APPENDIX C
CODE CHANGE PROPOSAL
NORTH CAROLINA
BUILDING CODE COUNCIL

B-6A

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Raleigh, North Carolina 27603
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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: Gary Embler, Chair of the BCC Residential Standing Committee PHONE: (919) 888-0284
REPRESENTING: BCC Residential Standing Committee
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North Carolina State Building Code, Volume 2024 NC Residential Code-Chapter 11 Section_____

CHECK ONE: [ ] Revise section to read as follows: [ ] Delete section and substitute the following:
[X] 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.

The 2024 NCRC-Chapter 11 is based on Chapter 11 of the 2021 IRC which can be viewed at: **Digital Codes (iccsafe.org)**
The 2021 IRC Chapter 11 is deleted and substituted with the 2018 NCRC Chapter 11.
The 2018 NC amendments to Chapter 11 of the 2021 IRC that make up the 2024 NCRC-Chapter 11 are shown in ATTACHMENT A below.

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 proposed to adopt and incorporate Chapter 11 (Energy) of the 2018 edition of the NC Residential Code, into the 2024 edition of the NC Residential Code.

Signature: *CARL MARTIN* Date: May 1, 2023 FORM 11/26/19

ATTACHMENT A

THIS DOCUMENT CONTAINS PROPOSED 2018 NORTH CAROLINA AMENDMENTS TO THE 2021 EDITION OF THE INTERNTATIONAL RESIDENTIAL CODE (IRC) FOR THE PURPOSE OF ESTABLISHING THE 2024 EDITION OF THE NORTH CAROLINA RESIDENTIAL CODE.

UNDERLINED TEXT INDICATES 2018 NORTH CAROLINA PROPOSED AMENDMENTS TO THE 2021 INTERNATIONAL RESIDENTIAL CODE FOR THE 2024 NORTH CAROLINA RESIDENTIAL CODE.

~~STRUCKTHROUGH~~ TEXT INDICATES IRC TEXT THAT IS PROPOSED TO BE REMOVED FROM THE 2024 NORTH CAROLINA RESIDENTIAL CODE.

TEXT THAT IS HIGHLIGHTED IN YELLOW INDICATES PROPOSED NORTH CAROLINA AMENDMENTS THAT ARE NEW OR DIFFERRENT THAN THE 2018 NORTH CAROLINA RESIDENTIAL CODE.

Part IV—Energy Conservation

CHAPTER 11 [RE]
ENERGY EFFICIENCY

User note:

About this chapter: *The purpose of Chapter 11 [RE] is to provide minimum design requirements that will promote efficient utilization of energy in buildings. The requirements are directed toward the design of building envelopes with adequate thermal resistance and low air leakage, and toward the design and selection of mechanical, water heating, electrical and illumination systems that promote effective use of depletable energy resources.*

SECTION N1101
GENERAL

N1101.1 Scope. This chapter regulates the energy efficiency for the design and construction of buildings regulated by this code.

Note: The text of Sections N1101.2 through N1113 parallels the text of the 2021 edition of the International Energy Conservation Code — Residential Provisions (IECC-R). ***The section numbers appearing in parenthesis after each section number are the section numbers of the corresponding text in the*** IECC-R***. If a section does not have a section number in parenthesis after it, then there is no corresponding text in the*** IECC-R.

N1101.2 (R101.3) Intent. This chapter shall regulate the design and construction of ***buildings*** for the effective use and conservation of energy over the useful life of each ***building***. This chapter is intended to provide flexibility to permit the use of innovative approaches and techniques to achieve this objective. This chapter is not intended to abridge safety, health or environmental requirements contained in other applicable codes or ordinances.

N1101.3 (R101.5.1) Compliance materials. The ***code official*** shall be permitted to approve specific computer software, worksheets, compliance manuals and other similar materials that meet the intent of this chapter.

N1101.4 (R102.1.1) Above code programs. The ***code official*** or other authority having ***jurisdiction*** shall be permitted to deem a national, state or local energy efficiency program to exceed the energy efficiency required by this code. ***Buildings approved*** in writing by such an energy efficiency program shall be considered to be in compliance with this code. The requirements identified in Table N1105.2, as applicable, shall be met.

N1101.5 (R103.2) Information on construction documents. Construction documents shall be drawn to scale on suitable material. Electronic media documents are permitted to be submitted when ***approved*** by the ***code official***. Construction documents shall be of sufficient clarity to indicate the location, nature and extent of the work proposed, and show in sufficient detail pertinent data and features of the building, systems and equipment as herein governed. Details shall include the following as applicable:

1. Energy compliance path.
2. Insulation materials and their ***R*** values.
3. Fenestration ***U*** factors and solar heat gain coefficients (SHGC).
4. Area-weighted ***U*** factor and solar heat gain coefficient (SHGC) calculations.
5. Mechanical system design criteria.
6. Mechanical and service water heating systems and equipment types, sizes and efficiencies.
7. Equipment and system controls.
8. Duct sealing, duct and pipe insulation and location.
9. Air sealing details.

N1101.5.1 (R103.2.1) Building thermal envelope depiction. The ***building thermal envelope*** shall be represented on the ***construction documents***.

N1101.6 (R202) Defined terms. The following words and terms shall, for the purposes of this chapter, have the meanings shown herein.

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.

ACCESS (TO). **That which enables a device, appliance or equipment to be reached by *ready access* or by a means that first requires the removal or movement of a panel or similar obstruction.**

ADDITION. An extension or increase in the ***conditioned space*** floor area, number of stories or height of a building or structure.

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.

ALTERATION. Any construction, retrofit or renovation to an existing structure other than ***repair*** or ***addition***. Also, a change in a building, electrical, gas, mechanical or plumbing system that involves an extension, ***addition*** or change to the arrangement, type or purpose of the original installation.

AUTOMATIC. Self acting, operating by its own mechanism when actuated by some impersonal influence, as, for example, a change in current strength, pressure, temperature or mechanical configuration (see "***Manual***").

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 SITE. A contiguous area of land that is under the ownership or control of one entity.

BUILDING THERMAL ENVELOPE. The ***basement walls***, ***exterior walls***, floors, ceilings, 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.**

CIRCULATING HOT WATER SYSTEM. A specifically designed water distribution system where one or more pumps are operated in the service hot water piping to circulate heated water from the water heating equipment to fixtures and back to the water heating equipment.

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

CONDITIONED FLOOR AREA. The horizontal projection of the floors associated with the ***conditioned space***.

CONDITIONED SPACE. An area, room or space that is enclosed within the ***building thermal envelope*** and that is directly heated or cooled 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.

DEMAND RECIRCULATION WATER SYSTEM. A water distribution system where one or more pumps prime the service hot water piping with heated water on demand for hot water.

DIMMER. **A control device that is capable of continuously varying the light output and energy use of light sources.**

DUCT. A tube or conduit utilized for conveying air. The air passages of self-contained systems are not to be construed as air ducts.

DUCT SYSTEM. A continuous passageway for the transmission of air that, in addition to ducts, includes duct fittings, dampers, plenums, fans and accessory air-handling ***equipment*** and ***appliances***.

DWELLING UNIT. A single unit providing complete independent living facilities for one or more persons, including permanent provisions for living, sleeping, eating, cooking and sanitation.

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 COST. The total estimated annual cost for purchased energy for the building functions regulated by this code, including applicable demand charges.

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.

HIGH-EFFICACY LIGHT SOURCES. Compact fluorescent lamps, light-emitting diode (LED) lamps, T-8 or smaller diameter linear fluorescent lamps, other lamps with an efficacy of not less than 65 lumens per watt, or luminaires with an efficacy of not less than 45 lumens per watt.

HISTORIC BUILDING. Any building or structure that is one or more of the following:

1. Listed, or certified as eligible for listing by the State Historic Preservation Officer or the Keeper of the National Register of Historic Places, in the National Register of Historic Places.
2. Designated as historic under an applicable state or local law.
3. Certified as a contributing resource within a National Register-listed, state-designated or locally-designated historic district.

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.

INSULATING SHEATHING. An insulating board with a core material 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 where the listing states either that the equipment, material, product or service meets identified standards or has been tested and found suitable for a specified purpose.

MANUAL. Capable of being operated by personal intervention (see "***Automatic***").

OCCUPANT SENSOR CONTROL. **An automatic control device that detects the presence or absence of people within an area and causes lighting, equipment or appliances to be regulated accordingly.**

ON-SITE RENEWABLE ENERGY. **Energy from renewable energy resources harvested at the building site.**

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.

READY ACCESS (TO). **That which enables a device, appliance or equipment to be directly reached without requiring the removal or movement of any panel or similar obstruction.**

RENEWABLE ENERGY CERTIFICATE (REC). **An instrument that represents the environmental attributes of one megawatt hour of renewable energy; also known as an energy attribute certificate (EAC).**

RENEWABLE ENERGY RESOURCES. **Energy derived from solar radiation, wind, waves, tides, landfill gas, biogas, biomass or extracted from hot fluid or steam heated within the earth.**

REPAIR. The reconstruction or renewal of any part of an existing ***building*** for the purpose of its maintenance or to correct damage.

REROOFING. The process of recovering or replacing an existing roof covering. See "***Roof recover***" and "***Roof replacement***."

RESIDENTIAL BUILDING. For this chapter, includes detached one- and two-family dwellings and townhouses as well as Group R-2, R-3 and R-4 buildings three stories or less in height above ***grade plane***.

ROOF ASSEMBLY. A system designed to provide weather protection and resistance to design loads. The system consists of a roof covering and ***roof deck*** or a single component serving as both the roof covering and the ***roof deck***. A ***roof assembly*** includes the roof covering, underlayment, and ***roof deck***, and can also include a thermal barrier, ignition barrier, insulation or a vapor retarder.

ROOF RECOVER. The process of installing an additional roof covering over an existing roof covering without removing the existing roof covering.

ROOF REPAIR. Reconstruction or renewal of any part of an existing roof for the purposes of its maintenance.

ROOF REPLACEMENT. The process of removing the existing roof covering, repairing any damaged substrate and installing a new roof covering.

***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 ($h \times ft^2 \times °F/Btu$) [$(m^2 \times K)/W$].

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.

SUNROOM. A one-story structure attached to a dwelling with a glazing area in excess of 40 percent of the gross area of the structure's ***exterior walls*** and roof.

THERMAL DISTRIBUTION EFFICIENCY (TDE). **The resistance to changes in air heat as air is conveyed through a distance of air duct. TDE is a heat-loss calculation evaluating the difference in the heat of the air between the air**

duct inlet and outlet caused by differences in temperatures between the air in the duct and the duct material. TDE is expressed as a percent difference between the inlet and outlet heat in the duct.

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.

THERMOSTAT. An automatic control device used to maintain temperature at a fixed or adjustable set point.

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 × ft^2 × °F) [W/(m^2 × K)].

VENTILATION. The natural or mechanical process of supplying conditioned or unconditioned air to, or removing such air from, any space.

VENTILATION AIR. That portion of supply air that comes from outside (outdoors) plus any recirculated air that has been treated to maintain the desired quality of air within a designated space.

VISIBLE TRANSMITTANCE [VT]. The ratio of visible light entering the space through the fenestration product assembly to the incident visible light. Visible Transmittance includes the effects of glazing material and frame and is expressed as a number between 0 and 1.

WHOLE HOUSE MECHANICAL VENTILATION SYSTEM. An exhaust system, supply system, or combination thereof that is designed to mechanically exchange indoor air with outdoor air when operating continuously or through a programmed intermittent schedule to satisfy the whole house ventilation rates.

ZONE. A space or group of spaces within a ***building*** with heating or cooling requirements that are sufficiently similar so that desired conditions can be maintained throughout using a single controlling device.

N1101.7 (R301.1) Climate zones. Climate zones from Figure N1101.7 or Table N1101.7 shall be used for determining the applicable requirements in Sections N1101 through N1113. Locations not indicated in Table N1101.7 shall be assigned a climate zone in accordance with Section N1101.7.2.

N1101.7.1 (R301.2) Warm Humid counties. In Table N1101.7, Warm Humid counties are identified by an asterisk.

N1101.7.2 (R301.3) Climate zone definitions. To determine the climate zones for locations not listed in this code, use the following information to determine climate zone numbers and letters in accordance with Items 1 through 5.

1. Determine the thermal climate zone, 0 through 8, from Table N1101.7.2 using the heating (HDD) and cooling degree days (CDD) for the location.

2. Determine the moisture zone (Marine, Dry or Humid) in accordance with Items 2.1 through 2.3.

2.1. If monthly average temperature and precipitation data are available, use the Marine, Dry and Humid definitions to determine the moisture zone (C, B or A).

2.2. If annual average temperature information (including degree days) and annual precipitation (i.e., annual mean) are available, use Items 2.2.1 through 2.2.3 to determine the moisture zone. If the moisture zone is not Marine, then use the Dry definition to determine whether Dry or Humid.

2.2.1. If thermal climate zone is 3 and CDD50°F ≤ 4,500 (CDD10°C ≤ 2500), climate zone is Marine (3C).

2.2.2. If thermal climate zone is 4 and CDD50°F ≤ 2,700 (CDD10°C ≤ 1500), climate zone is Marine (4C).

2.2.3. If thermal climate zone is 5 and CDD50°F ≤ 1,800 (CDD10°C ≤ 1000), climate zone is Marine (5C).

2.3. If only degree day information is available, use Items 2.3.1 through 2.3.3 to determine the moisture zone. If the moisture zone is not Marine, then it is not possible to assign Humid or Dry moisture zone for this location.

2.3.1. If thermal climate zone is 3 and CDD50°F ≤ 4,500 (CDD10°C ≤ 2500), climate zone is Marine (3C).

2.3.2. If thermal climate zone is 4 and CDD50°F ≤ 2,700 (CDD10°C ≤ 1500), climate zone is Marine (4C).

2.3.3. If thermal climate zone is 5 and CDD50°F ≤ 1,800 (CDD10°C ≤ 1000), climate zone is Marine (5C).

3. Marine (C) Zone definition: Locations meeting all of the criteria in Items 3.1 through 3.4.

3.1. Mean temperature of coldest month between 27°F (3°C) and 65°F (18°C).

3.2. Warmest month mean < 72°F (22°C).

3.3. Not fewer than four months with mean temperatures over 50°F (10°C).

3.4. Dry season in summer. The month with the heaviest precipitation in the cold season has at least three times as much precipitation as the month with the least precipitation in the rest of the year. The cold season is October through March in the Northern Hemisphere and April through September in the Southern Hemisphere.

4. Dry (B) definition: Locations meeting the criteria in Items 4.1 through 4.4.

4.1. Not Marine (C).

4.2. If 70 percent or more of the precipitation, ***P***, occurs during the high sun period, defined as April through September in the Northern Hemisphere and October through March in the Southern Hemisphere, then the dry/humid threshold is in accordance with **Equation 11-1.**

$P < 0.44 \times (T - 7)$

[$P < 20.0 \times (T + 14)$ in SI units] (Equation 11-1)

where:

P = Annual precipitation, inches (mm).

T = Annual mean temperature, °F (°C).

4.3. If between 30 and 70 percent of the precipitation, ***P***, occurs during the high sun period, defined as April through September in the Northern Hemisphere and October through March in the Southern Hemisphere, then the dry/humid threshold is in accordance with **Equation 11-2.**

$P < 0.44 \times (T - 19.5)$

[$P < 20.0 \times (T + 7)$ in SI units] (Equation 11-2)

where:

P = Annual precipitation, inches (mm).

T = Annual mean temperature, °F (°C).

4.4. If 30 percent or less of the precipitation, ***P***, occurs during the high sun period, defined as April through September in the Northern Hemisphere and October through March in the Southern Hemisphere, then the dry/humid threshold is in accordance with **Equation 11-3.**

$P < 0.44 \times (T - 32)$

[$P < 20.0 \times T$ in SI units] (Equation 11-3)

where:

P = Annual precipitation, inches (mm).

T = Annual mean temperature, °F (°C).

5. Humid (A) definition: Locations that are not Marine (C) or Dry (B).

TABLE N1101.7.2 **(R301.3)**

THERMAL **CLIMATE ZONE DEFINITIONS**

ZONE NUMBER	THERMAL CRITERIA	
	IP Units	SI Units
0	10,800 < CDD50ºF	6000 < CDD10ºC

1	9,000 < CDD50°F < 10,800	5000 < CDD10°C < 6000
2	6,300 < CDD50°F ≤ 9,000	3500 < CDD10°C ≤ 5000
3	CDD50°F ≤ 6,300 AND HDD65°F ≤ 3,600	CDD10°C ≤ 3500 AND HDD18°C ≤ 2000
4	CDD50°F ≤ 6,300 AND 3,600 < HDD65°F ≤ 5,400	CDD10°C ≤ 3500 AND 2000 < HDD18°C ≤ 3000
5	CDD50°F < 6,300 AND 5,400 < HDD65°F ≤ 7,200	CDD10°C < 3500 AND 3000 < HDD18°C ≤ 4000
6	7,200 < HDD65°F ≤ 9,000	4000 < HDD18°C ≤ 5000
7	9,000 < HDD65°F ≤ 12,600	5000 < HDD18°C ≤ 7000
8	12,600 < HDD65°F	7000 < HDD18°C

For SI: °C = [(°F) – 32]/1.8.

N1101.8 (R301.4) Tropical climate region. The tropical climate region shall be defined as:

1. Hawaii, Puerto Rico, Guam, American Samoa, US Virgin Islands, Commonwealth of Northern Mariana Islands; and
2. Islands in the area between the Tropic of Cancer and the Tropic of Capricorn.

N1101.9 (R302.1) Interior design conditions. The interior design temperatures used for heating and cooling load calculations shall be a maximum of 72°F (22°C) for heating and minimum of 75°F (24°C) for cooling.

N1101.10 (R303.1) Identification. Materials, systems and equipment shall be identified in a manner that will allow a determination of compliance with the applicable provisions of this code.

N1101.10.1 (R303.1.1) Building thermal envelope insulation. An ***R*** value identification mark shall be applied by the manufacturer to each piece of ***building thermal envelope*** insulation that is 12 inches (305 mm) or greater in width. Alternatively, the insulation installers shall provide a certification that indicates the type, manufacturer and ***R*** value of insulation installed in each element of the ***building thermal envelope***. For blown-in or sprayed fiberglass and cellulose insulation, the initial installed thickness, settled thickness, settled ***R*** value, installed density, coverage area and number of bags installed shall be indicated on the certification. For sprayed polyurethane foam (SPF) insulation, the installed thickness of the areas covered and the ***R*** value of the installed thickness shall be indicated on the certification. For ***insulated siding***, the ***R*** value shall be on a label on the product's package and shall be indicated on the certification. The insulation installer shall sign, date and post the certification in a conspicuous location on the job site.

Exception: For roof insulation installed above the deck, the ***R*** value shall be ***labeled*** as required by the material standards specified in Table R906.2.

N1101.10.1.1 (R303.1.1.1) Blown-in or sprayed roof and ceiling insulation. The thickness of blown-in or sprayed fiberglass and cellulose roof and ceiling insulation shall be written in inches (mm) on markers that are installed at not less than one for every 300 square feet (28 m^2) throughout the attic space. The markers shall be affixed to the trusses or joists and marked with the minimum initial installed thickness with numbers not less than 1 inch (25 mm) in height. Each marker shall face the attic access opening. The thickness and installed ***R***-value of sprayed polyurethane foam insulation shall be indicated on the certification provided by the insulation installer.

N1101.10.2 (R303.1.2) Insulation mark installation. Insulating materials shall be installed such that the manufacturer's ***R*** value ***mark*** is readily observable at inspection. For insulation materials that are installed without an observable manufacturer's *R* value mark, such as blown or draped products, an insulation certificate complying with Section N1101.10.1 shall be left immediately after installation by the installer, in a conspicuous location within the building, to certify the installed *R* value of the insulation material.

N1101.10.3 (R303.1.3) Fenestration product rating. ***U*** factors of fenestration products such as windows, doors and ***skylights*** shall be determined in accordance with NFRC 100.

Exception: Where required, garage door ***U*** factors shall be determined in accordance with either NFRC 100 or ANSI/DASMA 105.

U factors shall be determined by an accredited, independent laboratory, and ***labeled*** and certified by the manufacturer.

Products lacking such a ***labeled U*** factor shall be assigned a default ***U*** factor from Table N1101.10.3(1) or N1101.10.3(2). The ***solar heat gain coefficient*** (SHGC) and visible transmittance (VT) of glazed fenestration products such as windows, glazed doors and ***skylights*** shall be determined in accordance with NFRC 200 by an accredited, independent laboratory, and ***labeled*** and certified by the manufacturer. Products lacking such a ***labeled*** SHGC or VT shall be assigned a default SHGC or VT from Table N1101.10.3(3).

TABLE N1101.10.3(1) [R303.1.3(1)]

DEFAULT GLAZED WINDOW, GLASS DOOR AND SKYLIGHT *U*-FACTORS

FRAME TYPE	WINDOW AND GLASS DOOR		SKYLIGHT	
	Single pane	Double pane	Single	Double
Metal	1.20	0.80	2.00	1.30
Metal with Thermal Break	1.10	0.65	1.90	1.10
Nonmetal or Metal Clad	0.95	0.55	1.75	1.05
Glazed Block	0.60			

TABLE N1101.10.3(2) [R303.1.3(2)]

DEFAULT OPAQUE DOOR *U*-FACTORS

DOOR TYPE	OPAQUE ***U***-FACTOR
Uninsulated Metal	1.20
Insulated Metal	0.60
Wood	0.50
Insulated, nonmetal edge, not exceeding 45% glazing, any glazing double pane	0.35

TABLE N1101.10.3(3) [R303.1.3(3)]

DEFAULT GLAZED FENESTRATION SHGC AND VT

	SINGLE GLAZED		DOUBLE GLAZED		GLAZED BLOCK
	Clear	Tinted	Clear	Tinted	
SHGC	0.8	0.7	0.7	0.6	0.6
VT	0.6	0.3	0.6	0.3	0.6

N1101.10.4 (R303.1.4) Insulation product rating. The thermal resistance, ***R***-value, of insulation shall be determined in accordance with Part 460 of US-FTC CFR Title 16 in units of h × ft^2 × °F/Btu at a mean temperature of 75°F (24°C).

N1101.10.4.1 (R303.1.4.1) Insulated siding. The thermal resistance, ***R***-value, of ***insulated siding*** shall be determined in accordance with ASTM C1363. Installation for testing shall be in accordance with the manufacturer's instructions.

N1101.10.5 (R303.1.5) Air-impermeable insulation. Insulation having an air permeability not greater than 0.004 cubic feet per minute per square foot [0.002 L/(s × m^2)] under pressure differential of 0.3 inch water gauge (75 Pa) when tested in accordance with ASTM E2178 shall be determined air-impermeable insulation.

N1101.11 (R303.2) Installation. Materials, systems and equipment shall be installed in accordance with the manufacturer's instructions and this code.

N1101.11.1 (R303.2.1) Protection of exposed foundation insulation. Insulation applied to the exterior of ***basement walls***, ***crawl space*** walls and the perimeter of slab-on-grade floors shall have a rigid, opaque and weather-resistant protective covering to prevent the degradation of the insulation's thermal performance. The protective covering shall cover the exposed exterior insulation and extend not less than 6 inches (153 mm) below grade.

N1101.12 (R303.3) Maintenance information. Maintenance instructions shall be furnished for equipment and systems that require preventive maintenance. Required regular maintenance actions shall be clearly stated and incorporated on a readily visible label. The label shall include the title or publication number for the operation and maintenance manual for that particular model and type of product.

N1101.13 (R401.2) Application. Residential buildings shall comply with Section N1101.13.5 and Section N1101.13.1, N1101.13.2, N1101.13.3 or N1101.13.4.

Exception: Additions, alterations, repairs and changes of occupancy to existing buildings complying with Section N1109.

N1101.13.1 (R401.2.1) Prescriptive Compliance Option. The Prescriptive Compliance Option requires compliance with Sections N1101 through N1104.

N1101.13.2 (R401.2.2) Total Building Performance Option. The Total Building Performance Compliance Path requires compliance with Section N1105.

N1101.13.3 (R401.2.3) Energy Rating Index Option. The Energy Rating Index (ERI) option requires compliance with Section N1106.

N1101.13.4 (R401.2.4) Tropical Climate Region Option. The Tropical Climate Region Option requires compliance with Section N1107.

N1101.13.5 (R401.2.5) Additional energy efficiency. This section establishes additional requirements applicable to all compliance approaches to achieve additional energy efficiency.

1. For buildings complying with Section N1101.13.1, one of the additional efficiency package options shall be installed according to Section N1108.2.
2. For buildings complying with Section N1101.13.2, the building shall meet one of the following:
    2.1. One of the additional efficiency package options in Section N1108.2 shall be installed without including such measures in the proposed design under Section N1105.
    2.2. The proposed design of the building under Section N1105.3 shall have an annual energy cost that is less than or equal to 95 percent of the annual energy cost of the standard reference design.
3. For buildings complying with the Energy Rating Index alternative Section N1101.13.3, the Energy Rating Index value shall be at least 5 percent less than the Energy Rating Index target specified.

The option selected for compliance shall be identified on the certificate required by Section N1101.14. *

N1101.14 (R401.3) Certificate. A permanent certificate shall be completed by the builder or other ***approved*** party and posted on a wall in the space where the furnace is located, a utility room or an ***approved*** location inside the ***building***. Where located on an electrical panel, the certificate shall not cover or obstruct the visibility of the circuit directory ***label***, service disconnect ***label*** or other required ***labels***. The certificate shall indicate the following:

1. The predominant ***R*** values of insulation installed in or on ceilings, roofs, walls, foundation components such as slabs, ***basement walls***, ***crawl space walls*** and floors, and ducts outside ***conditioned spaces***.
2. ***U*** factors of fenestration and the ***solar heat gain coefficient*** (SHGC) of fenestration. Where there is more than one value for any component of the building envelope, the certificate shall indicate both the value covering the largest area and the area weighted average value if available.
3. The results from any required duct system and building envelope air leakage testing performed on the building.
4. The types, sizes and efficiencies of heating, cooling and service water-heating equipment. Where a gas-fired unvented room heater, electric furnace, or baseboard electric heater is installed in the residence, the certificate

shall indicate "gas fired unvented room heater," "electric furnace" or "baseboard electric heater," as appropriate. An efficiency is not required to be indicated for gas fired unvented room heaters, electric furnaces and electric baseboard heaters.

5. Where on site ***photovoltaic panel*** systems have been installed, the array capacity, inverter efficiency, panel tilt and orientation shall be noted on the certificate.

6. For buildings where an Energy Rating Index score is determined in accordance with Section N1106, the Energy Rating Index score, both with and without any on-site generation, shall be listed on the certificate.

7. The code edition under which the structure was permitted and the compliance path used.

SECTION N1102 (R402)
BUILDING THERMAL ENVELOPE

N1102.1 (R402.1) General. The ***building thermal envelope*** shall comply with the requirements of Sections N1102.1.1 through N1102.1.5.

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 N1102.
   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.

N1102.1.1 (R402.1.1) Vapor retarder. Wall assemblies in the ***building thermal envelope*** shall comply with the vapor retarder requirements of Section R702.7.

N1102.1.2 (R402.1.2) Insulation and fenestration criteria. The ***building thermal envelope*** shall meet the requirements of Table N1102.1.2 based on the ***climate zone*** specified in Section N1101.7. Assemblies shall have a *U*-factor equal to or less than that specified in Table N1102.1.2. Fenestration shall have a *U*-factor and glazed fenestration SHGC equal to or less than that specified in Table N1102.1.2.

TABLE R1102.1.2 (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	FRAME WALL ***U***-FACTOR	MASS WALL ***U***-FACTOR[b]	FLOOR ***U***-FACTOR	BASEMENT WALL ***U***-FACTOR	CRAWL SPACE WALL ***U***-FACTOR
0	**0.50**	**0.75**	**0.25**	**0.035**	**0.084**	**0.197**	**0.064**	**0.360**	**0.477**
1	0.50	0.75	**0.25**	0.035	0.084	0.197	0.064	0.360	0.477
2	0.40	0.65	**0.25**	0.026	0.084	0.165	0.064	0.360	0.477
3	0.30	0.55	**0.25**	0.026	0.060	0.098	0.047	0.091[c]	0.136
4 except Marine	0.30	0.55	**0.40**	0.024	0.045	0.098	0.047	0.059	0.065
5 and Marine 4	0.30	0.55	**NR**	0.024	0.045	0.082	0.033	0.050	0.055
6	0.30	0.55	**NR**	0.024	0.045	0.060	0.033	0.050	0.055
7 and 8	0.30	0.55	**NR**	0.024	0.045	0.057	0.028	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 0.17 in Climate Zones **0 and** 1, 0.14 in Climate Zone 2, 0.12 in Climate Zone 3, 0.087 in Climate Zone 4 except Marine, 0.065 in Climate Zone 5 and Marine 4, and 0.057 in Climate Zones 6 through 8.

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. There are no SHGC requirements in the Marine Zone.

f. A maximum *U*-factor of 0.32 shall apply in Marine Climate Zone 4 and Climate Zones 5 through 8 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.

N1102.1.3 (R402.1.3) R-value alternative. Assemblies with ***R***-value of insulation materials equal to or greater than that specified in Table N1102.1.3 shall be an alternative to the *U* factor in Table N1102.1.2.

TABLE N1102.1.3 **(R402.1.3)**

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

CLIMATE ZONE	FENESTRATION ***U***-FACTOR[b,i]	SKYLIGHT[b] ***U***-FACTOR	GLAZED FENESTRATION SHGC[b,e]	CEILING ***R***-VALUE	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
0	NR	0.75	0.25	30	13 or 0 + 10	3/4	13	0	0	0
1	NR	0.75	0.25	30	13 or 0 + 10	3/4	13	0	0	0
2	0.40	0.65	0.25	49	13 or 0 + 10	4/6	13	0	0	0
3	0.30	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 except Marine	0.30	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 and Marine 4	0.30	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
6	0.30	0.55	NR	60	20 + 5ci or 13 + 10ci or 0 + 20	15/20	30	15ci or 19 or 13 + 5ci	10ci, 4 ft	15ci or 19 or 13 + 5ci
7 and 8	0.30	0.55	NR	60	20 + 5ci or 13 + 10ci or 0 + 20	19/21	38	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 shall not be required in Warm Humid locations as defined by Figure N1101.7 and Table N1101.7.

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 N1102.2.5. 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 Zones 3 through 8 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.

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 incompliance 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 (R402.2) Specific insulation requirements. In addition to the requirements of Section N1102.1, insulation shall meet the specific requirements of Sections N1102.2.1 through N1102.2.12.

N1102.2.1 (R402.2.1) Ceilings with attic spaces. 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, 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 insulation and fenestration criteria in Section N1102.1.2 and the Total UA alternative in Section N1102.1.5.

N1102.2.2 (R402.2.2) Ceilings without attics. Where Section N1102.1.3 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 N1102.1.3 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 N1102.1.5.

N1102.2.3 (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 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 N1102.1.3 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 N1102.1.3 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 0 through 4 shall not be required to comply with the insulation level of the surrounding surfaces provided that 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 N1102.1.5.

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 or retainer, or dam shall be installed to prevent loose-fill insulation from spilling into 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.

N1102.2.5 (R402.2.5) Mass walls. Mass walls where used as a component of the ***building thermal envelope*** shall be one of the following:

1. Above-ground walls of concrete block, concrete, insulated concrete form, masonry cavity, brick but not brick veneer, adobe, compressed earth block, rammed earth, solid timber, mass timber or solid logs.
2. Any wall having a heat capacity greater than or equal to 6 Btu/ft^2 × °F (123 kJ/m^2 × K).

N1102.2.6 (R402.2.6) Steel-frame ceilings, walls, and floors. Steel-frame ceilings, walls, and floors shall comply with the insulation requirements of Table N1102.2.6 or the *U*-factor requirements of Table N1102.1.2. The calculation of the *U*-factor for a steel-frame envelope assembly shall use a series-parallel path calculation method.

TABLE N1102.2.6 (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-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 + 5	R-0 + 15 or R-13 + 9 or R-15 + 8.5 or R-19 + 8 or 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 + 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

For SI: 1 inch = 25.4 mm.

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.

N1102.2.7 (R402.2.7) Floors. Floor ***cavity*** insulation shall comply with one of the following:

1. **Insulation 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.

N1102.2.9.1 (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 extend the distance provided in Table N1102.1.3 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.

N1102.2.11 (R402.2.11) Masonry veneer. Insulation shall not be required on the horizontal portion of a foundation that supports a masonry veneer.

N1102.2.12 (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 enclosing ***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*** 0 through 4 and R-24 in Climate Zones 5 through 8.
2. The minimum wall insulation ***R*** value shall be R-13 in all climate zones. Walls separating a ***sunroom*** or heated garage with ***thermal isolation*** from ***conditioned space*** shall comply with the ***building thermal envelope*** requirements of this code.

N1102.3 (R402.3) Fenestration. In addition to the requirements of Section N1102, fenestration shall comply with Sections N1102.3.1 through N1102.3.5.

N1102.3.1 (R402.3.1) *U* factor. An area-weighted average of fenestration products shall be permitted to satisfy the ***U*** factor requirements.

N1102.3.2 (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 N1102.1.2 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 N1102.1.2.

N1102.3.3 (R402.3.3) Glazed fenestration exemption. 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 N1102.1.2. This exemption shall not apply to the Total UA alternative in Section N1102.1.5.

N1102.3.4 (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 N1102.1.2. This exemption shall not apply to the and the Total UA alternative in Section N1102.1.5.

N1102.3.5 (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 2 through 8, 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 a sunroom or heated garages with thermal isolation from conditioned space shall comply with the building thermal envelope requirements of this code.

N1102.4 (R402.4) Air leakage. The ***building thermal envelope*** shall be constructed to limit air leakage in accordance with the requirements of Sections N1102.4.1 through N1102.4.5.

N1102.4.1 (R402.4.1) Building thermal envelope. The ***building thermal envelope*** shall comply with Sections N1102.4.1.1 through N1102.4.1.3. The sealing methods between dissimilar materials shall allow for differential expansion and contraction.

N1102.4.1.1 (R402.4.1.1) Installation. The components of the ***building thermal envelope*** as indicated in Table N1102.4.1.1 shall be installed in accordance with the manufacturer's instructions and the criteria indicated in Table N1102.4.1.1, 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 N1102.4.1.1 (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.**	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.**

(continued)

TABLE N1102.4.1.1 (R402.4.1.1)—continued

AIR BARRIER 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.	—

For SI: 1 inch = 25.4 mm.

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.

N1102.4.1.2 (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 5.0 air changes per hour or 0.28 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 or ASTM E1827 and reported at a pressure of 0.2 inch w.g. (50 Pascals). 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 N1102.4.1.1, 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** *conditioned spaces* **in accordance with Sections N1102.2.12 and N1102.3.5, 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.

Exception: When testing individual dwelling units, an air leakage rate not exceeding 0.30 cubic feet per minute per square foot [0.008 $m^3/(s \times m^2)$] 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 water gauge (50 Pa), shall be permitted in all climate zones for:

1. Attached single- and multiple-family building dwelling units.

2. Buildings or dwelling units that are 1,500 square feet (139.4 m^2) or **smaller.**

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

N1102.4.1.3 **(R402.4.1.3)** Leakage rate. Where complying with Section N1101.13.1, the building or *dwelling unit* shall have an air leakage rate not exceeding 5.0 air changes per hour in Climate Zones 0, 1 and 2, and 3.0 air changes per hour in Climate Zones 3 through 8, when tested in accordance with Section N1102.4.1.2.

N1102.4.2 (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.

N1102.4.3 (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: Site-built windows, ***skylights*** and doors.

N1102.4.4 (R402.4.4) Rooms containing fuel-burning appliances. In Climate Zones 3 through 8, where opencombustion airducts 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 N1102.1.3, 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 N1103. 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 Sections N1102.4.2 and R1006.

N1102.4.5 (R402.4.5) 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.

N1102.4.6 (R402.4.6) 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.

N1102.5 (R402.5) Maximum fenestration U-factor and SHGC. The area-weighted average maximum fenestration ***U*** factor permitted using tradeoffs from Section N1102.1.5 or N1105 shall be 0.48 in Climate Zones 4 and 5 and 0.40 in Climate Zones 6 through 8 for vertical fenestration, and 0.75 in Climate Zones 4 through 8 for ***skylights***. The area-weighted average maximum fenestration SHGC permitted using tradeoffs from Section N1105 in Climate Zones 0 through 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.

SECTION N1103 (R403)
SYSTEMS

N1103.1 (R403.1) Controls. Not less than one thermostat shall be provided for each separate heating and cooling system.

N1103.1.1 (R403.1.1) Programmable thermostat. The thermostat controlling the primary heating or cooling system of the ***dwelling unit*** shall be capable of controlling the heating and cooling system on a daily schedule to maintain different temperature set points at different times of the day and different days of the week. This thermostat shall include the capability to set back or temporarily operate the system to maintain ***zone*** temperatures

of not less than 55°F (13°C) to not greater than 85°F (29°C). The thermostat shall be programmed initially by the manufacturer with a heating temperature setpoint of not greater than 70°F (21°C) and a cooling temperature setpoint of not less than 78°F (26°C).

N1103.1.2 (R403.1.2) Heat pump supplementary heat. Heat pumps having supplementary electric resistance heat shall have controls that, except during defrost, prevent supplemental heat operation when the heat pump compressor can meet the heating load.

N1103.2 (R403.2) Hot water boiler outdoor temperature reset. The manufacturer shall equip each gas, oil and electric boiler (other than a boiler equipped with a tankless domestic water heating coil) with automatic means of adjusting the water temperature supplied by the boiler to ensure incremental change of the inferred heat load will cause an incremental change in the temperature of the water supplied by the boiler. This can be accomplished with outdoor reset, indoor reset or water temperature sensing.

N1103.3 (R403.3) Ducts. Ducts and air handlers shall be installed in accordance with Sections N1103.3.1 through N1103.3.7.

N1103.3.1 (R403.3.1) Ducts located outside conditioned space. Supply and return ducts located outside *conditioned space* shall be insulated to an *R* value of not less than R-8 for ducts 3 inches (76 mm) in diameter and larger and not less than R-6 for ducts smaller than 3 inches (76 mm) in diameter. Ducts buried beneath a building shall be insulated as required by this section or have an equivalent thermal distribution efficiency. Underground ducts utilizing the thermal distribution efficiency method shall be listed and labeled to indicate the R value equivalency.

N1103.3.2 (R403.3.2) Ducts located in conditioned space. For ductwork to be considered inside a ***conditioned space***, it shall comply with one of the following:

1. The duct system is located completely within the ***continuous air barrier*** and within the ***building thermal envelope.***
2. Ductwork in ventilated attic spaces is buried within ceiling insulation in accordance with Section N1103.3.3 and all of the following conditions exist:
   2.1. The air handler is located completely within the ***continuous air barrier*** and within the ***building thermal envelope***.
   2.2. The duct leakage, as measured either by a rough-in test of the ducts or a post-construction total system leakage test to outside the ***building thermal envelope*** in accordance with Section N1103.3.6, is less than or equal to 1.5 cubic feet per minute (42.5 L/min) per 100 square feet (9.29 m^2) of ***conditioned floor area*** served by the duct system.
   2.3. The ceiling insulation ***R*** value installed against and above the insulated duct is greater than or equal to the proposed ceiling insulation ***R*** value, less the ***R*** value of the insulation on the duct.
3. Ductwork in floor cavities located over unconditioned space shall have the following:
   3.1. A continuous air barrier installed between unconditioned space and the duct.
   3.2. Insulation installed in accordance with Section N1102.2.7.
   3.3. A minimum R-19 insulation installed in the cavity width separating the duct from unconditioned space.
4. Ductwork located within exterior walls of the building thermal envelope shall have the following:
   4.1. A continuous air barrier installed between unconditioned space and the duct.
   4.2. Minimum R-10 insulation installed in the cavity width separating the duct from the outside sheathing.
   4.3. The remainder of the cavity insulation fully insulated to the drywall side.

N1103.3.3 (R403.3.3) Ducts buried within ceiling insulation. Where supply and return air ducts are partially or completely buried in ceiling insulation, such ducts shall comply with all of the following:

1. The supply and return duct shall have an insulation ***R*** value not less than R-8.
2. At all points along each duct, the sum of the ceiling insulation ***R*** values against and above the top of the duct, and against and below the bottom of the duct shall be not less than R-19, excluding the ***R*** value of the duct insulation.

3. In Climate Zones 0A, 1A, 2A and 3A, the supply ducts shall be completely buried within ceiling insulation, insulated to an ***R*** value of not less than R-13 and in compliance with the vapor retarder requirements of Section M1601.4.6.

Exception: Sections of the supply duct that are less than 3 feet (914 mm) from the supply outlet shall not be required to comply with these requirements.

N1103.3.3.1 (R403.3.3.1) Effective *R* value of deeply buried ducts. Where using the Total Building Performance Compliance Option in accordance with Section N1101.13.2, sections of ducts that are installed in accordance with Section N1103.3.3, located directly on or within 5.5 inches (140 mm) of the ceiling, surrounded with blown-in attic insulation having an ***R***-value of R-30 or greater and located such that the top of the duct is not less than 3.5 inches (89 mm) below the top of the insulation, shall be considered as having an effective duct insulation ***R*** value of R-25.

N1103.3.4 (R403.3.4) Sealing. Ducts, air handlers and filter boxes shall be sealed. Joints and seams shall comply with Section M1601.4.1.

N1103.3.4.1 (R403.3.4.1) Sealed air handler. Air handlers shall have a manufacturer's designation for an air leakage of not greater than 2 percent of the design airflow rate when tested in accordance with ASHRAE 193.

N1103.3.5 (R403.3.5) Duct testing. Ducts shall be pressure tested in accordance with ANSI/RESNET/ICC 380 or ASTM E1554 to determine air leakage by one of the following methods:

1. Rough-in test: Total leakage shall be measured with a pressure differential of 0.1 inch w.g. (25 Pa) across the system, including the manufacturer's air handler enclosure if installed at the time of the test. Registers shall be taped or otherwise sealed during the test.
2. Postconstruction test: Total leakage shall be measured with a pressure differential of 0.1 inch w.g. (25 Pa) across the entire system, including the manufacturer's air handler enclosure. Registers shall be taped or otherwise sealed during the test.

Exception: A duct air-leakage test shall not be required for ducts serving heating, cooling or ventilation systems that are not integrated with ducts serving heating or cooling systems.

N1103.3.6 (R403.3.6) Duct leakage. The total leakage of the ducts, where measured in accordance with Section N1103.3.5, shall be as follows:

1. Rough-in test: The total leakage shall be less than or equal to 4.0 cubic feet per minute (113.3 L/min) per 100 square feet (9.29 m^2) of ***conditioned floor area*** where the air handler is installed at the time of the test. Where the air handler is not installed at the time of the test, the total leakage shall be less than or equal to 3.0 cubic feet per minute (85 L/min) per 100 square feet (9.29 m^2) of ***conditioned floor area***.
2. Postconstruction test: Total leakage shall be less than or equal to 4.0 cubic feet per minute (113.3 L/min) per 100 square feet (9.29 m^2) of conditioned floor area.
3. Test for ducts within thermal envelope: Where all ducts and air handlers are located entirely within the building thermal envelope, total leakage shall be less than or equal to 8.0 cubic feet per minute (226.6 L/min) per 100 square feet (9.29 m^2) of conditioned floor area.

N1103.3.7 (R403.3.7) Building cavities. ***Building*** framing cavities shall not be used as ducts or plenums.

N1103.4 (R403.4) Mechanical system piping insulation. Mechanical system piping capable of carrying fluids greater than 105°F (41°C) or less than 55°F (13°C) shall be insulated to an ***R***-value of not less than R-3.

N1103.4.1 (R403.4.1) Protection of piping insulation. Piping insulation exposed to weather shall be protected from damage, including that caused by sunlight, moisture, equipment maintenance and wind. The protection shall provide shielding from solar radiation that can cause degradation of the material. Adhesive tape shall be prohibited.

N1103.5 (R403.5) Service hot water systems. Energy conservation measures for service hot water systems shall be in accordance with Sections N1103.5.1 through N1103.5.3.

N1103.5.1 Heated water circulation and temperature maintenance systems. Heated water circulation systems shall be in accordance with Section N1103.5.1.1. Heat trace temperature maintenance systems shall be in accordance with Section N1103.5.1.2. Automatic controls, temperature sensors and pumps shall be in a location with access. Manual controls shall be in a location with ready access.

N1103.5.1.1 (R403.5.1.1) Circulation systems. Heated water circulation systems shall be provided with a circulation pump. The system return pipe shall be a dedicated return pipe or a cold water supply pipe. Gravity

and thermosyphon circulation systems shall be prohibited. Controls for circulating hot water system pumps shall automatically turn off the pump when the water in the circulation loop is at the desired temperature and when there is no demand for hot water. The controls shall limit the temperature of the water entering the cold water piping to not greater than 104°F (40°C).

N1103.5.1.1.1 (R403.5.1.1.1) Demand recirculation water systems. Where installed, ***demand recirculation water systems*** shall have controls that start the pump upon receiving a signal from the action of a user of a fixture or appliance, sensing the presence of a user of a fixture or sensing the flow of hot or tempered water to a fixture fitting or appliance.

N1103.5.1.2 Heat trace systems. Electric heat trace systems shall comply with IEEE 515.1 or UL 515. Controls for such systems shall automatically adjust the energy input to the heat tracing to maintain the desired water temperature in the piping in accordance with the times when heated water is used in the occupancy.

N1103.5.2 (R403.5.2) Hot water pipe insulation. Insulation for service hot water piping with a thermal resistance, ***R*** value, of not less than R-3 shall be applied to the following:

1. Piping ¾ inch (19 mm) and larger in nominal diameter located inside the ***conditioned space***.
2. Piping serving more than one ***dwelling unit***.
3. Piping located outside the ***conditioned space***.
4. Piping from the water heater to a distribution manifold.
5. Piping located under a floor slab.
6. Buried piping.
7. Supply and return piping in circulation and recirculation systems other than cold water pipe return demand recirculation systems.

N1103.5.3 (R403.5.3) Drain water heat recovery units. Where installed, drain water heat recovery units shall comply with CSA B55.2. Drain water heat recovery units shall be tested in accordance with CSA B55.1. Potable water side pressure loss of drain water heat recovery units shall be less than 3 psi (20.7 kPa) for individual units connected to one or two showers. Potable water side pressure loss of drain water heat recovery units shall be less than 2 psi (13.8 kPa) for individual units connected to three or more showers.

N1103.6 (R403.6) Mechanical ventilation. *Buildings* and ***dwelling units*** shall be provided with mechanical ***ventilation*** that complies with the requirements of Section M1505 or with other ***approved*** means of ***ventilation***. Outdoor air intakes and exhausts shall have automatic or gravity dampers that close when the ***ventilation*** system is not operating.

N1103.6.1 (R403.6.1) Heat or energy recovery ventilation. Dwelling units shall be provided with a heat recovery or energy recovery ventilation system in Climate Zones 7 and 8. The system shall be balanced with a minimum sensible heat recovery efficiency of 65 percent at 32°F (0°C) at a flow greater than or equal to the design airflow.

N1103.6.2 (R403.6.2) Whole-dwelling mechanical ventilation system fan efficacy. Fans used to provide whole-dwelling mechanical ventilation shall meet the efficacy requirements of Table N1103.6.2 at one or more rating points. Fans shall be tested in accordance with HVI 916 and listed. The airflow shall be reported in the product listing or on the label. Fan efficacy shall be reported in the product listing or shall be derived from the input power and airflow values reported in the product listing or on the label. Fan efficacy for fully ducted HRV, ERC, balanced and in-line fans shall be determined at a static pressure of not less than 0.2 inch water column (49.82 Pa). Fan efficacy for ducted range hoods, bathroom, and utility room fans shall be determined at a static pressure of not less than 0.1 inch water column (24.91 Pa).

TABLE N1103.6.2 (R403.6.2)

WHOLE-DWELLING MECHANICAL VENTILATION SYSTEM FAN EFFICACY[a]

FAN LOCATION	AIRFLOW RATE MINIMUM (CFM)	MINIMUM EFFICACY (CFM/WATT)
HRV, ERV	Any	1.2 cfm/watt

In-line supply or exhaust fan	Any	3.8 cfm/watt
Other exhaust fan	< 90	2.8 cfm/watt
Other exhaust fan	≥ 90	3.5 cfm/watt
Air-handler that is integrated to tested and listed HVAC equipment	Any	1.2 cfm/watt

For SI: 1 cubic foot per minute = 28.3 L/min.
a. Design outdoor airflow rate/watts of fan used.

N1103.6.3 (R403.6.3) Testing. Mechanical ventilation systems shall be tested and verified to provide the minimum ventilation flow rates required by Section N1103.6. Testing shall be performed according to the ventilation equipment manufacturer's instructions, or by using a flow hood or box, flow grid, or other airflow measuring device at the mechanical ventilation fan's inlet terminals or grilles, outlet terminals or grilles, or in the connected ventilation ducts. 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.

Exception: Kitchen range hoods that are ducted to the outside with 6-inch (152 mm) or larger duct and not more than one 90-degree (1.57 rad) elbow or equivalent in the duct run.

N1103.7 (R403.7) Equipment sizing and efficiency rating. Heating and cooling ***equipment*** shall be sized in accordance with ACCA Manual S based on ***building*** loads calculated in accordance with ACCA Manual J or other ***approved*** heating and cooling calculation methodologies. New or replacement heating and cooling ***equipment*** shall have an efficiency rating equal to or greater than the minimum required by federal law for the geographic location where the ***equipment*** is installed.

N1103.8 (R403.8) Systems serving multiple dwelling units. Systems serving multiple ***dwelling units*** shall comply with Sections *C*403 and *C*404 of the ***International Energy Conservation Code*** – Commercial Provisions instead of Section N1103.

N1103.9 (R403.9) Snow-melt system controls. Snow- and ice-melting systems, supplied through energy service to the building, shall include automatic controls capable of shutting off the system when the pavement temperature is greater than 50°F (10°C) and precipitation is not falling, and an automatic or manual control that will allow shutoff when the outdoor temperature is greater than 40°F (4.8°C).

N1103.10 (R403.10) Energy consumption of pools and spas. The energy consumption of pools and permanent spas shall be controlled by the requirements in Sections N1103.10.1 through N1103.10.3.

N1103.10.1 (R403.10.1) Heaters. The electric power to heaters shall be controlled by an on-off switch that is an integral part of the heater mounted on the exterior of the heater in a location with *ready access*, or external to and within 3 feet (914 mm) of the heater. Operation of such switch shall not change the setting of the heater thermostat. Such switches shall be in addition to a circuit breaker for the power to the heater. Gas-fired heaters shall not be equipped with continuously burning ignition pilots.

N1103.10.2 (R403.10.2) Time switches. Time switches or other control methods that can automatically turn heaters and pump motors off and on according to a preset schedule shall be installed for heaters and pump motors. Heaters and pump motors that have built-in time switches shall be in compliance with this section.

Exceptions:

1. Where public health standards require 24-hour pump operation.
2. Pumps that operate solar- and waste-heat recovery pool heating systems.

N1103.10.3 (R403.10.3) Covers. Outdoor heated pools and outdoor permanent spas shall be provided with a vapor-retardant cover or other ***approved*** vapor-retardant means.

Exception: Where more than 75 percent of the energy for heating, computed over an operation season of not **fewer** than 3 calendar months, is from a heat pump or an on-site renewable energy system, covers or other vapor-retardant means shall not be required.

N1103.11 (R403.11) Portable spas. The energy consumption of electric powered portable spas shall be controlled by the requirements of APSP 14.

N1103.12 (R403.12) Residential pools and permanent residential spas. Where installed, the energy consumption of residential swimming pools and permanent residential spas shall be controlled in accordance with the requirements of APSP 15.

SECTION N1104 (R404)
ELECTRICAL POWER AND LIGHTING SYSTEMS

N1104.1 (R404.1) Lighting equipment. All permanently installed lighting fixtures, excluding kitchen appliance lighting fixtures, shall contain only high-efficacy lighting sources.

N1104.1.1 (R404.1.1) Exterior lighting. Connected exterior lighting for Group R-2, R-3 and R-4 buildings shall comply with Section C405.4 of the ***International Energy Conservation Code*** – Commercial Provisions.

Exceptions:

1. **Detached one- and two-family dwellings.**
2. **Townhouses.**
3. **Solar-powered lamps not connected to any electrical service.**
4. Luminaires controlled by a motion sensor.

N1104.1.2 (R404.1.1) Fuel gas lighting equipment. Fuel gas lighting systems shall not have continuously burning pilot lights.

N1104.2 (R404.2) Interior lighting controls. Permanently installed lighting fixtures shall be controlled with a dimmer, an occupant sensor control or another control that is installed or built into the fixture.

Exception: **Lighting controls shall not be required for the following:**

1. **Bathrooms.**
2. **Hallways.**
3. **Exterior lighting fixtures.**
4. Lighting designed for safety or security.

N1104.3 (R404.3) Exterior lighting controls. Where the total permanently installed exterior lighting power is greater than 30 watts, the permanently installed exterior lighting shall comply with the following:

1. Lighting shall be controlled by a manual on and off switch that permits automatic shut-off actions.

   Exception: **Lighting serving multiple *dwelling units*.**

2. **Lighting shall be automatically shut off when daylight is present and satisfies the lighting needs.**
3. Controls that override automatic shut-off actions shall not be allowed unless the override automatically returns automatic control to its normal operation within 24 hours.

SECTION N1105 (R405)
TOTAL BUILDING **PERFORMANCE**

N1105.1 (R405.1) Scope. This section establishes criteria for compliance using total building performance analysis. Such analysis shall include heating, cooling, mechanical ventilation and service water-heating energy only.

N1105.2 (R405.2) Performance-based compliance. Compliance based on total building performance requires that a *proposed design* meets all of the following:

1. The requirements of the sections indicated within Table N1105.2.
2. The building thermal envelope greater than or equal to levels of efficiency and solar heat gain coefficients in Table R402.1.1 or R402.1.3 of the 2009 International Energy Conservation Code.
3. An annual energy cost that is less than or equal to the annual energy cost of the standard reference design. Energy prices shall be taken from a source approved by the code official, such as the Department of Energy,

Energy Information Administration's State Energy Data System Prices and Expenditures reports. Code officials shall be permitted to require time-of-use pricing in energy cost calculations.

Exception: The energy use based on source energy expressed in Btu or Btu per square foot of conditioned floor area shall be permitted to be substituted for the energy cost. The source energy multiplier for electricity shall be 3.16. The source energy multiplier for fuels other than electricity shall be 1.1.

TABLE N1105.2 (R405.2)

REQUIREMENTS FOR TOTAL BUILDING PERFORMANCE

SECTION[a]	TITLE
General	
N1101.13.5	Additional energy efficiency
N1101.14	Certificate
Building Thermal Envelope	
N1102.1.1	Vapor retarder
N1102.2.3	Eave baffle
N1102.2.4.1	Access hatches and doors
N1102.2.10.1	Crawl space wall insulation installation
N1102.4.1.1	Installation
N1102.4.1.2	Testing
N1102.5	Maximum fenestration U-factor and SHGC
Mechanical	
N1103.1	Controls
N1103.3, including N1103.3.1, except Sections N1103.3.2, N1103.3.3 and N1103.3.6	Ducts
N1103.4	Mechanical system piping insulation
N1103.5.1	Heated water circulation and temperature maintenance systems
N1103.5.3	Drain water heat recovery units
N1103.6	Mechanical ventilation
N1103.7	Equipment sizing and efficiency rating
N1103.8	Systems serving multiple dwelling units
N1103.9	Snow melt system controls
N1103.10	Energy consumption of pools and spas
N1103.11	Portable spas
N1103.12	Residential pools and permanent residential spas
Electrical Power and Lighting Systems	
N1104.1	Lighting equipment
N1104.2	Interior lighting controls

a. Reference to a code section includes all the relative subsections except as indicated in the table.

N1105.3 (R405.3) Documentation. Documentation of the software used for the performance design and the parameters for the ***building*** shall be in accordance with Sections N1105.3.1 through N1105.3.2.2.

N1105.3.1 (R405.3.1) Compliance software tools. Documentation verifying that the methods and accuracy of the compliance software tools conform to the provisions of this section shall be provided to the ***code official***.

N1105.3.2 (R405.3.2) Compliance report. Compliance software tools shall generate a report that documents that the ***proposed design*** complies with Section N1105.3. A compliance report on the ***proposed design*** shall be submitted with the application for the building permit. Upon completion of the building, a confirmed compliance report based on the confirmed condition of the building shall be submitted to the ***code official*** before a certificate of occupancy is issued.

Compliance reports shall include information in accordance with Sections N1105.3.1 and N1105.3.2.2.

N1105.3.2.1 (R405.3.2.1) Compliance report for permit application. A compliance report submitted with the application for building permit shall include the following:

1. Building street address, or other ***building site*** identification.
2. The name of the individual performing the analysis and generating the compliance report.
3. The name and version of the compliance software tool.
4. Documentation of all inputs entered into the software used to produce the results for the reference design and/or the rated home.
5. A certificate indicating that the proposed design complies with Section N1105.3. The certificate shall document the building components' energy specifications that are included in the calculation, including component level insulation *R* values or *U* factors; duct system and building envelope air leakage testing assumptions; and the type and rated efficiencies of proposed heating, cooling, mechanical ventilation and service water heating equipment to be installed. If on site renewable energy systems will be installed, the certificate shall report the type and production size of the proposed system.
6. When a site specific report is not generated, the proposed design shall be based on the worst case orientation and configuration of the rated home.

N1105.3.2.2 (R405.3.2.2) Compliance report for certificate of occupancy. A compliance report submitted for obtaining the certificate of occupancy shall include the following:

1. Building street address, or other building site identification.
2. Declaration of the total building performance path on the title page of the energy report and the title page of the building plans.
3. A statement, bearing the name of the individual performing the analysis and generating the report, indicating that the as-built building complies with Section N1105.3.
4. The name and version of the compliance software tool.
5. A site-specific energy analysis report that is in compliance with Section N1105.3.
6. A final confirmed certificate indicating compliance based on inspection, and a statement indicating that the confirmed rated design of the built home complies with Section N1105.3. The certificate shall report the energy features that were confirmed to be in the home, including component-level insulation *R*-values or *U* factors; results from any required duct system and building envelope air leakage testing; and the type and rated efficiencies of the heating, cooling, mechanical ventilation and service water heating equipment installed.
7. Where on site renewable energy systems have been installed, the certificate shall report the type and production size of the installed system.

N1105.4 (R405.4) Calculation procedure. Calculations of the performance design shall be in accordance with Sections N1105.4.1 and N1105.4.2.

N1105.4.1 (R405.4.1) General. Except as specified by this section, the ***standard reference design*** and ***proposed design*** shall be configured and analyzed using identical methods and techniques.

N1105.4.2 (R405.4.2) Residence specifications. The ***standard reference design*** and ***proposed design*** shall be configured and analyzed as specified by Table N1105.4.2(1). Table N1105.4.2(1) shall include, by reference, all notes contained in Table N1102.1.3.

TABLE N1105.4.2(1) [R405.4.2(1)]

SPECIFICATIONS FOR THE STANDARD REFERENCE AND PROPOSED DESIGNS

BUILDING COMPONENT	STANDARD REFERENCE DESIGN	PROPOSED DESIGN
Above-grade walls	Type: mass where the proposed wall is a mass wall; otherwise wood frame.	As proposed
	Gross area: same as proposed.	As proposed
	U-factor: as specified in Table N1102.1.2.	As proposed
	Solar absorptance = 0.75.	As proposed
	Emittance = 0.90.	As proposed
Basement and crawl space walls	Type: same as proposed.	As proposed
	Gross area: same as proposed.	As proposed
	U-factor: as specified in Table N1102.1.2, with the insulation layer on the interior side of the walls.	As proposed
Above-grade floors	Type: wood frame.	As proposed
	Gross area: same as proposed.	As proposed
	U-factor: as specified in Table N1102.1.2.	As proposed
Ceilings	Type: wood frame.	As proposed
	Gross area: same as proposed.	As proposed
	U-factor: as specified in Table N1102.1.2.	As proposed
Roofs	Type: composition shingle on wood sheathing.	As proposed
	Gross area: same as proposed.	As proposed
	Solar absorptance = 0.75.	As proposed
	Emittance = 0.90.	As proposed
Attics	Type: vented with an aperture of 1 ft^2 per 300 ft^2 of ceiling area.	As proposed
Foundations	Type: same as proposed.	As proposed
	Foundation wall area above and below grade and soil characteristics: same as proposed.	As proposed
Opaque doors	Area: 40 ft^2.	As proposed
	Orientation: North.	As proposed
	U-factor: same as fenestration as specified in Table N1102.1.2.	As proposed
Vertical fenestration other than opaque doors	Total area[h] = (a) The proposed glazing area, where the proposed glazing area is less than 15 percent of the conditioned floor area. (b) 15 percent of the conditioned floor area, where the proposed glazing area is 15 percent or more of the conditioned floor area.	As proposed
	Orientation: equally distributed to four cardinal compass orientations (N, E, S & W).	As proposed

	U factor: as specified in Table N1102.1.2.	As proposed
	SHGC: as specified in Table N1102.1.2 except for climate zones without an SHGC requirement, the SHGC shall be equal to 0.40.	As proposed
	Interior shade fraction: 0.92 − (0.21 × SHGC for the standard reference design).	Interior shade fraction: 0.92 − (0.21 × SHGC as proposed)
	External shading: none	As proposed
Skylights	None	As proposed
Thermally isolated sunrooms	None	As proposed

(continued)

TABLE N1105.4.2(1) [R405.4.2(1)]—continued
SPECIFICATIONS FOR THE STANDARD REFERENCE AND PROPOSED DESIGNS

BUILDING COMPONENT	STANDARD REFERENCE DESIGN	PROPOSED DESIGN
Air exchange rate	The air leakage rate at a pressure of 0.2 inch w.g. (50 Pa) shall be Climate Zones 0 through 2: 5.0 air changes per hour. Climate Zones 3 through 8: 3.0 air changes per hour.	The measured air exchange rate.[a]
	The mechanical ventilation rate shall be in addition to the air leakage rate and shall be the same as in the proposed design, but not greater than 0.01 × *CFA* + 7.5 × (N_{br} + 1) where: *CFA* = conditioned floor area, ft^2. N_{br} = number of bedrooms. The mechanical ventilation system type shall be the same as in the proposed design. Energy recovery shall not be assumed for mechanical ventilation.	The mechanical ventilation rate[b] shall be in addition to the air leakage rate and shall be as proposed.
Mechanical ventilation	Where mechanical ventilation is not specified in the proposed design: None Where mechanical ventilation is specified in the proposed design, the annual vent fan energy use, in units of kWh/yr, shall equal (1/e_f) ×[0.0876 × *CFA* + 65.7 × (N_{br}+1)] where: e_f = the minimum exhaust fan efficacy, as specified in Table N1103.6.2, corresponding to the system type at a flow rate of 0.01 × ***CFA*** + 7.5 × (N_{br}+1) ***CFA*** = **conditioned floor area**, ft^2. N_{br} = number of bedrooms.	As proposed
Internal gains	IGain, in units of Btu/day per dwelling unit, shall equal 17,900 + 23.8 ×*CFA* + 4,104 × N_{br} where: ***CFA*** = conditioned floor area, ft^2. N_{br} = number of bedrooms.	Same as standard reference design.
Internal mass	Internal mass for furniture and contents: 8 pounds per square foot of floor area.	Same as standard reference design, plus any additional mass specifically designed as a thermal storage element[c] but not integral to the building envelope or structure.

Structural mass	For masonry floor slabs: 80 percent of floor area covered by R-2 carpet and pad, and 20 percent of floor directly exposed to room air.	As proposed
	For masonry basement walls: as proposed, but with insulation as specified in Table N1102.1.3, located on the interior side of the walls.	As proposed
	For other walls, ceilings, floors, and interior walls: wood frame construction.	As proposed
Heating systems[d, e]	For other than electric heating without a heat pump: as proposed. Where the proposed design utilizes electric heating without a heat pump, the standard reference design shall be an air source heat pump meeting the requirements of Section C403 of the IECC—Commercial Provisions. Capacity: sized in accordance with Section N1103.7.	As proposed
Cooling systems[d, f]	As proposed. Capacity: sized in accordance with Section N1103.7.	As proposed

(continued)

TABLE N1105.4.2(1) [R405.4.2(1)]—continued
SPECIFICATIONS FOR THE STANDARD REFERENCE AND PROPOSED DESIGNS

<table>
<tr><th>BUILDING COMPONENT</th><th>STANDARD REFERENCE DESIGN</th><th colspan="3">PROPOSED DESIGN</th></tr>
<tr><td rowspan="7">Service water heating[d, g]</td><td rowspan="7">As proposed.
Use, in units of gal/day = 30 + (10 × N_{br})
where:
N_{br} = number of bedrooms.</td><td colspan="3">As proposed
Use, in units of gal/day = 25.5 + (8.5 × N_{br}) × (1 − HWDS)
where:
N_{br} = number of bedrooms.
HWDS = factor for the compactness of the hot water distribution system.</td></tr>
<tr><td colspan="2">Compactness ratio[i] factor</td><td>HWDS</td></tr>
<tr><td>1 story</td><td>2 or more stories</td><td></td></tr>
<tr><td>> 60%</td><td>> 30%</td><td>0</td></tr>
<tr><td>> 30% to ≤ 60%</td><td>> 15% to ≤ 30%</td><td>0.05</td></tr>
<tr><td>> 15% to ≤ 30%</td><td>> 7.5% to ≤ 15%</td><td>0.10</td></tr>
<tr><td>≤ 15%</td><td>≤ 7.5%</td><td>0.15</td></tr>
<tr><td>Thermal distribution systems</td><td>Duct insulation: in accordance with Section N1103.3.1.
A thermal distribution system efficiency (DSE) of 0.88 shall be applied to both the heating and cooling system efficiencies for all systems other than tested duct systems.
Duct location: same as proposed design.
— Exception: For nonducted heating and cooling systems that do not have a fan, the standard reference design thermal distribution system efficiency (DSE) shall be 1.
For tested duct systems, the leakage rate shall be 4 cfm (113.3 L/min) per 100 ft^2 (9.29 m^2) of conditioned floor area at a pressure of differential of 0.1 inch w.g. (25 Pa).</td><td colspan="3">Duct insulation: as proposed.
As tested or, where not tested, as specified in Table N1105.4.2(2).</td></tr>
</table>

Thermostat	Type: Manual, cooling temperature setpoint = 75°F; Heating temperature setpoint = 72°F.	Same as standard reference design.
Dehumidistat	Where a mechanical ventilation system with latent heat recovery is not specified in the proposed design: None. Where the proposed design utilizes a mechanical ventilation system with latent heat recovery: Dehumidistat type: manual, setpoint = 60% relative humidity. Dehumidifier: whole-dwelling with integrated energy factor = 1.77 liters/kWh.	Same as standard reference design.

(continued)

TABLE N1105.4.2(1) [R405.4.2(1)]—continued

SPECIFICATIONS FOR THE STANDARD REFERENCE AND PROPOSED DESIGNS

For SI: 1 square foot = 0.93 m^2, 1 British thermal unit = 1055 J, 1 pound per square foot = 4.88 kg/m^2, 1 gallon (US) = 3.785 L, °C = (°F – 32)/1.8,

1 degree = 0.79 rad.

a. Where required by the code official, testing shall be conducted by an approved party. Hourly calculations as specified in the ASHRAE *Handbook of Fundamentals,* or the equivalent, shall be used to determine the energy loads resulting from infiltration.

b. The combined air exchange rate for infiltration and mechanical ventilation shall be determined in accordance with Equation 43 of 2001 ASHRAE *Handbook of Fundamentals,* page 26.24 and the "Whole-house Ventilation" provisions of 2001 ASHRAE *Handbook of Fundamentals,* page 26.19 for intermittent mechanical ventilation.

c. Thermal storage element shall mean a component that is not part of the floors, walls or ceilings that is part of a passive solar system, and that provides thermal storage such as enclosed water columns, rock beds, or phase-change containers. A thermal storage element shall be in the same room as fenestration that faces within 15 degrees (0.26 rad) of true south, or shall be connected to such a room with pipes or ducts that allow the element to be actively charged.

d. For a proposed design with multiple heating, cooling or water heating systems using different fuel types, the applicable standard reference design system capacities and fuel types shall be weighted in accordance with their respective loads as calculated by accepted engineering practice for each equipment and fuel type present.

e. For a proposed design without a proposed heating system, a heating system having the prevailing federal minimum efficiency shall be assumed for both the standard reference design and proposed design.

f. For a proposed design home without a proposed cooling system, an electric air conditioner having the prevailing federal minimum efficiency shall be assumed for both the standard reference design and the proposed design.

g. For a proposed design with a nonstorage-type water heater, a 40-gallon storage-type water heater having the prevailing federal minimum energy factor for the same fuel as the predominant heating fuel type shall be assumed. For a proposed design without a proposed water heater, a 40-gallon storage-type water heater having the prevailing federal minimum efficiency for the same fuel as the predominant heating fuel type shall be assumed for both the proposed design and standard reference design.

h. For residences with conditioned basements, R-2 and R-4 residences, and for townhouses, the following formula shall be used to determine glazing area:

$AF = A_s \times FA \times F$

where:

AF = Total glazing area.

A_s = Standard reference design total glazing area.

FA = (Above-grade thermal boundary gross wall area)/(above-grade boundary wall area + 0.5 × below-grade boundary wall area).

F = (above-grade thermal boundary wall area)/(above-grade thermal boundary wall area + common wall area) or 0.56, whichever is greater.

and where:

Thermal boundary wall is any wall that separates conditioned space from unconditioned space or ambient conditions.

Above-grade thermal boundary wall is any thermal boundary wall component not in contact with soil.

Below-grade boundary wall is any thermal boundary wall in soil contact.

Common wall area is the area of walls shared with an adjoining dwelling unit.

i. The factor for the compactness of the hot water distribution system is the ratio of the area of the rectangle that bounds the source of hot water and the fixtures that it serves (the "hot water rectangle") divided by the floor area of the dwelling.

1. Sources of hot water include water heaters, or in multiple-family buildings with central water heating systems, circulation loops or electric heat traced pipes.
2. The hot water rectangle shall include the source of hot water and the points of termination of all hot water fixture supply piping.
3. The hot water rectangle shall be shown on the floor plans and the area shall be computed to the nearest square foot.

4. Where there is more than one water heater and each water heater serves different plumbing fixtures and appliances, it is permissible to establish a separate hot water rectangle for each hot water distribution system and add the area of these rectangles together to determine the compactness ratio.
5. The basement or attic shall be counted as a story when it contains the water heater.
6. Compliance shall be demonstrated by providing a drawing on the plans that shows the hot water distribution system rectangle(s), comparing the area of the rectangle(s) to the area of the dwelling and identifying the appropriate compactness ratio and HWDS factor.

TABLE N1105.4.2(2) [R405.4.2(2)]

DEFAULT DISTRIBUTION SYSTEM EFFICIENCIES FOR PROPOSED DESIGNS[a]

DISTRIBUTION SYSTEM CONFIGURATION AND CONDITION	FORCED AIR SYSTEMS	HYDRONIC SYSTEMS[b]
Distribution system components located in unconditioned space	—	0.95
Untested distribution systems entirely located in conditioned space[c]	0.88	1
"Ductless" systems[d]	1	—

a. Default values this table are for untested distribution systems, which must still meet minimum requirements for duct system insulation.
b. Hydronic systems shall mean those systems that distribute heating and cooling energy directly to individual spaces using liquids pumped through closed-loop piping and that do not depend on ducted, forced airflow to maintain space temperatures.
c. Entire system in conditioned space shall mean that no component of the distribution system, including the air handler unit, is located outside of the conditioned space.
d. Ductless systems shall be allowed to have forced airflow across a coil but shall not have any ducted airflow external to the manufacturer's air handler enclosure.

N1105.5 (R405.5) Calculation software tools. Calculation software, where used, shall be in accordance with Sections N1105.5.1 through N1105.5.3.

N1105.5.1 (R405.5.1) Minimum capabilities. Calculation procedures used to comply with this section shall be software tools capable of calculating the annual energy consumption of all building elements that differ between the ***standard reference design*** and the ***proposed design*** and shall include the following capabilities:

1. Computer generation of the ***standard reference design*** using only the input for the ***proposed design***. The calculation procedure shall not allow the user to directly modify the building component characteristics of the ***standard reference design***.
2. Calculation of whole building (as a single ***zone***) sizing for the heating and cooling ***equipment*** in the ***standard reference design*** residence in accordance with Section N1103.6.
3. Calculations that account for the effects of indoor and outdoor temperatures and part-load ratios on the performance of heating, ventilating and air-conditioning ***equipment*** based on climate and ***equipment*** sizing.
4. Printed ***code official*** inspection checklist listing each of the ***proposed design*** component characteristics from Table N1105.4.2(1) determined by the analysis to provide compliance, along with their respective performance ratings such as ***R*** value, ***U*** factor, SHGC, HSPF, AFUE, SEER and EF.

N1105.5.2 (R405.5.2) Specific approval. Performance analysis tools meeting the applicable provisions of Section N1105 shall be permitted to be ***approved***. Tools are permitted to be ***approved*** based on meeting a specified threshold for a ***jurisdiction***. The ***code official*** shall be permitted to approve such tools for a specified application or limited scope.

N1105.5.3 (R405.5.3) Input values. When calculations require input values not specified by Sections N1102, N1103, N1104 and N1105, those input values shall be taken from an ***approved*** source.

SECTION N1106 (R406)
ENERGY RATING INDEX
COMPLIANCE ALTERNATIVE

N1106.1 (R406.1) Scope. This section establishes criteria for compliance using an Energy Rating Index (ERI) analysis.

N1106.2 (R406.2) ERI compliance. Compliance based on the Energy Rating Index (ERI) requires that the rated design meet all of the following:

1. **The requirements of the sections indicated within Table N1106.2.**
2. Maximum ERI of Table N1106.5.

TABLE N1106.2 **(R406.2)**
REQUIREMENTS FOR ENERGY RATING INDEX

SECTION[a]	TITLE
General	
N1101.13.5	Additional efficiency packages
N1101.14	Certificate
Building Thermal Envelope	
N1102.1.1	Vapor retarder
N1102.2.3	Eave baffle
N1102.2.4.1	Access hatches and doors
N1102.2.10.1	Crawl space wall insulation installation
N1102.4.1.1	Installation
N1102.4.1.2	Testing
Mechanical	
N1103.1	Controls
N1103.3 except Sections N1103.3.2, N1103.3.3 and N1103.3.6	Ducts
N1103.4	Mechanical system piping insulation
N1103.5.1	Heated water circulation and temperature maintenance systems
N1103.5.3	Drain water heat recovery units
N1103.6	Mechanical ventilation
N1103.7	Equipment sizing and efficiency rating
N1103.8	Systems serving multiple dwelling units
N1103.9	Snow melt system controls
N1103.10	Energy consumption of pools and spas
N1103.11	Portable spas
N1103.12	Residential pools and permanent residential spas
Electrical Power and Lighting Systems	
N1104.1	Lighting equipment
N1104.2	Interior lighting controls
N1106.3	Building thermal envelope

a. Reference to a code section includes all of the relative subsections except as indicated in the table.

N1106.3 (R406.3) Building thermal envelope. Building and portions thereof shall comply with Section N1106.3.1 or N1106.3.2.

N1106.3.1 (R406.3.1) On-site renewables are not included. Where on-site renewable energy is not included for compliance using the ERI analysis of Section N1106.4, the proposed total building thermal envelope UA, which is sum of U-factor times assembly area, shall be less than or equal to the building thermal envelope UA using the prescriptive U-factors from Table N1102.1.2 multiplied by 1.15 in accordance with Equation 11-4. The area-weighted maximum fenestration SHGC permitted in Climate Zones 0 through 3 shall be 0.30.

$UA_{Proposed\ design} = 1.15 \times UA_{Prescriptive\ reference\ design}$

(Equation 11-4)

N1106.3.2 (R406.3.2) On-site renewables are included. Where on-site renewable energy is included for compliance using the ERI analysis of Section N1106.4, the building thermal envelope shall be greater than or equal to the levels of efficiency and SHGC in Table N1102.1.2, or Table R402.1.4 of the 2015 ***International Energy Conservation Code***.

N1106.4 (R406.4) Energy Rating Index. The Energy Rating Index (ERI) shall be determined in accordance with RESNET/ICC 301 except that the ***ERI reference design*** ventilation rate shall be in accordance with Equation 11-5.

Ventilation rate, CFM = (0.01 × total square foot area of house) + [7.5 × (number of bedrooms + 1)]

(Equation 11-5)

Energy used to recharge or refuel a vehicle used for transportation on roads that are not on the ***building site*** shall not be included in the ***ERI reference design*** or the ***rated design***. For compliance purposes, any reduction in energy use of the rated design associated with on-site renewable energy shall not exceed 5 percent of the total energy use.

N1106.5 (R406.5) ERI-based compliance. Compliance based on an ERI analysis requires that the ***rated*** *proposed* ***design*** and confirmed built dwelling be shown to have an ERI less than or equal to the appropriate value indicated in Table N1106.5 when compared to the ***ERI reference design***.

TABLE N1106.5 (R406.5)

MAXIMUM ENERGY RATING INDEX

CLIMATE ZONE	ENERGY RATING INDEX
0 1	52
2	52
3	51
4	54
5	55
6	54
7	53
8	53

N1106.6 (R406.6) Verification by approved agency. Verification of compliance with Section N1106 as outlined in Sections N1106.4 and N1106.6 shall be completed by an ***approved*** third party. Verification of compliance with Section N1106.2 shall be completed by the authority having jurisdiction or an approved third party inspection agency in accordance with Section R105.4.

N1106.7 (R406.7) Documentation. Documentation of the software used to determine the ERI and the parameters for the ***residential building*** shall be in accordance with Sections N1106.7.1 through N1106.7.4.

N1106.7.1 (R406.7.1) Compliance software tools. Software tools used for determining ERI shall be ***Approved*** Software Rating Tools in accordance with RESNET/ICC 301.

N1106.7.2 (R406.7.2) Compliance report. Compliance software tools shall generate a report that documents that the home and the ERI score of the ***rated design*** comply with Sections N1106.2, N1106.3 and N1106.4. Compliance documentation shall be created for the proposed design and shall be submitted with the application for the building permit. Confirmed compliance documents of the built dwelling unit shall be created and submitted to the code official for review before a certificate of occupancy is issued. Compliance reports shall include information in accordance with Sections N1106.7.2.1 and N1106.7.2.2.

N1106.7.2.1 (R406.7.2.1) Proposed compliance report for permit application. Compliance reports submitted with the application for a building permit shall include the following:

1. **Building street address, or other *building site* identification.**
2. **Declaration of ERI on the title page and on the building plans.**
3. **The name of the individual performing the analysis and generating the compliance report.**
4. **The name and version of the compliance software tool.**
5. **Documentation of all inputs entered into the software used to produce the results for the reference design and/or the rated home.**
6. **A certificate indicating that the proposed design has an ERI less than or equal to the appropriate score indicated in Table N1106.5 when compared to the ERI reference design. The certificate shall document the building component energy specifications that are included in the calculation, including: component level insulation *R*-values or *U*-factors; assumed duct system and building envelope air leakage testing results; and the type and rated efficiencies of proposed heating, cooling, mechanical ventilation and service water heating equipment to be installed. If on-site renewable energy systems will be installed, the certificate shall report the type and production size of the proposed system.**
7. When a site specific report is not generated, the proposed design shall be based on the worst case orientation and configuration of the rated home.

N1106.7.2.2 (R406.7.2.2) Confirmed compliance report for a certificate of occupancy. A confirmed compliance report submitted for obtaining the certificate of occupancy shall be made site and address specific and include the following:

1. **Building street address or other *building site* identification.**
2. **Declaration of ERI on the title page and on the building plans.**
3. **The name of the individual performing the analysis and generating the report.**
4. **The name and version of the compliance software tool.**
5. Documentation of all inputs entered into the software used to produce the results for the reference design and/or the rated home.
6. A final confirmed certificate indicating that the confirmed rated design of the built home complies with Sections N1106.2 and N1106.4. The certificate shall report the energy features that were confirmed to be in the home, including: component level insulation R-values or U-factors; results from any required duct system and building envelope air leakage testing; and the type and rated efficiencies of the heating, cooling, mechanical ventilation, and service water heating equipment installed. Where on-site renewable energy systems have been installed on or in the home, the certificate shall report the type and production size of the installed system.

N1106.7.3 (R406.7.3) Renewable energy certificate (REC) documentation. Where on-site renewable energy is included in the calculation of an ERI, one of the following forms of documentation shall be provided to the code official:

1. **Substantiation that the RECs associated with the on-site renewable energy are owned by, or retired on behalf of, the homeowner.**
2. A contract that conveys to the homeowner the RECs associated with the on-site renewable energy, or conveys to the homeowner an equivalent quantity of RECs associated with other renewable energy.

N1106.7.4 (R406.7.4) Additional documentation. The ***code official*** shall be permitted to require the following documents:

1. Documentation of the building component characteristics of the ***ERI reference design***.

2. A certification signed by the builder providing the building component characteristics of the ***rated design***.

3. Documentation of the actual values used in the software calculations for the ***rated design***.

N1106.7.5 (R406.7.5) Specific approval. Performance analysis tools meeting the applicable subsections of Section N1106 shall be ***approved***. Documentation demonstrating the approval of performance analysis tools in accordance with Section N1106.7.1 shall be provided.

N1106.7.6 (R406.7.6) Input values. Where calculations require input values not specified by Sections N1102, N1103, N1104 and N1105, those input values shall be taken from RESNET/ICC 301.

SECTION N1107 (R407)
TROPICAL CLIMATE REGION COMPLIANCE PATH

N1107.1 **(R407.1)** Scope. This section establishes alternative criteria for residential buildings in the tropical region at elevations less than 2,400 feet (731.5 m) above sea level. **

N1107.2 **(R407.2)** Tropical climate region. Compliance with this section requires the following:

1. Not more than one-half of the occupied space is air conditioned.
2. The occupied space is not heated.
3. Solar, wind or other renewable energy source supplies not less than 80 percent of the energy for service water heating.
4. Glazing in conditioned spaces has a solar heat gain coefficient (SHGC) of less than or equal to 0.40, or has an overhang with a projection factor equal to or greater than 0.30.
5. Permanently installed lighting is in accordance with Section N1104.
6. The exterior roof surface complies with one of the options in Table C402.3 of the International Energy Conservation Code or the roof or ceiling has insulation with an *R* value of R-15 or greater. Where attics are present, attics above the insulation are vented and attics below the insulation are unvented.
7. Roof surfaces have a slope of not less than $^{1}/_{4}$ unit vertical in 12 units horizontal (21 percent slope). The finished roof does not have water accumulation areas.
8. Operable fenestration provides a ventilation area of not less than 14 percent of the floor area in each room. Alternatively, equivalent ventilation is provided by a ventilation fan.
9. Bedrooms with exterior walls facing two different directions have operable fenestration on exterior walls facing two directions.
10. Interior doors to bedrooms are capable of being secured in the open position.
11. A ceiling fan or ceiling fan rough-in is provided for bedrooms and the largest space that is not used as a bedroom.

SECTION N1108 (R408)
ADDITIONAL EFFICIENCY PACKAGE OPTIONS

N1108.1 **(R408.1) Scope.** This section establishes additional efficiency package options to achieve additional energy efficiency in accordance with Section N1101.13.5.

N1108.2 (R408.2) Additional efficiency package options. Additional efficiency package options for compliance with Section N1101.13.5 are set forth in Sections N1108.2.1 through N1108.2.5.

N1108.2.1 (R408.2.1) Enhanced envelope performance option. The total building thermal envelope UA, the sum of U-factor times assembly area, shall be less than or equal to 95 percent of 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 UA calculation shall be performed in accordance with Section N1102.1.5. The area-weighted average SHGC of all glazed fenestration shall be less than or equal to 95 percent of the maximum glazed fenestration SHGC in Table N1102.1.2.

N1108.2.2 (R408.2.2) More efficient HVAC equipment performance option. Heating and cooling equipment shall meet one of the following efficiencies:

1. **Greater than or equal to 95 AFUE natural gas furnace and 16 SEER air conditioner.**
2. **Greater than or equal to 10 HSPF/16 SEER air source heat pump.**
3. Greater than or equal to 3.5 COP ground source heat pump. For multiple cooling systems, all systems shall meet or exceed the minimum efficiency requirements in this section and shall be sized to serve 100 percent of the cooling design load. For multiple heating systems, all systems shall meet or exceed the minimum efficiency requirements in this section and shall be sized to serve 100 percent of the heating design load.

N1108.2.3 (R408.2.3) Reduced energy use in service water-heating option. The hot water system shall meet one of the following efficiencies:

1. **Greater than or equal to 82 EF fossil fuel service water-heating system.**
2. **Greater than or equal to 2.0 EF electric service water-heating system.**
3. Greater than or equal to 0.4 solar fraction solar water heating system.

N1108.2.4 (R408.2.4) More efficient duct thermal distribution system option. The thermal distribution system shall meet one of the following efficiencies:

1. **100 percent of ducts and air handlers located entirely within the building thermal envelope.**
2. **100 percent of ductless thermal distribution system or hydronic thermal distribution system located completely inside the building thermal envelope.**
3. 100 percent of duct thermal distribution system located in conditioned space as defined by Section N1103.3.2.

N1108.2.5 (R408.2.5) Improved air sealing and efficient ventilation system option. The measured air leakage rate shall be less than or equal to 3.0 ACH50, with either an Energy Recovery Ventilator (ERV) or Heat Recovery Ventilator (HRV) installed. Minimum HRV and ERV requirements, measured at the lowest tested net supply airflow, shall be greater than or equal to 75 percent Sensible Recovery Efficiency (SRE), less than or equal to 1.1 cubic feet per minute per watt (0.03 m^3/min/watt) and shall not use recirculation as a defrost strategy. In addition, the ERV shall be greater than or equal to 50 percent Latent Recovery/Moisture Transfer (LRMT).

SECTION N1109 (R501) EXISTING BUILDINGS—GENERAL

N1109.1 (R501.1) Scope. The provisions of Sections N1109 through N1113 shall control the ***alteration***, ***repair***, ***addition*** and **change of occupancy** of existing ***buildings*** and structures.

N1109.1.1 (R501.1.1) General. Except as specified in this chapter, this code shall not be used to require the removal, ***alteration*** or abandonment of, nor prevent the continued use and maintenance of, an existing ***building*** or ***building*** system lawfully in existence at the time of adoption of this code. Unaltered portions of the existing *building*, or *building* supply system shall not be required to comply with this code.

N1109.2 (R501.2) Compliance. ***Additions***, ***alterations***, ***repairs*** or changes of occupancy to, or relocation of, an existing ***building***, ***building*** system or portion thereof shall comply with Section N1110, N1111, N1112 or N1113, respectively, in this code. Changes where unconditioned space is changed to *conditioned space* shall comply with Section N1110.

N1109.3 (R501.3) Maintenance. ***Buildings*** and structures, and parts thereof, shall be maintained in a safe and sanitary condition. Devices and systems that are required by this code shall be maintained in compliance with the code edition under which installed. The ***owner*** or the owner's authorized agent shall be responsible for the maintenance of ***buildings*** and structures. The requirements of this chapter shall not provide the basis for removal or abrogation of energy conservation, fire protection and safety systems and devices in existing structures.

N1109.4 (R501.4) Compliance. ***Alterations***, ***repairs***, ***additions*** and changes of occupancy to, or relocation of, existing ***buildings*** and structures shall comply with the provisions for ***alterations***, ***repairs***, ***additions*** and changes of occupancy or relocation, respectively, in this code.

N1109.5 (R501.5) New and replacement materials. Except as otherwise required or permitted by this code, materials permitted by the applicable code for new construction shall be used. Like materials shall be permitted for ***repairs***, provided that hazards to life, health or property are not created. Hazardous materials shall not be used where the code for new construction would not allow their use in ***buildings*** of similar occupancy, purpose and location.

N1109.6 (R501.6) Historic buildings. Provisions of this chapter relating to the construction, ***repair***, ***alteration***, restoration and movement of structures, and **change of occupancy** shall not be mandatory for ***historic buildings*** provided that a report has been submitted to the ***building official*** and signed by the ***owner***, a ***registered design professional***, or a representative of the State Historic Preservation Office or the historic preservation authority having ***jurisdiction***, demonstrating that compliance with that provision would threaten, degrade or destroy the historic form, fabric or function of the ***building***.

SECTION N1110 (R502) ADDITIONS

N1110.1 (R502.1) General. ***Additions*** to an existing ***building***, ***building*** system or portion thereof shall conform to the provisions of this chapter as they relate to new construction without requiring the unaltered portion of the existing ***building*** or ***building*** system to comply with this chapter. ***Additions*** shall not create an unsafe or hazardous condition or overload existing ***building*** systems. An ***addition*** shall be deemed to comply with this chapter where the ***addition*** alone complies, where the existing ***building*** and ***addition*** comply with this chapter as a single ***building***, or where the ***building*** with the ***addition*** does not use more energy than the existing ***building***. ***Additions*** shall be in accordance with Section N1110.1.1 or N1110.1.2.

N1110.2 (R502.2) Change in space conditioning. Any unconditioned or low energy space that is altered to become ***conditioned space*** shall be required to be brought into full compliance with this chapter.

Exceptions:

1. Where the simulated performance option in Section N1105 is used to comply with this section, the annual energy cost of the proposed design is permitted to be 110 percent of the annual energy cost otherwise allowed by Section N1105.3.
2. Where the Total UA, as determined in Section N1102.1.5, of the existing building and the addition, and any alterations that are part of the project, is less than or equal to the Total UA generated for the existing building.
3. Where complying in accordance with Section N1105 and the annual energy cost or energy use of the addition and the existing building, and any alterations that are part of the project, is less than or equal to the annual energy cost of the existing building. The addition and any alterations that are part of the project shall comply with Section N1105 in its entirety.

N1110.3 (R502.3) Prescriptive compliance. ***Additions*** shall comply with Sections N1110.3.1 through N1110.3.4.

N1110.3.1 (R502.3.1) Building envelope. New ***building*** envelope assemblies that are part of the ***addition*** shall comply with Sections N1102.1, N1102.2, N1102.3.1 through N1102.3.5, and N1102.4.

Exception: New envelope assemblies are exempt from the requirements of Section N1102.4.1.2.

N1110.3.2 (R502.3.2) Heating and cooling systems. HVAC ducts newly installed as part of an ***addition*** shall comply with Section N1103.

Exception: Where ducts from an existing heating and cooling system are extended to an ***addition***.

N1110.3.3 (R502.3.3) Service hot water systems. New service hot water systems that are part of the ***addition*** shall comply with Section N1103.5.

N1110.3.4 (R502.3.4) Lighting. New lighting systems that are part of the ***addition*** shall comply with Section N1104.1.

SECTION N1111 (R503) ALTERATIONS

N1111.1 (R503.1) General. ***Alterations*** to any ***building*** or structure shall comply with the requirements of the code for new construction, without requiring the unaltered portions of the existing building or building system to comply with this chapter. ***Alterations*** shall be such that the existing ***building*** or structure is not less conforming with the provisions of this chapter than the existing building or structure was prior to the ***alteration***.

Alterations shall not create an unsafe or hazardous condition or overload existing ***building*** systems. ***Alterations*** shall be such that the existing ***building*** or structure does not use more energy than the existing ***building*** or structure prior to the ***alteration***. ***Alterations*** to existing ***buildings*** shall comply with Sections N1111.1.1 through N1111.1.4.

N1111.1.1 (R503.1.1) Building envelope. ***Building*** envelope assemblies that are part of the ***alteration*** shall comply with Section N1102.1.2 or N1102.1.4, Sections N1102.2.1 through N1102.2.12, N1102.3.1, N1102.3.2, N1102.4.3 and N1102.4.5.

Exception: The following ***alterations*** shall not be required to comply with the requirements for new construction provided that the energy use of the ***building*** is not increased:

1. Storm windows installed over existing fenestration.
2. Existing ceiling, wall or floor cavities exposed during construction provided that these cavities are filled with insulation.
3. Construction where the existing roof, wall or floor cavity is not exposed.
4. ***Roof recover***.
5. Roofs without insulation in the cavity and where the sheathing or insulation is exposed during ***reroofing*** shall be insulated either above or below the sheathing.
6. Surface-applied window film installed on existing single-pane fenestration assemblies to reduce solar heat gain provided that the code does not require the glazing or fenestration assembly to be replaced.

N1111.1.1.1 (R503.1.1.1) Replacement fenestration. Where some or all of an existing fenestration unit is replaced with a new fenestration product, including sash and glazing, the replacement fenestration unit shall meet the applicable requirements for ***U*** factor and SHGC as specified in Table N1102.1.3. Where more than one replacement fenestration unit is to be installed, an area-weighted average of the ***U*** factor, SHGC or both of all replacement fenestration units shall be an alternative that can be used to show compliance.

N1111.1.2 (R503.1.2) Heating and cooling systems. HVAC ducts newly installed as part of an ***alteration*** shall comply with Section N1103.

Exception: Where ducts from an existing heating and cooling system are extended to an addition.

N1111.1.3 (R503.1.3) Service hot water systems. New service hot water systems that are part of the ***alteration*** shall comply with Section N1103.5.

N1111.1.4 (R503.1.4) Lighting. New lighting systems that are part of the ***alteration*** shall comply with Section N1104.1.

Exception: ***Alterations*** that replace less than 10 percent of the luminaires in a space, provided that such ***alterations*** do not increase the installed interior lighting power.

SECTION N1112 (R504) REPAIRS

N1112.1 (R504.1) General. ***Buildings***, structures and parts thereof shall be repaired in compliance with Section N1109.3 and this section. Work on nondamaged components necessary for the required repair of damaged components shall be considered to be part of the ***repair*** and shall not be subject to the requirements for ***alterations*** in this chapter. Routine maintenance required by Section N1109.3, ordinary ***repairs*** exempt from ***permit***, and abatement of wear due to normal service conditions shall not be subject to the requirements for ***repairs*** in this section.

N1112.2 (R504.2) Application. For the purposes of this code, the following shall be considered to be ***repairs***:

1. Glass only replacements in an existing sash and frame.
2. Roof ***repairs***.
3. ***Repairs*** where only the bulb, ballast or both within the existing luminaires in a space are replaced provided that the replacement does not increase the installed interior lighting power.

SECTION N1113 (R505) CHANGE OF OCCUPANCY OR USE

N1113.1 (R505.1) General. Any space that is converted to a *dwelling unit* or portion thereof from another use or occupancy shall comply with this chapter.

Exception: Where the simulated performance option in Section N1105 is used to comply with this section, the annual energy cost of the ***proposed design*** is permitted to be 110 percent of the annual energy cost allowed by Section N1105.2.

N1113.1.1 (R505.1.1) Unconditioned space. Any unconditioned or low-energy space that is altered to become a conditioned space shall comply with Section N1108.

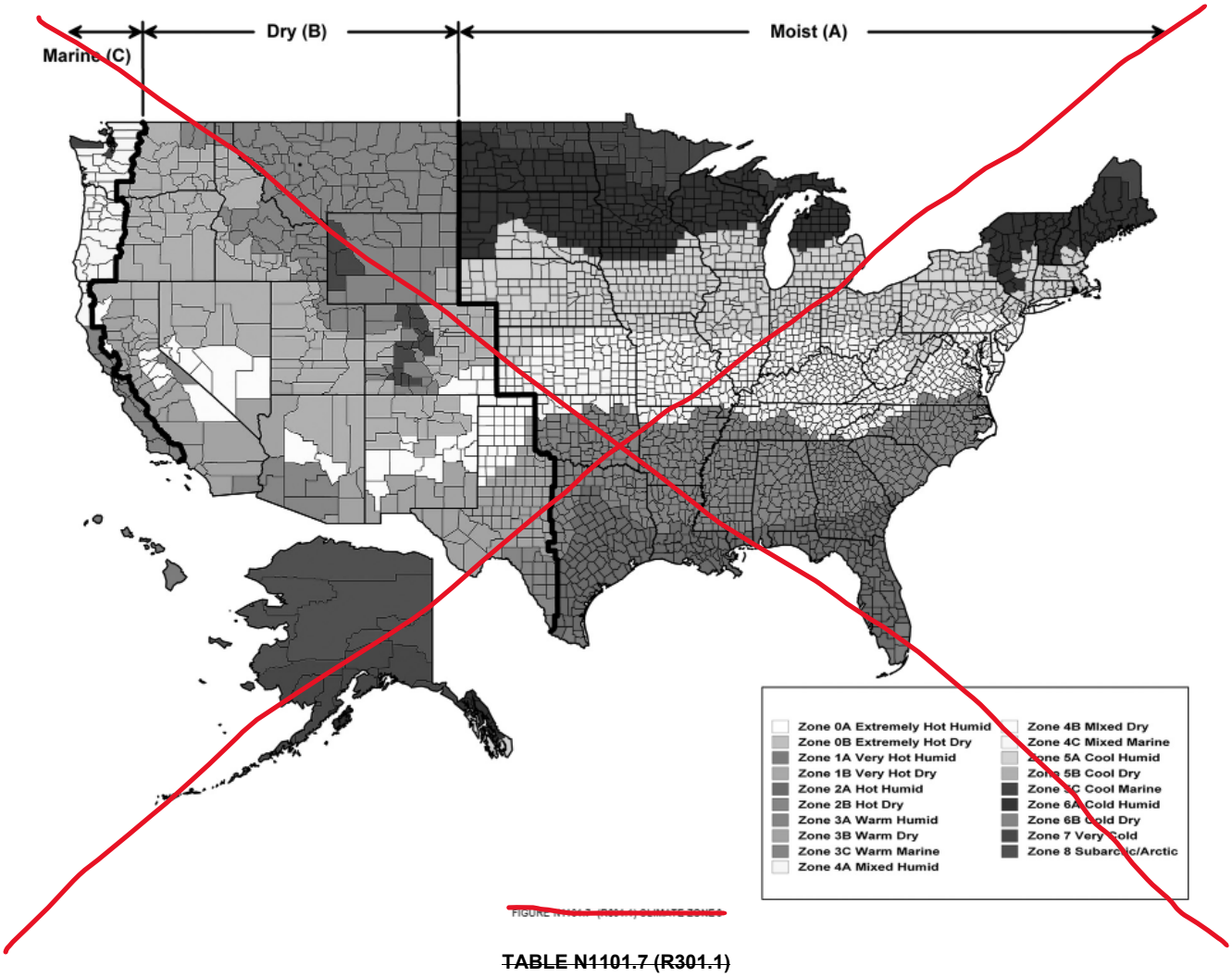


TABLE N1101.7 (R301.1)

CLIMATE ZONES, MOISTURE REGIMES, AND WARM HUMID DESIGNATIONS BY STATE, COUNTY AND TERRITORY[a]

a. Key: A – Moist, B – Dry, C – Marine. Absence of moisture designation indicates moisture regime is irrelevant. Asterisk (*) indicates a Warm Humid location.

US STATES
ALABAMA
3A Autauga*
2A Baldwin*
3A Barbour*

3A Bibb
3A Blount
3A Bullock*
3A Butler*
3A Calhoun
3A Chambers
3A Cherokee
3A Chilton
3A Choctaw*
3A Clarke*
3A Clay
3A Cleburne
2A Coffee*
3A Colbert
3A Conecuh*
3A Coosa
2A Covington*
3A Crenshaw*
3A Cullman
2A Dale*
3A Dallas*
3A DeKalb
3A Elmore*
2A Escambia*
3A Etowah
3A Fayette
3A Franklin
2A Geneva*
3A Greene
3A Hale
2A Henry*
2A Houston*
3A Jackson
3A Jefferson

3A Lamar
3A Lauderdale
3A Lawrence
3A Lee
3A Limestone
3A Lowndes*
3A Macon*
3A Madison
3A Marengo*
3A Marion
3A Marshall
2A Mobile*
3A Monroe*
3A Montgomery*
3A Morgan
3A Perry*
3A Pickens
3A Pike*
3A Randolph
3A Russell*
3A Shelby
3A St. Clair
3A Sumter
3A Talladega
3A Tallapoosa
3A Tuscaloosa
3A Walker
3A Washington*
3A Wilcox*
3A Winston
ALASKA
7 Aleutians East
7 Aleutians West
7 Anchorage

7 Bethel
7 Bristol Bay
8 Denali
7 Dillingham
8 Fairbanks North Star
6A Haines
6A Juneau
7 Kenai Peninsula
5C Ketchikan Gateway
6A Kodiak Island
7 Lake and Peninsula
7 Matanuska-Susitna
8 Nome
8 North Slope
8 Northwest Arctic
US STATES—continued
ALASKA *(continued)*
5C Prince of Wales Outer Ketchikan
5C Sitka
6A Skagway-Hoonah-Angoon
8 Southeast Fairbanks
7 Valdez-Cordova
8 Wade Hampton
6A Wrangell-Petersburg
7 Yakutat
8 Yukon-Koyukuk
ARIZONA
5B Apache
3B Cochise
5B Coconino
4B Gila
3B Graham
3B Greenlee
2B La Paz

2B Maricopa
3B Mohave
5B Navajo
2B Pima
2B Pinal
3B Santa Cruz
4B Yavapai
2B Yuma
ARKANSAS
3A Arkansas
3A Ashley
4A Baxter
4A Benton
4A Boone
3A Bradley
3A Calhoun
4A Carroll
3A Chicot
3A Clark
3A Clay
3A Cleburne
3A Cleveland
3A Columbia*
3A Conway
3A Craighead
3A Crawford
3A Crittenden
3A Cross
3A Dallas
3A Desha
3A Drew
3A Faulkner
3A Franklin
4A Fulton

3A Garland
3A Grant
3A Greene
3A Hempstead*
3A Hot Spring
3A Howard
3A Independence
4A Izard
3A Jackson
3A Jefferson
3A Johnson
3A Lafayette*
3A Lawrence
3A Lee
3A Lincoln
3A Little River*
3A Logan
3A Lonoke
4A Madison
4A Marion
3A Miller*
3A Mississippi
3A Monroe
3A Montgomery
3A Nevada
4A Newton
3A Ouachita
3A Perry
3A Phillips
3A Pike
3A Poinsett
3A Polk
3A Pope
3A Prairie

3A Pulaski
3A Randolph

US STATES—continued
ARKANSAS *(continued)*
3A Saline
3A Scott
4A Searcy
3A Sebastian
3A Sevier*
3A Sharp
3A St. Francis
4A Stone
3A Union*
3A Van Buren
4A Washington
3A White
3A Woodruff
3A Yell
CALIFORNIA
3C Alameda
6B Alpine
4B Amador
3B Butte
4B Calaveras
3B Colusa
3B Contra Costa
4C Del Norte
4B El Dorado
3B Fresno
3B Glenn
4C Humboldt
2B Imperial
4B Inyo

~~3B Kern~~
~~3B Kings~~
~~4B Lake~~
~~5B Lassen~~
~~3B Los Angeles~~
~~3B Madera~~
~~3C Marin~~
~~4B Mariposa~~
~~3C Mendocino~~
~~3B Merced~~
~~5B Modoc~~
~~6B Mono~~
~~3C Monterey~~
~~3C Napa~~
~~5B Nevada~~
~~3B Orange~~
~~3B Placer~~
~~5B Plumas~~
~~3B Riverside~~
~~3B Sacramento~~
~~3C San Benito~~
~~3B San Bernardino~~
~~3B San Diego~~
~~3C San Francisco~~
~~3B San Joaquin~~
~~3C San Luis Obispo~~
~~3C San Mateo~~
~~3C Santa Barbara~~
~~3C Santa Clara~~
~~3C Santa Cruz~~
~~3B Shasta~~
~~5B Sierra~~
~~5B Siskiyou~~
~~3B Solano~~

3C Sonoma
3B Stanislaus
3B Sutter
3B Tehama
4B Trinity
3B Tulare
4B Tuolumne
3C Ventura
3B Yolo
3B Yuba
COLORADO
5B Adams
6B Alamosa
5B Arapahoe
6B Archuleta
4B Baca
4B Bent
5B Boulder
5B Broomfield
6B Chaffee
5B Cheyenne
7 Clear Creek
6B Conejos
6B Costilla
5B Crowley
US STATES—continued
COLORADO *(continued)*
5B Custer
5B Delta
5B Denver
6B Dolores
5B Douglas
6B Eagle
5B Elbert

~~5B El Paso~~
~~5B Fremont~~
~~5B Garfield~~
~~5B Gilpin~~
~~7 Grand~~
~~7 Gunnison~~
~~7 Hinsdale~~
~~5B Huerfano~~
~~7 Jackson~~
~~5B Jefferson~~
~~5B Kiowa~~
~~5B Kit Carson~~
~~7 Lake~~
~~5B La Plata~~
~~5B Larimer~~
~~4B Las Animas~~
~~5B Lincoln~~
~~5B Logan~~
~~5B Mesa~~
~~7 Mineral~~
~~6B Moffat~~
~~5B Montezuma~~
~~5B Montrose~~
~~5B Morgan~~
~~4B Otero~~
~~6B Ouray~~
~~7 Park~~
~~5B Phillips~~
~~7 Pitkin~~
~~**4B** Prowers~~
~~5B Pueblo~~
~~6B Rio Blanco~~
~~7 Rio Grande~~
~~7 Routt~~

6B Saguache
7 San Juan
6B San Miguel
5B Sedgwick
7 Summit
5B Teller
5B Washington
5B Weld
5B Yuma
CONNECTICUT
5A (all)
DELAWARE
4A (all)
DISTRICT OF COLUMBIA
4A (all)
FLORIDA
2A Alachua*
2A Baker*
2A Bay*
2A Bradford*
2A Brevard*
1A Broward*
2A Calhoun*
2A Charlotte*
2A Citrus*
2A Clay*
2A Collier*
2A Columbia*
2A DeSoto*
2A Dixie*
2A Duval*
2A Escambia*
2A Flagler*
2A Franklin*

2A Gadsden*
2A Gilchrist*
2A Glades*
2A Gulf*
2A Hamilton*
2A Hardee*
2A Hendry*
2A Hernando*
2A Highlands*
2A Hillsborough*
2A Holmes*
2A Indian River*
2A Jackson*
US STATES—continued
FLORIDA *(continued)*
2A Jefferson*
2A Lafayette*
2A Lake*
2A Lee*
2A Leon*
2A Levy*
2A Liberty*
2A Madison*
2A Manatee*
2A Marion*
2A Martin*
1A Miami-Dade*
1A Monroe*
2A Nassau*
2A Okaloosa*
2A Okeechobee*
2A Orange*
2A Osceola*
1A Palm Beach*

2A Pasco*
2A Pinellas*
2A Polk*
2A Putnam*
2A Santa Rosa*
2A Sarasota*
2A Seminole*
2A St. Johns*
2A St. Lucie*
2A Sumter*
2A Suwannee*
2A Taylor*
2A Union*
2A Volusia*
2A Wakulla*
2A Walton*
2A Washington*
GEORGIA
2A Appling*
2A Atkinson*
2A Bacon*
2A Baker*
3A Baldwin
3A Banks
3A Barrow
3A Bartow
3A Ben Hill*
2A Berrien*
3A Bibb
3A Bleckley*
2A Brantley*
2A Brooks*
2A Bryan*
3A Bulloch*

3A Burke
3A Butts
2A Calhoun*
2A Camden*
3A Candler*
3A Carroll
3A Catoosa
2A Charlton*
2A Chatham*
3A Chattahoochee*
3A Chattooga
3A Cherokee
3A Clarke
3A Clay*
3A Clayton
2A Clinch*
3A Cobb
2A Coffee*
2A Colquitt*
3A Columbia
2A Cook*
3A Coweta
3A Crawford
3A Crisp*
3A Dade
3A Dawson
2A Decatur*
3A DeKalb
3A Dodge*
3A Dooly*
2A Dougherty*
3A Douglas
2A Early*
2A Echols*

2A Effingham*
US STATES—continued
GEORGIA *(continued)*
3A Elbert
3A Emanuel*
2A Evans*
3A Fannin
3A Fayette
3A Floyd
3A Forsyth
3A Franklin
3A Fulton
3A Gilmer
3A Glascock
2A Glynn*
3A Gordon
2A Grady*
3A Greene
3A Gwinnett
3A Habersham
3A Hall
3A Hancock
3A Haralson
3A Harris
3A Hart
3A Heard
3A Henry
3A Houston*
3A Irwin*
3A Jackson
3A Jasper
2A Jeff Davis*
3A Jefferson
3A Jenkins*

3A Johnson*
3A Jones
3A Lamar
2A Lanier*
3A Laurens*
3A Lee*
2A Liberty*
3A Lincoln
2A Long*
2A Lowndes*
3A Lumpkin
3A Macon*
3A Madison
3A Marion*
3A McDuffie
2A McIntosh*
3A Meriwether
2A Miller*
2A Mitchell*
3A Monroe
3A Montgomery*
3A Morgan
3A Murray
3A Muscogee
3A Newton
3A Oconee
3A Oglethorpe
3A Paulding
3A Peach*
3A Pickens
2A Pierce*
3A Pike
3A Polk
3A Pulaski*

3A Putnam
3A Quitman*
3A Rabun
3A Randolph*
3A Richmond
3A Rockdale
3A Schley*
3A Screven*
2A Seminole*
3A Spalding
3A Stephens
3A Stewart*
3A Sumter*
3A Talbot
3A Taliaferro
2A Tattnall*
3A Taylor*
3A Telfair*
3A Terrell*
2A Thomas*
2A Tift*
2A Toombs*
3A Towns
US STATES—continued
GEORGIA *(continued)*
3A Treutlen*
3A Troup
3A Turner*
3A Twiggs*
3A Union
3A Upson
3A Walker
3A Walton
2A Ware*

3A Warren
3A Washington
2A Wayne*
3A Webster*
3A Wheeler*
3A White
3A Whitfield
3A Wilcox*
3A Wilkes
3A Wilkinson
2A Worth*
HAWAII
1A (all)*
IDAHO
5B Ada
6B Adams
6B Bannock
6B Bear Lake
5B Benewah
6B Bingham
6B Blaine
6B Boise
6B Bonner
6B Bonneville
6B Boundary
6B Butte
6B Camas
5B Canyon
6B Caribou
5B Cassia
6B Clark
5B Clearwater
6B Custer
5B Elmore

6B Franklin
6B Fremont
5B Gem
5B Gooding
5B Idaho
6B Jefferson
5B Jerome
5B Kootenai
5B Latah
6B Lemhi
5B Lewis
5B Lincoln
6B Madison
5B Minidoka
5B Nez Perce
6B Oneida
5B Owyhee
5B Payette
5B Power
5B Shoshone
6B Teton
5B Twin Falls
6B Valley
5B Washington
ILLINOIS
5A Adams
4A Alexander
4A Bond
5A Boone
5A Brown
5A Bureau
4A Calhoun
5A Carroll
5A Cass

5A Champaign
4A Christian
4A Clark
4A Clay
4A Clinton
4A Coles
5A Cook
4A Crawford
4A Cumberland
5A DeKalb
5A De Witt
US STATES—continued
ILLINOIS *(continued)*
5A Douglas
5A DuPage
5A Edgar
4A Edwards
4A Effingham
4A Fayette
5A Ford
4A Franklin
5A Fulton
4A Gallatin
4A Greene
5A Grundy
4A Hamilton
5A Hancock
4A Hardin
5A Henderson
5A Henry
5A Iroquois
4A Jackson
4A Jasper
4A Jefferson

4A Jersey
5A Jo Daviess
4A Johnson
5A Kane
5A Kankakee
5A Kendall
5A Knox
5A Lake
5A La Salle
4A Lawrence
5A Lee
5A Livingston
5A Logan
5A Macon
4A Macoupin
4A Madison
4A Marion
5A Marshall
5A Mason
4A Massac
5A McDonough
5A McHenry
5A McLean
5A Menard
5A Mercer
4A Monroe
4A Montgomery
5A Morgan
5A Moultrie
5A Ogle
5A Peoria
4A Perry
5A Piatt
5A Pike

4A Pope
4A Pulaski
5A Putnam
4A Randolph
4A Richland
5A Rock Island
4A Saline
5A Sangamon
5A Schuyler
5A Scott
4A Shelby
5A Stark
4A St. Clair
5A Stephenson
5A Tazewell
4A Union
5A Vermilion
4A Wabash
5A Warren
4A Washington
4A Wayne
4A White
5A Whiteside
5A Will
4A Williamson
5A Winnebago
5A Woodford
INDIANA
5A Adams
5A Allen
4A Bartholomew
5A Benton
5A Blackford
5A Boone

4A Brown
US STATES—continued
INDIANA *(continued)*
5A Carroll
5A Cass
4A Clark
4A Clay
5A Clinton
4A Crawford
4A Daviess
4A Dearborn
4A Decatur
5A De Kalb
5A Delaware
4A Dubois
5A Elkhart
4A Fayette
4A Floyd
5A Fountain
4A Franklin
5A Fulton
4A Gibson
5A Grant
4A Greene
5A Hamilton
5A Hancock
4A Harrison
4A Hendricks
5A Henry
5A Howard
5A Huntington
4A Jackson
5A Jasper
5A Jay

4A Jefferson
4A Jennings
4A Johnson
4A Knox
5A Kosciusko
5A LaGrange
5A Lake
5A LaPorte
4A Lawrence
5A Madison
4A Marion
5A Marshall
4A Martin
5A Miami
4A Monroe
5A Montgomery
4A Morgan
5A Newton
5A Noble
4A Ohio
4A Orange
4A Owen
5A Parke
4A Perry
4A Pike
5A Porter
4A Posey
5A Pulaski
4A Putnam
5A Randolph
4A Ripley
4A Rush
4A Scott
4A Shelby

4A Spencer
5A Starke
5A Steuben
5A St. Joseph
4A Sullivan
4A Switzerland
5A Tippecanoe
5A Tipton
4A Union
4A Vanderburgh
5A Vermillion
4A Vigo
5A Wabash
5A Warren
4A Warrick
4A Washington
5A Wayne
5A Wells
5A White
5A Whitley
IOWA
5A Adair
5A Adams
US STATES—continued
IOWA *(continued)*
5A Allamakee
5A Appanoose
5A Audubon
5A Benton
6A Black Hawk
5A Boone
5A Bremer
5A Buchanan
5A Buena Vista

5A Butler
5A Calhoun
5A Carroll
5A Cass
5A Cedar
6A Cerro Gordo
5A Cherokee
5A Chickasaw
5A Clarke
6A Clay
5A Clayton
5A Clinton
5A Crawford
5A Dallas
5A Davis
5A Decatur
5A Delaware
5A Des Moines
6A Dickinson
5A Dubuque
6A Emmet
5A Fayette
5A Floyd
5A Franklin
5A Fremont
5A Greene
5A Grundy
5A Guthrie
5A Hamilton
6A Hancock
5A Hardin
5A Harrison
5A Henry
5A Howard

5A Humboldt
5A Ida
5A Iowa
5A Jackson
5A Jasper
5A Jefferson
5A Johnson
5A Jones
5A Keokuk
6A Kossuth
5A Lee
5A Linn
5A Louisa
5A Lucas
6A Lyon
5A Madison
5A Mahaska
5A Marion
5A Marshall
5A Mills
6A Mitchell
5A Monona
5A Monroe
5A Montgomery
5A Muscatine
6A O'Brien
6A Osceola
5A Page
6A Palo Alto
5A Plymouth
5A Pocahontas
5A Polk
5A Pottawattamie
5A Poweshiek

5A Ringgold
5A Sac
5A Scott
5A Shelby
6A Sioux
5A Story
5A Tama
5A Taylor
5A Union
5A Van Buren
5A Wapello
US STATES—continued
IOWA *(continued)*
5A Warren
5A Washington
5A Wayne
5A Webster
6A Winnebago
5A Winneshiek
5A Woodbury
6A Worth
5A Wright
KANSAS
4A Allen
4A Anderson
4A Atchison
4A Barber
4A Barton
4A Bourbon
4A Brown
4A Butler
4A Chase
4A Chautauqua
4A Cherokee

5A Cheyenne
4A Clark
4A Clay
4A Cloud
4A Coffey
4A Comanche
4A Cowley
4A Crawford
5A Decatur
4A Dickinson
4A Doniphan
4A Douglas
4A Edwards
4A Elk
4A Ellis
4A Ellsworth
4A Finney
4A Ford
4A Franklin
4A Geary
5A Gove
4A Graham
4A Grant
4A Gray
5A Greeley
4A Greenwood
4A Hamilton
4A Harper
4A Harvey
4A Haskell
4A Hodgeman
4A Jackson
4A Jefferson
5A Jewell

4A Johnson
4A Kearny
4A Kingman
4A Kiowa
4A Labette
4A Lane
4A Leavenworth
4A Lincoln
4A Linn
5A Logan
4A Lyon
4A Marion
4A Marshall
4A McPherson
4A Meade
4A Miami
4A Mitchell
4A Montgomery
4A Morris
4A Morton
4A Nemaha
4A Neosho
4A Ness
5A Norton
4A Osage
4A Osborne
4A Ottawa
4A Pawnee
5A Phillips
4A Pottawatomie
4A Pratt
5A Rawlins
4A Reno
US STATES—continued

KANSAS *(continued)*
5A Republic
4A Rice
4A Riley
4A Rooks
4A Rush
4A Russell
4A Saline
5A Scott
4A Sedgwick
4A Seward
4A Shawnee
5A Sheridan
5A Sherman
5A Smith
4A Stafford
4A Stanton
4A Stevens
4A Sumner
5A Thomas
4A Trego
4A Wabaunsee
5A Wallace
4A Washington
5A Wichita
4A Wilson
4A Woodson
4A Wyandotte
KENTUCKY
4A (all)
LOUISIANA
2A Acadia*
2A Allen*
2A Ascension*

2A Assumption*
2A Avoyelles*
2A Beauregard*
3A Bienville*
3A Bossier*
3A Caddo*
2A Calcasieu*
3A Caldwell*
2A Cameron*
3A Catahoula*
3A Claiborne*
3A Concordia*
3A De Soto*
2A East Baton Rouge*
3A East Carroll
2A East Feliciana*
2A Evangeline*
3A Franklin*
3A Grant*
2A Iberia*
2A Iberville*
3A Jackson*
2A Jefferson*
2A Jefferson Davis*
2A Lafayette*
2A Lafourche*
3A La Salle*
3A Lincoln*
2A Livingston*
3A Madison*
3A Morehouse
3A Natchitoches*
2A Orleans*
3A Ouachita*

2A Plaquemines*
2A Pointe Coupee*
2A Rapides*
3A Red River*
3A Richland*
3A Sabine*
2A St. Bernard*
2A St. Charles*
2A St. Helena*
2A St. James*
2A St. John the Baptist*
2A St. Landry*
2A St. Martin*
2A St. Mary*
2A St. Tammany*
2A Tangipahoa*
3A Tensas*
2A Terrebonne*
3A Union*
2A Vermilion*
3A Vernon*
US STATES—continued
LOUISIANA *(continued)*
2A Washington*
3A Webster*
2A West Baton Rouge*
3A West Carroll
2A West Feliciana*
3A Winn*
MAINE
6A Androscoggin
7 Aroostook
6A Cumberland
6A Franklin

6A Hancock
6A Kennebec
6A Knox
6A Lincoln
6A Oxford
6A Penobscot
6A Piscataquis
6A Sagadahoc
6A Somerset
6A Waldo
6A Washington
6A York
MARYLAND
5A Allegany
4A Anne Arundel
4A Baltimore
4A Baltimore (city)
4A Calvert
4A Caroline
4A Carroll
4A Cecil
4A Charles
4A Dorchester
4A Frederick
5A Garrett
4A Harford
4A Howard
4A Kent
4A Montgomery
4A Prince George's
4A Queen Anne's
4A Somerset
4A St. Mary's
4A Talbot

4A Washington
4A Wicomico
4A Worcester
MASSACHUSETTS
5A (all)
MICHIGAN
6A Alcona
6A Alger
5A Allegan
6A Alpena
6A Antrim
6A Arenac
6A Baraga
5A Barry
5A Bay
6A Benzie
5A Berrien
5A Branch
5A Calhoun
5A Cass
6A Charlevoix
6A Cheboygan
6A Chippewa
6A Clare
5A Clinton
6A Crawford
6A Delta
6A Dickinson
5A Eaton
6A Emmet
5A Genesee
6A Gladwin
6A Gogebic
6A Grand Traverse

5A Gratiot
5A Hillsdale
6A Houghton
5A Huron
5A Ingham
5A Ionia
6A Iosco
6A Iron
6A Isabella
US STATES—continued
MICHIGAN *(continued)*
5A Jackson
5A Kalamazoo
6A Kalkaska
5A Kent
7 Keweenaw
6A Lake
5A Lapeer
6A Leelanau
5A Lenawee
5A Livingston
6A Luce
6A Mackinac
5A Macomb
6A Manistee
7 Marquette
6A Mason
6A Mecosta
6A Menominee
5A Midland
6A Missaukee
5A Monroe
5A Montcalm
6A Montmorency

5A Muskegon
6A Newaygo
5A Oakland
6A Oceana
6A Ogemaw
6A Ontonagon
6A Osceola
6A Oscoda
6A Otsego
5A Ottawa
6A Presque Isle
6A Roscommon
5A Saginaw
5A Sanilac
6A Schoolcraft
5A Shiawassee
5A St. Clair
5A St. Joseph
5A Tuscola
5A Van Buren
5A Washtenaw
5A Wayne
6A Wexford
MINNESOTA
7 Aitkin
6A Anoka
6A Becker
7 Beltrami
6A Benton
6A Big Stone
6A Blue Earth
6A Brown
7 Carlton
6A Carver

7 Cass
6A Chippewa
6A Chisago
6A Clay
7 Clearwater
7 Cook
6A Cottonwood
7 Crow Wing
6A Dakota
6A Dodge
6A Douglas
6A Faribault
5A Fillmore
6A Freeborn
6A Goodhue
6A Grant
6A Hennepin
5A Houston
7 Hubbard
6A Isanti
7 Itasca
6A Jackson
6A Kanabec
6A Kandiyohi
7 Kittson
7 Koochiching
6A Lac qui Parle
7 Lake
7 Lake of the Woods
6A Le Sueur
6A Lincoln
US STATES—continued
MINNESOTA *(continued)*
6A Lyon

7 Mahnomen
7 Marshall
6A Martin
6A McLeod
6A Meeker
6A Mille Lacs
6A Morrison
6A Mower
6A Murray
6A Nicollet
6A Nobles
7 Norman
6A Olmsted
6A Otter Tail
7 Pennington
7 Pine
6A Pipestone
7 Polk
6A Pope
6A Ramsey
7 Red Lake
6A Redwood
6A Renville
6A Rice
6A Rock
7 Roseau
6A Scott
6A Sherburne
6A Sibley
6A Stearns
6A Steele
6A Stevens
7 St. Louis
6A Swift

6A Todd
6A Traverse
6A Wabasha
7 Wadena
6A Waseca
6A Washington
6A Watonwan
6A Wilkin
5A Winona
6A Wright
6A Yellow Medicine
MISSISSIPPI
3A Adams*
3A Alcorn
3A Amite*
3A Attala
3A Benton
3A Bolivar
3A Calhoun
3A Carroll
3A Chickasaw
3A Choctaw
3A Claiborne*
3A Clarke
3A Clay
3A Coahoma
3A Copiah*
3A Covington*
3A DeSoto
3A Forrest*
3A Franklin*
2A George*
3A Greene*
3A Grenada

2A Hancock*
2A Harrison*
3A Hinds*
3A Holmes
3A Humphreys
3A Issaquena
3A Itawamba
2A Jackson*
3A Jasper
3A Jefferson*
3A Jefferson Davis*
3A Jones*
3A Kemper
3A Lafayette
3A Lamar*
3A Lauderdale
3A Lawrence*
3A Leake
3A Lee
US STATES—continued
MISSISSIPPI *(continued)*
3A Leflore
3A Lincoln*
3A Lowndes
3A Madison
3A Marion*
3A Marshall
3A Monroe
3A Montgomery
3A Neshoba
3A Newton
3A Noxubee
3A Oktibbeha
3A Panola

2A Pearl River*
3A Perry*
3A Pike*
3A Pontotoc
3A Prentiss
3A Quitman
3A Rankin*
3A Scott
3A Sharkey
3A Simpson*
3A Smith*
2A Stone*
3A Sunflower
3A Tallahatchie
3A Tate
3A Tippah
3A Tishomingo
3A Tunica
3A Union
3A Walthall*
3A Warren*
3A Washington
3A Wayne*
3A Webster
3A Wilkinson*
3A Winston
3A Yalobusha
3A Yazoo
MISSOURI
5A Adair
5A Andrew
5A Atchison
4A Audrain
4A Barry

4A Barton
4A Bates
4A Benton
4A Bollinger
4A Boone
4A Buchanan
4A Butler
4A Caldwell
4A Callaway
4A Camden
4A Cape Girardeau
4A Carroll
4A Carter
4A Cass
4A Cedar
4A Chariton
4A Christian
5A Clark
4A Clay
4A Clinton
4A Cole
4A Cooper
4A Crawford
4A Dade
4A Dallas
5A Daviess
5A DeKalb
4A Dent
4A Douglas
3A Dunklin
4A Franklin
4A Gasconade
5A Gentry
4A Greene

5A Grundy
5A Harrison
4A Henry
4A Hickory
5A Holt
4A Howard
4A Howell
US STATES—continued
MISSOURI *(continued)*
4A Iron
4A Jackson
4A Jasper
4A Jefferson
4A Johnson
5A Knox
4A Laclede
4A Lafayette
4A Lawrence
5A Lewis
4A Lincoln
5A Linn
5A Livingston
5A Macon
4A Madison
4A Maries
5A Marion
4A McDonald
5A Mercer
4A Miller
4A Mississippi
4A Moniteau
4A Monroe
4A Montgomery
4A Morgan

4A New Madrid
4A Newton
5A Nodaway
4A Oregon
4A Osage
4A Ozark
3A Pemiscot
4A Perry
4A Pettis
4A Phelps
5A Pike
4A Platte
4A Polk
4A Pulaski
5A Putnam
5A Ralls
4A Randolph
4A Ray
4A Reynolds
4A Ripley
4A Saline
5A Schuyler
5A Scotland
4A Scott
4A Shannon
5A Shelby
4A St. Charles
4A St. Clair
4A St. Francois
4A St. Louis
4A St. Louis (city)
4A Ste. Genevieve
4A Stoddard
4A Stone

5A Sullivan
4A Taney
4A Texas
4A Vernon
4A Warren
4A Washington
4A Wayne
4A Webster
5A Worth
4A Wright
MONTANA
6B (all)
NEBRASKA
5A (all)
NEVADA
4B Carson City (city)
5B Churchill
3B Clark
4B Douglas
5B Elko
4B Esmeralda
5B Eureka
5B Humboldt
5B Lander
4B Lincoln
4B Lyon
4B Mineral
4B Nye
5B Pershing
US STATES—continued
NEVADA *(continued)*
5B Storey
5B Washoe
5B White Pine

NEW HAMPSHIRE
6A Belknap
6A Carroll
5A Cheshire
6A Coos
6A Grafton
5A Hillsborough
5A Merrimack
5A Rockingham
5A Strafford
6A Sullivan
NEW JERSEY
4A Atlantic
5A Bergen
4A Burlington
4A Camden
4A Cape May
4A Cumberland
4A Essex
4A Gloucester
4A Hudson
5A Hunterdon
4A Mercer
4A Middlesex
4A Monmouth
5A Morris
4A Ocean
5A Passaic
4A Salem
5A Somerset
5A Sussex
4A Union
5A Warren
NEW MEXICO

4B Bernalillo
4A Catron
3B Chaves
4B Cibola
5B Colfax
4B Curry
4B DeBaca
3B Doña Ana
3B Eddy
4B Grant
4B Guadalupe
5B Harding
3B Hidalgo
3B Lea
4B Lincoln
5B Los Alamos
3B Luna
5B McKinley
5B Mora
3B Otero
4B Quay
5B Rio Arriba
4B Roosevelt
5B Sandoval
5B San Juan
5B San Miguel
5B Santa Fe
3B Sierra
4B Socorro
5B Taos
5B Torrance
4B Union
4B Valencia
NEW YORK

5A Albany
5A Allegany
4A Bronx
5A Broome
5A Cattaraugus
5A Cayuga
5A Chautauqua
5A Chemung
6A Chenango
6A Clinton
5A Columbia
5A Cortland
6A Delaware
5A Dutchess
5A Erie
6A Essex
6A Franklin
US STATES—continued
NEW YORK *(continued)*
6A Fulton
5A Genesee
5A Greene
6A Hamilton
6A Herkimer
6A Jefferson
4A Kings
6A Lewis
5A Livingston
6A Madison
5A Monroe
6A Montgomery
4A Nassau
4A New York
5A Niagara

6A Oneida
5A Onondaga
5A Ontario
5A Orange
5A Orleans
5A Oswego
6A Otsego
5A Putnam
4A Queens
5A Rensselaer
4A Richmond
5A Rockland
5A Saratoga
5A Schenectady
5A Schoharie
5A Schuyler
5A Seneca
5A Steuben
6A St. Lawrence
4A Suffolk
6A Sullivan
5A Tioga
5A Tompkins
6A Ulster
6A Warren
5A Washington
5A Wayne
4A Westchester
5A Wyoming
5A Yates
NORTH CAROLINA
3A Alamance
3A Alexander
5A Alleghany

3A Anson
5A Ashe
5A Avery
3A Beaufort
3A Bertie
3A Bladen
3A Brunswick*
4A Buncombe
4A Burke
3A Cabarrus
4A Caldwell
3A Camden
3A Carteret*
3A Caswell
3A Catawba
3A Chatham
3A Cherokee
3A Chowan
3A Clay
3A Cleveland
3A Columbus*
3A Craven
3A Cumberland
3A Currituck
3A Dare
3A Davidson
3A Davie
3A Duplin
3A Durham
3A Edgecombe
3A Forsyth
3A Franklin
3A Gaston
3A Gates

4A Graham
3A Granville
3A Greene
3A Guilford
3A Halifax
US STATES—continued
NORTH CAROLINA *(continued)*
3A Harnett
4A Haywood
4A Henderson
3A Hertford
3A Hoke
3A Hyde
3A Iredell
4A Jackson
3A Johnston
3A Jones
3A Lee
3A Lenoir
3A Lincoln
4A Macon
4A Madison
3A Martin
4A McDowell
3A Mecklenburg
4A Mitchell
3A Montgomery
3A Moore
3A Nash
3A New Hanover*
3A Northampton
3A Onslow*
3A Orange
3A Pamlico

3A Pasquotank
3A Pender*
3A Perquimans
3A Person
3A Pitt
3A Polk
3A Randolph
3A Richmond
3A Robeson
3A Rockingham
3A Rowan
3A Rutherford
3A Sampson
3A Scotland
3A Stanly
4A Stokes
4A Surry
4A Swain
4A Transylvania
3A Tyrrell
3A Union
3A Vance
3A Wake
3A Warren
3A Washington
5A Watauga
3A Wayne
3A Wilkes
3A Wilson
4A Yadkin
5A Yancey
NORTH DAKOTA
6A Adams
6A Barnes

7 Benson
6A Billings
7 Bottineau
6A Bowman
7 Burke
6A Burleigh
6A Cass
7 Cavalier
6A Dickey
7 Divide
6A Dunn
6A Eddy
6A Emmons
6A Foster
6A Golden Valley
7 Grand Forks
6A Grant
6A Griggs
6A Hettinger
6A Kidder
6A LaMoure
6A Logan
7 McHenry
6A McIntosh
6A McKenzie
6A McLean
6A Mercer
US STATES—continued
NORTH DAKOTA *(continued)*
6A Morton
6A Mountrail
7 Nelson
6A Oliver
7 Pembina

7 Pierce
7 Ramsey
6A Ransom
7 Renville
6A Richland
7 Rolette
6A Sargent
6A Sheridan
6A Sioux
6A Slope
6A Stark
6A Steele
6A Stutsman
7 Towner
6A Traill
7 Walsh
7 Ward
6A Wells
6A Williams
OHIO
4A Adams
5A Allen
5A Ashland
5A Ashtabula
4A Athens
5A Auglaize
5A Belmont
4A Brown
4A Butler
5A Carroll
5A Champaign
5A Clark
4A Clermont
4A Clinton

5A Columbiana
5A Coshocton
5A Crawford
5A Cuyahoga
5A Darke
5A Defiance
5A Delaware
5A Erie
5A Fairfield
4A Fayette
4A Franklin
5A Fulton
4A Gallia
5A Geauga
4A Greene
5A Guernsey
4A Hamilton
5A Hancock
5A Hardin
5A Harrison
5A Henry
4A Highland
4A Hocking
5A Holmes
5A Huron
4A Jackson
5A Jefferson
5A Knox
5A Lake
4A Lawrence
5A Licking
5A Logan
5A Lorain
5A Lucas

4A Madison
5A Mahoning
5A Marion
5A Medina
4A Meigs
5A Mercer
5A Miami
5A Monroe
5A Montgomery
5A Morgan
5A Morrow
5A Muskingum
5A Noble
5A Ottawa
5A Paulding
US STATES—continued
OHIO *(continued)*
5A Perry
4A Pickaway
4A Pike
5A Portage
5A Preble
5A Putnam
5A Richland
4A Ross
5A Sandusky
4A Scioto
5A Seneca
5A Shelby
5A Stark
5A Summit
5A Trumbull
5A Tuscarawas
5A Union

5A Van Wert
4A Vinton
4A Warren
4A Washington
5A Wayne
5A Williams
5A Wood
5A Wyandot
OKLAHOMA
3A Adair
4A Alfalfa
3A Atoka
4B Beaver
3A Beckham
3A Blaine
3A Bryan
3A Caddo
3A Canadian
3A Carter
3A Cherokee
3A Choctaw
4B Cimarron
3A Cleveland
3A Coal
3A Comanche
3A Cotton
4A Craig
3A Creek
3A Custer
4A Delaware
3A Dewey
4A Ellis
4A Garfield
3A Garvin

3A Grady
4A Grant
3A Greer
3A Harmon
4A Harper
3A Haskell
3A Hughes
3A Jackson
3A Jefferson
3A Johnston
4A Kay
3A Kingfisher
3A Kiowa
3A Latimer
3A Le Flore
3A Lincoln
3A Logan
3A Love
4A Major
3A Marshall
3A Mayes
3A McClain
3A McCurtain
3A McIntosh
3A Murray
3A Muskogee
3A Noble
4A Nowata
3A Okfuskee
3A Oklahoma
3A Okmulgee
4A Osage
4A Ottawa
3A Pawnee

3A Payne
3A Pittsburg
3A Pontotoc
US STATES—continued
OKLAHOMA *(continued)*
3A Pottawatomie
3A Pushmataha
3A Roger Mills
3A Rogers
3A Seminole
3A Sequoyah
3A Stephens
4B Texas
3A Tillman
3A Tulsa
3A Wagoner
4A Washington
3A Washita
4A Woods
4A Woodward
OREGON
5B Baker
4C Benton
4C Clackamas
4C Clatsop
4C Columbia
4C Coos
5B Crook
4C Curry
5B Deschutes
4C Douglas
5B Gilliam
5B Grant
5B Harney

5B Hood River
4C Jackson
5B Jefferson
4C Josephine
5B Klamath
5B Lake
4C Lane
4C Lincoln
4C Linn
5B Malheur
4C Marion
5B Morrow
4C Multnomah
4C Polk
5B Sherman
4C Tillamook
5B Umatilla
5B Union
5B Wallowa
5B Wasco
4C Washington
5B Wheeler
4C Yamhill
PENNSYLVANIA
4A Adams
5A Allegheny
5A Armstrong
5A Beaver
5A Bedford
4A Berks
5A Blair
5A Bradford
4A Bucks
5A Butler

5A Cambria
5A Cameron
5A Carbon
5A Centre
4A Chester
5A Clarion
5A Clearfield
5A Clinton
5A Columbia
5A Crawford
4A Cumberland
4A Dauphin
4A Delaware
5A Elk
5A Erie
5A Fayette
5A Forest
4A Franklin
5A Fulton
5A Greene
5A Huntingdon
5A Indiana
5A Jefferson
5A Juniata
5A Lackawanna
US STATES—continued
PENNSYLVANIA *(continued)*
4A Lancaster
5A Lawrence
4A Lebanon
5A Lehigh
5A Luzerne
5A Lycoming
5A McKean

5A Mercer
5A Mifflin
5A Monroe
4A Montgomery
5A Montour
5A Northampton
5A Northumberland
4A Perry
4A Philadelphia
5A Pike
5A Potter
5A Schuylkill
5A Snyder
5A Somerset
5A Sullivan
5A Susquehanna
5A Tioga
5A Union
5A Venango
5A Warren
5A Washington
5A Wayne
5A Westmoreland
5A Wyoming
4A York
RHODE ISLAND
5A (all)
SOUTH CAROLINA
3A Abbeville
3A Aiken
3A Allendale*
3A Anderson
3A Bamberg*
3A Barnwell*

~~**2A** Beaufort*~~
~~3A Berkeley*~~
~~3A Calhoun~~
~~3A Charleston*~~
~~3A Cherokee~~
~~3A Chester~~
~~3A Chesterfield~~
~~3A Clarendon~~
~~3A Colleton*~~
~~3A Darlington~~
~~3A Dillon~~
~~3A Dorchester*~~
~~3A Edgefield~~
~~3A Fairfield~~
~~3A Florence~~
~~3A Georgetown*~~
~~3A Greenville~~
~~3A Greenwood~~
~~3A Hampton*~~
~~3A Horry*~~
~~**2A** Jasper*~~
~~3A Kershaw~~
~~3A Lancaster~~
~~3A Laurens~~
~~3A Lee~~
~~3A Lexington~~
~~3A Marion~~
~~3A Marlboro~~
~~3A McCormick~~
~~3A Newberry~~
~~3A Oconee~~
~~3A Orangeburg~~
~~3A Pickens~~
~~3A Richland~~

3A Saluda
3A Spartanburg
3A Sumter
3A Union
3A Williamsburg
3A York
SOUTH DAKOTA
6A Aurora
6A Beadle
5A Bennett
5A Bon Homme
6A Brookings
6A Brown
US STATES—continued
SOUTH DAKOTA *(continued)*
5A Brule
6A Buffalo
6A Butte
6A Campbell
5A Charles Mix
6A Clark
5A Clay
6A Codington
6A Corson
6A Custer
6A Davison
6A Day
6A Deuel
6A Dewey
5A Douglas
6A Edmunds
6A Fall River
6A Faulk
6A Grant

5A Gregory
5A Haakon
6A Hamlin
6A Hand
6A Hanson
6A Harding
6A Hughes
5A Hutchinson
6A Hyde
5A Jackson
6A Jerauld
5A Jones
6A Kingsbury
6A Lake
6A Lawrence
6A Lincoln
5A Lyman
6A Marshall
6A McCook
6A McPherson
6A Meade
5A Mellette
6A Miner
6A Minnehaha
6A Moody
6A Pennington
6A Perkins
6A Potter
6A Roberts
6A Sanborn
6A Shannon
6A Spink
5A Stanley
6A Sully

5A Todd
5A Tripp
6A Turner
5A Union
6A Walworth
5A Yankton
6A Ziebach
TENNESSEE
4A Anderson
3A Bedford
4A Benton
4A Bledsoe
4A Blount
4A Bradley
4A Campbell
4A Cannon
4A Carroll
4A Carter
4A Cheatham
3A Chester
4A Claiborne
4A Clay
4A Cocke
3A Coffee
3A Crockett
4A Cumberland
3A Davidson
3A Decatur
4A DeKalb
4A Dickson
3A Dyer
3A Fayette
4A Fentress
3A Franklin

3A Gibson
US STATES—continued
TENNESSEE *(continued)*
3A Giles
4A Grainger
4A Greene
3A Grundy
4A Hamblen
3A Hamilton
4A Hancock
3A Hardeman
3A Hardin
4A Hawkins
3A Haywood
3A Henderson
4A Henry
3A Hickman
4A Houston
4A Humphreys
4A Jackson
4A Jefferson
4A Johnson
4A Knox
4A Lake
3A Lauderdale
3A Lawrence
3A Lewis
3A Lincoln
4A Loudon
4A Macon
3A Madison
3A Marion
3A Marshall
3A Maury

4A McMinn
3A McNairy
4A Meigs
4A Monroe
4A Montgomery
3A Moore
4A Morgan
4A Obion
4A Overton
3A Perry
4A Pickett
4A Polk
4A Putnam
4A Rhea
4A Roane
4A Robertson
3A Rutherford
4A Scott
4A Sequatchie
4A Sevier
3A Shelby
4A Smith
4A Stewart
4A Sullivan
4A Sumner
3A Tipton
4A Trousdale
4A Unicoi
4A Union
4A Van Buren
4A Warren
4A Washington
3A Wayne
4A Weakley

4A White
3A Williamson
4A Wilson
TEXAS
2A Anderson*
3B Andrews
2A Angelina*
2A Aransas*
3A Archer
4B Armstrong
2A Atascosa*
2A Austin*
4B Bailey
2B Bandera
2A Bastrop*
3B Baylor
2A Bee*
2A Bell*
2A Bexar*
3A Blanco*
3B Borden
2A Bosque*
3A Bowie*
US STATES—continued
TEXAS *(continued)*
2A Brazoria*
2A Brazos*
3B Brewster
4B Briscoe
2A Brooks*
3A Brown*
2A Burleson*
3A Burnet*
2A Caldwell*

2A Calhoun*
3B Callahan
1A Cameron*
3A Camp*
4B Carson
3A Cass*
4B Castro
2A Chambers*
2A Cherokee*
3B Childress
3A Clay
4B Cochran
3B Coke
3B Coleman
3A Collin*
3B Collingsworth
2A Colorado*
2A Comal*
3A Comanche*
3B Concho
3A Cooke
2A Coryell*
3B Cottle
3B Crane
3B Crockett
3B Crosby
3B Culberson
4B Dallam
2A Dallas*
3B Dawson
4B Deaf Smith
3A Delta
3A Denton*
2A DeWitt*

3B Dickens
2B Dimmit
4B Donley
2A Duval*
3A Eastland
3B Ector
2B Edwards
2A Ellis*
3B El Paso
3A Erath*
2A Falls*
3A Fannin
2A Fayette*
3B Fisher
4B Floyd
3B Foard
2A Fort Bend*
3A Franklin*
2A Freestone*
2B Frio
3B Gaines
2A Galveston*
3B Garza
3A Gillespie*
3B Glasscock
2A Goliad*
2A Gonzales*
4B Gray
3A Grayson
3A Gregg*
2A Grimes*
2A Guadalupe*
4B Hale
3B Hall

3A Hamilton*
4B Hansford
3B Hardeman
2A Hardin*
2A Harris*
3A Harrison*
4B Hartley
3B Haskell
2A Hays*
3B Hemphill
3A Henderson*
US STATES—continued
TEXAS *(continued)*
1A Hidalgo*
2A Hill*
4B Hockley
3A Hood*
3A Hopkins*
2A Houston*
3B Howard
3B Hudspeth
3A Hunt*
4B Hutchinson
3B Irion
3A Jack
2A Jackson*
2A Jasper*
3B Jeff Davis
2A Jefferson*
2A Jim Hogg*
2A Jim Wells*
2A Johnson*
3B Jones
2A Karnes*

3A Kaufman*
3A Kendall*
2A Kenedy*
3B Kent
3B Kerr
3B Kimble
3B King
2B Kinney
2A Kleberg*
3B Knox
3A Lamar*
4B Lamb
3A Lampasas*
2B La Salle
2A Lavaca*
2A Lee*
2A Leon*
2A Liberty*
2A Limestone*
4B Lipscomb
2A Live Oak*
3A Llano*
3B Loving
3B Lubbock
3B Lynn
2A Madison*
3A Marion*
3B Martin
3B Mason
2A Matagorda*
2B Maverick
3B McCulloch
2A McLennan*
2A McMullen*

2B Medina
3B Menard
3B Midland
2A Milam*
3A Mills*
3B Mitchell
3A Montague
2A Montgomery*
4B Moore
3A Morris*
3B Motley
3A Nacogdoches*
2A Navarro*
2A Newton*
3B Nolan
2A Nueces*
4B Ochiltree
4B Oldham
2A Orange*
3A Palo Pinto*
3A Panola*
3A Parker*
4B Parmer
3B Pecos
2A Polk*
4B Potter
3B Presidio
3A Rains*
4B Randall
3B Reagan
2B Real
3A Red River*
3B Reeves
US STATES—continued

TEXAS *(continued)*
2A Refugio*
4B Roberts
2A Robertson*
3A Rockwall*
3B Runnels
3A Rusk*
3A Sabine*
3A San Augustine*
2A San Jacinto*
2A San Patricio*
3A San Saba*
3B Schleicher
3B Scurry
3B Shackelford
3A Shelby*
4B Sherman
3A Smith*
3A Somervell*
2A Starr*
3A Stephens
3B Sterling
3B Stonewall
3B Sutton
4B Swisher
2A Tarrant*
3B Taylor
3B Terrell
3B Terry
3B Throckmorton
3A Titus*
3B Tom Green
2A Travis*
2A Trinity*

2A Tyler*
3A Upshur*
3B Upton
2B Uvalde
2B Val Verde
3A Van Zandt*
2A Victoria*
2A Walker*
2A Waller*
3B Ward
2A Washington*
2B Webb
2A Wharton*
3B Wheeler
3A Wichita
3B Wilbarger
1A Willacy*
2A Williamson*
2A Wilson*
3B Winkler
3A Wise
3A Wood*
4B Yoakum
3A Young
2B Zapata
2B Zavala
UTAH
5B Beaver
5B Box Elder
5B Cache
5B Carbon
6B Daggett
5B Davis
6B Duchesne

5B Emery
5B Garfield
5B Grand
5B Iron
5B Juab
5B Kane
5B Millard
6B Morgan
5B Piute
6B Rich
5B Salt Lake
5B San Juan
5B Sanpete
5B Sevier
6B Summit
5B Tooele
6B Uintah
5B Utah
6B Wasatch
3B Washington
5B Wayne
US STATES—continued
UTAH *(continued)*
5B Weber
VERMONT
6A (all)
VIRGINIA
4A (all **except as follows:**)
5A Alleghany
5A Bath
3A Brunswick
3A Chesapeake
5A Clifton Forge
5A Covington

3A Emporia
3A Franklin
3A Greensville
3A Halifax
3A Hampton
5A Highland
3A Isle of Wight
3A Mecklenburg
3A Newport News
3A Norfolk
3A Pittsylvania
3A Portsmouth
3A South Boston
3A Southampton
3A Suffolk
3A Surry
3A Sussex
3A Virginia Beach
WASHINGTON
5B Adams
5B Asotin
5B Benton
5B Chelan
5C Clallam
4C Clark
5B Columbia
4C Cowlitz
5B Douglas
6B Ferry
5B Franklin
5B Garfield
5B Grant
4C Grays Harbor
5C Island

4C Jefferson
4C King
5C Kitsap
5B Kittitas
5B Klickitat
4C Lewis
5B Lincoln
4C Mason
5B Okanogan
4C Pacific
6B Pend Oreille
4C Pierce
5C San Juan
4C Skagit
5B Skamania
4C Snohomish
5B Spokane
6B Stevens
4C Thurston
4C Wahkiakum
5B Walla Walla
4C Whatcom
5B Whitman
5B Yakima
WEST VIRGINIA
5A Barbour
4A Berkeley
4A Boone
4A Braxton
5A Brooke
4A Cabell
4A Calhoun
4A Clay
4A Doddridge

4A Fayette
4A Gilmer
5A Grant
4A Greenbrier
5A Hampshire
5A Hancock
5A Hardy
5A Harrison
4A Jackson
US STATES—continued
WEST VIRGINIA *(continued)*
4A Jefferson
4A Kanawha
4A Lewis
4A Lincoln
4A Logan
5A Marion
5A Marshall
4A Mason
4A McDowell
4A Mercer
5A Mineral
4A Mingo
5A Monongalia
4A Monroe
4A Morgan
4A Nicholas
5A Ohio
5A Pendleton
4A Pleasants
5A Pocahontas
5A Preston
4A Putnam
4A Raleigh

5A Randolph
4A Ritchie
4A Roane
4A Summers
5A Taylor
5A Tucker
4A Tyler
4A Upshur
4A Wayne
4A Webster
5A Wetzel
4A Wirt
4A Wood
4A Wyoming
WISCONSIN
5A Adams
6A Ashland
6A Barron
6A Bayfield
6A Brown
6A Buffalo
6A Burnett
5A Calumet
6A Chippewa
6A Clark
5A Columbia
5A Crawford
5A Dane
5A Dodge
6A Door
6A Douglas
6A Dunn
6A Eau Claire
6A Florence

5A Fond du Lac
6A Forest
5A Grant
5A Green
5A Green Lake
5A Iowa
6A Iron
6A Jackson
5A Jefferson
5A Juneau
5A Kenosha
6A Kewaunee
5A La Crosse
5A Lafayette
6A Langlade
6A Lincoln
6A Manitowoc
6A Marathon
6A Marinette
6A Marquette
6A Menominee
5A Milwaukee
5A Monroe
6A Oconto
6A Oneida
5A Outagamie
5A Ozaukee
6A Pepin
6A Pierce
6A Polk
6A Portage
US STATES—continued
WISCONSIN *(continued)*
6A Price

5A Racine
5A Richland
5A Rock
6A Rusk
5A Sauk
6A Sawyer
6A Shawano
6A Sheboygan
6A St. Croix
6A Taylor
6A Trempealeau
5A Vernon
6A Vilas
5A Walworth
6A Washburn
5A Washington
5A Waukesha
6A Waupaca
5A Waushara
5A Winnebago
6A Wood
WYOMING
6B Albany
6B Big Horn
6B Campbell
6B Carbon
6B Converse
6B Crook
6B Fremont
5B Goshen
6B Hot Springs
6B Johnson
5B Laramie
7 Lincoln

6B Natrona
6B Niobrara
6B Park
5B Platte
6B Sheridan
7 Sublette
6B Sweetwater
7 Teton
6B Uinta
6B Washakie
6B Weston
US TERRITORIES
AMERICAN SAMOA
1A (all)*
GUAM
1A (all)*
NORTHERN MARIANA ISLANDS
1A (all)*
PUERTO RICO
1A (all **except as follows:**)*
2B Barraquitas
2B Cayey
VIRGIN ISLANDS
1A (all)*

TABLE N1101.7 (R301.1)
CLIMATE ZONES, MOISTURE REGIMES, AND WARM HUMID DESIGNATIONS BY STATE, COUNTY AND TERRITORY[a]

TABLE N1101.7 (R301.1)—continued
CLIMATE ZONES, MOISTURE REGIMES, AND WARM HUMID DESIGNATIONS BY STATE, COUNTY AND TERRITORY[a]
(continued)
(continued)

TABLE N1101.7 (R301.1)—continued
CLIMATE ZONES, MOISTURE REGIMES, AND WARM HUMID DESIGNATIONS BY STATE, COUNTY AND TERRITORY[a]
(continued)

Part IV—Energy Conservation

CHAPTER 11 [RE]

ENERGY EFFICIENCY

SECTION N1101
GENERAL

N1101.1 Scope.
This chapter regulates the energy efficiency for the design and construction of buildings regulated by this code.
Exception:
1. In accordance with N.C.G.S. 143-138 (b19), no energy conservation code provisions shall apply to detached and attached garages located on the same lot as a dwelling.

Note: *The text of the following Sections N1101.2 through N1105 is extracted from the 2018 edition of the North Carolina Energy Conservation C*ode—Residential Provisions *and has been editorially revised to conform to the scope and application of this code. The section numbers appearing in parenthesis after each section number are the section numbers of the corresponding text in the North Carolina Energy Conservation Code—Residential Provisions.*

N1101.2 (R101.3) Intent.
This chapter shall regulate the design and construction of buildings for the effective use and conservation of energy over the useful life of each *building*. This chapter is intended to provide flexibility to permit the use of innovative approaches and techniques to achieve this objective. This chapter is not intended to abridge safety, health or environmental requirements contained in other applicable codes or ordinances.

N1101.3 (R101.5.1) Compliance materials.
The *building official* shall be permitted to approve specific computer software, worksheets, compliance manuals and other similar materials that meet the intent of this code.

N1101.4 (R102.1.1) Above code programs. Deleted.

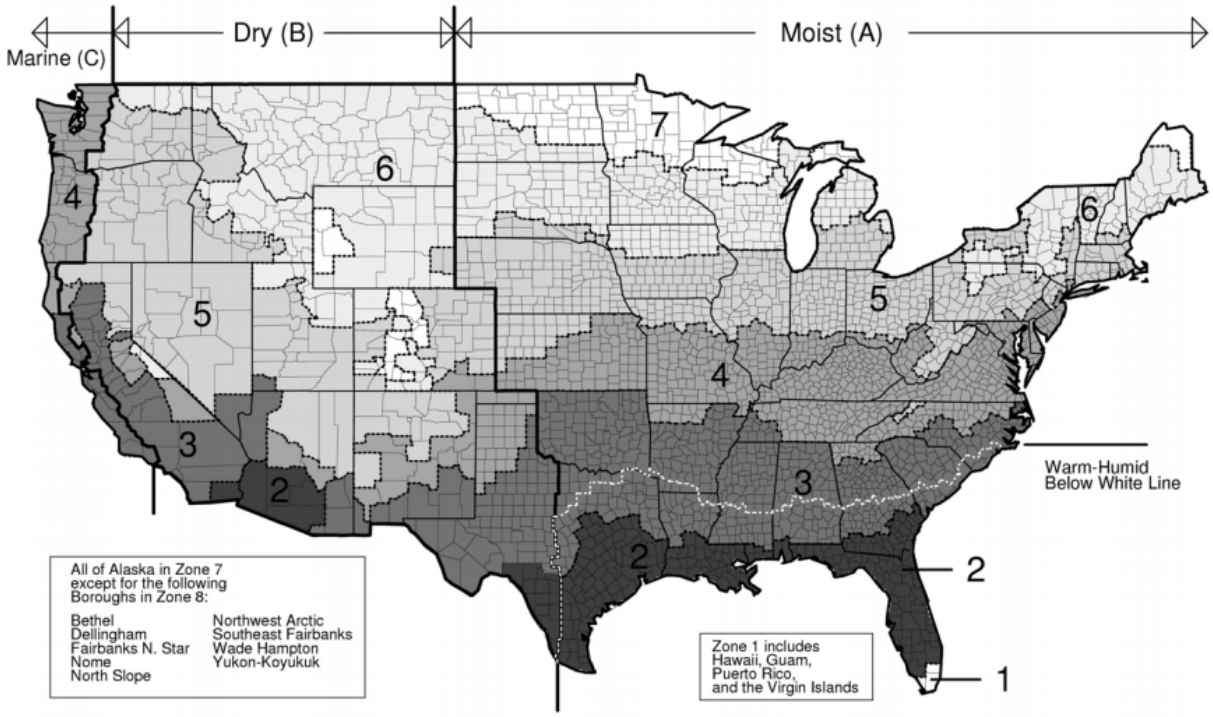
N1101.5 (R103.2) Information on construction documents. Deleted.

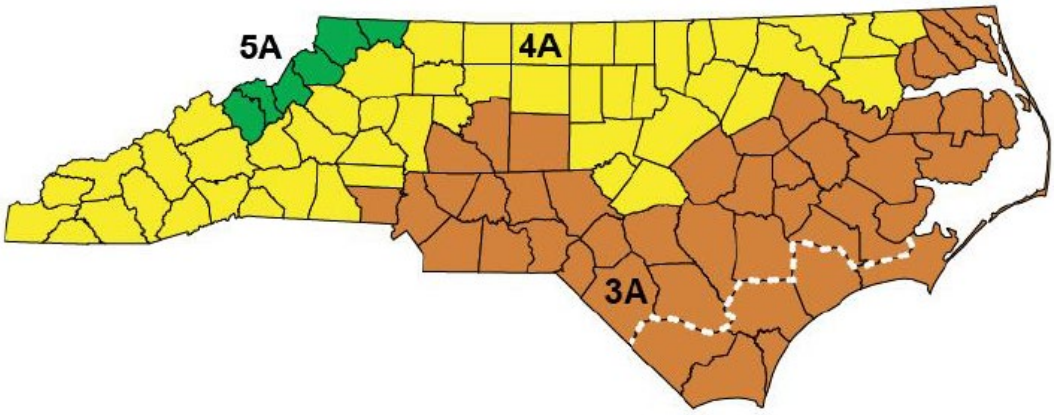
N1101.5.1 (R103.2.1) Thermal envelope depiction. Deleted.

N1101.6 (R202) Defined terms. Deleted. See Chapter 2.

N1101.7 (R301.1) Climate zones.

Climate zones from Figure N1101.7 or Table N1101.7 shall be used in determining the applicable requirements in Sections N1101 through N1111.





Warm and humid counties are below the dashed line.

FIGURE N1101.7 (R301.1)

CLIMATE ZONES

TABLE N1101.7 (R301.1)
CLIMATE ZONES, MOISTURE REGIMES, AND WARM-HUMID DESIGNATIONS BY STATE, COUNTY AND TERRITORY

Key: A – Moist
Asterisk (*) indicates a warm-humid location.

BY COUNTY

NORTH CAROLINA

4A Alamance
4A Alexander
5A Alleghany
3A Anson
5A Ashe
5A Avery
3A Beaufort
4A Bertie
3A Bladen
3A Brunswick*
4A Buncombe
4A Burke
3A Cabarrus
4A Caldwell
3A Camden
3A Carteret*
4A Caswell
4A Catawba
4A Chatham
4A Cherokee
3A Chowan
4A Clay
4A Cleveland
3A Columbus*
3A Craven
3A Cumberland
3A Currituck
3A Dare
3A Davidson
4A Davie
3A Duplin
4A Durham
3A Edgecombe
4A Forsyth
4A Franklin
3A Gaston
4A Gates
4A Graham
4A Granville
3A Greene
4A Guilford
4A Halifax
4A Harnett
4A Haywood
4A Henderson
4A Hertford
3A Hoke
3A Hyde
4A Iredell
4A Jackson
3A Johnston
3A Jones
4A Lee
3A Lenoir
4A Lincoln
4A Orange
3A Pamlico
3A Pasquotank
3A Pender*
3A Perquimans
4A Person
3A Pitt
4A Polk
3A Randolph
3A Richmond
3A Robeson
4A Rockingham
3A Rowan
4A Rutherford
3A Sampson
3A Scotland
3A Stanly
4A Stokes
4A Surry
4A Swain
4A Transylvania
3A Tyrrell
3A Union
4A Vance
4A Wake
4A Warren
3A Washington
5A Watauga
3A Wayne
4A Wilkes
3A Wilson
4A Yadkin
5A Yancey

4A Macon
4A Madison
3A Martin
4A McDowell
3A Mecklenburg
5A Mitchell
3A Montgomery
3A Moore
4A Nash
3A New Hanover*
4A Northampton
3A Onslow*

N1101.7.1 (R301.2) Warm humid counties.
Warm humid counties are identified in Table N1101.7 by an asterisk.

N1101.7.2 (R301.3) International climate zones. Deleted.

N1101.8 (R301.4) Tropical climate zone. Deleted.

N1101.9 (R302.1) Interior design conditions.
The interior design temperatures used for heating and cooling load calculations shall be a maximum of 72°F (22°C) for heating and minimum of 75°F (24°C) for cooling.

N1101.10 (R303.1) Identification.
Materials, systems and equipment shall be identified in a manner that will allow a determination of compliance with the applicable provisions of this code.

N1101.10.1 (R303.1.1) Building thermal envelope insulation.
An *R*-value identification mark shall be applied by the manufacturer to each piece of *building thermal envelope* insulation 12 inches (305 mm) or greater in width. Alternately, the insulation installers shall provide a certification listing the type, manufacturer and *R*-value of

insulation installed in each element of the *building thermal envelope*. For blown or sprayed insulation (fiberglass and cellulose), the initial installed thickness, settled thickness, settled *R*-value, installed density, coverage area and number of bags installed shall be *listed* on the certification. For insulated siding, the *R*-value shall be labeled on the product's package and shall be listed on the certification. The insulation installer shall sign, date and post the certification in a conspicuous location on the job site.

N1101.10.1.1 (R303.1.1.1) Blown or sprayed roof/ceiling insulation.
The thickness of blown-in or sprayed roof/ceiling insulation (fiberglass or cellulose) shall be written in inches (mm) on markers that are installed at least one for every 300 square feet (28 m^2) throughout the attic space. The markers shall be affixed to the trusses or joists and marked with the minimum initial installed thickness with numbers not less than 1 inch (25 mm) in height. Each marker shall face the attic access opening. Spray polyurethane foam thickness and installed *R*-value shall be *listed* on certification provided by the insulation installer.

N1101.10.2 (R303.1.2) Insulation mark installation.
Insulating materials shall be installed such that the manufacturer's *R*-value mark is readily observable upon inspection.

N1101.10.3 (R303.1.3) Fenestration product rating.

U-factors of fenestration products (windows, doors and skylights) shall be determined in accordance with NFRC 100. *U*-factors shall be determined by an accredited, independent laboratory, and *labeled* and certified by the manufacturer. Products lacking such a *labeled* *U*-factor shall be assigned a default *U*-factor from Tables N1101.10.3(1) or N1101.10.3(2). The solar heat gain coefficient (SHGC) and *visible transmittance* (VT) of glazed fenestration products (windows, glazed doors and skylights) shall be determined in accordance with NFRC 200 by an accredited, independent laboratory, and *labeled* and certified by the manufacturer. Products lacking such a *labeled* SHGC or VT shall be assigned a default SHGC or VT from Table N1101.10.3(3).

Exception: When a garage door is a part of the building thermal envelope garage door *U*-factors shall be determined in accordance with either NFRC 100 or ANSI/DASMA 105.

TABLE N1101.10.3(1)[R303.1.3(1)]
DEFAULT GLAZED FENESTRATION *U*-FACTORS

FRAME TYPE	SINGLE PANE	DOUBLE PANE	SKYLIGHT	
			Single	Double
Metal	1.20	0.80	2.00	1.30
Metal with Thermal Break	1.10	0.65	1.90	1.10
Nonmetal or Metal Clad	0.95	0.55	1.75	1.05
Glazed Block	0.60			

TABLE N1101.10.3(2)[R303.1.3(2)]
DEFAULT DOOR *U*-FACTORS

DOOR TYPE	*U*-FACTOR
Uninsulated Metal	1.20

Insulated Metal	0.60
Wood	0.50
Insulated, nonmetal edge, max 45% glazing, any glazing double pane	0.35

TABLE N1101.10.3(3)[R303.1.3(3)]
DEFAULT GLAZED FENESTRATION SHGC AND VT

	SINGLE GLAZED		DOUBLE GLAZED		GLAZED BLOCK
	Clear	Tinted	Clear	Tinted	
SHGC	0.8	0.7	0.7	0.6	0.6
VT	0.6	0.3	0.6	0.3	0.6

N1101.10.4 (R303.1.4) Insulation product rating.
The thermal resistance (*R*-value) of insulation shall be determined in accordance with the U.S. Federal Trade Commission *R*-value rule (CFR Title 16, Part 460) in units of h × ft^2 ×°F/Btu at a mean temperature of 75°F (24°C).

N1101.10.4.1 (R303.1.4.1) Insulated siding.
The thermal resistance (*R*-value) of insulated siding shall be determined in accordance with ASTM C 1363. Installation for testing shall be in accordance with the manufacturer's installation instructions.

N1101.11 (R303.2) Installation.
All materials, systems and equipment shall be installed in accordance with the manufacturer's instructions and this code.

N1101.11.1 (R303.2.1) Protection of exposed foundation insulation.
Insulation applied to the exterior of basement walls, crawlspace walls and the perimeter of slab-on-grade floors shall have an opaque and weather-resistant protective covering to prevent the degradation of the insulation's thermal performance. The protective covering shall cover the exposed exterior insulation and extend not less than 6 inches (153 mm) below grade.

N1101.12 (R303.3) Maintenance information.
Maintenance instructions shall be furnished for equipment and systems that require preventive maintenance.

N1101.13 (R401.2) Compliance.
Projects shall comply with one of the following:

1. Sections N1101.14 through N1104.

2. Section N1105 and the provisions of Sections N1101.14 through N1104 labeled "Mandatory."

3. An energy rating index (ERI) approach in Section N1106.

4. REScheck keyed to the 2018 IECC shall be permitted to demonstrate compliance with this code. Envelope requirements may not be traded off against the use of high

efficiency heating or cooling equipment. No trade-off calculations are needed for required termite inspection and treatment gaps.

N1101.13.1 (R401.2.1) Tropical zone. Deleted.

N1101.14 (R401.3) Certificate (Mandatory).
A permanent certificate shall be posted on or in the electrical distribution panel, in the attic next to the attic insulation card, or inside a kitchen cabinet or other approved location. The certificate shall not cover or obstruct the visibility of the circuit directory label, service disconnect label or other required labels. The builder, permit holder, or registered design professional shall be responsible for completing the certificate. The certificate shall list the predominant *R*-values of insulation installed in or on ceiling/roof, walls, foundation (slab, *basement wall*, crawlspace wall and floor) and ducts outside conditioned spaces; *U*-factors for fenestration and the solar heat gain coefficient (SHGC) of fenestration. Where there is more than one value for each component, the certificate shall list the value covering the largest area. The certificate shall indicate whether the building air leakage was visually inspected as required in Section N1102.4.2.1 or provide results of the air leakage testing required in Section N1102.4.2.2. The certificate shall provide results of duct leakage test required in Section N1103.3.3. Appendix E-1 contains a sample certificate.

SECTION N1102 (R402)

BUILDING THERMAL ENVELOPE

N1102.1 (R402.1) General (Prescriptive).
The *building thermal envelope* shall meet the requirements of Sections N1102.1.1 through N1102.1.5.

Exception: 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 N1102.

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.

2. Those that do not contain *conditioned space*.

N1102.1.1 (R402.1.1) Vapor retarder. Deleted.

N1102.1.2 (R402.1.2) Insulation and fenestration criteria.
The *building thermal envelope* shall meet the requirements of Table N1102.1.2 based on the climate zone specified in Section N1101.7.

TABLE N1102.1.2 (R402.1.2)
INSULATION AND FENESTRATION REQUIREMENTS BY COMPONENT[a]

CLIMATE ZONE	FENESTRATION *U*-FACTOR[b, j]	SKYLIGHT[b] *U*-FACTOR	GLAZED FENESTRATION SHGC[b, e, k]	CEILING *R*-VALUE[m]	WOOD FRAME WALL *R*-VALUE	MASS WALL *R*-VALUE[i]	FLOOR *R*-VALUE	BASEMENT[c,o] WALL *R*-VALUE	SLAB[d] *R*-VALUE & DEPTH	CRAWL SPACE[c] WALL *R*-VALUE
3	0.35	0.55	0.30	38 or 30ci[l]	15 or 13 + 2.5	5/13 or 5/10ci	19	5/13[f]	0	5/13
4	0.35	0.55	0.30	49 38 or 30ci[l]	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[l]	19[n] or 13 + 5[h] or 15+3[h]	13/17 or 13/12.5 ci	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. R-5 shall be added to the required slab edge *R*-values for heated slabs. 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 O.)

e. Deleted.

f. Basement wall insulation is not required in warm-humid locations as defined by Figure N1101.10 and Table N1101.10.

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 N1102.3.3, 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 N1102.3.3, 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" 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 2x4 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 N1102.1.4 (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 Zone 3, 0.07 in Zone 4, and 0.054 in Zone 5,4, and 0.057 in Zones 6 through 8.
c. Basement wall *U*-factor of 0.360 in warm-humid locations as defined by Figure N1101.10 (R301.1) and Table N1101.10 (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.

N1102.1.3 (R402.1.3) 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. 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 N1102.1.2, the manufacturer's labeled *R*-Value for insulated siding shall be reduced by R-0.6.

N1102.1.4 (R402.1.4) U-factor alternative.
An assembly with a *U*-factor equal to or less than that specified in Table N1102.1.4 shall be permitted as an alternative to the *R*-value in Table N1102.1.2.

N1102.1.5 (R402.1.5) 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 N1102.1.4 (multiplied by

the same assembly area as in the proposed building), the building shall be considered in compliance with Table N1102.1.2. 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.

N1102.2 (R402.2) Specific insulation requirements (Prescriptive).
In addition to the requirements of Section N1102.1, insulation shall meet the specific requirements of Sections N1102.2.1 through N1102.2.15.

N1102.2.1 (R402.2.1) Ceilings with attic spaces.
Where Section R1102.1.2 would require R-38 insulation in the ceiling, installing R-30 over 100 percent of the ceiling area requiring insulation shall be deemed to satisfy the requirement for R-38 wherever the full height of uncompressed R-30 insulation extends over the wall top plate at the eaves. This reduction shall not apply to the *U*-factor alternative approach in Section R1102.1.4 and the total UA alternative in Section R1102.1.5.

Exceptions:

1. When insulation is installed in a fully *enclosed attic floor system*, as described in Appendix E-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.

N1102.2.2 (R402.2.2) Ceilings without attic spaces.
Where Section N1102.1.2 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 N1102.1.2 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 N1102.1.4 and the total UA alternative in Section N1102.1.5.

N1102.2.3 (R402.2.3) Soffit baffle.
For air-permeable insulations in vented attics, a baffle shall be installed adjacent to soffit vents. The baffle shall extend over the top of the attic insulation. The baffle shall be permitted to be any solid material.

N1102.2.4 (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.

Exceptions:

1. Vertical doors that provide access from conditioned to unconditioned spaces shall be permitted to meet the fenestration requirements of Table N1102.1.2 based on the applicable climate zone specified in N1101.7.

2. Pull down stair systems shall be weatherstripped and insulated to a minimum R-5 insulation value such that the insulation does not interfere with proper operation of the stair. Non-rigid 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 Section R318.

N1102.2.5 (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 specification immediately following: 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), and any walls having a heat capacity greater than or equal to 6 Btu/ft_2 *°F[266 J/(m^2*K)].

N1102.2.6 (R402.2.6) Steel-frame ceilings, walls, and floors.

Steel-frame ceilings, walls, and floors shall meet the insulation requirements of Table N1102.2.6 or shall meet the *U*-factor requirements of Table N1102.1.4. The calculation of the *U*-factor for a steel-frame envelope assembly shall use a series-parallel path calculation method.

TABLE N1102.2.6 (R402.2.6)
STEEL-FRAME CEILING, WALL AND FLOOR INSULATION
(*R*-VALUE)

WOOD FRAME *R*-VALUE REQUIREMENT	COLD-FORMED STEEL 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-Framed Wall, 16″ on center	
R-13	R-13 + 4.2 or R-19 + 2.1 or R-21 + 2.8 or R-0 + 9.3 or R-15 + 3.8 or R-21 + 3.1
R-13 + 3	R-0 + 11.2 or R-13 + 6.1 or R-15 + 5.7 or R-19 + 5.0 or R-21 + 4.7
R-20	R-0 + 14.0 or R-13 + 8.9 or R-15 + 8.5 or R-19 + 7.8 or R-19 + 6.2 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-Framed Wall, 24″ 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 + 3.5 or R-21 + 3.1
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. Cavity insulation *R*-value is listed first, followed by continuous insulation *R*-value.
b. Insulation exceeding the height of the framing shall cover the framing.

N1102.2.7 (R402.2.7) Walls with partial structural sheathing. 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. This reduction shall not apply to the *U*-factor alternative approach in Section N1102.1.4 and the total UA alternative in Section N1102.1.5.

N1102.2.8 (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 support wires or other devices that hold the floor insulation in place against the subfloor shall be no more than 18 inches (457 mm). In addition, supports shall be located no further than 6 inches (152 mm) from each end of the insulation.

Exception: Enclosed floor cavity such as garage ceilings, cantilevers or buildings on pilings with 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.

N1102.2.9 (R402.2.9) Basement walls.
Walls associated with conditioned 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 N1102.1.2 and N1102.2.8. Foam plastic insulation applied to exterior of basement walls shall be provided with termite inspection and treatment gaps in accordance with Appendix O.

N1102.2.10 (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 N1102.1.2. 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 2 inch (51 mm) termite inspection gap consistent with Appendix O of this code.

N1102.2.11 (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 N1102.1.2.

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 mm) below the top of the masonry foundation wall and shall extend down to 3 inches (76 mm) above the top of the footing or concrete floor, 3 inches (76 mm) above the interior ground surface or 24 inches (610 mm) below the outside finished ground level, whichever is less. (See Appendix E-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 N1102.2.11. 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 Carolina-specific version of RESCHECK or the UA Alternative method or Section N1105.

TABLE N1102.2.11
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

For SI 1 inch = 25.4 mm
a. No insulation shall be required on masonry walls of 9 inches in height or less.

N1102.2.12 (R402.2.12) Masonry veneer.
Insulation shall not be required on the horizontal portion of the foundation that supports a masonry veneer.

N1102.2.13 (R402.2.13) Sunroom insulation.
S*unrooms* enclosing conditioned spaces shall meet the insulation requirements of this code.

Exception: For *sunrooms* with *thermal isolation*, and enclosing conditioned spaces, the following exceptions to the insulation *requirements* of this code shall apply:

1. The minimum ceiling insulation *R*-values shall be R-19 in Zones 3 and 4 and R-24 in Zone 5.

2. The minimum wall *R*-value shall be R-13 in all *climate zones*. New walls separating a *sunroom* with a *thermal isolation* from *conditioned space* shall meet the *building thermal envelope* requirements of this code.

N1102.2.14 (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 barrier. 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 an air barrier material. Polyethylene shall not be allowed. Rim joists are not required to be enclosed on all sides. Wall insulation shall be enclosed at the following locations when installed on exterior walls prior to being covered by subsequent construction, consistent with Appendix E-2.3 of this code:

1. Tubs

2. Showers

3. Stairs

4. Fireplace units (Enclose with rigid material only)

N1102.2.15 (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 Appendix E-2.3 of this code. Joints shall be air sealed. Non-insulating class I vapor retarders, such as polyethylene, shall not be allowed.

N1102.3 (R402.3) Fenestration (Prescriptive).
In addition to the requirements of Section N1102, fenestration shall comply with Sections N1102.3.1 through N1102.3.5.

N1102.3.1 (R402.3.1) U-factor.
An area-weighted average of fenestration products shall be permitted to satisfy the *U*-factor requirements.

N1102.3.2 (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 R1102.1.2 provided 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 not be permitted.

Exception: *Dynamic glazing* is not required to comply with this section when both the lower and higher labeled SHGC already comply with the requirements of Table N1102.1.2.

N1102.3.3 (R402.3.3) Glazed fenestration exemption.
Either two glazed fenestration assemblies or up to 24 square feet (2.2 m^2) of glazed fenestration per dwelling unit shall be permitted to be exempt from *U*-factor and SHGC requirements in Section N1102.1.2. This exemption shall not apply to the *U*-factor alternative approach in Section N1102.1.4 and the total UA alternative in Section N1102.1.5.

N1102.3.4 (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 N1102.1.2. This exemption shall not apply to the *U*-factor alternative approach in Section N1102.1.4 and the total UA alternative in Section N1102.1.5.

N1102.3.5 (R402.3.5) Sunroom fenestration.
S*unrooms* enclosing *conditioned space* shall meet the fenestration requirements of this code.

Exceptions:

1. For *sunrooms* with *thermal isolation* and enclosing *conditioned space* in *Climate Zones* 3 through 5, the maximum fenestration *U*-factor shall be 0.45 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 glazing.

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 substituted for minimum code compliant fenestration product assemblies without penalty.

New fenestration separating the *sunroom* with *thermal isolation* from *conditioned space* shall meet the *building thermal envelope* requirements of this code.

N1102.4 (R402.4) Air leakage control (Mandatory).
The building thermal envelope shall be constructed to limit air leakage in accordance with the requirements of Sections N1102.4.1 through N1102.4.6.

N1102.4.1 (R402.4.1) Building thermal envelope.
The *building thermal 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, gasketed, weatherstripped or otherwise sealed with an air barrier material, or solid material consistent with Appendix E-2.4 of this code:

1. Blocking 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:

1. Spray foam in building thermal envelope wall systems.

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

N1102.4.2 Air sealing.
Building envelope air tightness shall be demonstrated by compliance with Sections N1102.4.2.1 or N1102.4.2.2. Appendix E-3 contains optional sample worksheets for visual inspection or testing for the permit holder's use only.

N1102.4.2.1 Visual inspection option.
Building envelope tightness shall be considered acceptable when items providing insulation enclosure in Section N1102.2.14 and enclosure and air sealing in Section N1102.2.15 and air sealing in Section N1102.4.1 are addressed and when the items listed in Table N1102.4.2, applicable to the method of construction, are certified by the builder, permit holder or *registered design professional* via the certificate in Appendix E-1.

N1102.4.2.2 Testing option.
Building envelope tightness shall be considered acceptable when items providing insulation enclosure in Section N1102.2.14 and enclosure and air sealing in Section

N1102.2.15 and air sealing in Section N1102.4.1 are addressed and when tested air leakage is less than or equal to one of the two following performance measurements:

Test Criteria:

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, not temperature corrected, test 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 E 1827. 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 N1101.14.

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 acceptable; 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 equal to 5 ACH50 the envelope tightness is acceptable.

TABLE N1102.4.2
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)	Air barrier system is 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 E-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.

N1102.4.3 (R402.4.3) Fireplaces.
Site-built masonry fireplaces shall have dampers and comply with Section R1006 for combustion air.

N1102.4.4 (R402.4.4) Fenestration air leakage.
Windows, skylights and sliding glass doors shall have an air infiltration rate of no more than 0.3 cfm per square foot (1.5 L/s/m^2), and swinging doors no more than 0.5 cfm per square foot (2.6 L/s/m^2), when tested according to NFRC 400 or AAMA/WDMA/CSA 101/I.S.2/A440 by an accredited, independent laboratory and *listed* and *labeled* by the manufacturer.

Exception: Site-built windows, skylights and doors.

N1102.4.5 (R402.4.5) Rooms containing fuel-burning appliances. Deleted.

N1102.4.6 (R402.4.6) Recessed lighting.
Recessed luminaires installed in the *building thermal envelope* shall be sealed to limit air leakage between conditioned and unconditioned spaces. All recessed luminaires shall be IC-rated and *labeled* as having an air leakage rate not more than 2.0 cfm (0.944 L/s) when tested in accordance with ASTM E 283 at a 1.57 psf (75 Pa) pressure differential. All recessed luminaires shall be sealed with a gasket or caulk between the housing and the interior wall or ceiling covering.

N1102.5 (R402.5) Maximum fenestration U-factor and SHGC (Mandatory).
The area-weighted average maximum fenestration *U*-factor permitted using trade-offs from Section N1102.1.5 shall be 0.48. Maximum skylight *U*-factors shall be 0.65 in Zones 4 and 5 and 0.60 in Zone 3. The area-weighted average maximum fenestration SHGC permitted using trade-offs from Section N1105 in 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.

SECTION N1103 (R403)

SYSTEMS

N1103.1 (R403.1) Controls (Mandatory).
At least one thermostat shall be provided for each separate heating and cooling system.

N1103.1.1 (R403.1.1) Programmable thermostat.
When the primary heating system is a forced air furnace or heat pump, the thermostat controlling the primary heating or cooling system of the dwelling unit shall be capable of controlling the heating and cooling system on a daily schedule to maintain different

temperature set points at different times of the day. This thermostat shall include the capability to set back or temporarily operate the system to maintain *zone* temperatures down to 55°F (13°C) or up to 85°F (29°C). The thermostat shall initially be programmed by the manufacturer with a heating temperature set point no higher than 70°F (21°C) and a cooling temperature set point no lower than 78°F (26°C).

N1103.1.2 (R403.1.2) Heat pump supplementary heat (Mandatory).
Heat pumps having supplementary electric-resistance heat shall have controls that, except during defrost, prevent supplemental heat operation when the heat pump compressor can meet the heating load.

A heat strip outdoor temperature lockout thermostat shall be provided to prevent supplemental heat operation in response to the thermostat being changed to a warmer setting. The lockout shall be set no lower than 35°F (2°C) and no higher than 40°F (4°C).

Exceptions:

1. In lieu of a heat strip outdoor temperature lockout thermostat, the following time and temperature electric-resistance control may be used. After six minutes of compressor run time in heat mode, supplemental electric heat shall energize only if the leaving air temperature from the indoor coil is below 90°F (32°C). If the indoor coil leaving air temperature exceeds 100°F (38°C), supplemental heat shall automatically de-energize, but allow the compressor to continue to operate until the call is satisfied. No thermostat shall initiate supplemental electric heat at any time. Thermostat controlled emergency heat shall not be limited by outdoor temperature. Electric resistance supplemental heat during defrost shall operate normally without limitation.

2. In lieu of a heat strip outdoor temperature lockout thermostat, a programmable indoor thermostat with the capability to minimize the use of supplementary electrical resistance heat using an automatic temperature ramp up control feature shall be acceptable.

N1103.2 (R403.2) Hot water boiler outdoor temperature setback.
Hot water boilers that supply heat to the building through one- or two-pipe heating systems shall have an outdoor setback control that lowers the boiler water temperature based on the outdoor temperature.

N1103.3 (R403.3) Ducts.
Ducts and air handlers shall be in accordance with Sections N1103.3.1 through N1103.3.~~5~~4.

N1103.3.1 (R403.3.1) Insulation (Mandatory).

Supply and return ducts in unconditioned space and outdoors shall be insulated to a minimum R-8. Supply ducts inside semi-conditioned space shall be insulated to a minimum R-4; return ducts inside conditioned and semi-conditioned space are not required to be insulated. Ducts located inside conditioned space are not required to be insulated other than as may be necessary for preventing the formation of condensation on the exterior of cooling ducts.

Note:
Residential Spaces Insulation Rule per N.C. Session Law 2022-6 Section 20.10 (c) and N.C. Session Law 2022-46 Section 26.(a), expires 3/17/24. Supply and return air ducts located in ventilated or non- ventilated unconditioned spaces, other than attics, shall be insulated to a minimum R-4.2. Supply and return air ducts located in ventilated or non-ventilated unconditioned attic spaces shall be insulated to a minimum R-6.0. This two-year temporary rule expires March 17, 2024.

N1103.3.2 (R403.3.2) Sealing (Mandatory).
Ducts, air handlers, filter boxes and building cavities used as ducts shall be sealed. Joints and seams shall comply with either the *International Mechanical Code* or Section M1601.4.1 of this code, as applicable.

Exceptions:

1. Air-impermeable spray foam products shall be permitted to be applied without additional joint seals.

2. Deleted.

N1103.3.2.1 (R403.3.2.1) Sealed air handler. Deleted.

N1103.3.3 (R403.3.3) Duct leakage (Prescriptive) and duct testing (Mandatory).

Duct testing and duct leakage shall be verified by compliance with either Section N1103.3.3.1 or N1103.3.3.2. Duct testing shall be performed and 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. A single point depressurization, not temperature corrected, test is sufficient to comply with this provision, provided that the duct testing fan assembly(s) has been certified by the manufacturer to be capable of conducting tests in accordance with ASTM E1554-07.

The duct leakage information, including duct leakage test selected and result, tester name, date, and contact information, shall be included on the certificate described in Section N1101.14.

For the Test Criteria, the report shall be produced in the following manner: perform the HVAC system air leakage test and record the CFM25. Calculate the total square feet of Conditioned Floor Area (CFA) served by that system. Multiply CFM25 by 100, divide the result by the CFA and record the result. If the result is less than or equal to 5 CFM25/100SF for the “Total duct leakage test or less than or equal to 4 CFM25/100SF for the “Duct leakage to the outside” test, then the HVAC system air tightness is acceptable. Appendix E-3C contains optional sample worksheets for duct testing for the permit holder’s use only.

Exceptions:

1. Duct systems or portions thereof inside the building thermal envelope shall not be required to be leak tested.

2. Installation of a partial system as part of replacement, renovation or addition does not require a duct leakage test.

3. Duct systems (complete) serving areas of 750 square feet or less shall not need to be required to be leak tested.

N1103.3.3.1 Total duct leakage.
Total duct leakage less than or equal to 5 CFM (12 L/min) per 100 ft^2 (9.29 m^2) of conditioned floor area served by that system when tested at a pressure differential of 0.1 inches w.g. (25 Pa) across the entire system, including the manufacturer's air handler enclosure.

During testing:

1. Block, if present, ventilation air duct(s) connected to the conditioning system.

2. The duct air leakage testing equipment shall be attached to the largest return in the system or to the air handler.

3. The filter shall be removed and the air handler power shall be turned off.

4. Supply boots or registers and return boxes or grilles shall be taped, plugged, or otherwise sealed air tight.

5. The hose for measuring the 25 Pascals of pressure differential shall be inserted into the boot of the supply that is nominally closest to the air handler.

6. Specific instructions from the duct testing equipment manufacturer shall be followed to reach duct test pressure and measure duct air leakage.

N1103.3.3.2 Duct Leakage to the Outside.
Conduct the test using fan pressurization of distribution system and building at a fixed reference pressure for combined supply and return leak. Duct leakage to the outside shall be less than or equal to 4 CFM (12 L/min) per 100 ft^2 (9.29 m^2) of conditioned floor area served by that system when tested at a pressure differential of 0.1 inches w.g. (25 Pa) across the entire system, relative to the outside, including the manufacturer's air handler enclosure.

During testing:

1. Block, if present, the ventilation air duct(s) connected to the conditioning system.

2. The duct air leakage testing equipment shall be attached to the largest return in the system or to the air handler.

3. The filter shall be removed and the air handler power shall be turned off.
4. Supply boots or registers and return boxes or grilles shall be taped, plugged, or otherwise sealed air tight or as tight as possible.

5. The hose for measuring the 25 Pascals of pressure differential shall be inserted into the boot of the supply that is nominally closest to the air handler.

6. Open all interconnecting doors in the building, close dampers for fireplaces and other operable dampers.

7. Set up an envelope air moving/ flow-regulating/ flow measurement assembly, such as a blower door, following the manufacturer's prescribed procedure.

8. Specific instructions from the duct testing equipment manufacturer shall be followed to reach duct test pressure and measure duct air leakage used in combination with a blower door. Typical steps are as follows:

    a. Depressurize the ductwork system to 25 Pa using the measurement hose in Step 5 above.

    b. Depressurize the house to 25 Pa using an envelope air moving/ flow-regulating/ flow measurement assembly, such as a blower door.

    c. Correct the duct pressure to measure 0 Pa of pressure differential between the house and the ductwork system.

    d. Read the CFM of duct leakage using the procedures for the specific equipment being used. (Note that most automatically calculating pressure gauges cannot compute the CFM25 automatically with a duct-to-house difference in pressure of 0 Pa, so the gauge setting should be set to read CFM instead of CFM25).

N1103.3.4 (R403.3.4) Building cavities (Mandatory).
Building framing cavities shall not be used as supply ducts or supply plenums.

N1103.4 (R403.4) Mechanical system piping insulation (Mandatory).
Mechanical system piping capable of carrying fluids above 105°F (41°C) or below 55°F (13°C) shall be insulated to a minimum of R-3.

N1103.4.1 (R403.4.1) Protection of piping insulation. Deleted.

N1103.5 (R403.5) Service hot water systems.
All circulating service hot water piping shall be insulated to at least R-2. Circulating hot water systems shall include an automatic or readily *accessible* manual switch that can turn off the hot water circulating pump when the system is not in use.

N1103.5.1 (R403.5.1) Heated water circulation and temperature maintenance systems (Mandatory). Deleted.

N1103.5.1.1 (R403.5.1.1) Circulation systems. Deleted.

N1103.5.1.2 (R403.5.1.2) Heat trace systems. Deleted.

N1103.5.2 (R403.5.2) Demand recirculation systems. Deleted.

N1103.5.3 (R403.5.3) Hot water pipe insulation (Prescriptive). Deleted.

N1103.5.4 (R403.5.4) Drain water heat recovery units. Deleted.

N1103.6 (R403.6) Mechanical ventilation (Mandatory).
The building shall be provided with ventilation that meets the requirements of Section M1507 of this code or the *International Mechanical Code*, as applicable, or with other approved means of ventilation. Outdoor air intakes and exhausts shall have automatic or gravity dampers that close when the ventilation system is not operating.

N1103.6.1 (R403.6.1) Whole-house mechanical ventilation system fan efficacy.
Deleted.

N1103.7 (R403.7) Equipment sizing and efficiency rating (Mandatory).
Heating and cooling equipment shall be sized in accordance with ACCA Manual S based on building loads calculated in accordance with ACCA Manual J or other *approved* heating and cooling calculation methodologies. New heating and cooling equipment shall have an efficiency rating equal to or greater than the minimum required by federal law for the geographic location where the equipment is installed.

N1103.8 (R403.8) Systems serving multiple dwelling units (Mandatory).
Building mechanical systems and service water heating systems serving multiple dwelling units shall comply with Sections C403 and C404 of the IECC—Commercial Provisions in lieu of Section N1103.

N1103.9 (R403.9) Snow melt system controls (Mandatory).
Snow- and ice-melting systems, supplied through energy service to the building, shall include automatic controls capable of shutting off the system when the pavement temperature is above 50°F (10°C).

N1103.10 (R403.10) Pools and permanent spa energy consumption (Mandatory).
The energy consumption of pools and permanent spas shall be in accordance with Sections N1103.10.1 through N1103.10.

N1103.10.1 (R403.10.2) Heaters.
All heaters shall be equipped with a readily accessible on-off switch that is mounted outside of the heater to allow shutting off the heater without adjusting the thermostat setting. Gas-fired heaters shall not be equipped with constant burning pilot lights.

N403.10.2 (R403.10.3) Time switches.
Time switches or other control methods that can automatically turn off and on according to a preset schedule shall be installed for heaters and pump motors. Heaters and pump motors that have built-in time switches shall be in compliance with this section.

Exceptions:

1. Where public health standards require 24-hour pump operation.

2. Pumps that operate solar- and waste-heat-recovery pool heating systems.

N1103.10.3 (R403.10.4) Covers.
Outdoor heated pools and outdoor permanent spas shall be provided with a vapor retardant cover.

Exception: Pools deriving over 70 percent of the energy from heating from *site-recovered energy* or *solar energy source*.

N1103.11 (R403.11) Portable spas (Mandatory). Deleted.

N1103.12 (R403.12) Residential pools and permanent residential spas.
Residential swimming pools and permanent residential spas that are accessory to detached one- and two- family dwellings and townhouses 3 stories or less in height above grade plane and that are available only to the household and its guests shall be in accordance with APSP-15.

SECTION N1104 (R404)
ELECTRICAL POWER AND LIGHTING SYSTEMS
(MANDATORY)

N1104.1 (R404.1) Lighting equipment (Mandatory).
Not less than 75 percent of the lamps in permanently installed lighting fixtures shall be high-efficacy lamps or not less than 75 percent of the permanently installed lighting fixtures shall contain only high-efficacy lamps.

Exception: Low-voltage lighting.

N1104.1.1 (R404.1.1) Lighting equipment (Mandatory).
Fuel gas lighting systems shall not have continuously burning pilot lights.

SECTION N1105 (R405)
SIMULATED PERFORMANCE ALTERNATIVE
(PERFORMANCE)

N1105.1 (R405.1) Scope.
This section establishes criteria for compliance using simulated energy performance analysis. Such analysis shall include those items identified in Table N1105.5.2(1), as applicable. A *registered design professional* is required to perform the analysis if required by North Carolina licensure laws.

N1105.2 (R405.2) Mandatory requirements.
Compliance with this section requires that the mandatory provisions identified in Section N1101.13(2) be met.

N1105.3 (R405.3) Performance-based compliance.
Compliance based on simulated energy performance requires that a proposed residence (*proposed design)* be shown to have an annual energy cost that is less than or equal to the annual energy cost of the *standard reference design.* Energy prices shall be taken from a source *approved* by the *building official,* such as the Department of Energy, Energy Information Administration's *State Energy Price and Expenditure Report. Building officials* shall be permitted to require time-of-use pricing in energy cost calculations.

Exception: The energy use based on source energy expressed in Btu (J) or Btu per square foot (J/m^2) of *conditioned floor area* shall be permitted to be substituted for the energy cost. The source energy multiplier for electricity shall be 3.16. The source energy multiplier for fuels other than electricity shall be 1.1.

N1105.4 (R405.4) Documentation.
Documentation of the software used for the performance design and the parameters for the building shall be in accordance with Sections N1105.4.1 through N1105.4.3.

N1105.4.1 (R405.4.1) Compliance software tools.
Documentation verifying that the methods and accuracy of the compliance software tools conform to the provisions of this section shall be provided to the *building official.*

N1105.4.2 (R405.4.2) Compliance report.
Compliance software tools shall generate a report that documents that the *proposed design* complies with Section N1105.3. A compliance report on the *proposed design* shall be submitted.

A compliance report shall include the following:

1. Building street address, or other building site identification.

2. A statement indicating that the *proposed design* complies with Section N1105.3.

3. An inspection checklist documenting the building component characteristics of the *proposed design* as indicated in Table N1105.5.2(1). The inspection checklist shall show results for both the *standard reference design* and the *proposed design* with user inputs to the compliance software to generate the results.

4. A site-specific energy analysis report that is in compliance with Section N1105.3.

5. The name of the individual performing the analysis and generating the report.

6. The name and version of the compliance software tool.

N1105.4.3 (R405.4.3) Additional documentation.
The *building official* shall be permitted to require the following documents:

1. Documentation of the building component characteristics of the *standard reference design.*

2. A certification signed by the builder providing the building component characteristics of the *proposed design* as given in Table N1105.5.2(1).

3. Documentation of the actual values used in the software calculations for the *proposed design.*

N1105.5 (R405.5) Calculation procedure.
Calculations of the performance design shall be in accordance with Sections N1105.5.1 and N1105.5.2.

N1105.5.1 (R405.5.1) General.
Except as specified by this section, the *standard reference design* and *proposed design* shall be configured and analyzed using identical methods and techniques.

N1105.5.2 (R405.5.2) Residence specifications.
The *standard reference design* and *proposed design* shall be configured and analyzed as specified by Table N1105.5.2(1). Table N1105.5.2(1) shall include, by reference, all notes contained in Table N1102.1.2.

TABLE N1105.5.2(1)[R405.5.2(1)]
SPECIFICATIONS FOR THE STANDARD REFERENCE AND PROPOSED DESIGNS

BUILDING COMPONENT	STANDARD REFERENCE DESIGN	PROPOSED DESIGN
Above-grade walls	Type: mass wall if proposed wall is mass; otherwise wood frame.	As proposed
	Gross area: same as proposed	As proposed
	U-factor: as specified in Table N1102.1.4	As proposed
	Solar absorptance = 0.75	As proposed
	Remittance = 0.90	As proposed
Basement and crawl space walls	Type: same as proposed	As proposed
	Gross area: same as proposed	As proposed
	U-factor: from Table N1102.1.4, with insulation layer on interior side of walls	As proposed
Above-grade floors	Type: wood frame	As proposed
	Gross area: same as proposed	As proposed
	U-factor: as specified in Table N1102.1.4	As proposed
Ceilings	Type: wood frame	As proposed
	Gross area: same as proposed	As proposed
	U-factor: as specified in Table N1102.1.4	As proposed
Roofs	Type: composition shingle on wood sheathing	As proposed

	Gross area: same as proposed	As proposed
	Solar absorptance = 0.75	As proposed
	Emittance = 0.90	As proposed
Attics	Type: vented with aperture = 1 ft^2 per 300 ft^2 ceiling area	As proposed
Foundations	Type: same as proposed	As proposed
	Foundation wall area above and below grade and soil characteristics: same as proposed	As proposed
Opaque doors	Area: 40 ft^2	As proposed
	Orientation: North	As proposed
	U-factor: same as fenestration from Table N1102.1.4	As proposed
Vertical fenestration other than opaque doors	Total area[b] = (a) The proposed glazing area, where the proposed glazing area is less than 15 percent of the conditioned floor area (b) 15 percent of the conditioned floor area, where the proposed glazing area is 15 percent or more of the conditioned floor area	As proposed
	Orientation: equally distributed to four cardinal compass orientations (N, E, S & W).	As proposed
	U-factor: as specified in Table N1102.1.4	As proposed
	SHGC: as specified in Table N1102.1.2 except that for climates with no requirement (NR) SHGC = 0.40 shall be used.	As proposed
	Interior shade fraction: 0.92-(0.21 × SHGC for the standard reference design)	0.92-(0.21 × SHGC as proposed)
	External shading: none	As proposed
Skylights	None	As proposed
Thermally isolated sunrooms	None	As proposed
Air exchange rate	Air leakage rate of 5 air changes per hour in Climate Zones 3 through ~~8~~ 5 at a pressure of 0.2 inches w.g (50 Pa). The mechanical ventilation rate shall be in addition to the air leakage rate and the same as in the proposed design, but no greater than 0.01 × *CFA* + 7.5 ×(N_{br} + 1) where: *CFA* = conditioned floor area N_{br} = number of bedrooms Energy recovery shall not be assumed for mechanical ventilation.	For residences that are not tested, the same air leakage rate as the standard reference design. For tested residences, the mea-sured air exchange rate[a]. The mechanical ventilation rate[b] shall be in addition to the air leakage rate and shall be as pro-posed.

(continued)

TABLE N1105.5.2(1)[R405.5.2(1)]—continued
SPECIFICATIONS FOR THE STANDARD REFERENCE AND PROPOSED DESIGNS

BUILDING COMPONENT	STANDARD REFERENCE DESIGN	PROPOSED DESIGN
Mechanical ventilation	None, except where mechanical ventilation is specified by the proposed design, in which case: Annual vent fan energy use: kWh/yr = 0.03942 × *CFA* + 29.565 ×(*N*$_{br}$ +1) where: *CFA* = conditioned floor area *N*$_{br}$ = number of bedrooms	As proposed
Internal gains	IGain = 17,900 + 23.8 × *CFA* + 4104 × *N*$_{br}$ (Btu/day per dwelling unit)	Same as standard reference design.
Internal mass	An internal mass for furniture and contents of 8 pounds per square foot of floor area.	Same as standard reference design, plus any additional mass specifically designed as a thermal storage element[c] but not integral to the building envelope or structure.
Structural mass	For masonry floor slabs, 80 percent of floor area covered by R-2 carpet and pad, and 20 percent of floor directly exposed to room air.	As proposed
	For masonry basement walls, as proposed, but with insulation required by Table R402.1.4 located on the interior side of the walls	As proposed
	For other walls, for ceilings, floors, and interior walls, wood frame construction	As proposed
Heating systems[d,e]	As proposed for other than electric heating without a heat pump, where the proposed design utilizes electric heating without a heat pump the standard reference design shall be an air source heat pump meeting the requirements of Section C403 of the IECC-Commercial Provisions. Capacity: sized in accordance with Section N1103.7	As proposed
Cooling systems[d,f]	As proposed Capacity: sized in accordance with Section N1103.7.	As proposed
Service water heating[d,e,f]	As proposed Use: same as proposed design	As proposed gal/day = 30 +(10 × *N*$_{br}$)

Thermal distribution systems	Duct insulation: From Section N1103.3.1 A thermal distribution system efficiency (DSE) of 0.88 shall be applied to both the heating and cooling system efficiencies for all systems other than tested duct systems. For tested duct systems, the leakage rate shall be 4 cfm (113.3 L/min) per 100 ft^2 (9.29 m^2) of *conditioned floor* area at a pressure of differential of 0.1 inches w.g. (25 Pa).	As tested or as specified in Table N1105.5.2(2) if not tested. Duct insulation shall be the same as standard reference design.
Thermostat	Type: Manual, cooling temperature setpoint = 75°F; Heating temperature setpoint = 72°F	Same as standard reference

For SI:1 square foot = 0.93 m^2, 1 British thermal unit = 1055 J, 1 pound per square foot = 4.88 kg/m^2, 1 gallon (US)= 3.785 L,°C =(°F-32)/1.8, 1 degree = 0.79 rad.

a. Where required by the *code official*, testing shall be conducted by an *approved* party. Hourly calculations as specified in the ASHRAE *Handbook of Fundamentals*, or the equivalent shall be used to determine the energy loads resulting from infiltration.

b. The combined air exchange rate for infiltration and mechanical ventilation shall be determined in accordance with Equation 43 of 2001 ASHRAE *Handbook of Fundamentals*, page 26.24 and the "Whole-house Ventilation" provisions of 2001 ASHRAE *Handbook of Fundamentals*, page 26.19 for intermittent mechanical ventilation.

c. Thermal storage element shall mean a component not part of the floors, walls or ceilings that is part of a passive solar system, and that provides thermal storage such as enclosed water columns, rock beds, or phase-change containers. A thermal storage element must be in the same room as fenestration that faces within 15 degrees (0.26 rad) of true south, or must be connected to such a room with pipes or ducts that allow the element to be actively charged.

d. For a proposed design with multiple heating, cooling or water heating systems using different fuel types, the applicable standard reference design system capacities and fuel types shall be weighted in accordance with their respective loads as calculated by accepted engineering practice for each equipment and fuel type present.

e. For a proposed design without a proposed heating system, a heating system with the prevailing federal minimum efficiency shall be assumed for both the standard reference design and proposed design.

f. For a proposed design home without a proposed cooling system, an electric air conditioner with the prevailing federal minimum efficiency shall be assumed for both the standard reference design and the proposed design.

g. For a proposed design with a nonstorage-type water heater, a 40-gallon storage-type water heater with the prevailing federal minimum energy factor for the same fuel as the predominant heating fuel type shall be assumed. For the case of a proposed design without a proposed water heater, a 40-gallon storage-type water heater with the prevailing federal minimum efficiency for the same fuel as the predominant heating fuel type shall be assumed for both the proposed design and standard reference design.

TABLE N1105.5.2(2)[R405.5.2(2)]
DEFAULT DISTRIBUTION SYSTEM EFFICIENCIES FOR PROPOSED DESIGNS[a]

DISTRIBUTION SYSTEM CONFIGURATION AND CONDITION	FORCED AIR SYSTEMS	HYDRONIC SYSTEMS[b]
Distribution system components located in unconditioned space	—	0.95
Untested distribution systems entirely located in conditioned space[c]	0.88	1
"Ductless" systems[d]	1	—

For SI:1 cubic foot per minute = 0.47 L/s, 1 square foot = 0.093m^2, 1 pound per square inch = 6895 Pa, 1 inch water gauge = 1250 Pa.

a. Default values given by this table are for untested distribution systems, which must still meet minimum requirements for duct system insulation.
b. Hydronic systems shall mean those systems that distribute heating and cooling energy directly to individual spaces using liquids pumped through closed-loop piping and that do not depend on ducted, forced airflow to maintain space temperatures.
c. Entire system in conditioned space shall mean that no component of the distribution system, including the air handler unit, is located outside of the conditioned space.
d. Ductless systems shall be allowed to have forced airflow across a coil but shall not have any ducted airflow external to the manufacturer's air handler enclosure.

N1105.6 (R405.6) Calculation software tools.
Calculation software, where used, shall be in accordance with Sections N1105.6.1 through N1105.6.3.

N1105.6.1 (R405.6.1) Minimum capabilities.
Calculation procedures used to comply with this section shall be software tools capable of calculating the annual energy consumption of all building elements that differ between the *standard reference design* and the *proposed design* and shall include the following capabilities:

1. Computer generation of the *standard reference design* using only the input for the *proposed design.* The calculation procedure shall not allow the user to directly modify the building component characteristics of the *standard reference design*.

2. Calculation of whole-building (as a single *zone)* sizing for the heating and cooling equipment in the *standard reference design* residence in accordance with Section N1103.6.

3. Calculations that account for the effects of indoor and outdoor temperatures and part-load ratios on the performance of heating, ventilating and air-conditioning equipment based on climate and equipment sizing.

4. Printed *building official* inspection checklist listing each of the *proposed design* component characteristics from Table N1105.5.2(1) determined by the analysis to provide compliance, along with their respective performance ratings (*R*-value, *U*-factor, SHGC, HSPF, AFUE, SEER, EF are some examples).

N1105.6.2 (R405.6.2) Specific approval.
Performance analysis tools meeting the applicable provisions of Section N1105 shall be permitted to be *approved.* Tools are permitted to be *approved* based on meeting a specified threshold for a jurisdiction. The *building official* shall be permitted to approve tools for a specified application or limited scope.

N1105.6.3 (R405.6.3) Input values.
When calculations require input values not specified by Sections N1102, N1103, N1104 and N1105, those input values shall be taken from an *approved* source.

SECTION N1106 (R406)

ENERGY RATING INDEX

COMPLIANCE ALTERNATIVE

N1106.1 (R406.1) Scope.
This section establishes criteria for compliance using an Energy Rating Index (ERI) analysis.

N1106.2 (R406.2) Mandatory requirements.
Compliance with this section requires that the provisions identified in Sections N1101 through N1104 labeled "mandatory" be met. The building thermal envelope shall be greater than or equal to levels of efficiency and Solar Heat Gain Coefficient in Table N1106.2.1 or Table N1106.2.2. Minimum standards associated with compliance shall be the ANSI/RESNET/ICC 301-2014 *Standard for the Calculation and Labeling of the Energy Performance of Low-Rise Residential Buildings using an Energy Rating Index*. A North Carolina *registered design professional* is required to perform the analysis if required by North Carolina licensure laws.

> **Exception:** Supply and return ducts in unconditioned space and outdoors shall be insulated to a minimum R-8. Supply ducts inside semi-conditioned space shall be insulated to a minimum R-4; return ducts inside conditioned and semi-conditioned space are not required to be insulated. Ducts located inside conditioned space are not required to be insulated other than as may be necessary for preventing the formation of condensation on the exterior of cooling ducts.

TABLE N1106.2.1
MINIMUM INSULATION AND FENESTRATION REQUIREMENTS FOR ENERGY RATING INDEX COMPLIANCE[a]

	FENESTRATION VALUES			R-VALUES FOR								
CLIMATE ZONE	FENESTRATION U-FACTOR[b,j]	SKYLIGHT[b] U-FACTOR	GLAZED FENESTRATION SHGC[b,k]	CEILING[m]	UNVENTED[p] RAFTER ASSEMBLIES IN ATTICS CONTAINING DUCTWORK, AIR-IMPERMEABLE	UNVENTED[p] RAFTER ASSEMBLIES IN ATTICS CONTAINING DUCTWORK, AIR-PERMIABLE/ IMPERMEABLE	WOOD FRAME WALL	MASS WALL[i]	FLOOR	BASEMENT[c,o] WALL	SLAB[d]	CRAWL SPACE[e] WALL
3	0.35	0.65	0.3	30	20	15-10[q]	13	5/10	19	10/13[f]	0	5/13
4	0.35	0.6	0.3	38 or 30ci[l]	20	15-10[q]	15, 13+2.5[h]	5/10	19	10/13	10	10/13
5	0.35	0.6	NR	38 or 30ci[l]	25	15-20[q]	19[n], 13+5[h], or 15+3[h]	13/17	30[g]	10/13	10	10/13

For SI: 1 foot = 304.8 mm.
a. *R*-values are minimums. *U*-factors and SHGC are maximums.
b. The fenestration *U*-factor column excludes skylights. The SHGC column applies to all glazed fenestration.
c. "10/13" means R-10 continuous insulated sheathing on the interior or exterior of the home or R-13 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 18 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 O) 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 N1101.7 and Table N1101.7.
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 N1102.3.3, 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 N1102.3.3, 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 either to the insulation baffle or within 1" 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 2x4 wall are 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.
p. The air-impermeable insulation shall meet the requirements of the definition in Section R202. Air-impermeable insulation shall be installed in direct contact with the underside of the structural roof sheathing. For one- and two-family dwellings and townhouses, the insulation installation shall meet the requirements of R806.5 of the North Carolina Residential Code. For Residential Buildings other than one- and two-family dwellings and townhouses, the insulation installation shall meet the installation requirements of 1203.3 of the North Carolina Building Code. Exposed rafters shall be covered with R-7 insulation.
q. The value for air-permeable insulation is shown first and that for air-impermeable insulation second. Thus, R-15 + R-10 indicates that the minimum value for air-permeable insulation is R-15, and the minimum value for air-impermeable insulation is R-10. Air-impermeable insulation shall be installed in direct contact with the underside of the structural roof sheathing. The air-permeable insulation shall be installed directly under the air-impermeable insulation. Exposed rafters shall be covered with R-7 insulation.

TABLE N1106.2.2
EQUIVALENT U-FACTORS FOR TABLE N1106.2.1[a]

CLIMATE ZONE	FENESTRATION [d]	SKYLIGHT U-FACTOR	CEILING	UNVENTED [e] RAFTER ASSEMBLIES IN ATTICS CONTAINING DUCTWORK, AIR-IMPERMEABLE	UNVENTED [e] RAFTER ASSEMBLIES IN ATTICS CONTAINING DUCTWORK, AIR-PERMIABLE/ IMPERMEABLE	FRAME WALL	MASS WALL[b]	FLOOR	BASEMENT[d] WALL	CRAWL SPACE[c] WALL
3	0.35	0.65	0.0350	0.05	0.043[f]	0.082	0.141	0.047	0.059	0.136
4	0.35	0.60	0.0300	0.05	0.043[f]	0.077	0.141	0.047	0.059	0.065
5	0.35	0.60	0.0300	0.037	0.034[f]	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 N1101.7 and Table N1101.7.
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.

e. The air-impermeable insulation shall meet the requirements of the definition in section R202. Air-impermeable insulation shall be installed in direct contact with the underside of the structural roof sheathing. For one- and two-family dwellings and townhouses, the insulation installation shall meet the requirements of R806.5 of the North Carolina Residential Code. Exposed rafters shall be covered with R-7 insulation.
f. For air-permeable/ impermeable applications, Table N1106.2.1 shall be followed for minimum insulation values.

N1106.3 (R406.3) Energy rating index.
The Energy Rating Index (ERI) shall be a numerical integer value that is based on a linear scale constructed such that the *ERI reference design* has an Index value of 100 and a *residential building* that uses no net purchased energy has an Index value of 0. Each integer value on the scale shall represent a 1 percent change in the total energy use of the rated design relative to the total energy use of the *ERI reference design*. The ERI shall consider all energy used in the *residential building*.

N1106.3.1 (R406.3.1) ERI reference design.
The *ERI reference design* shall be configured such that it meets the minimum requirements of the 2006 *International Energy Conservation Code* prescriptive requirements.

The proposed *residential building* shall be shown to have an annual total normalized modified load less than or equal to the annual total loads of the *ERI reference design*.

N1106.4 (R406.4) ERI-based compliance.
Compliance based on an ERI analysis requires that the *rated design* be shown to have an ERI less than or equal to the appropriate value listed in Table N1106.4.1 or Table N1106.4.2, as applicable, when compared to the *ERI reference design*.

TABLE N1106.4.1 (R406.4.1)
MAXIMUM ENERGY RATING INDEX
(without calculation of on-site renewable energy)

CLIMATE ZONE	JAN. 1, 2019 – DEC. 31, 2022	JAN. 1, 2023 AND FORWARD
3	65	61
4	67	63
5	67	63

TABLE N1106.4.2 (R406.4.2)
MAXIMUM ENERGY RATING INDEX
(including calculation of on-site renewable energy)

CLIMATE ZONE	JAN. 1, 2019 – DEC. 31, 2022	JAN. 1, 2023 AND FORWARD
3	51	47
4	54	50
5	55	51

N1106.5 (R406.5) Verification.
Verification of compliance with Section N1106 shall be performed by the *licensed design professional* or certified HERS rater and the compliance documentation shall be provided to the *code official*. The *code official* shall inspect according to the requirements of Section N1106.6.2.

N1106.6 (R406.6) Documentation.
Documentation of the software used to determine the ERI and the parameters for the residential building shall be in accordance with Sections N1106.6.1 through N1106.6.3.

N1106.6.1 (R406.6.1) Compliance software tools.
Compliance software tools for this section shall be in compliance with ANSI/RESNET/ICC 301-2014.

N1106.6.2 (R406.6.2) Compliance report.
Compliance software tools shall generate a report that documents that the ERI of the *rated design* complies with Sections N1106.3 and N1106.4. The compliance documentation shall include the following information:

1. Address or other identification of the residential building.

2. An inspection checklist documenting the building component characteristics of the *rated design*. The inspection checklist shall show results for both the *ERI reference design* and the *rated design*, and shall document all inputs entered by the user necessary to reproduce the results.

3. Name of individual completing the compliance report.

4. Name and version of the compliance software tool.

N1106.6.3 (R406.6.3) Additional documentation. Deleted.

N1106.7 (R406.7) Calculation software tools.
Calculation software, where used, shall be in accordance with Sections N1106.7.1 through N1106.7.3.

N1106.7.1 R(406.7.1) Minimum capabilities.
Calculation procedures used to comply with this section shall be software tools capable of calculating the ERI as described in Section N1106.3 and shall be in compliance with ANSI/RESNET/ICC 301, and the software shall include the following capabilities:

1. Computer generation of the *ERI reference design* using only the input for the *rated design*.

The calculation procedure shall not allow the user to directly modify the building component characteristics of the *ERI reference design*.

2. Calculation of whole-building, as a single *zone*, sizing for the heating and cooling equipment in the *ERI reference design* residence in accordance with Section N1103.7.

3. Calculations that account for the effects of indoor and outdoor temperatures and part-load ratios on the performance of heating, ventilating and air-conditioning equipment based on climate and equipment sizing.

4. Printed *code official* inspection checklist listing each of the *rated design* component characteristics determined by the analysis to provide compliance, along with their respective performance ratings.

N1106.7.2 (406.7.2) Specific approval. Deleted.

N1106.7.3 (R406.7.3) Input values. Deleted.

SECTION N1107 (R501)
EXISTING BUILDINGS—GENERAL

N1107.1 (R501.1) Scope.
The provisions of Sections N1107 through N1111 shall control the *alteration*, repair, addition and change of occupancy of existing buildings and structures. When a section is identified to apply, the subsections to that section also apply.

N1107.1.1 (R501.1.1) Additions, alterations, or repairs: General.
Additions, alterations, or repairs to an existing building, building system or portion thereof shall comply with Section N1108, N1109 or N1110. Unaltered portions of the existing building or building supply system shall not be required to comply with this chapter.

N1107.2 (R501.2) Existing buildings.
Except as specified in this chapter, this code shall not be used to require the removal, *alteration* or abandonment of, nor prevent the continued use and maintenance of, an existing building or building system lawfully in existence at the time of adoption of this code.

N1107.3 (R501.3) Maintenance. Deleted.

N1107.4 (R501.4) Compliance.
Alterations, *repairs*, *additions* and changes of occupancy to, or relocation of, existing buildings and structures shall comply with the provisions for *alterations*, *repairs*, *additions* and changes of occupancy or relocation, respectively, in this code and the *International Building Code*, *International Fire Code*, *International Fuel Gas Code*, *International Mechanical Code*, *International Plumbing Code*, *North Carolina Existing Building Code* and NFPA 70.

N1107.5 (R501.5) New and replacement materials.
Except as otherwise required or permitted by this code, materials permitted by the applicable code for new construction shall be used. Like materials shall be permitted for repairs, provided no hazard to life, health or property is created. Hazardous materials shall not be used where the code for new construction would not permit their use in buildings of similar occupancy, purpose and location.

N1107.6 (R501.6) Historic buildings.
No provision of this chapter relating to the construction, *repair, alteration,* restoration and movement of structures, and *change of occupancy* shall be mandatory for *historic buildings*.

SECTION N1108 (R502)

ADDITIONS

N1108.1 (R502.1) General.
Additions to an existing building, building system or portion thereof shall conform to the provisions of this chapter as they relate to new construction without requiring the unaltered portion of the existing building or building system to comply with this chapter. Additions shall not create an unsafe or hazardous condition or overload existing building systems. An addition shall be deemed to comply with this chapter where the addition alone complies, where the existing building and addition comply with this chapter as a single building, or where the building with the addition uses no more energy than the existing building. Additions shall be in accordance with Section N1108.1.1 or N1108.1.2.

N1108.1.1 (R502.1.1) Prescriptive compliance.
Additions shall comply with Sections N1108.1.1.1 through N1108.1.1.4.

N1108.1.1.1 (R502.1.1.1) Building envelope.
New building envelope assemblies that are part of the addition shall comply with Sections N1102.1, N1102.2, N1102.3.1 through N1102.3.5, and N1102.4.

N1108.1.1.2 (R502.1.1.2) Heating and cooling systems.
New heating, cooling and duct systems that are part of the addition shall comply with Sections N1103.1, N1103.2, N1103.3, N1103.4 and N1103.6. New heating and cooling appliances shall be sized in accordance with Section N1103.7. Extensions of ducts from an existing system to a new addition shall require that the existing system be evaluated for the new design.

Exception: Installation of an addition to an existing duct system shall not require a duct leakage test.

N1108.1.1.3 (R502.1.1.3) Service hot water systems.
New service hot water systems that are part of the addition shall comply with Section N1103.5.

N1108.1.1.4 (R502.1.1.4) Lighting.
New lighting systems that are part of the addition shall comply with Section N1104.1.

N1108.1.2 (R502.1.2) Simulated Performance Alternative for additions
The addition shall comply with Section N1105, as applicable.

SECTION N1109 (R503)

ALTERATIONS

N1109.1 (R503.1) General.

Alterations to an existing building, building system or portion thereof shall conform to the provisions of this chapter as they relate to new construction without requiring the unaltered portions of the existing building or building system to comply with this chapter. Alterations shall not create an unsafe or hazardous condition or overload existing building systems. Alterations to existing buildings shall comply with Sections N1109.1.1 through N1109.2.

N1109.1.1 (R503.1.1) Building envelope.
Building envelope assemblies that are part of the alteration shall comply with Section N1102.1.2 or N1102.1.4, Sections N1102.2.1 through N1102.2.15, N1102.3.1, N1102.3.2, N1102.4.4 and N1102.4.6.

Exception: The following alterations to conditioned spaces need not comply with the requirements for new construction:

1. Storm windows installed over existing fenestration.

2. Existing ceiling, wall or floor cavities exposed during construction provided that these cavities are filled with insulation. Roof systems requiring air space for ventilation shall retain the ventilation space required.

3. Construction where the existing roof, wall or floor cavity is not exposed.

4. Roof recover and roof replacement such that the existing building or structure is no less conforming to the provisions of this code than the existing building or structure was prior to the *alteration*.

5. Deleted.

6. Surface applied window film installed on existing single pane fenestration assemblies to reduce solar heat gain.

7. Converting unconditioned attic space to conditioned attic space for one and two-family dwellings and townhouses. Ceilings shall be insulated to a minimum of R-30, walls shall be insulated to the exterior wall requirements in Table N1102.1.2 or Table N1102.1.4 and follow the backing requirements in Section N1102.2.14 and N1102.2.15.

N1109.1.1.1 (R503.1.1.1) Replacement fenestration.
Where an entire existing fenestration unit is replaced with a new fenestration product, including frame, sash and glazing, the replacement fenestration unit shall meet the applicable requirements for *U*-factor and SHGC in Table N1102.1.2.

Exception: *Alterations* that replace less than 50 percent of entire fenestration units may be replaced with like or better fenestration units to match existing fenestration assemblies.

N1109.1.2 (R503.1.2) Heating and cooling systems.
New heating, cooling and duct systems that are part of the alteration shall comply with Sections N1103.1, N1103.2, N1103.3, N1103.4, N1103.6, and N1103.7.

Exception: An *alteration* involving a partial system replacement to an existing duct system shall not require a duct leakage test.

N1109.1.3 (R503.1.3) Service hot water systems.
New service hot water systems that are part of the alteration shall comply with Section N1103.5.

N1109.1.4 (R503.1.4) Lighting.
New lighting systems that are part of the alteration shall comply with Section N1104.1.

Exception: Alterations that replace less than 50 percent of the luminaires in a space, provided that such alterations do not increase the installed interior lighting power.

N1109.2 (R503.2) Change in space conditioning.
In addition to the requirements of Section N1109.1, projects changing unconditioned space to conditioned space and costing more than $10,000 shall require 10 percent of the project cost to be used toward meeting the requirements of this chapter. Project costs for the purpose of this section is the total project cost listed on all permits related to the work required to convert the unconditioned space to conditioned space and excludes the 10 percent added from this section. Under this section, existing building envelope elements that become a part of the building thermal envelope and are not changed are not required to be upgraded. The additional 10 percent of the project cost shall be appropriated for additional energy conservation features of choice that are addressed in this chapter. In addition to the 10 percent project cost, any existing wall, ceiling, or floor cavities that are exposed during construction shall at a minimum be insulated to comply with this chapter or be insulated to fill the cavity, whichever is less. Roof systems requiring air space for ventilation shall retain the ventilation space required. Projects costing less than $10,000 are not subject to the 10 percent project cost addition provision.

SECTION N1110 (R504)

REPAIRS

N1110.1 (R504.1) General.
Repair of the building systems shall not make the building less conforming than it was before the *repair* was undertaken. Work on nondamaged components necessary for the required *repair* of damaged components shall be considered part of the *repair* and shall not be subject to the requirements for *alterations* in this chapter.

N1110.2 (R504.2) Materials.
Portions of walls that are part of the building thermal envelope shall be insulated in accordance with this code when the repair requires the removal of either the interior or exterior wall membrane such that the wall cavity is exposed during the repair.

Exception: Wall cavities containing existing insulation material.

R504.3 Glazing.
Repairs requiring the replacement of individual glass panes or sashes shall not require compliance with this code.

SECTION N1111 (R505)

CHANGE OF OCCUPANCY OR USE

N1111.1 (R505.1) General.
Alterations performed in spaces undergoing a change in occupancy shall comply with the requirements of this code. Unaltered portions of the existing building or building supply system shall not be required to comply with this code.

N1111.2 (R505.2) General. Deleted.