THE BRICK INDUSTRY ASSOCIATION
TECHNICAL NOTES on Brick Construction | 4A
1850 Centennial Park Drive, Reston, Virginia 20191 | www.gobrick.com | 703-620-0010
June 2016

Residential Energy Code Compliance

Abstract: This *Technical Note* presents current U.S. building and energy code criteria applicable to the design of wall assembly portions of residential structures of three stories or fewer. A brief description of compliance paths is provided, along with a comparison of code requirements to widely used measures of residential energy performance. An example of the preferred method for calculating R-values and U-factors for wood-frame walls with brick veneer is given. The minimum required thicknesses of various insulation products in each climate zone are indicated for common residential brick veneer assemblies.

Key Words: c.i. (continuous insulation), climate zone, energy, efficient, framing factor, HERS, *IRC*, *IECC*, insulation, LEED, parallel path, R-value, thermal bridging, thermal mass, trade-off, U-factor.

SUMMARY OF RECOMMENDATIONS:

General

- Refer to the *International Residential Code* (*IRC*) for energy-efficiency requirements applicable to most low-rise residential buildings
- Refer to the *International Energy Conservation Code* (*IECC*) and *Technical Note* 4B for energy efficiency requirements of residential buildings greater than three stories
- Consider alternative requirements and compliance paths for assemblies that do not achieve minimum R-value of insulation requirements
- Add continuous insulation to wood-framed wall assemblies to mitigate thermal bridging through the studs and to comply with insulation requirements
- Use the parallel path method to calculate the R-value/ U-factor of brick veneer assemblies with wood-frame backing
- Use framing factors representative of actual construction for accurate estimates of assembly performance
- Use energy compliance software to analyze potential trade-offs and account for thermal mass
- Do not use corrugated anchors (ties) to attach the veneer where continuous insulation is required
- Use energy software to determine compliance with more complex requirements, such as total building thermal UA and simulated energy performance
- Refer to *Technical Note* 4 for a detailed discussion of heat transfer analysis

IECC and *IRC* Requirements

- Refer to Table 1 for minimum R-value of insulation required
- Refer to Table 2 for maximum U-factors for wall assemblies allowed (insulation plus other materials)
- Where Energy Star v3 or LEED for Homes certification is desired, design walls to meet or exceed 2009 *IECC* minimum requirements

IECC/*IRC*-Compliant Wood Stud Wall Assemblies

- For walls with 2 × 4 backing or R-13 insulation between studs, refer to Table 3 and Table 5 for minimum thickness of continuous insulation required
- For walls with 2 × 6 backing or R-21 insulation between studs, refer to Table 4 and Table 6 for minimum thickness of continuous insulation required

IECC/*IRC* Compliance Path Selection

- To comply through insulation alone, use the R-value of insulation method; refer to Table 1, Table 3 and Table 4
- To minimize the insulation required, use the U-factor of wall assembly method which includes the thermal resistance of all the assembly's components; refer to Table 2, Table 5 and Table 6
- Where specific wall assemblies exceed permitted U-factors, use the total UA method to demonstrate that the total building thermal envelope UA does not exceed the total UA calculated using the U-factors in Table 2
- For greatest envelope design flexibility, use the simulated performance method to estimate annual energy consumption using energy modeling software

INTRODUCTION

The movement toward more energy-efficient homes began in earnest in the 1970s during the energy crisis. Since that time, residential energy code requirements have continued to evolve to produce increasingly energy-efficient structures. Residential energy efficiency is governed by the *International Residential Code* (*IRC*) [Ref. 7] and the residential provisions of the *International Energy Conservation Code* (*IECC*) [Ref. 6]. These model codes require energy-efficient measures for the building envelope as well as mechanical equipment. Historically, each edition of the model energy code reduced energy use by 1 to 3 percent over the previous edition. This pace continued until the 2009 *IECC*, which prescribed a 15 percent energy use reduction from the 2006 edition. The 2012 *IECC* requires homes to be 30 percent more energy efficient than the 2006 *IECC*, and homes complying with the 2015 *IECC* are slightly improved over the 2012 edition [Ref. 2].

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The focus on green building has spurred many builders and homeowners to demand improved energy performance beyond code requirements, including ENERGY STAR Homes [Ref. 4] and the Leadership in Energy and Environmental Design (LEED) for Homes [Ref. 8] rating system. This focus on energy efficiency of homes not only meets the goals of the green building movement, but also makes economic sense for those concerned with high utility bills.

Technical Note 4 provides general information on building thermal design, the terminology associated with energy analysis, and calculation of thermal resistance and transmission coefficients, also known as R-values and U-factors, as they relate to brick masonry. This *Technical Note* focuses on energy efficiency for low-rise residential buildings, including energy and building code requirements, thermal performance information on common residential masonry assemblies, and examples of energy-efficient wall designs with brick masonry. Specifics for commercial buildings and mid- to high-rise residential buildings can be found in *Technical Note* 4B. Information on passive solar design with brick masonry can be found in the *Technical Note* 43 Series.

CONSIDERATIONS FOR RESIDENTIAL DESIGNS

Low-rise residential buildings are generally less complicated than commercial ones and are often designed according to prescriptive criteria, from both a structural and energy performance standpoint. They generally do not include shelf angles or parapets or other complex assemblies, though they may include basements.

Prescriptive energy requirements for the building envelope dictate the required U-factor or the required R-value of insulation for a given wall assembly and include minimum thermal performance values for fenestration, doors and the opaque portions of the walls, floors and roof as a function of the climate zone in which the building is located. Climate zones as assigned by the *IECC* are shown in Figure 1.

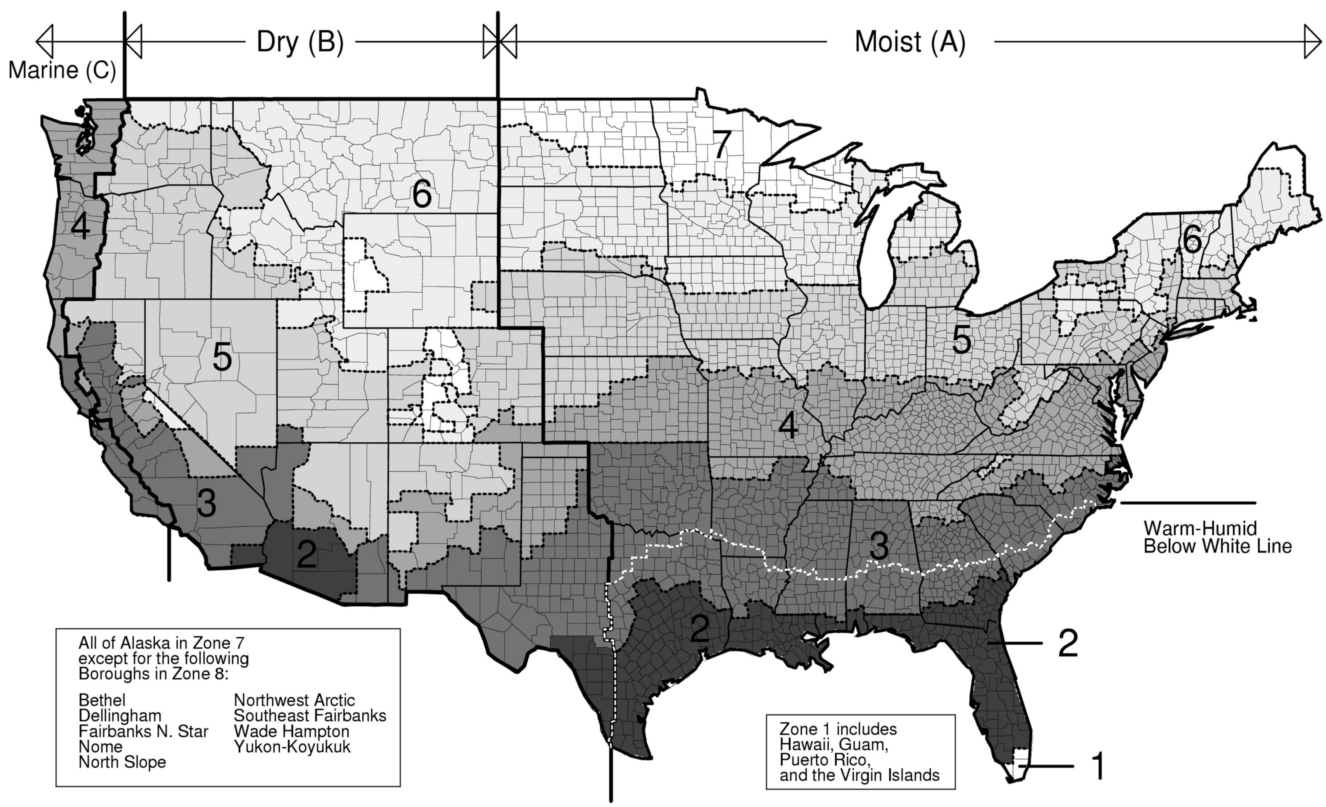

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Figure 1
2012 *IECC/IRC* Climate Zone Map

This prescriptive approach of specifying component R-values to achieve energy efficiency, though easy, does have several shortcomings. Because of its "cookbook" approach, trade-offs between different elements of the building envelope are not permitted (e.g., increasing roof insulation while decreasing wall insulation is not permitted). A better approach may be to use the prescriptive U-values for overall coefficient of heat transfer for each element or to comply with the overall building heat loss requirements (*UA*). Computer programs such as RES*check*™ [Ref. 9] make complying with energy requirements using trade-offs easier to accomplish, and the use of more advanced software can provide even more flexibility in design and account for the benefits of thermal mass.

RESIDENTIAL ENERGY CODES AND STANDARDS

IRC Requirements

In the U.S., the *International Residential Code* (*IRC*) governs the design of most low-rise residential buildings. Earlier editions of the *IRC* and the *IECC* had slightly different energy requirements for residential buildings; however, in the 2012 and 2015 editions, Chapter 11 of the *IRC* directly incorporates (transcribes) the residential energy provisions of the corresponding *IECC*, with only minor editorial changes.

IECC Residential Provisions Requirements

The *IECC* Residential Provisions apply to detached one- and two-family dwellings and to multiple single-family dwellings. Group R-2, R-3 and R-4 buildings, such as apartment houses, hotels, etc., three stories or fewer in height, are also covered by the *IECC* Residential Provisions. Residential buildings greater than three stories are covered by the Commercial Provisions of the *IECC* and are discussed in *Technical Note* 4B.

The *IECC* provides three paths for compliance for the building envelope. The first is a prescriptive path that specifies the required minimum level of insulation in the wall (R-value of insulation method). The second is a more flexible prescriptive method that specifies U-factors for the building envelope components such as the opaque walls, windows, etc. (U-factor of wall assembly method). This method also allows for trade-offs within the building envelope (total *UA* method). For example, building envelope trade-offs might permit less insulation in the wall if a more energy-efficient roof is used, as long as the total building heat transfer (*UA*) requirement is met. The third path is a performance path. The performance path is based on the total building energy cost budget for heating, cooling and service water heating energy. An annual energy use analysis (energy modeling) is required to comply with the performance path. The designer must select the compliance path to be used, knowing that the paths vary in complexity and flexibility, with the most complex offering the most flexibility, as shown in Figure 2. See the sections that follow for further discussion.

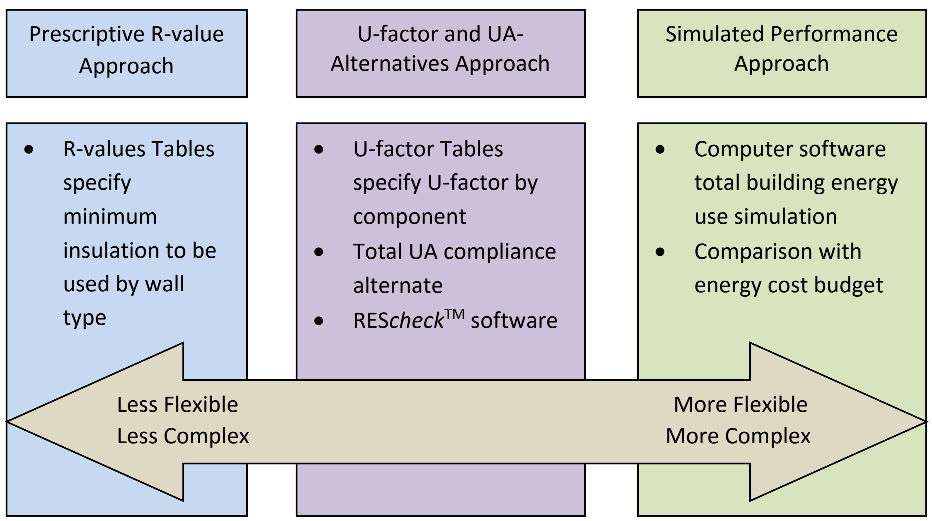


Figure 2
Envelope Insulation Code Compliance Paths

ENERGY STAR for Homes

ENERGY STAR for Homes is a voluntary energy efficiency program for low- to mid-rise residential buildings. "Each ENERGY STAR certified new home is independently verified to be at least 15 percent more energy efficient than a home built to the 2009 *International Energy Conservation Code* (*IECC*), and features additional measures that deliver a total energy efficiency improvement of up to 30 percent compared to a typical new home," according to the ENERGY STAR website. Though the overall energy use of an ENERGY STAR home is more efficient than what the 2009 *IECC* requires, the building envelope requirements for ENERGY STAR Version 3 specify that the wall insulation levels need only meet or exceed 2009 *IECC* levels.

Home Energy Rating System (HERS) Index

The Home Energy Rating System Index, known as the HERS Index [Ref. 5], is a nationally recognized system for measuring a home's energy performance. A certified Home Energy Rater assesses the energy efficiency of a home by evaluating the building envelope, mechanical systems and other elements of the completed home. The performance is then assigned a relative score. A standard new home built to the 2006 *IECC* requirements is assigned a rating of 100. A home with a rating of 80 is 20 percent more energy efficient than a standard new home. A home with a rating of 120 is 20 percent less energy efficient. The U.S. Department of Energy has determined that a typical resale home score 130 on the HERS Index. HERS ratings and energy code requirements vary depending upon climate zone and other factors. Figure 3 illustrates the average HERS Index rating of homes in the U.S. built to comply with *IECC* code requirements.

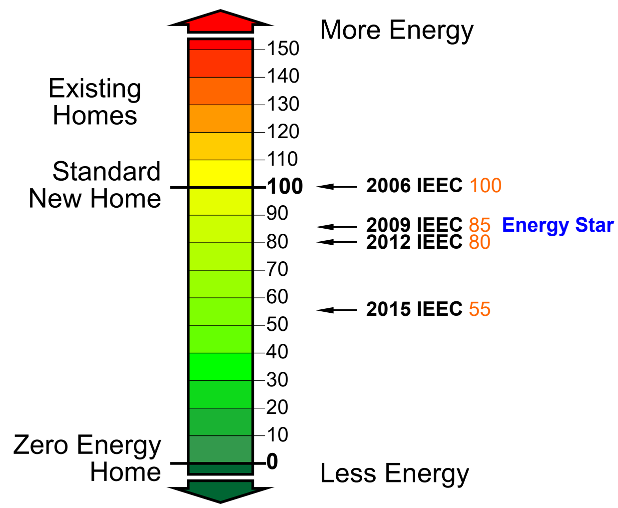


Figure 3
HERS Index and *IECC* Code Requirements

LEED for Homes

LEED for Homes is a voluntary green home rating program. It is organized into credits in seven categories: integrative process, location and transportation, sustainable sites, water efficiency, energy and atmosphere, materials and resources, and indoor environmental quality. Energy use is a major component of LEED v4 for Homes (LEED-H). LEED-H Minimum Energy Performance requires compliance with ENERGY STAR for Homes Version 3 as a prerequisite. In the LEED-H Annual Energy Use credit, points are earned based on percent improvement as compared with the prerequisite baseline energy cost budget or as compared with a HERS rating of 70.

IECC/*IRC* COMPLIANCE METHODS

The model residential energy codes and the "better than code" green building programs all include prescriptive building envelope provisions that specify either component R-values, assembly U-values or both. The most current energy code is the 2015 *IECC*. ENERGY STAR Version 3 and the most recent version of LEED for Homes, LEED v4, both reference the 2009 *IECC* prescriptive insulation tables. Prescriptive thermal requirements for walls from the *IECC* Residential Provisions and *IRC* are shown in Table 1 and Table 2 for wood-framed and mass walls based on climate zone (see Figure 1 or *IECC* Residential Provisions, Chapter 3).

The *IECC* defines mass walls as "above-grade walls of concrete block, concrete, insulated concrete form (ICF), masonry cavity, brick (other than brick veneer), earth (adobe, compressed earth block, rammed earth) and solid timber/logs…." Brick veneer alone is not considered a mass wall in the *IECC* Residential Provisions. Examples of wall assemblies that meet the prescriptive requirements of the 2015 *IECC* Residential Provisions, 2015 *IRC* and other codes are shown in the "Common Residential Masonry Wall Assemblies" section that follows.

R-Value of Insulation Method

The most familiar prescriptive method of building wall thermal design is to provide the minimum specified insulation amount (R-value) in the wall, as given in Table 1. This method allows only the insulation to contribute to the code-required R-value and does not consider the thermal resistance of other components or layers of the wall assembly. As building codes have become more stringent, complying with these provisions has become more challenging. Climate zones that formerly required only insulation between wood studs now require an added layer of continuous insulation to the exterior of studs (Table 1). This extra layer of insulation is intended to mitigate the effects of thermal bridging associated with stud wall construction. Similar requirements are specified for all components of the building envelope. The R-value method is simple but limiting and does not allow building envelope trade-offs.

Table 1

Prescriptive Minimum Wall Insulation (R-Value) Requirements[1]

	Wood-Frame Wall R-Value		Mass Wall R-Value[2]	
Climate Zone	**2015 *IECC/IRC* and 2012 *IECC/IRC***	**2009 *IECC*/ENERGY STAR v3/LEED-H v4**	**2015 *IECC/IRC* and 2012 *IECC/IRC***	**2009 *IECC*/ENERGY STAR v3/LEED-H v4**
1	13	13	3/4	3/4
2	13	13	4/6	4/6
3	20 or 13+5[3]	13	8/13	5/8
4 except Marine	20 or 13+5[3]	13	8/13	5/10
5 and Marine 4	20 or 13+5[3]	20 or 13+5[4]	13/17	13/17
6	20+5 or 13+10[3]	20 or 13+5[4]	15/20	15/19
7 and 8	20+5 or 13+10[3]	21	19/21	19/21

1. Based on 2015 *IECC* Table R402.1.2 (2015 *IRC* Table N1102.1.2), 2012 *IECC* Table R402.1.1 (2012 *IRC* Table N1102.1.4) and 2009 *IECC* Table 402.1.1.
2. The second R-value applies when more than half the insulation is on the interior of the mass wall.
3. First value is cavity insulation, between the studs. Second value is continuous insulation or insulated siding. "13+5" means R-13 cavity insulation plus R-5 continuous insulation or insulated siding. If structural sheathing covers 40 percent or less of the exterior, continuous insulation R-value is permitted to be reduced by no more than R-3 in the locations where structural sheathing is used to maintain a consistent total sheathing thickness.
4. "13+5" means R-13 cavity insulation plus R-5 insulated sheathing. If structural sheathing covers 25 percent or less of the exterior, then insulating sheathing is not required where structural sheathing is used. If structural sheathing covers more than 25 percent of the exterior, structural sheathing is required to be supplemented with insulated sheathing of at least R-2.

U-Factor of Wall Assembly Method

A more flexible, though still prescriptive, method to building envelope thermal design is the U-factor method. As an alternative to the R-value table, the *IECC* specifies the maximum assembly U-factor allowed for the entire wall assembly. This method permits all the components or layers of the wall assembly to contribute to the code-required U-factor, including sheathing, gypsum board, etc. Because specific insulation values are not dictated in this method, the designer has more flexibility to provide a wall assembly that complies with the overall heat transmission (U-factor) limits. Values must be lower than those given in Table 2 for compliance.

Total *UA* Method

The *IECC/IRC* also permits some portions of the building envelope to exceed maximum U-factors, so long as the total building thermal envelope *UA* (product of U-factor times assembly area) is less than or equal to the total *UA* resulting from using the maximum prescriptive values permitted by the U-factor method (multiplied by the same assembly area as in the proposed building). When this condition is met, the building is considered in compliance. The *UA* must be calculated using a method consistent with the ASHRAE *Handbook of Fundamentals* [Ref. 1] and is required to include the thermal bridging effects of framing materials. RES*check*™ [Ref. 9] is a free computer software compliance tool supported by the U.S. Department of Energy that makes evaluating trade-off compliance easy.

Table 2
Prescriptive Maximum Wall Assembly U-Factors[1]

	Frame Wall U-Factor			Mass Wall U-Factor			
Climate Zone	**2015 *IECC* and 2015 *IRC***	**2012 *IECC* and 2012 *IRC***	**2009 *IECC*, ENERGY STAR v3 and LEED-H v4**	**2015 *IECC*, 2012 *IECC* and 2012 *IRC***	**2015 *IECC*, 2012 *IECC* and 2012 *IRC*** (more than half of insulation is on interior)	**2009 *IECC*, ENERGY STAR v3 and LEED-H v4**	**2009 *IECC*, ENERGY STAR v3 and LEED-H v4** (more than half of insulation is on interior)
1	0.084	0.082	0.082	0.197	0.17	0.197	0.17
2	0.084	0.082	0.082	0.165	0.14	0.165	0.14
3	0.060	0.057	0.082	0.098	0.12	0.141	0.12
4 except Marine	0.060	0.057	0.082	0.098	0.087	0.141	0.10
5 and Marine 4	0.060	0.057	0.057	0.082	0.065	0.082	0.057
6	0.045	0.048	0.057	0.060	0.057	0.060	0.057
7 and 8	0.045	0.048	0.057	0.057	0.057	0.057	0.057

1. Based on 2015 *IECC* Table R402.1.4 (2015 *IRC* Table N1102.1.4), 2012 *IECC* Table R402.1.3 (2012 *IRC* Table N1102.1.3) and 2009 *IECC* Table 402.1.3.

Simulated Performance Method

As energy analysis methods have become more sophisticated, the limitations of prescriptive methods have been recognized. Prescriptive requirements typically fail to fully capture the beneficial effects of incorporating materials with thermal mass and do not accurately reflect actual building envelope performance. Whole-building dynamic energy simulation software (such as EnergyPlus or other DOE2-based programs) better account for the thermal storage properties of masonry and concrete materials. As demand for more energy-efficient buildings grows, so too does the use of these computer-based energy models.

The *IECC* and *IRC* permit design using simulated energy performance (software) in the performance-based compliance path. In this case, the simulated design must be equal to or less than the energy cost of a standard reference design. The building envelope requirements for the standard reference design are equal to the prescriptive values given in the U-factor table. Simulated design is also permitted as a compliance tool in LEED for Homes. The HERS Index and ENERGY STAR for Homes also allow software analysis to determine compliance.

ENERGY CODE COMPLIANT BRICK VENEER ASSEMBLIES

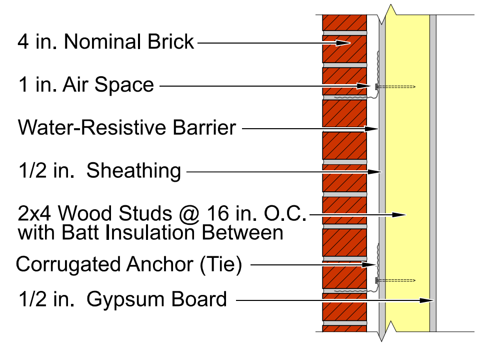
Technical Note 4 provides information on two-dimensional steady-state heat transfer analysis based on the ASHRAE *Handbook of Fundamentals* [Ref. 1]. This *Technical Note* provides a sample calculation of the R-value/U-factor for a brick veneer over wood-frame assembly, a common residential brick masonry wall system. R-values and U-factors for brick veneer assemblies over steel frame and masonry are presented in *Technical Note* 4B.

Brick Veneer with Wood Frame Example

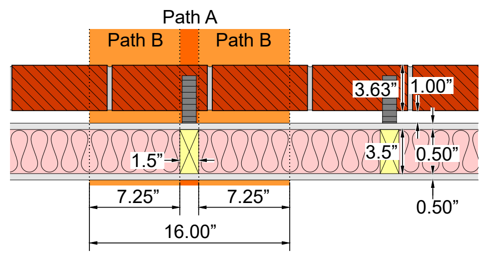
The brick veneer/wood-frame wall shown in Figure 4 has thermal bridges that occur at the wood studs and other framing. The parallel path method allows the average U-factor of the wall to be calculated by first calculating the U-factors in series of the two paths involved. The path at the wood stud is Path A, and the path at the insulation is Path B. Using the heat transmission coefficients for the various materials found in Table 1 of *Technical Note* 4, the calculation is shown in Figure 4.

Calculations

Assembly Components	Thermal Properties				
	k (thermal conductivity per in.)	x (in.)	C (k/x) (thermal conductance)	Path A (framing) 1/C (R-value)	Path B (insulated cavity) 1/C (R-value)
Outside air film			6.00	0.17	0.17
3⅝-in. face brick	6.67	3.625	1.84	0.54	0.54
1-in. air space				1.0	1.0
½-in. OSB sheathing				0.68	0.68
2 × 4 wood stud	0.800	3.5	0.229	4.37	
3½-in. (R-13) batt insulation					13.0
½-in. gypsum wallboard			2.250	0.45	0.45
Inside air film			1.470	0.68	0.68
				R_A = 7.89	**R_B = 16.52**



Section



Plan

If the wood studs spaced at 16 in. on center and wood framing occupy 25 percent of the wall, then:

$R_{avg} = 0.25\ R_A + 0.75\ R_B = (0.25)(7.89) + (0.75)(16.52) = 14.36\ (h \cdot ft^2 \cdot °F)/Btu$

$U_{avg} = 1/R_{avg} = 0.070\ Btu/(h \cdot ft^2 \cdot °F)$

Figure 4
Brick Veneer with Wood Frame Example Assembly

R-value and U-factor calculations often neglect top and bottom plates, as well as the framing around windows, doors and in corners, which can significantly impact the calculated values. In order to most accurately estimate actual performance, the example and calculations that follow include wood framing factors [Ref. 3] representative of actual home construction in the United States.

The wall assembly shown in Figure 4 meets the prescriptive insulation requirements of the 2015 *IECC* Residential Provisions and 2015 *IRC* in climate zones 1 and 2. To comply with the requirements in climate zones 3 through 5, an additional layer of R-5 continuous insulation is required in the cavity.

Other Brick Veneer/Wood Stud Wall Assemblies

Table 3, Table 4, Table 5 and Table 6 present the minimum thickness of various types of continuous insulation needed for common wood-framed wall assemblies with insulation between the studs to comply with insulation (R-value) and U-factor requirements of the *IECC* Residential Provisions and *IRC* in each U.S. climate zone. In addition, Table 5 and Table 6 provide estimated R-values and U-factors for the base assemblies listed, without the contribution of continuous insulation. The R-values and U-factors for complete assemblies that include continuous insulation can be calculated by following the procedure in the example below. Where continuous insulation is required, prescriptive code provisions do not permit corrugated ties to anchor the veneer, because the distance between the veneer and the sheathing would exceed 1 in. Like the example above, the values expressed in the tables are based on parallel path method calculations, assuming that the studs and framing occupy 25 percent (for 16 in. o.c. stud spacing) or 22 percent (for 24 in. o.c. stud spacing) of the wall area.

Example. Use the information from Table 3 and Table 5 to determine the R-values and U-factors of brick veneer assemblies with 2 × 4 wood framing that comply with the prescriptive requirements of the 2012 *IRC* in climate zone 6.

Solution. Table 5 indicates that the R-value of the wood-framed 2 × 4 base assembly with R-13 insulation between the studs is 14.36. Code compliance can be achieved by designing the assembly with insulation that meets the minimum R-value requirements shown in Table 1 or does not exceed the maximum U-factors in Table 2.

As shown in Table 1 previously, the 2012 *IRC* prescribes a minimum of R-13 insulation in the stud cavity and a minimum of R-10 continuous insulation (shown as 13 + 10). From Table 3, which indicates the needed thickness of continuous insulation for assemblies with R-13 insulation between the studs, 2 in. of polyiso, 2 in. of XPS or 3 in. of mineral wool are needed to comply with the minimum insulation (R-value) requirements of climate zone 6. Since each R-value is equal to or greater than R-10, the minimum insulation requirement is met.

Polyiso

$R_{Polyiso}$ = 2 in. × 6.1 = 12.2

XPS

R_{XPS} = 2 in. × 5 = 10

Mineral Wool

$R_{Mineral\ Wool}$ = 3 in. × 3.6 = 10.8

Table 2 shows that the maximum U-factor permitted by the 2012 *IRC* for a wood-framed wall located in climate zone 6 is 0.048. Table 5 shows that the minimum required thickness of continuous insulation needed for the wood-framed 2 × 4 assembly with R-13 insulation between the studs to achieve a U-factor of 0.048 or less is 1.25 in. of polyiso, 1.5 in. of XPS or 2 in. of mineral wool. R-values for these specific assemblies can be calculated by multiplying the R-value per inch of thickness of each insulation by the number of inches indicated in Table 5 and adding this value to the base assembly R-value. The U-factors for the assemblies can then be determined by taking the reciprocal of the total assembly R-value, as shown below.

$R_{total} = R_{insulation} + R_{base\ assembly}$

$U_{total} = 1/R_{total}$

Polyiso

$R_{Polyiso}$ = 1.25 in. × 6.1 = 7.63

R_{total} =7.63 + 14.36

R_{total} = 21.99 (h × ft² × °F)/Btu

XPS

R_{XPS} = 1.5 in. × 5 = 7.5

R_{total} = 7.5 + 14.36

R_{total} = 21.86 (h × ft² × °F)/Btu

Mineral Wool

$R_{Mineral\ Wool}$ = 2 in. × 3.6 = 7.2

R_{total} = 7.2 + 14.36

R_{total} =21.56 (h × ft² × °F)/Btu

As is often the case, this example shows that for the 2012 *IRC* requirements in climate zone 6, it takes less insulation to comply with building envelope requirements using the assembly U-factor method than using the minimum insulation (R-value) method. R-values and U-factors for any of the assemblies represented in Table 3, Table 4, Table 5 and Table 6 can be determined using this procedure.

Table 3

Thickness of Continuous Insulation Needed for Wood-Framed Assemblies with R-13 Insulation Between the Studs to Comply with Minimum Insulation (R-Value) Requirements[1]

Climate Zone	2015/2012 *IECC* Residential and *IRC*			2009 *IECC* Residential		
	Polyiso (in.)	XPS (in.)	Mineral Wool (in.)	Polyiso (in.)	XPS (in.)	Mineral Wool (in.)
1	Continuous insulation not required, corrugated ties may be used with nominal 1 in. air space					
2						
3	1	1	1.5			
4 except Marine	1	1	1.5			
5 and Marine 4	1	1	1.5	1	1	1.5
6	2	2	3	1	1	1.5
7 and 8	2	2	3	R-13 insulation not permitted, R-21 stud cavity insulation required		

1. Assumed insulation R-values: Polysio = R-6.1/in., XPS = R-5/in., Mineral Wool = R-3.6/in. Based on 2015 *IECC* Table R402.1.2 (2015 *IRC* Table N1102.1.2), 2012 *IECC* Table R402.1.1 (2012 *IRC* Table N1102.1.1) and 2009 *IECC* Table 402.1.1.

Table 4

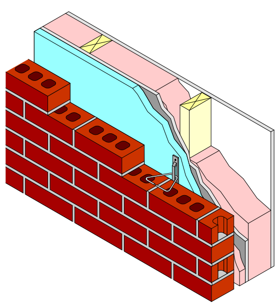
Thickness of Continuous Insulation Needed for Wood-Framed Assemblies with R-21 Insulation Between the Studs to Comply with Minimum Insulation (R-Value) Requirements[1]

Climate Zone	2015/2012 *IECC* Residential and *IRC*			2009 *IECC*		
	Polyiso (in.)	XPS (in.)	Mineral Wool (in.)	Polyiso (in.)	XPS (in.)	Mineral Wool (in.)
1	Continuous insulation not required, corrugated ties may be used with nominal 1 in. air space					
2						
3						
4 except Marine						
5 and Marine 4						
6	1.5	2	3			
7 and 8	1.5	2	3			

1. Assumed insulation R-values: Polysio = R-6.1/in., XPS = R-5/in., Mineral Wool = R-3.6/in. Based on 2015 *IECC* Table R402.1.2 (2015 *IRC* Table N1102.1.2), 2012 *IECC* Table R402.1.1 (2012 *IRC* Table N1102.1.1) and 2009 *IECC* Table 402.1.1.

Table 5

Thickness of Continuous Insulation Needed for Wood-Framed 2 × 4 Assemblies with R-13 Insulation Between the Studs to Comply with U-Factor Requirements[1]



Base Assembly Components

- Brick veneer
- 2 × 4 wood studs at 16 in. o.c.
- 1 in. air space
- ½ in. OSB sheathing
- R-13 insulation in stud cavity
- ½ in. gypsum wallboard

Assembly U-factor* = 0.070

Assembly R-value* = 14.36

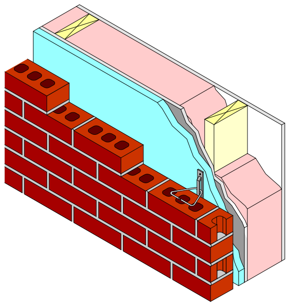
* Does not include continuous insulation. Calculated using heat transmission coefficients found in Table 1 of *Technical Note* 4.

Climate Zone	2015 *IECC* Residential/*IRC*			2012 *IECC* Residential/*IRC*			2009 *IECC* Residential		
	Polyiso (in.)	XPS (in.)	Mineral Wool (in.)	Polyiso (in.)	XPS (in.)	Mineral Wool (in.)	Polyiso (in.)	XPS (in.)	Mineral Wool (in.)
1	Continuous insulation not required; corrugated ties may be used with nominal 1 in. air space								
2									
3	0.5	0.5	0.75	0.5	0.75	1			
4 except Marine	0.5	0.5	0.75	0.5	0.75	1			
5 and Marine 4	0.5	0.5	0.75	0.5	0.75	1	0.5	0.75	1
6	1.25	1.5	2.5	1.25	1.5	2	0.5	0.75	1
7 and 8	1.25	1.5	2.5	1.25	1.5	2	0.5	0.75	1

1. Assumed insulation R-values: Polysio = R-6.1/in., XPS = R-5/in., Mineral Wool = R-3.6/in. Based on 2015 *IECC* Table R402.1.4 (2015 *IRC* Table N1102.1.4), 2012 *IECC* Table R402.1.3 (2012 *IRC* Table N1102.1.3) and 2009 *IECC* Table 402.1.3.

Table 6

Thickness of Continuous Insulation Needed for Wood-Framed 2 × 6 Assemblies with R-21 Insulation Between the Studs to Comply with U-Factor Requirements[1]



Base Assembly Components

- Brick veneer
- 2 × 6 wood studs at 16 in. o.c.
- 1 in. air space
- ½ in. OSB sheathing
- R-21 insulation in stud cavity
- ½ in. gypsum wallboard

Assembly U-factor* = 0.048

Assembly R-value* = 20.99

* Does not include continuous insulation. Calculated using heat transmission coefficients found in Table 1 of Technical Note 4.

Climate Zone	2015 *IECC* Residential/*IRC*			2012 *IECC* Residential/*IRC*			2009 *IECC* Residential		
	Polyiso (in.)	XPS (in.)	Mineral Wool (in.)	Polyiso (in.)	XPS (in.)	Mineral Wool (in.)	Polyiso (in.)	XPS (in.)	Mineral Wool (in.)
1	Continuous insulation not required; corrugated ties may be used with nominal 1 in. air space								
2									
3									
4 except Marine									
5 and Marine 4									
6	0.5	0.5	0.5						
7 and 8	0.5	0.5	0.5						

1. Assumed insulation R-values: Polysio = R-6.1/in., XPS = R-5/in., Mineral Wool = R-3.6/in. Based on 2015 *IECC* Table R402.1.4 (2015 *IRC* Table N1102.1.4), 2012 *IECC* Table R402.1.3 (2012 *IRC* Table N1102.1.3) and 2009 *IECC* Table 402.1.3.

SUMMARY

Residential brick masonry wall systems generally must comply with the residential provisions of the *International Energy Conservation Code* (*IECC*), which in the 2012 and 2015 editions are the same as the energy requirements found in the *International Residential Code*. The *IECC* provides three compliance paths for the building envelope: a prescriptive path that specifies the required minimum level of insulation in the wall (R-value of insulation method); a prescriptive approach that specifies U-factors for the building envelope components and allows trade-offs (U-factor of wall assembly method); and a performance path based on the total building energy cost budget for heating, cooling and service water heating energy.

This *Technical Note* provides example calculations for determining the thermal transmittance (U-factor) for brick veneer and wood stud wall systems common in residential construction.

> *The information and suggestions contained in this* Technical Note *are based on the available data and the experience of the engineering staff of the Brick Industry Association. The information contained herein must be used in conjunction with good technical judgment and a basic understanding of the properties of brick masonry. Final decisions on the use of the information contained in this* Technical Note *are not within the purview of the Brick Industry Association and must rest with the project architect, engineer and owner.*

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