Petition for Declaratory Statement on Mass Wall U-Factors

Submitted by
Florida Solar Energy Center
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DS 2012-039

Background

The Florida Solar Energy Center has submitted its EnergyGauge® USA v 3 0 code compliance software for approval as a UA Alternative code compliance calculation method. On implementing the UA Alternative method into EnergyGauge USA as prescribed by the FBC-EC, an inconsistency in the mass wall Equivalent U-Factors given in Table 402.1.1.3 became apparent This Declaratory Statement seeks remediation of this UA Alternative inconsistency in order that the UA Alternative method becomes equivalent to the performance-based method.

Table 402 1 1 of the FBC-EC provides required prescriptive component R-Values for Mass Walls as R-6 for exterior mass wall insulation applications and R-7 8 for mass wall applications with 50% or more of the insulation applied on the interior of a mass wall Likewise, Table 402 1 1.3 of the FBC-EC provides Equivalent U-Factors of 0.124 and 0.165 for interior and exterior mass wall insulation applications, respectively These Equivalent U-Factors are permitted as an alternative compliance method (see Section 402.1.1.2) to the R-Value requirements of Table 402.1.1.

However, the mass wall U-Factors provided in Table 402 1.1 3 are not equivalent to the component R-Values provided in Table 402 1 1 Section 402 1 1.1 provides the definition of the component R-Values to which Table 402.1.1 applies, as follows·

> "**402.1.1.1 *R*-value computation.** Insulation material used in layers, such as framing cavity insulation and insulating sheathing, shall be summed to compute the component *R*-value The manufacturer's settled *R*-value shall be used for blown insulation. *Computed R-values shall not include an R-value for other building materials or air films*" (emphasis added)

While Section 402 1 1 2 of the FBC-EC does not provide a definition for Equivalent U-Factor, it is widely accepted in engineering practice as the composite thermal transmittance of the building component from the interior air to the exterior air, including all materials within the building component and the air film resistances of the interior and exterior air films bounding the component. An example and discussion of the calculation of concrete block mass wall U-Factors using the parallel path and isothermal planes methods is provided by the 2009 ASHRAE Handbook of Fundamentals, Chapter 27, page 27 4

Examination of Tables 402 1 1 and 402 1 3 in the 2009 IECC illustrates this basic difference between R-values and Equivalent U-Factors IECC Table 402.1.1 prescribes R-Values for mass wall applications as R-3 for exterior applications and R-4 for applications where more than 50% of the insulation is on the mass wall interior (climate zone 1) IECC Table 402.1.3 provides Equivalent U-Factors of 0.197 and 0.17 for these exterior and interior insulation applications, respectively. Since thermal resistance and thermal transmittance are inversely related, the FBC-

EC assumes that the Equivalent U-Factor is equal to the simple reciprocal of the insulation R-Value. However, examination of the 2009 IECC tables shows that this is not the case for the IECC.

In the 2009 IECC, the reciprocal of the R-3 exterior mass wall application in IECC Table 402.1.1 equals 0.333 yet the alternative Equivalent U-Factor given in IECC Table 402.1.3 is 0.197 (which is equivalent to an overall composite wall R-value, including air films, of 5.08). For the interior application, the simple reciprocal of R-4 is 0.25 while the IECC Table 402.1.3 Equivalent U-Factor is given as 0.17 (which is equivalent to an overall composite wall R-value, including air films, of R-5.88). Thus, there is not a one-to-one reciprocal relationship between the component R-Value requirements of IECC Table 402.1.1 and the alternative Equivalent U-Factors of IECC Table 402.1.3. Therefore, the FBC-EC, which uses a one-to-one reciprocal relationship between the component R-Value and alternative Equivalent U-Factor, is not consistent with the methods employed in the 2009 IECC.

This same principle, albeit somewhat different for frame construction, is also in evidence for all other construction components in listed in IECC Tables 402.1.1 and 402.1.3, where the simple reciprocal of the component insulation R-Value listed in IECC Table 402.1.1 is never used as the Equivalent U-Factor listed in IECC Table 402.1.3.

EnergyGauge USA FlaRes, which is a detailed DOE-2-based, detailed hourly simulation model, has functioned as Florida's performance-based Code compliance software tool for a dozen years. It was used in the development of the 2010 FBC-EC to determine the equivalence between R-13 frame wall construction, which is the Florida baseline assumption and CMU (Concrete Masonry Unit) construction throughout Florida. In order to conduct this evaluation, it was necessary to model typical Florida CMU construction in detail. Table 1 below provides the detailed construction and thermal resistance characteristics used to model typical Florida CMU construction in EnergyGauge USA v.3.0, which is now an FBC-accredited Florida Code compliance software tool.

Table 1. Calculation of Typical Florida Mass Wall U-Factors

Component Thermal Resistances	**Insulation Position**	
	Inside	**Outside**
Exterior Air Film R-Value	0.17	0.17
Stucco R-Value	0.1999	0.1999
Exterior Insulation R-Value		6
Concrete Block R-Value	1.1002	1.1002
Interior Insulation R-Value	7.8	
Air Space R-Value		0.92
Drywall R-Value	0.4508	0.4508
Interior Air Film R-Value	0.68	0.68
Composite R-Value (in Series)	10.4009	9.5209
U-Factor (1/R-Composite)	**0.096146**	**0.105032**

Table 1 clearly illustrates that typical Florida CMU construction consists of many more thermal resistance elements than the designated insulation alone, making their composite resistance, including all materials and the interior and exterior air films, significantly different than the thermal resistance of just the insulation material.

The Problem

Table 402.1.1.3 of the FBC-EC for the U-Factor alternative is technically incorrect with respect to the minimum Component R-Values prescribed by Table 402.1.1. This is evidenced by the nationally accepted engineering standard of practice provided in Chapter 27 of the ASHRAE Handbook of Fundamentals. It is also evidenced by the fact that the method used to determine the Equivalent U-Factor for mass walls in Table 402.1.1.3 of the FBC-EC differs from the method used in the 2009 IECC.

In addition, the Florida Building Commission has adopted the principle of equivalence between Florida Code compliance methods, meaning that the performance-based simulation method, the Equivalent U-Factor method and the UA Alternative method should all be equivalent. In order to achieve this equivalence, it is necessary that the U-Factors for mass walls be the same for all methods.

Question 1:

Are the Equivalent U-Factors given in Table 402.1.1.3 of the FBC-EB for mass walls correct? If the answer is YES, then what is the basis of this determination, considering that the U-Factor of a mass wall component is technically deemed to represent the thermal transmittance of the entire mass wall composite, including all materials and the internal and external air film transmittances of the component? If the answer is NO, then how will Table 402.1.1.3 of the FBC-EC be modified to correct the Equivalent U-Factors for mass walls?