

The Vermont Residential Building Energy Standards



Vermont Residential Building Standards (RBES)

Energy Code Handbook

*A Guide to Complying with
Vermont's Residential Building Energy Standards (30 V.S.A. § 51)*

FIFTH EDITION

Base & Stretch Energy Code Effective September 1, 2020

Energy Code Assistance Center
855-887-0673 ~ toll free

Vermont Public Service Department
Efficiency & Energy Resources Division
112 State Street
Montpelier, VT 05620-2601
802-828-2811



This publication was prepared with the support of the U.S. Department of Energy.



Vermont Residential Building Energy Code

Basic Requirements ~ Summary

1	Air Sealing and Leakage	Seal all joints, access holes and other such openings in the building envelope, as well as connections between building assemblies. Air barrier installation must follow criteria established in Section 2.1a. Refer to Table 2-2 for a summary. Air leakage must be tested, using a blower door test by a certified professional. Refer to Section 2.1b for details.
2	Vapor Retarder	Provide an interior vapor retarder appropriate to wall insulation strategy; refer to Section 2.2.
3	Duct Location, Insulation, and Sealing	Ducts with any portion that runs outside the building thermal envelope must be sealed and tested for air tightness. Refer to Section 2.4c for details. Ducts, air handlers, and filter boxes must be located inside the building thermal envelope or be insulated to meet the same R-value as the immediately proximal surfaces. Building framing cavities may not be used as ducts or plenums.
4	HVAC Systems: Efficiency & Balancing	HVAC heating and cooling systems must comply with minimum federal efficiency standards. All HVAC systems must provide a means of balancing, such as air dampers, adjustable registers or balancing valves.
5	Equipment Sizing	Building heating and cooling loads must be calculated in accordance with ACCA Manual J or other approved calculation methodologies. Heating and cooling equipment must be sized in accordance with ACCA Manual S (ref. RBES R403.7), which includes restrictions on oversizing
6	Programmable Thermostat	The thermostat controlling the primary heating or cooling of the dwelling must be programmable, with exemptions for radiant systems on a dedicated zone, cold-climate heat pumps not designed for set-backs and Wi-Fi or “smart” internet-connected thermostats. Refer to RBES R403.1.1 for details.
7	Fireplaces and Solid Fuel-Burning Appliances	All fireplaces and solid fuel-burning appliances must have tight-fitting, gasketed metal, glass or ceramic doors with compression closure or compression latch system; combustion air supply must be provided directly from outdoors
8	Exhaust Fans and Appliances	Exhaust dampers are required for kitchen, bath and dryer fans. Makeup air is required for exhaust systems capable of 400 cubic feet per minute (CFM) or greater.
9	Ventilation	All homes must have an automatically controlled whole house ventilation system. See Chapter 3 for details.
10	Snow Melt System Controls	Snow and ice-melting systems must include automatic controls capable of shutting off the system when the pavement temperature is above 45°F (10°C) and precipitation is not falling or manual control that will allow shutoff when the outdoor temperature is above 40°F (4.8°C).
11	Electric Systems	In most cases, each unit of a multi-family dwelling must have a separate electric meter. See Appendix D for exceptions.
12	Mechanical System Piping Insulation and Circulating Hot Water Systems	Mechanical system piping capable of carrying fluids above 105°F (41°C) or below 55°F (13°C) must be insulated to a minimum of R-3. Circulating hot water systems must also include an automatic or readily accessible manual switch that turns off the hot water circulating pump when the system is not in use.
13	Lighting	A minimum of 90% of the lamps in permanently installed lighting fixtures must be high-efficiency lamps.
14	Electric Resistance Heat and Heat Pumps	Heating a building with electric resistance heating equipment is prohibited except under conditions described in section 2.4b. Heat pumps shall not have integrated supplementary electric resistance heat other than that provided for frost control.
15	Pools, Hot Tubs and Spas	All swimming pools must have a time clock to control the pump. Heated swimming pools must have both a heater on/off switch in an accessible location and a pool cover. Heaters may not have continuously burning pilot lights.
16	Certification	Complete a Vermont Residential Building Energy Standards (RBES) Certificate for each dwelling. Affix the RBES certificate to the electrical panel without covering or obstructing visibility of other labels. Send one copy to the Vermont Public Service Department and file one copy with the Town Clerk of the town in which the property is located.

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The Vermont Residential Building Energy Standards

How to Use This Handbook

This Handbook contains information explaining the key requirements of Vermont’s “Residential Building Energy Standards” (“RBES” or the “Energy Code”) for residential construction. Each chapter is divided into sections. For instance, a reference to “Section 2.3” indicates the third section of Chapter 2. Further divisions of a section are labeled with a letter (e.g., 2.3a, 2.3b, etc.). Tables and figures are numbered sequentially within each chapter. For example, the first table in Chapter 3 is Table 3-1, the second table is Table 3-2, etc.

This Handbook also includes references to sections in the RBES code language.

Visit <https://publicservice.vermont.gov/content/building-energy-standards> for a free viewable copy of the full RBES.

A printed copy can be obtained by calling the Energy Code Assistance Center at 855-887-0673, toll free.

When to Consult the Handbook

There are four main situations that call for a review of this Handbook:

1. When making additions, alterations, renovations or repairs to existing homes.
2. During the new construction design stage, review the requirements up front. It will be easier and less expensive at this stage to make any modifications needed to ensure compliance.
3. In the event of new construction design changes, review whether the home still complies when there are changes. This will ensure that there are no surprises upon completion.
4. Upon completion, State law requires every Vermont builder to certify that the home complies with the Energy Code as built, altered or repaired.



What’s New in RBES 2020?

Major changes from RBES 2015 include but are not limited to:

1. Clarification of definitions and other language
2. Insulation and fenestration criteria
 - Base Code: Prescriptive packages plus required points from a list of options based on the house size
 - Stretch Code: Similar package plus points approach as base code, but with more stringent prescriptive packages and more points required
3. Air Leakage Testing
 - Blower door testing by a certified tester is now **required** for both Base and Stretch Code
4. Electric resistance heating equipment is prohibited except under certain stringent conditions
5. Electric vehicle charging (Base & Stretch)
 - minimum charging infrastructure now required
6. HERS rating values include an adjustment factor that accounts for building size and shape in the calculation (Base & Stretch)
7. Solar Ready required for Stretch Code

The Vermont Residential Building Energy Standards

- ✓ **Introduction:** Vermont Residential Building Energy Standards — summarizes the key features of the Energy Code.
- ✓ **Chapter 1: Rules for Compliance** — explains in detail which buildings must comply and which are exempt.
- ✓ **Chapter 2: Basic Requirements** — explains in detail the mandatory requirements that all buildings must meet (aside from additional Prescriptive or Performance requirements).
- ✓ **Chapter 3: Ventilation and Combustion Safety Requirements** — discusses the importance of indoor air quality and how to achieve it.
- ✓ **Chapter 4: Existing Homes: Additions, Alterations, and Repairs** — explains requirements for additions, alterations and repairs.
- ✓ **Chapter 5: The Package Plus Points Compliance Method** – explains how to meet the Energy Code via the Package Plus Points compliance pathway. This method is similar to the Prescriptive Compliance Method from previous code cycles but with key changes.
- ✓ **Chapter 6: The REScheck™ Software Compliance Method** – explains how REScheck™ can be used to check for compliance.
- ✓ **Chapter 7: The Home Energy Rating Compliance Method** – explains how Energy Rating Index or Home Energy Rating System (“ERI” or “HERS”) can be used for compliance.
- ✓ **Chapter 8: Certification** — specifies how to accurately certify compliance with the Energy Code.

The **Appendices** include the minimum requirements for Stretch code, definitions and clarifications of terms used in this Handbook, default R-values and U-factors, guidelines for calculations, and Vermont-specific resources for builders.

If You Need Help

The Energy Code Assistance Center (ECAC) provides free technical assistance. Call toll-free: 855-887-0673.

The Vermont Residential Building Energy Standards (RBES) Energy Code

The Vermont Residential Building Energy Standards (“RBES”, the “Residential Energy Code” or simply the “Energy Code”) initially was passed by the Vermont legislature in May 1997. It is a minimum standard of energy efficiency that has applied to virtually all new residential construction in Vermont since July 1, 1998 with updates in 2006, 2011, 2015, and 2020. The 2020 Energy Code is based on the 2015 Vermont Residential Building Energy Standards, which are based on the International Energy Conservation Code® (IECC). The 2020 RBES also includes select IECC 2018 and 2021 updates with additionally stringent Vermont energy efficiency requirements.

What Buildings Must Comply?

- ★ Detached one- and two-family dwellings.
- ★ Multi-family and all other residential dwellings three stories or fewer in height.
- ★ Additions, alterations, renovations and repairs to existing residential buildings.
- ★ Factory-built modular homes not on a permanent chassis.
- ★ Residential buildings commencing construction on or after September 1, 2020 must comply with this Energy Code. Residential buildings for which construction commenced before September 1, 2020, if not complying with this Code, must comply with the previous version of RBES.
- ★ Act 250 projects commencing construction on or after September 1, 2020 must comply with the 2020 Stretch Code.
- ★ In towns that require a certificate of occupancy (COO), a RBES certificate is required before the COO can be issued.

This is a summary; see Chapter 1 for details.

What Buildings Are Exempt?

- ★ Commercial and high-rise residential buildings (over three stories); however, these must meet the Commercial Building Energy Standards (“CBES”). Residential portions of a mixed-use building that is three stories or less must meet the Residential Energy Code. Residential portions of mixed-use buildings include the living spaces in the building and the nonliving spaces in the building that serve only the residential users such as common hallways, laundry facilities, residential management offices, community rooms, storage rooms, and foyers.
- ★ Mobile homes on a permanent chassis (except for site-built components such as conditioned basements or crawl spaces).
- ★ Buildings or additions with very low energy use (those designed for a peak energy use of less than 3.4 Btu/hr. [1 Watt] per square foot of floor area).
- ★ Unconditioned buildings.
- ★ Hunting camps or summer camps. Note that summer camps are only exempt if constructed for non-winter occupation with only a biomass (wood) or other on-site renewable heating system.
- ★ Individual provisions of the code may be exempted when applied to historic buildings if the provision would threaten, degrade or destroy the historic form, fabric or function of the building. (See Chapter 4)

This is a summary; see Chapter 1 for details.

The Basic Steps for Meeting the Code

The Vermont Residential Energy Code encompasses two requirements:

- 1) A **technical requirement** (i.e., minimum standards for energy-efficient building components and construction practices) and
- 2) A **certification requirement** for reporting compliance. It is one of the few energy codes in the **country in which the builder may self-certify compliance**.

The law recognizes that it is the builder’s responsibility to understand the Residential Energy Code, to build to the minimum technical efficiency standards, and then to certify (on a one-page form) that the building complies with the law. Plan reviews or final inspections may be required by building code officials¹. However, an air leakage test by a certified inspector is now required for all homes. The whole process can be summarized as follows:

- 1. Determine whether you need to comply (Chapter 1);
- 2. Follow the Basic Requirements (Chapter 2);
- 3. Follow the minimum Ventilation and Combustion Safety Requirements (Chapter 3);
- 4. For existing homes, follow the requirements for additions, alterations, renovations and repairs (Chapter 4).
- 5. Select and complete the Compliance Method that works best for you, complete a blower door air leakage test (Chapters 5-7); and
- 6. Fill out, file and post the required compliance certificate (Chapter 8).

Compliance Methods

In order to comply with the Residential Energy Code, a home as built must meet all the Basic Requirements, Ventilation & Combustion Safety Requirements and the Prescribed Requirements using one of the compliance methods. Additions, alterations, renovations and repairs must meet the Existing Homes requirements pertaining to the portion(s) of the home affected.

The Energy Code is both simple and flexible in the ways a home can meet the technical requirements. There are three methods that can be used to comply. You select the one that works best for your design. There are three options that describe the thermal and efficiency values that are necessary to meet the minimum standards of the Energy Code. These vary in simplicity of use, as well as in the level of efficiency above the minimum standards that must be achieved. In general, the simplest methods specify the highest levels of efficiency, while the more complex methods are closest to the minimum efficiency standard of the Energy Code. The three compliance methods are:

Prescriptive Method	The simplest approach (the “Package Plus Points” approach) allows you to incorporate a prescribed set of features. Minimal calculations. (See Chapter 5.)
REScheck™ Software Method	Use your computer with REScheck™ software to easily analyze almost any design and determine whether any modifications are needed to meet the Base Code. Cannot be used for Stretch Code compliance. (See Chapter 6.)
Home Energy Rating Method	This approach gives full credit for air tightness, efficient heating, cooling and domestic water heating, and solar orientation. A certified Energy Rater is required to complete this approach. (See Chapter 7.)

¹ While the Residential Energy Code does not require inspections by code officials, it does not eliminate inspections related to Act 250 projects, spot checks for enforcement of other applicable codes, or inspections required by state or local codes.

The Residential Energy Code is both simple and flexible in the ways a home can meet the technical requirement. There are three methods that can be used to comply. You select the one that works best for your design.

Stretch Code

The Residential Energy Code includes two levels of stringency: Base Code and Stretch Code. The Base Code is the standard level most everyone must meet (see “Which Buildings Must Comply” above). The Stretch Code is the required level for all Act 250 projects and in Vermont towns that choose to implement a higher energy standard. In general, the Stretch Code includes the following:

- ★ Greater emphasis on continuous insulation on above grade walls;
- ★ Stronger preference for balanced (fresh air) ventilation systems; and
- ★ Higher points requirement to achieve compliance (see Table 5-5 Required Points by Building Size for Stretch Code and Table 5-6 Points Options for Stretch Code by Component)

Technical Assistance with Energy Code Requirements

Technical assistance with the Residential Energy Code is available at no charge. Contact the Energy Code Assistance Center (ECAC) at 855-887-0673 (toll free). ECAC services include:

- Workshops for builders on how to comply with the Vermont Residential Energy Code.
- Handbooks, forms, software and other Energy Code-related materials.
- Professional advice on how to easily meet the Energy Code.
- Information about state-of-the-art construction techniques and building details.
- Referral to energy-efficiency programs.
- Sources for energy-efficient products.
- Customized workshops and presentations on energy-efficient building practices.

Residential Energy Code Updates

The statute that governs the Vermont Residential Energy Code provides for regular review and updates to the provisions in the Energy Code. The review of the Residential Energy Code is administered by the Vermont Department of Public Service (PSD). Please address all comments and inquiries to:

Vermont Public Service Department
Efficiency & Energy Resources Division
112 State Street
Montpelier, Vermont 05620-2601
802-828-2811

E-CALL Hotline 855-887-0673

The E-CALL Hotline is staffed from 8 a.m. to 5 p.m. Monday through Friday. A voice mail is available at all other times. Call for free assistance with any Code-related questions or concerns you may have.

Energy Code 
Assistance Center

.....
This chapter discusses:

- ★ The builder's responsibilities under the Vermont Residential Energy Code.
- ★ What the Residential Energy Code does and does not cover.

Chapter 1

Rules for Compliance

Section 1.1

Builder's Responsibilities

Under the Vermont Residential Energy Code, it is your responsibility as a builder to determine *for each residential building project*:

1. Whether the building is required to meet the minimum technical requirements of the Energy Code, and
2. Whether a RBES Certificate must be completed and filed in order to meet certification requirements (a Certificate is **required** unless the building is exempt as specified in Section 1.3).

Section 1.2

Buildings That Must Comply

The following buildings must meet both the technical and the certification requirements of the Vermont Residential Energy Code:

- **Detached one- and two-family dwellings.**
- Multi-family and other residential buildings three stories or fewer in height and **residential portion of a mixed-use building 3 stories or fewer in height.**
- **Additions, alterations, renovations and repairs** (further detail in Chapter 4).
- **Factory-built modular homes** not subject to Title VI of the National Manufactured Housing Construction & Safety Standards Act of 1974 (i.e., homes not on a permanent chassis).
- **Site built components** (such as conditioned basements or crawlspaces) of mobile homes not subject to RBES must comply.

Exempt Buildings

The following buildings are exempt from both the technical and the certification requirements of the 2020 Vermont Residential Energy Code:

- **Commercial buildings**, portions classified as commercial, or high-rise residential (over three stories). These buildings must comply with the 2020 Commercial Building Energy Standards (CBES).
- **Mobile homes** subject to Title VI of the National Manufactured Housing Construction & Safety Standards Act of 1974 (i.e., single- and double-wide homes on a permanent chassis). Site-built components such as conditioned basements or crawl spaces are not exempt and must be constructed to meet the Residential Energy Code.
- **Buildings or additions with very low energy use**: Buildings or additions designed for a peak energy use of less than 3.4 Btu/h (1 Watt) per square foot of floor area. (Any occupied building intended to be heated and lived in will not meet this exemption.)
- **Unconditioned buildings** that are neither heated nor cooled.
- **Hunting camps and summer camps**. Note that summer camps are only exempt if constructed for non-winter occupation with *only* a biomass (wood) or other on-site renewable heating system.
- Individual provisions of the code may be exempted when applied to historic buildings if the provision would threaten, degrade or destroy the historic form, fabric or function of the building. (See Chapter 4)
- Unaltered portions of an existing building or building system do not need to comply.

Owner/Builder Special Provision

“Owner/builder” projects are exempt from the technical requirements of the Code, but the owner/builder must meet certification requirements by completing and filing a *Vermont Owner/Builder Disclosure Statement* at the Town Clerk’s Office where the home is located and with the Vermont Public Service Department. To qualify for this provision, *all* of the following criteria must be met:

1. The owner must be the person in charge of construction (i.e., the “general contractor”), directing the details of construction and the selection and installation of materials.
2. The owner must live in the building.
3. The owner must evaluate whether the home meets the Residential Energy Code.
4. Depending on whether the home meets the technical requirement of the Energy Code, the owner must complete one of two documents: either the *Vermont Residential Building Energy Standards Certificate* if the home meets the technical requirement, or the *Vermont Owner/Builder Disclosure Statement* if it does not. (See Chapter 8.)

5. Before entering into a binding purchase and sale agreement, the owner must disclose in writing (using the *Vermont Owner/Builder Disclosure Statement*) to a prospective buyer the nature and extent of any non-compliance with the Residential Energy Code.

Section 1.5

Act 250 Provision

Residential buildings commencing construction on or after September 1, 2020 must comply with this 2020 Energy Code. Residential buildings for which construction commenced before September 1, 2020, if not complying with this Energy Code, must comply with the previous version of RBES. Act 250 projects falling under the 2020 RBES must meet the stretch code provisions as described in Chapter 5.

Section 1.6

Penalty for Not Complying with the Residential Energy Code

If a home required by law to meet the RBES does not comply, a homeowner may seek damages in court within six years of occupancy or the filing of the required certification as noted in Section 1.1. (For details on the certification process, see Chapter 8.)

Chapter 2

Basic Requirements

The Residential Energy Code specifies basic minimum requirements that are mandatory for all buildings.

This chapter does not, however, specify minimum insulation R-values or maximum glazing or door U-values, which are detailed in Chapters 5 through 7.

Table 2-1. Basic Requirements - Summary

Vermont Residential Building Energy Code Basic Requirements ~ Summary		
1	Air Sealing and Leakage	Seal all joints, access holes and other such openings in the building envelope, as well as connections between building assemblies. Air barrier installation must follow criteria established in Section 2.1a. Refer to Table 2-2 for a summary. Air leakage must be tested, using a blower door test by a certified professional. Refer to Section 2.1b for details.
2	Vapor Retarder	Provide an interior vapor retarder appropriate to wall insulation strategy; refer to Section 2.2.
3	Duct Location, Insulation, and Sealing	Ducts with any portion that runs outside the building thermal envelope must be sealed and tested for air tightness. Refer to Section 2.4c for details. Ducts, air handlers, and filter boxes must be located inside the building thermal envelope or be insulated to meet the same R-value as the immediately proximal surfaces. Building framing cavities may not be used as ducts or plenums.
4	HVAC Systems: Efficiency & Balancing	HVAC heating and cooling systems must comply with minimum federal efficiency standards. All HVAC systems must provide a means of balancing, such as air dampers, adjustable registers or balancing valves.
5	Equipment Sizing	Building heating and cooling loads must be calculated in accordance with ACCA Manual J or other approved calculation methodologies. Heating and cooling equipment must be sized in accordance with ACCA Manual S (ref. RBES R403.7), which includes restrictions on oversizing
6	Programmable Thermostat	The thermostat controlling the primary heating or cooling of the dwelling must be programmable, with exemptions for radiant systems on a dedicated zone, cold-climate heat pumps not designed for set-backs and Wi-Fi or “smart” internet-connected thermostats. Refer to RBES R403.1.1 for details.
7	Fireplaces and Solid Fuel-Burning Appliances	All fireplaces and solid fuel-burning appliances must have tight-fitting, gasketed metal, glass or ceramic doors with compression closure or compression latch system; combustion air supply must be provided directly from outdoors
8	Exhaust Fans and Appliances	Exhaust dampers are required for kitchen, bath and dryer fans. Makeup air is required for exhaust systems capable of 400 cubic feet per minute (CFM) or greater.
9	Ventilation	All homes must have an automatically controlled whole house ventilation system. See Chapter 3 for details.
10	Snow Melt System Controls	Snow and ice-melting systems must include automatic controls capable of shutting off the system when the pavement temperature is above 45°F (10°C) and precipitation is not falling or manual control that will allow shutoff when the outdoor temperature is above 40°F (4.8°C).
11	Electric Systems	In most cases, each unit of a multi-family dwelling must have a separate electric meter. See Appendix D for exceptions.

Table continued on next page

12	Mechanical System Piping Insulation and Circulating Hot Water Systems	Mechanical system piping capable of carrying fluids above 105°F (41°C) or below 55°F (13°C) must be insulated to a minimum of R-3. Circulating hot water systems must also include an automatic or readily accessible manual switch that turns off the hot water circulating pump when the system is not in use.
13	Lighting	A minimum of 90% of the lamps in permanently installed lighting fixtures must be high-efficiency lamps.
14	Electric Resistance Heat and Heat Pumps	Heating a building with electric resistance heating equipment is prohibited except under conditions described in section 2.4b. Heat pumps shall not have integrated supplementary electric resistance heat other than that provided for frost control.
15	Pools, Hot Tubs and Spas	All swimming pools must have a time clock to control the pump. Heated swimming pools must have both a heater on/off switch in an accessible location and a pool cover. Heaters may not have continuously burning pilot lights.
16	Certification	Complete a Vermont Residential Building Energy Standards (RBES) Certificate for each dwelling. Affix the RBES certificate to the electrical panel without covering or obstructing visibility of other labels. Send one copy to the Vermont Public Service Department and file one copy with the Town Clerk of the town in which the property is located.

Section 2.1

Building Envelope

Section 2.1a

Air Leakage

A continuous, durable air barrier must be installed in the building envelope. All exterior joints, breaks, seams or penetrations in the building envelope that are sources of air leakage must be either sealed with durable caulking materials, closed with gasketing systems, taped or otherwise sealed. This includes windows and other (structural) interruptions. Refer to Figure 2-1 for an illustration of common methods used to create continuous air barriers relating to these details. **Air sealing must be verified by a blower door test (see Section 2.1b).**

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.

Consider that flexible air barriers may be less effective and durable than rigid air barriers. If flexible air barriers are used, they must be fully sealed at all seams and edges and supported per manufacturer's installation instructions. Flexible air barriers must not be made of kraft paper, or other materials that are easily torn. Note that typical installations of 'house wraps' are not detailed in a manner that would allow them to be effective air barriers. If polyethylene is used, its thickness must be ≥ 6 mil and it must be properly supported. Air-permeable insulation must not be used as an air sealing material; when installed in vertical walls, sloped ceilings and floors that are part of the thermal envelope, it must be enclosed on all six sides and in contact with a durable, air barrier. Open-cell or closed-cell foam must have a finished thickness ≥ 5.5 in. or 1.5 in. respectively, to qualify as an air barrier unless the manufacturer indicates otherwise.

In addition to the above guidance, Figure 2-1 on the next page details the list of air sealing requirements that, collectively, will reduce the blower door test leakage result. While all of the following air leakage checklist items must be in place, compliance with air sealing requirements is ultimately determined with blower door testing.

Figure 2-1. Examples of whole-building air sealing via (a) interior-side air barrier and (b) exterior-side air barrier

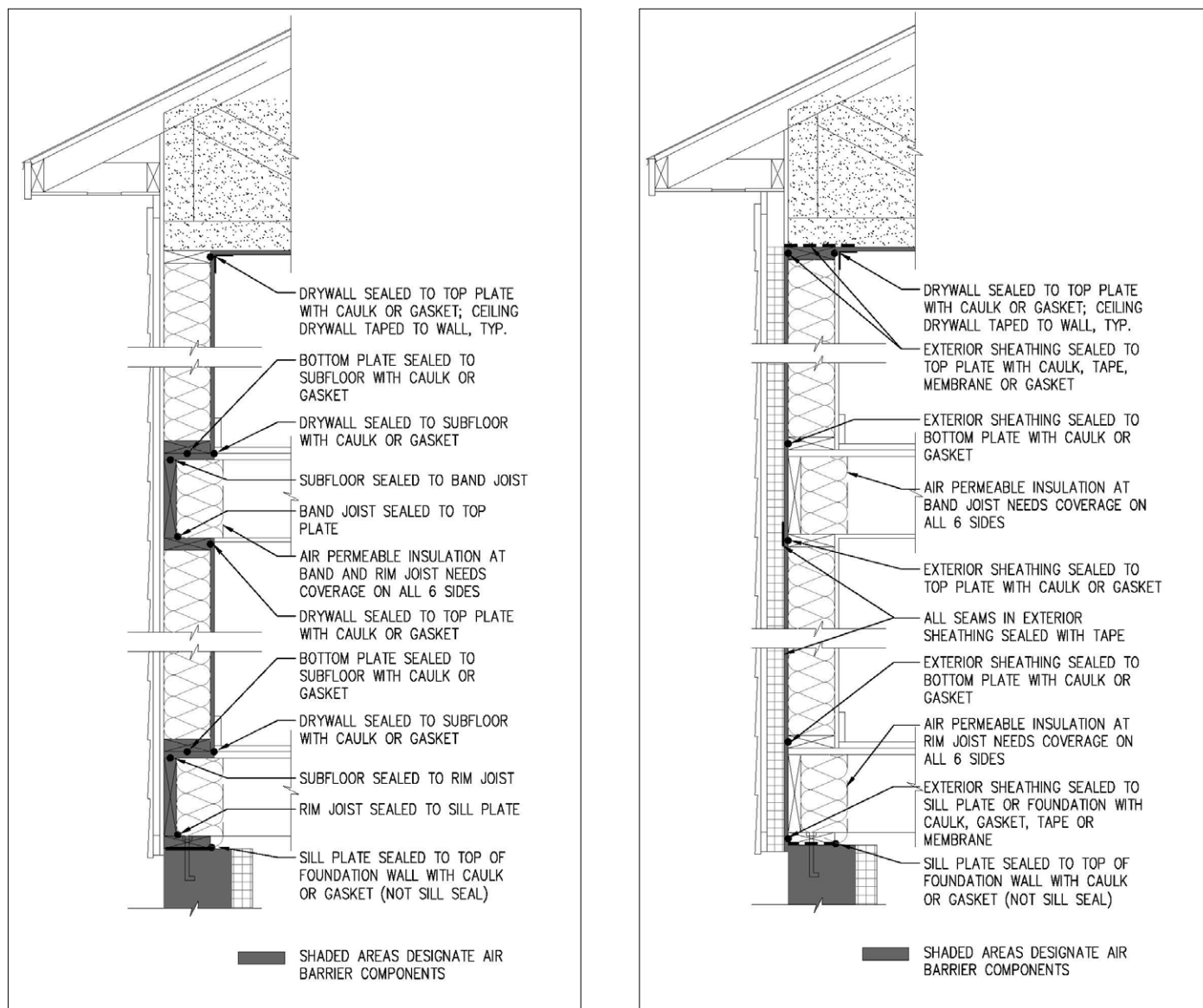
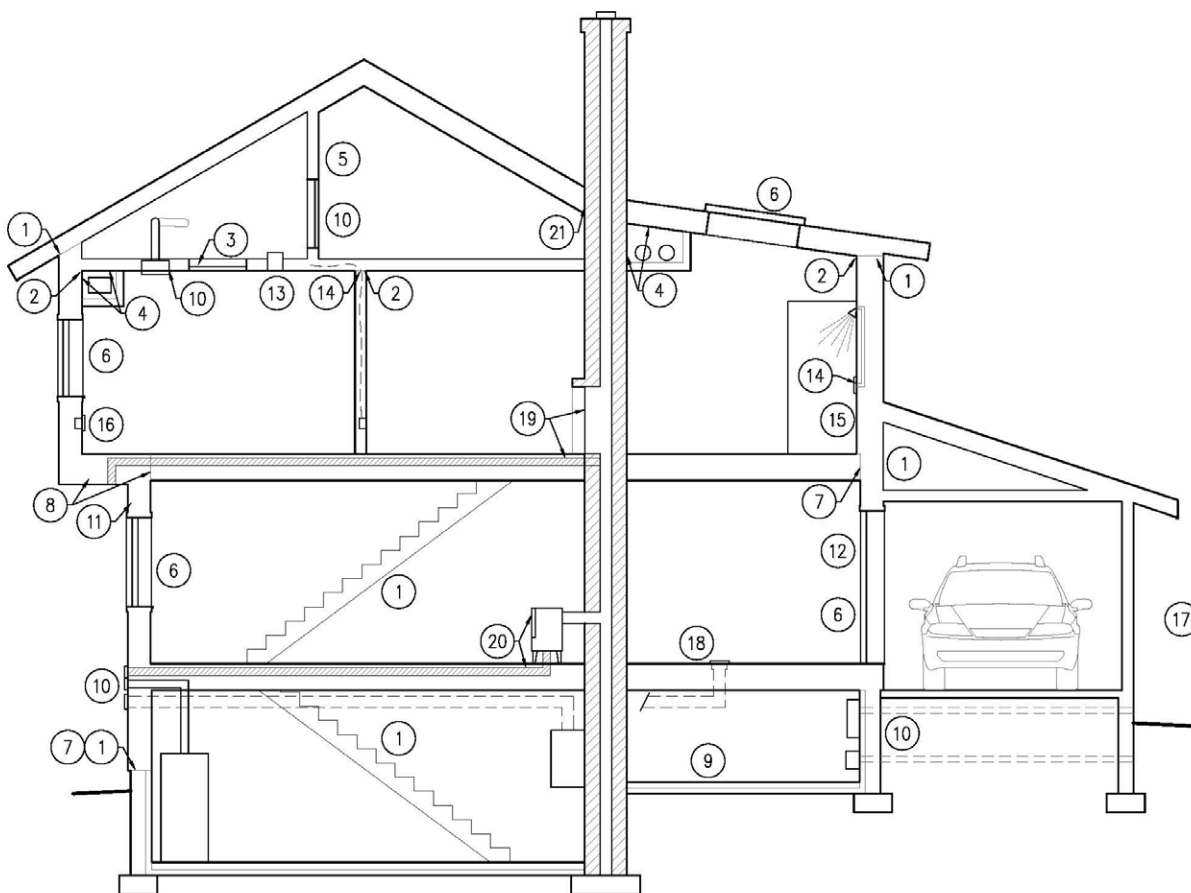


Table 2-2. Air Sealing Checklist

Air Sealing Checklist - [with limited insulation details in brackets]		
1	Walls	The junction of the foundation and sill plate must be sealed. The junction of the top plate and the top of exterior wall sheathing must be sealed. [Cavities within corners and headers of frame walls must be insulated by completely filling the cavity with a material having a thermal resistance of $\geq R-3$ per inch.] Exterior thermal envelope insulation for framed walls must be installed in substantial contact and continuous alignment with the air barrier. [Exterior thermal envelope insulation for framed walls that is air permeable must be enclosed on all six sides and in contact with a durable air barrier.] Air barrier and insulation requirements also apply for cases such as staircase framing at exterior walls (see Figure 2-2), porch/garage roof connections (see Figure 2-2), stepped foundation walls, and service entrances (holes).
2	Ceiling/attic	Top plates and wall-to-ceiling connections are sealed. A top-side air barrier above the flat insulation is not required in a flat attic.
3	Attic hatch or door	Access openings, drop down stairs or knee wall doors to unconditioned attic spaces must be sealed, insulated and gasketed for air-tight fit. [Insulate to surrounding R-values.]
4	Soffit	The air barrier in any dropped ceiling/soffit must be aligned with (in contact with) the insulation and any gaps in the air barrier must be sealed. The insulation must be enclosed on at least five sides and in contact with a durable, interior air barrier.
5	Knee Wall	Knee walls must be sealed. When part of the thermal envelope, knee wall insulation must be enclosed on all six sides and in contact with a durable, interior air barrier. See Figure 2-3 for one method to meet this requirement.
6	Windows, doors and skylights	The space between window/door jambs and framing, and skylights and framing must be sealed with minimally-expanding foam or other durable effective air sealing method.
7	Rim joist / sill or bottom plate	Rim joists must be insulated and include an air barrier. Junctions of the foundation and sill plate, sill plate and rim band, and rim band and subfloor must be sealed. When air permeable insulation is installed, a durable, interior air barrier must be installed at the rim joist. Penetrations through the bottom plates should be sealed.
8	Cantilevered and overhanging floors (including above garage)	The air barrier must be installed at any exposed edge of insulation. [Floor framing cavity insulation must be installed to maintain permanent contact with the underside of subfloor decking, or floor framing cavity insulation must 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.] See Figure 2-3 for one method to meet this requirement.
9	Crawl space	Exposed earth in unvented crawl spaces must be covered with a Class I vapor retarder with overlapping joints taped. [When used instead of installing a vapor barrier integral with the floor insulation, the vapor barrier must be permanently attached to the crawlspace walls.]
10	Shafts, penetrations	Duct shafts, utility penetrations and flue shafts opening to exterior or unconditioned space must be sealed. Doors or hatches in knee walls opening to exterior or unconditioned space must be insulated to surrounding insulation R-value levels and gasketed.
11	Narrow cavities	Batts in narrow cavities must be cut to fit, or narrow cavities filled by insulation that readily conforms to available space.
12	Garage separation	Air sealing must be provided between the garage and conditioned spaces. Door connecting garage to living space must be insulated and air sealed as an exterior door.
13	Recessed lighting and appliances	Recessed light fixtures and other appliances (speakers, exhaust fans, light shafts, etc.) installed in the building envelope must be ICAT (Insulation Contact and Air Tight) rated or airtight labeled and sealed with a gasket or caulk between the housing and the interior wall or ceiling cover. Fixtures and appliances must maintain required clearances of not less than $\frac{1}{2}$ " from combustible materials and not less than 3" from insulation material, or as required by manufacturer.
14	Plumbing and wiring	All plumbing and wiring penetrations must be sealed to the air barrier. In cavity walls, insulation must be placed between the exterior of the wall assembly and the pipes. [Insulation should not be installed on the interior of the piping. Batt insulation should be cut neatly to fit around wiring and plumbing in exterior walls, or insulation that on installation readily conforms to available space should extend behind piping and wiring and be in full contact with air barrier.]

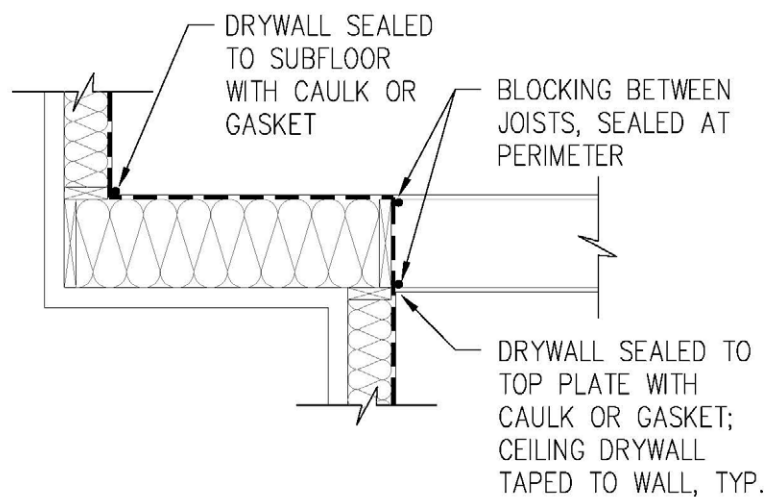
15	Shower or tub on exterior wall	Exterior walls adjacent to showers and tubs must have insulation filling any gaps or voids between those walls and unconditioned space. There must be a rigid durable air barrier separating the exterior wall from the shower or tub when using air-permeable insulation.
16	Electrical/phone box on exterior wall	The air barrier must be installed behind electrical or communication boxes, or air-sealed boxes must be installed. [Insulation should completely fill voids between the box and exterior sheathing.]
17	Common wall between attached homes or units	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 must be insulated to a minimum of R-10 on each side of the break in insulation continuity. The air barrier must be installed in common walls between dwelling units in order to completely isolate each unit from the other. Common walls must be sealed at junctions with outside walls and at the top pressure plane of the house.
18	HVAC register boots	HVAC register boots that penetrate building thermal envelope must be sealed to the subfloor or drywall.
19	Fireplace	A durable air barrier must be installed in contact with the insulation surrounding fireplaces. Fireplace must have compression/tight-fitting metal glass or ceramic doors. Combustion air must be supplied directly from the outdoors.
20	Woodstove	Woodstove must have compression/tight-fitting metal glass or ceramic doors. Combustion air must be supplied directly from the outdoors.
21	Chimney shaft or flue	Chimney or flue shafts opening to exterior or unconditioned space must be sealed.

Figure 2-2. Air sealing checklist corresponding details

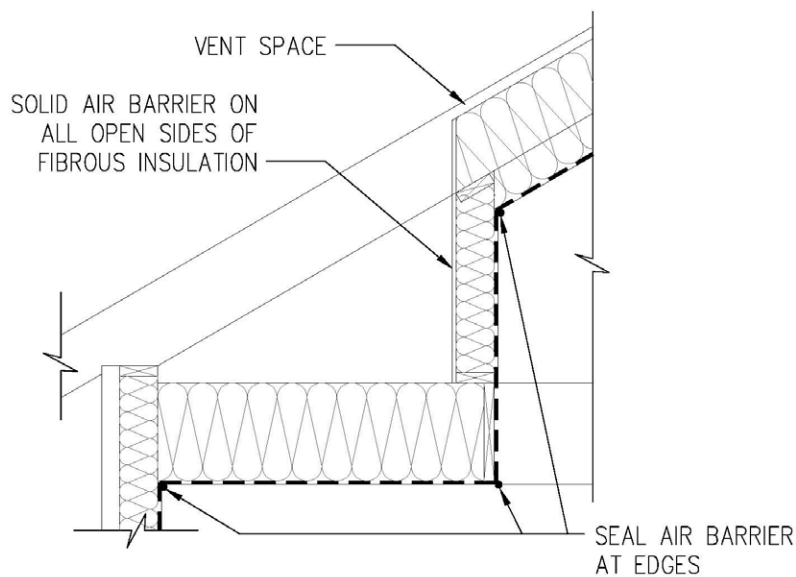


The following details show common problem areas, with example strategies for air sealing.

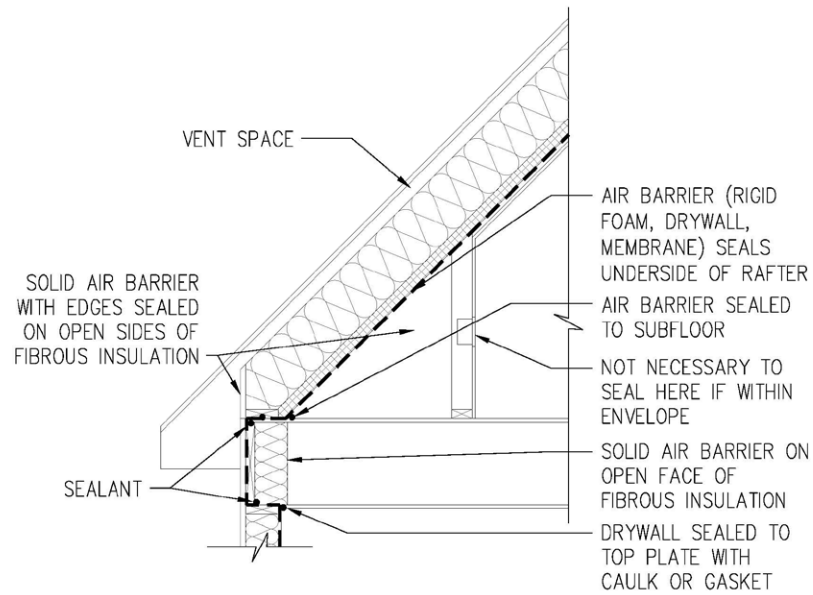
Figures 2-3. Four common problem areas, with example strategies to meet requirements



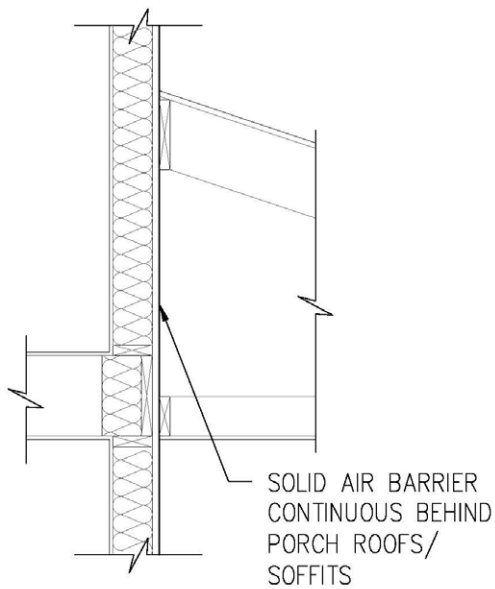
Overhanging (cantilevered) floor



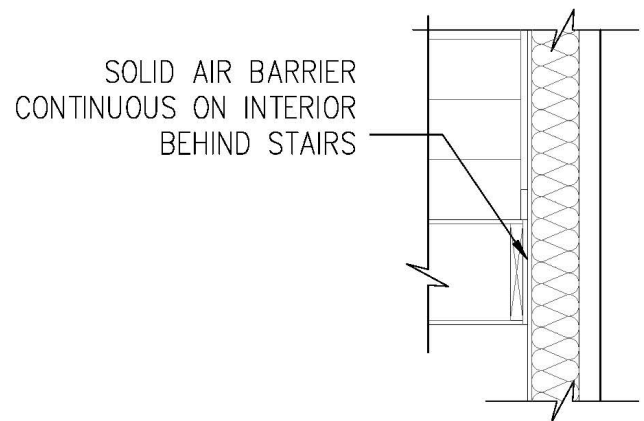
Kneewall



Kneewall (moved inside thermal envelope)



Porch roof



Stair on exterior wall

2.1b

Air Sealing Verification with Blower Door Test

Building envelope air tightness and insulation installation must be verified by a blower door test. Visual inspection only is no longer a compliance option.

Air leakage testing and verification must be conducted by an applicable Building Performance Institute (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 must be signed by the party conducting the test and the result must be recorded on the RBES Certificate for the building.

Single family attached homes, for example duplexes and side-by-side row houses or townhomes, must be tested/verified individually.

The result of the air sealing / blower door test is reported in ACH50 (air changes per hour when tested with a blower door at a pressure of 50 Pascals). Alternatively, the result can be reported in cubic feet per minute at 50 pascals (CFM50) per square foot of building thermal shell area; this includes all six (6) sides of the building. Refer to Section 2.1d for details.

2.1c

Blower Door Test Procedure

Tested air leakage must be less than three air changes per hour (ACH) when tested with a blower door at a pressure of 50 Pascals. Testing must occur after rough-in and after installation of penetrations of the building envelope, including penetrations for utilities, plumbing, electrical, ventilation and combustion appliances. The following protocol must be followed in preparing the building envelope for testing:

- Leave all supply registers and return grills open and uncovered.
- Leave all bathroom and kitchen fans open (i.e., in their normal operating condition). Only a permanently installed back draft damper in its normal condition may impede the flow of air.
- Leave any combustion air ducts or louvers to the exterior open. (If a homeowner or builder has sealed them off, open them for the test.)
- Leave any make-up air ducts with in-line dampers (e.g., for large kitchen exhaust fans or combustion air) as-is (unsealed). Only a permanently installed back draft damper or motorized damper, in its normal condition may impede the flow of air.
- Leave the dryer vent as-is, whether or not the dryer is in place during the test. Only a permanently installed back draft damper in its normal condition may impede the flow of air.
- Leave open any outside air duct supplying fresh air for intermittent ventilation systems (including a central-fan-integrated distribution system).
- Operable crawl-space vents, where present, are to be left in the open position.

- Open all interior doors within the conditioned space, including doors to conditioned basements. (Closet doors may be left closed unless the closet contains windows or access to the attic or crawl space.)
- Leave louvered openings of a whole-house fan as is. (If there is a seasonal cover in place during the test, leave it in place.)
- Close all doors to the exterior or unconditioned spaces; if any door to the exterior or unconditioned space lacks weather-stripping at testing time, it can be temporarily taped off.
- Close and latch all windows.
- Close chimney dampers.
- Either seal or fill water plumbing drains with p-traps that may be empty
- Seal off exterior duct openings to continuously operating fresh-air or exhaust-air ventilation systems (preferably at the exterior envelope)
- Close any adjustable window trickle ventilators and/or adjustable through-the-wall vents

Air density corrections should be made to account for air temperature and altitude based on CGSB or RESNET test standards.

2.1d

Air Sealing Reporting

For Base Code, the result of the air sealing / blower door test is reported in ACH50 or CFM50 per square foot of building thermal shell area which includes all six (6) sides of the building. For Stretch Code, the result must be reported in both ACH50 and CFM50 per square foot of building thermal shell area.

$ACH50 = CFM50 \times 60 / \text{Volume of house, in cubic feet}$

$CFM50/SF = CFM50 / \text{Total thermal shell area}^\dagger$

[†] The square footage to be used for the CFM50/SF calculation is based on *all six sides* of the *building thermal envelope* including the bottom side whether it is in contact with the ground (slab) or not (floor on piers). The building thermal shell area includes unfinished basements, exterior walls of storage/utility rooms, insulated knee walls and slanted ceilings that are part of the *building thermal envelope*, even if the space is not heated. Use exterior measurements to calculate thermal shell area.

Adiabatic surfaces are excluded, except when modeling individual multifamily dwellings. The volume is calculated as the volume of space within the building thermal shell area as defined above.

Example, ACH50: A home has a footprint of 800 sq. ft (20 ft x 40 ft), with a basement plus 2 stories above grade. Each level has 8 ft ceilings. The blower door / airtightness test measured 550 CFM50. The home's square footage is 3 x 800 sq. ft. = 2400 sq. ft. Its volume is 3 x (800 sq. ft x 8 ft) = 19,200 cu. ft.

$ACH50 = CFM50 \times 60 / \text{Volume} = 550 \text{ CFM50} \times 60 / 19,200 = \mathbf{1.72 \text{ ACH50}}$

Example, CFM50/SF:

For the CFM50/shell sq. ft. calculation, you need to figure out the building shell area, which is all 6 sides of the building (4 walls, ceiling, and bottom floor). Using the same home mentioned above, the 20 ft x 40 ft building has a 120 ft perimeter that is 26 ft high (3 levels of 8 ft each plus the 1 ft band joists between the basement/first floor and the first/second floor) so there are 3120 sq. ft of walls, plus 800 sq. ft of basement floor and 800 sq. ft of flat ceiling. This adds up to 4720 sq. ft of shell area. The calculation, then, is:

$$\text{CFM50/SF} = 550 \text{ CFM50} / 4720 \text{ sq. ft} = \mathbf{0.117 \text{ CFM50/SF}}$$

2.2a

Vapor Retarders

Effort 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 no less than 30% 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.

There are three major classes of vapor retarders. See Table 2-3 below.

Table 2-3. Vapor Retarder Classes and Examples

Vapor Retarder Class ²	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"

Class I or II vapor retarders are required on the interior side of frame walls. Exceptions:

- Basement/concrete foundation walls.
- Below grade portion of any wall.
- Construction where moisture or its freezing will not damage the materials.

²Test Procedure for vapor retarders: ASTM E-96 Test Method A (the desiccant method or dry cup method)

Low permeability exteriors – 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 (e.g. sheet polyethylene on interior and foil-faced foam board on exterior) shall require an engineering approved design. See Section 2.2b below for detail on adaptive vapor barriers.

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

1. Vented cladding over the following sheathing types:
 - a. Fiberboard;
 - b. Gypsum;
 - c. Plywood (CDX or comparable); or
 - d. Solid wood
2. Insulated sheathing with R-value 7.5 min. over 2x4 wall
3. Insulated sheathing with R-value 11.25 min. over 2x6 wall

2.2b

Vapor Control Approaches

In Vermont's climate, vapor is usually driven from inside to outside in winter. In summer, it can go either way but in homes using air conditioning vapor will usually move from outside to inside.

Three general vapor control approaches for walls include:

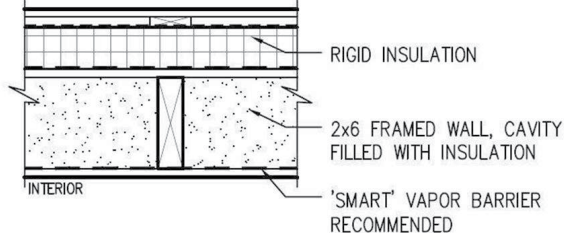
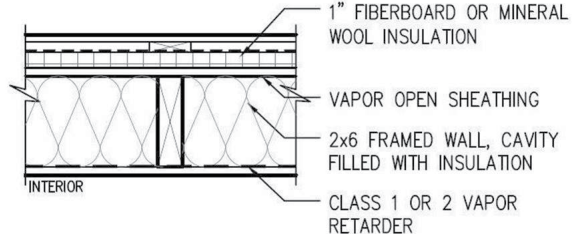
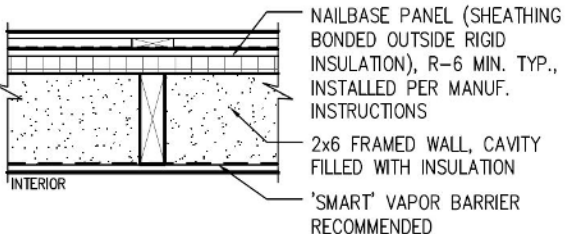
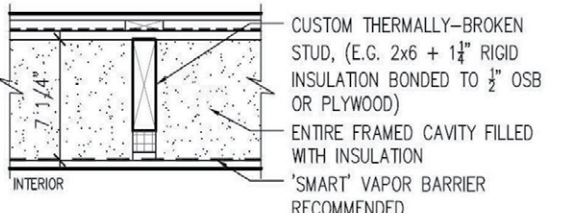
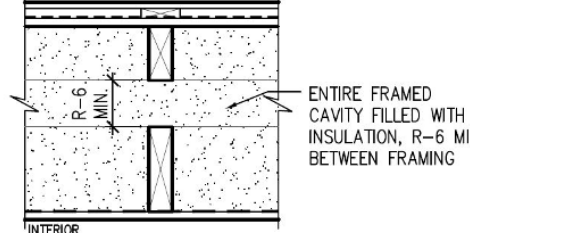
1. Vapor open / flow-through assembly – can dry through both sides of wall;
2. Vapor control layer assembly – slows vapor drive in one direction, typically warm-in-winter side; or
3. Adding enough exterior insulation to keep framing/sheathing above dewpoint.

Code language that restricts a Class I vapor retarder (e.g. poly) on the inside of a frame wall with low permeability insulating sheathing (such as foam) on the outside is meant to avoid building a wall that can trap moisture inside it (“vapor barrier sandwich”). An interior Class II vapor retarder would be allowed in this case, given its greater ability to allow drying to the inside.

Adaptive vapor retarders (also referred to as “smart” vapor retarders) have properties from multiple classes. These materials, which range from the kraft facing on batt insulation to advanced flexible sheeting products, are generally Class II under dry (typical winter) conditions and vapor open to Class III under humid (typical summer) conditions. This can slow down the outward vapor migration that may occur in winter, reducing the likelihood of condensation/frost, yet allow the house to dry to the inside under higher humidity conditions.

In the figures below, several common wall details are displayed with notes on why each can work in Vermont's climate. Wall assemblies to consider avoiding are on the next page. *Note: these are provided for general guidance only. Always consult a qualified professional.*

Figure 2-4. Wall assemblies that can work in Vermont

	<h3>EXTERIOR RIGID INSULATION</h3> <ul style="list-style-type: none"> Relies on sufficient insulation outboard of the sheathing to keep it above the dewpoint in winter; conservative building science suggests targeting minimum 50% of wall's total R-value outside the sheathing Smart vapor retarder on the inside slows outward vapor migration yet allows drying to the inside; poly on interior can increase this wall's risk of moisture problems If exterior rigid is fibrous (e.g. fiberboard), wall can dry outwards depending on properties of exterior layers
	<h3>THIN EXTERIOR RIGID INSULATION - VAPOR OPEN</h3> <ul style="list-style-type: none"> Sheathing spends time below dewpoint in winter, but with proper design, it can dry to both sides while resisting outward moisture migration in winter Poly on interior limits drying to the inside, and may increase risk of moisture problems
	<h3>NAILBASE PANEL</h3> <ul style="list-style-type: none"> Sheathing may spend time below dewpoint in winter, but likely first condensing surface is the foam; with proper design and attention to detail, it resists outward moisture migration in winter Smart vapor retarder on the inside slows outward vapor migration yet allows inward drying; poly on interior limits i drying to the inside and may increase risk of moisture problems Limited drying potential, so good taping is important to limit air/vapor passing through
	<h3>THERMALLY-BROKEN STUD</h3> <ul style="list-style-type: none"> Sheathing spends time below dewpoint in winter, but this design is essentially a better-insulated 2x8 cavity wall that can dry to the exterior (and interior, if smart vapor retarder used rather than poly)
	<h3>DOUBLE STUD</h3> <ul style="list-style-type: none"> Depending on detailing, wall can dry in one or both directions Fibrous insulation adds moisture buffering capability Poly on interior limits drying to the inside and may increase risk of moisture problems

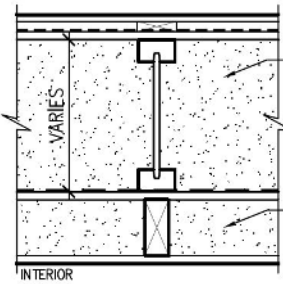
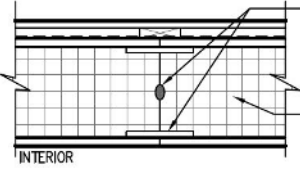
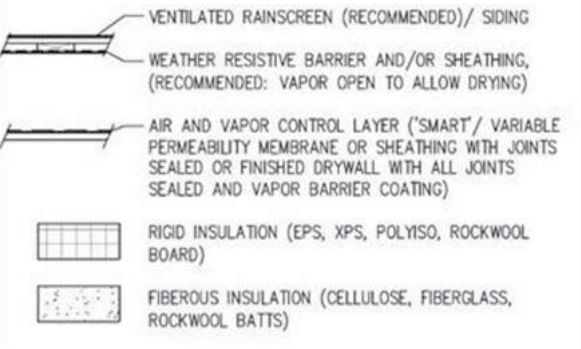
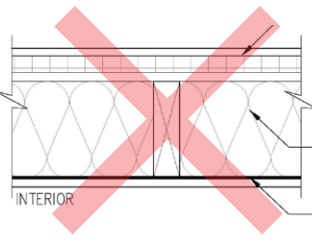
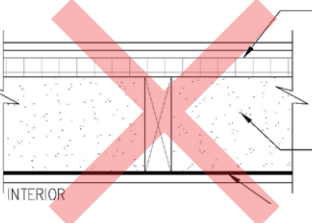
 <p>EXTERIOR I-JOIST OR LARSEN TRUSS, CAVITY FILLED WITH FIBROUS INSULATION, TYPICAL 50% TOTAL R-VALUE OF WALL</p> <p>2x INNER BEARING WALL. OPTIONAL: FILL WITH INSULATION OR LEAVE EMPTY FOR SERVICE CAVITY</p> <p>INTERIOR</p>	<h3>TJI LARSEN TRUSS</h3> <ul style="list-style-type: none"> Relies on sufficient insulation outboard of the sheathing to keep it above the dewpoint in winter; conservative building science suggests targeting min. 50% of wall's total R-value outside the sheathing Depending on detailing, wall can dry in one or both directions Poly on interior limits ability of inward drying to the inside and may increase risk of moisture problems
 <p>SEALANT, SPLINE, INSTALLED PER MANUFACTURER'S INSTRUCTIONS</p> <p>STRUCTURAL INSULATED PANEL (SIP)</p> <p>INTERIOR</p>	<h3>SIP</h3> <ul style="list-style-type: none"> If detailed correctly, resists moisture movement and there are no internal condensing surfaces Panel joints must be detailed correctly to avoid failure; note that timber frames may move over time, breaking essential seals, so taped seams (both interior and exterior) in addition to sealed joints recommended
<p>KEY NOTES:</p>  <p>VENTILATED RAINSCREEN (RECOMMENDED)/ SIDING</p> <p>WEATHER RESISTIVE BARRIER AND/OR SHEATHING, (RECOMMENDED: VAPOR OPEN TO ALLOW DRYING)</p> <p>AIR AND VAPOR CONTROL LAYER ('SMART'/ VARIABLE PERMEABILITY MEMBRANE OR SHEATHING WITH JOINTS SEALED OR FINISHED DRYWALL WITH ALL JOINTS SEALED AND VAPOR BARRIER COATING)</p> <p>RIGID INSULATION (EPS, XPS, POLYISO, ROCKWOOL BOARD)</p> <p>FIBROUS INSULATION (CELLULOSE, FIBERGLASS, ROCKWOOL BATTS)</p>	<p>The legend at left is a reference for Figure 2-4 and Figure 2-5. Important: A properly detailed rainscreen makes any of these assemblies safer from a moisture perspective.</p> <p>All moisture vapor control strategies rely on adequate indoor relative humidity control (e.g., mechanical ventilation), careful water-resistive barrier installation, and proper air-barrier installation practices (e.g., air-sealing the interior face of assemblies). A design professional with experience in hygrothermal analysis and design should be consulted for additional advice as needed, especially for abnormal conditions (e.g., high interior moisture generation from indoor pools or hot-tubs) or where alternative materials and solutions are considered. Two examples of walls that are higher at risk of moisture problems are detailed below in Figure 2-5.</p>

Figure 2-5. Two examples of walls that are higher risk

 <p>2x6 FRAMED WALL, FILLED WITH INSULATION</p> <p>POLY VAPOR BARRIER</p> <p>INTERIOR</p>	<h3>THIN EXTERIOR RIGID INSULATION WITHOUT DRYING</h3> <ul style="list-style-type: none"> Insulation isn't thick enough to prevent the sheathing from spending time below the dewpoint in winter Poly prevents drying inwards and most foamboard limits drying outward; if any moisture finds its way into the wall, it cannot dry quickly or easily Also considered a "vapor barrier sandwich"
 <p>NAILBASE PANEL (SHIMMED OUTSIDE RIGID INSULATION)</p> <p>2x6 FRAMED WALL, FILLED WITH INSULATION</p> <p>INTERIOR</p>	<h3>NAILBASE PANEL WITH POLY</h3> <ul style="list-style-type: none"> Insulation isn't thick enough to prevent the foam sheathing from spending time below the dewpoint in winter Poly prevents drying inwards and foam layer prevents drying outward; if any moisture finds its way into this wall, it cannot dry quickly or easily Also considered a "vapor barrier sandwich"

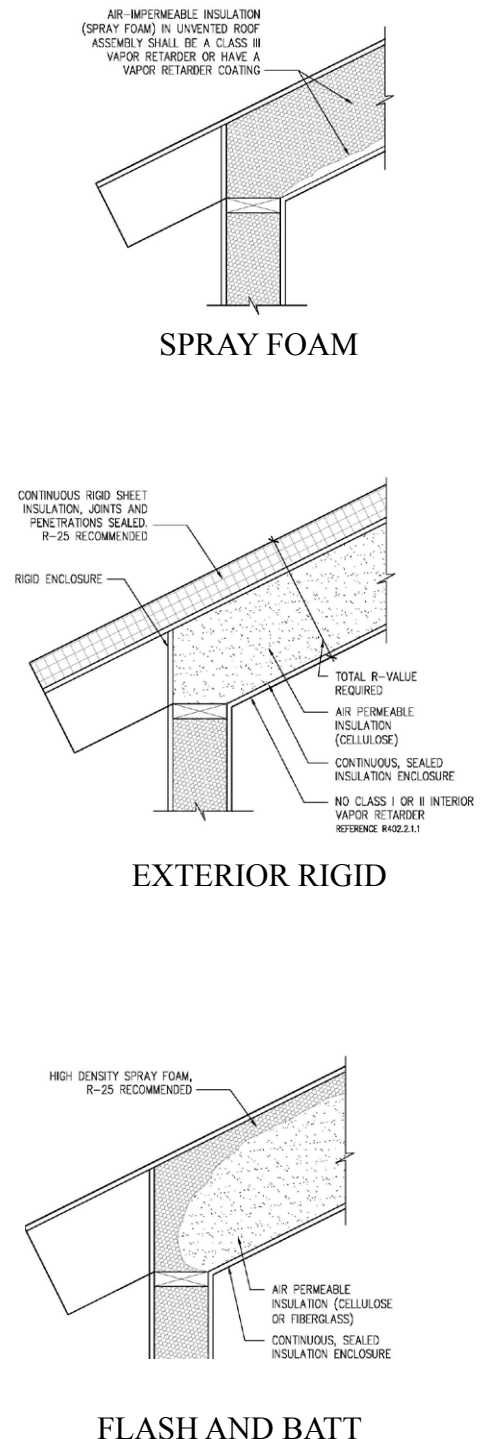
Unvented Attics

Unvented attic assemblies (spaces between the ceiling joists of the top story and the roof rafters) and unvented enclosed roof framing assemblies (ceilings applied directly to the underside of the roof framing members/rafters) are permitted in one- and two-family homes 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 or on the ceiling side of the unvented enclosed roof framing 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 must be a Class II vapor retarder or must have a Class II vapor retarder coating or covering in direct contact with the underside of the insulation.
5. One of the items below must be met, depending on the air permeability of the insulation directly under the structural roof sheathing. See Figure 2-6 for examples.
 - a) *Air-impermeable (e.g., spray foam) insulation only.* Insulation must be applied in direct contact with the underside of the structural roof sheathing.
 - b) *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 should be installed directly above the structural roof sheathing for condensation control. For reference, the International Residential Code requires at least R-25 rigid board insulation in Vermont's Climate Zone 6 (Ref. IRC 2018 Table R806.5) for unvented roof assemblies in this scenario.
 - c) *Air-impermeable and air-permeable insulation.* The air-impermeable (e.g., spray foam) insulation should be applied in direct contact with the underside of the structural roof sheathing for condensation control. For reference, the International Residential Code requires at least R-25 air-impermeable insulation in Vermont's Climate Zone 6 (Ref. IRC 2018 Table R806.5) for unvented roof assemblies in this scenario. The air-permeable (e.g., fiberglass or cellulose) insulation must be installed directly under the air-impermeable (e.g., spray foam) insulation.

Note that IRC 2018 provides for a calculation-based alternative to these 3 choices above, if sufficient rigid board or sheet insulation is installed directly above the structural roof sheathing to maintain the monthly average temperature of the underside of the structural roof sheathing above 45°F (7°C). For calculation purposes, an interior air temperature of 68°F (20°C) is assumed and the exterior air temperature is assumed to be the monthly average outside air temperature of the three coldest months.

Figure 2-6. Examples of unvented attic assemblies



Materials and Equipment Information

Insulation R-values and glazing and door U-factors must be clearly marked on the building plans or specifications. If two or more different insulation levels exist for the same component, record each level separately on the plans or specifications. (For example, if the walls adjacent to the garage have less insulation than the other walls, you must note both insulation levels.)

Insulation R-values and glazing and door U-factors must also be visible for each piece of the building thermal envelope. Note that the R-value of the insulation is often pre-printed directly on the insulation or can be determined from a striping code. Window U-factors are often included on the manufacturer label posted directly on the window. Windows and doors without visible U-factor labels must use default values from Tables B-1 and B-2 when assessing code compliance via Packages Plus Points, *REScheck*[™], or ERI/HERS Rating.

For blown or sprayed insulation, the initial installed thickness, the settled thickness, the coverage area, and the number of bags must be clearly posted at the job site. 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. The thickness of blown-in or sprayed fibrous attic insulation shall be written in inches on markers that are installed at least one for every 300 square feet 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" in height, facing the attic access opening.

Equipment efficiency make, and model number should be marked on the plans or specifications and manufacturer manuals for all installed heating and cooling equipment and service water heating equipment must be provided.

Section 2.4

Heating and Cooling

2.4a

Heat Pumps

Heat pumps must be certified “cold-climate heat pumps.” Heat pumps shall not have integrated electric-resistance heat other than that provided for frost control. Electric resistance heat as part of the heating system design, only as permitted per Section 2.4b, must be controlled so that it does not operate when the heat pump can meet the heating load.

Electric Resistance Heat

Heating with electric resistance heating equipment is prohibited except:

- 1. When replacing existing electrical resistance units;
- 2. In limited areas where other heating sources are cost-prohibitive or impractical, such as in bathrooms or a stairwell or other areas distant from the heat distribution system;
- 3. In buildings with cold-climate heat pumps 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, and
 - b. The building has a tested air tightness of ≤ 2.0 ACH50;
- 4. Multifamily buildings with heating loads ≤ 6.0 Btu/hour/square foot at design temperature.

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

Equipment Sizing

A heating design load calculation (and when applicable, a cooling design load calculation) for the purpose of sizing these systems must be performed by the HVAC contractor, supplier, designer, rater, consultant or engineer to ensure proper equipment sizing. ACCA Manual J, or comparable methods, are acceptable for determining design loads. Heating and cooling (when applicable) equipment must be sized according to ACCA manual S and may not be oversized more than indicated in Table 2-5. Thermal design parameters must be within specified limits. A maximum interior design temp of 72°F is to be used for heating calculations (minimum interior design temp of 75°F for cooling). Winter design temperature used depends on location. Minus 11°F may be used as a default for Vermont. Design temperature conditions must be recorded on the RBES certificate. See R302 in RBES for details and exceptions.

Table 2-5. Heating & cooling equipment sizing guide

Maximum Equipment Oversizing ACCA Manual S ~ Heating & Cooling Equipment Sizing Guide	
TYPE OF EQUIPMENT	MAXIMUM OVERSIZING
Air conditioners and heat pumps	15%
Fuel-fired heating equipment	40%

Duct Insulation

Air distribution systems for heating and cooling that are completely within the thermal envelope of the house do not require insulation.

Where supply and return air ducts are partially or completely buried in ceiling insulation, such ducts shall comply with both 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.

Thoughtful design of the duct system should ensure that ducts remain within the insulated and conditioned space of the house. Sometimes minor changes to the thermal envelope of the home can allow ductwork to remain enclosed within the thermal envelope. For instance, the roof trusses can be constructed with a duct chase incorporated into the truss. A dropped ceiling or soffit (in a hallway with rooms on either side, for example) can achieve a similar effect. This allows a complete thermal envelope with insulation and air barrier to be constructed outside the ductwork, while the interior finish ceiling conceals the ducts.

Duct Sealing

Ducts and other system components that convey heated or cooled air must be sealed. Sealant must be long-lasting and appropriate for the duct material. **Duct tape is not permitted.** Air-impermeable spray foam products may be used without additional joint seals. Paint-on mastic is commonly used. Joints and seams must be mechanically supported to prevent separation.

Heating and cooling ductwork must be tested for leakage in all homes where a part of the duct system is located outside the thermal envelope of the building. Air distribution systems for heating and cooling located completely within the thermal envelope of the house do not require leakage testing.

Duct leakage testing is performed by pressurizing the duct system with the duct terminations sealed. Complete duct leakage testing methods can be found within ASHRAE Standard 152 or the Mortgage Industry National Home Energy Rating Systems Standard (available through Residential Energy Services Network). Ducts are tested at a pressure of 0.1 inches w.g. (25 Pa).

Total duct leakage limits are as follows:

- Rough-in test: The total leakage must be less than or equal to 3 CFM per 100 square feet of conditioned floor area.
- Postconstruction test: Total leakage must be less than or equal to 4 CFM per 100 square feet of conditioned floor area.

2.4f

Duct Construction

Ductwork must be constructed and erected in accordance with one of the industry standards (e.g., NAIMA, SMACNA, ACCA). Building framing cavities may not be used as ducts or plenums.

2.4g

Balancing

The HVAC system must provide a means for balancing air and water systems. For air systems, this requirement can be met by installing manual dampers at each branch of the ductwork or by installing adjustable registers that can constrict the airflow into a room. For water systems, balancing valves can be installed to control the water flow to rooms or zones.

2.4h

Temperature Controls

The thermostat controlling the primary heating or cooling system of the dwelling unit shall be capable of controlling the heating and cooling system on a daily schedule to maintain different temperature set points at different times of the day. This thermostat shall include the capability to set back or temporarily operate the system to maintain zone temperatures down to 55°F (13°C) or up to 85°F (29°C). The thermostat shall initially be programmed by the builder or HVAC contractor 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 the elderly, disabled or those with special needs is permissible.

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

- 3. Radiant floor, wall, ceiling and/or beam system on dedicated zone.
- 4. Wifi or “smart” Internet-connected thermostats.
- 5. Cold climate heat pump not designed for setbacks. (In homes with cold climate heat pumps as the sole heating source, no 5-wire connection is required.)

Heat pump installations in homes with another heating system must include a thermostat that can prevent the back-up heat from turning on when the heating requirements can be met by the heat pump alone. A two-stage thermostat that controls the back-up heat on its second stage meets this requirement.

Hot water boilers or air source heat pumps that supply heat to the building through one- or two-pipe heating systems must have an outdoor setback control that adjusts output water temperature based on the outdoor temperature.

HVAC Piping Insulation

All HVAC piping (such as in hydronic heating systems) conveying fluids at temperatures greater than 105°F or chilled fluids at less than 55°F must be insulated to a minimum of R-3. Pipe insulation is not required for piping installed within HVAC equipment.

Section 2.5

(Potable) Water Heating

2.5a

Hot Water Circulation and Temperature Maintenance Systems

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

Heat trace systems. Controls for electric heat trace systems must 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.

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 must be a demand recirculation water system. Pumps must have controls that comply with both of the following:

1. The control must 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 must limit the temperature of the water entering the cold-water piping to 104°F (40°C).

2.5b

Swimming Pools, Hot Tubs and Spas

All heated pools, hot tubs, and spas must be equipped with an on/off pool heater switch mounted for easy access (in addition to the circuit breaker for power to the heater). Heaters fired by natural or LP gas cannot have continuously burning pilot lights. Heated pools and hot tubs require a pool cover unless over 70% of the heating energy is from non-depletable sources (such as solar heat).

All swimming pool pumps must be equipped with a time clock that can automatically turn off heaters and pumps according to a preset schedule, except where public health standards require 24-hour operation or where pumps operate solar-and-waste-heat recovery pool heating systems.

Section 2.6

Electrical

In most cases, each individual dwelling unit in a multi-family building must have its own electric meter. **Exception:** This requirement does not apply to assisted-care facilities, publicly subsidized housing, or housing for the elderly or disabled that does not have electric space heat or electric domestic hot water systems, and where the operator of the institution is paying the electric bills and not charging each resident separate, consumption-based usage charges for electricity.

For Act 250 projects, check the Act 250 permit, as electric resistance space heating may be prohibited.

Section 2.7

Dampers

Exhaust dampers are required for kitchen and bathroom exhaust fans and for clothes dryers.

Section 2.8

Lighting

A minimum of 90% of the lamps (bulbs) in permanently installed lighting fixtures must be high-efficacy lamps.

High-efficacy bulbs are light-emitting diode (LED) lamps, compact fluorescent lamps, T-8 or smaller diameter linear fluorescent lamps, or lamps with a minimum efficiency of 65 lumens per watt or light fixtures with a minimum efficiency of 55 lumens per watt.

In determining the number or percent of lamps, each user-replaceable lamp (or light string) connected to a permanently installed fixture counts as one lamp. For example, a 12-bulb chandelier counts as 12 (not 1) and a 3-bulb vanity fixture counts as 3 (not 1).

Electric Vehicle Charging Stations

For multifamily developments of 10 or more dwelling units, 4% of parking spaces must have a socket capable of providing either a Level 1 or Level 2 charge (see below).

- A Level 1 Electric Vehicle Charging Parking Space requires one 120V 20-amp grounded AC receptacle, NEMA 5-20R or equivalent, within 5 feet of the centerline.
- A Level 2 Electric Vehicle Charging Parking Space 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 of the centerline.

Exemptions: The following types of parking spaces do not need to comply:

1. Parking spaces intended exclusively for storage of vehicles for retail sale or vehicle service.
2. Parking spaces that are separated from the meter by a public right-of-way, such as a road.
3. Parking spaces which are limited to parking durations of less than an hour.
4. The number of parking spaces that are marked for “EV use only” need not exceed the number of EV cars driven by occupants of the building.

Chapter 3

Ventilation and Combustion Safety Requirements

Section 3.1

Ventilation

The Vermont Residential Building Energy Code requires all newly constructed homes to be mechanically ventilated with a whole-house ventilation system. There are also requirements for combustion equipment aimed at reducing the likelihood of flue gas venting problems. This chapter provides details on these requirements.

3.1a

Whole House Ventilation Requirement

Every new home must have a system consisting of fans, controls, and ducts or equivalent that provides the fresh air for the dwelling unit. There are four compliance options for meeting the whole house ventilation requirement:

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

The whole house ventilation system must meet the flow requirement (cubic feet per minute, or CFM) for the home size (Section 3.1b); use fans that meet efficiency, durability, and noise requirements (Section 3.1c); and have automatic controls, that is, operate *without the need for anyone to turn it on or off* (Section 3.1d).

There are two main categories of whole house ventilation systems:

- **Balanced ventilation systems.** Balanced systems provide fresh air (from outdoors) for ventilation. Supply and exhaust air are of equal capacity to achieve pressure equalization in the home. Heat recovery ventilators (HRVs) and energy recovery ventilators (ERVs) heat exchangers that transfer energy from the outgoing (exhaust) air to the incoming (fresh) air. Balanced ventilation systems are also called fresh air systems, as they deliver outdoor air into living spaces. When correctly installed, balanced systems do not significantly affect the air pressure in the house and save money by recovering heat from exhaust air before dumping it outside, unlike exhaust-only systems.
- **Exhaust-only systems** remove stale indoor air using single or multiple fans. Incoming air typically comes through leaks in the building shell. These systems tend to depressurize the home which can cause back drafting of combustion appliances and do not recover heat from the exhaust air. The most commonly used exhaust-only option is to pair an ENERGY STAR® bath fan with a programmable controller that does not rely on a user to switch it on.

These categories are compared in Figure 3-1 and Table 3-1.

Figure 3-1. Comparison of Exhaust-Only (left side) and Balanced (right side) Ventilation System Types [Source: Breathe Easy With Balanced Ventilation, GreenBuildingAdvisor.com]

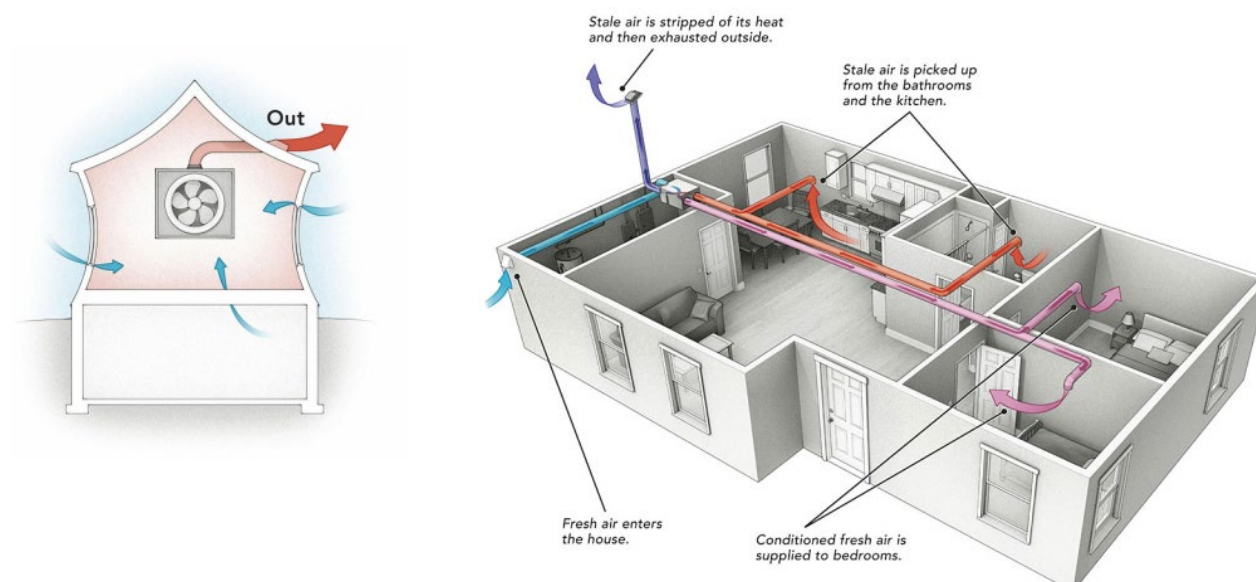


Table 3-1. Comparison of Exhaust-Only and Balanced Ventilation System Types

Factor	Exhaust-Only Ventilation	Balanced Ventilation
Fresh Air Source	Little or no control over where the home's fresh air comes from	Control over where fresh air comes from (i.e. outdoors)
Fresh Air Delivery	Little or no control over where the home's fresh air goes	Control over where fresh air goes
Simplicity / Cost	Simple / relatively inexpensive	More complicated / costly
Pressure Effects	Depressurized building can lead to back drafting ³	No induced infiltration or exfiltration Low or no impact on combustion appliances if balanced
Filtration	Cannot filter fresh air	Ability to filter fresh air
Energy recovery	Cannot recover energy	Ability to recover energy from exhaust air

Equipment must be installed according to the manufacturer's instructions. All ventilation systems must have a provision for circulating air to all finished living spaces, such as distribution ducts, grilles, transoms or door undercuts. If door undercuts are used, they must be at least 0.5 inch above the finished floor surface.

³Back drafting - When a fan removes air from a space, it changes the air pressure in the space. Exhaust fans diminish the pressure in the space, or "depressurize" it. Depressurization tends to draw in outside air, garage air and soil gas, and it can interfere with or even reverse the flow of flue gases in chimneys. The amount of pressure generated depends on the amount of air being moved and the air tightness of the space. For best performance, both positive and negative pressures from fans should be minimized. The most critical situation to avoid is substantial depressurization in rooms with combustion appliances.

Whole House Flow Requirement

Depending on which of the four compliance options from Section 3.1a is chosen, the flow requirement varies. Flow rates can be tested on site using approved methods (e.g., a flow hood or a calibrated orifice combined with a digital manometer). **Note:** CFM = cubic feet per minute.

- 1. To get required the CFM using **ASHRAE 62.2-2016**, do a calculation that accounts for the home characteristics. The easiest way to determine the CFM is to use a free online calculator such as that offered by Residential Energy Dynamics (<http://www.residentialenergydynamics.com/REDCalcFree/Tools/ASHRAE6222016>). Note that to claim infiltration credit, actual blower door test result must be entered. Coordinate with your blower door air leakage tester to determine sizing requirements.
- 2. To get the required CFM using **BSC Standard 01-2015**, do a calculation that accounts for the home characteristics, whether the system is balanced or exhaust-only, and whether the system is distributed. The equation is in section 4 of the standard, available at https://buildingscience.com/sites/default/files/bsc_standard_01-2015_ventilation_for_new_low-rise_residential_buildings_0.pdf
- 3. To get the required CFM using **Passive House Standards**, check with the particular standard you are using (PHIUS or PHI). Generally speaking, the supply air requirement is 18 CFM/person or 0.3 ACH; the extract air is 35 CFM per kitchen, 24 CFM per full bathroom, and 12 CFM per half bath or utility/storage room. The design CFM is the greater of the extract or supply requirement.

The advantage of these three methods is that they adjust the ventilation needs to the house and/or occupants. There is a prescriptive method of CFM calculation that is simpler but does not account for the characteristics of the house and/or occupants to the same level.

- 4. If not using the methods above, take the **Prescriptive** approach to determining CFM. The ventilation system must be tested to provide a minimum of 15 CFM plus 15 CFM for each bedroom. For example, a 4-bedroom home would require 15 CFM + (4 x 15) CFM = 75 CFM. If the ventilation system is not tested, capacity must meet or exceed the amount listed in Table 3-2 using fan flow ratings in accordance with HVI 911.

Table 3 2. Capacity Requirements for Whole-House Ventilation Systems

Number of Bedrooms	Minimum Rated Capacity (CFM)	Minimum Number of Fans
1	50	1
2	75	1
3	100	1
4	125	Centrally ducted systems: 1, All other systems: 2 or more
5	150	Centrally ducted systems: 1, All other systems: 2 or more
Homes over 3000 sq. ft.	0.05 x sq. ft. of conditioned space	Centrally ducted systems: 1, All other systems: 2 or more

Fan Requirements

Fans installed as part of a whole-house ventilation system must meet the following requirements.

- **Durability:** Fans must be rated for “continuous duty.”
- **Efficiency:** Bathroom fans between 10-89 CFM must have an efficacy of 1.4 CFM per watt or greater. Bathroom fans over 90 CFM must have an efficacy of 2.8 CFM per watt or greater. Inline fans must have an efficacy of 2.8 CFM per watt or greater. HRVs or ERVs must provide 1.2 CFM per watt or greater. Single-port fans (those with only one connection to the conditioned space) must not exceed 50 watts as listed by the manufacturer. This refers to fan power only; it does not include power used for lights, heaters, nightlights, timers, etc. This power limit does not apply to multi-port fans that have more than one connection to the living space.
- **Sound:** Whole-house ventilation equipment located less than 4 feet from louvers, grilles or openings must have a sound rating no greater than 1.5 sones. For reference, common ceiling-mounted exhaust fans range from about .5 sone to 5 sones or more.

Exhaust fans meeting the EPA ENERGY STAR® standard for household ventilation equipment are considered to meet the three requirements above.

Controls

The whole-house ventilation system must have an automatic control or be capable of being set remotely for continuous operation. That is, it runs without relying on a person to turn it on or off. Continuous operation or timed switches are examples of accepted strategies; twist or crank-style timers or switches controlled solely by a humidity sensor (humidistat, or de-humidistat) are not acceptable as controls for the whole-house system.

Continuously operated systems shall not have local controls that have the ability to turn the system off. However, these systems must have a remotely mounted (i.e., not in the living space) on/off switch provided it is appropriately labeled.

Installation

All ventilation equipment (both whole-house and local) must be installed according to the manufacturer’s instructions and in accordance with the following requirements:

- Fan housings for ceiling- or wall-mounted fans must be air-sealed to the ceiling or wall opening.
- Inlet grilles for ducted systems must be air-sealed to the ceiling or wall.
- Smooth wall ducts (e.g. metal or composite) must be used for all duct runs longer than 8 feet.
- All ducts in unheated locations must be insulated.

- Mechanical fasteners — not just tape — must be used to connect the ducts to the fan.
- All joints, seams and connections must be securely fastened and sealed with welds, gaskets, o-rings, mastics (adhesives), mastic embedded fabric systems or approved tapes. **Note:** Standard “duct tape” is not allowed for sealing ducts since it dries out, becomes brittle and falls off.
- Remote (not in living space) whole house fans must be acoustically isolated from the structure/framing of the building and from attached hard ducts. This is generally done by using at least 1 foot, but no more than 2 feet, of insulated, flexible ducting. (This requirement does not apply to fans mounted in ceilings or walls.)
- Intake openings, if used, must be located a minimum of 10 feet from any hazardous or noxious contaminant, such as vents, chimneys, fuel fills, streets, alleys, parking lots and loading docks. The bottom of the intake opening(s) must be at least 1 foot above the expected snow accumulation level.
- Outside openings for both supply and exhaust must be protected with screens, louvers or grilles having a minimum opening size of ¼ inch and a maximum opening size of ½ inch.

3.1f

Local (Spot) Ventilation

Bathrooms, kitchens and laundry rooms are places where pollutants may be generated in high concentration. When these areas are being used, an exhaust fan directs pollutants directly to the outdoors before they can negatively impact air quality in the home.

All bathrooms containing a bathtub, shower, spa or similar bathing fixture must have an exhaust fan with a minimum tested capacity of 50 CFM for intermittent fans, or 20 CFM for continuously operated (24 hours per day) fans. If the whole-house ventilation system does not provide adequate local ventilation, a separate fan with the specified capacity must be installed.

3.1g

Clothes Dryers

All clothes dryers must be exhausted to outdoors according to the manufacturer’s instructions (except clothes dryers designed by the manufacturer to be unvented and to not contribute to the interior moisture load, such as condensing dryers and heat pump dryers). Dryer exhaust systems must be independent of all other systems and must transport the dryer exhaust all the way to the outdoors (not to the attic or other space).

Exhaust (Range) Hoods

Mechanical exhaust hood systems capable of exhausting in excess of 400 CFM must be provided with makeup air at a rate approximately equal to the exhaust air rate. The makeup air systems must also be equipped with a means of closure and be automatically controlled to start and operate simultaneously with the mechanical exhaust system.

Combustion Safety

The Residential Energy Code requires the installation of appropriate combustion equipment in order to reduce the likelihood of venting problems. Primarily, it requires that air for combustion be provided for chimney-vented devices.

Additions, Alterations, Renovations and Repairs

Combustion safety requirements must be met when heating or cooling equipment is replaced or when alterations will likely change the air leakage characteristics of the home. Examples of alterations that could change the air leakage characteristics of a building are:

- Replacement of windows.
- Replacement of insulation in more than half of the wall area.
- Sealing significant air leakage holes in any part of the building.
- Adding or removing ductwork.
- Sealing a fireplace.
- Adding insulated sheathing at the time of siding replacement.
- Insulating any formerly uninsulated parts of the building.

The worst-case depressurization test is conducted by creating the largest combustion appliance zone (CAZ) depressurization due to the combined effects of door position, exhaust appliance operation, and air handler fan operation. A base pressure must be measured with all fans off and doors open. The worst-case depressurization is the pressure difference between worst-case and the base pressure.

Oil and Gas Appliances

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

RBES requires all new homes containing chimney-vented combustion devices to be provided with combustion and dilution air as required by the gas and oil codes (National Fire Protection Association [NFPA] Standard 54 [for gas] and Standard 31 [for oil].) Although these entire codes may not be in effect in certain areas of

Vermont, the requirements for combustion and dilution air have been incorporated into the Energy Code and therefore apply regardless of whether a locality has adopted the oil and gas codes.

The Energy Code specifically states that all new homes built in accordance with the RBES meet the definition of “unusually tight construction” as defined in the oil and gas codes. This means that combustion and dilution air may not be taken from the living space, and that the combustion and dilution air must be provided regardless of the volume of the space.

Additionally, in most cases, **RBES prohibits taking that air from garages, attics or crawl spaces.** Although NFPA 54 and 31 both allow combustion air to be taken from bordering spaces, this is specifically prohibited in Vermont. In general, combustion and dilution air must be taken from outdoors.

Exception: If all the combustion devices in the home are either direct-vent appliances (also called sealed combustion; whereby all air for combustion is supplied directly from outdoors and all flue gases are discharged directly to outdoors) or mechanical draft appliances (where a fan is used to remove flue gases), or the home is all-electric, the combustion and dilution air requirements for oil and gas appliances do not apply.

3.2b

Solid-Fuel Appliances

All solid fuel-burning (i.e., wood, pellets and coal) appliances must have tight-fitting (defined as gasketed doors with compression closure or compression latch system) metal, glass or ceramic doors. **Note:** that many common glass bi-fold fireplace doors do not meet the requirements of RBES Code without modification. The only exception to this is a home certified to have passed the worst-case testing procedure outlined in RBES Appendix RA – Recommended Procedure for Worst-Case Testing of Atmospheric Venting Systems; the test must be done by an approved third party, with a written report of the results signed by that party.

Solid fuel-burning appliances must have ducted combustion air from outdoors. This exterior air intake:

- Cannot take air from within the garage, attic or basement.
- Cannot terminate to the exterior higher than the firebox nor have a vertical rise within 18 inches of the firebox.
- Where a woodstove or fireplace is installed below grade (e.g. in a basement), the combustion air intake on the home’s exterior may be located above the firebox if the combustion air supply point is below the firebox and the combustion air intake point is greater than 15 inches below the top of the chimney.
- Must deliver combustion air to the firebox. For older woodstoves and cookstoves where direct connection of combustion air is not possible, combustion air may be delivered within 24 inches of the stove’s air intake opening.
- Must be screened with ¼ inch mesh.
- Exterior air inlet shall be installed so as to remain free of obstruction from snow.

- Must be a minimum of 6 square inches and not more than 55 square inches. The passageway must be constructed of non-combustible, masonry or 30-gauge (or thicker) metal, with a minimum 1-inch clearance to combustibles for the length of the combustion air intake.

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 without those exterior air supply ducts according to the manufacturer's installation instructions. *There is no exemption from the exterior air supply requirement. It is not permitted to use fresh air from a whole-house ventilation system to provide make-up air / fresh air for solid fuel appliances. The manufacturers of some factory-built fireplaces, masonry fireplaces and solid-fuel-burning appliances list exterior air supply ducts as optional, but in Vermont it is required.*

3.2c

Spillage Testing

All combustion equipment that is not power-vented or direct-vented (wherein combustion air is drawn directly from the outdoors), shall establish complete draft without spillage under “worst-case” conditions within two minutes. This requirement must be met in new homes and in existing homes after code applicable renovations, alterations or repairs to the building envelope, mechanical equipment, combustion vent system or ductwork.

Appendix RA – Recommended Procedure for Worst-Case Testing of Atmospheric Venting systems and the current Building Performance Institute (BPI) standard ANSI/BPI-1200 are recommended test procedures that may be used to meet this requirement.

Existing Homes: Additions, Alterations, and Repairs

Additions, alterations and repairs to existing homes, conducted after September 1, 2020, must comply with the requirements in Chapter 4. The following are circumstances where existing homes must comply with the Code.

- **Additions:** Any extension or increase in the conditioned space floor area or height of a building or structure.
- **Alterations:** 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.
- **Repairs:** The reconstruction or renewal of any part of an existing building for the purpose of its maintenance or to correct damage.
- **Changes in Space Conditioning:** Any nonconditioned or low-energy space that is altered to become conditioned space.
- **Changes in Use:** Spaces undergoing a change in use that would result in an increase in demand for either fossil fuel or electrical energy.
- **Major renovations** to homes under an Act 250 permit that trigger an Act 250 permit amendment request would need to follow Stretch Code requirements after September 1, 2020.
- **Historic Buildings:** Construction, repair, alteration, restoration and movement of structures, and change of occupancy related to a historic building need to comply unless a “Historic Building Exemption Report” has been submitted to the State Historic Preservation Office (SHPO) and has been signed by the owner or registered design professional demonstrating that compliance with a particular provision would threaten, degrade or destroy the historic form, fabric or function of the building. The SHPO will review and validate the exemption request. A template for the report is available on both the SHPO and PSD websites.
- **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.
- **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.

Exceptions

The following building conditions do not have to comply with any of the Code requirements:

1. Unaltered portions of the existing building or building supply system.
2. Storm windows installed over existing fenestration.
3. Connections or repairs to, or maintenance of existing mechanical systems do not constitute an alteration to that system. Where ducts from an existing heating and cooling system are extended to an addition, duct systems with less than 40 linear feet in unconditioned spaces are not required to be tested.
4. Glass-only replacements in an existing sash and frame.
5. Existing ceiling, wall or floor cavities exposed during construction, provided that these cavities are filled with insulation.
6. Construction where the existing roof, wall or floor cavity is not exposed.
7. Reroofing projects where neither the sheathing nor the insulation is exposed. If either the sheathing or insulation is exposed, then the cavity needs to be filled with insulation; this does not require building the roof up. Roofs without insulation in the cavity and where the sheathing or insulation is exposed during reroofing must be insulated either above or below the sheathing.
8. Alterations that replace less than 50% of the permanent light fixtures in the space where the alteration is taking place, provided that such alterations do not increase the installed interior lighting power.
9. Alterations or repairs that replace only the bulb and ballast within the existing light fixtures in a space provided that the alteration does not increase the installed interior lighting power.
10. Historic Buildings: No provisions of this code relating to the construction, repair, alteration, restoration and movement of structures, and change of occupancy shall be mandatory for historic buildings if it is demonstrated that compliance with that provision would adversely affect the historic building. If an exemption is needed, a “Historic Building Exemption Report” must be submitted to the State Historic Preservation Office (SHPO). The report must be signed by the owner or registered design professional and demonstrate that compliance with a particular provision would threaten, degrade or destroy the historic form, fabric or function of the building. The SHPO will review and validate the exemption request.

Compliance

Portions of the building that are altered must be brought into full compliance with the code that relates to that portion of the building with above exceptions. 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. Alterations and repairs 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.

Compliance can be achieved through any of the compliance paths, which include the following approaches: Package-Plus-Points (see Chapter 5), REScheck™ software (see Chapter 6), or a Home Energy Rating System (HERS) rating (see Chapter 7). For renovations, remodeling, or additions, a Home Energy Rating can be used to demonstrate compliance by rating the entire building, including the new and remodeled portions. Rating the entire building requires including both the existing and new sections of the building, to meet either the maximum HERS of 61 for Base Code or 54 for Stretch Code using the software version listed in Chapter 7.

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.

Section 4.3

Prescriptive Compliance for Additions

An addition shall be deemed to comply with the 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 prior to the addition as demonstrated by an overall weighted U-factor

New building envelope assemblies that are part of the addition shall comply with the full requirements for new construction defined in Chapter 2, including the Specific Insulation Requirements, Fenestration Requirements, and Air Leakage requirements.

- Air leakage testing (see Appendix A) is not required for additions complying based on the attributes of the addition alone, for alterations, or for repairs. Additions complying 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 must be tested and verified as having an air leakage rate not exceeding 3.0 ACH50.

The building thermal envelope shall comply with one of the Packages defined in Table 5-1 of Chapter 5 of the Handbook, and attain the required points needed based on addition size as called out in Table 4-1 below. The Points Options for Base Code Table (5-3 in the Handbook) is to be used for defining points for compliance with the Prescriptive Packages.

⁴The report form is available on both the SHPO and PSD websites: <https://accd.vermont.gov/historic-preservation/review-compliance> and https://publicservice.vermont.gov/energy_efficiency/rbes. For guidance on how to think intentionally when addressing energy efficiency for Vermont's historic buildings, please visit <https://accd.vermont.gov/historic-preservation/planning> or contact the SHPO at accd.projectreview@vermont.gov.

Table 4-1. Required points by addition size

REQUIRED POINTS BY ADDITION SIZE	
Building/Dwelling Size	Required Points
Alterations	0 points
Additions < 250 square feet	0 points
Addition > 250 < 500 square feet	1 point
Addition > 500 < 1,000 square feet	2 points
Addition > 1,000 square feet	3 points

Section 4.4

U-Factor Alternative and UA Alternative Compliance for Additions

U-factor alternative. An assembly with a U-factor equal to or less than that specified in Table 4-2 (RBES Table R402.1.4) shall be permitted as an alternative to the R-values in Base Package Table 5-1 of the Handbook. The building must still comply with the Points Table for Additions (Table 4-1) and the Points by Component Table (Table 5-3)

Table 4-2. Equivalent U-Factors

EQUIVALENT U-FACTORS								
Fenestration U-Factor	Sky-Light U-Factor	Ceiling U-Factor	Frame Wall U-Factor	Mass Wall U-Factor ^b	Floor U-Factor	Basement U-Factor	Crawl Space Wall U-Factor	Slab & Unheated D Slab U-Factor & Depth
0.27	0.55	0.022	0.044	0.060	0.030	0.035	0.035	0.066, 4ft

Where the existing building and addition comply with this code as a single building, the U-factor alternative or UA alternative compliance method shall be permitted, provided that:

- a. airtightness is less than or equal to 2.0 ACH50 tested, and
 - b. the ventilation system is: Balanced; with ECM fan(s) plus $\geq 70\%$ SRE for HRV, or $\geq 65\%$ SRE for ERV.
- Alternatively, 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 4-1 by the same assembly area as in the proposed building, the building shall be considered to be in compliance, with the same caveats for points. Exception: Additions complying based on the attributes of the addition alone using the U-factor alternative compliance method are not required to comply with the airtightness limit (a) or the balanced ventilation system and heat recovery efficiency requirements (b) above.

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 4-2 (RBES Code R402.1.4) by the same assembly area as in the proposed building.

The Prescriptive method is the easiest way to ensure compliance with the Residential Energy Code. This chapter reviews:

- ★ Homes eligible for the Prescriptive Method.
- ★ When and how to use the Prescriptive Method.

Chapter 5

The Package-Plus-Points Prescriptive Compliance Method

The Package-Plus-Points prescriptive method is a simple and flexible way to plan for and demonstrate compliance with the RBES Energy Code. It requires you to build a home that meets:

1. The **Basic Requirements** (see Chapter 2);
2. The **Ventilation and Combustion Safety Requirements** (see Chapter 3);
3. The **Packages-Plus-Points Requirements** (see tables in this chapter).

If you do not use this compliance method, the other options are to use the **REScheck™ Software Compliance Method** (Chapter 6) or energy rating services via the **Home Energy Rating Compliance Method** (Chapter 7).

Section 5.1

When to Use the Packages-Plus-Points Method

The Packages-Plus-Points method is for homes whose thermal and heating efficiency values match or exceed those of a predefined package in the Packages Table for your house type AND attain the specified number of points based on your house type

and size. Refer to tables in this Chapter. Homes with metal framing for exterior walls cannot use this method.

If the values for your home do not meet the values specified in one of the Packages and/or you do not achieve/plan to achieve the number of points required, you must use a software or energy rating services compliance method. The two alternatives are the **REScheck™ Software Compliance Method** (Chapter 6) or the **Home Energy Rating Method** (Chapter 7).

Section 5.2

Meeting BASE Code Using the Packages-Plus-Points Method

Buildings must meet the **Basic Requirements** (see inside front cover and Chapter 2) and **Ventilation and Combustion Safety Requirements** (see Chapter 3). Be prepared to identify nominal R-values and U-factors for the building components for your home using manufacturers' product information. If a single building component in your home has two or more different thermal values (i.g., R-38 ceiling and R-49 ceiling), calculate the average U-factor then convert back to R-value. (See Appendix C if you need help.)

Then, take the following three steps during the design stage, whenever there are design changes, and upon construction completion, and steps 4 and 5, below upon completion of construction:

1. Select one of the five base packages listed in Table 5-1; and
2. Determine the number of points needed to comply with Table 5-2 based on building size; and
3. Incorporate a sufficient number of points from Table 5-3 to meet the points requirements from Table 5-2.

Note that the Log Homes package (Package #5) applies to homes with an assembly of individual structural logs for use as an exterior or interior load bearing wall, shear wall or non-load bearing wall. Insulation may be applied to the interior or exterior log surface to increase wall U-factor when the weather side is constructed in compliance with ICC 400-2017.

The R-values for your home must be *equal to or greater than* the selected package. The U-factors for your home must be *equal to or less than* the selected package. All requirements in the footnotes of Table 5-1 and Table 5-3 must be met.

If your home meets or exceeds the requirements for one of the predefined Packages AND meets the Points needed, you can proceed to step 4. **If your home does not meet the requirements** for one of the Packages or does not have enough Points, consider whether it is feasible to make a design change, or consider another compliance method (Chapters 6 and 7).

Selecting the Correct Table for the Prescriptive Method

To determine the minimal Prescriptive Requirements, determine which house type applies to your project and use the corresponding table:

★ **Single-family and multi-family homes:** Detached one- or two-family residential buildings. (Duplexes are considered single-family homes for the purposes of the Code.) See Table 5-1.

★ **Log homes:** Homes with an assembly of individual structural logs for use as an exterior or interior load bearing wall, shear wall, or non-load bearing wall. See Table 5-1.

4. Obtain a **blower door air leakage test** from a certified tester. See Section 2.1b for details.
5. **Upon completion of construction, self-certify your compliance** with the Energy Code by filing a Vermont Residential Building Energy Standards Certificate. The certificate is a statement that the home meets or exceeds the requirements of the Energy Code. The process:
 - a. Complete the certificate when the home is 100% finished and has met the blower door air leakage test. See Chapter 8 for detailed instructions on filing.
 - b. Within 30 days, send one copy each to:
 - The Town Clerk for the town or city in which the home is located. (**Note:** Check local procedures before filing the certificate; local fees and forms may be required.)

Vermont Public Service Department
 Efficiency and Energy Resources Division
 112 State Street
 Montpelier, VT 05620-2601

If the home is participating in a utility “new construction” program, check with the utility; you may need to provide a copy in order to receive an efficiency incentive or rebate. Be sure to keep one copy for your records as well.

6. **Post the original certificate in the home**, affixing it on or near the electrical service panel or heating equipment.

When to Evaluate Using the Prescriptive Method

To ensure Code compliance, compare the appropriate Prescriptive Table with your home:

1. During the design stage.
2. Whenever there are design changes.
3. Upon completion.

Prescriptive Tables begin on the next page.

Select the appropriate table
 (Tables 5-1 and 5-2 and 5-3 are for Base Code)
 for your project.

Table 5-1. Requirements by component for base packages

REQUIREMENTS BY COMPONENT FOR BASE PACKAGES					
Component ^a	Package 1 Standard	Package 2 SIPS	Package 3 Thick Wall	Package 4 Cavity Only	Package 5 Log Homes
Ceiling	R-49 ^f	R-28 cont.	R-49 ^f	R-60g attic / R-49 ^f slope	Construct log home to ICC 400-2017 "Standard on the Design and Construction of Log Structures" OR Table R402.1.6 in RBES code language
Wood Frame Walls	R-20+5 ^e OR 13+10 ^e	R-21 cont.	R-20+12 ^e	R-20 cavity	
Common Wall Insulation	R-10	R-10	R-10	R-10	
Floor	R-30	R-30	R-30	R-38	
Basement/Crawl Space Wall ^c	R-15 (continuous) OR 20 (cavity) OR R-13+5	R-15 (continuous) OR 20 (cavity) OR R-13+5	R-20 (continuous) OR R-13+10 ^e	R-20 (continuous) OR R-13+10 ^e	
Slab Edge ^d	R-15, 4ft OR R-10 perimeter + R-7.5 under entire rest of slab	R-15, 4ft OR R-10 perimeter + R-7.5 under entire rest of slab	R-10, 4 ft	R-15, 4 ft OR R-10 perimeter + R-7.5 under entire rest of slab	
Heated Slab ^d	R-15 (edge and under)	R-15 (edge and under)	R-15 (edge and under)	R-15 (edge and under)	
Fenestration ^b (Window and Door)	U-0.30 max.	U-0.30 max.	U-0.30 max.	U-0.28 max.	
Skylight ^b	U-0.55 max.	U-0.55 max.	U-0.55 max.	U-0.55 max.	
Air Leakage ⁱ	≤3.0 ACH50 ^h tested	≤3.0 ACH50 ^h tested	≤3.0 ACH50 ^h tested	≤3.0 ACH50 ^h tested	
Duct Leakage	Inside thermal boundary	Inside thermal boundary	4 CFM25 per 100 sq. ft. of CFA ⁱ	Inside thermal boundary	
Percent High Efficacy Lamps ⁱ	90%	90%	90%	100%	

For SI: 1 foot = 304.8 mm.

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.

b. The fenestration U-factor row excludes skylights.

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, so "13+10" means R-13 cavity insulation plus R-10 continuous insulation.

f. 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 RBES Section R402.2.1). Multifamily buildings using continuous insulation with a maximum U-factor of 0.023 for the ceiling assembly satisfies this requirement.

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 RBES Section R402.2.1.)

h. "ACH50" = air changes per hour at 50 Pascals building pressure as measured with a blower door

i. "CFA" = conditioned floor area

j. See RBES Table R402.4.1.1 for further details.

Table 5-2. Required points by building size for Base Code

REQUIRED POINTS BY BUILDING SIZE FOR BASE CODE	
Building/Dwelling Size	Required Points
Multifamily < 2000 square feet	4 points
<2000 square feet	5 points
2000 to 4000 square feet	7 points
>4000 square feet	10 points

Building size for the above points table is determined by the finished conditioned floor area per dwelling unit within the building thermal envelope, including unfinished basements and storage/utility spaces. The Multifamily < 2000 square feet point requirement cannot be used for semidetached (semiattached, side-by-side), row houses and townhouses, defined as single family dwellings in Definitions Appendix F. Multifamily dwelling unit size is based on the average dwelling size for the building.

Table 5-3. Points options for Base Code, by component

POINTS OPTIONS FOR BASE CODE, BY COMPONENT			
Envelope	Slab	R-10 below entire slab	1 pt
	Walls: Upgraded	Above grade walls R-20+12 (or U-factor maximum 0.033 wall assembly ^a) (Not available for stretch package 3) OR^b	2 pt
	Walls: High-R	Above grade walls \geq R-40 (cavity and continuous) (or U-factor maximum 0.025 wall assembly ^a)	3 pt
	Ceiling	R-80 attic flat / R-60 sloped, vaulted and cathedral	1 pt
	Windows	Average U-factor \leq 0.27 OR^b Average U-factor \leq 0.22	1 pt 2 pt
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	1 pt
	Tight	ACH50 \leq 2.0 and balanced ventilation with ECM ^c fans and \geq 70% SRE ^d for HRV ^e , \geq 65% SRE ^d for ERV ^e OR^b	3 pt
	Very Tight	ACH50 \leq 1.0 and balanced ventilation with ECM ^c fans and \geq 80% SRE ^d for HRV ^e , \geq 75% SRE ^d for ERV ^e	4 pt
Heating and Cooling ^f	Basic	ENERGY STAR ^g basic: (1) Gas/propane furnace \geq 95 AFUE, Oil furnace \geq 85 AFUE, (2) Gas/Propane Boiler \geq 90 AFUE, Oil Boiler \geq 87 AFUE, (3) Heat pump HSPF \geq 9.0; and any AC is SEER \geq 14.5 OR^b	1 pt
	Advanced	Whole building heat/cool is (1) NEEP-listed heat pump combination ^g , (2) GSHP ^h , closed loop and COP \geq 3.3, (3) AWHP ⁱ COP \geq 2.5 and max. 120°F distribution design temperature, (4) Advanced wood heating system	3 pt
Water	Basic	ENERGY STAR ^g basic: Fossil fuel [EF 0.67 for \leq 55 gal; EF 0.77 for $>$ 55 gal] OR^b	3 pt
	Advanced	ENERGY STAR ^g advanced: Electric [EF or UEF \geq 2.00 for \leq 55 gal; EF \geq 2.20 for $>$ 55 gal]	2 pt
	Low Flow	All showerheads \leq 1.75 gpm ^j , all lavatory faucets \leq 1.0 gpm ^j , and all toilets \leq 1.28 gpf ^k OR^b	1 pt
	Certified ^l	Certified water efficient design per WERS, WaterSense, or RESNET HERS _{H2O}	2 pt
	Inside thermal boundary	Drain water heat recovery system on primary showers and tubs	1 pt
	User-Demand	Controlled hot water recirculation system with user-demand via push-button for furthest fixtures ^m	1 pt
Renewable	Solar Ready	Home is Solar Ready per RBES Section R407.5, OR^b	1 pt
	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	Max 4 pt
	Solar Hot Water	Solar hot water system designed to meet at least 50% of annual hot water load	2 pt
Other Measures	Monitoring	Install whole-building energy monitoring system, min. 5 circuits and homeowner access to data ⁿ	1 pt
	EV Ready	Level 2 electric vehicle charger-ready per RBES Section R407.4 ^o	2 pt
	Battery	Min. 6 kWh grid-connected dispatchable demand-response-enabled battery backup	1 pt

Notes:

- a. Parallel path U-factor calculation
- b. “OR” indicates that points are not additive; one component **or** the following one can be selected, but not both
- c. “ECM” = Electronically Commutated Motor
- d. “SRE” = System Recovery Efficiency; SRE value used must be the HVI default listed value, or the Passive House Certified SRE if applicable
- e. “H/ERV” = Heat or Energy Recovery Ventilation
- f. Heating and cooling system points only available if all components of primary systems comply
- g. Northeast Energy Efficiency Partnerships (NEEP) maintains a specification and list of products that meet criteria for efficient operation in Vermont’s cold climate. Ref: NEEP’s *Cold Climate Air Source Heat Pump List*, <https://ashp.neep.org/#/>
- h. “GSHP” = ground-source heat pump
- i. “AWHP” = Air-to-Water Heat Pump
- j. “gpm” = gallons per minute
- k. “gpf” = gallons per flush. Applies to new construction only.
- l. 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.
- m. Timer and motion-based sensors are not compliant with this requirement
- n. A disaggregation sensor that monitors only the mains is considered compliant
- o. Points are limited to one per dwelling. Additional Level 2 charging equipment receives no more points

Meeting STRETCH Code Using the Packages-Plus-Points Method

Buildings must meet the **Basic Requirements** (see inside front cover and Chapter 2), **Ventilation and Combustion Safety Requirements** (see Chapter 3), the requirements in Appendix A and be prepared to identify nominal R-values and U-factors for the building components for your home using manufacturers' product information. If a single building component in your home has two or more different thermal values (i.g., R-38 ceiling and R-49 ceiling), calculate the average U-factor, then convert back to R-value. (See Appendix C if you need help.)

Then, take the following three steps during the design stage, whenever there are design changes, and upon construction completion, and steps 4 and 5, below upon completion of construction:

1. Select one of the five base packages listed in Table 5-4; **and**
2. Determine the number of points needed to comply with Table 5-5 based on building size; and
3. Incorporate a sufficient number of points from Table 5-6 to meet the points requirements from Table 5 5.

The R-values for your home must be equal to or greater than the selected package. The U-factors for your home must be *equal to or less* than the selected package. All requirements in footnotes of Table 5-4 and Table 5-6 must be met.

If your home meets or exceeds the requirements for one of the predefined Packages AND meets the Points needed, you can proceed to step 4. **If your home does not meet the requirements** for one of the Packages or does not have enough Points, consider whether it is feasible to make a design change, or consider another compliance method (Chapters 6 and 7)

4. Obtain a **blower door air leakage test** from a certified tester. See Section 2.1b above for details.
5. **Upon completion of construction**, self-certify your compliance with the Energy Code by filing a Vermont Residential Building Energy Standards Certificate. The certificate is a statement that your home meets or exceeds the requirements of the Energy Code. The process:

- a. Complete the certificate when the home is 100% finished and has met the blower door air leakage test. See Chapter 8 for detailed instructions on filing.

- b. Within 30 days, send one copy each to:

- The Town Clerk for the town or city in which the home is located. (Note: Check local procedures before filing the certificate; local fees and forms may be required.)
- Vermont Public Service Department
Efficiency and Energy Resources Division
112 State Street
Montpelier, VT 05620-2601

If the home is participating in a utility “new construction” program, check with the utility; you may need to provide a copy in order to receive an efficiency incentive or rebate. Be sure to keep one copy for your records as well.

6. **Post the original certificate in the home**, affixing the label on or near the electrical service panel or heating equipment.

Table 5-4. Requirements by component for Stretch Code packages

REQUIREMENTS BY COMPONENT FOR STRETCH PACKAGES			
Component ^a	Package 1- Standard	Package 2 - SIPS	Package 3 - Thick Wall
Ceiling R-Value	R-60g attic / R-49f slope	R-36 cont.	R-49 ^f
Wood Frame Wall R-Value	R-20+5e OR R-13+10e	R-21 cont.	R-20+12 ^e
Common Wall Insulation	R-10	R-10	R-10
Floor R-Value	R-30	R-30	R-30
Basement/Crawl Space Wall ^c R-Value	R-20 (continuous) OR R-13+10 ^e	R-20 (continuous) OR R-13+10 ^e	R-20 (continuous) OR R-13+10 ^e
Slab Edge ^d	R-15, 4ft OR R-10 perimeter + R-7.5 under entire rest of slab	R-15, 4ft OR R-10 perimeter + R-7.5 under entire rest of slab	R-15, 4ft OR R-10 perimeter + R-7.5 under entire rest of slab
Heated Slab ^d	R-15 (edge and under)	R-15 (edge and under)	R-15 (edge and under)
Fenestration ^b (Window and Door)	U-0.28 max.	U-0.28 max.	U-0.30 max.
Skylight ^b	U-0.55 max.	U-0.55 max.	U-0.55 max.
Air Leakage ⁱ	≤3.0 ACH50h tested	≤3.0 ACH50h tested	≤3.0 ACH50h tested
Ventilation	Balanced; ECM ^l fan plus ≥70% SRE ^k for HRV _j , ≥65% SRE for ERV ^l	Balanced; ECM ^l fan plus ≥70% SRE ^k for HRV _j , ≥65% SRE for ERV ^l	Balanced; ECM ^l fan plus ≥70% SRE ^k for HRV _j , ≥65% SRE for ERV ^l
Duct Leakage	Inside thermal boundary	Inside thermal boundary	Inside thermal boundary
Percent High Efficacy Lamps ⁱ	90%	90%	90%

For SI: 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa.

- 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 not be less than the R-value specified in the table.
- b. The fenestration U-factor row excludes skylights.
- c. The continuous portion of basement and crawlspace insulation can be met through interior, exterior or a 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, so “13 + 10” means R-13 cavity insulation plus R-10 continuous insulation. These insulation requirements can be met through any combination of insulation R-values that yields an equivalent effective R-value using a series-parallel path calculation method.

- f. 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 RBES Section R402.2.1.) Multifamily buildings using continuous insulation with a maximum U-factor of 0.023 for the ceiling assembly satisfies this requirement.
- 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 RBES Section R402.2.1.)
- h. “ACH50” = air changes per hour at 50 Pascals building pressure as measured with a blower door.
- i. See RBES Table R402.4.1.1 for further details.
- j. “H/ERV” = Heat or Energy Recovery Ventilation
- k. “SRE” = System Recovery Efficiency
- l. “ECM” = Electronically Commutated Motor

Table 5-5. Required points by building size for Stretch Code

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

Building size for the above points table is determined by the finished conditioned floor area per dwelling unit within the building thermal envelope, including unfinished basements and storage/utility spaces. The Multifamily < 2000 square feet point requirement cannot be used for semidetached (semiattached, side-by-side), row houses and townhouses, as defined as single family dwellings in Definitions Appendix F. Multifamily dwelling unit size is based on the average dwelling size for the building.

Table 5-6. Points options for Stretch Code, by component

POINTS OPTIONS FOR STRETCH CODE, BY COMPONENT			
Envelope	Slab	R-10 below entire slab	1 pt
	Walls: Upgraded	Above grade walls R-20+12 (or U-factor maximum 0.033 wall assembly ^a) (Not available for stretch package 3) OR ^b	2 pt
	Walls: High-R	Above grade walls \geq R-40 (cavity and continuous) (or U-factor maximum 0.025 wall assembly ^a)	3 pt
	Ceiling	R-80 attic flat / R-60 sloped, vaulted and cathedral	1 pt
	Windows	Average U-factor \leq 0.22	2 pt
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	1 pt
	Tight	ACH50 \leq 2.0 and balanced ventilation with ECM ^c fans and \geq 70% SRE ^d for HRV ^e , \geq 65% SRE ^d for ERV ^e OR ^b	1 pt
	Very Tight	ACH50 \leq 1.0 and balanced ventilation with ECM ^c fans and \geq 80% SRED for HRV ^e , \geq 75% SRE ^d for ERV ^e	4 pt
Heating and Cooling ^f	Basic	ENERGY STAR ^g basic: (1) Gas/propane furnace \geq 95 AFUE, Oil furnace \geq 85 AFUE, (2) Gas/Propane Boiler \geq 90 AFUE, Oil Boiler \geq 87 AFUE, (3) Heat pump HSPF \geq 9.0; and any AC is SEER \geq 14.5 OR ^b	1 pt
	Advanced	Whole building heat/cool is (1) NEEP-listed heat pump combination ^g , (2) GSHP ^h , closed loop and COP \geq 3.3, (3) AWHP ⁱ COP \geq 2.5 and max. 120°F distribution design temperature, (4) Advanced wood heating system	3 pt
Water	Basic	ENERGY STAR ^g basic: Fossil fuel [EF 0.67 for \leq 55 gal; EF 0.77 for $>$ 55 gal] OR ^b	1 pt
	Advanced	ENERGY STAR ^g advanced: Electric [EF or UEF \geq 2.00 for \leq 55 gal; EF \geq 2.20 for $>$ 55 gal]	2 pt
	Low Flow	All showerheads \leq 1.75 gpm ^j , all lavatory faucets \leq 1.0 gpm ^j , and all toilets \leq 1.28 gpf ^k OR ^b	1 pt
	Certified ^l	Certified water efficient design per WERS, WaterSense, or RESNET HERS _{H2O}	2 pt
	Drain Water Heat Recovery	Drain water heat recovery system on <i>primary showers</i> and tubs	1 pt
	User-Demand	Controlled hot water recirculation system with user-demand via push-button for furthest fixtures ^m	1 pt
Renewable	Solar Ready	Home is Solar Ready per RBES Section R407.5	Req'd
	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	Max 4 pt
	Solar Hot Water	Solar hot water system designed to meet at least 50% of annual hot water load	2 pt
Other Measures	Monitoring	Install whole-building energy monitoring system, min. 5 circuits and homeowner access to data ⁿ	1 pt
	EV Ready	Level 2 electric vehicle charger-ready per RBES Section R407.4 ^o	2 pt
	Battery	Min. 6 kWh grid-connected dispatchable demand-response-enabled battery backup	1 pt

Notes:

- a. Parallel path U-factor calculation
- b. "OR" indicates that points are not additive; one component **or** the following one can be selected, but not both
- c. "ECM" = Electronically Commutated Motor
- d. "SRE" = System Recovery Efficiency; SRE value used must be the HVI default listed value, or the Passive House Certified SRE if applicable
- e. "H/ERV" = Heat or Energy Recovery Ventilation
- f. Heating and cooling system points only available if all components of primary systems comply
- g. Northeast Energy Efficiency Partnerships (NEEP) maintains a specification and list of products that meet criteria for efficient operation in Vermont's cold climate. Ref: NEEP's *Cold Climate Air Source Heat Pump List*, <https://ashp.neep.org/#/>
- h. "GSHP" = ground-source heat pump
- i. "AWHP" = Air-to-Water Heat Pump
- j. "gpm" = gallons per minute
- k. "gpf" = gallons per flush. Applies to new construction only.
- l. 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.
- m. Timer and motion-based sensors are not compliant with this requirement
- n. A disaggregation sensor that monitors only the mains is considered compliant
- o. Points are limited to one per dwelling. Additional Level 2 charging equipment receives no more points

Building assembly and window examples

This section contains examples of assemblies and window information that can be used to comply with code.

5.4a

Above Grade Walls

Refer to Section 2.2b for diagrams of several above grade wall types with notes on moisture safety. When deciding on insulation strategy, consider that continuous insulation is more effective than cavity insulation of the same R-value, because thermal bridging or thermal “short circuiting” across studs is avoided. To illustrate this, Table 5-8 gives the typical “effective” R-value of a variety of insulation strategies for above grade walls, considering only the insulation and framing materials (wood studs at R-1 per inch) as examples of different effective wall R-values and U-factors.

Table 5-7. R-value of insulation strategies for above grade walls†

Wall assembly	Effective R-value	U-factor
2x6 16" o.c. with R-21 in cavity	R-16.6	0.060
2x6 24" o.c. with R-21 in cavity	R-17.9	0.056
2x6 16" o.c. with R-30 in cavity	R-21.2	0.047
2x6 16" o.c. with R-21 in cavity + R-5 cont.	R-21.6	0.046
2x6 16" o.c. with R-21 in cavity + R-15 cont.	R-31.6	0.032

†Source: REM/Rate v15.7 energy models

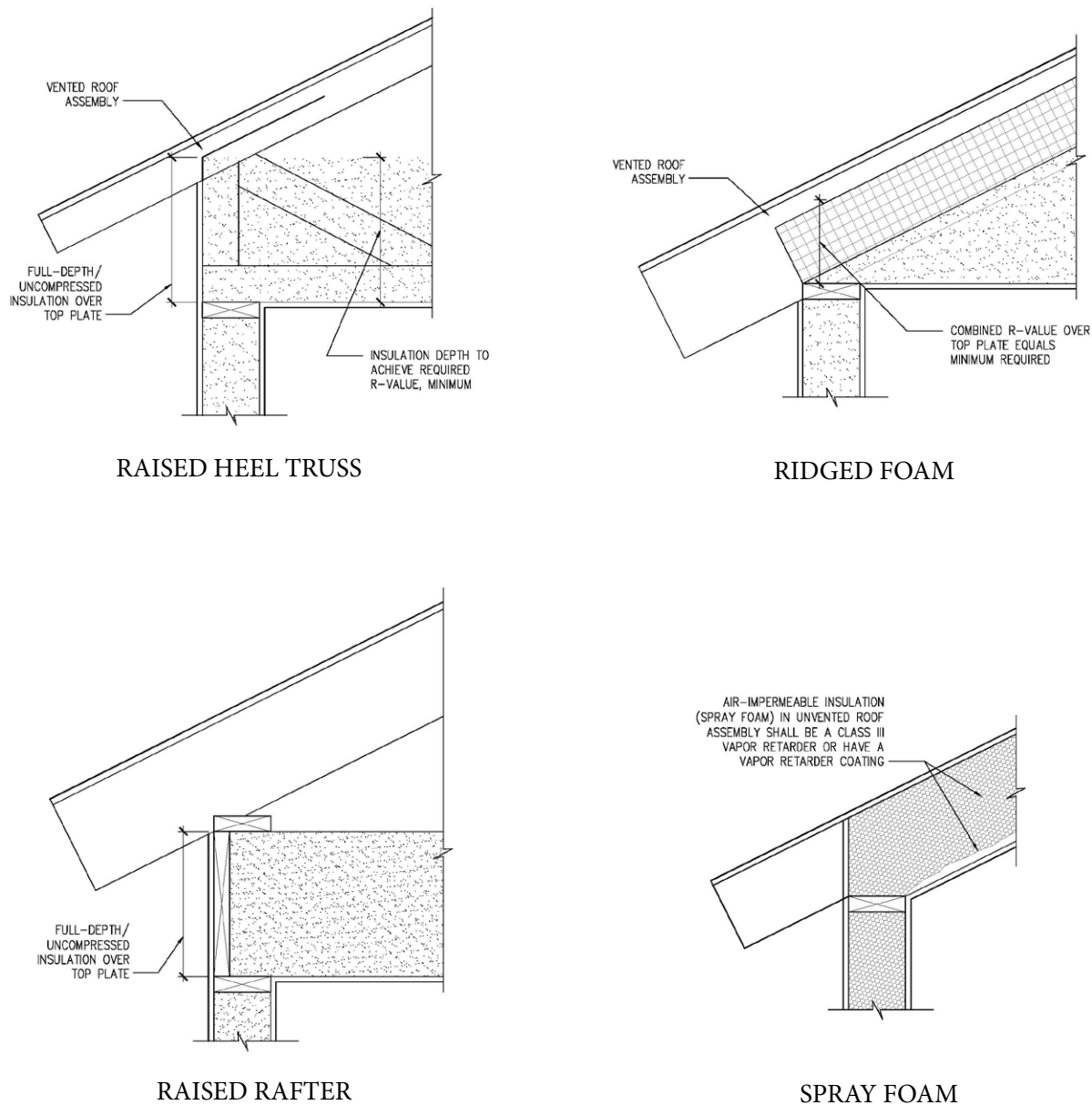
Note that:

- Using 24" o.c. stud spacing instead of 16" o.c. can increase the effective R-value by more than R-1
- Adding continuous insulation increases R-value more effectively than adding more cavity insulation

Raised Truss/Rafter

In order to take full credit for ceiling flat insulation, there must be a consistent R-value across the entire ceiling, including the top plates of all exterior walls, using a configuration similar to one of the examples in Figure 5-1, below. The two examples on the left side show uniform insulation thickness over the exterior wall top plate, best practice for new construction. The examples on the right are alternatives to uniform insulation thickness over the exterior wall top plate, which can be employed in existing homes where uniform insulation thickness may not be possible.

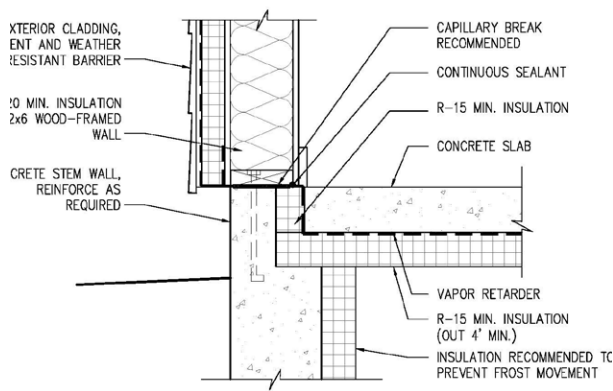
Figure 5-1. Raised truss/rafter options to achieve uniform insulation thickness across exterior wall top plate



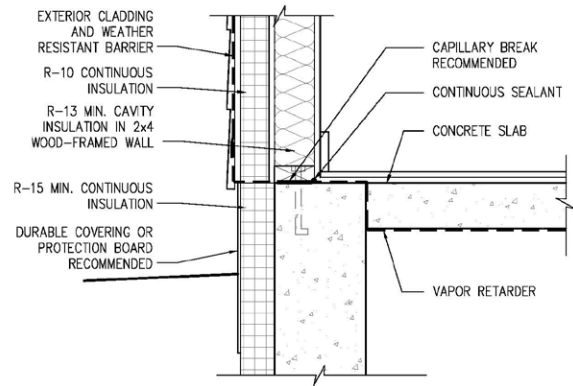
Slab Edge Insulation

Slab edge insulation is often overlooked. The details in Figure 5-2 provide several examples that illustrate how this can be done effectively.

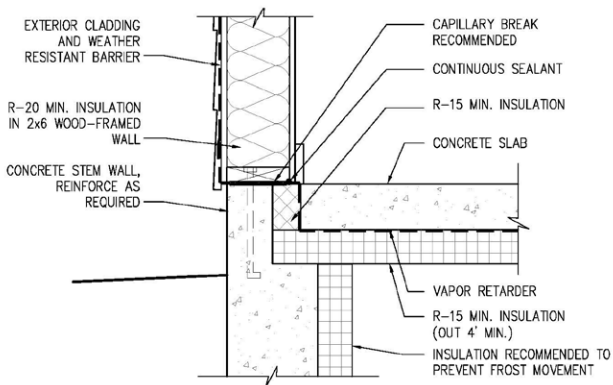
Figure 5-2. Slab edge examples for different above-grade wall configurations



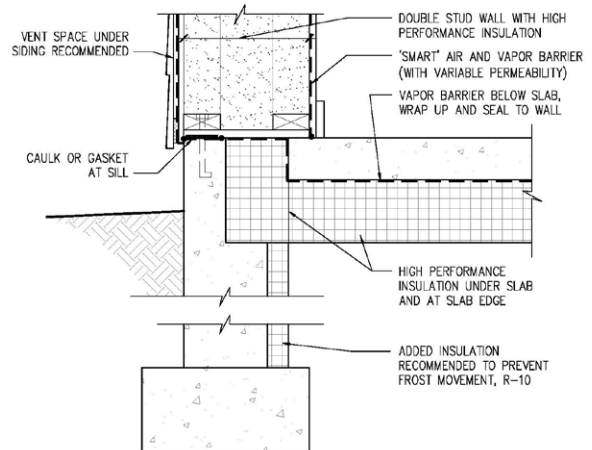
2x6 ABOVE GRADE WALL (R-20+5 SHOWN)



2x6 ABOVE GRADE WALL (R-20 SHOWN)



2x4 ABOVE GRADE WALL (R-13+10 SHOWN)

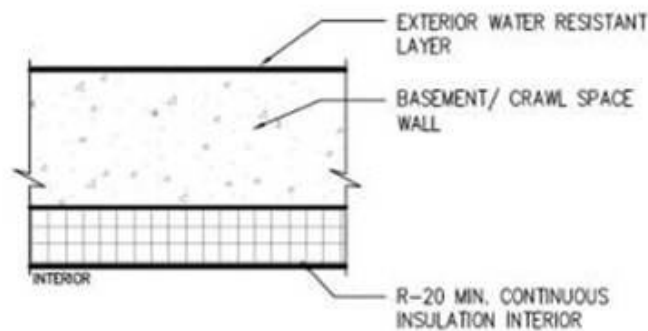


DOUBLE STUD WALL (R-40 SHOWN)

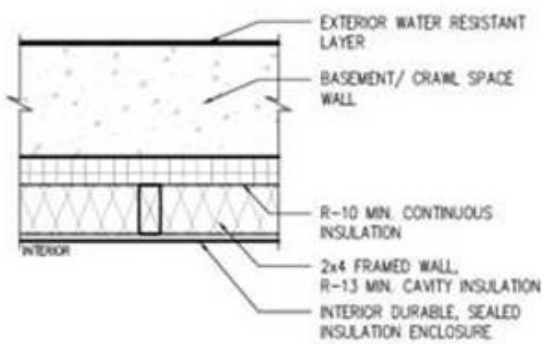
Foundation walls

The examples in Figure 5-3 show ways to meet the prescriptive requirement for Base Code packages 3 and 4, and all three Stretch Code packages; refer to Table 5-1 and Table 5-4.

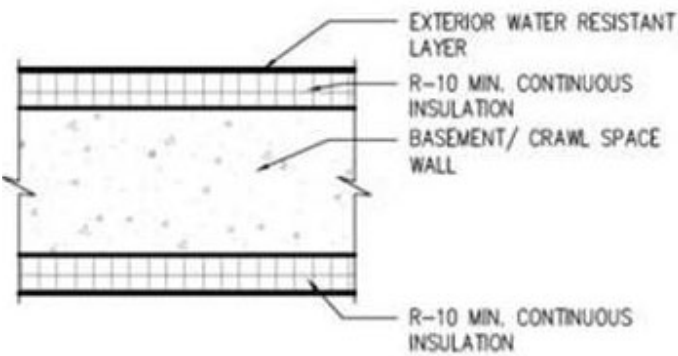
Figure 5-3. Foundation wall insulation configurations that can meet the Energy Code



INTERIOR CONTINUOUS INSULATION



INTERIOR CAVITY + CONTINUOUS INSULATION



ICF (INTERIOR + EXTERIOR) INSULATION

This chapter explains:
 ★ How the Software Method works.
 ★ The advantages of this method.
 ★ System requirements.
 ★ How to obtain the software.

Chapter 6

The *REScheck* Software Compliance Method

The *REScheck*™ Software Compliance Method involves the use of *REScheck*™ software to determine a home's compliance with the Residential Energy Code. This customized approach accommodates varied building techniques — including 24" stud spacing, stress-skin panels and metal framing — and offers flexibility in meeting the Code's Requirements. For this Method, you build a home that meets:

1. **The Basic Requirements** (see Chapter 2);
2. The *Ventilation and Combustion Safety Requirements* (see Chapter 3);
3. Using *REScheck*™ software, enter data on the home's thermal and efficiency values. The program determines if the home "passes."

In addition, in order to comply with the *REScheck*™ compliance method, there must be both:

- Balanced mechanical ventilation system with minimum efficiencies (see details below), and
- Air leakage must be ≤ 2.0 ACH50 tested.

If the above minimum features are not included in the home, the *REScheck*™ compliance method cannot be used.

If you do not use this compliance method, the other options are to use **the Packages-Plus-Points Compliance Method** (Chapter 5) or energy rating services via the **Home Energy Rating Compliance Method** (Chapter 7).

System Requirements

The current version of *REScheck* software requires Windows 2010 or later. Mac users will need to use *REScheck-Web*

Important note: *REScheck*™ cannot be used to demonstrate Stretch Code compliance.

How the Software Method Works

Using *REScheck*™ software, you simply specify component types (for example, 16" o.c. wood-frame walls), their area and their R-values or U-factors. There is no need to calculate average R-values and U-factors; you just enter the value of each component separately, along with its square footage, and the software performs the calculations.

Unlike the Packages-Plus-Points method, there are no “exempt” door or window areas; you enter data on each part of the thermal envelope, including all access hatches. The software performs all the calculations and determines if your home complies with the Residential Energy Code.

REScheck™ enables you to quickly compare different insulation levels in different parts of your building to arrive at a package that works best for you, providing that you take care to (a) ensure the building will meet $ACH50 \leq 2.0$ and (b) install a balanced mechanical ventilation system that meets the heat or energy recovery efficiency required.

Section 6.2

Using *REScheck*™ Software

At the design stage, whenever the design changes during construction, and again upon completion of construction for verification, complete steps 1 through 7. Upon completion of construction, complete steps 8 and 9:

1. **Review the Basic Requirements** summarized on the inside front cover (or refer to Chapter 2 for detailed explanations). Your project must meet all Basic Requirements.
2. **Follow the Ventilation and Combustion Safety Requirements.** (See Chapter 3)
3. Ensure that you meet two key construction requirements for using *REScheck*™:
 - a. At completion, the building meets the **air leakage requirement** for *REScheck*™ compliance of ≤ 2.0 ACH50 tested.
 - b. Install a **balanced ventilation system** with ECM fan(s), plus $\geq 70\%$ system recovery efficiency (“SRE”) for heat recovery ventilators (“HRV”), or $\geq 65\%$ SRE for energy recovery ventilators (“ERV”).
4. **Calculate the square footage of the building components** (windows, walls, ceilings, etc.). If you have components with different insulation values (for example, two flat ceilings with different R-values), calculate the square feet of each one separately. All parts of the thermal envelope must be included. Refer to the software manual or help function for details.
5. **Enter the basic project information** using *REScheck*™ software. Enter building component data, choosing from the available descriptions and keying in areas (square footage), R-values and U-factors. See Section 4.5, Total UA Alternative and Table 4-2. See the software manual or help function for complete instructions.

6. The software continuously displays “passes” or “fails.” **If your building does not pass at first, make changes in building components until it does.** (For example, to determine whether more efficient windows will bring the home into compliance, simply change the window U-factor; the result displays almost instantaneously.) Contact the Energy Code Assistance Center at 855-887-0673 for any assistance you may need. If construction is complete and it does not pass, consider whether it is feasible to use another compliance method.
7. **After construction, obtain a blower door air leakage test** from a certified air leakage tester to verify compliance with the air leakage requirement for *REScheck*™ compliance of ≤ 2.0 ACH50 tested.
8. **Upon completion of construction, self-certify your compliance** with the Energy Code by filing a Vermont Residential Building Energy Standards Certificate. The Certificate is your documentation that the home meets or exceeds the requirements of the Residential Energy Code. The process:
 - a. Complete the certificate when the home is 100% finished. (See Chapter 8 for detailed instructions.)
 - b. Within 30 days, send one copy each to:
 - The Town Clerk for the town or city in which the home is located.
(Note: Check local procedures before filing the certificate; local fees and forms may be required.)
 - The Vermont Public Service Department
Efficiency and Energy Resources Division
112 State Street
Montpelier, VT 05620-2601

If the home is participating in a utility “new construction” program, check with the utility. You may need to provide a copy in order to receive an efficiency incentive or rebate. Be sure to keep one copy for your records as well.

9. **Post the original certificate in the home**, affixing the label on or near the electrical service panel or heating equipment.

Section 6.4

How to Obtain *REScheck* Software

The *REScheck*™ software can be accessed at: <http://www.energycodes.gov/REScheck>

This chapter explains:

- ★ How home energy ratings can be used to demonstrate Code compliance.
- ★ The advantages of the Home Energy Rating method of compliance.

Chapter 7

The Home Energy Rating Compliance Method

Section 7.1

How the Home Energy Rating Method Works

The Home Energy Rating method is a “professional services” compliance method that a builder may utilize in order to demonstrate compliance with the Code.

This method is fundamentally different from the other two compliance methods (Packages-Plus-Points and *REScheck*™ software) because it requires sophisticated energy modeling tools to demonstrate that a new home meets or exceeds the technical requirement of the Energy Code. It utilizes a home energy rating, which is an independent, detailed analysis of the home’s energy efficiency. This method also can model complex buildings or buildings with unusual features, such as a high glazing percentage.

Home Energy Ratings offer the added benefit of having a professional review your project. Currently Efficiency Vermont offers Home Energy Rating services at no charge for homes that successfully met all residential new construction program requirements.

In order to comply with the Residential Energy Code using this method, a home must meet all of the Basic Requirements for Home Energy Ratings (Table 7-1), the Ventilation & Combustion Safety Requirements and meet the specific Home Energy Rating target scores listed later in this chapter.

If you do not use this compliance method, the other options are to use the **Packages-Plus-Points Compliance Method** (Chapter 5) or the *REScheck*™ **Compliance Method** (Chapter 6).

For this method, you must build a home that meets:

- The **Basic Requirements** (see Chapter 2);
- The **Ventilation and Combustion Safety Requirements** (see Chapter 3); and
- Achieve an energy rating of less than or equal to 61 for Base Code or 54 for Stretch Code (see Table 7-2 below).
- For Stretch Code, the requirements in Appendix A.

Section 7.2

Advantages of the Home Energy Rating Method

- **Less math and forms:** A professional energy specialist performs the calculations and fills out the Vermont Residential Building Energy Standards Certificate. [Note: the builder must sign and file the certificate]
- **Ventilation System Testing:** A professional energy specialist may test performance to determine compliance with the Energy Code ventilation requirements. Blower Door Air Leakage Testing: The Energy Code-required air leakage test can be provided at no charge by an Efficiency Vermont professional energy specialist for projects completing their residential new construction program.
- **Blower Door Air Leakage Testing:** The Energy Code-required air leakage test can be provided at no charge by an Efficiency Vermont professional energy specialist for projects completing their residential new construction program.
- **Credit for airtightness and solar gain:** Other compliance methods do not allow builders to “earn credit” for building a house tighter than the maximum ACH50. Because the rating process includes the actual air tightness value, the energy rating can give credit for incremental improvements in air sealing. Likewise, solar gain is factored into the building model, so buildings with significant solar gain can take credit for being partially heated by the sun.
- **Credit for efficient domestic hot water (DHW) systems, including solar-heated systems:** The other compliance methods assume minimum efficiency for DHW. Energy ratings can account for increased DHW efficiency.
- **Credit for efficient heating and cooling systems.**
- **Credit for electrically efficient lighting and appliances:** Your contractor should be able to provide up-to-date energy ratings for appliances and lighting, which can be incorporated

into the design to help ensure the home's compliance with the Energy Code.

Section 7.3

The Home Energy Rating

A home energy rating is a standard measure of a home's energy efficiency. In order to be used for Energy Code compliance, home energy ratings must be performed by a Vermont state-accredited rating organization. A certified Home Energy Rater does a detailed assessment of your home, which gets compared against a "reference home" – a model home of the exact size and shape as the actual home - so that your score is always relative to homes of the same size, shape and type. The result of the energy model is the Home Energy Rating Score (HERS) "index" that tells how energy efficient the home is, like a home's MPG (miles-per-gallon) rating. The lower the score, the more energy efficient the home (a net zero home gets a score of 0).

A signature is still required on Vermont Residential Building Energy Standards certificate for homes meeting the RBES performance requirements **through the Energy Rating Compliance method.**

Section 7.4

Minimum Thermal Envelope Efficiency Levels for HERS Compliance

While the HERS Rating method of compliance allows for trade-offs among building thermal envelope efficiency levels, there are minimum levels below which envelope efficiency levels may not be traded off. Table 7-1 lists the minimum thermal envelope efficiency levels for compliance through Home Energy Rating method.

Table 7-1 Minimum thermal envelope efficiency levels for HERS compliance

Mandatory Requirements Minimum Thermal Envelope Efficiency Levels for HERS Compliance	
<i>Component</i>	<i>Requirement^a</i>
Air Leakage	≤ 3 ACH50
Slab insulation	Unheated: R-10, 4ft; Heated: R-15
Basement/Foundation Walls	R-15 continuous / R-19 cavity
Floors	R-30
Windows/Skylights	U-0.30 / U-0.55
Above Grade Framed Walls	R-20 cavity or R-13 cavity + R-5 continuous
Ceilings	R-49

Table 7-2 shows the maximum HERS scores allowed for compliance with the Base and Stretch Codes for all residential structures, including log homes.

Table 7-2 Maximum HERS scores for Base and Stretch Codes

	Maximum HERS Energy Rating Index[†]	Note
Base Code	61	Up to 5 of these points may be achieved with renewables
Stretch Code	54	Up to 5 of these points may be achieved with renewables

[†]Based on REM/Rate version 15.7 using “HERS Index with Index Adjustment Factor”.

HERS Compliance Process

Home Energy Rating services can be used to verify Code compliance of a completed home. The recommended procedure is to follow these steps:

1. **Plan Review:** Submit plans and specifications to the HERS rater. If the home is not on track to meet the Energy Code as designed, the HERS rater recommends changes that will ensure compliance.
2. **Design Changes:** In the event that changes are made to the thermal and mechanical efficiency features, modifications can be analyzed to determine whether the new design complies with the Energy Code.
3. **Final Inspection:** When the home is complete, the HERS rater conducts a final inspection, including a blower-door test to evaluate the home's airtightness. A final energy model is created, resulting in a HERS score. Final documentation is provided showing whether the home meets the Energy Efficiency criteria of the Energy Code.
4. **Upon completion of construction, self-certify your compliance** with the Residential Energy Code by filing a *Vermont Residential Building Energy Standards Certificate*. The Certificate is your documentation that the home meets or exceeds the requirements of the Energy Code. The process:
 - a. Complete the certificate when the home is *100% finished*. (See Chapter 8 for detailed instructions.)
 - b. Within 30 days, send one copy each to:
 - *The town clerk* for the town or city in which the home is located. (Note: Check local procedures before filing the certificate; local fees and forms may be required.)
 - *The Vermont Public Service Department*
Efficiency and Energy Resources Division
112 State Street
Montpelier, VT 05620-2601
5. **Post the original certificate in the home**, affixing the label on or near the electrical service panel or heating equipment.

Chapter 8

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Certification

The Vermont Residential Energy Code is one of the few codes in the country where the builder self-certifies that the home complies with the law. Builders are responsible for understanding the Energy Code, for building to the minimum (or better) standards, and for completing and filing a certificate.

Section 8.1

Types of Certification

Certification is accomplished by verifying the thermal and efficiency features of the home in the as-built condition. These features are recorded on one of two documents, depending on the situation:

1. If the home meets the technical requirement of the Residential Energy Code, a *Vermont Residential Building Energy Standards Certificate* (Figure 8-1) must be completed, filed and posted in the home.
2. If the home qualifies for the Owner/Builder Special Provision (see Section 1.4), a *Vermont Owner/Builder Disclosure Statement* (Figure 8-2) must be completed, filed and disclosed to prospective buyers. Homes covered under this provision do not have to meet the technical requirement of the Code, but documentation must be provided to the buyer prior to a purchase and sales agreement when the home is sold.

Section 8.2

The ‘Vermont Residential Building Energy Standards Certificate’

A *Vermont Residential Building Energy Standards Certificate* must be filed for each home covered by the Residential Energy Code. The certificate documents compliance with the Energy Code and represents a statement that the information it contains is accurate. The certificates must be printed and posted on or near the electric-service panel or heating equipment. After the certificate is filled out, you need to produce the necessary copies for filings and for your records. It is permissible to photocopy an original certificate and post the copy on or near the electrical panel or heating equipment in the home.

Note: Read the instructions in their entirety before completing the Vermont RBES Certificate.

For additions, alterations, renovations and repairs to existing homes, include a brief description of the project under the Existing Home Project Description section of the form and fill out the portions of the form pertaining to your project. For Owner/Builder projects, the Owner/Builder form should be completed (see Figure 8-2).

Fig. 8. 1: Example of the Vermont Residential Building Energy Standards Certificate

2020 Vermont Residential Building Energy Standards (RBES) Certificate					
<p>This certificate is for projects started on or after September 1, 2020.</p> <p><i>Before completing this form, refer to the instructions in Chapter 8 of the Residential Energy Code Handbook (5th edition).</i></p> <p><i>For additions, alterations, renovations or repairs, only fill out applicable portions of certificate.</i></p>					
Property Address (Street, City, ZIP Code) _____					
Construction START Date _____		Construction FINISH Date _____		Act 250 (Y/N): _____ Act 250 Permit # _____	
#Units _____	#Stories _____	#Sq. Ft. _____	#Bedrooms _____		
Foundation: <input type="checkbox"/> Basement <input type="checkbox"/> Slab On Grade <input type="checkbox"/> Crawl Space <input type="checkbox"/> Other: _____					
<div style="float: right; border: 1px solid black; padding: 5px; width: 250px;"> Applicable Code: <input type="checkbox"/> Base <input type="checkbox"/> Stretch Project Description <input type="checkbox"/> Single family <input type="checkbox"/> Renovation / alteration * <input type="checkbox"/> Multi-family <input type="checkbox"/> Addition * <input type="checkbox"/> Log home <input type="checkbox"/> Repair * </div>					
*Existing Home Project Description: _____					
Compliance Method <input type="checkbox"/> Option 1: Package-Plus-Points Ref. RBES for full requirements of each point option					
(MUST select Option 1, Option 2, or Option 3) BASE / STRETCH (circle one) Package # _____ Points required: _____ (Base requires 4-10pts / Stretch 6-12pts, see Tables R402.1.2.2 and R407.2.1.2) Points achieved: _____					
<input type="checkbox"/> Envelope: Slab, R-10 under all (1pt) <input type="checkbox"/> ACH50 ≤ 2.0 and qualifying HRV/ERV (3pts for Base OR 1pt for Stretch)					
<input type="checkbox"/> Envelope: Walls-Upgraded, R20+12 (2pts) <input type="checkbox"/> ACH50 ≤ 1.0 and qualifying HRV/ERV (4pts) <input type="checkbox"/> Solar ready (1pt, Base only)					
<input type="checkbox"/> Envelope: Walls-High-R, R-40 (3pts) <input type="checkbox"/> ENERGY STAR DHW (1pt) <input type="checkbox"/> On-site generation (1-4pts)					
<input type="checkbox"/> Envelope: Ceiling, R-80 flat / 60 sloped (1pt) <input type="checkbox"/> ENERGY STAR electric DHW (2pts) _____ kW _____ pts					
<input type="checkbox"/> Envelope: Windows 0.27 (1pt, Base only) <input type="checkbox"/> Low flow fixtures (1pt) <input type="checkbox"/> Solar hot water (2pts)					
<input type="checkbox"/> Envelope: Windows 0.22 (2pts) <input type="checkbox"/> Drain water heat recovery (1pt) <input type="checkbox"/> Building energy monitoring (1pt)					
<input type="checkbox"/> Pre-drywall blower door (1pt), result _____ <input type="checkbox"/> User-demand hot water recirculation (1pt) <input type="checkbox"/> Level 2 EV-ready (1pt)					
<input type="checkbox"/> ENERGY STAR heating and cooling (1pt) <input type="checkbox"/> Water certification (2pts) <input type="checkbox"/> 6 kWh battery backup (1pt)					
<input type="checkbox"/> Advanced heating and cooling (3pts) List cert. type _____ ¹ See RBES for MF exception					
<input type="checkbox"/> Option 2: REScheck™ software (Base only)					
<input type="checkbox"/> HRV/ERV installed (mandatory)					
<input type="checkbox"/> Tested ACH50 (must be under 2.0)					
<input type="checkbox"/> UA (from REScheck™)					
<input type="checkbox"/> Option 3: HERS/ERI					
<input type="checkbox"/> HERS Result (Overall)					
<input type="checkbox"/> HERS without Renewables					
<input type="checkbox"/> REM/Rate Version #					
<input type="checkbox"/> IAF incorporated into model					
Approved Rater Name: _____					
(Maximum HERS: 61 Base, 54 Stretch)					
Thermal Envelope					
Basement: R-_____ Basement / Crawl Space Walls _____ Basement Insulation Depth (ft) _____ U-_____ Basement Windows <input type="checkbox"/> NFRC <input type="checkbox"/> Default					
Slab: R-_____ Unheated Slab (Under) _____ R-_____ Heated Slab (Under) _____ R-_____ Perimeter Slab Edge					
Wall/Ceiling: R-_____ Above-Grade Walls _____ R-_____ Flat Ceilings _____ Area (sq ft) _____ R-_____ Sloped Ceilings _____ Area (sq ft)					
Other: R-_____ Floors over Unheated Spaces _____ R-_____ Attic Access Hatch / Door <input type="checkbox"/> NA					
Fenestration U-_____ Windows <input type="checkbox"/> NFRC <input type="checkbox"/> Default U-_____ Doors <input type="checkbox"/> NFRC <input type="checkbox"/> Default U-_____ Skylights <input type="checkbox"/> NFRC <input type="checkbox"/> Default					
Air Sealing / Blower Door Test _____ ACH50 (Building volume used: _____ cu ft) Blower Door Result _____ CFM50					
(must report either ACH50 _____ CFM50/sq ft of building shell (6 sides; Thermal shell area used: _____ sq ft) Date of Test _____					
or CFM50/sq ft for Base Code) Both measurements are required for Stretch Code Air Leakage Tester Name: _____					
Ventilation System <input type="checkbox"/> Balanced, SRE _____ % Flow verification: <input type="checkbox"/> Rated, OR <input type="checkbox"/> Measured → _____ Exhaust air flow (total cfm) _____ Supply air flow (total cfm)					
(must select one) <input type="checkbox"/> Exhaust-Only Flow verification: <input type="checkbox"/> Rated, OR <input type="checkbox"/> Measured → _____ Exhaust air flow (total cfm)					
Combustion Safety <input type="checkbox"/> Exterior (outdoor) air supply is provided for solid fuel-burning appliances and fireplaces, OR <input type="checkbox"/> NA (no solid fuel burning appliance or fireplace in home)					
(verify all) <input type="checkbox"/> Solid fuel burning appliances and fireplaces have gasketed doors with compression closure, OR <input type="checkbox"/> NA (no solid fuel burning appliance or fireplace in home)					
<input type="checkbox"/> Spillage testing conducted on combustion equipment not directly-vented, OR <input type="checkbox"/> NA (no equipment, or all equipment directly-vented)					
Mechanical System Design Load Calculation Method: <input type="checkbox"/> ACCA Manual J, OR <input type="checkbox"/> Other Approved Method (List) _____					
(must complete all) Calculation details: (Ref. RBES R302 for design temperature exceptions)					
_____ Winter design temp, outdoor dry-bulb (VT range: -11 to 1°F) _____ Summer design temp, outdoor dry-bulb (typ. max. 84°F), OR <input type="checkbox"/> No cooling					
_____ Winter design temp, indoor (max 72°F) _____ Summer design temp, indoor (min. 75°F), OR <input type="checkbox"/> No cooling					
_____ Heating design load, Btu/hr _____ Cooling design load, Btu/hr, OR <input type="checkbox"/> No cooling					
_____ Primary heating system size, Btu/hr _____ Primary cooling system size, Btu/hr, OR <input type="checkbox"/> No cooling					
_____ HSPF or COP or AFUE (circle which) _____ SEER or COP (circle which), OR <input type="checkbox"/> No cooling					
<input type="checkbox"/> Programmable thermostat, OR <input type="checkbox"/> Exempt; list reason _____					
Ducts <input type="checkbox"/> Ducts located completely within conditioned space, OR <input type="checkbox"/> NA (no ducts)					
_____ Duct tightness result (CFM @ 25 Pa)					
Test performed at <input type="checkbox"/> Rough-in (max 3 CFM per 100 sq ft of cond. floor area), OR <input type="checkbox"/> Post-construction (max 4 CFM per 100 sq ft of cond. floor area)					
Other Requirements Mandatory (Base and Stretch): <input type="checkbox"/> Mechanical system piping, min. R-3 <input type="checkbox"/> Multi-family: EV charging requirement is met: _____ # spaces					
<input type="checkbox"/> 90% of lamps high efficacy <input type="checkbox"/> Automatic or gravity dampers for vent. system intake and exhaust					
Mandatory (Stretch Code Only): <input type="checkbox"/> Single-family: Solar ready <input type="checkbox"/> Single-family: One Level 1 EV-charging space					
Where applicable: <input type="checkbox"/> Circulating service hot water piping, R-3 <input type="checkbox"/> Pools: All requirements per R403.10 are met <input type="checkbox"/> Automatic controls for snow-melt systems					
I certify to _____ (Owner) that the above information is correct and that the premises listed have been constructed in accordance with the Vermont Residential Building Standards (RBES) created under 30 V.S.A. § 51. Date: _____					
Signature: _____ Printed Name: _____					
Company: _____ Phone: _____					
<small>30 V.S.A. § 51 requires this certificate label to be permanently affixed to the inside electrical service panel or heating or cooling equipment or nearby in a visible location. Copies of the certificate and REScheck Compliance Certificate or Home Energy Rating Certificate (if Option 2 or 3 used) also must be provided to 1) the Dept. of Public Service, 112 State St., Montpelier, VT 05602, and 2) the town clerk of the town where the property is located. NOTE: Noncompliance with RBES may result in action for damages under 30 V.S.A. § 51. This label does not specify all 2020 RBES requirements. QUESTIONS? CALL THE VT PUBLIC SERVICE DEPARTMENT at 802-828-2811 or the Energy Code Assistance Center at 855-887-0673.</small>					

Instructions for Completing the ‘Vermont Residential Building Energy Standards Certificate’

Read these instructions in their entirety before completing the Vermont RBES Certificate for your home. Items are listed in **bold** in the order they appear on the certificate.

1. In the box located in the upper right corner, check **Base** or **Stretch** code, and mark which type of home it is (Single family, Multi-family, Log home) and also whether it is a **Renovation / alteration, Addition or Repair**.
2. List the **Property Address**, including the **City** and **Zip code**.
3. List the **Construction START** and **Construction FINISH** dates by **Month/Year**. **Construction START** is when site work began, when the ground was first dug to prepare for a below grade foundation or slab on grade, etc. **Construction FINISH** is when the dwelling is sufficiently ready for occupancy.
4. If the dwelling received an **Act 250 Permit**, write in “**Yes**” and list the **Act 250 Permit #**. If not, write “**No**”.
5. Project Description: Multi-family homes: Write in the number of **Units**. For all Projects, write in the number of **Stories** above grade, and the **Square feet** of area within the thermal enclosure, which includes unconditioned spaces such as an unheated basement, as long as they are within the insulated and air sealed area of the home. Do not include heated garages in this calculation. Write in the **Number of Bedrooms**. For Existing Homes Project Description include a brief description of the work done.
6. **Foundation Type**: Check all that apply.
 - Under **Compliance Method**, check the compliance path by which you determined technical compliance with the Code. You must select Option 1, 2, or 3.
 - **Option 1: Package-Plus-Points**:
 - Circle **BASE** or **STRETCH**
 - Fill in the Package # you utilized, and the Points required (based on square footage) and Points achieved. A simplified overview of points is provided in the Certificate for your ease of reference. For full requirements, review the Handbook.
 - As required, write in the information needed for Pre-drywall blower door result, Water certification type, the amount of kW on-site generation and corresponding points.
 - **Option 2: REScheck™ software**:
 - Verify that an HRV or ERV was installed per the requirement
 - Fill in the tested airtightness ACH50 result
 - List the *REScheck*™ software UA result for your home calculated by *REScheck*™.
 - **Option 3: HERS/ERI**: If compliance is determined using a home energy rating,
 - List the **HERS Result (Overall)** and the **HERS without Renewables result**,
 - List the **REM/Rate Version # and verify that Index Adjustment Factor (IAF)** was included in the result
 - List the Approved Rater Name.

8. **Thermal Envelope:** Where applicable, list the nominal R-value of the insulation. If any component has more than one R-value (e.g., R-38 ceiling and R-49 ceiling), calculate an average R-value and enter that figure on the form. (See Section C.5, “How to Calculate Average R-values and U-factors.”) For basement walls, list the vertical height of the basement insulation in **Basement Insulation Depth** in feet (ft.). Where applicable, list the U-factor for fenestration. If the U-factor is not an NFRC (National Fenestration Rating Council) **Rating**, list the **Default Rating** (refer to Appendix B, Tables B-1 and B-2). Check rating type for windows and skylights — either **NFRC or Default Rating**.
9. **Air Sealing / Blower Door Test:** Report either ACH50 or CFM50/sq. ft. Report the air leakage rate in units of air changes per hour at 50 Pascals (ACH50). As an option for Base Code and required for Stretch code, report in 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. Include the **building volume used** in calculating ACH50 and/or the 6-side building thermal shell area used in calculating CFM50/sq. ft. **Provide the Blower Door Result, Date of Test and the Air Leakage Tester Name.**
10. **Ventilation System:** Mark whether the ventilation system is **Balanced** (and include the SRE%, or sensible recovery efficiency) or **Exhaust-only**. Check if the **Flow verification** is **Rated** or if it is **Measured**. If **Measured**, for Balanced systems write in the **Exhaust air flow (total cfm)** and **Supply air flow (total cfm)**. For Exhaust-Only systems, write in the **Exhaust air flow (total cfm)**. See Chapter 5 for details regarding SRE.
11. **Combustion Safety:** Check if **exterior (outdoor) air supply** requirements have been met for solid fuel-burning appliances and fireplaces or mark **NA** to verify that no solid fuel-burning appliances or fireplaces exist in the home. Check if **solid fuel burning appliances and fireplaces** have gasketed doors with compression closure or mark **NA**. Check if **spillage testing was conducted on combustion equipment that is not directly vented** or mark **NA**.
12. **Mechanical System:** Identify the **Design Load Calculation Method** used: check **ACCA Manual J** or fill in the Other Approved Method used. Fill in the **Calculation details** by writing in the result or marking the appropriate answer (e.g. No cooling). Check **Programmable thermostat** or list the **reason** for exemption. Note that the **heating** (and **cooling**, if modeled) **design temperatures used in the calculations must be listed**.
13. **Ducts:** Check if ducts are **located completely within conditioned space** or mark **NA** if there are no ducts. Write in the **Duct tightness result** (CFM @ 25 Pa). Mark when the **Test** was performed: **Rough-in** (max 3 CFM per 100 sq ft of conditioned floor area) or **Post-construction** (max 4 CFM per 100 square foot of conditioned floor area).
14. **Other Requirements:** Check all that apply.
15. Under the certification section, list the name of the **Owner** of the dwelling. Write in the Date (month and year) the certificate is signed and completed. The **Signature** is either the builder who directed construction or another party authorized to certify Code compliance. The Printed Name is that of the person whose Signature is presented (the builder or other authorized party to certify Code compliance). **Company:** List the business name of the party certifying compliance. List the **Phone** number of the **Company** certifying compliance (including area code).

Filing the ‘Vermont Residential Building Energy Standards Certificate’

Once the certificate is completed, you need to file the required copies and attach the original to the house:

1. Make at least three copies of the completed certificate, retaining one for your records.
2. Attach the original certificate to the house by permanently affixing it on or near the electrical service panel or heating equipment, without covering or obstructing the visibility of the circuit directory label, service disconnect label or other required labels.
3. Within 30 days of completing construction, send one copy each to:
 - The Town Clerk for the town or city in which the home is located. (Note: Check local procedures before filing the certificate; local fees and forms may be required.)
 - The Vermont Public Service Department
Efficiency & Energy Resources Division
112 State Street
Montpelier VT 05620-2601

To order additional certificates,
contact one of these resources:

- ★ Energy Code Assistance
Center
1-855-887-0673.
- ★ Vermont Public Service
Department
1-802-828-2811.

Section 8.3

The ‘Vermont Owner/Builder Disclosure Statement’

As outlined in Section 1.4, “Owner/builder” projects are exempt from the technical requirements of the Code, but the owner/builder must meet certification requirements by completing and filing a disclosure statement. To qualify for this provision, all of the following criteria must be met:

1. The property must not be subject to Act 250.
2. The owner must be the person in charge of construction (i.e., the “general contractor”), directing the details of construction and the selection and installation of materials.
3. The owner must live in the building.
4. The owner must evaluate whether the home meets the Residential Building Energy Standards.
5. Depending on whether the home meets the technical requirement of the Energy Code, the owner must complete one of two documents: either the Vermont Residential Building Energy Standards Certificate if the home meets the technical requirements, or the Vermont Owner/Builder Disclosure Statement if it does not.

Before entering into a binding purchase and sale agreement, the owner must disclose in writing (using the Owner-Builder Disclosure Form) to a prospective buyer the nature and extent of any non-compliance with the Energy Code.

Section 8.3a

Instructions for Completing the ‘Vermont Owner/Builder Disclosure Statement’

Read the instructions in their entirety before completing the Vermont Owner/Builder Disclosure Form. (See sample on the next page.) This Form is very similar to the Vermont Residential Building Energy Standards Certificate in Section 8.2; follow the instructions in Section 8.2a to fill out either one. There are only three differences between the two forms:

1. The Vermont Owner/Builder Disclosure Statement cannot be used for Act 250 projects. (Act 250 projects must meet the technical requirement of the Residential Building Energy Standards.)
2. The signature area on this form does not include a space for you to list a company name.
3. This form states that the home does not meet the Energy Code’s technical requirement.

Section 8.3b

Filing the Vermont Owner/Builder Disclosure Statement

If you are using the form to notify a potential buyer, you must do so before entering into a binding purchase and sales agreement. The process for filing this statement is identical to that for the Vermont Residential Building Energy Standards Certificate (Section 8.2).

Figure 8.2: The Vermont Owner/Builder Disclosure Statement.

2020 Vermont Residential Building Energy Standards (RBES) Certificate					
This certificate is for projects started on or after September 1, 2020. Before completing this form, refer to the instructions in chapter 8 of the Residential Energy Code Handbook (5th edition). For additions, alterations, renovations or repairs, only fill out applicable portions of certificate.					
Property Address (Street, City, ZIP Code) _____				Applicable Code : <input type="checkbox"/> Base <input type="checkbox"/> Stretch Project Description <input type="checkbox"/> Single family <input type="checkbox"/> Renovation / alteration * <input type="checkbox"/> Multi -family <input type="checkbox"/> Addition * <input type="checkbox"/> Log home <input type="checkbox"/> Repair *	
Construction START Date _____		Construction FINISH Date _____		Act 250 (Y/N) _____	
Act 250 Permit # _____		* Existing Home Project Description: _____			
# Units _____		# Stories _____		# Conditioned Sq. Ft. _____	
# Bedrooms _____		Foundation: <input type="checkbox"/> Basement <input type="checkbox"/> Slab On Grade <input type="checkbox"/> Crawl Space <input type="checkbox"/> Other: _____			
Compliance Method MUST select Option 1, Option 2, or Option 3		<input type="checkbox"/> Option 1: Package-Plus-Points <small>Ref. RBES for full requirements of each point option</small> BASE / STRETCH (circle one) Points required: _____ (Base requires 4-10pts / Stretch 6-12pts, see Handbook Tables 5-2 and 5-5) Package # _____ Points achieved: _____			
<input type="checkbox"/> Envelope: Slab, R-10 under all (1pt) <input type="checkbox"/> Envelope: Walls-Upgraded, R20+12 (2pts) <input type="checkbox"/> Envelope: Walls-High-R, R-40 (3pts) <input type="checkbox"/> Envelope: Ceiling, R-80 flat / 60 sloped (1pt) <input type="checkbox"/> Envelope: Windows 0.27 (1pt, Base only) <input type="checkbox"/> Envelope: Windows 0.22 (2pts) <input type="checkbox"/> Pre-drywall blower door (1pt), result _____ <input type="checkbox"/> ENERGY STAR heating and cooling (1pt) <input type="checkbox"/> Advanced heating and cooling (3pts)		<input type="checkbox"/> ACH50 ≤ 2.0 and qualifying HRV/ERV (3pts for Base OR 1pt for Stretch) <input type="checkbox"/> ACH50 ≤ 1.0 and qualifying HRV/ERV (4pts) <input type="checkbox"/> ENERGY STAR DHW (1pt) <input type="checkbox"/> ENERGY STAR electric DHW (2pts) <input type="checkbox"/> Low flow fixtures (1pt) <input type="checkbox"/> Drain water heat recovery (1pt) <input type="checkbox"/> User-demand hot water recirculation (1pt) <input type="checkbox"/> Water certification (2pts) <input type="checkbox"/> List cert. type _____			
		<input type="checkbox"/> Solar ready (1pt, Base only) <input type="checkbox"/> On-site generation (1-4pts) _____ kW _____ pts <input type="checkbox"/> Solar hot water (2pts) <input type="checkbox"/> Building energy monitoring (1pt) <input type="checkbox"/> Level 2 EV-ready (1pt) <input type="checkbox"/> 6 kWh battery backup (1pt) <input type="checkbox"/> *See RBES for MF exception			
		<input type="checkbox"/> Option 2: REScheck software (cannot be used for Stretch Code) <input type="checkbox"/> Passes _____ UA result _____ Max. UA			
		<input type="checkbox"/> Option 3: HERS / ERI _____ HERS Result (Overall) _____ HERS without Renewables _____ REM/Rate Version # IAF incorporated into model Approved Rater Name: _____ (Maximum HERS: 61 Base, 54 Stretch)			
Thermal Envelope Basement: R-_____ Basement / Crawl Space Walls _____ Basement Insulation Depth (ft) _____ U-_____ Basement Windows <input type="checkbox"/> NFRC <input type="checkbox"/> Default Slab: R-_____ Unheated Slab (Under) _____ R-_____ Heated Slab (Under) _____ R-_____ Perimeter Slab Edge _____ Wall/Ceiling: R-_____ Above-Grade Walls _____ R-_____ Flat Ceilings _____ Area (sq ft) _____ R-_____ Sloped Ceilings _____ Area (sq ft) Other: R-_____ Floors over Unheated Spaces _____ R-_____ Attic Access Hatch / Door <input type="checkbox"/> NA Fenestration U-_____ Windows <input type="checkbox"/> NFRC <input type="checkbox"/> Default U-_____ Doors <input type="checkbox"/> NFRC <input type="checkbox"/> Default U-_____ Skylights <input type="checkbox"/> NFRC <input type="checkbox"/> Default					
Air Sealing / Blower Door Test _____ ACH50 _____ Date of test _____ (must report either ACH50 _____ CFM50/sq ft of building shell (6 sides) Air Leakage Tester Name: _____ or CFM50/sq ft for Base Code) Both measurements are required for Stretch Code					
Ventilation System <input type="checkbox"/> Balanced, SRE _____ % Flow verification: <input type="checkbox"/> Rated, OR <input type="checkbox"/> Measured → _____ Exhaust air flow (total cfm) _____ Supply air flow (total cfm) (must select one) <input type="checkbox"/> Exhaust-Only Flow verification: <input type="checkbox"/> Rated, OR <input type="checkbox"/> Measured → _____ Exhaust air flow (total cfm)					
Combustion Safety (verify all) <input type="checkbox"/> Exterior (outdoor) air supply is provided for solid fuel-burning appliances and fireplaces, OR <input type="checkbox"/> NA (no solid fuel burning appliance or fireplace in home) <input type="checkbox"/> Solid fuel burning appliances and fireplaces have gasketed doors with compression closure, OR <input type="checkbox"/> NA (no solid fuel burning appliance or fireplace in home) <input type="checkbox"/> Spillage testing conducted on combustion equipment not directly-vented, OR <input type="checkbox"/> NA (no equipment, or all equipment directly-vented)					
Mechanical System (must complete all) Design Load Calculation Method: <input type="checkbox"/> ACCA Manual J, OR <input type="checkbox"/> Other Approved Method (List) _____ Calculation details: (Ref. RBES R302 for design temperature exceptions) _____ Winter design temp, outdoor dry-bulb (VT range: -11 to 1°F) _____ Summer design temp, outdoor dry-bulb (typ. max. 84°F), OR <input type="checkbox"/> No cooling _____ Winter design temp, indoor (max 72°F) _____ Summer design temp, indoor (min. 75°F), OR <input type="checkbox"/> No cooling _____ Heating design load, Btu/hr _____ Cooling design load, Btu/hr, OR <input type="checkbox"/> No cooling _____ Primary heating system size, Btu/hr _____ Primary cooling system size, Btu/hr, OR <input type="checkbox"/> No cooling _____ HSPF or COP or AFUE (circle which) _____ SEER or COP (circle which), OR <input type="checkbox"/> No cooling <input type="checkbox"/> Programmable thermostat, OR <input type="checkbox"/> Exempt; list reason _____					
Ducts <input type="checkbox"/> Ducts located completely within conditioned space, OR <input type="checkbox"/> NA (no ducts) _____ Duct airtightness test result (CFM @ 25 Pa) Test performed at <input type="checkbox"/> Rough-in (max 3 CFM per 100 sq ft of cond. floor area), OR <input type="checkbox"/> Post-construction (max 4 CFM per 100 sq ft of cond. floor area)					
Other Requirements Mandatory (Base and Stretch): <input type="checkbox"/> Mechanical system piping, min. R-3 <input type="checkbox"/> Multi-family: EV charging requirement is met: _____ # spaces <input type="checkbox"/> 90% of lamps high efficacy <input type="checkbox"/> Automatic or gravity dampers for vent. system intake and exhaust Mandatory (Stretch Code Only): <input type="checkbox"/> Single-family: Solar ready <input type="checkbox"/> Single-family: One Level 1 EV-charging space Where applicable: <input type="checkbox"/> Circulating service hot water piping, R-3 <input type="checkbox"/> Pools: All requirements per R403.10 are met <input type="checkbox"/> Automatic controls for snow-melt systems					
I certify to _____ (Owner) that the above information is correct and that the premises listed have been constructed in accordance with the Vermont Residential Building Standards (RBES) created under 30 V.S.A. § 51. Date: _____ Signature: _____ Printed Name: _____ Company: _____ Phone: _____					
30 V.S.A. § 51 requires this certificate label to be permanently affixed to the inside electrical service panel or heating or cooling equipment or nearby in a visible location. Copies of the certificate (and Home Energy Rating Certificate if Option 3 is used) also must be provided to 1) the Dept. of Public Service, 112 State St., Montpelier, VT 05602, and 2) the town clerk of the town where the property is located. NOTE: Noncompliance with RBES may result in action for damages under 30 V.S.A. § 51. This label does not specify all 2020 RBES requirements. QUESTIONS? CALL the Energy Code Assistance Center at 855-887-0673 or the VT PUBLIC SERVICE DEPARTMENT at 802-828-2811.					

For copies of this form, photocopy this page or contact the Energy Code Assistance Center (855-887-0673).

Additional Minimum Stretch Code Requirements

Section A.1

Package Plus Points

The Stretch Code envelope and fenestration requirements are listed above in Section 5.3.

Section A.2

Home Energy Rating Compliance Method

Home Energy Rating System (HERS) index requirements for Stretch Code, as detailed in Chapter 7, are a maximum HERS index of 54, with up to 5 of these points that may be achieved with renewables. When using the HERS compliance method for stretch code, the building must comply with Sections A.3 through A.5.

Section A.3

Air Leakage Testing

Buildings subject to the Stretch Code must be tested in the same way as those under Base Code (see Section 2.1).

However, for Stretch Code the result must be recorded in both ACH50 and CFM50 per square foot of building thermal shell area (based on all six sides of the building).

Electric Vehicle (EV) Charging

For single family housing, one Level 1 (see below) parking space is required with an accessible socket.

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

- Level 1 Electric Vehicle Charging Parking requires one 120V 20-amp grounded AC receptacle, NEMA 5- 20R or equivalent, within 5 feet 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 of the centerline for each EV Charging Parking Space.

The following exemptions do not need to comply:

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, such as a road.
3. Parking spaces which are limited to parking durations of less than an hour.

The number of parking spaces that are marked for “EV use only” need not exceed the number of EV cars driven by occupants of the building.

Solar Ready Zone

New detached one- and two-family dwellings, and multiple single family dwellings (townhouses) with not less than 600 ft² (55.74 m²) of roof area oriented between 110° and 270° of true north must comply.

The following are exceptions to the Solar Ready Zone requirement:

1. New residential buildings with a permanently installed on-site renewable energy system.
2. A building with a solar-ready zone that is shaded for more than 70% of daylight hours annually.
3. Buildings and structures as designed and shown in construction documents that do not meet the conditions for a solar-ready zone area.
4. Buildings with possible location(s) for ground mounted systems identified in the submitted construction documents. Buildings claiming this exception must either install appropriate electrical conduit to the site of the proposed ground mounted solar array or include a solar site evaluation that supports the siting of the proposed ground mounting location.

Construction Document Requirements for Solar Ready Zone

Construction documents shall indicate the solar ready zone where applicable.

Solar-Ready Zone Area

The total solar-ready zone area shall consist of an area not less than 300 ft2 (27.87 m2) exclusive of mandatory access or set back areas. New multiple single family dwellings (townhouses) three stories or less in height above grade plane and with a total floor area less than or equal to 2,000 ft2 (185.8 m2) per dwelling shall have a solar-ready zone area of not less than 150 ft2 (13.94 m2). Multifamily buildings should maximize the solar-ready zone by consolidating mechanicals, access, set back areas and other roof obstructions with a goal of 40% of the roof area available for the solar-ready zone. The solar-ready zone shall be composed of areas not less than five feet (1,524 mm) in width and not less than 80 ft2 (7.44 m2) 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.

Obstructions

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

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.

Interconnection Pathway

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

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.

Default Values

The tables in this appendix can be used to determine thermal and efficiency values for building components when those values are not labeled or when they are unknown. Default thermal and efficiency values in this appendix include:

Component	Table to Use	Values Provided in Table
Windows, glazed doors, skylights.....	Table B-1.....	U-Factors
Doors.....	Table B-2.....	U-Factors

Table B-1

U-Values for Windows & Skylights ⁶				
FRAME TYPE	SINGLE PANE	DOUBLE PANE	SKYLIGHT	
			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 B-2

U-Values for Doors	
DOOR TYPE	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

⁶ The U-factors in these tables can be used in the absence of tested U-factors. The product cannot receive credit for a feature that cannot be clearly detected. Where a composite of materials from two different product types is used, the product must be assigned the higher U-factor.

Appendix C

Guidelines for Calculations

Some calculations must be performed in order to determine technical compliance with the Vermont Residential Energy Code. In order to use the Package Plus Points Prescriptive method, you may need to calculate average R-values or U-factors for one or more building components.

Section C.1

When to Perform Calculations

There are three times the required calculations should be performed:

1. **At the Planning Stage:** During the design stage, take building dimensions and insulation characteristics from the building plans, specifications and drawings. (You will use these values to determine whether the building meets the Package Plus Points Prescriptive Requirements for the compliance path you select.)
2. **In the Event of Design Changes:** If there are any changes to the energy-related components of a project, you will need to determine whether the building still meets the technical requirement of the Energy Code.
3. **After Completion:** Upon completion of construction, determine whether the as-built home differs from the original design. If building dimensions, window thermal properties, R-values, or U-factors change, you will need to review your calculations in order to determine whether the building meets the Package Plus Points Prescriptive Requirements.

Section C.2

How to Define the Building Envelope

The thermal requirements of the Energy Code pertain to all surfaces of the building envelope, so it is important to understand the definition and extent of the building envelope in a house.

The building envelope includes all components of a building that enclose conditioned spaces, even if it is not currently heated or cooled (e.g. an unfinished basement without heat but that could be heated later on since the foundation walls are insulated and it's inside the thermal envelope). Building envelope components separate conditioned spaces from unconditioned spaces or from outside air. For

example, walls and doors between an unheated garage and a living area are part of the building envelope; walls separating an unheated garage from the outside are not.

Although floors of conditioned basements and conditioned crawl spaces are technically part of the building envelope, the Energy Code does not always specify insulation requirements for these components. Thus, except for the walkout portion of a conditioned basement (which is treated as a “slab on grade” and needs perimeter insulation), you can ignore these components when determining the building envelope. See Appendix F, “Definitions,” for more information.

Section C.3

How to Calculate the Glazing Percentage

The glazing percentage expresses how much of the exterior wall area of the building envelope is taken up by windows. The procedure is as follows:

1. Sum the total Gross Wall Area in square feet, using exterior dimensions.

INCLUDE in the Gross Wall Area:

- All above-grade wall square footage, including windows, sliding and patio doors, glass block and door areas.
- Band joist areas enclosing conditioned space.
- All knee-wall areas enclosing conditioned space.
- Basement wall areas enclosing conditioned space in which more than 50% of the wall is above grade; include entire basement wall area including windows, doors and below grade portion (see example on next page).

DO NOT INCLUDE in the Gross Wall Area:

- Band joist areas of insulated floors over unconditioned space or outdoors.
- Wall, window and door areas of conditioned basements in which more than 50% of the wall is below grade.
- Wall, window and door areas of unconditioned spaces, regardless of the portion above or below grade (such as unconditioned basements and garages).
- Skylights.

2. Sum the Glazing Area in square feet.

Use the rough opening dimensions for flat windows and doors. For bay or bow windows, use the actual surface area of the glass and frame.

INCLUDE in the Glazing Area:

- All windows, sliding and patio doors, glass block and skylights.
- Basement window areas in conditioned basements, regardless of the portion above or below grade.

DO NOT INCLUDE in the Glazing Area:

- Window areas in unconditioned spaces (such as unconditioned basements and garages).

3. Calculate the Glazing Percentage.

Divide the Glazing Area by the Gross Wall Area and multiply the result by 100.

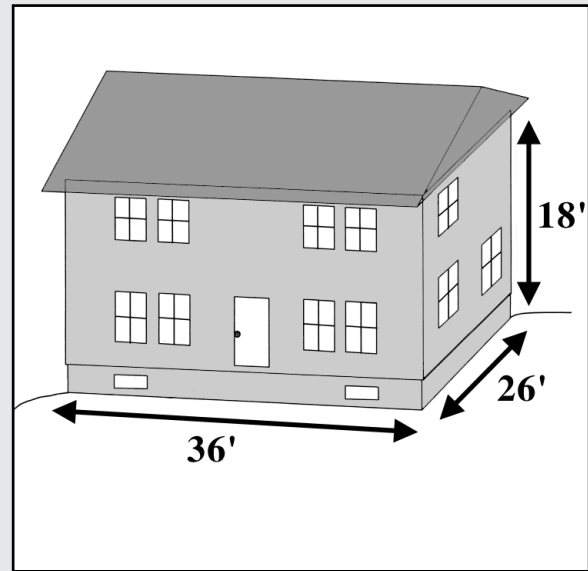
$(\text{Glazing Area} / \text{Gross Wall Area}) \times 100 = \text{Glazing \%}$

Using the Glazing Percentage Rules

Ace Jones is building a two-story colonial house with a conditioned basement for a customer. Prior to construction, he reviews the plans to be sure that what he is proposing will meet the Residential Energy Code. Since he plans to use the U-factor compliance method, he must calculate the Glazing Percentage

Walls: 124' perimeter lineal feet ($26' + 26' + 36' + 36'$)
x 18' high (two 8' walls plus 2 band joists)
2,232 sq. ft.

Windows: 16 windows @ 15 sq. ft. = 240 sq. ft.
+ 4 basement windows @ 4.5 sq. ft. = 18 sq. ft.
258 sq. ft.



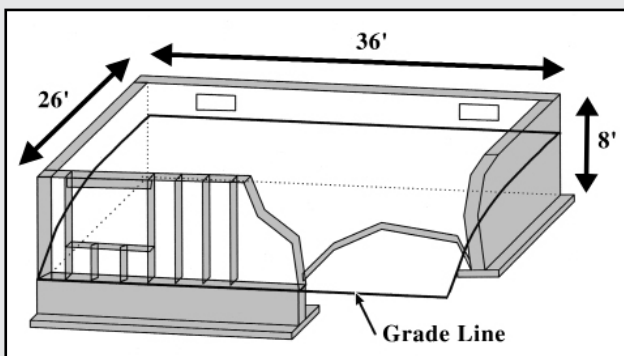
Example A: House with a Standard Basement

For the house over a standard basement with each wall mostly below grade, Ace calculates the Glazing Percentage as follows:

1. Gross Wall Area.....2,232 sq. ft.
2. Glazing Area258 sq. ft.
3. Glazing Percentage.....($258 / 2,232$) x 100 = 11.6%

Example B: House with a Walkout Basement

The customers re-site their house to a more sloped area, giving them a walkout basement. With this new siting, one basement wall is now fully above grade, while the other three remain more than 50% below grade. The customers also want to add 60 square feet of windows to the walkout basement wall. Ace re-calculates the glazing percentage to determine whether this new design will comply with the Residential Energy Code:



1. Gross Wall Area:
 $2,232 + 288 = 2,520$ sq. ft.

Each basement wall must be considered individually. Since only one 36' wall is more than 50% above grade, it is now included in the Gross Wall Area; $36' \times 8' \text{ high} = 288$ sq. ft.

2. Glazing Area:
 $258 + 60 = 318$ sq. ft.
3. Glazing Percentage:
 $(318 / 2,520) \times 100 = 12.6\%$

Understanding Thermal Values

In order to meet the technical requirements of the Energy Code, you need to determine the thermal value of various building components. The thermal performance of all components except windows and doors is expressed in terms of R-value; for windows and doors, performance is expressed in terms of *U-factor*.

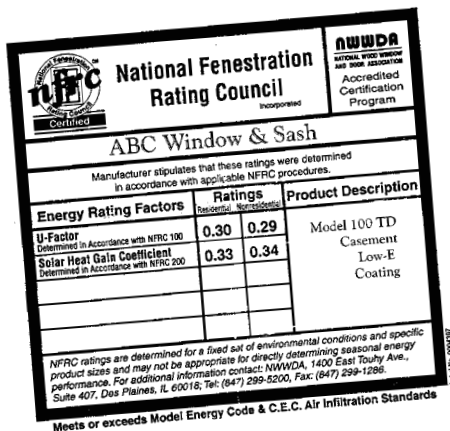
Section C.4a

R-value

R-values are specified in the Residential Building Energy Standards for all building components except windows and doors. The higher a component's R-value, the better insulation (i.e., resistance to heat flow) it provides.

Use the nominal R-values as listed by the manufacturer on the packaging of the insulation for determining compliance with the Energy Code. (For loose-fill insulation, the R-value per inch of thickness for a given area of coverage is listed on the bag.)

Section C.4b



U-factor

Windows and doors are labeled in U-values. A U-value is the measure of how well a component *conducts* heat. A smaller U-value results in lower heat flow, and therefore less heat loss. Higher U-values mean greater heat loss. The U-value is the reciprocal of the R-value, which is the *resistance* to heat flow ($U\text{-value} = 1/R\text{-value}$).

To determine the U-values for glazing and doors in your building project, refer to the tables in Appendix B or use the values supplied by the manufacturer, *provided* the label states that the U-value has been tested and documented in accordance with the National Fenestration Rating Council (NFRC) test procedures. *Do not use center-of-glass or center-of-door U-values.*

▲ Example of a manufacturer's NFRC label showing the window U-value (called the "U-Factor" here).

Section C.5

How to Calculate Average R-values and U-values

Section C.5a

Average R-values

If a home has two different types of thermal values for a single component (such as an R-38 and an R-49 flat ceiling) and you want to use the Package Plus Points Prescriptive method, you must average the two thermal values in order to arrive at one component value. This single R-value is then compared to the required R-value in the appropriate table.

Use the following procedure to determine the average R-value for a building component with two or more thermal values:

1. Note the description and R-value of each of the parts.
2. Divide 1 by this R-value; the resulting figure becomes the U-factor. (U-factor = $1/R$)
3. Determine the area of this portion of the building component in square feet.
4. Multiply the U-factor by the area; the product is the “UA” for this part.
5. Repeat steps 1-4 for each additional part.
6. Add up the total UAs (#4) and the areas (#3).
7. Divide the total area by the total UA; this is the average R-value.

Example: Determining the Average Attic R-value

Lets say part of your attic is R-38 and the other part is R-60. The total attic area is 1,000 square feet. The average R-value is calculated at 49.9.

Description	R-value	U-value (1/R-value)	Area	U-value x Area "UA"
Attic 1	38	0.026	350	9.2
Attic 2	60	0.017	650	10.8
			Total Area = 1000	Total UA = 20.0
			Area / UA = Average R-value $1000 / 20.0 = 49.9$	

$$\text{Area} / \text{UA} = \text{R-value}$$

Section C.5b

Average U-factors

For windows and doors — which use U-factors rather than R-values — the calculation is the same, except there is no need to convert R-values to U-factors and back again. The procedure is as follows:

Example: Determining the Average Window U-factors

Lets say that you have 16 low-E windows (U-value 0.30), and a low-E/argon gas patio door (U-value 0.32). The average U-value is calculated to be 0.30.

Description	R-value	U-value (1/R-value)	Area	U-value x Area "UA"
Windows		0.30	240	72.0
Patio Door		0.32	40	12.8
			Total Area = 280	Total UA = 84.8
			UA / Area = Average U-value $84.8 / 280 = 0.30$	

$$\text{UA} / \text{Area} = \text{U-factor}$$

1. Note the description and U-factor of each of the parts.
2. Determine the area of this portion of the building component in square feet.
3. Multiply the U-factor by the area; this becomes the UA for that part.
4. Repeat steps 1-3 for each additional part.
5. Add up the total UAs (#3) and the areas (#2).
6. Divide the total UA by the total area; **this is the average U-factor.**

Appendix D

Vermont Resources for Energy Efficiency & Utility Services

Energy Code Assistance Center

For questions, information, software and other Code-related materials, call the Energy Code Hotline toll-free at 855-887-0673.

The Energy Code Assistance Center offers workshops on the Code throughout Vermont to teach builders what the Code involves and how to comply. The schedule is available by calling the Energy Code Hotline.

Residential Energy Code Web Site

For more detail and background on the Vermont Residential Buildings Energy Code, check the web site maintained by the Public Service Department at <http://publicservice.vermont.gov>.

Burlington Electric Department:

The Burlington Electric Department (BED) is Vermont's largest municipally owned electric utility serving more than 19,600 customers. BED is the exclusive provider of electric service to the City of Burlington. BED works with Vermont Gas Systems and Efficiency Vermont to offer customers the Vermont ENERGY STAR® Homes new construction and renovation service in Burlington. This service is designed to help the builder, developer and building owner exceed the required Burlington Guidelines for Energy-Efficient Construction (based on RBES) and take advantage of the highest-efficiency electrical equipment available. By participating in this program, customers enjoy energy savings and lower operating expenses, while the community benefits from a clean, low-cost power supply. Information: 802-865-7300 or www.burlingtonelectric.com.

Building Performance Professionals Association

BPPA supports and represents its members as we work to promote Vermont's building performance industry and to ensure the energy efficiency, comfort and safety of our residential and commercial buildings. www.bpps-vt.org

Efficiency Vermont

Efficiency Vermont is the nation's first statewide provider of energy-efficiency services. Efficiency Vermont provides technical advice, financial assistance and design guidance to help make Vermont homes, farms and businesses energy efficient. Information: 888-921-5990 or efficiencyvermont.com.

Vermont Builders & Remodelers Association

Since 1957, the Vermont Builders and Remodelers Association has been Northern Vermont's Trade Association. They are actively involved in building issues and other activities in support of the building industry. Information is at <https://www.homebuildersvt.com/>

American Institute of Architects - Vermont

AIA-VT represents and supports architects and building in Vermont. Information is at <https://www.aiavt.org/>.

Vermont Public Service Department

The Vermont Public Service Department (PSD), Planning & Energy Resources Division, is responsible for the administration of the Residential Energy Code. For questions regarding Code interpretation, rules and enforcement, contact PSD at 802-828-2811.

VEIC

Vermont Energy Investment Corp. is the nonprofit organization that operates Efficiency Vermont for the State of Vermont. As part of that role, VEIC issues home energy ratings for new homes. The ratings can be used for marketing purposes or to qualify for special mortgage programs. Home energy ratings also can be used to show compliance with the Residential Energy Code. Contact VEIC at 800-639-6069.

Vermont Gas Systems

Vermont Gas Systems supplies natural gas service to northwestern Vermont and has provided energy-efficiency programs since 1992. If you're building a new home, trying to save energy in an existing home, or installing a new furnace, boiler or hot water heater, Vermont Gas has efficiency experts on staff and energy-efficiency programs to help you make the best decisions for your specific situation. Vermont Gas Systems partners with Efficiency Vermont to offer customers the Vermont ENERGY STAR® Homes new construction and renovation service. Information: 802-863-4511 or www.vermontgas.com.

Residential Building Energy Standards Statute

The Vermont Residential Energy Code (officially “Residential Building Energy Standards” or “RBES”), is Vermont’s statewide residential energy code. Created by a task force assembled by Governor Howard Dean in the fall of 1995, the Residential Energy Code was enacted by the Vermont Legislature (Act 20) in May 1997 with the support of many groups and organizations, including home builders’ associations, utilities, environmental groups, housing and energy professionals, and state agencies. The initial Residential Energy Code took effect July 1, 1997.

The RBES Statute, VSA 30 § 51, calls for the code to be updated promptly after the issuance of updated standards for residential construction under the International Energy Conservation Code® (IECC).

The Fifth Edition of the Vermont Residential Building Energy Standard (RBES) is based on the language in the 2015 edition of the IECC and includes all of the efficiency improvements included in IECC 2018 as well as some of the improvements proposed for IECC 2021 to insure continued progression in efficiency in the Vermont RBES. The Vermont RBES are designed to promote the optimal utilization of energy and non-depletable resources in all communities, large and small. This comprehensive energy conservation code establishes minimum regulations for energy-efficient buildings using prescriptive and performance-related provisions. RBES is founded on broad-based principles that make possible the use of new materials and energy-efficient designs.

For More Information

For additional information about the legislation, contact the Vermont Public Service Department (PSD) at 802-828-2811. For a copy of the complete legislation and more detail on the Code, visit the PSD web site at <https://publicservice.vermont.gov/content/building-energy-standards>.

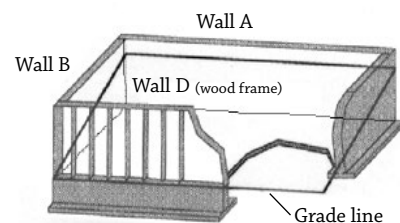
Appendix F

Definitions

Above Grade Wall	A wall more than 50% above grade and enclosing <i>conditioned space</i> . This includes between-floor spandrels, peripheral edges of floors, roof and basement knee walls, dormer walls, gable end walls, walls enclosing a mansard roof and skylight shafts.
Accessible	Admitting close approach as a result of not being guarded by locked doors, elevation or other effective means (see also Readily Accessible).
Addition	An extension or increase in the <i>conditioned space</i> floor area or height of a building or structure.
Adiabatic	Building surfaces that do not lose heat due to similar temperatures on both sides of that surface, such as shared walls between multifamily units.
AFUE	<i>Annual Fuel Utilization Efficiency</i> . 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.
Air Barrier	An air barrier is a durable assembly that blocks air flow between conditioned space and unconditioned space. 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.
Alteration	Any construction or renovation to an existing structure other than repair or addition. Also, a change in a mechanical system that involves an extension, addition or change to the arrangement, type or purpose of the original installation.
Approved	Approval by the <i>code official or other authority having jurisdiction</i> as a result of investigation and tests conducted by him or her, or by reason of accepted principles or tests by nationally recognized organizations.
Approved Agency	An established and recognized agency regularly engaged in conducting tests or furnishing inspection services, when such agency has been approved by the <i>code official or other authority having jurisdiction, where one exists</i> .
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 also Manual).
Average R-value	For a single building component with two different thermal values, it is possible to calculate a “weighted” or “average” R-value. See Appendix C.5 for instructions.
Base Code	The standard RBES Energy Code, as distinct from the higher stringency <i>Stretch Code</i> .
Basement Wall	A wall 50% or more below grade and enclosing <i>conditioned space</i> .
Basement Windows	Windows that are installed in concrete walls of basements, generally less than 10 square feet.
Basic Requirements	The set of fixed requirements applicable to all homes using the Prescriptive and Software methods of compliance.
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,” “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.
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.

Figure F-1: Walkout Basement Example

Wall A is more than 50% below grade (basement wall)
All others are 5% or more above grade (exterior walls)



Blower Door	A calibrated fan that temporarily fits in an exterior door which is used to test and measure building air leakage. Such a test is required to determine code compliance in every home and must be conducted by a certified air leakage tester, as determined by the Vermont Department of Public Service.
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). It is about the equivalent amount of heat produced by burning a wooden match, 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.
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 Envelope	The basement walls, exterior walls, floor, roof, and any other building element that encloses <i>conditioned space</i> . This boundary also includes the boundary between <i>conditioned space</i> and any exempt or unconditioned space. See Figures F-2 and F-3 below.
Building Site	A contiguous area of land that is under the ownership or control of one entity.
Ceiling	<p>Ceiling requirements apply to portions of the roof and/or ceiling through which heat flows. Ceiling components include the interior surface of flat ceilings below attics, the interior surface of cathedral or vaulted ceilings, the interior surface of dormers, and bay window roofs. Ceiling components do <i>not</i> include skylights, which are considered part of glazing. The ceiling requirements also apply to floors over outside air, including floor cantilevers, floors of an elevated home, and floors of overhangs (such as the floor above a recessed entryway or open carport).</p> <ul style="list-style-type: none"> ● Ceiling area should be measured from the exterior dimensions over the conditioned space (including the <i>sloped</i> area cathedral ceilings). ● Ceiling insulation that does not maintain a consistent R-value across the entire ceiling (including over the top of exterior walls) cannot be given full R-value credit. If a “raised truss” or other means of ensuring full insulation R-value over the top of exterior walls is not installed, you must install R-49 insulation.
Ceiling Flats	Horizontal portions of the building with unconditioned or exposed space above and conditioned space below.
Ceiling Slopes	Exterior portions of the building with unconditioned or exposed space above and with conditioned space below that are between 1° and 60° of horizontal. (See also Exterior Wall)
Code Official	The officer or other designated authority charged with the administration and enforcement of this code, or a duly authorized representative. The Department of Public Service is not the code official and shall not be required to conduct inspections of construction or construction documents.
Commercial Building	For this code, all buildings that are not included in the definition of “residential buildings”, excluding mobile homes.

Figure F-2:

Building Envelope Example 1

The dark line delineates the building envelope. This illustration shows a house over a conditioned basement (i.e., no basement ceiling insulation), with a sun room over unconditioned crawl space (i.e., insulation in crawl space ceiling).

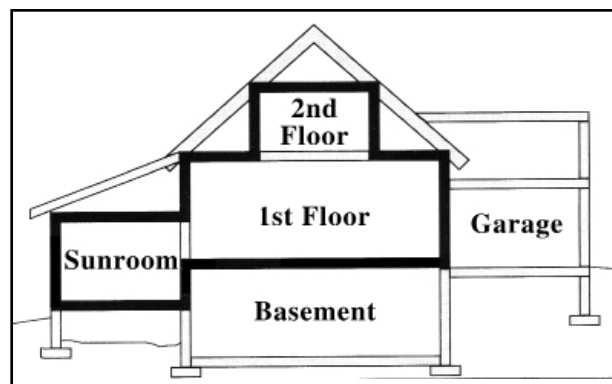
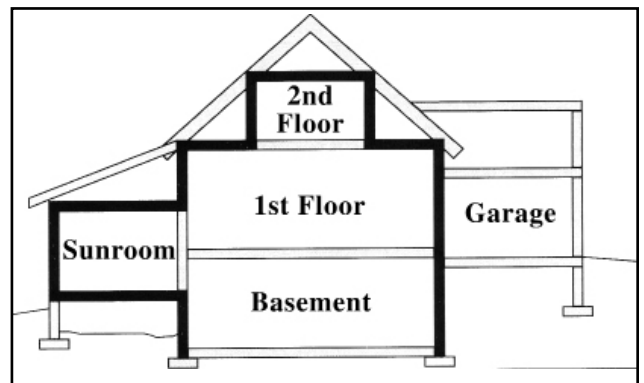


Figure F-3:

Building Envelope Example 2

This depicts the same house with an unconditioned basement (i.e., basement ceiling insulation). Note that the wall between sun room and basement is included.

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 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.
Continuous Air Barrier	A combination of materials and assemblies that restrict or prevent the passage of air through the building thermal envelope.
Continuous Insulation (ci)	Insulating material that is continuous across all structural members without thermal bridges other than fasteners and service openings. It is installed on the interior or exterior, or is integral to any opaque surface, of the building envelope.
COP	<i>Coefficient of Performance.</i> The ratio of the rate of heat delivered (or heat removed) to the rate of energy input, in consistent units, for a complete heat pump (or cooling) system under designated operating conditions. Do not consider supplemental heat when checking compliance with the heat pump equipment. A COP of 1.0 equals 100% efficient.
Covered Buildings	See Chapter 1 for complete definitions of buildings that are covered and not covered by the Residential Energy Code.
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.
Demand Recirculation Water	The quantity of air moved in 1 minute. A measurement typically applied to ventilation equipment.
Demand Recirculation Water System	A water distribution system where pump(s) prime the service hot water piping with heated water upon demand for hot water.
Direct-Vent Appliances	Appliances that are constructed and installed so that all air for combustion is derived directly from the outside atmosphere and all flue gases are discharged directly to the outside atmosphere.
Doors	Doors include all openable opaque assemblies located in exterior walls of the building envelope. <ul style="list-style-type: none"> ● <i>If door is less than 50% glass:</i> Doors with less than 50% glass are treated as a single door assembly, in which case an average U-value (a U-value that includes both the glass and opaque area) must be used. ● <i>If door is more than 50% glass:</i> The entire opaque and glass areas of doors with more than 50% glass (i.e., sliding or patio doors) are considered glazing. ● If you have a decorative or other less energy-efficient door, you need not include that door in the U-value requirements for doors when using the Prescriptive method. The Residential Energy Code allows one door to be exempt when using either of these methods.
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 housekeeping unit of one or more rooms providing complete, independent living facilities, including permanent provisions for living, sleeping, eating, cooking and sanitation.
EER	<i>Energy Efficiency Ratio.</i> The ratio of net equipment cooling capacity in Btu/hour 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 Factor	The seasonal efficiency rating (e.g., 0.61 “EF” or “Energy Factor”) for domestic water heaters as determined by a standardized Department of Energy test procedure.
Energy Rating	A uniform method of ranking homes based on energy efficiency. Energy rating scores range from 0 to 100 points and 1 to 5 Stars Plus. Eighty points, the beginning of the 4 Star range, is considered “energy efficient.” The Residential Energy Code allows an energy rating to be used to document compliance. See Chapter 7 for details.
Energy Recovery Ventilation System (ERV)	Systems that employ air-to-air heat exchangers to recover energy from exhaust air for the purpose of preheating, precooling, humidifying or dehumidifying outdoor ventilation air prior to supplying the air to a space, either directly or as part of an HVAC system. Moisture and heat are typically transferred from one air stream to another.
Exterior Envelope	See Building Envelope.
Exempt Buildings	See Chapter 1 for complete definitions of buildings that are covered and not covered by the Residential Energy Code.

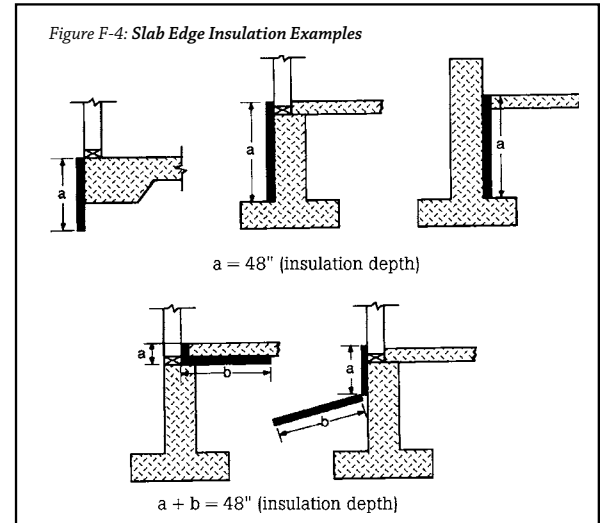
Exterior Walls	Walls including both above-grade walls and basement walls.
Fenestration	Skylights, roof windows, vertical windows (fixed or moveable), opaque doors, glazed doors, glazed block and combination opaque/glazed doors. Fenestration includes products with glass and nonglass glazing materials.
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.
Floors	<p>Floors are considered individually for compliance purposes depending on their configuration and exposure:</p> <ul style="list-style-type: none"> Floors over “unconditioned spaces” (such as floors over an unheated garage, a vented crawl space, or an unconditioned basement) must be insulated. “Exposed” floors over outside air (such as floors of overhangs, cantilevers, and floors of an elevated home) must be insulated to the R-values of ceiling flats. Slab-on-grade floors of conditioned spaces must be insulated along the slab perimeter and are not required to be insulated underneath. Floors of basements and crawl spaces are not subject to an insulation requirement and do not have to be included as a building envelope component, even if the basement or crawl space is conditioned. In these cases, the walls must be insulated. Floors separating two conditioned spaces are not subject to an insulation requirement and do not have to be included as a building envelope component (although the band joist of these floors is considered part of the exterior walls for calculation purposes and is subject to the same R-value requirements).
Furnace, Warm Air	A self-contained, indirect-fired or electrically heated furnace that supplies heated air through ducts to spaces that require it.
Glazing	<p>Glazing is any translucent or transparent material in exterior openings of buildings (including windows, skylights, sliding glass doors, swinging/patio glass doors, basement windows and glass block). If a door has more than 50% glass (e.g., swinging or patio doors), it is considered part of the glazing area and not a “door.” If a door has less than 50% glass, the entire unit (opaque and glass areas) is defined as a “door.”</p> <ul style="list-style-type: none"> Windows in the exterior walls of <i>conditioned</i> basements (i.e., without ceiling insulation) <i>should</i> be included in the glazing-area calculations. Windows in walls of basements or crawl spaces with insulated ceilings are <i>not</i> included. Also be sure to include skylights in glazing area calculations and U-value requirements. Window U-value requirements for conditioned basements are treated separately from the rest of the glazing in the house under the Prescriptive method.
Glazing Area	The area of a glazing assembly is the interior surface area of the entire assembly, including glazing, sash, curbing, and other framing elements. The rough opening is also acceptable (for flat windows).
Glazing Percentage	The total glazing area divided by the gross wall area, then multiplied by 100.
Gross Wall Area	Includes the opaque area of above-grade walls, the opaque area of any individual wall of a conditioned basement more than 50% above grade (including the below-grade portions), all windows and doors (including windows and doors of conditioned basements), and the peripheral edges of floors (i.e., band joists).
Heat Pump	A refrigeration system that extracts heat from one substance and transfers it to another portion of the same substance or to a second substance at a higher temperature for a beneficial purpose.
Heat Recovery Ventilation System (HRV)	A factory-assembled device or combination of devices, including fans or blowers, designed to provide outdoor air for ventilation in which heat or heat and moisture is transferred between two isolated intake and exhaust air streams.
Heating Seasonal Performance Factor	(HSPF) The total heating output of a heat pump during its normal annual usage period for heating, in Btu's, 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 Lamps	Light Emitting Diode (LED) or compact fluorescent lamps, T-8 or smaller diameter linear fluorescent lamps, or lamps with a minimum efficacy of not less than 65 lumens per watt; or light fixtures of not less than 55 lumens per watt. 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	<p>Any building or structure that is one or more of the following:</p> <ol style="list-style-type: none"> 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. Designated as historic under an applicable state or local law. Certified as a contributing resource within a National Register-listed, state-designated or locally designated historic district
Home Energy Rating	See also "Energy Rating". A home energy rating system accredited by the Vermont Public Service Department that provides a numerical rating

System (HERS)	In compliance with 21 V.S.A. § 267(a). 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.
Hunting Camp	A seasonal building used as a temporary residence only during hunting season.
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. <ul style="list-style-type: none"> ● 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 also HVAC System Equipment). ● 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.)
Infiltration	The uncontrolled inward air leakage into a building caused by the pressure effects of wind or the effect of differences in the indoor and outdoor air density or both.
Insulated Siding	A type of continuous insulation with manufacturer-installed insulating material as an integral part of the cladding product having a minimum <i>R</i> -value of <i>R</i> -2.
Level 1 Electric Vehicle Charging Station	Level 1 charging uses a standard 120V outlet.
Level 2 Electric Vehicle Charging Station	Level 2 uses a 240 volt AC charging.
Lighting	See "High-Efficacy Lamps/Lighting".
Log Home	A home in which the primary exterior walls are made of lengths of whole logs, one on top of the other, with the inside and outside surfaces the opposite sides of the same logs.
Local Ventilation	A mechanical ventilation system including fans, controls and ducts, dedicated to exhausting moisture-laden air to the outside of the building from the room or space in which the moisture is generated.
Manual	Capable of being operated by personal intervention (see also Automatic).
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" must 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 VSA § 51.)
Mobile Home	Homes subject to Title VI of the National Manufactured Housing Construction & Safety Standards Act of 1974 (i.e., single- and double-wide homes on a permanent chassis with detachable wheels). Mobile homes are exempt from the Residential Energy Code, but site-built components (e.g., conditioned basements or crawl spaces) must comply.
Manufactured Home	Factory-built modular homes that are <i>not</i> subject to Title VI of the National Manufactured Housing Construction & Safety Standards Act of 1974 (i.e., homes not on a permanent chassis).
Multi-family	A building containing three or more dwelling units.
Multiport	A whole-house ventilation system that has more than one exhaust or supply port inside the house.
NFPA	National Fire Protection Agency. Within the Residential Energy Code, NFPA 54 references the "Gas Code"; NFPA 31 references the "Oil Code."
Net Wall Area	Gross wall area minus the rough opening area of all glazing and doors. Also called the "opaque area." The net wall area includes the opaque wall area of all above-grade walls enclosing conditioned spaces, the opaque area of conditioned basement walls more than 50% above grade (including the below-grade portions), and peripheral edges of floors (i.e., band joists). The net wall area does <i>not</i> include windows, doors, or other such openings.

Nominal R-value	The R-value of an insulating material as listed on its packaging.
Occupancy	The purpose for which a building, or portion thereof, is utilized or occupied.
Occupancy Classifications	<p>Residential Group R is the occupancy group used for buildings that include sleeping rooms and are not institutional and are not generally regulated by the International Residential Code. The IRC typically regulates single family homes and duplexes, any structure with more than two units is in the IBC. There are four different occupancy groups within R.</p> <p>The first occupancy group is R-1. This group is for transient uses like hotels, motels and boarding houses.</p> <p>The next group is R-2. R-2 is the group we see most often and it for residences where occupants are primarily permanent. This includes apartments, dormitories, fraternities and sororities. It also includes vacation timeshares (again with more than two units) and convents and monasteries. Congregate living facilities with 16 or fewer occupants go into group R-3.</p> <p>R-3 is for permanent occupancies that aren't R-1, R-2, R-4 or I. These include 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 R-3. Where these facilities are in a single family home they must comply with the IRC.</p> <p>R-4 is for residential care/assisted living facilities including more than five and not more than 16 occupants.</p>
Opaque Areas	All exposed areas of the building envelope which enclose conditioned space, except openings for windows, skylights, doors and building service systems.
Outdoor Air	Air taken from the outdoors and, therefore, not previously circulated through the building.
Owner-Builder	<p>If all of the following apply:</p> <ul style="list-style-type: none"> 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 must itemize how the home does not comply with RBES, and must itemize which measures do not meet the RBES standards in effect at the time construction commenced. Any certificate must be recorded in the land records where the property is located, and sent to the Public Service Department, within 30 days following sale of the property by the owner.
Owner-Builder Disclosure Statement	The form that an owner-builder must complete — and disclose to a prospective buyer before entering into a binding purchase and sale agreement — if the home does not meet the technical requirement of the Vermont Residential Energy Code. The owner must complete this form (see Chapter 8), and file copies with the appropriate town clerk and the Public Service Department, within 30 days of construction completion.
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.
Packaged Terminal Heat Pump	A PTAC capable of using the refrigeration system in a reverse cycle or heat pump mode to provide heat.
Power-Vented Appliance	Appliances that operate with a positive vent static pressure (NFPA Category III) and utilize a mechanical fan to exhaust combustion gases from the appliance to the outside atmosphere.
Prescriptive Method	The easiest procedure for demonstrating compliance with the technical requirements of the Residential Energy Code. Homes must comply with all of the Basic Requirements in addition to one of the packages in the corresponding Prescriptive Requirements Table. See Chapter 5.
Prescriptive Requirements	The thermal (R-value and U-value) and heating efficiency (AFUE) values needed to meet the technical requirements of the Energy Code.
Primary Fuel	The fuel type that is used by the automatic heating system that is designed to provide heat to the majority of the building. Wood is never the primary fuel if there is another automatic heating system in place, regardless of the amount of heat it provides.
Primary Heating System	The automatic heating system that is designed to provide heat to the majority of the building. A wood system is never the primary heating system if there is another automatic heating system in place, regardless of the amount of heat it provides.
Raised Truss	Any roof/ceiling construction that allows the insulation to achieve its full thickness or R-value over the top plate of exterior walls. Several constructions allow for this, including elevating the heel (sometimes referred to as an “energy truss,” “raised-heel truss” or “Arkansas truss”), use of cantilevered or oversized trusses, lowering the ceiling joists, framing with a raised rafter plate,

	or installing higher R-value insulation over the exterior wall top plates. See Figure B-1 for examples.
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 gauge). Prescriptive compliance with the Vermont Residential Building Energy Standard requires that all fan capacities be rated at 0.1 inch (25 Pa) of water gauge.
Rated Design	A description of the proposed <i>building</i> 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 also Accessible).
RBES Certificate	See “Vermont RBES Certificate.”
Recovery Efficiency	For water heaters, the percent of energy consumed that is transferred to heat the water when the appliance is firing. Does not include stand-by or off-cycle losses (see also Energy Factor).
Renewable Energy	Means energy produced using a technology that relies on a resource that is being consumed at a harvest rate at or below its natural regeneration rate including, but not limited to solar hot water, solar hot air, solar photovoltaics, wind, and hydro. A. Methane gas and other flammable gases produced by the decay of sewage treatment plant wastes or landfill wastes and anaerobic digestion of agricultural products, byproducts, or wastes must be considered renewable energy resources, but no form of solid waste, other than agricultural or silvicultural waste, must be considered renewable. B. The only portion of electricity produced by a system of generating resources that must be considered renewable is that portion generated by a technology that qualifies as renewable. C. Technologies using the following fuels shall not be considered renewable energy supplies: coal, oil, propane, and natural gas. D. <i>Biomass</i> is considered renewable.
Reroofing	The process of recovering or replacing an existing <i>roof covering</i> . See “Roof recover” and “Roof replacement.”
REScheck™	Computer software available from the Residential Energy Code Assistance Center that determines compliance with the technical requirements of the Residential Energy Code. See Chapter 6.
Residential Buildings	For this code, includes R-3 buildings, as well as R-2 and R-4 buildings three stories or fewer in height above grade.
Residential Construction	New construction of residential buildings, or the construction of residential additions, alterations, renovations, or repairs.
Roof Recover	The process of installing an additional <i>roof covering</i> over a prepared existing <i>roof covering</i> without removing the existing <i>roof covering</i> .
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 <i>roof covering</i> , repairing any damaged substrate and installing a new <i>roof covering</i> .
Room Air Conditioner	An enclosed 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	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 ($h \cdot ft^2 \cdot ^\circ F/Btu$) [$(m^2 \cdot K)/W$].
Seasonal Energy Efficiency Ratio (SEER)	The total cooling output of an air conditioner during its normal annual usage period for cooling, in Btu/hour, 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.
Self-Certify	The act of certifying that a home complies with the Residential Energy Code through the following steps: 1) performing an analysis to determine if a home as planned will comply; 2) verifying that the home as built will comply; and 3) signing and filing the required documentation.
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.
Single-Family Home	As defined by the Residential Energy Code, a single-family building is a detached one- or two-family (i.e., duplex) residential building. Log homes (see definition) are considered separately.
Skylight	Glass or other transparent or translucent glazing material installed at a slope of less than 60 degrees (1.05 rad) from horizontal.
Slab Edge	<p>The perimeter of a slab-on-grade floor, where the top edge of the slab floor is above the finished grade or 12 inches or less below the finished grade. Insulation must be installed with the required R-value to a depth of at least 48" using any of the following configurations:</p> <ul style="list-style-type: none"> • The slab insulation extends from the top of the slab downward. • The slab insulation extends from the top of the slab downward to the bottom of the slab and then horizontally underneath the slab for a minimum total distance of at least 48 inches. • The slab insulation extends from the top of the slab downward to the bottom of the slab and then horizontally away from the slab for a minimum total distance equal to at least 48 inches. The horizontal insulation must be covered by pavement or at least 10" of soil. • The top edge of insulation installed between the exterior wall and the interior slab can be cut at a 45 degree angle away from the exterior wall.
Sloped Ceiling	See "Ceiling Slopes."
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 Truss	Any construction that does not permit the roof/ceiling insulation to achieve the required R-value over the exterior walls.
Stretch Code	A building energy code that achieves greater energy savings than the base RBES. The Stretch Code is required for Act 250 projects and may be adopted by municipalities.
Summer Camps	Residential buildings constructed for non-winter occupation with only a biomass (wood) or other on-site renewable heating system.
Sunroom	A one-story structure attached to a dwelling with a glazing area in excess of 40% of the gross area of the structure's exterior walls and roof.
System	A combination of central or terminal equipment or components or controls, accessories, interconnecting means and terminal devices by which energy is transformed so as to perform a specific function, such as HVAC, service water heating or illumination.
Thermal Isolation	Physical and space conditioning separation from <i>conditioned space(s)</i> . The <i>conditioned space(s)</i> shall be controlled as separate zones for heating and cooling or conditioned by separate equipment.
Thermal Resistance (R)	<p>The reciprocal of thermal conductance ($h \cdot \text{ft}^2 \cdot ^\circ\text{F}/\text{Btu}$) [$(\text{m}^2 \cdot \text{K})/\text{W}$].</p> <p>Overall Thermal Resistance (Ro): The reciprocal of overall thermal conductance ($h \cdot \text{ft}^2 \cdot ^\circ\text{F}/\text{Btu}$) [$(\text{m}^2 \cdot \text{K})/\text{W}$]. The overall thermal resistance of the gross area or individual component of the exterior building envelope (such as roof/ceiling, exterior wall, floor, crawl space wall, foundation, window, skylight, door, opaque wall, etc.), which includes the area-weighted R-values of the specific component assemblies (such as air film, insulation, drywall, framing, glazing, etc.).</p>
Thermal Transmittance (U)	The coefficient of heat transmission (air to air). It is the time rate of heat flow per unit area and unit temperature difference between the warm-side and cold-side air films ($\text{Btu}/\text{hr} \cdot \text{ft}^2 \cdot ^\circ\text{F}$) [$\text{W}/(\text{m}^2 \cdot \text{K})$]. The U-factor applies to combinations of



Transmittance	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.																				
Overall Thermal Transmittance (Uo):	The overall (average) heat transmission of a gross area of the exterior building envelope (Btu/h · ft2 · °F) [W/(m2 · K)]. The Uo-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.																				
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Thermostat	An automatic control device used to maintain temperature at a fixed or adjustable set point.																				
UA	The U-value times the area of a building component.																				
Unconditioned Spaces	Spaces enclosed within buildings that do not fall under the definition of “conditioned space.” For example: garages separated from the house by insulated walls and/or ceilings; attics separated from the house by insulated floors; and basements and crawl spaces with insulated ceilings.																				
Unitary Cooling	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.																				
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; and 3. New buildings constructed in compliance with the RBES shall be considered built of unusually tight construction.																				
U-factor	A measure of how well a material (or series of materials) conducts heat. U-factors for window and door assemblies are the reciprocal of the assembly R-value ($U = 1 / R$). Windows and doors are usually rated using U-factor rather than R-value. Lower numbers mean less heat loss and better performance. Equivalent to “U-factor.”																				
Vapor Permeable Membrane	A material or covering having a permeance rating of 5 perms (2.9 · 1040 kg/Pa · s · m²) or greater, when tested in accordance with the desiccant method using Procedure A of ASTM E 96. A vapor permeable material permits the passage of moisture vapor.																				
Vapor Retarder	A vapor-resistant material, membrane or covering such as foil, plastic sheeting or insulation facing. 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 must be defined using the desiccant method with Procedure A of ASTM E 96 as follows: <table><tr><td>Vapor Retarder Class⁷</td><td>Perm Rating (Dry Cup)</td><td>Description</td><td>Examples of Materials</td></tr><tr><td>Class I</td><td>0.1 perm or less</td><td>Vapor impermeable or “Vapor Barrier”</td><td>Rubber membrane, sheet polyethylene, glass, foils</td></tr><tr><td>Class II</td><td>0.1 -1.0 perm</td><td>Vapor semi-impermeable</td><td>Oil-based paint, Kraft-faced batt, vinyl wall coverings, stucco</td></tr><tr><td>Class III</td><td>1.0 – 10 perm</td><td>Vapor semi-permeable</td><td>Plywood, OSB, EPS, XPS, most latex paints, heavy asphalt-impregnated building paper, wood board sheathing</td></tr><tr><td>Vapor Open</td><td>>10 perm</td><td>Vapor permeable</td><td>Unpainted gypsum board, unfaced fiberglass, cellulose, many “housewraps”</td></tr></table>	Vapor Retarder Class ⁷	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”
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Vapor Open	>10 perm	Vapor permeable	Unpainted gypsum board, unfaced fiberglass, cellulose, many “housewraps”																		
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.																				
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. <ul style="list-style-type: none">● Mechanical draft venting system: A venting system designed to remove flue or vent gases by mechanical means, that																				

	<p>consists of an induced draft portion under nonpositive static pressure or a forced draft portion under positive static pressure.</p> <ul style="list-style-type: none"> - 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. - 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. <ul style="list-style-type: none"> ● 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. ● Whole-House Ventilation System, Single Port: A whole-house ventilation system that has only one connection to the conditioned space and one connection to outdoor air. ● Whole-House Ventilation System, Supply Only: Supply-only systems provide outdoor air for ventilation via a single fan or multiple fans. Stale air may exhaust through typical leaks in the building envelope. Supply-only systems may pressurize the indoor environment. ● Whole-House Ventilation System, Exhaust Only: Exhaust only systems exhaust stale indoor air via a single fan, multiple fans or the installation of dual-purpose fans (i.e., serving both localized and whole house ventilation functions). Fresh incoming air may be provided by installed inlet ports or from typical leaks in the building envelope. Exhaust only systems may depressurize the indoor environment. ● Whole-House Ventilation System, Multi-Port: A whole house ventilation system that has more than one exhaust or supply port inside the house. ● Whole-House Ventilation System, Single-Port: A whole house ventilation system that has only one connection to the conditioned space and one connection to outdoor air.
Vermont RBES Certificate	<i>Vermont Residential Building Energy Standards Certificate.</i> The one-page form that itemizes the energy components of a building and indicates its compliance with the Residential Energy Code. The builder must sign and affix this certificate to the property and provide one copy each to the local town clerk and the Public Service Department within 30 days of construction completion. See Chapter 8.
Vertical Fenestration	Windows (fixed or move- able), 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.
Water Heater	If a water heater is used as the primary means of heating a house, one of the Professional Services methods must be used to document compliance with the Code.
Wood Stove	If a wood stove is used as the primary means of heating a house, the HER compliance method (see Chapter 7) must be used to document compliance with the Energy Code.
Whole House Mechanical Ventilation System	An exhaust system, supply system, or combination thereof that is designed to mechanically exchange indoor air with outdoor air when operating continuously or through a programmed intermittent schedule to satisfy the whole house ventilation rates.
Zone	A space or group of spaces within a building with heating or cooling requirements that are sufficiently similar so that desired conditions can be maintained throughout using a single controlling device.

Table 5-1. Requirements by component for base packages

REQUIREMENTS BY COMPONENT FOR BASE PACKAGES					
<i>Component^a</i>	<i>Package 1 Standard</i>	<i>Package 2 SIPS</i>	<i>Package 3 Thick Wall</i>	<i>Package 4 Cavity Only</i>	<i>Package 5 Log Homes</i>
Ceiling	R-49 ^f	R-28 cont.	R-49 ^f	R-60g attic / R-49 ^f slope	Construct log home to ICC 400-2017 "Standard on the Design and Construction of Log Structures" OR Table R402.1.6 in RBES code language
Wood Frame Walls	R-20+5 ^e OR 13+10 ^e	R-21 cont.	R-20+12 ^e	R-20 cavity	
Common Wall Insulation	R-10	R-10	R-10	R-10	
Floor	R-30	R-30	R-30	R-38	
Basement/Crawl Space Wall^c	R-15 (continuous) OR 20 (cavity) OR R-13+5	R-15 (continuous) OR 20 (cavity) OR R-13+5	R-20 (continuous) OR R-13+10 ^e	R-20 (continuous) OR R-13+10 ^e	
Slab Edge^d	R-15, 4ft OR R-10 perimeter + R-7.5 under entire rest of slab	R-15, 4ft OR R-10 perimeter + R-7.5 under entire rest of slab	R-10, 4 ft	R-15, 4 ft OR R-10 perimeter + R-7.5 under entire rest of slab	
Heated Slab^d	R-15 (edge and under)	R-15 (edge and under)	R-15 (edge and under)	R-15 (edge and under)	
Fenestration^b (Window and Door)	U-0.30 max.	U-0.30 max.	U-0.30 max.	U-0.28 max.	
Skylight^b	U-0.55 max.	U-0.55 max.	U-0.55 max.	U-0.55 max.	
Air Leakageⁱ	≤3.0 ACH50 ^h tested	≤3.0 ACH50 ^h tested	≤3.0 ACH50 ^h tested	≤3.0 ACH50 ^h tested	
Duct Leakage	Inside thermal boundary	Inside thermal boundary	4 CFM25 per 100 sq. ft. of CFA ⁱ	Inside thermal boundary	
Percent High Efficacy Lampsⁱ	90%	90%	90%	100%	

For SI: 1 foot = 304.8 mm.

- ^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.
- ^b The fenestration U-factor row excludes skylights.
- ^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, so "13+10" means R-13 cavity insulation plus R-10 continuous insulation.

- ^f 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 RBES Section R402.2.1). Multifamily buildings using continuous insulation with a maximum U-factor of 0.023 for the ceiling assembly satisfies this requirement.
- ^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 RBES Section R402.2.1.)
- ^h "ACH50" = air changes per hour at 50 Pascals building pressure as measured with a blower door
- ⁱ "CFA" = conditioned floor area
- ^j See RBES Table R402.4.1.1 for further details.