

1. TITLE OF RULE FILING:

Vermont Residential Building Energy Standard (RBES)

2. ADOPTING AGENCY:

Department of Public Service

3. PRIMARY CONTACT PERSON:

*(A PERSON WHO IS ABLE TO ANSWER QUESTIONS ABOUT THE CONTENT OF THE RULE).*

Name: Kelly Launder

Agency: DPS, Planning and Energy Resources Division

Mailing Address: 112 State Street, Drawer 20, Montpelier,  
Vt 05620-2601

Telephone: 802 828 - 4039 Extension: Fax: 802 828 - 2342

E-Mail: kelly.launder@state.vt.us

Web URL *(WHERE THE RULE WILL BE POSTED)*:

<http://publicservice.vermont.gov>

4. SECONDARY CONTACT PERSON:

*(A SPECIFIC PERSON FROM WHOM COPIES OF FILINGS MAY BE REQUESTED OR WHO MAY ANSWER QUESTIONS ABOUT FORMS SUBMITTED FOR FILING IF DIFFERENT FROM THE PRIMARY CONTACT PERSON).*

Name:

Agency:

Mailing Address:

Telephone: - Extension: Fax: -

E-Mail:

5. LEGAL AUTHORITY / ENABLING LEGISLATION:

*(THE SPECIFIC STATUTORY OR LEGAL CITATION FROM SESSION LAW INDICATING WHO THE ADOPTING ENTITY IS AND THUS WHO THE SIGNATORY SHOULD BE. THIS SHOULD BE A SPECIFIC CITATION NOT A CHAPTER CITATION).*

Sec. 11. 21 V.S.A. § 266 RESIDENTIAL BUILDING ENERGY STANDARDS

6. CONCISE SUMMARY **(150 WORDS OR LESS)**:

The provisions of this code regulate the design of building envelopes for adequate thermal resistance and low air leakage and the design and selection of mechanical, ventilation, electrical, service water-heating and illumination systems and equipment which will enable effective use of energy in new residential

## Proposed Rule Coversheet

building construction. It is intended that these provisions provide flexibility to permit the use of innovative approaches and techniques to achieve effective utilization of energy.

### 7. EXPLANATION OF WHY THE RULE IS NECESSARY:

In accordance with 21 V.S.A. § 266, the commissioner of public service is required to amend the residential building energy standards in a manner that complies with the 2009 edition of the International Energy Conservation Code (IECC). Vermont law also requires the commissioner of the department of public service to periodically amend and update the RBES through administrative rules. This rule is the second administrative rule amendment to the RBES.

### 8. LIST OF PEOPLE, ENTERPRISES AND GOVERNMENT ENTITIES AFFECTED BY THIS RULE:

The department of public service, new home owners, existing home owners, builders, building designers, home energy raters and municipalities.

### 9. BRIEF SUMMARY OF ECONOMIC IMPACT(150 WORDS OR LESS):

This rule is an update on a legislatively adopted code that has been in effect for all residential new construction since 1998. Adoption of the rule will have a minor cost impact on all of the parties involved in new home construction, purchase, and ownership, and existing home renovation. It will assure the benefits of reduced energy costs, reduced environmental impacts, and improved indoor air quality for the lifetime of the home.

### 10. A HEARING is scheduled.

### 11. HEARING INFORMATION

(THE FIRST HEARING SHALL BE NO SOONER THAN 30 DAYS FOLLOWING THE POSTING OF NOTICES ONLINE).

Date: 1/5/2011

Time: 10:00 AM

Proposed Rule Coversheet

Location: GIGA Conference Room, 112 State Street,  
Montpelier, VT 05602 (3<sup>rd</sup> floor of the Chittenden Bank  
Bldg.)

12. DEADLINE FOR COMMENT (NO EARLIER THAN 7 DAYS FOLLOWING LAST HEARING):

1/12/2011

13. KEYWORDS (PLEASE PROVIDE AT LEAST 3 KEYWORDS OR PHRASES TO AID IN THE SEARCHABILITY OF THE RULE NOTICE ONLINE).

residential energy code

RBES

residential building energy standards

# Administrative Procedures – Economic Impact Statement

## Instructions:

In completing the economic impact statement, an agency analyzes and evaluates the anticipated costs and benefits to be expected from adoption of the rule. This form must be completed for the following filings made during the rulemaking process:

- Proposed Rule Filing
- Final Proposed Filing
- Adopted Rule Filing
- Emergency Rule Filing

Rules affecting or regulating public education and public schools must include cost implications to local school districts and taxpayers in the impact statement (see 3 V.S.A. § 832b for details).

The economic impact statement also contains a section relating to the impact of the rule on greenhouse gases. Agencies are required to explain how the rule has been crafted to reduce the extent to which greenhouse gases are emitted (see 3 V.S.A. § 838(c)(4) for details).

All forms requiring a signature shall be original signatures of the appropriate adopting authority or authorized person.

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**Certification Statement:** As the adopting Authority of this rule (see 3 V.S.A. § 801 (b) (11) for a definition), I conclude that this rule is the most appropriate method of achieving the regulatory purpose. In support of this conclusion I have attached all findings required by 3 V.S.A. §§ 832a, 832b, and 838(c) for the filing of the rule entitled:

**Rule Title: Vermont Residential Building Energy Standards  
(RBES)**

\_\_\_\_\_, on \_\_\_\_\_.  
(signature) (date)

Printed Name and Title:

David O'brien  
Commissioner  
Department Of Public Service

## Economic Impact Statement

*BE AS SPECIFIC AS POSSIBLE IN THE COMPLETION OF THIS FORM, GIVING FULL INFORMATION ON YOUR ASSUMPTIONS, DATABASES, AND ATTEMPTS TO GATHER OTHER INFORMATION ON THE NATURE OF THE COSTS AND BENEFITS INVOLVED. COSTS AND BENEFITS CAN INCLUDE ANY TANGIBLE OR INTANGIBLE ENTITIES OR FORCES WHICH WILL MAKE AN IMPACT ON LIFE WITHOUT THIS RULE.*

### 1. TITLE OF RULE FILING:

Vermont Residential Building Energy Standards (RBES)

### 2. ADOPTING AGENCY:

Department of Public Service

### 3. CATEGORY OF AFFECTED PARTIES:

*LIST CATEGORIES OF PEOPLE, ENTERPRISES, AND GOVERNMENTAL ENTITIES POTENTIALLY AFFECTED BY THE ADOPTION OF THIS RULE AND THE ESTIMATED COSTS AND BENEFITS ANTICIPATED:*

The substantive changes to be implemented by this rule in comparison to the existing statute are listed below along with their impacts on each category of affected parties.

#### Homeowners

The following are substantive changes that will affect homeowners, divided into two categories: Mechanical Systems and Insulation and Fenestration. The total additional costs to homeowners from these changes are estimated to be \$1,450-\$2,300 (this doesn't include the potential additional costs for windows, of \$5-\$10 per window, as that will vary depending on the number of windows). Most of these changes will also result in significant energy and cost savings for the homeowner over time.

#### Mechanical Systems

1. Prohibit unvented room heaters. No cost to the homeowner. Will benefit homeowner health and safety by limiting exposure to combustion gases.
2. Require spillage testing of chimney vented equipment. Negligible cost to the homeowner. This is a two-minute test conducted by the contractor/inspector. This will result in health/safety benefits for the homeowner by limiting exposure to combustion gases backdrafting from mechanical equipment.
3. Require 50% of lamps in lighting fixtures to be high efficacy. Minor cost impact to homeowner for the purchase of compact fluorescent lamps (<\$100). This will result in significant energy and money savings for the homeowner over the life of the lamps.
4. Specify maximum oversizing percentages. This sets limits on oversizing mechanical equipment. This will result in cost savings for the homeowner as well as energy savings.

## Economic Impact Statement

5. Require programmable thermostat. This will cost the homeowner <\$100 and result in significant energy and cost savings.
6. Prohibit continuously burning pilot lights. This will result in energy and cost savings for the homeowner.

### Insulation and Fenestration

1. Reduction in maximum fenestration U-factor. This will result in added cost to the homeowner of roughly \$5-\$10 per window but will result in significant energy and cost savings over the life of fenestration products.
2. Increased minimum insulation levels. This change will result in added cost to the homeowner over the existing code as builders pass on the additional cost of construction. However, this will result in significantly lower energy consumption, more durable homes, and increased occupant comfort, along with cost savings. The following are estimates of additional costs for proposed changes to insulation and fenestration criteria.
  - Above grade wall insulation: \$100-\$200
  - Basement wall insulation: \$300-\$500
  - Crawlspace wall insulation: \$200-\$400
  - Slab edge insulation: \$250-\$400
3. Reduced maximum air and duct leakage. Increased air sealing requirements will add additional costs of roughly \$400-\$600 and result in additional energy and cost savings.

### Building Professionals

The following are substantive changes that will affect building professionals, divided into two categories: Mechanical Systems and Insulation and Fenestration.

#### Mechanical Systems

1. Prohibit unvented room heaters. No additional costs or benefits to building professionals.
2. Require spillage testing of chimney vented equipment. This will result in an increase in cost for building professionals for the time required to conduct testing. However, as this is only a two-minute test, any additional cost would be minor.
3. Require 50% of lamps in lighting fixtures to be high efficacy. This will not impact building professionals.
4. Specify maximum oversizing percentages. This sets limits on oversizing mechanical equipment. This will not impact building professionals.
5. Require programmable thermostat. This will not impact building professionals.
6. Prohibit continuously burning pilot lights. This will not impact building professionals.

#### Insulation and Fenestration

1. Reduced maximum fenestration U-factor. This will result in added cost to the builder that will be passed on to the homeowner.
2. Increased insulation R-values and reduced U-factors. This will result in added cost to the builder that will be passed

## Economic Impact Statement

on to the homeowner. This will also require builders to adapt to different building practices and materials.

3. Reduced maximum air and duct leakage. Increased air sealing requirements will add minor additional costs to the building professional, which will be passed to the homeowner.

### 4. IMPACT ON SCHOOLS:

*INDICATE ANY IMPACT THAT THE RULE WILL HAVE ON PUBLIC EDUCATION, PUBLIC SCHOOLS, LOCAL SCHOOL DISTRICTS AND/OR TAXPAYERS:*

No impact

### 5. COMPARISON:

*COMPARE THE ECONOMIC IMPACT OF THE RULE WITH THE ECONOMIC IMPACT OF OTHER ALTERNATIVES TO THE RULE, INCLUDING NO RULE ON THE SUBJECT OR A RULE HAVING SEPARATE REQUIREMENTS FOR SMALL BUSINESS:*

The only alternative to this rule would be to adopt the IECC 2009 code as is. This would result in fewer additional costs and significantly less energy savings. However this would fail to address health, safety and comfort issues addressed by the proposed modifications. The up-front cost of this alternative would likely be less than the proposed rule, though the energy savings would be lower, resulting in a higher cost to the homeowner in the long run through added energy costs.

### 6. FLEXIBILITY STATEMENT:

*COMPARE THE BURDEN IMPOSED ON SMALL BUSINESS BY COMPLIANCE WITH THE RULE TO THE BURDEN WHICH WOULD BE IMPOSED BY ALTERNATIVES CONSIDERED IN 3 V.S.A. § 832a:*

No impact

### 7. GREENHOUSE GAS IMPACT: EXPLAIN HOW THE RULE WAS CRAFTED TO REDUCE THE EXTENT TO WHICH GREENHOUSE GASES ARE EMITTED, EITHER DIRECTLY OR INDIRECTLY, FROM THE FOLLOWING SECTORS OF ACTIVITIES:

#### A. TRANSPORTATION —

*IMPACTS BASED ON THE TRANSPORTATION OF PEOPLE OR PRODUCTS (e.g., “THE RULE HAS PROVISIONS FOR CONFERENCE CALLS INSTEAD OF TRAVEL TO MEETINGS” OR “LOCAL PRODUCTS ARE PREFERENTIALLY PURCHASED TO REDUCE SHIPPING DISTANCE.”):*

No impact

#### B. LAND USE AND DEVELOPMENT —

*IMPACTS BASED ON LAND USE AND DEVELOPMENT, FORESTRY, AGRICULTURE ETC. (e.g., “THE RULE WILL RESULT IN ENHANCED, HIGHER DENSITY DOWNTOWN DEVELOPMENT.” OR “THE RULE MAINTAINS OPEN SPACE, FORESTED LAND AND /OR AGRICULTURAL LAND.”):*

No impact

Economic Impact Statement

C. BUILDING INFRASTRUCTURE —

*IMPACTS BASED ON THE HEATING, COOLING AND ELECTRICITY CONSUMPTION NEEDS (e.g., “THE RULE PROMOTES WEATHERIZATION TO REDUCE BUILDING HEATING AND COOLING DEMANDS.” OR “THE PURCHASE AND USE OF EFFICIENT ENERGY STAR APPLIANCES IS REQUIRED TO REDUCE ELECTRICITY CONSUMPTION.”):*

This rule promotes weatherization to reduce building heating and cooling demands. This rule also requires the use of efficient appliances and mechanical systems, which will reduce energy consumption.

D. WASTE GENERATION / REDUCTION —

*IMPACTS BASED ON THE GENERATION OF WASTE OR THE REDUCTION, REUSE, AND RECYCLING OPPORTUNITIES AVAILABLE (e.g., “THE RULE WILL RESULT IN REUSE OF PACKING MATERIALS.” OR “AS A RESULT OF THE RULE, FOOD AND OTHER ORGANIC WASTE WILL BE COMPOSTED OR DIVERTED TO A ‘METHANE TO ENERGY PROJECT’.”):*

No impact

E. OTHER —

*IMPACTS BASED ON OTHER CRITERIA NOT PREVIOUSLY LISTED:*

# Administrative Procedures – Public Input Statement

## Instructions:

In completing the public input statement, an agency describes what it did do, or will do to maximize the involvement of the public in the development of the rule. This form must be completed for the following filings made during the rulemaking process:

- Proposed Rule Filing
- Final Proposed Filing
- Adopted Rule Filing
- Emergency Rule Filing

### 1. TITLE OF RULE FILING:

Vermont Residential Building Energy Standards (RBES)

### 2. ADOPTING AGENCY:

Department of Public Service

### 3. PLEASE LIST THE STEPS THAT HAVE BEEN OR WILL BE TAKEN TO MAXIMIZE PUBLIC INVOLVEMENT IN THE DEVELOPMENT OF THE PROPOSED RULE:

The Department of Public Service undertook a broad-based consensus building process to develop this rule. Between March and July 2010, the Department held seven meetings around the state to present information on proposed changes to RBES to interested stakeholders. The Department also invited representative stakeholders from affected communities to participate in the RBES Update Advisory Committee. Stakeholders included builders, consumer advocates, electric and gas utilities, building code officials, building component manufacturers, hearth products manufacturers, log home industry, heating fuel dealers, lenders, and Realtors.

Most members of the Advisory Committee were present at each stakehold meeting though one additional meeting was held for the Advisory Committee on July 14, 2010 . At this meeting the Department presented a draft of the proposed Vermont changes to the 2009 International Energy Conservation Code (IECC). The Department then modified the IECC to incorporate the amendments recommended by the RBES Update Advisory Committee and stakeholders. The final draft RBES update was provided to the Advisory Committee and stakeholders in

Public Input Statement.

August 2010. DPS then developed the draft rule based on feedback from the Advisory Committee and stakeholders in early September 2010.

The Department also plans to hold a public hearing and post the hearing announcement in the newspaper and post on the DPS website. The Department of Public Service will inform all previously informed stakeholders (including those listed in #4 below) of the upcoming hearing.

4. BEYOND GENERAL ADVERTISEMENTS, PLEASE LIST THE PEOPLE AND ORGANIZATIONS THAT HAVE BEEN OR WILL BE INVOLVED IN THE DEVELOPMENT OF THE PROPOSED RULE:

Kelly Launder, VT DPS; Jim Porter, VT DPS; Chet Pasho, Preferred Building Systems; Mike Wickenden, PSB Contract Administrator; Scott Harrington, Vermont Gas; Jeff Gephart, Vermont Energy Star Homes; Chris Gordon, VEIC; Jeremy King, Vermont Gas; Dave Adams, VHFA; Joe Erdelyi, VHFA; Mark Tebbets, NEEP; Brian Fisher, Vermont Gas; Emily Levin, VEIC; Chris Burns, BED; Ward Smith, HBRA-VT; Matt Cota, Vermont Fuel Dealers Association; Richard Faesy, VEIC; Ken Bellyea, VT Association of Realtors; Li Ling Young, VEIC; Christopher D'Elia, VT Bankers Associations; Sandy Vitzthum, American Institute of Architects; Geoff Wilcox, CVOEO Weatherization; John Lincoln, BED; Rob Picket, Log Homes Council; Jason Pidgeon, VT Mortgage Bankers Association; Mike Dewein, Building Codes Assistance Project; Mark Halverson, PNNL; Jim Buckley, Buckley Rumford Co; Linda Connell, PNNL; Rosemarie Bartlett, PNNL; Bruce Courtot, VEIC; John Unger Murphy, Murphy's Cell Tech; Bradley Talbot, VLPA; Chuck Reiss, BSR; Dave Anderson, VHFA; Joe Sinagra, HBRA-VT; Matt Sharpe, VEIC; Todd Taylor, PNNL; Robert Lucas, PNNL; Jean Boulin, DOE; Tim Frost, HBRA-VT; Gordon Clements, Gordon's Window Décor; Carolyn Sarno, NEEP; Bill Fey, Alliance to Save Energy; Don Vigneau, NEEP; Dennis Bates, Vermont Sun Structures; Ken Tohinaka, VEIC; Robert Howe, VT Dept. of Public Safety.

# **Administrative Procedures – Scientific Information Statement**

## **Instructions:**

In completing the Scientific Information Statement, an agency shall provide a brief summary of the scientific information including reference to any scientific studies upon which the proposed rule is based, for the purpose of validity.

This form is only required when a rule relies on scientific information for its validity.

### 1. TITLE OF RULE FILING:

Vermont Residential Building Energy Standard (RBES)

### 2. ADOPTING AGENCY:

Department of Public Service

### 3. BRIEF EXPLANATION OF SCIENTIFIC INFORMATION:

RBES is based on the 2009 edition of the International Energy Conservation Code (IECC 2009). In order to receive American Recovery and Reinvestment Act (ARRA) funds, Governor Douglas provided a letter of assurance on behalf of the State of Vermont to the U.S. Department of Energy (DOE) that the State will update its residential energy code to meet or exceed the IECC 2009, to comply with Section 410 of Title IV of ARRA. Subsequently, the Vermont Legislature adopted Act No. 45 of 2009, Sec. 11 21 V.S.A. § 266 RESIDENTIAL BUILDING ENERGY STANDARDS, which also required the update of the Standards to IECC 2009.

The primary substantive differences applicable to Vermont between the IECC 2009 and the 2005 RBES is the inclusion of minimum requirements for all additions (vs. additions 500 square feet or greater), and upgrades to energy equipment and systems in existing buildings. This standard is based on a review of standards existing in other jurisdictions and current practices in Vermont and incorporates 2005 RBES requirements that are not included in IECC 2009, including standards for mechanical ventilation.

## Scientific Information Statement

### 4. CITATION OF SOURCE DOCUMENTATION OF SCIENTIFIC INFORMATION:

Section 410 of Title IV of the American Recovery and Reinvestment Act (ARRA) of 2009 provided guidance on state energy code requirement.

The March 12, 2009 Solicitation for State Energy Program (SEP) Formula Grants under the ARRA of 2009 also provided guidance.

The ventilation standard support was published on the DPS website as two papers; "Mechanical Ventilation for Residential New Construction in Vermont: A Review of Codes, Standards, and Research With Recommendations for a Vermont Ventilation Standard" (August 18, 1999) and "A Field Study of Exhaust Only Ventilation Systems Performance in Residential New Construction in Vermont" (August 26, 1999).

### 5. INSTRUCTIONS ON HOW TO OBTAIN COPIES OF THE SOURCE DOCUMENTS OF THE SCIENTIFIC INFORMATION FROM THE AGENCY OR OTHER PUBLISHING ENTITY:

ARRA is available at <http://thomas.loc.gov/cgi-bin/query/z?c111:h1>:

The SEP sollicitaion is available at [http://ww1.eere.energy.gov/wip/pdfs/sep\\_arra\\_foa.pdf](http://ww1.eere.energy.gov/wip/pdfs/sep_arra_foa.pdf)

The ventilation studies are available by request to the DPS.

# **Administrative Procedures – Incorporation by Reference Statement**

## **Instructions:**

In completing the incorporation by reference statement, an agency describes any materials that are incorporated into the rule by reference and why the full text was not reproduced within the rule.

This form is only required when a rule incorporates materials by referencing another source without reproducing the text within the rule itself (e.g. federal or national standards, or regulations).

Copies of incorporated materials will be held by the Office of the Secretary of State until adoption or formal withdrawal of the rule is complete. Materials will be returned to the agency upon completion of the rule.

All forms requiring a signature shall be original signatures of the appropriate adopting authority or authorized person.

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**Certification Statement:** As the adopting Authority of this rule (see 3 V.S.A. § 801 (b) (11) for a definition), I certify that the text of the matter incorporated has been reviewed by an official of the agency. I further certify that the agency has the capacity and intent to enforce the rule entitled:

**Rule Title: Vermont Residential Building Energy Standard**

\_\_\_\_\_, on \_\_\_\_\_  
(signature) (date)

Printed Name and Title:

David O'brien

Commissioner

Vermont Department Of Public Service

Incorporation by Reference Statement

1. TITLE OF RULE FILING:

Vermont Residential Building Energy Standard (RBES)

2. ADOPTING AGENCY:

Vermont Department of Public Service

3. DESCRIPTION (*DESCRIBE THE MATERIALS INCORPORATED BY REFERENCE*):

The proposed RBES update is based on the International Energy Conservation Code 2009 (IECC2009). This code references a body of standards from a spectrum of organizations with an interest in home construction, performance, and safety. The referenced standards are incorporated in the update as "Chapter Six -Referenced Standards" and are an attachment to this document.

4. OBTAINING COPIES: (*EXPLAIN HOW THE MATERIAL(S) CAN BE OBTAINED BY THE PUBLIC, AND AT WHAT COST*):

The referenced standards are listed in the code by promulgating agency and contact information for each is provided. By and large, these standards are readily available as part of the professional literature of the building industry and code enforcement community.

5. MODIFICATIONS (*PLEASE EXPLAIN ANY MODIFICATION TO THE INCORPORATED MATERIALS E.G., WHETHER ONLY PART OF THE MATERIAL IS ADOPTED AND IF SO, WHICH PART(S) ARE MODIFIED*):

The referenced standards are adopted as promulgated except as specifically modified within the proposed RBES.

6. REASONS FOR INCORPORATION BY REFERENCE (*EXPLAIN WHY THE AGENCY DECIDED TO INCORPORATE THE MATERIALS RATHER THAN REPRODUCE THE MATERIAL IN FULL WITHIN THE TEXT OF THE RULE*):

The referenced standards are unlikely to be of sufficient interest to the overwhelming majority of the affected parties to merit the cost and complexity of full-text inclusion. Additionally a RBES Handbook will be completed, printed and available for distribution that explains the code requirements in a more simplified manner.

7. THE INCORPORATED MATERIALS HAVE BEEN REVIEWED BY THE FOLLOWING OFFICIAL OF THE AGENCY:

2011 Vermont Residential Building Energy Standards

ISBN: 978-1-58001-742-8 (soft-cover edition)

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## PREFACE

### Introduction

Internationally, code officials recognize the need for a modern, up-to-date energy conservation code addressing the design of energy-efficient building envelopes and installation of energy efficient mechanical, lighting and power systems through requirements emphasizing performance. The *2011 Vermont Residential Building Energy Standards* (RBES) is based on the *International Energy Conservation Code*® 2009 edition, and is designed to meet these needs through model code regulations that will result in the optimal utilization of fossil fuel and non-depletable resources in all communities, large and small.

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

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

### Development

The first edition of the *International Energy Conservation Code* (1998) was based on the 1995 edition of the *Model Energy Code* promulgated by the Council of American Building Officials (CABO) and included changes approved through the CABO Code Development Procedures through 1997. CABO assigned all rights and responsibilities to the International Code Council and its three statutory members at that time, including Building Officials and Code Administrators International, Inc. (BOCA), International Conference of Building Officials (ICBO) and Southern Building Code Congress International (SBCCI). The 2009 edition presents the code as originally issued, with changes reflected in the 2000, 2003 and 2006 editions and further changes approved through the ICC Code Development Process through 2008. A new edition such as this is promulgated every three years.

This 2011 RBES code is founded on principles intended to establish provisions consistent with the scope of an energy conservation code that adequately conserves energy; provisions that do not unnecessarily increase construction costs; provisions that do not restrict the use of new materials, products or methods of construction; and provisions that do not give preferential treatment to particular types or classes of materials, products or methods of construction.

### Background

During the 1995 legislative session, identical bills addressing the issue of energy efficiency standards in new residential construction were introduced in both the Vermont House and the Senate. Although neither bill was voted upon, considerable committee work was devoted to the bills.

At the end of the 1995 legislative session, there was a consensus among the parties involved in working on this issue that the creation of a Task Force to examine the issues related to a proposed energy efficiency standard might offer an opportunity to address the concerns of all interested parties. To this end, the Governor's Task Force on Energy Efficiency Standards for New Residential Construction was created by Governor Howard Dean in late September of 1995 and was charged with developing a specific legislative proposal prior to the 1996 legislative session.

The Governor's Task Force included stakeholders from many different perspectives on this issue. After three months of intensive committee and subcommittee work, this Task Force reached a consensus that the legislature should adopt a code and they agreed that this code should include the following provisions<sup>1</sup>:

- The code should be kept current by establishing a three-year cycle for revision and modification of the code through rule making. This should be established via a partnership between the Department of Public Service (DPS);
- Compliance with the code should be given the presumption of compliance with Act 250 Criterion 9(f), Energy conservation;
- To demonstrate compliance, builders should be required to complete a form self-certifying that the energy efficiency requirements of the code have been met for each new home that is built;
- Owner/builders should be allowed to build a home that does not comply with the code as long as they disclose how that home is deficient to subsequent prospective buyers; and
- In order to address indoor air quality, a requirement for automatic, mechanical ventilation systems should be included

in the first update of the code three years from adoption.

Act 20, the *Vermont Residential Building Energy Standards* (RBES), was adopted by statute in 1997 and incorporated virtually all of the Task Force’s recommendations. Since that time, an Energy Code Assistance Center has been established to provide builders and consumers with information on the code and answers to their questions. Workshops have also been held throughout the state to train builders, architects and trade allies about the code requirements and how to comply.

## Update Process

The RBES Statute, Act 20, called for the code to be updated every three years beginning in 1999. The DPS is required by the statute to form an advisory committee of stakeholders similar to the original Task Force to provide the Commissioner of Labor and Industry with recommendations prior to that agency conducting a formal rule-making process to update the standards.

The statute reads:

“(c) Revision and interpretation of energy standards. On or about January 1, 1999, and at least every three years thereafter, the commissioner of labor and industry shall amend and update the RBES, by means of administrative rules adopted in accordance with 3 V.S.A. Chapter 25. The department of public service shall provide technical assistance and expert advice to the commissioner in the interpretation of the RBES and in the formulation of specific proposals for amending the RBES. At least a year prior to final adoption of each required revision of the RBES, the DPS shall convene an advisory committee to include one or more mortgage lenders, builders, building designers, utility representatives and other persons with experience and expertise, such as consumer advocates and energy conservation experts. The advisory committee may provide the commissioner with additional recommendations for revision of the RBES.

The Vermont Energy Act of 2009 (Act 45), called for the commissioner of public service to amend and update the RBES to ensure that residential construction be designed and constructed in a manner that complies with the 2009 edition of the IECC. These amendments must be effective on final adoption, by means of administrative rules, no later than January 1, 2011.

The Vermont DPS held a series of six stakeholder meetings in 2010 to gather feedback on proposed changes to RBES. The Vermont DPS also convened an advisory committee of interested stakeholders to review the current code and make recommendations for changes and improvements. The revisions to the 2009 edition of the *International Energy Conservation Code* presented in this document were drafted based on input received from these meetings.

## Effective Use of the 2011 Residential Building Energy Standards

The 2011 *Vermont Residential Building Energy Standards* (RBES) is a code that regulates minimum energy conservation requirements for new buildings. The 2011 RBES addresses energy conservation requirements for all aspects of energy uses in residential construction, including heating and ventilating, lighting, water heating, and power usage for appliances and building systems.

The 2011 RBES is a design document. For example, before one constructs a building, the designer must determine the minimum insulation *R*-values and fenestration *U*-factors for the building exterior envelope. The RBES sets forth minimum requirements for exterior envelope insulation, window and door *U*-factors and SHGC ratings, duct insulation, lighting and power efficiency, mechanical ventilation, and water distribution insulation.

## Arrangement and Format of 2011 RBES

Before applying the requirements of 2011 RBES it is beneficial to understand its arrangement and format. 2011 RBES, like other codes published by ICC, is arranged and organized to follow sequential steps that generally occur during a plan review or inspection. 2011 RBES is divided into five different parts:

Chapters	Subjects
1–2	Administration and definitions
3	General Requirements
4	Energy efficiency for residential buildings
5	Reserved
6	Referenced standards

The following is a chapter-by-chapter synopsis of the scope and intent of the provisions of the *2011 Vermont Residential Building Energy Standards*:

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

**Chapter 2 Definitions.** All terms that are defined in the code are listed alphabetically in Chapter 2. While a defined term may be used in one chapter or another, the meaning provided in Chapter 2 is applicable throughout the code. Where understanding of a term’s definition is especially key to or necessary for understanding of a particular code provision, the term is shown in *italics* wherever it appears in the code. This is true only for those terms that have a meaning that is unique to the code. In other words, the generally understood meaning of a term or phrase might not be sufficient or consistent with the meaning prescribed by the code; therefore, it is essential that the code-defined meaning be known. Guidance regarding tense, gender and plurality of defined terms as well as guidance regarding terms not defined in this code is provided.

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

**Chapter 4 Residential Energy Efficiency.** Chapter 4 contains the energy-efficiency-related requirements for the design and construction of residential buildings regulated under this code. It should be noted that the definition of a *residential building* in this code is unique for this code. In this code, a *residential building* is an R-2, R-3 or R-4 building three stories or less in height. All other R-1 buildings, including residential buildings greater than three stories in height, are regulated by the energy conservation requirements in the Vermont Commercial Building Energy Standards (CBES). The applicable portions of a residential building must comply with the provisions within this chapter for energy efficiency. This chapter defines requirements for the portions of the building and building systems that impact energy use in new residential construction and promotes the effective use of energy. The provisions within the chapter promote energy efficiency in the building envelope, the heating and cooling system and the service water heating system of the building.

**Chapter 5 Reserved.**

**Chapter 6 Referenced Standards.** The code contains numerous references to standards that are used to regulate materials and methods of construction. Chapter 6 contains a comprehensive list of all standards that are referenced in the code. The standards are part of the code to the extent of the reference to the standard. Compliance with the referenced standard is necessary for compliance with this code. By providing specifically adopted standards, the construction and installation requirements necessary for compliance with the code can be readily determined. The basis for code compliance is, therefore, established and available on an equal basis to the code official, contractor, designer and owner. Chapter 6 is organized in a manner that makes it easy to locate specific standards. It lists all of the referenced standards, alphabetically, by acronym of the promulgating agency of the standard. Each agency’s standards are then listed in either alphabetical or numeric order based upon the standard identification. The list also contains the title of the standard; the edition (date) of the standard referenced; any addenda included as part of the ICC adoption; and the section or sections of this code that reference the standard.

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## CHAPTER 1 ADMINISTRATION

### PART 1—SCOPE AND APPLICATION

#### SECTION 101

##### SCOPE AND GENERAL REQUIREMENTS

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

**101.2 Scope.** This code applies to *residential buildings*.

**101.3 Intent.** This code shall regulate the design and construction of buildings for the effective use of energy. This code is intended to provide flexibility to permit the use of innovative approaches and techniques to achieve the effective use of energy. This code is not intended to abridge safety, health or environmental requirements contained in other applicable codes or ordinances.

**101.4 Applicability.** Where, in any specific case, different sections of this code specify different materials, methods of construction or other requirements, the most restrictive shall govern. Where there is a conflict between a general requirement and a specific requirement, the specific requirement shall govern.

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

**101.4.2 Historic buildings.** Any building or structure that is listed in the State or National Register of Historic Places; designated as a historic property under local or state designation law or survey; certified as a contributing resource with a National Register listed or locally designated historic district; or with an opinion or certification that the property is eligible to be listed on the National or State Registers of Historic Places either individually or as a contributing building to a historic district by the State Historic Preservation Officer or the Keeper of the National Register of Historic Places, are exempt from this code.

**101.4.3 Additions, alterations, renovations or repairs.** Additions, alterations, renovations or repairs to an existing building, building system or portion thereof shall conform to the provisions of this code as they relate to new construction without requiring the unaltered portion(s) of the existing building or building system to comply with this code. Additions, alterations, renovations or repairs shall not create an unsafe or hazardous condition or overload existing building systems. An addition shall be deemed to comply with this code if the addition alone complies or if the existing building and addition comply with this code as a single building.

**Exception:** The following need not comply provided the energy use of the building is not increased:

1. Storm windows installed over existing fenestration.
2. Glass only replacements in an existing sash and frame.
3. Existing ceiling, wall or floor cavities exposed during construction provided that these cavities are already filled with insulation.
4. Construction where the existing roof, wall or floor cavity is not exposed.
5. Reroofing for roofs where neither the sheathing nor the insulation is exposed. Roofs without insulation in the cavity and where the sheathing or insulation is exposed during reroofing shall be insulated either above or below the sheathing.
6. Replacement of existing doors that separate *conditioned space* from the exterior shall not require the installation of a vestibule or revolving door, provided, however, that an existing vestibule that separates a *conditioned space* from the exterior shall not be removed.
7. Alterations that replace less than 50 percent of the luminaires in the space where the alteration is taking place, provided that such alterations do not increase the installed interior lighting power.
8. Alterations that replace only the bulb and ballast within the existing luminaires in a space provided that the *alteration* does not increase the installed interior lighting power.

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

**101.4.5 Change in space conditioning.** Any nonconditioned space that is altered to become *conditioned space* shall be required to be brought into full compliance with this code.

**101.4.6 Mixed occupancy.** Where a building includes both *residential* and *commercial* occupancies, each occupancy shall be separately considered and meet the applicable provisions of Chapter 4 for *residential portions of the building* and the Vermont *Commercial Building Energy Standards (C BES)* for *commercial portions of the building*.

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

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

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

1. **Low Energy Use Buildings.** Those with a peak design rate of energy usage less than 3.4 Btu/h-ft<sup>2</sup> (10.7 W/m<sup>2</sup>) or 1.0 watt/ft<sup>2</sup> (10.7 W/m<sup>2</sup>) of floor area for space conditioning purposes.
2. **Unconditioned Buildings.** Those that do not contain *conditioned space*.
3. **Mobile homes.** Homes subject to Title VI of the National Manufactured Housing Construction and Safety Standards Act of 1974 (42 U.S.C. §§ 5401-5426).
4. **Hunting camps.** Residential buildings shall not include hunting camps.
5. **Owner-built homes.** Residential construction by an owner, if all of the following apply:
  1. The owner of the residential construction is the *builder*, as defined in 21 V.S.A §§ 266 a1, and;
  2. The residential construction is used as a dwelling by the owner, and;
  3. The owner in fact directs the details of construction with regard to the installation of materials not in compliance with the RBES, and;
  4. The owner discloses in writing to a prospective buyer, before entering into a binding purchase and sales agreement, with respect to the nature and extent of any noncompliance with the RBES.

Any statement or certificate given to a prospective buyer shall itemize how the home does not comply with RBES, and shall itemize which measures do not meet the RBES in effect at the time construction commenced. Any certificate given under this subsection shall be recorded in the land records where the property is located, and sent to the department of public service, within 30 days following sale of the property by the owner. The department of public service will develop and make available to the public a certificate that itemizes how the home does not comply with RBES.

## SECTION 102 ALTERNATE MATERIALS—METHOD OF CONSTRUCTION, DESIGN OR INSULATING SYSTEMS

**102.1 General.** This code is not intended to prevent the use of any material, method of construction, design or insulating system not specifically prescribed herein, provided that such construction, design or insulating system has been *approved* by the *code official or other authority having jurisdiction* as meeting the intent of this code.

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

## PART 2—ADMINISTRATION AND ENFORCEMENT

### SECTION 103 CONSTRUCTION DOCUMENTS

**103.1 General.** Where required, construction documents and other supporting data shall be submitted in one or more sets with each application for a permit. The construction documents shall be prepared by a registered design professional where required by the statutes of the jurisdiction in which the project is to be constructed. Where special conditions exist, the *code official or other authority having jurisdiction* is authorized to require necessary construction documents to be prepared by a registered design professional.

**103.2 Information on construction documents.** Construction documents shall be drawn to scale upon suitable material. Electronic media documents are permitted to be submitted when *approved* by the *code official or other authority having jurisdiction*. Construction documents shall be of sufficient clarity to indicate the location, nature and extent of the work proposed, and show in sufficient detail pertinent data and features of the building, systems and equipment as herein governed. Details shall include, but are not limited to, as applicable, insulation materials and their *R*-values; fenestration *U*-factors and SHGCs; area-weighted *U*-factor and SHGC calculations; mechanical system design criteria; mechanical and service water heating system and equipment types, sizes and efficiencies; economizer description; equipment and systems controls; fan motor horsepower (hp) and controls; duct sealing, duct and pipe insulation and location; lighting fixture schedule with wattage and control narrative; and air sealing details.

**103.3 Examination of documents.** The *code official or other authority having jurisdiction* shall examine or cause to be examined the accompanying construction documents and shall ascertain whether the construction indicated and described is in accordance with the requirements of this code and other pertinent laws or ordinances.

**103.3.1 Approval of construction documents.** When the *code official or other authority having jurisdiction* issues a permit where construction documents are required, the construction documents shall be endorsed in writing and stamped “Reviewed for Code Compliance.” Such *approved* construction documents shall not be changed, modified or altered without authorization from the *code official or other authority having jurisdiction*. Work shall be done in accordance with the *approved* construction documents.

One set of construction documents so reviewed shall be retained by the *code official or other authority having jurisdiction*. The other set shall be returned to the applicant,

kept at the site of work and shall be open to inspection by the *code official* or a duly authorized representative.

**103.3.2 Previous approvals.** This code shall not require changes in the construction documents, construction or designated occupancy of a structure for which a lawful permit has been heretofore issued or otherwise lawfully authorized, and the construction of which has been pursued in good faith within 180 days after the effective date of this code and has not been abandoned.

**103.3.3 Phased approval.** The *code official or other authority having jurisdiction* shall have the authority to issue a permit, where applicable, for the construction of part of an energy conservation system before the construction documents for the entire system have been submitted or *approved*, provided adequate information and detailed statements have been filed complying with all pertinent requirements of this code. The holders of such permit shall proceed at their own risk without assurance that the permit for the entire energy conservation system will be granted.

**103.4 Amended construction documents.** Changes made during construction that are not in compliance with the *approved* construction documents shall be resubmitted for approval as an amended set of construction documents.

**103.5 Retention of construction documents.** One set of *approved* construction documents shall be retained by the *code official or other authority having jurisdiction* for a period of not less than 180 days from date of completion of the permitted work, or as required by state or local laws.

**SECTION 104  
INSPECTIONS**

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

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

**104.3 Final inspection.** The building shall have a final inspection and not be occupied until *approved*, where required, by a code official or other authority having jurisdiction.

**104.4 Reinspection.** A building shall be reinspected when determined necessary by the *code official or other authority having jurisdiction*.

**104.5 Approved inspection agencies.** The *code official or other authority having jurisdiction* is authorized to accept reports of *approved* inspection agencies, provided such agencies satisfy the requirements as to qualifications and reliability.

**104.6 Inspection requests.** It shall be the duty of the holder of the permit or their duly authorized agent to notify the *code official or other authority having jurisdiction* when work is ready for inspection. It shall be the duty of the permit holder to provide access to and means for inspections of such work that are required by this code.

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

**104.8 Approval.** After the prescribed tests and inspections indicate that the work complies in all respects with this code, a notice of approval shall be issued by the *code official or other authority having jurisdiction*.

**104.8.1 Revocation.** The *code official or other authority having jurisdiction* is authorized to, in writing, suspend or revoke a notice of approval issued under the provisions of this code wherever the certificate is issued in error, or on the basis of incorrect information supplied, or where it is determined that the building or structure, premise, or portion thereof is in violation of any ordinance or regulation or any of the provisions of this code.

**SECTION 105  
VALIDITY**

**105.1 General.** If a portion of this code is held to be illegal or void, such a decision shall not affect the validity of the remainder of this code.

**SECTION 106  
REFERENCED STANDARDS**

**106.1 General.** The codes and standards referenced in this code shall be those listed in Chapter 6, and such codes and standards shall be considered as part of the requirements of this code to the prescribed extent of each such reference.

**106.2 Conflicting requirements.** Where the provisions of this code and the referenced standards conflict, the provisions of this code shall take precedence.

**106.3 Application of references.** References to chapter or section numbers, or to provisions not specifically identified by number, shall be construed to refer to such chapter, section or provision of this code.

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

## CHAPTER 2 DEFINITIONS

### SECTION 201 GENERAL

**201.1 Scope.** Unless stated otherwise, the following words and terms in this code shall have the meanings indicated in this chapter.

**201.2 Interchangeability.** Words used in the present tense include the future; words in the masculine gender include the feminine and neuter; the singular number includes the plural and the plural includes the singular.

**201.3 Terms defined in other codes.** Terms that are not defined in this code but are defined in the *International Building Code*, *International Fire Code*, *International Fuel Gas Code*, *International Mechanical Code*, *International Plumbing Code* or the *International Residential Code* shall have the meanings ascribed to them in those codes.

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

### SECTION 202 GENERAL DEFINITIONS

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

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

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

**AIR BARRIER.** Material(s) assembled and joined together to provide a barrier to air leakage through the building envelope. An air barrier may be a single material or a combination of materials.

**AIR TRANSPORT FACTOR.** The ratio of the rate of useful sensible heat removal from the conditioned space to the energy input to the supply and return fan motor(s), expressed in consistent units and under the designated operating conditions.

**ALTERATION.** Any construction or renovation to an existing structure other than repair or addition. Also, a change in a mechanical system that involves an extension, addition or change to the arrangement, type or purpose of the original installation.

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

**APPROVED.** Approval by the *code official or other authority having jurisdiction* as a result of investigation and tests conducted by him or her, or by reason of accepted principles or tests by nationally recognized organizations.

**AUTOMATIC.** Self-acting, operating by its own mechanism when actuated by some impersonal influence, as, for example, a change in current strength, pressure, temperature or mechanical configuration (see “Manual”).

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

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

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

**BTU.** Abbreviation for British thermal unit, which is the quantity of heat required to raise the temperature of 1 pound (0.454 kg) of water 1°F (0.56°C), (1 Btu = 1,055 J).

**BUILDER.** The general contractor or other person in charge of construction, who has the power to direct others with respect to the details to be observed in construction.

**BUILDING.** Any structure used or intended for supporting or sheltering any use or occupancy.

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

**CATEGORY I COMBUSTION APPLIANCE.** A combustion appliance that operates with a non-positive vent static pressure and with a vent gas temperature that avoids excessive condensate production in the vent.

**CATEGORY II COMBUSTION APPLIANCE.** A combustion appliance that operates with a non-positive vent static pressure and with a vent gas temperature that may cause excessive condensate production in the vent.

**CATEGORY III COMBUSTION APPLIANCE.** An appliance that operates with a positive vent static pressure and with a vent gas temperature that avoids excessive condensate production in the vent.

**CATEGORY IV COMBUSTION APPLIANCE.** An appliance that operates with a positive vent static pressure and with a vent gas temperature that may cause excessive condensate production in the vent.

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

**C-FACTOR (THERMAL CONDUCTANCE).** The coefficient of heat transmission (surface to surface) through a building component or assembly, equal to the time rate of heat flow per unit area and the unit temperature difference between the

warm side and cold side surfaces (Btu/hft<sup>2</sup> x °F) [W/(m<sup>2</sup> x K)].

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

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

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

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

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

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

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

**CONDITIONED SPACE.** An area or room within a building that meets one or more of the following criteria: (a) is provided with positive heating and/or cooling supply; (b) contains uninsulated ducts, pipes, or other systems designed to distribute heating and/or cooling; (c) is separated from any area or room that meets either (a) or (b) by an uninsulated wall, ceiling, or floor, or an opening.

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

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

#### **DAYLIGHT ZONE.**

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

one-half the distance to adjacent skylight or vertical fenestration, whichever is least.

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

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

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

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

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

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

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

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

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

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

**ENERGY ANALYSIS.** A method for estimating the annual energy use of the *proposed design* and *standard reference design* based on estimates of energy use.

**ENERGY COST.** The total estimated annual cost for purchased energy for the building functions regulated by this code, including applicable demand charges.

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

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

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

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

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

**EXTERIOR ENVELOPE.** See “Building envelope.”

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

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

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

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

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

**FENESTRATION.** Skylights, roof windows, vertical windows (fixed or moveable), opaque doors, glazed doors, glazed block and combination opaque/glazed doors. Fenestration includes products with glass and nonglass glazing materials.

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

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

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

**FURNACE DUCT.** A furnace normally installed in distribu-

tion ducts of air-conditioning systems to supply warm air for heating and which depends on a blower not furnished as part of the duct furnace for air circulation.

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

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

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

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

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

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

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

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

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

**HIGH-EFFICACY LAMPS.** Compact fluorescent lamps, T-8 or smaller diameter linear fluorescent lamps, or lamps with a minimum efficacy of:

1. 60 lumens per watt for lamps over 40 watts,
2. 50 lumens per watt for lamps over 15 watts to 40 watts, and
3. 40 lumens per watt for lamps 15 watts or less.

**HOME ENERGY RATING SYSTEM (HERS).** A home energy rating system accredited by the Vermont DPS that provides a numerical rating in compliance with 21 V.S.A. § 267(a). The purpose of this procedure is to ensure that accurate and consistent home energy ratings are performed by accredited HERS providers in Vermont and to promote an objective, cost-effective, sustainable home energy rating process as a compliance method for residential building energy codes; as qualification for energy programs designed to reach specific energy-saving goals; and as a way to provide Vermont’s housing market the ability to differentiate residences based on their energy efficiency.

**HUMIDISTAT.** A regulatory device, actuated by changes in

humidity, used for automatic control of relative humidity.

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

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

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

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

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

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

**LABELED.** Equipment, materials or products to which have been affixed a label, seal, symbol or other identifying mark of a nationally recognized testing laboratory, inspection agency or other organization concerned with product evaluation that maintains periodic inspection of the production of the above-labeled items and whose labeling indicates either that the equipment, material or product meets identified standards or has been tested and found suitable for a specified purpose.

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

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

**LOW-VOLTAGE LIGHTING.** Lighting equipment powered

through a transformer such as a cable conductor, a rail conductor and track lighting.

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

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

**MULTIFAMILY DWELLING.** A building containing three or more dwelling units.

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

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

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

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

**PACKAGED TERMINAL AIR CONDITIONER (PTAC).** A factory-selected wall sleeve and separate unencased combination of heating and cooling components, assemblies or sections (intended for mounting through the wall to serve a single room or zone). It includes heating capability by hot water, steam or electricity. (For the complete technical definition, see ARI 310/380.)

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

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

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

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

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

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

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

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

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

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

**RENEWABLE ENERGY SOURCES.** Sources of energy (excluding minerals) derived from incoming solar radiation, including natural daylighting and photosynthetic processes; from phenomena resulting therefrom, including wind, waves and tides, lake or pond thermal differences; and from the internal heat of the earth, including nocturnal thermal exchanges.

**REPAIR.** The reconstruction or renewal of any part of an existing building.

**RESIDENTIAL BUILDING.** For this code, includes R-3 buildings, as well as R-2 and R-4 buildings three stories or less in height above grade.

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

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

air, and shall be permitted to also include means for ventilating and heating.

**R-VALUE (THERMAL RESISTANCE).** The inverse of the time rate of heat flow through a body from one of its bounding surfaces to the other surface for a unit temperature difference between the two surfaces, under steady state conditions, per unit area ( $h \cdot \text{ft}^2 \cdot ^\circ\text{F}/\text{Btu}$ ) [ $(\text{m}^2 \cdot \text{K})/\text{W}$ ].

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

**SEALED COMBUSTION VENTING SYSTEM.** A venting system designed so that all air for combustion is derived directly from the outside atmosphere and all flue gases are discharged directly to the outside atmosphere. See also DIRECT VENT APPLIANCES.

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

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

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

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

**SKYLIGHT.** Glass or other transparent or translucent glazing material installed at a slope of 15 degrees (0.26 rad) or more from vertical. Glazing material in skylights, including unit skylights, solariums, sunrooms, roofs and sloped walls is included in this definition.

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

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

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

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

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

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

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

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

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

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

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

**THERMAL CONDUCTANCE.** Time rate of heat flow through a body (frequently per unit area) from one of its bounding surfaces to the other for a unit temperature difference between surfaces, under steady conditions ( $\text{Btu/h} \cdot \text{ft}^2 \cdot ^\circ\text{F}$ ) [ $\text{W}/(\text{m}^2 \cdot \text{K})$ ].

**THERMAL ISOLATION.** Physical and space conditioning separation from *conditioned space(s)*. The *conditioned space(s)* shall be controlled as separate zones for heating and cooling or conditioned by separate equipment.

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

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

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

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

films on both sides of a building element.

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

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

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

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

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

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

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

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

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

**VAPOR PERMEABLE MEMBRANE.** A material or covering having a permeance rating of 5 perms ( $2.9 \cdot 1040 \text{ kg}/\text{Pa} \cdot \text{s} \cdot \text{m}^2$ ) or greater, when tested in accordance with the desiccant method using Procedure A of ASTM E 96. A vapor permeable material permits the passage of moisture vapor.

**VAPOR RETARDER CLASS.** A measure of the ability of a material or assembly to limit the amount of moisture that passes through that material or assembly. Vapor retarder class shall be defined using the desiccant method with Procedure A of ASTM E 96 as follows:

- Class 1: 0.1 perm or less
- Class 2:  $0.1 < \text{perm} < 1.0$  perm
- Class 3:  $1.0 < \text{perm} < 10$  perm

**VENTILATION.** The natural or mechanical process of supplying conditioned or unconditioned air to, or removing such air from, any space.

**VENTILATION AIR.** That portion of supply air that comes from outside (outdoors) plus any recirculated air that has been treated to maintain the desired quality of air within a designated space.

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

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

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

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

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

**WHOLE HOUSE VENTILATION SYSTEM.** A mechanical ventilation system including fans, controls and ducts, which is installed for the express purpose of providing, directly or indirectly, all or a portion of the occupant's fresh-air ventilation needs for the entire dwelling unit.

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

**WHOLE HOUSE VENTILATION SYSTEM, INTEGRATED SUPPLY.** Integrated systems provide outdoor air for ventilation via an outdoor air connection directly to the return air plenum of a forced-air furnace system at a point within 4 feet (1219 mm) upstream of the forced-air system fan or as specified in accordance with the manufacturer's installation instructions. The upstream outdoor air duct interface shall neither be directly connected to the furnace cabinet, nor connected to the return air plenum in such a way that would violate the manufacturer's listing of the appliance.

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

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

**WHOLE HOUSE VENTILATION SYSTEMS, SUPPLY ONLY.** Supply only systems provide outdoor air for ventilation via a single fan or multiple fans. Stale air may exhaust through typical leaks in the building envelope. Supply only systems may pressurize the indoor environment

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

**ZONE.** A space or group of spaces within a building with heating or cooling requirements that are sufficiently similar so that desired conditions can be maintained throughout using a single controlling device.



GENERAL REQUIREMENTS

SECTION 301  
RESERVED

SECTION 302  
DESIGN CONDITIONS

**302.1 Interior design conditions.** The interior design temperatures used for heating and cooling load calculations shall be a maximum of 72°F (22°C) for heating and minimum of 75°F (24°C) for cooling.

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

TABLE 302.2  
THERMAL DESIGN PARAMETERS

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

For SI: °C = [(°F) - 32]/1.8.

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

SECTION 303  
MATERIALS, SYSTEMS AND EQUIPMENT

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

**303.1.1 Building thermal envelope insulation.** An *R*-value identification mark shall be applied by the manufacturer to each piece of *building thermal envelope* insulation 12 inches (305 mm) or greater in width. Alternately, the insulation installers shall provide a certification listing the type, manufacturer and *R*-value of insulation installed in each element of the *building thermal envelope*. For blown or sprayed insulation (fiberglass and cellulose), the initial installed thickness, settled thickness, settled *R*-value, installed density, coverage area and number of bags installed shall be *listed* on the certification. For sprayed polyurethane foam (SPF) insulation, the installed

thickness of the areas covered and *R*-value of installed thickness shall be *listed* on the certification. The insulation installer shall sign, date and post the certification in a conspicuous location on the job site.

**303.1.1.1 Blown or sprayed roof/ceiling insulation.**

The thickness of blown-in or sprayed roof/ceiling insulation (fiberglass or cellulose) shall be written in inches (mm) on markers that are installed at least one for every 300 square feet (28 m<sup>2</sup>) throughout the attic space. The markers shall be affixed to the trusses or joists and marked with the minimum initial installed thickness with numbers a minimum of 1 inch (25 mm) in height. Each marker shall face the attic access opening. Spray polyurethane foam thickness and installed *R*-value shall be *listed* on certification provided by the insulation installer.

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

**303.1.3 Fenestration product rating.** *U*-factors of fenestration products (windows, doors and skylights) shall be determined in accordance with NFRC 100 by an accredited, independent laboratory, and labeled and certified by the manufacturer. Products lacking such a labeled *U*-factor shall be assigned a default *U*-factor from Table 303.1.3(1) or 303.1.3(2). The solar heat gain coefficient (SHGC) of glazed fenestration products (windows, glazed doors and skylights) shall be determined in accordance with NFRC 200 by an accredited, independent laboratory, and labeled and certified by the manufacturer. Products lacking such a labeled SHGC shall be assigned a default SHGC from Table 303.1.3(3).

TABLE 303.1.3(1)  
DEFAULT GLAZED FENESTRATION U-FACTOR

FRAME TYPE	SINGLE PANE	DOUBLE PANE	SKYLIGHT	
			Single	Double
Metal	1.20	0.80	2.00	1.30
Metal with Thermal Break	1.10	0.65	1.90	1.10
Nonmetal or Metal Clad	0.95	0.55	1.75	1.05
Glazed Block	0.60			

TABLE 303.1.3(2)  
DEFAULT DOOR U-FACTORS

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

TABLE 303.1.3(3)  
DEFAULT GLAZED FENESTRATION SHGC

SINGLE GLAZED		DOUBLE GLAZED		GLAZED BLOCK
Clear	Tinted	Clear	Tinted	
0.8	0.7	0.7	0.6	0.6

**303.1.4 Insulation product rating.** The thermal resistance (*R*-value) of insulation shall be determined in accordance with the U.S. Federal Trade Commission *R*-value rule (CFR Title 16, Part 460, May 31, 2005) in units of h X ft<sup>2</sup> X °F/Btu at a mean temperature of 75°F (24°C).

**303.2 Installation.** All materials, systems and equipment shall be installed in accordance with the manufacturer’s installation instructions and the *International Building Code*.

**303.2.1 Protection of exposed foundation insulation.**

Insulation applied to the exterior of basement walls, crawl-space walls and the perimeter of slab-on-grade floors shall have a rigid, opaque and weather-resistant protective covering to prevent the degradation of the insulation’s thermal performance. The protective covering shall cover the exposed exterior insulation and extend a minimum of 6 inches (153 mm) below grade.

**303.3 Maintenance information.** Maintenance instructions shall be furnished for equipment and systems that require preventive maintenance. Required regular maintenance actions shall be clearly stated and incorporated on a readily accessible label. The label shall include the title or publication number for the operation and maintenance manual for that particular model and type of product.

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

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

**304.1.1 Compliance.** Compliance with Section 304 shall be achieved by meeting Section 304.2 or 304.3.

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

TABLE 304.2 MINIMUM REQUIRED LOCAL EXHAUST

Occupancy Classification	Mechanical Exhaust Capacity (cfm)
Bathrooms	50 cfm intermittent or 20 cfm continuous

**304.3 Whole house ventilation (MANDATORY).** Every home built to RBES shall be mechanically ventilated by a whole house ventilation system as defined in Chapter 2. The whole house ventilation system shall be one of three types: “exhaust only” in accordance with Section 304.3.1, “supply only” in accordance with Section 304.3.2 or “balanced” in accordance with Section 304.3.3.

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

**304.3.2 Supply only systems.** Supply only systems provide outdoor air for ventilation via a single fan or multiple fans. Stale air may exhaust through typical leaks in the building envelope. Supply only systems may pressurize the indoor environment.

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

**304.3.2.1 Integrated supply systems.** Integrated systems provide outdoor air for ventilation via an outdoor air connection directly to the return air plenum of a forced-air furnace system at a point within 4 feet (1219 mm) upstream of the forced-air system fan or as specified in accordance with the manufacturer’s installation instructions. The upstream outdoor air duct interface shall neither be directly connected to the furnace cabinet, nor connected to the return air plenum in such a way that would violate the manufacturer’s listing of the appliance.

**304.3.2.1.1 System operation.** The outdoor air duct for integrated supply systems shall be equipped with a damper as follows:

1. A motorized damper connected to a ventilation controller as required by Section 304.8; or
2. A manually operated damper or other constant air-flow regulating device installed such that performance verification of the whole house outdoor air requirements of Section 304.6.1 have been verified.

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

**304.3.4 Single-port systems.** A whole house ventilation system that has only one connection to the conditioned space and one connection to outdoor air.

**304.3.5 Multiport systems.** A whole house ventilation system that has more than one exhaust or supply port inside the house. Multiport systems may be either exhaust

only, supply only or balanced systems.

**304.4 Whole house air circulation.** Provisions shall be made to allow air flow to all finished living spaces by installation of distribution ducts, undercutting doors, installation of grilles, transoms or equivalent means. Door undercuts shall be at least  $\frac{1}{2}$  inch (12.7 mm) above the surface of the finished floor covering.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

**304.9 Installation requirements.** Ventilation equipment shall be installed according to the manufacturer’s instructions and in accordance with Sections 304.9.1 through 304.9.8.

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

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

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

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

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

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

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

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

snow accumulation level.

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

weather conditions.

**304.10 Clothes dryer exhaust.** Clothes dryers shall be exhausted in accordance with the manufacturer's instructions. Dryer exhaust systems shall be independent of all other systems and shall convey the moisture and any products of combustion to the outside of the building.

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

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**TABLE 304.6  
PRESCRIPTIVE FAN CAPACITY REQUIREMENTS**

NUMBER OF BEDROOMS	MINIMUM NOMINAL RATED TOTAL FAN CAPACITY <sup>a</sup> (at 0.1 inches w.g.)	MINIMUM NUMBER OF FANS TO MEET WHOLE HOUSE AIRFLOW RATES
1	50 cfm	1
2	75 cfm	1
3	100 cfm	1
4	125 cfm	Centrally ducted systems—1 All other systems—2 or more
5	150 cfm	Centrally ducted systems—1 All other systems—2 or more
Homes > 3,000 ft. <sup>2</sup>	cfm = 0.05 . ft. <sup>2</sup>	Centrally ducted systems—1 All other systems—2 or more

For SI: 1 cubic foot per minute = 0.0004719 m<sup>3</sup>/s, 1 cubic foot per minute per square foot = 0.00508 m<sup>3</sup>/(s . m<sup>2</sup>).

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

## SECTION 305

### COMBUSTION SAFETY

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

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

**305.3 Fuel gas, kerosene and oil-burning equipment.** Every new home built to the RBES that contains Category I or II natural draft venting fuel-burning appliances shall be provided with combustion and dilution air as required by Section 5.3 of NFPA 54 for fuel-gas utilization equipment or Section 1-9 of NFPA 31 for oil-burning equipment. Direct vent appliances that do not draw combustion air from inside of the building are not required to be considered in the determination of the combustion and dilution air requirements.

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

**305.3.1 Crawl space and attic space.** For the purposes of

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

**305.3.2 Unvented Room Heaters.** Unvented fuel-fired heaters, including room heaters and unvented fireplaces are prohibited.

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

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

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

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

**305.4.2 Exterior air supply requirements.** Solid fuel-burning appliances and fireplaces shall be equipped with an exterior air supply according to the provisions of sections 305.4.2.1 through 305.4.2.7.

**Exception:** Factory-built fireplaces, masonry fireplaces and solid fuel-burning appliances that list exterior air

supply ducts as optional or required for proper installation are permitted to be installed with those exterior air supply ducts according to the manufacturer's installation instructions.

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

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

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

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

**Exception:** For older woodstoves and cookstoves where direct connection of combustion air is not possible, combustion air may be delivered within 24" of the stoves air intake opening.

**305.4.2.4** The air inlet shall be screened with ¼" mesh.

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

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

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

## CHAPTER 4

# RESIDENTIAL ENERGY EFFICIENCY

### SECTION 401 GENERAL

**401.1 Scope.** This chapter applies to residential buildings.

**401.2 Compliance.** Projects shall comply with those sections identified as “mandatory” and with either sections identified as “prescriptive” herein, or the performance approach set forth in Section 405.

**401.3 Certificate of compliance.** A certification may be issued and signed by a builder, a licensed professional engineer, a licensed architect or an accredited home energy rating organization. If certification is not issued by a licensed professional engineer, a licensed architect or an accredited home energy rating organization, it shall be issued by the builder. Any certification shall certify that residential construction meets the RBES. The department of public service will develop and make available to the public a certificate that lists key features of the RBES. Any person certifying shall use this certificate or one substantially like it to certify compliance with the RBES. Certification shall be issued by completing and signing a certificate and permanently affixing it to the electrical service panel, without covering or obstructing the visibility of the circuit directory label, service disconnect label or other required labels. The certificate shall certify that the residential building has been constructed in compliance with the requirements of the

RBES. The person certifying under this subsection shall provide a copy of the certificate to the department of public service and shall assure that a certificate is recorded and indexed in the town land records. A builder may contract with a licensed professional engineer, a licensed architect or an accredited home energy rating organization to issue certification and to indemnify the builder from any liability to the owner of the residential construction caused by noncompliance with the RBES.

### SECTION 402 BUILDING THERMAL ENVELOPE

#### 402.1 General (Prescriptive).

**402.1.1 Insulation and fenestration criteria.** The *building thermal envelope* shall meet the requirements of Table 402.1.1. Log homes shall meet the requirements of Table 402.1.3

**402.1.2 R-value computation.** Insulation material used in layers, such as framing cavity insulation and insulating sheathing, shall be summed to compute the component *R*-value. The manufacturer’s settled *R*-value shall be used for blown insulation. Computed *R*-values shall not include an *R*-value for other building materials or air films.

TABLE 402.1.1  
INSULATION AND FENESTRATION REQUIREMENTS BY COMPONENT<sup>a</sup>

FENESTRATION <i>U</i> -FACTOR <sup>b</sup>	SKYLIGHT <sup>b</sup> <i>U</i> -FACTOR	MAXIMUM GLAZING AREA <sup>c</sup>	CEILING <i>R</i> - VALUE	WOOD FRAME WALL <i>R</i> -VALUE	MASS WALL <i>R</i> - VALUE <sup>e</sup>	FLOOR <i>R</i> - VALUE	BASEMENT <sup>g</sup> WALL <i>R</i> -VALUE	SLAB <i>R</i> - VALUE & DEPTH	HEATED SLAB <i>R</i> - VALUE <sup>h</sup>	CRAWL SPACE WALL <i>R</i> - VALUE <sup>g</sup>
0.32	0.55	20%	49	20 or 13+5 <sup>d</sup>	15/20	30 <sup>f</sup>	15/20	15, 4 ft	15	15/20

For SI: 1 foot = 304.8 mm.

- a. *R*-values are minimums. *U*-factors are maximums. R-19 batts compressed into a nominal 2 × 6 framing cavity such that the *R*-value is reduced by R-1 or more shall be marked with the compressed batt *R*-value in addition to the full thickness *R*-value.
- b. The fenestration *U*-factor column excludes skylights.
- c. Glazing area includes window and skylight opening area, plus actual glazed area of glass in doors. Sunrooms are exempt from this requirement.
- d. “13+5” means R-13 cavity insulation plus R-5 insulated sheathing. If structural sheathing covers 25 percent or less of the exterior, insulating sheathing is not required where structural sheathing is used. If structural sheathing covers more than 25 percent of exterior, structural sheathing shall be supplemented with insulated sheathing of at least R-2.
- e. The second *R*-value applies when more than half the insulation is on the interior of the mass wall.
- f. Or insulation sufficient to fill the framing cavity, with R-20 as the absolute minimum.
- g. “15/20” means R-15 continuous insulated sheathing on the interior or exterior of the home or R-20 cavity insulation at the interior of the basement wall. “15/20” shall be permitted to be met with R-13 cavity insulation on the interior of the basement wall plus R-5 continuous insulated sheathing on the interior or exterior of the home.
- h. R-15 shall be required beneath the entire slab for heated slabs.

**TABLE 402.1.2  
EQUIVALENT U-FACTORS<sup>a</sup>**

FENESTRATION U-FACTOR	SKYLIGHT U-FACTOR	MAXIMUM GLAZING AREA <sup>b</sup>	CEILING U-FACTOR	FRAME WALL U-FACTOR	MASS WALL U-FACTOR <sup>c</sup>	FLOOR U-FACTOR	BASEMENT WALL U-FACTOR	SLAB U-FACTOR & DEPTH	HEATED SLAB U-FACTOR <sup>c</sup>	CRAWL SPACE WALL U-FACTOR
0.32	0.55	20%	0.020	0.050	0.060	0.033	0.050	0.066, 4 ft	0.066	0.050

- a. Nonfenestration *U*-factors shall be obtained from measurement, calculation or an approved source.
- b. Glazing area includes window and skylight opening area, plus actual glazed area of glass in doors. Sunrooms are exempt from this requirement.
- c. When more than half the insulation is on the interior, the mass wall *U*-factors shall be the same as the frame wall *U*-factor
- d. Foundation *U*-factor requirement shown in Table 402.1.2 include wall construction and interior air films but exclude soil conductivity and exterior air films. *U*-factors for determining code compliance in accordance with Section 402.1.4 (total UA alternative) of Section 405 (Simulated Performance Alternative) shall be modified to include soil conductivity and exterior films.
- e. Required beneath the entire slab.

**TABLE 402.1.3  
LOG HOME INSULATION AND FENESTRATION REQUIREMENTS BY COMPONENT<sup>a</sup>**

FENESTRATION U-FACTOR <sup>b</sup>	SKYLIGHT U-FACTOR	MAXIMUM GLAZING AREA <sup>c</sup>	CEILING U-FACTOR	MASS WALL U-FACTOR <sup>d</sup>	FLOOR U-FACTOR <sup>e</sup>	BASEMENT WALL U-FACTOR <sup>f</sup>	SLAB U-FACTOR & DEPTH	HEATED SLAB U-FACTOR <sup>g</sup>	CRAWL SPACE WALL U-FACTOR
0.30	0.55	20%	0.020	Log	0.026	0.050	0.066, 4 ft	0.066	0.050

For SI: 1 foot = 304.8 mm.

- a. *U*-factors are maximums.
- b. The fenestration *U*-factor column excludes skylights.
- c. Glazing area includes window and skylight opening area, plus actual glazed area of glass in doors. Sunrooms are exempt from this requirement.
- d. Log walls must comply with ICC400 with an average minimum wall thickness of 5" or greater, and have a heating AFUE of 90% (gas) or 85% (oil). Boilers must have a modulating aquastat or outdoor temperature limit control.
- e. Or insulation sufficient to fill the framing cavity, with U-0.05 as the absolute minimum.
- f. Foundation *U*-factor requirements shown in Table 402.1.3 include wall construction and interior air films but exclude soil conductivity and exterior air films. *U*-factors for determining code compliance in accordance with Section 402.1.4 (total UA alternative) of Section 405 (Simulated Performance Alternative) shall be modified to include soil conductivity and exterior films.
- g. Required beneath the entire slab.

**402.1.3 U-factor alternative.** An assembly with a *U*-factor equal to or less than that specified in Table 402.1.2 shall be permitted as an alternative to the *R*-value in Table 402.1.1.

**402.1.4 Total UA alternative.** If the total *building thermal envelope* UA (sum of *U*-factor times assembly area) is less than or equal to the total UA resulting from using the *U*-factors in Table 402.1.2 and Table 402.1.3 (multiplied by the same assembly area as in the proposed building), the building shall be considered in compliance with Table 402.1.1. The UA calculation shall be done using a method consistent with the ASHRAE *Handbook of Fundamentals* and shall include the thermal bridging effects of framing materials. The SHGC requirements shall be met in addition to UA compliance.

**402.2 Specific insulation requirements (Prescriptive).**

**402.2.1 Ceilings with attic spaces.** R-38 shall be deemed to satisfy the requirement for R-49 wherever the full height of uncompressed R-38 insulation extends over the wall top plate at the eaves. This reduction shall not apply to the *U*-factor alternative approach in Section 402.1.2, 402.1.3 and the total UA alternative in Section 402.1.4.

**402.2.2 Ceilings without attic spaces.** Where the design of the roof/ceiling assembly does not allow sufficient space for the required insulation, the minimum required insulation for such roof/ceiling assemblies shall be R-30. This reduction of insulation from the requirements of Sec-

tion 402.1.1 shall be limited to 500 square feet (46 m<sup>2</sup>) or 20 percent of the total insulated ceiling area, whichever is less. This reduction shall not apply to the *U*-factor alternative approach in Section 402.1.3 and the total UA alternative in Section 402.1.4.

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

**402.2.4 Mass walls.** Mass walls for the purposes of this chapter shall be considered above-grade walls of concrete block, concrete, insulated concrete form (ICF), masonry cavity, brick (other than brick veneer), earth (adobe, compressed earth block, rammed earth) and solid timber/logs.

**402.2.5 Steel-frame ceilings, walls, and floors.** Steel-frame ceilings, walls and floors shall meet the insulation requirements of Table 402.2.5 or shall meet the *U*-factor requirements in Table 402.1.3. The calculation of the *U*-factor for a steel-frame envelope assembly shall use a series- parallel

path calculation method.

**TABLE 402.2.5**  
**STEEL-FRAME CEILING, WALL AND FLOOR INSULATION**  
**(R-VALUE)**

WOOD FRAME R-VALUE REQUIREMENT	COLD-FORMED STEEL EQUIVALENT R-VALUE <sup>a</sup>
<b>Steel Truss Ceilings<sup>b</sup></b>	
R-30	R-38 or R-30 + 3 or R-26 + 5
R-38	R-49 or R-38 + 3
R-49	R-38 + 5
<b>Steel Joist Ceilings<sup>b</sup></b>	
R-30	R-38 in 2, 4 or 2, 6 or 2, 8 R-49 in any framing
R-38	R-49 in 2, 4 or 2, 6 or 2, 8 or 2, 10
<b>Steel-Framed Wall</b>	
R-13	R-13 + 5 or R-15 + 4 or R-21 + 3 or R-0 + 10
R-19	R-13 + 9 or R-19 + 8 or R-25 + 7
R-21	R-13 + 10 or R-19 + 9 or R-25 + 8
<b>Steel Joist Floor</b>	
R-13	R-19 in 2.6 R-19 + 6 in 2.8 or 2, 10
R-19	R-19 + 6 in 2.6 R-19 + 12 in 2.8 or 2, 10

- a. Cavity insulation R-value is listed first, followed by continuous insulation R-value.  
b. Insulation exceeding the height of the framing shall cover the framing.

**402.2.6 Floors.** Floor insulation shall be installed to maintain permanent contact with the underside of the subfloor decking.

**402.2.7 Basement walls.** Walls associated with conditioned basements shall be insulated from the top of the *basement wall* down to 10 feet (3048 mm) below grade or to the basement floor, whichever is less. Walls associated with unconditioned basements shall meet this requirement unless the floor overhead is insulated in accordance with Sections 402.1.1 and 402.2.6.

**402.2.8 Slab-on-grade floors.** Slab-on-grade floors with a floor surface less than 12 inches (305 mm) below grade shall be insulated in accordance with Table 402.1.1. The insulation shall extend downward from the top of the slab on the outside or inside of the foundation wall. Insulation located below grade shall be extended the distance provided in Table 402.1.1 by any combination of vertical insulation, insulation extending under the slab or insulation extending out from the building. Insulation extending away from the building shall be protected by pavement or by a minimum of 10 inches (254 mm) of soil. The top edge of the insulation installed between the *exterior wall* and the edge of the interior slab shall be permitted to be cut at a 45-degree (0.79 rad) angle away from the *exterior wall*. Slab-edge insulation is not required in jurisdictions designated by the *code official or other authority having jurisdiction* as having a very heavy termite infestation.

**402.2.9 Crawl space walls.** As an alternative to insulating floors over crawl spaces, crawl space walls shall be permitted to be insulated when the crawl space is not vented to the outside. Crawl space wall insulation shall be permanently

fastened to the wall and extend downward from the floor to the finished grade level and then vertically and/or horizontally for at least an additional 24 inches (610 mm). Exposed earth in unvented crawl space foundations shall be covered with a continuous Class I vapor retarder in accordance with the *ASTM E 96*. All joints of the vapor retarder shall overlap by 6 inches (153 mm) and be sealed or taped. The edges of the vapor retarder shall extend at least 6 inches (153 mm) up the stem wall and shall be attached to the stem wall.

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

**402.2.11 Sunroom insulation.** All *sunrooms* shall meet the insulation requirements of this code.

**Exception:** For *sunrooms* with *thermal isolation*, the following exceptions to the insulation requirements of this code shall apply: (1) The minimum ceiling insulation R-values shall be R-30; and (2) The minimum wall R-value shall be R-13. New wall(s) separating a *sunroom* with *thermal isolation* from *conditioned space* shall meet the *building thermal envelope* requirements of this code.

**402.2.12 Common, party, and fire walls.** Whenever continuity of the *building thermal envelope* is broken at walls separating dwelling units in Group R-2 building, including common, party, and fire walls, such walls shall be insulated to a minimum of R-10 on each side of the break in insulation continuity, and the walls shall be air sealed in accordance with Section 402.4.

#### 402.3 Fenestration. (Prescriptive).

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

**402.3.3 Glazed fenestration exemption.** Up to 15 square feet (1.4 m<sup>2</sup>) of glazed fenestration per dwelling unit shall be permitted to be exempt from U-factor and SHGC requirements in Section 402.1.1. This exemption shall not apply to the U-factor alternative approach in Section 402.1.3 and the Total UA alternative in Section 402.1.4.

**402.3.4 Opaque door exemption.** One side-hinged opaque door assembly up to 24 square feet (2.22 m<sup>2</sup>) in area is exempted from the U-factor requirement in Section 402.1.1. This exemption shall not apply to the U-factor alternative approach in Section 402.1.3 and the total UA alternative in Section 402.1.4.

**402.3.5 Sunroom U-factor.** All *sunrooms* shall meet the fenestration requirements of this code.

**Exception:** For *sunrooms* with *thermal isolation*, the following exceptions to the fenestration requirements of this code shall apply: (1) the maximum fenestration U-factor shall be 0.45; and (2) the maximum skylight U-factor shall be 0.55. New fenestration separating the *sunroom* with *thermal isolation* from *conditioned space* shall meet the *building thermal envelope* requirements of this code.

**402.3.6 Replacement fenestration.** Where some or all of an existing fenestration unit is replaced with a new fenestration product, including sash and glazing, the replacement fenestration unit shall meet the applicable requirements for U-factor and SHGC in Table 402.1.1.

#### 402.4 Air leakage (Mandatory).

**402.4.1 Building thermal envelope.** The *building thermal envelope* shall comply with Sections 402.4.1.1 and 402.4.1.2. The sealing methods between dissimilar

materials shall allow for differential expansion and contraction.

**402.4.1.1 Installation.** The components of the *building thermal envelope* as listed in Table 402.4 shall be installed in accordance with the manufacturer's instructions and the criteria listed in Table 402.4, as applicable to the method of construction. Where required by the *code official or other authority having jurisdiction*, an *approved* party shall inspect all components and verify compliance.

**402.4.1.2 Air sealing and insulation.** Building envelope air tightness and insulation installation shall be demonstrated to comply with one of the following options given by Section 402.4.2.1 or 402.4.2.2:

**402.4.1.2.1 Testing option.** Building envelope tightness and insulation installation shall be considered acceptable when tested air leakage is less than five air changes per hour (ACH) when tested with a blower door at a pressure of 50 pascals (1 psf). Testing shall occur after rough in and after installation of penetrations of the building envelope, including penetrations for utilities, plumbing, electrical, ventilation and combustion appliances. The following protocol shall be followed in preparing the building envelope for testing:

1. Leave all supply registers and return grills open and uncovered.
2. Leave all bathroom and kitchen fans open (i.e., in their normal operating condition). Only a permanently installed back draft damper in its normal condition may impede the flow of air.
3. Leave any combustion air ducts or louvers to the exterior open. (If a homeowner or builder has sealed them off, open them for the test.)
4. Leave any make-up air ducts with in-line dampers (e.g., for large kitchen exhaust fans or combustion air) as-is (unsealed). Only a permanently installed back draft damper or motorized damper, in its normal condition may impede the flow of air.
5. Leave the dryer vent as-is, whether or not the dryer is in place during the test. Only a permanently installed back draft damper in its normal condition may impede the flow of air.
6. Leave open any outside air duct supplying fresh air for intermittent ventilation systems (including a central-fan-integrated distribution system)
7. Operable crawl-space vents, where present, are to be left in the open position.
8. Open all interior doors within the conditioned space, including doors to conditioned basements. (Closet doors may be left closed unless the closet contains windows or access to the attic or crawl space).
9. Leave louvered openings of a whole-house fan as is. (If there is a seasonal cover in place during the test, leave it in place.)
10. Close all doors to the exterior or unconditioned spaces; if any door to the exterior or unconditioned space lacks weather-stripping at testing time, it can be temporarily taped off.
11. Close and latch all windows.
12. Close chimney dampers.
13. Either seal or fill with water plumbing drains with p-traps that may be empty.

14. Seal off exterior duct openings to *continuously operating* fresh-air or exhaust-air ventilation systems (preferably at the exterior envelope).
15. Close any adjustable window trickle ventilators and/or adjustable through-the-wall vents.
16. If an evaporative cooler has been supplied with a device used to seal openings to the exterior during the winter, that device should be installed for the test.

**402.4.1.2.2 Visual inspection option.** Building envelope tightness and insulation installation shall be considered acceptable when the items listed in Table 402.4, applicable to the method of construction, are field verified. Where required by the *code official or other authority having jurisdiction*, an *approved* party independent from the installer of the insulation shall inspect the air barrier and insulation.

**402.4.3 Fireplaces.** New wood-burning fireplaces shall have gasketed doors and outdoor combustion air.

**402.4.4 Fenestration air leakage.** Windows, skylights and sliding glass doors shall have an air infiltration rate of no more than 0.3 cfm per square foot (1.5 L/s/m<sup>2</sup>), and swinging doors no more than 0.5 cfm per square foot (2.6 L/s/m<sup>2</sup>), when tested according to NFRC 400 or AAMA/WDMA/ CSA 101/I.S.2/A440 by an accredited, independent laboratory and *listed* and *labeled* by the manufacturer.

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

**402.4.5 Recessed lighting.** Recessed luminaires and other appliances installed in the *building thermal envelope* shall be sealed to limit air leakage between conditioned and unconditioned spaces. All recessed luminaires shall be IC-rated and WA State Approved or *labeled* having an air leakage rate not more than 2.0 cfm (0.994 L/s) when tested in accordance with ASTM E 283 at a 1.57 psf (75 Pa) pressure differential. All recessed luminaires and other appliances shall be sealed with a gasket or caulk between the housing and the interior wall or ceiling covering.

**402.5 Maximum fenestration U-factor (Mandatory).** The area-weighted average maximum fenestration *U*-factor permitted using trade-offs from Section 402.1.4 shall be 0.32 for vertical fenestration, and 0.60 for skylights.

**402.6 Vapor retarders.** Class I or II vapor retarders are required on the interior side of frame walls.

Exceptions:

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

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

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

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

- Class I: Sheet polyethylene, unperforated aluminum foil.
- Class II: Kraft-faced fiberglass batts.
- Class III: Latex or enamel paint.

**TABLE 402.4.  
AIR BARRIER AND INSULATION INSPECTION COMPONENT CRITERIA**

<b>COMPONENT</b>	<b>INSULATION INSTALLATION CRITERIA</b>	<b>AIR BARRIER CRITERIA</b>
General Requirements	Air permeable insulation installed in all vertical walls, sloped ceilings, and floors within the thermal envelope shall be enclosed on all six sides and in contact with a durable, rigid air barrier.	A continuous, durable, rigid air barrier shall be installed in the building envelope. Breaks or joints in the air barrier shall be sealed. Air permeable insulation shall not used as a sealing material.
Ceiling / attic	In any dropped ceiling/soffit on a flat attic ceiling, the insulation shall be enclosed on five sides and in contact with a durable, rigid interior air barrier. . A top- side air barrier is not required in a flat attic.	Air barrier in any dropped ceiling / soffit is substantially aligned and in contact with insulation and any gaps in the air barrier shall be sealed. Access openings, drop down stairs or knee wall doors to unconditioned attic spaces shall be insulated and gasketed.
Walls	All corners and headers shall be insulated. Exterior thermal envelope insulation for framed walls shall be enclosed on all six sides and in contact with a durable, rigid air barrier in.	Junction of foundation and sill plate shall be sealed. The junction of the top plate and top of exterior walls shall be sealed. When part of the thermal envelope knee wall insulation shall be enclosed on all six sides and in contact with a durable, rigid interior air barrier.
Fenestration		Space between fenestration jambs and framing and skylights and framing shall be sealed with minimum expanding foam.
Rim joists	Rim joists shall be insulated and air sealed.	Junctions of the foundation and sill plate, sill plate and rim-band, and rim band and subfloor shall be sealed. When air permeable insulation is installed a durable, rigid interior air barrier shall be installed at the rim joist.
Floors (including above garage and cantilevered floors).	Insulation shall be installed to maintain permanent contact with underside of subfloor decking.	Air barrier shall be installed at any exposed edge of insulation.
Crawl space walls	Where provided in lieu of floor insulation, insulation shall be permanently attached to crawlspace walls.	Exposed earth in unvented crawlspaces shall be covered with Class I vapor retarder with overlapping joints taped.
Shafts, penetrations		Duct shafts, utility penetrations, and flue shafts opening to exterior or unconditioned space shall be air sealed. Doors or hatches in knee walls opening to exterior or unconditioned space shall be insulated and gasketed.
Narrow cavities	Batts in narrow cavities shall be cut to fit; narrow cavities are filled by sprayed/blown insulation that on installation readily conforms to the available cavity space.	
Garage separation		Air sealing shall be provided between the garage and conditioned spaces.

Recessed lighting and appliances		Recessed light fixtures and other appliances (speakers, exhaust fans, light shafts, etc) installed in the building thermal envelope shall be IC rated, airtight labeled (or “Washington State Approved”) and installed with all accessories and techniques required for an IC air-tight labeled can to be air tight or equivalent: 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.
Plumbing and Wiring	Insulation shall be placed between the exterior of the wall assembly and pipes. Batt insulation shall be cut and fitted around wiring and plumbing, or for insulation that on installation readily conforms to available space such insulation shall fill all space between piping and wiring and shall be in full contact with all air barriers.	All plumbing and wiring penetrations shall be sealed to the air barrier.
Shower / tub on exterior wall	Exterior walls adjacent to showers and tubs shall have insulation filling any gaps or voids between tub or shower walls and unconditioned space.	Exterior walls adjacent to showers and tubs shall have a durable, rigid air barrier separating the exterior wall from the shower and tubs.
Electrical / phone box on exterior walls	Insulation completely fills voids between the box and exterior sheathing	Air barrier extends behind electrical or communication boxes or air sealed type boxes shall be installed or created.
Common wall		Air barrier shall be installed in common wall between dwelling units. Common walls shall be sealed at junctions with outside walls and at the top pressure plane of the house.
HVAC register boots		HVAC register boots that penetrate building thermal envelope shall be sealed to subfloor or drywall.
Fireplace		A durable, rigid air barrier shall be installed in contact with insulation. Fireplace shall have compression closure doors and combustion air supplied from the outdoors.

a. Inspection of log walls shall be in accordance with the provisions of ICC-400.

**SECTION 403  
SYSTEMS**

**403.1 Controls (Mandatory).** At least one thermostat shall be provided for each separate heating and cooling system.

**403.1.1 Programmable thermostat.** Where the primary heating system is a forced-air furnace, forced air split system heat pump, packaged unit heat pump, water boiler, or steam boiler, at least one thermostat per dwelling unit

shall be capable of controlling the heating and cooling system on a daily schedule to maintain different temperature set points at different times of the day. This thermostat shall include the capability to set back or temporarily operate the system to maintain zone temperatures down to 55°F (13°C) or up to 85°F (29°C). The thermostat shall initially be programmed with a heating temperature set point no higher than 70°F

(21°C) and a cooling temperature set point no lower than 78°F (26°C).

**Exception:** Solid fuel appliances and spaces served by radiant floor heating.

**403.1.2 Heat pump supplementary heat (Mandatory).**

Heat pumps having supplementary electric-resistance heat shall have controls that, except during defrost, prevent supplemental heat operation when the heat pump compressor can meet the heating load.

**403.2 Ducts.**

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

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

**403.2.2 Sealing (Mandatory).** All ducts, air handlers, filter boxes and interior building cavities used as ducts shall be sealed. Joints and seams shall comply with ACCA Manual D. Duct tightness shall be verified by either of the following:

1. Postconstruction test: Leakage to outdoors shall be less than or equal to 6 cfm (113.3 L/min) per 100 ft<sup>2</sup> (9.29 m<sup>2</sup>) of *conditioned floor area* when tested at a pressure differential of 0.1 inches w.g. (25 Pa) across the entire system, including the manufacturer’s air handler enclosure. All register boots shall be taped or otherwise sealed during the test.
2. Rough-in test: Total leakage shall be less than or equal to 3 cfm (85.0 L/min) per 100 ft<sup>2</sup> (9.29 m<sup>2</sup>) of *conditioned floor area* when tested at a pressure differential of 0.1 inches w.g. (25 Pa) across the roughed in system, including the manufacturer’s air handler enclosure. All register boots shall be taped or otherwise sealed during the test. If the air handler is not installed at the time of the test, total leakage shall be less than or equal to 4 cfm (113.3 L/min) per 100 ft<sup>2</sup> (9.29 m<sup>2</sup>) of *conditioned floor area*.

**Exceptions:** Duct tightness test is not required if the air handler and all ducts are located within *conditioned space*.

**403.2.3 Building cavities (Mandatory).** Building framing cavities shall not be used as supply ducts. Framing cavities may be used as return ducts only in interior spaces.

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

**403.4 Circulating hot water systems (Mandatory).** All circulating service hot water piping shall be insulated to at least R-3. Circulating hot water systems shall include an automatic or readily *accessible* manual switch that can turn off the hot-water circulating pump when the system is not in use.

**403.5 Mechanical ventilation (Mandatory).** Outdoor air intakes and exhausts shall have automatic or gravity dampers that close when the ventilation system is not operating.

**403.6 Equipment sizing (Mandatory).** Heating and cooling equipment shall be sized in accordance with ACCA Manual S based on building loads calculated in accordance with ACCA Manual J or other approved heating and cooling calculation methodologies. In addition, heating and cooling equipment shall be sized in accordance with Table 403.6 below.

**TABLE 403.6 HEATING AND COOLING EQUIPMENT SIZING**

UNIT	MAXIMUM PERCENTAGE OVERSIZING	MINIMUM EFFICIENCY & TEST PROCEDURES
Air Conditioners	15%	Air Cooled: AHRI 210/240
Multi-speed Air-Source Heat Pumps and Ground-Source Heat Pumps	15%	Air Cooled: AHRI 210/240 Water or Ground: ASHRA/ASHRAE 13256-1
Single-speed Air-Source Heat Pumps and Ground Source Heat Pumps	15%	Air Cooled: AHRI 210/240 Water or Ground: ASHRA/ASHRAE 13256-1 Packaged: AHRI 310/380
All Fuel-Fired Heating Appliances	40%	DOE 10 CFR Part 430 or: Gas Fired: ANSI Z21.47 Oil Fired: UL 727

a. Equipment shall be sized in accordance with ACCA Manual S, based on building loads calculated in accordance with ACCA Manual J or other approved heating and cooling calculation methodologies:

1. Indoor and outdoor coils shall be matched for size;
  2. Outdoor temperatures shall follow the design parameters specified in Section 302;
  3. Indoor temperatures shall be 75 F for cooling and 72 F for heating;
- b. Once the appropriate equipment size is determined, if that specific size does not exist, the next larger size of manufactured equipment shall be acceptable, regardless of the percentage listed.
- c. Multi-speed units shall be permitted to exceed the listed percentage only to the cooling capacity necessary to control humidity levels.

**403.7 Systems serving multiple dwelling units (Mandatory).** Systems serving multiple dwelling units shall comply with Sections 503 and 504 in lieu of Section 403.

**403.8 Snow melt system controls (Mandatory).** Snow-and-ice-melting systems, supplied through energy service to the building, shall include automatic controls capable of shutting off the system when the pavement temperature is above 50°F, and no precipitation is falling and an automatic or manual control that will allow shutoff when the outdoor temperature is above 40°F.

**403.9 Pools, hot tubs and spas (Mandatory).** Pools, hot tubs and spas shall comply with Sections 403.9.1 through 403.9.3.

**403.9.1 Heaters.** All heaters shall be equipped with a readily *accessible* on-off switch to allow shutting off the heater without adjusting the thermostat setting. Heaters fired by natural or LP gas shall not have continuously burning pilot lights.

**403.9.2 Time switches.** Time switches that can automatically turn off and on heaters and pumps according to a preschedule shall be installed on heaters and pumps.

**Exceptions:**

1. Where public health standards require 24-hour pump operation.
2. Where pumps are required to operate solar- and waste-heat-recovery pool heating systems.

**403.9.3 Covers.** Heated pools, hot tubs and spas shall be provided with a vapor-retardant cover. Pools, hot tubs and spas capable of being heated to more than 90°F (32°C) shall be provided with a cover having a minimum insulation value of R-12.

**Exception:** Pools deriving over 60 percent of the energy for heating from site-recovered energy or solar energy source.

## SECTION 404

### ELECTRICAL POWER AND LIGHTING SYSTEMS

**404.1 Lighting equipment (Mandatory).** A minimum of 50 percent of the lamps in permanently installed lighting fixtures shall be high-efficacy lamps.

**404.2 Electric Resistance Heating Equipment.** In the City of Burlington, the use of electric resistance heating equipment is prohibited, except where such equipment can be shown to exhibit the lowest life-cycle cost.

## SECTION 405

### SIMULATED PERFORMANCE ALTERNATIVE (Performance)

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

**405.2 Mandatory requirements.** Compliance with this section requires that the mandatory provisions identified in Section 401.2 be met. All supply and return ducts not completely inside the *building thermal envelope* shall be insulated to meet the same R-value requirement that applies to immediately proximal surfaces.

**405.3 Performance-based compliance.** Compliance based on simulated energy performance requires that a proposed residence (*proposed design*) be shown to have an annual energy cost that is less than or equal to the annual energy cost of the *standard reference design*. Energy prices shall be taken from a source *approved* by the *code official or other authority having jurisdiction*, such as the Department of Energy, Energy Information Administration's *State Energy Price and Expenditure Report*. *Code officials* shall be permitted to require time-of-use pricing in energy cost calculations.

**Exception:** The energy use based on source energy expressed in Btu or Btu per square foot of *conditioned floor area* shall be permitted to be substituted for the energy cost. The source energy multiplier for electricity shall be 3.16. The source energy multiplier for fuels other than electricity shall be 1.1.

#### 405.4 Documentation.

**405.4.1 Compliance software tools.** Documentation verifying that the methods and accuracy of the compliance software tools conform to the provisions of this section shall be provided to the *code official or other authority having jurisdiction*.

**405.4.2 Compliance report.** Compliance software tools shall generate a report that documents that the *proposed design* complies with Section 405.3. The compliance documentation shall include the following information:

1. Address or other identification of the residence;
2. An inspection checklist documenting the building component characteristics of the *proposed design* as listed in Table 405.5.2(1). The inspection checklist shall show results for both the *standard reference design* and the *proposed design*, and shall document all inputs entered by the user necessary to reproduce the results;
3. Name of individual completing the compliance report; and
4. Name and version of the compliance software tool.

**Exception:** Multiple orientations. When an otherwise identical building model is offered in multiple

orientations, compliance for any orientation shall be permitted by documenting that the building meets the performance requirements in each of the four cardinal (north, east, south and west) orientations.

**405.4.3 Additional documentation.** The *code official or other authority having jurisdiction* shall be permitted to require the following documents:

1. Documentation of the building component characteristics of the *standard reference design*.
2. A certification signed by the builder providing the building component characteristics of the *proposed design* as given in Table 405.5.2(1).
3. Documentation of the actual values used in the software calculations for the *proposed design*.

#### 405.5 Calculation procedure.

**405.5.1 General.** Except as specified by this section, the *standard reference design* and *proposed design* shall be configured and analyzed using identical methods and techniques.

**405.5.2 Residence specifications.** The *standard reference design* and *proposed design* shall be configured and analyzed as specified by Table 405.5.2(1). Table 405.5.2(1) shall include by reference all notes contained in Table 402.1.1.

#### 405.6 Calculation software tools.

**405.6.1 Minimum capabilities.** Calculation procedures used to comply with this section shall be software tools capable of calculating the annual energy consumption of all building elements that differ between the *standard reference design* and the *proposed design* and shall include the following capabilities:

1. Computer generation of the *standard reference design* using only the input for the *proposed design*. The calculation procedure shall not allow the user to directly modify the building component characteristics of the *standard reference design*.
2. Calculation of whole-building (as a single *zone*) sizing for the heating and cooling equipment in the *standard reference design* residence in accordance with Section M1401.3 of the *International Residential Code*.
3. Calculations that account for the effects of indoor and outdoor temperatures and part-load ratios on the performance of heating, ventilating and air-conditioning equipment based on climate and equipment sizing.
4. Printed *code official or other authority having jurisdiction* inspection checklist listing each of the *proposed design* component characteristics from Table 405.5.2(1) determined by the analysis to provide compliance, along with their respective performance ratings (e.g., R-value, U-factor, SHGC, HSPF, AFUE, SEER, EF, etc.).

**405.6.2 Specific approval.** Performance analysis tools meeting the applicable sections of Section 405 shall be permitted to be *approved*. Tools are permitted to be *approved* based on meeting a specified threshold for a jurisdiction. The *code official or other authority having jurisdiction* shall be permitted to approve tools for a specified application or limited scope.

**405.6.3 Input values.** When calculations require input values not specified by Sections 402, 403, 404 and 405, those input values shall be taken from an *approved* source.

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**TABLE 405.5.2(1)  
SPECIFICATIONS FOR THE STANDARD REFERENCE AND PROPOSED DESIGNS**

BUILDING COMPONENT	STANDARD REFERENCE DESIGN	PROPOSED DESIGN
Above-grade walls	Type: mass wall if proposed wall is mass; otherwise wood frame. Gross area: same as proposed U-factor: from Table 402.1.3 Solar absorptance = 0.75 Emittance = 0.90	As proposed As proposed As proposed As proposed As proposed
Basement and crawl space walls	Type: same as proposed Gross area: same as proposed U-factor: from Table 402.1.3, with insulation layer on interior side of walls.	As proposed As proposed As proposed
Above-grade floors	Type: wood frame Gross area: same as proposed U-factor: from Table 402.1.3	As proposed As proposed As proposed
Ceilings	Type: wood frame Gross area: same as proposed U-factor: from Table 402.1.3	As proposed As proposed As proposed
Roofs	Type: composition shingle on wood sheathing Gross area: same as proposed Solar absorptance = 0.75 Emittance = 0.90	As proposed As proposed As proposed As proposed
Attics	Type: vented with aperture = 1 ft <sup>2</sup> per 300 ft <sup>2</sup> ceiling area	As proposed
Foundations	Type: same as proposed foundation wall area above and below grade and soil characteristics: same as proposed.	As proposed As proposed
Doors	Area: 40 ft <sup>2</sup> Orientation: North U-factor: same as fenestration from Table 402.1.3.	As proposed As proposed As proposed
Glazing <sup>a</sup>	Total area <sup>b</sup> = (a) The proposed glazing area; where proposed glazing area is less than 15% of the conditioned floor area. (b) 15% of the conditioned floor area; where the proposed glazing area is 15% or more of the conditioned floor area. Orientation: equally distributed to four cardinal compass orientations (N, E, S & W). U-factor: from Table 402.1.3 SHGC: From Table 402. 1.1 Interior shade fraction: Summer (all hours when cooling is required) = 0.70 Winter (all hours when heating is required) = 0.85 <sup>c</sup> External shading: none	As proposed   As proposed  As proposed  As proposed
Skylights	None	As proposed
Thermally isolated sunrooms	None	As proposed

*(continued)*

TABLE 405.5.2(1)—continued  
 SPECIFICATIONS FOR THE STANDARD REFERENCE AND PROPOSED DESIGNS

BUILDING COMPONENT	STANDARD REFERENCE DESIGN	PROPOSED DESIGN
Air exchange rate	Specific leakage area (SLA) <sup>e</sup> = 0.00036 assuming no energy recovery	For residences that are not tested, the same as the standard reference design. For residences without mechanical ventilation that are tested in accordance with ASHRAE 119, Section 5. 1, the measured air exchange rate <sup>f</sup> but not less than 0.35 ACH For residences with mechanical ventilation that are tested in accordance with ASHRAE 119, Section 5. 1, the measured air exchange rate <sup>e</sup> combined with the mechanical ventilation rate, <i>f</i> which shall not be less than $0.01 \times CFA + 7.5 \times (N_b + 1)$ where: CFA = conditioned floor area N <sub>b</sub> = number of bedrooms
Mechanical ventilation	Annual vent fan energy use: $kWh/yr = 0.03942 \times CFA + 29.565 \times (N_b, +1)$ where: CFA = conditioned floor area N <sub>b</sub> = number of bedrooms	As proposed
Internal gains	IGain = $17,900 + 23.8 \times CFA + 4104 \times N_b$ , (Btu/day per dwelling unit)	Same as standard reference design
Internal mass	An internal mass for furniture and contents of 8 pounds per square foot of floor area.	Same as standard reference design, plus any additional mass specifically designed as a thermal storage element <sub>g</sub> but not integral to the
Structural mass	For masonry floor slabs, 80% of floor area covered by R-2 carpet and pad, and 20% of floor directly exposed to room air.	As proposed
	For masonry basement walls, as proposed, but with insulation required by Table 402.1.3 located on the interior side of the walls	As proposed
	For other walls, for ceilings, floors, and interior walls, wood frame construction	As proposed
Heating systems <sup>b</sup>	As proposed Capacity: sized in accordance with Section M1401.3 of the <i>International Residential Code</i>	As proposed
Cooling systems <sup>h, j</sup>	As proposed Capacity: sized in accordance with Section M1401.3 of the <i>International Residential Code</i>	As proposed
Service H <sub>2</sub> O heating <sup>h, k, i</sup>	As proposed Use: same as proposed design	As proposed gal/day = $30 + (10 \times N_b)$

Thermal distribution systems	A thermal distribution system efficiency (DSE) of 0.88 shall be applied to both the heating and cooling system efficiencies for all systems other than tested duct systems. Duct insulation: From Section 403.2.1. For tested duct systems, the leakage rate shall be the applicable maximum rate from Section 403.2.2.	As tested or as specified in Table 405.5.2(2) if not tested
Thermostat	Type: Manual, cooling temperature setpoint = 75 F; Heating temperature setpoint = 72 F	Same as standard reference

For SI: 1 square foot = 0.93 m<sup>2</sup>; 1 British thermal unit = 1055 J; 1 pound per square foot = 4.88 kg/m<sup>2</sup>; 1 gallon (U.S.) = 3.785 L; °C = (°F-3)/1.8, 1 degree = 0.79 rad.

- a. Glazing shall be defined as sunlight-transmitting fenestration, including the area of sash, curbing or other framing elements, that enclose conditioned space. Glazing includes the area of sunlight-transmitting fenestration assemblies in walls bounding conditioned basements. For doors where the sunlight-transmitting opening is less than 50 percent of the door area, the glazing area is the sunlight transmitting opening area. For all other doors, the glazing area is the rough frame opening area for the door including the door and the frame.
- b. For residences with conditioned basements, R-2 and R-4 residences and townhouses, the following formula shall be used to determine glazing area:  
 $AF = A_s \times FA \times F$   
 where:  
 $AF$  = Total glazing area.  
 $A_s$  = Standard reference design total glazing area.  
 $FA$  = (Above-grade thermal boundary gross wall area)/(above-grade boundary wall area + 0.5 × below-grade boundary wall area).  
 $F$  = (Above-grade thermal boundary wall area)/(above-grade thermal boundary wall area + common wall area) or 0.56, whichever is greater.  
 and where:  
 Thermal boundary wall is any wall that separates conditioned space from unconditioned space or ambient conditions.  
 Above-grade thermal boundary wall is any thermal boundary wall component not in contact with soil.  
 Below-grade boundary wall is any thermal boundary wall in soil contact.  
 Common wall area is the area of walls shared with an adjoining dwelling unit.
- c. For fenestrations facing within 15 degrees (0.26 rad) of true south that are directly coupled to thermal storage mass, the winter interior shade fraction shall be permitted to be increased to 0.95 in the proposed design.
- d. Where leakage area ( $L$ ) is defined in accordance with Section 5.1 of ASHRAE 119 and where:  
 $SLA = L/CFA$  where  $L$  and  $CFA$  are in the same units.
- e. Tested envelope leakage shall be determined and documented by an independent party approved by the *code official or other authority having jurisdiction*. Hourly calculations as specified in the 2001 ASHRAE *Handbook of Fundamentals*, Chapter 26, page 26.2 1, Equation 40 (Sherman-Grimsrud model) or the equivalent shall be used to determine the energy loads resulting from infiltration.
- f. The combined air exchange rate for infiltration and mechanical ventilation shall be determined in accordance with Equation 43 of 2001 ASHRAE *Handbook of Fundamentals*, page 26.24 and the “Whole-house Ventilation” provisions of 2001 ASHRAE *Handbook of Fundamentals*, page 26.19 for intermittent mechanical ventilation.
- g. Thermal storage element shall mean a component not part of the floors, walls or ceilings that is part of a passive solar system, and that provides thermal storage such as enclosed water columns, rock beds, or phase-change containers. A thermal storage element must be in the same room as fenestration that faces within 15 degrees (0.26 rad) of true south, or must be connected to such a room with pipes or ducts that allow the element to be actively charged.
- h. For a proposed design with multiple heating, cooling or water heating systems using different fuel types, the applicable standard reference design system capacities and fuel types shall be weighted in accordance with their respective loads as calculated by accepted engineering practice for each equipment and fuel type present.
- i. For a proposed design without a proposed heating system, a heating system with the prevailing federal minimum efficiency shall be assumed for both the standard reference design and proposed design. For electric heating systems, the prevailing federal minimum efficiency air-source heat pump shall be used for the standard reference design.
- j. For a proposed design home without a proposed cooling system, an electric air conditioner with the prevailing federal minimum efficiency shall be assumed for both the standard reference design and the proposed design.
- k. For a proposed design with a nonstorage-type water heater, a 40-gallon storage-type water heater with the prevailing federal minimum energy factor for the same fuel as the predominant heating fuel type shall be assumed. For the case of a proposed design without a proposed water heater, a 40-gallon storage-type water heater with the prevailing federal minimum efficiency for the same fuel as the predominant heating fuel type shall be assumed for both the proposed design and standard reference design.

**TABLE 405.5.2(2)**  
**DEFAULT DISTRIBUTION SYSTEM EFFICIENCIES FOR PROPOSED DESIGNS<sup>a</sup>**

DISTRIBUTION SYSTEM CONFIGURATION AND CONDITION:	FORCED AIR SYSTEMS	HYDRONIC SYSTEMS <sup>b</sup>
Distribution system components located in unconditioned space	—	0.95
Untested distribution systems entirely located in conditioned space <sup>c</sup>	0.88	1
“Ductless” systems <sup>d</sup>	1	—

For SI: 1 cubic foot per minute = 0.47 L/s; 1 square foot = 0.093m<sup>2</sup>; 1 pound per square inch = 6895 Pa; 1 inch water gauge = 1250 Pa.

- a. Default values given by this table are for untested distribution systems, which must still meet minimum requirements for duct system insulation.
- b. Hydronic systems shall mean those systems that distribute heating and cooling energy directly to individual spaces using liquids pumped through closed loop piping and that do not depend on ducted, forced airflow to maintain space temperatures.
- c. Entire system in conditioned space shall mean that no component of the distribution system, including the air handler unit, is located outside of the conditioned space.
- d. Ductless systems shall be allowed to have forced airflow across a coil but shall not have any ducted airflow external to the manufacturer’s air handler enclosure.

**CHAPTER 5**

(<RESERVED>)

## CHAPTER 6 REFERENCED STANDARDS

This chapter lists the standards that are referenced in various sections of this document. The standards are listed herein by the promulgating agency of the standard, the standard identification, the effective date and title, and the section or sections of this document that reference the standard. The application of the referenced standards shall be as specified in Section 107.

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

Standard reference number	Title	Referenced in code section number
AAMA/WDMA/CSA 101/1.S.2/A c440—05	Specifications for Windows, Doors and Unit Skylights.....	402.4.4

**AHRI** Air Conditioning, Heating, and Refrigeration Institute  
4100 North Fairfax Drive  
Suite 200  
Arlington, VA 22203

Standard reference number	Title	Referenced in code section number
210/240—94	Unitary Air-Conditioning and Air-Source Heat Pump Equipment.....	Table 403.6
310/380—93	Standard for Packaged Terminal Air-Conditioning and Heat Pumps.....	Table 403.6

**ANSI** American National Standards Institute  
25 West 43rd Street  
Fourth Floor  
New York, NY 10036

Standard reference number	Title	Referenced in code section number
Z21.10.3—98	Gas Water Heaters, Volume III - Storage Water Heaters with Input Ratings Above 75,000 Btu per Hour, Circulating Tank and Instantaneous—with Addenda Z21.10.3a-99.....	Table 403.6
Z21.56—98	Gas-Fired Pool Heaters—with Z21.56a—with Addenda-1999.....	Table 403.6

**ASHRAE** American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.  
1791 Tullie Circle, NE  
Atlanta, GA 30329-2305

Standard reference number	Title	Referenced in code section number
119—88 (RA 2004)	Air Leakage Performance for Detached Single-family Residential Buildings .....	Table 405.5.2(1)

ANSI/ASHRAE/ACCA

ASHRAE—2001, 2005      ASHRAE Handbook of Fundamentals . . . . . 402.1.4, Tables 302.2, 405.5.2(1)

# ASTM

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

Standard reference number	Title	Referenced in code section number
E 283—04	Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls and Doors Under Specified Pressure Differences Across the Specimen.....	402.4.5
E 96—00	Standard Test Methods for Water Vapor Transmission of Materials .....	402.6
E 779—99	Standard Test Method for Determining Air Leakage Rate by Fan Pressurization .....	402.2.3.9

# CGSB

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

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

# CSA

Canadian Standards Association  
5060 Spectrum Way  
Mississauga, Ontario, Canada L4W 5N6

Standard reference number	Title	Referenced in code section number
101/LS.2/A440—08	Specifications for Windows, Doors and Unit Skylights.....	402.4.4

# DOE

U.S. Department of Energy  
c/o Superintendent of Documents  
U.S. Government Printing Office  
Washington, DC 20402-9325

Standard reference number	Title	Referenced in code section number
(Current Edition)	State Energy Prices and Expenditure Report.....	405.3

**ICC**

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

Standard reference number	Title	Referenced in code section number
IBC—09	International Building Code*	201.3, 303.2, 402.2.9
IFC—09	International Fire Code*	201.3
IFGC—09	International Fuel Gas Code*	201.3
IPC—09	International Plumbing Code*	201.3
IRC—09	International Residential Code*	201.3, 403.2.2, 403.6, 405.6.1, Table 405.5.2(1)
ICC 400	Standard on the Design and Construction of Log Structures	Table 402.1.3

**HUD**

U.S. Department of Housing and Urban Development  
451 7th Street, S.W.  
Washington, DC 20410

Standard reference number	Title	Referenced in code section number
42. U.S.C - 74	National Manufactured Housing Construction and Safety Standards Act, Title IV §§ 5401-5426.	101.5.2

**HVI**

Home Ventilating Institute  
30 W. University Drive  
Arlington Heights, IL 60004

Standard reference number	Title	Referenced in code section number
911—01	Certified Home Ventilating Products Directory—Residential Equipment	304.5.1, 304.5.2, 304.5.3, 304.6

**NFPA**

National Fire Protection Association  
1 Batterymarch Park  
Quincy, MA 02269-9101

Standard reference number	Title	Referenced in code section number
NFPA 31-97	Installation of Oil-Burning Equipment	305.2, 305.3
NFPA 54-99	National Fuel Gas Code	305.2, 305.3

**NFRC**

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

Standard reference number	Title	Referenced in code section number
100—04	Procedure for Determining Fenestration Product U-factors—Second Edition	303.1.3
200—04	Procedure for Determining Fenestration Product Solar Heat Gain Coefficients and Visible Transmittance at Normal Incidence—Second Edition	303.1.3
400—04	Procedure for Determining Fenestration Product Air Leakage—Second Edition	402.4.4

**US—FTC**

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

Standard reference number	Title	Referenced in code section number
CFR Title 16	R-value Rule	303.1.4

**WDMA**

Window and Door Manufacturers Association  
1400 East Touhy Avenue, Suite 470  
Des Plaines, IL 60018

Standard reference number	Title	Referenced in code section number
AAMA/WDMA/CSA 101/LS.2/A440—08	Specifications for Windows, Doors and Unit Skylights	402.4.4