

# CHAPTER 1 [RE]

## SCOPE AND ADMINISTRATION

### PART 1—SCOPE AND APPLICATION

#### SECTION R101 SCOPE AND GENERAL REQUIREMENTS

##### **R101.1 Title.**

This code shall be known as the 2019 *Vermont Residential Building Energy Standards* (RBES), and shall be cited as such. It is referred to herein as “this code.”

##### **R101.2 Scope.**

This code applies to *residential buildings* and the *building sites* and associated systems and equipment, including one family dwellings, two family dwellings, and multi-family housing three stories or less in height.

##### **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 building science or safety, health or environmental requirements contained in other applicable codes or ordinances.

##### **R101.4 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.

##### **R101.4.1 Mixed occupancy.**

With respect to a structure that is three stories or less in height and is a mixed-use building that shares residential and commercial users, the term “residential building” shall include the living spaces in the structure and the nonliving spaces in the structure that serve only the residential users such as common hallways, laundry facilities, residential management offices, community rooms, storage rooms, and foyers. The “residential building” shall comply with all requirements of RBES, and all other aspects of the building shall comply with the *Vermont Commercial Building Energy Standards* (CBES).

##### **R101.5 Compliance.**

*Residential buildings* shall meet the provisions of Chapter 4.

##### **R101.5.1 Compliance materials.**

The *code official* or *other authority having jurisdiction* shall be permitted to approve specific computer software, worksheets, compliance manuals and other similar materials that meet the intent of this code.

### **R101.5.2 Exempt buildings.**

The following buildings, or portions thereof, shall be exempt from the provisions of this code:

1. **Low Energy Use Buildings.** Those with a peak design rate of energy usage less than  $3.4 \text{ Btu/h} \cdot \text{ft}^2$  ( $10.7 \text{ W/m}^2$ ) or  $1.0 \text{ watt/ft}^2$  ( $10.7 \text{ W/m}^2$ ) of floor area for space conditioning purposes.
2. **Unconditioned Buildings.** Those that do not contain *conditioned space*.
3. **Mobile homes.** Homes subject to Title VI of the National Manufactured Housing Construction and Safety Standards Act of 1974 (42 U.S.C. §§ 5401- 5426). On-site constructed basements and crawlspaces must comply with this code.
4. **Hunting camps.** Residential buildings shall not include hunting camps.
5. **Summer camps.** Residential buildings constructed for non-winter occupation with only a biomass (wood) or other on-site renewable heating system.
6. **Owner-built homes.** Residential construction by an owner, if all of the following apply:
  - 6.1. The owner of the residential construction is the *builder*, as defined in 30 V.S.A § 51.(a)(1), and;
  - 6.2. The residential construction is used as a dwelling by the owner, and;
  - 6.3. The owner in fact directs the details of construction with regard to the installation of materials not in compliance with the RBES, and;
  - 6.4. The owner discloses in writing to a prospective buyer, before entering into a binding purchase and sales agreement, with respect to the nature and extent of any noncompliance with the RBES.

Any statement or certificate given to a prospective buyer shall itemize how the home does not comply with RBES, and shall itemize which measures do not meet the RBES in effect at the time construction commenced. Any certificate given under this subsection shall be recorded in the land records where the property is located, and sent to the Public Service Department (PSD), within 30 days following sale of the property by the owner. A certificate that itemizes how the home does not comply with RBES is available from the PSD.

### **R101.6 Authority having jurisdiction.**

In any instance where there is no state or local code official or other authority having jurisdiction, the PSD is not considered to be the “other authority having jurisdiction, where one exists,” and those sections of this code requiring involvement by that entity do not apply. All other code requirements still apply.

### **R101.7 Base and Stretch Code.**

The “Base Code” is the RBES Energy Code that is applicable throughout Vermont, except for

projects subject to 10 V.S.A. Chapter 151 (Act 250), and in any municipalities that have adopted the more stringent “Stretch Code.”

#### **R101.8 Compliance options.**

There are three thermal efficiency compliance options:

1. **Prescriptive Packages:** For the Base Code, Table 402.2.1, includes alternative packages in the accompanying 2019 RBES Handbook. For the Stretch Code, Table 407.1 includes alternative packages in the 2019 RBES Handbook.
2. **REScheck<sup>TM</sup>:** The U.S. Department of Energy’s REScheck<sup>TM</sup> software.
3. **Home Energy Rating System (HERS):** A HERS energy rating that demonstrates compliance with Section 406.4 for the Base Code or Section 407.2.2 for the Stretch Code. (All HERS Index values in this code are based on REM/Rate version 15.7.)

## **SECTION R102 ALTERNATIVE MATERIALS, DESIGN AND METHODS OF CONSTRUCTION AND EQUIPMENT**

### **R102.1 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. The *code official* or other authority having jurisdiction, where one exists, may approve an alternative material, design or method of construction upon application of the owner or the owner’s authorized agent. The *code official* or other authority having jurisdiction 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 and safety. Where the alternative material, design or method of construction is not *approved*, the *code official* or other authority having jurisdiction shall respond to the applicant, in writing, stating the reasons why the alternative was not *approved*.

#### **R102.1.1 Above code programs.**

The *code official* or other authority having jurisdiction, *where one exists*, shall be permitted to deem a national, state or local energy-efficiency program to exceed the energy efficiency required by this code. *Buildings approved* in writing by such an energy-efficiency program, official or authority shall be considered to be in compliance with this code. The requirements identified as “mandatory” in Chapter 4 shall be met.

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

### **SECTION R103 CONSTRUCTION DOCUMENTS**

#### **R103.1 General.**

Where required, construction documents, technical reports and other supporting data shall be submitted in one or more sets 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 or other authority having jurisdiction, where one exists*, is authorized to require necessary construction documents to be prepared by a registered design professional.

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

### **R103.2 Information on construction documents.**

Where required, construction documents shall be drawn to scale upon suitable material. Electronic media documents are permitted to be submitted where *approved* by the *code official or other authority having jurisdiction, where one exists*. 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. Insulation materials and their *R*-values.
2. Fenestration *U*-factors and *solar heat gain coefficients* (SHGC).
3. Area-weighted *U*-factor and *solar heat gain coefficients* (SHGC) calculations.
4. Mechanical system design criteria.
5. Mechanical and service water-heating systems and equipment types, sizes and efficiencies.
6. Equipment and system controls and control strategies.
7. Duct sealing, duct and pipe insulation and location.
8. Air sealing details.

#### **R103.2.1 Building thermal envelope depiction.**

The *building thermal envelope* shall be represented on the construction documents.

### **R103.3 Examination of documents.**

The *code official or other authority having jurisdiction, where one exists*, 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 or other authority having jurisdiction, where one exists*, 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.

#### **R103.3.1 Approval of construction documents.**

When the *code official or other authority having jurisdiction, where one exists*, 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 or other authority having jurisdiction, where one exists*. 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 or other authority having jurisdiction, where one exists*. 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 other authority having jurisdiction, where one exists*, or a duly authorized representative.

#### **R103.3.2 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.

#### **R103.3.3 Phased approval.**

The *code official or other authority having jurisdiction, where one exists*, 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.

#### **R103.4 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.

#### **R103.5 Retention of construction documents.**

One set of *approved* construction documents shall be retained by the *code official or other authority having jurisdiction, where one exists*, 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 R104 INSPECTIONS**

#### **R104.1 General.**

Where required, construction or work for which a permit is required shall be subject to inspection by the *code official or other authority having jurisdiction, where one exists*, 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.

## **R104.2 Required inspections.**

The *code official* or other authority having jurisdiction or his or her designated agent, upon notification, shall make the inspections set forth in Sections R105.2.1 through R105.2.5.

### **R104.2.1 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.

### **R104.2.2 Framing and rough-in inspection.**

Inspections at framing and rough-in shall be made before application of interior finish and shall verify compliance with the code as to: types of insulation and corresponding *R-values* and their correct location and proper installation; fenestration properties such as *U-factor* and SHGC and proper installation; and air leakage controls as required by the code; and approved plans and specifications.

### **R104.2.3 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.

### **R104.2.4 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.

## **R104.3 Required approvals.**

Work shall not be done beyond the point indicated in each successive inspection without first obtaining the approval of the *code official* or other authority having jurisdiction, *where one exists*. The *code official* or other authority having jurisdiction, *where one exists*, upon notification, shall make the requested inspections and shall either indicate the portion of the construction that is satisfactory as completed, or notify the permit holder or his or her agent wherein the same fails to comply with this code. Any portions that do not comply shall be corrected and such portion shall not be covered or concealed until authorized by the *code official* or other authority having jurisdiction, where one exists.

### **R104.3.1 Final inspection.**

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

## **R104.4 Reinspection.**

A *building* shall be reinspected when determined necessary by the *code official* or other authority having jurisdiction, where one exists.

## **R104.5 Approved inspection agencies.**

The *code official* or other authority having jurisdiction, *where one exists*, 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.

**R104.6 Inspection requests.**

It shall be the duty of the holder of the permit or their duly authorized agent to notify the *code official or other authority having jurisdiction, where one exists*, 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.

**R104.7 Reinspection and testing.**

Where any work or installation does not pass an initial test or inspection, the necessary corrections shall be made to achieve compliance with this code. The work or installation shall then be resubmitted to the *code official or other authority having jurisdiction, where one exists*, for inspection and testing.

**R104.8 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 or other authority having jurisdiction, where one exists*.

**R104.8.1 Revocation.**

The *code official or other authority having jurisdiction, where one exists*, 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 R105  
VALIDITY**

**R105.1 General.**

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 R106  
REFERENCED STANDARDS**

**R106.1 Referenced codes and standards.**

The codes and standards referenced in this code shall be those listed in Chapter 6, and such codes and standards shall be considered as part of the requirements of this code to the prescribed extent of each such reference and as further regulated in Sections R106.1.1 and R106.1.2.

**R106.1.1 Conflicts.**

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

**R106.1.2 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.

**R106.2 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.

**R106.3 Other laws.**

The provisions of this code shall not be deemed to nullify any provisions of local, state or federal law.

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# 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*, *International Plumbing Code* or the *International Residential Code* shall have the meanings ascribed to them in those codes.

### **R201.4 Terms not defined.**

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

## SECTION R202 GENERAL DEFINITIONS

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

**ACCESSIBLE.** Admitting close approach as a result of not being guarded by locked doors, elevation or other effective means (see “*Readily accessible*”).

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

**AIR BARRIER.** An air barrier is a durable assembly that blocks air flow through the *building thermal envelope* and its assemblies. Air barriers must be continuous, sealed at all joints, penetrations, and interruptions using durable sealants intended for such use and compatible with all adjacent materials, and able to resist pressures without displacement or damage.

**AIR-IMPERMEABLE INSULATION.** An insulation that functions as an air barrier material.

**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.

**ANNUAL FUEL UTILIZATION EFFICIENCY (AFUE).** The ratio of annual output energy to annual input energy which includes any non-heating season pilot input loss, and for gas or oil-fired furnaces or boilers, does not include electrical energy.

**APPROVED.** Acceptable to the *code official or other authority having jurisdiction, where one exists.*

**APPROVED AGENCY.** An established and recognized agency regularly engaged in conducting tests or furnishing inspection services, when such agency has been *approved* by the *code official or other authority having jurisdiction, where one exists.*

**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").

**BASE CODE.** The standard RBES Energy Code, as distinct from the higher stringency *Stretch Code.*

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

**BATHROOM.** A room containing a bathtub, shower, spa or similar bathing fixture.

**BEDROOM.** A room or space 70 square feet or greater, with egress window and closet, used or intended to be used for sleeping. A "den," "library," or "home office" with a closet, egress window, and 70 square feet or greater or other similar rooms shall count as a bedroom, but living rooms and foyers shall not. (Source: RESNET)

**BIOMASS.** The vegetation removed from the forest, usually logging slash, small-diameter trees, tops, limbs, or trees. This includes wood logs, wood pellets and wood chips.

**BTU.** Abbreviation for British thermal unit, which is the quantity of heat required to raise the temperature of 1 pound (0.454 kg) of water 1°F (0.56°C), (1 Btu = 1,055 J), or about the amount of energy in one wooden kitchen match burned end to end.

**BUILDER.** The general contractor or other person in charge of construction, who has the power to direct others with respect to the details to be observed in construction. (Source: VT 30 V.S.A. § 51)

**BUILDING.** Any structure used or intended for supporting or sheltering any use or occupancy, including any mechanical systems, service water heating systems and electric power and lighting systems located on the building site and supporting the building.

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

**BUILDING THERMAL ENVELOPE.** The *basement walls, exterior walls, floor, roof* and any other *building elements* that enclose *conditioned space.* This boundary also includes the boundary between *conditioned space* and exempt or unconditioned space.

**CATEGORY I COMBUSTION APPLIANCE.** An appliance which operates with a non-positive vent static pressure and with a vent gas temperature that avoids excessive condensate production in the vent. (Source: NFPA 54)

**CATEGORY II COMBUSTION APPLIANCE.** An appliance which operates with a non-positive vent static pressure and with a vent gas temperature that may cause excessive condensate production in the vent. (Source: NFPA 54)

**CATEGORY III COMBUSTION APPLIANCE.** An appliance which operates with a positive vent static pressure and with a vent gas temperature that avoids excessive condensate production in the vent. (Source: NFPA 54)

**CATEGORY IV COMBUSTION APPLIANCE.** An appliance which operates with a positive vent static pressure and with a vent gas temperature that may cause excessive condensate production in the vent. (Source: NFPA 54)

**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)].

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

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

**CODE OFFICIAL, VERMONT.** The officer or other designated authority charged with the administration and enforcement of this code, or a duly authorized representative. The Public Service Department is not the code official and shall not be required to conduct inspections of construction or construction documents.

**COEFFICIENT OF PERFORMANCE (COP)—COOLING.** The ratio of the rate of heat removal to the rate of energy input in consistent units, for a complete cooling system or factory-assembled equipment, as tested under a nationally recognized standard or designated operating conditions.

**COEFFICIENT OF PERFORMANCE (COP)—HEAT PUMP—HEATING.** The ratio of the rate of heat delivered to the rate of energy input, in consistent units, for a complete heat pump system under designated operating conditions. Supplemental heat shall not be considered when checking compliance with the heat pump equipment.

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

**COMMERCIAL BUILDING ENERGY STANDARDS (CBES).** The Vermont non-residential Energy Code, based on the IECC 2018.

**CONDENSER.** A heat exchanger designed to liquefy refrigerant vapor by removal of heat.

**CONDENSING UNIT.** A specific refrigerating machine combination for a given refrigerant, consisting of one or more power-driven compressors, condensers, liquid receivers (when required), and the regularly furnished accessories.

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

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**CONDITIONED SPACE.** An area, room or space that is enclosed within the *building thermal envelope* and that is directly or indirectly heated or cooled. Spaces are indirectly heated or cooled where they communicate through openings with conditioned spaces, where they are separated from conditioned spaces by uninsulated walls, floors or ceilings, or where they contain uninsulated ducts, piping or other sources of heating or cooling.

**CONSTRUCTION DOCUMENTS.** The physical drawings and specifications that outline the *building*.

**CONTINUOUS AIR BARRIER.** A combination of materials and assemblies that restrict or prevent the passage of air through the *building thermal envelope*.

**CONTINUOUS INSULATION (ci).** Insulating material that is continuous across all structural members without thermal bridges other than fasteners and service openings. It is installed on the interior or exterior, or is integral to any opaque surface, of the *building envelope*.

**CRAWL SPACE WALL.** The opaque portion of a wall that encloses a crawl space and is partially or totally below grade.

**CUBIC FEET PER MINUTE (CFM).** The quantity of air moved in 1 minute. A measurement typically applied to ventilation equipment.

**CURTAIN WALL.** Fenestration products used to create an external nonload-bearing wall that is designed to separate the exterior and interior environments.

#### **DAYLIGHT ZONE.**

1. **Under skylights.** The area under skylights whose horizontal dimension, in each direction, is equal to the sky-light dimension in that direction plus either the floor-to-ceiling height or the dimension to a ceiling height opaque partition, or one-half the distance to adjacent skylights or vertical fenestration, whichever is least.
2. **Adjacent to vertical fenestration.** The area adjacent to vertical fenestration which receives daylight through the fenestration. For purposes of this definition and unless more detailed analysis is provided, the daylight *zone* depth is assumed to extend into the space a distance of 15 feet (4572 mm) or to the nearest ceiling height opaque partition, whichever is less. The daylight *zone* width is assumed to be the width of the window plus 2 feet (610 mm) on each side, or the window width plus the distance to an opaque partition, or the window width plus one-half the distance to adjacent skylight or vertical fenestration, whichever is least.

**DEADBAND.** The temperature range in which no heating or cooling is used.

**DEGREE DAY, COOLING.** A unit, based on temperature difference and time, used in estimating cooling energy consumption and specifying nominal cooling load of a building in summer. For any one day, when the mean temperature is more than 65°F, there are as many degree days as there are degrees Fahrenheit difference in temperature between the mean temperature for the day and 65°F. Annual cooling degree days (CDD) are the sum of the degree days over a calendar year.

**DEGREE DAY, HEATING.** A unit, based upon temperature difference and time, used in estimating heating energy consumption and specifying nominal heating load of a building in winter. For any one day, when the mean temperature is less than 65°F, there are as many degree days as there are degrees Fahrenheit difference in temperature between the mean temperature for the day and 65°F. Annual heating degree days are the sum of the degree days over a calendar year.

**DEMAND CONTROL VENTILATION (DCV).** A ventilation system capability that provides for the automatic reduction of outdoor air intake below design rates when the actual occupancy of spaces served by the system is less than design occupancy.

**DEMAND RECIRCULATION WATER SYSTEM.** A water distribution system having one or more recirculation pumps that pump water from a heated water supply pipe back to the heated water.

**DIRECT-VENT APPLIANCES.** Appliances that are constructed and installed so that all air for combustion is derived directly from the outside atmosphere and all flue gases are discharged directly to the outside atmosphere. See also Sealed Combustion Venting System.

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

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

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

**DYNAMIC GLAZING.** Any fenestration product that has the fully reversible ability to change its performance properties, including U-factor, solar heat gain coefficient (SHGC), or visible transmittance (VT).

**ECONOMIZER, AIR.** A duct and damper arrangement and automatic control system that allows a cooling system to supply outside air to reduce or eliminate the need for mechanical cooling during mild or cold weather.

**ECONOMIZER, WATER.** A system where the supply air of a cooling system is cooled indirectly with water that is itself cooled by heat or mass transfer to the environment without the use of mechanical cooling.

**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 EFFICIENCY RATIO (EER).** The ratio of net equipment cooling capacity in Btu/h to total rate of electric input in watts under designated operating conditions. When consistent units are used, this ratio becomes equal to COP (see also "Coefficient of performance").

**ENERGY RECOVERY VENTILATION SYSTEM.** Systems that employ air-to-air heat exchangers to recover energy from exhaust air for the purpose of preheating, precooling, humidifying or dehumidifying outdoor ventilation air prior to supplying the air to a space, either directly or as part of an HVAC system.

**ENERGY SIMULATION TOOL.** An *approved* software program or calculation-based methodology that projects the annual energy use of a *building*.

**ENTRANCE DOOR.** Fenestration products used for ingress, egress and access in nonresidential buildings, including, but not limited to, exterior entrances that utilize latching hardware and automatic closers and contain over 50-percent glass specifically designed to withstand heavy use and possibly abuse.

**ERI REFERENCE DESIGN.** A version of the *rated design* that meets the minimum requirements of the 2006 *International Energy Conservation Code*.

**EVAPORATOR.** That part of the system in which liquid refrigerant is vaporized to produce refrigeration.

**EXTERIOR ENVELOPE.** See “Building Thermal Envelope.”

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

**FAN BRAKE HORSEPOWER (BHP).** The horsepower delivered to the fan’s shaft. Brake horsepower does not include the mechanical drive losses (belts, gears, etc.).

**FAN SYSTEM BHP.** The sum of the fan brake horsepower of all fans that are required to operate at fan system design conditions to supply air from the heating or cooling source to the *conditioned space(s)* and return it to the source or exhaust it to the outdoors.

**FAN SYSTEM DESIGN CONDITIONS.** Operating conditions that can be expected to occur during normal system operation that result in the highest supply fan airflow rate to conditioned spaces served by the system.

**FAN SYSTEM MOTOR NAMEPLATE HP.** The sum of the motor nameplate horsepower of all fans that are required to operate at design conditions to supply air from the heating or cooling source to the *conditioned space(s)* and return it to the source or exhaust it to the outdoors.

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

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

**FINISHED AREA.** An enclosed area in a house that is suitable for year-round use, embodying walls, floors, and ceilings that are similar to the rest of the house.

**FINISHED CONDITIONED FLOOR AREA (FCFA).** The floor area in square feet of a home that is within the conditioned space of the building, and also is finished area, as measured in accordance with ANSI Standard Z765-2003 (with the exception that floor areas with ceiling heights of less than 5 feet will be included in finished square footage).

**FURNACE DUCT.** A furnace normally installed in distribution ducts of air-conditioning systems to supply warm air for heating and which depends on a blower not furnished as part of the duct furnace for air circulation.

**FURNACE, WARM AIR.** A self-contained, indirect-fired or electrically heated furnace that supplies heated air through ducts to spaces that require it.

**GROSS AREA OF EXTERIOR WALLS.** The normal projection of all exterior walls, including the area of all windows and doors installed therein (see “Exterior wall”).

**HEAT.** The form of energy that is transferred by virtue of a temperature difference or a change in state of a material.

**HEAT CAPACITY (HC).** The amount of heat necessary to raise the temperature of a given mass by 1°F (0.6°C). The heat capacity of a building element is the sum of the heat capacities of each of its components.

**HEAT PUMP.** A refrigeration system that extracts heat from one substance and transfers it to another portion of the same substance or to a second substance at a higher temperature for a beneficial purpose.

**HEAT RECOVERY VENTILATION SYSTEM (HRV).** A factory-assembled device or combination of devices, including fans or blowers, designed to provide outdoor air for ventilation in which heat or heat and moisture is transferred between two isolated intake and exhaust air streams.

**HEAT TRAP.** An arrangement of piping and fittings, such as elbows, or a commercially available heat trap that prevents thermosiphoning of hot water during standby periods.

**HEATED SLAB.** Slab-on-grade construction in which the heating elements, hydronic tubing, or hot air distribution system is in contact with, or placed within or under, the slab.

**HEATING SEASONAL PERFORMANCE FACTOR (HSPF).** The total heating output of a heat pump during its normal annual usage period for heating, in Btus, divided by the total electric energy input during the same period, in watt hours, as determined by DOE 10 CFR Part 430, Subpart B, Test Procedures, and based on Region 4.

**HEAT PUMP WATER HEATER.** A water heater that uses electricity and a refrigeration cycle to move heat from the ambient air to heat water instead of directly heating water.

**HIGH-EFFICACY LAMPS/ LIGHTING.** Compact fluorescent lamps, light-emitting diode (LED) lamps, T-8 or smaller diameter linear fluorescent lamps, or lamps with a minimum efficacy of not less than 65 lumens per watt; or light fixtures of not less than 55 lumens per watt.

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

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

**HOME ENERGY RATING SYSTEM (HERS).** A home energy rating system accredited by the Vermont Public Service Department that provides a numerical rating in compliance with 30 V.S.A. § 52. The purpose of this procedure is to ensure that accurate and consistent home energy ratings are performed by accredited HERS providers in Vermont and to promote an objective, cost-effective, sustainable home energy rating process as a compliance method for residential building energy codes; as qualification for energy programs designed to reach specific energy-saving goals; and as a way to provide Vermont's housing market the ability to differentiate residences based on their energy efficiency.

**HUMIDISTAT.** A regulatory device, actuated by changes in humidity, used for automatic control of relative humidity.

**HVAC.** Heating, ventilating and air conditioning.

**HVAC SYSTEM.** The equipment, distribution network and terminals that provide either collectively or individually the processes of heating, ventilating or air conditioning to a building.

**HVAC SYSTEM COMPONENTS.** HVAC system components provide, in one or more factory-assembled packages, means for chilling or heating water, or both, with controlled temperature for delivery to terminal units serving the conditioned spaces of the building. Types of HVAC system components include, but are not limited to, water chiller packages, reciprocating condensing units and water source (hydronic) heat pumps (see "HVAC system equipment").

**HVAC SYSTEM EQUIPMENT.** HVAC system equipment provides, in one (single package) or more (split system) factory-assembled packages, means for air circulation, air cleaning, air cooling with controlled temperature and dehumidification and, optionally, either alone or in combination with a heating plant, the functions of heating and humidifying. The cooling function is either electrically or heat operated and the refrigerant condenser is air, water or evaporatively cooled. Where the equipment is provided in more than one package, the separate packages shall be designed by the manufacturer to be used together. The equipment shall be permitted to provide the heating function as a heat pump or by the use of electric or fossil-fuel-fired elements. (The word "equipment" used without a modifying adjective, in accordance with common industry usage, applies either to HVAC system equipment or HVAC system components.)

**HUNTING CAMP.** A seasonal building used as a temporary residence only during hunting season.

**INFILTRATION.** The uncontrolled inward air leakage into a *building* caused by the pressure effects of wind or the effect of differences in the indoor and outdoor air density or both.

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

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

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**LABELED.** Equipment, materials or products to which have been affixed a label, seal, symbol or other identifying mark of a nationally recognized testing laboratory, inspection 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.

**LEVEL 1 ELECTRIC VEHICLE CHARGING.** Level 1 charging uses a standard alternating current 120V outlet.

**LEVEL 2 ELECTRIC VEHICLE CHARGING.** Level 2 uses a 240V alternating current outlet for faster charging than Level 1.

**LIGHTING.** See “High-Efficacy Lamps/Lighting.”

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

**LOCAL VENTILATION.** A mechanical ventilation system including fans, controls and ducts, dedicated to exhausting moisture-laden and/or contaminated air to the outside of the building from a room or space in which the moisture or contamination is generated or supplying outdoor air to that space.

**LOW-VOLTAGE LIGHTING.** Lighting equipment powered through a transformer such as a cable conductor, a rail conductor and track lighting.

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

**MECHANICAL VENTILATION.** The mechanical process of supplying conditioned or unconditioned air to, or removing such air from, any space by powered fans. For purposes of this standard, mechanical ventilation does not include processes driven by wind, such as turbine ventilators.

**MIXED-USE.** With respect to a structure that is three stories or less in height and is a mixed-use building that shares residential and commercial users, the term “residential building” shall include the living spaces in the structure and the nonliving spaces in the structure that serve only the residential users such as common hallways, laundry facilities, residential management offices, community rooms, storage rooms, and foyers. (From Vermont 30 V.S.A. § 51.)

**MULTIFAMILY DWELLING.** A building containing three or more dwelling units where the occupants are primarily permanent in nature and which are adjacent vertically or horizontally. If built side-by-side, at least one of the following is true: (1) they do not have a wall that extends from ground to roof, (2) they share a heating system, or (3) they have interstructural public utilities such as water supply/sewage disposal.

**NAMEPLATE HORSEPOWER.** The nominal motor horsepower rating stamped on the motor nameplate.

**OCCUPANCY.** The purpose for which a building, or portion thereof, is utilized or occupied.

**OCCUPANCY CLASSIFICATIONS.** Residential Group R is the occupancy group used for buildings that include sleeping rooms and are not institutional and are not generally regulated by the *International Residential Code*. The IRC typically regulates single family homes and duplexes, any structure with more than two units is in the International Building Code (IBC). There are four different occupancy groups within R.

Occupancy group **R-1**: transient uses like hotels, motels and boarding houses.

Occupancy group **R-2**: (most common) residences where occupants are primarily permanent, including apartments, dormitories, fraternities and sororities. It also includes vacation timeshares (with more than two units), convents and monasteries. Congregate living facilities with 16 or fewer occupants are in Group R-3.

Occupancy group **R-3**: permanent occupancies that aren't R-1, R-2, R-4 or I, including buildings that are in the IBC but have no more than two units. Adult facilities and child care facilities that provide accommodation for five or less people less than 24 hours a day are R-3. Where these facilities are in a single family home they must comply with the IRC.

Occupancy group **R-4**: residential care/assisted living facilities including more than five and not more than 16 occupants.

**OPAQUE AREAS.** All exposed areas of a building envelope which enclose conditioned space, except openings for windows, skylights, doors and building service systems.

**OUTDOOR AIR.** Air taken from the outdoors and, therefore, not previously circulated through the building.

**OWNER BUILDER.** If all of the following apply:

- (A) The owner of the residential construction is the builder, as defined under this chapter.
- (B) The residential construction is used as a dwelling by the owner.
- (C) The owner in fact directs the details of construction with regard to the installation of materials not in compliance with RBES.
- (D) The owner discloses in writing to a prospective buyer, before entering into a binding purchase and sales agreement, with respect to the nature and extent of any noncompliance with RBES. Any statement or certificate given to a prospective buyer shall itemize how the home does not comply with RBES, and shall itemize which measures do not meet the RBES standards in effect at the time construction commenced. Any certificate shall be recorded in the land records where the property is located, and sent to the Department of Public Service, within 30 days following sale of the property by the owner.

**PACKAGED TERMINAL AIR CONDITIONER (PTAC).** A factory-selected wall sleeve and separate unencased combination of heating and cooling components, assemblies or sections

(intended for mounting through the wall to serve a single room or zone). It includes heating capability by hot water, steam or electricity. (For the complete technical definition, see ARI 310/380.)

**PACKAGED TERMINAL HEAT PUMP.** A PTAC capable of using the refrigeration system in a reverse cycle or heat pump mode to provide heat. (For the complete technical definition, see ARI 310/380.)

**POSITIVE COOLING SUPPLY.** Mechanical cooling deliberately supplied to a space, such as through a supply register.

Additionally, mechanical cooling indirectly supplied to a space through uninsulated surfaces of space-cooling components, such as evaporator coil cases and cooling distribution systems which continually maintain air temperatures within the space of 85°F (29°C) or lower during normal operation. To be considered exempt from inclusion in this definition, such surfaces shall comply with the insulation requirements of this code.

**POSITIVE HEAT SUPPLY.** Heat deliberately supplied to a space by design, such as a supply register, radiator or heating element. Additionally, heat indirectly supplied to a space through uninsulated surfaces of service water heaters and space-heating components, such as furnaces, boilers and heating and cooling distribution systems which continually maintain air temperature within the space of 50°F (10°C) or higher during normal operation. To be considered exempt from inclusion in this definition, such surfaces shall comply with the insulation requirements of this code.

**POWER-VENTED APPLIANCE.** Appliances that operate with a positive vent static pressure (Category III) and utilize a mechanical fan to exhaust combustion gases from the appliance to the outside atmosphere.

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

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

**RATED CAPACITY.** In terms of ventilation, the volume of air (in cfm) that the fan can move against a given static pressure (in inches or water gage). Prescriptive compliance with the *Vermont Residential Building Energy Standards* requires that all fan capacities be rated at 0.1 inch (25 Pa) of water gage.

**RATED DESIGN.** A description of the proposed *building* used to determine the energy rating index.

**RBES.** Vermont Residential Building Energy Standards.

**READILY ACCESSIBLE.** Capable of being reached quickly for operation, renewal or inspection without requiring those to whom ready access is requisite to climb over or remove obstacles or to resort to portable ladders or access equipment (see “*Accessible*”).

**REFRIGERANT.** A substance utilized to produce refrigeration by its expansion or vaporization or absorption.

**RENEWABLE ENERGY SOURCES.** Means energy produced using a technology that relies on a resource that is being consumed at a harvest rate at or below its natural regeneration rate including, but not limited to solar hot water, solar hot air, solar photovoltaics, wind, and hydro.

- (A) Methane gas and other flammable gases produced by the decay of sewage treatment plant wastes or landfill wastes and anaerobic digestion of agricultural products, byproducts, or wastes shall be considered renewable energy resources, but no form of solid waste, other than agricultural or silvicultural waste, shall be considered renewable.
- (B) The only portion of electricity produced by a system of generating resources that shall be considered renewable is that portion generated by a technology that qualifies as renewable.
- (C) Technologies using the following fuels shall not be considered renewable energy supplies: coal, oil, propane, and natural gas.
- (D) Biomass is considered renewable.

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

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

**RESIDENTIAL BUILDING.** For this code, includes detached one- and two-family dwellings, multifamily housing and multiple single-family dwellings (townhouses as well as *Group R-2*, R-3 and R-4 buildings three stories or less in height above grade plane. (See “Occupancy Classifications”).

**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, roof deck, insulation, vapor retarder and interior finish. The gross area of a roof assembly consists of the total interior surface of all roof/ceiling components, including opaque surfaces, dormer and bay window roofs, trayed ceilings, overhead portions of an interior stairway to an unconditioned attic, doors and hatches, glazing and skylights exposed to conditioned space, that are horizontal or sloped at an angle less than 60 degrees (1.1 rad) from the horizontal (see “Exterior wall”). A roof assembly, or portions thereof, having a slope of 60 degrees (1.1 rad) or greater from horizontal shall be considered in the gross area of exterior walls and thereby excluded from consideration in the roof assembly. Skylight shaft walls 12 inches (305 mm) in depth or greater (as measured from the ceiling plane to the roof deck) shall be considered in the gross area of exterior walls and are thereby excluded from consideration in the roof assembly.

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

**ROOM AIR CONDITIONER.** An encased assembly designed as a unit for mounting in a window or through a wall, or as a console. It is designed primarily to provide free delivery of conditioned air to an enclosed space, room or zone. It includes a prime source of refrigeration for cooling and dehumidification and means for circulating and cleaning air, and shall be permitted to also include means for ventilating and heating.

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

**SASH CRACK.** The sum of all perimeters of all window sashes, based on overall dimensions of such parts, expressed in feet. If a portion of one sash perimeter overlaps a portion of another sash perimeter, only count the length of the overlapping portions once.

**SCREW LAMP HOLDERS.** A lamp base that requires a screw-in-type lamp, such as a compact-fluorescent, incandescent, or tungsten-halogen bulb.

**SEALED COMBUSTION VENTING SYSTEM.** A venting system designed so that all air for combustion is derived directly from the outside atmosphere and all flue gases are discharged directly to the outside atmosphere. (See also "Direct-vent Appliances.")

**SEASONAL ENERGY EFFICIENCY RATIO (SEER).** The total cooling output of an air conditioner during its normal annual usage period for cooling, in Btu/h, divided by the total electric energy input during the same period, in watt-hours, as determined by DOE 10 CFR Part 430, Subpart B, Test Procedures.

**SENSIBLE RECOVERY EFFICIENCY (SRE):** The net sensible energy recovered by the supply airstream as adjusted by electric consumption, case heat loss or heat gain, air leakage, airflow mass imbalance between the two airstreams and the energy used for defrost (when running the Very Low Temperature Test), as a percent of the potential sensible energy that could be recovered plus the exhaust fan energy. This value is used to predict and compare Heating Season Performance of the HRV/ERV unit.

[https://www.hvi.org/proddirectory/CPD%20Files/Sec3\\_cover.pdf](https://www.hvi.org/proddirectory/CPD%20Files/Sec3_cover.pdf)

**SERVICE SYSTEMS.** All energy-using systems in a building that are operated to provide services for the occupants or processes housed therein, including HVAC, service water heating, illumination, transportation, cooking or food preparation, laundering and similar functions.

**SERVICE WATER HEATING.** Supply of hot water for purposes other than comfort heating.

**SKYLIGHT.** Glass or other transparent or translucent glazing material installed at a slope of less than 60 degrees (1.05 rad) from horizontal.

**SIMULATION TOOL.** An approved software program or calculation-based methodology that projects the hour-by-hour loads and annual energy use of a building.

**SLAB-ON-GRADE EDGE INSULATION.** Insulation around, or underneath, the perimeter of the floor slab when the top edge of the floor perimeter slab is above the finished grade or 12 inches (305 mm) or less below the finished grade.

**SLEEPING UNIT.** A room or space in which people sleep, which can also include permanent provisions for living, eating, and either sanitation or kitchen facilities but not both. Such rooms and spaces that are also part of a dwelling unit are not *sleeping units*.

**SOLAR ENERGY SOURCE.** Source of natural daylighting and of thermal, chemical or electrical energy derived directly from conversion of incident solar radiation.

**SOLAR HEAT GAIN COEFFICIENT (SHGC).** The ratio of the solar heat gain entering the space through the fenestration assembly to the incident solar radiation. Solar heat gain includes directly transmitted solar heat and absorbed solar radiation that is then reradiated, conducted or convected into the space.

**SONE.** A subjective unit of loudness for an average listener equal to the loudness of a 1,000-hertz (cycles per second) sound that has an intensity 40 decibels above the listener's own threshold of hearing.

**STANDARD REFERENCE DESIGN.** A version of the *proposed design* that meets the minimum requirements of this code and is used to determine the maximum annual energy use requirement for compliance based on total building performance.

**STANDARD TRUSS.** Any construction that does not permit the roof/ceiling insulation to achieve the required *R*-value over the exterior walls.

**STOREFRONT.** A nonresidential system of doors and windows mullied as a composite fenestration structure that has been designed to withstand heavy use. *Storefront* systems include, but are not limited to, exterior fenestration systems that span from the floor level or above to the ceiling of the same story on commercial buildings.

**STRETCH CODE.** A building energy code that achieves greater energy savings than the base RBES. The Stretch Code is required for Act 250 projects and may be adopted by municipalities.

**SUMMER CAMPS.** Residential buildings constructed for non-winter occupation with only a biomass (wood) or other on-site renewable heating system.

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

**SYSTEM.** A combination of central or terminal equipment or components or controls, accessories, interconnecting means and terminal devices by which energy is transformed so as to perform a specific function, such as HVAC, service water heating or illumination.

**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.

**THERMAL RESISTANCE (R).** The reciprocal of thermal conductance ( $h \cdot \text{ft}^2 \cdot ^\circ\text{F}/\text{Btu}$ ) [ $(\text{m}^2 \cdot \text{K})/\text{W}$ ].

**THERMAL RESISTANCE, OVERALL (R<sub>o</sub>).** The reciprocal of overall thermal conductance ( $h \cdot \text{ft}^2 \cdot ^\circ\text{F}/\text{Btu}$ ) [ $(\text{m}^2 \cdot \text{K})/\text{W}$ ]. The overall thermal resistance of the gross area or individual component of the exterior building envelope (such as roof/ceiling, exterior wall, floor, crawl space wall, foundation, window, skylight, door, opaque wall, etc.), which includes the area-weighted *R*-values of the specific component assemblies (such as air film, insulation, drywall, framing, glazing, etc.).

**THERMAL TRANSMITTANCE (U).** (Also known as “thermal conduction”). The coefficient of heat transmission (air to air). It is the time rate of heat flow per unit area and unit temperature difference between the warm-side and cold-side air films ( $\text{Btu}/\text{hr} \cdot \text{ft}^2 \cdot ^\circ\text{F}$ ) [ $\text{W}/(\text{m}^2 \cdot \text{K})$ ].

The *U*-factor applies to combinations of different materials used in series along the heat flow path, single materials that comprise a building section, cavity airspaces and surface air films on both sides of a building element.

**THERMAL TRANSMITTANCE, OVERALL (U<sub>o</sub>).** The overall (average) heat transmission of a gross area of the exterior building envelope ( $\text{Btu}/\text{h} \cdot \text{ft}^2 \cdot ^\circ\text{F}$ ) [ $\text{W}/(\text{m}^2 \cdot \text{K})$ ].

The *U<sub>o</sub>*-factor applies to the combined effect of the time rate of heat flow through the various parallel paths, such as windows, doors and opaque construction areas, comprising the gross area of one or more exterior building components, such as walls, floors or roof/ceilings.

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

**TOILET ROOM.** A room containing a water closet and, frequently, a lavatory, but not a bathtub, shower, spa or similar bathing fixture.

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

**UNITARY COOLING AND HEATING EQUIPMENT.** One or more factory-made assemblies which include an evaporator or cooling coil, a compressor and condenser combination, and which shall be permitted to include a heating function as well. When heating and cooling equipment is provided in more than one assembly, the separate assemblies shall be designed to be used together.

**UNITARY HEAT PUMP.** One or more factory-made assemblies which include an indoor conditioning coil, compressor(s) and outdoor coil or refrigerant-to-water heat exchanger, including means to provide both heating and cooling functions. When heat pump equipment is provided in more than one assembly, the separate assemblies shall be designed to be used together.

**UNUSUALLY TIGHT CONSTRUCTION.** Construction meeting the following requirements:

1. Storm windows or weatherstripping on openable windows and doors; and
2. Caulking or sealants applied to areas, such as joints around window and door frames, between sole plates and floors, between wall-ceiling joints, between wall panels, at penetrations for plumbing, electrical and gas lines, and at other openings.
3. Buildings constructed in compliance with the RBES shall be considered built of unusually tight construction.

**VAPOR PERMEABLE MEMBRANE.** A material or covering having a permeance rating of 10 perms ( $2.9 \cdot 1040 \text{ kg/Pa} \cdot \text{s} \cdot \text{m}^2$ ) or greater, when tested in accordance with the desiccant method using Procedure A of ASTM E96. A vapor permeable material permits the passage of moisture vapor.

**VAPOR RETARDER.** A vapor-resistant material, membrane or covering such as foil, plastic sheeting or insulation facing with a permeance rating of less than 10. Vapor retarders limit the amount of moisture vapor that passes through a material or wall assembly.

**VAPOR RETARDER CLASS.** A measure of the ability of a material or assembly to limit the amount of moisture that passes through that material or assembly. Vapor retarder class shall be defined using the desiccant method with Procedure A of ASTM E96 as follows:

Class 1: 0.1 perm or less, such as sheet polyethylene, unperforated aluminum foil.

Class 2:  $0.1 < \text{perm} < 1.0$  perm, such as kraft-faced fiberglass batts.

Class 3:  $1.0 < \text{perm} < 10$  perm, such as latex or enamel paint.

**VENTING SYSTEM.** A continuous open passageway from the flue collar or draft hood of a solid fuel, gas-burning, kerosene or oil-burning appliance to the outside atmosphere for the purpose of removing flue or vent gases. A venting system is usually composed of a vent or a chimney and vent connector, if used, assembled to form the open passageway.

**Mechanical draft venting system.** A venting system designed to remove flue or vent gases by mechanical means, that consists of an induced draft portion under nonpositive static pressure or a forced draft portion under positive static pressure.

1. Forced-draft or power venting system. A portion of a venting system using a fan or other mechanical means to cause the removal of flue or vent gases under positive static vent pressure.
2. Induced draft venting system. A portion of a venting system using a fan or other mechanical means to cause the removal of flue or vent gases under nonpositive static vent pressure.

**Natural draft venting system.** A venting system designed to remove flue or vent gases under nonpositive static vent pressure entirely by natural draft.

**Sealed combustion venting system.** A venting system designed so that all air for combustion is derived directly from the outside atmosphere and all flue gases are discharged directly to the outside atmosphere.

**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.

**VERTICAL FENESTRATION.** Windows (fixed or moveable), opaque doors, glazed doors, glazed block and combination opaque/glazed doors composed of glass or other transparent or translucent glazing materials and installed at a slope of a least 60 degrees (1.05 rad) from horizontal.

**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 requirements.

**WHOLE HOUSE VENTILATION SYSTEM, BALANCED.** Balanced systems provide outdoor air for ventilation such that supply and exhaust air quantities are of equal capacity to achieve pressure equalization, such as heat recovery ventilator, an air-to-air heat exchanger or any other system that is designed to provide mechanical supply as well as mechanical exhaust.

**WHOLE HOUSE VENTILATION SYSTEM, EXHAUST ONLY.** Exhaust only systems exhaust stale indoor air via a single fan, multiple fans or the installation of dual-purpose fans (i.e., serving both localized and whole house ventilation functions). Fresh incoming air may be provided by installed inlet ports or from typical leaks in the building envelope. Exhaust only systems may depressurize the indoor environment.

**WHOLE HOUSE VENTILATION SYSTEM, MULTI-PORT.** A whole house ventilation system that has more than one exhaust or supply port inside the house.

**WHOLE HOUSE VENTILATION SYSTEM, SINGLE-PORT.** A whole house ventilation system that has only one connection to the conditioned space and one connection to outdoor air.

**WINDOW PROJECTION FACTOR.** A measure of the portion of glazing that is shaded by an eave or overhang.

**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 [RESERVED]

## 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.

### 302.2 Exterior design conditions.

The following design parameters in Table 302.2 shall be used for calculations required under this code.

TABLE 302.2  
THERMAL DESIGN PARAMETERS

CONDITION	VALUE
Winter <sup>a</sup> , Design Dry-Bulb	-11°F
Summer <sup>a</sup> , Design Dry-Bulb	84°F
Summer, Design Wet Bulb	69°F
Degree Days Heating <sup>b</sup>	7,771
Degree Days Cooling <sup>b</sup>	2,228

For SI: °C = [(°F) - 32]/1.8.

- a. The outdoor design temperature is selected from the columns of 97<sup>1</sup>/<sub>2</sub>- percent values for winter and 2<sup>1</sup>/<sub>2</sub>-percent values for summer from tables in the ASHRAE *Handbook of Fundamentals*. Adjustments shall be permitted to reflect local climates which differ from the tabulated temperatures, or local weather experience determined by the code official or other authority having jurisdiction, where one exists.
- b. The degree days heating (base 65°F) and cooling (base 65°F) shall be selected from NOAA "Annual Degree Days to Selected Bases Derived from the 1971-2000 Normals," the ASHRAE *Handbook of Fundamentals*, data available from adjacent military installations or other sources of local weather data acceptable to the code official or other authority having jurisdiction, where one exists.

## 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.

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### **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 *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.

#### **R303.1.1.1 Blown or sprayed roof and 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 not less than 1 inch (25 mm) in height. Each marker shall face the attic access opening. Spray polyurethane foam thickness and installed *R*-value shall be *listed* on certification provided by the insulation installer.

### **R303.1.2 Insulation mark installation.**

Insulating materials shall be installed such that the manufacturer's *R*-value mark is readily observable upon inspection.

### **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) or R303.1.3(2). The *solar heat gain coefficient* (SHGC) and *visible transmittance* (VT) of glazed fenestration products windows, glazed doors and *skylights* shall be determined in accordance with NFRC 200 by an accredited, independent laboratory, and labeled and certified by the manufacturer. Products lacking such a labeled SHGC or VT shall be assigned a default SHGC or VT from Table R303.1.3(3).

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

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

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

DOOR TYPE	OPAQUE <i>U</i> -FACTOR
Uninsulated Metal	1.20
Insulated Metal	0.60
Wood	0.50
Insulated, nonmetal edge, max 45% glazing, any glazing double pane	0.35

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

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

**R303.1.4 Insulation product rating.**

The thermal resistance, *R*-value, of insulation shall be determined in accordance with Part 460 of US-FTC CFR Title 16 in units of  $h \cdot ft^2 \cdot ^\circ F/Btu$  at a mean temperature of 75°F (24°C).

**R303.1.4.1 Insulated siding.**

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

**R303.2 Installation.**

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

**R303.2.1 Protection of exposed foundation insulation.**

Insulation applied to the exterior of *basement walls*, 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 not less than 6 inches (153 mm) below grade.

**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 *accessible* label. The label shall include the title or publication number for the operation and maintenance manual for that particular model and type of product.

**SECTION 304  
DESIGN CRITERIA FOR RESIDENTIAL  
VENTILATION SYSTEMS**

**304.1 Scope.**

This section shall govern ventilation of the dwelling unit(s) within Type R-1 residential buildings, Type R-2 residential buildings and multiple single-family attached dwellings (townhouses) not more than three stories in height.

**304.1.1 Compliance.**

Compliance with Section 304 shall be achieved by meeting Section 304.2 through 304.11 or demonstrating compliance with one of the following alternatives:

1. ASHRAE Standard 62.2-2016 (Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings)
2. BSC Standard 01-2015 (Ventilation for New Low-Rise Residential Buildings)
3. Passive house ventilation requirements (PHI or PHIUS)

Whole house balanced ventilation systems that are controlled using closed-loop feedback based on pollutant levels (e.g. carbon dioxide or volatile organic compounds) are not subject to ventilation rate minimums in standards referenced above, or Section 304.6.1.1.

**304.2 Local ventilation.**

Ventilation fans in bathrooms containing a bathtub, shower, spa or similar bathing fixture and not included in the whole house ventilation system shall be sized to meet the net capacity rates as required in Table 304.2. Whole house ventilation fans serving both localized and whole house ventilation functions shall be sized to meet the net capacity rates as required by Section 304.6 and must meet all other requirements listed in Section 304.3, as applicable.

TABLE 304.2  
MINIMUM REQUIRED LOCAL EXHAUST

OCCUPANCY CLASSIFICATION	MECHANICAL EXHAUST CAPACITY (CFM)
Bathrooms	50 cfm intermittent or 20 cfm continuous

**304.3 Whole house ventilation (MANDATORY).**

Every home and dwelling unit built to RBES shall be mechanically ventilated by a whole house

ventilation system as defined in Chapter 2. The whole house ventilation system shall be one of two types: “exhaust only” or “balanced.”

**304.4 Whole house air circulation.**

Provisions shall be made to allow air flow to all finished living spaces by installation of distribution ducts, undercutting doors, installation of grilles, transoms or equivalent means. Door undercuts shall be at least ½ inch (12.7 mm) above the surface of the finished floor covering.

**304.5 Fan motor requirements.**

Fans installed for the purpose of providing whole house ventilation must meet the minimum requirements as specified in this section.

**Exception:** Fans installed exclusively for local ventilation purposes are exempt from meeting the fan motor requirements listed in Section 304.5.

**304.5.1 Fan durability.** Whole house ventilation fan motors shall be rated for “continuous duty” and have manufacturer flow ratings as listed in HVI 911.

**304.5.2 Fan power consumption.**

Single-port whole house ventilation equipment shall not exceed 50 watts as listed by the manufacturer on the fan motor or as listed in accordance with HVI 911. Power used for lights, sensors, heaters, timers or night lights shall not be included in the determination of power consumption.

**304.5.3 Fan noise.**

Whole house ventilation equipment located less than 4 feet (1219 mm) from louvers, grilles or openings shall have a sound rating no greater than 1.5 sones as determined in accordance with HVI 911.

**304.5.4 Performance verification.**

In-field measurements of exhaust fan flows shall be conducted using a manufactured flow-measuring device in accordance with the manufacturer’s instructions. Acceptable devices include a calibrated orifice combined with a digital manometer or a flow hood. All measuring devices shall be accurate to within 10 percent of measured flow.

**304.6 Net capacity requirements.**

Whole house ventilation system fans shall be installed according to the manufacturer’s installation instructions and shall have the manufacturer’s fan flow ratings as listed in accordance with HVI 911. Unless the whole house system is tested according to procedures in Section 304.6.1, the minimum continuous flow rate that the ventilation system must be capable of supplying during its operation shall be based on the rate per bedroom as specified in Table 304.6.

TABLE 304.6  
PRESCRIPTIVE FAN CAPACITY REQUIREMENTS

NUMBER OF BEDROOMS	MINIMUM NOMINAL RATED TOTAL FAN CAPACITY <sup>a</sup> (at 0.1 inches w.g.)	MINIMUM NUMBER OF FANS TO MEET WHOLE HOUSE AIRFLOW RATES
1	50 cfm	1
2	75 cfm	1

3	100 cfm	1
4	125 cfm	All other systems—2 or more, or Centrally ducted systems—1
5	150 cfm	All other systems—2 or more, or Centrally ducted systems—1
Homes > 3,000 ft <sup>2</sup>	cfm = 0.05 • ft <sup>2</sup>	All other systems—2 or more, or Centrally ducted systems—1

0004719 m<sup>3</sup>/s, 1 cubic foot per minute per square foot = 0.00508 m<sup>3</sup>/(s • m<sup>2</sup>).

a. Represents the total installed rated capacity of all fans designed for whole house ventilation.

### 304.6.1 Testing option.

Testing may be done to verify that the whole house ventilation system satisfies the ventilation requirements of this section in accordance with Sections 304.1.1, 304.6.1.1 and 304.6.1.2.

#### 304.6.1.1 Minimum outdoor air.

Automatic operation of the ventilation system shall not reduce the minimum continuous ventilation rate below 15 cfm of outdoor air per bedroom plus 15 cfm during occupancy. Exception: Whole house approach in accordance using one of the compliance alternatives in Section 304.1.1.

#### 304.6.1.2 Performance verification.

In-field measurements of exhaust fan flows shall be conducted using a manufactured flow-measuring device in accordance with the manufacturer's instructions. Acceptable devices include a calibrated orifice combined with a digital manometer or a flow hood. All measuring devices shall be accurate to within 10 percent of measured flow.

### 304.7 Ventilation required during periods of occupancy.

Ventilation shall be provided continuously or intermittently during the period that the building is occupied.

### 304.8 Controls.

Whole house ventilation systems shall be capable of being set remotely for continuous operation or shall be provided with an automatic control for intermittent operation. All whole house ventilation controls shall be readily accessible.

**Exception:** Fans installed expressly for local ventilation purposes.

#### 304.8.1 Intermittent operation.

Intermittently operated whole house ventilation systems shall be capable of being set remotely for continuous operation; or shall be provided with an automatic control capable of operating without the need for occupant intervention, such as a time switch or some other control device. Twist or crank-style timers are prohibited as control devices for whole house ventilation systems. Operation controlled solely by a humidity sensor (humidistat or dehumidistat) does not qualify.

#### 304.8.2 Continuous operation.

Continuously operated whole house ventilation systems shall not be provided with local controls unless that control only operates the whole house ventilation system both intermittently at high speed and continuously at low speed.

#### **304.8.2.1 On/off switch for continuous operation.**

An on/off switch for continuously operated whole-house ventilation systems shall be remotely installed and appropriately labeled.

### **304.9 Installation requirements.**

Ventilation equipment shall be installed according to the manufacturer's instructions and in accordance with Sections 304.9.1 through 304.9.8.

#### **304.9.1 Fan housings.**

Fan housings for single-port exhaust only systems must be sealed to the ceiling or wall.

#### **304.9.2 Inlet grills.**

Inlet grills for multipoint exhaust ventilation systems or balanced whole house ventilation systems must be sealed to the ceiling or wall.

#### **304.9.3 Ducts.**

Smooth wall ducts (e.g. metal or composite) must be used for all duct runs longer than 8 feet (2438 mm). Ducts shall be insulated when installed in an unheated location.

#### **304.9.4 Fasteners.**

Mechanical fasteners must be used to connect all ducts to the fan(s) without impeding the operation of the fan or any internal backdraft damper.

#### **304.9.5 Joints and connections.**

All joints, seams and connections shall be securely fastened and sealed with welds, gaskets, o-rings, mastics (adhesives), mastic embedded fabric systems or approved tapes.

#### **304.9.6 Noise abatement.**

Remote whole house ventilation fans shall be acoustically isolated from the structural elements of the building and from attached ducts using at least 1 foot (305 mm), but not more than 2 feet (610 mm) of insulated flexible duct.

#### **304.9.7 Intake openings.**

Mechanical and gravity outside air intake openings for balanced whole house systems, integrated supply systems or heat recovery ventilating systems that are installed in accordance with Section 304 shall be located a minimum of 10 feet (3048 mm) from any hazardous or noxious contaminant, such as vents, chimneys, plumbing vents, fuel fills and vents, streets, alleys, parking lots and loading docks, except as otherwise specified in this code.

The bottom of the intake termination shall be located at least 12 inches (305 mm) above the normally expected snow accumulation level.

#### **304.9.8 Outside opening protection.**

Air exhaust and in take openings located in exterior walls shall be protected with corrosion-resistant screens, louvers or grilles having a minimum opening size of  $\frac{1}{4}$  inch (6.4 mm) and a maximum opening size of  $\frac{1}{2}$  inch (12.7 mm), in any dimension. Openings shall be protected against local weather conditions.

### **304.10 Clothes dryer exhaust.**

Clothes dryers shall be exhausted in accordance with the manufacturer's instructions. Dryer

exhaust systems shall be independent of all other systems and shall convey the moisture and any products of combustion to the outside of the building.

**Exception:** This section shall not apply to listed and labeled condensing (ductless) clothes dryers

### **304.11 Makeup air required.**

Exhaust hood systems capable of exhausting in excess of 400 cubic feet per minute ( $0.19 \text{ m}^3/\text{s}$ ) shall be provided with makeup air at a rate approximately equal to the exhaust air rate. Such makeup air systems shall be equipped with a means of closure and shall be automatically controlled to start and operate simultaneously with the exhaust system.

## **SECTION 305 COMBUSTION SAFETY (MANDATORY)**

### **305.1 General.**

The provisions of this section shall govern the requirements for combustion and dilution air for fuel-burning appliances in every new home built to RBES, when ever a new heating system is installed, or whenever alteration, renovation or repair work creates *unusually tight construction* as defined in NFPA 54 and NFPA 31.

### **305.2 Unusually tight construction.**

For the purpose of applying the provisions of Section 305 to fuel gas, kerosene and oil-burning equipment, buildings constructed in compliance with the RBES shall be considered so tight that normal infiltration does not meet combustion air requirements, and therefore, of unusually tight construction as defined in NFPA 54 and NFPA 31.

### **305.3 Fuel gas, kerosene and oil-burning equipment.**

Every new home built to the RBES that contains Category I or II natural draft venting fuel-burning appliances shall be provided with combustion and dilution air as required by NFPA 54 for fuel-gas utilization equipment or NFPA 31 for oil-burning equipment. Direct vent appliances that do not draw combustion air from inside of the building are not required to be considered in the determination of the combustion and dilution air requirements.

**Exception:** Where all combustion devices in the home have a sealed combustion venting system, a mechanical draft venting system or are direct-vent appliances, then the combustion and dilution air requirements of this section do not apply.

#### **305.3.1 Crawl space and attic space.**

For the purposes of applying the provisions of Section 305, an opening to a naturally ventilated crawl space or attic space is not considered equivalent to an opening outdoors and is therefore prohibited for the purposes of supplying combustion and dilution air.

#### **305.3.2 Unvented room heaters.**

Unvented fuel-fired heaters, including room heaters and unvented fireplaces are prohibited.

### **305.4 Solid fuel-burning appliances and fireplaces.**

All solid fuel-burning appliances and fireplaces shall meet the provisions of this section.

### **305.4.1 Gasketed doors.**

All solid fuel-burning appliances and fireplaces shall have tight-fitting (defined as gasketed doors with compression closure or compression latch system) metal glass or ceramic doors.

**Exception:** Any home certified to have passed the Canadian General Standards Board 51.71 “Spillage Test” is not required to have tight-fitting doors. The CGSB Spillage Test creates a “worst-case” condition to determine whether the appliances can vent properly even with the house closed tight and all the exhaust equipment running.

### **305.4.2 Spillage testing.**

All chimney-vented equipment shall establish complete draft without spillage under “worst-case” conditions within two minutes. If any chimney-vented equipment fails this requirement, mechanically induced pressure relief shall be provided such that the requirement is met.

#### **305.4.2 Exterior air supply requirements.**

Solid fuel-burning appliances and fireplaces shall be equipped with an exterior air supply according to the provisions of Sections 305.4.2.1 through 305.4.2.7. Factory-built fireplaces, masonry fireplaces and solid fuel-burning appliances that list exterior air supply ducts as optional or required for proper installation are permitted to be installed with those exterior air supply ducts according to the manufacturer’s installation instructions.

##### **305.4.2.1**

Combustion air shall not be taken from within the garage, attic, or basement.

##### **305.4.2.2**

The exterior air inlet shall not terminate to the exterior higher than the firebox and shall not rise vertically within 18 inches of the firebox.

**Exception:** Where woodstove or fireplace is installed below grade (in a basement), air intake is permitted to terminate above the firebox if the combustion air supply point is below the firebox and the combustion air intake point is greater than 15 inches (381 mm) below the top of the wood stove or fireplace chimney.

##### **305.4.2.3**

The exterior air intake must deliver combustion air to the firebox.

**Exception:** For older woodstoves and cookstoves where direct connection of combustion air is not possible, combustion air may be delivered within 24 inches (610 mm) of the stove’s air intake opening.

##### **305.4.2.4**

The air inlet shall be screened with ¼ inch (6 mm) mesh.

##### **305.4.2.5**

The air inlet shall be closable and designed to prevent debris from dropping into the air intake.

**305.4.2.6**

The exterior air inlet shall be installed so as to remain free of obstruction from snow.

**305.4.2.7 Passageway.**

The combustion air passageway for unlisted exterior air supply ducts shall be a minimum of 6 square inches (3870 mm<sup>2</sup>) and not more than 55 square inches (0.035 m<sup>2</sup>). The passageway shall be non-combustible, masonry or 30 gauge (or thicker) metal, have 1 inch clearance to combustibles for the length of the combustion air intake. Combustion air systems for listed fireplaces shall be constructed according to the fireplace manufacturer's instructions.

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# CHAPTER 4 [RE] RESIDENTIAL ENERGY EFFICIENCY

## SECTION R401 GENERAL

### R401.1 Scope.

This chapter applies to *residential buildings*.

### R401.2 Compliance.

Projects shall comply with one of the following:

1. “*Prescriptive packages*”: Sections R401 through R404.
2. “*REScheck™ software*”: Section R405 and the provisions of Sections R401 through R404 indicated as “Mandatory.”
3. “*Home Energy Rating System (HERS)*”: An energy rating index (ERI) approach in Section R406.

### R401.3 Certificate of Compliance.

A certification may be issued and signed by a builder, a licensed professional engineer, a licensed architect or an accredited home energy rating organization. If certification is not issued by a licensed professional engineer, a licensed architect or an accredited home energy rating organization, it shall be issued by the builder. Any certification shall certify that residential construction meets the RBES. The Department of Public Service will develop and make available to the public a certificate that lists key features of the RBES. Any person certifying shall use this certificate or one substantially like it to certify compliance with the RBES. Certification shall be issued by completing and signing a certificate and permanently affixing it to the electrical service panel, without covering or obstructing the visibility of the circuit directory label, service disconnect label or other required labels. The certificate shall certify that the residential building has been constructed in compliance with the requirements of the RBES. The person certifying under this subsection shall provide a copy of the certificate to the Department of Public Service and shall assure that a certificate is recorded and indexed in the town land records. A builder may contract with a licensed professional engineer, a licensed architect or an accredited home energy rating organization to issue certification and to indemnify the builder from any liability to the owner of the residential construction caused by noncompliance with the RBES.

## SECTION R402 BUILDING THERMAL ENVELOPE

### R402.1 General (Prescriptive).

The *building thermal envelope* shall meet the requirements of Sections R402.1.1 through R402.1.5.

## Exceptions:

The following *buildings*, or portions thereof, separated from the remainder of the building by *building thermal envelope* assemblies complying with this section shall be exempt from the *building thermal envelope* provisions of Section R402.

1. **Low Energy Use Buildings.** 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. **Unconditioned Buildings.** Those that do not contain *conditioned space*.
3. **Mobile homes.** Homes subject to Title VI of the National Manufactured Housing Construction and Safety Standards Act of 1974 (42 U.S.C. §§ 5401- 5426).
4. **Hunting camps.** Residential buildings shall not include hunting camps.
5. **Summer camps.** Residential buildings constructed for non-winter occupation with only a biomass (wood) or other on-site renewable heating system.
6. **Owner-built homes.** Residential construction by an owner, if all of the following apply:
  - 6.1. The owner of the residential construction is the *builder*, as defined in 30 V.S.A. § 51, and;
  - 6.2. The residential construction is used as a dwelling by the owner, and;
  - 6.3. The owner in fact directs the details of construction with regard to the installation of materials not in compliance with the RBES, and;
  - 6.4. The owner discloses in writing to a prospective buyer, before entering into a binding purchase and sales agreement, with respect to the nature and extent of any noncompliance with the RBES. Any statement or certificate given to a prospective buyer shall itemize how the home does not comply with RBES, and shall itemize which measures do not meet the RBES in effect at the time construction commenced.
7. Log homes designed in accordance with ICC 400-2017.

### 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 1405.3 of the *International Building Code*, as applicable, or with R402.2.15 in this document

### R402.1.2 Insulation and fenestration criteria.

The *building thermal envelope* shall meet the requirements of either:

1. Prescriptive/Points Approach: tables R402.1.2.1, R402.1.2.2 and R402.1.2.3; or
2. U-Factor Alternative Approach: table R402.1.4; or
3. Log Home Approach: 402.1.5.

### 402.1.2.1 Prescriptive/Points Approach – Base Packages.

Projects shall comply by:

1. selecting one of the four base packages listed in Table R402.1.2.1;
2. determining the points needed to comply with Table R402.1.2.2 based on building size; and
3. incorporating a sufficient number of points from Table R402.1.2.3 to meet the points requirements from Table R402.1.2.2.

**TABLE R402.1.2.1  
INSULATION AND FENESTRATION REQUIREMENTS BY COMPONENT FOR BASE  
PACKAGES**

Component <sup>a</sup>		Package 1	Package 2	Package 3	Package 4
		“Standard”	“SIPS”	“Thick Wall”	“Cavity Only”
<b>Envelope</b>	Ceiling R-Value	R-49 <sup>g</sup>	R-28 cont.	R-49 <sup>g</sup>	R-60 <sup>h</sup> attic / R-49 <sup>g</sup> slope
	Wood Frame Wall R-Value	R-20+5 <sup>f</sup> OR 13+10 <sup>f</sup>	R-21 cont.	R-20+12 <sup>f</sup>	R-20 cavity
	Floor R-Value	R-30 <sup>e</sup>	R-30 <sup>e</sup>	R-30 <sup>e</sup>	R-38 <sup>e</sup>
	Basement/Crawl Space Wall <sup>c</sup> R-Value	R-15 (continuous) OR 20 (cavity)	R-15 (continuous) OR 20 (cavity)	R-20 (continuous) OR R-13+10 <sup>f</sup>	R-20 (continuous) OR R-13+10 <sup>f</sup>
	Slab Edge <sup>d</sup> R-Value	R-15, 4ft	R-15, 4 ft	R-10, 4ft	R-15, 4 ft
	Heated Slab R-Value (Edge and Under)	R-15	R-15	R-15	R-15
	Fenestration <sup>b</sup> (Window and Door) max. U-Value	U-0.30	U-0.30	U-0.30	U-0.27
	Skylight <sup>b</sup> max. U-Value	U-0.55	U-0.55	U-0.55	U-0.55
<b>Air Leakage and Ventilation</b>	Air Leakage <sup>i</sup>	≤3.0 ACH50 tested	≤3.0 ACH50 tested	≤3.0 ACH50 tested	≤3.0 ACH50 tested
	Ventilation	EOV <sup>j</sup> 64 cfm; 24 hr/d; ≤50 w (ASHRAE 62.2-2013)	EOV <sup>j</sup> 64 cfm; 24 hr/d; ≤50 w (ASHRAE 62.2-2013)	EOV <sup>j</sup> 64 cfm; 24 hr/d; ≤50 w (ASHRAE 62.2-2013)	EOV <sup>j</sup> 64 cfm; 24 hr/d; ≤50 w (ASHRAE 62.2-2013)
<b>Mechanicals</b>	Duct Leakage	Inside thermal boundary	Inside thermal boundary	4 CFM25 per 100 sq. ft. of CFA <sup>k</sup>	Inside thermal boundary
<b>Lighting</b>	Percent High Efficacy Lamps <sup>l</sup>	90% High Efficacy Lamps	90% High Efficacy Lamps	90% High Efficacy Lamps	100% High Efficacy Lamps

For SI: 1 foot = 304.8 mm.

- a. *R*-values are minimums. *U*-factors and SHGC are maximums. Where insulation is installed in a cavity that is less than the label or design thickness of the insulation, the installed *R*-value of the insulation shall be not less than the *R*-value specified in the table.
- b. The fenestration *U*-factor row excludes skylights.
- c. Basement and crawlspace insulation can be met through either R-15 or R-20 continuous insulation or R-20 cavity insulation or R-13 continuous plus R-10 continuous insulation, either interior or exterior.

- d. "4 ft" can be horizontal or vertical coverage including slab edge. "Edge and under" requires complete coverage. Up to 8 lineal feet of exposed slab edge may be insulated to R-10.
- e. Or insulation sufficient to fill the framing cavity.
- f. The first value is cavity insulation, the second value is continuous insulation, so "13+10" means R-13 cavity insulation plus R-10 continuous insulation. R-25 can be met through any combination of insulation R-values, cavity, or cavity and continuous insulation.
- g. Installing R-38 over 100 percent of the ceiling area requiring insulation shall be deemed to satisfy the requirement for R-49 insulation wherever the full height of uncompressed R-38 insulation extends over the wall top plate at the eaves. (See Section R402.2.1.)
- h. Installing R-49 over 100 percent of the ceiling area requiring insulation shall be deemed to satisfy the requirement for R-60 insulation wherever the full height of uncompressed R-49 insulation extends over the wall top plate at the eaves. (See Section R402.2.1.)
- i. "ACH50" = air changes per hour at 50 Pascals building pressure as measured with a blower door
- j. "EOV" = Exhaust Only Ventilation, "cfm" = cubic feet per minute, "hr/d" = hours per day, ASHRAE 62.2-2013 = see section R304
- k. "CFA" = conditioned floor area
- l. See definition in R202

### R402.1.2.2 Required Points by Building Size.

Determine the number of points required by building size from Table R402.1.2.2, then select the components from Table 402.1.2.3 to accumulate the required number of points.

Required points are based on building size, which is determined by the area within the *building thermal envelope*, including unfinished basements, if present. *Multifamily dwelling* requirements for points shall be based on the average *dwelling unit* size in each *multifamily dwelling* building.

**TABLE R402.1.2.2  
REQUIRED POINTS BY BUILDING SIZE**

Building Size	Required Points
Multifamily < 2000 square feet	4 points
<2000 square feet	5 points
2000 to 4000 square feet	7 points
>4000 square feet	10 points

### R402.1.2.3 Points by Component.

After determining the number of points required using Table R402.1.2.2, select the components from Table 402.1.2.3 to accumulate the required number of points.

**TABLE R402.1.2.3  
POINTS BY COMPONENT**

Component	Description	Points	
<b>Envelope</b>	Slab	R-10 below entire slab	1
	Walls - Upgraded	AG walls R-20+12 (or U-factor maximum 0.033 wall assembly) (Exception: not available for base package 3) <b>OR</b> <sup>b</sup>	2
	Walls – High-R	AG walls $\geq$ R-40 (U-factor 0.025)	3
	Windows	Average U-factor $\leq$ 0.27 <b>OR</b> <sup>b</sup>	1
		Average U-factor $\leq$ 0.22	2
<b>Air Leakage and Ventilation</b>	Pre-Drywall	ACH50 is tested with blower door before drywall installed <b>OR</b> <sup>b</sup>	1
	Tight	ACH50 $\leq$ 2.0 and balanced H/ERV <sup>c</sup> with $\leq$ 70% SRE <sup>d</sup> and ECM <sup>e</sup> fans <b>OR</b> <sup>b</sup>	3

	Very Tight	ACH50 $\leq$ 1.0 and balanced H/ERV <sup>c</sup> with $\leq$ 80% SRE <sup>d</sup> and ECM <sup>e</sup> fans	4
Heating and Cooling <sup>a</sup>	Basic	ENERGY STAR basic: (1) Gas/propane furnace $\geq$ 95 AFUE, Oil furnace $\geq$ 85 AFUE, (2) Gas/Propane Boiler $\geq$ 90 AFUE, Oil Boiler $\geq$ 87 AFUE, (3) Heat pump HSPF $\geq$ 9.0; PLUS any AC is SEER $\geq$ 14.5 <b>OR</b> <sup>b</sup>	1
	Advanced	Advanced: Whole building heat/cool is (1) NEEP-listed heat pump combination, (2) GSHP, closed loop and COP $\geq$ 3.3, (3) ATWHP <sup>f</sup> COP $\geq$ 2.5 and 120F design temp, (4) Advanced wood heating system	3
Domestic Hot Water	Basic	ENERGY STAR basic: Fossil fuel [EF 0.67 for $\leq$ 55 gal; EF 0.77 for > 55 gal] <b>OR</b> <sup>b</sup>	1
	Advanced	ENERGY STAR advanced: Electric [EF or UEF $\geq$ 2.00 for $\leq$ 55 gal; EF $\geq$ 2.20 for > 55 gal]	2
	Low Flow	All showerheads $\leq$ 1.75 gpm <sup>g</sup> , all lav. faucets $\leq$ 1.0 gpm <sup>g</sup> , and all toilets $\leq$ 1.28 gpf <sup>h</sup> (for new construction only) <b>OR</b> <sup>b</sup>	1
	Certified	Certified water efficient design per WERS, WaterSense, or RESNET <sub>H2O</sub> (for new construction only)	2
	Drain Heat Recovery	Drain water heat recovery system on primary showers and tubs	1
	On-Demand	Controlled on-demand hot water recirculation system for furthest bathroom	1
Solar	Solar Ready	Home is Solar Ready per R407.4	1
	Solar Hot Water	Solar hot water system designed to meet at least 50% of annual hot water load	1
	Solar PV	Solar Photovoltaic (PV), 1 point per 1.5 kW per housing unit of renewable generation on site	1 per 1.5 kW, max. 4
Other Measures	Monitoring	Install whole-building energy monitoring system, min. 5 circuits and homeowner access to data	1
	EV Ready	Level 2 electric vehicle charger-ready per 407.3	1
	Battery	Min. 6 kWh grid-connected dispatchable demand-response-enabled battery backup	1

For SI: 1 foot = 304.8 mm.

- Heating and cooling system points are only available if all components of primary systems comply
- “OR”** indicates that points are not additive; one component OR the following one can be selected, but not both.
- “H/ERV” = Heat or Energy Recovery Ventilation
- “SRE” = System Recovery Efficiency
- “ECM” = Electronically Commutated Motor
- “ATWHP” = Air-to-Water Heat Pump
- “gpm” = gallons per minute
- “gpf” = gallons per flush

#### R402.1.3 R-value computation.

Insulation material used in layers, such as framing *cavity insulation* or continuous insulation, shall be summed to compute the corresponding component *R*-value. The manufacturer’s settled *R*-value shall be used for blown insulation. Computed *R*-values shall not include an *R*-value for other building materials or air films. Where insulated siding is used for the purpose of complying with the continuous insulation requirements of Table R402.1.2, the manufacturer’s labeled *R*-value for insulated siding shall be reduced by R-0.6.

**R402.1.4 *U*-factor alternative.**

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

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**TABLE R402.1.4**  
**EQUIVALENT *U*-FACTORS<sup>a</sup>**

FENESTRATION U-FACTOR	SKYLIGHT U-FACTOR	CEILING U-FACTOR	FRAME WALL U-FACTOR	MASS WALL U-FACTOR <sup>b</sup>	FLOOR U-FACTOR	BASEMENT WALL U-FACTOR	CRAWL SPACE WALL U-FACTOR	SLAB & UNHEATED SLAB U-FACTOR & DEPTH
0.27	0.55	0.022	0.044	0.060	0.030	0.035	0.035	0.066, 4 ft

For SI: 1 foot = 304.8 mm.

- a. Nonfenestration *U*-factors shall be obtained from measurement, calculation or an approved source.
- b. When more than half the insulation is on the interior, the mass wall *U*-factors shall be a maximum of 0.057.

**R402.1.5 Total UA alternative.**

Where the total *building thermal envelope UA*, the sum of *U*-factor times assembly area, is less than or equal to the total UA resulting from multiplying the *U*-factors in Table R402.1.4 by the same assembly area as in the proposed *building*, the *building* shall be considered to be in compliance with Table R402.1.2. The UA calculation shall be performed using a method consistent with the ASHRAE *Handbook of Fundamentals* and shall include the thermal bridging effects of framing materials. In addition to UA compliance, the SHGC requirements shall be met.

**TABLE R402.1.5**  
**LOG HOME INSULATION, FENESTRATION AND HEATING REQUIREMENTS BY COMPONENT<sup>a</sup>**

FENESTRATION U-FACTOR <sup>b</sup>	SKYLIGHT U-FACTOR	MAXIMUM GLAZING AREA <sup>c</sup>	CEILING R-VALUE	LOG WALL <sup>d</sup>	FLOOR R-VALUE <sup>e</sup>	BASEMENT/ CRAWL SPACE WALL U-VALUE <sup>f</sup>	SLAB R-VALUE & DEPTH	HEATED SLAB R-VALUE <sup>g</sup>	HEATING SYSTEM AFUE <sup>h</sup>
0.30	0.55	20%	49	≥ 5" Log	38	15/20	15, 4 ft.	15 edge and under	90% gas/LP, 85% oil

For SI: 1 foot = 304.8 mm.

- a. *U*-factors are maximums, *R*-values are minimums.
- b. The fenestration *U*-factor column excludes skylights.
- c. Glazing area includes window and skylight opening area, plus actual glazed area of glass in doors, as a percentage of wall area. Sunrooms are exempt from this requirement.
- d. Log walls must comply with ICC 400 with an average minimum average wall thickness of 5" or greater. Non-log exterior walls shall be insulated in accordance with Table 402.2.1.
- e. Or insulation sufficient to fill the framing cavity, with R-38 as the absolute maximum.
- f. Basement walls shall be R-15 continuous insulation or R-20 cavity full basement height.
- g. Heated slabs shall be completely insulated around the perimeter and under the entire slab.
- h. Boilers must have an outdoor temperature reset or thermal purge control.

## **R402.2 Specific insulation requirements (Prescriptive).**

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

Table 402.1.4 defines the reference conditions for a code compliant home in Vermont. The specific *U*-factors are not necessarily required as long as the home can demonstrate equivalent or lower energy use as compared to the same home built with these components installed. This equivalency can be demonstrated by selecting one of the packages in Table 402.1.2, selecting an alternative package in the 2019 RBES Handbook, using *REScheck*<sup>TM</sup> software to demonstrate equivalency, or obtaining a Home Energy Rating System (HERS) rating that meets Section 406.

### **R402.2.1 Ceilings with attic spaces.**

Where Section R402.1.2 would require R-49 insulation in the ceiling, installing R-38 over 100 percent of the ceiling area requiring insulation shall be deemed to satisfy the requirement for R-49 insulation wherever the full height of uncompressed R-38 insulation extends over the wall top plate at the eaves. Where Section R402.1.2 would require R-60 insulation in the ceiling, installing R-49 over 100 percent of the ceiling area requiring insulation shall be deemed to satisfy the requirement for R-60 insulation wherever the full height of uncompressed R-49 insulation extends over the wall top plate at the eaves. This reduction shall not apply to the *U*-factor alternative approach in Section R402.1.4 and the Total UA alternative in Section R402.1.5.

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### **R402.2.2 Ceilings without attic spaces.**

Where Section R402.1.2 would require insulation levels above R-30 and the design of the roof/ceiling assembly does not allow sufficient space for the required insulation, the minimum required insulation for such roof/ceiling assemblies shall be R-30. Insulation shall extend over the top of the wall plate to the outer edge of such plate and shall not be compressed. This reduction of insulation from the requirements of Section R402.1.2 shall be limited to 500 square feet (46 m<sup>2</sup>) or 20 percent of the total insulated ceiling area, whichever is less. This reduction shall not apply to the *U*-factor alternative approach in Section R402.1.4 and the Total UA alternative in Section R402.1.5.

#### **402.2.2.1 Unvented attic assemblies.**

Unvented attic assemblies (spaces between the ceiling joists of the top story and the roof rafters) shall be permitted in one- and two-family dwellings and multiple single-family dwellings (townhouses) if all the following conditions are met:

1. The unvented attic space is completely contained within the building thermal envelope.
2. No interior vapor retarders (Class I or II) are installed on the ceiling side (attic floor) of the unvented attic assembly.
3. Where wood shingles or shakes are used, a minimum  $\frac{1}{4}$  inch (6 mm) vented air space separates the shingles or shakes and the roofing underlayment above the structural sheathing.
4. Any air-impermeable (e.g., spray foam) insulation shall be a Class III vapor retarder, or shall have a vapor retarder coating, or covering in direct contact with the underside of the insulation.
5. Either Item 5.1, 5.2 or 5.3 shall be met, depending on the air permeability of the insulation directly under the structural roof sheathing.
  - 5.1. Air-impermeable (e.g., spray foam) insulation only. Insulation shall be applied in direct contact with the underside of the structural roof sheathing.
  - 5.2. Air-permeable (e.g., fiberglass or cellulose) insulation only. In addition to the air-permeable insulation installed directly below the structural sheathing, rigid board sheet insulation shall be installed directly above the structural roof sheathing as specified in Table R402.4.1.1 for condensation control.
  - 5.3. Air-impermeable and air-permeable insulation. The air-impermeable (e.g., spray foam) insulation shall be applied in direct contact with the underside of the structural roof sheathing as specified in Table R402.4.1.1 for condensation control. The air-permeable (e.g., fiberglass or cellulose) insulation shall be installed directly under the air-impermeable (e.g., spray foam) insulation.

### **R402.2.3 Eave baffle.**

For air-permeable insulations in vented attics, a baffle shall be installed adjacent to soffit and eave vents. Baffles shall maintain an opening equal 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.

### **R402.2.4 Access hatches and doors.**

Access doors from *conditioned spaces* to *unconditioned spaces* such as attics and crawl spaces shall be weatherstripped and insulated to a level equivalent to the insulation on the surrounding surfaces. Access shall be provided to all equipment that prevents damaging or compressing the insulation. A wood-framed or equivalent baffle or retainer is required to be provided when loose-fill insulation is installed, the purpose of which is to prevent the loose-fill insulation from spilling into the living space when the attic access is opened, and to provide a permanent means of maintaining the installed *R*-value of the loose-fill insulation.

**Exception:** Vertical doors that provide access from *conditioned spaces* to *unconditioned spaces* shall be permitted to meet the fenestration requirements of Table R402.1.2.

### **R402.2.5 Mass walls.**

Mass walls for the purposes of this chapter shall be considered above-grade walls of concrete block, concrete, insulated concrete form (ICF), masonry cavity, brick (other than brick veneer), earth (adobe, compressed earth block, rammed earth) and, solid timberlogs, or any other walls having a heat capacity greater than or equal to  $6 \text{ Btu/ft}^2 \cdot ^\circ\text{F}$  ( $123 \text{ kJ/m}^2 \cdot \text{K}$ ).

### **R402.2.6 Steel-frame ceilings, walls and floors.**

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

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

<b>WOOD FRAME R-VALUE REQUIREMENT</b>	<b>COLD-FORMED STEEL EQUIVALENT R-VALUE<sup>a</sup></b>
<b>Steel Truss Ceilings<sup>b</sup></b>	
R-30	R-38 or R-30 + 3 or R-26 + 5
R-38	R-49 or R-38 + 3
R-49	R-38 + 5
<b>Steel Joist Ceilings<sup>b</sup></b>	
R-30	R-38 in 2 x 4 or 2 x 6 or 2 x 8 R-49 in any framing
R-38	R-49 in 2 x 4 or 2 x 6 or 2 x 8 or 2 x 10
<b>Steel-Framed Wall, 16" on center</b>	
R-13	R-13 + 4.2 or R-19 + 2.1 or R-21 + 2.8 or R-0 + 9.3 or R-15 + 3.8 or R-21 + 3.1
R-13 + 3	R-0 + 11.2 or R-13 + 6.1 or R-15 + 5.7 or R-19 + 5.0 or R-21 + 4.7
R-20	R-0 + 14.0 or R-13 + 8.9 or R-15 + 8.5 or R-19 + 7.8 or R-19 + 6.2 or R-21 + 7.5
R-20 + 5 or R-25	R-13 + 12.7 or R-15 + 12.3 or R-19 + 11.6 or R-21 + 11.3 or R-25 + 10.9
R-21	R-0 + 14.6 or R-13 + 9.5 or R-15 + 9.1 or R-19 + 8.4 or R-21 + 8.1 or R-25 + 7.7
<b>Steel Framed Wall, 24" on center</b>	
R-13	R-0 + 9.3 or R-13 + 3.0 or R-15 + 2.4
R-13 + 3	R-0 + 11.2 or R-13 + 4.9 or R-15 + 4.3 or R-19 + 3.5 or R-21 + 3.1
R-20	R-0 + 14.0 or R-13 + 7.7 or R-15 + 7.1 or R-19 + 6.3 or R-21 + 5.9
R-20 + 5	R-13 + 11.5 or R-15 + 10.9 or R-19 + 10.1 or R-21 + 9.7 or R-25 + 9.1
R-21	R-0 + 14.6 or R-13 + 8.3 or R-15 + 7.7 or R-19 + 6.9 or R-21 + 6.5 or R-25 + 5.9
<b>Steel Joist Floor</b>	
R-13	R-19 in 2 x 6, or R-19 + 6 in 2 x 8 or 2 x 10
R-19	R-19 + 6 in 2 x 6, or R-19 + 12 in 2 x 8 or 2 x 10

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

**R402.2.7 Walls with partial structural sheathing.**

Where Section R402.1.2 would require continuous insulation on *exterior walls* and structural sheathing covers 40 percent or less of the gross area of all *exterior walls*, the continuous insulation *R*-value shall be permitted to be reduced by an amount necessary to result in a consistent total sheathing thickness, but not more than R-3, on areas of the walls covered by structural sheathing. This reduction shall not apply to the *U*-factor alternative approach in Section R402.1.4 and the Total UA alternative in Section R402.1.5.

#### **R402.2.8 Floors.**

Floor framing-*cavity insulation* shall be installed to maintain permanent contact with the underside of the subfloor decking.

**Exception:** The floor framing-*cavity insulation* shall be permitted to be in contact with the topside of sheathing or continuous insulation installed on the bottom side of floor framing where combined with insulation that meets or exceeds the minimum wood frame wall *R*-value in Table R402.1.2 and that extends from the bottom to the top of all perimeter floor framing members.

#### **R402.2.9 Basement walls.**

Walls associated with conditioned basements shall be insulated from the top of the *basement wall* down to 10 feet (3048 mm) below grade or to the basement floor, whichever is less. Walls associated with unconditioned basements shall meet this requirement unless the floor overhead is insulated in accordance with Sections R402.1.2 and R402.2.8.

#### **R402.2.10 Slab-on-grade floors.**

Slab-on-grade floors with a floor surface less than 12 inches (305 mm) below grade shall be insulated in accordance with Table R402.1.2. The insulation shall extend downward from the top of the slab on the outside or inside of the foundation wall. Insulation located below grade shall be extended the distance provided in Table R402.1.2 by any combination of vertical insulation, insulation extending under the slab or insulation extending out from the *building*. Insulation extending away from the *building* shall be protected by pavement or by not less than 10 inches (254 mm) of soil. The top edge of the insulation installed between the *exterior wall* and the edge of the interior slab shall be permitted to be cut at a 45-degree (0.79 rad) angle away from the *exterior wall*. Slab-edge insulation is not required in jurisdictions designated by the *code official or other authority having jurisdiction, where one exists*, as having a very heavy termite infestation.

#### **R402.2.11 Crawl space walls.**

As an alternative to insulating floors over crawl spaces, crawl space walls shall be permitted to be insulated when the crawl space is not vented to the outside. Crawl space wall insulation shall be permanently fastened to the wall and extend downward from the floor to the finished grade level and then vertically and/or horizontally for at least an additional 24 inches (610 mm). Exposed earth in unvented crawl space foundations shall be covered with a continuous Class I vapor retarder in accordance with the *International Building Code* or *International Residential Code*, as applicable. All joints of the vapor retarder shall overlap by 6 inches (153 mm) and be sealed or taped. The edges of the vapor retarder shall extend not less than 6 inches (153 mm) up the stem wall and shall be attached to the stem wall.

#### **R402.2.12 Masonry veneer.**

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

#### **R402.2.13 Sunroom insulation.**

*Sunrooms* enclosing *conditioned space* shall meet the insulation requirements of this code.

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

1. The minimum ceiling insulation *R*-value shall be R-30.
2. The minimum wall insulation *R*-value shall be R-13. Walls separating a *sunroom* with a *thermal isolation* from *conditioned space* shall meet the *building thermal envelope* requirements of this code.

**R402.2.14 Common, party, and fire walls.**

Whenever continuity of the building thermal envelope is broken at walls separating dwelling units in Group R-2 building, including common, party, and fire walls, such walls shall be insulated to a minimum of R-10 on each side of the break in insulation continuity, and the walls shall be air sealed in accordance with Section R402.4.

**R402.2.15 Frame walls.**

Efforts must be made to protect insulated cavities from airborne water vapor and condensation. Air sealing the interior face of the assembly, controlled mechanical ventilation (targeting 30% relative humidity), exterior continuous insulation and proper consideration of the vapor permeance of materials are all design elements that can contribute to this protection. Consultation with design professionals on these details is strongly encouraged.

**R402.2.15.1 Vapor retarders.** Class I or II vapor retarders shall be provided on the interior side of frame walls. Exceptions:

1. Basement walls.
2. Below *grade* portion of any wall.
3. Construction where moisture or its freezing will not damage the materials.

**R402.2.15.2 Low permeability insulating sheathing.** Where a Class II vapor retarder is used in combination with a low permeability insulating sheathing installed as continuous insulation on the exterior side of frame walls, the Class II vapor retarder shall have a vapor permeance greater than 1 perm when measured by ASTM E96 water method (Procedure B). Use of a Class I interior vapor retarder in frame walls with a Class I vapor retarder on the exterior side shall require an approved design.

**R402.2.15.3 Class III vapor retarders.** Class III vapor retarders shall be permitted where any one of the following conditions is met:

1. Vented cladding over fiberboard.
2. Vented cladding over gypsum.
3. Insulated sheathing with *R*-value 7.5 minimum over 2 × 4 wall.
4. Insulated sheathing with *R*-value 11.25 minimum over 2 × 6 wall.

**402.2.15.4 Material vapor retarder class.** The *vapor retarder class* shall be based on the manufacturer's certified testing or a tested assembly. The following shall be deemed to meet the class specified:

Class I: Sheet polyethylene, unperforated aluminum foil.

Class II: Kraft-faced fiberglass batts.

Class III: Latex or enamel paint.

### **R402.3 Fenestration (Prescriptive).**

In addition to the requirements of Section R402, fenestration shall comply with Sections R402.3.1 through R402.3..

#### **R402.3.1 U-factor.**

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

#### **R402.3.2 Glazed fenestration SHGC.**

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

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

**Exception:** *Dynamic glazing* is not required to comply with this section when both the lower and higher labeled SHGC already comply with the requirements of Table R402.1.1.

#### **R402.3.3 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 *U*-factor alternative approach in Section R402.1.4 and the Total UA alternative in Section R402.1.5.

#### **R402.3.4 Opaque door exemption.**

One side-hinged opaque door assembly up to 24 square feet (2.22 m<sup>2</sup>) in area is exempted from the *U*-factor requirement in Section R402.1.4. This exemption shall not apply to the *U*-factor alternative approach in Section R402.1.4 and the total UA alternative in Section R402.1.5.

#### **R402.3.5 Sunroom fenestration.**

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

**Exception:** For *sunrooms* with *thermal isolation* and enclosing *conditioned space*, the maximum fenestration *U*-factor shall be 0.45 and the maximum *skylight U*-factor shall not exceed 0.55.

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

**R402.4 Air leakage (Mandatory).**

The *building thermal envelope* shall be constructed to limit air leakage in accordance with the requirements of Sections R402.4.1 through R402.4.4. 5.

**R402.4.1 Building thermal envelope.**

The *building thermal envelope* shall comply with Sections R402.4.1.1 and R402.4.1.2. The sealing methods between dissimilar materials shall allow for differential expansion and contraction.

**R402.4.1.1 Installation.**

The components of the *building thermal envelope* as listed in Table R402.4.1.1 shall be installed in accordance with the manufacturer's instructions and the criteria listed in Table R402.4.1.1, as applicable to the method of construction.

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**TABLE R402.4.1.1  
AIR BARRIER AND INSULATION INSTALLATION<sup>a</sup>**

<b>COMPONENT</b>	<b>AIR BARRIER CRITERIA</b>	<b>INSULATION INSTALLATION CRITERIA</b>
General requirements	<p>A continuous, durable air barrier shall be installed in the building envelope.</p> <p>The exterior thermal envelope contains a continuous, durable air barrier.</p> <p>Breaks or joints in the air barrier shall be sealed.</p> <p>An air barrier is defined as any durable solid (non-porous) material that completely blocks air flow between conditioned space and unconditioned space, including necessary accessories to provide adequate support to resist positive and negative pressures without displacement or damage. The air barrier should be continuous and be durably connected to all penetrations, windows and other (structural) interruptions.</p> <p>Open-cell or closed-cell foam shall have a finished thickness <math>\geq 5.5</math> in. or 1.5 in., respectively, to qualify as an air barrier unless the manufacturer indicates otherwise.</p> <p>As a rule, flexible air barriers are less effective and durable than rigid air barriers. If flexible air barriers are used, they shall be fully sealed at all seams and edges and supported per manufacturer's installation instructions. Flexible air barriers shall not be made of kraft paper, or other materials that are easily torn. If polyethylene is used, its thickness shall be <math>\geq 6</math> mil.</p> <p>Materials meeting ASTM E2357 Standard Test Method for Determining Air Leakage of Air Barrier Assemblies are acceptable.</p>	<p>Air-permeable insulation shall not be used as a sealing material; when installed in vertical walls, sloped ceilings, and floors within the thermal envelope, it shall be enclosed on all six sides and in contact with a durable, air barrier.</p>
Ceiling/attic	<p>The air barrier in any dropped ceiling/soffit shall be aligned with (in contact with) the insulation and any gaps in the air barrier shall be sealed.</p> <p>Access openings, drop down stairs or knee wall doors to unconditioned attic spaces shall be sealed, insulated and gasketed.</p>	<p>The insulation in any dropped ceiling/soffit shall be aligned with (in contact with) the air barrier and shall be enclosed on five sides and in contact with a durable, interior air barrier. A top-side air barrier is not required in a flat attic.</p>
Walls	<p>The junction of the foundation and sill plate shall be sealed. The junction of the top plate and the</p>	<p>Cavities within corners and</p>

	<p>top of exterior wall sheathing shall be sealed. Knee walls shall be air sealed. When part of the thermal envelope, knee wall insulation shall be enclosed on all six sides and in contact with a durable, interior air barrier.</p>	<p>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. Exterior thermal envelope insulation for framed walls shall be installed in substantial contact and continuous alignment with the air barrier. Exterior thermal envelope insulation for framed walls shall be enclosed on all six sides and in contact with a durable, air barrier.</p>
Windows, skylights and doors	<p>The space between window/door jambs and framing, and skylights and framing shall be sealed with minimally-expanding foam.</p>	—
Rim joists	<p>Rim joists shall include the air barrier. Junctions of the foundation and sill plate, sill plate and rim band, and rim band and subfloor shall be sealed. When air permeable insulation is installed, a durable, interior air barrier shall be installed at the rim joist</p>	<p>Rim joists shall be insulated.</p>
Floors (including above garage and cantilevered floors)	<p>The air barrier shall be installed at any exposed edge of insulation.</p>	<p>Floor framing cavity insulation shall be installed to maintain permanent contact with the underside of subfloor decking, or floor framing cavity insulation shall be permitted to</p>

		be in contact with the top side of sheathing, or with continuous insulation installed on the underside of floor framing and extending from the bottom to the top of all perimeter floor framing members.
Crawl space walls	Exposed earth in unvented crawl spaces shall be covered with a Class I vapor retarder with overlapping joints taped.	Where provided instead of floor insulation, insulation shall be permanently attached to the crawlspace walls.
Shafts, penetrations	Duct shafts, utility penetrations, and flue shafts opening to exterior or unconditioned space shall be sealed. Doors or hatches in knee walls opening to exterior or unconditioned space shall be insulated and gasketed.	—

(continued)

**TABLE R402.4.1.1—continued  
AIR BARRIER AND INSULATION INSTALLATION**

COMPONENT	AIR BARRIER CRITERIA	INSULATION INSTALLATION CRITERIA
Narrow cavities		Batts in narrow cavities shall be cut to fit, 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.	
Recessed lighting and appliances	Recessed light fixtures and other appliances (speakers, exhaust fans, light shafts, etc.) installed in the building thermal envelope shall be IC rated, airtight labeled (or "Washington State Approved") and sealed with a gasket or caulk between the housing and the interior wall or ceiling cover. Fixtures and appliances shall maintain required clearances of not less than ½ " from combustible material and not less than 3" from insulation material, or	Recessed light fixtures installed in the building thermal envelope shall be air tight and IC rated.

	as required by manufacturer's installation requirements.	
Plumbing and wiring	All plumbing and wiring penetrations shall be sealed to the air barrier.	Insulation shall be placed between the exterior of the wall assembly and pipes. Batt insulation shall be cut neatly to fit around wiring and plumbing in exterior walls, or insulation that on installation readily conforms to available space shall extend behind piping and wiring and shall be in full contact with all air barriers.
Shower/tub on exterior wall	Exterior walls adjacent to showers and tubs shall have insulation filling any gaps or voids between tub or shower walls and unconditioned space.	Exterior walls adjacent to showers and tubs shall have a rigid durable, air barrier separating the exterior wall from the shower and tubs and be insulated.
Electrical/phone box on exterior walls	The air barrier shall be installed behind electrical or communication boxes or air-sealed boxes shall be installed.	Insulation completely fills voids between the box and exterior sheathing.
Common wall	Whenever continuity of the building thermal envelope is broken at walls separating dwelling units in Group R-2 building, including common, party, and fire walls, such walls shall be insulated to a minimum of R-10 on each side of the break in insulation continuity.	Air barrier shall be installed in common wall between dwelling units. Common walls shall be sealed at junctions with outside walls and at the top pressure plane of the house.
HVAC register boots	HVAC register boots that penetrate building thermal envelope shall be sealed to the subfloor or drywall.	
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.	
Fireplace	A durable air barrier shall be installed in contact with insulation. Fireplace shall have compression closure doors and combustion air supplied from the outdoors.	

- a. In addition, inspection of log walls shall be in accordance with the provisions of ICC 400-2017.

**R402.4.1.2 Air Leakage Testing.**

The *building* or dwelling unit shall be tested and verified as having an air leakage rate not exceeding three (3) air changes per hour. Testing shall be conducted in accordance with RESNET/ICC 380, ASTM E779 or ASTM E1827 and reported at a pressure of 0.2 inch w.g. (50 Pascals). Testing and verification shall be conducted by an applicable Building Performance Institutes (BPI) Professional, a Home Energy

Rating System (HERS) Energy Rater, HERS Field Inspector, or a Vermont Public Service Department approved air leakage tester. A written report of the results of the test shall be signed by the party conducting the test. Testing shall be performed at any time after creation of all penetrations of the *building thermal envelope*.

During testing:

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

**R402.4.1.3 Reporting.** Air leakage testing shall be reported on the RBES Certificate in units of air changes per hour at 50 Pascals (ACH50).

Optional: Report cubic feet per minute at 50 Pascals (CFM50) per square foot of building thermal shell area. Building thermal shell area shall include all six (6) sides of the building.

#### **R402.4.2 Fireplaces.**

New wood-burning fireplaces shall have tight-fitting flue dampers or doors, and outdoor combustion air. Where using tight-fitting doors on factory-built fireplaces *listed* and *labeled* in accordance with UL 127, the doors shall be tested and *listed* for the fireplace. Where using tight-fitting doors on masonry fireplaces, the doors shall be listed and labeled in accordance with UL 907.

#### **R402.4.3 Fenestration air leakage.**

Windows, *skylights* and sliding glass doors shall have an air infiltration rate of no more than 0.3 cfm per square foot (1.5 L/s/m<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.

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

#### **R402.4.4 Rooms containing fuel-burning appliances.**

Where open combustion air ducts provide combustion air to open combustion fuel burning appliances, the appliances and combustion air opening shall be located outside the *building thermal envelope* or enclosed in a room, isolated from inside the thermal envelope. Such rooms shall be sealed and insulated in accordance with the envelope requirements of Table

R402.1.2, where the walls, floors and ceilings shall meet not less than the *basement wall R-value* requirement. The door into the room shall be fully gasketed and any water lines and ducts in the room insulated in accordance with Section R403. The combustion air duct shall be insulated where it passes through *conditioned space* to 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 R402.4.2 and Section R1006 of the *International Residential Code*.

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#### **R402.4.5 Recessed lighting.**

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

#### **R402.5 Maximum fenestration U-factor and SHGC (Mandatory).**

The area-weighted average maximum fenestration *U*-factor permitted using tradeoffs from Section R402.1.5 or R405 shall be 0.30 for vertical fenestration, and 0.55 for skylights.

## **SECTION R403 SYSTEMS**

#### **R403.1 Controls (Mandatory).**

At least one thermostat shall be provided for each separate heating and cooling system.

##### **R403.1.1 Programmable thermostat.**

The thermostat controlling the primary heating or cooling system of the dwelling unit shall be capable of controlling the heating and cooling system on a daily schedule to maintain different temperature set points at different times of the day. This thermostat shall include the capability to set back or temporarily operate the system to maintain *zone* temperatures down to 55°F (13°C) or up to 85°F (29°C). The thermostat shall initially be programmed by the manufacturer with a heating temperature set point no higher than 70°F (21°C) and a cooling temperature set point no lower than 78°F (26°C). Adjustments to these settings for elderly, disabled or those with special needs is permissible.

The following exceptions are allowed as long as 5-wire connection to thermostat location is provided:

1. Radiant floor system on its own zone
2. Cold climate heat pump not designed for setbacks
3. Wifi or "smart" Internet-connected thermostats

##### **R403.1.2 Heat pump supplementary heat**

Heat pumps shall not have integrated supplementary electric-resistance heat other than that provided for frost control. See R404.2 for guidance on electric resistance heating equipment other than heat pumps.

#### **R403.2 Hot water boiler outdoor temperature setback.**

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

**R403.3 Ducts.**

Ducts and air handlers for space conditioning shall be in accordance with Sections R403.3.1 through R403.3.5.

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### **R403.3.1 Insulation (Prescriptive).**

All supply and return ducts shall be insulated to meet the same *R*-value requirement that applies to immediately proximal surfaces.

**Exception:** Ducts or portions thereof located completely inside the *building thermal envelope*.

### **R403.3.2 Sealing (Mandatory).**

Ducts, air handlers and filter boxes shall be sealed. Joints and seams shall comply with either 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.

#### **R403.3.2.1 Sealed air handler.**

Air handlers 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.

### **R403.3.3 Duct testing**

Ducts shall be pressure tested to determine air leakage by one of the following methods:

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

#### **Exceptions:**

1. A duct air leakage test shall not be required where the ducts and air handlers are located entirely within the *building thermal envelope*.
2. A duct air-leakage test shall not be required for ducts serving heat or energy recovery ventilators that are not integrated with ducts serving heating or cooling systems.

A written report of the results of the test shall be signed by an individual certified as either a Building Performance Institute (BPI) Heating Professional or Air Conditioning/Heat Pump Professional, a Home Energy Rating System (HERS) Energy Rater or HERS Field Inspector or a Vermont Public Service Department approved duct leakage tester, and provided to the *code official or other authority having jurisdiction, where one exists*, and to the *Public Service Department* along with the RBES certificate upon completion of the construction project.

**R403.3.4 Duct leakage (Prescriptive).**

The total leakage of the ducts, where measured in accordance with Section R403.3.3, shall be as follows:

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1. Rough-in test: The total leakage shall be less than or equal to 3 cubic feet per minute (85 L/min) per 100 square feet (9.29 m<sup>2</sup>) of conditioned floor area.
2. Postconstruction test: Total leakage shall be less than or equal to 4 cubic feet per minute (113.3 L/min) per 100 square feet (9.29 m<sup>2</sup>) of conditioned floor area.

#### **R403.3.5 Building cavities (Mandatory).**

*Building* framing cavities shall not be used as ducts or plenums.

#### **R403.3.6 Ducts buried within ceiling insulation.**

Where supply and return air ducts are partially or completely buried in ceiling insulation, such ducts shall comply with all of the following:

1. The supply and return ducts shall have an insulation *R*-value not less than R-8.
2. At all points along each duct, the sum of the ceiling insulation *R*-value against and above the top of the duct, and against and below the bottom of the duct, shall be not less than R-40, excluding the *R*-value of the duct insulation.

#### **R403.3.7 Ducts located in conditioned space.**

For ducts to be considered as inside a conditioned space, such ducts shall comply with either of the following:

1. The duct system shall be located completely within the continuous air barrier and within the building thermal envelope.
2. The ducts shall be buried within ceiling insulation in accordance with Section R403.3.6 and all of the following conditions shall exist:
  - 2.1. The air handler is located completely within the *continuous air barrier* and within the building thermal envelope.
  - 2.2. The duct leakage, as measured either by a rough-in test of the ducts or a post-construction total system leakage test to outside the building thermal envelope in accordance with Section R403.3.4, is less than or equal to 1.5 cubic feet per minute (42.5 L/min) per 100 square feet (9.29 m<sup>2</sup>) of conditioned floor area served by the duct system.
  - 2.3. The ceiling insulation *R*-value installed against and above the insulated duct is greater than or equal to the proposed ceiling insulation *R*-value, less the *R*-value of the insulation on the duct.

#### **R403.4 Mechanical system piping insulation (Mandatory).**

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

##### **R403.4.1 Protection of piping insulation.**

Piping insulation exposed to weather shall be protected from damage, including that caused

by sunlight, moisture, equipment maintenance and wind, and shall provide shielding from solar radiation that can cause degradation of the material. 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 Sections R403.5.1 and R403.5.4.

##### **R403.5.1 Heated water circulation and temperature maintenance systems (Mandatory).**

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 *accessible*. Manual controls shall be readily *accessible*.

###### **R403.5.1.1 Circulation systems.**

Heated water circulation systems shall be provided with a circulation pump. The system return pipe shall be a dedicated return pipe or a cold water supply pipe. Gravity and thermosyphon circulation systems shall be prohibited. Controls for circulating hot water system pumps shall start the pump based on the identification of a demand for hot water within the occupancy. The controls 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.

###### **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 Demand recirculation systems.**

A water distribution system having one or more recirculation pumps that pump water from a heated water supply pipe back to the heated water source through a cold water supply pipe shall be a *demand recirculation water system*. Pumps shall have controls that comply with both of the following:

1. The controls shall 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.
2. The controls shall limit the temperature of the water entering the cold water piping to 104°F (40°C).

##### **R403.5.3 Hot water pipe insulation (Prescriptive).**

Insulation for hot water pipe with a minimum thermal resistance, *R*-value, of R-3 shall be applied to the following:

1. Piping  $\frac{3}{4}$  inch (19.1 mm) and larger in nominal diameter.

2. Piping serving more than one dwelling unit.
3. Piping located outside the *conditioned space*.
4. Piping from the water heater to a distribution manifold.
5. Piping located under a floor slab.
6. Buried piping.
7. Supply and return piping in recirculation systems other than demand recirculation systems.

**R403.5.4 Drain water heat recovery units.**

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

**R403.6 Mechanical ventilation (Mandatory).**

The *building* shall be provided with ventilation that meets the requirements of the *International Residential Code* or *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 Whole-house mechanical ventilation system fan efficacy.**

Mechanical ventilation system fans shall meet the efficacy requirements of Table R403.6.1. Where an air handler that is integral to tested and *listed* HVAC equipment is used to provide whole-house mechanical ventilation, the air handler shall be powered by an electronically commutated motor.

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

FAN LOCATION	AIR FLOW RATE MINIMUM (CFM)	MINIMUM EFFICACY (CFM/WATT)	AIR FLOW RATE MAXIMUM (CFM)
HRV or ERV	Any	1.2 cfm/watt	Any
Range hoods	Any	2.8 cfm/watt	Any
In-line fan	Any	2.8 cfm/watt	Any
Bathroom, utility room	10	1.4 cfm/watt	< 90
Bathroom, utility room	90	2.8 cfm/watt	Any

a. When tested in accordance with HVI Standard 916.  
For SI: 1 cfm = 28.3 L/min.

**Exception:** Where mechanical ventilation fans are integral to tested and listed HVAC equipment, they shall be powered by an electronically commutated motor.

**R403.7 Equipment sizing and efficiency rating (Mandatory).**

Heating and cooling equipment shall be sized in accordance with ACCA Manual S based on *building* loads calculated in accordance with ACCA Manual J or other *approved* heating and cooling calculation methodologies. New or replacement heating and cooling equipment shall have an efficiency rating equal to or greater than the minimum required by federal law for Climate Zone 6.

**R403.8 Systems serving multiple dwelling units (Mandatory).**

Systems serving multiple dwelling units shall comply with Sections C403 and C404 of the 2019 *Vermont Commercial Building Energy Standards* (CBES) in lieu of Section R403.

**R403.9 Snow melt and ice system controls (Mandatory).**

Snow- and ice-melting systems, supplied through energy service to the building, shall include automatic controls capable of shutting off the system when the pavement temperature is above 45°F (10°C) and precipitation is falling, and an automatic or manual control that will allow shutoff when the outdoor temperature is above 40°F (4.8°C).

**R403.10 Pools and permanent spa energy consumption (Mandatory).**

The energy consumption of pools and permanent spas shall be in accordance with Sections R403.10.1 through R403.10.4.

**R403.10.1 Residential pools and permanent residential spas.**

Swimming pools and permanent spas that are accessory to detached one- and two-family dwellings and townhouses three stories or less in height above grade plane and that are available only to the household and its guests shall be in accordance with APSP-145.

#### **R403.10.2 Heaters.**

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

#### **R403.10.3 Time switches.**

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

#### **Exceptions:**

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

#### **R403.10.4 Covers.**

Outdoor heated pools and outdoor permanent spas shall be provided with an insulated a vapor-retardant cover of at least R-12 or other *approved* vapor-retardant means.

**Exception:** Where more than 75 percent of the energy for heating, computed over an operation season, is from site-recovered energy, such as from a heat pump or solar energy source, covers or other vapor-retardant means shall not be required.

#### **R403.11 Portable spas (Mandatory).**

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.**

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

## **SECTION R404 ELECTRICAL POWER AND LIGHTING SYSTEMS**

#### **R404.1 Lighting equipment (Mandatory).**

Not less than 90 percent of the lamps (or “bulbs”) in permanently installed lighting fixtures shall be high-efficacy lamps. Where multiple replaceable lamps are connected to a permanently installed lighting fixture, the number of lamps is to be used.

##### **R404.1.1 Lighting equipment (Mandatory).**

Fuel gas lighting systems shall not have continuously burning pilot lights.

#### **R404.2 Electric resistance heating equipment.**

The use of electric resistance heating equipment is prohibited.

Exceptions:

1. In bathrooms and in multifamily stairwells;
2. When at least 80% of the annual heating load of the building can be met with a heat pump(s) and any supplemental electric resistance heat is controlled to restrict it from coming on above 5°F outdoor temperature.

**R404.3 Electric vehicle charging.**

For multifamily developments of 10 or more dwelling units, 4% of parking spaces (rounded up to the nearest whole number) shall have a socket capable of providing either a level 1 or level 2 charge (see below) within 5 feet of the centerline of the parking space (“EV Charging Parking Space”).

Parking spaces with electric vehicle charging shall be marked for EV use only.

Level 1 requires one 120V 20 amp grounded AC receptacle, NEMA 5- 20R, or equivalent, for each EV Charging Parking Space.

Level 2 requires one 208/240V 40 amp grounded AC connection for electric vehicle charging through dedicated Electric Vehicle Supply Equipment (EVSE) with J1772 connector or AC receptacle, NEMA 14-50, or equivalent for each EV Charging Parking Space.

This guideline does not stipulate how use of the EVSE is provided.

**TABLE 404.3**

<b>NUMBER OF PARKING SPOTS</b>	<b>REQUIRED NUMBER OF EV CHARGING PARKING SPACES</b>
10–25	1
26–50	2
51–75	3
76–100	4, etc.

## SECTION R405 SIMULATED PERFORMANCE ALTERNATIVE USING RESCHECK™ SOFTWARE (PERFORMANCE)

### **R405.1 Scope.**

This section establishes criteria for compliance using simulated energy performance analysis. Such analysis shall include heating, cooling and service water heating energy only.

### **R405.2 Mandatory requirements.**

Compliance with this section requires that the mandatory provisions identified in Section R401.2 be met. All supply and return ducts not completely inside the *building thermal envelope* shall be insulated to meet the same *R*-value requirement that applies to immediately proximal surfaces.

### **R405.3 Performance-based compliance.**

Compliance is based on documentation from *REScheck*™ modeling software that indicates the home meets or exceeds the target UA for that building.

## SECTION R406 ENERGY RATING INDEX COMPLIANCE ALTERNATIVE

### **R406.1 Scope.**

This section establishes criteria for compliance using an Energy Rating Index (ERI) analysis. This approach uses a Home Energy Rating System (HERS) Energy Rating provided by a Vermont Public Service Department-approved accredited HERS provider. The “ERI” referenced herein is the same as the RESNET HERS Index.

### **R406.2 Mandatory requirements.**

Compliance with this section requires that the mandatory provisions identified in Sections R401 and R403.5.3 be met. The *building thermal envelope* shall be greater than or equal to levels of efficiency and *Solar Heat Gain Coefficient* in Table 402.1.2 of the 2009 *International Energy Conservation Code* for Climate Zone 6.

**Exception:** Supply and return ducts not completely inside the *building thermal envelope* shall be insulated to a minimum of R-6.

### **R406.3 Energy Rating Index.**

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

#### **R406.3.1 ERI reference design.**

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

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

#### **R406.4 ERI-based compliance.**

Compliance based on an ERI analysis requires that the *rated design* be shown to have an ERI less than or equal to 61 when compared to the *ERI reference design*. Up to 5 ERI points can be earned with renewables.

This includes all residential structures, including log homes. Based on REM/Rate version 15.7. If the HERS Index scale is revised, the Public Service Department may update these Index points.

#### **R406.5 Verification by approved agency.**

Verification of compliance with Section R406 shall be completed by a *certified HERS Rater working under the authority of a Vermont PSD-approved accredited HERS Provider*.

#### **R406.6 Documentation.**

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

##### **R406.6.1 Compliance software tools.**

Documentation verifying that the methods and accuracy of the compliance software tools conform to the provisions of this section shall be provided to the *code official or other authority having jurisdiction, where one exists* and be an approved Software Rating Tools in accordance with RESNET/ICC 301.

##### **R406.6.2 Compliance report.**

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

1. Address or other identification of the residential building.
2. An inspection checklist documenting the building component characteristics of the *rated design*. The inspection checklist shall show results for both the *ERI reference design* and the *rated design*, and shall document all inputs entered by the user necessary to reproduce the results.
3. Name of individual completing the compliance report.
4. Name and version of the compliance software tool.

**Exception:** Multiple orientations. Where an otherwise identical building model is offered in multiple orientations, compliance for any orientation shall be permitted by documenting that the building meets the performance requirements in each of the four (north, east, south and west) cardinal orientations.

##### **R406.6.3 Additional documentation.**

The *code official or other authority having jurisdiction, where one exists*, shall be permitted to require the following documents:

1. Documentation of the building component characteristics of the *ERI reference design*.
2. A certification signed by the builder providing the building component characteristics of the *rated design*.
3. Documentation of the actual values used in the software calculations for the *rated design*.

#### **R406.7 Calculation software tools.**

Calculation software, where used, shall be in accordance with Sections R406.7.1 through R406.7.3.

##### **R406.7.1 Minimum capabilities.**

Calculation procedures used to comply with this section shall be software tools capable of calculating the ERI as described in Section R406.3, and shall include the following capabilities:

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

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

2. Calculation of whole building, as a single *zone*, sizing for the heating and cooling equipment in the *ERI reference design* residence in accordance with Section R403.7.
3. Calculations that account for the effects of indoor and outdoor temperatures and part-load ratios on the performance of heating, ventilating and air-conditioning equipment based on climate and equipment sizing.
4. Printed *code official or other authority having jurisdiction, where one exists*, inspection checklist listing each of the *rated design* component characteristics determined by the analysis to provide compliance, along with their respective performance ratings.

##### **R406.7.2 Specific approval.**

Performance analysis tools meeting the applicable sections of Section R406 shall be *approved*. Tools are permitted to be *approved* based on meeting a specified threshold for a jurisdiction. The *code official or other authority having jurisdiction, where one exists*, shall approve tools for a specified application or limited scope.

##### **R406.7.3 Input values.**

Where calculations require input values not specified by Sections R402, R403, R404 and R405, those input values shall be taken from an approved source such as RESNET/ ICC 301.

## **SECTION R407 VERMONT STRETCH CODE**

### **R407.1 Scope.**

This section establishes criteria for compliance with Vermont's "Stretch Code," as defined in 30

V.S.A. § 51. Act 250 residential projects and residential buildings in municipalities that adopt the Stretch Code shall demonstrate compliance with R407.2. All other requirements in the RBES shall apply.

### R407.2 Compliance

Compliance for Stretch Code shall be documented through R407.2.1 Required Points by Building size or R407.2.2 ERI-based compliance for Stretch Code.

#### R407.2.1 Required Points by Building Size.

Projects shall comply by:

1. selecting one of the three base packages listed in Table R407.2.1.1;
2. determining the points needed to comply with Table R407.2.1.2. based on building size; and
3. incorporating a sufficient number of points from Table R407.2.1.3 to meet the points requirements from Table R407.2.1.2.

**TABLE R407.2.1.1  
INSULATION AND FENESTRATION REQUIREMENTS BY COMPONENT FOR STRETCH  
PACKAGES**

Component <sup>a</sup>		Package 1	Package 2	Package 3
		"Standard"	"SIPS"	"Thick Wall"
<b>Envelope</b>	Ceiling R-Value	R-60 <sup>h</sup> attic / R-49 <sup>g</sup> slope	R-36 cont.	R-49 <sup>g</sup>
	Wood Frame Wall R-Value	R-20+5 <sup>f</sup> OR 13+10 <sup>f</sup>	R-21 cont.	R-20+12 <sup>f</sup>
	Floor R-Value	R-30 <sup>e</sup>	R-30 <sup>e</sup>	R-30 <sup>e</sup>
	Basement/Crawl Space Wall <sup>c</sup> R-Value	R-20 (continuous) OR R-13+10 <sup>f</sup>	R-20 (continuous) OR R-13+10 <sup>f</sup>	R-20 (continuous) OR R-13+10 <sup>f</sup>
	Slab Edge <sup>d</sup> R-Value	R-15, 4ft	R-15, 4 ft	R-15, 4ft
	Heated Slab R-Value (Edge and Under)	R-15	R-15	R-15
	Fenestration <sup>b</sup> (Window and Door) max. U-Value	U-0.27	U-0.27	U-0.30
	Skylight <sup>b</sup> max. U-Value	U-0.55	U-0.55	U-0.55
<b>Air Leakage and Ventilation</b>	Air Leakage <sup>i</sup>	≤3.0 ACH50 tested	≤3.0 ACH50 tested	≤3.0 ACH50 tested
	Ventilation	Balanced; min. SRE 70	Balanced; min. SRE 70	Balanced; min. SRE 70
<b>Mechanicals</b>	Duct Leakage	Inside thermal boundary	Inside thermal boundary	Inside thermal boundary
<b>Lighting</b>	Percent <i>High Efficacy Lamps</i> <sup>j</sup>	90% <i>High Efficacy Lamps</i>	90% <i>High Efficacy Lamps</i>	90% <i>High Efficacy Lamps</i>

For SI: 1 foot = 304.8 mm.

- a. *R*-values are minimums. *U*-factors and SHGC are maximums. Where insulation is installed in a cavity that is less than the label or design thickness of the insulation, the installed *R*-value of the insulation shall be not less than the *R*-value specified in the table.
- b. The fenestration *U*-factor row excludes skylights.
- c. Basement and crawlspace insulation can be met through either R-15 or R-20 continuous insulation or R-20 cavity insulation or R-13 continuous plus R-10 continuous insulation, either interior or exterior.
- d. “4 ft” can be horizontal or vertical coverage including slab edge. “Edge and under” requires complete coverage. Up to 8 lineal feet of exposed slab edge may be insulated to R-10.
- e. Or insulation sufficient to fill the framing cavity.
- f. The first value is cavity insulation, the second value is continuous insulation, so “13+10” means R-13 cavity insulation plus R-10 continuous insulation. R-25 can be met through any combination of insulation *R*-values, cavity, or cavity and continuous insulation.
- g. Installing R-38 over 100 percent of the ceiling area requiring insulation shall be deemed to satisfy the requirement for R-49 insulation wherever the full height of uncompressed R-38 insulation extends over the wall top plate at the eaves. (See Section R402.2.1.)
- h. Installing R-49 over 100 percent of the ceiling area requiring insulation shall be deemed to satisfy the requirement for R-60 insulation wherever the full height of uncompressed R-49 insulation extends over the wall top plate at the eaves. (See Section R402.2.1.)
- i. “ACH50” = air changes per hour at 50 Pascals building pressure as measured with a blower door
- j. See definition in R202

**TABLE R407.2.1.2  
REQUIRED POINTS BY BUILDING SIZE**

Building Size	Required Points
Multifamily < 2000 square feet average unit size	6 points
<2000 square feet	7 points
2000 to 4000 square feet	9 points
>4000 square feet	12 points

**TABLE R407.2.1.3  
POINTS BY COMPONENT**

Component	Description	Points	
<b>Envelope</b>	Slab	R-10 below entire slab	1
	Walls - High-R	AG walls R-20+12 (or U-factor maximum 0.033 wall assembly) (Exception: not available for stretch package 3) <b>OR</b> <sup>b</sup>	2
		AG walls ≥ R-40 (U-factor 0.025)	3
	Windows	Average U-factor ≤ 0.22	2
<b>Air Leakage and Ventilation</b>	Pre-Drywall	ACH50 is tested with blower door before drywall installed <b>OR</b> <sup>b</sup>	1
	Tight	ACH50 ≤ 2.0 <sup>b</sup>	1
	Very Tight	ACH50 ≤ 1.0 and balanced H/ERV <sup>c</sup> with ≤80% SRE <sup>d</sup> and ECM <sup>e</sup> fans	4
<b>Heating and Cooling<sup>a</sup></b>	Basic	ENERGY STAR basic: (1) Gas/propane furnace ≥95 AFUE, Oil furnace ≥85 AFUE, (2) Gas/Propane Boiler ≥90 AFUE, Oil Boiler ≥87 AFUE, (3) Heat pump HSPF ≥9.0; PLUS any AC is SEER ≥14.5 <b>OR</b> <sup>b</sup>	1
	Advanced	Advanced: Whole building heat/cool is (1) NEEP-listed heat pump combination, (2) GSHP, closed loop and COP ≥ 3.3, (3) ATWHP <sup>f</sup> COP ≥2.5 and 120F design	3

		temp, (4) Advanced wood heating system	
<b>Water</b>	Basic	ENERGY STAR basic: Fossil fuel [EF 0.67 for ≤ 55 gal; EF 0.77 for > 55 gal] <b>OR</b> <sup>b</sup>	1
	Advanced	ENERGY STAR advanced: Electric [EF or UEF ≥ 2.00 for ≤ 55 gal; EF ≥ 2.20 for > 55 gal]	2
	Low Flow	All showerheads ≤ 1.75 gpm <sup>g</sup> , all lav. faucets ≤ 1.0 gpm <sup>g</sup> , and all toilets ≤ 1.28 gpf <sup>h</sup> (for new construction only) <b>OR</b> <sup>b</sup>	1
	Certified	Certified water efficient design per WERS, WaterSense, or RESNET <sub>H2O</sub> (for new construction only)	2
	Drain Heat Recovery	Drain water heat recovery system on primary showers and tubs	1
	On-Demand	Controlled on-demand hot water recirculation system for furthest bathroom	1
<b>Solar</b>	Solar Ready	Home is Solar Ready per R407.4 <b>OR</b> <sup>b</sup>	1
	Solar PV	Solar Photovoltaic (PV), 1 point per 1.5 kW per housing unit of renewable generation on site	1 per 1.5 kW, max. 4
	Solar Hot Water	Solar hot water system designed to meet at least 50% of annual hot water load	2
<b>Other Measures</b>	Monitoring	Install whole-building energy monitoring system, min. 5 circuits and homeowner access to data	1
	EV Ready	Level 2 electric vehicle charger-ready per 407.3	1
	Battery	Min. 6 kWh grid-connected dispatchable demand-response-enabled battery backup	1

For SI: 1 foot = 304.8 mm.

- a. Heating and cooling system points are only available if all components of primary systems comply
- b. “**OR**” indicates that points are not additive; one component OR the following one can be selected, but not both.
- c. “H/ERV” = Heat or Energy Recovery Ventilation
- d. “SRE” = System Recovery Efficiency
- e. “ECM” = Electronically Commutated Motor
- f. “ATWHP” = Air-to-Water Heat Pump
- g. “gpm” = gallons per minute
- h. “gpf” = gallons per flush

#### **R407.2.2 ERI-based compliance for Stretch Code.**

Compliance based on an ERI analysis requires that the *rated design* be shown to have an ERI less than or equal to 54 when compared to the *ERI reference design*. Up to 5 ERI points can be earned with renewables.

**R407.3 Air Leakage Testing for Stretch Code.** In addition to the requirements in R402.1.2 for testing air leakage, air leakage testing shall be reported on the RBES Certificate in units of air changes per hour at 50 Pascals (ACH50) in addition to cubic feet per minute (cfm) at 50 Pascals (CFM50) per square foot of building thermal shell area. Building thermal shell area shall include all six (6) sides of the building.

**R407.4 Electric vehicle charging for Stretch Code.**

For single family housing, one Level 1 parking space is required with accessible socket.

For multifamily developments of 10 or more dwelling units, at least 10% of parking spaces (rounded up to the nearest whole number) shall have either Level 2 charging installed or be Level 2 “ready”, including space in the panel for at least one minimum 40-ampere branch circuit to be provided to garages and/or the exterior of the building to accommodate a future dedicated Society of Automotive Engineers (SAE) standard J1772-approved Level 2 Electric Vehicle Service Equipment (EVSE). The circuits shall have no other outlets. The service panel shall provide sufficient capacity and space to accommodate the circuit and over-current protective device. A permanent and visible label stating “EV READY” shall be posted in a conspicuous place at both the service panel and the circuit termination point. The termination of the conduit shall be located within 5 feet of the centerline of the parking space (“EV Charging Parking Space”).

Level 1 requires one 120V 20 amp grounded AC outlet, or equivalent, for each EV Charging Parking Space.

Level 2 requires one 208/240V 40 amp grounded AC outlet, or equivalent, for each EV Charging Parking Space.

**TABLE 407.4**

NUMBER OF PARKING SPOTS	REQUIRED NUMBER OF EV CHARGING PARKING SPACES
10-19	1
20-29	2
30-39	3
40-49	4, etc.

**R407.5 Solar Ready Zone for Stretch Code.**

**R407.5.1 General.**

New detached one- and two-family dwellings, and multiple single-family dwellings (townhouses) with not less than 600 ft<sup>2</sup> (55.74 m<sup>2</sup>) of roof area oriented between 110° and 270° of true north shall comply with sections 407.5.

**EXCEPTIONS:**

1. New residential buildings with a permanently installed on-site renewable energy system.
2. A building with a solar-ready zone that is shaded for more than 70% of daylight hours annually.
3. Buildings and structures as designed and shown in *construction documents* that do not meet the conditions for a solar-ready zone area.

4. Buildings with possible location(s) for ground mounted systems identified in the submitted *construction documents*. Buildings claiming this exception must either install appropriate electrical conduit to the site of the proposed ground mounted solar array or include a solar site evaluation that supports the siting of the proposed ground mounting location.

#### **R407.5.2 Construction Document Requirements for Solar Ready Zone**

*Construction documents* shall indicate the solar ready zone where applicable.

#### **R407.5.3 Solar-Ready Zone Area.**

The total solar-ready zone area shall consist of an area not less than 300 ft<sup>2</sup> (27.87 m<sup>2</sup>) exclusive of mandatory access or set back areas. New multiple single-family dwellings (townhouses) three stories or less in height above grade plane and with a total floor area less than or equal to 2,000 ft<sup>2</sup> (185.8 m<sup>2</sup>) per dwelling shall have a solar-ready zone area of not less than 150 ft<sup>2</sup> (13.94 m<sup>2</sup>). The solar-ready zone shall be composed of areas not less than five feet (1,524 mm) in width and not less than 80 ft<sup>2</sup> (7.44 m<sup>2</sup>) exclusive of access or required set back areas.

For ground-mounted systems, possible locations of the panels must be identified in the submitted *construction documents* and be supported by a solar site evaluation. At least one potential location must be identified in the *construction documents* for the future installation of the panels.

#### **R407.5.4 Obstructions.**

Solar-ready zones shall consist of an area free from obstructions, including but not limited to vents, chimneys, and roof-mounted equipment.

#### **R407.5.5 Roof Load Documentation.**

The structural design loads for roof dead load and roof live load shall be clearly indicated on the *construction documents*.

#### **R407.5.6 Interconnection Pathway.**

*Construction documents* shall indicate pathways for routing of conduit (or plumbing for solar thermal systems) from the solar-ready zone to the electrical service panel or service hot water system. Alternatively, install two 1" minimum diameter EMT conduits from the main electrical panel location to the attic or other area easily accessible to the solar array's proposed location. Conduits for future solar installations are to be capped and labeled at both ends.

#### **R407.5.7 Electrical Service Reserved Space.**

The main electrical service panel shall have a reserved space to allow installation of a dual pole circuit breaker for future solar electric installation and shall be labeled "For Future Solar Electric." The reserved space shall be positioned at the opposite (load) end from the input feeder location or main circuit location. Note: this requirement is in addition to the electrical service reserved space for electric vehicle charging.

# CHAPTER 5 (RE) 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 Additions, alterations, or repairs: General.**

*Additions, alterations, or repairs* to an existing *building, building* system or portion thereof shall comply with Section R502, R503 or R504. Unaltered portions of the existing *building* or *building* supply system shall not be required to comply with this code. Connections or repairs to, or maintenance of existing mechanical systems do not constitute an alteration to that system.

#### **R501.1.2 Compliance approaches.**

Thermal efficiency can be achieved through any of the compliance paths, including any one of the following approaches: prescriptive packages, *REScheck*<sup>TM</sup> software, or a Home Energy Rating System (HERS) rating.

### **R501.2 Existing buildings.**

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

### **R501.3 Maintenance.**

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

### **R501.4 Compliance.**

*Alterations, repairs, additions* and changes of occupancy to, or relocation of, existing *buildings* and structures shall comply with the provisions for *alterations, repairs, additions* and changes of occupancy or relocation, respectively, in the *International Residential Code, International Building Code, International Fire Code, International Fuel Gas Code, International Mechanical Code, International Plumbing Code, International Property Maintenance Code, International Private Sewage Disposal Code* and NFPA 70.

### **R501.5 New and replacement materials.**

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

### **R501.6 Historic buildings.**

No provision of this code relating to the construction, *repair*, *alteration*, restoration and movement of structures, and *change of occupancy* shall be mandatory for *historic buildings* provided a "Historic Building Exemption Report" obtained from the State Historic Preservation Office has been submitted to the State Historic Preservation Office and signed by either the owner, an owner's agent, a registered *design professional*, or a representative of the historic preservation authority having jurisdiction, demonstrating that compliance with that provision would threaten, degrade or destroy the historic fabric or function of the building. The State Historic Preservation Office, upon receipt of the report, will review and validate the exemption request. Upon request, a copy of the report shall be provided to the local authority having jurisdiction.

## **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 without requiring the unaltered portion of the existing *building* or *building* system to comply with this code. *Additions* shall not create an unsafe or hazardous condition or overload existing *building* systems. An *addition* shall be deemed to comply with this code where the *addition* alone complies, where the existing *building* and *addition* comply with this code as a single *building*, or where the *building* with the *addition* does not use more energy than the existing *building*. *Additions* shall be in accordance with Section R502.1.1 or R502.1.2.

#### **R502.1.1 Prescriptive compliance.**

*Additions* shall comply with Sections R502.1.1.1 through R502.1.1.4.

##### **R502.1.1.1 Building envelope.**

New *building* envelope assemblies that are part of the *addition* shall comply with Sections R402.1, R402.2, R402.3.1 through R402.3.5, and R402.4.

**Exception:** Where *nonconditioned* space is changed to conditioned space, the building envelope of the addition shall comply where the UA, as determined in Section 402.1.4, of the existing building and the addition, and any alterations that are part of the project, is less than or equal to UA generated for the existing *building*.

##### **R502.1.1.2 Heating and cooling systems.**

New heating, cooling and duct systems that are part of the *addition* shall comply with Sections R403.1, R403.2, R403.3, R403.5 and R403.6. Connections or repairs to, or maintenance of existing mechanical systems do not constitute an alteration to that system.

**Exception:** Where ducts from an existing heating and cooling system are extended to an *addition*, duct systems with less than 40 linear feet (12.19 m) in *unconditioned spaces* shall not be required to be tested in accordance with Section R403.3.3.

**R502.1.1.3 Service hot water systems.**

New service hot water systems that are part of the *addition* shall comply with Section R403.4. Connections or repairs to, or maintenance of existing mechanical systems do not constitute an alteration to that system.

**R502.1.1.4 Lighting.**

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

**R502.1.2 Existing plus addition compliance (Simulated Performance Alternative).**

Where *nonconditioned* space is changed to conditioned space, the addition shall comply where the annual energy cost or energy use of the addition and the existing building, and any alterations that are part of the project, is less than or equal to the annual energy cost of the existing *building* when modeled in accordance with Section R405. The *addition* and any *alterations* that are part of the project shall comply with any of the Chapter 4 compliance options 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. *Alterations* shall be such that the existing *building* or structure is not less conforming to the provisions of this code than the existing *building* or structure was prior to the *alteration*.

*Alterations* to an existing *building*, *building* system or portion thereof shall conform to the provisions of this code as they relate to new construction without requiring the unaltered portions of the existing *building* or *building* system to comply with this code. *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 Sections R503.1.1 through R503.2.

**R503.1.1 Building envelope.**

*Building* envelope assemblies that are part of the *alteration* shall comply with Section R402.1.2 or R402.1.4, Sections R402.2.1 through R402.2.13, R402.3.1, R402.3.2, R402.4.3 and R402.4.4. Uninsulated or under-insulated wall, floor and roof building cavities that are filled with insulation only need to fill that cavity with insulation, and are not required to meet the *R*-value requirements in Table R402.1.2.

**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. Existing ceiling, wall or floor cavities exposed during construction provided that these cavities are filled with insulation.

3. Construction where the existing roof, wall or floor cavity is not exposed.
4. Roof recover.
5. Roofs without insulation in the cavity and where the sheathing or insulation is exposed during reroofing shall be insulated either above or below the sheathing.
6. Surface-applied window film installed on existing single pane fenestration assemblies to reduce solar heat gain provided the code does not require the glazing or fenestration assembly to be replaced.

#### **R503.1.1.1 Replacement fenestration.**

Where some or all of an existing fenestration unit is replaced with a new fenestration product, including sash and glazing, the replacement fenestration unit shall meet the applicable requirements for *U*-factor and SHGC as specified Table R402.1.2. Where more than one replacement *fenestration* unit is to be installed, an area-weighted average of the *U*-factor, SHGC or both of all replacement *fenestration* units shall be an alternative that can be used to show compliance.

#### **R503.1.2 Heating and cooling systems.**

New heating, cooling and duct systems that are part of the *alteration* shall comply with Sections R403.1, R403.2, R403.3 and R403.6. Connections or repairs to, or maintenance of existing mechanical systems do not constitute an alteration to that system.

**Exception:** Where ducts from an existing heating and cooling system are extended, duct systems with less than 40 linear feet (12.19 m) in *unconditioned spaces* shall not be required to be tested in accordance with Section R403.3.3.

#### **R503.1.3 Service hot water systems.**

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

#### **R503.1.4 Lighting.**

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

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

#### **R503.2 Change in space conditioning.**

Any nonconditioned or low-energy space that is altered to become *conditioned space* shall be required to be brought into full compliance with this code.

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

## SECTION R504 REPAIRS

### R504.1 General.

*Buildings*, structures and parts thereof shall be repaired in compliance with Section R501.3 and this section. Work on nondamaged components necessary for the required *repair* of damaged components shall be considered 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 and are exempt from meeting RBES requirements.

### 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.

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

### R505.2 General.

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

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

## 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 106.

### AAMA

American Architectural Manufacturers Association  
1827 Walden Office Square  
Suite 550  
Schaumburg, IL 60173-4268

Standard reference number	Title	Referenced in code section number
AAMA/WDMA/CSA 101/I.S.2/A C440—11	North American Fenestration Standard/ Specifications for Windows, Doors and Unit Skylights	R402.4.3

### ACCA

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

Standard reference number	Title	Referenced in code section number
Manual J—2011	Residential Load Calculation Eighth Edition	R403.7
Manual S—13	Residential Equipment Selection	R403.7

### APSP

The Association of Pool and Spa Professionals  
2111 Eisenhower Avenue  
Alexandria, VA 22314

Standard reference number	Title	Referenced in code section number
APSP 14—11	American National Standard for Portable Electric Spa Energy Efficiency	R403.10.1, 403.11
APSP 15a—2013	American National Standard for Residential Swimming Pool and Spa Energy Efficiency— <b>includes Addenda A Approved January 9, 2013</b>	R403.12

### ASHRAE

ASHRAE  
1791 Tullie  
Circle NE  
Atlanta, GA  
30329-2305

Standard reference number	Title	Referenced in code section number
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ASHRAE—2013	ASHRAE Handbook of Fundamentals	Table 303.2, R402.1.5, Table R405.5.2(1)
ASHRAE 62.2	Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings	303.1.1
ASHRAE 193—2010	Method of Test for Determining the Airtightness of HVAC Equipment	R403.3.2.1

## ASTM

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

Standard reference number	Title	Referenced in code section number
C 1363—11	Standard Test Method for Thermal Performance of Building Materials and Envelope Assemblies by Means of a Hot Box Apparatus	. R303.1.4.1
E 283—04	Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls and Doors Under Specified Pressure Differences Across the Specimen	R402.4.5
E 779—10	Standard Test Method for Determining Air Leakage Rate by Fan Pressurization	R402.4, 407.2
E 1827—11	Standard Test Methods for Determining Airtightness of Building Using an Orifice Blower Door	R402.4, 407.2
E 2357	Standard Test Method for Determining Air Leakage of Air Barrier Assemblies	Table 402.4.1.1

## CGSB

Canadian General Standards Board  
222 Queens Street  
14th Floor, Suite 1402  
Ottawa, Ontario, Canada K1A 1G6

Standard reference number	Title	Referenced in code section number
51.71—95	The Spillage Test-Method to Determine the Potential for Pressure-Induced Spillage from Vented, Fuel-Fired, Space Heating Appliances, Water Heaters and Fireplaces	305.4.1

## CSA

CSA Group  
8501 East Pleasant Valley  
Cleveland, OH 44131-5575

Standard reference number	Title	Referenced in code section number
AAMA/WDMA/CSA 101/I.S.2/A440—11	North American Fenestration Standard/Specification for Windows, Doors and Unit Skylights	R402.4.3
CSA 55.1—2012	Test Method for measuring efficiency and pressure loss of drain water heat recovery units	R403.5.4
CSA 55.2—2012	Drain water heat recovery units	R403.5.4

# DASMA

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

Standard reference number	Title	Referenced in code section number
105—92(R2004)—13	Test Method for Thermal Transmittance and Air Infiltration of Garage Doors	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
ICC 400—12	Standard on the Design and Construction of Log Structures	Table R402.1.5, Table 402.4.1.1
IECC—09	2009 International Energy Conservation Code <sup>®</sup>	R406.2
IECC—06	2006 International Energy Conservation Code <sup>®</sup>	R406.3.1
IFC—15	International Fire Code <sup>®</sup>	R201.3, R501.4
IFGC—15	International Fuel Gas Code <sup>®</sup>	R201.3, R501.4
IMC—15	International Mechanical Code <sup>®</sup>	R201.3, R403.3.2, R403.6, R501.4
IPC—15	International Plumbing Code <sup>®</sup>	R201.3, R501.4
IPSDC—15	International Private Sewage Disposal Code <sup>®</sup>	501.4
IPMC—15	International Property Maintenance Code <sup>®</sup>	501.4
IRC—15	International Residential Code <sup>®</sup>	R201.3, R402.1.1, R402.2.11, R402.4.4, R403.3.2, R403.6, R501.4

# IEEE

The Institute of Electrical and Electronic Engineers, Inc.  
3 Park Avenue  
New York, NY 1016-5997

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

# NFPA

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

Standard reference number	Title	Referenced in code section number
31—06	Installation of Oil-Burning Equipment National Fuel Gas Code	R305.1, R305.2, R305.3
54—09		R305.1, R305.2, R305.3
70—14	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—2009	Procedure for Determining Fenestration Products <i>U</i> -factors—Second Edition	R303.1.3
200—2009	Procedure for Determining Fenestration Product Solar Heat Gain Coefficients and Visible Transmittance at Normal Incidence—Second Edition	R303.1.3
400—2009	Procedure for Determining Fenestration Product Air Leakage—Second Edition	R402.4.3

## UL

UL LLC  
333 Pfingsten Road  
Northbrook, IL 60062

Standard reference number	Title	Referenced in code section number
127—11	Standard for Factory Built Fireplaces	R402.4.2
515—11	Electrical Resistance Heat Tracing for Commercial and Industrial Applications including revisions through November 30, 2011	R403.5.1.2

## 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 (May 31, 2005)	R-value Rule	R303.1.4

## WDMA

Window and Door Manufacturers Association  
2025 M Street, NW Suite 800  
Washington, DC 20036-3309

Standard reference number	Title	Referenced in code section number
AAMA/WDMA/CSA 101/I.S.2/A440— 11	North American Fenestration Standard/Specification for Windows, Doors and Unit Skylights	R402.4.3

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# APPENDIX RA

## RECOMMENDED PROCEDURE FOR WORST-CASE TESTING OF ATMOSPHERIC VENTING SYSTEMS UNDER R402.4 OR R405 CONDITIONS $\leq 5ACH_{50}$

(This appendix is informative and is not part of the code.)

### SECTION RA101 SCOPE

#### RA101.1 General.

This appendix is intended to provide guidelines for worst-case testing of atmospheric venting systems. Worst-case testing is recommended to identify problems that weaken draft and restrict combustion air.

### SECTION RA201 GENERAL DEFINITIONS

**COMBUSTION APPLIANCE ZONE (CAZ).** A contiguous air volume within a building that contains a Category I or II atmospherically vented appliance or a Category III or IV direct-vent or integral vent appliance drawing combustion air from inside the building or dwelling unit. The CAZ includes, but is not limited to, a mechanical closet, a mechanical room, or the main body of a house or dwelling unit.

**DRAFT.** The pressure difference existing between the *appliance* or any component part and the atmosphere that causes a continuous flow of air and products of *combustion* through the gas passages of the *appliance* to the atmosphere.

**Mechanical or induced draft.** The pressure difference created by the action of a fan, blower or ejector that is located between the *appliance* and the *chimney* or vent termination.

**Natural draft.** The pressure difference created by a vent or *chimney* because of its height and the temperature difference between the *flue* gases and the atmosphere.

**SPILLAGE.** Combustion gases emerging from an appliance or venting system into the combustion appliance zone during burner operation.

### SECTION RA301 TESTING PROCEDURE

### **RA301.1 Worst-case testing of atmospheric venting systems.**

Buildings or dwelling units containing a Category I or II atmospherically vented appliance; or a Category III or IV direct-vent or integral vent appliance drawing combustion air from inside of the building or dwelling unit, shall have the Combustion Appliance Zone (CAZ) tested for spillage, acceptable draft and carbon monoxide (CO) in accordance with this section. Where required by the *code official or other authority having jurisdiction, where one exists*, 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 or other authority having jurisdiction, where one exists*. Testing shall be performed at any time after creation of all penetrations of the *building thermal envelope* and prior to final inspection.

**Exception:** Buildings or dwelling units containing only Category III or IV direct-vent or integral vent appliances that do not draw combustion air from inside of the building or dwelling unit.

The enumerated test procedure as follows shall be complied with during testing:

1. Set combustion appliances to the pilot setting or turn off the service disconnects for combustion appliances. Close exterior doors and windows and the fireplace damper. With the building or dwelling unit in this configuration, measure and record the baseline ambient pressure inside the building or dwelling unit CAZ. Compare the baseline ambient pressure of the CAZ to that of the outside ambient pressure and record the difference (Pa).
2. Establish worst case by turning on the *clothes dryer* and all exhaust fans. Close all interior doors that make the CAZ pressure more negative. Turn on the air handler, where present, and leave on if, as a result, the pressure in the CAZ becomes more negative. Check interior door positions again, closing only the interior doors that make the CAZ pressure more negative. Measure net change in pressure from the CAZ to outdoor ambient pressure, correcting for the base ambient pressure inside the home. Record “worst case depressurization” pressure and compare to Table RA301.1(1).

Where CAZ depressurization limits are exceeded under worst-case conditions in accordance with Table A301.1(1), additional combustion air shall be provided or other modifications to building air-leakage performance or exhaust appliances such that depressurization is brought within the limits prescribed in Table RA301.1(1).

3. Measure worst-case spillage, acceptable draft and carbon monoxide (CO) by firing the fuel-fired appliance with the smallest Btu capacity first.
  - a. Test for spillage at the draft diverter with a mirror or smoke puffer. An appliance that continues to spill flue gases for more than 60 seconds fails the spillage test.
  - b. Test for CO measuring undiluted flue gases in the throat or flue of the appliance using a digital gauge in parts per million (ppm) at the 10-minute mark. Record CO ppm readings to be compared with Table RA301.1(3) upon completion of Step 4. Where the spillage test fails under worst case, go to Step 4.

- c. Where spillage ends within 60 seconds, test for acceptable draft in the connector not less than 1 foot (305 mm), but not more than 2 feet (610 mm) downstream of the draft diverter. Record draft pressure and compare to Table RA301.1(2).
  - d. Fire all other connected appliances simultaneously and test again at the draft diverter of each appliance for spillage, CO and acceptable draft using procedures 3a through 3c.
4. Measure spillage, acceptable draft, and carbon monoxide (CO) under natural conditions—without *clothes dryer* and exhaust fans on—in accordance with the procedure outlined in Step 3, measuring the net change in pressure from worst case condition in Step 3 to natural in the CAZ to confirm the worst case depressurization taken in Step 2. Repeat the process for each appliance, allowing each vent system to cool between tests.
  5. Monitor indoor ambient CO in the breathing zone continuously during testing, and abort the test where indoor ambient CO exceeds 35 ppm by turning off the appliance, ventilating the space, and evacuating the building. The CO problem shall be corrected prior to completing combustion safety diagnostics.
  6. Make recommendations based on test results and the retrofit action prescribed in Table RA301.1(3).

**TABLE RA301.1(1)  
CAZ DEPRESSURIZATION LIMITS**

VENTING CONDITION	LIMIT (Pa)
Category I, atmospherically vented water heater	-2.0
Category I or II atmospherically vented boiler or furnace common-vented with a Category I atmospherically vented water heater	-3.0
Category I or II atmospherically vented boiler or furnace, equipped with a flue damper, and common vented with a Category I atmospherically vented water heater	-5.0
Category I or II atmospherically vented boiler or furnace alone	
Category I or II atmospherically vented, fan-assisted boiler or furnace common vented with a Category I atmospherically vented water heater	
Decorative vented, gas appliance	
Power-vented or induced-draft boiler or furnace alone, or fan-assisted water heater alone	-15.0
Category IV direct-vented appliances and sealed combustion appliances	-50.0

For SI: 6894.76 Pa = 1.0 psi.

**TABLE RA301.1(2)  
ACCEPTABLE DRAFT TEST CORRECTION**

OUTSIDE TEMPERATURE (°F)	MINIMUM DRAFT PRESSURE REQUIRED (Pa)
< 10	-2.5
10 – 90	(Outside Temperature ÷ 40) – 2.75

> 90	-0.5
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For SI: 6894.76 Pa = 1.0 psi.

**TABLE RA301.1(3)  
ACCEPTABLE DRAFT TEST CORRECTION**

CARBON DIOXIDE LEVEL (ppm)	AND OR	SPILLAGE AND ACCEPTABLE DRAFT TEST RESULTS	RETROFIT ACTION
0 – 25	and	Passes	Proceed with work
$25 < x \leq 100$	and	Passes	Recommend that CO problem be resolved
$25 < x \leq 100$	and	Fails in worst case only	Recommend an appliance service call and repairs to resolve the problem
$100 < x \leq 400$	or	Fails under natural conditions	<b>Stop!</b> Work shall not proceed until appliance is serviced and problem resolved
> 400	and	Passes	<b>Stop!</b> Work shall not proceed until appliance is serviced and problem resolved
> 400	and	Fails under any condition	<b>Emergency!</b> Shut off fuel to appliance and call for service immediately

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