where frost heave can also



FIGURE 4. Insulating systems that take advantage of the full framing cavity may warrant special consideration in energy code compliance. (Photo: Meyer Buildings)

be a concern, the foundation insulation at the perimeter of the building needs to address both concerns (frost heave and energy efficiency). The foundation insulation is also one of the most difficult parts of the project to modify after the building is constructed, so the builder has just one good chance to get this part of the project right for each building. Also, the building foundation insulation may not be required to be very thick (or may not be required at all) to meet energy code requirements according to a COMcheck analysis, but such a code-compliant solution may still result in a situation where warm, moist air repeatedly encounters a cooler surface (below the dew point), causing condensation and potentially the formation of mold or frost or both on building materials that are not designed for use in moist environments. In such situations, uncomfortable interior environments and mold may result. I suggest that anyone interested in knowing more about good design and construction practices refer to both of Bohnhoff's 2010 articles (links to the electronic versions are given in the References below).

Vestibule Requirement and Exemptions in the Energy Code

Just as the energy code controls the maximum amount of air leakage so that the insulation isn't rendered useless, vestibules are required on frequently used doors to minimize the amount of unconditioned air that enters a building through the open doors. Air exchange that occurs through these doors can drastically increase the amount of energy required to heat or cool the building as unconditioned air enters the conditioned space.

The energy code default requirement is that all exterior doors shall have vestibules to minimize air infiltration. Vestibule requirements are listed in IECC §C402.5.7, which also indicates that vestibules are not required for the following:

1. buildings in climate zones 1 and 2
2. doors not intended to be used by the public or intended solely for employee use
3. doors opening directly from a sleeping unit or dwelling unit
4. doors that open directly from a space less than 3,000 square feet in area
5. revolving doors
6. doors used primarily to facilitate vehicular movement or material handling and adjacent personnel doors
7. doors that have an air curtain that meets specific performance, testing, control and installation requirements.

In my experience designing commercial post-frame buildings in cold climates, exemptions 4 and 6 have been used most often. Exemption 2 was modified in recent editions of the IECC with the added language "or intended solely for employee use," which will make this exemption useful in more post-frame buildings that are too large to use Exemption 4 and for doors not located adjacent to garage doors (exemption 6).

SUMMARY

Post-frame buildings can easily incorporate energy-efficient measures that help them meet and exceed energy code requirements. Designers and builders who pay attention to a few key areas will provide well-insulated, comfortable and energy-efficient buildings for their occupants and owners. These key areas include air leakage, COMcheck analysis and documentation, garage door specifications, foundation insulation details and vestibule requirements. **FBN**

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