

Vermont Residential Energy Code

Handbook

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

Edition E-1.0
March 1998

Energy Code Assistance Center
255 South Champlain St.
Burlington, VT 05401
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



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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 This 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 technical requirement of the Energy Code, review the Basic Requirements on the inside front cover, and read Chapter 3, "The Fast-Track Method."*
- ★ *For an overview of the Code, read the following chapters:*
 - ✓ **Introduction: The Vermont Residential Energy Code** — summarizes the key features of the Code.
 - ✓ **Chapter 1: Rules for Compliance** — explains in detail what buildings must comply and what buildings are exempt.
 - ✓ **Chapter 2: Guidelines for Calculations** — illustrates how to perform the necessary calculations.
 - ✓ **Chapter 7: The Certificate** — specifies how to accurately certify compliance with the Code.
- ★ *The Appendices are also recommended. The Appendices include definitions (the place to look for clarification of terms used throughout the handbook), default R- and U-values, additional details about Basic Requirements, and Vermont-specific resources for builders.*

If You Need Help

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

. This chapter
. summarizes the
. key features of
. the Vermont
. Residential
. Energy Code that
. takes full effect
. July 1, 1998.
. .

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), it is a minimum standard of energy efficiency that applies to virtually *all new residential construction in Vermont starting July 1, 1998*. Most new homes built in Vermont already meet or are very close to meeting the Code.

What Buildings Must Comply?

- ★ Detached one- and two-family dwellings.
- ★ Multifamily and all other residential dwellings 3 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 Contact the Inspection Services Division of the Burlington Department of Public Works (863-9094) for information on city code requirements for renovations.

. A detailed survey of 200
. homes built in Vermont
. between 1993 and 1994
. found that 66% of the
. homes would meet most of
. the technical requirements
. of what is now the
. Vermont Residential
. Energy Code. Many
. builders will need to do
. very little to comply with
. the Code; others may find
. that some improvements —
. such as basement
. insulation and/or the use
. of low-E windows — are
. necessary.
. .

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

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.² The whole process can be summarized as follows:

1. Determine whether you need to comply (Chapter 1);
2. Follow the Rules for Calculations (Chapter 2);
3. Select and complete the Compliance Method that works best for you (Chapters 3-6); and
4. Fill out, file and post the required compliance certificate (Chapter 7).

Compliance Methods

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

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

Five 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 five compliance methods are:

- Fast-Track Method** The simplest approach. Allows you to incorporate a prescribed set of features. Minimal calculations. (See Chapter 3.)
- 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 4.)
- VTcheck Software Method** Use your computer with VTcheck software to easily analyze almost any design and determine whether any modifications are needed to meet the Code. (See Chapter 5.)
- 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 and solar orientation. (See Chapter 6.)
- Systems Analysis Method** Hire an architect or engineer to perform a state-approved systems analysis, which can accommodate any design. (See Chapter 6.)

² 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 review, appeals, and exemption procedures. 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*

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 — 1-888-37-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, Energy Mortgages and home energy ratings
- ★ Sources for energy-efficient products
- ★ Customized workshops and presentations on energy-efficient building practices. (Call for information.)

E-CALL Hotline

1-888-37-ECALL

(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 to learn about upcoming workshops, as well as to register and place orders for handbooks, certificates and other Code-related materials.

Energy Code 
Assistance Center

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.** Call the Energy Code Assistance Center (1-888-37-ECALL) to obtain a copy of the Multifamily Supplement to the Energy Code, which details technical and certification provisions for multifamily buildings.
- ★ **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 7.)
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.) Residential buildings with Act 250 permits dated after July 1, 1997, must comply with the Code in effect at the time construction begins. (If you fail to comply with the Energy Code as required by Act 250, you will be in violation of Act 250 and subject to the enforcement mechanisms of that Act as well as the Energy Code.)

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 7.)

· This chapter
· explains how to
· calculate:
· ★ Glazing
· percentages
· ★ Average
· R-values
· ★ Average
· U-values.
·

Chapter 2

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 2.1

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 2.2

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.

Section 2.3

How to Calculate the Glazing Percentage

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

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

INCLUDE in the Gross Wall Area:

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

DO NOT INCLUDE in the Gross Wall Area:

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

2. Sum the Glazing Area in square feet.

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

INCLUDE in the Glazing Area:

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

DO NOT INCLUDE in the Glazing Area:

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

3. Calculate the Glazing Percentage.

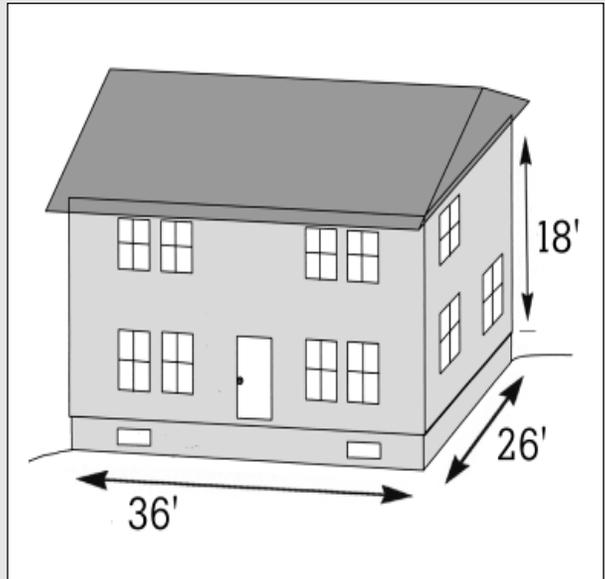
Divide the Glazing Area by the Gross Wall Area and multiply the result by 100.

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

· 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 through
 · adjacent uninsulated
 · building surfaces. Base-
 · ments and crawl spaces
 · without ceiling insulation
 · are considered conditioned
 · space.

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 (2 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.

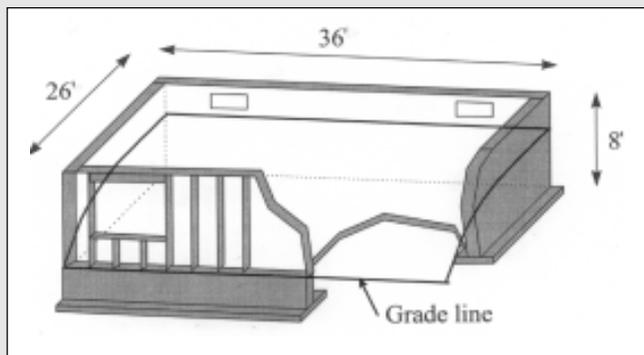
Example A: House with a Standard Basement

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 $(258 / 2,232) \times 100 = 11.6\%$

Example B: House with a Walkout Basement

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



1. Gross Wall Area: $2,232 + 288 = 2,520$ sq. ft.
 Each basement wall must be considered individually. Since only one 36' wall is more than 50% above grade, it is now included in the Gross Wall Area; $36' \times 8' \text{ high} = 288$ sq. ft.
2. Glazing Area: $258 + 60 = 318$ sq. ft.
3. Glazing Percentage: $(318 / 2,520) \times 100 = 12.6\%$

Section 2.4

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 2.4a

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 2.4b

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 ($U\text{-value} = 1/R\text{-value}$).

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

Section 2.5

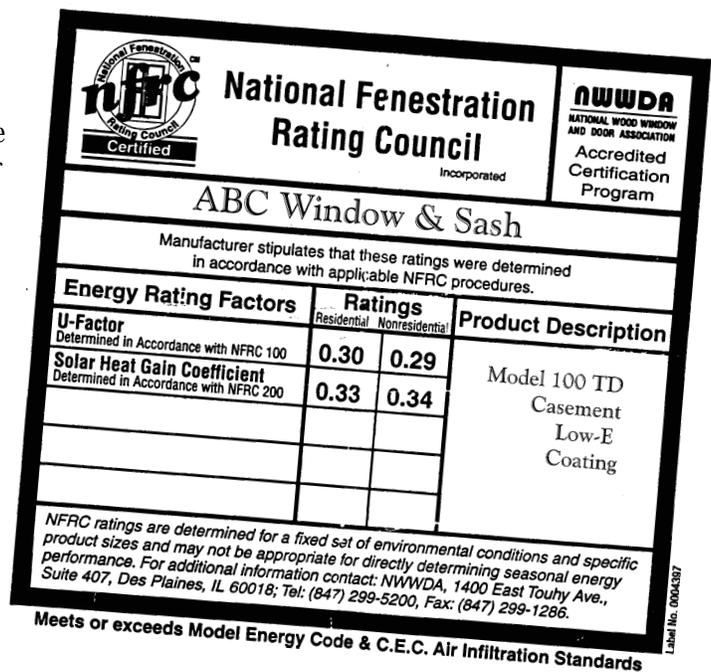
How to Calculate Average R-values and U-values

Section 2.5a

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:



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

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 2.5b

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.**

- This chapter reviews:
- ★ Homes eligible for the Fast-Track Method – a simple method for meeting the Energy Code and the easiest way to ensure compliance
- ★ When and how to use the Fast-Track Method
- ★ Fast-Track Performance Requirements

Chapter 3

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 two components to the Energy Code’s technical requirement that must be evaluated for each home: the **Basic Requirements** (see inside front cover) 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*.

Section 3.1

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 18.) It can be used for all types of homes *except*:

- ★ homes using metal framing for exterior walls (see Chapter 5 or 6); and
- ★ homes using wood heat as the primary heating system (see Chapter 6).

If the values for your home do not meet the values specified in one of the six packages and you do not want to change your design, you can choose another compliance method, such as the Trade-Off Method (Chapter 4), the VT*check* Software Method (Chapter 5) or the Professional Services Method (Chapter 6).

Section 3.2

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

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

- **There Are Two 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); and
- ★ **The Performance Requirements:** requirements that vary based on the compliance method selected.

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. **Calculate your home's Glazing Percentage.** (See Section 2.3 if you need help.)
3. **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 2.5 if you need help.)
4. **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.*
5. **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.

6. **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 7.

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 works for you, consider another compliance method (Chapters 4, 5 or 6).

7. **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 7 for detailed instructions.)

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 3-1.

★ **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 3-2.

★ **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 3-3.

*When to Evaluate
with Fast-Track*

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

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

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.

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

Fast-Track Tables
for single-family, log
and multifamily homes
begin on the next page.

Fast-Track Performance Table for Single-Family Homes

Table 3-1

Performance Requirements						
Single-Family Homes ~ Fast-Track Method						
Component	Typical Pkg	Pkg 1	Pkg 2	Pkg 3	Pkg 4	Pkg 5
1. Ceiling Flats	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 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 2.5a.)
- 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 2.5b to calculate average U-values.)
- C **Window and Door Exemptions:** You can exclude up to 3% 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).

Fast-Track Performance Table for Log Homes

Table 3-2

Performance Requirements

Log Homes ~ Fast-Track Method

Component	Typical Pkg	Pkg 1	Pkg 2	Pkg 3	Pkg 4	Pkg 5
1. Ceiling Flats	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 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 2.5a.)
- 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 2.5b to calculate average U-values.)
- C **Window and Door Exemptions:** You can exclude up to 3% 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).

Fast-Track Performance Table for Multifamily Homes

Table 3-3

Performance Requirements

Multifamily Homes ~ Fast-Track Method

Component	Typical Pkg	Pkg 1	Pkg 2	Pkg 3	Pkg 4	Pkg 5
1. Ceiling Flats	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 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 2.5a.)
- 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 2.5b to calculate average U-values.)
- C **Window and Door Exemptions:** You can exclude up to 3% 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).

This chapter reviews:

- ★ A simple method of Code compliance that accommodates a variety of building designs.
- ★ How high efficiency values in one component can compensate for lower efficiency values in another component
- ★ When and how to use the Trade-Off Method
- ★ Trade-Off Performance Requirements

Chapter 4

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 Two 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);
and
- ★ **The Performance Requirements:** requirements that vary based on the pre-defined compliance packages (see Tables 4-1, 4-2 and 4-3).

Section 4.1

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 Chapter 5 or 6); and
- ★ homes using wood heat as the primary heating system (see Chapter 6).

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 5) or the Professional Services Method (Chapter 6).

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. **Calculate your home's Glazing Percentage.** (See Section 2.3 if you need help.)
3. **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 2.5 if you need help.)
4. **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.*
5. **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.
6. **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 24), you would reference Table 4-1a on the facing page for minimum window U-value, glazing percentage, and AFUE .
7. **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 25, 27 and 29.)
8. **If your home meets or exceeds the requirements for :**
 - ★ a package in the Performance Requirements Table, *and*
 - ★ 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 9.

· *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 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
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

- 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 5 and 6).
9. **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 7 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.
10. **Post the original certificate in the home**, affixing the label on or near the electrical service panel or heating equipment.

The Trade-Off Performance
Tables for single-family,
log and multifamily homes
begin on the next page.

Trade-Off Performance Requirements for Single-Family Homes

Table 4-1

Performance Requirements

Single-Family Homes ~ Trade-Off Method

Component	Typical Pkg	Pkg. 1	Pkg. 2	Pkg. 3	Pkg. 4	Pkg. 5
1. Ceiling Flats	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 4-1a	See Table 4-1b		See Table 4-1c	See Table 4-1d	See Table 4-1e
11. Heating AFUE	(Typical Pkg)	(Packages 1 & 2)		(Package 3)	(Package 4)	(Package 5)
12. Glazing Percentage	on next page	on next page		on next page	on next page	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 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 2.5a.)
- 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 2.5b to calculate average U-values.)
- C **Window and Door Exemptions:** You can exclude up to 3% 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.

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 2.3 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 2.4 and 2.5 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).

Max. Glazing %	Minimum AFUE												
18%													
17%													
16%													
15%													
14%										83			
13%													
12%													
	.30	.32	.34	.36	.38	.40	.42	.44	.46	.48	.50	.52	.54

Maximum Average Window U-Value

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

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	90
	.30	.32	.34	.36	.38	.40	.42	.44	.46	.48	.50	.52	.54

Maximum Average Window U-Value

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	89
	.30	.32	.34	.36	.38	.40	.42	.44	.46	.48	.50	.52	.54

Maximum Average Window U-Value

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	91
12%	M	M	M	M	M	81	82	83	84	86	86	87	88
	.30	.32	.34	.36	.38	.40	.42	.44	.46	.48	.50	.52	.54

Maximum Average Window U-Value

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	91
12%	M	M	M	M	M	81	82	83	84	85	86	87	87
	.30	.32	.34	.36	.38	.40	.42	.44	.46	.48	.50	.52	.54

Maximum Average Window U-Value

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	91
12%	M	M	M	M	M	M	81	82	83	84	85	86	86
	.30	.32	.34	.36	.38	.40	.42	.44	.46	.48	.50	.52	.54

Maximum Average Window U-Value

Trade-Off Performance Requirements for Log Homes

Table 4-2

Performance Requirements				
Log Homes ~ Trade-Off Method				
<i>Component</i>	<i>Typical Pkg</i>	<i>Pkg. 1</i>	<i>Pkg. 2</i>	<i>Pkg. 3</i>
1. Ceiling Flats	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	See	See	See	See
11. Heating AFUE	Table 4-2a <i>(Typical Pkg)</i>	Table 4-2b <i>(Package 1)</i>	Table 4c <i>(Package 1)</i>	Table 4-2d <i>(Package 3)</i>
12. Glazing Percentage	on next page	on next page	on next page	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 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 2.5a.)
- 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 2.5b to calculate average U-values.)
- C **Window and Door Exemptions:** You can exclude up to 3% 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 4-2a

Log Home Trade-Off ~ Typical Package

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	.54	

Maximum Average Window U-Value

Table 4-2b

Log Home Trade-Off ~ Package 1

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	92	
	.30	.32	.34	.36	.38	.40	.42	.44	.46	.48	.50	.52	.54	

Maximum Average Window U-Value

Table 4-2c

Log Home Trade-Off ~ Package 2

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	92	
12%	M	M	81	82	83	84	85	86	87	88	89	90	91	
	.30	.32	.34	.36	.38	.40	.42	.44	.46	.48	.50	.52	.54	

Maximum Average Window U-Value

Table 4-2d

Log Home Trade-Off ~ Package 3

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	92	
13%	M	M	81	82	83	84	85	86	87	88	89	90	91	
12%	M	M	M	81	82	83	84	85	86	87	88	89	90	
	.30	.32	.34	.36	.38	.40	.42	.44	.46	.48	.50	.52	.54	

Maximum Average Window U-Value

Trade-Off Tables for Log Homes

How to Use the Trade-Off Tables

- 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 2.3 for details.
- 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 2.4 and 2.5 for details.
- Refer to the appropriate table for the compliance package you have selected.**
- 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).

Sample Trade-Off Table

Max. Glazing %	Minimum AFUE													
18%														
17%														
16%														
15%														
14%												83		
13%														
12%														
	.30	.32	.34	.36	.38	.40	.42	.44	.46					

Maximum Average Window U-Value

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

Trade-Off Performance Requirements for Multifamily Homes

Table 4-3

Performance Requirements

Multifamily Homes ~ Trade-Off Method

Component	Typical Pkg	Pkg. 1	Pkg. 2	Pkg. 3	Pkg. 4	Pkg. 5
1. Ceiling Flats	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	See	See	See	See	See
11. Heating AFUE	Table 4-3a (Typical Pkg)	Table 4-3b (Packages 1 & 2)	Table 4-3c (Package 3)	Table 4-3d (Package 4)	Table 4-3e (Package 5)	Table 4-3e (Package 5)
12. Glazing Percentage	on next page	on next page	on next page	on next page	on next page	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 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 2.5a.)
- 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 2.5b to calculate average U-values.)
- C **Window and Door Exemptions:** You can exclude up to 3% 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 4-3a

Multifamily Trade-Off ~ Typical Package

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	89		
	.30	.32	.34	.36	.38	.40	.42	.44	.46	.48	.50	.52	.54		

Maximum Average Window U-Value

Table 4-3b

Multifamily Trade-Off ~ Packages 1 & 2

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	89		
	.30	.32	.34	.36	.38	.40	.42	.44	.46	.48	.50	.52	.54		

Maximum Average Window U-Value

Table 4-3c

Multifamily Trade-Off ~ Package 3

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	87		
	.30	.32	.34	.36	.38	.40	.42	.44	.46	.48	.50	.52	.54		

Maximum Average Window U-Value

Table 4-3d

Multifamily Trade-Off ~ Package 4

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	86		
	.30	.32	.34	.36	.38	.40	.42	.44	.46	.48	.50	.52	.54		

Maximum Average Window U-Value

Table 4-3e

Multifamily Trade-Off ~ Package 5

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	85		
	.30	.32	.34	.36	.38	.40	.42	.44	.46	.48	.50	.52	.54		

Maximum Average Window U-Value

Trade-Off Tables for Multifamily Homes

How to Use the Trade-Off Tables

- 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 2.3 for details.
- 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 2.4 and 2.5 for details.
- Refer to the appropriate table for the compliance package you have selected.**
- 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).

Max. Glazing %	Minimum AFUE														
18%															
17%															
16%															
15%															
14%								83							
13%															
12%	.30	.32	.34	.36	.38	.40	.42	.44	.46	.48	.50	.52	.54		

Maximum Average Window U-Value

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 5

The VTcheck Software Compliance Method

The Software Compliance Method involves the use of *VTcheck*, a Windows-based software tool, 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 5.1

How the Software Method Works

Using *VTcheck* 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;¹ 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, as described in Section 5-4. The software performs all the calculations and determines if your home complies with the Energy Code.

VTcheck 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.

Section 5.2

System Requirements

- ★ PC with an Intel 386 processor (or higher)
- ★ Windows 3.1, Windows 95 or Windows NT operating system
- ★ 2 MB RAM
- ★ 2 MB of free hard disk space
- ★ VGA (or Super VGA) monitor

Note: A DOS version (with lower memory and disk-space requirements) is available as well.

¹ Door and window exemptions are specified in the Table Qualifiers (item C) for each Performance Requirements Table. (See chapters 3 and 4.)

Section 5.3

Using VTcheck 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. 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. Refer to the software manual for details.
3. Enter the basic project information using VTcheck software, including the correct weather site (see table on page 34). 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 for complete instructions.
4. Perform the VTcheck software compliance test. The software very quickly 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.
5. Upon completion of construction, repeat step 4 and 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:

In order to comply with the Energy Code using this method, a home must meet all of the Basic Requirements (see inside front cover) and must pass the VTcheck compliance test.

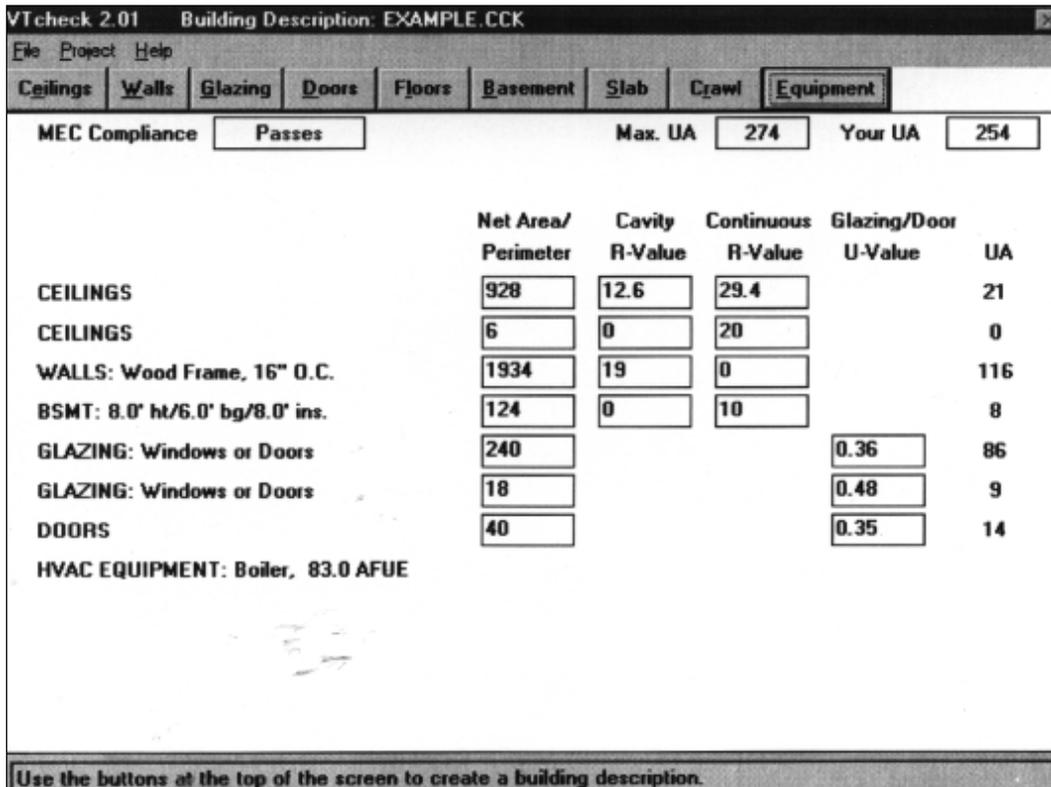


Figure 5-1: Example of a VTcheck screen accessed when entering building-component data.

- a. Complete the certificate when the home is *100% finished*. (See Chapter 7 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.
8. **Post the original certificate in the home**, affixing the label on or near the electrical service panel or heating equipment.

Section 5.4

How to Determine Your Home’s Climate Zone

VTcheck software requires you to enter the “climate zone” for the town where the house you are building is located. Five Vermont towns are considered representative of the different winter temperature ranges throughout the state. These five “climate zone towns” are:

- ★ Burlington (noted as “B” in the table on the next page)
- ★ Chelsea (C)
- ★ St. Johnsbury (J)
- ★ Newport (N)
- ★ Vernon (V)

Reference Table 5-1 on the following page when inputting the climate zone town for your project. Select the climate zone town that corresponds to the town where your home is being built. Note that the climate zone town closest to your building site is not necessarily the right selection.

Section 5.5

How to Obtain *VTcheck* Software

The *VTcheck* software and instruction manual are available by contacting the Energy Code Assistance Center at 1-888-37-ECALL (373-2255).

Table 5-1

Vermont Climate Zones Table

For instructions on the use of this table, see Section 5.4 on the preceding page

Addison V	Danby B	Leicester B	Richmond J	Tunbridge N
Albany C	Danville C	Lemington C	Ripton N	Underhill J
Alburg B	Derby N	Lincoln N	Rochester N	Vergennes B
Andover J	Dorset B	Londonderry N	Rockingham B	Vernon V
Arlington V	Dover N	Lowell C	Roxbury N	Vershire N
Athens B	Dummerston V	Ludlow N	Royalton J	Victory C
Bakersfield N	Duxbury J	Lunenburg N	Rupert V	Waitsfield N
Baltimore B	East Haven C	Lyndon N	Rutland City V	Walden C
Barnard N	Eden C	Maidstone N	Rutland Town V	Wallingford B
Barnet J	Elmore C	Manchester V	Ryegate J	Waltham B
Barre City N	Enosburg J	Marlboro B	Salisbury B	Wardsboro N
Barre Town N	Essex J	Marshfield N	Sandgate V	Warren N
Barton C	E. Montpelier N	Mendon N	Searsburg N	Washington N
Belvidere C	Fair Haven V	Middlebury B	Shaftsbury V	Waterbury N
Bennington V	Fairfax J	Middlesex N	Sharon J	Waterford J
Benson V	Fairfield J	Middletown Springs B	Sheffield J	Waterville N
Berkshire J	Fairlee J	Milton B	Shelburne B	Weathersfield J
Berlin N	Fayson N	Monkton J	Sheldon J	Wells V
Bethel J	Ferrisburg B	Montgomery N	Sherburne C	West Fairlee N
Bloomfield N	Fletcher J	Montpelier N	Shoreham V	West Haven V
Bolton J	Franklin J	Moretown N	Shrewsbury N	West Rutland V
Bradford J	Georgia B	Morgan C	South Hero B	West Windsor J
Braintree N	Glastenbury C	Morristown N	Springfield B	Westfield C
Brandon B	Glover C	Mount Holly N	Stamford B	Westford J
Brattleboro V	Gorton N	Mount Tabor B	Stannard C	Westminter B
Bridgewater N	Goshen J	New Haven B	Starksboro J	Westmore C
Bridport V	Grafton B	Newark C	Stockbridge N	Weston N
Brighton C	Granby C	Newbury J	Stowe N	Weybridge B
Bristol J	Grand Isle B	Newfane B	Stratford N	Wheelock C
Brookfield N	Granville N	Newport N	Stratton C	Whiting B
Brookline B	Greensboro C	North Hero B	St. Albans City B	Whitingham B
Brownington C	Guildhall N	Northfield N	St. Albans Town B	Williamstown N
Brunswick N	Guilford V	Norton C	St. George B	Williston B
Burke C	Halifax B	Norwich J	St. Johnsbury J	Wilmington J
Burlington B	Hancock N	Orange N	Sudbury B	Windham J
Cabot C	Hardwick N	Orwell V	Sunderland V	Windsor J
Calais N	Hartford J	Panton B	Sutton C	Winhall N
Cambridge J	Hartland J	Pawlet V	Swanton B	Winooski B
Canaan C	Highgate B	Peachan N	Theford J	Wolcott N
Castleton V	Hinesburg J	Peru C	Tinmouth J	Woodbury C
Cavendish J	Holland C	Pittsfield N	Topsham N	Woodford N
Charleston C	Hubbardton V	Pittsford B	Townshend B	Woodstock N
Charlotte B	Huntington J	Plainfield N	Troy N	Worcester N
Chelsea N	Hyde Park N	Plymouth C		
Chester B	Ira B	Pomfret N		
Chittenden J	Irasburg N	Poultney V		
Clarendon B	Isle la Motte B	Pownal V		
Colchester B	Jamaica J	Proctor V		
Concord N	Jay C	Putney B		
Corinth N	Jericho J	Randolph N		
Cornwall V	Johnson N	Reading N		
Coventry N	Kirby C	Readsboro B		
Craftsbury C	Landgrove N	Richford J		

Vermont Climate Zone Key

<i>Climate Zone</i>	<i>Town</i>	<i>Corresponding Initial</i>
Burlington	B
Chelsea	C
St. Johnsbury	J
Newport	N
Vernon	V

. This chapter explains:
 . ★ How home energy
 . ratings and systems
 . analysis can
 . demonstrate Code
 . compliance
 . ★ The advantages of
 . having a professional
 . certify compliance
 .

Chapter 6

The Professional Services Compliance Method

Section 6.1

How the Professional Services Method Works

A builder may contract with a professional to determine if the home meets the requirements of the Vermont Energy Code. Professional services may consist of a professional who performs one of the previously discussed compliance methods (Fast-Track, Trade-Off or VT*check* software) as a service for a builder. Whether a builder or a professional evaluates Code compliance using one of these three methods, the technical requirement remains the same.

However, there are two additional, “professional services” compliance methods that a builder may wish to consider in order to demonstrate compliance with the Code. These methods are fundamentally different from the other three because they require sophisticated energy modeling tools to demonstrate that a new home meets or exceeds the technical requirement of the Code. These two methods are:

- ★ Home Energy Rating Method performed by a Vermont state-accredited rating organization
- ★ Systems Analysis Method, as described in Chapter 4 of CABO-MEC 1995 (the 1995 edition of the *Model Energy Code* prepared by the Council of American Building Officials).

Because these methods use sophisticated modeling methods, the results are often very close to the minimum requirements of the Code. These methods also have the ability to model complex buildings or buildings with unusual features, such as high glazing percentages.

Section 6.2

Basic Requirements for Professional Services

The Basic Requirements for Professional Services 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 and those required by the law that created the Vermont Residential Energy Code (Act 20, 1997). They are listed in Table 6-1 on the following page.

. In order to comply with
 . the Energy Code using
 . this method, a home
 . must meet all of the
 . Basic Requirements for
 . Professional Services
 . (Table 6-1) and demon-
 . strate that it uses less
 . energy than a similar
 . home built to Energy
 . Code standards.
 .

Table 6-1

Basic Requirements for Professional Services

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 at least one of the following: (a) tight-fitting doors; (b) a tight-fitting chimney damper; or (c) a chimney cap damper.
5	Exhaust Fans	Exhaust dampers are required for kitchen, bath and dryer fans.
6	Electric Systems	In multifamily dwellings, equip each unit with a separate electric meter.
7	Certification	Complete a <i>Vermont Residential Building Energy Standards Certificate</i> for each dwelling. Send one copy to the Vermont Department of Public Service and one copy to the town clerk for the town in which the property is located, and affix the original on or near the home's electrical panel or heating equipment.

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

Section 6.3

The Home Energy Rating Method

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

In the near future, a formal accreditation process will be set up to determine how and by whom home energy ratings can be issued in Vermont. Until that time, the Vermont Department of Public Service has ruled that home energy ratings can be used to determine whether a home is in compliance with the Energy Code. However, 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 home must meet the Basic Requirements for Professional Services (Table 6-1) *and* earn a minimum energy rating score of:

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

There are three phases to home energy ratings:

- 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. It is your responsibility as builder to sign and file the *Vermont Residential Building Energy Standards Certificate*.

Section 6.3a

Advantages of the Home Energy Rating Method

- ★ *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.

Section 6.4

Systems Analysis Method

The Systems Analysis Method is fully described in Chapter 4 of 1995 CABO-MEC (the 1995 edition of the *Model Energy Code* prepared by the Council of American Building Officials). Licensed architects or engineers who analyze the building using this method are able to certify compliance with the Code. They also are able to sign the *Vermont Residential Building Energy Standards Certificate* and assume any liabilities associated with the certificate.

Section 6.4a

Advantages of the Professional Services Method

- ★ *No math, less paperwork:* A professional performs the calculations and documents compliance.
- ★ *Credit for building performance:* Depending on the calculation method used, you may be able to take credit for airtightness, solar gain, or other performance aspects of your building that are not incorporated into some of the other methods.

Sample Vermont Residential Building Energy Standards Certificate

1997 VT RESIDENTIAL BUILDING ENERGY STANDARDS CERTIFICATE	
Before completing this form, refer to instructions Act 250 Permit #: _____ <input type="checkbox"/> N/A	
Site: _____ <small>Address Town Zip</small>	
Electric Utility: _____	
Construction Start/Completion Date: _____ / _____ <small>Month / Year Month / Year</small>	
Project Description:	<input type="checkbox"/> Single family <input type="checkbox"/> Log Home <input type="checkbox"/> Addition <input type="checkbox"/> Conditioned <input type="checkbox"/> Multi-family Units _____ # Stories: _____ sq.ft.: _____
Foundation Type:	<input type="checkbox"/> Basement <input type="checkbox"/> Crawlspace <input type="checkbox"/> Slab on grade
Floors:	R- _____ Perimeter Slab Edge R- _____ Under Slab R- _____ Over Unheated Spaces
Walls:	R- _____ Above Grade R- _____ Basement R- _____ Crawlspace Depth/Insulation: _____ ft.
Ceilings:	R- _____ Flat R- _____ Sloped
Doors:	U- _____ U- _____ U- _____ Glass Doors
Windows:	U- _____ NFRC/Default Rating U- _____ NFRC/Default Rating <small>(Circle rating type)</small> U- _____ NFRC/Default Rating U- _____ NFRC/Default Rating <small>(basement)</small>
Net window glazing (rough opening) area as a percent of gross exterior wall area: _____ %	
Space Heat:	Fuel: <input type="checkbox"/> Oil <input type="checkbox"/> Kerosene <input type="checkbox"/> Propane <input type="checkbox"/> Natural gas <input type="checkbox"/> Wood <input type="checkbox"/> Electric Resistance <input type="checkbox"/> Heat pump <input type="checkbox"/> Solar <input type="checkbox"/> Other <small>(Check all that apply. Circle primary fuel and system)</small>
	System: <input type="checkbox"/> Boiler <input type="checkbox"/> Furnace <input type="checkbox"/> Space heater <input type="checkbox"/> Stove <input type="checkbox"/> Other Primary heat system efficiency _____ <input type="checkbox"/> AFUE <input type="checkbox"/> HSPF
Air Conditioning:	Central A/C system efficiency _____ <input type="checkbox"/> SEER <input type="checkbox"/> COP <input type="checkbox"/> EER
Domestic Hot Water:	Fuel: <input type="checkbox"/> Oil <input type="checkbox"/> Kerosene <input type="checkbox"/> Propane <input type="checkbox"/> Natural gas <input type="checkbox"/> Wood <input type="checkbox"/> Electric Resistance <input type="checkbox"/> Heat Pump <input type="checkbox"/> Solar Preheat <input type="checkbox"/> Other <small>(Check all that apply. Circle primary fuel and system)</small>
	System: <input type="checkbox"/> Stand Alone Tank <input type="checkbox"/> Indirect Fired Tank <input type="checkbox"/> Tankless Coil <input type="checkbox"/> On Demand <input type="checkbox"/> Other Primary domestic hot water system efficiency _____ Energy Factor (EF)
Compliance Path:	<input type="checkbox"/> Prescriptive <input type="checkbox"/> Performance <input type="checkbox"/> Systems analysis RBEScheck maximum required UA _____ Your home UA _____ Final home energy rating _____ Company _____ Date _____
Other Energy Features: _____	
THE 1997 VERMONT RBES MEETS OR EXCEEDS CABO/MEC 1995 (EXCEPT FOR LOG HOMES)	
I certify to _____ (owner) the premises listed above have been constructed in accordance with the 1997 Vermont Residential Energy Building Standards (RBES) created under 21 V.S.A. § 266.	
Signature _____	Company _____
Print Name _____	() Phone _____ Date _____
21 V.S.A. § 266 requires that this certification label be permanently affixed to inside electrical service panel/heating or cooling equipment/nearby in a visible location, and a copy be provided to the Department of Public Service Energy Efficiency Division, 112 State Street, Drawer 20, Montpelier, VT 05620-2601, and filed in the town land records. NOTE: Non-compliance with RBES may result in action for damages created under 21 V.S.A. § 266. This label does not specify all 1997 Vermont RBES requirements.	
Questions?? Call VT Department of Public Service: 1-800-642-3281 (in-state) or 1-802-828-4056	

- 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
- ★ Utility New Construction Programs
see Appendix D
- ★ Act 250 Environmental Board
1-802-828-3309

Fig. 7-1: Example of the Vermont Residential Building Energy Standards Certificate

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 7.2a

Completing the ‘Vermont Residential Building Energy Standards Certificate’

Read these instructions in their entirety before completing your 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**. (Contact the Energy Code Assistance Center [1-888-373-2255] for the Multifamily Supplement to the Energy Code, which details technical and certification provisions for multifamily buildings.) Write in the number of **Stories** above grade, and the **Conditioned sq. ft.** area, excluding unconditioned spaces, such as an unconditioned garage.
6. **Foundation Type:** Check off all that apply.
7. **Floors, Walls and 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 2.5, “How to Calculate Average R-values and U-values.”)
For basement walls, list the vertical height of the basement insulation in **Depth/Insulation** 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). **Circle 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. List the **Net window (rough opening) glazing area as a percent of gross exterior wall area**. (See Section 2.3, “How to Calculate the Glazing Percentage.”)
10. **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).

11. **Air Conditioning:** List the **Central A/C system efficiency** and check whether the value is **SEER, COP** or **EER**, if applicable. (See Appendix A for definitions.)
12. **Domestic Hot Water:** 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.
13. Under **Compliance Path**, check the compliance path by which you determined technical compliance with the Code. The table below corresponds the methods to the compliance paths listed on the certificate.

Method		Compliance Path
Fast Track	=	Prescriptive
Trade-Off	=	Prescriptive
VT <i>check</i> Software	=	Performance
Home Energy Rating	=	Systems Analysis
Systems Analysis	=	Systems Analysis

- ★ If compliance is determined using the VT*check* Software Method (equivalent to “RBEScheck”), list the **VTcheck 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**.
 - ★ For a home energy rating or systems analysis, list the **Company** that performed the analysis, and the **Date** that the final rating or analysis was conducted.
14. **Other Energy Features:** At the builder’s option, list additional information as appropriate, such as whether the dwelling has a mechanical ventilation system (exhaust only, heat recovery ventilator), or the infiltration rating determined by a blower door test in air changes per hour (AC/hr).
 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 7.2b

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 inside 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 7.3

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 7.3a

Completing the ‘Vermont Owner/Builder Disclosure Statement’

Read the instructions in their entirety *before* completing the form. (See sample on following two pages.) This form is very similar to the *Vermont Residential Building Energy Standards Certificate* in Section 7.2; follow the instructions in Section 7.2a 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 project 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 7.3b

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 7.2b.

Sample Vermont Owner/Builder Disclosure Statement (Part 1 of 2)

VERMONT OWNER/BUILDER DISCLOSURE STATEMENT

THIS HOME IS NOT REQUIRED TO MEET THE TECHNICAL REQUIREMENTS OF
1997 VERMONT RESIDENTIAL BUILDING ENERGY STANDARDS (RBES)

Before completing this form, refer to instructions. Note: 21 V.S.A. § 266 requires that Act 250 construction meet the 1997 RBES. This form applies to non-Act 250 construction only.

Site: _____
Address
Town
Zip

Electric Utility: _____

Construction Start/Completion Date: _____ / _____
Month/Year
Month/Year

The owner is hereby notifying a prospective buyer, in accordance with 21 V.S.A. § 266, the 1997 Vermont Residential Building Energy Standards, that this home includes the following energy efficiency features, but does *not* meet the RBES minimum requirements. In order to meet the standards, additional insulation, a more efficient space heating system, or fewer or more efficient windows and/or doors need to be installed.

Project Description: Single Family Log Home Addition Multifamily
Units _____ # Stories: _____ Conditioned sq. ft. _____

Foundation Type: Basement Crawlspace Slab on Grade

Floors: R- _____ Slab Edge Perimeter R- _____ Under Slab
R- _____ Over Unheated Spaces

Walls: R- _____ Above Grade R- _____ Basement
R- _____ Crawlspace Depth/Insulation: _____ ft.

Ceilings: R- _____ Flat R- _____ Sloped

Doors: U- _____ U- _____ U- _____ Glass Doors

Windows: U- _____ NFRC / Default Rating U- _____ NFRC / Default Rating
(Circle rating type)
U- _____ NFRC / Default Rating U- _____ NFRC / Default Rating
(basement)

Window glazing (rough opening) area as a percent of gross exterior wall area: _____ %

Figure 7-2: Example of the front and back (next page) of the *Vermont Owner/Builder Disclosure Statement*. For copies of this form, contact the Energy Code Assistance Center (1-888-37-ECALL).

Space Heat:

Check all that apply. Circle primary fuel and system.

Fuel: Oil Kerosene Propane Natural Gas Wood

Electric Resistance Heat Pump Solar Other

System: Boiler Furnace Space Heater Stove Other

Primary heat system efficiency _____ AFUE HSPF

Air Conditioning:

Central A/C system efficiency _____ SEER COP EER

Domestic Hot Water:

Check all that apply. Circle primary fuel and system.

Fuel: Oil Kerosene Propane Natural Gas Wood

Electric Resistance Heat Pump Solar Other

System: Stand-Alone Tank Indirect-Fired Tank Tankless Coil

On Demand Other

Primary domestic hot water system efficiency _____ Energy Factor (EF)

Compliance Path

Fast-Track Trade-Off VTcheck Software

Analyzed:

VTcheck maximum required UA _____ Your Home UA _____

Final home energy rating score _____ Date _____

Company _____

Other Energy Features: _____

I certify that the above information is accurate and that the premises listed above have *not* been constructed to meet the technical requirements of the 1997 Vermont Residential Building Energy Standards (RBES) established in accordance with 21 V.S.A § 266.

Signature of Owner _____

Print Name _____

Phone _____

Date _____

For any new residential construction built after July 1, 1998 that does not meet the 1997 Vermont Residential Building Energy Standards (RBES), 21 V.S.A. § 266 requires that: "the residential construction is used as a dwelling by the owner, the owner in fact directs the details of construction with regard to the installation of materials not in compliance with RBES, and the owner discloses in writing to a prospective buyer before entering into a binding purchase and sales agreement, with respect to the nature and extent of any noncompliance with RBES. Any statement or certificate given to a prospective buyer shall itemize how the home does not comply with RBES, and shall itemize which measures do not meet the RBES standards in effect at the time construction commenced."

This form or a document that includes similar information must be recorded in the town land records where the property is located and sent, within 30 days following the sale of the property by the owner, to: Vermont Department of Public Service, Energy Efficiency Division, 112 State Street Drawer 20, Montpelier, VT 05620-2601; telephone: 1-800-642-3281 (within Vermont only); or 802-828-4056.

For questions or information, call the Energy Code Assistance Center hotline at 1-888-37-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	<p><i>Annual Fuel Utilization Efficiency.</i> 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 used for both gas and oil equipment. By federal law, the minimum efficiency permitted is 80% AFUE for boilers and 78% AFUE for furnaces.</p> <ul style="list-style-type: none"> ★ When using a hot water heater as the primary means of heating a house, 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 2.5 for instructions.
Basement Wall	<p>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.</p> <ul style="list-style-type: none"> ★ <i>If wall is at least 50% below grade:</i> 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. ★ <i>If wall is at least 50% above grade:</i> 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. ★ <i>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.</i> (The VTcheck software enables you to trade off the basement wall insulation depth as well as the insulation R-value).
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.
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

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)

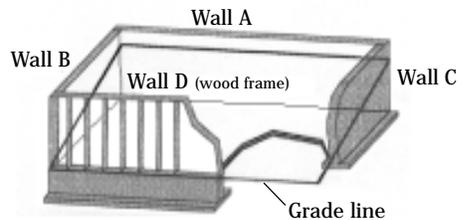


Figure A-2:
Building Envelope Example 1
 The dark line delineates the building envelope. This illustration shows a house over a conditioned basement (i.e., no basement ceiling insulation), with a sun room over unconditioned crawlspace (i.e., insulation in crawlspace ceiling).

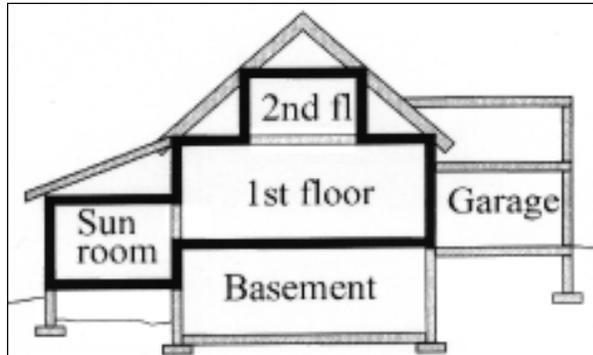
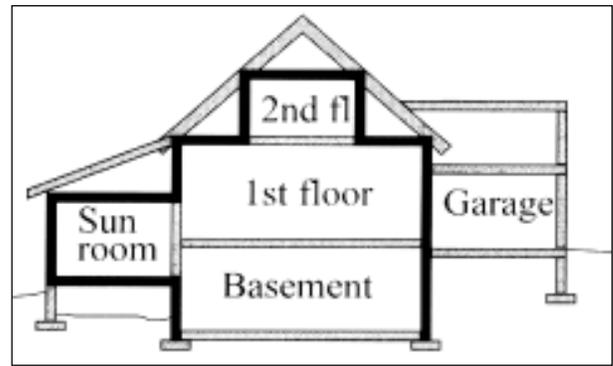


Figure A-3:
Building Envelope Example 2
 This depicts the same house with an unconditioned basement (i.e., basement ceiling insulation). Note that the wall between sun room and basement is included.

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 through 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

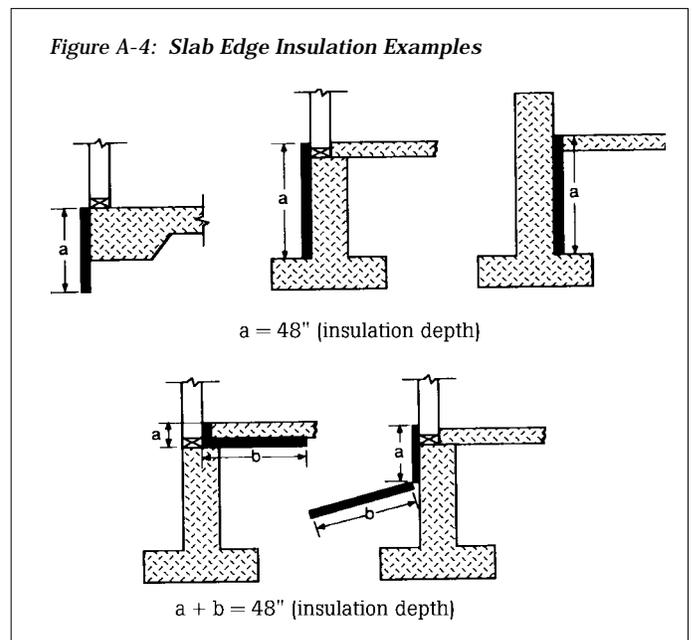
Crawl space wall-insulation requirements are for the exterior walls of unventilated crawl spaces (i.e., not directly vented to the outside) below uninsulated floors. A crawl space wall component includes the opaque portion of a wall that encloses a crawl space and is partially or totally below grade. 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.

Doors	<p>Doors include all openable opaque assemblies located in exterior walls of the building envelope.</p> <ul style="list-style-type: none"> ★ <i>If door is less than 50% glass:</i> Doors with less than 50% glass are treated as a single door assembly, in which case an average U-value (a U-value that includes both the glass and opaque area) must be used. ★ <i>If door is more than 50% glass:</i> The entire opaque and glass areas of doors with more than 50% glass (i.e., sliding or patio doors) are considered glazing. ★ If you have a decorative or other less energy-efficient door, you need not include that door in the U-value requirements for doors when using the Fast-Track and Trade-Off methods. The Energy Code allows one door to be exempt when using either of these methods.
Dwelling Unit	A single housekeeping unit of one or more rooms providing complete, independent living facilities, including permanent provisions for living, sleeping, eating, cooking and sanitation.
EER	<i>Energy Efficiency Ratio.</i> The ratio of net equipment cooling capacity in Btu/hour to total rate of electric input in watts under designated operating conditions. When consistent units are used, this ratio becomes equal to COP.
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. 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 6 for details.
Envelope	See Building Envelope.
Exempt Buildings	See Chapter 2 for complete definitions of buildings that are covered and not covered by the Energy Code.
Exterior Walls	<p>Exterior walls are surfaces in the building envelope within 30% of vertical, including:</p> <ul style="list-style-type: none"> ★ 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 3.
Floors	<p>Floors are considered individually for compliance purposes depending on their configuration and exposure:</p> <ul style="list-style-type: none"> ★ Floors over "unconditioned spaces" (such as floors over an unheated garage, a vented crawl space, or an unconditioned basement) must be insulated. ★ <i>"Exposed" floors over outside air</i> (such as floors of overhangs, cantilevers, and floors of an elevated home) <i>must be insulated to the R-values of ceiling flats.</i> ★ Slab-on-grade floors of conditioned spaces must be insulated along the slab perimeter and are not required to be insulated underneath. ★ Floors of basements and crawl spaces are not subject to an insulation requirement and do not have to be included as a building envelope component, even if the basement or crawl space is conditioned. In these cases, the walls must be insulated. ★ Floors separating two conditioned spaces are not subject to an insulation requirement and do not have to be included as a building envelope component (although the band joist of these floors is considered part of the exterior walls for calculation purposes and is subject to the same R-value requirements).
Glazing	<p>Glazing is any translucent or transparent material in exterior openings of buildings (including windows, skylights, sliding glass doors, swinging/patio glass doors, basement windows and glass block). If a door has more than 50% glass (e.g., swinging or patio doors), it is considered part of the glazing area and not a "door." If a door has less than 50% glass, the entire unit (opaque <i>and</i> glass areas) is defined as a "door."</p> <ul style="list-style-type: none"> ★ Windows in the exterior walls of <i>conditioned</i> basements (i.e., without ceiling insulation) <i>should</i> be included in the glazing area calculations. Windows in walls of basements or crawlspaces with insulated ceilings are <i>not</i> included. Also be sure to include skylights in glazing area calculations and U-value requirements. ★ Window U-value requirements for conditioned basements are treated separately from the rest of the glazing in the house under the 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).
HSPF	<i>Heating Seasonal Performance Factor.</i> 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	<i>Heating, Ventilation and Air Conditioning System.</i> 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 <i>not</i> subject to Title VI of the National Manufactured Housing Construction & Safety Standards Act of 1974 (i.e., homes not on a permanent chassis).
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.)
Net Wall Area	Gross wall area minus the rough opening area of all glazing and doors. Also called the “opaque area.” The net wall area includes the opaque wall area of all above-grade walls enclosing conditioned spaces, the opaque area of conditioned basement walls more than 50% above grade (including the below-grade portions), and peripheral edges of floors (i.e., band joists). The net wall area does <i>not</i> include windows, doors, or other such openings.
Nominal R-value	The R-value of an insulating material as listed on its packaging.
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.
Primary Fuel	The fuel type that is used by the automatic heating system that is designed to provide heat to the majority of the building. Wood is never the primary fuel if there is another automatic heating system in place, regardless of the amount of heat it provides.
Primary Heating System	The automatic heating system that is designed to provide heat to the majority of the building. A wood system is never the primary heating system if there is another automatic heating system in place, regardless of the amount of heat it provides.
Raised Truss	Any roof/ceiling construction that allows the insulation to achieve its full thickness or R-value over the top plate of exterior walls. Several constructions allow for this, including elevating the heel (sometimes referred to as an “energy truss,” “raised-heel truss” or “Arkansas truss”), use of cantilevered or oversized trusses, lowering the ceiling joists, framing with a raised rafter plate, or installing higher R-value insulation over the exterior wall top plates. See Figure B-1 for examples.
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 <i>all</i> 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	<i>Seasonal Energy Efficiency Ratio</i> . 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	<p>The perimeter of a slab-on-grade floor, where the top edge of the slab floor is above the finished grade or 12 inches or less below the finished grade. Insulation must be installed with the required R-value to a depth of at least 48" using any of the following configurations:</p> <ul style="list-style-type: none"> ★ The slab insulation extends from the top of the slab downward. ★ The slab insulation extends from the top of the slab downward to the bottom of the slab and then horizontally underneath the slab for a minimum total distance of at least 48". ★ 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.
Sloped Ceiling	See "Ceiling Slopes."
Technical Requirement	The technical requirement of the Energy Code consists of two components: Basic Requirements (see inside front cover and Appendix C) and Performance Requirements (see Chapters 3 to 6) 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 4.
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.
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 (see Chapter 7) within 30 days of construction completion.

VTcheck

Computer software available from the Energy Code Assistance Center that determines compliance with the technical requirements of the Energy Code. See Chapter 5.

Water Heater

If a water heater is used as the primary means of heating a house, one of the Professional Services methods must be used to document compliance with the Code.

Wood Stove

If a wood stove is used as the primary means of heating a house, one of the Professional Services compliance methods (see Chapter 6) 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-Value Table for Windows, Glazed Doors & Skylights¹

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 Doors¹

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	0.41

1 The U-values in this tables 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	
.92 x boiler AFUE = Energy Factor	<i># of Bedrooms</i>	<i>Energy Factor</i>
	2	.45
	3	.50
	4	.55
	5	.60
	6	.65

Guidelines for Raised Trusses/Rafters

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.

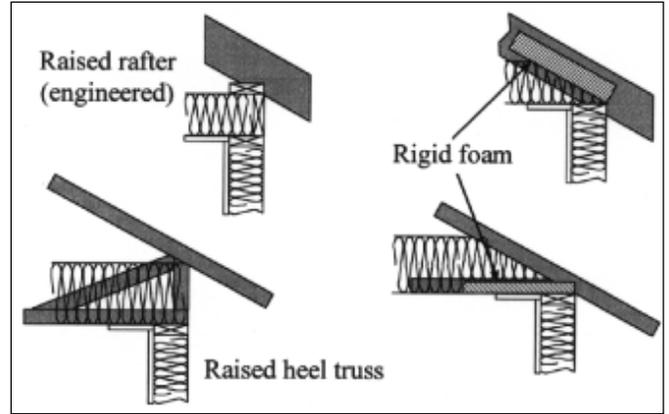


Figure B-1:
Raised Truss Examples

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 3 through 6. Also, some of the packages for the compliance methods in chapters 3 through 6 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 Professional Services Method (Chapter 6). Refer to Table 6-1 for a summary of basic requirements that apply to those methods.

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

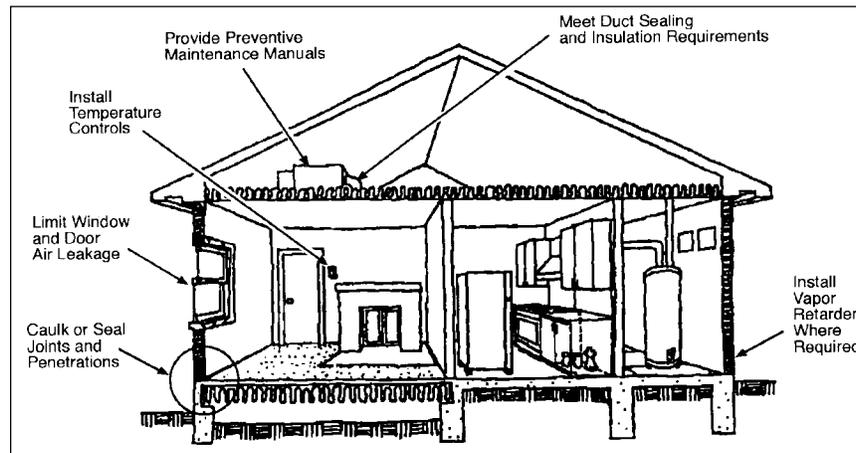


Figure C-1:
Some of the Basic
Requirements

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.

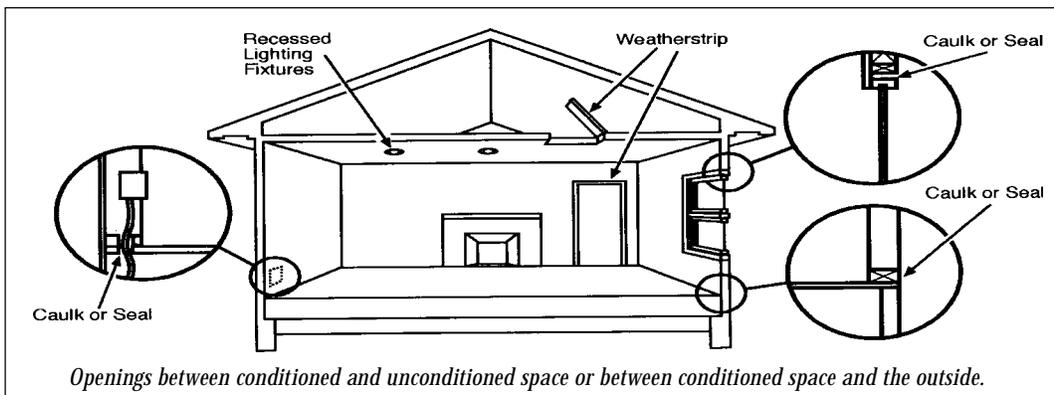


Figure C-2:
Typical Openings
in the Building Envelope
That Should be Sealed

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.

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 Chapter 5.

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.

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;
- ★ for exhaust air (mechanical ventilation) ducts; 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 must be provided if condensation will create a problem.

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

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, etc.).

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 Energy 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.)

Table C-2
Minimum HVAC Piping Insulation Thickness¹

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 The 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:

$$\text{New Minimum Thickness} = \frac{4.6 \times \text{Table 2-3 Thickness}}{\text{Actual R-Value}}$$

For materials with an R-value less than R-4, the minimum insulation thickness must be increased as follows:

$$\text{New Minimum Thickness} = \frac{4.0 \times \text{Table 2-3 Thickness}}{\text{Actual R-Value}}$$

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.3g

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 on the facing page. 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.4c 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

All dwelling units in multifamily buildings must be equipped with separate electric meters.

Table C-3

Minimum Pipe Insulation Thickness for Circulating Potable Water Systems

Heated Water Temperature (°F)	Insulation Thickness in Inches by Pipe Sizes ¹			
	<i>Non-Circulating Runouts</i>	<i>Circulating Mains and Runouts</i>		
	Up to 1'	Up to 1.25"	1.5" to 2.0"	Over 2"
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.

Dampers

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

- ★ tight-fitting doors;
- ★ a tight-fitting chimney damper; or
- ★ a chimney cap damper.

Vermont Energy Code		
Basic Requirements ~ Summary		
<i>Note: This is a summary. See Appendix C for full details.</i>		
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 (IC) 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 may be 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 Appendix C.
10	Fireplaces	Fireplaces must incorporate at least one of the following: (a) tight-fitting doors; (b) a tight-fitting chimney damper; or (c) a chimney cap damper.
11	Exhaust Fans	Exhaust dampers are required for kitchen, bath and dryer fans.
12	Electric Systems	In multifamily dwellings, equip each unit with a separate electric meter.
13	Certification	Complete a <i>Vermont Residential Building Energy Standards Certificate</i> for each dwelling. Send one copy to the Vermont Department of Public Service and one copy to the town clerk for the town in which the property is located, and affix the original to the home's electrical panel or heating equipment.

Appendix D

Vermont New Construction Programs & Resources

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.

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.

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

Vermont Star Homes Program

This residential new construction energy-efficiency program is sponsored by several Vermont utilities (Burlington Electric Dept., Central Vermont Public Service, Citizens Utilities, Green Mountain Power, Vermont Electric Co-op, Vermont Gas Systems) and applies to most of the state. Builders choose the “Vermont Star” or “Vermont Advantage” option. Cash incentives and rebates are available for lighting, refrigerators, mechanical ventilation, energy ratings, and builder training. Information: 800-893-1997.

Other Utility New Construction Programs

Several utilities offer other incentive programs for energy-efficient construction. Two of these are Vermont Gas Systems (800-639-8081) and Washington Electric Cooperative (800-932-5245). Check with your local utility about any programs they may be offering.

Residential Energy Efficiency Program (REEP)

REEP is a program sponsored by Vermont state agencies and utilities to serve low-income multifamily housing of five or more units. For qualified projects, REEP offers design review, technical analysis of measures, and assistance with Code compliance requirements — all at no cost to the owner. Financial incentives for qualifying energy-efficiency measures are available. For information call 800-639-6069.

Home Builders Associations

The Home Builders Association is a trade organization for builders and related businesses. They are actively involved with building issues and other activities in support of the building industry. There are two chapters of the National Association of Home Builders (in Washington, D.C., at 800-368-5242) located in Vermont:

- ★ Home Builders Association of Central Vermont
802-773-0672
- ★ Home Builders Association of Northern Vermont
802-879-7766

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. They meet monthly and sponsor occasional educational events. Information: 802-482-3295.

Energy Rated Homes of Vermont

Energy Rated Homes of Vermont (ERH-VT) 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 can also be used to show compliance with the Energy Code. Contact ERH-VT at 800-639-6069.

Residential Building Energy Standards Legislation

The Vermont Energy Code (officially “Residential Building Energy Standards” or “RBES”), is Vermont’s first 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 Code is based on the Council of American Building Officials *Model Energy Code* (“CABO-MEC”), which is recognized as the national consensus code for residential energy efficiency and was cited as such in the 1992 federal Energy Policy Act. The intent of CABO-MEC is to “regulate the design of building envelopes for adequate thermal resistance and low air leakage and the design and selection of mechanical, electrical, service water-heating and illumination systems and equipment which will enable effective use of energy in new building construction.” At the same time, its provisions are designed to “provide flexibility to permit the use of innovative approaches and techniques to achieve effective utilization of energy.”

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. It also changes the way that single-family, multifamily and log homes comply with the Code, and calls for a mechanical-ventilation standard to be adopted in the next round of code updates. The Legislature established a process for updating the Vermont Energy Code every three years, conforming with the CABO-MEC update cycle.

Starting July 1, 1997, only Act 250 projects had to comply with the Energy Code; effective July 1, 1998, virtually *all* residential new construction in Vermont must comply.

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.