IRC CHAPTER 11 ENERGY CONSERVATION
PUBLIC COMMENT DRAFT #1 UPDATE
DECEMBER 26, 2022

THE FOLLOWING IS AN UPDATE TO THE STRIKETHROUGH/UNDERLINE IRC CHAPTER 11 ENERGY CONSERVATION PUBLIC COMMENT DRAFT #1 UPDATED WITH ERRATA FROM PUBLIC COMMENT AND STAFF. THE ERRATA COLLECTED FROM PUBLIC COMMENT ARE PLACED AT THE END OF THE DOCUMENT FOR REFERENCE.

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 (Not subject to public input). ~~This chapter regulates the energy efficiency for the design and construction of buildings regulated by this code.~~This chapter applies to the design and construction of residential buildings as regulated by this code.

Note: *The text of* ***Sections N1101.2*** *through* ***N1113*** *parallels the text of the 2024 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 (Not subject to public input). ~~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.~~This chapter provides market-driven, enforceable requirements for the design and construction of residential buildings, providing minimum efficiency requirements for buildings that result in the maximum level of energy efficiency that is safe, technologically feasible, and life cycle cost effective, considering economic feasibility, including potential costs and savings for consumers and building owners, and return on investment. Additionally, the code provides jurisdictions with optional supplemental requirements, including requirements that lead to achievement of zero energy buildings, presently, and, through glidepaths that achieve zero energy buildings by 2030 and on additional timelines sought by governments, and achievement of additional policy goals as identified by the Energy and Carbon Advisory Council and approved by the Board of Directors. The code may include non-mandatory appendices incorporating additional energy efficiency and greenhouse gas reduction resources developed by the Code Council and others. Requirements contained in the code will include, but not be limited to, prescriptive- and performance-based pathways. The code will aim to simplify code requirements to facilitate the code's use and compliance rate. The code is updated on a three-year cycle with each subsequent edition providing increased energy savings over the prior edition. The IECC residential provisions shall include an update to Chapter 11 of the International Residential Code. This code is intended to provide flexibility to permit the use of innovative approaches and techniques to achieve this intent. This code 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 and~~ and ~~the~~ proposed total *building thermal envelope UA, which is the sum of U-factor times assembly area, shall be less* ~~is greater~~ 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 4-1. The area-weighted maximum fenestration SHGC permitted in Climate Zones 0 through 3 shall be 0.30. ~~levels of efficiency and solar heat gain coefficients (SHGC) in Tables 402.1.1 and **402.1.3** of the 2009 *International Energy Conservation Code*~~.

$$UA_{\text{Proposed design}} \leq 1.15 \times UA_{\text{Prescriptive reference design}}$$

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.

APPROVED SOURCE. An independent person, firm or corporation, approved by the *code official*, who is competent and experienced in the application of engineering principles to materials, methods or system analyses.

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***").

AUTOMATIC SHUT-OFF CONTROL. A device capable of automatically turning loads off without manual intervention. Automatic shut-off controls include devices such as, but not limited to, occupancy sensors, vacancy sensors, door switches, programmable time switches (i.e., timeclocks), or count-down timers.

AUTOMOBILE PARKING SPACE. A space within a building or private or public parking lot, exclusive of driveways, ramps, columns, office and work areas, for the parking of an automobile. Content

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.

CONSTRUCTION DOCUMENTS. Written, graphic and pictorial documents prepared or assembled for describing the design, location and physical characteristics of the elements of a project necessary for obtaining a building permit.

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.

DEMAND RESPONSE SIGNAL. A signal that indicates a price or a request to modify electricity consumption for a limited time period.

DEMAND RESPONSIVE CONTROL. A control capable of receiving and automatically responding to a demand response signal.

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

DISTRIBUTION SYSTEM EFFICIENCY (DSE). A system efficiency factor that adjusts for the energy losses associated with delivery of energy from the equipment to the source of the load.

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 AIRFLOW BALANCING. The measurement and adjustment of the delivered airflow to the intended locations.

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.

ELECTRIC VEHICLE (EV). An automotive-type vehicle for on-road use, such as passenger automobiles, buses, trucks, vans, neighborhood electric vehicles, and electric motorcycles, primarily powered by an electric motor that draws current from a building electrical service, EVSE, a rechargeable storage battery, a fuel cell, a photovoltaic array, or another source of electric current.

ELECTRIC VEHICLE CAPABLE SPACE (EV CAPABLE SPACE). .. A designated automobile parking space that is provided with electrical infrastructure, such as, but not limited to, raceways, cables, electrical capacity, and panelboard or other electrical distribution equipment space, necessary for the future installation of an EVSE.

ELECTRIC VEHICLE READY SPACE (EV READY SPACE). An automobile parking space that is provided with a branch circuit and either an outlet, junction box or receptacle, that will support an installed EVSE.

ELECTRIC VEHICLE SUPPLY EQUIPMENT (EVSE). .. Equipment for plug-in power transfer including the ungrounded, grounded and equipment grounding conductors, and the electric vehicle connectors, attached plugs, personal protection system and all other fittings, devices, power outlets or apparatus installed specifically for the purpose of transferring energy between the premises

wiring and the electric vehicle.

ELECTRIC VEHICLE SUPPLY EQUIPMENT INSTALLED SPACE (EVSE SPACE). An automobile parking space that is provided with a dedicated EVSE connection

EMITTANCE. The ratio of the radiant heat flux emitted by a specimen to that emitted by a blackbody at the same temperature and under the same conditions.

ENCLOSED REFLECTIVE AIR SPACE. An unventilated cavity with a low-emittance surface bounded on all sides by building components.

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*.

EXTERIOR WALL ENVELOPE. A system or assembly of exterior wall components, including exterior wall finish materials, that provides protection of the building structural members, including framing and sheathing materials, and conditioned interior space, from the detrimental effects of the exterior environment.

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.

F-FACTOR (THERMAL TRANSMITTANCE). The perimeter heat loss factor for slab-on-grade floors (Btu/h·ft·°F) [W/(m·K)].

GRADE PLANE. A reference plane representing the average of the finished ground level adjoining the building at all exterior walls. Where the finished ground level slopes away from the exterior wall, the reference plane shall be established by the lowest points withing the area between the building and the lot line or, where the lot line is more than 6 feet (1829 mm) from the building between the structure and a point 6 feet (1829 mm) from the building.

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.** Any lamp 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.

KNEE WALL. An above-grade wall assembly, or wall defined by vertical truss members, of any height that separate conditioned space from unconditioned buffer spaces, such as ventilated attics and entry porch roofs, rather than ambient outdoors.

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.

LIVING SPACE. Space within a dwelling unit utilized for living, sleeping, eating, cooking, bathing, washing and sanitation purposes.

LOW-SLOPED ROOF. A roof slope less than 2 units vertical in 12 units horizontal (17 percent slope).

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.

PILOT LIGHT, CONTINUOUSLY BURNING. A small gas flame used to ignite gas at a larger burner. Once lit, a continuously pilot light remains in operation until manually interrupted. Pilot light ignition systems with the ability to switch between intermittent and continuous mode are considered continuous.

PILOT LIGHT, INTERMITTENT. A pilot which is automatically ignited when an appliance is called on to operate and which remains continuously ignited during each period of main burner operation. The pilot is automatically extinguished when each main burner operating cycle is completed.

PILOT LIGHT, INTERRUPTED. A pilot which is automatically ignited prior to the admission of fuel to the main burner and which is automatically extinguished after the main flame is established.

PILOT LIGHT, ON-DEMAND. A pilot which, once placed into operation, is intended to remain ignited for a predetermined period of time following an automatic or manual operation of the main burner gas valve.

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

RADIANT BARRIER. A material having a low emittance surface of 0.1 or less installed in building assemblies.

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.

REFLECTIVE INSULATION. A material with a surface emittance of 0.1 or less in an assembly consisting of one or more enclosed reflective air spaces.

RENEWABLE ENERGY CERTIFICATE (REC). ~~An~~ A market based instrument that represents and conveys the environmental attributes of one megawatt hour of renewable ~~energy~~electricity generation and could be sold separately from the underlying physical electricity associated with renewable energy resources ; also known as an energy attribute and 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.~~An alteration that includes the removal of all existing layers of roof assembly materials down to the roof deck and installing replacement materials above the existing roof deck.

***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.

SIMULATED BUILDING PERFORMANCE. A process in which the proposed building design is compared to a standard reference design for the purposes of estimating relative energy use against a baseline to determine code compliance.

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.

SOLAR-READY ZONE. A section or sections of the roof or building overhang designated and reserved for the future installation of a solar photovoltaic or solar thermal system

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~~ simulated building performance.

STEEP-SLOPED ROOF. A roof slope 2 units vertical in 12 units horizontal (17 percent slope) or greater.

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.

WORK AREA . That portion or portions of a building consisting of all reconfigured spaces as indicated on the construction documents. Work area excludes other portions of the building where

incidental work entailed by the intended work must be performed and portions of the building where work not initially intended by the owner is specifically required by this code.

ZONAL HEATING. A heating system in which each zone or room has a separate heater with a single controller in each zone.

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**.

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[a]

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
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
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
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*
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*
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
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
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
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
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
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
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*
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
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
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
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
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
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
4B 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
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
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
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
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
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
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
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
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*
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*

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
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
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
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
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)*

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

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.~~Equation 11-2.

$$P < 0.44 \text{ x } (T\text{-}7)$$

$$[P < 20.0 \text{ x } (T + 14) \text{ in SI units}]$$

(Equation 11-2)

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.~~Equation 11-3.

$$P < 0.44 \text{ x } (T\text{-}19.5)$$

$$[P < 20.0 \text{ x } (T + 7) \text{ in SI units}]$$

(Equation 11-3)

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.~~Equation 11-4

$$P < 0.44 \text{ x } (T\text{-}32)$$

$$[P < 20.0 \text{ x } T \text{ in SI units}]$$

(Equation 11-4)

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 < CDD50ºF < 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 reflective insulation, the number of reflective sheet(s), the number and thickness of the enclosed reflective air space(s) and the R-value for the installed assembly, shall be listed 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.

Exception: For roof insulation installed above the deck, the R-value shall be labeled as specified by the material standards in Table 1508.2 of the *International Building Code* or Table R906.2, as applicable.

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.

N1101.11.2 (R303.2.2) Radiant barrier Where installed, radiant barriers shall comply with the requirements of ASTM C1313/C1313M.

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~~ either 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** and N1108.

N1101.13.2 (R401.2.2) ~~Total~~ Simulated Building Performance Option. The ~~Total~~ Simulated 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 N1105.2** 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, and where applicable, the additional efficiency measures selected for compliance with N1108.
8. Where a solar-ready zone is provided, the certificate shall indicate the location, and dimensions.

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 or *F*-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 N1102.1.2(R402.1.2)
MAXIMUM ASSEMBLY *U*-FACTORS[a] AND FENESTRATION REQUIREMENTS

CLIMATE ZONE	0	1	2	3	4 except Marine	5 and Marine 4	6	7 and 8
FENESTRATION *U*-FACTOR[f]	0.50	0.50	0.40	0.30	0.30	~~0.30~~0.28[e]	~~0.30~~0.28[e]	~~0.30~~0.27[e]
SKYLIGHT *U*-FACTOR	~~0.75~~0.60	~~0.75~~0.60	~~0.65~~0.60	~~0.55~~0.53	~~0.55~~0.53	~~0.55~~0.50	~~0.55~~0.50	~~0.55~~0.50
GLAZED FENESTRATION SHGC[d, ~~e~~]	0.25	0.25	0.25	0.25	0.40	~~0.40~~NR	NR	NR
CEILING *U*-FACTOR	0.035	0.035	~~0.026~~0.030	~~0.026~~0.030	~~0.024~~0.026	~~0.024~~0.026	~~0.024~~0.026	~~0.024~~0.026
WOOD FRAME WALL *U*-FACTOR	0.084	0.084	0.084	0.060	0.045	0.045	0.045	0.045
MASS WALL *U*-FACTOR[b]	0.197	0.197	0.165	0.098	0.098	0.082	0.060	0.057
FLOOR *U*-FACTOR	0.064	0.064	0.064	0.047	0.047	0.033	0.033	0.028
BASEMENT WALL *U*-FACTOR	0.360	0.360	0.360	0.091[c]	0.059	0.050	0.050	0.050
UNHEATED SLAB F-FACTOR[g]	0.73	0.73	0.73	0.54	0.51	0.51	0.48	0.48
HEATED SLAB F-FACTOR[g]	0.74	0.74	0.74	0.66	0.66	0.66	0.66	0.66
CRAWL SPACE WALL *U*-FACTOR	0.477	0.477	0.477	0.136	0.065	0.055	0.055	0.055

For SI: 1 foot = 304.8 mm.

a. Nonfenestration *U*-factors and F-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 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~~0.28.

~~e. There are no SHGC requirements in the Marine Zone.~~
~~f.~~e. A maximum *U*-factor of ~~0.32~~0.30 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.

f. Roofs with insulation entirely above deck shall comply with Section C402.2.1 and the Group R U-factors ofTable C402.1.2.
g. F-factors for slabs correspond to the R-values of Table N1102.1.3 and the installation conditions of Section N1102.2.10.1.

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 or F-factor in **Table N1102.1.2**. *R*-values of insulation materials for the assemblies specified in Appendix BE that have a *U*-factor less than or equal to the *U*-factor required by Table N1102.1.2 shall be permitted.

TABLE N1102.1.3(R402.1.3)
INSULATION MINIMUM *R*-VALUES AND FENESTRATION REQUIREMENTS BY COMPONENT[a]

CLIMATE ZONE	0	1	2	3	4 except Marine	5 and Marine 4	6	7 and 8
FENESTRATION *U*-FACTOR[b, i]	~~NR~~0.50	~~NR~~0.50	0.40	0.30	0.30	~~0.30~~0.28[i,h]	~~0.30~~0.28[i,h]	~~0.30~~0.27[i,h]
SKYLIGHT[b] *U*-FACTOR	~~0.75~~0.60	~~0.75~~0.60	~~0.65~~0.60	~~0.55~~0.53	~~0.55~~0.53	~~0.55~~0.50	~~0.55~~0.50	~~0.55~~0.50
GLAZED FENESTRATION SHGC[b, e]	0.25	0.25	0.25	0.25	0.40	~~0.40~~NR	NR	NR
CEILING *R*-VALUE[i]	30	30	~~49~~38	~~49~~38	~~60~~49	~~60~~49	~~60~~49	~~60~~49
WOOD FRAME WALL *R*-VALUE[g]	13 or 0&10ci	13 or 0&10ci	13 or 0&10ci	20 or 13&5ci or 0&15ci	30 or 20&5ci or 13&10ci or 0&20ci	30 or 20&5ci or 13&10ci or 0&20ci	30 or 20&5ci or 13&10ci or 0&20ci	30 or 20&5ci or 13&10ci or 0&20ci
MASS WALL *R*-VALUE[h]	3/4	3/4	4/6	8/13	8/13	13/17	15/20	19/21
FLOOR *R*-VALUE[j]	13 or 7+5ci or 10ci	13 or 7+5ci or 10ci	13 or 7+5ci or 10ci	19 or 13+5ci or 15ci	19 or 13+5ci or 15ci	30 or 19+7.5ci or 20ci	30 or 19+7.5ci or 20ci	38 38 or 19+10ci or 25ci
BASEMENT[c, g] WALL *R*-VALUE	0	0	0	5ci or 13[f]	10ci or 13	15ci or 19 or 13&5ci	15ci or 19 or 13&5ci	15ci or 19 or 13&5ci
UNHEATED SLAB[d] R-VALUE & DEPTH	0	0	0	10ci, 2 ft	10ci, 34 ft	10ci, 34 ft	10ci, 4 ft	10ci, 4 ft
HEATED SLAB[d] R-VALUE & DEPTH	R-5ci edge and R-5 full slab	R-5ci edge and R-5 full slab	R-5ci edge and R-5 full slab	R10ci, 2 ft and R-5 full slab	R10ci, 3 ft and R-5 full slab	R10ci, 3 ft and R-5 full slab	R10ci, 4 ft and R-5 full slab	R10ci, 4 ft and R-5 full slab
CRAWL SPACE[c, g] WALL R-VALUE	0	0	0	5ci or 13[f]	10ci or 13	15ci or 19 or 13&5ci	15ci or 19 or 13&5ci	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~~0.28.

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. Slab insulation shall be installed in accordance with Section N1102.2.10.1.~~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.~~e. Basement wall insulation shall not be required in Warm Humid locations as defined by **Figure N1101.7** and **Table N1101.7**.

➡

~~g.~~f. 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.~~g. Mass walls shall be in accordance with **Section N1102.2.6**. The second *R*-value applies where more than half of the insulation is on the interior of the mass wall.

~~i.~~ h. A maximum *U*-factor of ~~0.32~~ 0.30 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, or
   2. In windborne debris regions where protection of openings is required by Section R301.2.1.2.

i. Roofs with insulation entirely above deck shall comply with Section C402.2.1 and the Group R R-values of Table C402.1.2.

j. "30 or 19+7.5ci or 20ci" means R30 cavity insulation alone or R19 cavity insulation with R7.5 continuous insulation or R20 continuous insulation alone.

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~~ Component performance alternative. Where the proposed total

building thermal envelope thermal conductance ~~UA, the sum of *U*-factor times assembly area,~~ is less than or equal to the required total building thermal envelope conductance using ~~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~~ total thermal conductance shall be ~~performed~~ determined in accordance with Equation 11-5. Proposed U-factors and slab-on-grade F-factors shall be taken from ANSI/ASHRAE/IES Standard 90.1 Appendix A or determined using a method consistent with the ASHRAE *Handbook of Fundamentals* and shall include the thermal bridging effects of framing materials. In addition to ~~UA~~ total thermal conductance compliance, the SHGC requirements of **Table N1102.1.2** and the maximum fenestration *U*-factors of **Section N1102.6** shall be met.

$$(Up\ A + F\ P) \leq (Ur\ A + Fr\ P)$$

(Equation 11-5)

Up A = the sum of proposed U-factors times the assembly areas in the proposed building.
Fp P = the sum of proposed F-factors times the slab-on-grade perimeter lengths in the proposed building.
Ur A = the sum of U-factors in Table N1102.1.2 times the same assembly areas as in the proposed building.
Fr P = the sum of F-factors in Table N1102.1.2 times the same slab-on-grade perimeter lengths as in the proposed building.

Exception: For Climate Zones 0, 1, and 2, the value of FrP shall equal the value of FpP

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 **N1102.2.13**.

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

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) Attic knee wall Attic knee wall assemblies that separate conditioned space from unconditioned attic spaces shall meet the same insulation requirements as above-grade walls. Such knee walls shall have an air barrier between conditioned an unconditioned space.

N1102.2.3.1 (R402.2.3.1) Truss framing separating conditioned and unconditioned space. Where vertical roof truss framing members are used to separate conditioned space and unconditioned space, they shall meet the same insulation requirements as the above-grade walls.

~~**N1102.2.3**~~**N1102.2.4 (R402.2.4) 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**~~**N1102.2.5 (R402.2.5) 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**~~**N1102.2.5.1 (R402.2.5.1) Access hatch and door insulation installation and retention.** Vertical or horizontal access hatches and doors from *conditioned spaces* to *unconditioned spaces* such as attics and crawl spaces shall be weatherstripped. Access that prevents damaging or compressing the insulation shall be provided to all equipment. Where loose-fill insulation is installed, a wood-framed or equivalent baffle, retainer, or dam shall be installed to prevent loose-fill insulation from spilling into living space from higher to lower sections of the attic, and from attics covering conditioned spaces to unconditioned spaces. The baffle or retainer shall provide a permanent means of maintaining the installed *R*-value of the loose-fill insulation.

~~**N1102.2.5**~~**N1102.2.6 (R402.2.6) 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**~~**N1102.2.7 (R402.2.7) Steel-frame ceilings, walls, and floors.** Steel-frame ceilings, walls, and floors shall comply with the ~~insulation requirements of Table N1102.2.7 or the~~ *U*-factor requirements of **Table N1102.1.2**. The calculation of the *U*-factor for a steel-~~frame~~ framed ceilings and walls in an envelope assembly shall ~~use a series-parallel path calculation method~~be determined in accordance with AISI S250 as modified herein.

1. Where the steel-framed wall contains no cavity insulation, and uses continuous insulation to satisfy the U-factor maximum, the steel-framed wall member spacing is permitted to be installed at any on center spacing.
2. Where the steel-framed wall contains framing spaced at 24 inches (610 mm) on center with a 23 percent framing factor or framing spaced at 16 inches (400 mm) on center with a 25 percent framing factor, the next lower framing member spacing input values shall be used when calculating using AISI S250.
3. Where the steel-framed wall contains less than 23 percent framing factors the AISI S250 shall be used without any modifications.

4. Where the steel-framed wall contains other than standard C-shape framing members the AISI S250 calculation option for other than standard C-shape framing is permitted to be used.

~~**N1102.2.7**~~**N1102.2.8 (R402.2.8) 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~~values of the cavity and continuous insulation components or the R-value of continuous insulation only shall equal the required insulation component *R*-~~value~~values for floors. Cavity insulation ~~Insulation~~ shall extend from the bottom to the top of all perimeter floor framing members and the framing members shall be air sealed.

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~~**N1102.2.8**~~**N1102.2.9 (R402.2.9) 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 **N1102.2.8**.
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 N1102.5**.
6. The building thermal envelope separating the basement from adjacent conditioned spaces complies with **Section N1102.5**.

~~**N1102.2.8.1**~~**N1102.2.9.1 (R402.2.9.1) 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**~~**N1102.2.10 (R402.2.10) Slab-on-grade floors.** Slab-on-grade floors, in contact with the ground, with a floor surface within 24 ~~less than 12~~ inches (600~~305~~ mm) above or 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**~~**N1102.2.10.1 (R402.2.10.1) Slab-on-grade floor insulation installation.** Where installed, the slab edge continuous insulation shall extend downward from the top of the slab on the outside or inside of the foundation wall. Insulation located below grade shall be extended the vertical distance provided in Table N1102.1.3, but need not exceed the footing depth in accordance with Section 403.1.4 of the International Residential Code. ~~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.~~ Alternatively, a proposed design for slab insulation R-value and installation shall comply with Table N1102.1.2, Section N1102.1.5, or Section N1105. Where a proposed design includes insulation ~~Insulation~~ extending away from the

building, it 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. Where installed, full slab insulation shall be continuous under the entire area of the slab-on-grade floor, except at structural column locations and service penetrations. Slab edge insulation required at the heated slab perimeter shall not be required to extend below the bottom of the heated slab and shall be continuous with the full slab insulation.

~~**N1102.2.10**~~**N1102.2.11 (R402.2.11) 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 N1102.2.8**.

~~**N1102.2.10.1**~~**N1102.2.11.1 (R402.2.11.1) Crawl space wall insulation installation.** ~~Where crawl~~ Crawl space wall insulation ~~is installed, it~~ shall comply with the following: ~~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).~~

1. Where exterior crawl space wall insulation is installed, it shall be permanently attached to the wall and extend downward from the sill plate to not less than the base of the foundation wall.
2. Where interior crawl space wall insulation is installed, it shall be permanently attached to the foundation wall and extend downward from the sill plate at the top of the foundation wall to not less than the interior floor of the crawl space.

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

~~**N1102.2.12**~~**N1102.2.13 (R402.2.13) 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) Radiant barriers. Where installed to reduce thermal radiation, radiant barriers shall be installed in accordance with ASTM C1743.

~~**N1102.3**~~**N1102.4 (R402.4) Fenestration.** In addition to the requirements of **Section N1102**, fenestration shall comply with **Sections N1102.4.1** through **N1102.4.5**.

~~**N1102.3.1**~~**N1102.4.1 (R402.4.1) *U*-factor.** An area-weighted average of fenestration products shall be permitted to satisfy the *U*-factor requirements.

~~**N1102.3.2**~~**N1102.4.2 (R402.4.2) 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**~~**N1102.4.3 (R402.4.3) 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**~~**N1102.4.4 (R402.4.4) 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**~~**N1102.4.5 (R402.4.5) 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**~~**N1102.5 (R402.5) Air leakage.** The *building thermal envelope* shall be constructed to limit air leakage in accordance with the requirements of **Sections N1102.5.1** through **N1102.5.5**.

~~**N1102.4.1**~~**N1102.5.1 (R402.5.1) Building thermal envelope.** The *building thermal envelope* shall comply with **Sections N1102.5.1.1** through **N1102.5.1.3**. The sealing methods between dissimilar materials shall allow for differential expansion and contraction.

~~**N1102.4.1.1**~~**N1102.5.1.1 (R402.5.1.1) Installation.** The components of the *building thermal envelope* as indicated in **Table N1102.5.1.1** shall be installed in accordance with the manufacturer's instructions and the criteria indicated in **Table N1102.5.1.1**, 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~~TABLE N1102.5.1.1(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~~ A sealed air barrier shall be installed in any dropped ceiling or soffit to separate it from unconditioned space ~~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 air sealed with gasketing materials that allow for repeated entrance over time.	The insulation in any dropped ceiling/ soffit shall be aligned with the air barrier. Access hatches and doors shall be installed and insulated in accordance with Section N1102.2.5 Eave Baffles shall be installed in accordance with Section N1102.2.4.
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.	Framing cavities around windows, skylights and doors shall be completely filled with insulation or insulated per window manufacturer's instructions.
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 N1102.2.11**. 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 N1102.2.11**. Conditioned basement foundation wall insulation shall be installed in accordance with **Section N1102.2.9.1**. Slab-on-grade floor insulation shall be installed in accordance with **Section N1102.2.11**.
Shafts, penetrations	Duct and flue shafts and other similar penetrations to exterior or unconditioned space shall be sealed. 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 N1101.10**–**N1101.12** and **N1102.2.8**.
Recessed lighting	Recessed light fixtures installed in the building thermal envelope shall be air sealed in accordance with **Section N1102.5.5**.	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.
Showers, tubs, and fireplaces adjacent to the building thermal envelope~~/tub on exterior wall~~	~~The~~ An air barrier ~~installed at exterior walls adjacent to showers and tubs~~ shall separate insulation in the *building thermal envelope* ~~wall~~ from the shower, ~~or~~ tub, and fireplace assemblies.	Exterior framed walls adjacent to showers, ~~and~~ tubs and fireplaces shall be insulated.
Electrical~~/phone box on exterior walls~~,communication, and other equipment boxes, housings, and enclosures	~~The air barrier shall be installed behind electrical and communication boxes. Alternatively, air-sealed boxes shall be installed.~~Boxes, housing, and enclosures that penetrate the air barrier shall be caulked, taped, gasketed, or otherwise sealed to the air barrier element being penetrated. All concealed openings into the box, housing, or enclosure shall be sealed. The continuity of the air barrier shall be maintained around boxes, housings, and enclosures that penetrate the air barrier. Alternatively, air-sealed boxes shall be installed in accordance with N1102.5.6.	Boxes, housing, and enclosures shall be burried in or surrounded by insulation.
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.	HVAC supply and return register boots located in the building's thermal envelope shall be buried and surrounded by insulation.

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.	—
Common walls or double walls	Air sealing materials recognized in a listed fire-resistance rated common wall or double wall design and installed in accordance with the listing, or air sealing materials recognized in an approved design, shall be used. Common walls or double walls shall be considered an exterior wall for the purposes of air barrier and air sealing application of this Table.	Insulation materials recognized in the listed common wall or double-wall design and installed in accordance with the listing, or insulation materials recognized in the approved design, shall be used.

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~~ Insulation full enclosure is not required in unconditioned/ventilated attic spaces and at rim joists.

~~N1102.4.1.2~~N1102.5.1.2 (R402.5.1.2) Testing and maximum air leakage rate. The *building* or each *dwelling unit* in the building shall be tested for air leakage. The maximum air leakage rate for any *building* or *dwelling unit* under any compliance path shall not exceed 4.0~~5.0~~ air changes per hour or 0.22~~0.28~~ cfm/ft^2 (1.1 L/s x m^2)~~cubic feet per minute (CFM) per square foot [0.0079 m^3/(s × m^2)]~~ of building or dwelling unit enclosure area. Testing shall be conducted in accordance with ANSI/RESNET/ICC 380, ASTM E779, ~~or~~ ASTM E1827 or ASTM E3158 and reported at a pressure differential of 0.2 inch ~~w.g.~~ water gauge (50 ~~Pascals~~Pa). 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.

Exceptions:

1. When testing individual dwelling units, an air leakage rate not exceeding 0.27 cubic feet per minute per square foot [1.35 L/s x 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:
   1.1 Attached single and multiple family building dwelling units.
   1.2 Buildings or dwelling units that are 1,500 square feet (139.4 m^2) or smaller.

2. For heated, attached private garages and heated, detached private garages accessory to one- and two-family dwellings and townhouses not more than three stories above grade plane in height, building envelope tightness and insulation installation shall be considered acceptable where the items in Table N1102.5.1.1, 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 N1102.2.13 and N1102.4.5, as applicable.
3. Where tested in accordance with N1102.5.1.2, testing of each dwelling unit is not required.

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**~~**N1102.5.1.3 (R402.5.1.3) Prescriptive air leakage ~~Leakage~~ rate.** Where complying with **Section N1101.13.1**, the building or each *dwelling unit* in the building shall have an air leakage rate not exceeding 4.0~~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 5~~8~~, and 2.5 air changes per hour in Climate Zones 6 through 8, when tested in accordance with **Section N1102.5.1.2**.

~~**N1102.4.2**~~**N1102.5.2 (R402.5.2) 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.

N1102.5.2.1 (R402.5.2.1) Gas fireplace efficiency. All gas fireplace heaters rated to ANSI Z21.88 shall be listed and labeled with a fireplace efficiency (FE) rating of 50 percent or greater in accordance with CSA P.4.1. Vented gas fireplaces (decorative appliances) certified to ANSI Z21.50 shall be listed and labeled, including their FE

ratings, in accordance with CSA P.4.1.

~~**N1102.4.3**~~**N1102.5.3 (R402.5.3) 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**~~**N1102.5.4 (R402.5.4) 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 N1102.5.2** and **R1006**.

~~**N1102.4.5**~~**N1102.5.5 (R402.5.5) 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**~~**N1102.5.6 (R402.5.6) Air-sealed electrical ~~Electrical~~ and communication outlet boxes ~~(air-sealed boxes)~~.** Air-sealed electrical ~~Electrical~~ and communication outlet boxes ~~installed in~~ that penetrate the air barrier of the building thermal envelope shall be caulked, taped, gasketed, or otherwise sealed to the air barrier element being penetrated ~~limit air leakage between conditioned and unconditioned spaces~~. Air-sealed ~~Electrical and communication outlet~~ boxes shall buried in or surrounded by insulation. Air-sealed boxes shall be tested and marked 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~~ Air-sealed boxes shall be installed ~~per the~~ in accordance with the manufacturer's instructions ~~and with any supplied components required to achieve compliance with NEMA OS 4~~.

~~**N1102.5**~~**N1102.6 (R402.6) 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,~~ are configured to prevent supplemental heat operation when the capacity of the heat pump compressor can meet the heating load. Limit supplemental heat operation to only those times when one of the following applies:

1. The vapor compression cycle cannot provide the necessary heating energy to satisfy the thermostat setting.
2. The heat pump is operating in defrost mode.
3. The vapor compression cycle malfunctions.
4. The thermostat malfunctions.

N1103.1.3 Continuously Burning Pilot Light. Gas fireplace systems are not permitted to be equipped with a continuously burning pilot light.

Exception: Any fireplace equipped with an on-demand, intermittent or interrupted ignition pilot light (as defined in ANSI Z21.20) is not considered to have a continuously burning pilot light.

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.~~Duct systems. Duct Supply and Duct Return shall be designed and sized in accordance with M1601.1 or Section 603.2 of the *International Mechanical Code*, as applicable.Ducts and air handlers shall be installed in accordance with **Sections N1103.3.2** through **N1103.3.8**.

N1103.3.1 Design and sizing Duct systems shall be designed and sized in accordance with ANSI/ACCA Manual D.

~~N1103.3.1~~N1103.3.2 (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**~~**N1103.3.3 (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 or unvented attic with vapor diffusion port is buried within ceiling insulation in accordance with **Section N1103.3.4** 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 N1103.3.7**, 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:~~Ductwork located in wall or floor building assemblies separating unconditioned from conditioned space shall com-ply with the following:
   3.1. A *continuous air barrier* ~~installed between unconditioned space and the duct.~~shall be installed as part of the building assembly between the duct and the unconditioned space.
   3.2. ~~Insulation installed in accordance with **Section N1102.2.8**.~~Ducts shall be installed in accordance with Section N1103.4.1.

      Exception: Where the building assembly cavities containing ducts have been air sealed in accordance with Section N1102.5.1, duct insulation is not required.

   3.3. ~~A minimum R-19 insulation installed in the cavity width separating the duct from unconditioned space.~~Not less than R-10 insulation, and not less than 50 percent of the required R-value specified in Table N1102.1.3, shall be located between the duct and the unconditioned space.
   3.4 For ducts in these building assemblies to be considered within conditioned space, the air handling equipment shall be installed within conditioned 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**~~**N1103.3.4 (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.

4. In Climate Zones 0A, 1A, 2A and 3A when installed in an unvented attic with vapor diffusion port, the supply ducts shall be completely buried within ceiling insulation, insulated to an R-value of not less than R-8 and in compliance with the vapor retarder requirements of Section 604.11 of the International Mechanical Code or Section M1601.4.6, as applicable.

   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.

   4.1 Air permeable insulation installed in unvented attics shall be in compliance with the requirements of Section R806.5.2.

~~N1103.3.3.1~~N1103.3.4.1 (R403.3.3.1) Effective *R*-value of deeply buried ducts. Where using the ~~Total~~ Building Simulated Performance Compliance Option in accordance with **Section N1101.13.2**, sections of ducts that are installed in accordance with **Section N1103.3.4**, ~~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~~N1103.3.5 (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~~N1103.3.5.1 (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~~N1103.3.6 (R403.3.5) Duct system testing. Each duct system ~~Ducts~~ shall be ~~pressure~~ tested for air leakage in accordance with ANSI/RESNET/ICC 380 or ASTM E1554 ~~to determine air leakage by one of the following methods:~~.Total leakage shall be measured with a pressure differential of 0.1 inch w.g.(25 Pa) across the system. Registers shall be sealed during the test. A written report of the test results shall be signed by the party conducting the test and provided to the code official. Duct system leakage testing at either rough-in or post-construction shall be permitted.

~~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~~ Testing shall not be required for ~~ducts~~ duct systems serving heating, cooling or ventilation systems that are not integrated with ~~ducts~~ duct systems serving heating or cooling systems.

~~N1103.3.6~~N1103.3.7 (R403.3.6) Duct system leakage. ~~The total leakage of the ducts, where measured in accordance with **Section N1103.3.6**, shall be as follows:~~The total measured duct system leakage shall not be greater than the values in Table N1103.3.7. For buildings

complying with Section N1105 or N1106, where duct system leakage to outside is tested in accordance with ANSI/RESNET/ICC 380 or ASTM E1554, the leakage to outside value shall not be used for compliance with this section, but shall be permitted to be used in the calculation procedures of Section N1105 and N1106.

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*.~~

Exception: Duct systems designed so the individual room airflow shall be within the greater of ± 20 percent, or 25 CFM of the design/application requirements for the supply and return ducts. This shall be demonstrated by using a duct airflow balancing procedure as specified by ANSI/ACCA 5 QI or by other approved methods.

TABLE N1103.3.7(R403.3.6)
MAXIMUM TOTAL DUCT SYSTEM LEAKAGE

	ROUGH IN	POST CONSTRUCTION
Duct systems serving more than 1,000 ft2 of conditioned floor area	**cfm/100 ft^2 (LPM/ 9.29 m^2)**	**cfm/100 ft^2 (LPM/ 9.29 m^2)**
Air handler is not installed	3 (85)	NA
Air handler is installed	4 (113.3)	4 (113.3)
Duct systems located in conditioned space, with air handler installed	8 (226.6)	8 (226.6)
Duct systems serving less than or equal to 1,000 ft^2 of conditioned floor area	**cfm (LPM)**	**cfm (LPM)**
Air handler is not installed	30 (849.5)	NA
Air handler is installed	40 (1132.7)	40 (1132.7)
Duct systems located in conditioned space, with air handler installed	80 (2265.4)	80 (2265.4)

~~**N1103.3.7**~~**N1103.3.8 (R403.3.8) 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~~ physical damage, and wind. The protection shall provide shielding from solar radiation that can cause degradation of the material and shall be removable no less than 6 feet (1828 mm) from the equipment for maintenance. 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.**~~N1103.5.5.

N1103.5.1 (R403.5.1) 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 104ºF (40ºC).

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 (R403.5.1.2) 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~~ comply with Table N1103.5.2 and shall be applied to the following:

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

Exception: Cold water returns in demand recirculation water systems.

TABLE N1103.5.2(R403.5.2)
MINIMUM PIPE INSULATION THICKNESS

FLUID OPERATING TEMPERATURE RANGE AND USAGE (°F)	INSULATION CONDUCTIVITY		MINIMUM PIPE INSULATION THICKNESS(in inches)
	Conductivity Btu × in./(h × ft^2× °F)[a]	Mean Rating Temperature,°F	
141-200	0.25-0.29	125	1.0
105-140	0.21-0.28	100	1.0

For SI: 1 inch = 25.4 mm, °C = [(°F) – 32]/1.8.

a For insulation outside the stated conductivityrange listed in Table N1103.5.2, the minimum thickness (T) listed in Table N1103.5.2, shall bedetermined as follows:

$$T = r[(1 + t/r)^{K/k} - 1]$$

T = Minimum insulation thickness.
r = Actual outside radius of pipe.
t = Insulation thickness listed in the table for applicable fluid temperature and pipe size; 1-inch.
K = Conductivity of alternate material at mean rating temperature indicated for the applicable fluidtemperature (Btu × in/h × ft2 × °F).
k = The upper value of the conductivity range listed in Table N1103.5.2 for the applicable fluidtemperature.

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.

N1103.5.4 (R403.5.4) Water volume determination The water volume in the piping shall be calculated in accordance with this sec-tion. Water heaters, circulating water systems and heat trace temperature maintenance systems shall be considered to be sources of heated water. The volume shall be the sum of the internal volumes of pipe, fittings, valves, meters and mani-folds between the nearest source of heated water and the termination of the fixture supply pipe. The volume in the piping shall be determined from Table N1103.5.4. The volume contained within fixture shutoff valves, within flexible water sup-ply connectors to a fixture fitting and within a fixture fitting shall not be included in the water volume determination. Where heated water is supplied by a recirculating system or heat-traced piping, the volume shall include the portion of the fitting on the branch pipe that supplies water to the fixture.

TABLE N1103.5.4(R403.5.4)
INTERNAL VOLUME OF VARIOUS WATER DISTRIBUTION TUBING

OUNCES OF WATER PER FOOT OF TUBE									
NOMINAL SIZE (inches)	COPPER TYPE M	COPPER TYPE L	COPPER TYPE K	CPVC CTS SDR 11	CPVC SCH 40	CPVC SCH 80	PE-RT SDR 9	COMPOSITE ASTM F1281	PEX CTS SDR 9
3/8	1.06	0.97	0.84	N/A	1.17	-	0.64	0.63	0.64
1/2	1.69	1.55	1.45	1.25	1.89	1.46	1.18	1.31	1.18
3/4	3.43	3.22	2.90	2.67	3.38	2.74	2.35	3.39	2.35
1	5.81	5.49	5.19	4.43	5.53	4.57	3.91	5.56	3.91
1 1/4	8.70	8.36	8.09	6.61	9.66	8.24	5.81	8.49	5.81
1 1/2	12.18	11.83	11.45	9.22	13.20	11.38	8.09	13.88	8.09
2	21.08	20.58	20.04	15.79	21.88	19.11	13.86	21.48	13.86

For SI: 1 foot = 304.8 mm, 1 inch = 25.4 mm, 1 liquid ounce = 0.030L, 1 oz/ft^2 = 305.15 g/m^2.

N/A = Not available.

N1103.5.5 (R403.5.5) Demand responsive water heating Electric storage water heaters with a rated water storage volume of 40 gallons (150L) to 120 gallons (450L) and a nameplate input rating equal to or less than 12kW shall be provided with demand responsive controls in accordance with Table N1103.5.5 (R403.5.5) or another equivalent approved standard.

Exceptions:

1. Water heaters that are capable of delivering water at a temperature of 180°F (82°C) or greater.
2. Water heaters that comply with Section IV, Part HLW or Section X of the ASME Boiler and Pressure Vessel Code.
3. Water heaters that use 3-phase electric power.

TABLE N1103.5.5(R403.5.5)
DEMAND RESPONSIVE CONTROLS FOR WATER HEATING

Equipment Type	Controls	
	Manufactured Before 7/1/2025	Manufactured On or After 7/1/ 2025
Electric storage water heaters	ANSI/CTA-2045-B Level 1 and also capable of initiating water heating to meet the temperature set point in response to a demand response signal.	ANSI/CTA-2045-B Level 2, except "Price Stream Communication" functionality as defined in the standard.

N1103.6 (R403.6) Mechanical ventilation. The *buildings* and dwelling units complying with **Section N1102.5.1** 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 6, 7, and 8. The system shall be a balanced ventilation system with a ~~minimum~~ sensible ~~heat~~ recovery efficiency (SRE) of no less than 65 percent at 32°F (0°C) at ~~a flow~~ an airflow greater than or equal to the design airflow. The SRE shall be determined from a listed value or from interpolation of listed values.

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~~ the test procedure referenced by Table N1103.6.2 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~~ERV, 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~~SYSTEM TYPE	AIRFLOW RATE ~~MINIMUM~~ (CFM)	MINIMUM EFFICACY (CFM/ WATT)	TEST PROCEDURE
HRV, ERV, or balanced	Any	1.2 ~~cfm/ watt~~	HRV or ERV: CAN/CSA 439; Balanced without heat or energy recovery: ASHRAE Standard 51 (ANSI/ AMCA Standard 210)
Range hood	Any	2.8	ASHRAE 51 (ANSI/AMCA Standard 210)
In-line supply or exhaust fan	Any	3.8 ~~cfm/ watt~~	
Other exhaust fan	< 90	2.8 ~~cfm/ watt~~	
	≥ 90 and <200	3.5 ~~cfm/ watt~~	
	≥200	4.0	
Air-handler that is integrated to tested and listed HVAC equipment	Any	1.2 ~~cfm/ watt~~	Outdoor airflow as specified. Air-handler fan power determined in accordance with the HVAC appliance's test method referenced by Section C403.3.2 of the IECC-Commercial Provisions.

For SI: 1 cubic foot per minute = ~~28.3 L/min~~ 0.47 L/s.

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**, in accordance with ANSI/RESNET/ICC 380. ~~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.

Exceptions:

1. Kitchen range hoods that are ducted to the outside with ducting having a diameter of 6 inches~~6-inch~~ (152 mm) or larger, a length of 10ft (3048 mm) or less, ~~duct~~ and not more than ~~one~~ two 90-degree (1.57 rad) ~~elbow~~ elbows or equivalent ~~in the duct run~~shall not require testing.
2. A third-party test shall not be required where the ventilation system has an integrated diagnostic tool used for airflow measurement, programmable airflow settings, and a user interface that communicates the installed airflow rate.

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.

N1103.7.1 (R403.7.1) Electric resistance zone heated units. All detached one- and two-family dwellings and townhouses in Climate Zones 4-8 using electric resistance zonal heating as the primary heat source shall install one additional heating unit in the largest living zone. The additional unit shall have an HSPF greater than 7.4 (6.3 HSPF2). Building permit drawings shall specify the heating equipment type and location of the heating system.

Exceptions:

1. Total installed heating capacity of 2 kW per dwelling or less.
2. Dwellings that have central ducted or ductless cooling or heating systems.

N1103.8 (R403.8) Systems serving multiple dwelling units. Systems serving multiple *dwelling units* shall comply with **Sections C403** and **C404** of the *International Energy Conservation Code*—Commercial Provisions instead of **Section N1103**.

N1103.9 (R403.9) Snow melt and ice 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) Roof and gutter deicing controls. Roof and gutter deicing systems, including but not limited to self-regulating cable, shall include automatic controls configured to shut off the system when the outdoor temperature is above 40°F (4.8°C) maximum and shall include one of the following:

1. A moisture sensor configured to shut off the system in the absence of moisture, or
2. A programmable timer configured to shut off the system for 8 hours minimum at night.

~~**N1103.10**~~**N1103.11 (R403.11) Energy consumption of pools and spas.** The energy consumption of pools and permanent spas shall be controlled by the requirements in **Sections N1103.11.1** through **N1103.11.3**.

~~**N1103.10.1**~~**N1103.11.1 (R403.11.1) 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**~~**N1103.11.2 (R403.11.2) 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**~~**N1103.11.3 (R403.11.3) 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**~~**N1103.12 (R403.12) Portable spas.** The energy consumption of electric-powered portable spas shall be controlled by the requirements of APSP 14.

~~**N1103.12**~~**N1103.13 (R403.13) 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, AND RENEWABLE ENERGY SYSTEMS

N1104.1 (R404.1) Lighting equipment. All permanently installed luminaires ~~lighting fixtures~~, ~~excluding kitchen appliance lighting fixtures,~~ shall be capable of operation with an efficacy of not less than 45 lumens per watt or shall contain lamps ~~only high-efficacy lighting sources~~capable of operation at 65 lumens per watt or greater.

Exceptions:

1. kitchen appliance lighting.
2. antimicrobial lighting used for the sole purpose of disinfecting.

TABLE N1104.1(R404.1)
LIGHTING POWER ALLOWANCES FOR BUILDING EXTERIORS

Base site allowance	400 watts
Uncovered parking areas and drives	0.4 W/ft^2
Building Grounds	
Walkways and ramps less than 10 feet wide	0.50 W/linear foot
Walkways and ramps 10 feet wide or greater, plaza areas, special feature areas	0.10 W/ft^2
Dining areas	0.65 W/ft^2
Stairways	0.70 W/ft^2
Pedestrian tunnels	0.12 W/ft^2
Landscaping	0.04 W/ft^2
Building entrances and Exits	
Pedestrian and vehicular entrances and exits	14 W/linear foot of opening
Entry canopies	0.25 W/ft^2

For SI: 1 watt per square foot = 10.76 w/m^2, 1 foot = 304.8 mm.

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~~ Sections N1104.1.2 through N1104.1.5.

Exceptions:

1. Detached one- and two-family dwellings.
2. Townhouses.
3. Group R-3 buildings that do not contain more than 2 dwelling units
~~3.~~4. Solar-powered lamps not connected to any electrical service.
~~4.~~5. Luminaires controlled by a motion sensor.
~~5.~~6. Lamps and luminaires that comply with Section N1104.1

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

N1104.1.2 (R404.1.2) Exterior lighting power requirements. The total exterior connected lighting power shall be not greater than the exterior lighting power allowance calculated in accordance with Section N1104.1.3. The total exterior connected lighting power shall be the total maximum rated wattage of all lighting that is powered through the energy service for the building.

Exceptions: Lighting used for the following applications shall not be included.

1. Lighting approved because of safety considerations.
2. Exit signs.
3. Specialized signal, directional and marker lighting associated with transportation.
4. Temporary lighting.
5. Lighting for water features and swimming pools.
6. Lighting controlled from within dwelling units.

N1104.1.3 (R404.1.3) Exterior Lighting Power Allowance. The total area or length of each area type multiplied by the value for the area type in Table N1104.1 shall be the lighting power (watts) allowed for each area type. For area types not listed, the area type that most closely represents the proposed use of the area shall be selected. The total exterior lighting power allowance (watts) shall be the sum of the base site allowance plus the watts from each area type.

N1104.1.4 (R404.1.4) Additional exterior lighting power. Additional exterior lighting power allowance shall be available for the building facades at 0.075 W/ft^2 (0.807 w/m^2) of gross above-grade wall area. This additional power allowances shall be used only for the luminaires serving the facade and shall not be used to increase any other lighting power allowance.

N1104.1.5 (R404.1.5) Gas lighting. Gas-fired lighting appliances shall not be equipped with continuously burning pilot ignition systems.

N1104.2 (R404.2) ~~Interior lighting controls.~~Controls for individual dwelling units

~~Permanently~~ All permanently installed luminaires ~~lighting fixtures~~ shall be controlled as required in Sections N1104.2.1 and N1104.2.2 ~~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~~safety or security lighting fixtures:

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

N1104.2.1 (R404.2.1) Habitable spaces. All permanently installed luminaires in habitable spaces shall be controlled with a dimmer or an automatic shut-off control that automatically turns off lights within 20 minutes after all occupants have left the space and shall incorporate a manual control to allow occupants to turn the lights on or off.

N1104.2.2 (R404.2.2) Specific locations. All permanently installed luminaires in garages, unfinished basements, laundry rooms, and utility rooms shall be controlled by an automatic shut-off control that automatically turns off lights within 20 minutes after all occupants have left the space and shall incorporate a manual control to allow occupants to turn the lights on or off.

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.

N1104.4 (R404.4) Renewable energy certificate (REC) documentation. Where renewable energy generation is used to comply with this code, the documentation shall be provided to the code official by the property owner or owner's authorized agent which demonstrates that where

RECs or EACs are associated with that portion of renewable energy used to comply with this code, the RECs or EACs shall be retained, or retired, on behalf of the property owner.

N1104.5 (R404.5) Electric readiness. Systems using fossil fuel: water heaters, household clothes dryers, conventional cooking tops or conventional ovens shall comply with the requirements of Sections N1104.5.1 through N1104.5.4.

N1104.5.1 (R404.5.1) Cooking products. An individual branch circuit outlet with a rating not less than 250-volts, 40-amperes shall be installed, and terminate within three feet of conventional cooking tops, conventional ovens or cooking products combining both.

Exception: Cooking products not installed in an individual dwelling unit.

N1104.5.2 (R404.5.2) Household Clothes Dryers. An individual branch circuit outlet with a rating not less than 240-volts, 30-amperes shall be installed, and terminate within three feet (304 mm) of each household clothes dryer.

Exception: Clothes dryers that serve more than one dwelling unit and are located outside of a dwelling unit.

N1104.5.3 (R404.5.3) Water heaters. An individual branch circuit outlet with a rating not less than either 240-volts, 30-amperes or 120V, 20-amperes shall be installed, and terminate within three feet (304 mm) of each fossil fuel water heater.

Exception: Water heaters in a centralized water heating system serving multiple dwelling units in a R-2 occupancy.

N1104.5.4 (R404.5.4) Electrification-ready circuits. The unused conductors required by Sections N1104.5.1 through N1104.5.3 shall be labeled with the word “spare.” Space shall be reserved in the electrical panel in which the branch circuit originates for the installation of an overcurrent device. Capacity for the circuits required by Sections N1104.5.1 through N1104.5.3 shall be included in the load calculations of the original installation.

N1104.6 (R404.6) Renewable energy infrastructure. The building shall comply with the requirements of N1104.6.1 or N1104.6.2.

N1104.6.1 (R404.6.1) One- and two- family dwellings and townhouses. One- and two-family dwellings and townhouses shall comply with Sections N1104.6.1.1 through N1104.6.1.4.

Exceptions:

1. A dwelling unit with a permanently installed on-site renewable energy system.
2. A dwelling unit with a solar-ready zone area that is less than 500 square feet (46 m^2) of roof area oriented between 110 degrees and 270 degrees of true north.
3. A dwelling unit with less than 500 square feet (46m^2) of roof area oriented between 110 degrees and 270 degrees of true north.
4. Dwelling units where 50 percent of the solar-ready area is shaded from direct-beam sunlight by natural objects or by structures that are not part of the building for more than 2500 annual hours between 8:00 a.m. and 4:00 p.m.
5. A dwelling unit that complies with Appendix AX.
6. A dwelling unit with a renewable energy power purchase agreement with a duration of not less than 15 years from a utility or a community renewable energy facility and for not less than 80 percent of the estimated whole-building electric use on an annual basis.
7. A dwelling unit less than or equal to 1,500 square feet of living space floor area located above grade plane.

N1104.6.1.1 (R404.6.1.1) Solar-ready zone area. The total area of the solar-ready zone shall not be less than 250 square feet (23.2 m^2) and shall be composed of areas not less than 5.5 feet (1676 mm) in one direction and not less than 80 square feet (7.4 m^2) exclusive of access or set back areas as required by the *International Residential Code*.

Exception: Dwelling units in townhouses three stories or less in height above grade plane and with a total floor area less than or equal to 2,000 square feet (186 m^2) per dwelling shall be permitted to have a solar-ready zone area of not less than 150 square feet (14 m^2).

N1104.6.1.2 (R404.6.1.2) Obstructions. Solar-ready zones shall be free from obstructions, including but not limited to vents, chimneys, and roof-mounted equipment.

N1104.6.1.3 (R404.6.1.3) Electrical service reserved space. The main electrical service panel shall have a reserved space for a dual pole circuit breaker and shall be labeled “For Future Solar Electric.” The reserved space shall be at the opposite (load) end of the busbar from the primary energy source.

N1104.6.1.4 (R404.6.1.4) Electrical interconnection. An electrical junction box shall be installed within 24 inches (610 mm) of the main electrical service panel and shall be connected to a capped roof penetration sleeve or a location in the attic that is within 3 feet (914 mm) of the solar-ready zone by a minimum 1 inch (25 mm) nonflexible metallic conduit or permanently installed wire as approved by the code official. Where the interconnection terminates in the attic, location shall be no less than 12 inches (35 mm) above ceiling insulation. Both ends of the interconnection shall be labeled “For Future Solar Electric”.

N1104.6.2 (R404.6.2) Group R occupancies. Buildings in Group R-2, R-3 and R-4 shall comply with *International Energy Conservation Code* Commercial Appendix CB.

N1104.7 (R404.7) Electric Vehicle Power Transfer Infrastructure. New automobile parking spaces for one- and two-family dwellings and townhouses shall be provided in accordance with Sections N1104.7.1 through N1104.7.5.

N1104.7.1 (R404.7.1) Quantity. New one- and two-family dwellings and townhouses with a designated attached or detached garage or other onsite private parking provided adjacent to the dwelling unit shall be provided with one EV-capable, EV-ready, or EVSE installed space per dwelling unit.

N1104.7.2 (R404.7.2) EV Capable Spaces. Each EV capable space used to meet the requirements of Section N1104.7.1 shall comply with all of the following:

1. A continuous raceway or cable assembly shall be installed between an enclosure or outlet located within 3 feet (914 mm) of the EV capable space and a suitable panelboard or other onsite electrical distribution equipment.
2. Installed raceway or cable assembly shall be sized and rated to supply a minimum circuit capacity in accordance with N1104.7.4.
3. The electrical distribution equipment to which the raceway or cable assembly connects shall have sufficient dedicated space and spare electrical capacity for a 2-pole circuit breaker or set of fuses.
4. The electrical enclosure or outlet and the electrical distribution equipment directory shall be marked: "For future electric vehicle supply equipment (EVSE)."

N1104.7.3 (R404.7.3) EV Ready Spaces. Each branch circuit serving EV ready spaces shall comply with all of the following:

1. Terminate at an outlet or enclosure, located within 3 feet (914 mm) of each EV ready space it serves.
2. Have a minimum circuit capacity in accordance with N1104.7.4.
3. The panelboard or other electrical distribution equipment directory shall designate the branch circuit as "For electric vehicle supply equipment (EVSE)" and the outlet or enclosure shall be marked "For electric vehicle supply equipment (EVSE)."

N1104.7.4 (R404.7.4) Circuit Capacity. For one- and two-family dwellings and townhouses, the capacity of electrical infrastructure serving each EV capable space, EV ready space and EVSE space shall have a rated capacity not less than 8.3 kVA (or 40A at 208/240V) for each EV capable space, EV ready space or EVSE space it serves. Where a circuit is shared or managed it shall be in accordance with NFPA 70.

Exceptions:

1. Where the local electric distribution entity has certified in writing that it is not able to provide 100% of the necessary distribution capacity within 2 years after the estimated date of the certificate of occupancy. The required EV charging infrastructure shall be reduced based on the available existing electric distribution capacity.
2. Where substantiation has been approved that meeting the requirements of Section N1104.7.4.1 will alter the local utility infrastructure design requirements on the utility side of the meter so as to increase the utility side cost to the builder or developer by more than $400.00 per dwelling unit.

N1104.7.4.1 (R404.7.4.1) Circuit capacity management. The capacity of each branch circuit serving multiple EVSE spaces, EV ready space or EV capable spaces designed to be controlled by an energy management system providing load management in accordance with NFPA 70, shall have a capacity of not less than 2.7 kVA per space.

N1104.7.5 (R404.7.5) EVSE installation. For one- and two-family dwellings and townhouses, EVSE shall be installed in accordance with NFPA 70 and shall be listed and labeled in accordance with UL 2202 or UL 2594. For R-2 occupancies, EVSE shall be installed in accordance with NFPA 70 and Section N1104.7.5.1 and shall be listed and labeled in accordance with UL 2202 and UL 2594.

N1104.7.5.1 (R404.7.5.1) EVSE minimum charging rate. Each installed EVSE shall comply with one of the following:

1. Be capable of charging at a rate of not less than 6.2 kVA (or 30A at 208/240V).
2. Where serving EVSE spaces allowed to have a circuit capacity of not less than 2.7 kVA in accordance with N1104.7.4.1 and controlled by an energy management system providing load management, be capable of simultaneously charging each EVSE space at a rate of not less than 2.1 kVA.

SECTION N1105 (R405)
TOTAL BUILDING PERFORMANCE

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

N1105.2 (R405.2) Simulated performance ~~Performance~~ based compliance. Compliance based on ~~total~~ simulated 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 proposed total building thermal envelope UA, which is the sum of the 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 1.08 in Climate Zones 0, 1 and 2, and 1.15 in Climates Zones 3 through 8, in accordance with Equation 11-6. ~~shall be 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*.~~The area-weighted maximum fenestration SHGC permitted in Climate Zones 0 through 3 shall be 0.30.

$$\text{For Climate Zones 0-2: } UA_{\text{Proposed design}} \leq 1.08 \times UA_{\text{Prescriptive reference design}}$$
$$\text{For Climate Zones 3-8: } UA_{\text{Proposed design}} \leq 1.15 \times UA_{\text{Prescriptive reference design}}$$

(Equation 11-6)

3. For buildings without a fuel burning appliance for space heating or water heating, the ~~An~~ annual energy cost of the proposed design that is less than or equal to 85 percent of the annual energy cost of the *standard reference design*. For buildings with a fuel burning appliance for space heating or water heating, the annual energy cost of the proposed design that is less than or equal to 80 percent of the annual energy cost of the standard reference design. For dwelling units with greater than 5,000 square feet (465 m^2) of living space floor area located above grade plane, the annual energy cost of the proposed design shall be reduced by an additional 5 percent of 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.

   Exceptions:

   1. 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.~~ multipliers for all energy sources shall be obtained from ASHRAE Standard 105 (Tables K2, K4, or K8) or from another data source approved by the code official.
   2. The energy use based on site energy expressed in Btu or Btu per square foot of conditioned floor area shall be permitted to be substituted for the energy cost for an all-electric building with on-site renewable energy installed.

TABLE N1105.2(R405.2)
REQUIREMENTS FOR ~~TOTAL~~ SIMULATED 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	Attic knee or pony wall
N1102.2.4	Eave baffle
N1102.2.5.1	Access hatches and doors
N1102.2.9	Basement walls
N1102.2.9.1	Basement wall insulation installation
N1102.2.10.1	Slab-on-grade floor insulation installation
N1102.2.11.1	Crawl space wall insulation installation
N1102.5.1.1	Installation
N1102.5.1.2	Testing
N1102.5.2	Fireplaces
N1102.5.3	Fenestration air leakage
N1102.5.4	Rooms containing fuel burning appliances
N1102.5.5	Recessed lighting
N1102.5.6	Air Sealed electrical and communication outlet boxes
N1102.6	Maximum fenestration *U*-factor and SHGC
Mechanical	
N1103.1	Controls
N1103.2	Hot Water boiler temperature reset
N1103.3, ~~including **N1103.3.2**, except **Sections N1103.3.3**, **N1103.3.4** and **N1103.3.7**~~	~~Ducts~~Duct systems
N1103.4	Mechanical system piping insulation
N1103.5 except Section N1103.5.2	Service hot water systems
~~**N1103.5.1**~~	~~Heated water circulation and temperature maintenance systems~~
N1103.5.2	Hot water pipe insulation

~~**N1103.5.3**~~	~~Drain water heat recovery units~~
N1103.6	Mechanical ventilation
N1103.7, except Section N1103.7.1	Equipment sizing and efficiency rating
N1103.8	Systems serving multiple dwelling units
N1103.9	Snow melt and ice system controls
N1103.11	Energy consumption of pools and spas
N1103.12	Portable spas
N1103.13	Residential pools and permanent residential spas
Electrical Power and Lighting Systems	
N1104.1	Lighting equipment
N1104.2	Interior lighting controls
N1104.5	Electric readiness
N1104.6	Renewable energy infrastructure
N1104.7	Electric vehicle power transfer infrastructure

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~~ proposed design and the parameters for the baseline *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 N1105.3.2.1** 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~~ simulated 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~~ proposed 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 or slab extension ~~area~~ above ~~and below~~ grade: 1 foot (30 cm) Foundation wall or slab extension below grade: same as proposed Foundation wall or slab perimeter length: same as proposed ~~and soil~~ Soil characteristics: same as proposed.	As proposed
	Foundation wall U-factor or slab F-factor: as specified in Table N1102.1.2	
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
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, 4, and 5: 3.0 air changes per hour. Climate Zones 6 through 8: 2.5 air changes per hour. ~~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-B x M ~~0.01 × *CFA* + 7.5 × (N_{br} + 1)~~ where: B = 0.01 × CFA + 7.5 × (Nbr + 1), cfm. M = 1.0 where the measured air exchange rate is ≥ 3.0 air changes per hour at 50 Pascals, and otherwise, M = minimum (1.7, Q/B) Q = the proposed mechanical ventilation rate, cfm. CFA = conditioned floor area, ft2. Nbr = number of bedrooms. The mechanical ventilation system type shall be the same as in the proposed design. Heat recovery or energy ~~Energy~~ recovery shall ~~not~~ be modeled assumed for mechanical ventilation where required by Section N1103.6.1. Heat recovery or energy recovery shall not be modeled for mechanical ventilation where not required by Section N1103.6.1..	The mechanical ventilation rate[b] ,Q, 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)]~~(8.76 x B x M)/ef where: e_f = the minimum fan efficacy, as specified in **Table N1103.6.2**, corresponding to the system type at a flow rate of B x M~~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.

<table>
<tr><td rowspan="3">Structural mass</td><td>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.</td><td>As proposed</td></tr>
<tr><td>For masonry basement walls: as proposed, but with insulation as specified in Table N1102.1.3, located on the interior side of the walls.</td><td>As proposed</td></tr>
<tr><td>For other walls, ceilings, floors, and interior walls: wood frame construction.</td><td>As proposed</td></tr>
<tr><td rowspan="6">Heating systems[d, e, j, k]</td><td>~~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**.~~</td><td>~~As proposed~~</td></tr>
<tr><td>Fuel Type/Capacity: Same as proposed design</td><td>As proposed</td></tr>
<tr><td>Product class: Same as proposed design</td><td>As proposed</td></tr>
<tr><td>Efficiencies:</td><td>As proposed</td></tr>
<tr><td>Heat pump: Complying with 10 CFR §430.32</td><td>As proposed</td></tr>
<tr><td>Non-electric furnaces: Complying with 10 CFR §430.32</td><td>As proposed</td></tr>
<tr><td>Non-electric boilers: Complying with 10 CFR §430.32</td><td>As proposed</td></tr>
<tr><td rowspan="3">Cooling systems[d, f, k]</td><td>~~As proposed.~~
~~Capacity: sized in accordance with **Section N1103.7**.~~</td><td>~~As proposed~~</td></tr>
<tr><td>Fuel Type: Electric
Capacity: Same as proposed design</td><td>As proposed</td></tr>
<tr><td>Efficiencies: Complying with 10 CFR §430.32</td><td>As proposed</td></tr>
<tr><td>Service water heating[d, g, k]</td><td>~~As proposed.~~
Use, in units of gal/day = 25.5 + (8.5 × N_{br})
where:
N_{br} = number of bedrooms.</td><td>~~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.
<table>
<tr><th colspan="2">Compactness ratio[i] factor</th><th>HWDS</th></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>
</table></td></tr>
</table>

<table>
<tr><td rowspan="6"></td><td rowspan="3"></td><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 colspan="2">Fuel Type: Same as proposed design</td><td colspan="3">As proposed</td></tr>
<tr><td colspan="2">Rated Storage Volume: Same as proposed design</td><td colspan="3">As proposed</td></tr>
<tr><td colspan="2">Draw Pattern: Same as proposed design</td><td colspan="3">As proposed</td></tr>
<tr><td colspan="2">Efficiencies: Uniform Energy Factor complying with 10 CFR §430.32</td><td colspan="3">As proposed</td></tr>
<tr><td colspan="2">Tank Temperature: 120° F (48.9° C)</td><td colspan="3">Same as standard reference design</td></tr>
<tr><td rowspan="4">Thermal distribution systems</td><td colspan="2">Duct insulation: in accordance with Section N1103.3.2.</td><td colspan="3">Duct insulation: as proposed</td></tr>
<tr><td colspan="2">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" rowspan="3">Duct location: as proposed</td></tr>
<tr><td>Foundation type</td><td>Slab on grade</td><td>Unconditioned crawl space</td><td>Basement or conditioned crawl space</td></tr>
<tr><td>Duct location (supply and return)</td><td>One-story building: 100% in unconditioned attic

All other: 75% in unconditioned attic and 25% inside conditioned space</td><td>One-story building: 100% in unconditioned attic

All other: 75% in unconditioned attic and 25% inside conditioned space</td><td>50% inside conditioned space

50% unconditioned attic</td></tr>
</table>

	Duct system leakage to outside: For duct systems serving > 1,000ft2 of conditioned floor area, the duct leakage to outside rate shall be 4 cfm (113.3 L/min) per 100 ft2 (9.29 m2) of conditioned floor area. For duct systems serving ≤ 1,000ft2 of conditioned floor area, the duct leakage to outside rate shall be 40 cfm (1132.7 L/min).	Duct System Leakage to Outside: The measured total duct system leakage rate shall be entered into the software as the duct system leakage to outside rate. **Exceptions:** 1. When duct system leakage to outside is tested in accordance ANSI/ RESNET/ICC 380 or ASTM E1554, the measured value shall be permitted to be entered. 2. When total duct system leakage is measured without the air handler installed, the simulation value shall be 4 cfm (113.3 L/ min) per 100 ft^2(9.29 m^2) of conditioned floor area.
	For hydronic systems and ductless systems a ~~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.~~	~~As tested or, where not tested,~~ For hydronic systems and ductless systems, DSE shall be as specified in **Table N1105.4.2(2)**.
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.

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 without a proposed water heater,~~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~~ the following assumptions shall be made for both the proposed design and standard reference design.
   Fuel Type: Same as the predominant heating fuel type
   Rated Storage Volume: 40 Gallons
   Draw Pattern: Medium
   Efficiency: Uniform Energy Factor complying with 10 CFR §130.32

h. For residences with conditioned basements, R-2 and R-4 residences, and for ~~townhouses~~townhouse units, 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.

j. For a proposed design with electric resistance heating, a split system heat pump complying with 10 CFR §430.32 (2021) shall be assumed modeled in the standard reference design.

k. For heating systems, cooling systems, or water heating systems not included in Table N1105.4.2(1), the standard reference design shall be the same as proposed design.

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	NA	0.95
~~Untested distribution systems~~Distribution system components entirely located in conditioned space[c]	~~0.88~~NA	1
"Ductless" systems[d]	1	NA

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 N1103.7**.
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 *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~~ values indicated in **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
N1102.2.4	Eave baffle
N1102.2.5.1	Access hatches and doors
N1102.2.9	Basement walls
N1102.2.9.1	Basement wall insulation installation
N1102.2.10.1	Slab-on-grade floor insulation installation
N1102.2.11.1	Crawl space wall insulation installation
N1102.5.1.1	Installation
N1102.5.1.2	Testing
N1102.5.2	Fireplaces
N1102.5.3	Fenestration air leakage
N1102.5.4	Rooms containing fuel burning appliances
N1102.5.5	Recessed lighting
N1102.5.6	Air sealed electrical and communication outlet boxes
N1106.3	Building thermal envelope
Mechanical	
N1103.1	Controls
N1103.2	Hot Water boiler temperature reset
N1103.3 except ~~Sections N1103.3.2, N1103.3.3 and N1103.3.6~~	~~Ducts~~Duct systems
N1103.4	Mechanical system piping insulation
N1103.5 except Section N1103.5.2	Service hot water systems
~~**N1103.5.1**~~	~~Heated water circulation and temperature maintenance systems~~
N1103.5.2	Hot water pipe insulation
~~**N1103.5.3**~~	~~Drain water heat recovery units~~
N1103.6	Mechanical ventilation
N1103.7, except Section N1103.7.1	Equipment sizing and efficiency rating

N1103.8	Systems serving multiple dwelling units
N1103.9	Snow melt and ice system controls
N1103.11	Energy consumption of pools and spas
N1103.12	Portable spas
N1103.13	Residential pools and permanent residential spas
Electrical Power and Lighting Systems	
N1104.1	Lighting equipment
N1104.2	Interior lighting controls
N1104.5	Electric readiness
N1104.6	Renewable energy infrastructure
N1104.7	Electric Vehicle power transfer infrastructure

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** or **N1106.3.2**.~~

~~**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 2018 *International Energy Conservation Code*.~~

~~**N1106.3.1**~~**N1106.3 (R406.3)** ~~**On-site renewables are not included.**~~**Building thermal envelope** ~~Where on-site renewable energy is not included for compliance using the ERI analysis of **Section N1106.4**, the~~ 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~~ 1.08 in Climate Zones 0, 1, and 2, and by 1.15 in Climates Zones 3 through 8, in accordance with **Equation 11-7**~~.~~ Equation 11-7. The area-weighted maximum fenestration SHGC permitted in Climate Zones 0 through 3 shall be 0.30.

$$\text{For Climate Zones 0-2: } UA_{\text{Proposed design}} \leq 1.08 \times UA_{\text{Prescriptive reference design}}$$

$$\text{For Climate Zones 3-8: } UA_{\text{Proposed design}} \leq 1.15 \times UA_{\text{Prescriptive reference design}}$$

(Equation 11-7)

N1106.4 (R406.4) Energy Rating Index. The Energy Rating Index (ERI) shall be determined in accordance with ANSI/RESNET/ICC 301 The mechanical ventilation rates used for the purpose of determining the ERI shall not be construed to establish minimum ventilation requirements for compliance with this code. ~~except that the *ERI reference design* ventilation rate shall be in accordance with 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*., as follows:

1. Where on-site renewables are not installed, the maximum ENERGY RATING INDEX NOT INCLUDING OPP applies.
2. Where on-site renewables are installed, the maximum ENERGY RATING INDEX INCLUDING OPP applies.

Exception: Where the ERI analysis excludes OPP, the maximum ENERGY RATING INDEX NOT INCLUDING OPP shall be permitted.

TABLE N1106.5(R406.5)
MAXIMUM ENERGY RATING INDEX

CLIMATE ZONE	ENERGY RATING INDEX NOT INCLUDING OPP	ENERGY RATING INDEX INCLUDING OPP
0–1	~~52~~51	40
2	~~52~~51	40
3	~~51~~50	40
4	~~54~~53	40
5	~~55~~54	40
6	~~54~~53	40
7	~~53~~52	40
8	~~53~~52	40

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 power production is included in the calculation of an ERI, documentation shall comply with Section N1104.4. ~~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 REQUIREMENTS ~~PACKAGE OPTIONS~~

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

N1108.2 (R408.2) Additional energy efficiency credit requirements ~~package options~~. Two of the additional ~~Additional~~ efficiency ~~package options for compliance with Section N1101.13.5 are set forth in **Sections N1108.2.1** through **N1108.2.5**.~~measures shall be selected from Table N1108.2 that meet or exceed a total of ten credits. Five additional credits shall be selected for dwelling units with greater than 5,000 square feet (465 m^2) of living space floor area located above grade plane. Each measure selected shall meet the relevant subsections of Section N1108 and receive credit as specified in Table N1108.2 for the specific Climate Zone. Interpolation of credits between measures shall not be permitted.

TABLE N1108.2(R408.2)
CREDITS FOR ADDITIONAL ENERGY EFFICIENCY

Measure Number	Measure Description	Credit Value								
		Climate Zone 0 & 1	Climate Zone 2	Climate Zone 3	Climate Zone 4	Climate Zone 4C	Climate Zone 5	Climate Zone 6	Climate Zone 7	Climate Zone 8
N1108.2.1.1(1)	≥2.5% Reduction in total UA	0	0	0	1	1	1	1	1	1
N1108.2.1.1(2)	≥5% reduction in total UA	0	1	1	2	2	3	3	3	3
N1108.2.1.1(3)	>7.5% reduction in total UA	0	1	2	2	2	3	3	4	4
N1108.2.1.2(1)	0.22 U-factor windows	1	2	2	3	3	4	4	4	5
N1108.2.1.2(2)	U-factor and SHGC for windows per Table R408.2.1	1	1	1	0	0	0	0	1	2
N1108.2.1.3	Cool Roof	TBD	TBD	TBD	TBD	TBD	0	0	0	0
N1108.2.2(1)	High performance cooling system option 1	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
N1108.2.2(2)	High performance cooling system option 2	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
N1108.2.2(3)	High performance gas furnace option 1	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
N1108.2.2(4)	High performance gas furnace and cooling system option 1	0	0	0	0	0	TBD	TBD	TBD	0
N1108.2.2(5)	High performance gas furnace and cooling system option 2	TBD	TBD	TBD	TBD	TBD	0	0	0	TBD

N1108.2.2(6)	High performance gas furnace and heat pump system option 1	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
N1108.2.2(7)	High performance gas furnace option 2	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
N1108.2.2(8)	High performance heat pump system option 1	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
N1108.2.2(9)	High performance heat pump system option 2	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
N1108.2.2(10)	High performance heat pump system option 3	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
N1108.2.2(11)	Ground source heat pump	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
N1108.2.2(12)	Ductless - Single zone	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
N1108.2.2(13)	Ductless - Multizone (Non-ducted indoor unit)	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
N1108.2.2(14)	Ductless - Multizone (Ducted or Mixed)	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
N1108.2.3(1)	Gas-fired storage water heaters	7	6	5	3	3	2	2	3	1
N1108.2.3(2)	Gas-fired instantaneous water heaters	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
N1108.2.3(3)	Electric water heaters	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
N1108.2.3(4)	Electric water heaters	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
N1108.2.3(5)	Solar hot water heating system	4	5	6	6	6	6	5	5	4

N1108.2.3(6)	Compact hot water distribution	2	2	2	2	2	2	2	2	2
N1108.2.4(1)	More efficient distribution system	4	6	7	10	10	12	13	15	16
N1108.2.4(2)	100% of ducts in conditioned space	4	6	8	12	12	15	17	19	20
N1108.2.4(3)	Reduced total duct leakage	1	1	1	1	1	1	2	2	2
N1108.2.5(1)	2 ACH50 air leakage rate with ERV or HRV installed	1	4	5	10	10	13	15	8	8
N1108.2.5(2)	2 ACH50 air leakage rate with balanced ventilation	2	3	2	4	4	5	6	6	6
N1108.2.5(3)	1.5 ACH50 air leakage rated with ERV or HRV installed	2	4	6	12	12	15	18	11	11
N1108.2.5(4)	1 ACH50 air leakage rate with ERV or HRV installed	2	5	6	14	14	17	21	14	14
N1108.2.6	Energy efficient appliances	9	8	8	7	7	5	5	5	4
N1108.2.7	Renewable energy measures	17	16	17	11	11	9	8	7	4
N1108.2.9	Demand reponsive thermostat	1	1	1	1	1	1	1	1	1

N1108.2.1 (R408.2.1) Enhanced envelope ~~performance option~~ options. ~~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**.~~The *building thermal envelope* shall meet the following:

1. Section N1108.2.1.1 or N1108.2.1.2
2. Section N1108.2.1.3

N1108.2.1.1 (R408.2.1.1) Enhanced envelope performance UA The proposed total building thermal envelope UA shall be calculated in accordance with Section N1102.1.5 and shall meet one of the following:

1. Not less than 2.5 percent of the total UA of the building thermal envelope.

2. Not less than 5 percent of the total UA of the building thermal envelope.
3. Not less than 7.5 percent of the total UA of the building thermal envelope.

N1108.2.1.2 (R408.2.1.2) Improved fenestration Vertical fenestration shall meet one of the following:

1. *U*-factor equal to or less than 0.22.
2. *U*-factor and SHGC equal or less than that specified in Table N1108.2.1.2

TABLE N1108.2.1.2(R408.2.1.2)
IMPROVED FENESTRATION

Climate Zone	Fenestration U-factor	Fenestration SHGC
0	0.32	0.23
1	0.32	0.23
2	0.30	0.23
3	0.25	0.25
4	NA	NA
5	NA	NA
6	NA	NA
7 and 8	0.25	NA

N1108.2.1.3 (R408.2.1.3) Roof reflectance. Roofs shall comply with one or more of the options in Table N1108.2.1.3.

TABLE N1108.2.1.3(R408.2.1.3)
MINIMUM ROOF REFLECTANCE[a]

ROOF SLOPE	THREE-YEAR AGED SOLAR REFLECTANCE INDEX[b]
Low-slope	75[b,c]
Steep-slope	16

a. The use of area-weighted averages to comply with these requirements shall be permitted. Materials lacking 3-year-aged tested values for solar reflectance shall be assigned a 3-year aged solar reflectance in accordance with Section N1108.2.1.3.1.
b. Aged solar reflectance tested in accordance with ASTM C1549, ASTM E903 or ASTM E1918 or CRRC-S100.
c. Aged solar reflectance tested in accordance with ASTM C1549, ASTM E903 or ASTM E1918 or CRRC-S100.

N1108.2.1.3.1 (R408.2.1.3.1) Aged solar reflectance Where an aged solar reflectance required by Section N1102.6 is not available, it shall be determined in accordance with Equation 11-8.

$$R_{aged} = [0.2+0.7(R_{initial}-0.2)]$$

(Equation 11-8)

R_{aged} = The aged solar reflectance
$R_{initial}$ = The initial solar reflectance determined in accordance with CRRC-S100

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

Centrally Ducted Systems:

1. Greater than or equal to ~~95 AFUE natural gas furnace and~~ 16 SEER (15.2 SEER2) and 12 EER (11.5 EER2) air conditioner.
2. Greater than or equal to 18 SEER (16.9 SEER2) and 14 EER (13.4 EER2) air conditioner.
3. Greater than or equal to 92 AFUE natural gas furnace.
4. Greater than or equal to 95 AFUE natural gas furnace and 15.2 SEER2 in Climate Zones 5, 6 and 7.
5. Greater than or equal to 95 AFUE natural gas furnace and 16.0 SEER2 in other Climate Zones for air conditioner.
6. Greater than or equal to 95 AFUE natural gas furnace and 8.5 HSPF2/16.0 SEER2 air source heat pump.
7. Greater than or equal to 96 AFUE natural gas furnace.
8. Greater than or equal to 8.5 HSPF2/16.0 SEER2 air source heat pump.
9. Greater than or equal to 9 HSPF (7.6 HSPF2)/16 SEER (15.2 SEER2) air source heat pump

~~2.~~10. Greater than or equal to 10 HSPF (8.5 HSPF2)/~~16~~ 18 SEER (16.9 SEER2) air source heat pump.

~~3.~~11. Greater than or equal to 3.5 COP ground source heat pump.

Ductless Systems:

12. Single Zone: 8.5 HSPF2/16.9 SEER2 variable speed air source heat pump

13. Multi Zone: 8.5 HSPF2/16.9 SEER2 variable speed air source heat pump (Non-Ducted Indoor Units)
14. Multi Zone: 8.5 HSPF2/15.2 SEER2 variable speed air source heat pump (Ducted or Mixed Indoor Units)

~~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:~~For measure numbers N1108.2.3 (1) through N1108.2.3 (5), the hot water system shall meet one of the UniformEnergy Factors (UEF) or Solar Uniform Energy Factors (SUEF): in Table N1108.2.3. For measure number N1108.2.3 (6), the hot water system shall comply with N1108.2.3.1.

~~1. Greater than or equal to 0.82 EF fossil fuel service water-heating system.~~
~~2. Greater than or equal to 2.0 EF~~ 2.9 UEF ~~electric service water-heating system.~~
~~3.~~4. ~~Greater than or equal to 0.4 solar fraction solar water-heating system.~~

To field or plan review verify that the system meets the prescribed limit, one of the following must be done:

1. At plan review, referencing ounces of water per foot of tube on plans as per Table N1103.5.4.
2. At rough in (plumbing), referencing ounces of water per foot of tube installed as per Table N1103.5.4.
3. At final inspection. In accordance with Department of Energy's Zero Energy Ready Home National Specification (Rev. 07 or higher) footnote on Hot water delivery systems

TABLE N1108.2.3(R408.2.3)
Service water-heating efficiencies

Measure Number	Water Heater	Size and Draw Pattern	Type	Efficiency
N1108.2.3(1)	Gas-fired storage water heaters	≤ 55 gallons, Medium		UEF≥0.81
		≤ 55 gallons, High		UEF≥0.86
N1108.2.3(2)	Gas-fired instantaneous water heaters	Medium or High		UEF≥0.95
N1108.2.3(3)	Electric water heaters	Low, Medium, or High	Integrated HPWH	UEF≥3.30
N1108.2.3(4)	Electric water heaters	Low, Medium, or High	Integrated HPWH, 120 Volt/15 Amp Circuit	UEF≥2.20
		Low, Medium, or Hight	Split-system HPWH	UEF≥2.20
N1108.2.3(5)	Solar water heaters		Electric backup	SUEF≥3.00
			Gas backup	SUEF≥1.80

N1108.2.3.1 Compact hot water distribution. For Compact Hot Water Distribution system credit, the volume shall store not more than 16 ounces of water in the nearest source of heated water and the termination of the fixture supply pipe when calculated using Section N1103.5.4. When the hot water source is the nearest primed plumbing loop or trunk, this shall be primed with an on-demand recirculation pump and shall run a dedicated ambient return line from the furthest fixture or end of loop to the water heater. In order to claim this credit, the dwelling shall have a minimum of 1.5 bathrooms.
To field or plan review, verify that the system meets the prescribed limit, one of the following must be done:

1. At plan review, referencing ounces of water per foot of tube on plans as per Table N1103.5.4.
2. At rough in (plumbing), referencing ounces of water per foot of tube installed as per Table N1103.5.4.
3. At final inspection, in accordance with Department of Energy's Zero Energy Ready Home National Specification (Rev. 07 or higher) footnote on Hot water delivery systems.

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.~~1. 100 percent of ductless thermal distribution system or hydronic thermal distribution system located completely inside the building thermal envelope.
~~3.~~2. 100 percent of duct thermal distribution system located in conditioned space as defined by **Section N1103.3.3**.

3. When ducts are located outside conditioned space, the total leakage of the ducts, measured in accordance with N1103.3.5, shall be in accordance with one of the following:
   3.1 Where air handler is installed at the time of testing, 2.0 cubic feet per minute (0.94 L/s) per 100 square feet (9.29 m^2) of conditioned floor area.
   3.2 Where air handler is not installed at the time of testing, 1.75 cubic feet per minute (0.83 L/s) per 100 square feet (9.29 m^2) of conditioned floor area.
4. Duct systems designed so the individual room airflow shall be within ±20 percent of the design/application requirements for the supply and return ducts. This shall be demonstrated by using a duct airflow balancing procedure as specified by ANSI/ACCA 5 QI or by other approved methods.

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).~~The measured air leakage rate shall be one of the following:

1. Less than or equal to 2.0 ACH50, with either an Energy Recovery Ventilator (ERV) or Heat Recovery Ventilator (HRV) installed.
2. Less than or equal to 2.0 ACH50, with balanced ventilation as defined in Section 202 of the 2021 *International Mechanical Code*.
3. Less than or equal to 1.5 ACH50, with either an ERV or HRV installed.
4. Less than equal to 1.0 ACH50, with either an ERV or 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).~~

HRV and ERV Sensible Recovery Efficiency (SRE) shall be no less than 75 percent at 32°F (0°C), at the lowest listed net airflow. ERV Latent Recovery/Moisture Transfer (LRMT) shall be no less than 50 percent, at the lowest listed net airflow. In Climate Zone 8, recirculation shall not be used as a defrost strategy.

N1108.2.6 (R408.2.6) Energy efficient appliances Appliances installed in a dwelling unit shall meet the product energy efficiency specifica-tions listed in Table N1108.2.7, or equivalent energy efficiency specifications. Not less than three appliance types from Table N1108.2.7 shall be installed for compliance with this section

TABLE N1108.2.6(R408.2.6)
APPLICANCE SPECIFICATION REFERENCE DOCUMENT

Refrigerator	Energy Star Program Requirements, Product Specification for Consumer Refrigeration Products, Version 5.1 (08/05/2021)
Dishwasher	Energy Star Program Requirements for Residential Dishwashers, Version 6.0 (01/ 29/2016)
Clothes dryer	Energy Star Program Requirements, Product Specification for Clothes Dryers, Version 1.1 (05/05/2017)
Clothes washer	Energy Star Program Requirements, Product Specification for Clothes Washers, Version 8.1 (02/05/2018)

N1108.2.7 (R408.2.7) Renewable energy Renewable energy resources shall be permanently installed that have the rated capacity to produce a minimum of 1.0 watt of on-site renewable energy per square foot of conditioned floor area. To qualify for this option, re-newable energy certificate (REC) documentation shall meet the requirements of N1104.4.

N1108.2.8 (R408.2.8) Demand response The thermostat controlling the primary heating or cooling system of each dwelling unit shall be provided with a demand responsive control capable of communicating with the Virtual End Node (VEN) using a wired or wireless bi-directional communication pathway that provides the occupant the ability to voluntarily participate in utility demand response programs, where available. The thermostat shall be capable of executing the following actions in response to a demand response signal:

1. Automatically increasing the zone operating cooling set point by the following values: 1°F (0.5°C), 2°F (1°C), 3°F (1.5°C), and 4°F (2°C).
2. Automatically decreasing the zone operating heating set point by the following values: 1°F (0.5°C), 2°F (1°C), 3°F (1.5°C), and 4°F (2°C).

Thermostats controlling single stage HVAC systems shall comply with Section N1108.2.8.1. Thermostats controlling variable capacity systems shall comply with Section N1108.2.8.2. Thermostats controlling multi-stage HVAC systems shall comply with either Section N1108.2.8.1 or N1108.2.8.2.Where a demand response signal is not available the thermostat shall be capable of performing all other functions

N1108.2.8.1 (R408.2.8.1) Single stage HVAC system controls. Thermostats controlling single stage HVAC systems shall be provided with a demand responsive control that complies with one of the following:

1. Certified OpenADR 2.0a VEN, as specified under Clause 11, Conformance
2. Certified OpenADR 2.0b VEN, as specified under Clause 11, ConformanceList item content...
3. Certified by the manufacturer as being capable of responding to a demand response signal from a certified OpenADR 2.0b VEN by automatically implementing the control functions requested by the VEN for the equipment it controls
4. IEC 62746-10-1
5. IEC 62746-10-1
6. The physical configuration and communication protocol of CTA 2045-A or CTA-2045-B

N1108.2.8.2 (R408.2.8.2) Variable capacity and two stage HVAC system controls. Thermostats controlling variable capacity and two stage HVAC systems shall be provided with a demand responsive control that complies with the communication and

performance requirements of AHRI 1380.

N1108.2.9 (R408.2.9) Opaque walls. For buildings in climate zones 4 and 5, the maximum U-factor of 0.060 shall be permitted to be used for wood frame walls for compliance with Table R402.1.2 where complying with one or more of the following:

1. Primary space heating is provided by a heat pump that meets one of the efficiencies in N1108.2.2.
2. All installed water heaters are heat pumps that meet one of the efficiencies in N1108.2.3.
3. In addition to the number of credits required by Section N1108.2, three additional credits are achieved.
4. Renewable energy resources are installed to meet the requirements of N1108.2.7.

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*.

N1109.7 (R501.7) Change in space conditioning.Title Any unconditioned or low-energy space that is altered to become conditioned space shall be required to be brought into full compliance with this code.

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 otherwise allowed by Section N1105.2.

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 building 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~~N1110.2 (R502.2) Prescriptive compliance. *Additions* shall comply with **Sections N1110.2.1** through ~~**N1110.2.4**~~N1110.2.5.

~~N1110.3.1~~N1110.2.1 (R502.2.1) Building envelope. New *building* envelope assemblies that are part of the *addition* shall comply with **Sections N1102.1**, **N1102.2**, **N1102.4.1** through **N1102.4.5**, and **N1102.5**.

Exception: New envelope assemblies are exempt from the requirements of **Section N1102.5.1.2**.

~~N1110.3.2~~N1110.2.2 (R502.2.2) Heating and cooling systems. HVAC ducts newly installed as part of an *addition* shall comply with **Section N1103**.

Exception: Where ducts from an existing heat*ing and cooling system are extended ~~to~~ into an addition* Section N1103.3.5 and Section N1103.3.6 shall not be required.

~~N1110.3.3~~N1110.2.3 (R502.2.3) Service hot water systems. New service hot water systems that are part of the *addition* shall comply with **Section N1103.5**.

~~N1110.3.4~~N1110.2.4 (R502.2.4) Lighting. New lighting systems that are part of the *addition*

shall comply with **Section N1104.1**.

N1110.2.5 (R502.2.5) Additional efficiency packages Additions shall comply with Section N1114. Alterations to the existing building that are not part of the addition, but per-mitted with the addition, shall be permitted to be used to achieve this requirement.

Exceptions:

1. Additions that increase the building's total conditioned floor area by less than 25 percent.
2. Additions that do not include the addition or replacement of equipment covered in Sections N1103.5 or N1103.7.
3. Additions that do not contain conditioned space.
4. Where the addition alone or the existing building and addition together comply with Section N1105 or N1106.

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**~~N1111.1.5.

N1111.1.1 (R503.1.1) Building envelope. *Alterations of existing building thermal envelope assemblies shall comply with this section. New* ~~*Building*~~ building thermal envelope assemblies that are part of the *alteration* shall comply with Section N1102. ~~**Section N1102.1.2** or **N1102.1.4**~~N1102.1.3, ~~**Sections N1102.2.1** through **N1102.2.13**, **N1102.4.1**, **N1102.4.2**, **N1102.5.3** and **N1102.5.5**~~.In no case shall the R-value of insulation be reduced or the U-factor of a building thermal envelope assembly be increased as part of a building thermal envelope alteration.

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.~~2. *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.~~3. 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.

4. In no case shall the R-value of insulation be reduced or the U-factor of a building thermal envelope assembly be increased as part of a building thermal envelope alteration.

N1111.1.1.1 (R503.1.1.1) ~~**Replacement fenestration.**~~**Fenestration alterations** Where

new fenestration area is added to an existing building, the new fenestration shall comply with Section N1102.3. 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.

N1111.1.1.2 (R503.1.1.2) Roof alterations Roof insulation complying with Section N1102.1 or an approved design shall be provided for the following roof alteration conditions as applicable:

1. An alteration to roof-ceiling construction where there is no insulation above conditioned space.
2. Roof replacements for roofs with insulation entirely above deck,

Exceptions: Where compliance with Section N1102.1 cannot be met due to limiting conditions on an existing roof, the following shall be permitted to demonstrate compliance with the insulation requirements:

1. Construction documents that include a report by a registered design professional or other approved source documenting details of the limiting conditions affecting compliance with the insulation requirements.
2. Construction documents that include a roof design by a registered design professional or other approved source that minimize deviation from the insulation requirements.
3. Conversion of an unconditioned attic space into conditioned space, and
4. Replacement of ceiling finishes exposing cavities or surfaces of the roof-ceiling construction to which insulation can be applied.

N1111.1.1.3 (R503.1.1.3) Above-grade wall alterations Above-grade wall alterations shall comply with the following requirements as applicable:

1. Where interior finishes are removed exposing wall cavities, the existing cavity shall be filled with existing or new insulation complying with Section R303.1.4;
2. Where exterior wall coverings and fenestration are removed and replaced for the full extent of any exterior wall assembly, continuous insulation shall be provided where required in accordance with Section N1102.1 or an approved design;
3. Where Items 1 and 2 apply, the entire wall assembly shall be insulated in accordance with Section N1102.1; and,
4. Where new interior finishes or exterior wall coverings are applied to the full extent of any exterior wall assembly of mass construction, insulation shall be provided where required in accordance with Section N1102.1 or an approved design.

Where any of the above requirements are applicable, the above-grade wall alteration shall comply with the insulation and water vapor retarder requirements of Section R702.7. Where the exterior wall coverings are removed and replaced, the above-grade wall alteration shall comply with the water and wind resistance requirements of Section R703.1.1.

N1111.1.1.4 (R503.1.1.4) Floor alterations Where an alteration to a floor or floor overhang exposes cavities or surfaces to which insulation can be applied and the floor or floor overhang is part of the building thermal envelope, the floor or floor overhang shall be brought into compliance with Section N1102.1 or an approved design. This requirement shall apply to floor alterations where the floor cavities or surfaces are exposed and accessible prior to construction.

N1111.1.1.5 (R503.1.1.5) Below-grade wall alterations Where a blow-grade space is changed to conditioned space, the below-grade walls shall be insulated where required in accordance with Section N1102.1. Where the below-grade space is conditioned space and a below-grade wall is altered by removing or adding interior finishes, it shall be insulated where required in accordance with Section N1102.1.

N1111.1.1.6 (R503.1.1.6) Air barrier Building thermal envelope assemblies altered in accordance with Section N1111.1.1 shall be provided with an air barrier in accordance with Section N1102.4. The air barrier shall not be required to be made continuous with unaltered portions of the building thermal envelope. Testing requirements of Section N1102.4.1.2 shall not be required.

N1111.1.2 (R503.1.2) Heating and cooling systems. New heating and cooling and duct systems that are part of the alteration shall comply with Section N1103 and this section ~~HVAC ducts newly installed as part of an *alteration* shall comply with **Section N1103**~~. Alterations to heating, cooling and duct systems shall comply with this section.

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

N1111.1.2.1 (R503.1.2.1) Ducts 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.

N1111.1.2.2 (R503.1.2.2 System Sizing. New heating and cooling equipment that is part of an alteration shall be sized in accordance with Section N1103.7 based on the existing building features as modified by the alteration.

Exception: Where it has been demonstrated to the *code official* that compliance with this section would result in heating or cooling equipment that is incompatible with the remaining portions of the existing heating or cooling system.

N1111.1.2.3 (R503.1.2.3) Duct Leakage Where an alteration includes any of the following, ducts shall be tested in accordance with Section N1103.3.5 and shall have a total leakage less than or equal to 12.0 cubic feet per minute (339.9 L/min) per 100 square feet (9.29 m^2) of conditioned floor area:

1. Where 25 percent or more of the registers that are part of the duct system are relocated.
2. Where 25 percent or more of the total length of all ducts in the system are relocated.
3. Where the total length of all ducts in the system is increased by 25 percent or more.

Exception: Duct systems located entirely inside a conditioned space in accordance with Section N1103.3.2.

N1111.1.2.4 (R503.1.2.4) Controls New heating and cooling equipment that are part of the alteration shall comply with Sections N1103.1 and N1103.2

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.

N1111.1.5 (R503.1.5) Additional Efficiency Packages Alterations shall comply with Section N1114 where the alteration contains replacement of two or more of the following:

1. HVAC unitary systems or HVAC central heating or cooling equipment serving the work area of the alteration.
2. Water heating equipment serving the work area of the alteration.
3. 50 percent or more of the lighting fixtures in the work area of the alteration.
4. 50 percent or more of the area of interior surfaces of the thermal envelope in the work area of the alteration.
5. 50 percent or more the area of the building's exterior wall envelope.

Exceptions:

1. Alterations that are permitted with an addition complying with Section N1110.3.5.
2. Alterations that comply with Section N1105 or N1106.

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 building 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**.

N1114
ADDITIONAL EFFICIENCY PACKAGE OPTIONS

N1114.1 (R506.1) General Where required in Section N1110 or N1111, the building shall comply with one or more additional efficiency package options in accordance with the following:

1. Enhanced envelope performance in accordance with Section N1108.2.1.
2. More efficient HVAC equipment performance in accordance with Section N1108.2.2.

3. Reduced energy use in service water-heating in accordance with Section N1108.2.3.
4. More efficient duct thermal distribution system in accordance with Section N1108.2.4.
5. Improved air sealing and efficient ventilation system in accordance with Section N1108.2.5.

APPENDIX AT [RE]SOLAR-READY PROVISIONS—DETACHED ONE- AND TWO-FAMILY DWELLINGS AND TOWNHOUSES

The provisions contained in this appendix are not mandatory unless specifically referenced in the adopting ordinance.

User note:

About this appendix: *Harnessing the heat or radiation from the sun's rays is a method to reduce the energy consumption of a building. Although Appendix AT does not require solar systems to be installed for a building, it does require the space(s) for installing such systems, providing pathways for connections and requiring adequate structural capacity of roof systems to support solar systems.*

Section numbers in parenthesis are those in ***Appendix RB*** *of the residential provisions of the* International Energy Conservation Code®.

SECTION AT101 (RB101) SCOPE

AT101.1 (RB101.1) General. These provisions shall be applicable for new construction where solar-ready provisions are required.

SECTION AT102 (RB102) GENERAL DEFINITION

AT102.1 (RB102.1) General. The following term shall, for the purpose of this appendix, have the meaning shown herein.

SOLAR-READY ZONE. A section or sections of the roof or building overhang designated and reserved for the future installation of a solar photovoltaic or solar thermal system.

SECTION AT103 (RB103) SOLAR-READY ZONE

AT103.1 (RB103.2) General. New detached one- and two-family dwellings, and townhouses with not less than 600 square feet (55.74 m^2) of roof area oriented between 110 degrees and 270 degrees of true north, shall comply with **Sections AT103.2** through **AT103.10**.

Exceptions:

1. New residential buildings with a permanently installed on-site renewable energy system.
2. A building where all areas of the roof that would otherwise meet the requirements of Section AT103 are in full or partial shade for more than 70 percent of daylight hours annually.

AT103.2 (RB103.2) Construction document requirements for solar-ready zone. *Construction documents* shall indicate the solar-ready zone.

AT103.3 (RB103.3) Solar-ready zone area. The total solar-ready zone area shall be not less than 300 square feet (27.87 m^2) exclusive of mandatory access or setback areas as required by the ***International Fire Code***. New townhouses three stories or less in height above *grade plane* and with a total floor area less than or equal to 2,000 square feet (185.8 m^2) per dwelling shall have a solar-ready zone area of not less than 150 square feet (13.94 m^2). The solar-ready zone shall be composed of areas not less than 5 feet (1524 mm) in width and not less than 80 square feet (7.44 m^2) exclusive of access or set-back areas as required by the ***International Fire Code***.

AT103.4 (RB103.4) Obstructions. Solar-ready zones shall be free from obstructions, including but not limited to vents, chimneys, and roof-mounted equipment.

AT103.5 (RB103.5) Shading. The solar-ready zone shall be set back from any existing or new, permanently affixed object on the building or site that is located south, east or west of the solar zone a distance not less than two times the object's height above the nearest point on the roof surface. Such objects include, but are not limited to, taller portions of the building itself, parapets, chimneys, antennas, signage, rooftop equipment, trees and roof plantings.

AT103.6 (RB103.6) Capped roof penetration sleeve. A capped roof penetration sleeve shall be provided adjacent to a solar-ready zone located on a roof slope of not greater than 1 unit vertical in 12 units horizontal (8-percent slope). The capped roof penetration sleeve shall be sized to accommodate the future photovoltaic system conduit, but shall have an inside diameter of not less than $1^1/_4$ inches (32 mm).

AT103.7 (RB103.7) Roof load documentation. The structural design loads for roof dead load and roof *live load* shall be clearly indicated on the *construction documents*.

AT103.8 (RB103.8) Interconnection pathway. *Construction documents* shall indicate pathways for routing of conduit or plumbing from the solar-ready zone to the electrical service panel or service hot water system.

AT103.9 (RB103.9) Electrical service reserved space. The main electrical service panel shall have a reserved space to allow installation of a dual pole circuit breaker for future solar electric installation and shall be *labeled* "For Future Solar Electric." The reserved space shall be positioned at the opposite (load) end from the input feeder location or main circuit location.

AT103.10 (RB103.10) Construction documentation certificate. A permanent certificate, indicating the solar-ready zone and other requirements of this section, shall be posted near the electrical distribution panel, water heater or other conspicuous location by the builder or *registered design professional*.

APPENDIX AU
ELECTRIC ENERGY STORAGE PROVISIONS

AU101
SCOPE

AU101.1 General These provisions shall be applicable for new construction where solar-ready measures or an onsite solar PV system are required.

AU102
GENERAL DEFINITION

AU102.1 ENERGY STORAGE SYSTEM (ESS). One or more devices, assembled together, capable of storing energy in order to supply electrical energy at a future time.

AU103
ELECTRICAL ENERGY STORAGE

AU103.1 Electrical energy storage One- and two-family dwellings, townhouse units, and Group R-3 occupancies shall either comply with AU103.2 or AU103.3. Buildings with Group R-2 and R-4 occupancies shall comply with AU103.4.

AU103.2 Electrical energy storage energy capacity. Each building shall have a ESS with a minimum rated energy capacity of 5 kWh with a minimum of four ESS supplied branch circuits.

AU103.3 Electrical energy storage system ready. Each building shall be energy storage ready in accordance with Sections AU103.3.1 through AU103.3.4.

AU103.3.1 Energy storage system space. Interior or exterior space with dimensions and locations in accordance with Section R328 and Section 110.26 of NFPA 70 shall be reserved to allow for the future installation of an energy storage system.

AU103.3.2 System Isolation Equipment Space. Space shall be reserved to allow for the future installation of a transfer switch within 3 feet (305mm) of the main panelboard. Raceways shall be installed between the panelboard and the transfer switch location to allow the connection of an ESS.

AU103.3.3 Panelboard with backed-up load circuits. A dedicated raceway from the main service to a panelboard that supplies the branch circuits served by the ESS. All branch circuits are permitted to be supplied by the main service panel prior to the installation of an ESS. The trade size of the raceway shall be not less than one inch. The panelboard that supplies the branch circuits shall be labeled "Subpanel reserved for future battery energy storage system to supply essential loads."

AU103.3.4 Branch circuits served by ESS. A minimum of four branch circuits shall be identified and have their source of supply collocated at a single panelboard supplied by the ESS. The following end uses shall be served by the branch circuits:

1. A refrigerator.
2. One lighting circuit near the primary egress.
3. A sleeping room receptacle outlet.

AU103.4 Electrical energy storage system. Buildings with Group R-2 and R-4 occupancies shall comply with C405.15.

APPENDIX AX ZERO NET ENERGY RESIDENTIAL BUILDING PROVISIONS

The provisions contained in this appendix are not mandatory unless specifically referenced in the adopting ordinance.

User Note:

About this appendix: *This appendix provides requirements for residential buildings intended to result in ~~net~~ zero net energy consumption over the course of a year. Where adopted by ordinance as a requirement,* ***Section AX101*** *and Section RC103.2, RC103.4, and RC103.5~~language is~~ are intended to replace* ***Section N1101.13****.Sections N1101.1, N1101.2, N1106.2, N1106.4, and N1106.5,respectively. Where adopted by ordinance as a requirement, Sections N1101.3 (Certificate), N11R406.1(Scope), N1106.3 (Building Thermal Envelope), N1106.6 (Verification by approved agency) and N1106.7 (Documentation) are not replaced.*

SECTION AX 101 (RC101)
~~COMPLIANCE~~ GENERAL

AX101.1 ~~Compliance.~~ Scope. ~~Existing *residential buildings* shall comply with **Sections N1109** through N1113 N113. New *residential buildings* shall comply with **Section AX102**.~~This appendix applies to new residential buildings.

AX101.2 Application Residential buildings shall comply with Section N1106.

Exception: Additions, alterations, repairs and changes of occupancy to existing buildings complying with Chapter 5.

AX101.3 Certificate [no change, same as N1101.3].

AX102
GENERAL DEFINITION

COMMUNITY RENEWABLE ENERGY FACILITY (CREF). A facility that produces energy from renewable energy resources and that is qualified as a community energy facility under applicable jurisdictional statutes and rules.

FINANCIAL RENEWABLE ENERGY POWER PURCHASE AGREEMENT (FPPA) . A financial arrangement between a renewable electricity generator and a purchaser wherein the purchaser pays or guarantees a price to the generator for the project's renewable generation. Also known as a "financial power purchase agreement" and "virtual power purchase agreement."

PHYSICAL RENEWABLE ENERGY POWER PURCHASE AGREEMENT (PPPA). A contract for the purchase of renewable electricity from a specific renewable electricity generator by a purchaser of renewable electricity.

~~AX102~~AX103
ZERO NET ENERGY RESIDENTIAL BUILDINGS

AX103.1 ERI compliance (Replace N1106.2). Compliance based on the ERI requires that the rated design meets one of the following:

1. The requirements of the sections indicated within Table N1106.2 and Sections N1106.3 through N1106.7, or

2. The requirements of ASHRAE/IES Standard 90.2, including:
   2.1 The ERI requirements of ASHRAE/IES 90.2 Table 6-1 without the use of on-site power production (OPP),List item content...
   2.2 The requirements of Sections N1102.4.1.1, N1102.4.1.2, N1106.3, N1104.5 (Electric Readiness), N1104.7 (Electric Vehicle Power Transfer Infrastructure), and
   2.3 The maximum ERI including adjusted OPP of Table AX103.3 determined in accordance with AX103.3.

AX103.2 Building thermal envelope. [no change, same as N1106.3]

AX103.3 Energy Rating Index zero net energy score. ~~Compliance with this section requires that the rated design be shown to have a score less than or equal to the values in **Table AX102.2** when compared to the *ERI reference design*~~ The Energy Rating Index (ERI) not including renewable energy resources shall be determined in accordance with RESNET/ICC 301. ~~for both of the following:~~The Energy Rating Index (ERI) including renewable energy resources shall bedetermined in accordance with ANSI/RESNET/ICC 301, except where electrical energy isprovided from a community renewable energy facility (CREF) or contracted from a physical orfinancial renewable energy power purchase agreement that meets requirements of AX106.4.1, onsitepower production (OPP) shall be adjusted in accordance with Equation AX-1.

1. ~~ERI value not including on-site power production (OPP) calculated in accordance with RESNET/ICC 301.~~
2. ~~ERI value including on-site power production calculated in accordance with RESNET/ICC 301 with the OPP in Equation 4.1.2 of RESNET/ICC 301 adjusted in accordance with **Equation AX-1**.~~

~~Adjusted OPP = OPP + CREF + REPC~~

~~where:~~ ~~**(Equation AX-1)**~~

~~**CREF (Community Renewable Energy Facility power production):** The yearly energy, in kilowatt hour equivalent (kWheq), contracted from a community renewable energy facility that is qualified under applicable state and local utility statutes and rules, and that allocates bill credits to the rated home.~~

~~**REPC (Renewable Energy Purchase Contract power production):** The yearly energy, in kilowatt hour equivalent (kWheq), contracted from an energy facility that generates energy with photovoltaic, solar thermal, *geothermal energy*, or wind systems, and that is demonstrated by an energy purchase contract or lease with a duration of not less than 15 years.~~

$$\text{Adjusted OPP} = \text{OPP}_{\text{kWh}} + \text{CREF}_{\text{kWh}} + \text{PPPA}_{\text{kWh}} + \text{FPPA}_{\text{kWh}}$$

OPP_{kWh} = Annual electrical energy from on-site renewable energy, in units of kilowatt-hours (kWh).
CREF_{kwh} = Annual electrical energy from a community renewable energy facility (CREF), in units of kilowatt-hours(kWh).
PPPA_{kwh} = Where not included as OPP, the annual electrical energy contracted from a physical renewable energy power purchase agreement, in units of kilowatt-hours (kWh).
FPPA_{kwh} = Where not included as OPP, the annual electrical energy contracted from a financial renewable energy power purchase agreement (FPPA), in units of kilowatt-hours (kWh).

TABLE AX103.3(RC102.2)
MAXIMUM ENERGY RATING INDEX[a]

CLIMATE ZONE	ENERGY RATING INDEX NOT INCLUDING ~~OPP~~RENEWABLE ENERGY	ENERGY RATING INDEX INCLUDING ADJUSTED OPP ~~(as proposed)~~
0	42	0
1	~~43~~42	0
2	~~45~~42	0
3	~~47~~42	0
4	~~47~~42	0
5	~~47~~42	0
6	~~46~~42	0
7	~~46~~42	0
8	~~46~~42	0

~~a. The building shall meet the mandatory requirements of **Section N1106.2**, and the building thermal envelope shall be greater than or equal to the levels of efficiency and SHGC in Table N1102.1.2 or Table N1102.1.4 of the 2015 *International Residential Code*.~~

AX103.3.1 Power purchase agreement contract. The renewable energy shall be delivered or credited to the building site under an energy contract with a duration of not less than 10 years. The contract shall be structured to survive a partial or full transfer of ownership of the building property.

AX103.4 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 both values indicated in Table AX103.3 when compared to the ERI reference design.

AX103.5 Verification by approved agency. [no change, same as R406.6]

AX103.6 Documentation [no change, same as N1106.7]

APPENDIX AY
ALL-ELECTIC RESIDENTIAL BUILDINGS

Appendix AY requires the installation of all-electric equipment and appliances in new construction in order to reduce carbon emissions and improve the safety and health of residential buildings. Where adopted as a requirement, Section AY103.1 is intended to replace R401.2.

AY101
GENERAL

AY101.1 Intent The intent of this Appendix is to amend the *International Energy Conservation Code* to reduce greenhouse gas emissions and improve the safety and health of buildings by not permitting combustion equipment in buildings.

AY101.2 Scope This appendix applies to new residential buildings.

AY102
GENERAL DEFINITIONS

AY102.1
ALL-ELECTRIC BUILDING. A building that contains no combustion equipment, or plumbing for combustion equipment, installed within the building, or building site. APPLIANCE. A device or apparatus that is manufactured and designed to utilize energy and for which this code provides specific requirements.
COMBUSTION EQUIPMENT. Any equipment or appliance used for space heating, service water heating, cooking, clothes drying and/or lighting that uses fuel gas or fuel oil.
EQUIPMENT. Piping, ducts, vents, control devices and other components of systems other than appliances that are permanently installed and integrated to provide control of environmental conditions for buildings. This definition shall also include other systems specifically regulated in this code.
FUEL GAS. A natural gas, manufactured gas, liquified petroleum gas or a mixture of these.
FUEL OIL. Kerosene or any hydrocarbon oil having a flash point not less than 100°F (38°C).

AY103
ALL-ELECTRIC RESIDENTIAL BUILDINGS

AY103.1 Application Residential buildings shall be *all-electric buildings* and comply with Section R401.2.5 and either Sections R401.2.1, R401.2.2, R401.2.3 or R401.2.4.

APPENDIX BE
APPENDIX BE ALTERNATIVE BUILDING THERMAL ENVELOPE INSULATION R-VALUE OPTIONS

BE101
ABOVE-GRADE WALL ASSEMBLIES

BE101.1 Title Wood frame walls. Wood frame above-grade wall assemblies shall comply with both the cavity insulation and continuous insulation Rvalues and framing conditions specified by Table RD101.1 where the tabulated U-factors are less than or equal to those needed for compliance with Section R402.1.2. For assemblies not addressed by the conditions of Table RD101.1, U-factors shall be determined by using accepted engineering practice or by testing in accordance with ASTM C1363 and shall be subject to approval by the code official in accordance with Section R102.1. Use of a lesser framing fraction than the indicated maximums in Table BE101.1 shall require wall framing layout details for each above-grade wall elevation to be included on approved construction documents and shall be inspected for compliance.

TABLE BE101.1
ASSEMBLY U-FACTORS FOR WOOD FRAME WALLS[a,b,c,d,e]

Wood Stud Size and Spacing	Cavity Insulation Installed R-value	Continuous Insulation R-Value																		
		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	20	25	30
2x4 (12 inches o.c)	0	0.324	0.239	0.190	0.158	0.136	0.119	0.106	0.096	0.087	0.080	0.074	0.069	0.064	0.060	0.057	0.054	0.042	0.035	0.030
	11	0.094	0.085	0.078	0.072	0.067	0.062	0.059	0.055	0.052	0.050	0.047	0.045	0.043	0.041	0.040	0.038	0.032	0.027	0.024
	12	0.090	0.082	0.075	0.069	0.064	0.060	0.057	0.054	0.051	0.048	0.046	0.044	0.042	0.040	0.039	0.037	0.031	0.027	0.024
	13	0.087	0.079	0.072	0.067	0.063	0.059	0.055	0.052	0.049	0.047	0.045	0.043	0.041	0.039	0.038	0.036	0.031	0.027	0.023
	14	0.084	0.076	0.070	0.065	0.061	0.057	0.054	0.051	0.048	0.046	0.044	0.042	0.040	0.038	0.037	0.036	0.030	0.026	0.023
	15	0.082	0.074	0.068	0.063	0.059	0.055	0.052	0.049	0.047	0.045	0.043	0.041	0.039	0.038	0.036	0.035	0.030	0.026	0.023
	16	0.079	0.072	0.066	0.062	0.058	0.054	0.051	0.048	0.046	0.044	0.042	0.040	0.038	0.037	0.036	0.034	0.029	0.025	0.022
	17	0.077	0.070	0.065	0.060	0.056	0.053	0.050	0.047	0.045	0.043	0.041	0.039	0.038	0.036	0.035	0.034	0.029	0.025	0.022
	18	0.076	0.069	0.063	0.059	0.055	0.052	0.049	0.046	0.044	0.042	0.040	0.038	0.037	0.036	0.034	0.033	0.028	0.025	0.022
	19	0.074	0.067	0.062	0.058	0.054	0.051	0.048	0.045	0.043	0.041	0.039	0.038	0.036	0.035	0.034	0.032	0.028	0.024	0.022
	20	0.072	0.066	0.061	0.056	0.053	0.050	0.047	0.044	0.042	0.040	0.039	0.037	0.036	0.034	0.033	0.032	0.027	0.024	0.021
2x6 (12 inches o.c.)	0	0.0313	0.230	0.183	0.153	0.131	0.115	0.102	0.093	0.084	0.078	0.072	0.067	0.063	0.059	0.055	0.053	0.041	0.034	0.029
	18	0.065	0.060	0.056	0.053	0.050	0.048	0.045	0.043	0.041	0.040	0.038	0.037	0.035	0.034	0.033	0.032	0.027	0.024	0.021
	19	0.063	0.059	0.055	0.052	0.049	0.047	0.044	0.042	0.040	0.039	0.037	0.036	0.035	0.033	0.032	0.031	0.027	0.024	0.021
	20	0.062	0.057	0.054	0.051	0.048	0.046	0.043	0.041	0.040	0.038	0.037	0.035	0.034	0.033	0.032	0.031	0.026	0.023	0.021
	21	0.060	0.056	0.053	0.050	0.047	0.045	0.043	0.041	0.039	0.037	0.036	0.035	0.033	0.032	0.031	0.030	0.026	0.023	0.021
	22	0.059	0.055	0.052	0.049	0.046	0.044	0.042	0.040	0.038	0.037	0.035	0.034	0.033	0.032	0.031	0.030	0.026	0.023	0.020
	23	0.058	0.054	0.051	0.048	0.045	0.043	0.041	0.039	0.038	0.036	0.035	0.033	0.032	0.031	0.030	0.029	0.025	0.022	0.020
	24	0.057	0.053	0.050	0.047	0.044	0.042	0.040	0.039	0.037	0.035	0.034	0.033	0.032	0.031	0.030	0.029	0.025	0.022	0.020
	25	0.056	0.052	0.049	0.046	0.044	0.042	0.040	0.038	0.036	0.035	0.034	0.032	0.031	0.030	0.029	0.028	0.025	0.022	0.020
	30	0.052	0.048	0.045	0.043	0.041	0.039	0.037	0.035	0.034	0.033	0.031	0.030	0.029	0.028	0.027	0.027	0.023	0.021	0.019
	35	0.049	0.046	0.043	0.040	0.038	0.036	0.035	0.033	0.032	0.031	0.030	0.029	0.028	0.027	0.026	0.025	0.022	0.020	0.018
2x8 (12 inches o.c.)	0	0.308	0.226	0.179	0.149	0.128	0.112	0.100	0.091	0.083	0.076	0.070	0.066	0.061	0.058	0.054	0.052	0.041	0.034	0.029
	20	0.056	0.053	0.050	0.047	0.045	0.043	0.041	0.039	0.038	0.036	0.035	0.034	0.033	0.032	0.031	0.030	0.026	0.023	0.020
	21	0.055	0.052	0.049	0.046	0.044	0.042	0.040	0.039	0.037	0.036	0.034	0.033	0.032	0.031	0.030	0.029	0.025	0.022	0.020
	22	0.053	0.050	0.048	0.045	0.043	0.041	0.039	0.038	0.036	0.035	0.034	0.033	0.032	0.031	0.030	0.029	0.025	0.022	0.020
	23	0.052	0.049	0.047	0.044	0.042	0.040	0.039	0.037	0.036	0.034	0.033	0.032	0.031	0.030	0.029	0.028	0.025	0.022	0.020
	24	0.051	0.048	0.046	0.044	0.042	0.040	0.038	0.037	0.035	0.034	0.033	0.032	0.031	0.030	0.029	0.028	0.024	0.022	0.019
	25	0.050	0.047	0.045	0.043	0.041	0.039	0.037	0.036	0.035	0.033	0.032	0.031	0.030	0.029	0.028	0.027	0.024	0.021	0.019
	30	0.046	0.044	0.041	0.039	0.038	0.036	0.035	0.033	0.032	0.031	0.030	0.029	0.028	0.027	0.026	0.026	0.023	0.020	0.018
	35	0.043	0.041	0.039	0.037	0.035	0.034	0.032	0.031	0.030	0.029	0.028	0.027	0.026	0.026	0.025	0.024	0.021	0.019	0.017
	40	0.041	0.039	0.037	0.035	0.033	0.032	0.031	0.030	0.029	0.028	0.027	0.026	0.025	0.024	0.024	0.023	0.020	0.018	0.017
2x4 (16 inches o.c.)	0	0.331	0.243	0.193	0.161	0.138	0.120	0.107	0.097	0.088	0.081	0.075	0.069	0.065	0.061	0.057	0.054	0.043	0.035	0.030
	11	0.092	0.083	0.076	0.071	0.066	0.061	0.058	0.054	0.052	0.049	0.047	0.045	0.043	0.041	0.039	0.038	0.032	0.027	0.024
	12	0.088	0.080	0.073	0.068	0.063	0.059	0.056	0.053	0.050	0.048	0.045	0.043	0.041	0.040	0.038	0.037	0.031	0.027	0.024
	13	0.084	0.077	0.071	0.066	0.061	0.057	0.054	0.051	0.049	0.046	0.044	0.042	0.040	0.039	0.037	0.036	0.030	0.026	0.023
	14	0.081	0.074	0.068	0.064	0.059	0.056	0.053	0.050	0.047	0.045	0.043	0.041	0.039	0.038	0.037	0.035	0.030	0.026	0.023
	15	0.079	0.072	0.066	0.062	0.058	0.054	0.051	0.049	0.046	0.044	0.042	0.040	0.039	0.037	0.036	0.034	0.029	0.025	0.023
	16	0.077	0.070	0.065	0.060	0.056	0.053	0.050	0.047	0.045	0.043	0.041	0.039	0.038	0.036	0.035	0.034	0.029	0.025	0.022
	17	0.075	0.068	0.063	0.058	0.055	0.052	0.049	0.046	0.044	0.042	0.040	0.039	0.037	0.036	0.034	0.033	0.028	0.025	0.022
	18	0.073	0.066	0.061	0.057	0.053	0.050	0.048	0.045	0.043	0.041	0.039	0.038	0.036	0.035	0.034	0.033	0.028	0.024	0.022
	19	0.071	0.065	0.060	0.056	0.052	0.049	0.047	0.044	0.042	0.040	0.039	0.037	0.036	0.034	0.033	0.032	0.027	0.024	0.021
	20	0.069	0.063	0.059	0.055	0.051	0.048	0.046	0.043	0.041	0.039	0.038	0.036	0.035	0.034	0.032	0.031	0.027	0.024	0.021
2x6 (16 inches o.c.)	0	0.322	0.236	0.187	0.156	0.133	0.117	0.104	0.094	0.086	0.079	0.073	0.068	0.063	0.059	0.056	0.053	0.042	0.034	0.029
	18	0.063	0.059	0.055	0.052	0.049	0.047	0.044	0.042	0.041	0.039	0.037	0.036	0.035	0.034	0.032	0.031	0.027	0.024	0.021
	19	0.061	0.057	0.054	0.051	0.048	0.046	0.043	0.042	0.040	0.038	0.037	0.035	0.034	0.033	0.032	0.031	0.027	0.023	0.021
	20	0.060	0.056	0.052	0.050	0.047	0.045	0.042	0.041	0.039	0.037	0.036	0.035	0.033	0.032	0.031	0.030	0.026	0.023	0.021
	21	0.058	0.055	0.051	0.048	0.046	0.044	0.042	0.040	0.038	0.037	0.035	0.034	0.033	0.032	0.031	0.030	0.026	0.023	0.020

	22	0.057	0.053	0.050	0.047	0.045	0.043	0.041	0.039	0.037	0.036	0.035	0.033	0.032	0.031	0.030	0.029	0.025	0.022	0.020
	23	0.056	0.052	0.049	0.046	0.044	0.042	0.040	0.038	0.037	0.035	0.034	0.033	0.032	0.031	0.030	0.029	0.025	0.022	0.020
	24	0.055	0.051	0.048	0.046	0.043	0.041	0.039	0.038	0.036	0.035	0.033	0.032	0.031	0.030	0.029	0.028	0.025	0.022	0.020
	25	0.054	0.050	0.047	0.045	0.042	0.040	0.039	0.037	0.035	0.034	0.033	0.032	0.031	0.030	0.029	0.028	0.024	0.022	0.019
	30	0.050	0.046	0.044	0.041	0.039	0.037	0.036	0.034	0.033	0.032	0.031	0.029	0.029	0.028	0.027	0.026	0.023	0.020	0.018
	35	0.047	0.043	0.041	0.039	0.037	0.035	0.033	0.032	0.031	0.030	0.029	0.028	0.027	0.026	0.025	0.025	0.022	0.019	0.017
2x8 (16 inches o.c.)	0	0.317	0.232	0.184	0.152	0.131	0.115	0.102	0.092	0.084	0.077	0.071	0.066	0.062	0.058	0.055	0.052	0.041	0.034	0.029
	20	0.055	0.052	0.049	0.046	0.044	0.042	0.040	0.039	0.037	0.036	0.035	0.033	0.032	0.031	0.030	0.029	0.026	0.023	0.020
	21	0.053	0.050	0.048	0.045	0.043	0.041	0.040	0.038	0.037	0.035	0.034	0.033	0.032	0.031	0.030	0.029	0.025	0.022	0.020
	22	0.052	0.049	0.047	0.044	0.042	0.040	0.039	0.037	0.036	0.034	0.033	0.032	0.031	0.030	0.029	0.028	0.025	0.022	0.020
	23	0.051	0.048	0.046	0.043	0.041	0.040	0.038	0.036	0.035	0.034	0.033	0.032	0.031	0.030	0.029	0.028	0.024	0.022	0.020
	24	0.050	0.047	0.045	0.043	0.041	0.039	0.037	0.036	0.034	0.033	0.032	0.031	0.030	0.029	0.028	0.027	0.024	0.021	0.019
	25	0.049	0.046	0.044	0.042	0.040	0.038	0.037	0.035	0.034	0.033	0.032	0.031	0.030	0.029	0.028	0.027	0.024	0.021	0.019
	30	0.045	0.042	0.040	0.038	0.037	0.035	0.034	0.032	0.031	0.030	0.029	0.028	0.027	0.027	0.026	0.025	0.022	0.020	0.018
	35	0.042	0.039	0.037	0.036	0.034	0.033	0.031	0.030	0.029	0.028	0.027	0.027	0.026	0.025	0.024	0.024	0.021	0.019	0.017
	40	0.039	0.037	0.035	0.034	0.032	0.031	0.030	0.029	0.028	0.027	0.026	0.025	0.024	0.024	0.023	0.022	0.020	0.018	0.016
2x4 (24 inches o.c.)	0	0.339	0.248	0.196	0.163	0.139	0.122	0.108	0.098	0.089	0.081	0.075	0.070	0.065	0.061	0.058	0.055	0.043	0.035	0.030
	11	0.089	0.081	0.075	0.069	0.065	0.061	0.057	0.054	0.051	0.048	0.046	0.044	0.042	0.040	0.039	0.037	0.031	0.027	0.024
	12	0.085	0.078	0.072	0.067	0.062	0.058	0.055	0.052	0.049	0.047	0.045	0.043	0.041	0.039	0.038	0.036	0.031	0.027	0.023
	13	0.082	0.075	0.069	0.064	0.060	0.056	0.053	0.050	0.048	0.046	0.044	0.042	0.040	0.038	0.037	0.036	0.030	0.026	0.023
	14	0.079	0.072	0.067	0.062	0.058	0.055	0.052	0.049	0.047	0.044	0.042	0.041	0.039	0.037	0.036	0.035	0.030	0.026	0.023
	15	0.076	0.070	0.065	0.060	0.056	0.053	0.050	0.048	0.045	0.043	0.041	0.040	0.038	0.037	0.035	0.034	0.029	0.025	0.022
	16	0.074	0.068	0.063	0.058	0.055	0.052	0.049	0.046	0.044	0.042	0.040	0.039	0.037	0.036	0.034	0.033	0.028	0.025	0.022
	17	0.072	0.066	0.061	0.057	0.053	0.050	0.048	0.045	0.043	0.041	0.039	0.038	0.036	0.035	0.034	0.033	0.028	0.024	0.022
	18	0.070	0.064	0.059	0.055	0.052	0.049	0.046	0.044	0.042	0.040	0.039	0.037	0.036	0.034	0.033	0.032	0.027	0.024	0.021
	19	0.068	0.062	0.058	0.054	0.051	0.048	0.045	0.043	0.041	0.039	0.038	0.036	0.035	0.034	0.032	0.031	0.027	0.024	0.021
	20	0.066	0.061	0.056	0.053	0.050	0.047	0.044	0.042	0.040	0.039	0.037	0.036	0.034	0.033	0.032	0.031	0.027	0.023	0.021
2x6 (24 inches o.c.)	0	0.330	0.241	0.191	0.159	0.136	0.119	0.106	0.095	0.087	0.080	0.074	0.068	0.064	0.060	0.057	0.053	0.042	0.035	0.030
	18	0.061	0.057	0.054	0.051	0.048	0.046	0.044	0.042	0.040	0.038	0.037	0.036	0.034	0.033	0.032	0.031	0.027	0.024	0.021
	19	0.060	0.056	0.052	0.050	0.047	0.045	0.043	0.041	0.039	0.037	0.036	0.035	0.034	0.032	0.031	0.030	0.026	0.023	0.021
	20	0.058	0.054	0.051	0.048	0.046	0.044	0.042	0.040	0.038	0.037	0.035	0.034	0.033	0.032	0.031	0.030	0.026	0.023	0.020
	21	0.057	0.053	0.050	0.047	0.045	0.043	0.041	0.039	0.037	0.036	0.035	0.033	0.032	0.031	0.030	0.029	0.025	0.022	0.020
	22	0.055	0.052	0.049	0.046	0.044	0.042	0.040	0.038	0.037	0.035	0.034	0.033	0.032	0.031	0.030	0.029	0.025	0.022	0.020
	23	0.054	0.051	0.048	0.045	0.043	0.041	0.039	0.037	0.036	0.035	0.033	0.032	0.031	0.030	0.029	0.028	0.025	0.022	0.020
	24	0.053	0.049	0.047	0.044	0.042	0.040	0.038	0.037	0.035	0.034	0.033	0.032	0.031	0.030	0.029	0.028	0.024	0.022	0.019
	25	0.052	0.048	0.046	0.043	0.041	0.039	0.038	0.036	0.035	0.033	0.032	0.031	0.030	0.029	0.028	0.027	0.024	0.021	0.019
	30	0.047	0.044	0.042	0.040	0.038	0.036	0.035	0.033	0.032	0.031	0.030	0.029	0.028	0.027	0.026	0.025	0.022	0.020	0.018
	35	0.044	0.041	0.039	0.037	0.035	0.034	0.032	0.031	0.030	0.029	0.028	0.027	0.026	0.025	0.025	0.024	0.021	0.019	0.017
2x8 (24 inches o.c.)	0	0.326	0.238	0.188	0.156	0.133	0.117	0.104	0.094	0.085	0.078	0.072	0.067	0.063	0.059	0.056	0.053	0.042	0.034	0.029
	20	0.054	0.051	0.048	0.046	0.043	0.042	0.040	0.038	0.037	0.035	0.034	0.033	0.032	0.031	0.030	0.029	0.025	0.022	0.020
	21	0.052	0.049	0.047	0.044	0.042	0.041	0.039	0.037	0.036	0.035	0.033	0.032	0.031	0.030	0.029	0.029	0.025	0.022	0.020
	22	0.051	0.048	0.046	0.043	0.041	0.040	0.038	0.037	0.035	0.034	0.033	0.032	0.031	0.030	0.029	0.028	0.024	0.022	0.020
	23	0.050	0.047	0.044	0.042	0.041	0.039	0.037	0.036	0.034	0.033	0.032	0.031	0.030	0.029	0.028	0.028	0.024	0.021	0.019
	24	0.048	0.046	0.044	0.041	0.040	0.038	0.036	0.035	0.034	0.033	0.032	0.031	0.030	0.029	0.028	0.027	0.024	0.021	0.019
	25	0.047	0.045	0.043	0.041	0.039	0.037	0.036	0.034	0.033	0.032	0.031	0.030	0.029	0.028	0.027	0.027	0.023	0.021	0.019
	30	0.043	0.041	0.039	0.037	0.035	0.034	0.033	0.032	0.030	0.029	0.029	0.028	0.027	0.026	0.025	0.025	0.022	0.020	0.018
	35	0.040	0.038	0.036	0.034	0.033	0.032	0.030	0.029	0.028	0.027	0.027	0.026	0.025	0.024	0.024	0.023	0.021	0.018	0.017
	40	0.037	0.035	0.034	0.032	0.031	0.030	0.029	0.028	0.027	0.026	0.025	0.024	0.024	0.023	0.022	0.022	0.019	0.018	0.016

For SI: 1 W/m^2-K = 0.176 Btu/hr-ft^2-F

a. Linear interpolation of U-factors shall be permitted between continuous insulation and cavity insulation R-values. For non-standard stud spacing, use the next lesser stud spacing shown in the table.

b. Table values are based on the parallel path calculation procedure as applicable to wood frame assemblies and requires compliance with the following assembly conditions:
   1. Maximum framing fractions of 28% (assumed for 12”oc studs), 25% (assumed for 16”oc studs), and 22% (assumed for 24”oc studs) with 4% attributed to headers in all cases. The framing fraction is the percentage of overall opaque wall area occupied by framing members.
   2. Wood framing materials or species with a minimum thermal resistivity of R-1.25 per inch.
   3. Exterior sheathing with a minimum R-value of R-0.62 as based on wood structural panel. For walls having no exterior sheathing or sheathing of lesser R-value, footnote d shall be used to adjust the tabulated U-factor.
   4. Siding of a minimum R-0.62 as based on the assumption of vinyl siding. For walls with siding having a lower R-value, footnote d shall be used to adjust the tabulated U-factor.
   5. Interior finish of a minimum R-0.45 based on 1/2” gypsum. For walls having no interior finish or a finish of lesser R-value, footnote d shall be used to adjust the tabulated U-factor.
   6. Cavity insulation with a rated R-value installed as required by the manufacturer’s installation instructions to satisfy the indicated installed Rvalue, considering a reduced R-value for compression in an enclosed cavity where applicable.
   7. Continuous insulation specified in accordance with the indicated rated R-value and installed continuously over all exterior wood framing, including studs, plates, headers, and rim joists.
   8. Indoor air film R-value of 0.68 and outdoor air-film R-value of 0.17.

c. Where any of the building materials that are continuous over the interior or exterior wall surface vary from those stated in footnote b, it is permissible to adjust the U-factor as follows: Uadj = 1/ [1/U + Rd] where U is the U-factor from the table and Rd is the increase (positive) or decrease (negative) in the cumulative R-value of building material layers on the outside and inside faces of the wall, excluding the continuous insulation R-value if present.

d. For a specific continuous insulation R-value not addressed in this table, the U-factor of the assembly shall be permitted to be determined as follows: Uadj = 1/[1/Unci + Rci] where Unci is the U-factor from the table for no continuous insulation (0 R-value column) and Rci is the specific rated R-value of continuous insulation added to the assembly.

e. For double wall framing, the U-factor shall be permitted to be determined by combining the U-factors for single wall framing from the table as follows: Ucombined = 1/[1/U1 + 1/U2] where U1 and U2 are the U-factors from the table for each of the adjacent parallel walls in the double wall assembly.

f. The use of insulation in accordance with this table does not supersede requirements in Section R702.7 of the International Residential Code for use of insulation and water vapor retarders to control water vapor.

BE101.2 Mass walls. Reserved.

BE101.3 Cold-formed steel frame walls. Reserved.

BE102
ROOF AND CEILING ASSEMBLIES. RESERVED

BE103
FLOOR ASSEMBLIES. RESERVED.

BE104
BASEMENT WALLS. RESERVED.

BE105
CRAWLSPACE WALLS. RESERVED.

BE106
SLABS-ON-GRADE. RESERVED.

R407.2 - Slope Conversion (952)

IECC: R407.2; IRCECC: N1107.2

Proponents: Aaron Phillips, representing Asphalt Roofing Manufacturers Association (aphillips@asphaltroofing.org)

2024 International Energy Conservation Code [RE Project]

Revise as follows:

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 R404.
6. The exterior roof surface complies with one of the options in Table C402.3 of the *International Energy Conservation Code*–Commercial Provisions 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 (~~2~~1-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.

2024 ENERGY Chapter11

Revise as follows:

N1107.2 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 (~~2~~1-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.

Reason: This comment corrects an existing error in the conversion of 1/4:12 slope to percent slope in item number 7 of IECC Section R407.2 and IRC Section N1107.2.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.

Corrects a conversion error between units, makes no technical change, and will not affect cost of construction.

Footnote h erratum (971)

IECC: TABLE R402.1.3; IRCECC: TABLE N1102.1.3

Proponents: Thomas Culp, representing Glazing Industry Code Committee (culp@birchpointconsulting.com)

2024 International Energy Conservation Code [RE Project]

Revise as follows:

TABLE R402.1.3 INSULATION MINIMUM R-VALUES AND FENESTRATION REQUIREMENTS BY COMPONENT[a]

Portions of table not shown remain unchanged.

For SI: 1 foot = 304.8 mm.

NR = Not Required.
ci = continuous insulation.

h. A maximum *U*-factor of ~~0.32~~ 0.30 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 of the *International Residential Code*.

2024 ENERGY Chapter11

Revise as follows:

TABLE N1102.1.3 INSULATION MINIMUM R-VALUES AND FENESTRATION REQUIREMENTS BY COMPONENT[a]

Portions of table not shown remain unchanged.

h. A maximum *U*-factor of ~~0.32~~ 0.30 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.

Reason: This is just an erratum. This change was already approved by the consensus committee in REPI-28 for both footnote e of Table R402.1.2 and footnote h of Table R402.1.3. However, the public review draft only included this change for the first table, but it was missed in the second table (for both the IECC and chapter 11 of the IRC). This change corrects that.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This is just an erratum correction.

R402.5.1.3 Prescriptive air leakage rate (1036)

IECC: R402.5.1.3

Proponents: Alex Smith, representing NAHB (asmith@nahb.org)

2024 International Energy Conservation Code [RE Project]

Revise as follows:

R402.5.1.3 Prescriptive air leakage rate. When complying with Section R401.2.1, the building or each dwelling unit in the building shall have an air leakage rate not exceeding ~~5.0~~ 4.0 air changes per hour in Climate Zones 0, 1 and 2, 3.0 air changes per hour in Climate Zones 3 through 5, and 2.5 air changes per hour in Climate Zones 6 through 8, when tested in accordance with Section R402.5.1.2.

Reason: This section did not get updated from 5ACH50 to 4ACH50. This is a coordination item.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This will have no change on construction costs. This is an editorial change.

R405 Errata (1043)

IECC: TABLE R405.4.2(1)

Proponents: Vladimir Kochkin, representing NAHB (vkochkin@nahb.org)

2024 International Energy Conservation Code [RE Project]

Revise as follows:

TABLE R405.4.2(1) SPECIFICATIONS FOR THE STANDARD REFERENCE AND PROPOSED DESIGNS

Portions of table not shown remain unchanged.

<table>
<tr><th>BUILDING COMPONENT</th><th>STANDARD REFERENCE DESIGN</th><th colspan="4">PROPOSED DESIGN</th></tr>
<tr><td rowspan="7">Heating systems[d, e, j, k]</td><td>~~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 R403.7.~~</td><td colspan="4"></td></tr>
<tr><td>Fuel Type/Capacity: Same as proposed design</td><td colspan="4">As proposed</td></tr>
<tr><td>Product class: Same as proposed design</td><td colspan="4">As proposed</td></tr>
<tr><td>Efficiencies:</td><td colspan="4">As proposed</td></tr>
<tr><td>Heat pump: Complying with 10 CFR §430.32</td><td colspan="4">As proposed</td></tr>
<tr><td>Non-electric furnaces: Complying with 10 CFR §430.32</td><td colspan="4">As proposed</td></tr>
<tr><td>Non-electric boilers: Complying with 10 CFR §430.32</td><td colspan="4">As proposed</td></tr>
<tr><td rowspan="3">Cooling systems[d, f, k]</td><td>~~As proposed.~~
~~Capacity: sized in accordance with Section R403.7.~~</td><td colspan="4"></td></tr>
<tr><td>Fuel Type: Electric
Capacity: Same as proposed design</td><td colspan="4">As proposed</td></tr>
<tr><td>Efficiencies: Complying with 10 CFR §430.32</td><td colspan="4">As proposed</td></tr>
<tr><td rowspan="11">Service water heating[d, g, k]</td><td rowspan="6">~~As proposed.~~
Use, in units of gal/day = 25.5 + (8.5 × N_{br})
where: N_{br} = number of bedrooms.</td><td colspan="4">~~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>Fuel Type: Same as proposed design</td><td colspan="4">As proposed</td></tr>
<tr><td>Rated Storage Volume: Same as proposed design</td><td colspan="4">As proposed</td></tr>
<tr><td>Draw Pattern: Same as proposed design</td><td colspan="4">As proposed</td></tr>
<tr><td>Efficiencies: Uniform Energy Factor complying with 10 CFR §430.32</td><td colspan="4">As proposed</td></tr>
<tr><td>Tank Temperature: 120° F (48.9° C)</td><td colspan="4">Same as standard reference design</td></tr>
</table>

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.

g. For a proposed design without a proposed water heater, the following assumptions shall be made for both the proposed design and standard reference design.

Fuel Type: Same as the predominant heating fuel type

Rated Storage Volume: 40 Gallons

Draw Pattern: Medium

Efficiency: Uniform Energy Factor complying with 10 CFR §130.32

j. For a proposed design with electric resistance heating, a split system heat pump complying with 10 CFR §430.32 (2021) shall be ~~assumed~~ modeled in the standard reference design.

Reason: ERRATA
This submission includes several errata items that were incorrectly incorporated into the public comment draft. This submission does not include any new changes.

1. Language on electric resistance has been moved to a footnote to the table. The duplicative language in the table has been deleted.

2. In footnote j the word "assumed" was replaced with "modeled" and was deleted.

3. Under Cooling systems, the old language was removed.

4. Under Service water heating, the old language was removed.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
errata

Errata to correct Prescriptive Air Leakage Rate in CZ 0-2 to 4 ACH50 (1050)

IECC: R402.5.1.3

Proponents: Gayathri Vijayakumar, representing Steven Winter Associates, Inc. (gvijayakumar@swinter.com)

2024 International Energy Conservation Code [RE Project]

Revise as follows:

R402.5.1.3 Prescriptive air leakage rate. When complying with Section R401.2.1, the building or each dwelling unit in the building shall have an air leakage rate not exceeding ~~5.0~~ 4.0 air changes per hour in Climate Zones 0, 1 and 2, 3.0 air changes per hour in Climate Zones 3 through 5, and 2.5 air changes per hour in Climate Zones 6 through 8, when tested in accordance with Section R402.5.1.2.

Reason: The Consensus Committee approved REPI-63 which changed the 5.0 to 4.0 ACH50. This Errata is simply aligning this section with what was approved. While Omnibus made edits related to REPI-64 which affects this same section, there were no edits related to CZ 0-2 in Omnibus (as noted in the file circulated in the Sept 26th agenda).

Bibliography: None

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This is an Errata, correcting an already approved REPI.

Simulated Building Performance Definition editorial fix (1185)

IECC: SECTION 202

Proponents: Robert Salcido, representing DOE (victor.salcido@pnnl.gov)

2024 International Energy Conservation Code [RE Project]

Revise as follows:

SIMULATED BUILDING PERFORMANCE. A process in which the proposed building design is compared to a standard reference design for the purposes of estimating rela-tive energy use against a baseline to determine code compliance.

Reason: Editorial fix for definition

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
No Cost Impact

R403.3 Reference (1196)

IECC: R403.3

Proponents: Hendrik Shank, representing New York State, Department of State (hendrikus.shank@dos.ny.gov); Daniel Carroll, representing Division of Building Standards & Codes (daniel.carroll@dos.ny.gov)

2024 International Energy Conservation Code [RE Project]

Revise as follows:

R403.3 Duct systems. Ducts and air handlers shall be installed in accordance with Sections R403.3.1 through ~~R403.3.7~~ R403.3.8.

Reason: The reason for this code change proposal is to correct this Provision so it references the correct Code Section.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This code change proposal is editorial so there is no cost impact associated with it.

R502.2 Correction (1202)

IECC: R502.2

Proponents: Daniel Carroll, representing Division of Building Standards & Codes (daniel.carroll@dos.ny.gov); Hendrik Shank, representing New York State, Department of State (hendrikus.shank@dos.ny.gov)

2024 International Energy Conservation Code [RE Project]

Revise as follows:

R502.2 Prescriptive compliance. *Additions* shall comply with Sections R502.2.1 through~~. R502.3.5~~ R502.2.5.

Reason: This proposal is to modify this section, so it references the correct code section. There is no Section R502.3.5

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This code change proposal is editorial so there is no cost impact associated with it.

R504.2 Editorial Revisions (1204)

IECC: R504.2

Proponents: Hendrik Shank, representing New York State, Department of State (hendrikus.shank@dos.ny.gov); Daniel Carroll, representing Division of Building Standards & Codes (daniel.carroll@dos.ny.gov)

2024 International Energy Conservation Code [RE Project]

Revise as follows:

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~~*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.

Reason: The purpose of this formatting change is to italicize the word “roof” in the term “Roof *repairs*” because “roof repair” is a defined term in Chapter 2.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This code change proposal is editorial so there is no cost impact associated with it.

REPI-26 errata for slab F-factors and R-values and related text (1234)

IECC: 1 (New)

Proponents: Jay Crandell, representing Foam Sheathing Committee of the American Chemistry Council (jcrandell@aresconsulting.biz)

2024 International Energy Conservation Code [RE Project]

Add new text as follows:

1

ERRATA FOR REPI-26 (Missing in cdpACCESS public review draft) -- See attached file for staff

Reason: See attached errata.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This is provided as errata with no cost impact.

Table R405.4.2(1) Errata Air Exchange Rate CZ 0-2 (1352)

IECC: TABLE R405.4.2(1)

Proponents: Alisa McMahon, representing self (mcmahon.gbac@cox.net)

2024 International Energy Conservation Code [RE Project]

Revise as follows:

TABLE R405.4.2(1) SPECIFICATIONS FOR THE STANDARD REFERENCE AND PROPOSED DESIGNS

Portions of table not shown remain unchanged.

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~~ 4.0 air changes per hour. Climate Zones 3, 4, and 5: 3.0 air changes per hour. Climate Zones 6 through 8: 2.5 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 B x M where: B = 0.01 × CFA + 7.5 × (Nbr + 1), cfm. M = 1.0 where the measured air exchange rate is > = 3.0 air changes per hour at 50 Pascals, and otherwise, M = minimum (1.7, Q/B) Q = the proposed mechanical ventilation rate, cfm. CFA = conditioned floor area, ft2. Nbr = number of bedrooms. The mechanical ventilation system type shall be the same as in the proposed design. Heat recovery or energy recovery shall be modeled for mechanical ventilation where required by Section R403.6.1. Heat recovery or energy recovery shall not be modeled for mechanical ventilation where not required by Section R403.6.1.	The mechanical ventilation rate[b], Q, shall be in addition to the air leakage rate and shall be as proposed.

Reason: See Proposal “Errata to correct Prescriptive Air Leakage Rate in CZ 0-2 to 4 ACH50 (1050)” and R402.5.1.2 (maximum air leakage rate under any compliance path shall not exceed 4.0 ACH).

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
Errata.

RED1-199-22

IECC: TABLE R402.1.2, TABLE R402.1.3; IRCECC: TABLE N1102.1.2, TABLE N1102.1.3

Proponents: Jennifer Hatfield, representing Fenestration & Glazing Industry Alliance (formerly AAMA) (jen@jhatfieldandassociates.com)

2024 International Energy Conservation Code [RE Project]

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

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 R402.2.6. 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 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 0.28.

e. A maximum *U*-factor of 0.30 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 of the *International Residential Code*.

f. Roofs with insulation entirely above deck shall comply with Section C402.2.1 and the Group R U-factors of Table C402.1.2.

g. F-factors for heated slabs correspond to the configuration described by footnote (d) of Table R402.1.3

Revise as follows:

TABLE R402.1.3 INSULATION MINIMUM R-VALUES AND FENESTRATION REQUIREMENTS BY COMPONENT[a]

CLIMATE ZONE	0	1	2	3	4 except Marine	5 and Marine 4	6	7 and 8
FENESTRATION U-FACTOR[b, i]	0.50	0.50	0.40	0.30	0.30	0.28 [h]	0.28 [h]	0.27 [h]
SKYLIGHT[b] *U*-FACTOR	0.60	0.60	0.60	0.53	0.53	0.50	0.50	0.50
GLAZED FENESTRATION SHGC[b, e]	0.25	0.25	0.25	0.25	0.40	NR	NR	NR
CEILING *R*-VALUE[i]	30	30	38	38	49	49	49	49
WOOD FRAME WALL R-VALUE[g]	13 or 0&10ci	13 or 0&10ci	13 or 0&10ci	20 or 13&5ci or 0&15ci	30 or 20&5ci or 13&10ci or 0&20ci	30 or 20&5ci or 13&10ci or 0&20ci	30 or 20&5ci or 13&10ci or 0&20ci	30 or 20&5ci or 13&10ci or 0&20ci
MASS WALL R-VALUE[h]	3/4	3/4	4/6	8/13	8/13	13/17	15/20	19/21
FLOOR *R*-VALUE[h, i]	13 or 7+5ci or 10ci	13 or 7+5ci or 10ci	13 or 7+5ci or 10ci	19 or 13+5ci or 15ci	19 or 13+5ci or 15ci	30 or 19+7.5ci or 20ci	30 or 19+7.5ci or 20ci	38 or 19+10ci or 25ci
BASEMENT[c, g] WALL *R*-VALUE	0	0	0	5ci or 13[f]	10ci or 13	15ci or 19 or 13&5ci	15ci or 19 or 13&5ci	15ci or 19 or 13& 5ci
SLAB[d] R-VALUE & DEPTH	0	0	0	10ci, 2 ft	10ci, 4 ft	10ci, 4 ft	10ci, 4 ft	10ci, 4 ft
CRAWL SPACE[c, g] WALL R-VALUE	0	0	0	5ci or 13[f]	10ci or 13	15ci or 19 or 13&5ci	15ci or 19 or 13&5ci	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 0.28.

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

f. 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.

g. Mass walls shall be in accordance with Section R402.2.6. The second *R*-value applies where more than half of the insulation is on the interior of the mass wall.

h. A maximum *U*-factor of 0.3 0~~2~~ shall apply in Marine Climate Zone 4 and Climate Zones 5~~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 of the *International Residential Code*.

i. Roofs with insulation entirely above deck shall comply with Section C402.2.1 and the Group R R-values of Table C402.1.2.

j. "30 or 19+7.5ci or 20ci" means R30 cavity insulation alone or R19 cavity insulation with R7.5 continuous insulation or R20 continuous insulation alone.

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TABLE N1102.1.2 MAXIMUM ASSEMBLY U-FACTORS[a] AND FENESTRATION REQUIREMENTS

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 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 0.28.

e. A maximum *U*-factor of 0.30 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.

f. Roofs with insulation entirely above deck shall comply with Section C402.2.1 and the Group R U-factors ofTable C402.1.2.

g. F-factors for heated slabs correspond to the configuration described by footnote (d) of Table R402.1.3.

Revise as follows:

TABLE N1102.1.3 INSULATION MINIMUM R-VALUES AND FENESTRATION REQUIREMENTS BY COMPONENT[a]

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 0.28.

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. Basement wall insulation shall not be required in Warm Humid locations as defined by Figure N1101.7 and Table N1101.7.

f. 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.

g. Mass walls shall be in accordance with Section N1102.2.6. The second *R*-value applies where more than half of the insulation is on the interior of the mass wall.

h. A maximum *U*-factor of 0.3 0~~2~~ shall apply in Marine Climate Zone 4 and Climate Zones 5~~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.

i. Roofs with insulation entirely above deck shall comply with Section C402.2.1 and the Group R R-values of Table C402.1.2.

j. "30 or 19+7.5ci or 20ci" means R30 cavity insulation alone or R19 cavity insulation with R7.5 continuous insulation or R20 continuous insulation alone.

Reason: This public comment is errata as it simply addresses what we believe was an error in Public Comment Draft #1. It simply aligns with the consensus proposal, REPI-28, that was adopted during the first round by making edits to the following footnotes:

- Table R402.1.3, footnote h – the consensus agreement that passed changed this from 0.32 to 0.30 and it should be for CZs Marine 4 and 5-8 (matching the same change to Table R402.1.2, footnote e).
- This same error is in Table N1102.1.3, footnote h of the IRC, Chapter 11 document and the fix aligns with Table N1102.1.2, footnote e.

The proposal includes both Tables to show how this errata provides for consistency between table footnotes.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
Simply fixing what we believe to be a publishing error in PC Draft #1.

Erratum - R408.2.5 - REPI-140 - ERV and Improved Air Sealing (1456)

IRCECC: N1108.2.5; IECC: R408.2.5

Proponents: Mike Moore, representing Broan-NuTone (mmoore@statorllc.com)

2024 ENERGY Chapter11

Revise as follows:

N1108.2.5 Improved air sealing and efficient ventilation system option. The measured air leakage rate shall be one of the following:

1. Less than or equal to 2.0 ACH50, with either an Energy Recovery Ventilator (ERV) or Heat Recovery Ventilator (HRV) installed.
2. Less than or equal to 2.0 ACH50, with balanced ventilation as defined in Section 202 of the 2021 *International Mechanical Code*.
3. Less than or equal to 1.5 ACH50, with either an ERV or HRV installed.
4. Less than equal to 1.0 ACH50, with either an ERV or 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).~~

HRV and ERV Sensible Recovery Efficiency (SRE) shall be no less than 75 percent at 32°F (0°C), at the lowest listed net airflow. ERV Latent Recovery/Moisture Transfer (LRMT) shall be no less than 50 percent, at the lowest listed net airflow. In Climate Zone 8, recirculation shall not be used as a defrost strategy.

2024 International Energy Conservation Code [RE Project]

Revise as follows:

R408.2.5 Improved air sealing and efficient ventilation system option. The measured air leakage rate shall be one of the following:

1. Less than or equal to 2.0 ACH50, with either an Energy Recovery Ventilator (ERV) or Heat Recovery Ventilator (HRV) installed.
2. Less than or equal to 2.0 ACH50, with balanced ventilation as defined in Section 202 of the 2021 *International Mechanical Code*.
3. Less than or equal to 1.5 ACH50, with either an ERV or HRV installed.
4. Less than equal to 1.0 ACH50, with either an ERV or 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).~~

HRV and ERV Sensible Recovery Efficiency (SRE) shall be no less than 75 percent at 32°F (0°C), at the lowest listed net supply airflow. ERV Latent Recovery/Moisture Transfer (LRMT) shall be no less than 50 percent, at the lowest listed net supply airflow. In Climate Zone 8, recirculation shall not be used as a defrost strategy.

Reason: This erratum modifies the PC#1 version to align with the IECC-R CC action on April 7, 2022, approving REPI-140-21, as modified.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
As an erratum, this modification will neither increase nor decrease the cost of construction.