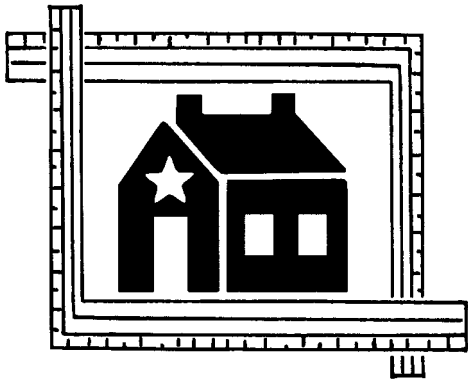


Vermont Residential Building Energy Code

Handbook

A Guide to Complying with
Vermont's Residential Building Energy Standards (Act 20, 1997)

Edition 2.0 • September 2004

Effective January 1, 2005

Energy Code Assistance Center
255 South Champlain St., Suite 7
Burlington, VT 05401-4894
888-37-ECALL (373-2255) ~ *toll free*
802-658-1643 ~ *fax*

Vermont Department of Public Service
Energy Efficiency Division
112 State Street, Drawer 20
Montpelier, VT 05620-2601
800-642-3281 ~ *toll free within Vermont*
802-828-4056

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

How to Use This Handbook

This handbook puts all the information you need to know about Vermont's Energy Code for new residential construction into one publication. Each chapter is divided into sections. 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 chronologically within each chapter. For example, the first table in Chapter 3 is Table 3-1, the second table is Table 3-2, etc.

When to Consult the Handbook

There are three times during the course of new home construction to review this handbook:

1. During the 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.
2. In the Event of Design Changes: Review whether the home still complies when there are changes. This will ensure that there are no surprises upon completion.
3. Upon Completion: State law requires every Vermont builder to self-certify that the home complies with the Code as built.

What to Read

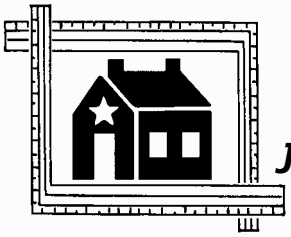
★ To quickly learn if the home you're building will meet the Code's technical requirements:

- ✓ Review the **Basic Requirements** on the inside front cover,
- ✓ Follow the **Ventilation Requirements** (Chapter 2), and
- ✓ Read **Chapter 4, "The Fast-Track Method."**

★ For an overview of the Code, read the following chapters:

- ✓ **Introduction: The Vermont Residential Building Energy Code** — summarizes the key features of the Code.
- ✓ **Chapter 1: Rules for Compliance** — explains in detail which buildings must comply and which are exempt.
- ✓ **Chapter 2: Ventilation Requirements** — discusses the importance of indoor air quality and how to achieve it in energy-efficient construction.
- ✓ **Chapter 3: Guidelines for Calculations** — illustrates how to perform the necessary calculations.
- ✓ **Chapter 8: Certification** — specifies how to accurately certify compliance with the Code.

★ Read the Appendices. The Appendices include definitions and clarifications of terms used in this handbook, default R- and U-values, additional details about Basic Requirements, and Vermont-specific resources for builders.



What's New Starting in January 2005

There are two major revisions to the Vermont Residential Building Energy Code that take effect January 1, 2005:

1. A simple, automatic-ventilation system is required to exhaust and introduce outside air. Most common is a low-wattage bath fan on a programmable timer. A more comprehensive system, such as a heat-recovery ventilator system, may be preferred but is not required. The capacity of the ventilation system is based on number of bedrooms or the square footage of the home.
2. All houses built to the Energy Code requirements are considered to be "unusually tight construction"; therefore, all new construction must provide combustion air from the outside for all combustion heating systems.

Both of these requirements are discussed in Chapter 2 of this handbook.

If You Need Help

The Energy Code Assistance Center provides free technical assistance. Call toll-free 888-37-ECALL (1-888-373-2255).

Contents

** Table 4-1 is located on the inside back cover as well.*

Chapter 6: The VT*check* Software Compliance Method

Chapter 7: The Home Energy Rating Compliance Method

Chapter 8: Certification

Appendices

** The Basic Requirements Summary Table is located on the inside front cover as well.*

This chapter summarizes the key features of the Vermont Residential Building Energy Code as it takes effect in January 2005.

Introduction

The Vermont Residential Energy Code

The Vermont Residential Energy Code — officially called the "Residential Building Energy Standards" (RBES) and generally referred to as simply the Energy Code — was passed by the Vermont legislature in May 1997. Based on the Council of American Building Officials' Model Energy Code (1995 CABO-MEC) and Vermont admendments to the 2000 International Energy Conservation Code (2000 IECC), it is a minimum standard of energy efficiency that has applied to virtually all new residential construction in Vermont since July 1, 1998.

What Buildings Must Comply?

★ Detached one- and two-family dwellings.

★ Multifamily and all other residential dwellings three stories or less in height.

★ Additions of 500 square feet or more.

★ Factory-built modular homes not on a permanent chassis.

This is a summary; see Chapter 1 for details.

What Buildings Are Exempt?

★ Residential buildings started before July 1, 1998.

★ Act 250 projects permitted before July 1, 1997.

★ Commercial and high-rise residential buildings (except for the residential portion of a mixed-use building).

★ Mobile homes on a permanent chassis with detachable wheels (except for site-built components such as conditioned basements or crawlspaces).

★ Buildings or additions with very low energy use (those designed for a peak energy use of less than 3.4 Btu/h [1 Watt] per square foot of floor area).

★ Unconditioned buildings.

★ Renovations outside the city of Burlington.[1]

★ Hunting camps.

This is a summary; see Chapter 1 for details.

[1] For renovations within Burlington, contact the Inspection Services Division of the Burlington Department of Public Works (863-9094) for information on city code requirements.

The Basic Steps for Meeting the Code

The Vermont Energy Code encompasses two requirements: a **technical requirement** (i.e., minimum standards for energy-efficient building components and construction practices); and a **certification requirement** for reporting compliance. It is one of the few codes in the country in which the builder *self-certifies* compliance.

The law recognizes that it is the builder's responsibility to understand the 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. No plan reviews or final inspections by Code officials are involved.[1] The whole process can be summarized as follows:

1. Determine whether you need to comply (Chapter 1).
2. Follow the minimum ventilation and combustion-air requirements (Chapter 2).
3. Follow the Rules for Calculations (Chapter 3);
4. Select and complete the Compliance Method that works best for you (Chapters 4-7); and
5. Fill out, file and post the required compliance certificate (Chapter 8).

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

Compliance Methods

The technical requirement of the Energy Code consists of three components:

- ★ **Basic Requirements:** a list of fixed requirements (see inside front cover).
- ★ **Ventilation & Combustion-Air Requirements:** (see Chapter 2).
- ★ **Performance Requirements:** requirements that vary based on the compliance method selected.

In order to comply with the Energy Code, a home, *as built*, must meet all of the Basic Requirements and the Performance Requirements for one of the compliance methods.

Four different methods of complying with the Energy Code have been designed. They all prescribe the thermal and efficiency values that are necessary to meet the minimum standards of the Code. They vary in simplicity of use, as well as in the level of efficiency above the minimum standard 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 Code. The four compliance methods are:

Fast-Track Method	The simplest approach. Allows you to incorporate a prescribed set of features. Minimal calculations. (See Chapter 4.)
Trade-Off Method	Almost as simple as the Fast-Track method, but accommodates more designs. You "trade off" various Fast-Track requirements for other features in your design. (See Chapter 5.)
VT*check* Software Method	Use your computer with VT*check* software to easily analyze almost any design and determine whether any modifications are needed to meet the Code. (See Chapter 6.)
Home Energy Rating Method	Achieve a minimum score of 82 (the high end of a 4 Star rating) to comply. This approach gives full credit for air tightness efficient domestic hot water heating, and solar orientation. (See Chapter 7.)

[1] While the 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 local codes.

Energy Code Administration

The Vermont Department of Public Service is working to establish procedures for reviews, appeals and exemptions. These procedures have not been finalized at this time. Please direct any questions regarding administrative authority to the Vermont Department of Public Service at 800-642-3281 (toll free in state) or 802-828-4056.

Energy Code Updates

The legislation to create the Vermont Residential Energy Code provides for regular review and updates to the provisions in the Code. The review of the Energy Code will be administered by the Vermont Department of Public Service. Please address all comments and inquiries to:

Vermont Department of Public Service
Energy Efficiency Division
112 State Street, Drawer 20
Montpelier, Vermont 05620-2601
1-800-642-3281 *toll free within Vermont* or
802-828-4056

Technical Assistance

Technical assistance with the Energy Code is available at no charge. Please contact:

Energy Code Assistance Center
255 South Champlain Street
Burlington, Vermont 05401
1-888-37-ECALL (373-2255) *toll free*

E-CALL Hotline
888-37-ECALL
(888-373-2255)

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

Energy Code Assistance Center

The Energy Code Assistance Center (ECAC) is funded by the Vermont Department of Public Service and the U.S. Department of Energy. Services include:

- ★ Toll-free assistance hotline: 888-37-ECALL (888-373-2255)
- ★ Workshops for builders on how to comply with the Vermont Residential Energy Code
- ★ Handbooks, forms, software and other Code-related materials
- ★ Professional advice on how to easily meet the Code
- ★ Information about state-of-the-art construction techniques and building details
- ★ Referral to utility energy-efficiency programs.
- ★ Sources for energy-efficient products
- ★ Customized workshops and presentations on energy-efficient building practices

This chapter discusses:

★ The builder's responsibilities under the Vermont Residential Energy Code

★ What the Energy Code does and does not cover.

Chapter 1

Rules for Compliance

Section 1.1

Builder's Responsibilities

Under the Vermont 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 Code and
2. Whether a document must be completed and filed in order to meet certification requirements (a document 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 Energy Code:

★ **Detached one- and two-family dwellings.**

★ **Multifamily and other residential buildings three stories or less in height**.

★ **Additions of 500 square feet or more**. The addition itself must meet the requirements, regardless of the features of the existing house. Only the materials and equipment being installed need to comply with the Code. For example, if a new addition is designed to use the heating system of the home to which it is attached, you are not required to change the heating system; however, the new walls, windows, ceilings and foundation would have to comply with the Code.

★ **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).

Section 1.3

Exempt Buildings

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

- ★ **Existing buildings** for which construction commenced before July 1, 1998.
- ★ **Act 250 projects** permitted before July 1, 1997.
- ★ **Commercial buildings** or portions classified as commercial or high-rise residential. (A residential portion of a mixed-use building must meet the Energy Code.)
- ★ **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 with detachable wheels). Site-built components such as conditioned basements or crawlspaces are not exempt.
- ★ **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.
- ★ **Renovations** except for those in Burlington which has its own municipal code. (Contact the Inspection Services Division of the Burlington Department of Public Works at 863-9094 for details.)
- ★ **Hunting camps**

Section 1.4

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 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"), having the power to direct others with respect to the details of construction and the installation of materials that do not comply with the Energy Code.
3. The owner must live in the building.
4. The owner must evaluate whether the home meets the Energy Code.
5. Depending on whether the home meets the technical requirement of the 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.)
6. Before entering into a binding purchase and sale agreement, the owner must disclose in writing to a prospective buyer the nature and extent of any non-compliance with the Energy Code. This disclosure must itemize measures not meeting the standard.

Section 1.5

Act 250 Provision

Residential buildings that have an *Act 250 permit dated prior to July 1, 1997*, are not required to meet the Energy Code. (This provision applies to both the technical and the certification requirements.)

Section 1.6

Burlington Residential Energy-Efficiency Standards

The City of Burlington has its own energy-efficiency standards that cover all new residential structures and all additions and/or renovations to existing buildings. For renovation work, the standards apply to any building component covered by the standards that is being replaced. For example, if a building owner replaces only the windows, the replacement windows must comply with the standards, but any untouched components (walls, ceilings, heating system, etc.) are not required to comply.

For all new residential structures and all additions over 500 square feet, Burlington has adopted (as of July 1, 1998) the Vermont Residential Energy Code. However, Burlington maintains the *renovation* requirement cited above.

Section 1.7

Penalty for Not Complying with the Energy Code

If a home required by law to meet the Energy Code does not comply, a home owner 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

Ventilation Requirements

Section 2.1

Ventilation

Revisions to the Vermont Residential Building Energy Code that take effect January 1, 2005, require all newly constructed homes to be mechanically ventilated. There also are requirements for combustion equipment aimed at reducing the likelihood of flue gas venting problems. This chapter provides details on both of these new requirements.

Section 2.1a

Whole House Ventilation

Every home must have a system consisting of fans, controls and ducts that provides the fresh air for the dwelling unit. The whole-house ventilation system must meet the requirements listed in this chapter and be installed according to the manufacturer's instructions. It must be capable of supplying the specified amount of air during all periods of occupancy automatically, without the need for anyone to turn it on or off.

Section 2.1b

Local Ventilation

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

Section 2.1c

System Types

There are three types of ventilation systems.

- ★ **Exhaust-only systems** remove stale, indoor air using single or multiple fans. Incoming air is provided by installed inlet ports or by typical leaks in the building shell. These systems tend to depressurize the building.
- ★ **Supply-only systems** provide outdoor air by blowing it into the building. Stale air is exhausted through typical leaks in the building shell. These systems tend to positively pressurize the building. Although exhaust fans are not part of these systems, the Code still requires the installation of exhaust fans in all bathrooms (in this case, as local exhaust).

  One type of supply-only system uses a ducted inlet to the return plenum of a forced-air heating system and uses the air-handler fan to pull in outside air. These "integrated" systems can provide fresh air without using a separate fan. Systems integrated with the furnace must have either a motorized damper connected to a control capable of providing the required air flow or some other device that has been verified by on-site performance testing.
- ★ **Balanced systems** use fans to move air in both directions at once. Most of these systems use a heat exchanger to transfer some of the heat from one air stream to another. These systems usually are called heat recovery ventilators (HRVs), energy recovery ventilators (ERVs), or air-to-air heat exchangers. When correctly installed, balanced systems do not significantly affect the air pressure in the house.

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 one-half inch above the finished floor surface.

Pressure Effects

When a fan blows air in or out of 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 chimneys. Positive pressure, created when a fan blows air into a space, tends to push indoor air out and can cause condensation problems in cold weather. 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 effect to avoid is substantial depressurization in rooms with chimneys.

Section 2.1d

Fan Requirements

Fans installed as part of a whole-house ventilation system must meet the following requirements. (Fans installed as local exhaust do not need to meet these requirements.)

- ★ ***Durability***: Fans must be rated for "continuous duty."
- ★ ***Efficiency:*** 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 2 sones.

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

What's a Sone?

A sone is a measure of loudness. One sone has been described as being like a quiet refrigerator. Sound volume is important in ventilation systems because most people will disable a fan they find annoying. Ceiling-mounted exhaust fans range from about 1/2 sone to five sones or more.

Section 2.1e

Capacity

Whole-house ventilation systems that are not tested must be able to provide the minimum *rated* flow rates listed in Table 2.1.

Alternatively, flow rates can be tested on site, using approved methods (i.e., a flow hood or a calibrated orifice combined with a digital manometer). If the system is tested, it does not need to meet the capacity requirements of Table 2.1, but it must provide a minimum of 15 cubic feet per minute (CFM) plus 15 CFM for each bedroom.

Table 2.1

Capacity Requirements for Whole-House Ventilation Systems

# of Bedrooms	*Minimum Rated Capacity (CFM[1])*	*Minimum # of Fans (if not centrally ducted system)*
1	50	1
2	75	1
3	100	1
4	125	2
5	150	2
Homes over 3000 sq. ft.	0.05 x sq. ft.	2

[1] *CFM = cubic feet per minute*

Section 2.1f

Controls

The ventilation system must have an automatic control or be capable of being set remotely for continuous operation.

Intermittently operated systems must have an automatic control capable of operating the system without the need for occupant intervention, such as a time switch. Twist or crank-style timers are not acceptable as controls for the whole-house system.

Continuously operated systems must have a remotely mounted (i.e, not in the living space) on/off switch that is appropriately labeled. Continuously operated systems cannot have any local controls unless such controls affect the speed only and cannot turn the system off.

Section 2.1g

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 sealed to the ceiling or wall.
- ★ Inlet grilles for ducted systems must be sealed to the ceiling or wall.

- ★ Ducts that run more than 8 feet must be a smooth wall (not corrugated or flexible material). All ducts in unheated locations must be insulated.
- ★ Mechanical fasteners — not tape — must be used to connect the ducts to the fan.
- ★ Joints and connections must be securely fastened and air-sealed with durable and appropriate materials. Standard duct tape is not allowed for sealing ducts.
- ★ Noise reduction of remote whole-house fans must be provided by isolating the fan from the hard ducting 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.) The fan also must be acoustically isolated from the framing of the building.
- ★ 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.

Section 2.1h

Clothes Dryers

All clothes dryers must be exhausted to outdoors, according to the manufacturer's instructions. 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).

Section 2.2

Combustion Safety

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

Section 2.2a

Oil and Gas Appliances

The Code 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 (Chapters 5 in both the 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 Code and therefore apply regardless of whether a particular locality has adopted the oil and gas codes.

The Code specifically states that all new homes built in accordance with the Code 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, **the Code prohibits taking that air from 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 appli-

ances (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), the combustion and dilution air requirements for oil and gas appliances do not apply.

Section 2.2b

Solid-Fuel Appliances

Solid-fuel appliances must have tight-fitting metal, glass or ceramic doors. Exception: Any home certified to have passed the Canadian General Standards Board 51.71 "Spillage Test" is not required to have tight-fitting doors. The CGSB Spillage Test creates a "worst-case" condition to determine whether the appliances can vent properly even with the house closed tight and all the exhaust equipment running.

In most cases, solid-fuel appliances must have ducted combustion air from outdoors. This exterior air intake:

- ★ Must not be located within the garage or basement.
- ★ Must not be located higher than the firebox.
- ★ Must be screened with ¼" mesh.
- ★ Can be in the sides or back of the firebox, or within 24 inches of the firebox opening on or near the floor.
- ★ Must be closable and designed to prevent combustible material from dropping into concealed combustible spaces.
- ★ Must be constructed of noncombustible, corrosion-resistant material, with a minimum 1-inch clearance to combustibles for all parts of the duct within 5 feet of the firebox.
- ★ Must be a minimum of 6 square inches and not more than 55 square inches.

Exception: Factory-built fireplaces, masonry fireplaces, and solid-fuel-burning appliances that list exterior air supply ducts as optional or required for proper installation are permitted to be installed with those exterior air supply ducts according to the manufacturer's installation instructions.

This chapter explains how to calculate:

- ★ Glazing percentages
- ★ Average R-values
- ★ Average U-values.

Chapter 3

Guidelines for Calculations

Some calculations must be performed in order to determine technical compliance with the Vermont Energy Code. In order to use either of the two simplest compliance paths — the Fast-Track and Trade-Off methods — you must determine the glazing percentage. Also, depending on the design, you may need to calculate average R-values or U-values for one or more building components.

Section 3.1

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 Performance Requirements for the compliance method 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 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, U-values or heating system AFUE have changed, you will need to review your calculations in order to determine whether the building meets the Performance Requirements.

Section 3.2

How to Define the Building Envelope

The thermal requirements of the 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. 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 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 A, "Definitions," for more information.

A space is "**conditioned**" if heating and/or cooling is deliberately supplied to it or is indirectly supplied through uninsulated surfaces of water or heating equipment, through uninsulated ducts, or though adjacent uninsulated building surfaces. Basements and crawl spaces without ceiling insulation are considered conditioned space.

Section 3.3

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)

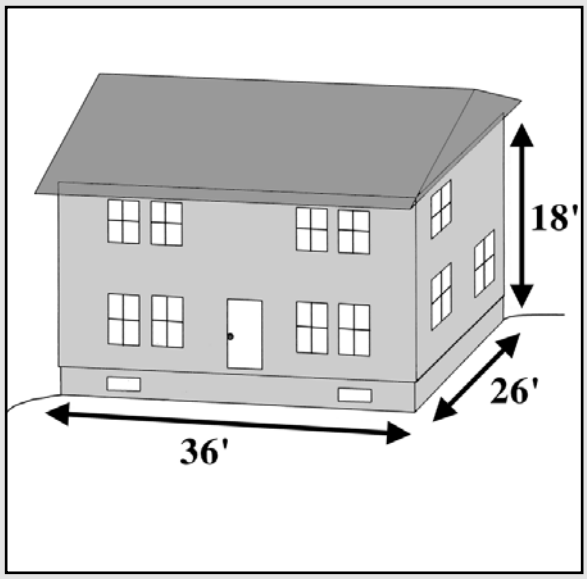
3. Calculate the Glazing Percentage.

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

(Glazing Area / Gross Wall Area) x 100 = 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 Energy Code. Since he plans to use either the Fast Track or Trade-Off 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.

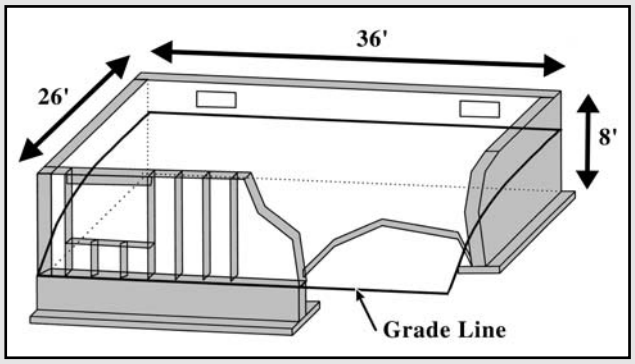
Example A: House with a Standard Basement

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 Area ..... 258 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 determines whether this new design will comply with the 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' x 8' high = 288 sq. ft.
2. Glazing Area: 258 + 60 = 318 sq. ft.
3. Glazing Percentage: (318 / 2,520) x 100 = 12.6%

Section 3.4

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-value*.

Section 3.4a

R-value

R-values are specified in the Energy Code 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.

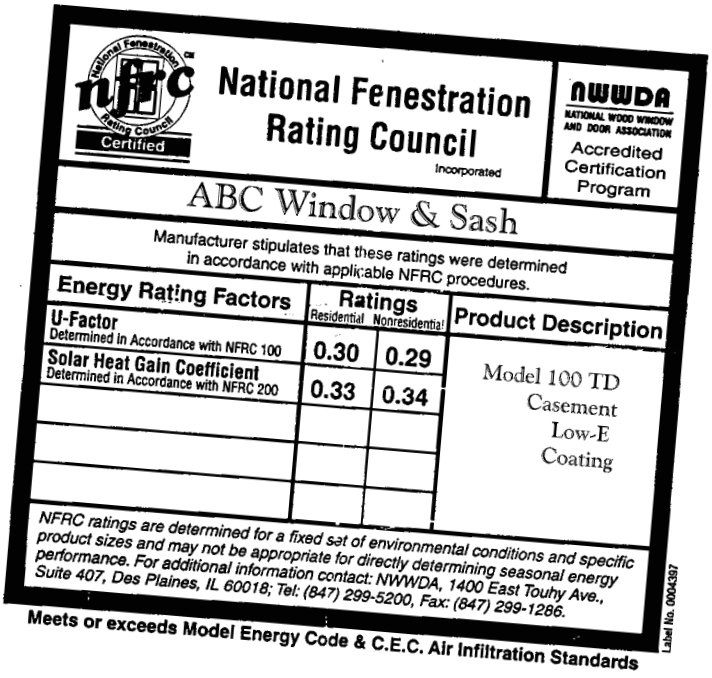
Use the nominal R-values as listed by the manufacturer on the packaging of the insulation for determining compliance with the Code. (For loose-fill insulation, the R-value per inch of thickness for a given area of coverage is listed on the bag.)

Section 3.4b

U-value

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-value = 1/R-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 3.5

How to Calculate Average R-values and U-values

Section 3.5a

Average R-values

If a home has two different types of thermal values for a single component (such as an R-30 and an R-49 flat ceiling) and you want to use the Fast-Track or Trade-Off 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-value. (U-value = 1/R)
3. Determine the area of this portion of the building component in square feet.
4. Multiply the U-value 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

Let's say one-half of your attic is R-30 and the other half is R-49. The total attic area is 1,000 square feet. The average R-value is calculated at 37.7.

Description	R-value	U-value (1/R-value)	Area	U-value x Area "UA"
Attic 1	30	.033	500	16.50
Attic 2	49	.02	500	10.00
			Total Area = 1000	Total UA = 26.5
			Area / UA = Average R-value 1000 / 26.5 = **37.7**	

Area / UA = R-value

Section 3.5b

Average U-values

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

Example: Determining the Average Window U-value

Let's say that you have two skylights (U-value .50), 16 low-E windows (U-value .35) and a low-E/argon gas patio door (U-value .30). The average U-value is calculated to be .35.

Description	R-value	U-value (1/R-value)	Area	U-value x Area "UA"
Skylights		.50	16	8.0
Windows		.35	240	84.0
Patio Door		.30	40	12.0
			Total Area = 296	Total UA = 104.0
			UA / Area = Average U-value 104.0 / 296 = **.35**	

UA/Area = U-value

1. Note the description and U-value of each of the parts.
2. Determine the area of this portion of the building component in square feet.
3. Multiply the U-value 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-value**.

The Fast-Track method is the easiest way to ensure compliance with the Energy Code. This chapter reviews:

★ Homes eligible for the Fast-Track Method

★ When and how to use the Fast-Track Method

★ Fast-Track Performance Requirements

Chapter 4

The Fast-Track Compliance Method

The Fast-Track Method is a simple way to compare your home's thermal and efficiency values to values that meet the Energy Code. There are three components to the Energy Code's technical requirement that must be evaluated for each home: the ***Basic Requirements*** (see inside front cover); the ***Ventilation Requirements*** (see Chapter 2); and the ***Performance Requirements*** (see tables in this chapter). Your home meets the Energy Code if the thermal and efficiency values for your home meet or exceed the values for both the *Basic* and the *Performance Requirements*.

There Are Three Components to the Technical Requirement of the Energy Code

In order to meet the technical requirement of the Energy Code, a home must meet or exceed all aspects of:

★ **The Basic Requirements:** a list of fixed requirements (see inside front cover);

★ **The Ventilation Requirements,** as outlined in Chapter 2; and

★ **The Performance Requirements:** requirements that vary based on the compliance method selected.

Section 4.1

When to Use the Fast-Track Method

The Fast-Track method is for homes whose thermal and heating efficiency values ("Performance Requirements") match or exceed those of a predefined package in the Performance Requirements Table for your house type. (Tables begin on page 24.) It can be used for all types of homes *except:*

- ★ homes using metal framing for exterior walls; see VT*check* Software Method *(*Chapter 6) or Home Energy Rating Method (Chapter 7); and
- ★ homes using wood heat as the primary heating system; see Home Energy Rating Method (Chapter 7).

If the values for your home do not meet the values specified in one of the six Fast-Track packages and you do not want to change your design, you can choose another compliance method, such as the Trade-Off Method (Chapter 5), the VT*check* Software Method (Chapter 6) or the Home Energy Rating Method (Chapter 7).

Section 4.2

How to Comply with the Code Using the Fast-Track Method

Take the following steps during the design stage, whenever there are design changes, and upon construction completion:

1. **Review the Basic Requirements** summarized on the inside front cover (or refer to Appendix C for detailed explanations). *Your project must meet all 13 Basic Requirements.*

2. **Follow the Ventilation Requirements**. (See Chapter 2.)

3. **Calculate your home's Glazing Percentage**. (See Section 3.3 if you need help.)

4. **Identify the nominal R- and U-values and AFUE** for the building components for your home using manufacturers' product information. Identify your thermal/efficiency values for every component listed in the Performance Table. If a single building component in your home has two or more different thermal values (i.e., R-30 ceiling and R-49 ceiling), calculate the average R- or U-value. (See Section 3.5 if you need help.)

5. **Select the appropriate Performance Requirements Table** for your project (see sidebar below). Review the six packages listed and choose the package with thermal values closest to those of your home. *Be sure to read the "Table Qualifiers" below the table and verify that your design complies with these conditions.*

6. **Compare the thermal and efficiency values for your home to the package you select**. Keep in mind that:

   - ★ The **R-values** for your home must be *equal to or* ***greater*** than the selected package.
   - ★ The **AFUE** for your heating system must be *equal to or* ***greater*** than the selected package.
   - ★ The **U-values** for your home must be *equal to or* ***less*** than the selected package.
   - ★ The **Glazing Percentage** for your home must be *equal to or* ***less*** than the selected package.

7. **If your home meets or exceeds the requirements** for one of the predefined packages (and also meets the Basic Requirements), the home complies with the Code's technical requirement, and you can proceed to step 8.

   If your home does *not* meet the requirements for one of the predefined packages in the Performance Table, consider whether it is feasible to make a design change. Very often a small modification — such as a heating system with a higher AFUE or windows with a lower U-value — is all that is necessary. If you determine that none of the predefined packages work for you, consider another compliance method (Chapters 5, 6 or 7).

Selecting the Correct Performance Table for the Fast-Track Method

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

★ **Single-family homes**: Detached one- or two-family residential buildings. (Duplexes are considered single-family homes for the purposes of the Code.) *See Table 4–1.*

★ **Log homes:** Homes with exterior walls made of lengths of whole logs, one on top of the other, with the inside and outside surfaces being the opposite sides of the same logs. *See Table 4–2.*

★ **Multifamily homes**: Residential buildings up to 3 stories in height and containing 3 or more attached dwelling units. (Examples: apartments, condos, townhouses, and rowhouses, but *not* hotels and motels.) *See Table 4–3.*

When to Evaluate Using the Fast-Track Method

To ensure Code compliance, compare the appropriate Fast-Track Performance Table with your home:

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

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 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*. 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 Department of Public Service*
   Energy Efficiency Division
   112 State St., Drawer 20
   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.

☞ Fast-Track Tables begin on the next page.

Select the appropriate table (Table 4.1 for single-family homes; Table 4.2 for log homes; or Table 4.3 or for multifamily homes) for your project.

Table 4-1

Performance Requirements

Single-Family Homes ~ *Fast-Track Method*

Component	*Package 1*	*Package 2*	*Package 3*	*Package 4*	*Package 5*	*Package 6*
1. Ceiling Flats & Exposed Floors	R-38	R-38	**R-49**	**R-49**	R-38	R-38
2. Ceiling Slopes	R-30	R-30	R-30	R-30	R-30	R-30
3. Above-Grade Walls	R-19	R-19	R-19	**R-21**	R-19	R-19
4. Floors over Unconditioned Spaces	R-30	R-30	R-30	R-30	R-30	R-30
5. Basement Walls (full height)	R-10	R-10	R-10	R-10	**R-15**	R-10
6. Slab Edge	R-10	R-10	R-10	R-10	**R-15**	R-10
7. Unvented Crawlspace Walls	R-10	R-10	R-10	R-10	**R-15**	R-10
8. Door U-value	.40	.40	.40	.40	.40	.40
9. Basement Window U-value	.60	.60	.60	.60	.60	.60
10. Window U-value	.40 or less	**.34 or less**	**.50 or less**	.40 or less	**.34 or less**	**.34 or less**
11. Heating AFUE	83%	**78% / 80 %**	**87%**	**81%**	**85%**	**84 %**
12. Glazing Percentage	12% or less	12% or less	12% or less	12% or less	**18% or less**	**15% or less**

Note: R-values and AFUE must be *equal to or greater* than the values shown. U-values and glazing percentage must be *equal to or less* than the values shown. Values in **bold** differ from Package 1, the typical package.

Table Qualifiers

These guidelines apply to all "Performance Requirements" tables in this handbook.

A **Thermal Values:** Use the nominal thermal values listed by the manufacturer. If the home's design specifies a component that has two different thermal values (i.e., R-30 ceiling and R-49 ceiling), an average R-value must be calculated for comparison. (See Section 3.5a.)

B **Window U-value:** Window U-value is the average U-value for all (non-basement) glazing, including windows, skylights, and sliding and patio doors. (See Section 3.5b to calculate average U-values.)

C **Window and Door Exemptions:** You can exclude up to 1% of the glazing area from the calculation of average U-value for windows, and one door from the calculation of average U-value for doors.

D **Default Thermal Values:** See Appendix B. Flat and sloped ceiling R-values assume "Raised truss" or equivalent as shown in Figure B-1 (Appendix B). If R-values are not maintained across the top of exterior walls, refer to Table B-4 (Appendix B) for equivalent R-values.

E **Slab Edge, Crawlspace & Basement Insulation:** Thermal values in this table require the following configurations: slab edge insulation must extend 4' or a combination of depth and width that equals 4'; crawlspace wall insulation must cover the full height of the wall and extend to a depth 12" below grade; and basement wall insulation must cover the full height of the basement wall.

F **Hatches:** R-values in this table require that all hatches between conditioned and unconditioned space are insulated to a minimum of R-19 and weatherstripped or sealed to prevent air leakage.

G **Minimum Efficiency:** "78% / 80%" indicates that 78% is the minimum AFUE for furnaces and 80% is the minimum AFUE for boilers (federal minimum standards).

H **Exposed Floors:** Insulate exposed floors (i.e., all floors exposed directly to the outside) to the values shown for ceiling flats.

I **Unconditioned Spaces:** Components that enclose unconditioned spaces do not need to be considered.

J **Thermal Values That Do Not Apply:** Ignore the values in the table if the building component is not part of the home (i.e., if there are no sloped ceilings, ignore the values).

Table 4-2

Performance Requirements

Log Homes ~ *Fast-Track Method*

Component	*Package 1*	*Package 2*	*Package 3*	*Package 4*	*Package 5*	*Package 6*
1. Ceiling Flats & Exposed Floors	R-38	R-38	**R-49**	**R-49**	R-38	R-38
2. Ceiling Slopes	R-30	R-30	R-30	R-30	R-30	R-30
3. Above-Grade Walls	Log	Log	Log	Log	Log	Log
4. Floors over Unconditioned Spaces	R-30	R-30	R-30	R-30	R-30	R-30
5. Basement Walls (full height)	R-10	**R-15**	R-10	R-10	**R-15**	R-10
6. Slab Edge	R-10	**R-15**	R-10	R-10	**R-15**	R-10
7. Unvented Crawlspace Walls	R-10	**R-15**	R-10	R-10	**R-15**	R-10
8. Door U-value	.40	.40	.40	.40	.40	.40
9. Basement Window U-value	.60	.60	.60	.60	.60	.60
10. Window U-value	.40 or less	**.30 or less**	**.50 or less**	.40 or less	.40 or less	**.30 or less**
11. Heating AFUE	86%	**81%**	**87%**	**85%**	**84%**	**84 %**
12. Glazing Percentage	12% or less	12% or less	12% or less	12% or less	12% or less	**15% or less**

Note: R-values and AFUE must be *equal to or greater* than the values shown. U-values and glazing percentage must be *equal to or less* than the values shown. Values in **bold** differ from Package 1, the typical package.

Table Qualifiers

These guidelines apply to all "Performance Requirements" tables in this handbook.

A **Thermal Values:** Use the nominal thermal values listed by the manufacturer. If the home's design specifies a component that has two different thermal values (i.e., R-30 ceiling and R-49 ceiling), an average R-value must be calculated for comparison. (See Section 3.5a.)

B **Window U-value:** Window U-value is the average U-value for all (non-basement) glazing, including windows, skylights, and sliding and patio doors. (See Section 3.5b to calculate average U-values.)

C **Window and Door Exemptions:** You can exclude up to 1% of the glazing area from the calculation of average U-value for windows, and one door from the calculation of average U-value for doors.

D **Default Thermal Values:** See Appendix B. Flat and sloped ceiling R-values assume "Raised truss" or equivalent as shown in Figure B-1 (Appendix B). If R-values are not maintained across the top of exterior walls, refer to Table B-4 (Appendix B) for equivalent R-values.

E **Slab Edge, Crawlspace & Basement Insulation:** Thermal values in this table require the following configurations: slab edge insulation must extend 4' or a combination of depth and width that equals 4'; crawlspace wall insulation must cover the full height of the wall and extend to a depth 12" below grade; and basement wall insulation must cover the full height of the basement wall.

F **Hatches:** R-values in this table require that all hatches between conditioned and unconditioned space are insulated to a minimum of R-19 and weatherstripped or sealed to prevent air leakage.

G **Minimum Efficiency:** "78% / 80%" indicates that 78% is the minimum AFUE for furnaces and 80% is the minimum AFUE for boilers (federal minimum standards).

H **Exposed Floors:** Insulate exposed floors (i.e., all floors exposed directly to the outside) to the values shown for ceiling flats.

I **Unconditioned Spaces:** Components that enclose unconditioned spaces do not need to be considered.

J **Thermal Values That Do Not Apply:** Ignore the values in the table if the building component is not part of the home (i.e., if there are no sloped ceilings, ignore the values).

Table 4-3

Performance Requirements

Multifamily Homes ~ *Fast-Track Method*

Component	*Package 1*	*Package 2*	*Package 3*	*Package 4*	*Package 5*	*Package 6*
1. Ceiling Flats & Exposed Floors	R-38	R-38	R-38	R-38	R-38	**R-49**
2. Ceiling Slopes	R-30	R-30	R-30	R-30	R-30	R-30
3. Above-Grade Walls	R-19	R-19	R-19	R-19	R-19	**R-21**
4. Floors over Unconditioned Spaces	R-30	R-30	R-30	R-30	R-30	R-30
5. Basement Walls (full height)	R-10	R-10	R-10	R-10	**R-15**	R-10
6. Slab Edge	R-10	R-10	R-10	R-10	**R-15**	R-10
7. Unvented Crawlspace Walls	R-10	R-10	R-10	R-10	**R-15**	R-10
8. Door U-value	.40	.40	.40	.40	.40	.40
9. Basement Window U-value	.60	.60	.60	.60	.60	.60
10. Window U-value	.40 or less	**.36 or less**	**.34 or less**	**.30 or less**	.40 or less	.40 or less
11. Heating AFUE	82%	**78% / 80 %**	**84%**	**85%**	**84%**	**85 %**
12. Glazing Percentage	15% or less	15% or less	**20% or less**	**25% or less**	**20% or less**	**20% or less**

Note: R-values and AFUE must be *equal to or greater* than the values shown. U-values and glazing percentage must be *equal to or less* than the values shown. Values in **bold** differ from Package 1, the typical package.

Table Qualifiers

These guidelines apply to all "Performance Requirements" tables in this handbook.

A **Thermal Values:** Use the nominal thermal values listed by the manufacturer. If the home's design specifies a component that has two different thermal values (i.e., R-30 ceiling and R-49 ceiling), an average R-value must be calculated for comparison. (See Section 3.5a.)

B **Window U-value:** Window U-value is the average U-value for all (non-basement) glazing, including windows, skylights, and sliding and patio doors. (See Section 3.5b to calculate average U-values.)

C **Window and Door Exemptions:** You can exclude up to 1% of the glazing area from the calculation of average U-value for windows, and one door from the calculation of average U-value for doors.

D **Default Thermal Values:** See Appendix B. Flat and sloped ceiling R-values assume "Raised truss" or equivalent as shown in Figure B-1 (Appendix B). If R-values are not maintained across the top of exterior walls, refer to Table B-4 (Appendix B) for equivalent R-values.

E **Slab Edge, Crawlspace & Basement Insulation:** Thermal values in this table require the following configurations: slab edge insulation must extend 4' or a combination of depth and width that equals 4'; crawlspace wall insulation must cover the full height of the wall and extend to a depth 12" below grade; and basement wall insulation must cover the full height of the basement wall.

F **Hatches:** R-values in this table require that all hatches between conditioned and unconditioned space are insulated to a minimum of R-19 and weatherstripped or sealed to prevent air leakage.

G **Minimum Efficiency:** "78% / 80%" indicates that 78% is the minimum AFUE for furnaces and 80% is the minimum AFUE for boilers (federal minimum standards).

H **Exposed Floors:** Insulate exposed floors (i.e., all floors exposed directly to the outside) to the values shown for ceiling flats.

I **Unconditioned Spaces:** Components that enclose unconditioned spaces do not need to be considered.

J **Thermal Values That Do Not Apply:** Ignore the values in the table if the building component is not part of the home (i.e., if there are no sloped ceilings, ignore the values).

The Trade–Off Method is a simple method of Code compliance that accommodates a variety of building designs. This chapter reviews:

- ★ When and how to use the Trade–Off Method
- ★ How high efficiency values in one component can compensate for lower efficiency values in another component
- ★ Trade–Off Performance Requirements

Chapter 5

The Trade–Off Compliance Method

The Trade-Off Method for meeting the technical requirements of the Energy Code allows more flexibility than the Fast-Track Method. As the name implies, you can "trade off" one component for another. For example, you might decide to install more efficient windows instead of a more efficient heating system.

The Trade-Off Method accommodates multiple designs through the use of "Trade-Off Tables." It requires minimal calculations and involves choosing one of six packages. If the thermal and efficiency values for your home *meet or surpass* all the Performance Requirements for the package you select, and the home meets all the Basic Requirements, the home complies with the Energy Code.

There Are Three Components to the Technical Requirement of the Energy Code

In order to meet the technical requirement of the Energy Code, a home must meet or exceed all aspects of:

- ★ **The Basic Requirements:** a list of fixed requirements (see inside front cover);
- ★ **The Ventilation Requirements,** as outlined in Chapter 2; and
- ★ **The Performance Requirements:** requirements that vary based on the pre-defined compliance packages when using the Trade–Off method (see Tables 5–1, 5–2 and 5–3).

Section 5.1

When to Use the Trade–Off Method

The Trade-Off Method is for homes whose thermal and efficiency values match or exceed the values for a pre-defined package that meets the Code. In addition, the Trade-Off Method can accommodate home designs for a wide range of window U-values, glazing percentages, and heating AFUEs. In this method, if one of these components is preventing the home from complying and cannot be changed, it is possible to specify a higher efficiency for one of the other two components, thereby bringing the home into compliance with the Code.

If your design doesn't fit the Fast Track Method, there is a good chance the Trade-Off Method will work. The Trade-Off Method can be used for all types of homes *except:*

- ★ homes using metal framing for exterior walls; see VT*check* Software Method *(*Chapter 6) or Home Energy Rating Method (Chapter 7); and
- ★ homes using wood heat as the primary heating system; see Home Energy Rating Method (Chapter 7).

If one of the packages in the Trade-Off tables doesn't work for you and you don't want to change your design, consider another compliance method, such as the VT*check* Software Method (Chapter 6) or the Home Energy Rating Method (Chapter 7).

Section 5.2

How to Comply with the Code Using the Trade-Off Method

The following steps should be followed at the design stage, when there are design changes, and upon construction completion:

1. **Review the Basic Requirements** summarized on the inside front cover (or refer to Appendix C for detailed explanations). *Your project must meet all 13 Basic Requirements.*
2. **Follow the Ventilation Requirements**. (See Chapter 2.)
3. **Calculate your home's Glazing Percentage**. (See Section 3.3 if you need help.)
4. **Identify the nominal R- and U-values and AFUE** for the building components for your home using manufacturers' product information. Identify your thermal/efficiency values for every component listed in the Performance Table. If a single building component in your home has two or more different thermal values (i.e., R-30 ceiling and R-49 ceiling), calculate the average R- or U-value. (See Section 3.5 if you need help.)
5. **Select the appropriate Performance Requirements Table** for your project (see sidebar below). Review the packages listed (there are up to six of them depending on the home type) and choose the package with thermal values that are met or exceeded by your home. *Be sure to read the "Table Qualifiers" below the table and verify that your design complies with these conditions.*
6. **Compare the thermal and efficiency values for your home to the package you select**. Keep in mind that:
   - ★ The **R-values** for your home must be *equal to or* ***greater*** than the selected package.
   - ★ The **AFUE** for your heating system must be *equal to or* ***greater*** than the selected package.
   - ★ The **U-values** for your home must be *equal to or* ***less*** than the selected package.
   - ★ The **Glazing Percentage** for your home must be *equal to or* ***less*** than the selected package.
7. **Determine Which Trade-Off Table to Use** (see the page following the Performance Table) For each package in the Performance Table, a Trade-Off Table is identified on row 10. For example, for Package 1 in the *Performance Requirements Table for Single-Family Homes*, (page 30), you would reference Table 5-1a on the facing page for minimum window U-value, glazing percentage, and AFUE .
8. **Determine the third "Trade-Off Value"** when you know the other two values. (See "How to Use the Trade-Off Tables" accompanying each set of tables on pages 31, 33 and 35.)
9. **If your home meets or exceeds the requirements** for:
   - ★ a package in the Performance Requirements Table, *and*

Selecting the Correct Performance Table for the Trade-Off Method

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

★ **Single-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 exterior walls made of lengths of whole logs, one on top of the other, with the inside and outside surfaces being the opposite sides of the same logs. *See Table 5-2.*

★ **Multifamily homes**: Residential buildings up to 3 stories in height and containing 3 or more attached dwelling units. (Examples: apartments, condos, townhouses, and rowhouses, but *not* hotels and motels.) *See Table 5-3.*

When to Evaluate with the Trade-Off Method

To ensure Code compliance, compare the Trade-Off Performance Table with your home:

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

- ★ the values identified in the corresponding Trade-Off Table, *and*
- ★ the Basic Requirements (summarized on the inside front cover; detailed in Appendix C)

...then the home complies with the Code's technical requirement, and you can proceed to step 10.

If your home does not equal or exceed any of the combinations that meet the Code, you may wish to consider a design change. Very often a small modification — such as a heating system with a higher AFUE or windows with a lower U-value — is all that is necessary. If you determine that a design change is not feasible, you may wish to consider one of the other two compliance methods (see Chapters 6 and 7).

10. **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 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*. 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 Department of Public Service*
      Energy Efficiency Division
      112 State St., Drawer 20
      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.

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

☞ Trade-Off Performance Tables begin on the next page.

Select the appropriate table (Table 5.1 for single-family homes; Table 5.2 for log homes; or Table 5.3 or for multifamily homes) for your project.

Table 5-1

Performance Requirements

Single-Family Homes ~ *Trade-Off Method*

Component	*Package 1*	*Package 2*	*Package 3*	*Package 4*	*Package 5*	*Package 6*
1. Ceiling Flats & Exposed Floors	R-38	R-38	**R-49**	**R-49**	R-38	R-38
2. Ceiling Slopes	**R-30**	**R-30**	**R-30**	**R-30**	**R-30**	**R-30**
3. Above-Grade Walls	R-19	**R-21**	R-19	**R-21**	R-19	**R-21**
4. Floors over Unconditioned Spaces	**R-30**	**R-30**	**R-30**	**R-30**	**R-30**	**R-30**
5. Basement Walls (full height)	R-10	R-10	R-10	R-10	**R-15**	**R-15**
6. Slab Edge	**R-10**	**R-10**	**R-10**	**R-10**	**R-15**	**R-15**
7. Unvented Crawlspace Walls	R-10	R-10	R-10	R-10	**R-15**	**R-15**
8. Door U-value	**.40**	**.40**	**.40**	**.40**	**.40**	**.40**
9. Basement Window U-value	.60	.60	.60	.60	.60	.60
10. Window U-value	*See* ***Table 5-1a*** *(Package 1) on next page*	*See* ***Table 5-1b*** *(Package 2 and 3) on next page*		*See* ***Table 5-1c*** *(Package 4) on next page*	*See* ***Table 5-1d*** *(Package 5) on next page*	*See* ***Table 5-1e*** *(Package 6) on next page*
11. Heating AFUE						
12. Glazing Percentage						

Note: R-values and AFUE must be *equal to or greater* than the values shown. U-values and glazing percentage must be *equal to or less* than the values shown. Values in **bold** differ from Package 1, the typical package.

Table Qualifiers

These guidelines apply to all "Performance Requirements" tables in this handbook.

A **Thermal Values:** Use the nominal thermal values listed by the manufacturer. If the home's design specifies a component that has two different thermal values (i.e., R-30 ceiling and R-49 ceiling), an average R-value must be calculated for comparison. (See Section 3.5a.)

B **Window U-value:** Window U-value is the average U-value for all (non-basement) glazing, including windows, skylights, and sliding and patio doors. (See Section 3.5b to calculate average U-values.)

C **Window and Door Exemptions:** You can exclude up to 1% of the glazing area from the calculation of average U-value for windows, and one door from the calculation of average U-value for doors.

D **Default Thermal Values:** See Appendix B. Flat and sloped ceiling R-values assume "Raised truss" or equivalent as shown in Figure B-1 (Appendix B). If R-values are not maintained across the top of exterior walls, refer to Table B-4 (Appendix B) for equivalent R-values.

E **Slab Edge, Crawlspace & Basement Insulation:** Thermal values in this table require the following configurations: slab edge insulation must extend 4' or a combination of depth and width that equals 4'; crawlspace wall insulation must cover the full height of the wall and extend to a depth 12" below grade; and basement wall insulation must cover the full height of the basement wall.

F **Hatches:** R-values in this table require that all hatches between conditioned and unconditioned space are insulated to a minimum of R-19 and weatherstripped or sealed to prevent air leakage.

G **Minimum Efficiency:** "78% / 80%" indicates that 78% is the minimum AFUE for furnaces and 80% is the minimum AFUE for boilers (federal minimum standards).

H **Exposed Floors:** Insulate exposed floors (i.e., all floors exposed directly to the outside) to the values shown for ceiling flats.

I **Unconditioned Spaces:** Components that enclose unconditioned spaces do not need to be considered.

J **Thermal Values That Do Not Apply:** Ignore the values in the table if the building component is not part of the home (i.e., if there are no sloped ceilings, ignore the values).

Use this table in conjunction with one of the Trade-Off tables on the facing page, choosing the Trade-Off table that matches the compliance package you have selected.

Table 5-1a

Single-Family Trade-Off ~ *Package 1*

Max. Glazing %	*Minimum AFUE*												
18%	85	86	88	90	91								
17%	84	85	87	89	90	91	92						
16%	82	84	86	87	88	89	90	92					
15%	81	83	84	85	87	88	89	90	91	92			
14%	M	81	83	84	85	86	87	88	89	90	92		
13%	M	M	81	82	84	85	86	87	88	89	90	92	
12%	M	M	M	81	82	83	84	85	86	87	88	89	
	.30	**.32**	**.34**	**.36**	**.38**	**.40**	**.42**	**.44**	**.46**	**.48**	**.50**	**.52**	

Maximum Average Window U-value

Table 5-1b

Single-Family Trade-Off ~ *Packages 2 and 3*

Max. Glazing %	*Minimum AFUE*												
18%	84	85	87	89	90	92							
17%	83	84	86	88	89	90	91						
16%	82	83	85	86	87	88	89	91					
15%	M	82	83	84	86	87	88	89	90	91			
14%	M	M	82	83	84	85	86	87	88	89	91		
13%	M	M	M	81	83	84	85	86	87	88	89	91	
12%	M	M	M	M	81	82	83	84	85	86	87	88	
	.30	**.32**	**.34**	**.36**	**.38**	**.40**	**.42**	**.44**	**.46**	**.48**	**.50**	**.52**	

Maximum Average Window U-value

Table 5-1c

Single-Family Trade-Off ~ *Package 4*

Max. Glazing %	*Minimum AFUE*												
18%	83	84	86	88	89	91	92						
17%	82	83	85	87	88	89	90	92					
16%	M	82	84	85	86	87	89	90	92				
15%	M	81	82	83	85	86	88	88	89	90	92		
14%	M	M	81	82	83	84	85	86	87	89	90	92	
13%	M	M	M	M	82	83	84	85	86	87	89	90	
12%	M	M	M	M	M	81	82	83	84	86	86	87	
	.30	**.32**	**.34**	**.36**	**.38**	**.40**	**.42**	**.44**	**.46**	**.48**	**.50**	**.52**	

Maximum Average Window U-value

Table 5-1d

Single-Family Trade-Off ~ *Package 5*

Max. Glazing %	*Minimum AFUE*												
18%	82	83	85	87	89	90	91						
17%	81	82	84	86	87	88	89	91					
16%	M	81	83	84	85	86	87	89	91				
15%	M	M	81	82	84	85	86	87	88	89	91		
14%	M	M	M	81	82	84	84	85	86	87	89	91	
13%	M	M	M	M	81	82	83	84	85	86	87	89	
12%	M	M	M	M	M	M	81	82	83	84	85	86	
	.30	**.32**	**.34**	**.36**	**.38**	**.40**	**.42**	**.44**	**.46**	**.48**	**.50**	**.52**	

Maximum Average Window U-value

Table 5-1e

Single-Family Trade-Off ~ *Package 6*

Max. Glazing %	*Minimum AFUE*												
18%	81	82	84	86	87	89	91	92					
17%	M	81	83	85	86	87	88	90	92				
16%	M	M	82	83	84	85	86	88	90	92			
15%	M	M	M	81	83	84	85	86	87	88	90	92	
14%	M	M	M	M	81	82	83	84	85	96	88	90	
13%	M	M	M	M	M	81	82	83	84	85	86	88	
12%	M	M	M	M	M	M	M	81	82	83	84	85	
	.30	**.32**	**.34**	**.36**	**.38**	**.40**	**.42**	**.44**	**.46**	**.48**	**.50**	**.52**	

Maximum Average Window U-value

Trade–Off Tables for Single–Family Homes

How to Use the Trade–Off Tables

1. **Calculate the glazing percentage.** If the calculation results in a number that is between the values listed in the table, use the higher value in the table (e.g., use 13% if your calculated percentage is 12.3%). *See Section 3.3 for details.*

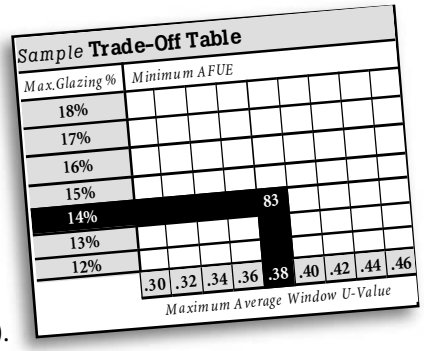
2. **Determine the window U-value.** If the window U-value as listed by the manufacturer is between the values listed in the table, use the higher value in the table (e.g., use .40 if the listed U-value is .39). *See Sections 3.4 and 3.5 for details.*

3. **Refer to the appropriate table for the compliance package you have selected.**

4. **Determine the unknown value.** The tables contain values for three building components: glazing percentage, window U-value, and heating AFUE. If you know the values of two components, you can identify the value of the third component.

   Example A: *Using the sample table below, find the AFUE when the glazing percentage = 14% and the window U-value = 0.38:* Enter the table from the left at the row representing the 14% glazing percentage. Travel right, stopping at the column where the window U-value is 0.38. The number at the intersection shows the minimum AFUE (83 in the sample table below) you can use.

   Example B: *Again using the sample table, find the U-value when the glazing percentage = 14% and the AFUE = 83:* Enter the table from the left at the row representing the 14% glazing percentage. Travel right, stopping at the column listing "83." Move down to the bottom row to read the minimum U-value (.38).



M = minimum AFUE
(78% for furnaces; 80% for boilers)

Performance Requirements

Log Homes ~ *Trade-Off Method*

Component	*Package 1*	*Package 2*	*Package 3*	*Package 4*
1. Ceiling Flats & Exposed Floors	R-38	**R-49**	R-38	**R-49**
2. Ceiling Slopes	**R-30**	**R-30**	**R-30**	**R-30**
3. Above-Grade Walls	Log	Log	Log	Log
4. Floors over Unconditioned Spaces	**R-30**	**R-30**	**R-30**	**R-30**
5. Basement Walls (full height)	R-10	R-10	**R-15**	**R-15**
6. Slab Edge	**R-10**	**R-10**	**R-15**	**R-15**
7. Unvented Crawlspace Walls	R-10	R-10	**R-15**	**R-15**
8. Door U-value	**.40**	**.40**	**.40**	**.40**
9. Basement Window U-value	.60	.60	.60	.60
10. Window U-value 11. Heating AFUE 12. Glazing Percentage	*See **Table 5-2a** (Package 1) on next page*	*See **Table 5-2b** (Package 2) on next page*	*See **Table 5-2c** (Package 3) on next page*	*See **Table 5-2d** (Package 4) on next page*

Note: R-values and AFUE must be *equal to or greater* than the values shown. U-values and glazing percentage must be *equal to or less* than the values shown. Values in **bold** differ from Package 1, the typical package.

Table Qualifiers

These guidelines apply to all "Performance Requirements" tables in this handbook.

A **Thermal Values:** Use the nominal thermal values listed by the manufacturer. If the home's design specifies a component that has two different thermal values (i.e., R-30 ceiling and R-49 ceiling), an average R-value must be calculated for comparison. (See Section 3.5a.)

B **Window U-value:** Window U-value is the average U-value for all (non-basement) glazing, including windows, skylights, and sliding and patio doors. (See Section 3.5b to calculate average U-values.)

C **Window and Door Exemptions:** You can exclude up to 1% of the glazing area from the calculation of average U-value for windows, and one door from the calculation of average U-value for doors.

D **Default Thermal Values:** See Appendix B. Flat and sloped ceiling R-values assume "Raised truss" or equivalent as shown in Figure B-1 (Appendix B). If R-values are not maintained across the top of exterior walls, refer to Table B-4 (Appendix B) for equivalent R-values.

E **Slab Edge, Crawlspace & Basement Insulation:** Thermal values in this table require the following configurations: slab edge insulation must extend 4' or a combination of depth and width that equals 4'; crawlspace wall insulation must cover the full height of the wall and extend to a depth 12" below grade; and basement wall insulation must cover the full height of the basement wall.

F **Hatches:** R-values in this table require that all hatches between conditioned and unconditioned space are insulated to a minimum of R-19 and weatherstripped or sealed to prevent air leakage.

G **Minimum Efficiency:** "78% / 80%" indicates that 78% is the minimum AFUE for furnaces and 80% is the minimum AFUE for boilers (federal minimum standards).

H **Exposed Floors:** Insulate exposed floors (i.e., all floors exposed directly to the outside) to the values shown for ceiling flats.

I **Unconditioned Spaces:** Components that enclose unconditioned spaces do not need to be considered.

J **Thermal Values That Do Not Apply:** Ignore the values in the table if the building component is not part of the home (i.e., if there are no sloped ceilings, ignore the values).

Use this table in conjunction with one of the Trade-Off tables on the facing page, choosing the Trade-Off table that matches the compliance package you have selected.

Table 5-2a

Log Home Trade-Off ~ *Package 1*

Max. Glazing %	*Minimum AFUE*												
18%	87	88	89	90	91	92							
17%	86	87	88	89	90	91	92						
16%	85	86	87	88	89	90	91	92					
15%	84	85	86	87	88	89	90	91	92				
14%	83	84	85	86	87	88	89	90	91	92			
13%	82	83	84	85	86	87	88	89	90	91	92		
12%	81	82	83	84	85	86	87	88	89	90	91	92	
	.30	**.32**	**.34**	**.36**	**.38**	**.40**	**.42**	**.44**	**.46**	**.48**	**.50**	**.52**	

Maximum Average Window U-value

Table 5-2b

Log Home Trade-Off ~ *Package 2*

Max. Glazing %	*Minimum AFUE*												
18%	86	87	88	89	90	91	92						
17%	85	86	87	88	89	90	91	92					
16%	84	85	86	87	88	89	90	91	92				
15%	83	84	85	86	87	88	89	90	91	92			
14%	82	83	84	85	86	87	88	89	90	91	92		
13%	81	82	83	84	85	86	87	88	89	90	91	92	
12%	M	81	82	83	84	85	86	87	88	89	90	91	
	.30	**.32**	**.34**	**.36**	**.38**	**.40**	**.42**	**.44**	**.46**	**.48**	**.50**	**.52**	

Maximum Average Window U-value

Table 5-2c

Log Home Trade-Off ~ *Package 3*

Max. Glazing %	*Minimum AFUE*												
18%	85	87	87	88	89	90	91						
17%	84	86	86	87	88	89	90	91	92				
16%	83	84	85	86	87	88	89	90	91				
15%	82	83	84	85	86	87	88	89	90	91	92		
14%	81	82	83	84	85	86	87	88	89	90	91	92	
13%	M	81	82	83	84	85	86	87	88	89	90	91	
12%	M	M	81	82	83	84	85	86	87	88	89	90	
	.30	**.32**	**.34**	**.36**	**.38**	**.40**	**.42**	**.44**	**.46**	**.48**	**.50**	**.52**	

Maximum Average Window U-value

Table 5-2d

Log Home Trade-Off ~ *Package 4*

Max. Glazing %	*Minimum AFUE*												
18%	84	85	86	87	88	89	90	92					
17%	83	84	85	86	87	88	89	90	91				
16%	85	83	84	85	86	87	88	89	90	92			
15%	81	82	83	84	85	86	87	88	89	90	91	92	
14%	M	81	82	83	84	85	86	87	88	89	90	91	
13%	M	M	81	82	83	84	85	86	87	88	89	90	
12%	M	M	M	81	82	83	84	85	86	87	88	89	
	.30	**.32**	**.34**	**.36**	**.38**	**.40**	**.42**	**.44**	**.46**	**.48**	**.50**	**.52**	

Maximum Average Window U-value

Trade-Off Tables for Log Homes

How to Use the Trade-Off Tables

1. **Calculate the glazing percentage.** If the calculation results in a number that is between the values listed in the table, use the higher value in the table (e.g., use 13% if your calculated percentage is 12.3%). *See Section 3.3 for details.*

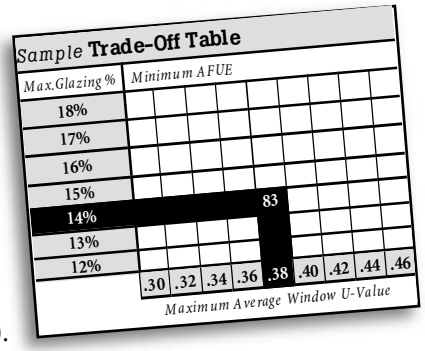
2. **Determine the window U-value.** If the window U-value as listed by the manufacturer is between the values listed in the table, use the higher value in the table (e.g., use .40 if the listed U-value is .39). *See Sections 3.4 and 3.5 for details.*

3. **Refer to the appropriate table for the compliance package you have selected.**

4. **Determine the unknown value.** The tables contain values for three building components: glazing percentage, window U-value, and heating AFUE. If you know the values of two components, you can identify the value of the third component.

   Example A: *Using the sample table below, find the AFUE when the glazing percentage = 14% and the window U-value = 0.38:* Enter the table from the left at the row representing the 14% glazing percentage. Travel right, stopping at the column where the window U-value is 0.38. The number at the intersection shows the minimum AFUE (83 in the sample table below) you can use.

   Example B: *Again using the sample table, find the U-value when the glazing percentage = 14% and the AFUE = 83:* Enter the table from the left at the row representing the 14% glazing percentage. Travel right, stopping at the column listing "83." Move down to the bottom row to read the minimum U-value (.38).



M = minimum AFUE
(78% for furnaces; 80% for boilers)

Table 5-3

Performance Requirements

Multifamily Homes ~ *Trade-Off Method*

Component	*Package 1*	*Package 2*	*Package 3*	*Package 4*	*Package 5*	*Package 6*
1. Ceiling Flats & Exposed Floors	R-38	R-38	**R-49**	**R-49**	R-38	R-38
2. Ceiling Slopes	**R-30**	**R-30**	**R-30**	**R-30**	**R-30**	**R-30**
3. Above-Grade Walls	R-19	**R-21**	R-19	**R-21**	R-19	**R-21**
4. Floors over Unconditioned Spaces	**R-30**	**R-30**	**R-30**	**R-30**	**R-30**	**R-30**
5. Basement Walls (full height)	R-10	R-10	R-10	R-10	**R-15**	**R-15**
6. Slab Edge	**R-10**	**R-10**	**R-10**	**R-10**	**R-15**	**R-15**
7. Unvented Crawlspace Walls	R-10	R-10	R-10	R-10	**R-15**	**R-15**
8. Door U-value	**.40**	**.40**	**.40**	**.40**	**.40**	**.40**
9. Basement Window U-value	.60	.60	.60	.60	.60	.60
10. Window U-value	*See* ***Table 5-3a*** *(Package 1) on next page*	*See* ***Table 5-3b*** *(Package 2 and 3) on next page*		*See* ***Table 5-3c*** *(Package 4) on next page*	*See* ***Table 5-3d*** *(Package 5) on next page*	*See* ***Table 5-3e*** *(Package 6) on next page*
11. Heating AFUE						
12. Glazing Percentage						

Note: R-values and AFUE must be *equal to or greater* than the values shown. U-values and glazing percentage must be *equal to or less* than the values shown. Values in **bold** differ from Package 1, the typical package.

Table Qualifiers

These guidelines apply to all "Performance Requirements" tables in this handbook.

A **Thermal Values:** Use the nominal thermal values listed by the manufacturer. If the home's design specifies a component that has two different thermal values (i.e., R-30 ceiling and R-49 ceiling), an average R-value must be calculated for comparison. (See Section 3.5a.)

B **Window U-value:** Window U-value is the average U-value for all (non-basement) glazing, including windows, skylights, and sliding and patio doors. (See Section 3.5b to calculate average U-values.)

C **Window and Door Exemptions:** You can exclude up to 1% of the glazing area from the calculation of average U-value for windows, and one door from the calculation of average U-value for doors.

D **Default Thermal Values:** See Appendix B. Flat and sloped ceiling R-values assume "Raised truss" or equivalent as shown in Figure B-1 (Appendix B). If R-values are not maintained across the top of exterior walls, refer to Table B-4 (Appendix B) for equivalent R-values.

E **Slab Edge, Crawlspace & Basement Insulation:** Thermal values in this table require the following configurations: slab edge insulation must extend 4' or a combination of depth and width that equals 4'; crawlspace wall insulation must cover the full height of the wall and extend to a depth 12" below grade; and basement wall insulation must cover the full height of the basement wall.

F **Hatches:** R-values in this table require that all hatches between conditioned and unconditioned space are insulated to a minimum of R-19 and weatherstripped or sealed to prevent air leakage.

G **Minimum Efficiency:** "78% / 80%" indicates that 78% is the minimum AFUE for furnaces and 80% is the minimum AFUE for boilers (federal minimum standards).

H **Exposed Floors:** Insulate exposed floors (i.e., all floors exposed directly to the outside) to the values shown for ceiling flats.

I **Unconditioned Spaces:** Components that enclose unconditioned spaces do not need to be considered.

J **Thermal Values That Do Not Apply:** Ignore the values in the table if the building component is not part of the home (i.e., if there are no sloped ceilings, ignore the values).

Use this table in conjunction with one of the Trade-Off tables on the facing page, choosing the Trade-Off table that matches the compliance package you have selected.

Table 5-3a

Multifamily Trade-Off ~ *Package 1*

Max. Glazing %	*Minimum AFUE*												
30%	89	91											
25%	84	86	88	90	92								
20%	82	83	84	85	86	87	88	90	91				
15%	M	M	M	M	81	82	83	84	85	86	87	88	
	.30	**.32**	**.34**	**.36**	**.38**	**.40**	**.42**	**.44**	**.46**	**.48**	**.50**	**.52**	

Maximum Average Window U-value

Table 5-3b

Multifamily Trade-Off ~ *Packages 2 and 3*

Max. Glazing %	*Minimum AFUE*												
30%	88	90											
25%	83	85	87	89	91								
20%	81	82	83	84	85	86	87	89	90				
15%	M	M	M	M	M	81	82	83	84	85	86	88	
	.30	**.32**	**.34**	**.36**	**.38**	**.40**	**.42**	**.44**	**.46**	**.48**	**.50**	**.52**	

Maximum Average Window U-value

Table 5-3c

Multifamily Trade-Off ~ *Package 4*

Max. Glazing %	*Minimum AFUE*												
30%	87	89	91										
25%	82	84	86	88	90	92							
20%	M	81	82	83	84	85	86	88	89	91	92		
15%	M	M	M	M	M	M	81	82	83	84	85	86	
	.30	**.32**	**.34**	**.36**	**.38**	**.40**	**.42**	**.44**	**.46**	**.48**	**.50**	**.52**	

Maximum Average Window U-value

Table 5-3d

Multifamily Trade-Off ~ *Package 5*

Max. Glazing %	*Minimum AFUE*												
30%	86	88	90	92									
25%	81	83	85	87	89	91							
20%	M	81	81	82	83	84	85	87	88	90	91		
15%	M	M	M	M	M	M	M	81	82	83	84	85	
	.30	**.32**	**.34**	**.36**	**.38**	**.40**	**.42**	**.44**	**.46**	**.48**	**.50**	**.52**	

Maximum Average Window U-value

Table 5-3e

Multifamily Trade-Off ~ *Package 6*

Max. Glazing %	*Minimum AFUE*												
30%	85	87	89	91									
25%	M	82	84	86	88	90	92						
20%	M	M	M	81	82	83	84	86	87	89	90	92	
15%	M	M	M	M	M	M	M	M	81	82	83	84	
	.30	**.32**	**.34**	**.36**	**.38**	**.40**	**.42**	**.44**	**.46**	**.48**	**.50**	**.52**	

Maximum Average Window U-value

Trade-Off Tables for Multifamily Homes

How to Use the Trade-Off Tables

1. **Calculate the glazing percentage.** If the calculation results in a number that is between the values listed in the table, use the higher value in the table (e.g., use 13% if your calculated percentage is 12.3%). *See Section 3.3 for details.*

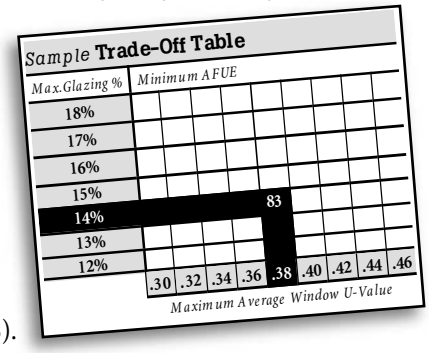
2. **Determine the window U-value.** If the window U-value as listed by the manufacturer is between the values listed in the table, use the higher value in the table (e.g., use .40 if the listed U-value is .39). *See Sections 3.4 and 3.5 for details.*

3. **Refer to the appropriate table for the compliance package you have selected.**

4. **Determine the unknown value.** The tables contain values for three building components: glazing percentage, window U-value, and heating AFUE. If you know the values of two components, you can identify the value of the third component.

   Example A: *Using the sample table below, find the AFUE when the glazing percentage = 14% and the window U-value = 0.38:* Enter the table from the left at the row representing the 14% glazing percentage. Travel right, stopping at the column where the window U-value is 0.38. The number at the intersection shows the minimum AFUE (83 in the sample table below) you can use.

   Example B: *Again using the sample table, find the U-value when the glazing percentage = 14% and the AFUE = 83:* Enter the table from the left at the row representing the 14% glazing percentage. Travel right, stopping at the column listing "83." Move down to the bottom row to read the minimum U-value (.38).



M = minimum AFUE
(78% for furnaces; 80% for boilers)

This chapter explains:

- ★ How the Software Method works
- ★ The advantages of this method
- ★ System requirements
- ★ How to obtain the software

Chapter 6

The VT*check* Software Compliance Method

The Software Compliance Method involves the use of VT*check*, a Vermont-specific version of MEC*check* software, to determine a home's compliance with the Energy Code. This customized approach accommodates varied building techniques — including 24″ stud spacing, stress-skin panels and metal framing — and offers greater flexibility in meeting the Code's Performance Requirements than the Fast-Track or Trade-Off methods. You enter data on the home's thermal and efficiency values, and the program determines if the home "passes." If the home passes and meets all of the Basic Requirements (see inside front cover), the home complies with the Energy Code.

Section 6.1

How the Software Method Works

Using VT*check* software, you simply specify component types (for example, 16″-o.c. wood-frame walls), their area and their R- or U-values. There is no need to calculate average R- and U-values; you just enter the value of each component separately, and the software performs the calculations.

Unlike the Fast-Track and Trade-Off methods, there are no "exempt" door or window areas; you enter data on each part of the thermal envelope, including all access hatches. You also select the weather site that corresponds to your town, using the drop-down menu available in the software. The software performs all the calculations and determines if your home complies with the Energy Code.

VT*check* enables you to quickly compare different insulation levels in different parts of your building to arrive at a package that works best for you. A report can be printed for use in the field as a final-inspection checklist as well as for your files.

System Requirements
The current version of VT*check* software requires Windows 95 or later. If you are using Windows 3.1, contact the Energy Code Assistance Center for a copy of Version 2.

Section 6.2

System Requirements

The current version of VT*check* requires Windows 95 or later. If you are using Windows 3.1, contact the Energy Code Assistance Center to request a copy of VT*check* Version 2.

In order to comply with the Energy Code using this method, a home must:

1) meet all of the Basic Requirements (noted on inside front cover),

2) follow the Ventilation Requirements (see Chapter 2), and

3) pass the VT*check* compliance test.

Section 6.3

Contents of the Residential Energy Code CD

The energy code CD includes:

1. The VT*check* application for Windows operating systems
2. VT*check* version for Macintosh computers
3. Internet link to *Adobe Acrobat Reader*™, making it possible to read the:
   a. VT*check* User's Guide
   b. Vermont Residential Energy Code Handbook
   c. Code materials order form
   d. "What to do with the certificate" information sheet

To install the software, insert the CD. For the Windows version, open the Win_PC folder and open the setup file. Macintosh users should open the Mac folder, then choose the folder that matches your operating system and open the setup file.

The support materials on the CD can be accessed using *Adobe Acrobat Reader.*™ If you do not already have this software, you can download for free by using the Internet link on the CD.

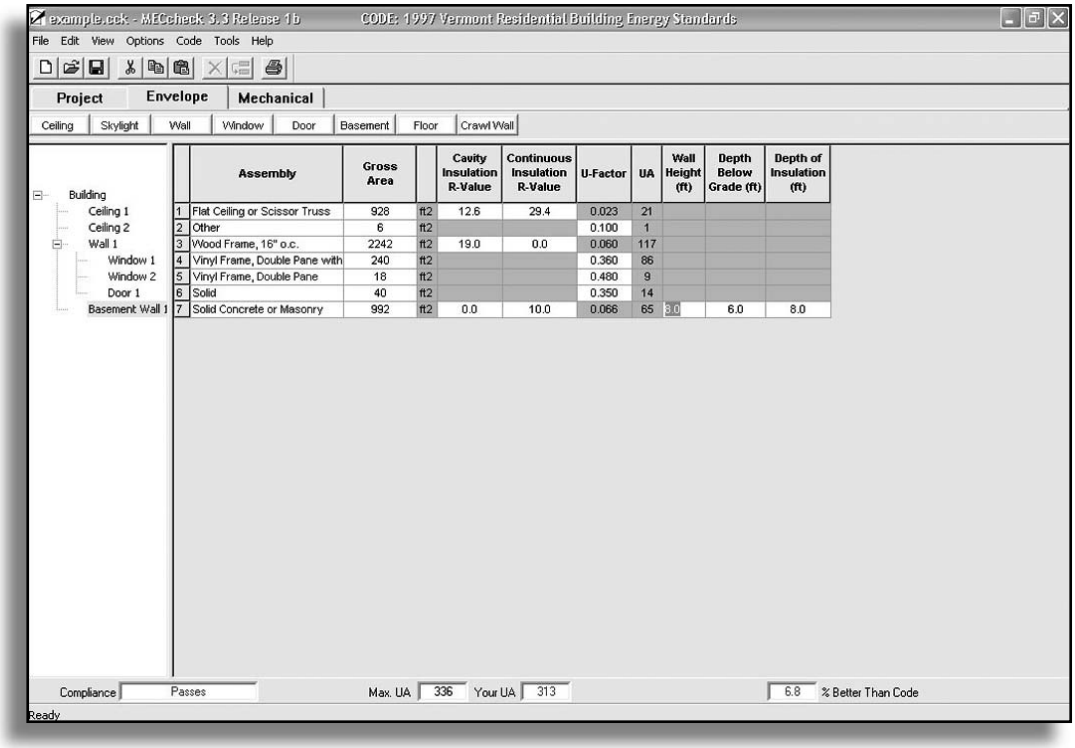


Figure 6-1: Example of a VT*check* screen accessed when entering building-component data.

Section 6.4

Using VT*check* Software

At the design stage, whenever the design changes during construction, and again upon completion of construction for verification:

1. **Review the Basic Requirements** summarized on the inside front cover (or refer to Appendix C for detailed specifications). *Your project must meet all 13 Basic Requirements.*
2. **Follow the Ventilation Requirements** (Chapter 2).
3. **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.
4. **Enter the basic project information** using VT*check* software, including the correct town. Enter building component data, choosing from the available descriptions and keying in areas (square footage), R-values and U-values. Enter the heating system AFUE. See the software manual or help function for complete instructions.
5. The software continuously displays "passes" or "fails." **If your building doesn't 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-value; the result displays almost instantaneously.) Contact the Energy Code Assistance Center at 1-888-37-ECALL for any assistance you may need.
6. **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 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 Department of Public Service*
        Energy Efficiency Division
        112 State St., Drawer 20
        Montpelier, VT 05620-2601

   Be sure to keep one copy of the certificate for your records as well.
7. **Post the original certificate in the home**, affixing the label on or near the electrical service panel or heating equipment.

Section 6.5

How to Obtain VT*check* Software

The VT*check* software CD is available by contacting the Energy Code Assistance Center at 1-888-37-ECALL (373-2255). You also can download the software at:

www.state.vt.us/psd/Menu/EE_and_Renewable/ee12.htm

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 an additional, "professional services" compliance method that a builder may wish to consider in order to demonstrate compliance with the Code. This method is fundamentally different from the other three compliance methods (Fast Track, Trade-Off and VT*check* software) because it requires sophisticated energy-modeling tools to demonstrate that a new home meets or exceeds the technical requirement of the Code. It utilizes a home energy rating, which is an independent, detailed analysis of the home's energy efficiency. This method also has the ability to model complex buildings or buildings with unusual features, such as high glazing percentages.

Section 7.2

Advantages of the Home Energy Rating Method

In order to comply with the Energy Code using this method, a home must meet all of the Basic Requirements for Home Energy Ratings (Table 7-1) and demonstrate that it uses less energy than a similar home built to Energy Code standards.

- ★ *Ventilation System Testing:* A professional energy specialist may test exhaust fan performance to determine compliance with the Code ventilation requirements outlined in Chapter 2.
- ★ *No math:* A professional energy specialist performs the calculations and completes the *Vermont Residential Building Energy Standards Certificate*.
- ★ *Credit for airtightness and solar gain:* Most of the compliance methods make an assumption about how much air the house leaks, and the Code does not allow builders to "earn credit" for building a tighter house unless the house is tested. Because the rating process includes the test, the calculations can incorporate the results. Likewise, solar gain is factored into the process, 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 DHW. Energy ratings are able to account for increased DHW efficiency.

★ *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 Code.

Section 7.3

Basic Requirements for Home Energy Ratings

The Basic Requirements for Home Energy Ratings are different than the Basic Requirements for other compliance methods because this method can model all aspects of the building. The only prescribed features are those not considered in building modeling, those required by the law that created the Vermont Residential Energy Code, and those mandated by the Ventilation Requirements (Chapter 2). They are listed in Table 7-1.

Table 7–1

Basic Requirements for Home Energy Ratings

See Appendix C for complete basic requirements.

1	**Vapor Retarder**	For non-vented framed ceilings, wall and floors, install a vapor retarder (i.e., 6 mil. plastic or vapor-barrier paint) on the warm-in-winter side of the insulation.
2	**Swimming Pools**	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.
3	**Domestic Hot Water**	Domestic hot water tanks must meet minimum federal efficiency standards that apply to all equipment manufactured after 1992. Except when the warranty would be voided by installing a tank wrap, tanks must have a minimum total R-value of 14. Stand-alone domestic water heaters must incorporate at least one of the following: (a) internal heat traps; (b) external heat traps; or(c) pipe insulation for the first accessible 6 feet on non-circulating hot and cold water pipes. For circulating systems, refer to Appendix C.
4	**Fireplaces**	Fireplaces must incorporate tight-fitting doors and either a tight-fitting chimney damper or a chimney cap damper.
5	**Exhaust Fans**	Exhaust dampers are required for kitchen, bath and dryer fans.
6	**Electric Systems**	In most cases, each unit of a multifamily dwelling must have a separate electric meter. See Appendix D for exceptions.
7	**Certification**	Complete a *Vermont Residential Building Energy Standards Certificate* for each dwelling. Send one copy to the Vermont Department of Public Service and one copy to the town clerk of the town in which the property is located, and affix the original on or near the home's electrical panel or heating equipment.

For full details about any of these requirements, see Appendix C.

Section 7.4

The Home Energy Rating

A home energy rating is a standard measure of a home's energy efficiency. In Vermont, the Department of Energy (DOE)-approved national "Star" rating system is used; new or existing homes receive 0 to 100 points and a rating of 1 Star to 5 Stars Plus based on the home's relative energy efficiency.

In order to be used for Code compliance, home energy ratings must be performed by a Vermont state-accredited rating organization. Rating organizations are not authorized to sign the *Vermont Residential Building Energy Standards Certificate*, so the builder must sign the certificate when choosing this method.

In order to comply with the Code using this method, a completed home must meet the Basic Requirements for Home Energy Ratings (Table 7-1), meet the Ventilation Requirements (Chapter 2), *and* earn a minimum energy rating score of:

- **82** if a single-family home
- **82** if a multifamily home
- **80** if a log home

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

1. **Plan Review:** You submit plans and specifications, and the rating organization issues a "proposed" energy rating. If the home does not meet the Code as designed, the organization 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 Code.
3. **Final Inspection:** When the home is complete, the rating organization conducts a final inspection, including a blower-door test to evaluate the home's airtightness. Final documentation is provided showing whether the home meets the Energy Code.

NOTE: It is your responsibility as builder to sign, file and post the Vermont Residential Building Energy Standards Certificate upon completion of construction. Here's how:

1. Complete the certificate when the home is *100% finished*. See Chapter 8 for detailed instructions.
2. 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 Department of Public Service*
     Energy Efficiency Division
     112 State St., Drawer 20
     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.
3. Post the original certificate in the home, affixing the label on or near the electrical service panel or heating equipment.

This chapter explains:

- ★ How self-certification works
- ★ How to complete the two types of certification
- ★ Where and when to file copies

Chapter 8

Certification

The Vermont 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 document.

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 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 new home covered by the Energy Code. The certificate documents compliance with the Code and represents your statement that the information it contains is accurate. The certificates are

VT RESIDENTIAL BUILDING ENERGY STANDARDS (RBES) CERTIFICATE

This certificate is for projects started after Dec. 31, 2004.

Before completing this form, refer to the instructions in Section 8.2a of the Energy Code Handbook (2nd edition).

_____ _____ ❑ NA
Property Address (street, town, ZIP Code) Act 250 Permit #

_____
Electric Utility serving this address

_____ _____
Construction START Date Construction FINISH Date

_____ _____ _____ _____
Units # Stories # Conditioned Sq. Ft. #Bedrooms

Project Description
❑ Single Family ❑ Log Home
❑ Multifamily ❑ Addition

Foundation Type
❑ Basement ❑ Slab on Grade
❑ Crawl Space

R-_____ Basement/Crawl Space Walls _____' Depth of Basement Insulation (ft) U-_____ Basemt Windows ❑ NFRC ❑ Default

R-_____ Under Slab R-_____ Floors over Unheated Spaces R-_____ Sloped Ceilings

R-_____ Perimeter Slab Edge R-_____ Above-Grade Walls R-_____ Flat Ceilings

U-_____ Windows ❑ NFRC ❑ Default U-_____ Doors ❑ NFRC ❑ Default U-_____ Skylights ❑ NFRC ❑ Default

Space Heating Fuel: ❑ Oil ❑ Kerosene ❑ LP Gas ❑ Natural Gas ❑ Wood ❑ Electric Resistance ❑ Heat Pump ❑ Solar ❑ Other

Space Heating System: ❑ Boiler ❑ Furnace ❑ Space Heater ❑ Stove ❑ Other

Primary Heating System Efficiency: _____ % ❑ AFUE ❑ HSPF

Central Air Conditioning Efficiency: _____ % ❑ SEER ❑ COP ❑ N/A

Water Heating Fuel: ❑ Oil ❑ Kerosene ❑ LP Gas ❑ Natural Gas ❑ Wood ❑ Electric Resistance ❑ Heat Pump ❑ Solar ❑ Other

Water Heating System: ❑ Stand-Alone Tank ❑ Indirect-Fired Tank ❑ On Demand ❑ Tankless Coil ❑ Other

Primary Hot Water System Efficiency: _____ % Energy Factor

Ventilation System: ❑ Exhaust ❑ Supply ❑ Balanced

Ventilation Air Flow: _____ % ❑ Rated ❑ Measured

OTHER ENERGY FEATURES: _____

_____

Code-Compliance Method Used:

❑ Fast Track *Glazing Percentage:* _____ % *Package #:* _____

❑ Trade-Off *Glazing Percentage:* _____ % *Package #:* _____

❑ VT*check* Software *Maximum UA:* _____ *Your UA:* _____

❑ Home Energy Rating *Rating Score:* _____

Rated by: _____

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 21 V.S.A. §266.

_____
Signature Print Name Company Phone # Date

21 V.S.A. §266 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 also must be provided, within 30 days following the sale of the property, to 1) the Dept. of Public Service, Energy Efficiency Division, 112 State St., Drawer 20, Montpelier, VT 05620-2601, and 2) the town clerk of the town where the property is located. NOTE: Noncompliance with RBES may result in action for damages under 21 V.S.A. §266. This label does not specify all 1997 RBES requirements.

QUESTIONS? CALL THE VT DEPT. OF PUBLIC SERVICE: 800-642-3281 (in state) OR 802-828-4056 (out of state).

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

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

printed on a one-page label with a peel-off back so they can be posted on or near the electric-service panel or heating equipment). After the certificate is filled out, it must be photocopied 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.

Section 8.2a

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. If the dwelling received an Act 250 Permit, list the **Act 250 Permit #**. If not, check **N/A**.
2. List the dwelling **Site**, including the complete street *and* mailing **Address**, **Town** and **Zip** code.
3. List the **Electric Utility** providing electric service to the dwelling. If the dwelling has no electricity, state none. If electricity is provided by a stand-alone system, indicate the system type, such as photovoltaic, wind turbine, propane generator, etc.
4. List the **Construction Start** and **Construction Completion** 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 Completion** is when the dwelling is sufficiently ready for occupancy.
5. **Project Description:** Check off all that apply. **Multi-family homes:** Write in the number of **Units**. For all Projects, write in the number of **Stories** above grade, and the **Conditioned sq. ft.** area, excluding unconditioned spaces, such as an unconditioned garage or unheated basement. Write in the **Number of Bedrooms**.
6. **Foundation Type:** Check off all that apply.
7. **Floors, Walls**, **Slabs, Flat Ceilings and Sloped Ceilings:** 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 that figure on the form. (See Section 3.5, "How to Calculate Average R-values and U-values.")

   For basement walls, list the vertical height of the basement insulation in **Insulation Depth** in feet (**ft.**).
8. **Doors** and **Windows:** Where applicable, list the **U**-Value. If the **U**-value is not an **NFRC** (National Fenestration Rating Council) **Rating**, list the **Default Rating** (refer to Appendix B, Table B-1). **Check rating type** — either **NFRC** or **Default Rating**.

   Note: If there is not enough space in this section to list each thermal envelope component, list additional information under **Other Energy Features**.
9. **Space Heat:** Check off all **Fuel** and **System** types that apply. **Circle primary fuel and system**. List the **primary heating system efficiency**, and check whether the value is **AFUE** (boilers and furnaces) or **HSPF** (heat pumps).
10. **Air Conditioning:** List the **Central A/C system efficiency** and check whether the value is **SEER** or **COP** , if applicable. (See Appendix A for definitions.)
11. **Water Heating** (domestic): Check off all **Fuel** and **System** types that apply. **Circle primary fuel and system**. List the **Primary domestic hot water system efficiency Energy Factor (EF)**, available from the manufacturer. *If* the hot water is supplied by an indirect -storage tank, multiply the boiler AFUE by 0.92. Example: **EF** = 0.92 x 87% AFUE = **0.80**

To order additional certificates, contact one of these resources:

- ★ Energy Code Assistance Center
  1-888-373-2255
- ★ Vermont Department of Public Service
  1-800-642-3281
- ★ The organizations listed in Appendix E, "Vermont Resources for Energy Efficiency & Utility Services"
- ★ Act 250 Environmental Board
  1-802-828-3309

12. **Ventilation System:** Check off all that apply (See Chapter 2 for reference). List the **Ventilation Air Flow** rate in cubic feet per minute and check off if the flow rate is either **Rated** or **Tested**.
13. Under **Code Compliance Path**, check the compliance path by which you determined technical compliance with the Code.

    ★ If compliance is determined using the Fast Track or Trade-Off tables, list the net window (rough opening) glazing area as a percent of gross wall area. (See Section 3.3, "How to Calculate the Glazing Percentage.") Write in the number of the package used. The package number is shown at the top of each of the Fast Track or Trade-Off tables.

    ★ If compliance is determined using the VT*check* Software Method, list the **VT*check* maximum required UA** value and **Your home UA** value calculated by VT*check*.

    ★ If compliance is determined using a home energy rating, list the **Final home energy rating** and the **Company** that determined the final rating score.
14. **Other Energy Features:** At the builder's option, list additional information as appropriate, such as the infiltration rating determined by a blower door test in air changes per hour (AC/hr), or other information.
15. Under the certification section, list the name of the **owner** of the dwelling.
16. **Signature:** This is the signature of either the builder who directed construction or of another party authorized to certify Code compliance. **Company**: List the business name of the party certifying compliance. **Print** the **Name** of the person whose **Signature** is presented. List the **Phone** number of the **Company** certifying compliance (including area code) and the **Date** (month and year) the certificate is signed and completed.

Section 8.2b

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.
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 Department of Public Service (Energy Efficiency Division, 112 State Street, Drawer 20, Montpelier VT 05620-2601).

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"), having the power to direct others with respect to the details of construction and the installation of materials that do not comply with the Energy Code.
3. The owner must live in the building.
4. The owner must evaluate whether the home meets the Energy Code.
5. The owner must complete and file a *Vermont Owner/Builder Disclosure Statement.*
6. Before entering into a binding purchase and sale agreement, the owner must provide a copy of this statement to a prospective buyer.

Section 8.3a

Instructions for Completing the 'Vermont Owner/Builder Disclosure Statement'

Read the instructions in their entirety *before* completing the 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 Energy Code.)
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 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. Once the home is sold, you need to file the required copies with the town and state. The process for filing this statement is identical to that for the *Vermont Residential Building Energy Standards Certificate* in Section 8.2b.

VERMONT OWNER/BUILDER DISCLOSURE STATEMENT

This home does NOT meet the technical requirements of the Vermont Residential Building Energy Standards (RBES) and is not required to do so.

Property Address (street, town, ZIP Code)

Electric Utility serving this address

Construction START Date _____ Construction FINISH Date _____

Units _____ # Stories _____ # Conditioned Sq. Ft. _____ #Bedrooms _____

Project Description

❑ Single Family ❑ Log Home
❑ Multifamily ❑ Addition

Foundation Type

❑ Basement ❑ Slab on Grade
❑ Crawl Space

R-_____ Basement/Crawl Space Walls

_____' Depth of Basement Insulation (ft)

U-_____ Basemt Windows ❑ NFRC ❑ Default

R-_____ Under Slab

R-_____ Floors over Unheated Spaces

R-_____ Sloped Ceilings

R-_____ Perimeter Slab Edge

R-_____ Above-Grade Walls

R-_____ Flat Ceilings

U-_____ Windows ❑ NFRC ❑ Default

U-_____ Doors ❑ NFRC ❑ Default

U-_____ Skylights ❑ NFRC ❑ Default

Space Heating Fuel: ❑ Oil ❑ Kerosene ❑ LP Gas ❑ Natural Gas ❑ Wood ❑ Electric Resistance ❑ Heat Pump ❑ Solar ❑ Other

Space Heating System: ❑ Boiler ❑ Furnace ❑ Space Heater ❑ Stove ❑ Other

Primary Heating System Efficiency: _____ % ❑ AFUE ❑ HSPF

Central Air Conditioning Efficiency: _____ % ❑ SEER ❑ COP ❑ N/A

Water Heating Fuel: ❑ Oil ❑ Kerosene ❑ LP Gas ❑ Natural Gas ❑ Wood ❑ Electric Resistance ❑ Heat Pump ❑ Solar ❑ Other

Water Heating System: ❑ Stand-Alone Tank ❑ Indirect-Fired Tank ❑ On Demand ❑ Tankless Coil ❑ Other

Primary Hot Water System Efficiency: _____ % Energy Factor

Ventilation System: ❑ Exhaust ❑ Supply ❑ Balanced

Ventilation Air Flow: _____ % ❑ Rated ❑ Measured

Code-Compliance Method Used:

❑ Fast Track *Glazing Percentage:* _____ % *Package #:* _____

❑ Trade-Off *Glazing Percentage:* _____ % *Package #:* _____

❑ VT*check* Software *Maximum UA:* _____ *Your UA:* _____

❑ Home Energy Rating *Rating Score:* _____

Rated by: _____

I certify that the above information is correct and that the premises listed above have NOT been constructed to meet the technical requirements of the Vermont Residential Building Standards (RBES) created under 21 V.S.A. §266.

Signature Date Print Name Phone

For Owner/Builder projects, 21 V.S.A. §266 requires sellers to provide this statement to prospective buyers, prior to entering into a binding purchase-and-sale agreement, which itemizes how the home **does not comply** with Vermont RBES. Seller must send copies, within 30 days following the sale of the property, to 1) the Dept. of Public Service, Energy Efficiency Division, 112 State St., Drawer 20, Montpelier, VT 05620-2601, and 2) the town clerk of the town where the property is located.

QUESTIONS? CALL THE VT DEPT. OF PUBLIC SERVICE: 800-642-3281 (in state) OR 802-828-4056 (out of state).

Figure 8-2: The *Vermont Owner/Builder Disclosure Statement*. For copies of this form, photocopy this page or contact the Energy Code Assistance Center (888-37-ECALL).

Appendix A

Definitions

Addition

The Energy Code applies to all new construction components of additions over 500 square feet. If new heating equipment is installed, it must meet the Code. If existing equipment, such as a heating system, is to be used in the new addition, it is not required that the existing equipment meet the Code.

AFUE

Annual Fuel Utilization Efficiency. This is the Energy Code's accepted measure of the efficiency of furnaces, boilers and space heaters. The AFUE is determined by a standard Department of Energy test method. By federal law, the minimum efficiency permitted is 80% AFUE for boilers and 78% AFUE for furnaces.

★ When using a hot water heater as the primary means of heating a house, the listed "Combined Appliance AFUE (CAFUE) should be used. If a CAFUE is not listed, the Recovery Efficiency should be considered equivalent to an AFUE rating.

★ AFUE requirements referenced throughout this handbook refer to the primary heating system in a building.

Average R-value

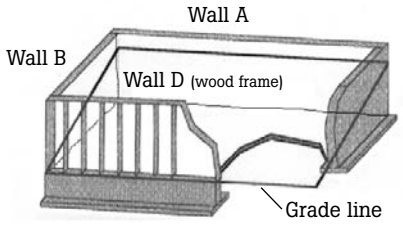
For a single building component with two different thermal values, it is possible to calculate a "weighted" or "average" R-value. See Section 3.5 for instructions.

Basement Wall

Basement walls that enclose conditioned space (i.e., those with no insulation in the basement ceiling) are part of the building envelope and must comply with the requirements of the Energy Code.
★ *If wall is at least 50% below grade:* To be considered a "basement wall," the average gross basement wall area (including openings) must be at least 50% below grade (i.e., Wall A in Figure A-1). In this case, do not add the basement wall area to gross exterior wall area.
★ *If wall is at least 50% above grade*: When using the Fast-Track or Trade-Off method, if a wall enclosing a conditioned basement space is at least 50% above grade (i.e., Wall D in Figure A-1), it is considered an "above-grade wall." For the purpose of calculating the exterior wall area and the average R-value, include this entire wall area with other exterior above-grade walls. Add any basement window area of that wall to the glazing area.
★ Treat walls on each side of the basement individually when determining if they are exterior or basement walls.
★ *When using the Fast-Track or Trade-Off methods, basement walls must be insulated from the top of the basement wall to 10 feet below ground level or to the basement floor, whichever is less.* (The VT*check* software enables you to trade off the basement wall insulation depth as well as the insulation R-value).

Figure A-1: ***Walkout Basement Example***

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



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 Fast-Track, Trade-Off and Software methods of compliance.

Bathroom

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

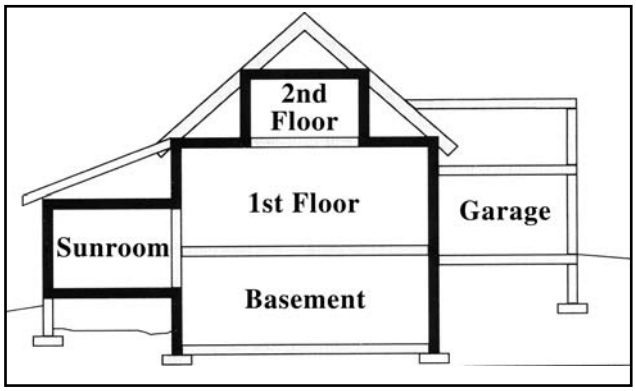


Figure A–2:
Building Envelope Example 1
The dark line delineates the building envelope. This illustration shows a house over a conditioned basement (i.e., no basement ceiling insulation), with a sun room over unconditioned crawlspace (i.e., insulation in crawlspace ceiling).

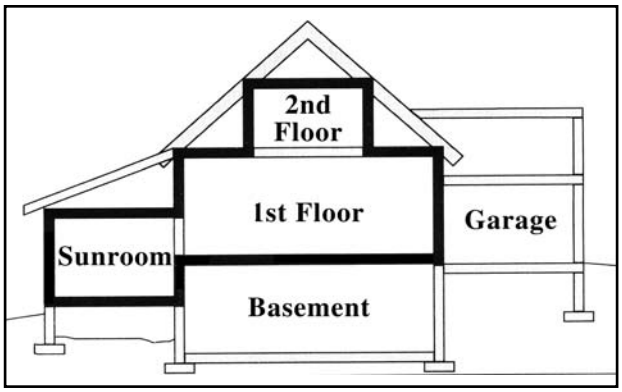


Figure A–3:
Building Envelope Example 2
This depicts the same house with an unconditioned basement (i.e., basement ceiling insulation). Note that the wall between sun room and basement is included.

Bedroom A room or space used or intended be used for sleeping. A "den," "library," "home office" or other similar rooms shall count as a bedroom for the purpose of computing fan sizing for whole-house ventilation systems.

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 Envelope The building envelope includes all components of a building that enclose conditioned spaces (see definition of "conditioned space"). 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 specify insulation of requirements for these components, and they can be ignored (except for the walkout portion of a conditioned basement, which is treated as a "slab on grade" and needs perimeter insulation).

Ceiling 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 *not* 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).
★ Ceiling area should be measured from the exterior dimensions over the conditioned space (including the *sloped* 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 use the default R-value from Table B-3.*

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 definition of "exterior wall.")

Commercial Building For the purposes of the Energy Code, all building types not defined as "residential" are considered commercial, including multifamily buildings over three stories in height. Residential portions of commercial buildings do have to comply with the Code.

Conditioned Space A space is conditioned if heating and/or cooling is deliberately supplied to it or indirectly supplied through uninsulated surfaces of water or heating equipment, through uninsulated ducts, or though adjacent uninsulated building surfaces. Basements and crawl spaces without ceiling insulation are considered conditioned space.

COP — *Coefficient of Performance.* 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.

Covered Buildings — See Chapter 1 for complete definitions of buildings that are covered and not covered by the Energy Code.

Crawl Space — Crawl space wall-insulation requirements are for the exterior walls of unventilated crawl spaces (i.e., not directly vented to the outside) below uninsulated floors. A crawl space wall component includes the opaque portion of a wall that encloses a crawl space and is partially or totally below grade. The crawl space wall insulation must extend from the top of the wall to at least 12 inches below the outside finished grade.

★ Ventilated crawl spaces (i.e., crawl spaces with vents) must have ceiling insulation and meet the R-value requirements for "floors over unconditioned spaces" when complying using the Fast-Track or Trade-Off methods.

Cubic Feet per Minute (CFM) — The quantity of air moved in 1 minute. A measurement typically applied to ventilation equipment.

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.ducts to spaces that require it.

Doors — Doors include all openable opaque assemblies located in exterior walls of the building envelope.

★ *If door is less than 50% glass*: 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.

★ *If door is more than 50% glass*: 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 Fast-Track and Trade-Off methods. The 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 — *Energy Efficiency Ratio.* 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.

Energy Code — Short term for Vermont's "Residential Building Energy Standards," or Act 20 of 1997.

Energy Factor — The seasonal efficiency rating (e.g., .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 Energy Code allows an energy rating to be used to document compliance. See Chapter 7 for details.

Envelope — See Building Envelope.

Exempt Buildings — See Chapter 1 for complete definitions of buildings that are covered and not covered by the Energy Code.

Exterior Walls — Exterior walls are surfaces in the building envelope within 30% of vertical, including:

★ the total area (opaque area, kneewalls, windows, and doors) of all above-grade walls enclosing conditioned spaces;

★ the area of the band joist and peripheral edges of floors; and

★ the total area (opaque area, kneewalls, windows and doors) of any individual basement wall that is 50% or more above grade that encloses a conditioned space (including the below-grade portion of the wall).

Fast-Track Method — The easiest procedure for demonstrating compliance with the technical requirements of the Energy Code. Homes must comply with all of the Basic Requirements in addition to one of the packages in the corresponding Fast-Track Performance Requirements Table. See Chapter 4.

Floors

Floors are considered individually for compliance purposes depending on their configuration and exposure:

★ Floors over "unconditioned spaces" (such as floors over an unheated garage, a vented crawl space, or a 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 proposes and is subject to the same R-value requirements).

Glazing

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."

★ Windows in the exterior walls of *conditioned* basements (i.e., without ceiling insulation) *should* be included in the glazing-area calculations. Windows in walls of basements or crawlspaces with insulated ceilings are *not* 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 Fast-Track and Trade-Off methods.

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 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.

Home Energy Rating System (HERS)

A home energy rating system accredited by the Vermont Dept. of Public Service that provides a numerical rating 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.

HSPF

Heating Seasonal Performance Factor. This is a rating value for heat pumps, defined as the total heating output of a heat pump during its normal annual usage period for heating, divided by the total electric power input in watt-hours during the same period.

HVAC System

Heating, Ventilation and Air Conditioning System. The equipment, distribution network, and terminals that provide either collectively or individually the processes of heating, ventilating, or air conditioning to a building.

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.

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 Energy Code, but site-built components (e.g., conditioned basements or crawlspaces) must comply.

Manufactured Home

Factory-built modular homes that are *not* subject to Title VI of the National Manufactured Housing Construction & Safety Standards Act of 1974 (i.e., homes not on a permanent chassis).

Multifamily

A multifamily building is a residential building three stories or less in height that contains three or more attached dwelling units. Multifamily buildings include apartments, condominiums, townhouses, and rowhouses. (Hotels and motels are considered commercial buildings, not residential or multifamily buildings, and therefore are not covered by this Code.)

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 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 *not* include windows, doors, or other such openings.

Nominal R-value — The R-value of an insulating material as listed on its packaging.

Opaque Areas — Also called the "net wall area." Opaque areas as referenced in this handbook include all areas of the building envelope except openings for windows, skylights, doors, and building service systems. For example, although solid wood and metal doors are opaque, they should not be included as part of the opaque wall area.

Owner-Builder — The person in charge of construction (i.e., the "general contractor"), having the power to direct others with respect to the details of construction and the installation of materials **NOT** in compliance with the Energy Code. To be defined as an owner-builder, the owner must live in the building. See Section 1.4 for complete criteria.

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 7), and file copies with the appropriate town clerk and the Department of Public Service, within 30 days of construction completion.

Performance Requirements — The thermal (R-value and U-value) and heating efficiency (AFUE) values needed to meet the technical requirements of the Energy Code.

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.

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.

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 if 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.

RBES — Residential Building Energy Standards, the energy-efficiency code for residential new construction in Vermont, enacted in May 1997 as Act 20 and commonly referred to as the Vermont Residential Energy Code or simply the Energy Code.

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 "Energy Factor").

Residential Buildings — One-family, two-family and multifamily dwellings of three stories or less in height. "Residential buildings" do not include hunting camps.

Residential Construction — New construction of residential buildings, or the construction of residential additions encompassing at least 500 square feet of new floor space. Before July 1, 1998, this definition as used here applies to residential construction that is subject to the jurisdiction of 10 V.S.A. chapter 151 (Act 250). Effective July 1, 1998, this definition applies to *all* new residential construction, regardless of whether it is subject to Act 250.

R-value — A measure of thermal resistance, or how well a material (or series of materials) resists the flow of heat. Insulation materials are commonly rated and labeled using R-value. Higher numbers mean better performance. R-values are additive; that is, adding an R-19 layer to an R-11 layer creates an R-30 assembly. R-value is the reciprocal of U-value (R = 1/U).

SEER — *Seasonal Energy Efficiency Ratio.* 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.

Self-Certify

The act of certifying that a home complies with the 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.

Single-Family Home

As defined by the 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.

Slab Edge

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:

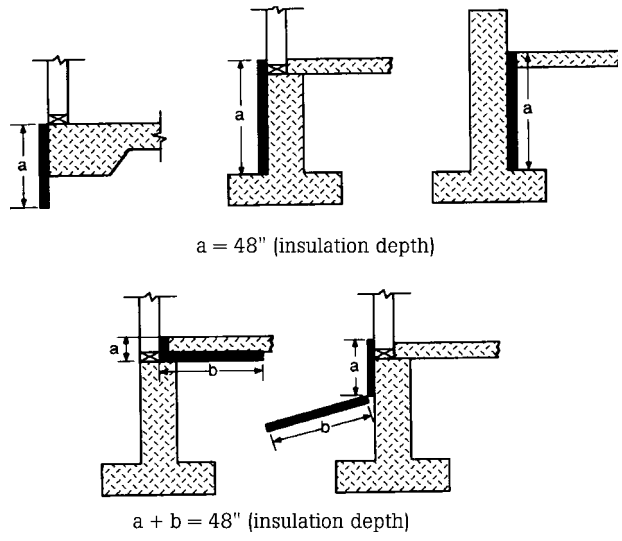
★ The slab insulation extends from the top of the slab downward.

★ 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".

★ 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". 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° angle away from the exterior wall.

Figure A-4: ***Slab Edge Insulation Examples***



Sloped Ceiling

See "Ceiling Slopes."

Technical Requirements

The technical requirement of the Energy Code consists of two components: the Basic Requirements (see inside front cover and Appendix C) and the Performance Requirements (see Chapters 4 to 7) of the Vermont Energy Code.

Trade-Off Method

A flexible procedure for demonstrating compliance with the technical requirements of the Energy Code through the use of lookup tables. See Chapter 5.

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 crawlspaces with insulated ceilings.

Unusually Tight Construction

Buildings constructed in compliance with the Vermont RBES are considered to have unusually tight construction. This type of construction meets the following requirements: (1) walls and ceilings exposed to the outside atmosphere have a continuous water vapor retarder with a rating of 1 perm (5.7×10^{-11} kg/Pa _ s _ m²) or less with openings gasketed or sealed; (2) storm windows or weatherstripping is installed on openable windows and doors; and (3) caulking or sealants are 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.

U-value

A measure of how well a material (or series of materials) conducts heat. U-values for window and door assemblies are the reciprocal of the assembly R-value (U = 1 / R). Windows and doors are usually rated using U-value rather than R-value. Lower numbers mean less heat loss and better performance. Equivalent to "U-factor."

Vermont RBES Certificate

Vermont Residential Building Energy Standards Certificate. The one-page, adhesive-backed form that itemizes the energy components of a building and indicates its compliance with the 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 Department of Public Service within 30 days of construction completion. See Chapter 8.

VT*check* Computer software available from the Energy Code Assistance Center that determines compliance with the technical requirements of the Energy Code. See Chapter 6.

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.

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.

Wood Stove If a wood stove is used as the primary means of heating a house, the Home Energy Rating compliance method (see Chapter 7) must be used to document compliance with the Code.

Appendix B

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-values
Doors	Table B-2	U-values
Integrated hot water equipment	Table B-3	Energy Factor
Ceiling insulation for standard trusses/rafters	Table B-4	R-value

Table B-1

U-Values for Windows, Glazed Doors & Skylights[1]

Frame/Glazing Features	Single Pane	Double Pane	Double Pane / Low E	Double Pane / Low-E / Argon
Metal Without Thermal Break				
Operable	1.30	0.87	0.71	0.68
Fixed	1.17	0.69	0.53	0.50
Door (Sliding Glass, Patio, etc.)	1.26	0.80	0.64	0.61
Skylight	1.92	1.30	1.14	1.11
Metal With Thermal Break				
Operable	1.07	0.67	0.51	0.48
Fixed	1.11	0.63	0.47	0.44
Door (Sliding Glass, Patio, etc.)	1.10	0.66	0.50	0.47
Skylight	1.93	1.13	0.97	0.94
Metal-Clad Wood				
Operable	0.98	0.60	0.44	0.41
Fixed	1.05	0.58	0.42	0.39
Door (Sliding Glass, Patio, etc.)	0.99	0.57	0.41	0.38
Skylight	1.50	0.88	0.72	0.69
Wood/Vinyl				
Operable	0.94	0.56	0.40	0.37
Fixed	1.04	0.57	0.41	0.38
Door (Sliding Glass, Patio, etc.)	0.98	0.56	0.40	0.37
Skylight	1.47	0.85	0.69	0.66
Glass Block Assemblies	0.60		N/A	

[1] The U-values in this table can be used in the absence of tested U-values. 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-value.

Table B-2

U-Value Table for Doors[1]

Opaque Door Material	Fully Opaque	Sq. Feet of Double-Glazed Glass in Door[2]				
		0-2.0	2.1-4.0	4.1-6.0	6.1-8.0	8.1-10
Steel Doors						
Without Foam Core	0.60	0.59	0.59	0.59	0.58	0.58
With Expanded Polystyrene Foam Core	0.35	0.37	0.39	0.41	0.43	0.45
With Urethane Foam Core	0.23	0.26	0.29	0.33	0.36	0.39
Wood Doors without Storm						
Panel With 7/16-in. Panels	0.54	0.54	0.54	0.55	0.55	0.55
Hollow Core Flush	0.46	0.47	0.48	0.49	0.50	0.51
Panel With 1-1/8-in. Panels	0.39	0.41	0.42	0.44	0.46	0.47
Solid Core Flush	0.40	0.42	0.43	0.45	0.46	0.48
Wood Doors with Storm						
Panel With 7/16-in. Panels	0.36	0.38	0.40	0.42	0.44	0.46
Hollow Core Flush	0.32	0.34	0.37	0.39	0.41	0.44
Panel With 1-1/8-in. Panels	0.28	0.31	0.34	0.36	0.39	0.42
Solid Core Flush	0.26	0.29	0.32	0.35	0.38	

[1] The U-values in this table can be used in the absence of tested U-values. 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-value.

[2] Includes single-glazed glass in wood door with storm.

Table B-3

How to Calculate Energy Factor for Integrated Domestic Hot Water Equipment

Indirect-Fired Tank	Tankless Coil	
	# of Bedrooms	*Energy Factor*
.92 x boiler AFUE = Energy Factor	2	.45
	3	.50
	4	.55
	5	.60
	6	.65

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 B-1.

If a "standard" truss or rafter is used instead of a "raised" truss or rafter, the R-values in Table B-4 must be used for ceiling insulation values.

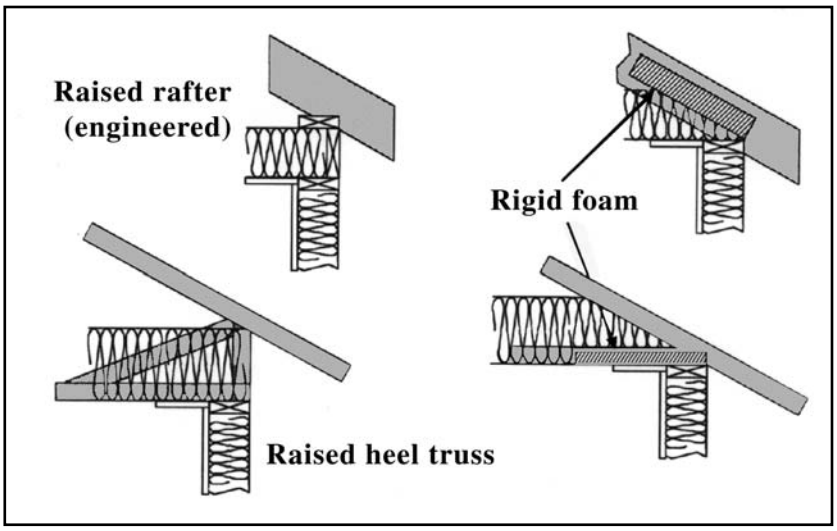


Figure B-1:
Raised Truss Examples

Table B-4

Ceiling Insulation R-Values for Standard Trusses/Rafters

In Order to Achieve:	Insulation must be installed with an R-Value of:	In Order to Achieve:	Insulation must be installed with an R-Value of:	In Order to Achieve:	Insulation must be installed with an R-Value of:
R-24	R-25	R-30	R-34	R-34	R-43
R-25	R-26	R-30	R-35	R-35	R-44
R-25	R-27	R-31	R-36	R-36	R-45
R-26	R-28	R-31	R-37	R-36	R-46
R-27	R-29	R-32	R-38	R-37	R-47
R-27	R-30	R-32	R-39	R-37	R-48
R-28	R-31	R-33	R-40	R-37	R-49
R-28	R-32	R-33	R-41	R-37	R-50
R-29	R-33	R-34	R-42	R-38	R-51

Appendix C

Basic Requirements

The Energy Code specifies basic minimum requirements that are mandatory for all buildings. This appendix details the basic requirements that are mandatory with all buildings under the Fast Track, Trade-Off, or VT*check* software compliance methods.

This chapter does not, however, specify minimum insulation R-values or maximum glazing or door U-values, which are detailed in chapters 4 through 7. Also, some of the packages for the compliance methods in chapters 4 through 7 specify equipment-efficiency requirements that are *higher* than the basic minimum standards outlined in this chapter.

Some but not all of these requirements are mandatory with the Home Energy Rating Method (Chapter 7). Refer to Table 7-1 for a summary of basic requirements that apply to those methods.

Figure C-1 illustrates several basic requirements. Refer to the *Basic Requirements Summary* on the inside front cover or at the end of this appendix for a concise outline of the requirements discussed in this chapter.

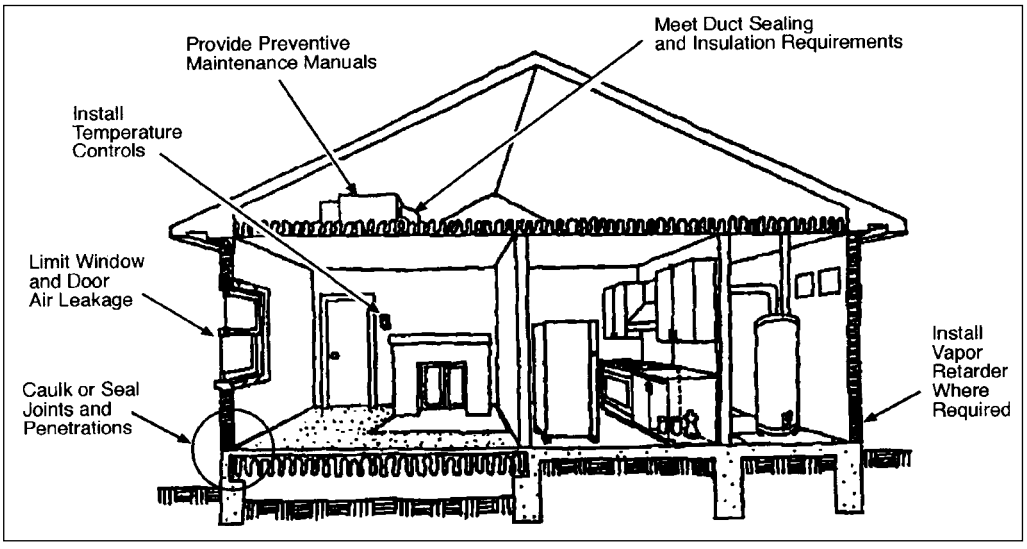
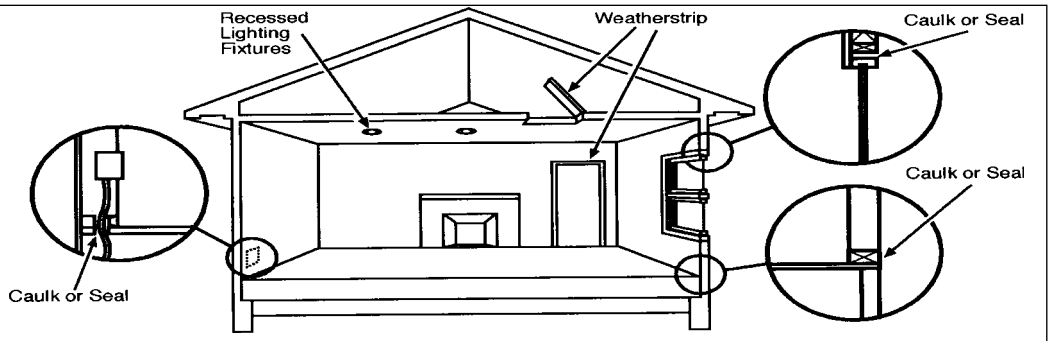


Figure C-1:
Some of the Basic Requirements



Openings between conditioned and unconditioned space or between conditioned space and the outside.

Figure C-2:
Typical openings in the building envelope that should be sealed

Section C.1

Building Envelope

Section C.1a

Air Leakage

Exterior joints, 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 covered with moisture-vapor-permeable house wrap. Air leakage locations include openings, cracks, and joints:

- ★ between wall cavities and window or door frames;
- ★ between wall assemblies or their sill-plates and foundations;
- ★ between walls and roof/ceilings or attic/ceiling seals and between separate wall panels;
- ★ penetrations of utility services through walls, floors, and roof assemblies, and penetration through the wall cavity of top and/or bottom plates; and
- ★ all other such openings in the building envelope.

This includes sealing around:

- ★ tubs and showers;
- ★ at the attic and crawl space panels;
- ★ at recessed lights; and
- ★ around all plumbing and electrical penetrations.

Recessed lighting fixtures installed in the building envelope must meet *one* of the following requirements:

1. Type IC rated, manufactured with no penetrations between the inside of the recessed fixture and ceiling cavity, and sealed or gasketed to prevent air leakage into the unconditioned space.

2. Type IC or non-IC rated, installed inside a sealed box constructed from a minimum ½" thick gypsum wall board or constructed from a performed polymeric vapor barrier, or other airtight assembly manufactured for this purpose, while maintaining required clearances of not less than ½" from combustible material and not less than 3" from insulation material.

Site-built windows and doors must be weatherstripped.

Section C.1b

Vapor Retarders

Vapor retarders must be installed in all non-vented framed ceilings, walls, and floors. Non-vented areas are framed cavities without vents or other openings that allow the free movement of air.

The vapor retarder must have a perm rating of 1.0 or less (tested in accordance with the American Society for Testing and Materials [ASTM] Standard E96-80) and must be installed on the "warm-in-winter side" of the insulation (between the insulation and the conditioned space).

Vapor retarders are not required where moisture or its freezing will not damage building materials and/or insulation.

Section C.2

Materials & Equipment Information

Insulation R-values and glazing and door U-values 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.) If credit is taken for high-efficiency heating or cooling equipment, the equipment efficiency, make and model number must also be marked on the plans or specifications.

Materials and equipment must be identified so that compliance with the Energy Code can be determined. There are several ways to label materials and equipment to satisfy this requirement.

- ★ By properly posting the *Vermont Residential Building Energy Standards Certificate* completed for every house. Materials and equipment must be identified on this label, which must then be posted in the residence (e.g., on the main electrical panel, on heating or cooling equipment or nearby in a visible location) to document the energy-efficiency features of the building.
- ★ By providing labels on all pertinent materials and equipment. For example, the R-value of the insulation is often pre-printed directly on the insulation or can be determined from a striping code. Window U-values are often included on the manufacturer label posted directly on the window.
- ★ By providing contractor statements certifying the products they have installed. For example, the insulation contractor would certify the R-value of the installed insulation.

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, or thickness markers must be placed in attics at least once every 300 square feet.

In addition, manufacturer manuals for all installed heating and cooling equipment and service water heating equipment must be provided.

Section C.3

Heating and Cooling

Section C.3a

Heating and Cooling Equipment Efficiencies

Heating and cooling equipment must meet the National Appliance Energy Conservation Act of 1987 (NAECA), which sets federally mandated equipment efficiency minimums for most residential equipment. Ensure that any equipment you are using that was manufactured before 1987 still meets these standards.

Table C-1

Minimum Efficiencies

for Typical Residential Heating Equipment

Equipment Type	*Minimum Efficiency*
Boiler	80% AFUE
Furnace	78% AFUE
Heat Pump	6.8 HSPF
Air Conditioner	10 SEER

Note: NAECA does not specify minimum efficiencies for groundwater-source heat pumps, duct furnaces, unit heaters, or wood stoves. For these items, the following requirements apply:

For groundwater-source heat pumps, the Energy Code specifies a minimum COP of 3.4 (heating mode) and a minimum EER of 11.0 (cooling mode) for high-temperature rating conditions (70 F). For low temperature rating conditions (50 F), the Code specifies a minimum COP of 3.0 (heating mode) and a minimum EER of 11.5 (cooling mode).

For duct furnaces and unit heaters, refer to Appendix D.

Section C.3b

Design Load Calculation

A heating and cooling (if applicable) design load calculation for the purpose of sizing these systems must be performed.

Table C-2

Minimum HVAC Piping Insulation Thickness[1]

Piping System Types	*Fluid Temp Range (°F)*	*Insulation Thickness in Inches by Pipe Sizes[2]*			
		Runouts[3]	*1" and less*	*1.25" to 2"*	*2.5" to 4"*
HEATING SYSTEMS					
• Low Pressure/Temperature	201 – 250	1.0	1.5	1.5	2.0
• Low Temperature	120 – 200	0.5	1.0	1.0	1.5
• Steam Condensate (for feed water)	Any	1.0	1.0	1.5	2.0
COOLING SYSTEMS					
• Chilled Water	40– 55	0.5	0.5	0.75	1.0

[1] Pipe insulation thicknesses specified in this table are based on insulation R-values ranging from R-4 to R-4.6 per inch of thickness. For materials with an R-value greater than R-4.6, the insulation thickness specified in this table may be reduced as follows: *New minimum thickness = 4.6 x Table 2 & 3 thickness / Actual R-value.* For materials with an R-value less than R-4, the minimum insulation thickness must be increased as follows: *New minimum thickness = 4 x Table 2 & 3 thickness / Actual R-value.*

[2] For piping exposed to outdoor air, increase thickness by 0.5".

[3] Applies to all runouts 2" and less, not exceeding 12' in length to individual terminal units.

For piping systems that fall outside the specified categories, see MEC Table 503.9.

Section C.3c

Duct Insulation

Supply and return ductwork for heating and cooling systems located in unconditioned spaces (such as attics, crawlspaces, unheated basements and garages, and exterior cavities) must be insulated to R-5 (except for return ducts in unconditioned basements only, for which the minimum is R-3.3). When ducts run outside the building, they must be insulated to at least R-8. When ducts are located in exterior building cavities, either:

- ★ the full insulation R-value requirement for that building component must be installed between the duct and the building exterior (i.e., rigid insulation in the wall cavity between the duct and the exterior sheathing), in which case the ducts do not require insulation, **or**
- ★ the ducts must be insulated to R-5 and the duct area must be treated as a separate component. (For example, if ducts insulated to R-5 are located in an exterior wall insulated to R-19, the area of the wall minus the duct area is a wall component with R-19 insulation, and the area of the ducts is a wall component with R-5 insulation.)

Duct insulation is *not* required in the following cases:

- ★ within heating, ventilating, and air conditioning (HVAC) equipment;
- ★ within conditioned spaces; and
- ★ when the design temperature difference between the air in the duct and the surrounding air is 15 degrees F or less.

Additional insulation with vapor barrier is required if condensation will create a problem.

Table C-3

Minimum Pipe Insulation for Circulating Potable Water Systems

Heated Water Temperature (°F)	Insulation Thickness by Pipe Sizes[1]			
	Non-Circulating Runouts	Circulating Mains and Runouts		
	Up to 1"	Up to 1.25"	1.5" to 2.0"	Over 2.0"
170–180	0.5	1.0	1.5	2.0
140-160	0.5	0.5	1.0	1.5
100-130	0.5	0.5	0.5	1.0

[1] Nominal pipe size and insulation thickness

Section C.3d

Duct Sealing

Ducts must be sealed using mastic with fibrous backing tape when:

- ★ located in unconditioned spaces;
- ★ not completely surrounded by conditioned space; or
- ★ when building cavities are used for ducts.

Note: This requirement is proposed for CABO-MEC 1998 and is permissible in Vermont, even though current Code language requires duct sealing in conditioned *and* unconditioned spaces.

Pressure-sensitive tape may be used for fibrous ducts, but only if approved for that use and installed according to NAIMA standards. **Duct tape is *not* permitted.**

Section C.3e

Duct Construction

Ductwork must be constructed and erected in accordance with one of the industry standards (e.g., NAIMA, SMACNA, ACCA).

Section C.3f

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.

Section C.3g

Temperature Controls

For all homes covered by the Code, each heating and cooling system must have a thermostat with at least the following range:

★ heating only .....55 to 75 degrees F

★ heating and cooling .....55 to 85 degrees F

For combined systems, the thermostat must be capable of operating the system in heating and in cooling in sequence (i.e., simultaneous operation is not permitted).

Heat pump installations 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.

For one- and two-family buildings, at least one thermostat must be provided for each separate system (heating, cooling, or combination heating and cooling). Electric baseboard heaters can be individually controlled by separate thermostats, or several baseboard heaters can be controlled by a single thermostat.

For multifamily buildings, each dwelling unit must have: (1) a separate thermostat and (2) a readily accessible manual or automatic means to restrict or shut off the heating and/or cooling input to each room. Operable diffusers or registers that can restrict or shut off the airflow into a room meet this requirement. In addition, at least one thermostat must be provided for each system or each zone in the non-dwelling portions of multifamily buildings. (For example, separate systems serving interior corridors or attached laundry rooms must have their own thermostat.)

Section C.3h

HVAC Piping Insulation

All HVAC piping (such as in hydronic heating systems) installed in unconditioned spaces and conveying fluids at temperatures greater than 120 degrees F or chilled fluids at less than 55 degrees F must be insulated to the thicknesses specified in Table C-2. Pipe insulation is not required for piping installed within HVAC equipment.

Section C.4

Service (Potable) Water Heating

Section C.4a

Domestic Hot Water Equipment Efficiencies

Water heating equipment must meet the National Appliance Energy Conservation Act of 1987 (NAECA), which sets federally mandated equipment efficiency minimums for most residential equipment. Residential-sized gas and oil equipment manufactured in the USA since 1987 meets these minimum efficiencies.

Section C.4b

Tank Insulation

Domestic hot water tanks must incorporate a minimum total R-14 insulation, except where a warranty is voided by installing tank wrap. Stand-alone domestic water heaters must include at least **one** of the following:

- ★ internal heat traps built into the water heater;
- ★ site-built external heat traps;
- ★ at least 0.5" pipe insulation for the first accessible 6' on noncirculating hot and cold water pipes.

Section C.4c

Circulating Service Hot Water Systems

Circulating hot water systems must have automatic or manual controls that allow the pumps to be conveniently turned off when the hot water system is not in operation.

Piping in circulating hot water systems must be insulated to the levels specified in Table C-2 unless an engineering calculation is provided that demonstrates that insulation will not reduce the annual energy requirements of the building.

Section C.4d

Swimming Pools

All heated swimming pools must be equipped with an on/off pool heater switch mounted for easy access. Heated pools require a pool cover unless over 20% of the heating energy is from non-depletable sources (such as solar heat). All swimming pool pumps must be equipped with a time clock.

Section C.5

Electrical

In most cases, each individual dwelling unit in a multifamily 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.

Section C.6

Dampers

Exhaust dampers are required for kitchen and bathroom exhaust fans, and for clothes dryers. Fireplaces must include tight-fitting doors *and* at least **one** of the following:

★ a tight-fitting chimney damper; or

★ a chimney cap damper.

Vermont Residential Building Energy Code

Basic Requirements ~ *Summary*

Note: This is an overview of key points. See full text of Appendix C for complete details.

1	**Air Leakage**	Seal all joints, access holes and other such openings in the building envelope, as well as connections between building assemblies. In insulated ceilings, recessed lights must be either(1) Insulation Contact (1C) rated and designed as airtight *or* (2) installed inside an airtight assembly, with a 0.5-inch clearance from combustible materials and a 3-inch clearance from insulation.
2	**Vapor Retarder**	For non-vented framed ceilings, wall and floors, install a vapor retarder (i.e., 6 mil. plastic or vapor-barrier paint) on the warm-in-winter side of the insulation.
3	**Duct Insulation**	In unconditioned basements, crawlspaces and attics, insulate supply and return ducts for heating and cooling systems to R-5. Insulate ducts outside the building to R-8.
4	**Duct Sealing**	In unconditioned spaces, seal ducts using mastic with fibrous backing tape. (Pressure-sensitive tape maybe used only for duct-board systems, in accordance with NAIMA standards.) **Duct tape is not permitted.**
5	**HVAC Systems: Efficiency & Balancing**	HVAC heating and cooling systems must comply with minimum federal efficiency standards 80% AFUE for residential boilers; 78% AFUE for furnaces). All HVAC systems must provide a means of balancing, such as air dampers, adjustable registers or balancing valves.
6	**Temperature Controls**	Each separate HVAC zone must have its own thermostat.
7	**HVAC Piping Insulation**	In unconditioned crawlspaces, basements or attics, insulate HVAC piping to R-4 (i.e., with a 1" thickness of foam or compressed fiberglass). Insulate HVAC piping outside the building to R-6.
8	**Swimming Pools**	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.
9	**Domestic Hot Water**	Domestic hot water tanks must meet minimum federal efficiency standards that apply to all equipment manufactured after 1992. Except when the warranty would be voided by installing a tank wrap, tanks must have a minimum total R-value of 14. Stand-alone domestic water heaters must incorporate at least one of the following: (a) internal heat traps; (b) external heat traps; or(c) pipe insulation for the first accessible 6 feet on non-circulating hot and cold water pipes. For circulating systems, refer to Section C4c.
10	**Fireplaces**	Fireplaces must incorporate tight-fitting doors and either a tight-fitting chimney damper or a chimney cap damper (preferably both).
11	**Exhaust Fans**	Exhaust dampers are required for kitchen, bath and dryer fans.
12	**Electric Systems**	In most cases, each unit of a multifamily dwelling must have a separate electric meter. See Appendix D for exceptions.
13	**Ventilation & Combustion Air**	All homes must have an automatically controlled ventilation system. Chimney-vented combustion devices must have combustion air. See Chapter 2 for details.

For details about any of these requirements, see the full text of this appendix.

Appendix D:

Multifamily Buildings

The Energy Code applies to multifamily buildings of three units or more if they are three stories or less. (Duplexes are considered in the same category as single-family homes.) The Code applies to dwelling units that include independent permanent provisions for living, sleeping, cooking and sanitation, such as apartments, condominiums and townhouses. It does not apply to hotels, motels, barracks, dormitories or nursing homes.

Section D.1

Space Heating and Cooling

Section D.1a

Equipment Efficiency

The Code uses several different measures of efficiency for heating and cooling systems, depending on the type of system. This information usually can be found on the unit's nameplate or obtained from the manufacturer. It also can be obtained by referring to certified product directories such as those published by the Air Conditioning and Refrigeration Institute (ARI) or the Gas Appliance Manufacturer's Association (GAMA).

Section D.1b

Heating Equipment

For small gas and oil systems, the Code's accepted measure of efficiency is Annual Fuel Utilization Efficiency (AFUE). For larger systems, Thermal Efficiency (TE) is used. This is defined as the unit's output rating divided by the input rating (sometimes referred to as "steady-state efficiency").

Heat pumps are rated for heating efficiency by using either Heating Seasonal Performance Factor (HSPF) or Coefficient of Performance (COP). Note that some of these systems are classified according to their cooling capacity, but the efficiencies listed in Table D-1 on the following page refer to heating mode efficiency. Heat pumps must have a control to prevent supplementary heater operation when the heating load can be met by the heat pump alone.

Section D.1c

Cooling Equipment

Air conditioners and heat pumps are rated for cooling efficiency by using either the Energy Efficiency Ratio (EER), Seasonal Energy Efficiency Ratio (SEER), or Integrated Part-Load Value (IPLV). Code requirements for cooling equipment are noted in Table D-2.

Section D.1d

Heating & Cooling Controls

Each dwelling unit must have an individual thermostat and a readily accessible manual or automatic means to restrict or shut off the heating or cooling input sto each room of each dwelling unit. Operable diffusers or registers that can restrict or shut off airflow into a room meet this requirement.

If non-dwelling portions (hallways, utility spaces, etc.) of the building are conditioned, each separate system must have its own zone. At a minimum, each floor of non-dwelling portions must be considered a zone and have its own thermostat.

Section D.2

Service Water Heating

Section D.2a

Equipment Efficiency

Water heating equipment sized for typical single-family applications is covered by the National Appliance Energy Conservation Act (NAECA) of 1987, which requires all equipment manufactured in the USA since 1987 to meet a minimum efficiency. Table D-3 lists the minimum efficiencies for larger systems not covered by NAECA. Unfired storage tanks must have a standby loss (% per hour) of ≤ 6.5 Btuh/ft.sq.

Circulating hot water systems must have automatic or manual controls that allow the pump to be conveniently turned off when the hot water system is not in operation. In addition, circulating-system piping must be insulated to the values shown in Table D-4.

Table D-1

Minimum Efficiencies for Heating Equipment

Type of Equipment	*Minimum Efficiency*
Gas Furnace <225,000 Btu/hr	78% AFUE
Gas Furnace >225,000 Btu/hr	80% TE at maximum capacity, 78% at minimum capacity
Oil Furnace <225,000 Btu/hr	78% AFUE
Oil Furnace >225,000 Btu/hr	81% TE
Gas Duct Furnace	78% at maximum capacity, 75% at minimum capacity
Gas Unit Heater	78% at maximum capacity, 74% at minimum capacity
Oil Unit Heater	81% TE
Gas Boiler <300,000 Btu/hr	80% AFUE
Gas Boiler >300,000 Btu/hr	80% TE
Oil Boiler < 300,000 Btu/hr	80% AFUE
Oil Boiler >300,000 Btu/hr	83% TE
Air Source Heat Pump <65,000 Btu/hr Cooling Capacity, Split System	6.8 HSPF
Air Source Heat Pump <65,000 Btu/hr Cooling Capacity, Single Package	6.6 HSPF
Air Source Heat Pump 65,000-135,000 Btu/hr Cooling Capacity	3.0 COP high-temperature rating, 2.0 COP low-temperature rating
Air Source Heat Pump >135,000 Btu/hr Cooling Capacity	2.9 COP high-temperature rating, 2.0 COP low-temperature rating
Water-Source Heat Pump	3.8 COP
Groundwater-Source Heat Pump	3.4 COP high-temperature rating, 3.0 COP low-temperature rating
Packaged Terminal Heat Pump	2.9 – (0.026 x Cap/1000) COP[1]

[1] "Cap" in this formula refers to the rated cooling capacity. If the unit's capacity is <7,000 Btu/hr, use 7,000 Btu/hr in the calculation. If the capacity is >15,000, use 15,000 in the calculation.

Section D.3

Building Air Tightness

The requirements for air tightness of the building shell are no different for multifamily buildings than for single-family residences, but multifamily buildings often have construction details not found in single-family homes.

Party/fire walls can be a challenge to air seal. They usually consist of multiple layers and cavities, not all of which are easily accessible at the location of the thermal envelope. In all buildings, it is important to achieve an effective air seal at the top of the building.

Party walls and firewalls should have a continuous and unbroken horizontal air seal at the attic floor. If this air seal is not built into the assembly, it may be necessary to access and fill

any cavities that extend above the attic floor. Builders should ensure that any air sealing at this location is in accordance with all local building and fire codes. In general, an air seal in this location is beneficial for both air sealing and fire protection, but specific materials may have to be used in order to maintain firewall integrity.

Multifamily buildings sometimes include parking on the bottom floor or an attached garage. As with smaller buildings, it is important to minimize any airflow from the parking area to the living space. The same applies to utility spaces that may contain air pollutants such as carbon monoxide, solvents, pesticides, cleaning agents, etc.

Multifamily buildings often have larger pollutant sources than smaller buildings. In addition, tall buildings experience greater stack effects in cold weather, and therefore are more likely to pull in whatever air is available at the bottom of the building. Any building with parking on the

Table D-2

Minimum Efficiencies for Cooling Equipment

Type of Equipment	*Minimum Efficiency*
Unitary Air Conditioner, <135,000 Btu/hr Cooling Capacity, Split System (except packaged terminal and room air conditioners)	10.0 SEER
Unitary Air Conditioner, <135,000 Btu/hr Cooling Capacity, Single Package (except packaged terminal and room air conditioners)	9.7 SEER
Unitary Air Conditioner, 65,000-135,000 Btu/hr Cooling Capacity (except packaged terminal and room air conditioners)	8.9 EER, 8.3 IPLV
Unitary Air Conditioner, 135,000-760,000 Btu/hr Cooling Capacity	8.5 EER, 7.5 IPLV
Unitary Air Conditioner, >760,000 Btu/hr Cooling Capacity	8.2 EER, 7.5 IPLV
Air-Source Heat Pump, 135,000-760,000 Btu/hr Cooling Capacity	8.5 EER, 7.5 IPLV
Air-Source Heat Pump, >760,000 Btu/hr Cooling Capacity	8.2 EER, 7.5 IPLV
Water-Source Heat Pump, <65,000 Btu/hr Cooling Capacity	9.3 EER standard rating, 10.2 EER low- temperature rating
Water-Source Heat Pump, 65,000-135,000 Btu/hr Cooling Capacity	10.5 EER
Groundwater-Source Heat Pump	11.0 EER standard rating; 11.5 EER low-temperature rating
Water-Cooled Unitary Air Conditioner, <65,000 Btu/hr Cooling Capacity	9.3 EER, 8.3 IPLV
Water-Cooled Unitary Air Conditioner, 65,000-135,000 Btu/hr Cooling Capacity	10.5 EER
Water-Cooled Unitary Air Conditioner, >135,000 Btu/hr Cooling Capacity	9.6 EER, 9.0 IPLV
Air-Cooled Condensing Unit	9.9 EER, 11.0 IPLV
Water-Cooled Condensing Unit	12.9 EER, 12.9 IPLV
Packaged Terminal Air Conditioner	10.0 – (0.16 x Cap/1000) EER standard rating; 12.2 – (0.20 x Cap/1000) EER low-temp rating[1]
Room Air Conditioner without reverse cycle, <6,000 Btu/hr	8.0 EER
Room Air Conditioner without reverse cycle, 6,000-8,000 Btu/hr	8.5 EER
Room Air Conditioner without reverse cycle, 8,000-14,000 Btu/hr	9.0 EER
Room Air Conditioner without reverse, cycle 14,000-20,000 Btu/hr	8.8 EER
Room Air Conditioner without reverse cycle, 20,000 Btu/hr	8.2 EER
Room Air Conditioner with reverse cycle and with louvered sides	8.5 EER
Room Air Conditioner with reverse cycle, without louvered sides	8.0 EER

[1] "Cap" in this formula refers to the rated cooling capacity. If the unit's capacity is <7,000 Btu/hr, use 7,000 Btu/hr in the calculation. If the capacity is >15,000, use 15,000 in the calculation.

bottom level should be carefully air sealed to prevent exhaust gas from being pulled into the building, even if the parking area is well-ventilated or open to the outdoors.

Section D.4

Electrical Service

In most cases, each individual dwelling unit in a multifamily 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.

Table D-3

Minimum Efficiencies for Service Water Heating Equipment

Equipment Type	*Minimum Efficiency*
Storage Electric >155,000 Btu/hr	78% TE
Storage Gas >75,000 Btu/hr	80% TE
Storage Oil >105,000 Btu/hr	80% TE
Instantaneous Gas >200,000 Btu/hr	77% TE
Instantaneous Oil >155,000 Btu/hr	77% TE

Note: Unfired storage tanks must have a standby loss (% per hour) of ≤ 6.5 Btuh/ft. sq.

Section D.5

Lighting Power Density

The lighting system in the nondwelling portions of multifamily residential buildings shall meet the applicable provisions of ASHRAE 90.1, summarized in Table D-5. The table lists the maximum power allowance for common usage areas found in multifamily buildings.

Table D-4

Minimum Pipe Insulation for Circulating Potable Water Systems

Heated Water Temperature (°F)	**Insulation Thickness by Pipe Sizes[1]**			
	Non-Circulating Runouts	*Circulating Mains and Runouts*		
	Up to 1"	*Up to 1.25"*	*1.5" to 2.0"*	*Over 2.0"*
170–180	0.5	1.0	1.5	2.0
140-160	0.5	0.5	1.0	1.5
100-130	0.5	0.5	0.5	1.0

[1] Nominal pipe size and insulation thickness

Table D-5

Lighting Power Density

Non-Dwelling Area in Multifamily Buildings	*Maximum Power Allowance*
Corridor/Hallway	0.7 watts per sq. ft.
Lobby	1.7 watts per sq. ft.
Electrical/Mechanical Room	1.3 watts per sq. ft.
Active Storage Areas	1.1 watts per sq. ft.

Appendix E

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 888-37-ECALL (888-373-2255).

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.

Energy Code Web Site

For more detail and background on the Vermont Residential Buildings Energy Code, check the web site maintained by the Department of Public Service at http://www.state.vt.us/psd.

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: 802-865-7337 or www.burlingtonelectric.com.

Building for Social Responsibility

BSR is a small group of Vermont builders and allied professionals concerned with the environmental, economic, and health effects of home construction. Members meet monthly and sponsor occasional educational events. Information: Building for Social Responsibility, PO Box 614, Hinesburg, VT 05461. Send e-mail to info@bsr-vt.org.

Efficiency Vermont

Efficiency Vermont is the nation's first statewide provider of energy-efficiency services. Efficiency Vermont is operated by an independent, nonprofit organization under contract to the Vermont Public Service Board. 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.

Home Builders & Remodelers Associations

These trade organizations are actively involved in building issues and other activities in support of the building industry. There are two chapters of the National Association of Home Builders (Washington, DC; 800-368-5242) located in Vermont:

- Home Builders and Remodelers Association of Southern Vermont: 802-773-0672
- Home Builders & Remodelers Association of Northern Vermont: 802-651-0519

continued on next page

Vermont Department of Public Service

The Vermont Department of Public Service (DPS), Energy Efficiency Division, is responsible for the administration of the Energy Code. For questions regarding Code interpretation, rules and enforcement, contact DPS at 800-642-3281 (toll free from anywhere in Vermont) or 802-828-4056.

Vermont Energy Investment Corporation

VEIC is a nonprofit organization that issues home energy ratings for new and existing 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 Energy Code. Contact VEIC at 800-639-6069.

Vermont ENERGY STAR® *Homes Service*

Efficiency Vermont and Vermont Gas Systems sponsor this voluntary residential new construction energy-efficiency service throughout the state. Cash incentives and rebates are available for integrating energy-efficient building design with high efficiency lighting and appliances. Energy Code support, builder and home owner/buyer training and advice, and home energy rating services are available. Services and incentives also are available for multi-family low-income housing and market-rate housing. Information: 800-893-1997.

Vermont Gas Systems

Vermont Gas Systems supplies natural gas service to northwestern Vermont and has provided energy-effciency 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.

Appendix F

Residential Building Energy Standards Legislation

The Vermont Energy Code (officially "Residential Building Energy Standards" or "RBES"), is Vermont's statewide residential new construction energy code. Created by a task force assembled by Governor Howard Dean in the fall of 1995, the 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 original Energy Code took effect July 1, 1997. As required by statute, the Energy Code followed an update process beginning in 1999. The Energy Code that takes effect January 1, 2005, is a direct result of that process.

The update process was led by the Vermont DPS in cooperation with the Vermont Department of Labor and Industry where they convened an advisory committee of interested stakeholders to review the current code and make recommendations for changes and improvements. The first meeting of the 1999 RBES Update Advisory Committee was held on May 28, 1999. Tasha Wallis, Deputy Commissioner of the Department of Labor and Industry (DLI), and Scudder Parker, Director of Energy Efficiency Division of DPS, acted as co-chairs. Jeff Forward of Richmond Energy Associates was hired by DPS to provide staffing to the committee.

The committee met a total of six times and discussed a wide variety of issues. Their final recommendations were published in a report dated December 1, 2000. The revisions to the 2000 edition of the International Energy Conservation Code presented in this document were drafted based on the concepts and elements published in the advisory committee's final report. The advisory committee was conducted primarily through a consensus-building process. Extensive outreach to affected stakeholders was performed to inform them about the process and to obtain their input.

The Vermont Residential Building Energy Standard (RBES), as based on the International Energy Conservation Code® 2000 edition, is 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. It is founded on broad-based principles that make possible the use of new materials and energy-efficient designs.

RBES requires efficiency greater than the 1995 Council of American Building Officials (CABO) Model Energy Code for single-family homes (+5%) and multifamily homes (+10%), and 20% lower efficiency for log homes. This RBES, as based on the 2000 edition of the IECC, is now one step closer to becoming fully compatible with all the International Codes ("I-Codes") published by the International Code Council (ICC), including the International Building Code, ICC Electrical Code, International Existing Building Code, International Fire Code, International Fuel Gas Code, International Mechanical Code, ICC Performance Code, International Plumbing Code, International Private Sewage Disposal Code, International Property Maintenance Code, International Residential Code, International Urban-Wildland Interface Code, and International Zoning Code.

In addition to adopting the provisions of CABO-MEC, the Vermont Energy Code includes additional, Vermont-specific requirements for exhaust vents, fireplaces and water-heater insulation.

For More Information

For additional information about the legislation, contact the Vermont Department of Public Service (DPS) at 800-642-3281 (in state) or 802-828-4056. For a copy of the complete legislation and more detail on the Code, visit the DPS web site at www.state.vt.us/psd.