
2020
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RESIDENTIAL BUILDING
ENERGY STANDARDS
VERMONT
DEPARTMENT OF PUBLIC SERVICE
ICC
INTERNATIONAL
CODE COUNCIL

~~2020~~2023 Vermont Residential Building Energy Standards

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PREFACE

Introduction

The ~~2020~~ 2023 *Vermont Residential Building Energy Standards* (RBES) is based on the ~~*2015*~~ *2020* *Vermont Residential Building Energy Standards*, which are based on the 2018 and 2015 *International Energy Conservation Code*® (IECC®). The ~~2020~~ 2023 RBES also includes ~~all of the~~ 2021 and 2018 IECC energy efficiency requirements as well as select language updates and additional, more stringent Vermont energy efficiency requirements.

This comprehensive energy conservation code establishes minimum regulations for energy efficient buildings using prescriptive and performance-related provisions. It is founded on broad-based principles that make possible the use of new materials and new energy efficient designs.

The *International Energy Conservation Code* provisions provide many benefits, among which is the model code development process that offers an international forum for energy professionals to discuss performance and prescriptive code requirements. This model code also encourages international consistency in the application of provisions.

Development

This ~~2020~~ 2023 RBES is founded on principles intended to establish provisions consistent with the scope of an energy conservation code that adequately conserves energy; provisions that do not unnecessarily increase construction costs; provisions that do not restrict the use of new materials, products or methods of construction; and provisions that do not give preferential treatment to particular types or classes of materials, products or methods of construction.

Background

The Vermont Residential Building Energy Standards (RBES) was adopted by statute (30 V.S.A. § 51) in 1997. Act 89 of 2013 established a Stretch Code defined as a building energy code for residential buildings that achieves greater energy savings than the RBES. The stretch code shall be available for adoption by municipalities under 24 V.S.A. §117 and shall apply in proceedings under 10 V.S.A. §151 (Act 250).

Update Process

The Residential Building Energy Standards statute requires that revisions to the RBES are made promptly after the issuance of updated standards under the *International Energy Conservation Code* (IECC). The Department of Public Service (PSD) is required to convene stakeholders that include mortgage lenders, builders, building designers, utility representatives, and other persons with experience and expertise prior to the adoption of a revised RBES to provide recommendations.

The ~~2020~~ 2023 RBES is based on the language in the 2015 edition of the IECC and includes efficiency improvements included in the 2018 and 2021 IECC to ensure continued progression in efficiency in the Vermont RBES. The 202~~0~~3 RBES ~~also provides a new~~builds on the "Package Plus Points" approach to code compliance~~.~~, initiated in 2020. (Previous code compliance was achieved through a "prescriptive package" approach). The addition of "points" provides builders and designers greater flexibility in complying with the RBES. The 2023 RBES also simplified the Packages and makes them applicable to both the Base Code and the Stretch Code, with the only difference being the number of Points needing to be achieved. The 2023 RBES also attempts to better address multifamily construction by aligning the standards between RBES and the Commercial Building Energy Standards (CBES) so that regardless of whether the multifamily building falls under RBES (up to three stories in height) or CBES (buildings four stories or higher), the energy standards should be consistent. The Code Collaborative Process undertaken in 2021 allowed for more in-depth discussions with stakeholders on topics and many of the suggestions are reflected in the 2023 RBES. The Vermont PSD also held a series of stakeholder meetings in ~~2018 and 2019~~2022 to gather feedback on proposed changes to the RBES. The revisions presented in this document were modified based on input received from these meetings.

EFFECTIVE USE OF THE 2020~~0~~3 VERMONT RESIDENTIAL BUILDING ENERGY STANDARDS

The ~~2020~~ 2023 *Vermont Residential Building Energy Standards* (RBES) is a code that regulates minimum energy conservation requirements for new buildings as well as additions, alterations, renovations, and repairs to existing buildings. The ~~2020~~2023 RBES addresses energy conservation requirements for all aspects of energy uses in residential construction, including heating and ventilating, lighting, water heating, and power usage for appliances and building systems.

The ~~2020~~2023 RBES is a design document. For example, before constructing a building, the designer must determine the minimum insulation *R*-values and fenestration *U*-factors for the building exterior envelope. The RBES sets forth minimum requirements for exterior envelope insulation, window and door *U*-factors and SHGC ratings, duct insulation, lighting and power efficiency, mechanical ventilation, and water distribution insulation.

Arrangement and Format of the ~~2020~~2023 RBES

The ~~2020~~2023 RBES, like other codes published by the International Code Council® (the ICC®), is arranged and organized to follow sequential steps that generally occur during a plan review or inspection. The ~~2020~~2023 RBES is divided into six different parts:

Chapters	Subjects
1-2	Scope, administration and definitions
3	General requirements
4	Residential energy efficiency
5	Existing buildings
6	Referenced standards

The following is a chapter-by-chapter synopsis of the scope and intent of the provisions of the ~~2020~~2023 *Vermont Residential Building Energy Standards*:

Chapter 1 Scope and Administration. This chapter contains provisions for the application, enforcement and administration of subsequent requirements of the code. In addition to establishing the scope of the code, Chapter 1 identifies which buildings and structures come under its purview. Chapter 1 is largely concerned with maintaining "due process of law" in enforcing the energy conservation criteria contained in the body of this code. Only through careful observation of the administrative provisions can the *code official or authority having jurisdiction*, where one exists, reasonably expect to demonstrate that "equal protection under the law" has been provided.

Chapter 2 Definitions. Chapter 2 is the repository of the definitions of terms used in the body of the code. Codes are technical documents and every word, term and punctuation mark can impact the meaning of the code text and the intended results. The code often uses terms that have a unique meaning in the code and the code meaning can differ substantially from the ordinarily understood meaning of the term as used outside of the code.

The terms defined in Chapter 2 are deemed to be of prime importance in establishing the meaning and intent of the code text. The user of the code should be familiar with and consult this chapter because the definitions are essential to the correct interpretation of the code and the user may not be aware that a term is defined.

Where understanding of a term's definition is especially key to or necessary for understanding of a particular code provision, the term is shown in *italics* wherever it appears in the code. This is true only for those terms that have a meaning that is unique to the code. In other words, the generally understood meaning of a term or phrase might not be sufficient or consistent with the meaning prescribed by the code; therefore, it is essential that the code-defined meaning be known.

Guidance regarding tense, gender and plurality of defined terms as well as guidance regarding terms not defined in this code is provided.

Chapter 3 General Requirements. Chapter 3 provides interior design conditions that are used as a basis for assumptions in heating and cooling load calculations, and provides basic material requirements for insulation materials and fenestration materials, and provides standards for residential mechanical ventilation and combustion safety.

Chapter 4 Residential Energy Efficiency. Chapter 4 contains the energy-efficiency-related requirements for the design and construction of residential buildings regulated under this code. It should be noted that the definition of a *residential building* in this code is unique for this code. In this code, a *residential building* is an R-2, R-3 or R-4 building three stories or less in height. All other R-1 buildings, including residential buildings greater than three stories in height, are regulated by the energy conservation requirements in the Vermont Commercial Building Energy Standards (CBES). The applicable portions of a residential building must comply with the provisions within this chapter for energy efficiency. This chapter defines requirements for the portions of the building and building systems that impact energy use in new residential construction and promotes the effective use of energy. The provisions within the chapter promote energy efficiency in the building envelope, the heating and cooling system, lighting and the service water heating system of the building. Vermont has adopted a two-tiered code structure with a "B~~b~~*ase C~~c~~ode*" that applies statewide, and a "*Stretch Code*" that is more stringent. The *Stretch Code* applies to all Act 250 development projects and is also available for municipalities that choose to adopt a higher energy standard.

Chapter 5 Existing Buildings. Chapter 5 of each set of provisions contains the technical energy efficiency requirements for existing buildings. Chapter 5 provisions address the maintenance of buildings in compliance with the code as well as how additions, alterations, repairs and changes of occupancy need to be addressed from the standpoint of energy efficiency. Specific provisions are provided for historic buildings.

Chapter 6 Referenced Standards. The code contains numerous references to standards that are used to regulate materials and methods of construction. Chapter 6 contains a comprehensive list of all standards that are referenced in the code. The standards are part of the code to the extent of the reference to the standard. Compliance with the referenced standard is necessary for compliance with this code. By providing specifically adopted standards, the construction and installation requirements necessary for compliance with the code can be readily determined. The basis for code compliance is, therefore, established and available on an equal basis to the *code official or authority having jurisdiction*, where one exists, contractor, designer and owner.

Chapter 6 is organized in a manner that makes it easy to locate specific standards. It lists all of the referenced standards, alphabetically, by acronym of the promulgating agency of the standard. Each agency's standards are then listed in either alphabetical or numeric order based on the standard identification. The list also contains the title of the standard; the edition (date) of the standard referenced; any addenda included as part of the ICC adoption; and the section or sections of this code that reference the standard.

Italicized Terms

Selected terms set forth in Chapter 2, Definitions, are italicized where they appear in code text. Such terms are not italicized where the definition set forth in Chapter 2 does not impart the intended meaning in the use of the term. The terms selected have definitions that the user should read carefully to facilitate better understanding of the code.

Marginal Markings

Solid vertical lines in the margins within the body of the code indicate Vermont specific additions and changes from the requirements of the 2015 IECC and the 2018 edition. Deletion indicators in the form of an arrow (➡) are provided in the margin where an entire section, paragraph, exception or table has been deleted or an item in a list of items or a table has been deleted.

Abbreviations and Notations

The following is a list of common abbreviations and units of measurement used in this code. Some of the abbreviations are for terms defined in Chapter 2. Others are terms used in various tables and text of the code.

AFUE	Annual fuel utilization efficiency
ATWHP	Air-to-water heat pump
bhp	Brake horsepower (fans)
Btu	British thermal unit
Btu/h-ft^2	Btu per hour per square foot
C-factor	See Chapter 2—Definitions
CDD	Cooling degree days
CFA	Conditioned floor area
cfm	Cubic feet per minute
cfm/ft^2	Cubic feet per minute per square foot
ci	Continuous insulation
COP	Coefficient of performance
CO_2e	Carbon dioxide equivalent
DCV	Demand control ventilation
°C	Degrees Celsius
°F	Degrees Fahrenheit
DWHR	Drain water heat recovery
DX	Direct expansion
E_c	Combustion efficiency

E_v	Ventilation efficiency
E_t	Thermal efficiency
ECM	Electronically commutated motor
EER	Energy efficiency ratio
EF	Energy factor
ERI	Energy rating index
EPD	Environmental product declaration
F-factor	See Chapter 2—Definitions
FDD	Fault detection and diagnostics
FEG	Fan efficiency grade
FL	Full load
ft^2	Square foot
GPF	Gallons per flush
GPM	Gallons per minute
GSHP	Ground-source heat pump
GWP	Global warming potential
HDD	Heating degree days
HERS	Home Energy Rating System
hp	Horsepower
H/ERV	Heat or energy recovery ventilation
HSPF	Heating seasonal performance factor
HVAC	Heating, ventilating and air conditioning
IEER	Integrated energy efficiency ratio
IPLV	Integrated Part Load Value
Kg/m^2	Kilograms per square meter
kW	Kilowatt
LPD	Light power density (lighting power allowance)
L/s	Liters per second
Ls	Liner system
m^2	Square meters
MERV	Minimum efficiency reporting value
NAECA	National Appliance Energy Conservation Act
NPLV	Nonstandard Part Load Value
Pa	Pascal
PF	Projection factor
pcf	Pounds per cubic foot
PSD	Department of Public Service (Vermont)
psf	Pounds per square foot
PTAC	Packaged terminal air conditioner
PTHP	Packaged terminal heat pump
R-value	See Chapter 2—Definitions
SCOP	Sensible coefficient of performance
SEER	Seasonal energy efficiency ratio
SHGC	Solar Heat Gain Coefficient
SPVAC	Single packaged vertical air conditioner
SPVHP	Single packaged vertical heat pump
SRE	System recovery efficiency
SRI	Solar reflectance index

SWHF	Service water heat recovery factor
U-factor	See Chapter 2—Definitions
VAV	Variable air volume
VRF	Variable refrigerant flow
VT	Visible transmittance
W	Watts
w.c.	Water column
w.g.	Water gauge

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CHAPTER 1 [RE]
ADMINISTRATION

PART 1—SCOPE AND APPLICATION

SECTION R101
SCOPE AND GENERAL REQUIREMENTS

R101.1 Title.
This code shall be known as the ~~2020~~2023 *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 multifamily housing three stories or less in height.

For the purpose of determining the building type that must comply with the RBES under Vermont statute, a multifamily building is a *residential building* or *mixed-use* building with three or more *dwelling units* three stories or less in height. Multifamily buildings of four stories or more in height must comply with the CBES (from Vermont 30 V.S.A. § 51.)

While many sections of this code (e.g., inspections, review of construction documents, compliance, etc.) do not pertain to most of Vermont that lacks a *code official or authority having ~~jurisdiction~~jurisdiction*, these sections are included to provide guidance for those jurisdictions that do have a *code official or authority having jurisdiction*.

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 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 Btu/h · ft^2 (10.7 W/m^2) or 1.0 watt/ft^2 (10.7 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 nonwinter occupation with only a biomass (wood) or other on-site renewable heating system.

6. **Yurts** with only a biomass (wood) or other on-site renewable heating and hot water system.

7. **Owner-built homes.** Residential construction by an owner, if all of the following apply:

    7.1. The owner of the residential construction is the *builder*, as defined in 30 V.S.A § 51(a)(1).

    7.2. The residential construction is used as a dwelling by the owner.

    7.3. The owner in fact directs the details of construction with regard to the installation of materials not in compliance with the RBES.

    7.4. 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 the 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 Department of Public Service (PSD) within 30 days following sale of the property by the owner. A certificate that itemizes how the home does not comply with the RBES is available from the PSD.

R101.6 Authority having jurisdiction.
In any instance where there is no state or local *code official or authority having jurisdiction*, the Vermont Public Service Department is not considered to be the "*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."

All *Base Code* requirements shall be met in addition to the requirements in the *Stretch Code* section R407 in order to be in compliance with the *Stretch Code*.

R101.8 Compliance options.
There are three thermal efficiency compliance options:

~~1.~~ **1. Package Plus Points:** For the *Base Code* and *Strech Code*, Table R402.2.1.1 lists the options for insulation and fenestration packages. Table R402.1.2.2 lists the additional points required for compliance based on building square footage for both *Base Code* and *Stretch Code*, and Table R402.1.2.3 lists the components and respective point values to be used to meet the point requirement in Table R402.1.2.2. ~~For the Stretch Code, Table R407.2.1.1 lists three options for insulation and fenestration packages, Table R407.2.1.2 lists the required additional points for compliance based on building square footage, and Table R407.2.1.3 lists the components and respective point values to be used to meet the point requirement in Table R407.2.1.2.~~

2. RES*check*™: The U.S. Department of Energy's RES*check*™ software.

3. Home Energy Rating System (HERS): A HERS energy rating that demonstrates compliance with Section 406.4 for the Base or Stretch Code ~~or Section 407.2.2 for the Stretch Code~~ based on REM v16.3.3 or later or Ekotrope version 4.0 or later that is accredited by RESNET at https://www.resnet.us/providers/accredited-providers/hers-software-tools/. ~~(All HERS Index values in this code are 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*

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 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, performance, fire resistance, durability and safety. Where the alternative material, design or method of construction is not *approved*, the *code official or 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 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, or in a digital format where allowed by the code *official or authority having jurisdiction*, where one exists, 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 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 authority having jurisdiction,* where one exists, is authorized to waive the requirements for construction documents or other supporting data if the *code official or 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 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.

~~8.~~ 9. Energy code compliance path.

R103.2.1 Building thermal envelope depiction.
The *building's thermal envelope* shall be represented on the construction documents.

R103.3 Examination of documents.
The *code official or 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 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. Compliance with this code shall be certified by a builder, licensed professional engineer, licensed architect, or an accredited home energy rating organization by completing, signing, and posting a Vermont Residential Building Energy Standards (RBES) Certificate. The person certifying 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.

R103.3.1 Approval of construction documents.
When the *code official or 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 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 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 authority having jurisdiction*, where one exists, or a duly authorized representative.

R103.3.2 Previous approvals.
Reserved.

R103.3.3 Phased approval.
The *code official or 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 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 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* *or authority having jurisdiction*, where one exists, 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 authority having jurisdiction*, where one exists, or his or her designated agent, upon notification, may make the inspections set forth in Sections R104.2.1 through R104.2.4.

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 (both interior and exterior); 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 system*, 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 authority having jurisdiction*, where one exists. The *code official or 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 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 authority having jurisdiction*, where one exists.

R104.5 Approved inspection agencies.
The *code official or 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 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 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 authority having jurisdiction*, where one exists.

R104.8.1 Revocation.
The *code official or 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.

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.

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

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.

ADVANCED WOOD HEATING SYSTEM. A wood pellet fueled central heating system that meets the standards established by the Vermont Clean Energy Development Fund and Efficiency Vermont and is listed on the Eligible Equipment Inventory posted at http://www.rerc-vt.org/advanced-wood-heating-system/eligible-equipment-inventory-eei.

AIR BARRIER. An air barrier is a durable solid (non-porous) 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 also functions as an air barrier material, having an air permeance equal to or less than 0.02 L/s-m^2 at 75 Pa pressure differential as tested in accordance with ASTM E2178 or E283.

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 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 authority having jurisdiction*, where one exists.

AUTHORITY HAVING JURISDICTION. The officer or other designated authority charged with the administration and enforcement of this code, or a duly authorized representative. For purposes of this code, the Vermont Public Service Department is not the authority having jurisdiction.

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").

BALANCED VENTILATION SYSTEM. See "Whole house balanced ventilation system~~, balanced~~."

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)

BIODIESEL. Mono alkyl esters derived from plant or animal matter that meet the registration requirements for fuels and fuel additives established by the Environmental Protection Agency under section 211 of the Clean Air Act (42 U.S.C. § 7545), and the requirements of ASTM D6751.

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 SHELL AREA. The sum of the area of ceiling, floors, and walls, slab (all "six sides") separating a *dwelling unit's conditioned space* from the exterior or from adjacent conditioned or unconditioned spaces. Wall height shall be measured from the finished floor of the *dwelling unit* to the underside of the floor above.

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.

CARBON DIOXIDE EQUIVALENT (CO_2E). A measure used to compare the impact of various greenhouse gases based on their global warming potential (GWP). CO_2e approximates the warming effect of a unit mass of a given greenhouse gas relative to that of carbon dioxide (CO_2).

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^2 ·°F) [W/(m^2 ·K)].

CAVITY INSULATION. Insulating material located between framing members.

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

CLIMATE ZONE. A geographical region based on climatic criteria as specified in this code. Vermont is *Climate Zone* 6.

CODE OFFICIAL OR AUTHORITY HAVING JURISDICTION. The officer or other designated authority charged with the administration and enforcement of this code, or a duly authorized representative. For purposes of this code, the Department of Public Service is not the *code official or authority having jurisdiction* 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.

COLD-CLIMATE HEAT PUMP. A heat pump with an inverter-driven, variable capacity compressor that is designed to provide full heating heat pump capacity and having a minimum COP of 1.75 or greater at an outside air temperature of 5°F.

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 nonresidential Energy Code, based on the 2018 *International Energy Conservation Code*.

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*. See also "Finished conditioned floor area."

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. See also "Finished conditioned floor area."

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

CONTINUOUS AIR BARRIER. A combination of materials and assemblies that 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 non load-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 skylight 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 to the heated water fixture upon user demand via push-button at the fixture.

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

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

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.”

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

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

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

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

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.

ELECTRIC VEHICLE CHARGING ~~READY~~ – LEVEL 2 ~~READY~~CAPABLE. Level 2 "~~ready~~capable" includes space in the ~~panel~~ utility room for panel(s) ~~for~~of 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 EVSE with a J1772 connector or NEMA 14-50, or equivalent, within 5 feet of the centerline for each EV charging parking space.
~~. 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.~~ A conduit or other unobstructed path to easily run a future wire to the parking spot shall also be provided.

ELECTRIC VEHICLE ~~READY~~CAPABLE PARKING SPACE. A parking space with all the requisite infrastructure in place within five feet to allow electrical wiring and connection to power for EVSE.

ELECTRIC VEHICLE SUPPLY EQUIPMENT (EVSE). ~~Level 2 (240 volt) Eelectrical infrastructure for charging electric vehicles. EVSE can be either Level 1 (120 V) or Level 2 (240 V).~~ Level 2 electric vehicle charging parking that requires one 208/240V 40 amp grounded connection for electric vehicle charging through dedicated EVSE with J1772 connector or AC receptacle, NEMA 14-50, or equivalent, within 5 feet (1524 mm) of the centerline for each EV charging parking space.

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 (ERV). Systems that employ air-to-air heat exchangers to recover sensible and latent 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 that are part of the *building thermal envelope*, 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.

GLOBAL WARMING POTENTIAL (GWP). GWP is an index for estimating the relative global warming contribution of atmospheric emissions of 1 kg of a particular greenhouse gas compared to emissions of 1 kg of CO_2. The following GWP values are used based on a 100-year time horizon: 1 for CO_2, < 10 for pentane (e.g., C_5H_{12}), and 1430 for R-134a (CH_2FCF_3).

GLOBAL WARMING POTENTIAL (GWP) INTENSITY. For the purposes of this document, GWP intensity refers to the GWP impact from materials (kg $CO2_e$) divided by the project's total conditioned floor area in square feet (ft^2).

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").

GROUND SOURCE HEAT PUMP. A heat pump that extracts heat from the ground or water within the ground.

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 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.

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 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 thermosyphoning 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.

HIGH-EFFICACY LIGHT SOURCES~~LAMPS/LIGHTING~~. ~~Compact fluorescent lamps, light-emitting diode (LED) lamps, T-8 or smaller diameter linear fluorescent lamps, or lamps~~ Non-linear medium screw- and pin-base lamps with a minimum efficacy of not less than ~~80~~65 lumens per watt; or light fixtures of not less than ~~54~~55~~55~~65 lumens per watt. In determining the number or percent of lamps, each replaceable lamp (or light string) connected to a permanently installed lighting fixture shall count as one lamp.

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 approved by the Vermont Department of Public Service 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* through the *building thermal envelope* caused by the pressure effects of wind or 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.

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 electric vehicle charging parking requires one 120V 20-ampere grounded AC receptacle, NEMA 5-20R or equivalent, within 5 feet of the centerline of each EV charging parking space.~~
~~Level 1 charging uses a standard alternating current 120V outlet.~~

~~**LEVEL 2 ELECTRIC VEHICLE CHARGING.** Level 2 electric vehicle charging parking requires one 208/240V 40-ampere grounded connection for electric vehicle charging through dedicated EVSE with a J1772 connector or AC receptacle, NEMA 14-50, or equivalent, within 5 feet of the centerline for each EV charging parking space.~~
~~Level 2 uses a 240V alternating current outlet.~~

LIGHTING. See "High-efficacy ~~lamps/lighting~~light sources."

LISTED. Equipment, materials, products or services included in a list published by an organization acceptable to the *code official or 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/BUILDING. ~~For the purpose of determining the building type that must comply with the RBES under Vermont statute, a multifamily building is a *residential building* or *mixed-use* building with three or more *dwelling units* three stories or less in height. Multifamily buildings of four stories or more in height must comply with the CBES. (From Vermont 30 V.S.A. § 51.) See Section R101.2 for scope. For the purpose of determining points in Section R402.1.2, a multifamily dwelling is a residential building containing units built one on top of another and those built side-by-side which do not have a ground-to-roof wall and/or have common facilities (i.e., attic, basement, heating plant, plumbing, etc.) (From www.census.gov)~~ 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.

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

NET ZERO ENERGY READY. A highly efficient and cost-effective building designed and constructed so that renewable energy could offset all or most of its annual energy consumption.

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*® (IRC®). The IRC typically regulates single family homes and duplexes, regulations for any structure with more than two units can be found in the *International Building Code*® (IBC®). There are four different occupancy groups within Group 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 are not Group 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 childcare facilities that provide accommodation for five or less people less than 24 hours a day are Group 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.

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

ON-SITE RENEWABLE ENERGY GENERATION. Energy from renewable energy resources that is generated ~~harvested~~ at the building site.

OPAQUE AREAS. All exposed areas of a building envelope which enclose *conditioned space*, except openings for windows, *skylights* and building service systems. Doors are considered opaque when they are 50-percent or greater opaque in surface area.

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.

PRIMARY SHOWERS. The one or two showers in the dwelling that will be used the most.

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*").

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

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

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

RENEWABLE ENERGY RESOURCES. Energy 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~~utilizes a renewable fuel or energy source.

(C) The following fuels shall not be considered renewable energy sources: coal, oil, propane, and fossil natural gas.

(D) *Biomass* is considered renewable.

(E) *Biodiesel* 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. A roof assembly can be part of the *building thermal envelope* if it also includes insulation and an air barrier. A roof assembly includes the roof covering, underlayment, roof deck, structural members, and if it is part of the thermal envelope, insulation, *air barrier, 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 that is part of the *thermal envelope*, 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 an ~~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 ($h \cdot ft^2 \cdot °F/Btu$) [$(m^2 \cdot K)/W$].

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 watthours, 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.

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.

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

SINGLE-FAMILY DWELLING. Fully detached, semidetached (semi-attached, side-by-side), row houses, and townhouses. In the case of attached units, each must be separated from the adjacent unit by a ground-to-roof wall in order to be classified as a single-family structure. Also, these units must not share heating/air-conditioning systems or utilities. (From www.census.gov).

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

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 mulled 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 ~~b~~Base RBES *Base Code*. 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 DISTRIBUTION EFFICIENCY (TDE). The resistance to changes in air heat as air is conveyed through a distance of air duct. TDE is a heat loss calculation evaluating the difference in the heat of the air between the air duct inlet and outlet caused by differences in temperatures between the air in the duct and the duct material. TDE is expressed as a percent difference between the inlet and outlet heat in the duct.

THERMAL CONDUCTANCE, OVERALL (U_o). The overall (average) heat transmission of a gross area of the exterior building envelope (Btu/h · ft^2 · F) [W/(m^2 · K)].

The U_o-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.

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 · ft^2 · °F/Btu) [(m^2 · K)/W].

THERMAL RESISTANCE, OVERALL (R_o). The reciprocal of overall thermal conductance (h · ft^2 · °F/Btu) [(m^2 · K)/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*). (See "Thermal conductance.") 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.

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

TINY HOUSE. A detached *dwelling unit* of less than 400 square feet of floor area excluding lofts.

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

TYPE III PRODUCT-SPECIFIC ENVIRONMENTAL PRODUCT DECLARATION (EPD). An EPD is a document that describes the results of a life cycle assessment (LCA) for a material or product. While there are industry-specific EPDs, which average results across multiple product manufacturers, product-specific EPDs are the most thorough type of EPD. Type III, product-specific EPDs cover a single product from a manufacturer and are reviewed by a third-party entity. They conform to ISO 14025 and either EN 15804 or ISO 21930. Like all product specific EPDs, the scope must cover the product's life-cycle from cradle to gate.

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

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 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 based on the manufacturer's certified testing of a tested assembly and defined using the desiccant method with Procedure A of ASTM E96 as follows:

VAPOR RETARDER CLASSES AND EXAMPLES

VAPOR RETARDER CLASS[a]	PERM RATING (DRY CUP)	DESCRIPTION	EXAMPLES OF MATERIALS
Class I	0.1 perm or less	Vapor impermeable or "Vapor Barrier"	Rubber membrane, sheet polyethylene, glass, foils
Class II	0.1 – 1.0 perm	Vapor semi-impermeable	Oil-based paint, Kraft-faced batt, vinyl wall coverings, stucco
Class III	1.0 – 10 perm	Vapor semi-permeable	Plywood, OSB, EPS, XPS, most latex paints, heavy asphalt-impregnated building paper, wood board sheathing
Vapor open	> 10 perm	Vapor permeable	Unpainted gypsum board, unfaced fiberglass, cellulose, many "housewraps"

a. Test Procedure for vapor retarders: ASTM E96 Test Method A (the desiccant method or dry cup method).

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 BALANCED 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, MULTIPORT. A whole house ventilation system that has more than one exhaust or supply port inside the house.

WHOLE HOUSE VENTILATION SYSTEM, SINGLEPORT. 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.

YURT. A circular tent on a wooden framework used as a *residential building*.

ZONE. A space or group of spaces within a *building's thermal envelope* 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.

R302.2 Climactic data.
The following design parameters in Table R302.2 shall be used for calculations required under this code.

Adjustments may be made only in the following cases:

1. Winter heating design temperatures for projects either:
   i. Located at an elevation of 1,500 feet (457 m) or higher, or
   ii. Located in Caledonia, Essex or Orleans counties.
   iii. Adjustments shall be made as listed in the National Climate Data Center for the specific weather station: http://www.ncdc.noaa.gov/cdo-web/.
2. As approved by the *code official or authority having jurisdiction*, where one exists.

TABLE R302.2
THERMAL DESIGN PARAMETERS

CONDITION	VALUE
Winter[a], Design Dry-Bulb	-11°F
Summer[a], Design Dry-Bulb	84°F
Summer, Design Wet Bulb	69°F
Degree Days Heating[b]	~~7,665~~7,771
Degree Days Cooling[b]	~~489~~388

For SI: °C = [(°F) - 32]/1.8.

a. The outdoor design temperature is selected from the columns of 97-percent values for winter and 2-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 authority having jurisdiction, where one exists.

b. The degree days heating (base 65°F) and cooling (base 65°F) are from https://www.climate-zone.com/climate/united-states/vermont/burlington ~~the NOAA "Annual Degree Days to Selected Bases Derived from the 1971–2000 Normals"~~ for 2022 ~~Burlington International Airport~~.

SECTION R303
MATERIALS, SYSTEMS AND EQUIPMENT

R303.1 Identification.

Materials, systems and equipment shall be identified in a manner that will allow a determination of compliance with the applicable provisions of this code.

R303.1.1 Building thermal envelope insulation.

An *R*-value identification mark shall be applied by the manufacturer to each piece of *building thermal envelope* insulation 12 inches (305 mm) or greater in width. Alternately, the insulation installers shall provide a certification listing the type, manufacturer and *R*-value of insulation installed in each element of the *building thermal envelope*. For blown or sprayed insulation (fiberglass and cellulose), the initial installed thickness, settled thickness, settled *R*-value, installed density, coverage area and number of bags installed shall be *listed* on the certification. For sprayed polyurethane foam (SPF) insulation, the installed thickness of the areas covered and *R*-value of installed thickness shall be *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^2) throughout the attic space. The markers shall be affixed to the trusses or joists and marked with the minimum initial installed thickness with numbers not less than 1 inch (25 mm) in height. Each marker shall face the attic access opening. Spray polyurethane foam minimum thickness and installed *R*-value shall be *listed* on certification provided by the insulation installer.

R303.1.2 Insulation mark installation.

Insulating materials shall be installed such that the manufacturer's *R*-value mark is readily observable upon inspection. For insulation materials that are installed without an observable manufacturer's R-value mark, such as blown or draped products, an insulation certificate complying with **Section R303.1.1** shall be left immediately after installation by the installer, in a conspicuous location within the building, to certify the installed R-value of the insulation material.

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 DOOR *U*-FACTORS

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

TABLE 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

Visible Transmission (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 · ft^2 · °F/Btu at a mean temperature of 75°F (24°C).

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

R303.1.5 Air-impermeable insulation.
Insulation having an air permeability not greater than 0.004 cubic feet per minute per square foot [0.002 L/(s × m2)] under pressure differential of 0.3 inch water gauge (75 Pa) when tested in accordance with **ASTM E2178** shall be determined air-impermeable insulation.

R303.2 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 R304
DESIGN CRITERIA FOR RESIDENTIAL VENTILATION SYSTEMS

R304.1 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 and *multifamily* buildings) not more than three stories in height.

R304.1.1 Compliance.
Compliance with Section 304 shall be achieved by installing a ~~*balanced*~~ *whole house balanced ventilation system* with minimum 70 *SRE* and 1.2 cfm/Watt, determined in accordance with HVI Publication 920 and listed in HVI Publication 911, while also meeting compliance with Sections 304.2 through 304.11 or demonstrating compliance with one of the following alternatives:

1. ASHRAE Standard 62.2—~~2016~~ 2019(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)

Exceptions:

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

2 *Tiny houses* may install an exhaust-only ventilation system.

R304.2 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 provide 50 CFM intermittent or 20 CFM continuous exhaust capacity. ~~meet the net capacity rates as required in Table R304.2~~. 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 R304.6 and must meet all other requirements listed in Section R304.3, as applicable.

TABLE R304.2
MINIMUM REQUIRED LOCAL EXHAUST

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

R304.3 ~~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."~~Reserved.

R304.4 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 $^{1}/_{2}$ inch (12.7 mm) above the surface of the finished floor covering.

R304.5 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.~~

R304.5.1 Fan durability.
Whole house ventilation fan motors shall be rated for "continuous duty" and have manufacturer flow ratings as listed in HVI 911.

~~**R304.5.2 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.~~

~~**R304.5.3 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.~~

~~**R304.5.34 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.~~

R304.6 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 R304.6.1, 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 R304.6.

TABLE R304.6
PRESCRIPTIVE FAN CAPACITY REQUIREMENTS FOR CENTRALLY DUCTED SYSTEMS

NUMBER OF BEDROOMS	MINIMUM NOMINAL RATED TOTAL FAN CAPACITY[a] (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	~~Centrally ducted systems—1, or All other systems—2 or more~~
5	150 cfm	~~Centrally ducted systems—1, or All other systems—2 or more~~
Homes > 3,000 ft^2	cfm = 0.05 · ft^2	~~Centrally ducted systems—1, or All other systems—2 or more~~

For SI: 1 cubic foot per minute = 0.0004719 m^3/s, 1 cubic foot per minute per square foot = 0.00508 $m^3/(s \cdot m^2)$.

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

R304.6.1 Testing option.

Testing may be done for Points to verify that the whole house ventilation system satisfies the ventilation requirements of this section in accordance with Sections R304.6.1.1 and R304.6.1.2.

R304.6.1.1 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 with using one of the compliance alternatives in Section R304.1.1.

R304.6.1.2 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.

R304.7 Ventilation required during periods of occupancy.
Ventilation shall be provided continuously or intermittently during the period that the building is occupied.

R304.8 Controls.
Whole house ventilation systems (balanced ~~or exhaust-only~~ ventilation) 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.

R304.8.1 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.

R304.8.2 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.

R304.8.2.1 On/off switch for continuous operation.
An on/off switch for continuously operated *whole-house ventilation systems* shall be remotely installed and appropriately labeled.

R304.9 Installation requirements.
Ventilation equipment shall be installed according to the manufacturer's instructions and in accordance with Sections R304.9.1 through R304.9.8.

R304.9.1 Fan housings.
Fan housings for single-port exhaust only systems must be sealed to the ceiling or wall.

R304.9.2 Inlet grills.
Inlet grills for multiport exhaust ventilation systems or ~~*balanced*~~ *whole house* *balanced* *ventilation systems* must be sealed to the ceiling or wall.

R304.9.3 Ducts.
Smooth wall ducts (for example, 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 ~~or outside the building thermal envelope.~~

R304.9.4 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.

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

R
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.

R304.9.7 Intake openings.
Mechanical and gravity outside air intake openings for ~~*balanced*~~ *whole house* *balanced* *ventilation 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.

R304.9.8 Outside opening protection.
Air exhaust and intake openings located in exterior walls shall be protected with corrosion-resistant screens, louvers or grilles having a minimum opening size of $^{1}/_{4}$ inch (6.4 mm) and a maximum opening size of $^{1}/_{2}$ inch (12.7 mm), in any dimension. Openings shall be protected against local weather conditions.

R304.9.9 Exhaust Dampers.
Dampers with positive closures shall be installed to keep outside air from entering the exhaust duct when the system is not operating.

Exception: Mechanical ventilation systems designed for continuous operation.

R304.10 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.

R304.11 Makeup air required.
Exhaust hood systems and clothes dryers capable of exhausting in excess of 400 cubic feet per minute (0.19 m^3/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 R305
COMBUSTION SAFETY (MANDATORY)

R305.1 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, whenever 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.

R305.2 Unusually tight construction.
For the purpose of applying the provisions of Section R305 to fuel gas, kerosene and oil-burning

equipment, *buildings* constructed in compliance with the RBES shall be considered of *unusually tight construction* as defined in NFPA 54 and NFPA 31.

R305.3 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.

R305.3.1 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.

R305.3.2 Unvented room heaters.
Unvented fuel-fired heaters, including room heaters and unvented fireplaces are prohibited.

R305.4 Solid fuel-burning appliances and fireplaces.
All solid fuel-burning appliances and fireplaces shall meet the provisions of this section.

R305.4.1 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 Appendix RA–Recommended Procedure for Worst-Case Testing of Atmospheric Venting Systems is not required to have tight-fitting doors.

R305.4.2 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.

R305.4.3 Exterior air supply requirements.
Solid fuel-burning appliances and fireplaces shall be equipped with an exterior air supply according to the provisions of Sections R305.4.3.1 through R305.4.3.7. 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 in place of Sections R305.4.3.1 through R305.4.3.7. This is not an exemption from the exterior air supply requirements.

R305.4.3.1
Combustion air shall not be taken from within the garage, attic, or basement.

R305.4.3.2
The exterior air inlet shall not terminate to the exterior higher than the firebox and the combustion air duct 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 chimney.

R305.4.3.3
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.

R305.4.3.4
The air inlet shall be screened with $^{1}/_{24}$ inch (136 ~~6~~ mm) mesh.

R305.4.3.5
The air inlet shall be closable and designed to prevent debris from dropping into the air intake.

R
305.4.3.6
The exterior air inlet shall be installed so as to remain free of obstruction from snow.

R305.4.3.7 Passageway.
The combustion air passageway for unlisted exterior air supply ducts shall be a minimum of 6 square inches (3870 mm^2) and not more than 55 square inches (0.035 m^2). 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.

CHAPTER 4 [RE]
RESIDENTIAL ENERGY EFFICIENCY

SECTION R401
GENERAL

R401.1 Scope.

This chapter applies to *residential buildings* compliance with both the *Base Code* and *Stretch Code*. *Stretch Code* requires compliance with all Base Code requirements throughout RBES, plus achieving the additional points specified in Table R402.1.2.2, following all requirements of the following sections, and complying with Section R407 Vermont Stretch Code.

R401.2 Compliance.

Projects for both *Base Code* and *Stretch Code* shall comply with one of the following:

1. **Package Plus Points:** Sections R402 through R404.

2. **RES*check*™ 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 ~~(Mandatory).~~ An *RBES certificate* is required to be issued. The *certificate* should be issued ~~U~~upon completion and before occupancy of any project subject to the Residential Building Energy Standards. A *certificat~~e~~ion* 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 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 ~~R402.1.6~~. R402.1.~~5~~6. for compliance with the *Base Code* and the *Stretch Code*.

Exception: 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 per square foot of floor space for space conditioning purposes (10.7 W/m^2 or 1.0 watt/ft^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).

4. **Hunting camps.** Residential buildings shall not include hunting camps.

5. **Summer camps.** Residential buildings constructed for nonwinter occupation with only a biomass (wood) or other on-site renewable heating system.

6. **Yurts** with only a biomass (wood) or other on-site renewable heating and hot water system.

7. **Owner-built homes.** Residential construction by an owner, if all of the following apply:

   7.1. The owner of the residential construction is the *builder*, as defined in 30 V.S.A. § 51.

   7.2. The residential construction is used as a dwelling by the owner.

   7.3. The owner in fact directs the details of construction with regard to the installation of materials not in compliance with the RBES.

   7.4. ~~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 the RBES~~

~~and shall itemize which measures do not meet the RBES in effect at the time construction commenced.~~ 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 the 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 Department of Public Service (PSD) within 30 days following sale of the property by the owner. A certificate that itemizes how the home does not comply with the RBES is available from the PSD.

8. **Tiny Houses.** While not specifically exempt, *tiny houses* as defined in Chapter 2 must comply with the envelope, insulation and fenestration requirements in R402.8. All other code provisions are still required with the exception that the mechanical ventilation system does not have to be heat recovery with balanced ventilation and may be exhaust-only.

R402.1.1 Vapor retarder.
Wall assemblies in ~~and roof or ceiling assemblies which are part of~~ the *building thermal envelope* shall comply with the vapor retarder requirements of Section R702.7 of the *International Residential Code* or Section ~~1405.3~~ 1404.3 of the *International Building Code*, as applicable., ~~or with Section R402.2.15 in this code.~~

R402.1.2 Insulation and fenestration criteria.
The *building thermal envelope* shall **comply** with one of the following only:

1. Package Plus Points Approach: Tables R402.1.2.1, R402.1.2.2 and R402.1.2.3.
2. *U*-Factor Alternative Approach: Section R402.1.4.
3. Total UA Approach: Section R402.1.5.
4. Log Home Approach: Section R402.1.6.
5. *Tiny House* Approach: Section R402.8.

Building science principles should be applied in all circumstances. Consult with a building science professional and refer to the Vermont Residential Energy Code Handbook for additional guidance and details.

R402.1.2.1 Package Plus Points Approach.
Projects shall comply with Items 1 through ~~4~~3: for both *Base Code* and *Stretch Code*:

1. Select one of the ~~five base~~ packages listed in Table R402.1.2.1. These standard packages apply to both *Base Code* and *Stretch Code*.

2. Determine the number of points needed to comply with Table R402.1.2.2 based on building size and whether the building needs to comply with *Base Code* or *Stretch Code*.~~.~~

3. Incorporate a sufficient number of points from Table R402.1.2.3 to meet the points requirements from Table R402.1.2.2.

4. ~~Cannot double dip on points in the manual~~. Points ~~need to~~can only be earned from ~~what~~ measures that are not already ~~isn't~~ required in the chosen ~~a~~ standard package~~the base code~~.

TABLE R402.1.2.1
INSULATION AND FENESTRATION REQUIREMENTS BY COMPONENT FOR ~~BASE~~ STANDARD PACKAGES FOR BASE CODE AND STRETCH CODE [a]

Component[f]	Package 1	Package 2
	"Standard Package"	"Log Homes"
Ceiling – flat attic[g]	**U-0.02~~5~~0:** R-~~50~~49[g]	
Ceiling – slope (no attic)	**U-0.02~~5~~5:** R-4~~9~~4[i]	
Above Grade Wall[b]	**U-0.044:** Examples: R-20+5ci[e] ~~OR~~ ~~R-23[f]+10ci~~ ~~OR~~ R-1~~5~~35+10-~~35~~ci ~~OR~~ R-2~~8~~0 (6~~8~~ ½ ¼" ci (SIP) or other)	Construct log home walls to ICC 400—2022 Standard on the Design and Construction of Log Structures Table 305.3.1.2 or Vermont RBES Table R402.1.6
Frame Floor	**U-0.029:** R-38	
Basement/Crawl[c]	R-20ci OR R13+10ci	
Slab, on grade[d]	R-20,4' (edge) OR R-15,4'(edge) + R-7.5~~15~~ (under entire slab)	
Slab, on grade, Heated[d]	R-20,4' (edge) + R-15 (under entire slab)	
Windows	**U-0.~~27~~30**	
Skylights	**U-0.41**	
Doors	**U-0.37**	

Air Leakage	0.15 CFM50/Sq. Ft. of Building Shell (~2 ACH50)[h]
Ducts	Inside thermal boundary

For SI: 1 foot = 304.8 mm. ~~CFA = conditioned floor area.~~

a. *R*-values are minimums. *U*-factors 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. See Section R402.1.4 for alternative compliance methods.

b. ~~The fenestration *U*-factor row excludes skylights.~~ These are *example* wall assemblies. Any wall assembly would need to meet required U values and should consider building science to avoid moisture concerns. See RBES Handbook for building science guidance and more example wall assemblies.

c. The continuous portion of basement and crawlspace insulation can be met through interior, exterior or combination.

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. "Heated slab" are those with embedded radiation.

e. The first value is cavity insulation, the second value is continuous insulation, or "ci", so "2~~10~~~~13~~ + ~~12~~05ci" means R-2~~11~~30 cavity insulation plus R-~~12~~5~~0~~ continuous insulation. ~~When used, continuous insulation values shall be at least R-5.~~

f. ~~R-23 could be met with dense-pack cellulose or spray foam in a 2x6 cavity~~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). ~~Multifamily buildings using continuous insulation with a maximum U-factor of 0.023 for the ceiling assembly satisfies this requirement.~~Consider building science principles in all design and construction. Buildings should be designed and constructed recognizing principles behind moisture vapor control approaches for cold climates. Maintain the envelope assembly's ability to adequately dry in at least one direction by not installing low-perm vapor retarder materials (e.g., vapor barrier) on both sides of an assembly, seek to optimize the assembly's ability to dry, and limit the potential for wetting. (From Applied Building Technologies Group, LLC).

g. ~~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.)~~If there is insufficient space in the eaves, installing R-38 over the top of exterior walls shall be deemed to satisfy the requirement for R-49 insulation provided the rest of the ceiling is R-49. (See Section R402.2.1). Multifamily buildings using continuous insulation with a maximum U-factor of 0.023 or tapered insulation with an average U-factor of 0.023 for the ceiling assembly satisfies this requirement. A minimum value of R-12 is required for tapered insulation.

h. "ACH50" = air changes per hour at 50 Pascals building pressure as measured with a blower door. CFM50/Sq. Ft. of Building Shell = amount of air leakage (in cubic feet per minute, or CFM) that leaks out of each square foot of the exterior surface all six sides of the building measured at 50 Pascals of pressure with a blower door.

i. ~~See Table R402.4.1.1 for further details. Insulation systems complying with Table R402.1.4 shall be deemed to comply with the *R*-value requirements of Table 402.1.2.1.~~ Installing R-38 over the top of exterior walls where insulation is compressed in the eaves shall be deemed to satisfy the requirement for R-44 where there is insufficient space in framing rafters for more than R-38 provided the rest of the ceiling is R-44. See R402.2.2 for more detail.

R402.1.2.2 Required points by building or addition size.

Determine the number of points required by building or addition size from Table R402.1.2.2. Building size for this table is determined by the *finished conditioned floor* area per dwelling unit ~~within~~ inside the *building thermal envelope*, including unfinished basements and storage/utility spaces. The Multifamily ~~less than 2,000 square feet (185.8 m^2) 0~~point requirement categories cannot be used for semi-detached (semi-attached, side-by-side), row houses, and townhouses, as defined as *single-family dwellings* in Section R202, General Definitions. *Multifamily dwelling* unit size is based on the average

finished conditioned floor area dwelling size for the building, excluding common areas, hallways, stairwells, etc..

~~This section establishes criteria for compliance with Vermont's "Stretch Code," as defined in 30 V.S.A. § 51. Residential projects under Act 250 jurisdiction as well as residential buildings in municipalities that adopt the Stretch Code shall demonstrate compliance with Section R402.1.2.2. All other requirements in the RBES shall apply.~~

~~All Base Code requirements shall be met in addition to the requirements in this Stretch Code section R402.1.2.2 in order to be in compliance with the Stretch Code.~~

TABLE R402.1.2.2
REQUIRED POINTS BY BUILDING SIZE FOR BASE CODE AND STRETCH CODE

BUILDING/DWELLING SIZE	BASE CODE REQUIRED POINTS	STRETCH CODE REQUIRED POINTS
Alterations	0	0
Additions < 250 square feet	0	0
Additions 250 to 500 square feet ~~Addition > 250 < 500 square feet~~	1	2
Addition ~~>~~ 5010 ~~<~~to 1,000 square feet~~Addition > 500 < 1,000 square feet~~	2	3
Addition > 1,000 square feet	3	4
Multifamily <650 square feet	0	1
Multifamily 650 to 900 square feet	1	2
Multifamily 900 to< 1,000250 square feet	2	3
Multifamily >1,000250 to 2,500 square feet	4	5
~~Multifamily~~ < 2,5000 square feet	54	7
~~< 2,000~~2,5001~~ to 4,000 square feet< 2,000 square feet~~	75	12
~~2,000 to 4,000 square feet~~	~~7~~	
> 4,000 square feet	10	15

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. The total number of points selected from Table 402.1.2.3 must meet or exceed the required points from Table 402.1.2.2.

TABLE R402.1.2.3

POINTS BY COMPONENT FOR BASE CODE AND STRETCH CODE

Component		Description	Points
Envelope	Slab (on or below grade, heated or unheated)	R-20 around perimeter and below entire slab **OR**[b]	2
		R-25 around perimeter and below entire slab	3
	Walls	R-28 2x6 cavity insulation with continuous (R20+9ci or similar) (U-0.036 wall assembly) **OR**[b]	1
		R-35 double stud or similar (cavity and continuous) (U-0.028 wall assembly) **OR**[b]	2
		R-40 double stud or similar (cavity and continuous) (U-0.025 wall assembly) **OR**[b]	3
		R-48 SIP 10 1/4" XPS or similar (cavity and continuous) (U-0.021 wall assembly)	4
	Ceiling	R-60 attic flats (U-0.018) and R-49 slopes, vaulted and cathedral (U-.020)	1
		R-80 attic flats (U-0.013) and R-60 slopes, vaulted and cathedral (U-.018)	2
	Floors - Exposed	R-49 (U-0.021)	1
	Windows	Average U-factor ≤ 0.27 **OR**[b]	1
		Average U-factor ≤ 0.25 **OR**[b]	2
		Average U-factor ≤ 0.21 **OR**[b]	3
		Average U-factor ≤ 0.18	4
	Doors - Exterior	U-0.26	1
Air Leakage	Tight	Tested to ≤0.11 CFM50/Sq. Ft. of Building Shell (6-sided) (~1.5 ACH50) **OR**[b]	1
	Tighter	Tested to ≤0.07 CFM50/Sq. Ft. of Building Shell (6-sided) (~1.0 ACH50) **OR**[b]	2
	Tightest	Tested to ≤0.03 CFM50/Sq. Ft. of Building Shell (6-sided) (~0.5 ACH50)	3
Mechanical Ventilation	Better Heat Recovery **OR**	Balanced ventilation with ECM fans and ≥80% SRE and ≥1.2 cfm/watt **OR**[b]	3
	Better Electrical Efficiency	Balanced ventilation with ECM fans and ≥70% SRE, and ≥2.0 cfm/watt	
	Mechanical Ventilation Testing	Mechanical ventilation systems shall be tested and verified to provide the minimum ventilation flow rates required by Section R403.6. Testing shall be performed according to the ventilation equipment manufacturer's instructions, or by using a flow hood or box, flow grid, or other airflow measuring device at the mechanical ventilation fan's inlet terminals or grilles, outlet terminals or grilles, or in the connected ventilation ducts.	1

Heating and Cooling[a]	Basic Equipment	ENERGY STAR basic: (1) Gas/propane furnace ≥ 95 AFUE, Oil furnace ≥ 85 AFUE; (2) Gas/propane boiler ≥ 90 AFUE, Oil boiler ≥ 87 AFUE; **OR**[b]	1
	Cold Climate Air Source Heat Pump	Whole building heating /cooling is ENERGY STAR v.6 labeled[d]	5
	Ground Source Heat Pump	Whole building heating /cooling is Ground Source Heat Pump (GSHP) and ENERGY STAR labeled[d]	10
	Air-to-Water Heat Pump	Whole building heating/cooling is Air-to-Water Heat Pump (ATWHP) COP ≥ 2.5	5
	Advanced Wood Heating System	Whole building heating/cooling is Advanced wood heating system from http://www.rerc-vt.org/advanced-wood-heating-system/eligible-equipment-inventory-eei	5
	Low-Temperature Hydronic Distribution System	Hydronic distribution system designed to meet building peak heating demand with 120-degree water	1
	Demand Responsive Thermostats	All electric heating thermostats provided with *demand responsive controls*	1
Water	Heat Pump Basic	Electric Heat Pump Water Heater UEF ≥ 2.20 **OR**[b]	3
	Heat Pump Advanced	Electric Heat Pump Water Heater UEF ≥ 3.30	5
	Low flow	All showerheads ≤ 1.75 gpm, all lavatory faucets ≤ 1.0 gpm, and all toilets ≤ 1.28 gpf[c] **OR**[b]	1
	Certified[e]	Certified water efficient design per WERS, WaterSense, or RESNET $HERS_{H2O}$	2
	Drain heat recovery	Drain water heat recovery system on *primary showers* and tubs	1
	Recirculation User-demand	Controlled hot water recirculation system with user-demand via push-button for furthest fixtures	1
	Pipe Insulation	All service hot water piping is insulated to at least R-4 from the hot water source to the fixture shutoff.	1
	Demand Responsive Controls	Electric storage water heater(s) provided with *demand responsive controls*	1

	Point of Use Electric Water Heater	Remote fixtures requiring hot water supplied from a localized source of hot water with no recirculating system.	1
	Solar Ready Zone	Follow R402.7 Solar –ready zone requirements. These points are only available for Base Code and not Stretch Code since Stretch Code requires following R402.7.	2
	Solar Hot Water	Solar hot water system designed to meet at least 50% of the annual hot water load	2
Renewables	On-Site Generation	Solar photovoltaic (PV) (or other on-site renewable energy system), 1 point per 1.5 kW per housing unit of renewable generation on site	1 per 1.5 kW, max. 4
Other Measures	Monitoring	Whole-building energy monitoring system installed, minimum 5 circuits and homeowner access to data	1
	Radon Mitigation System	Radon mitigation designed to https://www.epa.gov/radon/radon-standards-practice is installed and documented to homeowner	1
	Energy Model	Building energy model with projected annual energy use and costs developed, used in design and construction decisions, and provided to homeowner	1
	Battery	Minimum 6 kWh grid-connected dispatchable demand-response-enabled battery	1
	Advanced Lighting Controls	All lighting for at least 50% of floor area is controlled and/or continuously dimmed based by occupancy, daylight, load shedding, and/or schedule.	2
Insulation Embodied Carbon Emissions	Global Warming Potential (GWP)/square footage (kg CO2e/ ft^2)	Report the global warming potential (GWP) impact of project insulation materials as described in Section R-408. Use calculation table R408.1.1 to summarize insulation GWP intensity (kg CO2e/ft^2) for the project. Default global warming potential (GWP) values for common insulation products are provided in table R408.1.2. The calculation may utilize Type III, product-specific environmental product declaration (EPD) in lieu of default values for insulation products. If EPD values are used for a given insulation product, include the sum of lifecycle stages A1-A3 from the sourced EPD instead of default GWP value when completing the calculation. Include A5 and B1 GWP values for SPF and XPS products, as noted in R408. **OR**[b]	1

	Global Warming Potential (GWP)/square footage (kg CO2e/~~sq.~~ ft^2)	Demonstrate a calculated insulation GWP intensity (kg CO2e/ft^2) less than 0.5. Product-specific EPDs may be used in place of default values, subject to requirements in R408~~The calculation may utilize Type III, product-specific environmental product declaration (EPD) in lieu of default values for insulation products. If EPD values are used for a given insulation product, include the sum of lifecycle stages A1-A3 plus A5 plus B1 from the sourced EPD instead of default GWP value when completing the calculation. A5 and B1 can be excluded if there is no data in the EPD~~. **OR**[b]	2
		Demonstrate a calculated insulation GWP intensity (kg CO2e/ft^2) less than 0. Product-specific EPDs may be used in place of default values, subject to requirements in R408.~~The calculation may utilize Type III, product-specific environmental product declaration (EPD) in lieu of default values for insulation products. If EPD values are used for a given insulation product, include the sum of lifecycle stages A1-A3 plus A5 plus B1 from the sourced EPD instead of default GWP value when completing the calculation. A5 and B1 can be excluded if there is no data in the EPD.~~	3
Multifamily Buildings	Efficient Elevator Equipment	Elevators in the building qualify with Energy Efficiency Class A per ISO 25745-2, Table 7.	1
	Residential Kitchen Equipment	All dishwashers, refrigerators, and freezers comply with the most recent ENERGY STAR Most Efficient label.	2
	Water Heating System Submeters	Each individual dwelling unit served by a central service water-heating system is provided with a service hot water meter connected to a reporting system that provides individual dwelling unit reporting of actual domestic hot water use.	1

~~For SI: 1 foot = 304.8 mm.~~
~~NR = Not Required~~
~~ci = continuous insulation~~

For SI: 1 foot = 304.8 mm., ~~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, GSHP = Ground-source heat pump.

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. Applies to new construction only.
d. https://neep.org/initiatives/high-efficiency-products/emergingtechnologies/ashp/cold-climate-air-source-heat-pump https://www.energystar.gov/products/spec/central_air_conditioner_and_air_source_heat_pump_specification_version_6_0_pd
e. Certification standard as of 1/1/2019 or later. "WERS" = Water Efficiency Rating Score http://www.wers.us/.
EPA WaterSense compliance for all water products: https://www.epa.gov/watersense.
RESNET Water Energy Rating Index compliant:
http://www.resnet.us/professional/about/resnet_to_develop_water_efficiency_rating_system.
f. Points are limited to one per dwelling. Additional *Level 2 charging equipment EVSE* receives no more points.
a

R402.1.3 *R*-value computation.
Insulation material used in layers, such as framing cavity insulation, or continuous insulation Cavity insulation alone shall be used to determine compliance with the cavity insulation R-value requirements in **Tables R402.1.2.1 and R402.1.2.3**. Where cavity insulation is installed in multiple layers, the R-values of the cavity insulation layers shall be summed to compute the corresponding component *R*-value determine compliance with the cavity insulation R-value requirements. The manufacturer's settled *R*-value shall be used for blown insulation. Continuous insulation (ci) alone shall be used to determine compliance with the continuous insulation R-value requirements in **Table Tables R402.1.2.1 and R402.1.2.3**. Where continuous insulation is installed in multiple layers, the R-values of the continuous insulation layers shall be summed to determine compliance with the continuous insulation R-value requirements. Cavity insulation R-values shall not be used to determine compliance with the continuous insulation R-value requirements in **Table Tables R402.1.2.1 and R402.1.2. 3**. Computed *R*-values shall not include an *R*-value for other building materials or air films. Where insulated siding is used for the purpose of complying with the continuous insulation requirements of **Table Tables R402.1.2.1 and R402.1.2.32**, the manufacturer's labeled *R*-value for insulated siding shall be reduced by R-0.6. Average continuous insulation R-values across flat roofs meet the requirements of **Tables R402.1.2.1 and R402.1.2.3**,

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*-values in Tables R402.1.2.1 and R402.1.2.3. The building must still comply with Tables R402.1.2.21, R402.1.2.2, and Table R402.1.2.3.

An assembly with a *U*-factor equal to or less than that specified in Table R402.1.4 shall be permitted as an alternative compliance method with no Table R402.1.2.3 points required, provided that (a) airtightness is less than or equal to 0.15 CFM50/Sq. Ft. of Building Shell (~2 ACH50) 2.0 ACH50 tested, and (b) the ventilation system is: Balanced, with ECM fan(s) plus greater than or equal to 70-percent SRE for HRV, or greater than or equal to 65-percent SRE for ERV.complies with section R304.

Exception: The following are not required to comply with the airtightness limit (a) or the balanced ventilation system and heat recovery efficiency requirements (b).

1. Alterations.

2. Additions complying with this code based on the attributes of the addition alone using the *U*-factor alternative.

TABLE R402.1.4
EQUIVALENT *U*-FACTORS[a,c]

FENESTRATION *U*-FACTOR	SKYLIGHT *U*-FACTOR	CEILING *U*-FACTOR	FRAME WALL *U*-FACTOR	MASS WALL *U*-FACTOR[b]	FLOOR *U*-FACTOR	BASEMENT WALL *U*-FACTOR	CRAWL SPACE WALL *U*-FACTOR	SLAB ON GRADE & UNHEATED SLAB *U*-FACTOR & DEPTH
0.2730	0.4155	0.0202	0.044	0.060	0.03027	0.035 39	0.03539	0.0665, 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.
c. Airtightness of less than or equal to 0.15 CFM50/Sq. Ft. of Building Shell (~2 ACH50)2.0 ACH50 tested and balanced ventilation system with ECM fan(s) plus greater than or equal to 70-percent SRE for HRV, or greater than or equal to 65-percent SRE for ERV are required, compliant with R304, or the building must comply with Tables R402.1.2.2 and R402.1.2.3.

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 provided that (a) airtightness is less than or equal to 2.0 ACH500.15 CFM50/Sq. Ft. of Building Shell (~2 ACH50) tested, and (b) the ventilation system is: balanced, with ECM fan(s), plus greater than or equal to 70-percent SRE for HRV, or greater than or equal to 65-percent SRE for ERVcomplying with R304. The UA calculation shall be performed using a method consistent with the ASHRAE *Handbook of Fundamentals* and shall include the thermal bridging effects of framing materials. In addition to UA compliance, the SHGC requirements of **Table R402.1.2** and the maximum fenestration *U*-factors of **Section R402.5** shall be met.

Exception: The following are not required to comply with the airtightness limit (a) or the balanced ventilation system and heat recovery efficiency requirements (b).

1. Alterations.

2. Additions complying with this code based on the attributes of the addition alone using the Total UA alternative.

R402.1.6 Log homes.
ProjectsLog homes shall comply by doing all of the following steps:

1. Design log home in accordance with ICC 400—2022 or to the requirements of Table R402.1.6.

2. Determine the number of points needed to comply, using Table R402.1.2.2 based on building size.

3. Incorporate a sufficient number of points from Table R402.1.2.3 to meet the points requirement from Table R402.1.2.2.

TABLE R402.1.6
LOG HOME INSULATION, FENESTRATION AND HEATING REQUIREMENTS BY COMPONENT[a]

FENESTRATION *U*-FACTOR[b]	SKYLIGHT *U*-FACTOR	CEILING *R*-VALUE	LOG WALL[d]	FLOOR *R*-VALUE[e]	BASEMENT/ CRAWL SPACE WALL *U*-VALUE[f]	SLAB *R*-VALUE & DEPTH	HEATED SLAB *R*-VALUE[g]	AIR LEAKAGE i	HEATING SYSTEM AFUE[h]
0.30	0.4155	49	≥ 5 in. log	38	R-20ci OR R13+10ci	15, 4 ft. R-20,4' (edge) OR R-15,4'(edge) + R-7.5 (under)	15 edge and under R-20,4' (edge) OR R-15,4'(edge) + R-15 (under)	0.15 CFM50/ Sq. Ft. of Building Shell (~2 ACH50)	90% gas/LP, 85% oil ENERGY STAR basic: (1) Gas/propane furnace ≥ 95 AFUE, Oil furnace ≥ 85 AFUE; (2) Gas/propane boiler ≥ 90 AFUE, Oil boiler ≥ 87 AFUE;

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 inches or greater. Nonlog exterior walls shall be insulated in accordance with Table 402.2.1.
e. Alternatively, 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.
i. "ACH50" = air changes per hour at 50 Pascals building pressure as measured with a blower door. CFM50/Sq. Ft. of Building Shell = amount of air leakage (in cubic feet per minute, or CFM) that leaks out of each square foot of the exterior surface all six sides of the building measured at 50 Pascals of pressure with a blower door.

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 R402.2.15.

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~~ the top of exterior walls where insulation is compressed in the eaves 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~~provided that the balance of the ceiling is at R-49. Where Section R402.~~1.~~21 would require R-60 insulation in the ceiling, installing R-49 over ~~100 percent of the ceiling area requiring insulation~~ the top of exterior walls where insulation is compressed in the eaves 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~~provided the balance of the ceiling is at R-60. 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.

R402.2.2 Ceilings without attic spaces (slopes).
~~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 R402.1.32 shall be limited to 500 square feet (46 m^2) or 20 percent of the total insulated ceiling area, whichever is less.~~ Where Section R402.1.2 would require R-49 insulation in the ceiling, installing R-38 over the top of exterior walls where insulation is compressed in the eaves shall be deemed to satisfy the requirement for R-49 insulation provided that the balance of the ceiling is at R-49. Where Section R402.1 would require R-60 insulation in the ceiling, installing R-49 over the top of exterior walls where insulation is compressed in the eaves shall be deemed to satisfy the requirement for R-60 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 $^{1}/_{4}$ 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~~ a net free area opening equal to or greater than the net free area of the vent. The baffle shall extend over the top of the attic insulation. The baffle shall be permitted to be any solid material.
The baffle shall be installed to the outer edge of the exterior wall top plate so as to provide maximum space for attic insulation coverage over the top plate. Where soffit venting is not continuous, baffles shall be installed continuously to prevent ventilation air in the eave soffit from bypassing the baffle.

R402.2.4 Access hatches and doors.
Access hatches and doors from conditioned spaces to unconditioned spaces such as attics

and crawl spaces shall be weatherstripped and insulated to the same R-value required by ~~Table~~Section R402~~.1.3~~ for the wall or ceiling in which they are installed. ~~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 to unconditioned spaces shall be permitted to meet the fenestration requirements of Table R402.1.2.1.

The reduction shall not apply to the total UA alternative in Section R402.1.5.

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 timber/logs, or any other walls having a heat capacity greater than or equal to 6 Btu/ft^2 × °F (123 kJ/m^2 × 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.~~ Steel-frame ceilings, walls, and floors shall comply with the U-factor requirements of Table R402.1.2.1. The calculation of the U-factor for steel-framed ceilings and walls in an envelope assembly shall be determined in accordance with AISI S250 as modified herein.

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

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

WOOD FRAME *R*-VALUE REQUIREMENT	COLD-FORMED STEEL EQUIVALENT *R*-VALUE[a]
Steel Truss Ceilings[b]	
R-30	R-38 or R-30 + 3 or R-26 + 5
R-38	R-49 or R-38 + 3
R-49	R-38 + 5
Steel Joist Ceilings[b]	
R-30	R-38 in 2 × 4 or 2 × 6 or 2 × 8 R-49 in any framing
R-38	R-49 in 2 × 4 or 2 × 6 or 2 × 8 or 2 × 10
Steel-Framed Wall, 16″ on center	
R-13	R-13 + 4.2 or R-19 + 2.1 or R-21 + 2.8 or R-0 + 9.3 or R-15 + 3.8 or R-21 + 3.1
R-13 + 3	R-0 + 11.2 or R-13 + 6.1 or R-15 + 5.7 or R-19 + 5.0 or R-21 + 4.7
R-13 + 5	R-0 + 15 or R-13 + 9 or R-15 + 8.5 or R-19 + 8 or R-21 + 7
R-13+10	R-0+20 or R-13 + 15 or R-15 + 14 or R-19 + 13 or R-21 + 13
R-20	R-0 + 14.0 or R-13 + 8.9 or R-15 + 8.5 or R-19 + 7.8 or R-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
Steel Framed Wall, 24″ on center	
R-13	R-0 + 9.3 or R-13 + 3.0 or R-15 + 2.4
R-13 + 3	R-0 + 11.2 or R-13 + 4.9 or R-15 + 4.3 or R-19 + 3.5 or R-21 + 3.1
R-13 + 5	R-0 + 15 or R-13 + 7.5 or R-15 + 7 or R-19 + 6 or R-21 + 6
R-13 + 10	R-0 + 20 or R-13 + 13 or R-15 + 12 or R-19 + 11 or R-21 + 11
R-20	R-0 + 14.0 or R-13 + 7.7 or R-15 + 7.1 or R-19 + 6.3 or R-21 + 5.9
R-20 + 5	R-13 + 11.5 or R-15 + 10.9 or R-19 + 10.1 or R-21 + 9.7 or R-25 + 9.1
R-21	R-0 + 14.6 or R-13 + 8.3 or R-15 + 7.7 or R-19 + 6.9 or R-21 + 6.5 or R-25 + 5.9
Steel Joist Floor	
R-13	R-19 in 2 × 6, or R-19 + 6 in 2 × 8 or 2 × 10
R-19	R-19 + 6 in 2 × 6, or R-19 + 12 in 2 × 8 or 2 × 10

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 402.1.2.1 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 R402.1.2.1 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 R402.1.2.1. 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 R402.1.2.1 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 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 and ~~heated~~ conditioned garage insulation.
Sunrooms enclosing *conditioned space* and ~~heating~~ conditioned garages shall meet the insulation requirements of this code.

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

1. The minimum ceiling insulation *R*-value shall be R-~~30~~38.

2. The minimum wall insulation *R*-value shall be R-~~13~~20. Walls separating a *sunroom* or heated garage with a *thermal isolation* from *conditioned space* shall comply with ~~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-percent relative humidity during the winter season), exterior continuous insulation and proper consideration of the vapor permeance of materials are all design elements that can contribute to this protection.

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 /concrete foundation 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 on the interior side of frame walls, 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 engineered approved design.

R402.2.15.3 Class III vapor retarders.
Class III vapor retarders on the interior side of frame walls shall be permitted where any one of the following conditions is met:

1. Vented cladding over any of the following sheathing types:
   a. fiberboard.
   b. gypsum.
   c. plywood (CDX or comparable).
   d. solid wood.
2. Insulated sheathing with *R*-value 7.5 minimum over 2 × 4 wall.
3. Insulated sheathing with *R*-value 11.25 minimum over 2 × 6 wall.

R402.2.15.4 Material vapor retarder class.
The *vapor retarder class* shall be based on the manufacturer's certified testing of a tested assembly. See Section R202, General Definitions, for vapor retarder classes and examples.

R402.2.16 Building Science
Consider building science principles in all design and construction. Buildings should be designed and constructed recognizing principles behind moisture vapor control approaches for cold climates. Maintain the envelope assembly's ability to adequately dry in at least one direction by not installing low-perm vapor retarder materials (e.g., vapor barrier) on both sides of an assembly, seek to optimize the assembly's ability to dry, and limit the potential for wetting. (From Applied Building Technologies Group, LLC).

R402.3 Fenestration ~~(Prescriptive)~~.
In addition to the requirements of Section R402~~.~~.1.2.1~~1~~, fenestration shall comply with Sections R402.3.1 through R402.3.5.

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 R402.1.2.1 provided the ratio of the higher to lower labeled SHGC is greater than or equal to 2.4, and the *dynamic glazing* is automatically controlled to modulate the amount of solar gain into the space in multiple steps. *Dynamic glazing* shall be considered separately from other fenestration, and area-weighted averaging with other fenestration that is not dynamic glazing shall not be permitted.

Exception: *Dynamic glazing* is not required to comply with this section when both the lower and higher labeled SHGC already comply with the requirements of Table R402.1.2.1.

R402.3.3 Glazed fenestration exemption.

Up to 15 square feet (1.4 m^2) of glazed fenestration per dwelling unit shall be permitted to be exempt from *U*-factor and SHGC requirements in Section R402.1.2.1. 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^2) in area is exempted from the *U*-factor requirement in Section R402.1.2.1. 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 and ~~heated~~ conditioned garage fenestration.

Sunrooms and ~~heated~~ conditioned garages enclosing *conditioned space* shall meet the fenestration requirements of this code.

Exception: ~~For~~ *sunrooms and ~~heated~~ conditioned garages* with *thermal isolation* and enclosing *conditioned space*, the ~~maximum~~ fenestration *U*-factor shall not exceed ~~be~~ 0.3045 ~~and the maximum *skylight U*-factor shall not exceed 0.4155~~.

New fenestration separating ~~a~~the *sunroom* or heated garage 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 this Section~~s **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~~ through R402.4.1.3~~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.

TABLE R402.4.1.1
AIR BARRIER, AIR SEALING AND INSULATION INSTALLATION

COMPONENT	AIR BARRIER CRITERIA	INSULATION INSTALLATION CRITERIA
General conditions and appropriate materials for air barriers	A continuous, durable air barrier shall be installed in the building envelope. ~~The exterior thermal envelope contains a continuous, durable air barrier.~~ Breaks or joints in the air barrier shall be sealed. ~~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) inter-ruptions. Open-cell or closed-cell foam shall have a finished thickness greater than or equal to 5.5 in. or 1.5 in., respectively, to qualify as an air barrier unless the manufacturer indicates otherwise. If flexible air barriers are used, they shall be fully sealed at all seams and edges and supported in accordance with 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 greater than or equal to 6 mil. Materials meeting ASTM E2357 Standard Test Method for Determining Air Leakage of Air Barrier Assemblies are acceptable.	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.
Dropped ceilings/soffits	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. Access openings, drop down stairs or knee wall doors to unconditioned attic spaces shall be sealed, insulated and gasketed.	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.
Framing junctions and cavities	The junction of the foundation and sill	Cavities within corners and headers

	plate shall be sealed. The junction of the top plate and the 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.	of frame walls shall be insulated by completely filling the cavity with a material having a minimum thermal resistance of R-3 per inch. 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.
Windows, skylights and doors	The space between window/door jambs and framing, and skylights and framing shall be sealed with minimally-expanding foam, ~~.~~caulk with backer rod and sealant as well as flexible membranes supported by or adhered to rigid air barrier material.	—
Rim joists	Rim joists shall include ~~the~~ an exterior 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.	Rim joists shall be insulated and air sealed~~.~~ so that the insulation maintains permanent contact with the exterior rim board.[b]
Floors (including above garage and cantile vered floors)	The air barrier shall be installed at any exposed edge of insulation.	Floor framing cavity insulation shall be installed to maintain permanent contact with the underside of subfloor decking, or floor framing cavity insulation shall be permitted to 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~~Basement crawl space and slab foundations	Exposed earth in unvented crawl spaces shall be covered with a Class I vapor retarder/air barrier ~~with overlapping joints taped.~~in accordance with Section R402.2.10 with overlapping joints taped.in accordance with Section R402.2.10. Penetrations through concrete foundation walls and slabs shall be air sealed. Class 1 vapor retarders shall not be used as an air barrier on below-grade	Where provided instead of floor insulation, vapor barrier shall be ~~permanently attached to the crawlspace walls.~~ installed in accordance with Section R402.2.10. Conditioned basement foundation wall insulation shall be installed in accordance with Section R402.2.8~~.1~~. Slab-on-grade floor insulation shall be installed in accordance with Section R402.2.10.

	walls and shall be installed in accordance with Section R702.7 of the *International Residential Code*.	
Shafts, penetrations	Duct and flue shafts, and other penetrations~~utility penetrations, and flue shafts opening~~ to exterior or unconditioned space shall be sealed to allow for expansion, contraction and mechanical vibration. Utility penetrations of the air barrier shall be caulked, gasketed or otherwise sealed and shall allow for expansion, contraction of materials and mechanical vibration.~~.~~ Doors or hatches in knee walls opening to exterior or unconditioned space shall be insulated and gasketed.	Insulation shall be fitted tightly around utilities passing through shafts and penetrations in the building thermal envelope to maintain required *R*-value.—

(continued)

TABLE R402.4.1.1—continued
AIR BARRIER AND INSULATION INSTALLATION

COMPONENT	AIR BARRIER CRITERIA	INSULATION INSTALLATION CRITERIA
Narrow cavities	Narrow cavities of 1 inch or less that are not able to be insulated shall be air sealed.—	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*.	Insulated portions of the garage separation assembly shall be installed in accordance with Sections R303 and R402.2.7.and R402.2.7.—
Recessed lighting and appliances	Recessed light fixtures installed in the building thermal envelope shall be air sealed in accordance with Section R402.4.5. Recessed light fixtures and other appliances (speakers, exhaust fans, light shafts, etc.) installed in the building thermal envelope shall be ICAT (Insulation Contact and Air Tight) 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	Recessed light fixtures installed in the building thermal envelope shall be airtight and ICAT rated (ICAT-rated indicates Insulation Contact and Airtight and meets the IC and air tightness requirement), and shall be buried or surrounded with insulation.~~.~~

	and appliances shall maintain required clearances of not less than 1/2 inch from combustible material and not less than 3 inches from insulation material, or as required by manufacturer's installation requirements.	
Plumbing and wiring	~~All plumbing and wiring penetrations shall be sealed to the air barrier.~~ All holes created by wiring, plumbing or other penetrations in the air barrier assembly shall be air sealed.	Insulation shall be installed to fill the available space and surround wiring, plumbing, or other obstructions, unless the required *R*-value can be met by installing insulation and air barrier systems completely to the exterior side of the obstructions. Insulation shall be placed between the exterior of the wall assembly and pipes. Insulation should not be installed on the interior of the piping. 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 the 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. Fireplaces shall have compression closure doors and combustion air supplied from the out doors.	

a. In addition, inspection of log walls shall be in accordance with the provisions of ICC-400—2022~~2017~~.
b. Air barrier and insulation full enclosure is not required in unconditioned/ventilated attic spaces and at rim joints.

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~~ two (~~3~~2) air changes per hour or ~~X~~ 0.15 ~~c~~CFM50~~fm~~/Sq. Ft. Building Shell~~square feet of shell~~ area of all six sides of the building. Testing shall be conducted in accordance with **ANSI/RESNET/ICC 380**, **ASTM E779** or **ASTM E1827** and reported at a pressure of 0.2 inches w.g. (50 Pascals). Multifamily buildings shall comply with CBES C402.4. ~~for buildings up to five (5) stories of height above grade, and at 75 Pascals for buildings six (6) stories and taller~~. 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 Department of Public Service 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.

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

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) and CFM50/Sq. Ft. Building Shell area of all six sides of the building.

~~**Exception:** 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 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 2016~~9~~.

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^2), and swinging doors no more than 0.5 cfm per square foot (2.6 L/s/m^2), when tested according to **NFRC 400** or **AAMA/WDMA/CSA 101/I.S.2/A440** by an accredited, independent laboratory and *listed* and *labeled* by the manufacturer.

Exception: Site-built windows, skylights and doors.

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*.

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 ICAT-rated (Insulation Contact and Airtight) or 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.

R402.4.6 Electrical and communication outlet boxes (air-sealed boxes).
Electrical and communication outlet boxes installed in the building thermal envelope that ~~are through or outside~~penetrate the building air barrier shall be sealed to limit air leakage between conditioned and unconditioned spaces. Electrical and communication outlet boxes shall be tested in accordance with **NEMA OS 4**, Requirements for Air-Sealed Boxes for Electrical and Communication Applications, and shall have an air leakage rate of not greater than 2.0 cubic feet per minute (0.944 L/s) at a pressure differential of 1.57 psf (75 Pa). Electrical and communication outlet boxes shall be marked "NEMA OS 4" or "OS 4" in accordance with **NEMA OS 4**. Electrical and communication outlet boxes shall be installed per the manufacturer's instructions and with any supplied components required to achieve compliance with **NEMA OS 4**.

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 0.41~~55~~ for skylights.

R402.6 Vestibules.
Multifamily buildings three stories or less built above a parking garage require a vestibule in accordance with Section C402.4.7 from the Vermont Commercial Building Energy Standards (CBES).

R402.7 Solar-ready zone.

R402.7.1 General.
Solar-ready zone is required for Stretch Code but is optional for Base Code. Points are available for meeting the solar-ready zone requirements for Base Code.

For Stretch Code, ~~N~~new detached one- and two-family dwellings, and multiple single-family dwellings (townhouses) with not less than 600 square feet (55.74 m^2) of roof area oriented between 110 and 270 degrees of true north shall comply with this Section ~~R407.5.2.7. Multifamily buildings shall comply with CBES C402.5.~~

Exceptions:

1. New residential buildings with a permanently installed on-site renewable energy system.

2. A building where all areas of the roof that would otherwise meet the

requirements of Section R407.5 are in full or partial shade for more than 70 percent 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.

Multifamily buildings shall comply with CBES C402.5.

R402.7.2 Construction document requirements for solar-ready zone.

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

R402.7.3 Solar-ready zone area.

The total solar-ready zone area shall consist of an area not less than 300 square feet (27.87 m^2) per dwelling exclusive of mandatory access or setback 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 square feet (185.8 m^2) per dwelling shall have a solar-ready zone area of not less than 150 square feet (13.94 m^2) per dwelling. The solar-ready zone area shall be not less than 40 percent of the roof area calculated as the horizontally projected gross roof area less the area covered by skylights, occupied roof decks, vegetative roof areas and mandatory access or set back areas as required by the *International Fire Code*. The solar-ready zone shall be composed of areas not less than 5 feet (1524 mm) in width and not less than 80 square feet (7.44 m^2) exclusive of access or 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.

R402.7.4 Obstructions.

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

R402.7.5 Shading.

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

R402.7.6 Capped roof penetration sleeve.

A capped roof penetration sleeve shall be provided adjacent to a solar-ready zone located on a roof slope of not greater than 1 unit vertical in 12 units horizontal (8-percent slope). The capped roof penetration sleeve shall be sized to accommodate the future photovoltaic system conduit but shall have an inside diameter of not less than 11/4 inches (32 mm).

R402.7.7 Roof load documentation.

The structural design loads for roof dead load and roof live load to support the solar system shall be clearly indicated on the construction documents.

R402.7.8 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-inch 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, airtight and labeled at both ends.

R402.7.9 Electrical service reserved space.

The main electrical service panel shall have a reserved space to allow installation of a dual pole circuit breaker for future solar electric installation and shall be labeled "For Future Solar Electric." The reserved space shall be positioned at the opposite (load) end from the input feeder location or main circuit location. Note: this requirement is in addition to the electrical service reserved space for electric vehicle charging. This requirement is only for the building master panel and not individual dwelling unit panels in the case of multifamily buildings.

R402.7.10 Electrical energy storage system-ready area.

The floor area of the electrical energy storage system-ready area shall be not less than 2 feet (610 mm) in one dimension and 4 feet (1219 mm) in another dimension and located in accordance with Section 1207 of the *International Fire Code*. The location and layout diagram of the electrical energy storage system-ready area shall be indicated on the construction documents.

R402.7.10~~0~~1 Construction documentation certificate.

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

R402.8 *Tiny house~~s~~*.

Tiny Houses as defined in Chapter 2 must comply with the envelope, insulation and fenestration requirements below. All other code provisions are still required. ~~with the exception that the mechanical ventilation system is not required to be a *balanced ventilation system* and may~~

be ~~exhaust-only.~~

Tiny houses require the following:

- ceiling flat attic U-0.033 (R-30);
- ceiling slope U-0.04 (R-24);
- above grade walls U-0.08 (R-13);
- frame floors U-0.05 (R-21);
- basement/crawl space walls R-20 continuous (ci) or R13+10ci;
- slab on grade R-20 for 4' on edge or under, OR R-15,4'(edge) + R-15 (under entire slab);
- heated slab on grade R-20,4' (edge) + R-15 (under entire slab);
- windows U-0.30;
- doors U-0.37;
- air leakage 0.15 CFM50/Sq. Ft. of Building Shell (~2 ACH50);
- ducts inside thermal boundary.

Compliance with all other provisions of this code is required.

Exception: Mechanical ventilation system for *tiny houses* is not required to be a *balanced ventilation system* and may be exhaust-only.

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 and different days of the week. 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.

Exception: The following are allowed only where a 5-wire connection to thermostat location is provided:

1. Radiant floor, wall, ceiling and/or beam system on dedicated zone.
2. *Cold-climate heat pump* not designed for setbacks.
3. Wi-Fi or "smart" Internet-connected thermostats

.

R403.1.2 Ductless ~~H~~heat pump supplementary heat.

Ductless ~~H~~heat pumps shall not have integrated supplementary electric-resistance heat other than that provided for frost control. See Section R404.4~~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 R403.3.2~~75~~.

R403.3.1 Duct placement.

All ducts and air handlers shall be located within *conditioned space*.

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

~~**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.

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 structure where the ducts and air handlers are located entirely within the *building thermal envelope*.

2. 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 Department of Public Service approved duct leakage tester, and provided to the *code official or authority having jurisdiction*, where one exists, and to the *Department of Public Service* 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:

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^2) 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^2) 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 ductsductwork to be considered as inside a *conditioned space*, such ducts it shall comply with eitherone 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 shallDuctwork in ventilated attic spaces 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^2) of conditioned floor area served by the duct system.

2.3. The ceiling insulation *R*-value installed against and above the insulated duct is greater than or equal to the proposed ceiling insulation *R*-value, less the *R*-value of the insulation on the duct.

3. Ductwork in floor cavities located over unconditioned space shall comply with all of the following:
3.1. A continuous air barrier installed between unconditioned space and the duct.
3.2. Insulation installed in accordance with **Section R402.2.7**.
3.3. A minimum R-19 insulation installed in the cavity width separating the duct from unconditioned space
4. Ductwork located within exterior walls of the building thermal envelope shall comply with the following:
4.1. A continuous air barrier installed between unconditioned space or outdoors and the duct.
4.2. Minimum R-10 insulation installed in the cavity width separating the duct from the outside sheathing.
4.3. The remainder of the cavity insulation shall be fully insulated to the drywall side.

R403.4 Mechanical system piping insulation (Mandatory).
Mechanical system piping designed to carry fluids above 105°F (41°C) or below 55°F (13°C) shall be located within the building thermal envelope and insulated to a minimum of R-34.

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 through R403.5.4.

Exception: Systems serving multiple dwelling units shall comply with CBES C404, but will not be subject to the additional requirements outlined in Tables C406.1.1 and Table C406.1.2.

R403.5.1 Heated water circulation and temperature maintenance systems ~~(Mandatory)~~.
Where installed, ~~H~~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.
Where installed, ~~H~~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.
~~-~~The controls shall limit the temperature of the water entering the cold~~-~~water piping to not greater than 104ºF (40ºC).

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 control 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 control 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 service hot water pipe with a minimum thermal resistance (*R*-value) of R-~~3~~4 shall be applied to the following:

1. Piping $^{3}/_{4}$ inch (19.1 mm) and larger in nominal diameter located inside the *conditioned space*.
2. Piping 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 ~~in~~ piping.
7. Supply and return piping in circulation and recirculation systems other than cold water pipe return 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).~~
Follow the mechanical ventilation requirements in R304.
~~The building Buildings and *dwelling units* shall be provided with mechanical 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 Heat or energy recovery ventilation.** Dwelling units shall be provided with a heat recovery or energy recovery ventilation system. in Climate Zones 7 and 8. The system shall be balanced with a minimum sensible heat recovery efficiency of 65 percent at 32°F (0°C), determined in accordance with HVI Publication 920, at a flow greater than or equal to the design airflow.~~

~~**R403.6.1R403.6.2 Whole-housedwelling 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.Fans used to provide whole housedwellinghouse dwelling mechanical ventilation shall meet the efficacy requirements of Table R403.6.2 at one or more rating points. Fans shall be tested in accordance with HVI 916 and listed. The airflow shall be reported in the product listing or on the label. Fan efficacy shall be reported in the product listing or shall be derived from the input power and airflow values reported in the product listing or on the label. Fan efficacy for fully ducted HRV, ERC, balanced, and in-line fans shall be determined at a static pressure of not less than 0.2 inch w.c. (49.85 Pa). Fan efficacy for ducted range hoods, bathroom and utility room fans shall be determined at a static pressure of not less than 0.1 inch w.c. (24.91 Pa).

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

TABLE R403.6.1

WHOLE HOUSE FAN MECHANICAL VENTILATION SYSTEM FAN EFFICACY[a]

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 supply or exhaust fan	Any	32.8 cfm/watt	Any
Bathroom, utility roomOther exhaust fan	< 9010	2.81.4 cfm/watt	< 90
Bathroom, utility room Other exhaust fan	≥ 90	3.52.8 cfm/watt	Any
Air-handler that is integrated to tested and *listed* HVAC equipment	Any	1.2 cfm/watt	

For SI: 1 cfm = 28.3 L/min.

a. When tested in accordance with the 2018 *International Building Code*.Design outdoor airflow rate/watts of fan used.

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 20202023 *Vermont Commercial Building Energy Standards* (CBES) in lieu of Section R403 but

will not be subject to the additional requirements outlined in Tables C406.1.1 and Table 406.1.2.

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.
~~Residential swimming pools and residential 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 house-hold and its guests shall be in accordance with APSP-15.~~
Where installed, the energy consumption of residential swimming pools and permanent residential spas shall be controlled in accordance with the requirements of APSP 15a.

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 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 of not fewer than 3 calendar months, 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**.

SECTION R404
ELECTRICAL POWER AND LIGHTING SYSTEMS

R404.1 Lighting equipment ~~(Mandatory)~~.
~~Not less than 90 percent of the~~ All ~~lamps (or "bulbs") in~~ permanently installed lighting fixtures, excluding kitchen appliance lighting fixtures, shall contain only high-efficacy lighting sources. ~~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 in calculating the percentage.~~

R404.1.1 Exterior lighting.
~~Connected e~~Exterior lighting for residential buildings shall comply with Sections ~~C405~~ and C405.5 (Exterior Lighting Power Requirements) of the *Vermont Commercial Building Energy Standards* (CBES).~~54.~~4. ~~**Lighting equipment (Mandatory).**~~
~~Fuel gas lighting systems shall not have continuously burning pilot lights.~~

Exceptions:

1. Detached one- and two- family dwellings.
2. Townhouses.
3. Solar-powered lamps not connected to any electrical service.
4. Luminaires controlled by a motion sensor.
5. Lamps and luminaires that comply with Section R404.1.

R404.1.2 Lighting equipment for multifamily spaces ~~(Mandatory).~~
Multifamily buildings three-stories or less with common areas, stairwells, vestibules, lobbies, parking garages, and exterior parking areas and drives must meet the lighting power density (LPD) specifications of the *Vermont Commercial Building Energy Standards* (CBES). For parking garages, see Section C405.3.2; for uncovered parking areas and drives, see Section C405.~~5~~4.2.

R404.1.~~3~~2 Fuel gas lighting equipment. Fuel gas lighting systems ~~shall not have continuously burning pilot lights.~~ shall not be permitted.

R404.1.~~4~~34 Exterior lighting controls. Where the total permanently installed exterior lighting power is greater than 30 watts, the permanently installed exterior lighting shall comply with the following

1. Lighting shall be controlled by a manual on and off switch which permits automatic shut-off actions. Exception: Lighting serving multiple dwelling units.
2. Lighting shall be automatically shut off when daylight is present and satisfies the

lighting needs.
3. Controls that override automatic shut-off actions shall not be allowed unless the override automatically returns automatic control to its normal operation within 24 hours.

For multifamily buildings, follow C405.2.7 (Exterior Lighting Controls).

R404.2 Electric ~~resistance~~ heating equipment.
Heat pumps ~~having supplementary electric resistance heat~~ shall be certified *cold-climate heat pumps* only and shall have controls that, except during defrost, prevent supplementary electric heat operation where the heat pump compressor can meet the heating load.

Building heating with electric-resistance heating equipment is prohibited.

Exceptions:

1. Replacement of existing electrical resistance units.

2. Limited areas where other heating sources are cost prohibitive or impractical (for example, a small interior space such as a bathroom or stairwell, which is distant from the distribution system).

3. Buildings with cold-climate heat pump(s) as the primary heating system, provided that:

   a. The supplemental electric-resistance heat is controlled to prevent it from operating at an outside air temperature of 5°F or higher.

   b. The building has a tested air tightness of less than or equal to ~~2.0 ACH50~~0.15 CFM50/Sq. Ft. of Building Shell (~2 ACH50).

4. Multifamily buildings with heating loads less than or equal to 6.0 Btu/h/ft^2 at design temperature.

Note: Buildings served by the Burlington Electric Department (BED) must also receive approval from BED before installing electric resistance heating equipment.

R404.3 Electric vehicle charging.
One *Electric Vehicle Charging - Level 2 Capable* parking space or *Electric Vehicle Charging - Level 2 EVSE* is required for new construction based on Table R404.~~5~~3.

Exception: Electric vehicle parking spaces are not required if one of the following conditions apply:

1. Parking spaces intended exclusively for storage of vehicles for retail sale or vehicle service.
2. Parking spaces are separated from the meter by a public right-of-way.
3. Parking spaces which are limited to parking durations of less than one hour.
4. EV Capable Spaces are not required where no parking spaces are provided.

Parking spaces with *electric vehicle supply equipment* (*EVSE*) shall be marked for EV use only.

Exception: The number of parking spaces with *EVSE* that are marked for "EV use only" need not exceed the number of EV cars driven by occupants of the building. This exception does not reduce the number of EVSE spaces required, just the number that are marked for EV use only.

~~New parking lots serving *multifamily* developments of 10 or more dwelling units shall provide either Level 1 or Level 2 electrical service within 5 feet (1524 mm) of the centerline of the parking space (EV charging parking space) with the capacity to serve the number of electric vehicle charging parking spaces in Table R404.3. Electrical service capacity includes use of a listed cabinet, box or enclosure connected to a conduit linking the parking spaces with the electrical service.~~

~~**Exception:** Parking spaces are not counted in Table R404.3 if one of the following conditions applies:~~

~~1. Parking spaces intended exclusively for storage of vehicles for retail sale or vehicle service.~~

~~2. Parking spaces are separated from the meter by a public right-of-way.~~

~~3. Parking spaces which are limited to parking durations of less than one hour.~~

~~Parking spaces with *electric vehicle supply equipment* (EVSE) shall be marked for EV use only.~~

~~**Exception:** The number of parking spaces with EVSE that are marked for "EV use only" need not exceed the number of EV cars driven by occupants of the building. This exception does not reduce the number of EVSE spaces required, just the number that are marked for EV use only.~~

~~Level 1 electric vehicle charging parking requires one 120V 20 amp grounded AC receptacle, NEMA 5-20R or equivalent, within 5 feet (1524 mm) of the centerline of each EV charging parking space.~~

~~Level 2 electric vehicle charging parking requires one 208/240V 40 amp grounded connection for electric vehicle charging through dedicated EVSE with J1772 connector or AC receptacle, NEMA 14-50, or equivalent, within 5 feet (1524 mm) of the centerline for each EV charging parking space.~~

TABLE R404~~.~~3 REQUIRED LEVEL 2 CAPABLE ELECTRIC VEHICLE CHARGING PARKING SPACES FOR ~~MULTIFAMILY~~ ALL NEW BUILDINGS (BASE CODE and STRETCH CODE)

BUILDING/PARKING TYPE	MINIMUM REQUIRED NUMBER OF LEVEL 2 CAPABLE EV CHARGING PARKING SPACES
~~New~~ Single Family Home or Multifamily Building	~~1 per dwelling unit~~ 1 per dwelling unit or the number of parking

	spaces provided, whichever is less
Additional Parking Spaces	~~1 per dwelling unit~~25% of ~~remaining~~provided parking spaces not utilized by dwelling units, or 40 spaces, whichever is less

For *multifamily building* garage or covered parking, provide on electrical drawings the appropriate sized pathway to the building electrical room to accommodate a future electrical upgrade for Level 2 EVSE electric vehicle charging; provide adequate wall and floor space in the building electrical room for future EV charging related electrical equipment; provide the appropriate sized pathways to exterior on-grade surface parking spaces for future Level 2 EVSE electric vehicle charging; provide a line diagram on the electrical drawings demonstrating a pathway for future Level 2 EVSE electric vehicle charging. Quantity of future Level 2 EVSE electric vehicle charging stations shall be as required by Table R404.3.

R404.~~6~~4 200 Amp Electrical Service.

Each new ~~dwelling unit~~ building~~located in a Group R-2 building~~ except for individual multifamily units shall be supplied with at least ~~have~~ 200 amp electrical service in anticipation of increased electrical services that will need to be provided in the future.

R404.5 Dwelling electrical meter.

Each residential unit and each dwelling unit located i**n a** *Group R*-2 building shall have a separate electrical meter.

Exception: Buildings where a majority of the living units serve tenants at or below 80 percent of area median income~~Buildings serving low-income occupants~~.

R404.6 Electrical transformers.

Low-voltage dry-type distribution electric transformers shall meet the minimum efficiency requirements of Table R405.6 as tested and rated in accordance with the test procedure listed in DOE 10 CFR 431. The efficiency shall be verified through certification under an approved certification program or, where a certification program does not exist, the equipment efficiency ratings shall be supported by data furnished by the transformer manufacturer.

Exception: The following transformers are exempt:

1. Transformers that meet the *Energy Policy Act of 2005* exclusions based on the DOE 10 CFR 431 definition of special purpose applications.
2. Transformers that meet the *Energy Policy Act of 2005* exclusions that are not to be used in general purpose applications based on information provided in DOE 10 CFR 431.
3. Transformers that meet the *Energy Policy Act of 2005* exclusions with multiple voltage taps where the highest tap is not less than 20 percent more than the lowest tap.

4. Drive transformers.

5. Rectifier transformers.

6. Auto-transformers.

7. Uninterruptible power system transformers.

8. Impedance transformers.

9. Regulating transformers.

10. Sealed and nonventilating transformers.

11. Machine tool transformers.

12. Welding transformers.

13. Grounding transformers.

14. Testing transformers.

TABLE R405.6
MINIMUM NOMINAL EFFICIENCY LEVELS FOR 10 CFR 431 LOW-VOLTAGE DRY-TYPE DISTRIBUTION TRANSFORMERS

SINGLE-PHASE TRANSFORMERS		THREE-PHASE TRANSFORMERS	
kVA[a]	Efficiency (%)[b]	kVA[a]	Efficiency (%)[b]
15	97.70	15	97.89
25	98.00	30	98.23
37.5	98.20	45	98.40
50	98.30	75	98.60
75	98.50	112.5	98.74
100	98.60	150	98.83
167	98.70	225	98.94
250	98.80	300	99.02
333	98.90	500	99.14
—	—	750	99.23
—	—	1000	99.28

a. kiloVolt-Amp rating.
b. Nominal efficiencies shall be established in accordance with the DOE 10 CFR 431 test procedure for low-voltage dry-type transformers.

SECTION R405
ALTERNATIVE USING RES*check*™ SOFTWARE

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 applicable provisions in Sections ~~R402.1.1, R403.3.1, R403.5.3 and the mandatory provisions identified in Sections~~ R401.3, R402, R403 ~~and~~ R404 and Chapter 3 be met~~., and the building airtightness is less than or equal to 2.0 ACH50~~0.15 ~~CFM50/Sq. Ft. of Building Shell (~2 ACH50) tested, and the ventilation system is: balanced, with ECM fan(s), plus greater than or equal to 70 percent SRE for HRV, or greater than or equal to 65 percent SRE for ERV~~. ~~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 RES*check*™ modeling software that indicates the home meets or exceeds the target UA for that building.

SECTION R406
ENERGY RATING INDEX / HOME ENERGY RATING SYSTEM
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 Department of Public Service-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 applicable provisions in Sections ~~R402.1.1, R403.3.1, R403.5.3 and the mandatory provisions identified in Sections~~ R401.3, R402, R403 and R404 be met. The *building thermal envelope* shall be greater than or equal to levels of efficiency and *solar heat gain coefficients* 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/HERS-Bbased cCompliance for *Base Code* and *Stretch Code*.

Compliance based on an ERI analysis requires that the *rated design* be shown to have an ERI/HERS Index less than or equal to 61 54 for *Base Code* and less than or equal to 47 for *Stretch Code* 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. The ERI to be used to verify compliance is "HERS Index with IAF" using REM/Rate version 15.7ERS energy rating that demonstrates compliance with Section 406.4 for the Base or Stretch Code based on REM v16.3.3 or later or Ekotrope version 4.0 or later that is accredited by RESNET at https://www.resnet.us/providers/accredited-providers/hers-software-tools/. . Up to 5 ERI points can be earned with renewables. If the HERS Index scale is revised, the Department of Public Service may update these Index points.

TABLE R406.4
ERI/HERS COMPLIANCE FOR BASE CODE AND STRETCH CODE

BASE CODE	STRETCH CODE
5460	4759

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 R406.76.43.

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 authority having jurisdiction*, where one exists and be an approved Software Rating Tool 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.

R406.67.3 Renewable Eenergy cCertificate (REC) dDocumentation.

Where on-site renewable energy is included in the calculation of an ERI, one of the following forms of documentation shall be provided to the *code official or authority having jurisdiction,* where one exists:

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

~~R406.6.3~~R406.67.4 Additional documentation.

The *code official or 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 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 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. Residential projects under Act 250 jurisdiction as well as residential buildings in municipalities that adopt the *Stretch Code* shall demonstrate compliance with Section R407. All other requirements in the RBES shall apply.

All *Base Code* requirements shall be met in addition to the requirements in this *Stretch Code* section R407 in order to be in compliance with the Stretch Code.

R407.2 Compliance

Compliance for *Stretch Code* shall be documented through either Section R407~~2~~.1.2.1 "Package Plus Points Approach" or Section R406 ~~7.2.2 ERI-based compliance for Stretch Code~~"Energy Rating Index / Home Energy Rating System (HERS) Compliance Approach".

For both Base Code and Stretch Code compliance, in Section R402.1.2.1 "Package Plus Points Approach", the same standard package is used. Stretch Code then requires more Points than the Base Code. For ERI/HERS compliance, a lower HERS Index is required for Stretch Code than for Base Code.

Strech Code requires Soar

~~R407.2.1 Package Plus Points Approach.~~

~~**R407.2.1.1**~~
~~Projects shall comply by completing all of the following steps.~~

~~1. Select one of the three base packages listed in Table R407.2.1.1.~~

~~2. Determine the number of points needed to comply with Table R407.2.1.2. based on building size.~~

~~3. Incorporate a sufficient number of points from Table R407.2.1.3 to meet the points requirements from Table R407.2.1.2.~~

TABLE R407.2.1.3
POINTS BY COMPONENT

COMPONENT		DESCRIPTION	POINTS
Envelope	Slab	R-10 below entire slab	1
	Walls — Upgraded	Above grade walls R-20 + 12 or (*U*-factor maximum 0.033 wall assembly) (Not available for base package 3) OR [b]	2
	Walls — High-R	Above grade walls ≥ R-40 (cavity and continuous) or (*U*-factor maximum 0.025 wall assembly)	3
	Ceiling	R-80 attic flat/R-60 sloped, vaulted and cathedral	1
	Windows	Average *U*-factor ≤ 0.22	2
Air leakage and ventilation	Pre-drywall	ACH50 is tested with blower door after full insulation/primary air barrier completion but before insulation is fully enclosed/covered OR [b]	1
	Tight	ACH50 ≤ 2.0 and balanced ventilation with ECM fans and ≥ 70% SRE for HRV; ≥ 65% SRE for ERV OR [b]	1
	Very tight	ACH50 ≤ 1.0 and balanced ventilation with ECM fans and ≥ 80% SRE for HRV; ≥ 75% SRE for	4

		ERV	
Heating and cooling[a]	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 OR[b]	1
	Advanced	Whole building heat/cool is: (1) NEEP-listed[d] heat pump combination; (2) GSHP; closed loop and COP ≥ 3.3; (3) ATWHP COP ≥ 2.5 and 120°F design temp, (4) Advanced wood heating system	3
Water	Basic	ENERGY STAR basic: Fossil fuel [EF 0.67 for ≤ 55 gal; EF 0.77 for > 55 gal] OR[b] -	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, all lavatory faucets ≤ 1.0 gpm, and all toilets ≤ 1.28 gpf[c] - OR[b] -	1
	Certified[k] -	Certified water efficient design per WERS, WaterSense, or RESNET HERSH2O (for new construction only)	2

	Drain heat recovery	Drain water heat recovery system on primary showers and tubs	1
	User-demand	Controlled hot water recirculation system with user-demand via push-button for furthest fixtures	1
Renewables	On-site generation	Solar photovoltaic (PV) (or other on-site renewable energy system), 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
	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 ready for multifamily	Multifamily building complies with Solar Ready Zone Section R407.5.	1
	Monitoring	Install whole-building energy monitoring system, minimum 5 circuits and homeowner access to data	1
Other measures	EV ready	Level 2 electric vehicle charger-ready per Section R407.4[e]	1
	Battery	Minimum 6 kWh grid-connected	1

		~~dispatchable demand-response-enabled battery backup~~	

~~**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 54 456 when compared to the *ERI reference design*. This includes all residential structures, including log homes. The ERI to be used to verify compliance is "HERS Index with IAF" using REM/Rate version 15.7. Up to 5 ERI points can be earned with renewables.~~

~~**R407.3 Air leakage testing for Stretch Code.**~~

~~In addition to the requirements in Section 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 Electrical vehicle charging for Stretch Code.**~~

~~**R407.5 Solar-ready zone for Stretch Code.**~~

SECTION R408
INSULATION EMBODIED CARBON EMISSIONS

R408.1 Insulation Embodied Carbon

In order to earn Points from Table 402.1.2.3, ~~C~~complete calculation Table 408.1.1 to summarize estimated embodied carbon emissions from insulation materials used in the project. The output metric for this measure shall be global warming potential (GWP) intensity, capturing insulation GWP per conditioned square foot of project area. To complete the basic calculation, project teams shall provide the following information for foundation, wall, and roof insulation materials:

1. Insulation material type
2. Product R-value
3. Total surface area (ft^2)
4. Default, industry-average GWP value, from Table 408.1.2 or GWP values from *Type III Product-specific Environmental Product Declaration (EPD)*
5. Total project area (conditioned square feet)

Projects may substitute product-specific data for the default GWP value if the specified product has a lower reported GWP than the default value. Product-specific shall be substituted in Column G of the calculation Table 408.1.1. Substitution of default GWP values is only allowed when type III product-specific EPDs are sourced and noted in Column G. Projects shall use GWP values that include A1-A3 lifecycle stages, as documented in product-specific EPDs, with the exception of SPF and XPS products. For these products, the A5 and B1 values shall be

included in the documented GWP value to account for the on-site and offgassing impact of blowing agents. Projects shall provide the EPDs declaration number in Column G.

TABLE R408.1.1
INSULATION GLOBAL WARMING POTENTIAL CALCULATION

Table 1 - Insulation Global Warming Potential Calculation

A	B		C		D		E		
Assembly	Material *List insulation material type from Table 2*		Product R-Value		Surface Area (gross square feet)		Framing Factor ("1.0" for continuous, "0.8" for cavity)		Default G Warming (kg CO2e 1) *Use Defau values fro Leave blan products product sp will be pro*
Slab edge				X		X	1.0	X	
Under slab				X		X	1.0	X	
Basement walls				X		X	1.0	X	
Above grade walls, cavity				X		X	0.8	X	
Above grade walls, continuous				X		X	1.0	X	
Roof, flat				X		X	1.0	X	
Roof, sloped, cavity				X		X	0.8	X	
Roof, sloped, continuous				X		X	1.0	X	

	Input for basic calculation
	Inputs for product-specific data
	Calculation outputs

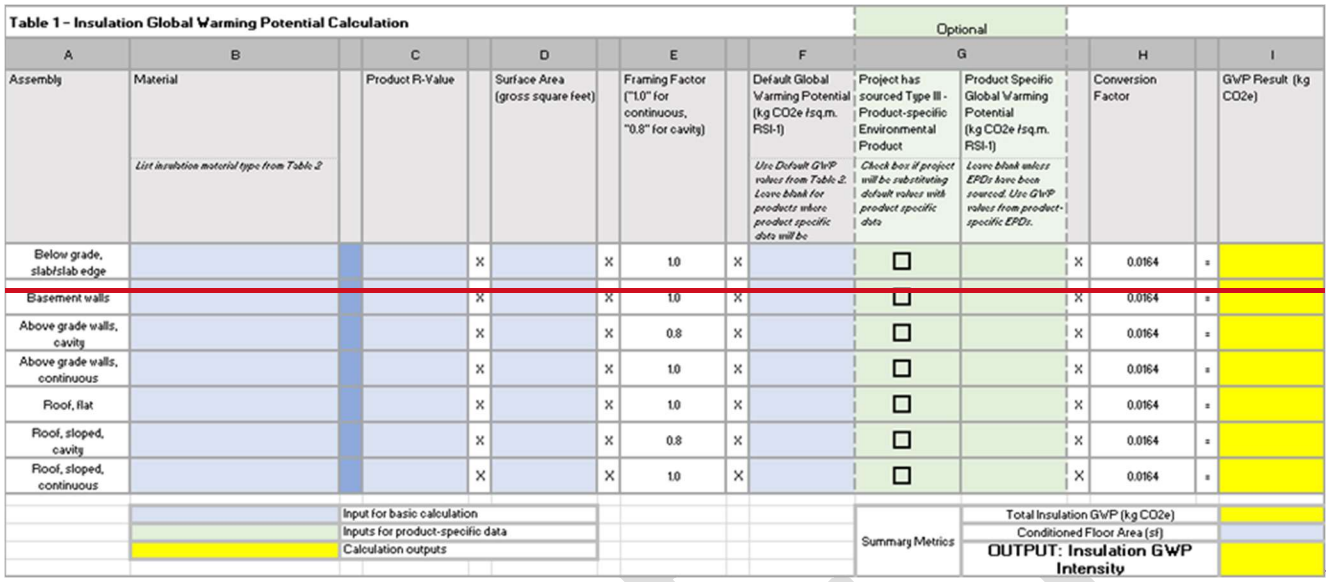

Table 1 – Insulation Global Warming Potential Calculation								Optional				
A	B		C		D		E	F	G		H	I
Assembly	Material *List insulation material type from Table 2*		Product R-Value		Surface Area (gross square feet)		Framing Factor ("1.0" for continuous, "0.8" for cavity)	Default Global Warming Potential (kg CO2e /sq.m. RSI-1) *Use Default GWP values from Table 2. Leave blank for products where product specific data will be*	Project has sourced Type III - Product-specific Environmental Product *Check box if project will be substituting default values with product specific data*	Product Specific Global Warming Potential (kg CO2e /sq.m. RSI-1) *Leave blank unless EPDs have been sourced. Use GWP values from product-specific EPDs.*	Conversion Factor	GWP Result (kg CO2e)
Below grade, slab/slab edge				x		x	1.0	x	☐		x 0.0164	=
Basement walls				x		x	1.0	x	☐		x 0.0164	=
Above grade walls, cavity				x		x	0.8	x	☐		x 0.0164	=
Above grade walls, continuous				x		x	1.0	x	☐		x 0.0164	=
Roof, flat				x		x	1.0	x	☐		x 0.0164	=
Roof, sloped, cavity				x		x	0.8	x	☐		x 0.0164	=
Roof, sloped, continuous				x		x	1.0	x	☐		x 0.0164	=
		Input for basic calculation							Summary Metrics	Total Insulation GWP (kg CO2e)		
		Inputs for product-specific data								Conditioned Floor Area (sf)		
		Calculation outputs								OUTPUT: Insulation GWP Intensity		

TABLE R408.1.2
DEFAULT INSULATION GLOBAL WARMING POTENTIAL VALUES

All values are from Building Emissions Accounting for Materials (BEAM)[a], unless noted.

Material	Default Global Warming Potential (kg CO2e /sq.m. RSI-1)
Cellular glass - Aggregate	3.93[b]
Cellulose - Densepack	-2.10
Cellulose - Blown/loosefill	-1.10
Cork - Board	-6.80
EPS/graphite - Board, unfaced, Type II - 15psi	2.80
EPS/graphite - Board, unfaced, Type IX - 25psi, graphite	3.40
EPS - Board, unfaced, Type I - 10psi	2.80
EPS - Board, unfaced, Type II- 15psi	3.80
EPS - Board, unfaced, Type IX- 25psi	4.80
Fiberglass - Batt, unfaced	0.70
Fiberglass - Blown/loosefill	1.00
Fiberglass - Blown/spray	1.93[c]
Hemp - Batt	-0.50
HempCrete	-3.00
Mineral wool - Batt, unfaced	1.70
Mineral wool - Blown	1.60
Mineral wool - Board, unfaced, "light" density	3.30
Mineral wool - Board, unfaced, "heavy" density	8.10
Phenolic foam - Board	1.54[d]
Polyiso - Wall Board	4.10
Polyiso - Roof Board	2.90

SPF – Spray, open cell	1.40
SPF – Spray, closed cell HFO	4.20
SPF – Spray, high density HFO	4.90
SPF – Spray, closed cell HFC	13.10
SPF – Spray, high density HFC	17.00
Straw – Panel	-6.50
Vacuum Insulated Panel	7.40
Wood fiber – Board, unfaced, European	-6.50
Wood fiber – Board, unfaced, North America	-10.30
Wood fiber – Batt, unfaced	-2.40
Wool (Sheep) – Batt	1.00
Wool (Sheep) – Loosefill	0.80
XPS – Board, 25psi HFC	55.50
XPS – Board, 25psi "Low GWP" (HFO/HFC)	4.90

[a] https://www.buildersforclimateaction.org/beam-estimator.html
[b] EPD Declaration Number NEPD-2012-889-EN
[c] EPD Declaration Number 4788647002.102.1
[d] EPD Declaration Number EPD-KSI-20190072-IBC1-EN

Table 2 - Default Insulation Global Warming Potential Values

Material	Default Global Warming Potential (kg CO2e /sq.m. RSI-1)	Material	Default Global Warming Potential (kg CO2e /sq.m. RSI-1)	Material	Default Global Warming Potential (kg CO2e /sq.m. RSI-1)
Straw - panel	10.88	EPS board, Type IX - 25psi	3.49	XPS - board, 25psi HFC	46.51
Wood fiber - board	7.13	SPF - closed cell HFO	4	XPS - board, 40psi HFC	54.04
HempCrete - block	5.67	Mineral wool - board high density	4.06	XPS - board, 60psi HFC	66.06
Cellulose - densepack, 3.5 5 pcf	2.16	SPF - roofing HFO	4.74	XPS - board, 100psi HFC	90.05
Wood fiber - batt	1.96	Mineral wool - blown	5.18		
Cellulose - blown/loosefill, 1.29 pcf	0.83	Fiberglass - board	7.37		
Fiberglass - batt	0.68	XPS - board, 15psi HFO/HFC	7.41		
Fiberglass - blown/loosefill	1.3	XPS - board, 25psi HFO/HFC	8.83		
Phenolic foam - board	1.54	XPS - board, 40psi HFO/HFC	10.26		
SPF - open cell	1.59	XPS - board, 60psi HFO/HFC	12.55		
Fiberglass - blown/spray	1.64	SPF - closed cell HFC	14.86		
Polyiso - board, foil faced	2.32	XPS - board, 100psi HFO/HFC	17.1		
EPS board, Type I - 10psi	2.63	SPF - roofing HFC	19.33		
Polyiso - board, GRF facers (roof)	2.63	SPF - 2K-LP HFC	25.46		
Mineral wool - batt	3.25	XPS - board, 15psi HFC	39.04		

Source: https://www.efficiencyvermont.com/news-blog/whitepapers/the-high-greenhouse-as-price-tag-on-residential-building-materials

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: Package Plus Points, RES*check*™ software, or a Home Energy Rating System (HERS) rating.

R501.2 ~~Existing buildings.~~General

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

R501.3 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.~~

Additions, alterations, or changes of occupancy to, or relocation of, an existing building, building system or portion thereof shall comply with Section R502, R503, R504 or R505, respectively, in this code. Changes where unconditioned space is changed to conditioned space shall comply with Section R502.

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

and location.

R501.6 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. Air leakage testing in accordance with Section R402.4.1.2 is not required for *additions* complying with this code based on the attributes of the *addition* alone. Where the existing *building* and the *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*, testing must be performed in accordance with Section R402.4.1.2 and an air leakage rate not exceeding three (3) air changes per hour at 50 Pascals (or 0.23 CFM50/Sq. Ft. building shell area, six sided) must be verified.

Exception: Where *unconditioned* space is changed to *conditioned* space, the building envelope of the addition shall comply where the UA, as determined in Section R402.1.5, of the existing building and the addition, and any alterations that are part of the project, is less than or equal to 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, R403.6 and R404. 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 R403.5. 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 *unconditioned* 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, without requiring the unaltered portions of the existing building or building system to comply with this code. *Alterations* shall be such that the existing *building* or structure is no less conforming to the provisions of this code than the existing *building* or structure was prior to the *alteration*.

~~*Alterations* 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~~R503.1.4.

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 R402.4.5. 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 R402.1.2.1, or incorporate any components in Table R402.1.2.3.

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 in 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, R403.6 and R404. 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 10~~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 unconditioned or low-energy space that is altered to become *conditioned space* shall be required to be brought into full compliance with this code.

Exception: Where the simulated performance (RES*check*™) 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 R501.4~~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 R501.4~~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.

R505.1.1 Hunting camps and summer camps.

If a *hunting camp* or a *summer camp* changes occupancy and becomes a residence, or is converted from an *unconditioned space* to a *conditioned space*, it must then be upgraded to comply with the 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~~.2.R405.3~~.

R505.2.1 Unconditioned space.

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

CHAPTER 6
REFERENCED STANDARDS

This chapter lists the standards that are referenced in various sections of this document. The standards are listed herein by the promulgating agency of the standard, the standard identification, the effective date and title, and the section or sections of this document that reference the standard. The application of the referenced standards shall be as specified in Section 106.

AAMA

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

AAMA/WDMA/CSA 101/I.S.2/A C440—17 North American Fenestration Standard/Specifications for Windows, Doors and Unit Skylights
R402.4.3

<https://store.fgiaonline.org/pubstore/PWDMAroductResults.asp?cat=0&src=440-17

ACCA

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

Manual J—16 Residential Load Calculation, Eighth Edition
R403.7

Manual S—14 Residential Equipment Selection
R403.7

https://www.acca.org/store#/productDetail/DB68FDFC-BB20-E511-80F5-C4346BAC9A78/

APSP

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

ANSI/APSP/ICC 14—2014 American National Standard for Portable Electric Spa Energy Efficiency
~~R403.10.1,~~ R403.11

https://webstore.ansi.org/Search/Find?in=1&st=ANSI%2FAPSP%2FICC+14-2014

ANSI/APSP/ICC 15a—201~~3~~31 American National Standard for Residential Swimming Pool and Spa Energy Efficiency—includes Addenda A Approved January 9, 2013
R403.~~12~~10.1

https://webstore.ansi.org/Search/Find?in=1&st=ANSI%2FAPSP%2FICC+15a-2013

ASHRAE

ASHRAE
1791 Tullie
Circle, NE
Atlanta, GA
30329-2305

ASHRAE—2017 ASHRAE Handbook of Fundamentals
R402.1.5

https://www.ashrae.org/technical-resources/ashrae-handbook

ASHRAE 62.2 Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings
R3043.1.1

https://www.techstreet.com/ashrae/standards/ashrae-62-2-2022?product_id=2501064

ASHRAE 193—2010 (RA2014) Method of Test for Determining the Airtightness of HVAC Equipment
R403.3.2.1

https://www.techstreet.com/standards/ashrae-193-2010-ra-2014?product_id=1873282

ASTM

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

C1363—11 Standard Test Method for Thermal Performance of Building Materials and Envelope Assemblies by Means of a Hot Box Apparatus
R303.1.4.1

https://www.astm.org/c1363-11.html

E283—04(2012) Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls and Doors Under Specified Pressure Differences Across the Specimen
R202 "Air-Impermeable Insulation," R402.4.5

https://www.astm.org/e0283-04r12.html

E779—10 Standard Test Method for Determining Air Leakage Rate by Fan Pressurization
R402.4.1.2, ~~407.2~~

https://www.astm.org/e0779-10.html

~~**E1554/E1554M—E2013: Standard Test Methods for Determining Air Leakage of Air Distribution Systems by Fan Pressurization**~~
~~**R403.3.5**~~

~~https://www.astm.org/e1554_e1554m-13r18.html~~

E1827—2011(2017) Standard Test Methods for Determining Airtightness of Building Using an Orifice Blower Door
~~R402.4, 407.2~~R402.4.1.2

https://www.astm.org/e1827-11r17.html

E2178—2013: Standard Test Method for Air Permanence of Building Materials
R202 "Air-Impermeable Insulation"~~403.1.5~~
~~E2357 Standard Test Method for Determining Air Leakage of Air Barrier Assemblies~~
~~Table 402.4.1.1~~

https://www.astm.org/e2178-13.html

CSA

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

R402.4.3

R403.5.4

CSA B55.2—2020 Drain Water Heat Recovery Units
R403.5.4

https://www.csagroup.org/store/product/2703427/

DASMA

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

105 - 2017
R303.1.3

https://www.dasma.com/wp-content/uploads/2022/03/ANSI-DASMA-105-2017-DASMA.pdf

HVI

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

HVI Publication 916 - Air Flow Test Procedure

Table R403.6.1

https://hvi.iwrapper.com/HVI_Certification_Program_Policies/Publication_916

HVI Publication 920 - Product Performance Certification Procedure

R304.1.1, R403.6.1
https://www.hvi.org/hvi-certified-ratings-programs/hvi-certification-program-policies-and-procedures/

HVI Publication 911: Certified Home Ventilating Products Directory - Section III - HRV/ERV Directory Listing

R304.5.1, R304.6
https://www.hvi.org/hvi-certified-products-directory/section-iii-hrv-erv-directory-listing/

ICC

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

ICC 400—17 Standard on the Design and Construction of Log Structures

Table R402.1.2.15, R402.1.6, Table R402.1.6, Table 402.4.1.1

https://shop.iccsafe.org/icc-400-2017-standard-on-the-design-and-construction-of-log-structures-1.html

~~**ICC 500—2020: ICC/NSSA Standard for the Design and Construction of Storm Shelters**~~
https://codes.iccsafe.org/content/ICC5002020P1

~~https://codes.iccsafe.org/content/ICC5002020P1~~

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

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National Electrical
Manufacturers
Association 1300 17th

Street North No. 900
Arlington, VA 22209

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

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

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

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UL LLC
333 Pfingsten Road
Northbrook, IL 60062

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US-FTC

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

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WDMA

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

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APPENDIX RA
RECOMMENDED PROCEDURE FOR WORST-CASE TESTING OF ATMOSPHERIC VENTING SYSTEMS UNDER R402.4 OR R405 CONDITIONS ≤ 5 ACH50

(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 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 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

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 < × ≤ 100	and	Passes	Recommend that CO problem be resolved
25 < × ≤ 100	and	Fails in worst case only	Recommend an appliance service call and repairs to resolve the problem
100 < × ≤ 400	or	Fails under natural conditions	**Stop!** Work shall not proceed until appliance is serviced and problem resolved
> 400	and	Passes	**Stop!** Work shall not proceed until appliance is serviced and problem resolved
> 400	and	Fails under any condition	**Emergency!** Shut off fuel to appliance and call for service immediately

APPENDIX RB
(DELETED)

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