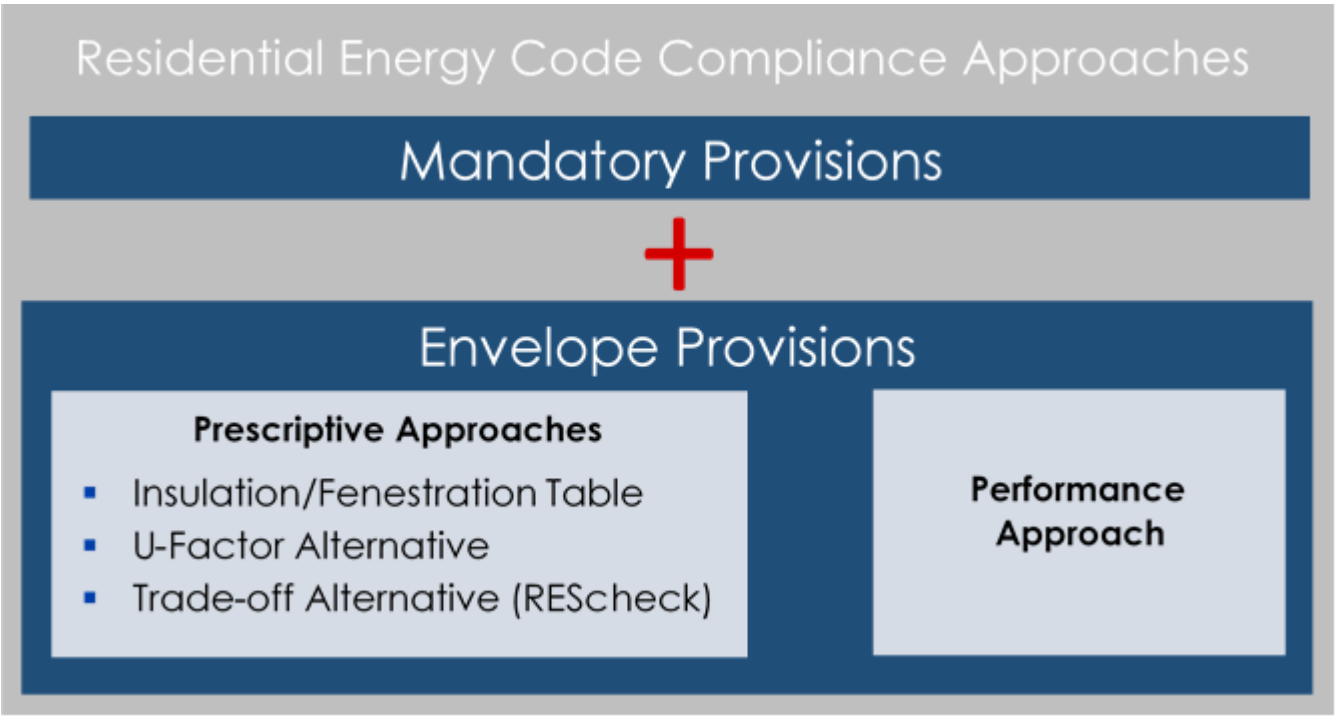
6. Residential Energy Code Compliance Approaches

Over the years, residential energy codes have grown to provide different compliance approaches with varying degrees of simplicity and flexibility in order to meet user needs. The simpler approaches are less flexible but are generally easier to use. New residential buildings must comply with both the "mandatory" provisions of the energy code as well as one of the thermal envelope approaches discussed below. There are three alternative prescriptive approaches and a performance approach included in the code.



Prescriptive Approaches

Insulation and Fenestration Requirements By Component Table. The most commonly used, but least flexible prescriptive alternative, is based on the *Insulation and Fenestration Requirements By Components Table* (Table R402.1.1). This table sets minimum requirements, R-values for opaque componets and U-factors for windows, doors and skylights. Montana amended the wood frame wall requirements. The R-values in the table on the next page refer only to the insulation and not to other components of the wall assembly. Log, concrete block, and insulated concrete form walls must comply with the "mass" wall requirements.This approach is quick and easy to use, but it is somewhat restrictive because the requirements typically are based on worst-case assumptions, and all requirements must be met exactly as specified.

When using the components table, insulation material used in layers, such as framing cavity insulation and insulating sheathing, is summed to calculate the component R-value. The manufacturer's settled R-value must be used for loose fill insulation. Calculated R-values used with the components table do not include the R-value for other building materials or air films. The nominal R-value is to be used with the components table.

R-Value Prescriptive Requirements		Table R402.1.1
Component	Insulation, Window, Door, and Skylight Requirements	Remarks
Windows & Doors	U-0.32	
Skylights	U-0.55	
Ceiling	R-49	R-38 complies if uncompressed insulation extends over top of exterior wall top plate
Wood Frame Wall	R-21 or R-13+5	First value is cavity insulation, second value (if present) is continuous sheathing
Mass Wall	R-15/R-20	Second value applies when more than half of R-value is on interior of mass wall
Floor	R-30	Insulation that fills cavity (R-19 minimum) also complies
Basment Wall	R-15/R-19	First value is continuous, second value is cavity
Slab	R-10, 4'	Insulation must extend downward continuously from top of slab for 4 feet vertically or horizontally
Crawlspace Wall	R-15/R-19	First value is continous inside or outside, second value is cavity insulation on inside

From Table R402.1.1 Insulation and Fenestration Requirements By Components (As Amended by Montana)

U-Factor Table R402.1.3	
Component	Insulation, Window, Door, and Skylight Requirements
Windows & Doors	U-0.32
Skylights	U-0.55
Ceiling	0.026
Wood Frame Wall	0.054
Mass Wall	0.06; 0.57 if >50% insul. on interior
Floor	0.033
Basment Wall	0.05
Crawlspace Wall	0.055

From Table Table R402.1.3 As Amended by Montana

U-Factor Alternative. Another prescriptive approach is the *U-factor Alternative* (R402.1.3). It is based on a table of U-factors (Table R402.1.3), shown above on the right, that consider the entire component assembly, both the insulation and other assembly elements. Each area of the envelope with a different thermal characteristic must be calculated individually before being used in the overall calculation.

When using the U-factor table, the characteristics of the entire assembly are considered. For example, in a wall, the insulating characteristics of the air films, sheathing, and interior finish as well as the insulation are included in the calculation. The area weighted U-factors of the wall and framing members and headers must be included in the calculation. Each envelope component (windows, skylights, walls, ceiling, floor, slab, and crawlspace) must each comply with the U-factor specified in Table R402.1.3.

Trade-off Alternative. The final prescriptive approach is the *Trade-off Alternative* (R402.1.4). The IECC calls it the *Total UA Alternative*. This approach is typically less restrictive than prescriptive approaches because components that exceed the requirements can compensate for those that do not meet the code. This approach is also based on the table of U-factors but allows tradeoffs between the different building envelope components. For example, windows that do not meet the U-factor requirement of the components table may be acceptable if additional roof or wall insulation is installed. Use of the REScheck™ software makes the Trade-off Alternative calulation much easier. The Trade-off Alternative is the most flexible of the prescriptive alternatives but is not as flexible as the Performance Approach discussed below.

The trade-off approach allows you to trade better energy efficiency in one building envelope component for decreased energy efficiency in another component. This method allows tradeoffs between the various envelope components. For example, the walls of a particular building may not meet the R-value table minimum requirement, but if the windows are better than code, the envelope as a whole may comply. In this method, each area of the envelope with a different thermal characteristic is multiplied by its associated area in square feet. The sum of all UA products (U-factor x area) for the proposed building is compared to a building based on the code maximum U-factors. If the UA total of the proposed building is less than the UA of the code-based building, then the building complies. REScheck™ software uses the Trade-off Alternative to demonstrate compliance. REScheck™ software may be obtained at no cost from www.energycodes.gov/rescheck.

Performance Approach

The Performance Approach is the most flexible of all compliance options but is also the most complex. The Performance Approach requires detailed inputs of all building energy systems. The analysis must be performed using a building performance simulation software that is approved by the building official.

The Performance Approach is seldom used despite offering the greatest flexibility in demonstrating energy code thermal envelope compliance. This alternative uses sophisticated energy-performance software, such as REMDesignTM, REM/DesignTM, or Energy GaugeTM, to determine if the proposed design has an annual energy cost less than or equal to a reference design. The reference design is often termed a geometric twin. The energy code mandatory provisions remain applicable when the performance compliance approach is used. Some of the building energy characteristics that can be considered using the performance alternative that are not considered by the prescriptive compliance approaches include:

- Exterior Shading
- Solar Heat Gain
- Innovative Framing Techniques
- Cool Roofing Systems
- Thermal Mass
- Solar Energy Systems
- Low Infiltration
- Insulation Identification

Which approach is the best for a particular building project?

Choosing the appropriate approach depends on the complexity and/or uniqueness of the building and the amount of time and money available for demonstrating compliance. The prescriptive components approach allows quick review of the requirements. If these requirements are too restrictive, try a trade-off approach. If credit is desired from nontraditional design approaches, then consider using the performance approach. For additions and remodels consider the following:

- Additions may use the prescriptive or trade-off approach.
- An addition project that also includes alterations to the existing part of the buildiing should show compliance separately for each part (the addition separately from alterations).
- For alterations, the prescriptive approach is preferable; otherwise the entire building would have to demonstrate compliance.

Summary

The alternative compliance approaches can yield different results. Performance approaches require more building details be used in the analysis. Prescriptive approaches tend to be conservative and use worst-case default assumptions in order for the prescriptive packages to apply to all buildings. The prescriptive approaches do not account for several features that affect energy use, which are included in the performance approach. The trade-off alternative is a compromise that is more flexible than using the insulation and fenestration table but not as complicated as the performance approach.

Plan Review

Section R401.2 allows residential buildings to comply with one of the prescriptive thermal envelope requirements or the performance option of Section 405. In either case the building must comply with all the provisions of Chapter 4 that are noted as mandatory requirements.

It should be noted that the prescriptive R-values of the complonents table may be used for compliance for some components while a U-factor calculation may be used for compliance of another. The same may be said for different wall areas. The prescriptive R-values of the complonents table may be used for compliance for one area of the frame wall while a U-factor calculation may be used for compliance of another area of the wall.

If the Total UA alternative is used then all thermal envelope components must be included in the calucaltion. REScheck™ software is often used to perform the Total UA alternative calculation.

Code References

R402.1.2 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.

R402.1.3 U-Factor Alternative. An assembly with a U-factor equal to or less than that specified in Table R402.1.3 shall be permitted as an alternative to the R-value in Table R402.1.1.

R402.1.4 Total UA Alternative. If the total building thermal envelope UA (sum of U-factor times assembly area) is less than or equal to the total UA resulting from using the U-factors in Table R402.1.3 (multiplied by the same assembly area as in the proposed building), the building shall be considered in compliance with Table R402.1.1. The UA calculation shall be done using a method consistent with the ASHRAE Handbook of Fundamentals and shall include the thermal bridging effects of framing materials. The SHGC requirements shall be met in addition to UA compliance.

Resources

2012 International Energy Conservation Code, Copyright August 2011 by the International Energy Codes Council, Inc., Falls Church, Virginia.

2012 IECC Code and Commentary, Copyright August 2012 by the International Energy Codes Council, Inc., Falls Church, Virginia.

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REScheck™**,** USDOE Building Energy Codes Program, https://www.energycodes.gov/rescheck

Building Energy Codes Resource Guide: Code Officials Edition, International Codes Council and the US DOE, October 2010, https://www.energycodes.gov/sites/default/files/.../co_edition_commercial.pdf