

Updates to U-Factor & R-Value Tables

2021 VRC/VECC Update Guide



Changes to Thermal Performance Requirements:

Summary: Maximum U-Factors and minimum R-Values stipulated by the energy code change regularly in response to updated cost-benefit analysis comparing the cost of implementing greater thermal resistance strategies versus that of heating and cooling energy. U-Factors and R-Values also vary by climate zone, and with Virginia's new climate zones these requirements now vary by jurisdiction. The values required by the Prescriptive compliance option are presented in table N1102.1.3 (R402.1.3) INSULATION MINIMUM R-VALUES AND FENESTRATION REQUIREMENTS BY COMPONENT.

Glazing

CLIMATE ZONE	FENESTRATION U-FACTOR	SKYLIGHT U-FACTOR	GLAZED FENESTRATION SHGC
3	0.30	0.55	0.25
4 except Marine	0.30	0.55	0.40
5 and Marine 4	0.30	0.55	0.40

Building Envelope - Walls

CLIMATE ZONE	WOOD FRAME WALL R-VALUE	MASS WALL R-VALUE	BASEMENT WALL R-VALUE	CRAWL SPACE WALL R-VALUE
3	15 cavity or 13 cavity+1ci	8/13	13 cavity or 5ci	13 cavity or 5ci
4 except Marine	15 cavity or 13 cavity+1ci	8/13	13 cavity or 10ci	13 cavity or 10ci
5 and Marine 4	15 cavity or 13 cavity+1ci	13/17	19 cavity or 15ci or 13 cavity+5ci	19 cavity or 15ci or 13 cavity+5ci

Building Envelope – Floors and Ceilings

CLIMATE ZONE	CEILING R-VALUE	FLOOR R-VALUE	SLAB R-VALUE & DEPTH
3	49	19	10ci, 2 ft
4 except Marine	60	19	10ci, 4 ft
5 and Marine 4	60	30	10cit, 4 ft

Notes:

- *“ci” refers to continuous – insulation material that is uninterrupted by framing components, such as insulated sheathing.*
- *Mass walls shall be in accordance with Section N1102.2.5 (R402.2.5). The second R-value applies where more than half of the insulation is on the interior of the mass wall.*
- *Crawlspace walls are not insulated only when the crawlspace is vented to the outside and the floor above is insulated.*

Changes of note affecting Virginia include:

- R-60 attic insulation for most of Virginia (climate zones 4 and 5).
- R-30 floor insulation for the five jurisdictions in climate zone 5
- 4 foot wide/deep slab insulation in climate zones 4 and 5
- R-19 cavity, R15 continuous, or 13+5 insulation for basement and crawlspace walls in climate zone 5

A home utilizing the Total Building Performance option is permitted to reduce the thermal performance of any building envelope component compared to the values listed in Table N1102.1.3 (R402.1.3) so long as the overall building package is calculated by approved software to obtain an annual energy cost not greater than that of the standard reference design home – and – so long as those building components perform at least as well as the prescriptive levels noted in Table R402.1.3 of the 2009 IECC. Additionally, the window U-Factors and SHGC values noted in Table N1102.1.2 (R402.1.2) must be met.

A home following the ERI compliance pathway is permitted to reduce the thermal performance of any building envelope as long as the proposed UA of the building is no more than 115% of the UA of the building using the values in Table N1102.1.2 (R402.1.2). The software used to generate an ERI score is also able to show UA compliance. Additionally, the ERI target in Table N1106.5 (R406.5) must be met, as well as the additional energy efficiency requirement of N1101.13.5 (R401.2.5). When on-site renewables are used for compliance these requirements are different and N1106.3.2. (R406.3.2) should be referenced.

Plan Review Focus: Construction documents should note which energy compliance path is being followed, insulation R-Values, and fenestration U-Factor and SHGC values.

Additional Resources:

- <https://www.greenbuildingadvisor.com/article/getting-slab-edge-insulation-right>
- <https://basc.pnnl.gov/search?keywords=Insulation>
- <https://sws.nrel.gov/spec/4> Detailed installation guidelines

2021 VRC/VECC Code References:

N1102.1.4 (R402.1.4) R-value computation. Cavity insulation alone shall be used to determine compliance with the cavity insulation R-value requirements in Table N1102.1.3. Where cavity insulation is installed in multiple layers, the R-values of the cavity insulation layers shall be summed to determine compliance with the cavity insulation R-value requirements. The manufacturer's settled R-value shall be used for blown-in insulation. Continuous insulation (ci) alone shall be used to determine compliance with the continuous insulation R-value requirements in Table N1102.1.3. Where continuous insulation is installed in multiple layers, the R-values of the continuous insulation layers shall be summed to determine compliance with the continuous insulation R-value requirements. Cavity insulation R-values shall not be used to determine compliance with the continuous insulation R-value requirements in Table N1102.1.3. Computed R-values shall not include an R-value for other building materials or air films. Where insulated siding is used for the purpose of complying with the continuous insulation requirements of Table N1102.1.3, the manufacturer's labeled R-value for insulated siding shall be reduced by R-0.6.

N1102.1.5 (R402.1.5) Total UA alternative. Where the total building thermal envelope UA, the sum of U-factor times assembly area, is less than or equal to the total UA resulting from multiplying the U-factors in Table N1102.1.2 by the same assembly area as in the proposed building, the building shall be considered to be in compliance with Table N1102.1.2. The UA calculation shall be performed using a method consistent with the ASHRAE Handbook of Fundamentals and shall include the thermal bridging effects of framing materials. In addition to UA compliance, the SHGC requirements of Table N1102.1.2 and the maximum fenestration U-factors of Section N1102.5 shall be met.

N1102.2.1 (R402.2.1) Ceilings with attics. Where Section N1102.1.3 requires R-49 insulation in the ceiling or attic, installing R-38 insulation over 100 percent of the ceiling or attic area requiring insulation shall satisfy the requirement for R-49 insulation wherever the full height of uncompressed R-38 insulation extends over the wall top plate at the eaves. Where Section N1102.1.2 requires R-60 insulation in the ceiling or attic, installing R-49 over 100 percent of the ceiling or attic area requiring insulation shall satisfy the requirement for R-60 insulation wherever the full height of uncompressed R-49 insulation extends over the wall top plate at the eaves. This reduction shall not apply to the insulation and fenestration criteria in Section N1102.1.2 and the Total UA alternative in Section N1102.1.5.

R402.2.2 Ceilings without attics. Where Section R402.1.3 requires insulation R-values greater than R-30 in the interstitial space above a ceiling and below the structural roof deck, and the design of the roof/ceiling assembly does not allow sufficient space for the required insulation, the minimum required insulation R-value for such roof/ceiling assemblies shall be R-30. Insulation shall extend over the top of the wall plate to the outer edge of such plate and shall not be compressed. This reduction of insulation from the requirements of Section R402.1.3 shall be limited to 500 square feet (46 m²) or 20 percent of the total insulated ceiling area, whichever is less. This reduction shall not apply to the Total UA alternative in Section R402.1.5.

R402.2.3 Eave baffle. For air-permeable insulation in vented attics, a baffle shall be installed adjacent to soffit and eave vents. Baffles shall maintain a net free area opening equal to or greater than the size of the vent. The baffle shall extend over the top of the attic insulation. The baffle shall be permitted to be any solid material. The baffle shall be installed to the outer edge of the exterior wall top plate so as to provide maximum space for attic insulation coverage over the top plate. Where soffit venting is not continuous, baffles shall be installed continuously to prevent ventilation air in the eave soffit from bypassing the baffle.

N1102.2.4 (R402.2.4) Access hatches and doors. Access doors from conditioned spaces to unconditioned spaces (e.g., attics and crawl spaces) shall be weather stripped and insulated in accordance with the following values:

1. Hinged vertical doors shall have a minimum overall R-5 insulation value;
2. Hatches and scuttle hole covers shall be insulated to a level equivalent to the insulation on the surrounding surfaces; and
3. Pull down stairs shall have a minimum of 75percent of the panel area having R-5 rigid insulation.

Access shall be provided to all equipment that prevents damaging or compressing the insulation. A wood-framed or equivalent baffle or retainer is required to be provided when loose fill insulation is installed, the purpose of which is to prevent the loose fill insulation from spilling into the living space when the attic access is opened, and to provide a permanent means of maintaining the installed R-value of the loose fill insulation.

N1102.2.4.1 (R402.2.4.1) Access hatch and door insulation installation and retention. Vertical or horizontal access hatches and doors from conditioned spaces to unconditioned spaces such as attics and crawl spaces shall be weatherstripped. Access that prevents damaging or compressing the insulation shall be provided to all equipment. Where loose-fill insulation is installed, a wood-framed or equivalent baffle, retainer, or dam shall be installed to prevent loose-fill insulation from spilling into living space from higher to lower sections of the attic, and from attics covering conditioned spaces to unconditioned spaces. The baffle or retainer shall provide a permanent means of maintaining the installed R-value of the loose-fill insulation.

R402.2.7 Floors. Floor cavity insulation shall comply with one of the following:

1. Installation shall be installed to maintain permanent contact with the underside of the subfloor decking in accordance with manufacturer instructions to maintain required R-value or readily fill the available cavity space.
2. Floor framing cavity insulation shall be permitted to be in contact with the top side of sheathing separating the cavity and the unconditioned space below. Insulation shall extend from the bottom to the top of all perimeter floor framing members and the framing members shall be air sealed.
3. A combination of cavity and continuous insulation shall be installed so that the cavity insulation is in contact with the top side of the continuous insulation that is installed on the underside of the floor framing separating the cavity and the unconditioned space below. The combined R-value of the cavity and continuous insulation shall equal the required R-value for floors. Insulation shall extend from the bottom to the top of all perimeter floor framing members and the framing members shall be air sealed.

N1102.2.8 (R402.2.8) Basement walls. Basement walls shall be insulated in accordance with Table N1102.1.3.

Exception: Basement walls associated with unconditioned basements where all of the following requirements are met:

1. The floor overhead, including the underside stairway stringer leading to the basement, is insulated in accordance with Section N1102.1.3 and applicable provisions of Sections N1102.2 and N1102.2.7.
2. There are no uninsulated duct, domestic hot water or hydronic heating surfaces exposed to the basement.
3. There are no HVAC supply or return diffusers serving the basement.
4. The walls surrounding the stairway and adjacent to conditioned space are insulated in accordance with Section N1102.1.3 and applicable provisions of Section N1102.2.
5. The door(s) leading to the basement from conditioned spaces are insulated in accordance with Section N1102.1.3 and applicable provisions of Section N1102.2, and weatherstripped in accordance with Section N1102.4.
6. The building thermal envelope separating the basement from adjacent conditioned spaces complies with Section N1102.4.

N1102.2.8.1 (R402.2.8.1) Basement wall insulation installation. Where basement walls are insulated, the insulation shall be installed from the top of the basement wall down to 10 feet (3048 mm) below grade or to the basement floor, whichever is less.

N1102.2.9 (R402.2.9) Slab-on-grade floors. Slab-on-grade floors with a floor surface less than 12 inches (305 mm) below grade shall be insulated in accordance with Table N1102.1.3.

Exception: Slab-edge insulation is not required in jurisdictions designated by the code official as having a very heavy termite infestation.

R402.2.9.1 Slab-on-grade floor insulation installation. Where installed, the insulation shall extend downward from the top of the slab on the outside or inside of the foundation wall. Insulation located below grade shall be extended the distance provided in Table R402.1.3 or the distance of the proposed design, as applicable, by any combination of vertical insulation, insulation extending under the slab or insulation extending out from the building. Insulation extending away from the building shall be protected by pavement or by not less than 10 inches (254 mm) of soil. The top edge of the insulation installed between the exterior wall and the edge of the interior slab shall be permitted to be cut at a 45-degree (0.79 rad) angle away from the exterior wall.

N1102.2.10 (R402.2.10) Crawl space walls. Crawl space walls shall be insulated in accordance with Table N1102.1.3.

Exception: Crawl space walls associated with a crawl space that is vented to the outdoors and the floor overhead is insulated in accordance with Table N1102.1.3 and Section N1102.2.7.

N1102.2.10.1 (R402.2.10.1) Crawl space wall insulation installation. Where crawl space wall insulation is installed, it shall be permanently fastened to the wall and shall extend downward from the floor to the finished grade elevation and then vertically or horizontally for not less than an additional 24 inches (610 mm). Exposed earth in unvented crawl space foundations shall be covered with a continuous Class I vapor retarder in accordance with this code. Joints of the vapor retarder shall overlap by 6 inches (153 mm) and be sealed or taped. The edges of the vapor retarder shall extend not less than 6 inches (153 mm) up the stem walls and shall be attached to the stem walls.

Definitions:

ABOVE-GRADE WALL. A wall more than 50 percent above grade and enclosing conditioned space. This includes between-floor spandrels, peripheral edges of floors, roof and basement knee walls, dormer walls, gable end walls, walls enclosing a mansard roof and skylight shafts.

AIR BARRIER. One or more materials joined together in a continuous manner to restrict or prevent the passage of air through the building thermal envelope and its assemblies.

APPROVED. Acceptable to the code official.

APPROVED AGENCY. An established and recognized agency that is regularly engaged in conducting tests furnishing inspection services, or furnishing product certification, where such agency has been approved by the code official.

BASEMENT WALL. A wall 50 percent or more below grade and enclosing conditioned space.

BUILDING. Any structure used or intended for supporting or sheltering any use or occupancy, including any mechanical systems, service water-heating systems and electric power and lighting systems located on the building site and supporting the building.

BUILDING THERMAL ENVELOPE. The basement walls, exterior walls, floors, ceiling, roofs and any other building element assemblies that enclose conditioned space or provide a boundary between conditioned space and exempt or unconditioned space.

CAVITY INSULATION. Insulating material located between framing members.

CLIMATE ZONE. A geographical region based on climatic criteria as specified in this code.

CONDITIONED SPACE. An area, room or space that is enclosed within the building thermal envelope and that is directly or indirectly heated or cooled. Spaces are indirectly heated or cooled where they communicate through openings with conditioned spaces, where they are separated from conditioned spaces by uninsulated walls, floors or ceilings, or where they contain uninsulated ducts, piping or other sources of heating or cooling.

CONTINUOUS AIR BARRIER. A combination of materials and assemblies that restrict or prevent the passage of air through the building thermal envelope.

CONTINUOUS INSULATION (ci). Insulating material that is continuous across all structural members without thermal bridges other than fasteners and service openings. It is installed on the interior or exterior, or is integral to any opaque surface, of the building envelope.

CRAWL SPACE WALL. The opaque portion of a wall that encloses a crawl space and is partially or totally below grade.

CURTAIN WALL. Fenestration products used to create an external nonload-bearing wall that is designed to separate the exterior and interior environments.

DWELLING UNIT ENCLOSURE AREA. The sum of the area of ceiling, floors, and walls separating a dwelling unit's conditioned space from the exterior or from adjacent conditioned or unconditioned spaces. Wall height shall be measured from the finished floor of the dwelling unit to the underside of the floor above.

ENERGY ANALYSIS. A method for estimating the annual energy use of the proposed design and standard reference design based on estimates of energy use.

ENERGY SIMULATION TOOL. An approved software program or calculation-based methodology that projects the annual energy use of a building.

ERI REFERENCE DESIGN. A version of the rated design that meets the minimum requirements of the 2006 International Energy Conservation Code.

EXTERIOR WALL. Walls including both above-grade walls and basement walls.

FENESTRATION. Products classified as either vertical fenestration or skylights.

- **Skylights.** Glass or other transparent or translucent glazing material installed at a slope of less than 60 degrees (1.05 rad) from horizontal including unit skylights, tubular daylighting devices, and glazing materials in solariums, sunrooms, roofs and sloped walls.
- **Vertical fenestration.** Windows that are fixed or operable, opaque doors, glazed doors, glazed block and combination opaque/glazed doors composed of glass or other transparent or translucent glazing materials and installed at a slope of not less than 60 degrees (1.05 rad) from horizontal.

FENESTRATION PRODUCT, SITE-BUILT. A fenestration designed to be made up of field-glazed or field-assembled units using specific factory cut or otherwise factory-formed framing and glazing units. Examples of site-built fenestration include storefront systems, curtain walls and atrium roof systems.

HEATED SLAB. Slab-on-grade construction in which the heating elements, hydronic tubing, or hot air distribution system is in contact with, or placed within or under, the slab.

INFILTRATION. The uncontrolled inward air leakage into a building caused by the pressure effects of wind or the effect of differences in the indoor and outdoor air density or both.

INSULATED SIDING. A type of continuous insulation with manufacturer-installed insulating material as an integral part of the cladding product having an R-value of not less than R-2.

LABELED. Equipment, materials or products to which have been affixed a label, seal, symbol or other identifying mark of a nationally recognized testing laboratory, approved agency or other organization concerned with product evaluation that maintains periodic inspection of the production of such labeled items and whose labeling indicates either that the equipment, material or product meets identified standards or has been tested and found suitable for a specified purpose.

LISTED. Equipment, materials, products or services included in a list published by an organization acceptable to the code official and concerned with evaluation of products or services that maintains periodic inspection of production of listed equipment or materials or periodic evaluation of services and whose listing states either that the equipment, material, product or service meets identified standards or has been tested and found suitable for a specified purpose.

OPAQUE DOOR. A door that is not less than 50-percent opaque in surface area.

PROPOSED DESIGN. A description of the proposed building used to estimate annual energy use for determining compliance based on total building performance.

RATED DESIGN. A description of the proposed building used to determine the energy rating index.

R-VALUE (THERMAL RESISTANCE). The inverse of the time rate of heat flow through a body from one of its bounding surfaces to the other surface for a unit temperature difference between the two surfaces, under steady state conditions, per unit area ($h \times ft^2 \times ^\circ F/Btu$) [$m^2 \times K/W$].

SERVICE WATER HEATING. Supply of hot water for purposes other than comfort heating.

SOLAR HEAT GAIN COEFFICIENT (SHGC). The ratio of the solar heat gain entering the space through the fenestration assembly to the incident solar radiation. Solar heat gain includes directly transmitted solar heat and absorbed solar radiation that is then reradiated, conducted or convected into the space.

STANDARD REFERENCE DESIGN. A version of the proposed design that meets the minimum requirements of this code and is used to determine the maximum annual energy use requirement for compliance based on total building performance.

THERMAL ISOLATION. Physical and space conditioning separation from conditioned spaces. The conditioned spaces shall be controlled as separate zones for heating and cooling or conditioned by separate equipment.

U-FACTOR (THERMAL TRANSMITTANCE). The coefficient of heat transmission (air to air) through a building component or assembly, equal to the time rate of heat flow per unit area and unit temperature difference between the warm side and cold side air films ($Btu/h \times ft^2 \times ^\circ F$) [$W/(m^2 \times K)$].

