

## CHAPTER 1 [RE]

### SCOPE AND ADMINISTRATION

#### SECTION R101

##### SCOPE AND GENERAL REQUIREMENTS

**R101.1 Title.** This code shall be known as the *Washington State Energy Code-Residential*, and shall be cited as such. It is referred to herein as "this code."

The 2021 edition of the Washington State Energy Code is hereby adopted. The Washington State Energy Code adopted under chapter 51-11R WAC shall become effective in all counties and cities of this state on March 15, 2024

**R101.2 Scope.** This code applies to the design and construction of detached one- and two-family dwellings and multiple single-family dwellings (townhouses). This code also applies to Group R-2, R-3 and R-4 buildings three stories or less in height above *grade plane* with *dwelling units* accessed directly from the exterior. This code shall be the maximum and minimum energy code for residential construction in each town, city and county. Residential *sleeping units*, Group I-1, Condition 2 assisted living facilities licensed by Washington state under chapter 388-78A WAC, Group I-1, Condition 2 residential treatment facilities licensed by Washington state under chapter 246-337 WAC, and Group R-2 buildings with *dwelling units* accessed from interior corridors or other interior spaces shall utilize the commercial building sections of the energy code regardless of the number of stories of height above grade plane.

**R101.3 Intent.** This code shall regulate the design and construction of buildings for the effective use and conservation of energy over the useful life of each building. This code is intended to provide flexibility to permit the use of innovative approaches and techniques to achieve this objective. 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 WSEC - Residential Provisions. *Commercial buildings* shall meet the provisions of WSEC - Commercial 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.

#### 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 WSEC - Commercial Provisions or WSEC - Residential Provisions.

**R102.2 Other laws.** The provisions of this code shall not be deemed to nullify any provisions of local, state or federal law. In addition to the requirements of this code, all occupancies shall conform to the provisions included in the state building code (chapter 19.27 RCW). In case of conflicts among codes enumerated in RCW 19.27.031 (1) through (4) and this code, an earlier named code shall govern over those following. In the case of conflict between the duct sealing and insulation requirements of this code and the duct insulation requirements of Sections 603 and 604 of the *International Mechanical Code*, the duct insulation requirements of this code shall govern.

**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 listed in Chapter 5, 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 differences 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.

## **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 official shall have the authority to approve an alternate 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 efficiency and safety. The code official shall respond in writing, stating the reasons why the alternative was *approved* or was not *approved*.

## **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 upon

suitable material. Electronic media documents are permitted to be submitted when *approved* by the *code official*. Construction documents shall be of sufficient clarity to indicate the location, nature and extent of the work proposed, and show in sufficient detail pertinent data and features of the building, systems and equipment as herein governed. Details shall include, but are not limited to, the following as applicable:

1. Energy compliance path per Section R401.2.
2. Insulation materials and their *R*-values.
3. Fenestration *U*-factors and SHGCs.
4. Area-weighted *U*-factor and SHGC calculations.
5. Mechanical system design criteria.
6. Mechanical and service water heating system and equipment types, sizes and efficiencies.
7. Equipment and systems controls
8. Duct sealing, duct and pipe insulation and location.
9. Air sealing details.
10. Selected efficiency credits per Section R406.

**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 holders 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 in Section R106.2 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.** 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*, which 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 component 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 specifications. 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 R105.2.4.

**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 **or exterior** finish and shall be used to verify compliance with this code as to types of insulation, corresponding *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 not be occupied until *approved*.

**R107.3 Reinspection.** A building shall be reinspected when 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 agencies not affiliated with the building design or construction, provided such agencies are *approved* as to qualifications and reliability relevant to the building components and systems they are inspecting or testing, and approval is granted prior to issuance 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 delegated 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 determination 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 so as 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 have no 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.** Whenever 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 involved, 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 fines established by the authority having jurisdiction.

## **SECTION R111 VIOLATIONS**

It shall be unlawful for any person, firm, or corporation to erect or construct any building, or remodel or rehabilitate any existing building or structure in the state, or allow the same to be done, contrary to or in violation of any of the provisions of this code.

## **SECTION R112 LIABILITY**

Nothing contained in this code is intended to be nor shall be construed to create or form the basis for any liability on the part of any city or county or its officers, employees or agents for any injury or damage resulting from the failure of a building to conform to the provisions of this code.



## CHAPTER 2 [RE]

### DEFINITIONS

#### 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*, *Uniform 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 enclosing *conditioned space* that is not a below-grade wall. This includes between-floor spandrels, peripheral edges of floors, roof and basement knee walls, dormer walls, gable end walls, walls enclosing a mansard roof and skylight shafts.

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

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

**ADVANCED FRAMED WALLS.** Studs framed on 24-inch centers with double top plate and single bottom plate. Corners use two studs or other means of fully insulating corners, and one stud is used to support each header. Headers consist of double 2x material with R-10 insulation between the header and exterior sheathing. Interior partition wall/exterior wall intersections are fully insulated in the exterior wall. (See **Standard Framing** and Appendix CA, of [chapter 51-11C WAC](#).)

**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 building, electrical, gas, mechanical or plumbing system that involves an extension, addition or change to the arrangement, type or purpose of the original installation.

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

**APPROVED AGENCY.** An established and recognized agency that is regularly engaged in conducting tests or 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.** See *above-grade wall* and *below-grade wall*.

**BELOW-GRADE WALL.** That portion of a wall in the *building thermal envelope* that is entirely below the finish grade and in contact with the ground.

**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 below-grade walls, above-grade 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.

**C-FACTOR (THERMAL CONDUCTANCE).** The coefficient of heat transmission (surface to surface) through a building component or assembly, equal to the time rate of heat flow per unit area and the unit temperature difference between the warm side and cold side surfaces (Btu/h ft<sup>2</sup> × °F) [W/(m<sup>2</sup> × K)].

**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 the fixture supply 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 buildings."

**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.

**CONNECTED THERMOSTAT.** An internet enabled device that automatically adjusts heating and cooling temperature settings.

**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 (c.i.).** 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.

**CURTAIN WALL.** Fenestration products used to create an external nonload-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.

**DUCTLESS MINI-SPLIT HEAT PUMP SYSTEM.** A heating and cooling system that is comprised of one or multiple indoor evaporator/air-handling units and an outdoor condensing unit that is connected by refrigerant piping and electrical wiring. A ductless mini-split system is capable of cooling or heating one or more rooms without the use of a central ductwork system.

**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 design* 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 below-grade walls.

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

**VERTICAL FENESTRATION.** Windows (fixed or operable), 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 from horizontal. Opaque areas such as spandrel panels are not considered vertical fenestration.

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

**FENESTRATION AREA.** Total area of the fenestration measured using the rough opening, and including the glazing, sash and frame.

**FENESTRATION PRODUCT, FIELD-FABRICATED.** A fenestration product whose frame is made at the construction site of standard dimensional lumber or other materials that were not previously cut, or otherwise formed with the specific intention of being used to fabricate a fenestration product or exterior door. Field fabricated does not include site-built fenestration.

**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).

**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-ON-GRADE FLOOR.** Slab-on-grade floor 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 BUILDINGS.** Buildings that are listed in or eligible for listing in the *National Register of Historic Places*, or designated as historic under an appropriate state or local law.

**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.

**INSULATING SHEATHING.** An insulating board with a core material having a minimum *R*-value of R-2.

**INSULATING SIDING.** A type of continuous insulation with manufacturer-installed insulating material as an integral part of the cladding product having a minimum *R*-value of R-2.

**INTEGRATED ENERGY EFFICIENCY RATIO (IEER).** A single-number figure of merit expressing cooling part-load EER efficiency for unitary air-conditioning and heat pump equipment on the basis of weighted operation

at various load capacities for the equipment.

**INTERMEDIATE FRAMED WALLS.** Studs framed on 16-inch centers with double top plate and single bottom plate. Corners use two studs or other means of fully insulating corners, and each opening is framed by two studs. Headers shall be insulated to R-10.

**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 the above-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 oil* 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.

**LOG STRUCTURE.** A type of construction whose primary structural elements are formed by a system of logs.

**LOG WALL.** An assembly of individual structural logs for use as an exterior or interior load bearing wall, shear wall or nonload bearing wall.

**LOW SLOPE.** A roof slope less than 2 units vertical in 12 units horizontal (17 percent slope).

**LOW-VOLTAGE LIGHTING.** A lighting system consisting of an isolating power supply, the low voltage luminaires, and associated equipment that are all identified for the use. The output circuits of the power supply operate at 30 volts (42.4 volts peak) or less under all load conditions.

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

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

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

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

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

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

**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 one 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, the following building types are residential buildings:

1. Detached one- and two-family dwellings.
2. Multiple single-family dwellings (townhouses).
3. Group R-3 occupancy areas in buildings three stories or less in height above grade plane whose *dwelling units* are accessed directly from the exterior.
4. Group R-2 occupancy areas in buildings three stories or less in height above grade plane whose *dwelling units* are accessed directly from the exterior.
5. Accessory structures to residential buildings.

Group R-2 buildings with *dwelling units* accessed from interior corridors or other interior spaces are not *residential buildings*.

**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 a prepared 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 or insulation 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 ( $h \cdot \text{ft}^2 \cdot ^\circ\text{F}/\text{Btu}$ ) [ $\text{m}^2 \cdot \text{K}/\text{W}$ ].

**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.

**SLAB-ON-GRADE FLOOR.** That portion of a slab floor of the *building thermal envelope* that is in contact with the ground and that is either above grade or is less than or equal to 24 inches below the final elevation of the nearest exterior grade.

**SMALL BUSINESS.** Any business entity (including a sole proprietorship, corporation, partnership or other legal entity) which is owned and operated independently from all other businesses, which has the purpose of making a profit, and which has fifty or fewer employees.

**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 which 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 FRAMING.** All framing practices not defined as "intermediate" or "advanced" shall be considered standard. (See **Advanced Framed Wall, Intermediate Framed Wall**).

**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.

**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 space(s)*. The *conditioned space(s)* shall be controlled as separate zones for heating and cooling or conditioned by separate equipment.

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

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

**UNHEATED SLAB-ON-GRADE FLOOR.** A slab-on-grade floor that is not a heated slab-on-grade floor.

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

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

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

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

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

## CHAPTER 3 [RE]

### GENERAL REQUIREMENTS

#### SECTION R301 CLIMATE ZONES

**R301.1 General.** Climate zones from Table R301.1 shall be used in determining the applicable requirements from Chapter 4.

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

Key: A - Moist, B - Dry, C - Marine. Absence of moisture designation indicates moisture regime is irrelevant.	
<b>WASHINGTON</b>	
5B Adams	4C Lewis
5B Asotin	5B Lincoln
5B Benton	4C Mason
5B Chelan	5B Okanogan
4C Clallam	4C Pacific
4C Clark	5B Pend Oreille
5B Columbia	4C Pierce
4C Cowlitz	4C San Juan
5B Douglas	4C Skagit
5B Ferry	5B Skamania
5B Franklin	4C Snohomish
5B Garfield	5B Spokane
5B Grant	5B Stevens
4C Grays Harbor	4C Thurston
4C Island	4C Wahkiakum
4C Jefferson	5B Walla Walla
4C King	4C Whatcom
4C Kitsap	5B Whitman
5B Kittitas	5B Yakima
5B Klickitat	



## SECTION R302 DESIGN CONDITIONS

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

**R302.2 Exterior design conditions.** The heating or cooling outdoor design temperatures shall be selected from Appendix RC.

## 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 12 inches (305 mm) or greater in width. Alternately, the insulation installers shall provide a certification listing the type, manufacturer and *R*-value of insulation installed in each element of the *building thermal envelope*. For blown or sprayed insulation (fiberglass and cellulose), the initial installed thickness, settled thickness, settled *R*-value, installed density, coverage area and number of bags installed shall be *listed* on the certification. For sprayed polyurethane foam (SPF) insulation, the installed thickness of the areas covered and *R*-value of 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 labeled on the product's package and shall be listed on the certification. The insulation installer shall sign, date and post the certification in a conspicuous location on the job site.

**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*.

**R303.1.1.1 Blown or sprayed roof/ceiling insulation.** The thickness of blown-in or sprayed roof/ceiling insulation (fiberglass or cellulose) shall be written in inches (mm) on markers that are installed at least one for every 300 square feet (28 m<sup>2</sup>) throughout the attic space. The markers shall be affixed to the trusses or joists and marked with the minimum initial installed thickness with numbers a minimum of 1 inch (25 mm) in height.

Each marker shall face the attic access opening. Spray polyurethane foam thickness and installed *R*-value shall be *listed* on certification provided by the insulation installer.

**R303.1.2 Insulation mark installation.** Insulating materials shall be installed such that the manufacturer's *R*-value mark is readily observable upon 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 (windows, doors and skylights) shall be determined in accordance with NFRC 100.

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

*U*-factors shall be determined by an accredited, independent laboratory, and labeled and certified by the manufacturer. Products lacking such a labeled *U*-factor shall be assigned a default *U*-factor from Table R303.1.3(1), R303.1.3(2) or R303.1.3(4). The solar heat gain coefficient (SHGC) and visible

transmittance (VT) of glazed fenestration products (windows, glazed doors and skylights) shall be determined in accordance with NFRC 200 by an accredited, independent laboratory, and labeled and certified by the manufacturer. Products lacking such a labeled SHGC or VT shall be assigned a default SHGC or VT from Table R303.1.3(3).

**Exceptions:**

1. Units without NFRC ratings produced by a *small business* may be assigned default *U*-factors from Table R303.1.3(5) for vertical fenestration.
2. Owner-built, nonoperable wood frame window consisting of a double pane unit with low-e ( $E=0.04$  or less), ½-inch airspace with argon fill.

**TABLE R303.1.3(1)**  
**DEFAULT GLAZED WINDOW, GLASS DOOR AND SKYLIGHT *U*-FACTOR**

FRAME TYPE	WINDOW AND GLASS DOOR		SKYLIGHT
	SINGLE PANE	DOUBLE PANE	
Metal	1.20	0.80	See Table R303.1.3(4)
Metal with Thermal Break <sup>a</sup>	1.10	0.65	
Nonmetal or Metal Clad	0.95	0.55	
Glazed Block	0.60		

- a. Metal Thermal Break = A metal thermal break framed window shall incorporate the following minimum design characteristics:

- 1) The thermal conductivity of the thermal break material shall be not more than 3.6 Btu-in/h/ft<sup>2</sup>/°F;
- 2) The thermal break material must produce a gap in the frame material of not less than 0.210 inches; and
- 3) All metal framing members of the products exposed to interior and exterior air shall incorporate a thermal break meeting the criteria in 1) and 2) above.

**R303.1.4 Insulation product rating.** The thermal resistance (*R*-value) of insulation shall be determined in accordance with the U.S. Federal Trade Commission *R*-value rule (C.F.R. Title 16, Part 460) in units of h × ft<sup>2</sup> × °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 installation 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 × m<sup>2</sup>)] 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 compliance 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.** All materials, systems and equipment shall be installed in accordance with the

manufacturer's installation instructions and the *International Building Code* or *International Residential Code*, as applicable.

**R303.2.1 Protection of exposed foundation insulation.** Insulation applied to the exterior of basement walls, crawlspace walls and the perimeter of slab-on-grade floors shall have 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 a minimum of 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.

**TABLE R303.1.3(2)**  
**DEFAULT OPAQUE DOOR U-FACTORS**

Door Type	No Glazed Fenestration	Single Glazing	Double Glazing with ¼ in. Airspace	Double Glazing with ½ in. Airspace	Double Glazing with e=0.10, ½ in. Argon
SWINGING DOORS (Rough opening – 38 in. x 82 in.)					
Slab Doors					
Wood slab in wood frame <sup>a</sup>	0.46				
6% glazed fenestration (22 in. x 8 in. lite)	–	0.48	0.47	0.46	0.44
25% glazed fenestration (22 in.x36 in. lite)	–	0.58	0.48	0.46	0.42
45% glazed fenestration (22 in.x64 in. lite)	–	0.69	0.49	0.46	0.39
More than 50% glazed fenestration	Use Table R303.1.3(1)				
Insulated steel slab with wood edge in wood frame <sup>a</sup>	0.16				
6% glazed fenestration (22 in. x 8 in. lite)	–	0.21	0.20	0.19	0.18
25% glazed fenestration (22 in.x36 in. lite)	–	0.39	0.28	0.26	0.23
45% glazed fenestration (22 in.x64 in. lite)	–	0.58	0.38	0.35	0.26
More than 50% g glazed fenestration	Use Table R303.1.3(1)				
Foam insulated steel slab with metal edge in steel frame <sup>b</sup>	0.37				
6% glazed fenestration (22 in. x 8 in. lite)	–	0.44	0.42	0.41	0.39
25% glazed fenestration (22 in.x36 in. lite)	–	0.55	0.50	0.48	0.44
45% glazed fenestration (22 in.x64 in. lite)	–	0.71	0.59	0.56	0.48
More than 50% glazed fenestration	Use Table R303.1.3(1)				
Cardboard honeycomb slab with metal edge in steel frame <sup>b</sup>	0.61				
Style and Rail Doors					
Sliding glass doors/French doors	Use Table R303.1.3(1)				
Site-Assembled Style and Rail Doors					
Aluminum in aluminum frame	–	1.32	0.99	0.93	0.79
Aluminum in aluminum frame with thermal break	–	1.13	0.80	0.74	0.63

Note: Appendix A Tables A107.1(2) through A107.1(4) of [chapter 51-11C WAC](#) may also be used if applicable.

a Thermally broken sill (add 0.03 for nonthermally broken sill).

b Nonthermally broken sill.

**TABLE R303.1.3(3)**  
**DEFAULT GLAZED FENESTRATION SHGC AND VT**

	SINGLE GLAZED		DOUBLE GLAZED		GLAZED BLOCK
	Clear	Tinted	Clear	Tinted	
<b>SHGC</b>	0.8	0.7	0.7	0.6	0.6
<b>VT</b>	0.6	0.3	0.6	0.3	0.6

**TABLE R303.1.3(4)**  
**DEFAULT U-FACTORS FOR SKYLIGHTS**

Fenestration Type	Frame Type			
	Aluminum Without Thermal Break	Aluminum With Thermal Break	Reinforced Vinyl/ Aluminum-Clad Wood or Vinyl	Wood or Vinyl-Clad Wood/ Vinyl without Reinforcing
Single Glazing				
glass	U-1.58	U-1.51	U-1.40	U-1.18
acrylic/polycarb	U-1.52	U-1.45	U-1.34	U-1.11
Double Glazing				
air	U-1.05	U-0.89	U-0.84	U-0.67
argon	U-1.02	U-0.86	U-0.80	U-0.64
Double Glazing, e=0.20				
air	U-0.96	U-0.80	U-0.75	U-0.59
argon	U-0.91	U-0.75	U-0.70	U-0.54
Double Glazing, e=0.10				
air	U-0.94	U-0.79	U-0.74	U-0.58
argon	U-0.89	U-0.73	U-0.68	U-0.52
Double Glazing, e=0.05				
air	U-0.93	U-0.78	U-0.73	U-0.56
argon	U-0.87	U-0.71	U-0.66	U-0.50
Triple Glazing				
air	U-0.90	U-0.70	U-0.67	U-0.51
argon	U-0.87	U-0.69	U-0.64	U-0.48
Triple Glazing, e=0.20				
air	U-0.86	U-0.68	U-0.63	U-0.47
argon	U-0.82	U-0.63	U-0.59	U-0.43
Triple Glazing, e=0.20 on 2 surfaces				
air	U-0.82	U-0.64	U-0.60	U-0.44
argon	U-0.79	U-0.60	U-0.56	U-0.40
Triple Glazing, e=0.10 on 2 surfaces				
air	U-0.81	U-0.62	U-0.58	U-0.42
argon	U-0.77	U-0.58	U-0.54	U-0.38
Quadruple Glazing, e=0.10 on 2 surfaces				
air	U-0.78	U-0.59	U-0.55	U-0.39
argon	U-0.74	U-0.56	U-0.52	U-0.36
krypton	U-0.70	U-0.52	U-0.48	U-0.32

Notes for Table R303.1.3(4)

1. U-factors are applicable to glass and plastic, flat and domed units, all spacers and gaps.
2. Emissivities shall be less than or equal to the value specified.
3. Gap fill shall be assumed to be air unless there is a minimum of 90% argon or krypton.
4. Aluminum frame with thermal break is as defined in footnote 1 to Table R303.1.3(1).

**TABLE R303.1.3(5)**  
**SMALL BUSINESS COMPLIANCE TABLE**  
**DEFAULT U-FACTORS FOR VERTICAL FENESTRATION**

Vertical Fenestration Description				Frame Type		
				Any Frame	Aluminum Thermal Break <sup>b</sup>	Wood/Vinyl/Fiberglass
Panes	Low-e <sup>a</sup>	Spacer	Fill			
Double <sup>c</sup>	A	Any	Argon	0.48	0.41	0.32
	B	Any	Argon	0.46	0.39	0.30
	C	Any	Argon	0.44	0.37	0.28
	C	High Performance	Argon	0.42	0.35	Deemed to comply <sup>e</sup>
Triple <sup>d</sup>	A	Any	Air	0.50	0.44	0.26
	B	Any	Air	0.45	0.39	0.22
	C	Any	Air	0.41	0.34	0.20
	Any double low-e	Any	Air	0.35	0.32	0.18

- a. Low-eA (emissivity) shall be 0.24 to 0.16.  
Low-eB (emissivity) shall be 0.15 to 0.08.  
Low-eC (emissivity) shall be 0.07 or less.
- b. Aluminum Thermal Break = An aluminum thermal break framed window shall incorporate the following minimum design characteristics:
  - 1) The thermal conductivity of the thermal break material shall be not more than 3.6 Btu-in/h/ft<sup>2</sup>/°F;
  - 2) The thermal break material must produce a gap in the frame material of not less than 0.210 inches; and
  - 3) All metal framing members of the products exposed to interior and exterior air shall incorporate a thermal break meeting the criteria in 1) and 2) above.
- c. A minimum air space of 0.375 inches between panes of glass is required for double glazing.
- d. A minimum air space of 0.25 inches between panes of glass is required for triple glazing.
- e. Deemed to comply glazing shall not be used for performance compliance.

## CHAPTER 4 [RE]

# RESIDENTIAL ENERGY EFFICIENCY

### SECTION R401 GENERAL

**R401.1 Scope.** This chapter applies to *residential buildings*. Group R-2 occupancy areas with *dwelling units* accessed from enclosed interior corridors or other enclosed interior spaces must comply with the Washington State Energy Code (WSEC), Commercial Provisions. Other Group R-2 occupancy areas are permitted to comply with the WSEC, Commercial Provisions, in lieu of the WSEC, Residential Provisions.

**Exception:** Water heaters that each serve only an individual Group R-2 *dwelling unit* in a building three stories or less above grade plane are permitted to comply with the requirements of the WSEC, Residential Provisions.

**R401.2 Compliance.** Projects shall comply with one of the following:

1. **Prescriptive Compliance Option:** Sections R401 through R404. In addition, *dwelling units* and *sleeping units* in a *residential building* shall comply with Section R406.
2. **Simulated Building Performance Option:** Section R405.
3. **Passive House Option:** 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*. When 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 ceiling/roof, walls, foundation (slab, *below-grade wall*, and/or floor) and ducts outside conditioned spaces.
2. *U*-factors for fenestration and the solar heat gain coefficient (SHGC) of fenestration. Where there is more than one value for each component, the certificate shall indicate the area weighted average value.
3. The results from any required duct system and *building thermal envelope* air leakage testing done on the building.
4. The results from the whole-house mechanical ventilation system flow rate test.
5. The types, sizes and efficiencies of heating, cooling, whole-house mechanical ventilation, and service water heating appliances. Where a gas-fired unvented room heater, electric furnace, or baseboard electric heater is installed in the residence, the certificate shall list "gas-fired unvented room heater," "electric furnace" or "baseboard electric heater," as appropriate. An efficiency shall not be *listed* for gas-fired unvented room heaters, electric furnaces or electric baseboard heaters.
6. Where *on-site photovoltaic panel* systems have been installed, the array capacity, inverter efficiency, panel tilt, orientation and estimated annual electrical generation shall be noted on the certificate.
7. The code edition under which the structure was permitted, and the compliance path used and, where applicable, the additional efficiency measures selected for compliance with Section R406.
8. The location and dimensions of a *solar-ready zone* where one is provided.

The *code official* may require that documentation for any required test results include an electronic record of the time, date and location of the test. A date-stamped smart phone photo or air leakage testing software may be used to satisfy this requirement.

## SECTION R402 BUILDING THERMAL ENVELOPE

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

1. U-factor: Sections R402.1.1, R402.1.2 and R402.1.6.
2. R-value: Sections R402.1.1, R402.1.3 and R402.1.4.
3. Component performance: Sections R402.1.1, R402.1.5 and R402.1.6.

**Exception:** The following buildings, or portions thereof, separated from the remainder of the building by building thermal envelope assemblies complying with this code shall be exempt from the building thermal envelope provisions of this code:

1. Those with a peak design rate of energy usage less than 3.4 Btu/h • ft<sup>2</sup> (10.7 W/m<sup>2</sup>) or 1.0 watt/ft<sup>2</sup> of floor area for space conditioning purposes.
2. Those that do not contain conditioned space.
3. Greenhouses isolated from any conditioned space and not intended for occupancy.

**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 equal to or less than specified in Table R402.1.2.

**TABLE R402.1.2  
INSULATION AND FENESTRATION REQUIREMENTS BY COMPONENT<sup>a</sup>**

CLIMATE ZONE 5 AND MARINE 4	
Vertical Fenestration U-Factor <sup>b</sup>	0.28
Skylight U-Factor	0.50
Ceiling U-Factor	0.024
Insulation entirely above roof deck	0.032
Above-Grade Wall U-Factor	0.045
Floor U-Factor	0.029
Unheated Slab on Grade F-Factor <sup>c</sup>	0.51
Heated Slab F-factor <sup>c</sup>	0.66
Below Grade 2' Depth	
Wall U-Factor	0.042
Slab F-Factor	0.59
Below Grade 3.5' Depth	
Wall U-Factor	0.040
Slab F-Factor	0.56
Below Grade 7' Depth	
Wall U-Factor	0.035
Slab F-Factor	0.50

For SI: 1 foot = 304.8 mm, ci = continuous insulation, int = intermediate framing.

- a. *U*-factors or *F*-factors shall be obtained from measurement, calculation or an approved source, or as specified in Section R402.1.5.
- b. A maximum *U*-factor of 0.32 shall apply to vertical fenestration products installed in buildings located above 4000 feet in elevation above sea level, or in windborne debris regions where protection of



openings is required under Section R301.2.1.2 of the International Residential Code.

- c. *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 *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.

**TABLE R402.1.3**  
**INSULATION MINIMUM R-VALUES AND FENESTRATION REQUIREMENTS BY COMPONENTS<sup>a</sup>**

CLIMATE ZONE 5 AND MARINE 4	
Vertical Fenestration U-Factor <sup>b, j</sup>	0.28
Skylight <sup>b</sup> U-Factor	0.50
Ceiling R-Value <sup>e</sup>	60
Insulation entirely above roof deck	30ci
Wood Frame Wall <sup>g, i</sup> R-Value	30 or 20+5ci or 13+10ci or 0+20ci
Floor R-Value <sup>i</sup>	30 or 19+7.5ci or 20ci
Below-Grade <sup>c, h</sup> Wall R-value	10/15/21 int + 5TB
Unheated Slab <sup>d, f</sup> R-Value & Depth	10, 4 ft
Heated Slab <sup>d</sup> R-Value & Depth	10, 3 ft and R-10 full slab

- a. *R*-values are minimums. *U*-factors and SHGC are maximums. When insulation is installed in a cavity which is less than the label or design thickness of the insulation, the compressed *R*-value of the insulation from Appendix CA Table CA101.4 of [chapter 51-11C WAC](#) shall not be less than the *R*-value specified in the table.
- b. The fenestration *U*-factor column excludes skylights.
- c. "10/15/21 +5TB" means R-10 continuous insulation on the exterior of the wall, or R-15 continuous insulation on the interior of the wall, or R-21 cavity insulation plus a thermal break between the slab and the basement wall at the interior of the basement wall. "10/15/21 +5TB" shall be permitted to be met with R-13 cavity insulation on the interior of the basement wall plus R-5 continuous insulation on the interior or exterior of the wall. "5TB" means R-5 thermal break between floor slab and basement wall.
- d. Slab insulation shall be installed in accordance with Section **R402.2.10.1**.
- e. For single rafter- or joist-vaulted ceilings, the insulation may be reduced to R-38 if the full insulation depth extends over the top plate of the exterior wall.
- f. R-7.5 continuous insulation installed over an existing slab is deemed to be equivalent to the required perimeter slab insulation when applied to existing slabs complying with Section R503.1.1. If foam plastic is used, it shall meet the requirements for thermal barriers protecting foam plastics.
- g. For log structures developed in compliance with Standard ICC 400, log walls shall meet the requirements for *climate zone 5* of ICC 400.
- h. Int. (intermediate framing) denotes framing and insulation as described in Section A103.2.2 including standard framing 16 inches on center, 78 percent of the wall cavity insulated and headers insulated with a minimum of R-10 insulation.
- i. The first value is cavity insulation, the second value is continuous insulation. Therefore, as an example, "R13+10" means R-13 cavity insulation plus R-10 continuous insulation.
- j. A maximum *U*-factor of 0.32 shall apply to vertical fenestration products installed in buildings located above 4000 feet in elevation above sea level, or in windborne debris regions where protection of openings is required under Section R301.2.1.2 of the International Residential Code.

**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 insulated siding shall be reduced by R-0.6.

**R402.1.5 Component performance alternative.** Where the proposed total *building thermal envelope* conductance ( $TC_p$ ) is less than or equal to the total *building thermal envelope* thermal conductance ( $TC_r$ ) 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. In addition to  $TC$  compliance, the maximum fenestration *U*-factors of Section R402.6 shall be met.

$$TC_p \leq TC_r$$

Equation 4-1

Where:

$$TC_p = U_pA + F_pP$$

$$TC_r = U_rA + F_rP$$

$U_pA$  = The sum of proposed *U*-factors times the assembly areas in the proposed building.

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

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

$F_rP$  = The sum of *F*-factors in Table R402.1.2 times the same slab-on-grade perimeter lengths as in the proposed building.

**R402.1.6 U-factor reference and calculations.** The *U*-factors for typical construction assemblies are included in Appendix CA in chapter 51-11C WAC. Proposed *U*-factors and slab-on-grade *F*-factors shall be taken from these values. Where proposed construction assemblies are not represented in Appendix CA, values shall be calculated in accordance with the ASHRAE *Handbook of Fundamentals* using the framing factors listed in Appendix CA where applicable and shall include the thermal bridging effects of framing materials. Fenestration *U*-factors shall comply with Section R303.1.3, Fenestration product rating.

**NOTE:** Below Grade Walls: The wall is assumed to extend from the slab upward to the top of the mud sill for the distance specified in Table CA104.1, with 6 inches of concrete wall extending above grade. This will be calculated separately from above grade walls using the wall height that best describes the system.

**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 R402.2.10.

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

**R402.2.1.1 Loose insulation in attic spaces.** Open-blown or poured loose fill insulation may be used in attic spaces where the slope of the ceiling is not more than 3 feet in 12 and there is at least 30 inches of clear distance from the top of the bottom chord of the truss or ceiling joist to the underside of the sheathing at the roof ridge.

**R402.2.2 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 R402.2.6. Such *knee walls* shall have an *air barrier* between

conditioned and unconditioned space.

**R402.2.2.1 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 R402.2.6.

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

**R402.2.4 Access hatches and doors.** Access hatches and doors from *conditioned spaces* 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.

**Exception:** Vertical doors providing access from *conditioned spaces* to *unconditioned spaces* that comply with the fenestration requirements of Table R402.1.3.

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

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

1. Above-grade walls of concrete block, concrete, insulated concrete form, masonry cavity, brick but not brick veneer, adobe, compressed earth block, rammed earth, mass timber or solid logs.
2. Any wall having a heat capacity greater than or equal to 6 Btu/ft<sup>2</sup> x °F (123 kJ/m<sup>3</sup> x K).

**R402.2.6 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* maximum, the steel-framed wall member spacing is permitted to be installed at any on-center spacing.
2. Where the steel-framed wall contains framing spaced at 24 inches (610 mm) on center with a 23 percent framing factor or framing spaced at 16 inches (400 mm) on center with a 25 percent framing factor, the next lower framing member spacing input values shall be used when calculating using AISI S250.
3. Where the steel-framed wall contains less than 23 percent framing factors 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.

**R402.2.7 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. Insulation supports shall be installed so spacing is no more than 24-inches on center.

4. Foundation vents shall be placed so that the top of the vent is below the lower surface of the floor insulation.
5. One of the following methods:
  - 5.1. *Cavity insulation* shall be installed to maintain permanent contact with the underside of the subfloor decking.
  - 5.2. *Cavity insulation* shall be installed to maintain contact with the top side of sheathing separating the cavity and the unconditioned space below. Insulation complying with the required wall insulation values shall extend from the bottom to the top of all perimeter floor framing members.
  - 5.3. A combination of *cavity insulation* and *continuous insulation* shall be installed so 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 complying with the required wall insulation values shall extend from the bottom to the top of all perimeter floor framing members.
  - 5.4. *Continuous insulation* shall be installed to maintain contact with the underside of the structural floor system. Insulation complying with the required wall insulation values shall extend from the bottom to the top of all perimeter floor framing members.

**Exceptions:**

1. When foundation vents are not placed so that the top of the vent is below the lower surface of the floor insulation, a permanently attached baffle shall be installed at an angle of 30° from horizontal, to divert air flow below the lower surface of the floor insulation.
2. Substantial contact with the surface being insulated is not required in enclosed floor/ceiling assemblies containing ducts where full R-value insulation is installed between the duct and the exterior surface.

**R402.2.8 Below-grade walls.** Below-grade exterior wall insulation used on the exterior (cold) side of the wall shall extend from the top of the below-grade wall to the top of the footing and shall be approved for below-grade use. Above-grade insulation shall be protected. Insulation used on the interior (warm) side of the wall shall extend from the top of the below-grade wall to the below-grade floor level and shall include R-5 rigid board providing a thermal break between the concrete wall and the slab.

**R402.2.9 Slab-on-grade floors.** The minimum thermal resistance (*R*-value) of the insulation around the perimeter of unheated or heated slab-on-grade floors shall be as specified in Table R402.1.3. The insulation shall be placed on the outside of the foundation or on the inside of the foundation wall. The insulation shall extend downward from the top of the slab for a minimum distance as shown in the table or to the top of the footing, whichever is less, or downward to at least the bottom of the slab and then horizontally to the interior or exterior for the total distance shown in the table. A two-inch by two-inch (maximum) pressure treated nailer may be placed at the finished floor elevation for attachment of interior finish materials. Insulation extending away from the building shall be protected by pavement or not less than 10 inches (254 mm) of soil.

**R402.2.9.1 Heated slab-on-grade floors.** The entire area of a heated slab-on-grade floor shall be thermally isolated from the soil with a minimum of R-10 insulation. The insulation shall be an approved product for its intended use. If a soil gas control system is present below the heated slab-on-grade floor, which results in increased convective flow below the heated slab-on-grade floor, the heated slab-on-grade floor shall be thermally isolated from the sub-slab gravel layer. R-10 heated slab-on-grade floor insulation is required for all compliance paths.

**R402.2.10 Masonry veneer.** Insulation shall not be required on the horizontal portion of the foundation that supports a masonry veneer.

**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 R402.4.6.

**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.

**R402.4.3 Glazed fenestration exemption.** Up to 15 square feet (1.4 m<sup>2</sup>) of glazed fenestration per dwelling unit shall be permitted to be exempt from *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 up to 24 square feet (2.22 m<sup>2</sup>) in area is exempted from the *U*-factor requirement in Section R402.1.2. This exemption shall not apply to component performance alternative in Section R402.1.5.

**R402.4.5 Combustion air openings.** Where open combustion air ducts provide combustion air to open combustion, space conditioning fuel burning appliances, the appliances and combustion air openings shall be located outside of the *building thermal envelope*, or enclosed in a room isolated from inside the thermal envelope. Such rooms shall be sealed and insulated in accordance with the envelope requirements of Table R402.1.3, where the walls, floors and ceilings shall meet the minimum of the below-grade wall *R*-value requirements. 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 a minimum of R-8.

**Exceptions:**

1. Direct vent appliances with both intake and exhaust pipes installed continuous to the outside.
2. Fireplaces and stoves complying with Section R402.4.6 of this code and Section R1006 of the *International Residential Code*.

**R402.4.6 Fireplaces.** New wood-burning fireplaces shall have tight-fitting flue dampers or doors and outdoor combustion air. When 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. When using tight-fitting doors on masonry fireplaces, the doors shall be listed and labeled in accordance with UL 907. Gas fireplaces shall comply with the efficiency requirements in Section R403.7.2.

**TABLE R402.5.1.1**  
**AIR BARRIER, AIR SEALING AND INSULATION INSTALLATION<sup>a</sup>**

COMPONENT	AIR BARRIER CRITERIA	INSULATION CRITERIA
General Requirements	A continuous air barrier shall be installed in the <i>building thermal envelope</i> . Breaks or joints in the air barrier shall be sealed.	Air-permeable insulation shall not be used as a sealing material.
Cavity insulation installation		All cavities in the thermal envelope shall be filled with insulation. The density of the insulation shall be at the manufacturers' product recommendation and said density shall be maintained for all volume of each cavity. Batt type insulation will show no voids or gaps and maintain an even density for the entire cavity. Batt insulation shall be installed in the recommended cavity depth. Where an obstruction in the cavity due to services, blocking, bracing or other obstruction exists, the batt product will be cut to fit the remaining depth of the cavity. Where the batt is cut around obstructions, loose fill insulation shall be placed to fill any surface or concealed voids, and at the manufacturers' specified density. Where faced batt is used, the installation tabs must be stapled to

		<p>the face of the stud. There shall be no compression to the batt at the edges of the cavity due to inset stapling installation tabs.</p> <p>Insulation that upon installation readily conforms to available space shall be installed filling the entire cavity and within the manufacturers' density recommendation.</p>
Ceiling/attic <sup>b</sup>	<p>An air barrier shall be installed in any dropped ceiling or soffit to separate it from unconditioned space.</p> <p>Access openings, drop down stair or knee wall doors to unconditioned attic spaces shall be sealed with gasketing materials that allow for repeated entrance over time.</p>	<p>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. Batt insulation installed in attic roof assemblies may be compressed at exterior wall lines to allow for required attic ventilation.</p>
Walls	<p>The junction of the foundation and sill plate shall be sealed. The junction of the top plate and top of exterior walls shall be sealed. Knee walls shall be sealed.</p>	<p>Cavities within corners and headers of frame walls shall be insulated by completely filling the cavity with a material having a thermal resistance of R-3 per inch minimum.</p> <p>Exterior <i>building thermal envelope</i> insulation for framed walls shall be installed in substantial contact and continuous alignment with the air barrier.</p>
Knee wall	<p>Knee walls shall have an air barrier between conditioned and unconditioned space.</p>	<p>Insulation installed in a knee wall assembly shall be installed in accordance with Section R402.2.2. Air-permeable insulation shall be enclosed inside an air barrier assembly.</p>

**TABLE R402.5.1.1 (continued)**  
**AIR BARRIER, AIR SEALING AND INSULATION INSTALLATION<sup>a</sup>**

COMPONENT	AIR BARRIER CRITERIA	INSULATION CRITERIA
Windows, skylights and doors	<p>The rough opening gap between framing and the frames of skylights, windows and doors shall be sealed in accordance with fenestration manufacturer's instructions.</p>	<p>Insulation shall not be required in the rough opening gap except as required by the fenestration manufacturer's instructions.</p>
Rim Joists	<p>Rim joists shall include an air barrier<sup>b</sup>.</p> <p>The junctions of the rim board to the sill plate and the rimboard and the subfloor shall be air sealed.</p>	<p>Rim joists shall be insulated so that the insulation maintains permanent contact with the exterior rim board.</p>
Floors (including above garage and cantilevered floors)	<p>Floor framing members that are part of the <i>building thermal envelope</i> shall be air sealed to maintain a continuous air barrier.</p>	<p>Floor insulation shall be installed in accordance with the requirements of Section R402.2.7.</p>
Basement, crawl space and slab foundations	<p>Exposed earth in unvented crawl spaces shall be covered with a Class I, black vapor retarder with overlapping joints taped.</p> <p>Penetrations through concrete foundation walls and slabs shall be air sealed.</p>	<p>Crawl space insulation, where provided instead of floor insulation, shall be installed in accordance with Section R402.2.10.</p> <p>Conditioned basement foundation wall insulation shall be installed in accordance with Section R402.2.8.</p>

	Class I vapor retarders shall not be used as an air barrier on below-grade <i>walls</i> and shall be installed in accordance with Section R702.7 of the <i>International Residential Code</i> .	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 air sealed. Utility penetrations of the air barrier shall be caulked, gasketed or otherwise sealed and shall allow for expansion and 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 <i>R</i> -value.
Narrow cavities	Narrow cavities, of 1 inch or less, not able to be insulated, shall be air sealed.	Batts in narrow cavities shall be cut to fit and installed to the correct density without any voids or gaps or compression, or narrow cavities shall be filled by insulation that on installation readily conforms to the available cavity space.
Garage separation	Air sealing shall be provided between the garage and conditioned spaces.	Insulated portions of the garage separation assembly shall be installed in accordance with Sections R303 and R402.2.8.
Recessed lighting	Recessed light fixtures installed in the building thermal envelope shall be air sealed in accordance with Section R402.5.3.	Recessed light fixtures installed in the building thermal envelope shall be air tight and IC rated and shall be buried in or surrounded with insulation.

**TABLE R402.5.1.1 (continued)**  
**AIR BARRIER, AIR SEALING AND INSULATION INSTALLATION<sup>a</sup>**

COMPONENT	AIR BARRIER CRITERIA	INSULATION CRITERIA
Plumbing, wiring or other obstructions	All holes created by wiring, plumbing or other obstructions in the air barrier assembly shall be air sealed.	Batt insulation shall be cut neatly to fit around wiring and plumbing in exterior walls. There shall be no voids or gaps or compression where cut to fit. Insulation that on installation readily conforms to available space shall extend behind piping and wiring. Insulation shall be installed to fill the available space and surround wiring, plumbing, or other obstructions, unless the required <i>R</i> -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 <i>building thermal envelope</i>	An air barrier shall separate insulation in the <i>building thermal envelope</i> 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, housings 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 R402.5.4.	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 penetrated by the boot.	HVAC supply and return register boots located within a <i>building</i>

		<i>thermal envelope</i> assembly shall be buried in or surrounded by insulation.
Concealed sprinklers	When required to be sealed, concealed fire sprinklers shall only be sealed in a manner that is recommended by the manufacturer. Caulking or other adhesive sealants shall not be used to fill voids between fire sprinkler cover plates and walls or ceilings.	
Common walls or double walls separating attached single-family dwellings or townhouses	<p>An interior air barrier shall be provided. Air sealing at the intersections with building thermal envelope shall be provided.</p> <p>Where installed in a fire-resistance-rated wall assembly, air sealing materials shall comply with one of the following:</p> <ol style="list-style-type: none"> <li>1. Be in accordance with an approved design for the fire-resistance-rated assembly.</li> <li>2. Be supported by approved data that shows the assembly as installed complies with the required fire-resistance rating.</li> </ol>	Insulation materials included in the approved common wall or double-wall design and installed in accordance with the approved design shall be permitted to be used.

- a. In addition, inspection of log walls shall be in accordance with the provisions of ICC-400.
- b. Insulation full enclosure is not required in unconditioned/ventilated attic spaces.

**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 air leakage.** 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 listed in Table R402.5.1.1 shall be installed in accordance with the manufacturer's instructions and the criteria listed 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.

**R402.5.1.2 Air leakage testing.** The building or each dwelling unit or sleeping unit in the building shall be tested for air leakage. Testing shall be conducted in accordance with RESNET/ICC 380, ASTM E779, ASTM E1827 or ASTM E3158 and reported at a pressure differential of 0.2 inch water gauge (50 Pa). Test pressure and leakage rate shall comply with Section R402.1.3. A written report of the test results, including verified location and time stamp of the date of the test, shall be signed by the testing agency and provided to the building owner and *code official*. Testing shall be performed at any time after creation of all penetrations of the *building thermal envelope*. Once visual inspection has confirmed air sealing has been conducted in accordance with Table R402.5.1.1, operable windows and doors manufactured by *small business* are permitted to be sealed off at the frame prior to the test.

Testing of single-family dwellings and townhouses shall be conducted in accordance with RESNET/ICC 380. Test pressure and leakage rate shall comply with Section R402.1.3.1.

For Group R-2 occupancies, testing shall be conducted in accordance with ASTM E779, ASTM E1827, or ASTM E3158. Test pressure and leakage rate shall comply with Section R402.1.3.2. The individual performing the air leakage test shall be trained and certified by a certification body that is, at the time of permit application, an ISO 17024 accredited certification body including, but not limited to, the Air Barrier Association of America.

During testing:

1. Exterior windows and doors, fireplace and stove doors shall be closed, but not sealed, beyond the intended weatherstripping or other infiltration control measures.
2. Dampers including exhaust, intake, makeup air, backdraft and flue dampers shall be closed,



but not sealed beyond intended infiltration control measures.

3. Interior doors, if installed at the time of the test, shall be open, access hatches to conditioned crawl spaces and conditioned attics shall be open.
4. Exterior or interior terminations for continuous ventilation systems and heat recovery ventilators shall be sealed.
5. Heating and cooling systems, if installed at the time of the test, shall be turned off.
6. Supply and return registers, if installed at the time of the test, shall be fully open.

**Exceptions:**

1. Additions less than 500 square feet of conditioned floor area.
2. 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 leakage 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.** Detached one- and two-family dwellings and multiple single-family dwellings (townhouses) shall comply with Section R402.5.1.3.1. Group R-2 multifamily buildings shall comply with Section R402.5.1.3.2.

**R402.5.1.3.1 Dwelling unit leakage rate.** The maximum air leakage rate for any *dwelling unit* under any compliance path shall not exceed 4.0 air changes per hour. Testing shall be conducted with a blower door test at a test pressure of 0.2 inches w.g. (50 Pa).

**Exception:** *Additions* tested with the existing home having a combined maximum air leakage rate of 7 air changes per hour. To qualify for this exception, the date of construction of the existing dwelling must be prior to the 2009 Washington State Energy Code.

**R402.5.1.3.2 Group R-2 multifamily building leakage rate.** For Group R-2 multifamily buildings, the maximum leakage rate for any *dwelling unit* shall not exceed 0.25 cfm per square foot of the dwelling unit enclosure area. Testing shall be conducted with a blower door at a test pressure of 0.2 inches w.g. (50 Pa). Doors and windows of adjacent *dwelling units* (including top and bottom units) shall be open to the outside during the test.

**R402.5.2 Air leakage of fenestration.** Windows, skylights and sliding glass doors shall have an air infiltration rate of no more than 0.3 cfm per square foot (1.5 L/s/m<sup>2</sup>), and swinging doors no more than 0.5 cfm per square foot (2.6 L/s/m<sup>2</sup>), when tested according to NFRC 400 or AAMA/WDMA/CSA 101/I.S.2/A440 by an accredited, independent laboratory and *listed* and *labeled* by the manufacturer.

**Exceptions:**

1. Field-fabricated fenestration products (windows, skylights and doors).
2. Custom exterior fenestration products manufactured by a small business provided they meet the applicable provisions of Chapter 24 of the *International Building Code*. Once visual inspection has confirmed the presence of a gasket, operable windows and doors manufactured by *small business* shall be permitted to be sealed off at the frame prior to the test.

**R402.5.3 Recessed lighting.** Recessed luminaires installed in the *building thermal envelope* shall be Type IC-rated and certified under ASTM E283 as having an air leakage rate not more than 2.0 cfm (0.944 L/s) when tested at a 1.57 psf (75 Pa) pressure differential and shall have a label attached showing compliance with this test method. All recessed luminaires shall be sealed with a gasket or caulk between the housing and the interior wall or ceiling covering.

**R402.5.4 Air-sealed electrical and communication outlet boxes.** Air-sealed electrical and communication outlet boxes that penetrate the *air barrier* of the *building thermal envelope* shall be

caulked, taped, gasketed, or otherwise sealed to the *air barrier* element being penetrated. Air-sealed boxes shall be buried in or surrounded by insulation. Air-sealed boxes shall be tested and marked in accordance with NEMA OS4. Air-sealed boxes shall be installed in accordance with the manufacturer's instructions.

**R402.6 Maximum fenestration U-factor.** The area-weighted average maximum fenestration *U*-factor permitted using tradeoffs from Section R402.1.5 or R405 shall be 0.48 for vertical fenestration, and 0.75 for skylights.

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

## SECTION R403 SYSTEMS

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

**R403.1.1 Programmable or connected thermostat.** Where the primary heating system is a forced-air furnace, at least one thermostat per dwelling unit shall be Energy Star certified and capable of controlling the heating and cooling system on a daily schedule to maintain different temperature set points at different times of the day and different days of the week. The thermostat shall allow for, at a minimum, a 5-2 programmable schedule (weekdays/weekends) and be capable of providing at least two programmable setback/setup periods per day. This thermostat shall include the capability to set back, set up or temporarily operate the system to maintain *zone* temperatures down to 55°F (13°C) or up to 85°F (29°C). The thermostat shall be programmed initially by the manufacturer with a heating temperature set point of not greater than 70°F (21°C) and a cooling temperature set point of not less than 78°F (26°C). The thermostat and/or control system shall have an adjustable deadband of not less than 10°F.

**Exceptions:**

1. Systems controlled by an occupant sensor that is capable of shutting the system off when no occupant is sensed for a period of up to 30 minutes.
2. Systems controlled solely by a manually operated timer capable of operating the system for no more than two hours.
3. Ductless mini-split heat pump systems that have an integral proprietary thermostat.

**R403.1.2 Heat pump supplementary heat.** Unitary air cooled heat pumps shall include controls that minimize supplemental heat usage during start-up, set-up, and defrost conditions. These controls shall anticipate need for heat and use compression heating as the first stage of heat. Controls shall indicate when supplemental heating is being used through visual means (e.g., LED indicators). Heat pumps equipped with supplementary heaters shall have controls that are configured to prevent supplemental heater operation above 40°F. At final inspection the auxiliary heat lock out control shall be set to 35°F or less. 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.

**R403.1.3 Continuously burning pilot lights.** The natural gas systems and equipment listed below are not permitted to be equipped with continuously burning pilot lights.

1. Fan-type central furnaces.
2. Household cooking appliances.

**Exception:** Household cooking appliances without electrical supply voltage connections and in which each pilot light consumes less than 150 Btu/hr.

3. Pool heaters.
4. Spa heaters.

## 5. Fireplaces

**Exception:** Any fireplace with on-demand, intermittent or interrupted ignition (as defined in ANSI Z21.20) is not considered continuous.

**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 an 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 R403.3.8.

**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 accordance with the ASHRAE Handbook of Fundamentals, ANSI/ACCA Manual D or other equivalent computation procedure.

**R403.3.2 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. *Ductwork* within a concrete slab or in the ground shall be insulated to R-10 with insulation designed to be used below grade. Underground *ductwork* utilizing the *thermal distribution efficiency* method shall be listed and labeled to indicate the *R*-value equivalency.

**R403.3.3 Duct systems located in conditioned space.** For duct systems to be considered as being located 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. All heating, cooling and ventilation system components shall be installed inside the *conditioned space* including, but not limited to, forced air ducts, hydronic piping, hydronic floor heating loops, convectors and radiators. Combustion equipment shall be direct vent or sealed combustion.
3. For forced air ducts, a maximum of 10 linear feet of return ducts and 5 linear feet of supply ducts is permitted to be located outside the *conditioned space*, provided they are insulated to a minimum of R-8.
  - 3.1. Metallic ducts located outside the *conditioned space* must have both transverse and longitudinal joints sealed with mastic.
  - 3.2. If flex ducts are used, they cannot contain splices. Flex duct connections must be made with nylon straps and installed using a plastic strapping tensioning tool.
4. Ductwork in floor cavities located over unconditioned space shall comply with all of the following:
  - 4.1. A *continuous air barrier* installed between unconditioned space and the duct.  
*Insulation installed in accordance with Section R402.2.7.*
  - 4.2. A minimum R-19 insulation installed in the cavity width separating the duct from unconditioned space.

**R403.3.4 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.

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

**R403.3.4.1 Effective *R*-value of deeply buried ducts.** Where complying using Section R405, sections of *ductwork* that are installed in accordance with Section R403.3.4 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.

**R403.3.5 Sealing.** *Ductwork, air-handling units* and filter boxes shall be sealed. Joints and seams shall comply with the *International Mechanical Code* or *International Residential Code*, as applicable.

**Exceptions:**

1. Air-impermeable spray foam products shall be permitted to be applied without additional joint seals.
2. For ducts having a static pressure classification of less than 2 inches of water column (500 Pa), additional closure systems shall not be required for continuously welded joints and seams, and locking-type joints and seams of other than the snap-lock and button-lock types.

**R403.3.5.1 Sealed *air-handling unit*.** *Air-handling units* shall have a manufacturer's designation for an air leakage of no more than 2 percent of the design air flow rate when tested in accordance with ASHRAE 193.

**R403.3.6 Duct system testing.** Each *duct system* shall be tested for air leakage in accordance with WSU RS-33, using the maximum duct leakage rates specified.

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 grills 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. A duct air leakage test shall not be required for ducts serving ventilation systems that are not integrated with ducts serving heating or cooling systems.
2. 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:
  - 2.1. The *duct system* is located entirely within *conditioned space*.
  - 2.2. The *ductwork* does not include *plenums* constructed of building cavities or gypsum board.
3. 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 m<sup>2</sup>) of *conditioned floor area*.~~
4. Where tested in accordance with Section R403.3.8, testing of each *duct system* is not required.

**R403.3.7 Duct system leakage.** The total measured *duct system* leakage shall not be greater than the values in Table R403.3.7 based on the *conditioned floor area*, number of ducted returns, and location of the *duct system*. For *buildings* complying with Section R405, where *duct system* leakage to outside is tested in accordance with WSU RS-33, 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.

**TABLE R403.3.7  
MAXIMUM TOTAL DUCT SYSTEM LEAKAGE**

EQUIPMENT AND DUCT CONFIGURATION	DUCT SYSTEMS SERVING MORE THAN 1,000 FT <sup>2</sup> OF CONDITIONED FLOOR AREA		DUCT SYSTEMS SERVING 1,000 FT <sup>2</sup> OR LESS OF CONDITIONED FLOOR AREA
	cfm/100 ft <sup>2</sup>		cfm
	Number of Ducted Returns <sup>a</sup>		
	< 3	≥ 3	Any
Space conditioning equipment is not installed <sup>b,c</sup>	3	4	30

All components of the duct system are installed <sup>c</sup>	4	6	40
Space conditioning equipment is not installed, but the ductwork is located entirely in conditioned space <sup>c,d</sup>	6	8	60
All components of the duct system are installed and entirely located in conditioned space <sup>c</sup>	8	12	80

For SI: 1 cubic foot per minute per square foot = 0.0033 LPM/m<sup>2</sup>, 1 cubic foot per minute = 28.3 LPM.

- 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.
- 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.
- 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 R403.3.3.
- 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.

**R403.3.8 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 the 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 action 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* leakage, an additional three *dwelling units* or *sleeping units*, including the corrected unit, shall be tested.

**R403.3.9 Building cavities.** *Building* framing cavities shall not be used as ducts or plenums. Installation of ducts in exterior walls, floors or ceilings shall not displace required envelope insulation.

**R403.4 Mechanical system piping insulation.** Mechanical system piping capable of carrying fluids above 105°F (41°C) or below 55°F (13°C) shall be insulated to a minimum of R-6.

**Exception:** Up to 200 feet of hydronic system piping installed within the conditioned space may be insulated with a minimum of ½-inch insulation with a *k* value of 0.28.

**R403.4.1 Protection of piping insulation.** Piping insulation, including termination ends, exposed to weather shall be protected from damage, including that caused by sunlight, moisture, physical contact, and wind, and shall provide shielding from solar radiation that can cause degradation of the material. Protection shall be removable for the exposed length or no less than six inches from the equipment for maintenance. Adhesive tape shall not be permitted.

**R403.5 Service hot water systems.** Energy conservation measures for service hot water systems shall be in accordance with this section. Service water-heating equipment shall meet the requirements of DOE 10 CFR Part 430 Uniform Energy Factor or the equipment shall meet the requirements of Section C404.2.

**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:
  - 1.1. 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.
  - 1.2. 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 Water volume determination.** 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. Water heaters, circulating water systems, and heat trace temperature maintenance systems shall be considered to be sources of heated water. The volume in the piping shall be determined from Table C404.3.1 in the Washington State Energy Code, Commercial Provisions or Table L502.7 of the *Uniform Plumbing Code*. 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.

**R403.5.3 Hot water pipe insulation.** Insulation for service hot water pipe, both within and outside the conditioned space, shall have a minimum thermal resistance (*R*-value) of R-3.

**Exception:** Pipe insulation is permitted to be discontinuous where it passes through studs, joists or other structural members and where the insulated pipes pass other piping, conduit or vents, provided the insulation is installed tight to each obstruction.

**R403.5.4 Drain water heat recovery units.** Drain water heat recovery units shall comply with CSA 55.2 or IAPMO PS 92. Drain water heat recovery units shall be in accordance with CSA 55.1 or IAPMO IGC 346-2017.

**R403.5.5 Water heater installation location.** Service hot water systems shall be installed within the building thermal envelope.

**Exceptions:**

1. Where the hot water system efficiency is greater than or equal to 2.0 UEF.
2. Tankless water heaters.
3. Gas heat pump water heaters intended for exterior installation.
4. Atmospheric vented gas water heaters.

**R403.5.6 Water heater insulation.** All tank-type water heaters in unconditioned spaces, or on concrete floors in conditioned spaces, shall be placed on an insulated surface with a minimum thermal resistance of R-10, and a minimum compressive strength of 40 psi or engineered to support the appliance.

**R403.5.7 Supplementary heat for heat pump water heating systems.** Heat pumps used for water heating and having supplementary water heating equipment shall have controls that limit supplementary water heating equipment operation to only those times when one of the following applies:

1. The heat pump water heater cannot meet hot water demand.
2. For heat pumps located in unconditioned space, the outside air temperature is below 40°F (4°C).
3. The heat pump is operating in defrost mode.
4. The vapor compression cycle malfunctions or loses power.

**Exception:** Heat trace temperature maintenance systems, provided the system capacity does not exceed the capacity of the heat pump water heating system.

**R403.6 Mechanical ventilation.** The *buildings* and *dwelling units* complying with Section R402.5.1 shall be provided with mechanical ventilation that meets the requirements of Section M1505 in 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 Fan efficacy for whole-house mechanical ventilation systems and outdoor air ventilation systems.** Mechanical ventilation system fans shall meet the efficacy requirements of Table R403.6.1 at one or more rating points. Fans shall be tested in accordance with the test procedure referenced by Table R403.6.1 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 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).

**TABLE R403.6.1  
WHOLE-DWELLING MECHANICAL VENTILATION SYSTEM FAN EFFICACY<sup>a</sup>**

SYSTEM TYPE	AIR FLOW RATE (CFM)	MINIMUM EFFICACY (CFM/WATT)	TEST PROCEDURE
HRV or ERV	Any	1.2 <sup>a</sup>	CAN/CSA C439
Balanced ventilation system without heat or energy recovery	Any	1.2 <sup>a</sup>	ANSI/AMCA 210-ANSI/ASHRAE 51
Range hoods	Any	2.8	
In-line supply or exhaust fan	Any	3.8	
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 DOE10 CFR 430 or other approved test method

For SI: 1 cfm = 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.

**R403.6.2 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 R403.6.3, testing of each mechanical ventilation system is not required.

**R403.6.3 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.

**R403.6.4 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. The output capacity of heating and cooling equipment shall not be greater than that of the smallest available equipment size that exceeds the loads calculated, including allowable oversizing limits. Equipment shall meet the minimum federal efficiency standards as referenced in Tables C403.3.2(1), C403.3.2(2), C403.3.2(3), C403.3.2(4), C403.3.2(5), C403.3.2(6), C403.3.2(7), C403.3.2(8) and C403.3.2(9) and tested and rated in accordance with the applicable test procedure.

**R403.7.1 Electric-resistance space heating.** Detached one- and two-family dwellings and townhouses 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.

**R403.7.2 Gas fireplace efficiency.** Vented gas fireplace heaters shall have a fireplace efficiency (FE) rating of not less than 50 percent as determined by 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, including their FE ratings. See also Section R403.1.3.

**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 WSEC--



Commercial Provisions in lieu 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 and ice melt system controls.** Snow and ice-melting systems, supplied through energy service to the building, shall include automatic controls capable of shutting off the system when the pavement temperature is above 50°F, and no precipitation is falling and an automatic or manual control that will allow shutoff when the outdoor temperature is above 40°F.

**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 include a moisture sensor configured to shut off the system in the absence of moisture.

**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 R403.10.4.2.

**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 settings of the heater thermostat. Such switches shall be in addition to a circuit breaker for the power to the heater.

**R403.10.2 Time switches.** Time switches or other control method that can automatically turn off and on heaters and pump motors 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 deemed in compliance with this requirement.

**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 operating season of not fewer than three calendar months, is from a heat pump or on-site renewable energy system, covers or other vapor-retardant means shall not be required.

**R403.10.4 Residential pool pumps.** Pool pump motors may not be split-phase or capacitor start-induction run type.

**R403.10.4.1 Two-speed capability.**

1. Pump motors: Pool pump motors with a capacity of 1 hp or more shall have the capability of operating at two or more speeds with low speed having a rotation rate that is no more than one-half of the motor's maximum rotation rate.
2. Pump controls: Pool pump motor controls shall have the capability of operating the pool pump with at least two speeds. The default circulation speed shall be the lowest speed, with a high speed override capability being for a temporary period not to exceed one normal cycle.

**R403.10.4.2 Pump operation.** Circulating water systems shall be controlled so that the circulation pump(s) can be conveniently turned off, automatically or manually, when the water system is not in operation.

**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.** The energy consumption of residential swimming pools and permanent residential spas shall be controlled in accordance with the requirements of APSP-15.

**R403.13 Reserved.**

## **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 electrical input of not greater than 3.0 watts.

**R404.1.1 Exterior lighting.** Connected exterior lighting for Group R-2, R-3 and R-4 *residential buildings* shall comply with Sections R404.1.1.1 through R404.1.1.4.

**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.

**R404.1.1.1 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*.

**R404.1.1.2 Exterior lighting power allowance.** The total area or length of each area type multiplied by the value for the area type in Table R404.1.1.2 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.

**TABLE R404.1.1.2  
LIGHTING POWER ALLOWANCES FOR BUILDING EXTERIORS**

Base Site Allowance	280 watts
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Uncovered Parking Areas and Drives	0.026 W/ft <sup>2</sup>
<b>Building Grounds</b>	
Walkways and Ramps	0.50 W/linear foot
Plaza Areas	0.049 W/ft <sup>2</sup>
Dining Areas	0.273 W/ft <sup>2</sup>
Stairways	Exempt
Pedestrian Tunnels	0.110 W/ft <sup>2</sup>
Landscaping	0.025 W/ft <sup>2</sup>
<b>Building Entrances and Exits</b>	
Pedestrian and Vehicular Entrances and Exits	9.8 W/linear foot of opening
Entry Canopies	0.126 W/ft <sup>2</sup>

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

**R404.1.1.3 Additional exterior lighting power.** Additional exterior lighting power allowances shall be available for the building facades at 0.075 W/ft<sup>2</sup> (0.807 w/m<sup>2</sup>) 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.

**R404.1.1.4 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 interior 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 shut-off actions.
2. Lighting shall be automatically shut off when daylight is present and satisfies the lighting needs.
3. Controls that override automatic shut-off actions shall not be allowed unless the override automatically returns automatic control to its normal operation within 24 hours.

**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. For structures less than 1,500 square feet of conditioned floor area, the annual site energy consumption shall be less than or equal to 64 percent of the annual site energy consumption of the *standard reference design*.
3. For structures 1,500 to 5,000 square feet of conditioned floor area, the annual site energy consumption shall be no more than 47 percent of the *standard reference design*.
4. For structures over 5,000 square feet of conditioned floor area, the annual site energy consumption shall be no more than 41 percent of the *standard reference design*.
5. For structures serving Group R-2 occupancies, the annual site energy consumption shall be less than or equal to 61 percent of the annual site energy consumption of the *standard reference design*. See Section R401.1 and *residential building* in Section R202 for Group R-2 scope.

Energy use derived from simulation analysis shall be expressed in Btu per square foot of *conditioned floor area* per year.

**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.

**TABLE R405.2**

### REQUIREMENTS FOR SIMULATED BUILDING PERFORMANCE

Section <sup>a</sup>	Title	Comments
<b>General</b>		
R401.3	Certificate	
<b>Envelope</b>		
R402.1.1	Vapor retarder	
R402.2.2	Attic knee wall	
R402.2.3	Eave baffle	
R402.2.4.1	Access hatches and doors	
R402.2.9	Slab-on-grade floors	
R402.4.5	Combustion air openings.	
R402.4.6	Fireplaces	
R402.5	Air leakage	
R402.6	Maximum fenestration U-factor	
<b>Systems</b>		
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	Equipment sizing and efficiency rating	Except for Section R403.7.1
R403.8	Systems serving multiple dwelling units	
R403.9.2	Snow and ice melt system controls	
R403.10	Energy consumption of pools and spas	
R403.11	Portable spas	
R403.12	Residential pools and permanent residential spas	
<b>Electrical Power and Lighting</b>		
R404.1	Lighting equipment	
R404.2	Interior lighting controls	

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

**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 methods 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.

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

<b>BUILDING COMPONENT</b>	<b>STANDARD REFERENCE DESIGN</b>	<b>PROPOSED DESIGN</b>
Above-grade walls	Type: Mass wall if proposed wall is mass; otherwise wood frame. Gross area: Same as proposed U-factor: From Table R402.1.2 Solar reflectance = 0.25 Emittance = 0.90	As proposed  As proposed As proposed As proposed As proposed
Below-grade walls	Type: Same as proposed Gross area: Same as proposed U-factor: From Table R402.1.2, with insulation layer on interior side of walls.	As proposed As proposed As proposed
Above-grade floors	Type: Wood frame Gross area: Same as proposed U-factor: From Table R402.1.2	As proposed As proposed As proposed
Ceilings	Type: Wood frame Gross area: Same as proposed	As proposed As proposed

	<i>U</i> -factor: From Table R402.1.2	As proposed
Roofs	Type: Composition shingle on wood sheathing Gross area: Same as proposed Solar reflectance = 0.25 Emittance = 0.90	As proposed As proposed As proposed As proposed
Attics	Type: Vented with aperture = 1 ft <sup>2</sup> per 300 ft <sup>2</sup> ceiling area	As proposed
Foundations	Type: Same 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. Foundation wall <i>U</i> -factor and slab <i>F</i> -factor: As specified in Table R402.1.2	As proposed
Opaque Doors	Area: 40 ft <sup>2</sup> Orientation: North <i>U</i> -factor: Same as fenestration from Table R402.1.2.	As proposed As proposed As proposed
Vertical fenestration other than opaque doors <sup>a</sup>	Total area <sup>h</sup> = (a) The proposed glazing area; where proposed glazing area is less than 15% of the conditioned floor area. (b) 15% of the conditioned floor area; where the proposed glazing area is 15% or more of the conditioned floor area. Orientation: Equally distributed to four cardinal compass orientations (N, E, S & W). <i>U</i> -factor: From Table R402.1.2 SHGC: From Table R402.1.3 except that for climates with no requirement (NR) SHGC = 0.40 shall be used. Interior shade fraction: 0.92 - (0.21 × SHGC for the standard reference design) External shading: None	As proposed  As proposed As proposed As proposed 0.92 - (0.21 × SHGC as proposed) As proposed
Skylights	None	As proposed

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

<b>BUILDING COMPONENT</b>	<b>STANDARD REFERENCE DESIGN</b>	<b>PROPOSED DESIGN</b>
Air leakage rate	For detached one-family dwellings: Air leakage rate of 3.0 air changes per hour at a pressure of 0.2 inch w.g. (50 Pa). For detached one-family dwellings that are 1,500 ft <sup>2</sup> or smaller and attached dwelling units or sleeping units: Air leakage rate of 0.27 cfm/ft <sup>2</sup> of the testing unit enclosure area at a pressure of 0.2 inch water gauge (50 Pa).	As proposed
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 no greater than $B \times M$ where: $B = 0.01 \times CFA + 7.5 \times (N_{br} + 1)$ $M = 1.0$ where the measured air leakage rate is $\geq 3.0$ air changes per hour at 50 Pascals, and otherwise, $M = \text{minimum } (1.7, Q/B)$ . $Q$ = the proposed mechanical ventilation rate, cfm. $CFA$ = conditioned floor area, ft <sup>2</sup> . $N_{br}$ = number of bedrooms.	As proposed.

Mechanical ventilation fan energy	<p>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 <a href="#">Section R403.6.1</a>. Heat recovery or energy recovery shall not be modeled for mechanical ventilation where not required by <a href="#">Section R403.6.1</a>.</p> <p>Where mechanical ventilation is not specified in the proposed design: None</p> <p>Where mechanical ventilation is specified in the proposed design, the annual vent fan energy use, in units of kWh/yr, shall equal <math>(8.76 \times B \times M)/ef</math> where:</p> <p><math>B</math> and <math>M</math> are determined in accordance with the air exchange mechanical ventilation rate row of this table.</p> <p><math>ef</math> = the minimum fan efficacy, as specified in <a href="#">Table R403.6.2</a>, corresponding to the system type at a flow rate of <math>B \times M</math>.</p>	As proposed
Internal gains	$IGain = 17,900 + 23.8 \times CFA + 4104 \times N_{br}$ (Btu/day per dwelling unit)	Same as standard reference design
Internal mass	An internal mass for furniture and contents of 8 pounds per square foot of floor area.	Same as standard reference design, plus any additional mass specifically designed as a thermal storage element <sup>c</sup> but not integral to the <i>building thermal envelope</i> or structure.
Structural mass	For masonry floor slabs, 80% of floor area covered by R-2 carpet and pad, and 20% of floor directly exposed to room air.	As proposed
	For masonry basement walls, as proposed, but with insulation required by Table R402.1.2 located on the interior side of the walls.	As proposed
	For other walls, for ceilings, floors, and interior walls, wood frame construction.	As proposed
Heating systems <sup>d, e, j, k</sup>	<p>The standard reference design shall be an air source heat pump meeting the requirements of Section C403 of the WSEC—Commercial Provisions.</p> <p>Capacity: Sized in accordance with Section R403.7</p> <p>Efficiency: Complying with 10 CFR § 430.32</p>	As proposed
Cooling systems <sup>d, f, k</sup>	<p>Same system type as proposed.</p> <p>Capacity: Sized in accordance with Section R403.6.</p> <p>Efficiency: Complying with 10 CFR § 430.32</p>	As proposed

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

BUILDING COMPONENT	STANDARD REFERENCE DESIGN	PROPOSED DESIGN
Service water heating <sup>d,e,f, g, k</sup>	The <i>standard reference design</i> shall be a heat pump water heater meeting the efficiency standards of <a href="#">Table C404.2</a> of chapter 51-11C WAC.	As proposed

	<p>Use, in units of gal/day – <math>25 + (8.5 \times N_{br})</math></p> <p>Where</p> <p><math>N_{br}</math> = number of bedrooms</p>	<p>Use, in units of gal/day = <math>25.5 + (8.5 \times N_{br}) \times (1-HWDS)</math></p> <p>Where:</p> <p><math>N_{br}</math> = number of bedrooms</p> <p>HWDS = factor for the compactness of the hot water distribution system.</p> <table> <tr> <th colspan="2">Compactness Ratio<sup>1</sup> Factor</th><th rowspan="2">HWDS</th></tr> <tr> <th>1 story</th><th>2 or more stories</th></tr> <tr> <td>&gt;60%</td><td>&gt;30%</td><td>0</td></tr> <tr> <td>&gt;30% to ≤60%</td><td>&gt;15% to ≤30%</td><td>0.05</td></tr> <tr> <td>&gt;15% to ≤30%</td><td>&gt;7.5% to ≤15%</td><td>0.10</td></tr> <tr> <td>&lt;15%</td><td>&lt;7.5%</td><td>0.15</td></tr> </table>	Compactness Ratio <sup>1</sup> 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
Compactness Ratio <sup>1</sup> 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																	
	Rated storage volume: Same as proposed design	As proposed																	
	Draw pattern: same as proposed design	As proposed																	
	Tank temperature: 120°F (48.9°C)	As proposed																	
Thermal distribution systems	Duct insulation: From Section R403.3.3	Duct insulation: As proposed <sup>m</sup>																	
	Duct location: same as proposed design	Duct location: As proposed																	
	A thermal distribution system efficiency (DSE) of 0.93 shall be applied to both the heating and cooling system efficiencies for all systems.	As specified in Table R405.5.2(2)																	
	<b>Exception:</b> For non-ducted heating and cooling systems that do not have a fan, the standard reference design distribution system efficiency (DSE) shall be 1.																		
Thermostat	Type: Manual, cooling temperature setpoint = 75°F; Heating temperature setpoint = 72°F	Same as standard reference																	

For SI: 1 square foot = 0.93 m<sup>2</sup>, 1 British thermal unit = 1055 J, 1 pound per square foot = 4.88 kg/m<sup>2</sup>, 1 gallon (U.S.) = 3.785 L, °C = (°F-3)/1.8, 1 degree = 0.79 rad

- Hourly calculations as specified in the ASHRAE *Handbook of Fundamentals*, or the equivalent, shall be used to determine the energy loads resulting from infiltration.
- 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.
- Thermal storage element shall mean a component not part of the floors, walls or ceilings that is part of a passive solar system, and that provides thermal storage such as enclosed water columns, rock beds, or phase-change containers. A thermal storage element must be in the same room as fenestration that faces within 15 degrees (0.26 rad) of true south, or must be connected to such a room with pipes or ducts that allow the element to be actively charged.
- 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.
- For a proposed design without a proposed heating system, a heating system with the prevailing federal minimum efficiency shall be assumed for both the standard reference design and proposed design.
- For a proposed design without a proposed cooling system, an electric air conditioner with the prevailing federal minimum efficiency shall be assumed for both the standard reference design and the proposed



design.

- g. For a proposed design 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: UEF complying with 10 CFR §430.32

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

$$AF = A_s \times FA \times F$$

Where:

$AF$  = Total fenestration area.

$A_s$  = Standard reference design total fenestration area.

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

$L$  and  $CFA$  are in the same units.

- i. The factor for the compactness of the hot water distribution system is the ratio of the area of the rectangle that bounds the source of hot water and the fixtures that it serves (the "hot water rectangle") divided by the floor area of the dwelling.
1. Sources of hot water include water heaters, or in multifamily buildings with central water heating systems, circulation loops or electric heat traced pipes.
  2. The hot water rectangle shall be shown on the floor plans and the area shall be computed to the nearest square foot.
  3. 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.
  4. The basement or attic shall be counted as a story when it contains the water heater.
  5. Compliance shall be demonstrated by providing a drawing on the plans that shows the hot water distribution system rectangle(s), comparing the area of the rectangle(s) to the area of the dwelling and identifying the appropriate compactness ratio and *HWDS* factor.
- j. For a proposed design with electric resistance heating, a split system heat pump complying with 10 CFR §430.32 (2021) shall be assumed modeled in the standard reference design.
- k. For heating systems, cooling systems, or water heating systems not included in this table, the standard reference design shall be the same as proposed design.

**TABLE R405.4.2(2)**  
**DEFAULT DISTRIBUTION SYSTEM EFFICIENCIES FOR PROPOSED DESIGNS<sup>a</sup>**

DISTRIBUTION SYSTEM CONFIGURATION AND CONDITION	FORCED AIR SYSTEMS	HYDRONIC SYSTEMS <sup>b</sup>
Distribution system components located in unconditioned space	NA	0.95
Distribution system components entirely located in conditioned space <sup>c</sup>	NA	1
Zonal systems <sup>d</sup>	1.00	NA

NA = Not Applicable

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

- a. Default values in this table are for untested distribution systems, which must still comply with Section R403.

- b. 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.
- c. Entire system in conditioned space means that no component of the distribution system is located outside of the conditioned space. All components must be located on the interior side of the thermal envelope (inside the insulation) and also inside of the air barrier. Refrigerant compressors and piping are allowed to be located outside.
- d. Zonal systems are systems where the heat source is located within each room. Systems are allowed to have forced airflow across a coil but must not have any ducted airflow external to the space conditioning equipment. Hydronic systems do not qualify.

**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 jurisdiction. 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. Calculation of whole-dwelling unit (as a single *zone*) sizing for the heating and cooling equipment in the *standard reference design* residence in accordance with Section R403.6.
- 2. Hourly calculations of building operation for a full calendar year (8,760 hours)
- 3. Calculations that account for hourly variations of indoor and outdoor temperatures and part-load ratios on the performance of heating, ventilating and air-conditioning equipment based on climate and equipment sizing.
- 4. Printed *code official* inspection checklist listing each of the *proposed design* component characteristics from Table R405.4.2(1) determined by the analysis to provide compliance, along with their respective performance ratings (e.g., *R*-value, *U*-factor, SHGC, HSPF2, AFUE, SEER2, UEF, etc.).

**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 all of the following:

- 1. Building street address, or other *building site* identification.
- 2. The name, organization and contact information 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*.
- 5. A certificate indicating that the *proposed design* complied with Section R405.2. The certificate shall document the building components' energy specifications that are included in the calculation including: component-level insulation *R*-values or *U*-factors; duct system and

*building 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. Additional documentation reporting estimated annual energy production shall be provided.

6. When a site-specific report is not generated, the proposed design shall be based on the worst-case orientation and configuration of the rated *dwelling unit*.

**R405.5.4.2 Compliance report for certificate of occupancy.** A compliance report generated for submission prior to obtaining the certificate of occupancy shall include all of 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, along with their organization and contact information, 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.
7. Where on-site renewable energy systems have been installed, the certificate shall report the type and production size of the installed system. Additional documentation reporting estimated annual energy production shall be provided.

## SECTION R406 ADDITIONAL ENERGY EFFICIENCY REQUIREMENTS

**R406.1 Scope.** This section establishes additional energy efficiency requirements for all new construction covered by this code, including additions subject to Section R502 and change of occupancy or use subject to Section R505 unless specifically exempted in Section R406. Credit from both Sections R406.2 and R406.3 are required.

**R406.2 Carbon emission equalization.** This section establishes a base equalization between fuels used to define the equivalent carbon emissions of the options specified. The permit shall define the base fuel selection to be used and the points specified in Table R406.2 shall be used to modify the requirements in Section R406.3.

**TABLE R406.2  
ENERGY EQUALIZATION CREDITS**

System Type	Description of Primary Heating Source	Credits	
		All Other	Group R-2 <sup>a</sup>
1	For combustion heating equipment meeting minimum federal efficiency standards for the equipment listed in Table C403.3.2(5) or C403.3.2(6)	0	0
2	For an initial heating system using a heat pump that meets federal standards for the equipment	1.5	0

System Type	Description of Primary Heating Source	Credits	
		All Other	Group R-2 <sup>a</sup>
	listed in Table C403.3.2(2) and supplemental heating provided by electric resistance or a combustion furnace meeting minimum standards listed in Table C403.3.2(5) <sup>b</sup>		
<b>3</b>	For heating system based on electric resistance only (either forced air or Zonal)	0.5	-0.5
<b>4<sup>c</sup></b>	For heating system using a heat pump that meets federal standards for the equipment listed in Table C403.3.2(2) or C403.3.2(9)  <b>or</b> Air to water heat pump units that are configured to provide both heating and cooling and are rated in accordance with AHRI 550/590	3.0	2.0
<b>5</b>	For heating system based on electric resistance with: 1. Inverter-driven ductless mini-split heat pump system installed in the largest zone in the dwelling, <b>or</b> 2. With 2kW or less total installed heating capacity per dwelling	2.0	0

- See Section R401.1 and residential building in Section R202 for Group R-2 scope.
- The gas back-up furnace will operate as fan-only when the heat pump is operating. The heat pump shall operate at all temperatures above 38°F (3.3°C) (or lower). Below that "changeover" temperature, the heat pump would not operate to provide space heating. The gas furnace provides heating below 38°F (3.3°C) (or lower).
- Additional points for the HVAC system are included in Table R406.3.

**R406.3 Additional energy efficiency requirements.** Each dwelling unit in a residential building shall comply with sufficient options from Tables R406.2 and R406.3 so as to achieve the following minimum number of credits:

- Small Dwelling Unit: ..... 5.0 credits  
Dwelling units less than 1500 square feet in conditioned floor area with less than 300 square feet of fenestration area. Additions to existing building greater than 500 square feet of heated floor area but less than 1500 square feet.
- Medium Dwelling Unit: ..... 8.0 credits  
All dwelling units that are not included in #1, #3 or #4.
- Large Dwelling Unit: ..... 9.0 credits  
Dwelling units exceeding 5000 square feet of conditioned floor area.
- Dwelling units serving Group R-2 occupancies: ..... 6.5 credits  
See Section R401.1 and *residential building* in Section R202 for Group R-2 scope.
- Additions 150 square feet to 500 square feet: ..... 2.0 credits

The drawings included with the building permit application shall identify which options have been selected and the point value of each option, regardless of whether separate mechanical, plumbing, electrical, or other permits are utilized for the project.

**TABLE R406.3  
ENERGY CREDITS**

OPTION	DESCRIPTION	CREDIT(S)	
		All Other	Group R-2 <sup>b</sup>
<b>1. EFFICIENT BUILDING THERMAL ENVELOPE OPTIONS</b>			
Only one option from Items 1.1 through 1.4 may be selected in this category.			
Compliance with the conductive UA targets is demonstrated using Section R402.1.5, component performance alternative, where [1-(Proposed UA/Target UA)] > the required %UA reduction			
1.1	Prescriptive compliance is based on Table R402.1.3 with the following modifications: Vertical fenestration U = 0.22.	0.5	0.5
1.2	Prescriptive compliance is based on Table R402.1.3 with the following modifications: Vertical fenestration U = 0.25 Floor R-38 Basement wall R-21 int plus R-5 ci Ceiling and single-rafter or joist-vaulted R-60 advanced Slab on grade R-10 perimeter and under entire slab Below grade slab R-10 perimeter and under entire slab <b>or</b> Compliance based on Section R402.1.5: Reduce the Total conductive UA by 15%.	1.0	1.0
1.3	Prescriptive compliance is based on Table R402.1.3 with the following modifications: Vertical fenestration U = 0.18 Ceiling and single-rafter or joist-vaulted R-60 advanced Floor R-38 Basement wall R-21 int plus R-12 ci Slab on grade R-10 perimeter and under entire slab Below grade slab R-10 perimeter and under entire slab <b>or</b> Compliance based on Section R402.1.5: Reduce the Total conductive UA by 22.5%.	1.5	0.5
1.4	Prescriptive compliance is based on Table R402.1.3 with the following modifications: Vertical fenestration U = 0.18 Ceiling and single-rafter or joist-vaulted R-60 advanced Wood frame wall R-21 int plus R-16 ci Floor R-48 Basement wall R-21 int plus R-16 ci Slab on grade R-20 perimeter and under entire slab Below grade slab R-20 perimeter and under entire slab <b>or</b> Compliance based on Section R402.1.5: Reduce the Total conductive UA by 30%.	2.5	2.0
<b>2. AIR LEAKAGE CONTROL AND EFFICIENT VENTILATION OPTIONS</b>			
Only one option from Items 2.1 through 2.3 may be selected in this category.			
2.1	Compliance based on Section R402.5.1.2: Reduce the tested air leakage to 2.0 air changes per hour maximum at 50 Pascals, or for R-2 Occupancies, optional compliance based on Section R402.5.1.2: Reduce the tested air leakage to 0.25 cfm/ft <sup>2</sup> maximum at 50 Pascals <b>and</b> All whole house ventilation requirements as determined by Section M1505.3 of the <i>International Residential Code</i> or Section 403.8 of the	1.0	1.0

OPTION	DESCRIPTION	CREDIT(S)	
		All Other	Group R-2 <sup>b</sup>
	<p><i>International Mechanical Code</i> shall be met with a heat recovery ventilation system with minimum sensible heat recovery efficiency of 0.65.</p> <p>To qualify to claim this credit, the building permit drawings shall specify the option being selected, and shall specify the maximum tested building air leakage, and shall show the heat recovery ventilation system.</p>		
2.2	<p>Compliance based on Section R402.5.1.2:</p> <p>Reduce the tested air leakage to 1.5 air changes per hour maximum at 50 Pascals, or for R-2 Occupancies, optional compliance based on Section R401.5.1.2: Reduce the tested air leakage to 0.20 cfm/ft<sup>2</sup> maximum at 50 Pascals</p> <p><b>and</b></p> <p>All whole house ventilation requirements as determined by Section M1505.3 of the <i>International Residential Code</i> or Section 403.8 of the <i>International Mechanical Code</i> shall be met with a heat recovery ventilation system with minimum sensible heat recovery efficiency of 0.75.</p> <p>To qualify to claim this credit, the building permit drawings shall specify the option being selected and shall specify the maximum tested building air leakage and shall show the heat recovery ventilation system.</p>	1.5	1.5
2.3	<p>Compliance based on Section R402.5.1.2:</p> <p>Reduce the tested air leakage to 0.6 air changes per hour maximum at 50 Pascals, or for R-2 Occupancies, optional compliance based on Section R402.5.1.2: Reduce the tested air leakage to 0.15 cfm/ft<sup>2</sup> maximum at 50 Pascals</p> <p><b>and</b></p> <p>All whole house ventilation requirements as determined by Section M1505.3 of the <i>International Residential Code</i> or Section 403.8 of the <i>International Mechanical Code</i> shall be met with a heat recovery ventilation system with minimum sensible heat recovery efficiency of 0.80. Duct insulation shall comply with Section R403.3.2.</p> <p>To qualify to claim this credit, the building permit drawings shall specify the option being selected and shall specify the maximum tested building air leakage and shall show the heat recovery ventilation system.</p>	2.0	2.0
<p><b>3. HIGH EFFICIENCY HVAC EQUIPMENT OPTIONS</b></p> <p>Only one option from Items 3.1 through 3.10 may be selected in this category. Item 3.11 may be taken with Items 3.1 or 3.2<sup>c</sup> only.</p>			
3.1 <sup>a</sup>	<p>For a System Type 1 in Table R406.2:</p> <p>Energy Star rated (U.S. North) Gas or propane furnace with minimum AFUE of 95%</p> <p><b>or</b></p> <p>Energy Star rated (U.S. North) Gas or propane boiler with minimum AFUE of 90%.</p> <p>To qualify to claim this credit, the building permit drawings shall specify the option being selected and shall specify the heating equipment type and the minimum equipment efficiency.</p>	1.0	1.0
3.2 <sup>a</sup>	<p>For secondary heating system serving System Type 2 in Table R406.2:</p> <p>Energy Star rated (U.S. North) Gas or propane furnace with minimum AFUE of 95%</p> <p><b>or</b></p> <p>Energy Star rated (U.S. North) Gas or propane boiler with minimum AFUE of 90%.</p>	0.5	0.5

OPTION	DESCRIPTION	CREDIT(S)	
		All Other	Group R-2 <sup>b</sup>
	To qualify to claim this credit, the building permit drawings shall specify the option being selected and shall specify the heating equipment type and the minimum equipment efficiency.		
3.3 <sup>a,c,d</sup>	<p>Air-source, centrally ducted heat pump with minimum HSPF2 of 8.1 (HSPF of 9.5).</p> <p>In areas where the winter design temperature as specified in Appendix RC is 23°F or below, a cold climate heat pump found on the NEEP cc ASHP qualified product list shall be used.</p> <p>To qualify to claim this credit, the building permit drawings shall specify the option being selected and shall specify the heating equipment type and the minimum equipment efficiency.</p>	0.5	NA
3.4 <sup>a,d</sup>	<p>Closed-loop ground source heat pump; with a minimum COP of 3.3</p> <p><b>or</b></p> <p>Open loop water source heat pump with a maximum pumping hydraulic head of 150 feet and minimum COP of 3.6.</p> <p>To qualify to claim this credit, the building permit drawings shall specify the option being selected and shall specify the heating equipment type and the minimum equipment efficiency.</p>	1.5	1.0
3.5 <sup>d</sup>	<p>Ductless mini-split heat pump system, zonal control: In homes where the primary space heating system is zonal electric heating, a ductless mini-split heat pump system with a minimum HSPF2 of 9 (HSPF of 10.0) shall be installed and provide heating to the largest zone of the housing unit.</p> <p>To qualify to claim this credit, the building permit drawings shall specify the option being selected and shall specify the heating equipment type and the minimum equipment efficiency.</p>	1.5	2.0
3.6 <sup>a</sup>	<p>Air-source, centrally ducted heat pump with minimum HSPF2 of 9.4 (HSPF of 11.0).</p> <p>A centrally ducted air source cold climate variable capacity heat pump (cc VCHP) found on the NEEP cc VCHP qualified product list with a minimum of 8.5 HSPF2 (10 HSPF) may be used to satisfy this requirement.</p> <p>In areas where the winter design temperature as specified in Appendix RC is 23°F or below, an air source centrally ducted heat pump shall be a cold climate variable capacity heat pump as listed on the NEEP qualified product list.</p> <p>To qualify to claim this credit, the building permit drawings shall specify the option being selected and shall specify the heating equipment type and the minimum equipment efficiency.</p>	1.0	N/A
3.7 <sup>a,d,e</sup>	<p>Ductless split system heat pumps with no electric resistance heating in the primary living areas. A ductless heat pump system with a minimum HSPF2 of 9 (HSPF of 10) shall be sized and installed to provide heat to entire dwelling unit at the design outdoor air temperature.</p> <p><b>Exception:</b> In homes with total heating loads of 24,000 or less using multi-zone mini-split systems with nominal ratings of 24,000 or less, the minimum HSPF s to claim this credit shall be 8.19 HSPF2 (or 9 HSPF).</p> <p>To qualify to claim this credit, the building permit drawings shall specify the option being selected, the heated floor area calculation, the heating equipment type(s), the minimum equipment efficiency, and total installed heat capacity (by equipment type).</p>	2.0	3.0
3.8 <sup>a,d</sup>	Air-to-water heat pump with minimum COP of 3.2 at 47°F, rated in accordance with AHRI 550/590 by an accredited or certified testing lab.	1.0	NA

OPTION	DESCRIPTION	CREDIT(S)	
		All Other	Group R-2 <sup>b</sup>
	To qualify to claim this credit, the building permit drawings shall specify the option being selected, the heated floor area calculation, the heating equipment type(s), the minimum equipment efficiency, and total installed heat capacity (by equipment type).		
3.9	Gas-fired heat pump(s) meeting ANSI Z21.40.2 and Z21.40.4 or CSA, with a minimum UEF of 1.15. For R-2 Occupancy, gas-fired heat pump(s) meeting ANSI Z21.40.2 and Z21.40.4 or CSA, with a minimum UEF of 1.15, shall serve all units. To qualify to claim this credit, the building permit drawings shall specify the option being selected and shall specify the heating equipment type and the minimum equipment efficiency.	1.5	1.5
3.10 <sup>f</sup>	Combination water heating and space heating system shall include one of the following: Gas-fired heat pump water heater(s) meeting Tier 2 of the NEEA Advanced Water Heating Specification for Gas-Fueled Residential Storage Water Heaters Version 1.0.  <b>or</b> For R-2 Occupancy, gas-fired heat pump water heater(s) meeting Tier 2 of the NEEA Advanced Water Heating Specification for Gas-Fueled Residential Storage Water Heaters Version 1.0., shall serve all units.  <b>or</b> For R-2 Occupancy, gas-fired heat pump(s) meeting ANSI Z21.40.2 and Z21.40.4 or CSA, with a minimum UEF of 1.15, shall serve all units. To qualify to claim this credit, the building permit drawings shall specify the option being selected and shall specify the water heater equipment type and the minimum equipment efficiency and, for solar water heating systems, the calculation of the minimum energy savings.	2.5	2.5
3.11 <sup>c</sup>	Connected thermostat meeting ENERGY STAR Certified Smart Thermostats/EPA ENERGY STAR specifications. To qualify to claim this credit, the building permit drawings shall specify the option being selected and shall specify the thermostat model.	0.5	0.5
<b>4. HIGH EFFICIENCY HVAC DISTRIBUTION SYSTEM OPTIONS</b>			
4.1	HVAC equipment and associated duct system(s) installation shall comply with the requirements of Section R403.3.2. Electric resistance heat, hydronic heating and ductless heat pumps are not permitted under this option. To qualify to claim this credit, the building permit drawings shall specify the option being selected and shall specify the heating equipment type and shall show the location of the heating and cooling equipment and all the ductwork.	0.5	N/A
<b>5. EFFICIENT WATER HEATING OPTIONS</b> Only one option from Items 5.3 through 5.8 may be selected in this category. Items 5.1 and 5.2 may be combined with any option.			
5.1	A drain water heat recovery unit(s) shall be installed, which captures waste water heat from at least two showers, including tub/shower combinations. It is acceptable, but not required, for sink water to be connected. Unit shall have a minimum efficiency of 40% if installed for equal flow or a minimum efficiency of 54% if installed for unequal flow. Such units shall be rated in accordance with CSA B55.1 or IAPMO IGC 346-2017 and be so labeled. To qualify to claim this credit, the building permit drawings shall include a plumbing diagram that specifies the drain water heat recovery units and the plumbing layout needed to install it. Labels or other	0.5	0.5



OPTION	DESCRIPTION	CREDIT(S)	
		All Other	Group R-2 <sup>b</sup>
	documentation shall be provided that demonstrates that the unit complies with the standard.		
5.2	For Compact Hot Water Distribution system credit, the volume shall store not more than 16 ounces of water between the nearest source of heated water and the termination of the fixture supply pipe where calculated using Section R403.5.2. <i>Construction documents</i> shall indicate the ounces of water in piping between the hot water source and the termination of the fixture supply. When the hot water source is the nearest primed plumbing loop or trunk, this must be primed with an On Demand recirculation pump and must run a dedicated ambient return line from the furthest fixture or end of loop to the water heater. To qualify for this credit, the dwelling must have a minimum of 1.5 bathrooms.	0.5	0.5
5.3	Water heating system shall include the following: Energy Star rated gas or propane water heater with a minimum UEF of 0.80. To qualify to claim this credit, the building permit drawings shall specify the option being selected and shall specify the water heater equipment type and the minimum equipment efficiency.	0.5	0.5
5.4	Water heating system shall include one of the following: Energy Star rated gas or propane water heater with a minimum UEF of 0.91 <b>or</b> Solar water heating supplementing a minimum standard water heater. Solar water heating will provide a rated minimum savings of 85 therms or 2000 kWh based on the Solar Rating and Certification Corporation (SRCC) Annual Performance of OG-300 Certified Solar Water Heating System <b>or</b> Water heater heated by ground source heat pump meeting the requirements of Option 3.4. To qualify to claim this credit, the building permit drawings shall specify the option being selected and shall specify the water heater equipment type and the minimum equipment efficiency and, for solar water heating systems, the calculation of the minimum energy savings.	1.0	1.0
5.5	Water heating system shall include one of the following: Gas-fired heat pump water heater(s) meeting Tier 2 of the NEEA Advanced Water Heating Specification for Gas-Fueled Residential Storage Water Heaters Version 1.0. <b>or</b> For R-2 Occupancy, gas-fired heat pump water heater(s) meeting Tier 2 of the NEEA Advanced Water Heating Specification for Gas-Fueled Residential Storage Water Heaters Version 1.0. shall supply domestic hot water to all units. <b>or</b> For R-2 Occupancy, gas-fired heat pump water heater(s) meeting ANSI Z21.40.2 and Z21.40.4 or CSA, with a minimum UEF of 1.15, shall supply domestic hot water to all units. To qualify to claim this credit, the building permit drawings shall specify the option being selected and shall specify the water heater equipment type and the minimum equipment efficiency and, for solar water heating systems, the calculation of the minimum energy savings.	1.5	1.5
5.6	Water heating system shall include one of the following: Electric heat pump water heater meeting the standards for Tier III of NEEA's advanced water heating specification <b>or</b>	2.0	2.5

OPTION	DESCRIPTION	CREDIT(S)	
		All Other	Group R-2 <sup>b</sup>
	<p>For R-2 Occupancy, electric heat pump water heater(s), meeting the standards for Tier III of NEEA's advanced water heating specification, shall supply domestic hot water to all units. If one water heater is serving more than one dwelling unit, all hot water supply and recirculation piping shall be insulated with R-8 minimum pipe insulation.</p> <p>To qualify to claim this credit, the building permit drawings shall specify the option being selected and shall specify the water heater equipment type and the minimum equipment efficiency.</p>		
5.7	<p>Water heating system shall include one of the following:</p> <p>Electric heat pump water heater with a minimum UEF of 2.9 and utilizing a split system configuration with the air-to-refrigerant heat exchanger located outdoors. Equipment shall meet Section 4, requirements for all units, of the NEEA standard <i>Advanced Water Heating Specification</i> with the UEF noted above</p> <p><b>or</b></p> <p>For R-2 Occupancy, electric heat pump water heater(s), meeting the standards for Tier III of NEEA's advanced water heating specification and utilizing a split system configuration with the air-to-refrigerant heat exchanger located outdoors, shall supply domestic hot water to all units. If one water heater is serving more than one dwelling unit, all hot water supply and recirculation piping shall be insulated with R-8 minimum pipe insulation.</p> <p>To qualify to claim this credit, the building permit drawings shall specify the option being selected and shall specify the water heater equipment type and the minimum equipment efficiency.</p>	2.5	3.0
5.8	<p>Combination water heating and space heating system shall include one of the following:</p> <p>Gas-fired heat pump water heater(s) meeting Tier 2 of the NEEA Advanced Water Heating Specification for Gas-Fueled Residential Storage Water Heaters Version 1.0.</p> <p><b>or</b></p> <p>For R-2 Occupancy, gas-fired heat pump water heater(s) meeting Tier 2 of the NEEA Advanced Water Heating Specification for Gas-Fueled Residential Storage Water Heaters Version 1.0., shall supply all units.</p> <p><b>or</b></p> <p>For R-2 Occupancy, gas-fired heat pump(s) meeting ANSI Z21.40.2 and Z21.40.4 or CSA, with a minimum UEF of 1.15, shall supply all units. To qualify to claim this credit, the building permit drawings shall specify the option being selected and shall specify the water heater equipment type and the minimum equipment efficiency and, for solar water heating systems, the calculation of the minimum energy savings.</p>	2.5	2.5
<b>6. RENEWABLE ELECTRIC ENERGY OPTION</b>			
6.1	<p>For each 600 kWh of electrical generation per housing unit provided annually by on-site wind or solar equipment a 0.5 credit shall be allowed, up to 4.5 credits. Generation shall be calculated as follows:</p> <p>For solar electric systems, the design shall be demonstrated to meet this requirement using the National Renewable Energy Laboratory calculator PVWATTS or alternative approved by the code official. Documentation noting solar access shall be included on the plans.</p> <p>For wind generation projects designs shall document annual power generation based on the following factors:</p> <p>The wind turbine power curve; average annual wind speed at the site; frequency distribution of the wind speed at the site and height of the tower.</p>	0.5 – 4.5	0.5 – 4.5

OPTION	DESCRIPTION	CREDIT(S)	
		All Other	Group R-2 <sup>b</sup>
	To qualify to claim this credit, the building permit drawings shall specify the option being selected and shall show the photovoltaic or wind turbine equipment type, provide documentation of solar and wind access, and include a calculation of the minimum annual energy power production.		
<b>7. APPLIANCE PACKAGE OPTION</b>			
7.1	<p>All of the following appliances shall be new and installed in the dwelling unit and shall meet the following standards:</p> <ol style="list-style-type: none"> <li>1. Dishwasher, standard – Energy Star rated, Most Efficient 2021 or Dishwasher, compact – Energy Star rated (Version 6.0)</li> <li>2. Refrigerator (if provided) – Energy Star rated (Version 5.1)</li> <li>3. Washing machine (Residential) – Energy Star rated (Version 8.1)</li> <li>4. Dryer – Energy Star rated, Most Efficient 2022</li> </ol> <p>To qualify to claim this credit, the building permit drawings shall specify the option being selected and shall show the appliance type and provide documentation of Energy Star compliance. At the time of inspection, all appliances shall be installed and connected to utilities. Dryer ducts and exterior dryer vent caps are not permitted to be installed in the <i>dwelling unit</i>.</p>	0.5	1.5

- An alternative heating source sized at a maximum of 0.5 Watts/ft<sup>2</sup> (equivalent) of heated floor area or 500 Watts, whichever is bigger, may be installed in the dwelling unit.
- See Section R401.1 and *residential building* in Section R202 for Group R-2 scope.
- Option 3.11 can only be taken with Options 3.1 and 3.3. To qualify to claim Option 3.11 with 3.3, the system shall be a 1-2 speed heat pump system. Variable capacity heat pumps are ineligible from claiming this option.
- This option may only be claimed if serving System Type 4 or 5 from Table R406.2.
- Primary living areas include living, dining, kitchen, family rooms, and similar areas.
- Option 3.10 may only be taken with Efficient Water Heating Option 5.1 or 5.2. Equipment sizing for space heating shall be calculated as provided in Section R403.7 with increased capacity to provide a minimum of 75 percent of peak hot water demand or shall be sized in accordance with *approved* manufacturer's specifications or guidance. Supplementary heat for water heating shall be in accordance with Section R403.5.7.

## SECTION R407 CERTIFIED PASSIVE HOUSE

**R407.1 General.** Projects shall comply with Section R407.2 or R407.3.

**R407.2 Passive House Institute U.S. (PHIUS).** Projects shall comply with PHIUS+ 2018 Passive Building Standard, including its USDOE Energy Star and Zero Energy Ready Home co-requisites, and performance calculations by PHIUS-approved software. Projects shall also comply with the provisions of Table R405.2.

**R407.2.1 PHIUS documentation.** Prior to the issuance of a building permit, the following items must be provided to the *code official*:

3. A list of compliance features.
4. A PHIUS precertification letter.

Prior to the issuance of a certificate of occupancy, the following item must be provided to the *code official*:

1. A PHIUS+ 2018 (or later) project certificate.

**R407.3 Passive House Institute (PHI).** Projects shall comply with Low Energy Building Standard, version 9f or later, including performance calculations by PHI-approved software. Projects shall also

comply with the provisions of Section R401 through R404.

**R407.3.1 PHI documentation.** Prior to the issuance of a building permit, the following items must be provided to the *code official*:

1. A list of compliance features.
2. A statement from a passive house certifier that the modeled energy performance is congruent with the plans and specifications, and that the modeled performance meets said standard.

Prior to the issuance of a certificate of occupancy, the following item must be provided to the *code official*:

1. A PHI Low Energy Building project certificate.

## CHAPTER 5

### EXISTING BUILDINGS

#### 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.

**R501.1.2 Thermostats for accessory dwelling units.** Where a separate dwelling unit, that provides independent facilities for living, sleeping, cooking, bathing and sanitation, is established within or attached to an existing dwelling unit, the heating and cooling for the newly-created dwelling unit shall be controllable with a separate programmable thermostat in accordance with Section R403.1.1.

**R501.2 Compliance.** Additions, alterations, repairs or changes of occupancy to, or relocation of, an existing building, building system or portion thereof shall comply with Sections 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, Uniform Plumbing Code, and International Residential Code*, 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 with the code edition under which installed. The owner or the owner's authorized agent shall be responsible for the maintenance of buildings and structures. The requirements of this chapter shall not provide the basis for removal or abrogation of energy conservation, fire protection and safety systems and devices in existing structures.

**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 hazards to life, health or property are not created. Hazardous materials shall not be used where the code for new construction would not permit their use in buildings of similar occupancy, purpose and location.

**R501.5 Historic buildings.** The *code official* may modify the specific requirements of this code for historic buildings and require alternative provisions which will result in a reasonable degree of energy efficiency. This modification may be allowed for those buildings or structures that are listed in the state or national register of historic places; designated as a historic property under local or state designation law or survey; certified as a contributing resource with a national register listed or locally designated historic district; or with an opinion or certification that the property is eligible to be listed on the national or state registers of historic places either individually or as a contributing building to a historic district by the state historic preservation officer or the keeper of the national register of historic places.

**R501.6 Changes 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 total building performance option in Section R405 is used to comply with this section, the annual energy use of the proposed design is permitted to be 110 percent of the annual energy use otherwise allowed by Section R405.3.

#### SECTION R502 ADDITIONS

**R502.1 General.** *Additions* to an *existing building*, building system or portion thereof shall conform to the provisions of this code as those provisions relate to new construction. *Additions* shall not create an

unsafe or hazardous condition or overload *existing building* systems.

**R502.1.1 Small additions.** *Additions* not greater than 150 square feet (13.9 m<sup>2</sup>) shall not be required to comply with Section R406.

**R502.2 Prescriptive compliance.** Additions shall comply with Sections R502.2.1 through R502.2.4.

**R502.2.1 Building envelope.** New *building thermal envelope* assemblies that are part of the addition shall comply with Sections R402.1, R402.2, R402.3.1 through R402.3.5, and R402.5.

**Exception:** Where nonconditioned space is changed to conditioned space, the *building thermal envelope* of the addition shall comply where the UA, as determined in Section R402.1.5, of the existing building and the addition, and any alterations that are part of the project, is less than or equal to the UA generated for the existing building.

**R502.2.1.1 Existing ceilings with attic spaces.** Where an *addition* greater than 150 square feet (13.9 m<sup>2</sup>) adjoins existing ceilings with attic spaces, the existing attic spaces shall comply with Section R402.

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

**Exception:** The following need not comply with the testing requirements of Section R403.3.3:

1. *Additions* of less than 150 square feet.
2. Duct systems that are documented to have been previously sealed as confirmed through field verification and diagnostic testing in accordance with procedures in WSU RS-33.
3. Existing duct systems constructed, insulated or sealed with asbestos.

**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.

**R502.3 Existing plus addition compliance (Total Building Performance).** Where nonconditioned space is changed to conditioned space the addition shall comply where the annual energy use of the addition and the existing building, and any alterations that are part of the project, is less than or equal to the annual energy use of the existing building when modeled in accordance with Section R405. The addition and any alterations that are part of the project shall comply with Section R405 in its entirety.

## 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 no 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 uses no more energy than the existing building or structure prior to the *alteration*. Alterations to existing buildings shall comply with Section R503.1.1 through R503.1.4.

The *code official* may approve designs of alterations which do not fully conform to all of the requirements of this code where in the opinion of the *code official* full compliance is physically impossible and/or economically impractical and:

1. The alteration improves the energy efficiency of the building; or
2. The alteration is energy efficient and is necessary for the health, safety, and welfare of the general public.

**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 R403. The *R*-value of insulation shall not be reduced, nor the *U*-factor of a *building thermal envelope* assembly increased as part of a *building thermal envelope alteration* except where the *building* after the alteration complies with Section R405.

**Exception:** The following alterations need not comply with the requirements for new construction provided the energy use of the building is not increased:

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

**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 SHGC in Table R402.1.3. Where more than one replacement fenestration unit is being installed, an area-weighted average of the *U*-factor and SHGC of all replacement fenestration shall be permitted to be used to demonstrate compliance.

**R503.1.1.2 Roof, ceiling and attic alterations.** Roof, ceiling and attic insulation shall comply with Section R402.1. Alternatively, 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 Section R703.1.1 of the *International Residential Code* or Section 1402.2 of the *International Building Code*, as applicable, and manufacturers' instructions.
3. 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.

**Exceptions:**

1. Where *ductwork* from an existing heating and cooling system is extended, duct systems with less than 40 linear feet in unconditioned spaces shall not be required to be tested in accordance with Section R403.2.2.
2. Existing duct systems constructed, insulated or sealed with asbestos.

**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 accordance 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 m<sup>2</sup>) 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.

**Exception:** Replacement of water heating equipment shall not be required to comply with Section R403.5.5.

**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.

## **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 that is necessary for the required *repair* of damaged components shall be considered part of the *repair* and shall not be subject to the requirements for *alterations* in this chapter. 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.

The code official may approve designs of repairs which do not fully conform with all of the requirements of this code where in the opinion of the *code official* full compliance is physically impossible and/or economically impractical and:

1. The repair improves the energy efficiency of the building; or
2. The repair is energy efficient and is necessary for the health, safety, and welfare of the general public.

**R504.2 Application.** For the purposes of this code, the following shall be considered repairs.

1. Glass only replacements in an existing sash and frame.
2. Roof repairs.
3. Repairs where only the bulb and/or ballast 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 not within the scope of Section R101.2 which is converted to space that is within the scope of Section R101.2 shall be brought into full compliance with this chapter.

Spaces undergoing a change in occupancy that would result in an increase in demand for either fossil fuel or electrical energy shall comply with this code.

Any space that is converted to a dwelling unit or portion thereof from another use or occupancy shall comply with this code.

**Exception:** Where the *simulated building performance* option in Section R405 is used to comply with this section, the annual energy use of the proposed design is permitted to be 110 percent of the annual energy use otherwise allowed by Section R405.3.

**R505.1.1 Unconditioned space.** Any unconditioned or low-energy space that is altered to become a *conditioned space* shall comply with Section R502.

## CHAPTER 6

### REFERENCED STANDARDS

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 R106.

#### ACCA

Air Conditioning Contractors of America  
2800 Shirlington Road, Suite 300  
Arlington, VA 22206

Standard reference number	Title	Referenced in code section number
Manual D--2023	Residential Duct Systems.....	R403.3.1
Manual J—16	Residential Load Calculation Eighth Edition .....	R403.6
Manual S—2023	Residential Equipment.....	R403.6

#### AISI

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

Standard reference number	Title	Referenced in code section number
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

America National Standards Institute  
25 West 43<sup>rd</sup> Street, 4<sup>th</sup> Floor  
New York, NY 10036

Standard reference number	Title	Referenced in code section number
Z21.20-2005 (R2016)	Automatic Gas Ignition Systems and Components .....	R403.13, R404.1.5
Z21.50-2019/CSA 2.22-19	Vented Decorative Gas Appliances .....	R403.7.1
Z21.88-2019/CSA 2.23-19	Vented Gas Fireplace Heaters .....	R403.7.1
Z21.40.2-1996	Gas-fired, Work Activated Air-Conditioning and Heat Pump Appliances (Internal Combustion) .....	Table R406.3
Z21.40.4-1996	Performance Testing and Rating of Gas-Fired, Air-Conditioning and Heat Pump Appliances .....	Table R406.3
ANSI/AMCA210-ANSI/ASHRAE 51—23	Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.....	Table R403.6.2
ANSI/ASHRAE 140—2017 (2020)	Standard Test Method for the Evaluation of Building Energy Analysis Computer Programs .....	R405.5.2

#### ASHRAE

American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.  
1791 Tullie Circle, NE  
Atlanta, GA 30329-2305

Standard reference number	Title	Referenced in code section number
ASHRAE—2021	ASHRAE Handbook of Fundamentals .....	R402.1.5, Table R405.5.2(1)
ASHRAE 90.1-2022	Energy Standard for Sites and Buildings Except Low-Rise Residential Buildings .....	Table R402.1.2
ASHRAE 193—2010 (RA 2014)	Method of Test for Determining the Airtightness of HVAC Equipment .....	R403.2.2.1

# ASTM

ASTM International  
100 Barr Harbor Drive  
West Conshohocken, PA 19428-2859

Standard reference number	Title	Referenced in code section number
C1313/C1313M—13 (2019)	Standard Specification for Sheet Radiant Barriers for Building Construction Applications .....	R303.2.2
C 1363-19	Standard Test Method for Thermal Performance of Building Materials and Envelope Assemblies by Means of a Hot Box Apparatus .....	R303.1.4.1
C 1743—19	Standard Practice for Installation and Use of Radiant Barrier Systems (RBS) in Residential Building Construction .....	R303.2.2, R402.3
E 283—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 .....	R402.5.3
E 779-19	Standard Test Method for Determining Air Leakage Rate by Fan Pressurization .....	R402.5.1.2
E1554/E1554M—13(2018)	Standard Test Methods for Determining Air Leakage of Air Distribution Systems by Fan Pressurization .....	R403.3.5
E1827-22	Standard Test Method for Determining Airtightness of Building Using an Orifice Blower Door .....	R402.5.1.2
E2178—21a	Standard Test Method for Air Permeance of Building Materials .....	R303.1.5
E3158—2018	Standard Test Method for Measuring the Air Leakage Rate of a Large or Multizone Building .....	R402.5.1.2

# CSA

Canadian Standards Association  
5060 Spectrum Way  
Mississauga, Ontario, Canada L4W 5N6

Standard reference number	Title	Referenced in code section number
AAMA/WDMA/CSA 101/I.S.2/A440—22	North American Fenestration Standard/Specification for Windows, Doors and Skylights .....	R402.5.2
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 Systems .....	R403.5.4, Table R406.2
CSA B55.2-20	Drain Water Heat Recovery Units .....	R403.5.4
CSA P.4.1-21	Testing Method for Measuring Fireplace Efficiency .....	R403.7.1

# DASMA

Door and Access System Manufacturers Association  
1300 Sumner Avenue  
Cleveland, OH 44115-2851

Standard reference number	Title	Referenced in code section number
ANSI/DASMA 105-2020	Test Method for Thermal Transmittance and Air Infiltration of Garage Doors .....	R303.1.3

# DOE

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

Standard reference number	Title	Referenced in code section number
10 CFR, Part 430—2021	Energy Conservation Program for Consumer Products: Energy and Water Conservation Standards and Their	

# FGIA

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

Standard reference number	Title	Referenced in code section number
AAMA/WDMA/CSA 101/I.S.2/A440—22	North American Fenestration Standard/ Specifications for Windows, Doors and Unit Skylights .....	R402.5.2

# HVI

Home Ventilating Institute  
1000 North Rand Road, Suite 214  
Wauconda, IL 60084

Standard reference number	Title	Referenced in code section number
916-18	Airflow Test Procedure .....	R303.1.3

# ICC

International Code Council, Inc.  
500 New Jersey Avenue, NW  
6th Floor  
Washington, DC 20001

Standard reference number	Title	Referenced in code section number
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 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-Includes Addendum A, Approved July 28, 2022, and Addendum B, Approved October 12, 2022 .....	R402.5.1.2
IBC—24	International Building Code .....	R201.3, R303.2, R402.2.10
ICC 400—17	Standard on the Design and Construction of Log Structures .....	Table R402.5.1.1
ICC 500—2020	ICC/NSSA Standard for the Design and Construction of Storm Shelters .....	R402.6
IFC—24	International Fire Code .....	R201.3
IFGC—24	International Fuel Gas Code .....	R201.3
IMC—24	International Mechanical Code .....	R201.3, R403.2.2, R403.5
IRC—24	International Residential Code .....	R201.3, R303.2, R402.2.10, R403.2.2, R403.5

# IEEE

The Institute of Electrical and Electronic Engineers, Inc.  
3 Park Avenue  
New York, NY 10016-5997

Standard reference number	Title	Referenced in code section number
515.1—2012	IEEE Standard for the Testing, Design, Installation and Maintenance of Electrical Resistance Trace Heating for Commercial Applications .....	R403.5.1.2

# ISO

International Organization for Standardization  
1, Rue de Varembe, Case Postal 56, CH-1211  
Geneva, Switzerland

Standard reference number	Title	Referenced in code section number
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## NEEA

Northwest Energy Efficiency Alliance  
421 SW 6<sup>th</sup> Ave, Suite 600  
Portland, OR 97204

Standard reference number	Title	Referenced in code section number
NEEA-2011	Northern Climate Specification for Heat Pump Water Heaters, Vers. 4.0 R406.3	..... Table
NEEA-2019	Advanced Water Heating Specifications for Gas-Fueled Residential Storage Water Heaters, Version 1.0	..... Table R406.3

## NEEP

Northeast Energy Efficiency Partnership, Inc.  
24 School Street, 2<sup>nd</sup> Floor  
Boston, MA 02108-4314

Standard reference number	Title	Referenced in code section number
cc ASHP Version 3.1	Cold Climate Air Source Heat Pump (ccASHP) Product List and Specifications: <a href="https://neep.org/heating-electrification/ccashp-specification-product-list">https://neep.org/heating-electrification/ccashp-specification-product-list</a>	..... Table R406.3

## NEMA

National Electrical Manufacturers Association  
1300 17<sup>th</sup> Street N No. 900  
Arlington, VA 22209

Standard reference number	Title	Referenced in code section number
OS 4—2016	Requirements for Air-Sealed Boxes for Electrical and Communications Applications	..... R402.5.4

## NFPA

National Fire Protection Association<sup>1</sup>  
1 Batterymarch Park  
Quincy, MA 02169-7417

Standard reference number	Title	Referenced in code section number
70—23	National Electrical Code	..... R501.4

## NFRC

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

Standard reference number	Title	Referenced in code section number
100—2023	Procedure for Determining Fenestration Products U-factors—Second Edition	.. R303.1.3
200—2023	Procedure for Determining Fenestration Product Solar Heat Gain Coefficients and Visible Transmittance at Normal Incidence—Second Edition	..... R303.1.3
400—2023	Procedure for Determining Fenestration Product Air Leakage—Second Edition	R402.5.2

## PHTA

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

Standard reference number	Title	Referenced in code section number
APSP 14-2019	American National Standard for Portable Electric Spa Energy Efficiency	..... R403.11

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

Standard reference number	Title	Referenced in code section number
ANSI/RESNET/ICC 301-2022	Standard for Calculating 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 .....	R405.5.2
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, R403.6.2, Table R405.4.2(1)

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

Standard reference number	Title	Referenced in code section number
UL 127—2011	Factory Built Fireplace—with Revisions through February 2020 .....	R402.3.6
UL 515—2015	Electrical Resistance Trace Heating for Commercial Applications .....	R403.5.1.2
UL 907—1994	Fireplace Accessories (with revisions through April 2010) .....	R402.3.6

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

Standard reference number	Title	Referenced in code section number
CFR Title 16—2015	R-value Rule .....	R303.1.4

**WDMA**Window and Door Manufacturers Association  
1400 East Touhy Avenue, Suite 470  
Des Plaines, IL 60018

Standard reference number	Title	Referenced in code section number
AAMA/WDMA/CSA 101/I.S.2/A440—22	North American Fenestration Standard/Specification for Windows, Doors and Unit Skylights .....	R402.5.2

**WSU**Washington State University Energy Extension Program  
905 Plum Street SE, Bldg 3  
PO Box 43165  
Olympia, WA 98506-3166

Standard reference number	Title	Referenced in code section number
WSU RS 33	Duct Testing Standard for New and Existing Construction Publication No. WSUEEP12-016.....	R403.3.6, R403.3.7, R502.2.2

## APPENDIX RA / RB

### OPTIONAL ENERGY EFFICIENCY MEASURES

**Appendix RA—Optional energy efficiency measures—One step.** Building owners may choose to use this appendix to achieve an additional 6 percent savings in building energy use. The number of additional energy efficiency credits required by Section R406.3 would be increased by the following amounts:

- 1.0 credit for each new single-family, two-family and townhouse dwelling unit.

- 0.5 credit for each new dwelling unit within an R-2 occupancy building.

- 0.5 credit for each addition smaller than 500 square feet to a single-family, two-family or townhouse dwelling unit.

- 1.0 credit for each addition of 500 square feet or larger to a single-family, two-family or townhouse dwelling unit.

Where Section R405, Simulated performance alternative, is used, the maximum allowable energy consumption shall be 92 percent of the value calculated according to Section R405.3.

**Appendix RB—Optional energy efficiency measures—Two step.** Building owners may choose to use this appendix to achieve an additional 12 percent savings in building energy use. The number of additional energy efficiency credits required by Section R406.3 would be increased by the following amounts:

- 2.0 credit for each new single-family, two-family and townhouse dwelling unit.

- 1.0 credit for each new dwelling unit within an R-2 occupancy building.

- 1.0 credit for each addition smaller than 500 square feet to a single-family, two-family or townhouse dwelling unit.

- 1.5 credit for each addition of 500 square feet or larger to a single-family, two-family or townhouse dwelling unit.

Where Section R405, Simulated performance alternative, is used, the maximum allowable energy consumption shall be 84 percent of the value calculated according to Section R405.3.

## APPENDIX RC

### EXTERIOR DESIGN CONDITIONS

As required by Sections C302.2 and R302.2, the heating or cooling outdoor design temperatures shall be selected from Table C-1.

**TABLE C-1**  
**OUTDOOR DESIGN TEMPERATURES**

Location	Outdoor Design Temp Heating (°F)	Outdoor Design Temp Cooling (°F)
Aberdeen 20NNE	25	83
Anacortes	24	72
Anatone	-4	89
Auburn	25	84
Battleground	19	91
Bellevue	24	83
Bellingham 2N	19	78
Blain	17	73
Bremerton	29	83
Burlington	19	77
Chehalis	21	87
Chelan	10	89
Cheney	4	94
Chesaw	-11	81
Clarkston	10	94
Cle Elum	1	91
Colfax 1NW	2	94
Colville AP	-2	92
Concrete	19	83
Connell 4NNW	6	100
Cougar 5E	25	93
Dallesport AP	14	99
Darrington RS	13	85
Davenport	5	92
Edmonds	24	82
Ellensburg AP	2	90
Elma	24	88
Ephrata AP	7	97
Everett Paine AFB	21	79
Forks 1E	23	81
Glacier RS	13	82
Glenoma (Kosmos)	18	89
Goldendale	7	94
Grays River Hatchery	24	86

Location	Outdoor Design Temp Heating (°F)	Outdoor Design Temp Cooling (°F)
Greenwater	1.4	84
Grotto	21	84
Hoquiam AP	26	79
Inchelium 2NW	0	92
John Day Dam	19	100
Long Beach 3NNE	25	77
Longview	24	87
Lower Granite Dam	14	98
Lower Monument Dam	18	103
Marysville	23	79
Metaline Falls	-1	89
Methow 2W	1	89
Nespelem 2S	-4	93
Newhalem	19	89
Newport	-5	92
Northport	2	92
Oak Harbor	16	74
Odessa	7	100
Olga 2SE	24	71
Olympia AP	17	85
Omak 2NW	3	90
Oroville	5	93
Othello	9	98
Packwood	16	90
Plain	-3	89
Pleasant View	16	98
Pomeroy	3	95
Port Angeles	28	75
Port Townsend	25	76
Prosser	12	97
Puyallup	19	86
Quilcene 2SW	23	83
Quinalt RS	25	84



Location	Outdoor Design Temp Heating (°F)	Outdoor Design Temp Cooling (°F)
Rainier, Longmire	15	85
Paradise RS	8	71
Raymond	28	81
Redmond	17	83
Republic	-9	87
Richland	11	101
Ritzville	6	99
Satus Pass	10	90
Seattle: SeaTac AP	24	83
Sedro Woolley 1E	19	78
Sequim	23	78
Shelton	23	85
Smyrna	8	102
Snohomish	21	81
Snoqualmie Pass	6	80
Spokane AP	4	92
Spokane CO	10	96
Stampede Pass	7	76
Stehekin 3 NW	12	85
Stevens Pass	6	77
Tacoma CO	29	82
Tatoosh Island	31	63
Toledo AP	17	84
Vancouver	22	88
Vashon Island	28	78
Walla Walla AP	6	96
Waterville	1	88
Wellpinit	1	93
Wenatchee CO	10	92
Whidbey Island	11	71
Willapa Harbor	26	81
Wilson Creek	3	96
Winthrop 1WSW	-12	91
Yakima AP	11	94

**ABBREVIATIONS:**  
Typical: "4(miles)NE"

AFB Air Force Base

AP Airport

CO City Office

RS Ranger Station

## APPENDIX RF

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

*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.

**TABLE RF102.1**  
**ASSEMBLY U-FACTORS FOR WOOD-FRAMED WALLS<sup>a, b, c, d, e, f</sup>**

WOOD STUD SIZE AND SPACING	CAVITY INSULATION INSTALLED 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 x 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 x 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
2 x 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 x 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 x 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
2 x 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	0.038	0.036	0.031	0.027
	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	0.045	0.043	0.041	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
2 x 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
2 x 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	0.326	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

For SI: 1 British thermal unit per hour per square foot per °Fahrenheit = 5.6783 W/m<sup>2</sup> × K.

- 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.
- 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.), 25 percent (assumed for 16-inch o.c.), and 22 percent (assumed for 24-inch o.c.) 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 greater than R-1.25 per inch.

3. 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.
  4. 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.
  5. 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.
  6. 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.
  7. Continuous insulation specified in accordance with the indicated rated  $R$ -value and installed continuously over all exterior wood framing, including studs, plates, headers and rim joists.
  8. Indoor air film  $R$ -value of 0.68 and outdoor air-film  $R$ -value of 0.17.
- c. Where any of the building materials that are continuous over the interior or exterior wall surface vary from those stated in Note b, it is permissible to adjust the  $U$ -factor as follows:  $U_{adj} = 1 / [1/U + R_d]$  where  $U$  is the  $U$ -factor from the table and  $R_d$  is the increase (positive) or decrease (negative) in the cumulative  $R$ -value of building material layers on the outside and inside faces of the wall, excluding the continuous insulation  $R$ -value if present.
  - d. For a specific continuous insulation  $R$ -value not addressed in this table, the  $U$ -factor of the assembly shall be permitted to be determined as follows:  
 $U_{adj} = 1 / [1/U_{nci} + R_{ci}]$  where  $U_{nci}$  is the  $U$ -factor from the table for no continuous insulation (0  $R$ -value column) and  $R_{ci}$  is the specific rated  $R$ -value of continuous insulation added to the assembly.
  - e. For double wall framing, the  $U$ -factor shall be permitted to be determined by combining the  $U$ -factors for single wall framing from the table as follows:  
 $U_{combined} = 1 / [1/U_1 + 1/U_2]$  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.
  - f. The use of insulation in accordance with this table does not supersede requirements in **Section R702.7** of the *International Residential Code* for use of insulation and water vapor retarders to control water vapor.

**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 WALLS<sup>a</sup>**

INSULATION CONFIGURATIONS <sup>b</sup>	WALL U-FACTOR <sup>c</sup> (Btu/h × ft2 × °F)	WALL EFFECTIVE U-FACTOR <sup>d</sup> 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	—
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	—

For SI: 1 British thermal unit per hour per square foot per °Fahrenheit = 5.6783 W/m<sup>2</sup> × K.

N/A = Not Applicable.

- a. 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.
- b. 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.
- c. Applicable to Sections R402.1.2, R405 and R406.
- d. 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 envelope. 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-GRADE<sup>a,b,c,d,e,f</sup>**

UNHEATED SLAB-ON-GRADE: INSULATION CONFIGURATIONS	<i>F</i> -FACTOR (Btu/h × ft × °F)
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 face <sup>a</sup> —slab edge insulated <sup>b</sup>	—
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 2 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
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 R-5 edge	0.46
R-7.5 entire slab area and R-3.5 edge	0.45
R-7.5 entire slab area and R-7.5 edge	0.41
R-10 entire slab area and R-5 edge	0.40
R-10 entire slab area and R-10 edge	0.36
R-15 entire slab area and R-5 edge	0.35
R-15 entire slab area and R15 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	0.40



remaining slab area	
R-15 slab edge and under slab perimeter inward 4 ft; R-10 remaining slab area	0.34
<b>HEATED SLAB-ON-GRADE: INSULATION CONFIGURATIONS</b>	<b>F-FACTOR (Btu/h × ft × °F)</b>
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

British thermal unit per hour per square foot per °Fahrenheit = 5.6783 W/m<sup>2</sup> × K.

- 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.
- Interpolation between *R*-values for a given insulation configuration type is permitted.
- 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.
- 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.

- e. 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.
- f. 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.
- g. 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.
- h. 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.