## 

2025 ILLINOIS RESIDENTIAL STRETCH ENERGY CODE DRAFT

1-11-25

AMENDMENTS TO THE 2024 IECC 1st Printing

New text to match 2023 Stretch amendment.

~~Deleted text to match 2023 Stretch amendment.~~

## IECC—RESIDENTIAL PROVISIONS

### CONTENTS

CHAPTER 1—SCOPE AND ADMINISTRATION 268

R101—Scope And General Requirements 268

R102—Applicability 268

R103—Code Compliance Agency 269

R104—Alternative Materials, Design and Methods of Construction and Equipment 269

R105—Construction Documents 269

R106—Fees 270

R107—Inspections 271

R108—Notice of Approval 272

R109—Means of Appeals 272

R110—Stop Work Order 272

CHAPTER 2—DEFINITIONS 273

R201—General 273

R202—General Definitions 273

CHAPTER 3—GENERAL REQUIREMENTS. 278

R301—Climate Zones 278

R302—Design Conditions 311

R303—Materials, Systems and Equipment 311

CHAPTER 4—RESIDENTIAL ENERGY EFFICIENCY 314

R401—General 314

R402—Building Thermal Envelope 314

R403—Systems 323

R404—Electrical Power, Lighting and Renewable Energy Systems 329

R405—Simulated Building Performance 330

R406—Energy Rating Index Compliance Alternative 337

R407—Tropical Climate Region Compliance Path 339

R408—Additional Efficiency Requirements 340

CHAPTER 5—EXISTING BUILDINGS 348

R501—General 348

R502—Additions 348

R503—Alterations 349

R504—Repairs 350

R505—Change of Occupancy or Use 351

CHAPTER 6—REFERENCED STANDARDS 352

APPENDIX RA BOARD OF APPEALS—RESIDENTIAL 357

RA101—General 357

APPENDIX RB SOLAR-READY PROVISIONS—DETACHED ONE- AND TWO-FAMILY DWELLINGS AND TOWNHOUSES 359

RB101—Scope 359

RB102—General Definition 359

RB103—Solar-Ready Zone 359

APPENDIX RC ZERO NET ENERGY RESIDENTIAL BUILDING PROVISIONS 360

RC101—General 360

RC102—General Definitions 360

RC103—Zero Net Energy Residential Buildings 360

RC104—Referenced Standards 361

APPENDIX RD ELECTRIC ENERGY STORAGE

PROVISIONS 362

RD101—Scope 362

RD102—General Definition 362

RD103—Electrical Energy Storage 362

APPENDIX RE ELECTRIC VEHICLE CHARGING INFRASTRUCTURE 363

RE101—Electric Vehicle Power Transfer 363

RE102—Referenced Standards 364

APPENDIX RF ALTERNATIVE BUILDING THERMAL

ENVELOPE INSULATION *R*-VALUE OPTIONS 365

RF101—General 365

RF102—Above-Grade Wall Assemblies 365

RF103—Roof and Ceiling Assemblies—Reserved 370

RF104—Floor Assemblies—Reserved 370

RF105—Basement and Crawl Space Walls 370

RF106—Slabs-on-Grade 371

APPENDIX RG 2024 IECC STRETCH CODE 373

RG101—Compliance 373

APPENDIX RH OPERATIONAL CARBON RATING AND

ENERGY REPORTING 375

RH101—General Definitions 375

RH102—Compliance 375

APPENDIX RI ON-SITE RENEWABLE ENERGY 377

RI101—General 377

RI102—General Definitions 377

RI103—On-site Renewable Energy 377

APPENDIX RJ DEMAND RESPONSIVE CONTROLS 379

RJ101—Demand Responsive Water Heating 379

RJ102—Referenced Standards 379

APPENDIX RK ELECTRIC-READY RESIDENTIAL BUILDING PROVISIONS 380

RK101—Electric Readiness 380

APPENDIX RL RENEWABLE ENERGY INFRASTRUCTURE 381

RL101—Renewable Energy Infrastructure 381

INDEX 383

RESOURCE RRA ALL-ELECTRIC RESIDENTIAL BUILDINGS . 386

RRA101—General 386

RRA102—General Definitions 386

RRA103—All-Electric Residential Buildings 386

**SCOPE AND ADMINISTRATION**



CHAPTER

**1**[RE]

**User notes:**

***About this chapter:*** *Chapter 1 establishes the limits of applicability of this code and describes how the code is to be applied and enforced. Chapter 1 is in two parts: Part 1—Scope and Application (Sections R101 and R102) and Part 2—Administration and Enforcement (Sections R103– R110). Section R101 identifies which buildings and structures come under its purview and references other I-Codes as applicable. Standards and codes are scoped to the extent referenced (see Section R102.4).*

*This code is intended to be adopted as a legally enforceable document, and it cannot be effective without adequate provisions for its administration and enforcement. The provisions of Chapter 1 establish the authority and duties of the code official appointed by the authority having jurisdiction and also establish the rights and privileges of the design professional, contractor and property owner.*

***QR code use:*** *A QR code is placed at the beginning of any section that has undergone technical revision. To see those revisions, scan the QR code with a smart device or enter the 7-digit code beneath the QR code at the end of the following URL: qr.iccsafe.org/ (see Formatting Changes to the 2024 International Codes for more information).*

***PART 1—SCOPE AND APPLICATION***

SECTION R101—SCOPE AND GENERAL REQUIREMENTS

**R101.1 Title.** This code shall be known as the *2025 Illinois Residentia*l *Stretch Energy ~~Conservation~~ Code* or code ~~of~~ **~~[NAME OF JURISDICTION~~]** and shall mean: ~~be cited as such. It is referred to herein as “this code.”~~

With respect to the residential buildings covered by 71 Ill Adm Code 600 Subpart D:

This Part, all additional requirements incorporated within Subpart D (including the 2024 International Energy Conservation Code Residential Provisions, including all published errata but excluding published supplements) and any statutorily authorized adaptations to the incorporated standards adopted by CDB is effective upon adoption by a Municipality and takes the place of the Illinois Energy Conservation Code with respect to residential buildings.

No unit of local government, including any home rule unit, may regulate energy-efficient building standards for residential buildings in a manner that is less stringent than the standards established pursuant to this *Illinois Residential Stretch Energy Code*.

**R101.1.1 Adoption.** The Board shall adopt amendments to this Code and include site energy index standards as established in the Energy Efficient Building Act [20 ILCS 3125/55] as follows:

By June 30, 2024, with a site energy index no greater than .50 of the 2006 IECC;

By December 31, 2025, with a site energy index no greater than .40 of the 2006 IECC;

By December 31, 2028, with a site energy index no greater than .33 of the 2006 IECC;

By December 31, 2031, with a site energy index no greater than .25 of the 2006 IECC.

**R101.2 Scope.** This code applies to the design and construction of detached one- and two-family dwellings and multiple single-family dwellings (townhouses) and Group R-2, R-3 and R-4 buildings three stories or less in height above *grade plane*.

**R101.2.1 Appendices.** Provisions in the appendices shall not apply unless specifically adopted. Appendices RE, RJ, RK and RL are hereby adopted into the *Illinois Residential Stretch Energy Code.*

**R101.3 Intent.** The IECC—Residential visions provide 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 nonmandatory appendices incorporating additional energy efficiency and greenhouse gas reduction resources developed by the International 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 3-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.

**R101.4 Compliance.** *Residential buildings* shall meet the provisions of the *Illinois Residential Stretch Energy Code* covered by 71 Ill Adm. Code 600 Subpart D.  The local authority having jurisdiction (AHJ) shall establish its own procedures for enforcement of the *Illinois Residential Stretch Energy Code*. Minimum compliance shall be demonstrated by submission of: ~~IECC Residential Provisions.~~ *~~Commercial buildings~~* ~~shall meet the provisions of Illinois Commercial Stretch Code Provisions.~~

**R101.4.1 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 code.

**R101.4.2 Professional Seals**.  The seal of the architect/engineer as required by Section 14 of the Illinois Architectural Practice Act [225 ILCS 305], Section 12 of the Structural Engineering Licensing Act [225 ILCS 340] and Section 14 of the Illinois Professional Engineering Practice Act [225 ILCS 325]; or

**R101.4.3 REScheck.**TM Compliance Certificates generated by the U.S. Department of Energy's REScheckTM Code compliance tool.

SECTION R102—APPLICABILITY

**R102.1 Applicability.** Where, in any specific case, different sections of this code specify different materials, methods of construction or other requirements, the most restrictive shall govern. Where there is a conflict between a general requirement and a specific requirement, the specific requirement shall govern.

**R102.1.1 Mixed residential and commercial buildings.** Where a *building* includes both *residential building* and *commercial building* portions, each portion shall be separately considered and meet the applicable provisions of the *Illinois Commercial Stretch Energy Code* ~~IECC Commercial Provisions~~ or *Illinois Residential Stretch Energy Code* ~~IECC Residential~~ ~~Code~~ ~~Provisions~~.

**R102.2 Other laws.** The provisions of this code shall not be deemed to nullify any provisions of local, state or federal law.

**R102.3 Application of references.** References to chapter or section numbers, or to provisions not specifically identified by number, shall be construed to refer to such chapter, section, or provision of this code

**R102.4 Referenced codes and standards.** The codes and standards referenced in this code shall be those indicated in Chapter 6, and such codes and standards shall be considered as part of the requirements of this code to the prescribed extent of each such reference and as further regulated in Sections R102.4.1 and R102.4.2.

**R102.4.1 Conflicts.** Where conflicts occur between provisions of this code and referenced codes and standards, the provisions of this code shall apply.

**R102.4.2 Provisions in referenced codes and standards.** Where the extent of the reference to a referenced code or standard includes subject matter that is within the scope of this code, the provisions of this code, as applicable, shall take precedence over the provisions in the referenced code or standard.

**R102.5 Partial invalidity.** If a portion of this code is held to be illegal or void, such a decision shall not affect the validity of the remainder of this code.

***PART 2—ADMINISTRATION AND ENFORCEMENT***

SECTION R103—CODE COMPLIANCE AGENCY

**R103.1 Creation of enforcement agency.** The **[INSERT NAME OF DEPARTMENT]** is hereby created and the official in charge thereof shall be known as the authority having jurisdiction (AHJ). The function of the agency shall be the implementation, administration and enforcement of the provisions of this code.

**R103.2 Appointment.** The AHJ shall be appointed by the chief appointing authority of the jurisdiction.

**R103.3 Deputies.** In accordance with the prescribed procedures of this jurisdiction and with the concurrence of the appointing authority, the AHJ shall have the authority to appoint a deputy AHJ, other related technical officers, inspectors and other employees. Such employees shall have powers as delegated by the AHJ.

SECTION R104—ALTERNATIVE MATERIALS, DESIGN AND METHODS OF CONSTRUCTION AND EQUIPMENT

**R104.1 General.** The provisions of this code are not intended to prevent the installation of any material or to prohibit any design or method of construction not specifically prescribed by this code, provided that any such alternative has been *approved*. The *code offi- cial* shall have the authority to approve an alternative material, design or method of construction upon the written application of the owner or the owner’s authorized agent. The *code official* shall first find that the proposed design is satisfactory and complies with the intent of the provisions of this code, and that the material, method or work offered is, for the purpose intended, not less than the equivalent of that prescribed in this code for strength, effectiveness, fire resistance, durability, energy conservation and safety. The *code official* shall respond to the applicant, in writing, stating the reasons why the alternative was *approved* or was not *approved*.

**R104.1.1 Above code programs.** The *code official* or other AHJ shall be permitted to deem a national, state or local energy-effi- ciency 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 Buildings certified in compliance with the Passive House Institute (PHI) or Passive House Institute U.S. (PHIUS) Passive Building Standards programs or buildings that comply with Appendix RC shall be deemed to meet the requirements with this code where such buildings also meet the requirements identified in Table R405.2 and the proposed total *building thermal envelope* thermal conductance (TC) shall be less than or equal to the total *building thermal envelope* TC using the prescriptive *U*-factors and *F*-factors from Table R402.1.2 multiplied by 1.08 in Climate Zones 0, 1 and 2, and by 1.15 in Climate Zones 3 through 8, in accordance with Equation 1-1. The area-weighted maximum *~~fenestration~~ solar heat gain coefficients* (SHGC) permitted in Climate Zones 0 through 3 shall be 0.30.

**Equation 1–1** For Climate Zones 0–2: *TCProposed design* ≤ 1.08 × *TCPrescriptive reference design*

For Climate Zones 3–8: *TCProposed design* ≤ 1.15 × *TCPrescriptive reference design*

SECTION R105—CONSTRUCTION DOCUMENTS

**R105.1 General.** *Construction documents*, technical reports and other supporting data shall be submitted in one or more sets, or in a digital format where allowed by the code *official*, with each application for a permit. The *construction documents* and technical reports shall be prepared by a registered design professional where required by the statutes of the jurisdiction in which the project is to be constructed. Where special conditions exist, the *code official* is authorized to require necessary *construction documents* to be prepared by a registered design professional.

**Exception:** The *code official* is authorized to waive the requirements for *construction documents* or other supporting data if the *code official* determines they are not necessary to confirm compliance with this code.

**R105.2 Information on construction documents.** *Construction documents* shall be drawn to scale on suitable material. Electronic media documents are permitted to be submitted where *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 coefficients* (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.

**R105.2.1 Building thermal envelope depiction.** The *building thermal envelope* shall be represented on the *construction documents*.

**R105.2.2 Solar-ready system.** Where a *solar-ready zone* is provided, the *construction documents* shall indicate details for a dedicated roof area for the *solar-ready zone*, roof dead load, roof live load, ground snow load and the routing of conduit or prewiring from the *solar-ready zone* to an electrical service panel or plumbing from the *solar-ready zone* to a *service water heating* system.

**R105.3 Examination of documents.** The *code official* shall examine or cause to be examined the accompanying *construction documents* and shall ascertain whether the construction indicated and described is in accordance with the requirements of this code and other pertinent laws or ordinances. The *code official* is authorized to utilize a registered design professional, or other *approved* entity not affiliated with the *building* design or construction, in conducting the review of the plans and specifications for compliance with the code.

**R105.3.1 Approval of construction documents.** When the *code official* issues a permit where *construction documents* are required, the *construction documents* shall be endorsed in writing and stamped “Reviewed for Code Compliance.” Such *approved construction documents* shall not be changed, modified or altered without authorization from the *code official*. Work shall be done in accordance with the *approved construction documents*.

One set of *construction documents* so reviewed shall be retained by the *code official*. The other set shall be returned to the applicant, kept at the site of work and shall be open to inspection by the *code official* or a duly authorized representative.

**R105.3.2 Previous approvals.** This code shall not require changes in the *construction documents*, construction or designated occupancy of a structure for which a lawful permit has been heretofore issued or otherwise lawfully authorized, and the construction of which has been pursued in good faith within 180 days after the effective date of this code and has not been abandoned.

**R105.3.3 Phased approval.** The *code official* shall have the authority to issue a permit for the construction of part of an energy conservation system before the *construction documents* for the entire system have been submitted or *approved*, provided adequate information and detailed statements have been filed complying with all pertinent requirements of this code. The hold- ers of such permit shall proceed at their own risk without assurance that the permit for the entire energy conservation system will be granted.

**R105.4 Amended construction documents.** Work shall be installed in accordance with the *approved construction documents*, and any changes made during construction that are not in compliance with the *approved construction documents* shall be resubmitted for approval as an amended set of *construction documents*.

**R105.5 Retention of construction documents.** One set of *approved construction documents* shall be retained by the *code official* for a period of not less than 180 days from date of completion of the permitted work, or as required by state or local laws.

SECTION R106—FEES

**R106.1 Payment of fees.** A permit shall not be valid until the fees prescribed by law have been paid. Nor shall an amendment to a permit be released until the additional fee, if any, has been paid.

**R106.2 Schedule of permit fees.** Where a permit is required, a fee for each permit shall be paid as required, in accordance with the schedule as established by the applicable governing authority.

**R106.3 Permit valuation.** The applicant for a permit shall provide an estimated value of the work for which the permit is being issued at the time of application. Such estimated valuations shall include the total value of the work, including materials and labor. Where, in the opinion of the *code official*, the valuation is underestimated, the permit shall be denied unless the applicant can show detailed estimates acceptable to the *code official*. The final valuation shall be *approved* by the *code official*.

**R106.4 Work commencing before permit issuance.** Any person who commences any work before obtaining the necessary permits shall be subject to an additional fee established by the *code official* that shall be in addition to the required permit fees.

**R106.5 Related fees.** The payment of the fee for the construction, *alteration*, removal or demolition of work done in connection to or concurrently with the work or activity authorized by a permit shall not relieve the applicant or holder of the permit from the payment of other fees that are prescribed by law.

**R106.6 Refunds.** The *code official* is authorized to establish a refund policy.

SECTION R107—INSPECTIONS

**R107.1 General.** Construction or work for which a permit is required shall be subject to inspection by the *code official* or his or her designated agent, and such construction or work shall remain visible and able to be accessed for inspection purposes until *approved*. It shall be the duty of the permit applicant to cause the work to remain visible and able to be accessed for inspection purposes. Neither the *code official* nor the jurisdiction shall be liable for expense entailed in the removal or replacement of any material, product, system or building compo- nent required to allow inspection to validate compliance with this code.

**R107.2 Required inspections.** The *code official* or his or her designated agent, upon notification, shall make the inspections set forth in Sections R107.2.1 through R107.2.7.

**R107.2.1 Footing and foundation inspection.** Inspections associated with footings and foundations shall verify compliance with the code as to *R-value*, location, thickness, depth of burial and protection of insulation as required by the code and *approved* plans and specifications.

**R107.2.2 Framing and air barrier rough-in inspection.** *Air barrier* inspections at framing and rough-in shall be made before the application of air permeable insulation and shall be used to verify compliance with this code and approved plans and specifica- tions. Exterior *air barriers* shall be permitted to be inspected after insulation is installed.

**R107.2.3 Plumbing rough-in inspection.** Inspections at plumbing rough-in shall verify compliance as required by the code and *approved* plans and specifications as to types of insulation and corresponding *R*-values and protection, and required controls. Where a *solar-ready zone* is provided for a solar thermal system, inspections shall verify pathways for routing of plumbing from *solar-ready zone* to *service water heating* system.

**R107.2.4 Mechanical rough-in inspection.** Inspections at mechanical rough-in shall verify compliance as required by the code and *approved* plans and specifications as to installed HVAC equipment type and size, required controls, system insulation and corresponding *R-value*, system air leakage control, programmable thermostats, *dampers*, whole-house *ventilation*, and minimum fan efficiency.

**Exception:** Systems serving multiple *dwelling units* shall be inspected in accordance with Section C107.2.4.

**R107.2.5 Electrical rough-in inspection.** Inspections at electrical rough-in shall verify compliance as required by the code and the *approved* plans and specifications as to the locations, distribution and capacity of the electrical system. Where the *solar-ready zone* is installed for electricity generation, inspections shall verify conduit or prewiring from *solar-ready zone* to electrical panel.

**R107.2.6 Insulation and fenestration rough-in inspection.** Inspections at insulation and *fenestration* rough-in shall be made before the application of interior finish and shall be used to verify compliance with this code as to types of insulation, correspond- ing *R*-values and their correct location and proper installation; and *fenestration* properties such as *U*-factors, SHGC and proper installation.

**R107.2.7 Final inspection.** The *building* shall have a final inspection and shall not be occupied until *approved*. The final inspec- tion shall include verification of the installation of all required *building* systems, equipment and controls and their proper operation and the required number of high-efficacy lamps and fixtures.

**R107.3 Reinspection.** A *building* shall be reinspected where determined necessary by the *code official*.

**R107.4 Approved third-party inspection agencies.** The *code official* is authorized to accept reports of third-party inspection agen- cies not affiliated with the *building* design or construction, provided that such agencies are *approved* as to qualifications and reliability relevant to the *building* components and systems that they are inspecting or testing, and approval is granted prior to issu- ance of the building permit.

**R107.4.1 Authorization of approved third-party inspection agency.** An *approved* third-party inspection agency shall provide all requested information for the *code official* to determine that the agency meets the applicable requirements specified in Sections R107.4.1.1 through R107.4.1.3 and to authorize its work in the jurisdiction.

**R107.4.1.1 Independence.** An *approved* third-party inspection agency shall be an independent business identity. The agency shall perform its duties in accordance with the scope of delegated responsibilities established by the *code official*. The agency shall disclose to the *code official* any conflicts of interest, including where fees for service are derived. The agency shall acknowledge in writing that it is authorized to work only within the scope of delegated responsibilities.

**R107.4.1.2 Equipment.** An *approved* third-party inspection agency shall have adequate equipment to perform inspections and tests required by the *code official* and this code. All testing equipment shall be periodically calibrated as required by the manufacturer, testing standards used in this code or certifications held by the *approved* third-party inspection agency.

**R107.4.1.3 Personnel.** Personnel assigned by an *approved* third-party inspection agency to perform inspections and testing shall be trained or credentialed, and documentation of training or credentials shall be available to the *code official* upon request.

**R107.4.1.4 Delegated authority.** Where *approved*, a third-party inspection agency shall have the authority to perform dele- gated inspections and determine compliance or noncompliance of work with *approved construction documents*.

**R107.4.2 Approved third-party inspection agency reporting.** An *approved* third-party inspection agency shall keep records of delegated inspections, tests and compliance documentation required by this code. The agency shall submit reports of delegated inspections and tests to the *code official* and to the owner or owner’s representative. Reports shall indicate the compliance deter- mination for the inspected or tested work based on *approved construction documents*. A final report documenting required delegated inspections and tests, and correction of any discrepancies noted in the inspections or tests, shall be submitted with other required compliance documentation at a time required by the *code official*.

**R107.5 Inspection requests.** It shall be the duty of the holder of the permit or their duly authorized agent to notify the *code official* when work is ready for inspection. It shall be the duty of the permit holder to provide *access to* and means for inspections of such work that are required by this code.

**R107.6 Reinspection and testing.** Where any work or installation does not pass an initial test or inspection, the necessary corrections shall be made to achieve compliance with this code. The work or installation shall then be resubmitted to the *code official* for inspection and testing.

SECTION R108—NOTICE OF APPROVAL

**R108.1 Approval.** After the prescribed tests and inspections indicate that the work complies in all respects with this code, a notice of approval shall be issued by the *code official*.

**R108.2 Revocation.** The *code official* is authorized to, in writing, suspend or revoke a notice of approval issued under the provisions of this code wherever the certificate is issued in error, or on the basis of incorrect information supplied, or where it is determined that the *building* or structure, premise, or portion thereof is in violation of any ordinance or regulation or any of the provisions of this code.

SECTION R109—MEANS OF APPEALS

**R109.1 General.** In order to hear and decide appeals of orders, decisions or determinations made by the *code official* relative to the application and interpretation of this code, there shall be and is hereby created a board of appeals. The board of appeals shall be appointed by the applicable governing authority and shall hold office at its pleasure. The board shall adopt rules of procedure for conducting its business and shall render all decisions and findings in writing to the appellant with a duplicate copy to the *code official*.

**R109.2 Limitations on authority.** An application for appeal shall be based on a claim that the true intent of this code or the rules legally adopted thereunder have been incorrectly interpreted, the provisions of this code do not fully apply or an equivalent or better form of construction is proposed. The board shall not have authority to waive requirements of this code.

**R109.3 Qualifications.** The board of appeals shall consist of members who are qualified by experience and training on matters pertaining to the provisions of this code and are not employees of the jurisdiction.

**R109.4 Administration.** The *code official* shall take action in accordance with the decision of the board.

SECTION R110—STOP WORK ORDER

**R110.1 Authority.** Where the *code official* finds any work regulated by this code being performed in a manner contrary to the provisions of this code or in a dangerous or unsafe manner, the *code official* is authorized to issue a stop work order.

**R110.2 Issuance.** The stop work order shall be in writing and shall be given to the owner of the property, the owner’s authorized agent or the person performing the work. Upon issuance of a stop work order, the cited work shall immediately cease. The stop work order shall state the reason for the order and the conditions under which the cited work is authorized to resume.

**R110.3 Emergencies.** Where an emergency exists, the *code official* shall not be required to give a written notice prior to stopping the work.

**R110.4 Failure to comply.** Any person who shall continue any work after having been served with a stop work order, except such work as that person is directed to perform to remove a violation or unsafe condition, shall be subject to fines established by the AHJ.

### DEFINITIONS



CHAPTER

**2**[RE]

**User notes:**

***About this chapter:*** *Codes, by their very nature, are technical documents. Every word, term and punctuation mark can add to or change the meaning of a technical requirement. It is necessary to maintain a consensus on the specific meaning of each term contained in the code. Chapter 2 performs this function by stating clearly what specific terms mean for the purpose of the code.*

SECTION R201—GENERAL

**R201.1 Scope.** Unless stated otherwise, the following words and terms in this code shall have the meanings indicated in this chapter.

**R201.2 Interchangeability.** Words used in the present tense include the future; words in the masculine gender include the feminine and neuter; the singular number includes the plural and the plural includes the singular.

**R201.3 Terms defined in other codes.** Terms that are not defined in this code but are defined in the *International Building Code*, *International Fire Code*, *International Fuel Gas Code*, *International Mechanical Code*, *International Plumbing Code* or the *International Residential Code* shall have the meanings ascribed to them in those codes.

**R201.4 Terms not defined.** Terms not defined by this chapter shall have ordinarily accepted meanings such as the context implies.

SECTION R202—GENERAL DEFINITIONS

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

**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 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.

**AIR-HANDLING UNIT.** A blower or fan used for the purpose of distributing supply air to a room, space or area.

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

**APPROVED.** Acceptable to the *code official.*

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

**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 SHUTOFF CONTROL.** A device capable of automatically turning loads off without *manual* intervention. *Automatic shutoff 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.

**BALANCED VENTILATION SYSTEM.** A ventilation system that simultaneously supplies outdoor air to and exhausts air from a space, where the mechanical supply airflow rate and the mechanical exhaust airflow rate are each within 10 percent of the average of the two airflow rates.

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

**BIODIESEL BLEND.** A homogeneous mixture of hydrocarbon oils and mono alkyl esters of long chain fatty acids.

**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, ceiling, roofs and any other *building* element assemblies that enclose *conditioned space* or provide a boundary between *conditioned space* and exempt or unconditioned space.

**CAVITY INSULATION.** Insulating material located between framing members.

**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.

**CODE OFFICIAL.** The officer or other designated authority charged with the administration and enforcement of this code or a duly authorized representative.

**COMMERCIAL BUILDING.** For this code, all buildings that are not included in the definition of “*Residential building*.”

**COMMON AREAS.** All conditioned spaces within Group R occupancy buildings that are not *dwelling units* or *sleeping units*.

**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 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 thermal* envelope.

**CONTINUOUS PILOT.** A pilot which, once placed in operation, is intended to remain ignited continuously until it is manually interrupted.

**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 non-load bearing wall that is designed to separate the exterior and interior environments.

**DAMPER.** A manually or automatically controlled device to regulate draft or the rate of flow of air or combustion gases.

**DEMAND RECIRCULATION WATER SYSTEM.** A water distribution system where one or more pumps prime the service hot water piping with heated water upon 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 SYSTEM.** A system that consists of *space conditioning equipment* and *ductwork*, and includes any apparatus installed in connection therewith.

**DUCTWORK.** The assemblies of connected *ducts*, plenums, boots, fittings, *dampers*, supply registers, return grilles, and filter grilles through which air is supplied to or returned from the space to be heated, cooled, or ventilated. Supply *ductwork* delivers air to the spaces from the *space conditioning equipment*. Return *ductwork* conveys air from the spaces back to the space *conditioning equipment*. *Ventilation ductwork* conveys air to or from any space.

**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.

**EMITTANCE.** The ratio of the radiant heat flux emitted by a specimen measured on a scale from 0 to 1, where a value of 1 indicates perfect release of thermal radiation.

**ENCLOSED REFLECTIVE AIRSPACE.** 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 RATING INDEX (ERI).** A numerical integer value that represents the relative energy performance of a *rated design* or constructed *dwelling unit* as compared with the energy performance of the *ERI Reference Design*, where an ERI value of 100 represents the energy performance of the *ERI Reference Design* and an ERI value of 0 represents a *rated desig*n or constructed *dwelling unit* with zero net energy performance.

**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*.

**EXISTING BUILDING.** A *building* erected prior to the date of adoption of the appropriate code, or one for which a legal building permit has been issued.

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

**FENESTRATION.** Products classified as either *vertical fenestration* or *skylights.*

**Skylights.** Glass or other transparent or translucent glazing material installed at a slope of less than 60 degrees (1.05 rad) from horizontal including unit skylights, tubular daylighting devices, and glazing materials in solariums, sunrooms, roofs and sloped walls.

**Vertical fenestration.** Windows that are fixed or operable, opaque doors, glazed doors, glazed block and combination opaque/glazed doors composed of glass or other transparent or translucent glazing materials and installed at a slope of not less than 60 degrees (1.05 rad) from horizontal.

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

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

**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).

**GAS HEAT PUMP SPACE HEATING SYSTEM.** Gas heat pump space heating systems consist of an outdoor combustion unit and heat exchanger(s) inside the building.  The outdoor combustion unit is installed outside the building envelope and uses the heat of combustion to drive a refrigeration cycle that pumps heat into the building.  Annual fuel utilization efficiencies (AFUE) greater than 120% and 140% are achieved by pumping the heat of combustion and additional heat from the ambient air into the building.  The heat is then distributed indoors via forced air hydronic air handler(s), via floors and other radiant systems, or through combinations of forced air and radiant systems.

**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 is established by the lowest points within 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*.

**HEAT EXCHANGER.** A device that transfers heat from one medium to another.

**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.

**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.

**INTERMITTENT IGNITION.** Type of ignition that is energized when an appliance is called on to operate and that remains continuously energized during each period of main burner operation and where the ignition is deenergized when the main burner operating cycle is completed.

**INTERRUPTED IGNITION.** Type of ignition that is energized prior to the admission of fuel to the main burner and that is deenergized when the main flame is established.

**KNEE WALL.** An *above-grade wall* assembly, or wall defined by vertical truss members, of any height that separates *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.

**LIQUID FUEL.** A *fuel oi*l or *biodiesel blend*.

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

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

**LOW SLOPE.** 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.

**OCCUPIABLE SPACE.** An enclosed space intended for human activities, excluding those spaces intended primarily for other purposes, such as storage rooms and equipment rooms, that are only intended to be occupied occasionally and for short periods of time.

**ON-DEMAND PILOT.** A pilot that, once placed into operation, is intended to remain ignited for a predetermined period of time follow- ing an *automatic* or *manual* operation of the main burner gas valve, after which the pilot is automatically extinguished when no *automatic* or *manual* operation of the main burner gas valve occurs during the predetermined period of time.

**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.

**PLENUM.** An enclosed portion of the *building* structure, other than an *occupiable space* being conditioned, that is designed to allow air movement and thereby serve as part of the supply or return *ductwork*.

**PROPOSED DESIGN.** A description of the proposed *dwelling unit* used to estimate annual energy use for determining compliance based on *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 *dwelling unit* 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 airspaces*.

**RENEWABLE ENERGY CERTIFICATE (REC).** A market-based instrument that represents and conveys the environmental attributes of 1 megawatt hour of renewable electricity generation and could be sold separately from the underlying physical electricity associated with *renewable energy resources*: also known as an energy attribute certificate (EAC).

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

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

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

**RESIDENTIAL BUILDING.** ~~For this code, 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~~*. A detached one-family or two-family dwelling or any building that is three stories or less in height above grade that contains multiple dwelling units, in which the occupants reside on a primarily permanent basis, such as a townhouse, a row house, an apartment house, a convent, a monastery, a rectory, a fraternity or sorority house, a dormitory, and a rooming house; provided, however, that when applied to a building located within the boundaries of a municipality having a population of 1,000,000 or more, the term “residential building” means a building  containing one or more dwelling units, not exceeding four stories above grade, where occupants are primarily permanent.

**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, an 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.** An *alteration* that includes the removal of all existing layers of *roof assembly* materials down to the roof deck and the installation of 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 × ft2 × °F/Btu) [(m2 × 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 to determine code compliance.

**SLEEPING UNIT.** A single unit that provides rooms or spaces for one or more persons, includes permanent provisions for sleeping and can include provisions for living, eating and either sanitation or kitchen facilities but not both. Such rooms and spaces that are part of a *dwelling unit* are not *sleeping units*.

**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.

**SPACE CONDITIONING.** The treatment of air so as to control the temperature, humidity, filtration or distribution of the air to meet the requirements of a *conditioned space*.

**SPACE CONDITIONING EQUIPMENT.** The *heat exchangers*, *air-handling units*, filter boxes and any apparatus installed in connection therewith used to provide *space conditioning*.

**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 simulated building performance.

**STEEP SLOPE.** A roof slope 2 units vertical in 12 units horizontal (17 percent slope) or greater.

**SUBSTANTIAL IMPROVEMENT.** Any *repair*, reconstruction, rehabilitation, *alteration*, *addition* or other improvement of a *building* or structure, the cost of which equals or is more than 50 percent of the market value of the structure before the improvement. Where the structure has sustained substantial damage as defined in the *International Building Code*, any repairs are considered *substantial improvement* regardless of the actual *repair* work performed. *Substantial improvement* does not include the following:

1. Improvement of a *building* ordered by the code official to correct health, sanitary or safety code violations.
2. *Alteration* of a historic building where the *alteration* will not affect the designation as a historic building.

**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.

**TESTING UNIT ENCLOSURE AREA.** The sum of the area of ceiling, floors, and walls separating a *dwelling unit’s* or *sleeping 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* or *sleeping unit* to the underside of the floor above.

**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 setpoint.

***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

× ft2 × °F) [W/(m2 × 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.

**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.

### GENERAL REQUIREMENTS



CHAPTER

**3**[RE]

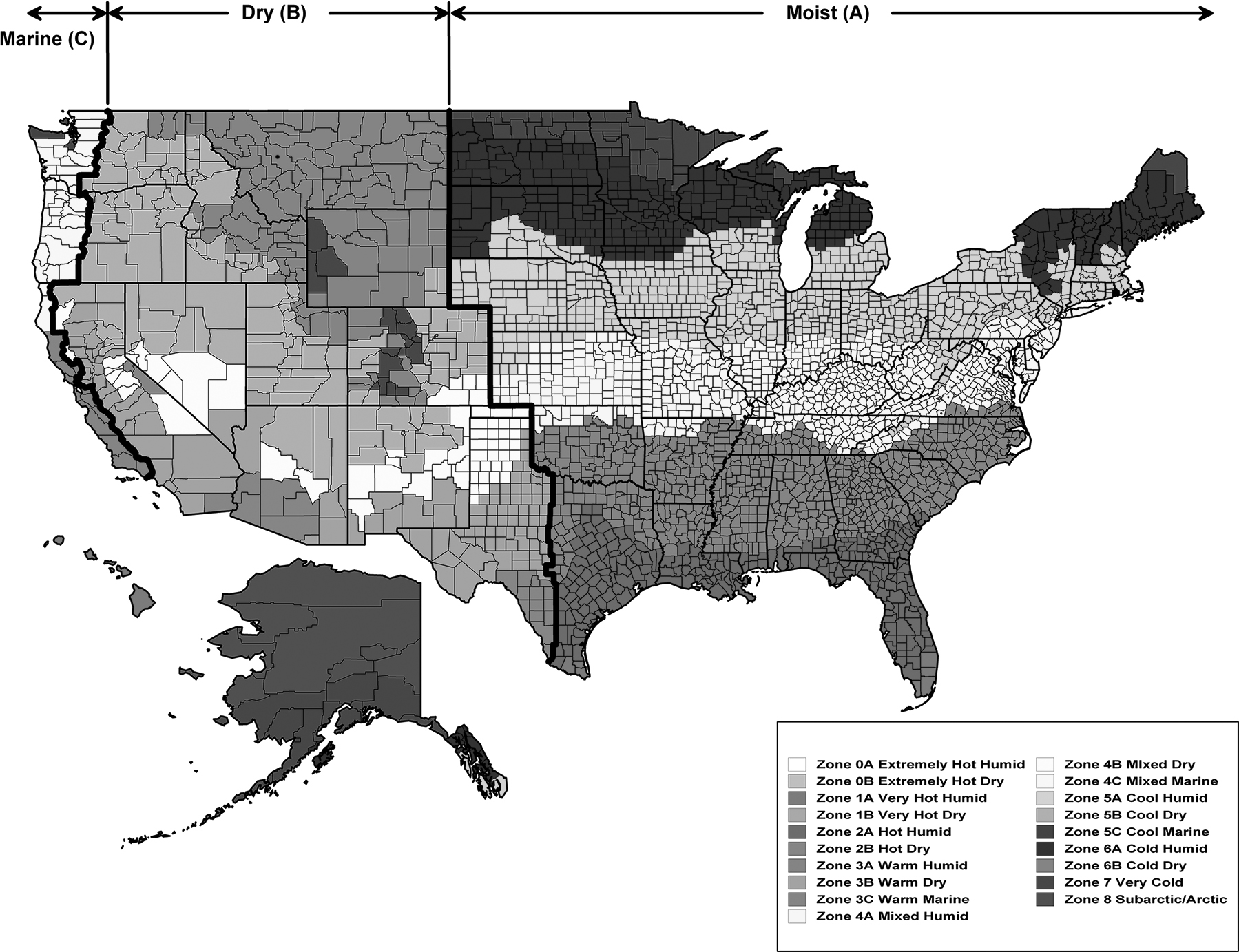
**User notes:**

***About this chapter:*** *Chapter 3 addresses broadly applicable requirements that would not be at home in other chapters having more specific coverage of subject matter. This chapter establishes climate zone by US counties and territories and includes methodology for determining climate zones elsewhere. It also contains product rating, marking and installation requirements for materials such as insulation, windows, doors and siding.*

SECTION R301—CLIMATE ZONES

**R301.1 General.** *Climate zones* from Figure R301.1 or Table R301.1 shall be used for determining the applicable requirements from Chapter 4. Locations not indicated in Table R301.1 shall be assigned a *climate zone* in accordance with Section R301.3.

**FIGURE R301.1—CLIMATE ZONES**



**TABLE R301.1—CLIMATE ZONES, MOISTURE REGIMES AND WARM HUMID DESIGNATIONS BY STATE, COUNTY AND TERRITORYa~~—continued~~**

|  |
| --- |
| **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 |

|  |
| --- |
| **US STATES—continued** |
| **ILLINOIS** *(continued)* |
| 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 |

**TABLE R301.1—CLIMATE ZONES, MOISTURE REGIMES AND WARM HUMID DESIGNATIONS BY STATE, COUNTY AND TERRITORYa—continued**

**R301.2 Warm Humid counties.** In Table R301.1, Warm Humid counties are identified by an asterisk.

**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 R301.3 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.
   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. 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.
      1. If thermal *climate zone* is 3 and CDD50°F ≤ 4,500 (CDD10°C ≤ 2500), *climate zone* is Marine (3C).
      2. If thermal *climate zone* is 4 and CDD50°F ≤ 2,700 (CDD10°C ≤ 1500), *climate zone* is Marine (4C).
      3. If thermal *climate zone* is 5 and CDD50°F ≤ 1,800 (CDD10°C ≤ 1000), *climate zone* is Marine (5C).
   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.
      1. If thermal *climate zone* is 3 and CDD50°F ≤ 4,500 (CDD10°C ≤ 2500), *climate zone* is Marine (3C).
      2. If thermal *climate zone* is 4 and CDD50°F ≤ 2,700 (CDD10°C ≤ 1500), *climate zone* is Marine (4C).
      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 the criteria in Items 3.1 through 3.4.
   1. Mean temperature of coldest month between 27°F (-3°C) and 65°F (18°C).
   2. Warmest month mean < 72°F (22°C).
   3. Not fewer than four months with mean temperatures over 50°F (10°C).
   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.
   1. Not Marine (C).
   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 thresh- old is in accordance with Equation 3-1.

**Equation 3-1** *P* < 0.44 × (*T* – 7)

[*P* < 20.0 × (*T* + 14) in SI units]

where:

*P* = Annual precipitation, inches (mm).

*T* = Annual mean temperature, °F (°C).

* 1. 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 3-2.

**Equation 3-2** *P* < 0.44 × (*T* – 19.5)

[*P* < 20.0 × (*T* + 7) in SI units]

where:

*P* = Annual precipitation, inches (mm).

*T* = Annual mean temperature, °F (°C).

* 1. 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 thresh- old is in accordance with Equation 3-3.

**Equation 3-3** *P* < 0.44 × (*T* – 32)

[*P* < 20.0 × *T* in SI units]

where:

*P* = Annual precipitation, inches (mm).

*T* = Annual mean temperature, °F (°C).

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

|  |  |  |
| --- | --- | --- |
| **TABLE R301.3—THERMAL CLIMATE ZONE DEFINITIONS** | | |
| **ZONE NUMBER** | **THERMAL CRITERIA** | |
| **IP Units** | **SI Units** |
| 0 | 10,800 < CDD50ºF | 6000 < CDD10°C |
| 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. | | |

**R301.4 Tropical climate region.** The tropical 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.

SECTION R302—DESIGN CONDITIONS

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

SECTION R303—MATERIALS, SYSTEMS AND EQUIPMENT

**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.

**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 sheets, the number and thickness of the enclosed reflective airspaces and the *R-value* for the installed assembly determined in accordance with Section R303.1.6 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 1508.2 of the *International Building Code* or Table R906.2 of the *International Residential Code*, as applicable.

**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 m2) throughout the attic space. The markers shall be affixed to the trusses or joists and marked with the mini- mum 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.

**R303.1.2 Insulation mark installation.** Insulating materials shall be installed such that the manufacturer’s *R-value* mark is read- ily 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 R303.1.1 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 of the *International Residential Code*, as applicable.

**R303.1.3 Fenestration product rating.** *U*-factors of *fenestration* products such as windows, doors and *skylights* shall be deter- mined 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 R303.1.3(1) or Table R303.1.3(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 R303.1.3(3).

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| **TABLE 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 | | | |

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| **TABLE 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 |

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| **TABLE 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 |

**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 × ft2 × °F/Btu at a mean temperature of 75°F (24°C).

**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.

**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 × m2)] under pressure differential of 0.3 inch water gauge (75 Pa) when tested in accordance with ASTM E2178 shall be determined air-impermeable insulation.

**R303.1.6 Airspaces.** Where the *R-value* of an enclosed reflective airspace or enclosed nonreflective airspace is used for compli- ance with this code, the airspace shall be enclosed in a cavity bounded on all sides by building components and constructed to minimize airflow into and out of the enclosed airspace. Airflow shall be deemed minimized where one of the following conditions occur:

1. The enclosed airspace is unventilated.
2. The enclosed airspace is bounded on one or more sides by an anchored masonry veneer, constructed in accordance with Chapter 7 of the *International Residential Code*, and vented by veneer weep holes located only at the bottom portion of the airspace and spaced not less than 15 inches (381 mm) on center with the top of the cavity airspace closed.

**Exception:** For ventilated cavities, the effect of the *ventilation* of airspaces located on the exterior side of the continuous *air barrier* and adjacent to and behind the exterior wall covering material shall be determined in accordance with ASTM C1363, modified with an airflow entering the bottom and exiting the top of the airspace at an air movement rate of not less than 70 millimeters per second.

**R303.2 Installation.** Materials, systems and equipment shall be installed in accordance with the manufacturer’s instructions and the *International Building Code* or the *International Residential Code*, as applicable.

**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.

**R303.2.2 Radiant barrier.** Where installed, radiant barriers shall comply with the requirements of ASTM C1313/C1313M and shall be installed in accordance with ASTM C1743.

**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.

### RESIDENTIAL ENERGY EFFICIENCY



CHAPTER

**4**[RE]

***User notes:***

***About this chapter:*** *Chapter 4 presents the paths and options for compliance with the energy efficiency provisions. Chapter 4 contains energy efficiency provisions for the building envelope, mechanical and water heating systems, lighting and additional efficiency requirements. A performance alternative, energy rating alternative, and tropical regional alternative are also provided to allow for energy code compliance other than by the prescriptive method.*

SECTION R401—GENERAL

**R401.1 Scope.** This chapter applies to residential buildings.

**R401.2 Application.** Residential buildings shall comply with Section R401.2.1, R401.2.2, or R401.2.3 ~~or R401.2.4~~.

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

**R401.2.1 Prescriptive Compliance Option.** The Prescriptive Compliance Option requires compliance with Sections R401 through R404, ~~and~~ Section R408 and appendices RE, RJ, RK and RL.

**R401.2.2 Simulated Building Performance Option.** The Simulated Building Performance Option requires compliance with Section R405.

**R401.2.3 Energy Rating Index Option.** The *Energy Rating Index* (ERI) Option requires compliance with Section R406.

**R401.2.4 Tropical Climate Region Option.** The Tropical Climate Region Option requires compliance with Section R407.

**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 thermal 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 thermal 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 shall not 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 R406, the *Energy Rating Index*

score, both with and without any on-site generation, shall be listed on the certificate.

1. The code edition under which the structure was permitted, the compliance path used and, where applicable, the additional efficiency measures selected for compliance with Section R408.
2. The location and dimensions of a *solar-ready zone* where one is provided.

SECTION R402—BUILDING THERMAL ENVELOPE

**R402.1 General.** The *building thermal envelope* shall comply with the requirements of one of the following:

1. Sections R402.1.1 through R402.1.4 and Section R402.1.6.
2. Sections R402.1.1, R402.1.5 and R402.1.6.

Exceptions:

1. The following low-energy *buildings*, or portions thereof, separated from the remainder of the building-by-building *thermal envelope* assemblies complying with this section shall be exempt from the *building thermal envelope* provisions of Section R402.
   1. Those with a peak design rate of energy usage less than 3.4 Btu/h × ft2 (10.7 W/m2) or 1.0 watt/ft2 of floor area for space-conditioning purposes.
   2. Those that do not contain *conditioned space*.
2. Log homes designed in accordance with ICC 400.

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

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

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| **TABLE R402.1.2—MAXIMUM ASSEMBLY *U*-FACTORSa AND FENESTRATION REQUIREMENTS** | | | | | | | | |
| **CLIMATE ZONE** | **0** | **1** | **2** | **3** | **4 EXCEPT MARINE** | **5 AND**  **MARINE 4** | **6** | **7 AND 8** |
| Vertical fenestration U-factor | 0.50 | 0.50 | 0.40 | 0.30 | 0.30 | 0.28d | 0.28d | 0.27d |
| Skylight U-factor | 0.60 | 0.60 | 0.60 | 0.53 | 0.53 | 0.50 | 0.50 | 0.50 |
| Glazed vertical fenestration SHGC | 0.25 | 0.25 | 0.25 | 0.25 | 0.40 | NR | NR | NR |
| Skylight SHGC | 0.28 | 0.28 | 0.28 | 0.28 | 0.40 | NR | NR | NR |
| Ceiling U-factor | 0.035 | 0.035 | 0.030 | 0.030 | 0.026 | 0.026 | 0.026 | 0.026 |
| Insulation entirely above roof deck | 0.039 | 0.039 | 0.039 | 0.039 | 0.032 | 0.032 | 0.032 | 0.028 |
| Wood-framed wall U-factor | 0.084 | 0.084 | 0.084 | 0.060 | 0.045 | 0.045 | 0.045 | 0.045 |
| Mass wall U-factorb | 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 | 0.091c | 0.059 | 0.050 | 0.050 | 0.050 |
| Unheated slab F-factore | 0.73 | 0.73 | 0.73 | 0.54 | 0.51 | 0.51 | 0.48 | 0.48 |
| Heated slab F-factore | 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.   1. Nonfenestration *U*-factors and *F*-factors shall be obtained from measurement, calculation, an *approved source*, or Appendix RF where such appendix is adopted or *approved*. 2. 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. 3. In Warm Humid locations as defined by Figure R301.1 and Table R301.1, the basement wall *U*-factor shall not exceed 0.360. 4. 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*. 5. *F*-factors for slabs shall correspond to the *R*-values of Table R402.1.3 and the installation conditions of Section R402.2.10.1. | | | | | | | | |

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

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| **TABLE R402.1.3—INSULATION MINIMUM *R*-VALUES AND FENESTRATION REQUIREMENTS BY COMPONENTa** | | | | | | | | |
| **CLIMATE ZONE** | **0** | **1** | **2** | **3** | **4 EXCEPT MARINE** | **5 AND**  **MARINE 4** | **6** | **7 AND 8** |
| Vertical fenestration U-factor | 0.50 | 0.50 | 0.40 | 0.30 | 0.30 | 0.28g | 0.28g | 0.27g |
| Skylight U-factor | 0.60 | 0.60 | 0.60 | 0.53 | 0.53 | 0.50 | 0.50 | 0.50 |
| Glazed vertical fenestration SHGC | 0.25 | 0.25 | 0.25 | 0.25 | 0.40 | NR | NR | NR |
| Skylight SHGC | 0.28 | 0.28 | 0.28 | 0.28 | 0.40 | NR | NR | NR |
| Ceiling R-value | 30 | 30 | 38 | 38 | 49 | 49 | 49 | 49 |
| Insulation entirely above roof deck | 25ci | 25ci | 25ci | 25ci | 30ci | 30ci | 30ci | 35ci |
| Wood-framed wall R-valuee | 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-valuef | 3/4 | 3/4 | 4/6 | 8/13 | 8/13 | 13/17 | 15/20 | 19/21 |

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| **TABLE R402.1.3—INSULATION MINIMUM *R*-VALUES AND FENESTRATION REQUIREMENTS BY COMPONENTa—continued** | | | | | | | | |
| **CLIMATE ZONE** | **0** | **1** | **2** | **3** | **4 EXCEPT MARINE** | **5 AND**  **MARINE 4** | **6** | **7 AND 8** |
| Floor R-valueh | 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 wall R-valueb, e | 0 | 0 | 0 | 5ci or 13d | 10ci or 13 | 15ci or 19 or 13&5ci | 15ci or 19 or 13&5ci | 15ci or 19 or 13&5ci |
| Unheated slab R-value & depthc | 0 | 0 | 0 | 10ci, 2 ft | 10ci, 3 ft | 10ci, 3 ft | 10ci, 4 ft | 10ci, 4 ft |
| Heated slab R-value & depthc | R-5ci edge and R-5 full slab | R-5ci edge and R-5 full slab | R-5ci edge and R-5 full slab | R-10ci, 2 ft and  R-5 full slab | R-10ci, 3 ft and R-5 full slab | R-10ci, 3 ft and R-5 full slab | R-10ci, 4 ft and  R-5 full slab | R-10ci, 4 ft and  R-5 full slab |
| Crawl space wall R-valueb, e | 0 | 0 | 0 | 5ci or 13d | 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.   1. *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. 2. “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 addi- tion to R-5 continuous insulation on the interior or exterior surface of the wall. 3. Slab insulation shall be installed in accordance with Section R402.2.10.1. 4. Basement wal*l* insulation is not required in Warm Humid locations as defined by Figure R301.1 and Table R301.1. 5. 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. 6. 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. 7. 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.    2. In windborne debris regions where protection of openings is required by Section R301.2.1.2 of the *International Residential Code*. 8. "30 or 19+7.5ci or 20ci" means R-30 cavity insulation alone or R-19 cavity insulation with R-7.5 continuous insulation or R-20 continuous insulation alone. | | | | | | | | |

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

**R402.1.5 Component performance alternative.** Where the proposed total *building thermal envelope* thermal conductance (TCp) is less than or equal to the total *building thermal envelope* thermal conductance (TCr) using factors in Table R402.1.2, the *building* shall be considered to be in compliance with Table R402.1.2. The total thermal conductance (TC) shall be determined in accordance with Equation 4-1. 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 TC compliance, the SHGC requirements of Table R402.1.2 and the maximum *fenestration U-factors* of Section R402.6 shall be met.

**Equation 4-1** *TCp*  *TCr*

where:

*TCp* = *UpA* + *FpP TCr* = *UrA* + *FrP*

*UpA* = the sum of proposed *U*-factors times the assembly areas in the proposed building.

*FpP* = the sum of the proposed *F*-factors times the slab-on-grade perimeter lengths in the proposed building.

*UrA* = the sum of *U*-factors in Table R402.1.2 times the same assembly areas as in the proposed building.

*FrP* = the sum of *F*-factors in Table R402.1.2 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*.

**R402.1.6 Rooms containing fuel-burning appliances.** In Climate Zones 3 through 8, where open combustion air *ducts* provide combustion air to open combustion fuel-burning appliances, the appliances and combustion air opening shall be located outside the *building thermal envelope* or enclosed in a room that is isolated from inside the *building thermal envelope*. Such rooms shall

be sealed and insulated in accordance with the *building thermal envelope* requirements of Table R402.1.3, where the walls, floors and ceilings shall meet a minimum of the *basement wall R-value* requirement. The door into the room shall be fully gasketed and any water lines and *ducts* in the room insulated in accordance with Section R403. The combustion air *duct* shall be insulated where it passes through *conditioned space* to an *R-value* of not less than R-8.

Exceptions:

1. Direct vent appliances with both intake and exhaust pipes installed continuous to the outside.
2. Fireplaces and stoves complying with Section R402.5.2 and Section R1006 of the *International Residential Code*.

**R402.2 Specific insulation requirements.** In addition to the requirements of Section R402.1, insulation shall meet the specific requirements of Sections R402.2.1 through R402.2.13.

**R402.2.1 Ceilings with attics.** Where Section R402.1.3 requires R-38 insulation in the ceiling or attic, installing R-30 over 100 percent of the ceiling or attic area requiring insulation shall satisfy the requirement for R-38 insulation wherever the full height of uncompressed R-30 insulation extends over the wall top plate at the eaves. Where Section R402.1.3 requires R-49 insulation in the ceiling or attic, installing R-38 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. This reduction shall not apply to the insulation and *fenestration* criteria in Section R402.1.2 and the component performance alternative in Section R402.1.5.

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

**R402.2.3 Attic knee wall.** Wood attic *knee wall* assemblies that separate *conditioned space* from unconditioned attic spaces shall comply with Table R402.1.3 for wood-framed walls. Steel attic knee wall assemblies shall comply with Section R402.2.7. Such *knee walls* shall have an *air barrier* between conditioned and unconditioned space.

**R402.2.3.1 Roof truss framing separating conditioned and unconditioned space.** Where wood vertical roof truss framing members are used to separate *conditioned space* and unconditioned space, they shall comply with Table R402.1.3 for wood- framed walls. Steel frame vertical roof truss framing members used to separate *conditioned space* and unconditioned space shall comply with Section R402.2.7.

**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.

**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 R402.1.3 for the wall or ceiling in which they are installed.

Exceptions:

1. Vertical doors providing access from *conditioned spaces* to unconditioned spaces that comply with the *fenestration*

requirements of Table R402.1.3 based on the applicable *climate zone* specified in Chapter 3.

1. 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 the hatch meets all of the following:
   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.

* 1. Not less than 75 percent of the panel area shall have an insulation *R-value* of R-13 or greater.
  2. The net area of the framed opening shall be less than or equal to 13.5 square feet (1.25 m2).
  3. The perimeter of the hatch edge shall be weather-stripped.

The reduction shall not apply to the component performance alternative in Section R402.1.5.

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

**R402.2.6 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/ft2 × °F (123 kJ/m2 × K).

**R402.2.7 Steel-frame ceilings, walls and floors.** Steel-frame ceilings, walls, and floors shall comply with the *U-factor* requirements of Table R402.1.2. The calculation of the *U-factor* for steel-framed ceilings and walls in a *building thermal envelope* assembly shall be determined in accordance with AISI S250, modified as follows:

1. Where the steel-framed wall contains no *cavity insulation*, and uses *continuous insulation* to satisfy the *U-factor* maxi- mum, 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 AISI S250 shall be used without any modifications.
4. Where the steel-framed wall contains other than standard C-shaped framing members the AISI S250 calculation option for other than standard C-shaped framing is permitted to be used.

**R402.2.8 Floors.** Floor *insulation* shall be installed in accordance with all of the following:

1. Table R402.1.2 or R402.1.3 and manufacturer’s instructions.
2. Floor framing members that are part of the *building thermal envelope* shall be air-sealed to maintain a *continuous air barrier*.
3. One of the following methods:
   1. *Cavity insulation* shall be installed to maintain permanent contact with the underside of the subfloor decking.
   2. *Cavity insulation* shall be installed to maintain 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.
   3. A combination of *cavity insulation* and *continuous insulation* shall be installed such that the *cavity insulation* maintains contact with the top side of the *continuous insulation* and the *continuous insulation* maintains contact with the underside of the structural floor system. Insulation shall extend from the bottom to the top of all perimeter floor framing members.
   4. *Continuous insulation* shall be installed to maintain contact with the underside of the structural floor system. Insulation shall extend from the bottom to the top of all perimeter floor framing members.

**R402.2.9 Basement walls.** *Basement walls* shall be insulated in accordance with Table R402.1.3.

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

1. The floor overhead, including the underside stairway stringer leading to the basement, is insulated in accordance with Section R402.1.3 and applicable provisions of Sections R402.2 and R402.2.8.
2. There are no uninsulated ductwork, domestic hot water piping, or hydronic heating surfaces exposed to the basement.
3. There are no HVAC supply or return diffusers serving the basement.
4. The walls surrounding the stairway and adjacent to *conditioned space* are insulated in accordance with Section R402.1.3 and applicable provisions of Section R402.2.
5. The door(s) leading to the basement from *conditioned spaces* are insulated in accordance with Section R402.1.3 and applicable provisions of Section R402.2, and weather-stripped in accordance with Section R402.5.
6. The *building thermal envelope* separating the basement from adjacent *conditioned spaces* complies with Section R402.5.

**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, or in accordance with the *proposed design* or the *rated design*, as applicable.

**R402.2.10 Slab-on-grade floors.** Slab-on-grade floors with a floor surface within 24 inches (610 mm) above or below grade shall be insulated in accordance with Section R402.2.10.1 or R402.2.10.2.

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

**R402.2.10.1 Slab-on-grade floor insulation installation.** For buildings complying with Section R401.2.1, 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 extend the vertical distance provided in Table R402.1.3, but need not exceed the footing depth in accordance with Section R403.1.4 of the *International Residential Code*. Where a proposed design includes 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*. 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.

**R402.2.10.2 Alternative slab-on-grade insulation configurations.** For *buildings* complying with Section R405 or R406, slab- on-grade insulation shall be installed in accordance with the *proposed design* or *rated design*.

**R402.2.11 Crawl space walls.** *Crawl space walls* shall be insulated in accordance with Section R402.2.11.1 or R402.2.11.2.

**Exception:** *Crawl space walls* associated with a crawl space that is vented to the outdoors and the floor overhead is insulated in accordance with Table R402.1.3 and Section R402.2.8.

**R402.2.11.1 Crawl space wall insulation installations.** Where installed, *crawl space wall* insulation shall be secured to the wall and extend downward from the sill plate to not less than the top of the foundation wall footing.

**Exception:** Where the *crawl space wall* insulation is installed on the interior side of the wall and the crawl space floor is more than 24 inches (610 mm) below the exterior grade, the crawl space wall insulation shall be permitted to 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 crawl space foundations shall be covered with a continuous Class I vapor retarder in accordance with the *International Building Code* or *International Residential Code*, as applicable. Joints of the vapor retarder shall overlap by 6 inches (153 mm) and be sealed or taped. The edges of the vapor retarder shall extend not less than 6 inches (153 mm) up stem walls and shall be attached to the stem walls.

**R402.2.11.2 Alternative crawl space wall insulation configurations.** For *buildings* complying with Section R405 or R406,

*crawl space wall* insulation shall be installed in accordance with the *proposed design* or *rated design*.

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

**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.

**R402.3 Radiant barriers.** Where installed, radiant barriers shall be installed in accordance with ASTM C1743.

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

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

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

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

**R402.4.3 Glazed fenestration exemption.** Not greater than 15 square feet (1.4 m2) of glazed *fenestration* per *dwelling unit* shall be exempt from the *U-factor* and SHGC requirements in Section R402.1.2. This exemption shall not apply to the component performance alternative in Section R402.1.5.

**R402.4.4 Opaque door exemption.** One side-hinged *opaque door* assembly not greater than 24 square feet (2.22 m2) in area shall be exempt from the *U-factor* requirement in Section R402.1.2. This exemption shall not apply to the component performance alternative in Section R402.1.5.

**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 garage with *thermal isolation* from *conditioned space* shall comply with the

*building thermal envelope* requirements of this code.

**R402.5 Air leakage.** The *building thermal envelope* shall be constructed to limit air leakage in accordance with the requirements of Sections R402.5.1 through R402.5.4.

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

**R402.5.1.1 Installation.** The components of the *building thermal envelope* as indicated in Table R402.5.1.1 shall be installed in accordance with the manufacturer’s instructions and the criteria indicated in Table R402.5.1.1, as applicable to the method of construction. Where required by the *code official,* an *approved* third party shall inspect all components and verify compliance.

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| **TABLE R402.5.1.1—AIR BARRIER, AIR SEALING AND INSULATION INSTALLATIONa** | | |
| **COMPONENT** | **AIR BARRIER, AIR SEALING CRITERIA** | **INSULATION INSTALLATION CRITERIA** |
| General requirements | A continuous air barrier shall be installed in the building thermal envelope.  Breaks or joints in the air barrier shall be sealed. | Air-permeable insulation shall not be used as a seal- ing material. |
| Ceiling/attic | An air barrier shall be installed in any dropped ceiling or soffit to separate it from unconditioned space.  Access openings, drop down stairs or knee wall doors to unconditioned attic spaces shall be 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 R402.2.5.  Eave baffles shall be installed in accordance with Section R402.2.4. |
| 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 building thermal envelope insulation for framed walls shall be installed in substantial contact and continuous alignment with the air barrier. |
| Knee wall | Knee walls shall have an air barrier between conditioned and unconditioned space | Insulation installed in a knee wall assembly shall be installed in accordance with Section R402.2.3.  Air-permeable insulation shall be enclosed inside an air barrier assembly. |
| Windows, skylights and doors | The rough opening gap between framing and the frames of skylights, windows and doors, shall be sealed in accordance with fenestration manufacturer’s instructions. | Insulation shall not be required in the rough open- ing gap except as required by the fenestration manufacturer’s instructions. |
| Rim joists | Rim joists shall include an air barrier.  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 | Floor framing members that are part of the building thermal envelope shall be air sealed to maintain a continuous air barrier.  Air permeable floor cavity insulation shall be enclosed. | Floor insulation shall be installed in accordance with the requirements of Section R402.2.8. |
| Basement, crawl space and slab foundations | Exposed earth in unvented crawl spaces shall be covered with a Class I vapor retarder/air barrier in accordance with Section R402.2.11.  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 of the *Interna- tional Residential Code*. | Crawl space insulation, where provided instead of floor insulation, shall be installed in accordance with Section R402.2.11.  Conditioned basement foundation wall insulation shall be installed in accordance with Section R402.2.9.1.  Slab-on-grade floor insulation shall be installed in accordance with Section R402.2.10. |
| Shafts, penetrations | Duct and flue shafts 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 insula- tion 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 assem- bly shall be installed in accordance with Sections R303 and R402.2.8. |
| Recessed lighting | Recessed light fixtures installed in the building ther- mal envelope shall be air sealed in accordance with Section R402.5.4. | Recessed light fixtures installed in the building ther- mal envelope shall be airtight and IC rated, and shall be buried in or surrounded with insulation. |

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| **TABLE R402.5.1.1—AIR BARRIER, AIR SEALING AND INSULATION INSTALLATIONa—continued** | | |
| **COMPONENT** | **AIR BARRIER, AIR SEALING CRITERIA** | **INSULATION INSTALLATION CRITERIA** |
| 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 | An air barrier shall separate insulation in the build- ing thermal envelope from the shower, tub or fireplace assemblies. | Exterior framed walls adjacent to showers, tubs and fireplaces shall be insulated. |
| Electrical, communication and other equipment boxes, housings and enclosures | 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.  Alternatively, air-sealed boxes shall be installed in accordance with Section R402.5.5. | Boxes, housing and enclosures shall be buried in or surrounded by insulation. |
| HVAC register boots | HVAC supply and return register boots shall be sealed to the subfloor, wall covering or ceiling pene- trated by the boot. | HVAC supply and return register boots located within a building thermal envelope assembly shall be buried in or surrounded by insulation. |
| Concealed sprinklers | Where required to be sealed, concealed fire sprin- klers 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 separating attached single- family dwellings or townhouses | An interior air barrier shall be provided. Air sealing at the intersections with building thermal envelope shall be provided.  Where installed in a fire-resistance-rated wall assembly, air sealing materials shall comply with one of the following:   1. Be in accordance with an approved design for the fire-resistance-rated assembly. 2. Be supported by approved data that shows the assembly as installed complies with the required fire-resistance rating. | Insulation materials recognized in the approved common wall or double-wall design and installed in accordance with the approved design shall be permitted to be used. |
| 1. Inspection of log walls shall be in accordance with the provisions of ICC 400. 2. Insulation full enclosure is not required in unconditioned/ventilated attic spaces and at rim joists. | | |

**R402.5.1.2 Air leakage testing.** The *building* or each *dwelling unit* or *sleeping unit* in the *building* shall be tested for air leak- age. Testing shall be conducted in accordance with ANSI/RESNET/ICC 380, ASTM E779, ASTM E1827 or ASTM E3158 and reported at a pressure differential of 0.2 inch water gauge (50 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.

During testing:

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

Exceptions:

* 1. 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 thermal envelope* tightness and insulation installation shall be considered acceptable where the items in Table R402.5.1.1, 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 installa-

tion criteria. Heated, attached private garage space and heated, detached private garage space shall be thermally isolated from all other habitable, *conditioned spaces* in accordance with Sections R402.2.13 and R402.4.5, as applicable.

* 1. Where tested in accordance with Section R402.5.1.2.1, testing of each *dwelling unit* or *sleeping unit* is not required.

**R402.5.1.2.1 Unit sampling.** For *buildings* with eight or more *dwelling units* or *sleeping units*, seven or 20 percent of the *dwelling units* or *sleeping units,* whichever is greater, shall be tested. Tested units shall include a top-floor unit, a ground-floor unit, a middle-floor unit and the *dwelling unit* or *sleeping unit* with the largest *testing unit enclosure area*. Where the air leak- age rate of a tested unit is greater than the maximum permitted rate, corrective actions shall be taken and the unit retested until it passes. For each tested *dwelling unit* or *sleeping unit* with an air leakage rate greater than the maximum permitted rate, three additional units, including the corrected unit, shall be tested. Where *buildings* have fewer than eight *dwelling units* or *sleeping units,* each unit shall be tested.

**R402.5.1.3 Maximum air leakage rate.** Where tested in accordance with Section R402.5.1.2, the air leakage rate for *buildings*, *dwelling units* or *sleeping units* shall be as follows:

1. Where complying with Section R401.2.1, the *building* or the *dwelling units* or *sleeping units* in the *building* shall have an air leakage rate not greater than 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.
2. Where complying with Section R401.2.2 or R401.2.3, the *building* or the *dwelling units* or *sleeping units* in the *building* shall have an air leakage rate not greater than 4.0 air changes per hour, or 0.22 cubic feet per minute per square foot [1.1 L/(s × m2)] of the *building thermal envelope* area or the dwelling *testing unit enclosure area*, as applicable.

Exceptions:

* 1. Where *dwelling units* or *sleeping units* are attached or located in an R-2 occupancy, and are tested without simultaneously testing adjacent *dwelling units* or *sleeping units*, the air leakage rate is permitted to be not greater than

0.27 cubic feet per minute per square foot [1.4 L/(s × m2)] of the *testing unit enclosure area*. Where adjacent *dwelling units* are simultaneously tested in accordance with ASTM E779, the air leakage rate is permitted to be not greater than 0.27 cubic feet per minute per square foot [1.4 L/(s × m2)] of the *testing unit enclosure area* that separates *conditioned space* from the exterior.

* 1. Where *buildings* have 1,500 square feet (139.4 m2) or less of *conditioned floor area*, the air leakage rate is permitted to be not greater than 0.27 cubic feet per minute per square foot [1.4 L/(s × m2)].

**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.

**R402.5.3 Fenestration air leakage.** Windows, *skylights* and sliding glass doors shall have an air *infiltration* rate of not greater than 0.3 cubic feet per minute per square foot (1.5 L/s/m2), and for swinging doors, not greater than 0.5 cubic feet per minute per square foot (2.6 L/s/m2), 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.

**R402.5.4 Recessed lighting.** Recessed luminaires installed in the *building thermal envelope* shall be sealed to limit air leakage between conditioned and *unconditioned spaces*. Recessed luminaires shall be IC-rated and *labeled* as having an air leakage rate of not greater than 2.0 cfm (0.944 L/s) when tested in accordance with ASTM E283 at a pressure differential of 1.57 psf (75 Pa). Recessed luminaires shall be sealed with a gasket or caulked between the housing and the interior wall or ceiling covering.

**R402.5.5 Air-sealed electrical and communication outlet boxes.** Air-sealed electrical and communication outlet boxes that penetrated the *air barrier* of the *building thermal envelope* shall be caulked, taped, gasketed or otherwise sealed to the *air barrier* element being penetrated. Air-sealed boxes shall be buried in or surrounded by insulation. Air-sealed boxes shall be tested and marked in accordance with NEMA OS 4. Air-sealed boxes shall be installed in accordance with the manufacturer’s instructions.

**R402.6 Maximum fenestration *U*-factor and SHGC.** The area-weighted average maximum *fenestration U-factor* permitted using tradeoffs from Section R402.1.5 or R405 shall be 0.48 in Climate Zones 4 and 5 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 R405 in Climate Zones 0 through 3 shall be 0.40.

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

SECTION R403—SYSTEMS

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

The primary heating or cooling system serving the dwelling unit shall comply with Sections R403.1.1, R403.1.2, and RJ102.

**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 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).

**R403.1.2 Heat pump supplementary heat.** Heat pumps having supplementary electric-resistance, *fuel gas*

or *liquid fuel* heating systems shall have controls that are configured to prevent supplemental heat operation

when the capacity of the heat pump compressor can meet the heating load. Supplemental heat operation shall be limited to only where 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.

**R403.2 Hot water boiler temperature reset.** Other than where equipped with tankless domestic water heating coils, the manufacturer shall equip each gas, *liquid fuel* and electric boiler with *automatic* means of adjusting the water temperature supplied by the boiler so that 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.

**R403.3 Duct systems.** *Duct systems* shall be installed in accordance with Sections R403.3.1 through R403.3.9.

**Exception:** *Ventilation ductwork* that is not integrated with *duct systems* serving heating or cooling systems.

**R403.3.1 Duct system design.** *Duct systems* serving one or two *dwelling units* or *sleeping units* shall be designed and sized in accordance with ANSI/ACCA Manual D. *Duct systems* serving more than two *dwelling units* or *sleeping units* shall be sized in accor- dance with the ASHRAE *Handbook of Fundamentals*, ANSI/ACCA Manual D or other equivalent computation procedure.

**R403.3.2 Building cavities.** *Building* framing cavities shall not be used as ductwork or plenums.

**R403.3.3 Ductwork located outside conditioned space.** Supply and return *ductwork* 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. *Ductwork* buried beneath a *building* shall be insulated as required per this section or have an equivalent *thermal distribution efficiency*. Underground *ductwork* utilizing the *thermal distribution efficiency* method shall be *listed* and *labeled* to indicate the *R-value* equivalency.

**R403.3.4 Duct systems located in conditioned space.** For *duct systems* to be considered inside a *conditioned space,* the *space conditioning equipment* shall be located completely on the conditioned side of the *building thermal envelope*. The *ductwork* shall comply with the following, as applicable:

1. The *ductwork* shall be located completely on the conditioned side of the *building thermal envelope*.
2. *Ductwork* in ventilated attic spaces or unvented attics with vapor diffusion ports shall be buried within ceiling insulation in accordance with Section R403.3.5 and shall comply with the following:
   1. The ductwork leakage, as measured either by a rough-in test of the supply and return *ductwork* or a post- construction *duct system* leakage test to outside the *building thermal envelope* in accordance with Section R403.3.7, is not greater than 1.5 cubic feet per minute (42.5 L/min) per 100 square feet (9.29 m2) of *conditioned floor area* served by the *duct system*.
   2. The ceiling insulation *R-value* installed against and above the insulated *ductwork* is greater than or equal to the proposed ceiling insulation *R-value*, less the *R-value* of the insulation on the *ductwork*.
3. *Ductwork* contained within wall or floor assemblies separating unconditioned from *conditioned space* shall comply with the following:
   1. A *continuous air barrier* shall be installed as part of the building assembly between the *ductwork* and the unconditioned space.
   2. *Ductwork* shall be installed in accordance with Section R403.3.3.

**Exception:** Where the building assembly cavities containing *ductwork* have been air sealed in accordance with Section R402.5.1 and insulated in accordance with Item 3.3, *duct* insulation is not required.

* 1. Not less than R-10 insulation, or not less than 50 percent of the required insulation *R-value* specified in Table R402.1.3, whichever is greater, shall be located between the *ductwork* and the unconditioned space.
  2. Segments of *ductwork* contained within these building assemblies shall not be considered completely inside

*conditioned space* for compliance with Section R405 or R406.

**R403.3.5 Ductwork buried within ceiling insulation.** Where supply and return *ductwork* is partially or completely buried in ceiling insulation, such *ductwork* shall comply with the following:

1. The supply and return *ductwork* shall be insulated with not less than R-8 insulation.
2. At all points along the *ductwork*, the sum of the ceiling insulation *R-value* against and above the top of the *ductwork*, and against and below the bottom of the *ductwork*, 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 *ductwork* 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 604.11 of the *International Mechanical Code* or Section M1601.4.6 of the *International Residential Code*, as applicable.

**Exception:** Sections of the supply *ductwork* that are less than 3 feet (914 mm) from the supply outlet.

1. In Climate Zones 0A, 1A, 2A and 3A where installed in an unvented attic with vapor diffusion ports, the supply *ductwork* shall be completely buried within the insulation in the ceiling assembly at the floor of the attic, 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 of the *International Residential Code*, as applicable.

**Exception:** Sections of the supply *ductwork* that are less than 3 feet (914 mm) from the supply outlet.

* 1. Air permeable insulation installed in unvented attics shall comply with Section R806.5 of the *International Residential Code*.

**R403.3.5.1 Effective *R*-value of deeply buried ducts.** Where complying using Section R405, sections of *ductwork* that are installed in accordance with Section R403.3.5 surrounded with blown-in attic insulation having an *R-value* of R-30 or greater and located such that the top of the *ductwork* 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.

**R403.3.6 Sealing.** *Ductwork*, *air-handling units* and filter boxes shall be sealed. Joints and seams shall comply with the *International Mechanical Code* or the *International Residential Code*, as applicable.

**R403.3.6.1 Sealed air-handling unit.** *Air-handling units* 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.

**R403.3.7 Duct system testing.** Each *duct system* shall be tested for air leakage in accordance with ANSI/RESNET/ICC 380 or ASTM E1554. Total leakage shall be measured with a pressure differential of 0.1 inch water gauge (25 Pa) across the *duct system* and shall include the measured leakage from the supply and return *ductwork*. 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 with or without the installation of registers or grilles. Where installed, registers and grilles shall be sealed during the test. Where registers and grilles are not installed, the face of the register boots shall be sealed during the test.

Exceptions:

1. Testing shall not be required for *duct systems* serving *ventilation* systems that are not integrated with *duct systems*

serving heating or cooling systems.

1. Testing shall not be required where there is not more than 10 feet (3048 mm) of total *ductwork* external to the *space conditioning equipment* and both the following are met:
   1. The *duct system* is located entirely within *conditioned space*.
   2. The *ductwork* does not include *plenums* constructed of building cavities or gypsum board.
2. Where the *space conditioning equipment* is not installed, testing shall be permitted. The total measured leakage of the supply and return *ductwork* shall be less than or equal to 3.0 cubic feet per minute (85 L/min) per 100 square feet (9.29 m2) of *conditioned floor area.*
3. Where tested in accordance with Section R403.3.9, testing of each *duct system* is not required.

**R403.3.8 Duct system leakage.** The total measured *duct system* leakage shall not be greater than the values in Table R403.3.8, based on the *conditioned floor area*, number of ducted returns, and location of the *duct system*. For *buildings* complying with Section R405 or R406, 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 R405 and R406.

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| **TABLE R403.3.8—MAXIMUM TOTAL DUCT SYSTEM LEAKAGE** | | | |
| **EQUIPMENT AND DUCT CONFIGURATION** | **DUCT SYSTEMS SERVING MORE THAN 1,000 FT2 OF CONDITIONED FLOOR AREA** | | **DUCT SYSTEMS SERVING 1,000 FT2 OR LESS OF CONDITIONED FLOOR AREA** |
| **cfm/100 ft2** | | **cfm** |
| **Number of ducted returnsa** | | |
| **< 3** | **≥ 3** | **Any** |
| Space conditioning equipment is not installedb, c | 3 | 4 | 30 |
| All components of the duct system are installedc | 4 | 6 | 40 |

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| **TABLE R403.3.8—MAXIMUM TOTAL DUCT SYSTEM LEAKAGE—continued** | | | |
| **EQUIPMENT AND DUCT CONFIGURATION** | **DUCT SYSTEMS SERVING MORE THAN 1,000 FT2 OF CONDITIONED FLOOR AREA** | | **DUCT SYSTEMS SERVING 1,000 FT2 OR LESS OF CONDITIONED FLOOR AREA** |
| **cfm/100 ft2** | | **cfm** |
| **Number of ducted returnsa** | | |
| **< 3** | **≥ 3** | **Any** |
| Space conditioning equipment is not installed, but the ductwork is located entirely in conditioned spacec, d | 6 | 8 | 60 |
| All components of the duct system are installed and entirely located in conditioned spacec | 8 | 12 | 80 |
| For SI: 1 cubic foot per minute per square foot = 0.0033 LPM/m2, 1 cubic foot per minute = 28.3 LPM.   1. A ducted return is a duct made of sheet metal or flexible duct that connects one or more return grilles to the return-side inlet of the air-handling unit. Any other method to convey air from return or transfer grilles to the air-handling unit does not constitute a ducted return for the purpose of determining maximum total duct system leakage allowance. 2. Duct system testing is permitted where space conditioning equipment is not installed, provided that the return ductwork is installed and the measured leakage from the supply and return ductwork is included. 3. For duct systems to be considered inside a conditioned space, where the ductwork is located in ventilated attic spaces or unvented attics with vapor diffusion ports, duct system leakage to outside must comply with Item 2.1 of Section R403.3.4. 4. Prior to the issuance of a certificate of occupancy, where the air-handling unit is not verified as being located in conditioned space, the total duct system leakage must be retested. | | | |

**R403.3.9 Unit sampling.** For *buildings* with eight or more *dwelling units* or *sleeping units,* the *duct systems* in the greater of seven or 20 percent of the *dwelling units* or *sleeping units* shall be tested, including a top floor unit, a ground floor unit, a middle floor unit and the unit with the largest *conditioned floor area*. Where buildings have fewer than eight *dwelling units* or *sleeping units*, the *duct systems* in each unit shall be tested. Where the leakage of a *duct system* is greater than the maximum permitted *duct system* leakage, corrective actions shall be made to the *duct system* and the *duct system* shall be system retested until it passes. For each tested *dwelling unit* or *sleeping unit* that has a greater total duct system leakage than the maximum permitted *duct system* leak- age, an additional three *dwelling units* or *sleeping units*, including the corrected unit, shall be tested.

**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.

**R403.4.1 Protection of piping insulation.** Piping insulation exposed to weather shall be protected from damage, including that caused by sunlight, moisture, physical contact and wind. The protection shall provide shielding from solar radiation that can cause degradation of the material and shall be removable not less than 6 feet (1828 mm) from the equipment for maintenance. Adhesive tape shall be prohibited.

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

**R403.5.1 Heated water circulation and temperature maintenance systems.** Heated water circulation systems shall be in accordance with Section R403.5.1.1. Heat trace temperature maintenance systems shall be in accordance with Section R403.5.1.2. *Automatic* controls, temperature sensors and pumps shall be in a location with access. *Manual* controls shall be in a location with *ready access*.

**R403.5.1.1 Circulation systems.** Heated water circulation systems shall be provided with a circulation pump. 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 system return pipe shall be a dedicated return pipe or a cold water supply pipe. Where a cold water supply pipe is used as the return pipe, a temperature sensor connected to the controls shall be located on the hot water supply not more than two feet (305 mm) from the connection to the cold water supply pipe. The controls shall limit the temperature of the water entering the cold water piping to not greater than 104°F (40°C).

**R403.5.1.1.1 Demand recirculation water systems.** *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. The controls shall limit pump operation by:

1. Shutting off the pump when the temperature sensor detects one of the following:
   1. An increase in the water temperature of not more than 10°F (5.6°C) above the initial temperature of the water in the pipe.
   2. The temperature of the water in the pipe reaches 104°F (40°C).
2. Limiting pump operation to a maximum of 5 minutes following activation.
3. Not activating the pump for at least 5 minutes following shutoff or when the temperature of the water in the pipe exceeds 104°F (40°C).

**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.

**R403.5.2 Hot water pipe insulation.** Insulation for service hot water piping shall comply with Table R403.5.2 and be applied to the following:

1. Piping 3/4 inch (19.1 mm) and larger in nominal diameter located inside the *conditioned space*.
2. Piping located outside the *conditioned space*.
3. Piping from the water heater to a distribution manifold.
4. Piping located under a floor slab.
5. Buried piping.
6. Supply and return piping in circulating hot water systems.

**Exception:** Cold water returns in *demand recirculation water systems*.

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| **TABLE R403.5.2—MINIMUM PIPE INSULATION THICKNESS** | | | |
| **FLUID OPERATING TEMPERATURE RANGE AND USAGE**  **(°F)** | **INSULATION CONDUCTIVITY** | | **MINIMUM PIPE INSULATION THICKNESS**  **(inches)** |
| **Conductivity Btu × in/(h × ft2 × °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 conductivity range listed in this table, the minimum thickness (*T*) listed in this table shall be determined as follows:  *T* = *r*[(1 + *t*/*r*)*Kk* - 1] where:  *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 fluid temperature (Btu × in/h × ft2 × °F).  *k* = The upper value of the conductivity range listed in this table for the applicable fluid temperature. | | | |

**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.

**R403.6 Mechanical ventilation.** The *buildings* and *dwelling units* complying with Section R402.5.1.1 shall be provided with mechanical *ventilation* that complies with the requirements of Section M1505 of the *International Residential Code* or the *International Mechanical Code*, as applicable, or with other *approved* means of *ventilation*. Outdoor air intakes and exhausts shall have *automatic* or gravity *dampers* that close when the *ventilation* system is not operating.

**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 sensible recovery efficiency (SRE) of not less than 65 percent at 32°F (0°C) at 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.

**R403.6.2 Fan efficacy for whole-house mechanical ventilation systems and outdoor air ventilation systems.** Fans used to provide whole-dwelling mechanical *ventilation* shall meet the efficacy requirements of Table R403.6.2 at one or more rating points. Fans shall be tested in accordance with the test procedure referenced by Table R403.6.2 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, ERV, balanced *ventilation* systems and in-line fans shall be determined at a static pressure of not less than 0.2 inch water gauge (50 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 gauge (25 Pa).

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| **TABLE R403.6.2—FAN EFFICACY FOR WHOLE-HOUSE MECHANICAL VENTILATION SYSTEMS AND OUTDOOR AIR VENTILATION SYSTEMSa** | | | |
| **SYSTEM TYPE** | **AIRFLOW RATE (CFM)** | **MINIMUM EFFICACY (CFM/WATT)** | **TEST PROCEDURE** |
| HRV or ERV | Any | 1.2a | CAN/CSA C439 |
| Balanced ventilation system without heat or energy recovery | Any | 1.2a | ANSI/AMCA 210-ANSI/ASHRAE 51 |
| Range hood | Any | 2.8 |

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| **TABLE R403.6.2—WHOLE-DWELLING MECHANICAL VENTILATION SYSTEM FAN EFFICACYa—continued** | | | |
| **SYSTEM TYPE** | **AIRFLOW RATE (CFM)** | **MINIMUM EFFICACY (CFM/WATT)** | **TEST PROCEDURE** |
| In-line supply or exhaust fan | Any | 3.8 | ANSI/AMCA 210-ANSI/ASHRAE 51 |
| Other exhaust fan | < 90 | 2.8 |
| ≥ 90 and < 200 | 3.5 |
| ≥ 200 | 4.0 |
| Air-handling unit that is integrated to tested and listed HVAC equipment | Any | 1.2 | Outdoor airflow as specified. Air-handling unit fan power determined in accordance with the applicable US Department of Energy Code of Federal Regulations DOE10 CFR 430 or other approved test method. |
| For SI: 1 cubic foot per minute = 28.3 L/min.  a. For balanced ventilation systems, HRVs and ERVs, determine the efficacy as the outdoor airflow divided by the total fan power. | | | |

**R403.6.3 Testing.** Mechanical *ventilation* systems shall be tested and verified to provide the minimum *ventilation* flow rates required by Section R403.6, in accordance with ANSI/RESNET/ICC 380. 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 (152 mm) or larger, a length of 10 feet (3028 mm) or less, and not more than two 90-degree (1.57 rad) elbows or equivalent 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, and a user interface that communicates the installed airflow rate.
  3. Where tested in accordance with Section R403.6.4, testing of each mechanical ventilation system is not required.

**R403.6.4 Unit sampling.** For *buildings* with eight or more *dwelling units* or *sleeping units,* the mechanical *ventilation* systems in the greater of seven units or 20 percent of the total units shall be tested. Tested systems shall include systems in a top floor unit, systems in a ground floor unit, systems in a middle floor unit, and the systems in the *dwelling unit* or *sleeping unit* with the largest *conditioned floor area*. Where *buildings* have fewer than eight *dwelling units* or *sleeping units*, the mechanical *ventilation* systems in each unit shall be tested. Where the *ventilation* flow rate of a mechanical *ventilation* system is less than the minimum permitted rate, corrective actions shall be taken and the system retested until it passes. For each tested *dwelling unit* or *sleeping unit* system with a *ventilation* flow rate lower than the minimum permitted, three additional systems, including the corrected system, shall be tested.

**R403.6.5 Intermittent exhaust control for bathrooms and toilet rooms.** Where an exhaust system serving a bathroom or toilet room is designed for intermittent operation, the exhaust system controls shall include one or more of the following:

1. A timer control with one or more delay setpoints that automatically turns off exhaust fans when the selected setpoint is reached. Not fewer than one delay-off setpoint shall be 30 minutes or less.
2. An *occupant sensor control* with one or more delay setpoints that automatically turns off exhaust fans in accordance with the selected delay setpoint after all occupants have vacated the space. Not fewer than one delay-off setpoint shall be 30 minutes or less.
3. A humidity control with an adjustable setpoint ranging between 50 percent or more and 80 percent or less relative humidity that automatically turns off exhaust fans when the selected setpoint is reached.
4. A contaminant control that responds to a particle or gaseous concentration and automatically turns off exhaust fans when a design setpoint is reached.

*Manual* off functionality shall not be used in lieu of the minimum setpoint functionality required by this section.

**Exception:** Bathroom and toilet room exhaust systems serving as an integral component of an outdoor air *ventilation* system or a whole-house mechanical *ventilation* system.

**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.

**R403.7.1 Electric-resistance space heating.** Detached one- and two-family dwellings and townhouses in Climate Zones 4 through 8 using electric-resistance space heating shall limit the total installed heating capacity of all electric-resistance space heating serving the *dwelling unit* to not more than 2.0 kW or shall install a heat pump in the largest space that is not used as a bedroom.

**R403.8 Systems serving multiple dwelling units.** Except for systems complying with Section R403.9, systems serving multiple *dwelling units* shall comply with Sections C403 and C404 of the *International Energy Conservation Code*—Commercial Provisions instead of Section R403.

**R403.9 Mechanical systems located outside of the building thermal envelope.** Mechanical systems providing heat outside of the

*building thermal envelope* of a *building* shall comply with Sections R403.9.1 through R403.9.4.

**R403.9.1 Heating outside a building.** Systems installed to provide heat outside a *building* shall be radiant systems. Such heating systems shall be controlled by an occupancy-sensing device or a timer switch, so that the system is automatically de-energized when occupants are not present.

**R403.9.2 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).

**R403.9.3 Roof and gutter deicing controls.** Roof and gutter deicing systems, including but not limited to self-regulating cable, shall include *automatic* controls that are configured to shut off the system when the outdoor temperature is above 40°F (4.4°C) and shall include one of the following:

1. A moisture sensor configured to shut off the system in the absence of moisture.
2. A daylight sensor or other means configured to shut off the system between sunset and sunrise.

**R403.9.4 Freeze protection system controls.** Freeze protection systems, such as heat tracing of outdoor piping and *heat exchangers*, including self-regulating heat tracing, shall include *automatic* controls configured to shut off the systems when outdoor air temperatures are above 40°F (4.4°C) or when the conditions of the protected fluid will prevent freezing.

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

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

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

Exceptions:

* 1. Where public health standards require 24-hour pump operation.
  2. Pumps that operate *on-site renewable energy* and waste-heat-recovery pool heating systems.

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

*approved* vapor-retardant means.

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

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

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

**R403.13 Gas fireplaces.** Gas fireplace systems shall not be equipped with a *continuous pilot* and shall be equipped with an *on- demand pilot*, *intermittent ignition* or *interrupted ignition,* as defined by ANSI Z21.20.

**Exception:** Gas-fired appliances using pilots within a *listed* combustion safety device.

**R403.13.1 Gas fireplace efficiency.** Vented gas fireplace heaters shall have a fireplace efficiency (FE) rating not less than 50 percent as determined in accordance with CSA P.4.1, and shall be *listed* and *labeled* in accordance with CSA/ANSI Z21.88. Vented gas fireplaces (decorative appliances) shall be *listed* and *labeled* in accordance with CSA/ANSI Z21.50.

SECTION R404—ELECTRICAL POWER, LIGHTING AND RENEWABLE ENERGY SYSTEMS

**R404.1 Lighting equipment.** All permanently installed luminaires shall be capable of operation with an efficacy of not less than 45 lumens per watt or shall contain lamps capable of operation with an efficacy of not less than 65 lumens per watt.

Exceptions:

* + 1. Appliance lamps.
    2. Antimicrobial lighting used for the sole purpose of disinfecting.
    3. General service lamps complying with DOE 10 CFR, Part 430.32.
    4. Luminaires with a rated electric input of not greater than 3.0 watts.

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| **TABLE R404.1—LIGHTING POWER ALLOWANCES FOR BUILDING EXTERIORS** | |
| **BASE SITE ALLOWANCE** | **280 WATTS** |
| Uncovered parking areas and drives | 0.026 W/ft2 |
| **Building grounds** | |
| Walkways and ramps | 0.50 W/linear foot |
| Plaza areas | 0.049 W/ft2 |
| Dining areas | 0.273 W/ft2 |
| Stairways | Exempt |
| Pedestrian tunnels | 0.110 W/ft2 |
| Landscaping | 0.025 W/ft2 |
| **Building entrances and exits** | |
| Pedestrian and vehicular entrances and exits | 9.8 W/linear foot of opening |
| Entry canopies | 0.126 W/ft2 |
| For SI: 1 watt per square foot = 10.76 w/m2, 1 foot = 304.8 mm. | |

**R404.1.1 Exterior lighting.** Connected exterior lighting for Group R-2, R-3 and R-4 *residential buildings* shall comply with Sections R404.1.2 through R404.1.5.

Exceptions:

* + - 1. Detached one- and two- family dwellings.
      2. Townhouses.
      3. Group R-3 *buildings* that do not contain more than two *dwelling units.*
      4. Solar-powered lamps not connected to any electrical service.
      5. Luminaires controlled by a motion sensor.
      6. Lamps and luminaires that comply with Section R404.1.

**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 R404.1.3. 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* for safety reasons.
2. Emergency lighting that is automatically off during normal operations.
3. Exit signs.
4. Specialized signal, directional and marker lighting associated with transportation.
5. Lighting for athletic playing areas.
6. Temporary lighting.
7. Lighting used to highlight features of art, public monuments and the national flag.
8. Lighting for water features and swimming pools.
9. Lighting controlled from within *sleeping units* and *dwelling units.*
10. Lighting of the exterior means of egress as required by the *International Building Code*.

**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 R404.1 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.

**R404.1.4 Additional exterior lighting power.** Additional exterior lighting power allowances shall be available for the building facades at 0.075 W/ft2 (0.807 w/m2) of gross *above-grade wall* area. These 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.

**R404.1.5 Gas lighting.** Gas-fired lighting appliances shall not be equipped with a *continuous pilot* and shall be equipped with an

*on-demand pilot*, *intermittent ignition* or *interrupted ignition* as defined by ANSI Z21.20.

**R404.2 Interior lighting controls.** All permanently installed luminaires shall be controlled as required in Sections R404.2.1 and R404.2.2.

**Exception:** Lighting controls shall not be required for safety or security lighting.

**R404.2.1 Habitable spaces.** All permanently installed luminaires in habitable spaces shall be controlled with a *manual dimmer* or with an *automatic* shutoff 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.

**R404.2.2 Specific locations.** All permanently installed luminaires in garages, unfinished basements, laundry rooms and utility rooms shall be controlled by an *automatic* shutoff 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.

**R404.3 Exterior lighting controls.** Exterior lighting controls shall comply with Section R404.3.1.

**R404.3.1 Controls for individual dwelling units.** 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 which permits *automatic* shutoff actions.
2. Lighting shall be automatically shut off when daylight is present and satisfies the lighting needs.
3. Controls that override *automatic* shutoff actions shall not be allowed unless the override automatically returns *automatic* control to its normal operation within 24 hours.

**R404.4 Renewable energy certificate (REC) documentation.** Where renewable energy generation is used to comply with this code, documentation shall be provided to the *code official* by the property owner or owner’s authorized agent demonstrating that where renewable energy certificates (RECs) or energy attributable certificates (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.

SECTION R405—SIMULATED BUILDING PERFORMANCE

**R405.1 Scope.** This section establishes criteria for compliance using *simulated building performance* analysis. Such analysis shall include heating, cooling, mechanical *ventilation* and service water-heating energy only. Such analysis shall be limited to *dwelling units*. Spaces other than *dwelling units* in Group R-2, R-3 or R-4 buildings shall comply with Sections R402 through R404.

**R405.2 Simulated building performance compliance.** Compliance based on *simulated building performance*

requires that a *building* comply with the following:

* 1. The requirements of the sections indicated within Table R405.2.
  2. The proposed total *building thermal envelope* thermal conductance (TC) shall be less than or equal to the required total *building thermal envelope* TC using the prescriptive *U*-factors and *F*-factors from Table R402.1.2 multiplied by 1.08 in Climate Zones 0, 1 and 2, and 1.15 in Climate Zones 3 through 8, in accordance with Equation 4-2 and Section R402.1.5. The area-weighted maximum fenestration SHGC permitted in Climate Zones 0 through 3 shall be 0.30.

**Equation 4-2** For Climate Zones 0–2: *TCProposed design*  1.08 × *TCPrescriptive reference design*

For Climate Zones 3–8: *TCProposed design*  1.15 × *TCPrescriptive reference design*

* 1. The site energy use of the *proposed design* shall be less than or equal to 71 percent of the site energy use of the *standard reference design*. ~~For each~~ *~~dwelling unit~~* ~~with one or more fuel-burning appliances for space heating, water heating, or both, the annual~~ *~~energy cost~~* ~~of the~~ *~~dwelling unit~~* ~~shall be less than or equal to 80 percent of the annual~~ *~~energy cost~~* ~~of the~~ *~~standard reference design~~*~~. For all other~~ *~~dwelling units~~*~~, the annual~~ *~~energy cost~~* ~~of the proposed design shall be less than or equal to 85 percent of the annual~~ *~~energy cost~~* ~~of the~~ *~~standard reference design~~*~~. For each dwelling unit with greater than 5,000 square feet (465 m~~~~2~~~~) of~~ *~~living space~~* ~~located above grade plane, the annual~~ *~~energy cost~~* ~~of the~~ *~~dwelling unit~~* ~~shall be reduced by an additional 5 percent of annual~~ *~~energy cost~~* ~~of the~~ *~~standard reference design~~*~~. Energy prices shall be taken from an~~ *~~approved~~* ~~source, such as the US 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 2.51. The source energy multipliers shall be 1.09 for natural gas, 1.15 for propane, 1.19 for fuel oil, and 1.30 for imported liquified natural gas.~~
    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.~~

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| **TABLE R405.2—REQUIREMENTS FOR SIMULATED BUILDING PERFORMANCE** | |
| **SECTIONa** | **TITLE** |
| **General** | |
| R401.3 | Certificate |
| **Building Thermal Envelope** | |
| R402.1.1 | Vapor retarder |
| R402.1.6 | Rooms containing fuel-burning appliances |
| R402.2.3 | Attic knee wall |
| R402.2.4 | Eave baffle |
| R402.2.5.1 | Access hatches and door insulation installation and retention |
| R402.2.10 | Slab-on-grade floors |
| R402.2.11 | Crawl space walls |
| R402.5.1.1 | Installation |
| R402.5.1.2 | Air leakage testing |
| R402.5.1.3 | Maximum air leakage rate |
| R402.5.2 | Fireplaces |
| R402.5.3 | Fenestration air leakage |
| R402.5.4 | Recessed lighting |
| R402.5.5 | Air-sealed electrical and communication outlet boxes |
| R402.6 | Maximum fenestration *U*-factor and SHGC |
| **Mechanical** | |
| R403.1 | Controls |
| R403.2 | Hot water boiler temperature reset |
| R403.3 | Duct systems |
| R403.4 | Mechanical system piping insulation |
| R403.5 | Service hot water systems |
| R403.6 | Mechanical ventilation |
| R403.7, except Section R403.7.1 | Equipment sizing and efficiency rating |
| R403.8 | Systems serving multiple dwelling units |
| R403.9.2 | Snow melt and ice system controls |
| R403.10 | Energy consumption of pools and spas |
| R403.11 | Portable spas |
| R403.12 | Residential pools and permanent residential spas |
| R403.13 | Gas fireplaces |
| **Electrical Power and Lighting Systems** | |
| R404.1 | Lighting equipment |
| R404.2 | Interior lighting controls |
|  |  |
| Appendices | |
| Appendix RE | Electric Vehicle Charging Infrastructure |
| Section RJ102 | Demand Responsive Heating and Cooling System |
| Appendix RK | Electric-Ready Residential Building Provisions |
| Appendix RL | Renewable Energy Infrastructure |
| a. Reference to a code section includes all the relative subsections except as indicated in the table. | |

**R405.3 Compliance documentation.** The following compliance reports, which document that the performance of the *proposed design* and the performance of the as-built *dwelling unit* comply with the requirements of Section R405, shall be submitted to the *code official*.

1. A compliance report in accordance with Section R405.5.4.1 shall be submitted with the application for the building permit.
2. A compliance report in accordance with Section R405.5.4.2 shall be submitted before a certificate of occupancy is issued.

**R405.4 Calculation procedure.** Performance calculations shall be in accordance with Sections R405.4.1 through R405.4.3. Except as specified by this section, the *standard reference design* and *proposed design* shall be configured and analyzed using identical meth- ods and techniques.

**R405.4.1 General.** Calculation procedures used to comply with Section R405 shall use a software tool, *approved* in accordance with Section R405.5, capable of calculating the annual energy consumption of all building elements that differ between the *standard reference design* and the *proposed design*.

**R405.4.2 Residence specifications.** The *standard reference design, proposed design* and as-built *dwelling unit* shall be configured and analyzed as specified by Table R405.4.2(1). Table R405.4.2(1) shall include, by reference, all notes contained in Table R402.1.3. Proposed *U*-factors and slab-on-grade *F*-factors shall be taken from Appendix RF, 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.

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| **TABLE 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 R402.1.2. | As proposed. |
| Solar reflectance = 0.25. | 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 R402.1.2, 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 R402.1.2. | As proposed. |
| Ceilings | Type: wood frame. | As proposed. |
| Gross area: same as proposed. | As proposed |
| U-factor: as specified in Table R402.1.2. | As proposed. |
| Roofs | Type: composition shingle on wood sheathing. | As proposed. |
| Gross area: same as proposed. | As proposed. |
| Solar reflectance = 0.25. | As proposed. |
| Emittance = 0.90. | As proposed. |
| Attics | Type: vented with an aperture of 1 ft2 per 300 ft2 of ceiling area. | As proposed. |
| Foundations | Type: same as proposed. | As proposed. |
| Foundation wall extension above and below grade: same as proposed. Foundation wall or slab perimeter length: same as proposed.  Soil characteristics: same as proposed. | As proposed. |
| Foundation wall U-factor and slab F-factor: as specified in Table R402.1.2. |  |
| Opaque doors | Area: 40 ft2. | As proposed. |
| Orientation: North. | As proposed. |
| U-factor: same as fenestration as specified in Table R402.1.2. | As proposed. |
| Vertical fenestration other than opaque doors | Total areah =   1. The proposed glazing area, where the proposed glazing area is less than 15 percent of the conditioned floor area. 2. 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 R402.1.2. | As proposed. |
| SHGC: as specified in Table R402.1.2 except for climate zones without an SHGC require- ment, 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. |

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| **TABLE R405.4.2(1)—SPECIFICATIONS FOR THE STANDARD REFERENCE AND PROPOSED DESIGNS—continued** | | |
| **BUILDING COMPONENT** | **STANDARD REFERENCE DESIGN** | **PROPOSED DESIGN** |
| Skylights | None | As proposed. |
| Thermally isolated sunrooms | None | As proposed. |
| Air leakage rate | For detached one-family dwellings, the air leakage rate at a pressure of 0.2 inch water gauge (50 Pa) shall be as follows:  Climate Zones 0 through 2: 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.  For detached one-family dwellings that are 1,500 ft2 or smaller and attached dwelling units or sleeping units, the air leakage rate at a pressure of 0.2 inch water gauge (50 Pa) shall be 0.27 cfm/ft2 of the testing unit enclosure area. | The measured air leakage rate.a |
| Mechanical ventilation rate | 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 × M  where:  B = 0.01 × CFA + 7.5 × (Nbr + 1), cfm.  M = 1.0 where the measured air leakage 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 measured mechanical ventilation rateb (Q)  shall be in addition to the measured air leakage rate. |
| Mechanical ventilation fan energy | 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.  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 (8.76 × B × M)/ef  where:  B and M are determined in accordance with the air exchange mechanical ventilation rate row of this table.  ef = the minimum fan efficacy, as specified in Table R403.6.2, corresponding to the system type at a flow rate of B × M. | As proposed. |
| Internal gains | IGain, in units of Btu/day per dwelling unit, shall equal 17,900 + 23.8 × CFA + 4,104 × Nbr  where:  CFA = conditioned floor area, ft2.  Nbr = 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 elementc but not integral to the building  thermal envelope or structure. |
| Structural mass | For masonry floor slabs: 80 percent of floor area covered by R-2 carpet and pad, and 20 percent of floor directly exposed to room air. | As proposed. |
| For masonry basement walls: as proposed, but with insulation as specified in Table R402.1.3, located on the interior side of the walls. | As proposed. |
| For other walls, ceilings, floors, and interior walls: wood-framed construction. | As proposed. |
| Heating systemsd, e, j, k | Fuel type/capacity: same as proposed design. | As proposed. |
| Product class: same as proposed design. | As proposed. |
| Efficiencies: |  |
| Heat pump: complying with 10 CFR §430.32. | As proposed. |
| Fuel gas and liquid fuel furnaces: complying with 10 CFR §430.32. | As proposed. |
| Fuel gas and liquid fuel boilers: complying with 10 CFR §430.32. | As proposed. |
| Cooling systemsd, f, k | Fuel type: electric.  Capacity: Same as proposed design. | As proposed. |
| Efficiencies: complying with 10 CFR §430.32. | As proposed. |

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| **TABLE R405.4.2(1)—SPECIFICATIONS FOR THE STANDARD REFERENCE AND PROPOSED DESIGNS—continued** | | | | | | | |
| **BUILDING COMPONENT** | **STANDARD REFERENCE DESIGN** | | | | **PROPOSED DESIGN** | | |
| Service water heatingd, g, k | Use, in units of gal/day = 25.5 + (8.5 × Nbr) where:  Nbr = number of bedrooms. | | | | Use, in units of gal/day = 25.5 + (8.5 × Nbr) × (1 – HWDS)  where:  Nbr = number of bedrooms. HWDS = factor for the compact- ness  of the hot water distribution system. | | |
| Compactness ratioi factor | | HWDS |
| 1 story | 2 or more stories |  |
| > 60% | > 30% | 0 |
| > 30% to  ≤ 60% | > 15% to  ≤ 30% | 0.05 |
| > 15% to  ≤ 30% | > 7.5% to  ≤ 15% | 0.10 |
| < 15% | < 7.5% | 0.15 |
| Fuel type: same as proposed design. | | | | As proposed. | | |
| Rated storage volume: same as proposed design. | | | | As proposed. | | |
| Draw pattern: same as proposed design. | | | | As proposed. | | |
| Efficiencies: Uniform Energy Factor complying with 10 CFR §430.32. | | | | As proposed. | | |
| Tank temperature: 120°F (48.9°C). | | | | Same as standard reference design. | | |
| Thermal distribution systems | Duct insulation: in accordance with Section R403.3.3. | | | | Duct insulation: as proposed.m | | |
| Duct location: | | | | Duct location: as proposed.l | | |
| Foundation type | Slab on grade | Unconditioned crawl space | Basement or condi- tioned crawl space | — | | |
| Duct location (supply and return) | One-story building: 100% in uncondi- tioned attic.  All other: 75% in unconditioned attic and 25% inside conditioned space. | One-story building: 100% in uncondi- tioned crawl space. All other: 75% in unconditioned crawl space and 25% inside condi- tioned space. | 75% inside conditioned space. 25% unconditioned attic. | 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. Where 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.   1. Where total duct system leakage is measured without space conditioning equipment installed, the simulation value shall be 4 cfm per 100 ft2 of conditioned floor area. | | |
| Duct system leakage to outside: for duct systems serving > 1,000 ft2 of conditioned floor area, the duct leakage to outside rate shall be 4 cfm per 100 ft2 of conditioned floor area.  For duct systems serving ≤ 1,000 ft2 of conditioned floor area, the duct leakage to outside rate shall be 40 cfm. | | | |
| Distribution system efficiency (DSE): for hydronic systems and ductless systems, a ther- mal DSE of 0.88 shall be applied to both the heating and cooling system efficiencies. | | | | Distribution system efficiency (DSE): for hydronic systems and ductless systems,  DSE shall be as specified in Table R405.4.2(2). | | |
| Thermostat | Type: Manual, cooling temperature setpoint = 75°F; Heating temperature setpoint = 72°F. | | | | Same as standard reference design. | | |

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| **TABLE R405.4.2(1)—SPECIFICATIONS FOR THE STANDARD REFERENCE AND PROPOSED DESIGNS—continued** | | |
| **BUILDING COMPONENT** | **STANDARD REFERENCE DESIGN** | **PROPOSED 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 m2, 1 British thermal unit = 1055 J, 1 pound per square foot = 4.88 kg/m2, 1 gallon (US) = 3.785 L, °C = (°F – 32)/1.8, 1 degree = 0.79 rad, 1 cubic foot per minute = 28.317 L/min.   1. Hourly calculations as specified in the ASHRAE *Handbook of Fundamentals,* or the equivalent, shall be used to determine the energy loads resulting from infiltration. 2. 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.   1. 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. 2. 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. 3. 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 refer- ence design and proposed design. 4. For a proposed design 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. 5. For a proposed design without a proposed water heater, the following assumptions shall be made for both the proposed design and standard reference design. For a proposed design with a heat pump water heater, the following assumptions shall be made for the standard reference design, except the fuel type shall be electric.   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 § 430.32   1. For residences with conditioned basements, R-2 and R-4 residences, and for townhouses, the following formula shall be used to determine glazing area:   *AF* = *As* × *FA* × *F*  where:  *AF* = Total glazing area.  *As* = 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.  1. 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. 2. Sources of hot water include water heaters, or in multiple-family buildings with central water heating systems, circulation loops or electric heat traced pipes. 3. The hot water rectangle shall include the source of hot water and the points of termination of all hot water fixture supply piping. 4. The hot water rectangle shall be shown on the floor plans and the area shall be computed to the nearest square foot. 5. 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. 6. The basement or attic shall be counted as a story when it contains the water heater. 7. 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 rectan- gle(s) to the area of the dwelling and identifying the appropriate compactness ratio and *HWDS* factor. 8. 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. 9. For heating systems, cooling systems, or water heating systems not included in this table, the standard reference design shall be the same as proposed design. 10. Only sections of ductwork that are installed in accordance with Section R403.3.4, Items 1 and 2 are assumed to be located completely inside conditioned space. All other sections of ductwork are not assumed to be located completely inside conditioned space. 11. Sections of ductwork installed in accordance with Section R403.3.5.1 are assumed to have an effective duct insulation *R*-value of R-25. | | |

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| **TABLE R405.4.2(2)—DEFAULT DISTRIBUTION SYSTEM EFFICIENCIES FOR PROPOSED DESIGNSa** | | |
| **DISTRIBUTION SYSTEM CONFIGURATION AND CONDITION** | **FORCED AIR SYSTEMS** | **HYDRONIC SYSTEMSb** |
| Distribution system components located in unconditioned space | NA | 0.95 |
| Distribution system components entirely located in conditioned spacec | NA | 1 |
| Ductless systemsd | 1 | NA |
| NA = Not Applicable.   1. Default values in this table are for untested distribution systems, which must still comply with Section R403. 2. Hydronic systems 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. 3. Entire system in conditioned space means that no component of the distribution system is located outside of the conditioned space. 4. Ductless systems are allowed to have forced airflow across a coil but must not have any ducted airflow external to the space conditioning equipment. | | |

**R405.4.3 Input values.** When calculations require input values not specified by Sections R402, R403, R404 and R405, those input values shall be taken from an *approved* source.

**R405.5 Calculation software tools.** Performance analysis tools meeting the applicable provisions of Sections R405.5.1 through R405.5.4 shall be permitted to be *approved*. Tools are permitted to be *approved* based on meeting a specified threshold for a jurisdic- tion. The *code official* shall be permitted to approve such tools for a specified application or limited scope.

**R405.5.1 Minimum capabilities.** *Approved* software tools 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-dwelling unit (as a single *zone*) sizing for the heating and cooling equipment in the *standard refer- ence design* residence in accordance with Section R403.7.
3. Hourly calculations of building operation for a full calendar year (8,760 hours).
4. Calculations that account for hourly variations of indoor and outdoor temperatures and part-load ratios on the perfor- mance of heating, ventilating and air-conditioning equipment based on climate and equipment sizing.

4. Printing of a *code official* inspection checklist listing each of the *proposed design* component characteristics from Table R405.4.2(1) determined by the analysis to provide compliance, along with their respective performance ratings such as *R-value*, *U-factor*, SHGC, HSPF2, AFUE, SEER2 and UEF.

**R405.5.2 Testing required by software vendors.** Prior to approval, software tools shall be tested by the software vendor in accordance with ANSI/ASHRAE 140 Class II, Tier 1 test procedures. During testing, hidden inputs that are not normally available to the user shall be permitted to avoid introducing source code changes strictly used for testing. Software vendors shall publish, on a publicly available website, the following ANSI/ASHRAE 140 test results, input files and modeler reports for each tested version of a software tool:

1. Test results demonstrating the software tool was tested in accordance with ANSI/ASHRAE 140.
2. The modeler report in ANSI/ASHRAE 140, Annex A2, Attachment A2.7.

**R405.5.3 Algorithms not tested.** Algorithms not tested in accordance with Section R405.5.2 shall be permitted in accordance with ANSI/RESNET/ICC 301. Numerical settings not tested, such as timestep duration and tolerances, shall be permitted where they represent a higher resolution than the numerical settings used for testing.

**R405.5.4 Compliance reports.** *Approved* software tools shall generate compliance reports in accordance with Sections R405.5.4.1 and R405.5.4.2.

**R405.5.4.1 Compliance report for permit application.** A compliance report generated for submission 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 to the software used to produce the results for the *standard reference design* and the

*proposed design*.

* 1. A certificate indicating that the *proposed design* complies with Section R405.2. The certificate shall document the building components’ energy specifications that are included in the calculation including: component-level insula- tion *R*-values or *U*-factors; *duct system* and *building thermal 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. Where *on-site renewable energy* systems will be installed, the certificate shall report the type and production size of the proposed system.
  2. Where a site-specific report is not generated, the *proposed design* shall be based on the worst-case orientation and configuration of the rated *dwelling unit*.

**R405.5.4.2 Compliance report for certificate of occupancy.** A compliance report generated for submission prior to obtain- ing the certificate of occupancy shall include the following:

1. Building street address, or other *building site* identification.
2. Declaration of the *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 R405.2.
4. The name and version of the compliance software tool.
5. A site-specific *energy analysis* report that is in compliance with the requirements of Section R405.4, where all inputs for the *proposed design* have been replaced in the simulation with confirmed energy features of the as-built *dwelling unit*.
6. A final confirmed certificate indicating compliance based on inspection, and a statement indicating that the as-built *building* complies with Section R405.2. The certificate shall report the energy features that were confirmed to be in the *building*, including component-level insulation *R*-*values* or *U*-*factors*; results from any required *duct system* and

*building thermal envelope* air leakage testing; and the type and rated efficiencies of the heating, cooling, mechanical

*ventilation* and service water-heating equipment installed.

1. When *on-site renewable energy* systems have been installed, the certificate shall report the type and production size of the installed system.

SECTION R406—ENERGY RATING INDEX COMPLIANCE ALTERNATIVE

**R406.1 Scope.** This section establishes criteria for compliance using an *Energy Rating Index* (ERI) analysis. Such analysis shall be limited to *dwelling units*. Spaces other than *dwelling units* in Group R-2, R-3 or R-4 buildings shall comply with Sections R402 through R404.

**R406.2 ERI compliance.** Compliance based on the *ERI* requires that the *rated design* and as-built *dwelling unit*

meet all of the following:

1. The requirements of the sections indicated within Table R406.2.
2. Maximum *ERI* values indicated in Table R406.5.

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| **TABLE R406.2—REQUIREMENTS FOR ENERGY RATING INDEX** | |
| **SECTIONa** | **TITLE** |
| **General** | |
| R401.3 | Certificate |
| **Building thermal envelope** | |
| R402.1.1 | Vapor retarder |
| R402.1.6 | Rooms containing fuel-burning appliances |
| R402.2.4 | Eave baffle |
| R402.2.5.1 | Access hatches and door insulation installation and retention |
| R402.2.10 | Slab-on-grade floors |
| R402.2.11 | Crawl space walls |
| R402.5.1.1 | Installation |
| R402.5.1.2 | Air leakage testing |
| R402.5.1.3 | Maximum air leakage rate |
| R402.5.2 | Fireplaces |
| R402.5.3 | Fenestration air leakage |
| R402.5.4 | Recessed lighting |
| R402.5.5 | Air-sealed electrical and communication outlet boxes |
| R406.3 | Building thermal envelope |
| **Mechanical** | |
| R403.1 | Controls |
| R403.2 | Hot water boiler temperature reset |
| R403.3 | Duct systems |
| R403.4 | Mechanical system piping insulation |
| R403.5 | Service hot water systems |
| R403.6 | Mechanical ventilation |
| R403.7, except Section R403.7.1 | Equipment sizing and efficiency rating |
| R403.8 | Systems serving multiple dwelling units |
| R403.9.2 | Snow melt and ice system controls |
| R403.10 | Energy consumption of pools and spas |
| R403.11 | Portable spas |
| R403.12 | Residential pools and permanent residential spas |
| R403.13 | Gas fireplaces |
| **Electrical power and lighting systems** | | |
| R404.1 | | Lighting equipment |
| R404.2 | | Interior lighting controls |
| Appendices | |
| Appendix RE | Electric Vehicle Charging Infrastructure |
| Section RJ102 | Demand Responsive Heating and Cooling System |
| Appendix RK | Electric-Ready Residential Building Provisions |
| Appendix RL | Renewable Energy Infrastructure |
| a. Reference to a code section includes all of the relative subsections except as indicated in the table. | |

**R406.3 Building thermal envelope.** The proposed total *building thermal envelope* thermal conductance (TC) shall be less than or equal to the required total *building thermal envelope* TC using the prescriptive *U*-factors and *F*-factors from Table R402.1.2 multiplied by 1.08 in Climate Zones 0, 1 and 2, and by 1.15 in Climates Zones 3 through 8, in accordance with Equation 4-2 and Section R402.1.5. The area-weighted maximum fenestration SHGC permitted in Climate Zones 0 through 3 shall be 0.30.

**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.

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*.

**R406.5 ERI-based compliance.** Compliance based on an *ERI* analysis requires that the *rated design* and each confirmed as-built *dwelling unit* be shown to have an *ERI* less than or equal to the appropriate value indicated in Table R406.5 where compared to the *ERI reference design* as follows:

1. Where on-site renewables are not installed, the values under ENERGY RATING INDEX NOT INCLUDING OPP apply.
2. Where on-site renewables are installed, the values under ENERGY RATING INDEX WITH OPP apply.

Exceptions:

* 1. ~~Where the~~ *~~ERI~~* ~~analysis excludes on-site power production (OPP), the values under ENERGY RATING INDEX NOT INCLUD- ING OPP shall be permitted to be applied.~~
  2. For buildings with 20 or more *dwelling units*, where *approved* by the *code official*, compliance shall be permitted using the Average Dwelling Unit *Energy Rating Index*, as calculated in accordance with ANSI/RESNET/ICC 301.

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| **TABLE R406.5—MAXIMUM ENERGY RATING INDEX** | | |
| **CLIMATE ZONE** | **~~ENERGY RATING INDEX NOT INCLUDING OPP~~**  **Energy Rating Index Without Combustion Equipmenta** | **~~ENERGY RATING INDEX WITH OPP~~**  **Energy Rating Index With Combustion Equipmentb** |
| ~~0 and 1~~ | ~~51~~ | ~~35~~ |
| ~~2~~ | ~~51~~ | ~~34~~ |
| ~~3~~ | ~~50~~ | ~~33~~ |
| 4 | ~~53~~ 54 | ~~40~~ 51 |
| 5 | ~~54~~ 55 | ~~43~~ 50 |
| ~~6~~ | ~~53~~ | ~~43~~ |
| ~~7~~ | ~~52~~ | ~~46~~ |
| ~~8~~ | ~~52~~ | ~~46~~ |

1. Any building that contains no *combustion equipment*.
2. Any building that contains *combustion equipment.*

**R406.6 Verification by approved agency.** Verification of compliance with Section R406 as outlined in Sections R406.5 and R406.7 shall be completed by an *approved* third party. Verification of compliance with Section R406.2 shall be completed by the authority having jurisdiction or an *approved* third-party inspection agency in accordance with Section R107.4.

**R406.7 Documentation.** Documentation of the software used to determine the *ERI* and the parameters for the *ERI reference design*

shall be in accordance with Sections R406.7.1 through R406.7.4.

**R406.7.1 Compliance software tools.** Software tools used for determining *ERI* shall be a*pproved* software rating tools as defined by ANSI/RESNET/ICC 301. Software vendors shall publish, on a publicly available website, documentation that the software tool has been validated using the Class II, Tier 1 test procedure in ANSI/ASHRAE 140.

**R406.7.2 Compliance report.** Compliance software tools shall generate a report that documents that the *ERI* of the *rated design* and as-built *dwelling unit* complies with Sections R406.2 through R406.5. 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 as- built *dwelling unit* shall be created and submitted to the *code official* for review before a certificate of occupancy is issued. Compli- ance reports shall include information in accordance with Sections R406.7.2.1 and R406.7.2.2.

**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. Declare *ERI* on title page and 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 *ERI reference design* and the

*rated design*.

* + 1. A certificate indicating that the proposed design has an *ERI* less than or equal to the appropriate score indicated in Table R406.5 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 thermal 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. Where *on- site renewable energy* systems will be installed, the certificate shall report the type and production size of the proposed system.
    2. When a site-specific report is not generated, the proposed design shall be based on the worst-case orientation and configuration of the rated *dwelling unit*.

**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 title page and on 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 *ERI reference design* and the as-built *dwelling unit*.
6. A final confirmed certificate indicating that the as-built *building* complies with Sections R406.2, R406.4 and R406.5. The certificate shall report the energy features that were confirmed to be in the *building*, including: component-level insulation *R*-*values* or *U*-*factors*; results from any required *duct system* and *building thermal envelope* air leakage test- ing; 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 *building*, the certificate shall report the type and production size of the installed system.

**R406.7.3 Renewable energy certificate (REC) documentation.** Where renewable energy power production is included in the calculation of an *ERI*, documentation shall comply with Section R404.4.

**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*.

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

**R406.7.6 Input values.** Where calculations require input values not specified by Sections R402, R403, R404 and R405, those input values shall be taken from ANSI/RESNET/ICC 301.

SECTION R407 —TROPICAL CLIMATE REGION COMPLIANCE PATH

**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.

**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 *low slope* roof surface complies with one of the options in Table R407.2 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 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.

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| **TABLE R407.2—MINIMUM LOW SLOPE ROOF REFLECTANCE AND EMITTANCE OPTIONSa** |
| **OPTIONS** |
| 3-year-aged solar reflectanceb of 0.55 and 3-year-aged thermal emittancec of 0.75 |
| 3-year-aged solar reflectance indexd of 64 |
| 1. The use of area-weighted averages to comply with these requirements shall be permitted. Materials lacking 3-year-aged tested values for either solar reflectance or thermal emittance shall be assigned both a 3-year-aged solar reflectance in accordance with Section R408.2.1.3.1and a 3-year-aged thermal emittance of 0.90. 2. Aged solar reflectance tested in accordance with ASTM C1549, ASTM E903, ASTM E1918 or CRRC S100. 3. Aged thermal emittance tested in accordance with ASTM C1371, ASTM E408 or CRRC S100. 4. Solar reflectance index (SRI) shall be determined in accordance with ASTM E1980 using a convection coefficient of 2.1 Btu/h × ft2 × °F (12 W/m2 × K). Calculation of aged SRI shall be based on aged-tested values of solar reflectance and thermal emittance. |

SECTION R408—ADDITIONAL EFFICIENCY REQUIREMENTS

**R408.1 Scope.** This section provides additional efficiency measures and credits required to comply with Section R401.2.1.   Buildings shall comply with either Section R408.2 or Section R408.3.

**R408.2 Additional energy efficiency credit requirements.** Residential buildings shall earn not less than ~~10~~ 30credits from ~~not less than two~~ measures specified in Table R408.2. Five additional credits shall be earned for *dwelling units* with more than 5,000 square feet (465 m2) of *living space* located above *grade plane*. To earn credit as specified in Table R408.2 for the applicable *climate zone*, each measure selected for compliance shall comply with the applicable subsections of Section R408 and receive credit as specified in Table R408.2 for the specific Climate Zone. Each *dwelling unit* or *sleeping unit* shall comply with the selected measure to earn credit. Interpolation of credits between measures shall not be permitted.

**RESIDENTIAL ENERGY EFFICIENCY**

**2024 INTERNATIONAL ENERGY CONSERVATION CODE®**

**341**

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| **TABLE R408.2—CREDITS FOR ADDITIONAL ENERGY EFFICIENCY** | | | | | | | | | | |
| **MEASURE NUMBER** | **MEASURE DESCRIPTION** | **CREDIT VALUE** | | | | | | | | |
| **Climate Zones 0 & 1** | **Climate Zone 2** | **Climate Zone 3** | **Climate Zone 4 Except Marine** | **Climate Zone 4 Marine** | **Climate Zone 5** | **Climate Zone 6** | **Climate Zone 7** | **Climate Zone 8** |
| R408.2.1.1(1) | ≥ 2.5% Reduction in total TC | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 |
| R408.2.1.1(2) | ≥ 5% reduction in total TC | 0 | 1 | 1 | 2 | 1 | 2 | 2 | 2 | 2 |
| R408.2.1.1(3) | > 7.5% reduction in total TC | 0 | 1 | 2 | 2 | 2 | 2 | 3 | 3 | 3 |
| R408.2.1.1(4) | > 10% reduction in total TC | 1 | 1 | 2 | 3 | 3 | 4 | 4 | 5 | 5 |
| R408.2.1.1(5) | > 15% reduction in total TC | 1 | 2 | 2 | 4 | 4 | 5 | 6 | 7 | 8 |
| R408.2.1.1(6) | > 20% reduction in total TC | 2 | 4 | 4 | 5 | 6 | 7 | 8 | 9 | 11 |
| R408.2.1.1(7) | > 30% reduction in total TC | 3 | 6 | 6 | 8 | 8 | 11 | 12 | 13 | 16 |
| R408.2.1.2(1) | *U*-factor and SHGC for vertical fenestration per Table R408.2.1.2 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 1 |
| R408.2.1.3(1) | Roof solar reflectance index (roof is part of the building thermal envelope and directly above cooled, conditioned space) | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| R408.2.1.3(2) | Roof solar reflectance index (roof is above an uncondi- tioned space that contains a duct system) | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| R408.2.1.4 | Reduced air leakage | 1 | 1 | 1 | 2 | 1 | 3 | NA | NA | NA |
| R408.2.2(1)b | Ground source heat pump | 14 | 14 | 14 | 15 | 10 | 15 | 17 | 18 | 21 |
| R408.2.2 (15) | High-performance gas heat pump space heating system (Option 1) |  |  |  | 8 |  | 11 |  |  |  |
| R408.2.2 (16) | High-performance gas heat pump space heating system (Option 2) |  |  |  | 11 |  | 16 |  |  |  |
| R408.2.2(2)b | High Performance Cooling (Option 1) | 5 | 4 | 3 | 2 | 1 | 1 | 1 | 1 | 1 |
| R408.2.2(3)b | High Performance Cooling (Option 2) | 6 | 4 | 3 | 2 | 1 | 1 | 1 | 1 | 1 |
| R408.2.2(4)b | High Performance Gas furnace (Option 1) | 0 | 1 | 2 | 5 | 3 | 6 | 7 | 7 | 9 |
| R408.2.2(5)b | High Performance Gas furnace (Option 2) | 0 | 1 | 2 | 4 | 3 | 5 | 6 | 7 | 8 |
| R408.2.2(6)b | High Performance Gas furnace (Option 3) | 0 | 1 | 1 | NA | NA | NA | NA | NA | NA |
| R408.2.2(7)b | High Performance Gas furnace and cooling (Option 1) | 5 | 5 | 4 | NA | NA | NA | NA | NA | NA |
| R408.2.2(8)b | High Performance Gas furnace and cooling (Option 2) | 6 | 5 | 5 | NA | NA | NA | NA | NA | NA |
| R408.2.2(9)b | High Performance Gas furnace and heat pump (Option 1) | 15 | 13 | 11 | NAe | NA | NA | NA | NA | NA |
| R408.2.2(10)b | High Performance Electric Heat pump with electric resistance backup (Option 1) | 13 | 12 | 11 | 12 | NA | NA | NA | NA | NA |
| R408.2.2(11)b | High Performance Gas furnace and cooling (Option 3) | NA | NA | NA | 5 | 4 | 6 | 7 | 7 | 9 |
| R408.2.2(12)b | High Performance Gas furnace and cooling (Option 4) | NA | NA | NA | 6 | 5 | 7 | 8 | 8 | 10 |
| R408.2.2(13)b | High Performance Gas furnace and heat pump (Option 2) | NA | NA | NA | 12 | 8 | 11 | 11 | 12 | 12 |
| R408.2.2(14)b | High Performance Electric Heat pump with electric resistance backup (Option 2) | NA | NA | NA | 12 | 8 | 12 | 13 | 14 | 16 |
| R408.2.3(1)(a)d | Gas-fired storage water heaters (Option 1) | 8 | 7 | 7 | 5 | 6 | 4 | 4 | 3 | 2 |

**RESIDENTIAL ENERGY EFFICIENCY**

**342**

**2024 INTERNATIONAL ENERGY CONSERVATION CODE®**

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| TABLE R408.2—CREDITS FOR ADDITIONAL ENERGY EFFICIENCY—continued | | | | | | | | | | |
| **MEASURE NUMBER** | **MEASURE DESCRIPTION** | **CREDIT VALUE** | | | | | | | | |
| **Climate Zones 0 & 1** | **Climate Zone 2** | **Climate Zone 3** | **Climate Zone 4 Except Marine** | **Climate Zone 4 Marine** | **Climate Zone 5** | **Climate Zone 6** | **Climate Zone 7** | **Climate Zone 8** |
| R408.2.3(1)(b)d | Gas-fired storage water heaters (Option 2) | 9 | 8 | 8 | 6 | 7 | 5 | 4 | 4 | 3 |
| R408.2.3(2)(a)d | Gas-fired instantaneous water heaters (Option 1) | 10 | 9 | 9 | 6 | 7 | 5 | 5 | 4 | 3 |
| R408.2.3(2)(b)d | Gas-fired instantaneous water heaters (Option 2) | 11 | 10 | 9 | 6 | 7 | 6 | 5 | 4 | 3 |
| R408.2.3(3)d | Electric water heaters (Option 1) | 10 | 9 | 9 | 7 | 6 | 4 | 3 | 3 | 2 |
| R408.2.3(4)d | Electric water heaters (Option 2) | 8 | 8 | 8 | 6 | 5 | 4 | 3 | 3 | 2 |
| R408.2.3(5)(a)d | Electric water heaters (Option 3) | 7 | 8 | 8 | 6 | 7 | 5 | 4 | 3 | 3 |
| R408.2.3(5)(b)d | Electric water heaters (Option 4) | 8 | 9 | 10 | 7 | 8 | 5 | 5 | 4 | 3 |
| R408.2.3(6)d | Electric water heaters (Option 5) | 10 | 9 | 9 | 7 | 6 | 4 | 3 | 3 | 2 |
| R408.2.3(7)(a)d | Solar hot water heating system (Option 1) | 13 | 13 | 13 | 9 | 8 | 5 | 4 | 4 | 3 |
| R408.2.3(7)(b)d | Solar hot water heating system (Option 2) | 10 | 9 | 9 | 6 | 7 | 6 | 5 | 4 | 3 |
| R408.2.3(8)c | Compact hot water distribution | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| R408.2.4(1)c | Ductless or hydronic thermal distribution | 3 | 4 | 5 | 7 | 8 | 10 | 10 | 10 | 14 |
| R408.2.4(2)c | 100% of duct systems in conditioned space | 2 | 3 | 4 | 6 | 7 | 9 | 9 | 9 | 13 |
| R408.2.4(3)c | ≥ 80% of ductwork inside conditioned space | 2 | 3 | 3 | 5 | 6 | 7 | 7 | 7 | 9 |
| R408.2.4(4)c | Reduced total duct system leakage | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 |
| R408.2.5(1)c | ERV or HRV installed | 0 | 0 | 0 | 0 | 1 | 3 | 2 | 2 | 2 |
| R408.2.5(2)c | ≤ 2.0 ACH50 with ERV or HRV installed | 0 | 0 | 0 | 4 | 4 | 8 | 5 | 5 | 5 |
| R408.2.5(3)c | ≤ 2.0 ACH50 with a balanced ventilation system | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 4 | 4 |
| R408.2.5(4)c | ≤ 1.5 ACH50 with ERV or HRV installed | 0 | 0 | 0 | 6 | 5 | 10 | 9 | 9 | 9 |
| R408.2.5(5)c | ≤ 1.0 ACH50 with ERV or HRV installed | 0 | 0 | 1 | 7 | 6 | 12 | 12 | 12 | 12 |
| R408.2.6a | Energy efficient appliances | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 |
| R408.2.7 | On-site renewable energy measures | 17 | 16 | 17 | 11 | 11 | 9 | 8 | 7 | 4 |
| ~~R408.2.8c~~ | ~~Demand responsive thermostat~~ | ~~1~~ | ~~1~~ | ~~1~~ | ~~1~~ | ~~1~~ | ~~1~~ | ~~1~~ | ~~1~~ | ~~1~~ |
| R408.2.10 | Whole-home lighting control | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| R408.2.11 | Higher efficacy lighting | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NA = Not Applicable.  Where the measure is selected, each dwelling unit, sleeping unit and common area where the measure is applicable must have the measure installed.  Where multiple heating or cooling systems are installed, credits shall be determined using a weighted average of the square footage served by each system.  Where the measure is selected, each dwelling unit and sleeping unit must comply with the measure.  Where the measure is selected, each dwelling unit shall be served by a water heater meeting the applicable requirements. Where multiple service water heating systems are installed, credits shall be determined using a weighted aver- age of the square footage served by each system.  Eleven credits are available for Climate Zone 4 where the following measure is used: gas furnace and heat pump (Option 3): greater than or equal to 95% AFUE fuel gas furnace and 7.8 HSPF2, 15.2 SEER2 and 10.0 EER2 air source heat pump. | | | | | | | | | | |

**R408.2.1 Enhanced building thermal envelope options.** The *building thermal envelope* shall comply with one or more of the following:

1. Section R408.2.1.1 or R408.2.1.2. Credit shall be permitted from only one measure.
2. Section R408.2.1.3.
3. Section R408.2.1.4.

**R408.2.1.1 Enhanced building thermal envelope performance.** The total *building thermal envelope* thermal conductance (TC) shall be calculated for the proposed building in accordance with Section R402.1.5 and shall be reduced by not less than the percentage indicated in Table R408.2 in comparison to the reference building.

**R408.2.1.2 Improved fenestration.** The area-weighted average *U-factor* and SHGC of all vertical *fenestration* shall be equal to or less than the values specified in Table R408.2.1.2.

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| **TABLE R408.2.1.2—IMPROVED FENESTRATION** | | |
| **CLIMATE ZONE** | ***U*-FACTOR** | **SHGC** |
| 0 | 0.32 | 0.23 |
| 1 | 0.32 | 0.23 |
| 2 | 0.30 | 0.23 |
| 3 | 0.28 | 0.23 |
| 4 except Marine 4 | 0.25 | 0.40 |
| 5 and Marine 4 | 0.25 | NR |
| 6 | 0.25 | NR |
| 7 and 8 | 0.25 | NR |
| NR = No Requirement. | | |

**R408.2.1.3 Roof solar reflectance index.** *Low slope* roofs in Climate Zones 0 through 2 shall earn credit for Table R408.2 measure numbers R408.2.1.3(1) and R408.2.1.3(2) where the 3-year-aged solar reflectance index (SRI) is greater than or equal to 75. To earn credit, not less than 95 percent of the roof area shall comply. The combined area of the following portions of roof shall not be greater than 5 percent of the roof area:

* 1. Portions that include or are covered by the following:
     1. Photovoltaic systems or components.
     2. Solar air or water-heating systems or components.
     3. Vegetative roofs or landscaped roofs.
     4. Above-roof decks or walkways.
     5. Skylights.
     6. HVAC systems and components, and other opaque objects mounted above the roof.
  2. Portions shaded during the peak sun angle on the summer solstice by permanent features of the *building*, permanent features of adjacent buildings or natural objects.
  3. Portions that are ballasted with a minimum stone ballast of 17 pounds per square foot (psf) (74 kg/m2) or 23 psf (117 kg/m2) pavers.

The 3-year-aged SRI shall be determined in accordance with ASTM E1980 using a convection coefficient of 2.1 Btu/h × ft2 × °F (12 W/m2 × K). Calculation of aged SRI shall be based on 3-year-aged solar reflectance values tested in accordance with ASTM C1549, ASTM E903, ASTM E1918 or CRRC S100 and 3-year-aged thermal *emittance* values tested in accordance with ASTM C1371, ASTM E408 or CRRC S100.

**R408.2.1.3.1 Aged solar reflectance.** Where a tested 3-year-aged solar reflectance value is not available, an assigned value shall be determined in accordance with Equation 4-3.

**Equation 4-3** *Raged* = [0.2 + 0.7(*Rinitial* – 0.2)] where:

*Raged* = The aged solar reflectance.

*Rinitial* = The initial solar reflectance determined in accordance with ASTM C1549, ASTM E903, ASTM E1918 or CRRC S100.

**R408.2.1.4 Reduced air leakage.** The *building* shall have a measured air leakage rate not less than 2.0 ACH50 and not greater than 2.5 ACH50 or the *dwelling units* in the *building* shall have an average measured air leakage rate not greater than 0.24 cubic feet per minute per square foot [1.2 L/(s × m2)].

**R408.2.2 More efficient HVAC equipment performance options.** Heating and cooling *equipment* shall meet one of the following measures as applicable for the *climate zone* where heating and cooling efficiencies are represented by Annual Fuel Utilization Efficiency (AFUE), Coefficient of Performance (COP), Energy Efficiency Ratio (EER and EER2), Heating Season Performance Factor (HSPF2) and Seasonal Energy Efficiency Ratio (SEER2). Where multiple heating or cooling systems are installed serving different *zones*, credits shall be earned based on the weighted average of square footage of the *zone* served by the system.

HVAC options applicable to all *climate zones*:

1. Ground source heat pump: Greater than or equal to 16.1 EER and 3.1 COP ground source heat pump.
2. Cooling (Option 1): Greater than or equal to 15.2 SEER2 and 12.0 EER2 air conditioner.
3. Cooling (Option 2): Greater than or equal to 16.0 SEER2 and 12.0 EER2 air conditioner.
4. Gas furnace (Option 1): Greater than or equal to 97 percent AFUE *fuel gas* furnace.
5. Gas furnace (Option 2): Greater than or equal to 95 percent AFUE *fuel gas* furnace. HVAC options applicable to Climate Zones 0, 1, 2 and 3:
6. Gas furnace (Option 3): Greater than or equal to 90 percent AFUE *fuel gas* furnace.
7. Gas furnace and cooling (Option 1): Greater than or equal to 90 percent AFUE *fuel gas* furnace and 15.2 SEER2 and 10.0 EER2 air conditioner.
8. Gas furnace and cooling (Option 2): Greater than or equal to 95 percent AFUE *fuel gas* furnace and 16.0 SEER2 and 10.0 EER2 air conditioner.
9. Gas furnace and heat pump (Option 1): Greater than or equal to 90 percent AFUE *fuel gas* furnace and 7.8 HSPF2, 15.2 SEER2 and 10.0 EER2 air source heat pump.
10. Heat pump (Option 1): Greater than or equal to 7.8 HSPF2, 15.2 SEER2, and 11.7 EER2 air source heat pump. HVAC options applicable to Climate Zones 4, 5, 6, 7 and 8:
11. Gas furnace and cooling (Option 3): Greater than or equal to 95 percent AFUE *fuel gas* furnace and 15.2 SEER2 and 12.0 EER2 air conditioner.
12. Gas furnace and cooling (Option 4): Greater than or equal to 97 percent AFUE *fuel gas* furnace and 16.0 SEER2 and 12.0 EER2 air conditioner.
13. Gas furnace and heat pump (Option 2): Greater than or equal to 95 percent AFUE *fuel gas* furnace and 8.1 HSPF2 and 15.2 SEER2 air source heat pump capable of meeting a capacity ratio ≥ 70 percent of heating capacity at 5°F (-15°C) versus rated heating capacity at 47°F (8.3°C).
14. Heat pump (Option 2): Greater than or equal to 8.1 HSPF2 and 15.2 SEER2 air source heat pump capable of meeting a capacity ratio ≥ 70 percent of heating capacity at 5°F (-15°C) versus rated heating capacity at 47°F (8.3°C).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.
15. Greater than or equal to 120 AFUE gas heat pump space heating system. The gas heat pump space heating system shall not be configured to provide cooling.
16. Greater than or equal to 140 AFUE gas heat pump space heating system. The gas heat pump space heating system shall not be configured to provide cooling.
17. 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. In Climate Zone 5A, air-source heat pumps shall meet the following requirements for cold climate heat pumps:

15.1 OP at 5°F (-15°C) ≥ 1.75

15.2 Percent of heating capacity at 5°F (-15°C) ≥ 70% of that at 47°F (8.34°C)

**R408.2.2.1 More efficient HVAC equipment for Climate Zone 4.** For Climate Zone 4, the following HVAC options shall also apply:

* 1. Gas furnace and heat pump (Option 3): Greater than or equal to 95 percent AFUE *fuel gas* furnace and 7.8 HSPF2, 15.2 SEER2 and 10.0 EER2 air source heat pump.
  2. Heat pump (Option 1): Greater than or equal to 7.8 HSPF2, 15.2 SEER2 and 11.7 EER2 air source heat pump.

**R408.2.3 Reduced energy use in service water-heating options.** For measure numbers R408.3.3(1) through R408.3.3(7), the installed hot water system shall meet one of the Uniform Energy Factors (UEF) or Solar Uniform Energy Factors (SUEF) in Table R408.2.3. For measure number R408.2.3(8), the hot water distribution system shall comply with Section R408.2.3.1.

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| **TABLE R408.2.3—SERVICE WATER HEATING EFFICIENCIES** | | | | |
| **MEASURE NUMBER** | **WATER HEATER** | **SIZE AND DRAW PATTERN** | **TYPE** | **EFFICIENCY** |
| R408.2.3(1)(a) | Gas-fired storage water heaters (Option 1) | All storage volumes, all draw patterns | — | UEF ≥ 0.81 |
| R408.2.3(1)(b) | Gas-fired storage water heaters (Option 2) | ≤ 55 gallons, high | — | UEF ≥ 0.86 |
| > 55 gallons, medium or high | — | UEF ≥ 0.86 |
| Rated input capacity > 75,000 Btu/h | — | UEF ≥ 0.86 or Et ≥ 94% |
| R408.2.3(2)(a) | Gas-fired instantaneous water heaters (Option 1) | All storage volumes, medium or high | — | UEF ≥ 0.92 |
| R408.2.3(2)(b) | Gas-fired instantaneous water heaters (Option 2) | All storage volumes, medium or high | — | UEF ≥ 0.95 |
| R408.2.3(3) | Electric water heaters (Option 1) | All storage volumes, low, medium, or high | Integrated HPWH | UEF ≥ 3.30 |
| R408.2.3(4) | Electric water heaters (Option 2) | All storage volumes, low, medium, or high | Integrated HPWH, 120 volt/15 amp circuit | UEF ≥ 2.20 |
| R408.2.3(5)(a) | Electric water heaters (Option 3) | All storage volumes, low, medium, or high | Split-system HPWH | UEF ≥ 2.20 |
| R408.2.3(5)(b) | Electric water heaters (Option 4) | All storage volumes, low, medium, or high | Split-system HPWH | UEF ≥ 3.75 |
| R408.2.3(6) | Electric water heaters (Option 5) | Rated input capacity > 12 kW | — | COP ≥ 3.00 |
| R408.2.3(7)(a) | Solar water heaters (Option 1) | All storage volumes, all draw patterns | Electric backup | SUEF ≥ 3.00 |
| R408.2.3(7)(b) | Solar water heaters (Option 2) | All storage volumes, all draw patterns | Gas backup | SUEF ≥ 1.80 |
| For SI: 1 British thermal unit per hour = 0.2931 W.  UEF = Uniform Energy Factor, Et = Thermal Efficiency, COP = Coefficient of Performance. | | | | |

**R408.2.3.1 Compact hot water distribution system option.** The pipe shall store not more than 16 ounces (0.47 L) of water between the nearest source of heated water and the termination of the fixture supply pipe when calculated using Section R408.2.3.1.1. Where the source of heated water is a circulation loop, the loop shall be primed with a *demand recirculation water system* that complies with Section R403.5.1.1.1. There shall be a dedicated return line for the loop that begins after the branch to the last fixture on the supply portion of the loop and runs back to the water heater.

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| **TABLE R408.2.3.1—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 | 5.17 | 4.43 | 5.53 | 4.57 | 3.91 | 5.56 | 3.91 |
| 11/4 | 8.70 | 8.36 | 8.09 | 6.61 | 9.66 | 8.24 | 5.81 | 8.49 | 5.81 |
| 11/2 | 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 = 0.030 L, 1 ounce per square foot = 305.15 g/m2. N/A = Not Available. | | | | | | | | | |

**R408.2.3.1.1 Water volume determination.** The water volume in the piping between a source of heated water and the termination of a fixture supply shall be calculated in accordance with this section. 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 manifolds 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 R408.2.3.3.1. The volume contained within fixture shutoff valves, within flexible water supply 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.

**R408.2.3.2 Water volume documentation.** Where compliance with Section R408.2.3(5) is required, construction documentation or final field inspection shall verify that the compact hot water distribution system meets the prescribed limit in Section R408.2.3(5) with one of the following:

1. Referencing ounces of water per foot of tube on plans as per Table R408.2.3.1.
2. Referencing ounces of water per foot of tube installed as per Table R408.2.3.1.
3. In accordance with Department of Energy's Zero Energy Ready Home National Specification (Rev. 07 or higher) footnote on Hot water delivery systems.

**R408.2.4 More efficient thermal distribution system options.** The thermal distribution system shall comply with one of the following:

* + 1. The ductless thermal distribution system or hydronic thermal distribution system is located completely on the conditioned side of the *building thermal envelope*.
    2. The *space conditioning equipment* is located inside *conditioned space*. In addition, 100 percent of the *ductwork* is located completely inside *conditioned space* as defined by Section R402.3.4, Items 1 and 2.
    3. The *space conditioning equipment* is located inside *conditioned space* and not less than 80 percent of *ductwork* is located completely inside *conditioned space* as defined by Section R402.3.4, Items 1 and 2. In addition, not more than 20 percent of *ductwork* is contained within building assemblies separating unconditioned from *conditioned space* as defined by Section R402.3.4, Item 3.
    4. Where *ductwork* is located outside conditioned space, the total leakage of the *duct system* measured in accordance with Section R402.3.7 is one of the following:
       1. Where the *space conditioning equipment* is installed at the time of testing, total leakage is not greater than 2.0 cubic feet per minute (0.94 L/s) per 100 square feet (9.29 m2) of *conditioned floor area*.
       2. Where the 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 ) of conditioned floor area. Where the *space conditioning equipment* is not installed at the time of testing, total leakage is not greater than 1.75 cubic feet per minute (0.83 L/s) per 100 square feet (9.29 m2) of *conditioned floor area*.

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

1. ~~Either an Energy Recovery Ventilator (ERV) or a Heat Recovery Ventilator (HRV) installed.~~

~~2.~~ 1 Less than or equal to 2.0 ACH50, with either an ERV or HRV installed.

~~3.~~ 2 Less than or equal to 2.0 ACH50, with a *balanced ventilation system*.

~~4.~~ 3 Less than or equal to 1.5 ACH50, with either an ERV or HRV installed.

~~5.~~ 4 Less than or equal to 1.0 ACH50, with either an ERV or HRV installed.

In addition, for measures requiring either an ERV or HRV, HRV and ERV Sensible Recovery Efficiency (SRE) shall be not less than 75 percent at 32°F (0°C) at the lowest *listed* net airflow. ERV Latent Recovery/Moisture Transfer (LRMT) shall be not less than 50 percent at the lowest *listed* net airflow. In Climate Zone 8, recirculation shall not be used as a defrost strategy.

**R408.2.6 Energy efficient appliances.** Each appliance of a type listed in Table R408.26 installed in a residential *building* shall comply with the efficiency requirements specified in that table. Each appliance specified in Table R408.2.6 shall be installed. A clothes washer shall be installed at each location plumbed for a clothes washer.

**Exception:** In *dwelling units* of Group R-2 occupancies where a dishwasher is not installed in each unit, not fewer than two appliance types complying with Table R408.2.6 shall be installed.

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| **TABLE R408.2.6—MINIMUM EFFICIENCY REQUIREMENTS: APPLIANCES** | | |
| **APPLIANCE TYPES** | **EFFICIENCY IMPROVEMENT** | **TEST PROCEDURE** |
| Refrigerator | Maximum Annual Energy Consumption (AEC), not greater than 620 kWh/yr | 10 CFR 430, Subpart B, Appendix A |
| Dishwasher | Maximum Annual Energy Consumption (AEC), not greater than 240 kWh/yr | 10 CFR 430, Subpart B, Appendix C1 |
| Clothes washer and clothes dryer | Clothes washer located within dwelling units:  Maximum Annual Energy Consumption (AEC), not greater than 130 kWh/yr, and Integrated Modified Energy Factor (IMEF) > 1.84 cu ft/kWh/cycle  Clothes washer not located within dwelling units and where dwelling units are not provided with rough-in plumbing for washers:  Modified Energy Factor (MEF) > 2.0 cu ft/kWh/cycle | 10 CFR 430, Subpart B, Appendices D1, D2 and J2 |
| For SI: 1 cubic foot per kilowatt hour per cycle = 0.028 m3/kWh/cycle. | | |

**R408.2.7 Renewable energy.** *Renewable energy resources* shall be permanently installed and have the rated capacity to produce not less than 1.0 watt of *on-site renewable energy* per square foot of *conditioned floor area*. To qualify for this option, *renewable energy certificate* (REC) documentation shall meet the requirements of Section R404.4.

**R408.2.8 Reserved. ~~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 R408.2.8.1. Thermostats controlling variable capacity systems shall comply with Section R408.2.8.2. Thermostats controlling multistage HVAC systems shall comply with either Section R408.2.8.1 or R408.2.8.2. Where a~~ *~~demand response signal~~* ~~is not available, the~~ *~~thermostat~~* ~~shall be capable of performing all other functions.~~

**~~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, Conformance.~~
  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. ~~The communication protocol required by a controlling entity, such as a utility or service provider, to participate in an automated demand response program.~~
  6. ~~The physical configuration and communication protocol of CTA 2045-A or CTA-2045-B.~~

**~~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 perfor- mance requirements of AHRI 1380.~~

**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-framed 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 Section R408.2.2.
2. All installed water heaters are heat pumps that meet one of the efficiencies in Section R408.2.3.
3. In addition to the number of credits required by Section R408.2, three additional credits are achieved.
4. *Renewable energy resources* are installed to meet the requirements of Section R408.2.7.

**R408.2.10 Whole-home lighting control.** The *dwelling unit* shall have a *manual* control by the main entrance that turns off all the permanently installed interior lighting or a lighting control system that has the capability to turn off all permanently installed interior lighting from remote locations.

Exceptions:

* 1. Up to 5 percent of the total lighting power may remain uncontrolled.
  2. Spaces where lighting is controlled by a count-down timer or *occupant sensor control*.

**R408.2.11 Higher efficacy lighting.** All spaces shall be provided with hardwired lighting with a lamp efficacy of 90 lumens per watt (lm/W) or a luminaire efficacy of 55 lm/W.

Exceptions:

1. Closets.
2. Other storage spaces.

**R408.3. Heat pump equipment and air tightness option.** Buildings shall comply with all of the following:

1. Heating and cooling equipment shall be electric heat pump equipment. In Climate Zone 5A, air-source heat pumps shall meet the following requirements for cold climate heat pumps:
   1. COP at 5°F (-15°C) ≥ 1.75
   2. Percent of heating capacity at 5°F (-15°C) ≥ 70% of that at 47°F (8.34°C)
2. Water heating equipment shall be a heat pump water heater.
3. The measured air leakage shall be less than or equal to 2.0 ACH50 with either an Energy Recovery Ventilator (ERV) or Heat Recovery Ventilator (HRV) with a sensible heat recovery efficiency (SRE) no less than 70 percent at 32°F (0°C) at an airflow greater than or equal to design airflow. The SRE shall be determined from a listed value or from interpolation of listed values. Construction documents shall include documentation of the SRE.

### EXISTING BUILDINGS



CHAPTER

**5**[RE]

*User notes:*

***About this chapter:*** *Many buildings are renovated or altered in numerous ways that could affect the energy use of the building as a whole. Chapter 5 requires the application of certain parts of Chapter 4 in order to maintain, if not improve, the conservation of energy by the renovated or altered building.*

SECTION R501—GENERAL

**R501.1 Scope.** The provisions of this chapter shall control the *alteration*, *repair*, *addition* and change of occupancy of existing *buildings* and structures.

**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.

**R501.2 Compliance.** *Additions*, *alterations*, *repairs* or changes of occupancy to, or relocation of, an existing *build- ing*, building system or portion thereof shall comply with Section R502, R503, R504 or R505, respectively, in this code and the provisions for alterations, repairs, additions and changes of occupancy or relocation, respectively, in the *International Building Code*, *International Existing Building Code*, *International Fire Code*, *International Fuel*

*Gas Code*, *International Mechanical Code*, *International Plumbing Code*, *International Property Maintenance Code*, *International Private Sewage Disposal Code*, *International Residential Code* and NFPA 70, as applicable. Changes where unconditioned space is changed to *conditioned space* shall comply with Section R501.6.

**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 conformance to 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.

**R501.4 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.

**R501.5 Historic buildings.** Provisions of this code 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 *code 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*.

**R501.6 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 Section R502.

**Exception:** Where the simulated performance option in Section R405 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 R405.2.

SECTION R502—ADDITIONS

**R502.1 General.** *Additions* to an *existing building*, building system or portion thereof shall conform to the provi- sions of this code as those provisions relate to new construction. *Additions* shall not create an unsafe or hazardous condition or overload *existing building* systems.

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

**R502.2.1 Building thermal envelope.** New *building thermal envelope* assemblies that are part of the *addition*

shall comply with Sections R402.1, R402.2, R402.4.1 through R402.4.5, and R402.5.

**Exception:** New *building thermal envelope* assemblies are exempt from the requirements of Section R402.5.1.2.

**R502.2.2 Heating and cooling systems.** HVAC *ductwork* newly installed as part of an *addition* shall comply with Section R403.

**Exception:** Where *ductwork* from an existing heating and cooling system is extended to an *addition*, Sections R403.3.7 and R403.3.8 shall not be required.

**R502.2.3 Service hot water systems.** New service hot water systems that are part of the *addition* shall comply with Section R403.5.

**R502.2.4 Lighting.** New lighting systems that are part of the *addition* shall comply with Section R404.1.

**R502.2.5 Additional energy efficiency credit requirements for additions.** *Additions* shall comply with sufficient measures from Table R408.2 to achieve not less than ten ~~five~~ credits. *Alterations* to the *existing building* that are not part of the *addition* but are permitted with an *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 Section R403.5 or R403.7.
3. *Additions* that do not increase *conditioned space*.
4. Where the *addition* alone or the *existing building* and *addition* together comply with Section R405 or R406.

SECTION R503—ALTERATIONS

**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 code. *Alterations* shall be such that the *existing building* or structure is not less conforming to the provisions of this code 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 struc- ture prior to the *alteration*. *Alterations* to *existing buildings* shall comply with Sections R503.1.1 through R503.1.5.

**R503.1.1 Building thermal envelope.** Alterations of *existing building thermal envelope* assemblies shall comply with this section. New *building thermal envelope* assemblies that are part of the *alteration* shall comply with Section R402. The *R-value* of insulation shall not be reduced, nor the *U-factor* of a *building ther-*

*mal envelope* assembly increased as part of a *building thermal envelope alteration* except where the *building* after the alteration complies with Section R405 or R406.

**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. *Roof recover*.
3. Surface-applied window film installed on existing single pane fenestration assemblies to reduce solar heat gain provided that the code does not require th
4. *Roof replacement* where *roof assembly* insulation is integral to or located below the structural roof deck.

**R503.1.1.1 Fenestration alterations.** Where new *fenestration* area is added to an *existing building*, the new *fenestration* shall comply with Section R402.4. 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 *solar heat gain coefficient* (SHGC) as specified in Table R402.1.3. 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.

**R503.1.1.2 Roof, ceiling and attic alterations.** Roof, ceiling and attic insulation shall comply with Section R402.1. Alterna- tively, where limiting conditions prevent compliance with Section R402.1, an *approved* design that minimizes deviation from Section R402.1 shall be provided for the following *alterations*:

1. An *alteration* to roof/ceiling construction other than *reroofing* where existing insulation located below the roof deck or an attic floor above *conditioned space* does not comply with Table R402.1.3.
2. *Roof replacements* or a roof *alteration* that includes removing and replacing the roof covering where the *roof assembly* includes insulation entirely above the roof deck. Where limiting conditions require use of an *approved* design to minimize deviation from Section R402.1 for a Group R-2 *building*, a registered design professional or other *approved source* shall provide *construction documents* that identify the limiting conditions and the means to address them.
3. Conversion of an unconditioned attic space into *conditioned space*.
4. Replacement of ceiling finishes exposing cavities or surfaces of the roof/ceiling.

**R503.1.1.3 Above-grade wall alterations.** *Above-grade wall alterations* shall comply with the following as applicable:

1. Where wall cavities are exposed, the exposed cavities shall be filled with insulation complying with Section R303.1.4. New cavities created shall be insulated in accordance with Section R402.1 or an *approved* design that minimizes deviation from Section R402.1. An interior vapor retarder shall be provided where required in accordance with Section R702.7 of the *International Residential Code* or Section 1404.3 of the *International Building Code*, as applicable.
2. Where exterior wall coverings and *fenestration* are added or replaced for the full extent of any exterior facade of one or more elevations of the *building*, *continuous insulation* shall be provided where required in accordance with Section R402.1 or the wall insulation shall be in accordance with an *approved* design that minimizes deviation from Section R402.1. Where specified, the *continuous insulation* requirement also shall comply with Section R702.7 of the *International Residential Code*. Replacement exterior wall coverings shall comply with the water-resistance requirements of

**EXISTING BUILDINGS**

Section R703.1.1 of the *International Residential Code* or Section 1402.2 of the *International Building Code*, as applicable, and manufacturers’ instructions.

1. 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 in accordance with Section R402.1 or an *approved* design that minimizes deviation from Section R402.1.

**R503.1.1.4 Floor alterations.** Where cavities in a floor or floor overhang are exposed and the floor or floor overhang is part of the *building thermal envelope*, the floor or floor overhang shall comply with Section R402.1 or an *approved* design.

**R503.1.1.5 Below-grade wall alterations.** Where an unconditioned below-grade space is changed to *conditioned space*, the *building thermal envelope* walls enclosing such space shall be insulated in accordance with Section R402.1. Where the below- grade space is *conditioned space* and where *building thermal envelope* walls enclosing such space are altered, they shall be insulated in accordance with Section R402.1.

**R503.1.1.6 Air barrier.** Altered *building thermal envelope* assemblies shall be provided with an *air barrier* in accordance with Section R402.5. Such an *air barrier* need not be continuous with unaltered portions of the *building thermal envelope*. Testing requirements of Section R402.5.1.2 shall not be required.

**R503.1.2 Heating and cooling systems.** New heating and cooling systems and *ductwork* that are part of the *alteration* shall comply with Section R403 and this section. *Alterations* to existing heating and cooling systems and *ductwork* shall comply with this section.

**~~Exception:~~** ~~Where~~ *~~ductwork~~* ~~from an existing heating and cooling system is extended.~~

**R503.1.2.1 Ductwork.** HVAC *ductwork* newly installed as part of an *alteration* shall comply with Section R403.

**Exception:** Where *ductwork* from an existing heating and cooling system is extended.

**R503.1.2.2 System sizing.** New heating and cooling equipment that is part of an *alteration* shall be sized in accordance with Section R403.7 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.

**R503.1.2.3 Duct system leakage.** Where an *alteration* includes any of the following, *duct systems* shall be tested in accor- dance with Section R403.3.7 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 m2) of *conditioned floor area*:

1. Twenty-five percent or more of the registers that are part of the *duct system* are relocated.
2. Twenty-five percent or more of the total length of all *ductwork* in the *duct system* is relocated.
3. The total length of all *ductwork* in the *duct system* is increased by 25 percent or more.

**Exception:** *Duct systems* located entirely inside a *conditioned space* in accordance with Section R403.3.4.

**R503.1.2.4 Controls.** New heating and cooling equipment that is part of the *alteration* shall comply with Sections R403.1 and R403.2.

**R503.1.3 Service hot water systems.** New service hot water systems that are part of the *alteration* shall comply with Section R403.5.

**R503.1.4 Lighting.** New lighting systems that are part of the *alteration* shall comply with Section R404.1.

**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.

**R503.1.5 Additional efficiency credit requirements for substantial improvements.** *Substantial improvements* shall comply with sufficient measures from Table R408.2 to achieve not less than three credits.

Exceptions:

1. *Alterations* that are permitted with an *addition* complying with Section R502.2.5.
2. *Alterations* that comply with Section R405 or R406.
3. *Substantial improvements* that do not include the *addition* or replacement of equipment covered in either Section R403.5 or R403.7.

SECTION R504—REPAIRS

**R504.1 General.** *Buildings*, structures and parts thereof shall be repaired in compliance with Section R501.3 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 R501.3, 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.

**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 R505—CHANGE OF OCCUPANCY OR USE

**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 R405 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 R405.2.

**R505.1.1 Unconditioned space.** Any unconditioned or low-energy space that is altered to become a *conditioned space* shall comply with Section R501.6.

### REFERENCED STANDARDS



CHAPTER

**6**[RE]

**User notes:**

***About this chapter:*** *This code contains numerous references to standards promulgated by other organizations that are used to provide requirements for materials and methods of construction. Chapter 6 contains a comprehensive list of all standards that are referenced in this code. These standards, in essence, are part of this code to the extent of the reference to the standard.*

*This chapter lists the standards that are referenced in various sections of this document. The standards are listed herein by the promulgating agency of the standard, the standard identification, the effective date and title, and the section or sections of this document that reference the standard. The application of the referenced standards shall be as specified in Section R108.*

**ACCA** *Air Conditioning Contractors of America, 1330 Braddock Place, Suite 350, Alexandria, VA 22314*

**ANSI/ACCA 1 Manual D—2023: Residential Duct Systems**

R403.3.1

**ANSI/ACCA 2 Manual J—2016: Residential Load Calculation**

R403.7

**ANSI/ACCA 3 Manual S—2023: Residential Equipment Selection**

R403.7

**ANSI/ACCA 5 QI—2010: HVAC Quality Installation Specification**

R408.2.4

**AHRI** *Air-Conditioning, Heating, and Refrigeration Institute, 2311 Wilson Blvd, Suite 400, Arlington, VA 22201*

**1380—2019: Demand Response through Variable Capacity HVAC Systems in Residential and Small Commercial Applications**

R408.2.8.2

**1430-2022 (I-P): Demand Flexible Electric Storage Water Heaters**

**AISI** *American Iron and Steel Institute, 25 Massachusetts Avenue, NW, Suite 800, Washington, DC 20001*

**AISI S250—22: North American Standard for Thermal Transmittance of Building Envelopes with Cold-Formed Steel Framing, with Supplement 1, Dated 2022**

R402.2.7

**ANSI** *American National Standards Institute, 25 West 43rd Street, 4th Floor, New York, NY 10036*

**ANSI Z21.20—2005 (R2016): Automatic Gas Ignition Systems and Components**

R403.13, R404.1.5

**ANSI/AMCA 210-ANSI/ASHRAE 51—23: Laboratory Methods of Testing Fans for Aerodynamic Performance Rating**

Table R403.6.2

**ANSI/ASHRAE 140—2017 (2020): Standard Method of Test for the Evaluation of Building Energy Analysis Computer Programs**

R405.5.2, R406.7.1

**ANSI/CTA-2045-A – 2018 : Modular Communications Interface for Energy Management**

**ANSI/CTA 2045-B—February 2021: Modular Communications Interface for Energy Management**

R408.2.8.1

**CSA/ANSI Z21.88—19/CSA 2.33—19: Vented Gas Fireplace Heaters**

R403.13.1

**Z21.50-19/CSA 2.22—2019: Vented Decorative Gas Appliances**

R403.13.1

**ASHRAE** *ASHRAE, 180 Technology Parkway NW, Peachtree Corners, GA 30092*

**ANSI/ASHRAE/IES 90.1—2022: Energy Standard for Sites and Buildings Except Low-Rise Residential Buildings**

R402.1.5, R402.2.10.2, R402.2.11.2, R405.2

**ASHRAE 193—2010(RA 2014): Method of Test for Determining the Airtightness of HVAC Equipment**

R403.3.6.1

**ASHRAE—2001: 2001 ASHRAE Handbook of Fundamentals**

Table R405.4.2(1)

**ASHRAE—2017: 2017 ASHRAE Handbook of Fundamentals**

R402.1.5, R403.3.1, R405.4.2, Table R405.4.2(1)

**ASME** *American Society of Mechanical Engineers, Two Park Avenue, New York, NY 10016-5990*

**ASTM** *ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959*

**C1313/C1313M—13(2019): Standard Specification for Sheet Radiant Barriers for Building Construction Applications**

R303.2.2

**C1363—19: Standard Test Method for Thermal Performance of Building Materials and Envelope Assemblies by Means of a Hot Box Apparatus**

R303.1.4.1

**C1371—15(2022): Standard Test Method for Determination of Emittance of Materials Near Room Temperature Using Portable Emissometers**

Table R407.2, R408.2.1.3

**C1549—16(2022): Standard Test Method for Determination of Solar Reflectance Near Ambient Temperature Using a Portable Solar Reflectometer**

Table R407.2, R408.2.1.3, R408.2.1.3.1

**C1743—19: Standard Practice for Installation and Use of Radiant Barrier Systems (RBS) in Residential Building Construction**

R303.2.2, R402.3

**E283/E283M—19: Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Skylights, Curtain Walls and Doors Under Specified Pressure Differences Across the Specimen**

R402.5.4

**E408—13(2019): Standard Test Methods for Total Normal Emittance of Surfaces Using Inspection-Meter Techniques**

Table R407.2, R408.2.1.3

**E779—19: Standard Test Method for Determining Air Leakage Rate by Fan Pressurization**

R402.5.1.2, R402.5.1.3

**E903—20: Standard Test Method for Solar Absorptance, Reflectance and Transmittance of Materials Using Integrating Spheres (Withdrawn 2005)**

Table R407.2, R408.2.1.3, R408.2.1.3.1

**E1554/E1554M—13(2018): Standard Test Methods for Determining Air Leakage of Air Distribution Systems by Fan Pressurization**

R403.3.7, R403.3.8, Table R405.4.2(1)

**E1827—22: Standard Test Methods for Determining Airtightness of Building Using an Orifice Blower Door**

R402.5.1.2

**E1918—21: Standard Test Method for Measuring Solar Reflectance of Horizontal and Low-Sloped Surfaces in the Field**

Table R407.2, R408.2.1.3, R408.2.1.3.1

**E1980—11(2019): Standard Practice for Calculating Solar Reflectance Index of Horizontal and Low-Sloped Opaque Surfaces**

Table R407.2, R408.2.1.3

**E2178—21a: Standard Test Method for Determining Air Leakage Rate and Calculation of Air Permanence of Building Materials**

R303.1.5

**E3158—18: Standard Test Method for Measuring the Air Leakage Rate of a Large or Multizone Building**

R402.5.1.2

**F1281—2017(2021)e1: Standard Specification for Electrofusion Type Polyethylene Fittings for Outside Diameter Controlled Polyethylene and Crosslinked Polyethylene Pipe and Tubing**

Table R408.2.3.1

**CRRC** *Cool Roof Rating Council, 2435 North Lombard Street, Portland, OR 97217*

**ANSI/CRRC S100—2021: Standard Test Methods for Determining Radiative Properties of Materials**

Table R407.2, R408.2.1.3, R408.2.1.3.1

**CSA** *CSA Group, 8501 East Pleasant Valley Road, Cleveland, OH 44131-5516*

**AAMA/WDMA/CSA 101/I.S.2/A440—22: North American Fenestration Standard/Specification for Windows, Doors, and Skylights**

R402.5.3

**CAN/CSA C439—18: Laboratory Methods of Test for Rating the Performance of Heat/Energy-Recovery Ventilators**

Table R403.6.2

**CSA B55.1—20: Test Method for Measuring Efficiency and Pressure Loss of Drain Water Heat Recovery Units**

R403.5.3

**CSA B55.2—20: Drain Water Heat Recovery Units**

R403.5.3

**CSA P.4.1—21: Testing Method for Measuring Fireplace Efficiency**

R403.13.1

**CTA** *Consumer Technology Association, Technology & Standards Department; 1919 S Eads Street, Arlington, VA 22202*

**ANSI/CTA-2045-A—2018: Modular Communications Interface for Energy Management**

R408.2.8.1

**ANSI/CTA-2045-B—2018: Modular Communications Interface for Energy Management**

R408.2.8.1

**BPVC** *Boiler and Pressure Vessel Code*

**DASMA** *Door & Access Systems Manufacturers Association, 1300 Sumner Avenue, Cleveland, OH 44115-2851*

**ANSI/DASMA 105—2020: Test Method for Thermal Transmittance and Air Infiltration of Garage Doors and Rolling Doors**

R303.1.3

**DOE** *US Department of Energy, 1000 Independence Avenue SW, Washington, DC 20585*

**10 CFR, Part 430—2021: Energy Conservation Program for Consumer Products: Energy and Water Conservation Standards and Their Compliance Dates**

Table R403.6.2, R404.1, Table R405.4.2(1), Table R408.2.6

**FGIA** *Fenestration & Glazing Industry Alliance (formerly American Architectural Manufacturers Association), 1900 E Golf Road, Suite 250, Schaumburg, IL 60173-4268*

**AAMA/WDMA/CSA 101/I.S.2/A440—22: North American Fenestration Standard/Specification for Windows, Doors, and Skylights**

R402.5.3

**ICC** *International Code Council, Inc., 200 Massachusetts Avenue, NW, Suite 250, Washington, DC 20001*

**ANSI/APSP/ICC 14—2019: American National Standard for Portable Electric Spa Energy Efficiency**

R403.11

**ANSI/PHTA/ICC 15a—2021: American National Standard for Residential Swimming Pool and Spa Energy Efficiency**

R403.12

**ANSI/RESNET/ICC 301—2022: Standard for the Calculation and Labeling of the Energy Performance of Dwelling and Sleeping Units Using an Energy Rating Index—includes Addendum A, Approved July 28, 2022, and Addendum B, Approved October 12, 2022**

R405.5.3, R406.4, R406.5, R406.7.1, R406.7.6,

**ANSI/RESNET/ICC 380—2022: Standard for Testing Airtightness of Building, Dwelling Unit and Sleeping Unit Enclosures; Airtightness of Heating and Cooling Air Distribution Systems, and Airflow of Mechanical Ventilation Systems**

R402.5.1.2, R403.3.7, R403.3.8, R403.6.3, Table R405.4.2(1)

**IBC—24: International Building Code®**

R201.3, R202, R303.1.1, R303.1.2, R303.2, R402.1.1, R402.2.11.1, R404.1.2, R501.2, R501.4, R503.1.1.3,

**ICC 400—22: Standard on the Design and Construction of Log Structures**

R402.1, Table R402.5.1.1

**ICC 500—20: ICC/NSSA Standard for the Design and Construction of Storm Shelters**

R402.6

**IEBC—24: International Existing Building Code®**

R501.2

**IECC—06: 2006 International Energy Conservation Code®**

R202

**IFC—24: International Fire Code®**

R201.3, R501.2

**IFGC—24: International Fuel Gas Code®**

R201.3, R501.2

**IMC—24: International Mechanical Code®**

R201.3, R403.3.5, R403.3.6, R403.6, R501.2

**IPC—24: International Plumbing Code®**

R201.3, R501.2

**IPMC—24: International Property Maintenance Code®**

R501.2

**IPSDC—24: International Private Sewage Disposal Code®**

R501.2

**IRC—24: International Residential Code®**

R201.3, R303.1.1, R303.1.2, R303.1.6, R303.2, R402.1.1, Table R402.1.2, Table R402.1.3, R402.1.6, R402.2.10.1, R402.2.11.1, R402.2.11.1, Table R402.5.1.1, R403.3.5, R403.3.6, R403.6, R501.2, R501.4, R503.1.1.3

**IEC** *IEC Regional Centre for North America, 446 Main Street, 16th Floor, Worcester, MA 01608*

**IEC 62746-10-1—2018: Systems interface between customer energy management system and the power management system – Part 10-1: Open automated demand response**

R408.2.8.1

**IECIEC Regional Centre for North America.***IEC 62746-10-1 - 2018: Systems interface between customer energy management system and the power management system - Part 10-1: Open automated demand response*

**IEEE** *Institute of Electrical and Electronics Engineers, Inc., 3 Park Avenue, 17th Floor, New York, NY 10016-5997*

* 1. **—2012: IEEE Standard for the Testing, Design, Installation and Maintenance of Electrical Resistance Trace Heating for Commercial Applications**

R403.5.1.2

**NEMA** *National Electrical Manufacturers Association, 1300 17th Street N #900, Arlington, VA 22209*

**OS 4—2016: Requirements for Air-Sealed Boxes for Electrical and Communication Applications**

R402.5.5

**NFPA** *National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471*

**70—23: National Electrical Code**

R501.2

**NFRC** *National Fenestration Rating Council, Inc., 6305 Ivy Lane, Suite 140, Greenbelt, MD 20770*

**100—2023: Procedure for Determining Fenestration Products *U*-Factors**

R303.1.3

**200—2023: Procedure for Determining Fenestration Product Solar Heat Gain Coefficient and Visible Transmittance at Normal Incidence**

R303.1.3

**400—2023: Procedure for Determining Fenestration Product Air Leakage**

R402.5.3

**OpenADR** *OpenADR Alliance, 111 Deerwood Road, Suite 200, San Ramon, CA 94583*

**OpenADR 2.0a and 2.0b—2019: Profile Specification Distributed Energy Resources**

R408.2.8.1

**OpenADR OpenADR Alliance.***OpenADR 2.0a and 2.0b – 2019: Profile Specification Distributed Energy Resources*

**PHTA** *Pool & Tub Alliance (formerly the APSP), 1650 King Street, Suite 602, Alexandria, VA 22314*

**ANSI/APSP/ICC 14—2019: American National Standard for Portable Electric Spa Energy Efficiency**

R403.11

**ANSI/PHTA/ICC 15—2021: American National Standard for Residential Swimming Pool and Spa Energy Efficiency**

R403.12

**RESNET** *Residential Energy Services Network, Inc., P.O. Box 4561, Oceanside, CA 92052-4561*

**ANSI/RESNET/ICC 301—2022: Standard for the Calculation and Labeling of the Energy Performance of Dwelling and Sleeping Units using an Energy Rating Index—includes Addendum A, Approved July 28, 2022, and Addendum B, Approved October 12, 2022**

R405.5.3, R406.4, R406.5, R406.7.1, R406.7.6

**ANSI/RESNET/ICC 380—2022: Standard for Testing Airtightness of Building, Dwelling Unit and Sleeping Unit Enclosures; Airtightness of Heating and Cooling Air Distribution Systems, and Airflow of Mechanical Ventilation Systems**

R402.5.1.2, R403.3.7, R403.3.8, R403.6.3, Table R405.4.2(1)

**UL** *UL LLC, 333 Pfingsten Road, Northbrook, IL 60062*

**127—2011: Standard for Factory-Built Fireplaces—with Revisions through February 2020**

R402.5.2

**515—2015: Electrical Resistance Trace Heating for Commercial Applications**

R403.5.1.2

**US-FTC** *United States-Federal Trade Commission, 600 Pennsylvania Avenue NW, Washington, DC 20580*

**CFR Title 16 (2015): *R*-Value Rule**

R303.1.4

**WDMA** *Window & Door Manufacturers Association, 2001 K Street NW, 3rd Floor North, Washington, DC 20006*

**AAMA/WDMA/CSA 101/I.S.2/A440—22: North American Fenestration Standard/Specification for windows, doors, and skylights**

R402.5.3

### BOARD OF APPEALS—RESIDENTIAL



APPENDIX

**RA**

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

**User notes:**

***About this appendix:*** *Appendix RA provides criteria for board of appeals members. Also provided are procedures by which the board of appeals should conduct its business.*

SECTION RA101—GENERAL

**RA101.1 Scope.** A board of appeals shall be established within the jurisdiction for the purpose of hearing applications for modification of the requirements of this code pursuant to the provisions of Section R109. The board shall be established and operated in accordance with this section, and shall be authorized to hear evidence from appellants and the *code official* pertaining to the appli- cation and intent of this code for the purpose of issuing orders pursuant to these provisions.

**RA101.2 Application for appeal.** Any person shall have the right to appeal a decision of the *code official* to the board. An application for appeal shall be based on a claim that the intent of this code or the rules legally adopted hereunder have been incorrectly interpreted, the provisions of this code do not fully apply or an equally good or better form of construction is proposed. The application shall be filed on a form obtained from the *code official* within 20 days after the notice was served.

**RA101.2.1 Limitation of authority.** The board shall not have authority to waive requirements of this code or interpret the administration of this code.

**RA101.2.2 Stays of enforcement.** Appeals of notice and orders, other than Imminent Danger notices, shall stay the enforcement of the notice and order until the appeal is heard by the board.

**RA101.3 Membership of board.** The board shall consist of five voting members appointed by the chief appointing authority of the jurisdiction. Each member shall serve for **[INSERT NUMBER OF YEARS]** years or until a successor has been appointed. The board members’ terms shall be staggered at intervals, so as to provide continuity. The *code official* shall be an ex officio member of said board but shall not vote on any matter before the board.

**RA101.3.1 Qualifications.** The board shall consist of five individuals, who are qualified by experience and training to pass on matters pertaining to building construction and are not employees of the jurisdiction.

**RA101.3.2 Alternate members.** The chief appointing authority is authorized to appoint two alternate members who shall be called by the board chairperson to hear appeals during the absence or disqualification of a member. Alternate members shall possess the qualifications required for board membership, and shall be appointed for the same term or until a successor has been appointed.

**RA101.3.3 Vacancies.** Vacancies shall be filled for an unexpired term in the same manner in which original appointments are required to be made.

**RA101.3.4 Chairperson.** The board shall annually select one of its members to serve as chairperson.

**RA101.3.5 Secretary.** The chief appointing authority shall designate a qualified clerk to serve as secretary to the board. The secretary shall file a detailed record of all proceedings, which shall set forth the reasons for the board’s decision, the vote of each member, the absence of a member and any failure of a member to vote.

**RA101.3.6 Conflict of interest.** A member with any personal, professional or financial interest in a matter before the board shall declare such interest and refrain from participating in discussions, deliberations and voting on such matters.

**RA101.3.7 Compensation of members.** Compensation of members shall be determined by law.

**RA101.3.8 Removal from the board.** A member shall be removed from the board prior to the end of their term only for cause. Any member with continued absence from regular meeting of the board may be removed at the discretion of the chief appointing authority.

**RA101.4 Rules and procedures.** The board shall establish policies and procedures necessary to carry out its duties consistent with the provisions of this code and applicable state law. The procedures shall not require compliance with strict rules of evidence, but shall mandate that only relevant information be presented.

**RA101.5 Notice of meeting.** The board shall meet upon notice from the chairperson, within 10 days of the filing of an appeal or at stated periodic intervals.

**RA101.5.1 Open hearing.** All hearings before the board shall be open to the public. The appellant, the appellant’s representative, the *code official* and any person whose interests are affected shall be given an opportunity to be heard.

**RA101.5.2 Quorum.** Three members of the board shall constitute a quorum.

**RA101.5.3 Postponed hearing.** When five members are not present to hear an appeal, either the appellant or the appellant’s representative shall have the right to request a postponement of the hearing.

**RA101.6 Legal counsel.** The jurisdiction shall furnish legal counsel to the board to provide members with general legal advice concerning matters before them for consideration. Members shall be represented by legal counsel at the jurisdiction’s expense in all matters arising from service within the scope of their duties.

**RA101.7 Board decision.** The board shall only modify or reverse the decision of the *code official* by a concurring vote of three or more members.

**RA101.7.1 Resolution.** The decision of the board shall be by resolution. Every decision shall be promptly filed in writing in the office of the *code official* within 3 days and shall be open to the public for inspection. A certified copy shall be furnished to the appellant or the appellant’s representative and to the *code official*.

**RA101.7.2 Administration.** The *code official* shall take immediate action in accordance with the decision of the board.

**RA101.8 Court review.** Any person, whether or not a previous party of the appeal, shall have the right to apply to the appropriate court for a writ of certiorari to correct errors of law. Application for review shall be made in the manner and time required by law following the filing of the decision in the office of the chief administrative officer.

### SOLAR-READY PROVISIONS—DETACHED ONE- AND TWO-FAMILY DWELLINGS AND TOWNHOUSES



APPENDIX

**RB**

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

**User notes:**

***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 RB 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 the systems.*

SECTION RB101—SCOPE

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

SECTION RB102—GENERAL DEFINITION

**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 RB103—SOLAR-READY ZONE

**RB103.1 General.** New detached one- and two-family dwellings, and townhouses with not less than 600 square feet (55.74 m2) of roof area oriented between 110 degrees and 270 degrees of true north shall comply with Sections RB103.2 through RB103.8.

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 RB103 are in full or partial shade for more than 70 percent of daylight hours annually.

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

**RB103.3 Solar-ready zone area.** The total *solar-ready zone* area shall be not less than 300 square feet (27.87 m2) exclusive of manda- tory 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 m2) per dwelling shall have a *solar-ready zone* area of not less than 150 square feet (13.94 m2). 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 m2) exclusive of access or setback areas as required by the *International Fire Code*.

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

**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.

**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 11/4 inches (32 mm).

**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*.

**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.

**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.

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

### ZERO NET ENERGY RESIDENTIAL BUILDING PROVISIO NS

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

**User notes:**

￼***￼****This appendix provides requirements for residential buildings intended to result in zero net energy consumption over the course of a year. Where adopted by ordinance as a requirement, Sections RC101.1, RC101.2, RC103.2, RC103.4 and RC103.5 are intended to replace Sections R401.1, R401.2, R406.2, R406.4 and R406.5, respectively. Where adopted by ordinance as a requirement, Sections R401.3 (Certificate), R406.1 (Scope), R406.3 (Building thermal envelope), R406.6 (Verification by approved agency) and R406.7 (Documentation) are not replaced.*

SECTION RC101—GENERAL

**RC101.1 Scope.** This appendix applies to new *residential buildings*.

**RC101.2 Application.** *Residential buildings* shall comply with Section R406.

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

**RC101.3 Certificate.** (No change, same as Section R401.3.)

SECTION RC102—GENERAL DEFINITIONS

**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.

SECTION RC103—ZERO NET ENERGY RESIDENTIAL BUILDINGS

**RC103.1 Scope.** (No change, same as Section R406.1.)

**RC103.2 ERI compliance.** Compliance based on the *ERI* requires that the *rated design* meets one of the following:

1. The requirements of the sections indicated within Table R406.2 and Sections R406.3 through R406.7, or
2. The requirements of ASHRAE/IES Standard 90.2, including:
   1. The *ERI* requirements of ASHRAE/IES Standard 90.2 Table 6-1 without the use of on-site power production (OPP).
   2. The requirements of Sections R402.5.1.1, R402.5.1.2, and R406.3.
   3. The maximum *ERI* including adjusted OPP of Table RC103.5 determined in accordance with Section RC103.4.

**RC103.3 Building thermal envelope.** (No change, same as Section R406.3.)

**RC103.4 Energy Rating Index.** The *Energy Rating Index* (ERI) not including *renewable energy resources* shall be determined in accor- dance with ANSI/RESNET/ICC 301. The *ERI* including *renewable energy resources* shall be determined in accordance with ANSI/RESNET/ICC 301, except where electrical energy is provided from a community renewable energy facility (CREF) or contracted from a physical or financial renewable energy power purchase agreement that meets requirements of Section RC103.4.1, on-site power production (OPP) shall be adjusted in accordance with Equation RC-1.

**Equation RC-1** Adjusted OPP = OPPkWh + CREFkWh + PPPAkWh + FPPAkWh where:

OPPkWh = Annual electrical energy from *on-site renewable energy*, in units of kilowatt-hours (kWh).

CREFkWh = Annual electrical energy from a community renewable energy facility (CREF), in units of kilowatt-hours (kWh).

PPPAkWh = Where not included as OPP, the annual electrical energy contracted from a physical renewable energy power purchase agreement, in units of kilowatt-hours (kWh).

FPPAkWh = 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).

**APPENDIX RC—ZERO NET ENERGY RESIDENTIAL BUILDING PROVISIONS**

**RC103.4.1 Renewable energy contract.** The renewable energy shall be delivered or credited to the *building site* under an energy contract with a duration of not less than 15 years. The contract shall be structured to survive a partial or full transfer of ownership of the building property.

**RC103.5 ERI-based compliance.** Compliance based on an *ERI* analysis requires that the *rated design* and confirmed built dwelling be shown to have an *ERI* less than or equal to both values indicated in Table RC103.5 when compared to the *ERI reference design*.

|  |  |  |
| --- | --- | --- |
| **TABLE RC103.5—MAXIMUM ENERGY RATING INDEX** | | |
| **CLIMATE ZONE** | **ENERGY RATING INDEX NOT INCLUDING RENEWABLE ENERGY** | **ENERGY RATING INDEX INCLUDING ADJUSTED OPP** |
| 0 | 42 | 0 |
| 1 | 42 | 0 |
| 2 | 42 | 0 |
| 3 | 42 | 0 |
| 4 | 42 | 0 |
| 5 | 42 | 0 |
| 6 | 42 | 0 |
| 7 | 42 | 0 |
| 8 | 42 | 0 |

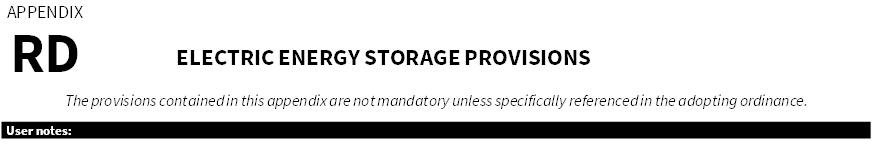
**RC103.6 Verification by approved agency.** (No change, same as Section R406.6.)

**RC103.7 Documentation.** (No change, same as Section R406.7.)

SECTION RC104—REFERENCED STANDARDS

**RC104.1 General.** See Table RC104.1 for standards that are referenced in various sections of this appendix. Stan- dards are listed by the standard identification with the effective date, standard title, and the section or sections of this appendix that reference the standard.

|  |  |  |
| --- | --- | --- |
| **TABLE RC104.1—REFERENCED STANDARDS** | | |
| **STANDARD ACRONYM** | **STANDARD NAME** | **SECTIONS HEREIN REFERENCED** |
| ASHRAE/IES 90.2—2018 | *Energy-Efficient Design of Low-Rise Residential Buildings, including approved addenda*  [Addenda A (approved Jan 2021), B (June 2021) and D (February 2022)] | RC103.2 |

￼￼***About this appendix:￼****This voluntary appendix provides requirements for electric energy storage readiness provisions.*

SECTION RD101—SCOPE

**RD101.1 General.** These provisions shall be applicable for new construction where solar-ready measures or an on-site solar PV system is required.

SECTION RD102—GENERAL DEFINITION

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

SECTION RD103—ELECTRICAL ENERGY STORAGE

**RD103.1 Electrical energy storage.** One- and two-family *dwellings*, townhouse units and Group R-3 occupan- cies shall comply with either Section RD103.2 or RD103.3. *Buildings* with Group R-2 and R-4 occupancies shall

comply with Section RD103.4.

**RD103.2 Electrical energy storage energy capacity.** Each *building* shall have an *ESS* with a rated energy capacity of not less than 5 kWh with not fewer than four *ESS*-supplied branch circuits.

**RD103.3 Electrical energy storage system readiness.** Each *building* shall be energy-storage ready in accordance with Sections RD103.3.1 through RD103.3.4.

**RD103.3.1 Energy storage system space.** Interior or exterior space with dimensions and locations in accordance with Section R330 of the *International Residential Code* and Section 110.26 of NFPA 70 shall be reserved to allow for the future installation of an *ESS*.

**RD103.3.2 System isolation equipment space.** Space shall be reserved to allow for the future installation of a transfer switch within 3 feet (305 mm) of the main panelboard. Raceways shall be installed between the panelboard and the transfer switch loca- tion to allow the connection of an *ESS*.

**RD103.3.3 Panelboard with backed-up load circuits.** A dedicated raceway shall be provided from the main service to a panel- board 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 1 inch (25 mm). The panelboard that supplies the branch circuits shall be labeled, “Subpanel reserved for future battery energy storage system to supply essential loads.”

**RD103.3.4 Branch circuits served by the ESS.** Not fewer than 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.

**RD103.4 Electrical energy storage system.** *Buildings* with Group R-2 and R-4 occupancies shall comply with Appendix CJ.

### ELECTRIC VEHICLE CHARGING INFRASTRUCTURE



APPENDIX

**RE**

*This Appendix is adopted into the 2025 Illinois Residential Stretch Energy Code and is mandatory. ~~The provisions contained in this appendix are not mandatory unless specifically referenced in the adopting ordinance.~~*

**User notes:**

*~~About this appendix: This appendix provides requirements for electric vehicle charging infrastructure for adopting jurisdictions.~~*

SECTION RE101—ELECTRIC VEHICLE POWER TRANSFER

RE101.1 Definitions.

**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.

**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, *electric vehicle supply equipment (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, a panel- board 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 an outlet, junction box or receptacle that will support an installed *EVSE.*

**ELECTRIC VEHICLE SUPPLY EQUIPMENT (EVSE).** Equipment for plug-in power transfer, including ungrounded, grounded and equip- ment grounding conductors; electric vehicle connectors; attached plugs; any 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.

**RE101.2 Electric vehicle power transfer infrastructure.** New residential *automobile parking spaces* for residential *buildings* shall be provided with *electric vehicle power* transfer infrastructure in accordance with Sections RE101.2.1 through RE101.2.5.

**RE101.2.1 Quantity.** New automobile parking spaces for one- and two-family dwellings and townhouses shall be provided in accordance with this section. All other new *residential* parking facilities shall be provided with electric vehicle power transfer infrastructure in accordance with Section C405.14 of the *Illinois Commercial Stretch Energy Code*. ~~New one- and two-family dwellings and townhouses with a designated attached or detached garage or other on-site private parking provided adjacent to the~~ *~~dwelling unit~~* ~~shall be provided with one~~ *~~EV capable~~*~~,~~ *~~EV ready~~* ~~or~~ *~~EVSE~~* ~~space per~~ *~~dwelling unit~~*~~. R-2 occupancies or allocated parking for R-2 occupancies in mixed-use~~ *~~buildings~~* ~~shall be provided with an~~ *~~EV capable space~~*~~,~~ *~~EV ready space~~* ~~or~~ *~~EVSE~~* ~~space for 40 percent of the~~ *~~dwelling units~~* ~~or~~ *~~automobile parking spaces~~*~~, whichever is less.~~

Exceptions:

1. Where the local electric distribution entity certifies in writing that it is not able to provide 100 percent of the necessary distribution capacity within 2 years after the estimated certificate of occupancy date, the required *EV* charging infra- structure shall be reduced based on the available existing electric distribution capacity.
2. Where substantiation is *approved* that meeting the requirements of Section RE101.2.5 will alter the local utility infra- structure 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 $450 per *dwelling unit*.

**RE101.2.2 EV capable spaces.** Each *EV capable space* used to meet the requirements of Section RE101.2.1 shall comply with all of the following:

* 1. A continuous raceway or cable assembly shall be installed between a suitable panelboard or other on-site electrical distribution equipment and an enclosure or outlet located within 3~~6~~ feet (1828 mm) of the *EV capable space*.
  2. The installed raceway or cable assembly shall be sized and rated to supply a minimum circuit capacity in accordance with Section RE101.2.5.
  3. The electrical distribution equipment to which the raceway or cable assembly connects shall have sufficient dedicated space and spare electrical capacity for a two-pole circuit breaker or set of fuses.
  4. The electrical enclosure or outlet and the electrical distribution equipment directory shall be marked: “For future elec- tric vehicle supply equipment (EVSE).”

**RE101.2.3 EV ready spaces.** Each branch circuit serving *EV ready spaces* shall comply with all of the following:

1. Termination at an outlet or enclosure, located within 3~~6~~ feet (1828 mm) of each *EV ready space* it serves and marked “For electric vehicle supply equipment (EVSE).”
2. Service by an electrical distribution system and circuit capacity in accordance with Section RE101.2.5.

**APPENDIX RE—ELECTRIC VEHICLE CHARGING INFRASTRUCTURE**

1. Designation on the panelboard or other electrical distribution equipment directory as “For electric vehicle supply equip- ment (EVSE).”

**RE101.2.4 EVSE spaces.** An installed *EVSE* with multiple output connections shall be permitted to serve multiple *EVSE spaces*. Each *EVSE* serving either a single *EVSE space* or multiple *EVSE spaces* shall comply with the following:

1. Be served by an electrical distribution system in accordance with Section RE101.2.5.
2. Have a nameplate charging capacity of not less than 7~~6~~.2 kVA (or 30A at 208/240V) per *EVSE space* served. Where an *EVSE* serves three or more *EVSE spaces* and is controlled by an energy management system in accordance with Section RE101.2.5, the nameplate charging capacity shall be not less than 2.1 kVA per *EVSE space* served.
3. Be located within 3~~6~~ feet (1828 mm) of each *EVSE space* it serves.
4. Be installed in accordance with NFPA 70 and be *listed* and *labeled* in accordance with UL 2202 or UL 2594.

**RE101.2.5 Electrical distribution system capacity.** The branch circuits and electrical distribution system serving each *EV capa- ble space*, *EV ready space* and *EVSE space* used to comply with Section RE101.2.1 shall comply with one of the following:

1. Sized for a calculated *EV* charging load of not less than 6.2 kVA per *EVSE*, *EV ready* or *EV capable space*. Where a circuit is shared or managed, it shall be in accordance with NFPA 70.
2. The capacity of the electrical distribution system and each branch circuit serving multiple *EVSE spaces*, *EV ready spaces* or *EV capable spaces* designed to be controlled by an energy management system in accordance with NFPA 70 shall be sized for a calculated *EV* charging load of not less than 2.1 kVA per space. Where an energy management system is used to control *EV* charging loads for the purposes of this section, it shall not be configured to turn off electrical power to *EVSE* or *EV ready spaces* used to comply with Section RE101.2.1.

SECTION RE102—REFERENCED STANDARDS

**RE102.1 General.** See Table RE102.1 for standards that are referenced in various sections of this appendix. Standards are listed by the standard identification with the effective date, standard title, and the section or sections of this appendix that reference the standard.

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| --- | --- | --- |
| **TABLE RE102.1—REFERENCED STANDARDS** | | |
| **STANDARD ACRONYM** | **STANDARD NAME** | **SECTIONS HEREIN REFERENCED** |
| UL 2202—2009 | *Electric Vehicle (EV) Charging System Equipment*—with revisions through February 2018 | RE101.2.4 |
| UL 2594—2016 | *Standard for Electric Vehicle Supply Equipment* | RE101.2.4 |

### ALTERNATIVE BUILDING THERMAL ENVELOPE INSULATION R-VALUE OPTIONS



APPENDIX

**RF**

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

**User notes:**

***About this appendix:*** *The purpose of this appendix is to provide expanded R-value options for determining compliance with the U-factor criteria prescribed in Section R402.1.2. It also supplements the limited selection of common insulation conditions addressed in the R- value approach of Table R402.1.3.*

SECTION RF101—GENERAL

**RF101.1 General.** This appendix shall be used as a basis to determine alternative building assembly and insulation component *R-value* solutions that comply with the maximum *U*-factors and *F*-factors in Table R402.1.2. Alternative building assembly insulation solutions determined in accordance with this appendix also shall comply with the requirements of Section R702.7 of the *International Residential Code*.

SECTION RF102—ABOVE-GRADE WALL ASSEMBLIES

**RF102.1 Wood-framed walls.** Wood-framed *above-grade wall* assemblies shall comply with both the *cavity insulation* and *continuous insulation R*-*values* and framing conditions specified by Table RF102.1 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 RF102.1, *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 R104.1. Use of a lesser framing fraction than the indicated maximums in Table RF102.1 shall require wall framing layout details on *approved construction documents* for each *above-grade wall* elevation and shall be inspected for compliance.

**APPENDIX RF—ALTERNATIVE BUILDING THERMAL ENVELOPE INSULATION R-VALUE OPTIONS**

**366**

**2024 INTERNATIONAL ENERGY CONSERVATION CODE®**

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **TABLE RF102.1—ASSEMBLY *U*-FACTORS FOR WOOD-FRAMED WALLSa, b, c, d, e, f** | | | | | | | | | | | | | | | | | | | | |
| **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** |
| 2 × 4 (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 |
| 2 × 6 (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 |
| 2 × 8 (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 |

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| **TABLE RF102.1—ASSEMBLY *U*-FACTORS FOR WOOD-FRAMED WALLSa, b, c, d, e, f—continued** | | | | | | | | | | | | | | | | | | | | |
| **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** |
| 2 × 4 (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 |
| 2 × 6 (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 | 0.046 | 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 |
| 2 × 8 (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 |

**APPENDIX RF—ALTERNATIVE BUILDING THERMAL ENVELOPE INSULATION R-VALUE OPTIONS**

**2024 INTERNATIONAL ENERGY CONSERVATION CODE®**

**367**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **TABLE RF102.1—ASSEMBLY *U*-FACTORS FOR WOOD-FRAMED WALLSa, b, c, d, e, f—continued** | | | | | | | | | | | | | | | | | | | | |
| **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** |
| 2 × 4 (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 |
| 2 × 6 (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 |
| 2 × 8 (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 |

**APPENDIX RF—ALTERNATIVE BUILDING THERMAL ENVELOPE INSULATION R-VALUE OPTIONS**

**368**

**2024 INTERNATIONAL ENERGY CONSERVATION CODE®**

**APPENDIX RF—ALTERNATIVE BUILDING THERMAL ENVELOPE INSULATION R-VALUE OPTIONS**

**2024 INTERNATIONAL ENERGY CONSERVATION CODE®**

**369**

For SI: 1 British thermal unit per hour per square foot per °Fahrenheit = 5.6783 W/m2 × K.

1. Linear interpolation of *U*-factors shall be permitted between continuous insulation and cavity insulation *R*-values. For nonstandard stud spacing, use the next-lesser stud spacing shown in the table.
2. Table values are based on the parallel path calculation procedure as applicable to wood-framed assemblies and require compliance with the following assembly conditions:
   * Framing fractions of not greater than 28 percent (assumed for 12-inch o.c. studs), 25 percent (assumed for 16-inch o.c. studs), and 22 percent (assumed for 24-inch o.c. studs) with 4 percent attributed to headers in all cases. The framing fraction is the percentage of overall opaque wall area occupied by framing members.
   * Wood framing materials or species with a thermal resistivity of not less than R-1.25 per inch.
   * Exterior sheathing with an *R*-value of not less than R-0.62 as based on wood structural panel. For walls having no exterior sheathing or sheathing of lesser *R*-value, Note d shall be used to adjust the tabulated *U*-factor.
   * Siding of not less than R-0.62 as based on the assumption of vinyl siding. For walls with siding having a lower *R*-value, Note d shall be used to adjust the tabulated *U*-factor.
   * Interior finish of not less than R-0.45 based on 1/2-inch gypsum. For walls having no interior finish or a finish of lesser *R*-value, Note d shall be used to adjust the tabulated *U*-factor.
   * Cavity insulation with a rated *R*-value installed as required by the manufacturer’s installation instructions to satisfy the indicated installed *R*-value, considering a reduced *R*-value for compression in an enclosed cavity where applicable.
   * 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.
   * Indoor air film *R*-value of 0.68 and outdoor air-film *R*-value of 0.17.
3. Where any of the building materials that are continuous over the interior or exterior wall surface vary from those stated in Note 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.
4. 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 insu- lation (0 *R*-value column) and *Rci* is the specific rated *R*-value of continuous insulation added to the assembly.
5. 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/*U*1 + 1/*U*2] where *U*1 and *U*2 are the *U*-factors from the table for each of the adjacent parallel walls in the double-wall assembly.
6. The use of insulation in accordance with this table does not supersede requirements in Section R702.7 for use of insulation and water vapor retarders to control water vapor.

**TABLE RF102.1—ASSEMBLY *U*-FACTORS FOR WOOD-FRAMED WALLSa, b, c, d, e, f—continued**

**RF102.2 Mass walls.** Reserved.

**RF102.3 Cold-formed steel frame walls.** Reserved.

SECTION RF103—ROOF AND CEILING ASSEMBLIES—RESERVED SECTION RF104—FLOOR ASSEMBLIES—RESERVED

**SECTION RF105—BASEMENT AND CRAWL SPACE WALLS**

**RF105.1 Basement and crawl space walls.** *U*-factors for basement and *crawl space walls* shall be as specified in accordance with Table RF105.1. Effective *U*-factors for the proposed and reference foundation wall design must be used to demonstrate compliance with Section R402.1.5. Effective *U*-factors shall not be used for other compliance methods referenced in Section R401.2.1.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **TABLE RF105.1—*U*-FACTORS FOR BASEMENT AND CRAWL SPACE WALLSa** | | | | | |
| **INSULATION CONFIGURATIONSb** | **WALL *U*-FACTORc**  **(Btu/h × ft2 × °F)** | **WALL EFFECTIVE *U*-FACTORd BY PERCENTAGE OF WALL HEIGHT PROJECTING ABOVE GRADE (Btu/h × ft2 × °F) FOR USE ONLY WITH SECTION R402.1.5** | | | |
| — | — | 50% | 35% | 20% | 5% |
| **Basement walls** | | | | | |
| Uninsulated and unfinished basement wall | 0.360 | 0.324 | 0.288 | 0.252 | 0.216 |
| Continuous insulation | — | — | — | — | — |
| R-5ci | 0.122 | 0.109 | 0.097 | 0.085 | 0.073 |
| R-7.5ci | 0.093 | 0.084 | 0.075 | 0.065 | 0.056 |
| R-10ci | 0.076 | 0.068 | 0.060 | 0.053 | 0.045 |
| R-15ci | 0.055 | 0.049 | 0.044 | 0.038 | 0.033 |
| R-20ci | 0.043 | 0.039 | 0.034 | 0.030 | 0.026 |
| R-25ci | 0.035 | 0.032 | 0.028 | 0.025 | 0.021 |
| Cavity insulation | — | — | — | — | — |
| R-11 | 0.076 | 0.068 | 0.060 | 0.053 | 0.045 |
| R-13 | 0.067 | 0.060 | 0.054 | 0.047 | 0.040 |
| R-15 | 0.060 | 0.054 | 0.048 | 0.042 | 0.036 |
| R-19 | 0.050 | 0.045 | 0.040 | 0.035 | 0.030 |
| R-21 | 0.045 | 0.041 | 0.036 | 0.032 | 0.027 |
| Cavity + continuous insulation | — | — | — | — | — |
| R-13 + R-5ci | 0.050 | 0.045 | 0.040 | 0.035 | 0.030 |
| R-13 + R-7.5ci | 0.045 | 0.040 | 0.036 | 0.031 | 0.027 |
| R-13 + R-10ci | 0.040 | 0.036 | 0.032 | 0.028 | 0.024 |
| R-19 + R-5ci | 0.040 | 0.036 | 0.032 | 0.028 | 0.024 |
| R-19 + R-7.5ci | 0.036 | 0.033 | 0.029 | 0.025 | 0.022 |
| R-19 + R-10ci | 0.033 | 0.030 | 0.027 | 0.023 | 0.020 |
| **Crawl space walls** | | | | | |
| Uninsulated crawl space wall | 0.477 | 0.429 | 0.382 | 0.334 | N/A |
| Continuous insulation | — | — | — | — | — |
| R-5ci | 0.141 | 0.127 | 0.113 | 0.099 | N/A |
| R-7.5ci | 0.104 | 0.094 | 0.083 | 0.073 | — |
| R-10ci | 0.083 | 0.074 | 0.066 | 0.058 | — |
| R-15ci | 0.058 | 0.053 | 0.047 | 0.041 | — |
| R-20ci | 0.045 | 0.041 | 0.036 | 0.032 | — |
| R-25ci | 0.037 | 0.033 | 0.030 | 0.026 | — |

**APPENDIX RF—ALTERNATIVE BUILDING THERMAL ENVELOPE INSULATION R-VALUE OPTIONS**

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| --- | --- | --- | --- | --- | --- |
| **TABLE RF105.1—*U*-FACTORS FOR BASEMENT AND CRAWL SPACE WALLSa—continued** | | | | | |
| **INSULATION CONFIGURATIONSb** | **WALL *U*-FACTORc**  **(Btu/h × ft2 × °F)** | **WALL EFFECTIVE *U*-FACTORd BY PERCENTAGE OF WALL HEIGHT PROJECTING ABOVE GRADE (Btu/h × ft2 × °F) FOR USE ONLY WITH SECTION R402.1.5** | | | |
| **Crawl space walls** | | | | | |
| Cavity insulation | — | — | — | — | — |
| R-11 | 0.083 | 0.074 | 0.066 | 0.058 | N/A |
| R-13 | 0.072 | 0.065 | 0.058 | 0.051 | — |
| R-15 | 0.065 | 0.058 | 0.052 | 0.045 | — |
| R-19 | 0.054 | 0.049 | 0.043 | 0.038 | — |
| R-21 | 0.048 | 0.043 | 0.038 | 0.033 | — |
| Cavity + continuous insulation | — | — | — | — | — |
| R-13 + R-5ci | 0.053 | 0.048 | 0.043 | 0.037 | N/A |
| R-13 + R-7.5ci | 0.047 | 0.042 | 0.038 | 0.033 | — |
| R-13 + R-10ci | 0.042 | 0.038 | 0.034 | 0.029 | — |
| R-19 + R-5ci | 0.043 | 0.038 | 0.034 | 0.030 | — |
| R-19 + R-7.5ci | 0.039 | 0.035 | 0.031 | 0.027 | — |
| R-19 + R-10ci | 0.035 | 0.032 | 0.028 | 0.025 | — |
| N/A = Not Applicable.  For SI: 1 British thermal unit per hour per square foot per °Fahrenheit = 5.6783 W/m2 × K.   1. The wall *U*-factor excludes exterior the air-film *R*-value and, for insulated assemblies, includes the following: R-0.68 for interior air film, R-0.45 for 1/2-inch gypsum panel finish (insulated basement walls only), and R-2.1 for 12-inch block basement wall or R-1.4 for 8-inch block crawl space wall, both with empty cells. Where cavity insulation is included between 2 × 4 or 2 × 6 framing on the interior side of a foundation wall, wood stud material with thermal resistivity of R-1.25/in is assumed to be spaced at not less than 16 inches on center with an assumed framing factor not greater than 0.15. 2. All insulation configurations extend from the top of the foundation wall to the floor of the basement or crawl space. Extrapolation to partial height insulation shall not be permitted; *U*-factors for such insulation configurations shall be determined by accepted engineering practice for modeling of thermal bridging and ground-coupled assemblies. 3. Applicable to Sections R402.1.2, R405 and R406. 4. Effective *U*-factors are adjusted to account for ground-coupling effects to provide equivalency to *U*-factors used for above-grade building thermal envelope assemblies. The effective *U*-factors are provided for use with Section R402.1.5 for evaluation of trade-offs with above-grade assemblies and other components of the building thermal enve- lope. The effective *U*-factor shall apply to the foundation wall area from the interior floor or ground surface to the top of the wall. Interpolation between *R*-values and percentage of wall height projecting above grade within a given insulation configuration type is permitted. | | | | | |

SECTION RF106—SLABS-ON-GRADE

**RF106.1 Slabs-on-grade.** *F*-factors for unheated and heated slabs-on-grade shall be as specified in Table RF106.1. All applicable adjustment factors in the table notes shall apply. *F*-factors for basement floor slabs and crawl space ground surfaces located below exterior grade shall be adjusted in accordance Note f as applicable.

|  |  |
| --- | --- |
| **TABLE RF106.1—*F*-FACTORS FOR SLABS-ON-GRADEa, b, c, d, e, f** | |
| **UNHEATED SLABS-ON-GRADE: INSULATION CONFIGURATIONS** | ***F*-FACTOR (Btu/h × ft × ºF)** |
| Uninsulated slab | — |
| Horizontal insulation under slab at slab perimeter—slab edge not insulated | — |
| ≥ R-5 for 2 ft | 0.70 |
| R-5 for 4 ft | 0.67 |
| ≥ R-10 for 4 ft | 0.64 |
| Vertical insulation on exterior faceg—slab edge insulatedh | — |
| R-2.5 for 2 ft | 0.66 |
| R-5 for 2 ft | 0.58 |
| R-7.5 for 2 ft | 0.56 |
| R-10 for 2 ft | 0.54 |
| R-15 for 3 ft | 0.52 |
| R-5 for 3 ft | 0.56 |
| R-7.5 for 3 ft | 0.54 |
| R-10 for 3 ft | 0.51 |
| R-15 for 3 ft | 0.49 |
| R-5 for 4 ft | 0.54 |

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| **TABLE RF106.1—*F*-FACTORS FOR SLABS-ON-GRADEa, b, c, d, e, f—continued** | |
| **UNHEATED SLABS-ON-GRADE: INSULATION CONFIGURATIONS** | ***F*-FACTOR (Btu/h × ft × °F)** |
| R-7.5 for 4 ft | 0.51 |
| R-10 for 4 ft | 0.48 |
| R-15 for 4 ft | 0.45 |
| Fully insulated slab—full slab area and slab edge continuously insulated | — |
| R-5 entire slab area and R-3.5 edge | 0.48 |
| R-5 entire slab area and edge | 0.46 |
| R-7.5 entire slab area and R-3.5 edge | 0.45 |
| R-7.5 entire slab area and edge | 0.41 |
| R-10 entire slab area and R-5 edge | 0.40 |
| R-10 entire slab area and edge | 0.36 |
| R-15 entire slab area and R-5 edge | 0.35 |
| R-15 entire slab area and edge | 0.30 |
| R-10 slab edge and under slab perimeter inward 4 ft; R-5 remaining slab area | 0.42 |
| R-15 slab edge and under slab perimeter inward 4 ft; R-5 remaining slab area | 0.40 |
| R-15 slab edge and under slab perimeter inward 4 ft; R-10 remaining slab area | 0.34 |
| **HEATED SLABS-ON-GRADE: INSULATION CONFIGURATIONS** | ***F*-FACTOR (Btu/h × ft × °F)** |
| Uninsulated | 1.35 |
| Fully insulated slab—full slab area and slab edge continuously insulated | — |
| R-5 entire slab area and R-3.5 edge | 0.77 |
| R-5 entire slab area and edge | 0.74 |
| R-7.5 entire slab area and R-3.5 edge | 0.71 |
| R-7.5 entire slab area and edge | 0.64 |
| R-10 entire slab area and R-5 edge | 0.62 |
| R-10 entire slab area and edge | 0.55 |
| R-15 entire slab area and R-5 edge | 0.54 |
| R-15 entire slab area and edge | 0.44 |
| R-20 entire slab area and R-7.5 edge | 0.44 |
| R-20 entire slab area and edge | 0.37 |
| R-5 entire slab area and R-10 slab edge extending downward for minimum 3 ft | 0.66 |
| R-10 slab edge and under slab perimeter inward 4 ft; R-5 remaining slab area | 0.66 |
| R-15 slab edge and under slab perimeter inward 4 ft; R-5 remaining slab area | 0.62 |
| R-15 slab edge and under slab perimeter inward 4 ft; R-10 remaining slab area | 0.51 |
| For SI: 1 British thermal unit per hour per square foot per °Fahrenheit = 5.6783 W/m2 × K.   1. For alternative slab-on-grade insulation configurations, *F*-factors shall be determined in accordance with accepted engineering practice for modeling three-dimensional ground-coupled building assemblies using project-specific building and site conditions to estimate annual energy use attributed to foundation heat transfer and converting the result to an equivalent air-to-air *F*-factor basis. 2. Interpolation between *R*-values for a given insulation configuration type is permitted. 3. Tabulated *F*-factors are based on a typical soil thermal conductivity of 0.75 Btu/h × ft × °F and shall be multiplied by one of the following adjustment factors as applicable to site soil conditions: (1) rock or any soil on sites with poor drainage or high water table, 1.2; (2) sandy soils, 1.1; (3) loam or clay soils on well-drained sites in dry climate zones*,* 0.85; and (4) for all other soil or site conditions, 1.00. Where soil conditions are unknown, use of 1.00 is permitted. 4. Tabulated *F*-factors are based on a slab area to perimeter length ratio of 9:1 and shall be multiplied by one of the following adjustment factors as applicable to a slab’s area to perimeter length ratio: 5:1, 0.7; 6:1, 0.8; 7:1, 0.9; 8:1, 0.95; 9:1, 1.0; 10:1, 1.05; 15:1, 1.2; 20:1, 1.35; 30:1, 1.5; and for ≥ 40:1, 1.7. 5. Tabulated *F*-factors are based on a slab perimeter edge projection above exterior finish grade of 6 inches. For portions of slab perimeter projecting 12 inches or more above grade, multiply the tabulated *F*-factors by one of the following adjustment factors as applicable: less than 12 inches, 1.0; 12 inches, 1.05; 18 inches, 1.1; 24 inches, 1.15; and 30 inches, 1.2. 6. For basement floor slabs, crawl space slabs or gravel floors, the tabulated *F*-factors shall be multiplied by one of the following adjustment factors based on the depth of the floor surface below exterior finish grade: less than 1 foot, 1.0; 1 foot, 0.95; 3 feet, 0.9; and 6 feet or more, 0.8. 7. Vertical insulation on the exterior shall extend for the indicated depth below finish grade and above grade to the top of the slab or stem wall. Where insulation is placed on the interior side of a foundation stem wall, it shall extend from the top of the slab to the indicated depth below the exterior finish grade and the applicable tabulated *F*-factor shall be multiplied by 1.05. 8. The *R*-value of the vertical insulation located on the interior side of a stem wall shall be permitted to be reduced to R-2.5 at the slab edge, not exceeding 6 inches thick, provided that the applicable *F*-factor is multiplied by 1.15 where R-5 vertical insulation is specified, 1.2 where R-10 vertical insulation is specified, or 1.25 where R-15 vertical insulation is specified. | |

### 2024 IECC STRETCH CODE



APPENDIX

**RG**

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

**User notes:**

***About this appendix:*** *This appendix provides requirements for residential buildings intended to result in lower energy consumption compared to adoption of the residential provisions of this code. Where adopted by ordinance as a requirement, Section RG101.1 language is intended to replace Section R405.2, Section RG101.2 language is intended to replace Section R406.5, and Section RG101.3 language is intended to replace Section R408.2. Where those sections of the code have been amended for other purposes, this appendix is only intended to increase the number of credits required in the Prescriptive path, to increase the energy cost savings in the Simulated Performance path, and to lower the maximum ERI in the ERI path.*

***ICC Council Policy-49 Note:*** *This voluntary appendix is intended for adopting authorities that wish to extend beyond the mandatory provisions of this code toward Zero Net Energy goals. For jurisdictions in the United States, compliance options appear to be available but may be limited in Climate Zones 0-3 if using only minimum efficiency mechanical and service water heating equipment. Adopting authorities may need to consider alternative means to expand methods for compliance under these conditions (see Section R104.1).*

SECTION RG101—COMPLIANCE

**RG101.1 (R405.2) Simulated building performance compliance.** Compliance based on *simulated building performance* requires that a *building* comply with the following:

1. The requirements of the sections indicated within Table R405.2.
2. The proposed total *building thermal envelope* thermal conductance, TC, shall be less than or equal to the *building thermal envelope* TC using the prescriptive *U*-factors and *F*-factors from Table R402.1.2 multiplied by 1.08 in Climate Zones 0, 1 and 2, and 1.15 in Climate Zones 3 through 8 in accordance with Equation 4-2 and Section R402.1.5. The area-weighted maximum fenestration SHGC permitted in Climate Zones 0 through 3 shall be 0.30.
3. For each *dwelling unit* with one or more fuel-burning appliances for space heating, water heating, or both, the annual *energy cost* of the *dwelling unit* shall be less than or equal to 70 percent of the annual *energy cost* of the *standard reference design*. For all other *dwelling units*, the annual *energy cost* of the *dwelling unit* shall be less than or equal to 75 percent of the annual *energy cost* of the *standard reference design*. For each *dwelling unit* with greater than 5,000 square feet (465 m2) of *living space* located above *grade plane*, the annual *energy cost* of the *dwelling unit* shall be reduced by an additional 5 percent of annual *energy cost* of the *standard reference design*. Energy prices shall be taken from an *approved source*, such as the US 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 2.51. The source energy multiplier for fuels other than electricity shall be 1.09.
  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*.

**RG101.2 (R406.5) ERI-based compliance.** Compliance based on an *Energy Rating Index* (ERI) analysis requires that the *rated design* and each confirmed as-built *dwelling unit* be shown to have an *ERI* less than or equal to the applicable value indicated in Table RG101.2 where 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 WITH OPP applies.

Exceptions:

* 1. Where the ERI analysis excludes on-site power production (OPP), the maximum ENERGY RATING INDEX NOT INCLUDING OPP shall be permitted.
  2. For *buildings* with 20 or more *dwelling units*, where *approved* by the *code official*, compliance shall be permitted using the Average Dwelling Unit *Energy Rating Index*, as calculated in accordance with ANSI/RESNET/ICC 301.

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| **TABLERG101.2 (R406.5)—MAXIMUM ENERGY RATING INDEX** | | |
| **CLIMATE ZONE** | **ENERGY RATING INDEX NOT INCLUDING OPP** | **ENERGY RATING INDEX WITH OPP** |
| 0 and 1 | 46 | 27 |
| 2 | 46 | 26 |

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| --- | --- | --- |
| **TABLERG101.2 (R406.5)—MAXIMUM ENERGY RATING INDEX—continued** | | |
| **CLIMATE ZONE** | **ENERGY RATING INDEX NOT INCLUDING OPP** | **ENERGY RATING INDEX WITH OPP** |
| 3 | 45 | 24 |
| 4 | 48 | 32 |
| 5 | 49 | 37 |
| 6 | 48 | 39 |
| 7 | 47 | 43 |
| 8 | 47 | 43 |

**RG101.3 (R408.2) Additional energy efficiency credit requirements.** *Residential buildings* shall earn not less than 20 credits from not less than two measures specified in Table R408.2. Five additional credits shall be earned for *dwelling units* with more than 5,000 square feet (465 m2) of *living space* located above *grade plane*. To earn credit as specified in Table R408.2 for the applicable *climate zone*, each measure selected for compliance shall comply with the applicable subsections of Section R408. Each *dwelling unit* or *sleeping unit* shall comply with the selected measure to earn credit. Interpolation of credits between measures shall not be permitted.

### OPERATIONAL CARBON RATING AND ENERGY REPORTING



APPENDIX

**RH**

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

**User notes:**

***About this appendix:*** *This appendix provides a means to evaluate a building’s greenhouse gas performance determined in accordance with*

*ANSI/RESNET/ICC 301.*

SECTION RH101—GENERAL DEFINITIONS

**CO2e INDEX.** A numerical integer value, calculated in accordance with ANSI/RESNET/ICC 301, that represents the relative Carbon Diox- ide equivalence (CO2e) emissions of a *rated design* as compared with the CO2e emissions of the CO2e reference design, where an Index value of 100 represents the CO2e performance of the CO2e reference design and an Index value of 0 (zero) represents a home that emits zero net CO2e annually.

SECTION RH102—COMPLIANCE

**RH102.1 Application (replaces Section R401.2).** *Residential buildings* shall comply with Section R406.

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

**RH102.2 Certificate (replaces Section R401.3).** 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, *base- ment 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 thermal 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 thermal 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 or electric baseboard heaters.
5. Where on-site photovoltaic panel systems have been installed, the array capacity, inverter efficiency, panel tilt and orienta- tion shall be noted on the certificate.
6. For *buildings* where an *Energy Rating Index* score is determined in accordance with Section R406, the *Energy Rating Index*

score and *CO2e Index*, both with and without any on-site generation, shall be listed on the certificate.

1. The code edition under which the structure was permitted.
2. Where a *solar-ready zone* is provided, the certificate shall indicate the location and dimensions.

**RH102.3 ERI and CO2e Index compliance (replaces Section R406.2).** Compliance based on the *ERI* and *CO2e Index* requires that the

*rated design* and as-built *dwelling unit* meet all of the following:

1. The requirements of the sections indicated in Table R406.2.
2. Maximum *ERI* values indicated in Table R406.5.
3. For all-electric *dwelling units*, maximum *CO2e Index* of 65, not including OPP, determined in accordance with ANSI/RESNET/ICC 301. For mixed-fuel *dwelling units*, a maximum *CO2e Index* established at the time of adoption of this appendix by the authority having jurisdiction based on the CO2e emissions data specific to the jurisdiction.

**RH102.4 Confirmed compliance report for a certificate of occupancy (replaces Section R406.7.2.2).** 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* and *CO2e Index* on title page and on *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 *ERI reference design* and the as- built *dwelling unit*.
6. A final confirmed certificate indicating that the as-built *building* has been verified to comply with Sections R406.2, R406.4 and R406.5. The certificate shall report the energy features that were confirmed to be in the *building*, including component-

level insulation *R*-values or *U*-factors; results from any required *duct system* and *building thermal envelope* air leakage test- ing; and the type and rated efficiencies of the heating, cooling, mechanical *ventilation* and service water-heating equipment installed. The certificate shall report the estimated *dwelling unit* energy use by fuel type, inclusive of all end uses. Where *on- site renewable energy* systems have been installed on or in the *building*, the certificate shall report the type and production size of the installed system.

### ON-SITE RENEWABLE ENERGY



APPENDIX

**RI**

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

**User notes:**

***About this appendix:*** *This proposal describes requirements for prescriptive solar PV that must be installed at the time of construction.*

SECTION RI101—GENERAL

**RI101.1 Scope.** These provisions shall apply where *on-site renewable energy* is required.

SECTION RI102—GENERAL DEFINITIONS

**ANNUAL SOLAR ACCESS.** The ratio of annual solar insolation with shade to the annual solar insolation without shade. Shading from obstructions located on the roof or any other part of the *building* are not included in the determination of annual solar access. Shading from existing permanent natural or person-made obstructions that are external to the *building*, including but not limited to trees, hills and adjacent structures, are included in annual solar access calculations.

**PHYSICAL RENEWABLE ENERGY POWER PURCHASE AGREEMENT.** A contract for the purchase of renewable electricity from a specific renewable electricity generator to a purchaser of renewable electricity.

**POTENTIAL SOLAR AREA ZONE.** The combined area of any *steep slope* roofs oriented between 90 degrees and 300 degrees of true north and any *low slope* roofs where the *annual solar access* is 70 percent or greater.

SECTION RI103—ON-SITE RENEWABLE ENERGY

**RI103.1 General.** *Buildings* shall comply with Section R401.2 and the requirements of this section.

**RI103.1.1 Installed capacity.** An *on-site renewable energy* system shall be installed on, or at the site of, the *building* with a peak rated capacity, measured under standard test conditions, in accordance with one of the following:

* 1. For one- and two- family dwellings, townhouses and other Group R-3 occupancies, the peak rated capacity shall be not less than 2 kW.
  2. For Group R-2 or R-4 residential buildings, the peak rated capacity shall be not less than 0.75 watts per square foot (8.07 W/m2) multiplied by the gross *conditioned floor area*.
  3. Where a *building* includes both commercial occupancies and R-2 or R-4 occupancies required to comply with this code, the peak capacity shall be not less than 0.75 watts per square foot (8.07 W/m2) multiplied by the gross *conditioned floor area* of the Group R-2 and R-4 occupancies.

The capacity of installed *on-site renewable energy* systems used to comply with this appendix shall be in addition to the total capacity of installed *on-site renewable energy* systems used to comply with all other requirements of this code.

Exceptions:

* + 1. A *building* with a permanently installed domestic solar water heating system sized with a solar savings fraction of not less than 0.5 based on the total *service water heating* load of all residential occupancies.
    2. One- and two-family dwellings, townhouses and other Group R-3 Occupancies in Climate Zone 4C, 5C or 8.
    3. Group R-2 or R-4 occupancies in Climate Zone 8.
    4. *Buildings* where the potential solar zone area is less than 300 square feet (28 m2).
    5. *Buildings* with a *physical 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. This exception shall not apply where off-site renewable energy credits are used to comply with the requirements of Section R408.
    6. *Buildings* that demonstrate compliance in accordance with Section RI103.1.1.1.

**RI103.1.1.1 Alternate capacity determination.** Where compliance is demonstrated in accordance with Section R405 and the *proposed design* and *standard reference design* are adjusted in accordance with Items 1 and 2, the required capacity of the installed renewable energy systems shall be permitted to differ.

1. *Proposed Design*. Where applicable, the *proposed design* shall comply with one of the following:
   1. Where one or more systems providing *on-site renewable energy* are included in the *construction documents*, the systems shall be modeled in the *proposed design* with a design capacity not greater than the required capacity in accordance with Section RI103.1.1. A combination of *on-site renewable energy* systems shall be permitted to be included in the *proposed design*.
   2. Where no *on-site renewable energy* systems are specified in the *construction documents*, no *on-site renew- able energy* systems shall be modeled in the *proposed design*.
2. *Standard Reference Design*. Where applicable, the *standard reference design* shall comply with one of the following:
   1. Where a *proposed design* includes one or more *on-site renewable energy* systems, the same systems shall be modeled identically in the *standard reference design* except the total rated capacity of all systems shall be equal to the required capacity in accordance with Section RI103.1.1. Where more than one type of *on-site renewable energy* system is modeled, the total capacity of each system shall be allocated in the same proportion as in the *proposed design*.
   2. Where the *proposed design* does not include any *on-site renewable energy* systems, an unshaded photovol- taic system shall be modeled in the *standard reference design* in accordance with the performance criteria in Table RI103.1.1.1.

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| **TABLE RI103.1.1.1—PERFORMANCE CRITERIA FOR STANDARD REFERENCE DESIGN PHOTOVOLTAIC SYSTEMS** | |
| **CRITERIA** | **DESIGN MODEL** |
| Size | Rated capacity not less than required in accordance with Section RI103.1.1. |
| Module type | Crystalline silicon panel with a glass cover, 19.1% nominal efficiency and temperature coefficient (Tc Power) of -0.37%/°C. |
| Array type | Rack-mounted array with installed nominal operating cell temperature (INOCT) of 103°F (45°C). |
| Total system losses (DC output) | 11.3% |
| Tilt | 0 degrees (mounted horizontally) |
| Azimuth | 180 degrees |
| For SI: °C = [(°F) – 32]/1.8. | |

**RI103.1.2 ERI with OPP requirements.** Where compliance is demonstrated in accordance with Section R406.5 using the *Energy Rating Index* with OPP, a project shall comply with the requirements of this appendix if the rated *proposed design* and confirmed built dwelling are shown to have an *ERI* less than or equal to the values in Table RI103.1.2.

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| **TABLE RI103.1.2—MAXIMUM ENERGY RATING INDEX INCLUDING OPP** | |
| **CLIMATE ZONE** | **ENERGY RATING INDEX WITH OPP** |
| 0 and 1 | 35 |
| 2 | 34 |
| 3 | 33 |
| 4 | 40 |
| 5 | 43 |
| 6 | 43 |
| 7 and 8 | 46 |

**RI103.2 Renewable energy certificate (REC) documentation.** Where *renewable energy certificates* (RECs) are associated with renewable energy power production required documentation shall comply with Section R404.4.

### DEMAND RESPONSIVE CONTROLS



APPENDIX

**RJ**

*This Appendix is adopted into the 2025 Illinois Residential Stretch Energy Code and is mandatory~~. The provisions contained in this appendix are not mandatory unless specifically referenced in the adopting ordinance.~~*

**User notes:**

***~~About this appendix:~~*** *~~This appendix can by adopted by authorities having jurisdiction seeking demand responsive controls to be integrated into water heating systems.~~*

SECTION RJ101—DEMAND RESPONSIVE WATER HEATING

**RJ101.1 Demand responsive water heating.** Electric storage water heaters with a rated water storage volume of 40 gallons (150 L) to 120 gallons (450 L) and a nameplate input rating equal to or less than 12 kW shall be provided with *demand responsive controls* in accordance with Table RJ101.1.

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 three-phase electric power.

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| **TABLE RJ101.1—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 | AHRI 1430 (I-P) or 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. | AHRI 1430 (I-P). |

**SECTION RJ102—DEMAND RESPONSIVE HEATING & COOLING SYSTEM**

**RJ102.1 Demand responsive thermostat.** The thermostat 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 homeowner 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 R403.1.2.1. Thermostats controlling variable capacity systems shall comply with Section R403.1.2.2. Thermostats controlling multi-stage HVAC systems shall comply with either Section R403.1.2.1 or R403.1.2.2. Where a *demand response signal* is not available the thermostat shall be capable of performing all other functions.

**Exception:** Assisted living facilities.

**RJ102.1.1 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, Conformance.
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. The communication protocol required by a controlling entity, such as a utility or service provider, to participate in an automated demand response program.
6. The physical configuration and communication protocol of CTA 2045-A or CTA-2045-B.

RJ102.1.1.2 Variable capacity and two stage HVAC system controls. Thermostats controlling variable capacity and two stage HVAC system shall be provided with a *demand responsive control* that complies with the communication and performance requirements of AHRI 1380.

SECTION RJ10~~2~~3—REFERENCED STANDARDS

**RJ10~~2~~3.1 General.** See Table RJ10~~2~~3.1 for standards that are referenced in various sections of this appendix. Standards are listed by the standard identification with the effective date, the standard title, and the section or sections of this appendix that reference this standard.

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| **TABLE RJ10~~2~~3.1—REFERENCED STANDARDS** | | |
| **STANDARD ACRONYM** | **STANDARD NAME** | **SECTIONS HEREIN REFERENCED** |
| AHRI 1430—2022 (I-P) | *Demand Flexible Electric Storage Water Heaters* | Table RJ101.1 |
| ASME BPVC | *ASME Boiler and Pressure Vessel Code* | RJ101.1 |

### ELECTRIC-READY RESIDENTIAL BUILDING PROVISIONS



APPENDIX

**RK**

*This Appendix is adopted into the 2025 Illinois Residential Stretch Energy Code and is mandatory. ~~The provisions contained in this appendix are not mandatory unless specifically referenced in the adopting ordinance~~.*

**User notes:**

***~~About this appendix:~~*** *~~This appendix can by adopted by authorities having jurisdiction seeking electrification readiness.~~*

SECTION RK101—ELECTRIC READINESS

**RK101.1 Electric readiness.** Water heaters, household clothes dryers, ~~and~~ cooking appliances and space heating equipment that use *fuel gas*

or *liquid fuel* shall comply with Sections RK101.1.1 through RK101.1.4.

**RK101.1.1 Cooking appliances.** A dedicated branch circuit outlet with a rating not less than 240 volts and not less than 40 amperes shall be installed and terminate within 3 feet (914 mm) of conventional cooking tops, conventional ovens or cooking appliances combining both.

**Exception:** Cooking appliances not installed in an individual *dwelling unit*.

**RK101.1.2 Household clothes dryers.** A dedicated branch circuit with a rating not less than 240 volts and not less than 30 amperes shall be installed and terminate within 3 feet (914 mm) of each household clothes dryer.

**Exception:** Clothes dryers not installed in an individual *dwelling unit*.

**RK101.1.3 Water heaters.** Locations of fossil fuel water heaters shall comply with all of the following:

1. An individual branch circuit outlet with a rating not less than either 240-volts, 30-amperes shall be installed, and terminate within three feet (304 mm) of each fossil fuel water heater.
2. The space for containing the future water heater shall have a height of not less than 7 ft (2 m), a width of not less than 3 ft (1 m), a depth of not less than 3ft (1 m) and with a volume of not less than 700 ft3 (20 m3).

**Exception:**

1. Water heaters in a centralized water heating system serving multiple dwelling units in an R-2 occupancy which comply with Section C405.17.
2. Where the space containing the water heater provides for air circulation sufficient for the operation of a heat pump water heater, the minimum room volume shall not be required.

~~A dedicated branch circuit with a rating either not less than 240 volts and not less than 30 amperes, or not less than 120 volts and not less than 20 amperes, shall be installed and terminate within 3 feet (914 mm) of each water heater.~~

**~~Exception:~~** ~~Water heaters serving multiple~~ *~~dwelling units~~* ~~in a R-2 occupancy.~~

**RK101.1.4 Combustion space heating.** A designated exterior location(s) in accordance with the following:

1. Natural drainage for condensate from cooling equipment heat pump operation or a condensate drain located within 3 feet (914 mm), and
2. A dedicated branch circuit in compliance with IRC Section E3702.11 based on heat pump space heating equipment sized in accordance with R403.7 and terminating within 3 feet (914 mm) of the location with no obstructions. Both ends of the branch circuit shall be labeled “For Future Heat Pump Space Heater.”

**RK101.1.~~4~~5 Electrification-ready circuits.** The unused conductors required by Sections RK101.1.1 through RK101.1.3 shall be labeled with the word “spare.” Space shall be reserved in the electrical panel in which the branch circuit originates for the instal- lation of an overcurrent device. Capacity for the circuits required by Sections RK101.1.1 through RK101.1.3 shall be included in the load calculations of the original installation.

### RENEWABLE ENERGY INFRASTRUCTURE



APPENDIX

**RL**

*This Appendix is adopted into the 2025 Illinois Residential Stretch Energy Code and is mandatory. ~~The provisions contained in this appendix are not mandatory unless specifically referenced in the adopting ordinance.~~*

**User notes:**

***~~About this appendix:~~*** *~~This appendix provides readiness requirements for renewable energy infrastructure.~~*

SECTION RL101—RENEWABLE ENERGY INFRASTRUCTURE

**RL101.1 Renewable energy infrastructure.** The *building* shall comply with the requirements of Section RL101.1.1 or RL101.1.2.

**RL101.1.1 One- and two-family dwellings and townhouses.** One- and two-family dwellings and town- houses shall comply with Sections RL101.1.1.1 through RL101.1.1.4.

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 m2) of roof area oriented between 110 degrees (1.92 rad) and 270 (4.71 rad) degrees of true north.
3. A *dwelling unit* with less than 500 square feet (46 m2) of roof area oriented between 110 degrees and 270 degrees of true north.
4. *Dwelling units* where 50 percent of the *solar-ready zone* area is shaded from direct-beam sunlight by natural objects or by structures that are not part of the *building* for more than 2,500 annual hours between 8:00 a.m. and 4:00 p.m.
5. A *dwelling unit* that complies with Appendix RC.
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 *dwelling unit* whole- building electric use on an annual basis.
7. A *dwelling unit* with less than or equal to 1,500 square feet (139 m2) of *living space* located above *grade plane*.

**RL101.1.1.1 Solar-ready zone area.** The total area of the *solar-ready zone* shall not be less than 250 square feet (23.2 m2) 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 m2) 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 m2) per dwelling shall be permitted to have a solar-ready zone area of not less than 150 square feet (14 m2).

**RL101.1.1.2 Obstructions.** *Solar-ready zones* shall be free from obstructions, including but not limited to vents, chimneys and roof-mounted equipment.

**RL101.1.1.3 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 Renewable Electric.” The reserved space shall be at the opposite (load) end of the busbar from the primary energy source.

**RL101.1.1.4 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 nonflexible metallic conduit not less than 1 inch (25 mm) in diameter or by permanently installed wire as *approved*. Where the interconnection terminates in the attic, the location shall be not less than 12 inches (35 mm) above ceiling insulation. Both ends of the interconnection shall be labeled “For Future Renewable Electric.”

**RL101.1.2 Group R occupancies.** Buildings in Group R-2, R-3 and R-4 occupancies shall comply with Section C405.15 of *the Illinois Commercial Stretch Energy Code*.~~Residential~~ *~~buildings~~* ~~other than one- and two-family dwellings and townhouses shall comply with Sections RL101.1.2.1 through RL101.1.2.8.~~

**~~RL101.1.2.1 General.~~** ~~A~~ *~~solar-ready zone~~* ~~shall be located on the roof of residential~~ *~~buildings~~* ~~that are oriented between 110 degrees and 270 degrees of true north or have~~ *~~low slope~~* ~~roofs.~~ *~~Solar-ready zones~~* ~~shall comply with Sections RL101.1.2.2 through RL101.1.2.8.~~

~~Exceptions:~~

* 1. ~~A~~ *~~building~~* ~~with a permanently installed on-site renewable energy system.~~
  2. ~~A~~ *~~building~~* ~~with a~~ *~~solar-ready zone~~* ~~area that is shaded for more than 70 percent of daylight hours annually.~~
  3. ~~A~~ *~~building~~* ~~where an~~ *~~approved~~* ~~party certifies that the incident solar radiation available to the~~ *~~building~~* ~~is not suit- able for a~~ *~~solar-ready zone~~*~~.~~
  4. ~~A~~ *~~building~~* ~~where an~~ *~~approved~~* ~~party certifies that the~~ *~~solar-ready zone~~* ~~area required by Section RL101.1.2.3 cannot be met because of rooftop equipment, skylights, vegetative roof areas or other obstructions.~~
  5. ~~A~~ *~~building~~* ~~that complies with Appendix RC.~~
  6. ~~A~~ *~~building~~* ~~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 electric use of the residential occupancy portion of the building on an annual basis.~~

**~~RL101.1.2.2 Construction document requirements for a~~ *~~solar-ready zone~~*~~.~~** *~~Construction documents~~* ~~shall indicate the~~ *~~solar- ready zone~~*~~.~~

**~~RL101.1.2.3 Solar-ready zone area.~~** ~~The total~~ *~~solar-ready zone~~* ~~area shall be not less than 40 percent of the roof area calcu- lated as the horizontally projected gross roof area less the area covered by penthouses, mechanical equipment, rooftop structures, skylights, occupied roof decks, vegetative roof areas and mandatory access or set back areas as required by the~~ *~~International Fire Code~~*~~. The~~ *~~solar-ready zone~~* ~~shall be a single area or smaller, separated sub-zone areas. Each sub-zone shall be not less than 5 feet (1524 mm) in width in the narrowest dimension.~~

**~~RL101.1.2.4 Obstructions.~~** *~~Solar-ready zones~~* ~~shall be free from obstructions, including pipes, vents, ducts, HVAC equipment, skylights and roof-mounted equipment.~~

**~~RL101.1.2.5 Roof loads and documentation.~~** ~~A collateral dead load of not less than 5 pounds per square foot (24.41 kg/m~~~~2~~~~) shall be included in the gravity and lateral design calculations for the~~ *~~solar-ready zone~~*~~. The structural design loads for roof dead load and roof live load shall be indicated on the~~ *~~construction documents~~*~~.~~

**~~RL101.1.2.6 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.~~

**~~RL101.1.2.7 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 and shall be labeled “For Future Renewable Electric.” The reserved spaces shall be positioned at the end of the panel that is opposite from the panel supply conductor connection.~~

**~~RL101.1.2.8 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.~~

**Above-Grade Wall** R202

**Access (to)** R202

**Access Hatches** R402.2.5 **Accessible** R202 **Addition**

Defined R202 Requirements R502

**Administration** Chapter 1

**Air Barrier**

Installation R402.5.1.1, Table R402.5.1.1

Testing R402.5.1.2

**Air Infiltration**

Requirements R402.5.1.2

### INDEX

**Climate Types**

Defined R301.3

**Climate Zone** R202

**Climate Zones** R301, Figure R301.1, Table R301.1

By state or territory Figure R301.1, Table R301.1

International climate zones R301.3, Table R301.3

Tropical R301.4

Warm humid Table R301.1, R301.2, Table R301.3

**Code Official** R202

**Commercial Building**

**Duct**

Opaque R402.4.4 Performance requirements

Table R405.4.2(1)

SHGC values Table R402.1.3

*U*-factors R402.1.4

Defined R202

Insulation R105.2, R401.3, R403.3.3, R403.3.4, R403.3.5

Sealing R105.2, R403.3.6

Tightness verification Postconstruction test R403.3.7 Rough-in test R403.3.7

Within conditioned space R403.3.4

**Air Leakage** R402.5, R403.3.7, R403.3.8

**Air-Handling Unit** R202, R403.3.6, R403.3.6.1, Table R403.3.8, Table R403.6.2

**Air-Impermeable Insulation** R202

**Alteration**

Defined R202 Requirements R503

**Alternate Materials** R104 **Approved** R202 **Approved Agency** R202

**Approved Source** R202, Table R402.1.2, R405.2, R405.4.3, Table R503.1.1.2

**Automatic** R202

**Automatic Shut-Off Control** R202, R404.2.1, R404.2.2

**Balanced Ventilation System** R202, R403.6.1, R403.6.2, Table R403.6.2, R408.2.5, Table R408.2

**Basement Wall**

Defined R202 Requirements R303.2.1,

Table R402.1.3, R402.2.9.1, Table R405.4.2(1)

**Biodiesel Blend** R202 **Biogas** R202 **Biomass** R202

**Board of Appeals** R109

Qualifications of members R109.3

**Building** R202

**Building Site** R202

**Building Thermal Envelope**

Air tightness R402.5.1

Compliance documentation R105.2, R401.3

Defined R202 Insulation R303.1.1

Insulation and fenestration criteria R402.1.2

Performance method Table R405.4.2(1)

Requirements R104.1.1, R402

**Cavity Insulation** R202

**Ceilings** R402.2.1, R402.2.2

Specification for standard reference design Table R405.4.2(1)

**Certificate** R401.3

**Change of Occupancy** R505 **Circulating Hot Water System** R202 **Circulation Systems** R403.5.1

Compliance R101.4 Defined R202

**Common Areas** R202

**Compliance and Enforcement** R101.4 Compliance report R405.5.4.2

**Conditioned Floor Area** R202 **Conditioned Space** R202 **Construction Documents** R105

Amended R105.4 Approval R105.3.1 Examination R105.3

Information required R105.2 Phased R105.3.3

Previous R105.3.2 Retention R105.5

Thermal envelope depiction R105.2.1

**Continuous Air Barrier** R202

**Continuous Insulation (ci)** R202 **Continuous Pilot** R202, R403.13, R404.1.5 **Controls**

Heat pump R403.1.2 Heating and cooling R403.1

Service water heating R403.5

**Crawl Space Wall**

Defined R202 Requirements R303.2.1,

Table R402.1.2, Table R402.1.3, R402.1.4, R402.2.11.1, Table R405.4.2(1)

**Curtain Wall** R202

**Damper** R107.2.4, R202, R402.5.1.2, R402.5.2, R403.6

**Default Distribution System Efficiencies**

Table R405.4.2(2)

**Definitions** Chapter 2 **Degree Day Cooling** R301.3 **Degree Day Heating** R301.3

**Demand Recirculation Water System**

Defined R202 Requirements R403.5.1.1.1

**Demand Response Signal** R202, R408.2.8, R408.2.8.1

**Demand Responsive Control** R202, R408.2.8, R408.2.8.1, R408.2.8.2

**Design Conditions** Chapter 3, R302

**Dimmer** R202

**Distribution System Efficiency (DSE)** R202, Table R405.4.2(1)

**Doors**

Attics and crawl spaces R402.2.5 Default *U*-factors Table R303.1.3(2)

**Duct System** R202

**Ductwork** R202, R402.2.9, R403.3, R403.3.2, R403.3.3, R403.3.4, R403.3.5, R403.3.5.1, R403.3.6, R403.3.7, Table R403.3.8,

Table R405.4.2(1), R408.2.4, Table R408.2, R502.2.2, R503.1.2, R503.1.2.1, R503.1.2.3

**Dwelling Unit**

Defined R202 Multiple units R403.8

**Dynamic Glazing** R402.4.2

**Eave Baffle**

Installation R402.2.4 **Electrical Power and Lighting** R404 **Emittance** R202, Table R405.4.2(1),

Table R407.2, R408.2.1.3

**Enclosed Reflective Air Space** R202

**Energy Analysis** R202

**Energy Analysis, Annual** Defined R202 Documentation R405.3 Requirements R405.3

**Energy Cost**

Defined R202

Energy Rating Index R202, R406.4 Energy Rating Index compliance

alternative R406

ERI-based compliance R406.5

**Energy Rating Index (ERI)** R202, R401.2.3, R401.3, R406.1, R406.2, Table R406.2, R406.4, R406.5, Table R406.5

**Energy Recovery Ventilation Systems**

Requirements Table R405.4.2(1) **Energy Simulation Tool** R202 **Envelope, Building Thermal** R202 **Envelope Design Procedures** R402 **Equipment Efficiencies** R105.2, R401.3 **Equipment Room**

For fuel-burning appliance R402.1.6 **ERI Reference Design** R202, R406.2 **Existing Building** R202, R401.2, R501.1,

R501.1.1, R501.2, R502.1, R502.2.5, R503.1,

R503.1.1, R503.1.1.1, R503.1.2.2

**Existing Buildings** Chapter 5

**Exterior Wall**

Defined R202

Thermal performance R402, R402.1.2, Table R405.4.2(1)

**Fees** R106

Refunds R106.6 Related fees R106.5

Schedule of permit fees R106.2

**Fenestration** R303.1.3, R402.4, R402.4.2, R402.5.3

Default *U*-factors Table R303.1.3(1) Defined R202

Rating and labeling R303.1.3, R402.1.2 Replacement R402.4.5

Requirements Table R402.1.3

**Fenestration Product, Site-Built** R202

**F-Factor (Thermal Transmittance)** R202, R402.1.2, Table R402.1.2, R402.1.5, R405.2, R405.4.2, Table R405.4.2(1), R406.3

**Fireplaces** R402.5.2

**Floors**

Above-grade Table R405.4.2(1) Insulation Table R402.5.1.1

Slab-on-grade insulation requirements R402.2.10.1

**Foundations**

Requirements Table R402.5.1.1, Table R405.4.2(1)

**Freeze Protection System Controls**

R403.9.4

**Fuel Gas** R202, R403.1.2, Table R405.4.2(1), R408.2.2, R408.2.2.1

**Fuel Oil** R202, R405.2

**Furnace Efficiency** Table R405.4.2(1)

**Glazed Fenestration** R402.4.2, R402.4.3

**Grade Plane** R101.2, R202, R402.5.1.2, R405.2, R408.2

**Heat Exchanger** R202, R403.9.4

**Heat Pump** R403.1.2

**Heated Slab** R202

**Heating and Cooling Loads** R302.1, R403.1.2

**Historic Building** R202, R501.5

**Hot Water**

Piping insulation R403.5.2

**Hot Water Boiler**

Outdoor temperature setback R403.2

**HVAC Systems**

Tests

Postconstruction R403.3.8 Rough-in-test R403.3.8

**Identification**

**(Materials, Equipment and System)**

R303.1

**Indirectly Conditioned Space** R202

**Infiltration** R202

**Infiltration, Air Leakage** R402.5, Table R405.4.2(1)

Defined R202 **Inspections** R107 **Insulated Siding** R202 **Insulation**

Air-impermeable R202, Table R402.5.1.1

Basement walls R402.2.9.1 Ceilings with attic spaces R402.2.1

Ceilings without attic spaces R402.2.2 Crawl space walls R402.2.11.1

Duct R403.3.3

Eave baffle R402.2.4 Floors R402.2.8

Hot water piping R403.5.2 Identification R303.1, R303.1.2

Installation R303.1.1, R303.1.1.1, R303.1.2, R303.2, Table R402.5.1.1

Masonry veneer R402.2.12 Mass walls R402.2.6

Mechanical system piping R403.4 Product rating R303.1.4 Protection of exposed foundation

R303.2.1

Protection of piping insulation R403.4.1

Requirements Table R402.1.3, R402.2 Slab-on-grade floors R402.2.10

Steel-frame ceilings, walls and floors Table R402.2.6

Sunroom R402.2.13

**Intermittent Ignition** R202, R403.13, R404.1.5

**Interrupted Ignition** R202, R403.13, R404.1.5

**Knee Wall** R202, R402.2.3, Table R402.5.1.1, R405.2

**Labeled**

Defined R202

Requirements R303.1.3, R402.5.3

**Lighting Systems** R404 Recessed R402.5.4, R404

**Liquid Fuel** R202, R403.1.2, R403.2, Table R405.4.2(1)

**Listed** R202

**Living Space** R202, R405.2, R408.2 **Log Homes** R402.1, Table R402.5.1.1 **Low Slope** R202, R407.2, Table R407.2,

R408.2.1.3

**Low-Energy Buildings** R402.1 **Low-Voltage Lighting** R202 **Luminaire**

Sealed R402.5.4

**Maintenance Information** R303.3

**Manual** R202

**Manuals** R101.4.1, R303.3

**Masonry Veneer**

Insulation R402.2.12

**Mass**

Wall R402.2.6

**Materials and Equipment** R303

**Mechanical Systems and Equipment** R403, R405.1

**Mechanical Ventilation** R403.6, R403.6.1, Table R405.4.2(1)

**Multiple Dwelling Units** R403.8

**Occupancy**

Requirements R102.1, R101.4 **Occupant Sensor Control** R202, R404.2 **Occupiable Space** R202

**On-Demand Pilot** R202, R403.13, R404.1.5

**On-Site Renewable Energy** R202, R403.5.1, R403.10.3, R406.3.2, R406.4

**Opaque Door** R202, R402.4.4

**Performance Analysis** R405

**Permit** R202

**Pipe Insulation** R403.4, R403.5.2 **Plans and Specifications** R105 **Plenum** R202, R403.3.2, R403.3.7

**Pools** R403.10

Covers R403.10.3 Heaters R403.10.1

Time switches R403.10.2

**Proposed Design**

Defined R202

Requirements R405, Table R405.4.2(1)

**Pumps**

Time switches R403.5.1.1, R403.10.2

**Radiant Barrier** R202, R303.2.2, R402.3

**Rated Design** R202 **Readily Accessible** R202 **Ready Access (to)** R202

**Referenced Standards** R108, Chapter 6 **Reflective Insulation** R202, R303.1.1 **Renewable Energy Certificate (REC)** R202,

R404.4, R406.7.3, R408.2.7

**Renewable Energy Resources** R202, R408.2.7

**Repair**

Defined R202 Requirements R504

**Reroofing** R202

**Residential Building**

Compliance R101.4 Defined R202

Energy Rating Index alternative R406 Simulated performance alternative

R405

**Roof Assembly**

Defined R202

Requirements R303.1.1.1, R402.2.2, Table R405.4.2(1)

**Roof Recover** R202, R503.1.1 **Roof Repair** R202, R504.2 **Roof Replacement** R202

***R*-Value (Thermal Resistance)** R202

**Scope** R101.2

**Service Hot Water**

Requirements R403.5 **Service Water Heating** R202 **Sheathing, Insulating**

**(see Insulating Sheathing)**

**SHGC (see Solar Heat Gain Coefficient) Shutoff Dampers** R403.6

**Simulated Building Performance** R202, R401.2.2, R405.1

Calculation procedure R405.4 Calculation software tools R405.5 Compliance R405.2

Compliance documentation R405.3

**Sizing**

Equipment and system R405.5.1

**Skylights** R303.1.3, R402.1.2, R402.4, Table R405.4.2(1)

**Sleeping Unit** R202, R402.5.1.2, R402.5.1.2.1, R402.5.1.3, R403.3.1, R403.3.9, R403.6.4,

R404.1.2, Table R405.4.2(1), R408.2,

Table R408.2

**Snow Melt System Controls** R403.9.2

**Solar Heat Gain Coefficient (SHGC)** R105.2, Table R303.1.3(3), R401.3, Table R402.1.3, R402.1.4, R402.4.2, R402.4.3, R402.4.5, R402.6

Defined R202

**Solar-Ready Zone** R105.2.2, R107.2.3, R107.2.5, R202, R401.3

**INDEX**

**Space Conditioning** R202, R402.1, R403.3.4, R403.3.7, Table R403.3.8, Table R405.4.2(1), Table R405.4.2(2), R408.2.4, R501.6

**Space Conditioning Equipment** R202, R403.3.4, R403.3.7, Table R403.3.8, Table R405.4.2(1), Table R405.4.2(2), R408.2.4

**Standard Reference Design**

Defined R202

Requirements R405, Table R405.4.2(1) **Standards, Referenced** Chapter 6, R108 **Steel Framing** R402.2.7

**Steep Slope** R202

**Stop Work Order** R110 Authority R110.1 Emergencies R110.3 Failure to comply R110.4 Issuance R110.2

**Substantial Improvement** R202, R503.1.5

**Sunroom** R402.2.13, R402.4.5, Table R405.4.2(1)

Defined R202 Insulation R402.2.13

**Swimming Pools** R403.10

**Testing Unit Enclosure Area** R202, R402.5.1.2.1, R402.5.1.3, Table R405.4.2(1)

**Thermal Distribution Efficiency (TDE)**

R202, R403.3.3

**Thermal Isolation** R402.2.13, R402.4.5, Table R405.4.2(1)

Defined R202

**Thermal Resistance [see R-value (Thermal Resistance)]**

**Thermal Transmittance [see U-Factor (Thermal Transmittance)]**

**Thermostat**

Controls R403.1 Defined R202

Programmable R403.1.1 **Time Switches** R403.10.2 **Townhouse** R202

**Tropical Climate Region** R301.4, R407.2

***U*-Factor (Thermal Transmittance)** R202

**Validity** R107

**Vapor Retarder** R402.1.1

**Ventilation** R403.6, R403.6.1, Table R405.4.2(1), R407.2

Defined R202 **Ventilation Air** R202 **Visible Transmittance (VT)**

Default glazed fenestration Table R303.1.3(3)

Defined R202

Exterior, defined R202 Mass R402.2.6

Steel-frame Table R402.2.6 With partial structural sheathing

R402.2.8

**Water Heating** R401.3, R403.5, R405.1, Table R405.4.2(1)

**Whole House Mechanical Ventilation System**

Defined R202

System fan efficacy R403.6.2

**Work Area** R202

**Zone** R202

**Wall**

Above-grade, defined R202 Standard reference design

Table R405.4.2(1)

Basement, defined R202 Installation R402.2.9.1 Standard reference design

Table R405.4.2(1)

Crawl space, defined R202 Installation R402.2.11.1 Standard reference design

Table R405.4.2(1)

RESOURCE

**RRA**

### ALL-ELECTRIC RESIDENTIAL BUILDINGS

*Resources are related information that are not part of the code.*

**User notes:**

***About this resource:*** *This resource provides code compliance pathways for residential buildings intended to result in all-electric buildings for adopting jurisdictions or individual projects.*

***ICC Council Policy-49 Note:*** *In considering whether to adopt the content in this resource, jurisdictions in the United States should note that federal law might be found to preempt the provisions it prescribes. See the Public Health and Welfare Act, 42 U.S.C. § 6297: Effect on other law. Whether the content of this resource or a modification thereof is subject to preemption may depend on court decisions or whether a waiver has been issued by the US Department of Energy pursuant to 42 U.S.C. § 6297(d).*

SECTION RRA101—GENERAL

**RRA101.1 Intent.** The intent of this resource 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 equip- ment in buildings.

**RRA101.2 Scope.** This resource applies to new *residential buildings*.

SECTION RRA102—GENERAL DEFINITIONS

**ALL-ELECTRIC BUILDING.** A building that contains no *combustion equipment*, or plumbing for combustion *equip- ment*, 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 or lighting that uses fuel gas or liquid fuel.

**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.

SECTION RRA103—ALL-ELECTRIC RESIDENTIAL BUILDINGS

**RRA103.1 Application.** Residential buildings shall be *all-electric buildings* and comply with Section R401.2.1, R401.2.2, R401.2.3 or R401.2.4