APPENDIX C B-6
CODE CHANGE PROPOSAL
NORTH CAROLINA
BUILDING CODE COUNCIL

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Petition for Rule Making Item Number _____

Granted by BCC _____ **Adopted by BCC** _____ **Approved by RRC** _____
Denied by BCC _____ **Disapproved by BCC** _____ **Objection by RRC** _____

PROPONENT: Dan Dittman PHONE: (919) 647-0012
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North Carolina State Building Code, Volume 2024 Energy Conservation Code – Section R402 Building Thermal Envelope

CHECK ONE: [X] Revise section to read as follows: [ ] Delete section and substitute the following:
[ ] Add new section to read as follows: [ ] Delete section without substitution:

~~LINE THROUGH MATERIAL TO BE DELETED~~ UNDERLINE MATERIAL TO BE ADDED

Please type. Continue proposal or reason on plain paper attached to this form. See reverse side for instructions.

See attached for code amendment proposal.

Will this proposal change the cost of construction?	Decrease [ ]	Increase [ ]	No	[X]
Will this proposal increase to the cost of a dwelling by $80 or more?		Yes [ ]	No	[X]
Will this proposal affect the Local or State funds?	Local [ ]	State [ ]	No	[X]
Will this proposal cause a substantial economic impact (≥$1,000,000)?		Yes [ ]	No	[X]

- Non-Substantial – Provide an economic analysis including benefit/cost estimates.
- Substantial – The economic analysis must also include 2-alternatives, time value of money and risk analysis.
- Pursuant to §143-138(a1)(2) a cost-benefit analysis is required for all proposed amendments to the NC Energy Conservation Code. The Building Code Council shall also require same for the NC Residential Code, Chapter 11.

REASON: This amendment is being filed to comply with the requirements of N.C. Sess. L. 2023-108, § 6 (eff. Aug. 16, 2023). As such, the proposal was not vetted for cost of construction, increasing the cost of a dwelling by $80 or more, affecting Local or State funds, or if it will cause a substantial impact due to the incremental impact of said Statute. Likewise, a cost-benefit analysis was not performed for the incremental impact of said Statute, because the code change was a directive by the North Carolina General Assembly to codify the language. This permanent rule change to the 2024 NC Energy Conservation Code is in response to the objection by the Rules Review Commission of the NC Office of Administrative Hearings at the 4/30/24 RRC meeting.

SECTION R402
BUILDING THERMAL ENVELOPE

R402.1 General ~~(Prescriptive).~~ The *building thermal envelope* shall comply with the requirements of Sections R402.1.1 through R402.1.5.

Exceptions:

1. The following low-energy *buildings*, or portions thereof, separated from the remainder of the building by *building thermal envelope* assemblies complying with this section shall be exempt from the *building thermal envelope* provisions of Section R402.
   1.1. Those with a peak design rate of energy usage less than 3.4 Btu/h × ft^2 (10.7 W/m^2) or 1.0 watt/ft^2 of floor area for space-conditioning purposes.
   1.2. Those that do not contain *conditioned space*.
2. Log homes designed in accordance with ICC 400.
3. **~~R402.1.1~~** Rooms containing fuel-burning appliances. In Climate Zones 3 through 5, where open combustion air ducts provide combustion air to open combustion fuel burning appliances, the appliances and combustion air opening shall be located outside the building thermal envelope or enclosed in a room that is isolated from inside the thermal envelope. Such rooms shall be sealed and insulated in accordance with the envelope requirements of Table R402.1.3, where the walls, floors and ceilings shall meet a minimum of the basement wall R-value requirement. The door into the room shall be fully gasketed and any water lines and ducts in the room insulated in accordance with Section R403. The combustion air duct shall be insulated where it passes through conditioned space to an R-value of not less than R-8.

   Exceptions:

   1. Direct vent appliances with both intake and exhaust pipes installed continuous to the outside.
   2. Fireplaces and stoves complying with Section R402.4.2 and Section R1006 of the International Residential Code.

R402.1.1 Vapor retarder. ~~Deleted.~~ Wall assemblies in the *building thermal envelope* shall comply with the vapor retarder requirements of Section R702.7 of the *International Residential Code* or Section 1404.3 of the *International Building Code*, as applicable.

R402.1.2 Insulation and fenestration criteria. The *building thermal envelope* shall meet the requirements of Table R402.1.2, based on the *climate zone* specified in Chapter 3. Assemblies shall have a *U*-factor equal to or less than that specified in Table R402.1.2. Fenestration shall have a *U*-factor and glazed fenestration SHGC equal to or less than that specified in Table R402.1.2.

R402.1.3 *R*-value alternative. Assemblies with *R*-value of insulation materials equal to or greater than that specified in Table R402.1.3 shall be an alternative to the *U*-factor in Table R402.1.2 □

~~R402.1.3~~ R402.1.4 *R*-value computation. ~~Insulation material used in layers, such as framing cavity insulation, or continuous insulation shall be summed to compute the corresponding component *R*-value. The manufacturer's settled *R*-value shall be used for blown insulation.~~ Cavity insulation alone shall be used to determine compliance with the cavity insulation *R*-value requirements in Table R402.1.3. 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 R402.1.3. 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 R402.1.3. 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 R402.1.3, the manufacturer's labeled *R*-value for the insulated siding shall be reduced by R-0.6.

~~R402.1.4 *U*-factor alternative.~~ ~~An assembly with a *U*-factor equal to or less than that specified in Table R402.1.4~~

~~shall be permitted as an alternative to the *R*-value in Table R402.1.2.~~

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 R402.1.2 by the same assembly area as in the proposed *building*, the *building* shall be considered to be in compliance with Table R402.1.2. 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 R402.1.2 and the maximum fenestration *U*-factors of Section R402.5 shall be met.

North Carolina approved version of REScheck software shall be permitted to demonstrate compliance with this ~~code~~ section. Envelope requirements may not be traded off against the use of high efficiency heating or cooling equipment. No tradeoff calculations are needed for required termite inspection and treatment gaps.

R402.2 Specific insulation requirements ~~(Prescriptive).~~ In addition to the requirements of Section R402.1, insulation shall meet the specific requirements of Sections R402.2.1 through ~~R402.2.15~~ R402.2.12.

R402.2.1 Ceilings with attic spaces. Where Section ~~R402.1.2~~ R402.1.3 requires ~~R-38~~ R-49 insulation in the ceiling or attic, installing ~~R-30~~ R-38 over 100 percent of the ceiling or attic area requiring insulation shall satisfy the requirement for ~~R-38~~ R-49 insulation wherever the full height of uncompressed ~~R-30~~ R-38 insulation extends over the wall top plate at the eaves. Where Section R402.1.3 requires R-60 insulation in the ceiling, installing R-49 over 100 percent of the ceiling 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 U-factor alternative~~ the insulation and fenestration criteria in Section ~~R402.1.4~~ R402.1.2 and the Total UA alternative in Section R402.1.5.

~~**Exceptions:**~~
~~1. When insulation is installed in a fully enclosed attic floor system, as described in Appendix 1.2.1, R-30 shall be deemed compliant.~~
~~2. In roof edge and other details such as bay windows, dormers, and similar areas where the space is limited, the insulation must fill the space up to the air baffle.~~

Exception. In other details such as bay window and dormer roofs, and similar areas where the space is limited, the available space shall be filled with insulation for unvented details, and to the insulation baffle for vented assemblies.

~~**R402.2.2 Ceilings without attic spaces.** Where Section R402.1.2 would require R-38 insulation and the design of the roof/ceiling assembly, including cathedral ceilings, bay windows and other similar areas, does not allow sufficient space for the required insulation, the minimum required insulation for such roof/ceiling assemblies shall be R-30. This reduction of insulation from the requirements of Section R402.1.2 shall be limited to 500 square feet (46 m^2) of the total insulated ceiling area. This reduction shall not apply to the *U*-factor alternative approach in Section R402.1.4 and the total UA alternative in Section R402.1.5.~~

R402.2.2 Ceilings without attic spaces

R402.2.2.1 Roof Ceiling Assemblies. Where Section R402.1.2 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 including cathedral ceilings, dormers, bay windows and other similar areas, 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 R402.1.2 shall be limited to 500 square feet (46 m^2) 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.

R402.2.2.2 Unvented attic and unvented enclosed rafter assembly alternate.

Where Table R402.1.3 requires R-38 or greater insulation in the ceiling, or Table R402.1.2 requires a ceiling U-factor of 0.030 or less, installing air-impermeable insulation, as follows, to the underside or directly above the roof deck shall be deemed to satisfy the R-value requirements: (i) R-20 (equivalent U-factor 0.05) for climate zone 3;(ii) R-25 (equivalent U-factor 0.037) for climate zone 4; and (iii) R-25 (equivalent U-factor 0.037) for climate zone 5. These air-impermeable insulation alternative R-value minimums apply in residences meeting the following criteria:

1. The unvented attic or unvented enclosed rafter assemblies are constructed under Section R806.5 of the North Carolina Residential Code.

2. The residence contains a mechanical ventilation system that operates on a positive, balanced, or hybrid pressure strategy in accordance with North Carolina Mechanical Code 403.3.
3. For residences with air-impermeable insulation installed below the roof deck, exposed portions of the roof rafters are wrapped by a minimum of R-3 insulation unless directly covered by drywall or finished ceiling material. For residences with air-impermeable insulation installed above the roof deck, roof rafters do not require insulation wrapping if air-impermeable insulation installed above the roof deck is continuous.
4. The residence obtains an ACH50 blower door test result of less than 3.0.
5. The residence contains heating, cooling, and ventilation equipment and ductwork within thermal envelope.

~~TABLE R402.1.4~~
EQUIVALENT *U*-FACTORS[a]

CLIMATE ZONE	FENESTRATION *U*-FACTOR[d]	SKYLIGHT *U*-FACTOR	CEILING *U*-FACTOR	FRAME WALL *U*-FACTOR	MASS WALL *U*-FACTOR[b]	FLOOR *U*-FACTOR	BASEMENT WALL *U*-FACTOR	CRAWL SPACE WALL *U*-FACTOR
3	0.35	0.55	0.030	0.077	0.141	0.047	0.091[c]	0.136
4	0.35	0.55	0.030	0.077	0.141	0.047	0.059	0.065
5	0.35	0.55	0.030	0.061	0.082	0.033	0.059	0.065

a. Nonfenestration *U*-factors shall be obtained from measurement, calculation or an approved source.
b. When more than half the insulation is on the interior, the mass wall *U*-factors shall be a maximum of 0.07 in Climate Zone 3, 0.07 in Climate Zone 4 and 0.054 in Climate Zone 5.
c. Basement wall *U*-factor of 0.360 in warm-humid locations as defined by Figure R301.1 and Table R301.1.
d. A maximum of two glazed fenestration product assemblies having a *U*-factor no greater than 0.55 and a SHGC no greater than 0.70 shall be permitted to be substituted for minimum code compliant fenestration product assemblies without penalty. When applying this note and using the REScheck "UA Trade-off" compliance method to allow continued use of the software, the applicable fenestration products shall be modeled as meeting the *U*-factor of 0.35 and the SHGC of 0.30, as applicable, but the fenestration products actual *U*-factor and actual SHGC shall be noted in the comments section of the software for documentation of application of this note to the applicable products. Compliance for these substitute products shall be verified compared to the allowed substituted maximum *U*-value requirement and maximum SHGC requirement, as applicable.

TABLE R402.1.2
MAXIMUM ASSEMBLY *U*-FACTORS[a] AND FENESTRATION REQUIREMENTS

CLIMATE ZONE	FENESTRATION *U*-FACTOR[f]	SKYLIGHT *U*-FACTOR	GLAZED FENESTRATION SHGC[d, e]	CEILING *U*-FACTOR[g,h]	WOOD FRAME WALL *U*-FACTOR	MASS WALL *U*-FACTOR[b]	FLOOR *U*-FACTOR	BASEMENT WALL *U*-FACTOR	CRAWL SPACE WALL *U*-FACTOR
3	0.30	0.55	0.25	0.026	0.060	0.098	0.047	0.091[c]	0.136
4	0.30	0.55	0.40	0.024	0.045	0.098	0.047	0.059	0.065
5	0.30	0.55	NR	0.024	0.045	0.082	0.033	0.050	0.055

For SI: 1 foot = 304.8 mm.
a. Nonfenestration *U*-factors shall be obtained from measurement, calculation or an approved source.
b. Mass walls shall be in accordance with Section R402.2.5. Where more than half the insulation is on the interior, the mass wall *U*-factors shall not exceed 0.12 in Climate Zone 3, 0.087 in Climate Zone 4, 0.065 in Climate Zone 5.
c. In Warm Humid locations as defined by Figure R301.1 and Table R301.1, the basement wall *U*-factor shall not exceed 0.360.
d. The SHGC column applies to all glazed fenestration.
Exception: In Climate Zones 0 through 3, skylights shall be permitted to be excluded from glazed fenestration SHGC requirements provided that the SHGC for such skylights does not exceed 0.30.
e. Deleted.
f. A maximum *U*-factor of 0.32 shall apply to vertical fenestration products installed in buildings located either:
1. Above 4,000 feet in elevation above sea level, or
2. In windborne debris regions where protection of openings is required by Section R301.2.1.2 of the *International Residential Code*.
g. Roofs insulated at the deck (above, below, or combination) shall meet the U-factors for the climate zone of the building location, unless meeting the allowance in footnote "h".
h. Alternately, per North Carolina General Assembly Session Law 2023-108, Section 6 (effective 8/16/23), unvented attic and unvented enclosed rafter assemblies can utilize R402.2.2.2 where the assembly can comply with the criteria listed under R402.2.2.2.

~~TABLE R402.1.2~~
INSULATION AND FENESTRATION REQUIREMENTS BY COMPONENT[a]

CLIMATE ZONE	FENESTRATION *U*-FACTOR[b,l]	SKYLIGHT[b] *U*-FACTOR	GLAZED FENESTRATION SHGC[b, k]	CEILING *R*-VALUE[m]	WOOD FRAME WALL *R*-VALUE	MASS WALL *R*-VALUE[i]	FLOOR *R*-VALUE	BASEMENT[c,g] WALL *R*-VALUE	SLAB[d] *R*-VALUE & DEPTH	CRAWL SPACE[c] WALL *R*-VALUE
3	0.35	0.55	0.30	38 or 30ci[j]	15 or 13+2.5[h]	5/13 or 5/10ci	19	5/13[f]	0	5/13
4	0.35	0.55	0.30	38 or 30ci[j]	15 or 13+2.5[h]	5/13 or 5/10ci	19	10 /15	10	10/15
5	0.35	0.55	NR	38 or 30ci[j]	19[g] or 13+5[h] or 15+3[h]	13/17 or 13/12.5ci	30[g]	10/15	10	10/19

For SI: 1 foot = 304.8 mm.

~~a. R-values are minimums. *U*-factors and SHGC are maximums. When insulation is installed in a cavity which is less than the label or design thickness of the insulation, the installed *R*-value of the insulation shall not be less than the *R*-value specified in the table.~~

~~b. The fenestration *U*-factor column excludes skylights. The SHGC column applies to all glazed fenestration.~~

~~c. "10/15" means R-10 continuous insulated sheathing on the interior or exterior of the home or R-15 cavity insulation at the interior of the basement wall or crawl space wall.~~

~~d. For monolithic slabs, insulation shall be applied from the inspection gap downward to the bottom of the footing or a maximum of 24 inches below grade, whichever is less. For floating slabs, insulation shall extend to the bottom of the foundation wall or 24 inches, whichever is less. (See Appendix R2). R-5 shall be added to the required slab edge *R*-values for heated slabs.~~

~~e. Deleted.~~

~~f. Basement wall insulation is not required in warm-humid locations as defined by Figure R301.1 and Table R301.1.~~

~~g. Or insulation sufficient to fill the framing cavity, R-19 minimum.~~

~~h. The first value is cavity insulation, the second value is continuous insulation, so "13+5" means R-13 cavity insulation plus R-5 continuous insulation. If structural sheathing covers 25 percent or less of the exterior, insulating sheathing is not required where structural sheathing is used. If structural sheathing covers more than 25 percent of exterior, structural sheathing shall be supplemented with insulated sheathing of at least R-2.~~

~~i. The second *R*-value applies when more than half the insulation is on the interior of the mass wall.~~

~~j. In addition to the exemption in Section R402.3.3, a maximum of two glazed fenestration product assemblies having a *U*-factor no greater than 0.55 shall be permitted to be substituted for minimum code compliant fenestration product assemblies without penalty.~~

~~k. In addition to the exemption in Section R402.3.3, a maximum of two glazed fenestration product assemblies having a SHGC no greater than 0.70 shall be permitted to be substituted for minimum code compliant fenestration product assemblies without penalty.~~

~~l. R-30 shall be deemed to satisfy the ceiling insulation requirement wherever the full height of uncompressed R-30 insulation extends over the wall top plate at the eaves. Otherwise R-38 insulation is required where adequate clearance exists or insulation must extend to either the insulation baffle or within 1 inch of the attic roof deck.~~

~~m. Table value required except for roof edge where the space is limited by the pitch of the roof; there the insulation must fill the space up to the air baffle.~~

~~n. R-19 fiberglass batts compressed and installed in a nominal 2 × 6 framing cavity is deemed to comply. Fiberglass batts rated R-19 or higher compressed and installed in a 2 × 4 wall is not deemed to comply.~~

~~o. Basement wall meeting the minimum mass wall specific heat content requirement may use the mass wall *R*-value as the minimum requirement.~~

TABLE R402.1.3

INSULATION MINIMUM *R*-VALUES AND FENESTRATION REQUIREMENTS BY COMPONENT[a]

CLIMATE ZONE	FENESTRATION ***U***-FACTOR[b, l]	SKYLIGHT[b] ***U***-FACTOR	GLAZED FENESTRATION SHGC[b, e]	CEILING ***R***-VALUE[i,k]	WOOD FRAME WALL ***R***-VALUE[g]	MASS WALL ***R***-VALUE[h]	FLOOR ***R***-VALUE	BASEMENT[c,g] WALL ***R***-VALUE	SLAB[d] ***R***-VALUE & DEPTH	CRAWL SPACE[c,g] WALL ***R***-VALUE
3	.30	0.55	0.25	49	20 or 13 + 5ci or 0 + 15	8/13	19	5ci or 13[f]	10ci, 2 ft	5ci or 13[f]

4	.30	0.55	0.40	60	20 + 5 or 13 + 10ci or 0 + 15	8/13	19	10ci or 13	10ci, 4 ft	10ci or 13
5	0.30[i]	0.55	0.40	60	20 + 5 or 13 + 10ci or 0 + 15	13/17	30	15ci or 19 or 13 + 5ci	10ci, 4 ft	15ci or 19 or 13 + 5ci

For SI: 1 foot = 304.8 mm.
NR = Not Required.

ci = continuous insulation.

a. *R*-values are minimums. *U*-factors and SHGC are maximums. Where insulation is installed in a cavity that is less than the label or design thickness of the insulation, the installed *R*-value of the insulation shall be not less than the *R*-value specified in the table.

b. The fenestration *U*-factor column excludes skylights. The SHGC column applies to all glazed fenestration.
Exception: In Climate Zones 0 through 3, skylights shall be permitted to be excluded from glazed fenestration SHGC requirements provided that the SHGC for such skylights does not exceed 0.30.

c. "5ci or 13" means R-5 continuous insulation (ci) on the interior or exterior surface of the wall or R-13 cavity insulation on the interior side of the wall. "10ci or 13" means R-10 continuous insulation (ci) on the interior or exterior surface of the wall or R-13 cavity insulation on the interior side of the wall. "15ci or 19 or 13 + 5ci" means R-15 continuous insulation (ci) on the interior or exterior surface of the wall; or R-19 cavity insulation on the interior side of the wall; or R-13 cavity insulation on the interior of the wall in addition to R-5 continuous insulation on the interior or exterior surface of the wall.

d. R-5 insulation shall be provided under the full slab area of a heated slab in addition to the required slab edge insulation *R*-value for slabs. as indicated in the table. The slab-edge insulation for heated slabs shall not be required to extend below the slab.

e. There are no SHGC requirements in the Marine Zone.

f. Basement wall insulation is not required in Warm Humid locations as defined by Figure R301.1 and Table R301.1.

g. The first value is cavity insulation; the second value is continuous insulation. Therefore, as an example, "13 + 5" means R-13 cavity insulation plus R-5 continuous insulation.

h. Mass walls shall be in accordance with Section R402.2.5. The second *R*-value applies where more than half of the insulation is on the interior of the mass wall.

i. A maximum *U*-factor of 0.32 shall apply in Climate Zone 5 to vertical fenestration products installed in buildings located either:
1. Above 4,000 feet in elevation, or
2. In windborne debris regions where protection of openings is required by Section R301.2.1.2 of the *International Residential Code*.

j. Roofs insulated at the deck (above, below, or combination) shall meet the U-factors in Table R402.1.2, unless meeting the allowance in footnote "k".

k. Alternately, per North Carolina General Assembly Session Law 2023-108, Section 6 (effective 8/16/23), unvented attic and unvented enclosed rafter assemblies can utilize R402.2.2.2 where the assembly can comply with the criteria listed under R402.2.2.2.

R402.2.3 Soffit baffle. For air-permeable insulation in vented attics, a baffle shall be installed adjacent to soffit 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.

~~**R402.2.4 Access hatches and doors.** Horizontal access hatches from conditioned spaces to *unconditioned spaces* such as attics and crawl spaces shall be weatherstripped and insulated to an R-10 minimum value and vertical doors to such spaces shall be weatherstripped and insulated to R-5. 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.~~

~~**Exception:**~~

~~1. Full size vertical doors that provide access from conditioned to unconditioned spaces shall be permitted to meet the fenestration requirements of Table R402.1.2 based on the applicable climate zone specified in Chapter 3.~~

~~2. Pull-down stair systems shall be weatherstripped and insulated with a minimum R-5 insulation. The insulation shall not interfere with proper operation of the stair. Nonrigid insulation materials are not allowed. Additional insulation systems that enclose the stair system from above are allowed. Exposed foam plastic must meet the~~

~~provisions of the Building Code or Residential Code, respectively.~~

R402.2.4 Access hatches and doors. Access hatches and doors from conditioned to unconditioned spaces such as attics and crawl spaces shall be insulated to the same *R*-value required by Table R402.1.3 for the wall or ceiling in which they are installed.

Exceptions:

1. Vertical doors providing access from conditioned spaces to unconditioned spaces that comply with the fenestration requirements of Table R402.1.3 based on the applicable climate zone specified in Chapter 3.
2. Horizontal pull-down, stair-type access hatches in ceiling assemblies that provide access from conditioned to unconditioned spaces in Climate Zones 3,4, & 5 shall not be required to comply with the insulation level of the surrounding surfaces provided the hatch meets all of the following:
   2.1. The average *U*-factor of the hatch shall be less than or equal to U-0.10 or have an average insulation *R*-value of R-10 or greater.
   2.2. Not less than 75 percent of the panel area shall have an insulation *R*-value of R-13 or greater.
   2.3. The net area of the framed opening shall be less than or equal to 13.5 square feet (1.25 m^2).
   2.4. The perimeter of the hatch edge shall be weatherstripped.

The reduction shall not apply to the total UA alternative in Section R402.1.5.

R402.2.4.1 Access hatches 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 or retainer, or dam shall be installed to prevent the loose-fill insulation from spilling into the living spaces, 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.

R402.2.5 Mass walls. Mass walls for the purposes of this chapter shall be considered 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, or any other walls meeting the following:

~~Masonry or concrete walls having a mass greater than r equal to 30 pounds per square foot (146 kg/m^2). Solid wood walls having a mass greater than 20 pounds per square foot (98 kg/m^2). Any walls having a heat capacity greater than or equal to 6 Btu/ ft^2 · K)].~~

- Masonry or concrete walls having a mass greater than or equal to 30 pounds per square foot (146 kg/m_2).
- Solid wood walls having a mass greater than 20 pounds per square foot (98 kg/m_2).
- Any walls having a heat capacity greater than or equal to 6 Btu/ft_2 · °F [266 J/(m_2 · K)].

R402.2.6 Steel-frame ceilings, walls and floors. Steel-frame ceilings, walls, and floors shall ~~meet~~ comply with the insulation requirements of Table R402.2.6 or the *U*-factor requirements of ~~Table R402.1.4~~ R402.1.2. The calculation of the *U*-factor for a steel-frame envelope assembly shall use a series-parallel path calculation method.

TABLE R402.2.6

STEEL-FRAME CEILING, WALL AND FLOOR INSULATION *R*-VALUES

WOOD FRAME ***R***-VALUE REQUIREMENT	COLD-FORMED STEEL-FRAME EQUIVALENT ***R***-VALUE[a]
Steel Truss Ceilings[b]	
R-30	R-38 or R-30 + 3 or R-26 + 5
R-38	R-49 or R-38 + 3

R-49	R-38 + 5
Steel Joist Ceilings[b]	
R-30	R-38 in 2 × 4 or 2 × 6 or 2 × 8 R-49 in any framing
R-38	R-49 in 2 × 4 or 2 × 6 or 2 × 8 or 2 × 10
Steel-frame Wall, 16 inches on center	
R-13	~~R-19+2.1~~ R-13 + 4.2 or R-21 + 2.8 or R-0 + 9.3 or R-15 + 3.8 or R-21 + 3.1
~~R-13+3~~ R-13 + 5	~~R-0 + 11.2~~ R-0 + 15 or ~~R-13 + 6.1~~ R-13 + 9 or ~~R-15+5.7~~ R-15 + 8.5 or ~~R-19 + 5.0~~ R-19 + 8 or ~~R-21+4.7~~ R-21 + 7
R-13 + 10	R-0 + 20 or R-13 + 15 or R-15 + 14 or R-19 + 13 or R-21 + 13
R-20	R-0 + 14.0 or R-13 + 8.9 or R-15 + 8.5 or R-19 + 7.8 or R-21 + 7.5
R-20 + 5	R-13 + 12.7 or R-15 + 12.3 or R-19 + 11.6 or R-21 + 11.3 or R-25 + 10.9
R-21	R-0 + 14.6 or R-13 + 9.5 or R-15 + 9.1 or R-19 + 8.4 or R-21 + 8.1 or R-25 + 7.7
Steel-frame Wall, 24 inches on center	
R-13	R-0 + 9.3 or R-13 + 3.0 or R-15 + 2.4
~~R-13 + 3~~	~~R-0+11.2 or R-13 + 4.9 or R-15 + 4.3 or R-19 + 6.3 or R-21 + 5.9~~
~~R-13 + 5~~	~~R-0 + 15 or R-13 + 7.5 or R-15 + 7 or R-19 + 6 or R-21 + 6~~
R-13 + 10	R-0 + 20 or R-13 + 13 or R-15 + 12 or R-19 + 11 or R-21 + 11
R-20	R-0 + 14.0 or R-13 + 7.7 or R-15 + 7.1 or R-19 + 6.3 or R-21 + 5.9
R-20 + 5	R-13 + 11.5 or R-15 + 10.9 or R-19 + 10.1 or R-21 + 9.7 or R-25 + 9.1
R-21	R-0 + 14.6 or R-13 + 8.3 or R-15 + 7.7 or R-19 + 6.9 or R-21 + 6.5 or R-25 + 5.9
Steel Joist Floor	
R-13	R-19 in 2 × 6, or R-19 + 6 in 2 × 8 or 2 × 10
R-19	R-19 + 6 in 2 × 6, or R-19 + 12 in 2 × 8 or 2 × 10

a. The first value is cavity insulation *R*-value; the second value is continuous insulation *R*-value. Therefore, for example, "R-30 + 3" means R-30 cavity insulation plus R-3 continuous insulation.
b. Insulation exceeding the height of the framing shall cover the framing.

~~**R402.2.8 Floors.** Floor framing cavity insulation shall be installed to maintain permanent contact with the underside of the subfloor decking. The distance between tension sup- port wires or other devices that hold the floor insulation in place against the subfloor shall be no more than 18 inches. In addition, supports shall be located no further than 6 inches from each end of the insulation.~~

~~**Exception:** An enclosed floor cavity such as garage ceilings, cantilevers or buildings on pilings with an enclosed floor cavity with the insulation fully in contact with the lower air barrier. In this case, the band boards shall be insulated to maintain thermal envelope continuity.~~

~~**R402.2.8**~~ **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. The distance between tension support wires or other devices that hold the floor insulation in place against the subfloor shall be no more than 18 inches. In addition, supports shall be located no further than 6 inches from each end of the insulation.

2. Floor framing cavity insulation shall be permitted to be in contact with the top side of sheathing/gypsum separating the cavity and the unconditioned space below. Insulation shall extend from the bottom to the top of all perimeter floor framing members (the band boards) 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.

~~**R402.2.9 Basement walls.** Walls associated with condi tioned basements shall be insulated from the top of the *basement wall* down to 10 feet (3048 mm) below grade or to the basement floor, whichever is less. Walls associated with unconditioned basements shall meet this requirement unless the floor overhead is insulated in accordance with Sections R402.1.2 and R402.2.8. Foam plastic insulation applied to exterior of basement walls shall be provided with termite inspection and treatment gaps in accordance with Appendix R2.~~

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

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 R402.1.3 and applicable provisions of Sections R402.2 and R402.2.7.
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 R402.1.3 and applicable provisions of Section R402.2.
5. The door(s) leading to the basement from conditioned spaces are insulated in accordance with Sections R402.1.3 and applicable provisions of Section R402.2, and weatherstripped in accordance with Section R402.4.
6. The building thermal envelope separating the basement from adjacent conditioned spaces complies with Section R402.4.

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. Foam plastic insulation applied to exterior of basement walls shall be provided with termite inspection and treatment gaps in accordance with Appendix R2.

~~**R402.2.10 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 R402.1.2. 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*. Slab edge insulation shall have a 2 inch termite inspection gap consistent with Appendix R2 of this code.~~

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 R402.1.3.

Exception: Deleted.

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*. Slab edge insulation shall have a 2-inch termite inspection gap consistent with Appendix R2 of this code.

~~**R402.2.11 Closed crawl space walls.** Where the floor above a closed crawl space is not insulated, the exterior crawlspace walls shall be insulated in accordance with Table R402.1.2.~~

~~Wall insulation may be located in any combination of the outside and inside wall surfaces and within the structural cavities or materials of the wall system.~~

~~Wall insulation requires that the exterior wall band joist area of the floor frame be insulated. Wall insulation shall begin 3 inches (76.2 mm) below the top of the masonry foundation wall and shall extend down to 3 inches (76.2 mm) above the top of the footing or concrete floor, 3 inches (76.2 mm) above the interior ground surface or 24 inches (609.6 mm) below the outside finished ground level, whichever is less. (See Appendix R1.2.2 details).~~

~~Termite inspection, clearance, and wicking gaps are allowed in wall insulation systems. Insulation may be omitted in the gap area without energy penalty. The allowable insulation gap widths are listed in Table 402.2.11. If gap width exceeds the allowances, one of the following energy compliance options shall be met:~~

~~1Wall insulation is not allowed and the required insulation value shall be provided in the floor system.~~

~~2Compliance shall be demonstrated with energy trade-off methods provided by a North Carolina specific version of REScheck or the UA Alternative method or Section R405.~~

~~**R402.2.11**~~ **R402.2.10 Crawl space walls.** Crawl space walls shall be insulated in accordance with Table R402.1.3.

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 R402.1.3 and Section R402.2.7.

R402.2.10.1 Crawl space wall insulation installations. 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 the *International Building Code* or *International Residential Code*, as applicable. 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 stem walls and shall be attached to the stem walls.

Wall insulation may be located in any combination of the outside and inside wall surfaces and within the structural cavities or materials of the wall system. Wall insulation requires that the exterior wall band joist area of the floor frame be insulated. Wall insulation shall begin 3 inches (76.2 mm) below the top of the masonry foundation wall and shall extend down to 3 inches (76.2 mm) above the top of the footing or concrete floor, 3 inches (76.2 mm) above the interior ground surface or 24 inches (609.6 mm) below the outside finished ground level, whichever is less. (See Appendix R1.2.2 details).

Termite inspection, clearance, and wicking gaps are allowed in wall insulation systems. Insulation may be omitted in the gap area without energy penalty. The allowable insulation gap widths are listed in Table 402.2.10. If gap width exceeds the allowances, one of the following energy compliance options shall be met:

1. Wall insulation is not allowed and the required insulation value shall be provided in the floor system.
2. Compliance shall be demonstrated with energy trade-off methods provided by ~~a North Carolinas specific version of REScheck or~~ the UA Alternative method or Section R401.2.2

TABLE ~~R402.2.11~~ R402.2.10
WALL INSULATION ALLOWANCES FOR TERMITE TREATMENT AND INSULATION GAPS

GAP WIDTH (inches)		INSULATION LOCATION	GAP DESCRIPTION
Minimum	Maximum		

2	3	Outside	Above grade inspection between top of insulation and bottom of siding
4	6	Outside	Below grade treatment
3[a]	4[a]	Inside	Wall inspection between top of insulation and bottom of sill
3[a]	4[a]	Inside	Clearance/wicking space between bottom of insulation and top of ground surface, footing, or concrete floor

a. No insulation shall be required on masonry walls of 9 inches in height or less.

~~**R402.2.12**~~ **R402.2.11 Masonry veneer.** Insulation shall not be required on the horizontal portion of a foundation that supports a masonry veneer.

~~**R402.2.13**~~ **R402.2.12 Sunroom and heated garage insulation.** *Sunrooms* enclosing *conditioned space* and heated garages shall meet the insulation requirements of this code.

Exception: For *sunrooms* and heated garages provided with *thermal isolation*, and enclosed *conditioned space*, the following exceptions to the insulation requirements of this code shall apply:

1. The minimum ceiling insulation *R*-values shall be R-19 in *Climate Zones* 3 and 4 and R-24 in *Climate Zone 5*~~.~~
2. The minimum wall insulation *R*-value shall be R-13 in all *climate zones*. ~~New walls~~ Walls separating a *sunroom* or heated garage with *thermal isolation* from *conditioned space* shall comply with the *building thermal envelope* requirements of this code.

~~**R402.2.14 Framed cavity walls.** The exterior thermal envelope wall insulation shall be installed in contact and continuous alignment with the building envelope air bar- rier. Insulation shall be free from installation gaps, voids, or compression. For framed walls, the cavity insulation shall be enclosed on all sides with solid rigid material or Rim joists are not required to be enclosed on all sides. Wall insulation shall be enclosed at the following loca- tions when installed on exterior walls prior to being covered by subsequent construction, consistent with the Appendix R1.2.3 of this code:~~

~~1.Tubs.~~

~~2.Showers.~~

~~3.Stairs.~~

~~4. Fireplace units (enclosed with rigid material only).~~

~~**R402.2.15 Attic knee walls.** Enclosure of wall cavity insulation also applies to walls that adjoin attic spaces by placing a rigid material or air barrier material on the attic space side of the wall on the attic space side of the wall consistent with the Appendix R1.2.3 of this code. Joints shall be air sealed. Noninsulating Class I vapor retarders, such as polyethylene, shall not be allowed.~~

R402.3 Fenestration ~~(Prescriptive).~~ In addition to the requirements of Section R402, fenestration shall comply with Sections R402.3.1 through R402.3.5.

R402.3.1 *U*-factor. An area-weighted average of fenestration products shall be permitted to satisfy the *U*-factor requirements.

R402.3.2 Glazed fenestration SHGC. An area-weighted average of fenestration products more than 50-percent glazed shall be permitted to satisfy the SHGC requirements.

Dynamic glazing shall be permitted to satisfy the SHGC requirements of Table R402.1.2 provided that the ratio of the higher to lower labeled SHGC is greater than or equal to 2.4, and the *dynamic glazing* is automatically controlled to modulate the amount of solar gain into the space in multiple steps. *Dynamic glazing* shall be considered separately from other fenestration, and area-weighted averaging with other fenestration that is not dynamic glazing shall be prohibited.

Exception: Dynamic glazing shall not be required to comply with this section where both the lower and higher labeled SHGC comply with the requirements of Table R402.1.2.

R402.3.3 Glazed fenestration exemption. ~~Either two glazed fenestration assemblies or up to 24 square feet (2.2 m^2).~~ Not greater than 15 square feet (1.4 m^2) of glazed fenestration per *dwelling unit* shall be exempt from the *U*-factor and SHGC requirements in Section R402.1.2. This exemption shall not apply to the Total UA alternative in Section R402.1.5.

R402.3.4 Opaque door. Opaque doors separating conditioned from *unconditioned* space shall have a maximum *U*-factor of 0.35.

Exception: One side-hinged opaque door assembly is exempted from the *U*-factor requirement in Section R402.1.2. This exemption shall not apply to the *U* fac- tor alternative approach in Section R402.1.4 and the total UA alternative in Section R402.1.5.

R402.3.4 Opaque door exemption. One side-hinged opaque door assembly not greater than 24 square feet (2.22 m^2) in area shall be exempt from the *U*-factor requirement in Section R402.1.2. This exemption shall not apply to the Total UA alternative in Section R402.1.5.

R402.3.5 Sunroom fenestration. *Sunrooms* enclosing *conditioned space* shall meet the fenestration requirements of this code.

Exceptions:

1. For *sunrooms* with *thermal isolation* and enclos- ing *conditioned space* in *Climate Zones* 3 through 5, the maximum fenestration *U* factor shall be 0.40 and the maximum skylight *U* factor shall be 0.75. Sunrooms with cooling systems shall have a maximum fenestration SHGC of 0.40 for all glaz- ing.
2. A maximum of two glazed fenestration product assemblies having a *U* factor no greater than 0.55 and, when cooling is provided, a SHGC no greater than 0.70 shall be permitted to be substi- tuted for minimum code compliant fenestration product assemblies without penalty.

R402.3.5 Sunroom and heated garage fenestration. *Sunrooms* and heated garages enclosing *conditioned space* shall comply with the fenestration requirements of this code.

Exception: In Climate Zones 3 through 5 for *sunrooms* and heated garages with *thermal isolation* and enclosing *conditioned space*, the fenestration *U*-factor shall not exceed 0.45 and the skylight *U*-factor shall not exceed 0.70.

New fenestration separating the a *sunroom* or heated garage with *thermal isolation* from *conditioned space* shall comply with the *building thermal envelope* requirements of this code.

R402.4 Air leakage control (Mandatory). The *building thermal envelope* shall be constructed to limit air leakage in accordance with the requirements of Sections R402.4.1 through R402.4.6 R402.4.5.

R402.4.1 Building thermal envelope. The building ther- mal envelope shall be durably sealed to limit infiltration. The sealing methods between dissimilar materials shall allow for differential expansion and contraction. For all homes, where present, the following shall be caulked, gas- keted, weatherstripped or otherwise sealed with an air bar- rier material, or solid material consistent with Appendix R1.2.4 of this code:

1Blocking and sealing floor/ceiling systems and under knee walls open to unconditioned or exterior space.

2. Capping and sealing shafts or chases, including flue shafts.

3. Capping and sealing soffit or dropped ceiling areas.

4. Sealing HVAC register boots and return boxes to subfloor or drywall.

5. Seal exterior house wrap material joints and seams per manufacturer's instructions or, if house wrap joints are not sealed, seal exterior sheathing and exposed band joist joints including perimeter joints and edges of these materials.

Exceptions:

1Spray foam in building thermal envelope wall systems.

2Wall sheathing joints where wall sheathing is fully glued to framing.

R402.4.2 Air sealing. Building envelope air tightness shall be demonstrated by compliance with Section R402.4.2.1 or R402.4.2.2. Appendix R3 contains optional sample worksheets for visual inspection or testing for the permit holder's use only.

R402.4.1 Building thermal envelope air leakage. The *building thermal envelope* shall comply with Sections R402.4.1.1 through R402.4.1.3. The sealing methods between dissimilar materials shall allow for differential expansion and contraction.

R402.4.1.1 Installation. The components of the *building thermal envelope* as indicated in Table R402.4.1.1 shall be installed in accordance with the manufacturer's instructions and the criteria indicated in Table R402.4.1.1, as applicable to the method of construction. Where required by the *code official,* an *approved* third party shall inspect all components and verify compliance.

TABLE ~~R402.4.2~~
AIR BARRIER INSPECTION

COMPONENT	CRITERIA
Ceiling/attic	Sealants or gaskets provide a continuous air barrier system joining the top plate of framed walls with either the ceiling drywall or the top edge of wall drywall to prevent air leakage. Top plate penetrations are sealed. For ceiling finishes that are not air barrier systems such as tongue-and-groove planks, air barrier systems (for example, taped house wrap), shall be used above the finish. Note: It is acceptable that sealants or gaskets applied as part of the application of the drywall will not be observable by the code official.
Walls	Sill plate is gasketed or sealed to subfloor or slab.
Windows and doors	Space between window and exterior door jambs and framing is sealed.
Floors (including above garage and cantilevered floors)	The air barrier shall be installed at any exposed edge of insulation.
Penetrations	Utility penetrations through the building thermal envelope, including those for plumbing, electrical wiring, ductwork, security and fire alarm wiring, and control wiring, shall be sealed.
Garage separation	Air sealing is provided between the garage and conditioned spaces. An air barrier system shall be installed between the ceiling system above the garage and the ceiling system of interior spaces.
Ceiling penetrations	Ceiling electrical box penetrations and ceiling mechanical box penetrations shall be caulked, gasketed, or sealed at the penetration of the ceiling finish. See Appendix R1.2.4. **Exception:** Ceiling electrical boxes and ceiling mechanical boxes not penetrating the building thermal envelope.
Recessed lighting	Recessed light fixtures are air tight, IC-rated, and sealed to drywall. **Exception:** Fixtures in conditioned space.

TABLE R402.4.1.1
AIR BARRIER, AIR SEALING AND INSULATION INSTALLATION[a]

COMPONENT	AIR BARRIER CRITERIA	INSULATION INSTALLATION CRITERIA
General requirements	A continuous air barrier shall be installed in the building envelope. Breaks or joints in the air barrier shall be sealed.	Air-permeable insulation shall not be used as a sealing material.
Ceiling/attic	The air barrier in any dropped ceiling or soffit shall be aligned with the insulation and any gaps in the air barrier shall be sealed. Access openings, drop down stairs or knee wall doors to unconditioned attic spaces shall be sealed.	The insulation in any dropped ceiling/soffit shall be aligned with the air barrier.

Walls	The junction of the foundation and sill plate shall be sealed. The junction of the top plate and the top of exterior walls shall be sealed. Knee walls shall be sealed.	Cavities within corners and headers of frame walls shall be insulated by completely filling the cavity with a material having a thermal resistance, *R*-value, of not less than R-3 per inch. Exterior thermal envelope insulation for framed walls shall be installed in substantial contact and continuous alignment with the air barrier.
Windows, skylights and doors	The space between framing and skylights, and the jambs of windows and doors, shall be sealed.	—
Rim joists	Rim joists shall include an exterior air barrier.[b] The junctions of the rim board to the sill plate and the rim board and the subfloor shall be air sealed.	Rim joists shall be insulated so that the insulation maintains permanent contact with the exterior rim board.[b]
Floors, including cantilevered floors and floors above garages	The air barrier shall be installed at any exposed edge of insulation.	Floor framing cavity insulation shall be installed to maintain permanent contact with the underside of subfloor decking. Alternatively, floor framing cavity insulation shall be in contact with the top side of sheathing, or continuous insulation installed on the underside of floor framing and extending from the bottom to the top of all perimeter floor framing members.
Basement crawl space and slab foundations	Exposed earth in unvented crawl spaces shall be covered with a Class I vapor retarder/air barrier in accordance with Section R402.2.10. Penetrations through concrete foundation walls and slabs shall be air sealed. Class 1 vapor retarders shall not be used as an air barrier on below-grade walls and shall be installed in accordance with Section R702.7 of the *International Residential Code*.	Crawl space insulation, where provided instead of floor insulation, shall be installed in accordance with Section R402.2.10. Conditioned basement foundation wall insulation shall be installed in accordance with Section R402.2.8.1. Slab-on-grade floor insulation shall be installed in accordance with Section R402.2.10.
Shafts, penetrations	Duct and flue shafts and other similar penetrations to exterior or unconditioned space shall be sealed to allow for expansion, contraction and mechanical vibration. Utility penetrations of the air barrier shall be caulked, gasketed or otherwise sealed and shall allow for expansion, contraction of materials and mechanical vibration.	Insulation shall be fitted tightly around utilities passing through shafts and penetrations in the building thermal envelope to maintain required *R*-value.
Narrow cavities	Narrow cavities of 1 inch or less that are not able to be insulated shall be air sealed.	Batts to be installed in narrow cavities shall be cut to fit or narrow cavities shall be filled with insulation that on installation readily conforms to the available cavity space.
Garage separation	Air sealing shall be provided between the garage and conditioned spaces.	Insulated portions of the garage separation assembly shall be installed in accordance with Sections R303 and R402.2.7.

TABLE R402.4.1.1—continued

AIR BARRIER, AIR SEALING AND INSULATION INSTALLATION[a]

COMPONENT	AIR BARRIER CRITERIA	INSULATION INSTALLATION CRITERIA
Recessed lighting	Recessed light fixtures installed in the building thermal envelope shall be air sealed in accordance with Section R402.4.5.	Recessed light fixtures installed in the building thermal envelope shall be airtight and IC rated, and shall be buried or surrounded with insulation.

Plumbing, wiring or other obstructions	All holes created by wiring, plumbing or other obstructions in the air barrier assembly shall be air sealed.	Insulation shall be installed to fill the available space and surround wiring, plumbing, or other obstructions, unless the required *R*-value can be met by installing insulation and air barrier systems completely to the exterior side of the obstructions.
Shower/tub on exterior wall	The air barrier installed at exterior walls adjacent to showers and tubs shall separate the wall from the shower or tub.	Exterior walls adjacent to showers and tubs shall be insulated.
Electrical/phone box on exterior walls	The air barrier shall be installed behind electrical and communication boxes. Alternatively, air-sealed boxes shall be installed.	—
HVAC register boots	HVAC supply and return register boots that penetrate building thermal envelope shall be sealed to the subfloor, wall covering or ceiling penetrated by the boot.	—
Concealed sprinklers	Where required to be sealed, concealed fire sprinklers shall only be sealed in a manner that is recommended by the manufacturer. Caulking or other adhesive sealants shall not be used to fill voids between fire sprinkler cover plates and walls or ceilings.	—

a. Inspection of log walls shall be in accordance with the provisions of ICC 400.
b. Air barrier and insulation full enclosure is not required in unconditioned/ventilated attic spaces and at rim joists.

~~**R402.4.2.1 Visual inspection option.** Building envelope tightness shall be considered acceptable when items providing insulation enclosure in Section R402.2.14 and enclosure and air sealing in Section R402.2.15 and air sealing in Section R402.4.1 are addressed and when the items listed in Table R402.4.2, applicable to the method of construction, are certified by the builder, permit holder or registered design professional via the certificate in Appendix R1.1.~~

~~**R402.4.2.2 Testing option.** Building envelope tightness shall be considered acceptable when items providing insulation enclosure in Section R402.2.14 and enclosure and air sealing in Section R402.2.15 and air sealing in Section R402.4.1 are addressed and when tested air leakage is less than or equal to one of the two following performance measurements:~~

~~1 0.30 CFM50/Square Foot of Surface Area (SFSA); or~~

~~2. Five (5) air changes per hour (ACH50)~~

~~when tested with a blower door fan assembly, at a pressure of 33.5 psf (50 Pa). A single point depressurization test (not temperature corrected) is sufficient to comply with this provision, provided that the blower door fan assembly has been certified by the manufacturer to be capable of conducting tests in accordance with ASTM E779 or ASTM E1827. Testing shall occur after rough in and after installation of penetrations of the building envelope, including penetrations for utilities, plumbing, electrical, ventilation and combustion appliances. Testing shall be reported by the permit holder, a North Carolina licensed general contractor, a North Carolina licensed HVAC contractor, a North Carolina licensed home inspector, a *registered design professional*, a certified *BPI Envelope Professional* or a certified *HERS rater*.~~

~~During testing:~~

~~1 Exterior windows and doors, fireplace and stove doors shall be closed, but not sealed;~~

~~2 Dampers shall be closed, but not sealed, including exhaust, backdraft, and flue dampers;~~

~~3 Interior doors shall be open;~~

~~4 Exterior openings for continuous ventilation systems, air intake ducted to the return side of the conditioning system, and energy or heat recovery ventilators shall be closed and sealed;~~

~~5 Heating and cooling system(s) shall be turned off; and~~

~~6 Supply and return registers shall not be sealed.~~

~~The air leakage information, building air leakage result, tester name, date, and contact information, shall be included on the certificate described in Section R401.3.~~

~~For Test Criteria 1 above, the report shall be produced in the following manner: perform the blower door test and record the *CFM50*. Calculate the total square feet of surface area for the building thermal envelope (all floors, ceilings, and walls including windows and doors, bounding conditioned space) and record the area. Divide *CFM50* by the total square feet and record the result. If the result is less than or equal to 0.30 CFM50/SFSA the envelope tightness is accept able; or~~

~~For Test Criteria 2 above, the report shall be produced in the following manner: Perform a blower door test and record the *CFM50*. Multiply the CFM50 by 60 minutes to create CFHour50 and record. Then calculate the total conditioned volume of the home and record. Divide the CFH50 by the total volume and record the result. If the result is less than or qual to 5 ACH50, the envelope tightness is acceptable.~~

R402.4.1.2 Testing. The *building* or *dwelling unit* shall be tested for air leakage. The maximum air leakage rate for any *building* or *dwelling unit* under any compliance path shall not exceed 4.0 air changes per hour or 0.23 cubic feet per minute (CFM) per square foot [0.0079 $m^3/(s \times m^2)$] of dwelling unit enclosure area. Testing shall be conducted in accordance with ANSI/RESNET/ICC 380, ASTM E779, ASTM E3158 or ASTM E1827 and reported at a pressure of 0.2 inch w.g. (50 Pascals). Alternately, if using a higher test pressure of 0.30 in. w.g.(75 Pa), a maximum air leakage rate of 0.30 cubic feet per minute per square foot of dwelling unit enclosure area shall be met. Where required by the *code official*, testing shall be conducted by an *approved* third party. A written report of the results of the test shall be signed by the party conducting the test and provided to the *code official*. Testing shall be performed at any time after creation of all penetrations of the *building thermal envelope* have been sealed.

Exception: For heated, attached private garages and heated, detached private garages accessory to one- and two-family dwellings and townhouses not more than three stories above *grade plane* in height, building envelope tightness and insulation installation shall be considered acceptable where the items in Table R402.4.1.1, applicable to the method of construction, are field verified. Where required by the code official, an *approved* third party independent from the installer shall inspect both air barrier and insulation installation criteria. Heated, attached private garage space and heated, detached private garage space shall be thermally isolated from all other habitable, *conditioned spaces* in accordance with Sections R402.2.12 and R402.3.5, as applicable.

During testing:

1. Exterior windows and doors, fireplace and stove doors shall be closed, but not sealed, beyond the intended weatherstripping or other infiltration control measures.
2. Dampers including exhaust, intake, makeup air, backdraft and flue dampers shall be closed, but not sealed beyond intended infiltration control measures.
3. Interior doors, where installed at the time of the test, shall be open.
4. Exterior or interior terminations for continuous ventilation systems shall be sealed.
5. Heating and cooling systems, where installed at the time of the test, shall be turned off.
6. Supply and return registers, where installed at the time of the test, shall be fully open.

Exceptions:

1. When testing individual dwelling units, an air leakage rate not exceeding 0.30 cubic feet per minute per square foot [0.008 m3/(s × m2)] of the dwelling unit enclosure area, tested in accordance with ANSI/RESNET/ICC 380, ASTM E779 or ASTM E1827 and reported at a pressure of 0.2 inch w.g. (50 Pa), shall be an accepted alternative permitted in all climate zones for:
    a. Attached single and multiple family building dwelling units.
    b. Buildings or dwelling units that are 1,500 square feet (139.4 m2) or smaller.
2. For heated, attached private garages and heated, detached private garages accessory to one and two-family dwellings and townhouses not more than three stories above grade plane in height, building envelope tightness and insulation installation shall be considered acceptable where the items in Table R402.4.1.1, applicable to the method of construction, are field verified. Where required by the code official, an approved third party independent from the installer shall inspect both air barrier and insulation installation criteria. Heated, attached private garage space and heated, detached private garage space shall be thermally isolated from all other habitable, conditioned spaces in accordance with Sections R402.2.12 and R402.3.5, as applicable.

Mechanical ventilation shall be provided in accordance with Section M1505 of the *International Residential Code* or Section 403.3.2 of the *International Mechanical Code*, as applicable, or with other *approved* means of ventilation.

R402.4.1.3 Leakage rate. When complying with Section R401.2.1, the building or dwelling unit shall have an air leakage rate not exceeding 3.0 air changes per hour in Climate Zones 3 through 5, when tested in accordance with Section R402.4.1.2.

~~**R402.4.3 Fireplaces.** Site-built masonry fireplaces shall have flue dampers and comply with Section R1006 of the *North Carolina Residential Code* for combustion air.~~

R402.4.2 Fireplaces. New wood-burning fireplaces shall have tight-fitting flue dampers or doors, and outdoor combustion air. Where using tight-fitting doors on factory-built fireplaces *listed* and *labeled* in accordance with UL 127, the doors shall be tested and *listed* for the fireplace.

~~**R402.4.4**~~ **R402.4.3 Fenestration air leakage.** Windows, *skylights* and sliding glass doors shall have an air infiltration rate of not greater than 0.3 cfm per square foot (1.5 L/s/m^2), and for swinging doors, not greater than 0.5 cfm per square foot (2.6 L/s/m^2), when tested in accordance with NFRC 400 or AAMA/WDMA/CSA 101/I.S.2/A440 by an accredited, independent laboratory and *listed* and *labeled* by the manufacturer.

Exception: ~~Field-fabricated~~ Site-built windows, *skylights* and doors.

~~**R402.4.5 Rooms containing fuel-burning appliances.** Deleted.~~

~~**R402.4.4 Rooms containing fuel-burning appliances.** In Climate Zones 3 through 8, 5, where open combustion air ducts provide combustion air to open combustion fuel-burning appliances, the appliances and combustion air opening shall be located outside the *building thermal envelope* or enclosed in a room that is isolated from inside the thermal envelope. Such rooms shall be sealed and insulated in accordance with the envelope requirements of Table R402.1.3, where the walls, floors and ceilings shall meet a minimum of the *basement wall R* value requirement. The door into the room shall be fully gasketed and any water lines and ducts in the room insulated in accordance with Section R403. The combustion air duct shall be insulated where it passes through *conditioned space* to an *R* value of not less than R-8.~~

~~**Exceptions:**~~

~~1. Direct vent appliances with both intake and exhaust pipes installed continuous to the outside.~~
~~2. Fireplaces and stoves complying with Section R402.4.2 and Section R1006 of the *International Residential Code*.~~

~~**R402.4.6 R402.4.5**~~ **R402.4.4 Recessed lighting.** Recessed luminaires installed in the *building thermal envelope* shall be sealed to limit air leakage between conditioned and *unconditioned spaces*. Recessed luminaires shall be IC-rated and *labeled* as having an air leakage rate of not greater than 2.0 cfm (0.944 L/s) when tested in accordance with ASTM E283 at a pressure differential of 1.57 psf (75 Pa). Recessed luminaires shall be sealed with a gasket or caulked between the housing and the interior wall or ceiling covering.

R402.4.5 Electrical and communication outlet boxes (air-sealed boxes). Electrical and communication outlet boxes installed in the building thermal envelope shall be sealed to limit air leakage between conditioned and unconditioned spaces. Electrical and communication outlet boxes shall be tested in accordance with NEMA OS 4, *Requirements for Air-Sealed Boxes for Electrical and Communication Applications*, and shall have an air leakage rate of not greater than 2.0 cubic feet per minute (0.944 L/s) at a pressure differential of 1.57 psf (75 Pa). Electrical and communication outlet boxes shall be marked "NEMA OS 4" or "OS 4" in accordance with NEMA OS 4. Electrical and communication outlet boxes shall be installed per the manufacturer's instructions and with any supplied components required to achieve compliance with NEMA OS 4.

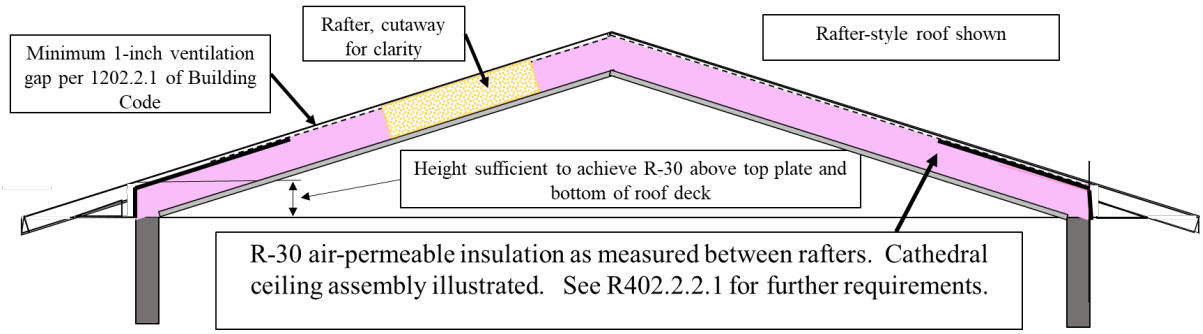
~~**R402.5 Maximum fenestration *U*-factor and SHGC (Mandatory).** The area-weighted average maximum fenestration *U*-factor permitted using trade-offs from Section R402.1.5 shall be 0.48. Maximum skylight *U*-factors shall be 0.65 in Climate Zones 4 and 5 and 0.60 in Climate Zone 3. The area-weighted average maximum fenestration SHGC permitted using trade-offs from Section R405 in Climate Zone 3 shall be 0.50.~~

~~**Exception:** A maximum of two glazed fenestration product assemblies having a *U*-factor no greater than 0.55 and a SHGC no greater than 0.70 shall be permitted to be substituted for minimum code compliant fenestration product assemblies without penalty.~~

R402.5 Maximum fenestration U-factor and SHGC. The area-weighted average maximum fenestration *U*-factor permitted using tradeoffs from Section R402.1.5 or R405 shall be 0.48 in Climate Zones 4 and 5 for vertical fenestration, and 0.75 in Climate Zones 4 through 5 for skylights. The area-weighted average maximum fenestration SHGC permitted using tradeoffs from Section R405 in *Climate Zone* 3 shall be 0.40.

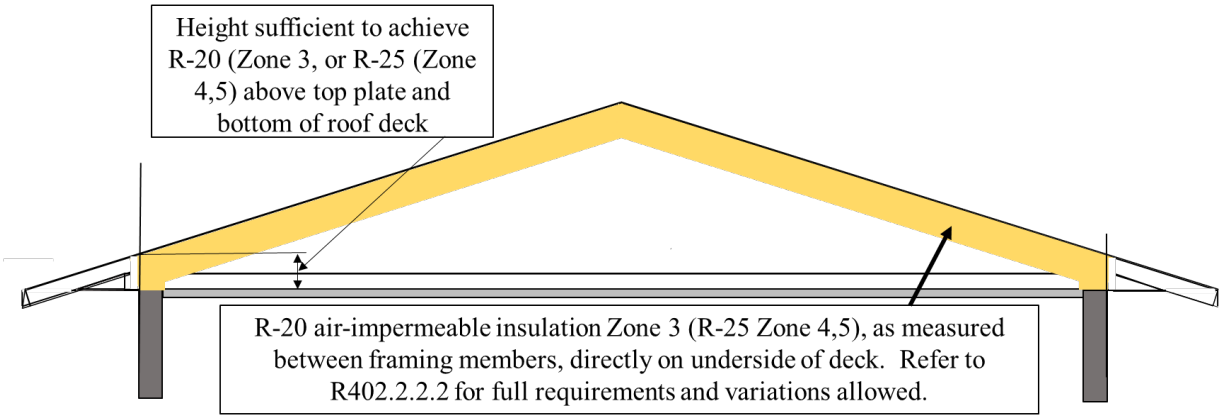
Exception: The maximum *U*-factor and solar heat gain coefficient (SHGC) for fenestration shall not be required in storm shelters complying with ICC 500.

APPENDIX R1.2.1 (Section R402.2.1) [2024]



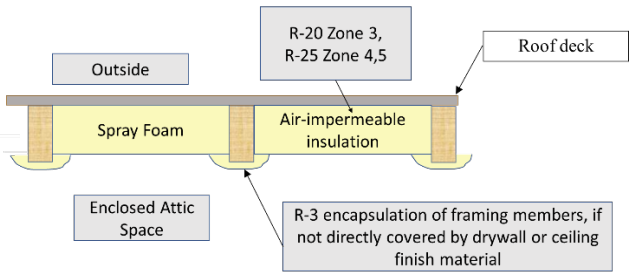
R402.2.2 Ceilings without attic spaces

R402.2.2.1 Roof Ceiling Assemblies – Cathedral ceiling assembly illustrated

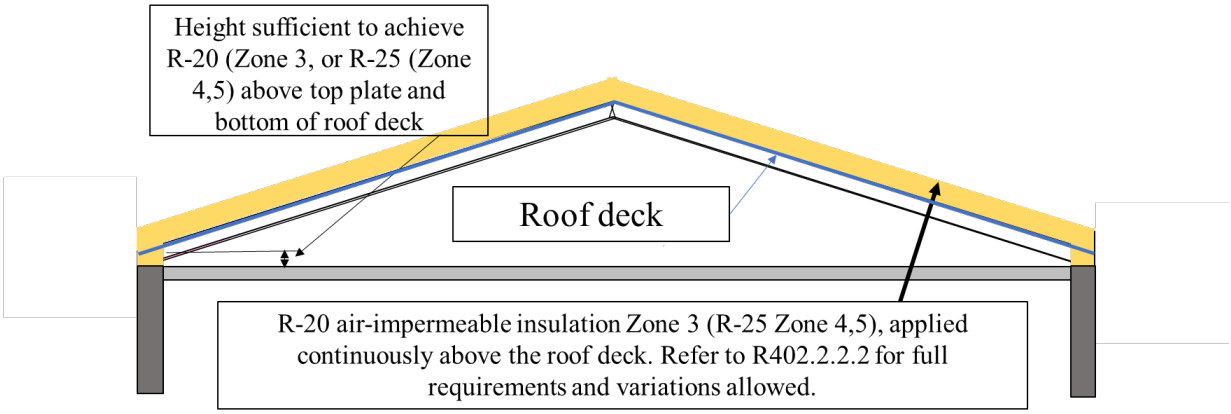


R402.2.2 Ceilings without attic spaces

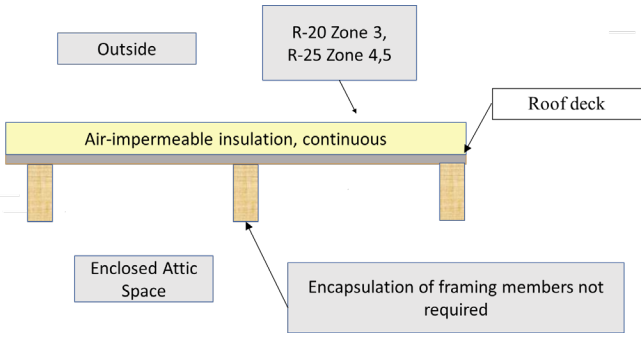
R402.2.2.2 Unvented attic and unvented enclosed rafter assembly alternate – below deck option illustrated.



R402.2.2.2 Unvented attic and unvented enclosed rafter assembly alternate cross section view – encapsulation of framing members illustrated



R402.2.2.2 Unvented attic and unvented enclosed rafter assembly alternate – above deck option illustrated.



R402.2.2.2 Unvented attic and unvented enclosed rafter assembly alternate cross section view with contiuous insulation above roof deck– encapsulation of framing members not required