Residential compliance with the IECC

Steel Framing Alliance

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Steel Framing Alliance

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Learning Objectives

1. To identify key building envelope issues in the International Energy Conservation Code (IECC) specific to CFS framing in residential buildings
2. To understand compliance methods and obtain an overview of potential solutions for residential buildings with respect to the IECC (2006 and 2009)

This presentation is designed to provide you with an overview of the International Energy Conservation Code or IECC and why it is important to understand the code and how it impacts steel framing. The key issues are related to insulation requirements as part of the thermal envelope.

This program will also address how the code is structured and ways to optimize the building design when using steel framing.

The focus is on the 2006 code that is currently the most widely used edition. However, changes that impact steel framing in the 2009 code are addressed where applicable.

Although this program addresses residential construction, many aspects of it apply to commercial buildings too.
The IECC is important because it will require a change to the way CFS buildings are constructed. In many areas, foam insulation on the exterior of walls will be encountered for the first time. Even in areas where the IECC has required foam insulation, in the past the code allowed many more opportunities for trade-offs that eliminated the foam insulation. As communities move toward adoption of the 2009 IECC, the opportunities for trade-offs will diminish, requiring new designs that include foam insulation.

It is easy to brush off the presence of foam until you realize the competitive disadvantage it poses for steel framing. In addition, the presence of foam insulation in thicknesses over 1 inch creates problems with siding attachment and detailing that require creative solutions.
It may come as a surprise, but as far back as 2000, the IECC required foam insulation on all exterior walls in every climate zone if built with steel framing. The code achieved this through a table that shows the need for continuous insulation in addition to cavity insulation. In 2000, R-11 insulation was the predominate type used in wood walls. The code required an additional layer of foam insulation of R-5 on the exterior of steel walls to deem it equivalent to a wood wall.
If it has been in the IECC since 2000 and I have not been required to use it so far, why be concerned with it now? The answer lies in the 2009 American Recovery and Reinvestment Act or ARRA. Under ARRA it states that accepted stimulus funds from the Federal government did so with strings attached. One of those strings is that states must adopt the 2009 IECC and subsequent later editions on a specific timetable. The ARRA also requires 90% compliance be verified by states. So you may not have been impacted by the IECC in the past, but that will soon change. Many states have started the process of adopting the 2009 IECC in mid-2011.
As shown here, the main issue with regard to steel framing is the extra cost that will be incurred with CFS walls. Fortunately, there are simple ways to avoid the foam on roofs and crawlspace. The main disadvantage is with walls. Thus walls will be the focus of this presentation.
The extra cost of foam is not the only issue to be addressed. A series of secondary issues occur when foam is added to a wall. Although not insurmountable, they do require some attention during the design stage.

Secondary concerns with foam sheathing

- Structural sheathing placement
- Window and door openings
- Attachment of siding
- Detail at gable ends
- Detail at bottom of wall
For those not familiar with continuous foam insulation, these are the typical products used for this purpose. Typically it is a semi-rigid panel that comes in a variety of thicknesses and sizes, but often in 4x8 sheets.
The IECC covers many types of buildings. This presentation covers primarily the residential requirements in Chapter 4 of the code.
These are some of the applications the code covers. This presentation will address new construction applications of the code.
There are two different types of compliance paths in Chapter 4 – prescriptive and simulated performance. The prescriptive paths offer simple tables with insulation values and other requirements for each component of the home. The performance relies on simulation software.

The prescriptive path has three different options. The R-value approach, the U-factor approach, and the UA alternative or UA trade-off approach.

<table>
<thead>
<tr>
<th>Prescriptive Path</th>
<th>Performance Path</th>
</tr>
</thead>
<tbody>
<tr>
<td>• R-value minimum</td>
<td>• Inputs values from each component into approved software to see if the building complies as a whole.</td>
</tr>
<tr>
<td>OR</td>
<td></td>
</tr>
<tr>
<td>• U-factor maximum</td>
<td></td>
</tr>
<tr>
<td>OR</td>
<td></td>
</tr>
<tr>
<td>• Total UA alternative</td>
<td></td>
</tr>
</tbody>
</table>
These are terms that describe the thermal performance of insulation or wall or other assembly. R-value describes the ability of insulation to resist heat flow. A higher R-value is better than a lower.

Thus the U-factor is another way to describe thermal performance. For example, a wall U-factor would describe the total performance of the wall including the impact of studs, sheathing, insulation, gypsum board.

A lower U-factor is better than a higher U-factor – opposite of the R-value.
Information related to the R-value option is covered in Table 402.1.1 of the IECC. In order to use the table, one needs to know the R-value of the insulation in each component. The example we use is R-13, a common insulation level used in walls. Table 402.1.1 requires the R-value for the insulation for any wall, floor, or ceiling/roof assembly in the building’s thermal envelope. It also introduces a need to know the U-factor of components like windows and skylights that have glass in them. Once you know the R-values and U-factors of your materials, you will need to compare them to the minimum requirements for your climate zone from Table 402.1.1 of the code.
To use Table 402.1.1, first determine your climate zone using the map in Chapter 3 of the IECC. For example, Tampa falls into the red section, or Climate Zone 2. Cleveland would fall into the green part of the map, or Climate Zone 5. The code also lists county level listings of the climate zones if the map is not clear.
Here is part of the table showing requirements for Climate Zones 4, 5, and 6. If for example, you are in Climate zone 5, the table would direct you to have at least R-20 wall insulation. The code sometimes give more than one R-value option. Note the R-13+5 in the table for walls in Climate Zone 5. In this case, a home’s walls can have either R-20 insulation in the wall cavity, or it may have R-13 cavity insulation with a layer of continuous insulation on the exterior over the studs or sheathing. The continuous insulation after the “+” sign in R-13+5 is typically a foam-based insulation board.
Also need to know:

- Insulation needed to make steel framing “equivalent” to wood

The code requires an adjustment to make the steel perform equivalent to a wood wall.
Steel framed assemblies shall meet the insulation requirements in the Table 402.2.4. The example highlighted is for a wood wall with R-13 cavity insulation. In this case, the IECC gives several options to achieve equivalent performance. For example, one could simply add R-5 foam insulation to the outside of the wall. The 2009 code allows the foam to be reduced to R-3 if using 24 on center stud spacing.

<table>
<thead>
<tr>
<th>Wood Frame R-value</th>
<th>Cold-Formed Steel Equivalent R-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Steel Truss Ceilings</td>
</tr>
<tr>
<td>R-30</td>
<td>R-38 or R-30 + 3 or R-26 + 5</td>
</tr>
<tr>
<td>R-38</td>
<td>R-49 or R-38 + 3</td>
</tr>
<tr>
<td>R-40</td>
<td>R-38 + 5</td>
</tr>
<tr>
<td></td>
<td>Steel Joist Ceilings</td>
</tr>
<tr>
<td>R-30</td>
<td>R-38 in 2x4, 2x6, or 2x8</td>
</tr>
<tr>
<td></td>
<td>R-49 any framing</td>
</tr>
<tr>
<td>R-30</td>
<td>R-49 2x4, 2x6, 2x10, or 2x15</td>
</tr>
<tr>
<td></td>
<td>Steel Framed Wall</td>
</tr>
<tr>
<td>R-13</td>
<td>R-13 +5 or R-15 +4, or R-21 +3</td>
</tr>
<tr>
<td>R-19</td>
<td>R-13 + 9 or R-19 +0 or R-25 +7</td>
</tr>
<tr>
<td>R-21</td>
<td>R-13 +10 or R-19 +9 or R-25 +8</td>
</tr>
<tr>
<td></td>
<td>Steel Joist Floor</td>
</tr>
<tr>
<td>R-13</td>
<td>R-19, 2x6</td>
</tr>
<tr>
<td></td>
<td>R-19 +6 in 2x8 or 2x10</td>
</tr>
<tr>
<td>R-19</td>
<td>R-19 +12 in 2x8 or 2x10</td>
</tr>
</tbody>
</table>

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The next prescriptive compliance path again deals mainly with the thermal envelope but is based on U-factors of the individual components. The U-factor represents the performance of the entire assembly, not just the insulation. For example, the framing in these walls or in the roof trusses has a lower R-value than the insulation. The U-factor accounts for these members.
Remember that the lower the U-factor, the better. And to comply with the code, we need to be equal to or less than the code specified U-factor. So a single pane window might have a U of 1.05 versus a U of 0.35 in a more efficient double pane, low E window.
In this case, let's assume a building is located in Hawaii. The map does not address Hawaii except in the side notes where we see that it would fall into Climate Zone 1.
Prescriptive U-factor option for Climate Zone 1 2006 IECC

- Floors $U = 0.064$
- Walls $U = 0.082$
- Attic/roofs $U = 0.035$

- Note that no action needed to create equivalence with wood with U-factor option

This slide shows an excerpt from the Equivalent U-factor table in the IECC Table 402.1.3. Using the wall as an example, the code requires a building to have a U-factor of 0.082 or less. The U-factor is material neutral so unlike with the R-value approach, there is no need to make modifications to the Table 402.1.3 requirements for a steel framed wall.
The next step is the Total UA Alternative compliance path. As mentioned earlier, this is sometimes called the Total UA method or the UA trade-off method. The benefit of the UA alternative method is that it allows one to decide where to put insulation in the most cost-effective manner. Say for example, you don’t want to have thick walls, which tend to require more attention to details at doors and windows and other transitions. One could use the UA-alternative option to eliminate the need for exterior wall foam insulation by adding more insulation into the attic or by using better windows.

To use the UA alternative path, you need the same information as with the U-factor prescriptive option including the climate zone, U-factor of your assemblies, and the Table 402.1.3 code requirements. The method requires an initial calculation of the code required total UA for the home. This is done by multiplying the area of the component by the U-factor in Table 402.1.3 for each component (walls, floors, roofs, doors, windows, etc) and summing them for a total UA. This total UA is the target that you must meet or be lower than in your home’s design. You can then use a simple equation to sum up the UA of all components in the home as designed and increase or decrease the U-factors of various components to arrive at an optimal solution.

For those who are intimidated by math, there is a simple to use computer tool called ResCheck, developed by the U.S. Department of Energy that does the UA alternative calculations for you. ResCheck is not only easy to use, but it is a free download.
There is a reason that the R-value option is the most widely used option in the code. It requires very little information that isn’t already labeled on the insulation, windows, or other products. The U-factor, UA Alternative, and the Simulated Performance paths require more detailed information, some of which is provided by manufacturers and others that either has to be calculated or sought from other published sources. For windows, doors and skylights, manufacturers provide the U-factors. Or they can be obtained from the NRFC database for most products at http://www.nfrc.org/windowshop/surveybegin.aspx.

For fairly conventional wall, floor, and ceiling assemblies, there are published sources from reputable organizations. For proprietary or innovative systems, the manufacturer would normally have to provide test data or U-factors based on calculations.
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Explain:
The simulated performance alternative can be used for building designs that do comply with all the prescriptive requirements in Chapter 4 of the IECC. Under the simulated performance alternative, a “Proposed design” will comply with the code if the calculated annual energy cost is not greater than a similar building (the “Standard design”) designed in accordance with Chapter 4.

The Proposed design uses the same energy sources, floor area, geometry, design conditions, occupancy, climate data, and usage schedule as the Standard design. Some energy-conserving strategies to improve the performance of the Proposed design include exterior shading of windows, passive solar design, thermal mass heat storage, improved thermal envelope, improved duct systems, reduced air infiltration, and high-efficiency heating, cooling, and water heating equipment.
Examples of software

- REScheck (free download from DoE)
- REM Design
- Energy Gauge (FSEC)
- Energy 10
- Others at DOE Software Directory
  (http://apps1.eere.energy.gov/buildings/tools_directory/)

*Explain:*

REScheck is universally recognized as an approved software, but there may be others depending upon local jurisdiction or state. For instance, the ENERGY STAR software, RemRate has a Compliance Report that shows whether a particular building has complied with different codes. 2009 IECC (or Chapter 11 of IRC) will be incorporated into RemDesign.
The most common trade-offs produced by a performance analysis typically include the envelope features. Most depend on the climate. For example, a window with a lower SHGC would be a good trade-off in the south, since a lower SHGC reduces the heat gain during the day and lowers cooling costs. Similarly, shading of the building can be used to trade-off insulation in the walls, ceilings, or other components. The benefit of the performance option is that it also allows trade-offs of components beyond the envelope insulation. These include air leakage, duct insulation, thermal mass, window area, internal shading of glazing, mechanical ventilation energy, and duct leakage.
Unfortunately, the changes to the 2009 IECC have removed the use of equipment as a tool for trade-offs in the code. Multiple changes are proposed to reinsert these features into the 2012, but for now, this option is not permitted in the 2009 IECC. But this is still a very viable method if you are using the 2006 or earlier editions.
Explain:

Air leakage compliance can be achieved by visual inspection by approved 3rd party or code official or via a Blower Door test.

Test must be performed after rough-in and after installations of all penetrations. Result must be below 7 ACH @ 50 pascals pressure difference between conditioned space and outdoors.

We have learned much over the years from the “Blower Door Test”

Air Leakage Can Be More Than a Third of the Total Heat Loss in a Conventionally Built Home

An Important ENERGY STAR® label Homes Requirement is an Air Tightness Test or Blower Door Test.
Do nothing different but run a simulation

- Relies on overdesign already in some component of the home
- Usually in the equipment or windows
- Works well in climate zones 1 and 2.
Bottom line

- If you want the convenience and simplicity of the R-Value prescriptive path, foam insulation will be required on CFS walls
- The U-factor approach is mostly useful for nonconventional assemblies
- The UA alternative and simulated performance options offer significant benefits but require more upfront effort and expense
- Some free and simple to use software exists.
Resource

- Thermal Design Guide (free download at www.steelframing.org)
- (800) 79-STEEL (Technical Assistance Steel Hotline)
- REScheck (http://www.energycodes.gov/rescheck/)