



2012

INTERNATIONAL  
ENERGY CONSERVATION  
CODE®

*A Member of the International Code Family®*

**IECC®**







# 2012 INTERNATIONAL ENERGY CONSERVATION CODE®

*A Member of the International Code Family®*

# 2012 IECC®

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2012 International Energy Conservation Code®

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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 *International Energy Conservation Code*<sup>®</sup>, in this 2012 edition, is designed to meet these needs through model code regulations that will result in the optimal utilization of fossil fuel and nondepletable resources in all communities, large and small.

This code contains separate provisions for commercial buildings and for low-rise residential buildings (3 stories or less in height above grade.) Each set of provisions in this code—IECC-Commercial Provisions and IECC-Residential Provisions are separately applied to buildings within their respective scopes. Each set of provisions are to be treated separately; they each contain a Scope and Administration chapter, a Definitions chapter, a General Requirements chapter, and a chapter containing energy efficiency requirements applicable to buildings within their scope.

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. This 2012 edition is fully compatible with all of the *International Codes*<sup>®</sup> (I-Codes<sup>®</sup>) published by the International Code Council (ICC)<sup>®</sup>, including: the *International Building Code*<sup>®</sup>, *International Existing Building Code*<sup>®</sup>, *International Fire Code*<sup>®</sup>, *International Fuel Gas Code*<sup>®</sup>, *International Green Construction Code*<sup>™</sup> (to be available March 2012), *International Mechanical Code*<sup>®</sup>, *ICC Performance Code*<sup>®</sup>, *International Plumbing Code*<sup>®</sup>, *International Private Sewage Disposal Code*<sup>®</sup>, *International Property Maintenance Code*<sup>®</sup>, *International Residential Code*<sup>®</sup>, *International Swimming Pool and Spa Code*<sup>™</sup> (to be available March 2012), *International Wildland-Urban Interface Code*<sup>®</sup> and *International Zoning Code*<sup>®</sup>.

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. This 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). This 2012 edition presents the code as originally issued, with changes reflected in the 2000, 2003, 2006 and 2009 editions and further changes approved through the ICC Code Development Process through 2010. A new edition such as this is promulgated every three years.

This 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.

## Adoption

The *International Energy Conservation Code* is available for adoption and use by jurisdictions internationally. Its use within a governmental jurisdiction is intended to be accomplished through adoption by reference in accordance with proceedings establishing the jurisdiction's laws. At the time of adoption, jurisdictions should insert the appropriate information in provisions requiring specific local information, such as the name of the adopting jurisdiction. These locations are shown in bracketed words in small capital letters in the code and in the sample ordinance. The sample adoption ordinance on page ix addresses several key elements of a code adoption ordinance, including the information required for insertion into the code text.

## Maintenance

The *International Energy Conservation Code* is kept up to date through the review of proposed changes submitted by code enforcement officials, industry representatives, design professionals and other interested parties. Proposed changes are carefully considered through an open code development process in which all interested and affected parties may participate.

The contents of this work are subject to change both through the Code Development Cycles and the governmental body that enacts the code into law. For more information regarding the code development process, contact the Codes and Standards Development Department of the International Code Council.

While the development procedure of the *International Energy Conservation Code* assures the highest degree of care, ICC, its members and those participating in the development of this code do not accept any liability resulting from compliance or noncompliance with the provisions because ICC and its members do not have the power or authority to police or enforce compliance with the contents of this code. Only the governmental body that enacts the code into law has such authority.

## Code Development Committee Responsibilities (Letter Designations in Front of Section Numbers)

In each code development cycle, proposed changes to the code are considered at the Code Development Hearings by the applicable International Code Development Committee. The IECC—Commercial Provisions (sections designated with a “C” prior to the section number) are primarily maintained by the Commercial Energy Code Development Committee. The IECC—Residential Provisions (sections designated with an “R” prior to the section number) are maintained by the Residential Energy Code Development Committee. This is designated in the chapter headings by a [CE] and [RE], respectively. Proposed changes to a code section or defined term, other than those designated by [CE] or [RE], that has a number beginning with a letter in brackets are considered by a different code development committee. For example, proposed changes to code sections or defined terms that have [M] in front of them are considered by the International Mechanical Code Development Committee.

Maintenance responsibilities for the IECC are designated as follows:

[CE] = Commercial Energy Code Development Committee

[M] = International Mechanical Code Development Committee

[RE] = Residential Energy Code Development Committee

Note that, for the development of the 2015 edition of the I-Codes, there will be two groups of code development committees and they will meet in separate years. The groupings are as follows:

<b>Group A Codes (Heard in 2012, Code Change Proposals Deadline: January 3, 2012)</b>	<b>Group B Codes (Heard in 2013, Code Change Proposals Deadline: January 3, 2013)</b>
International Building Code	Administrative Provisions (Chapter 1 all codes except the IECC, IRC and ICCPC, administrative updates to currently referenced standards, and designated definitions)
International Fuel Gas Code	International Energy Conservation Code
International Mechanical Code	International Existing Building Code
International Plumbing Code	International Fire Code
International Private Sewage Disposal Code	International Green Construction Code
	ICC Performance Code
	International Property Maintenance Code
	International Residential Code
	International Swimming Pool and Spa Code
	International Wildland-Urban Interface Code
	International Zoning Code

Code change proposals submitted for code sections that have a letter designation in front of them will be heard by the respective committee responsible for such code sections. Because different committees will meet in different years, it is possible that some proposals for this code will be heard by a committee in a different year than the year in which the primary committees for this code meets.

For example, the definition of the term “Energy Recovery Ventilation System” for the IECC—Commercial Provisions (page C-8) is the responsibility of the International Mechanical Code Development Committee, which is part of the Group A code hearings. Therefore, any proposed changes to this defined term will need to be submitted by the deadline for the Group A codes, so that the International Mechanical Code Development Committee can consider that proposed change during the 2012 Code Change Cycle.

It is very important that anyone submitting code change proposals understand which code development committee is responsible for the section of the code that is the subject of the code change proposal. For further information on the code development committee responsibilities, please visit the ICC web site at [www.iccsafe.org/scoping](http://www.iccsafe.org/scoping).

## Marginal Markings

Solid vertical lines in the margins within the body of the code indicate a technical change from the requirements of the 2009 edition. Deletion indicators in the form of an arrow (➡) are provided in the margin where an entire section, paragraph, exception or table has been deleted or an item in a list of items or a table has been deleted.

A single asterisk [\*] placed in the margin indicates that text or a table has been relocated within the code. A double asterisk [\*\*] placed in the margin indicates that the text or table immediately following it has been relocated there from elsewhere in the code. The following table indicates such relocations in the 2012 Edition of the *International Energy Conservation Code*.

<b>2012 LOCATION</b>	<b>2009 LOCATION</b>
C402.4.3	502.4.1
C408.2.2.1	503.2.9.1
C408.2.2.2	503.2.9.2
C408.2.5.2	503.2.9.3

## **Italicized Terms**

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

# Effective Use of the International Energy Conservation Code

The *International Energy Conservation Code* (IECC) is a model code that regulates minimum energy conservation requirements for new buildings. The IECC addresses energy conservation requirements for all aspects of energy uses in both commercial and residential construction, including heating and ventilating, lighting, water heating, and power usage for appliances and building systems.

The IECC 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. Depending on whether the building is for residential use or for commercial use, the IECC sets forth minimum requirements for exterior envelope insulation, window and door *U*-factors and SHGC ratings, duct insulation, lighting and power efficiency, and water distribution insulation.

## Arrangement and Format of the 2012 IECC

The IECC contains two separate sets of provisions—one for commercial buildings and one for residential buildings. Each set of provisions are applied separately to buildings within their scope. The IECC—Commercial Provisions apply to all buildings except for residential buildings 3 stories or less in height. The IECC—Residential Provisions apply to detached one- and two-family dwellings and multiple single family dwellings as well as Group R-2, R-3 and R-4 buildings three stories or less in height. These scopes are based on the definitions of “commercial building” and “residential building,” respectively, in Chapter 2 of each set of provisions. Note that the IECC—Commercial Provisions therefore contain provisions for residential buildings 4 stories or greater in height. Each set of provisions is divided into 4 different parts:

Chapters	Subjects
1-2	Administration and definitions
3	Climate zones and general materials requirements
4	Energy efficiency requirements
5	Referenced standards

The following is a chapter-by-chapter synopsis of the scope and intent of the provisions of the *International Energy Conservation Code* and applies to both the commercial and residential energy provisions:

**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.

Additional definitions regarding climate zones are found in Tables 301.3(1) and (2). These are not listed in Chapter 2.

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 specifies the climate zones that will serve to establish the exterior design conditions. In addition, Chapter 3 provides interior design conditions that are used as a basis for assumptions in heating and cooling load calculations, and provides basic material requirements for insulation materials and fenestration materials.

Climate has a major impact on the energy use of most buildings. The code establishes many requirements such as wall and roof insulation *R*-values, window and door thermal transmittance requirement (*U*-factors) as well as provisions that affect the mechanical systems based upon the climate where the building is located. This chapter contains information that will be used to properly assign the building location into the correct climate zone and is used as the basis for establishing requirements or elimination of requirements.

**Chapter 4 Energy Efficiency.** Chapter 4 of each set of provisions contains the technical requirements for energy efficiency.

**Commercial Energy Efficiency.** Chapter 4 of the IECC—Commercial Provisions contains the energy-efficiency-related requirements for the design and construction of most types of commercial buildings and residential buildings greater than three stories in height above grade. Residential buildings, townhouses and garden apartments three stories or less in height are covered in the IECC—Residential Provisions. This chapter defines requirements for the portions of the building and building systems that impact energy use in new commercial construction and new residential construction greater than three stories in height, 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.

**Residential Energy Efficiency.** Chapter 4 of the IECC—Residential Provisions 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 a detached one- and two-family dwelling and multiple single family dwellings as well as R-2, R-3 or R-4 building three stories or less in height. All other buildings, including residential buildings greater than three stories in height, are regulated by the energy conservation requirements in the IECC—Commercial Provisions. 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 Referenced Standards.** The code contains numerous references to standards that are used to regulate materials and methods of construction. Chapter 5 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 5 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.

# LEGISLATION

The International Codes are designed and promulgated to be adopted by reference by legislative action. Jurisdictions wishing to adopt the 2012 *International Energy Conservation Code* as an enforceable regulation governing energy efficient building envelopes and installation of energy efficient mechanical, lighting and power systems should ensure that certain factual information is included in the adopting legislation at the time adoption is being considered by the appropriate governmental body. The following sample adoption legislation addresses several key elements, including the information required for insertion into the code text.

## SAMPLE LEGISLATION FOR ADOPTION OF THE *INTERNATIONAL ENERGY CONSERVATION CODE* ORDINANCE NO. \_\_\_\_\_

A[N] [ORDINANCE/STATUTE/REGULATION] of the [JURISDICTION] adopting the 2012 edition of the *International Energy Conservation Code*, regulating and governing energy efficient building envelopes and installation of energy efficient mechanical, lighting and power systems in the [JURISDICTION]; providing for the issuance of permits and collection of fees therefor; repealing [ORDINANCE/STATUTE/REGULATION] No. \_\_\_\_\_ of the [JURISDICTION] and all other ordinances or parts of laws in conflict therewith.

The [GOVERNING BODY] of the [JURISDICTION] does ordain as follows:

**Section 1.** That a certain document, three (3) copies of which are on file in the office of the [TITLE OF JURISDICTION'S KEEPER OF RECORDS] of [NAME OF JURISDICTION], being marked and designated as the *International Energy Conservation Code*, 2012 edition, as published by the International Code Council, be and is hereby adopted as the Energy Conservation Code of the [JURISDICTION], in the State of [STATE NAME] for regulating and governing energy efficient building envelopes and installation of energy efficient mechanical, lighting and power systems as herein provided; providing for the issuance of permits and collection of fees therefor; and each and all of the regulations, provisions, penalties, conditions and terms of said Energy Conservation Code on file in the office of the [JURISDICTION] are hereby referred to, adopted, and made a part hereof, as if fully set out in this legislation, with the additions, insertions, deletions and changes, if any, prescribed in Section 2 of this ordinance.

**Section 2.** The following sections are hereby revised:

Sections C101.1 and R101.1. Insert: [NAME OF JURISDICTION].

Sections C108.4 and R108.4. Insert: [DOLLAR AMOUNT] in two places.

**Section 3.** That [ORDINANCE/STATUTE/REGULATION] No. \_\_\_\_\_ of [JURISDICTION] entitled [FILL IN HERE THE COMPLETE TITLE OF THE LEGISLATION OR LAWS IN EFFECT AT THE PRESENT TIME SO THAT THEY WILL BE REPEALED BY DEFINITE MENTION] and all other ordinances or parts of laws in conflict herewith are hereby repealed.

**Section 4.** That if any section, subsection, sentence, clause or phrase of this legislation is, for any reason, held to be unconstitutional, such decision shall not affect the validity of the remaining portions of this ordinance. The [GOVERNING BODY] hereby declares that it would have passed this law, and each section, subsection, clause or phrase thereof, irrespective of the fact that any one or more sections, subsections, sentences, clauses and phrases be declared unconstitutional.

**Section 5.** That nothing in this legislation or in the Energy Conservation Code hereby adopted shall be construed to affect any suit or proceeding impending in any court, or any rights acquired, or liability incurred, or any cause or causes of action acquired or existing, under any act or ordinance hereby repealed as cited in Section 3 of this law; nor shall any just or legal right or remedy of any character be lost, impaired or affected by this legislation.

**Section 6.** That the [JURISDICTION'S KEEPER OF RECORDS] is hereby ordered and directed to cause this legislation to be published. (An additional provision may be required to direct the number of times the legislation is to be published and to specify that it is to be in a newspaper in general circulation. Posting may also be required.)

**Section 7.** That this law and the rules, regulations, provisions, requirements, orders and matters established and adopted hereby shall take effect and be in full force and effect [TIME PERIOD] from and after the date of its final passage and adoption.



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# IECC—COMMERCIAL PROVISIONS

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# CHAPTER 1 [CE]

## SCOPE AND ADMINISTRATION

### PART 1—SCOPE AND APPLICATION

#### SECTION C101 SCOPE AND GENERAL REQUIREMENTS

**C101.1 Title.** This code shall be known as the *International Energy Conservation Code* of [NAME OF JURISDICTION], and shall be cited as such. It is referred to herein as “this code.”

**C101.2 Scope.** This code applies to *commercial buildings* and the buildings sites and associated systems and equipment.

**C101.3 Intent.** This code shall regulate the design and construction of buildings for the effective use and conservation of energy over the useful life of each building. This code is intended to provide flexibility to permit the use of innovative approaches and techniques to achieve this objective. This code is not intended to abridge safety, health or environmental requirements contained in other applicable codes or ordinances.

**C101.4 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.

**C101.4.1 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.

**C101.4.2 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.

**C101.4.3 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 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 a space, 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.

**C101.4.4 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. Where the use in a space changes from one use in Table C405.5.2(1) or (2) to another use in Table C405.5.2(1) or (2), the installed lighting wattage shall comply with Section C405.5.

**C101.4.5 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.

**C101.4.6 Mixed occupancy.** Where a building includes both *residential* and *commercial* occupancies, each occupancy shall be separately considered and meet the applicable provisions of IECC—Commercial Provisions or IECC—Residential Provisions.

**C101.5 Compliance.** *Residential buildings* shall meet the provisions of IECC—Residential Provisions. *Commercial*

*buildings* shall meet the provisions of IECC—Commercial Provisions.

**C101.5.1 Compliance materials.** The *code official* shall be permitted to approve specific computer software, worksheets, compliance manuals and other similar materials that meet the intent of this code.

**C101.5.2 Low energy buildings.** The following buildings, or portions thereof, separated from the remainder of the building by *building thermal envelope* assemblies complying with this code shall be exempt from the *building thermal envelope* provisions of this code:

1. 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. Those that do not contain *conditioned space*.

**SECTION C102  
ALTERNATE MATERIALS—METHOD  
OF CONSTRUCTION, DESIGN  
OR INSULATING SYSTEMS**

**C102.1 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* as meeting the intent of this code.

**C102.1.1 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 shall be met.

**PART 2—ADMINISTRATION AND ENFORCEMENT**

**SECTION C103  
CONSTRUCTION DOCUMENTS**

**C103.1 General.** 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* is authorized to require necessary construction documents to be prepared by a registered design professional.

**Exception:** The *code official* is authorized to waive the requirements for construction documents or other supporting data if the *code official* determines they are not necessary to confirm compliance with this code.

**C103.2 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*. 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.

**C103.3 Examination of documents.** The *code official* 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.

**C103.3.1 Approval of construction documents.** When the *code official* 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*. 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*. 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.

**C103.3.2 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.

**C103.3.3 Phased approval.** The *code official* shall have the authority to issue a permit for the construction of part of an energy conservation system before the construction documents for the entire system have been submitted or *approved*, provided adequate information and detailed statements have been filed complying with all pertinent requirements of this code. The holders of such permit shall proceed at their own risk without assurance that the permit for the entire energy conservation system will be granted.

**C103.4 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.

**C103.5 Retention of construction documents.** One set of *approved* construction documents shall be retained by the *code official* 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 C104 INSPECTIONS

**C104.1 General.** Construction or work for which a permit is required shall be subject to inspection by the *code official*.

**C104.2 Required approvals.** Work shall not be done beyond the point indicated in each successive inspection without first obtaining the approval of the *code official*. The *code official*, 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*.

**C104.3 Final inspection.** The building shall have a final inspection and not be occupied until *approved*.

**C104.4 Reinspection.** A building shall be reinspected when determined necessary by the *code official*.

**C104.5 Approved inspection agencies.** The *code official* is authorized to accept reports of *approved* inspection agencies, provided such agencies satisfy the requirements as to qualifications and reliability.

**C104.6 Inspection requests.** It shall be the duty of the holder of the permit or their duly authorized agent to notify the *code official* 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.

**C104.7 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* for inspection and testing.

**C104.8 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*.

**C104.8.1 Revocation.** The *code official* 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 C105 VALIDITY

**C105.1 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 C106 REFERENCED STANDARDS

**C106.1 Referenced codes and standards.** The codes and standards referenced in this code shall be those listed in

Chapter 5, and such codes and standards shall be considered as part of the requirements of this code to the prescribed extent of each such reference and as further regulated in Sections C106.1.1 and C106.1.2.

**C106.1.1 Conflicts.** Where differences occur between provisions of this code and referenced codes and standards, the provisions of this code shall apply.

**C106.1.2 Provisions in referenced codes and standards.** Where the extent of the reference to a referenced code or standard includes subject matter that is within the scope of this code, the provisions of this code, as applicable, shall take precedence over the provisions in the referenced code or standard.

**C106.2 Conflicting requirements.** Where the provisions of this code and the referenced standards conflict, the provisions of this code shall take precedence.

**C106.3 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.

**C106.4 Other laws.** The provisions of this code shall not be deemed to nullify any provisions of local, state or federal law.

## SECTION C107 FEES

**C107.1 Fees.** A permit shall not be issued until the fees prescribed in Section C107.2 have been paid, nor shall an amendment to a permit be released until the additional fee, if any, has been paid.

**C107.2 Schedule of permit fees.** A fee for each permit shall be paid as required, in accordance with the schedule as established by the applicable governing authority.

**C107.3 Work commencing before permit issuance.** Any person who commences any work before obtaining the necessary permits shall be subject to an additional fee established by the *code official*, which shall be in addition to the required permit fees.

**C107.4 Related fees.** The payment of the fee for the construction, *alteration*, removal or demolition of work done in connection to or concurrently with the work or activity authorized by a permit shall not relieve the applicant or holder of the permit from the payment of other fees that are prescribed by law.

**C107.5 Refunds.** The *code official* is authorized to establish a refund policy.

## SECTION C108 STOP WORK ORDER

**C108.1 Authority.** Whenever the *code official* finds any work regulated by this code being performed in a manner either contrary to the provisions of this code or dangerous or unsafe, the *code official* is authorized to issue a stop work order.

## SCOPE AND ADMINISTRATION

**C108.2 Issuance.** The stop work order shall be in writing and shall be given to the owner of the property involved, or to the owner's agent, or to the person doing the work. Upon issuance of a stop work order, the cited work shall immediately cease. The stop work order shall state the reason for the order, and the conditions under which the cited work will be permitted to resume.

**C108.3 Emergencies.** Where an emergency exists, the *code official* shall not be required to give a written notice prior to stopping the work.

**C108.4 Failure to comply.** Any person who shall continue any work after having been served with a stop work order, except such work as that person is directed to perform to remove a violation or unsafe condition, shall be liable to a fine of not less than [AMOUNT] dollars or more than [AMOUNT] dollars.

### SECTION C109 BOARD OF APPEALS

**C109.1 General.** In order to hear and decide appeals of orders, decisions or determinations made by the *code official* relative to the application and interpretation of this code, there shall be and is hereby created a board of appeals. The *code official* shall be an ex officio member of said board but shall have no vote on any matter before the board. The board of appeals shall be appointed by the governing body and shall hold office at its pleasure. The board shall adopt rules of procedure for conducting its business, and shall render all decisions and findings in writing to the appellant with a duplicate copy to the *code official*.

**C109.2 Limitations on authority.** An application for appeal shall be based on a claim that the true intent of this code or the rules legally adopted thereunder have been incorrectly interpreted, the provisions of this code do not fully apply or an equally good or better form of construction is proposed. The board shall have no authority to waive requirements of this code.

**C109.3 Qualifications.** The board of appeals shall consist of members who are qualified by experience and training and are not employees of the jurisdiction.

## CHAPTER 2 [CE]

# DEFINITIONS

### SECTION C201 GENERAL

**C201.1 Scope.** Unless stated otherwise, the following words and terms in this code shall have the meanings indicated in this chapter.

**C201.2 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.

**C201.3 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.

**C201.4 Terms not defined.** Terms not defined by this chapter shall have ordinarily accepted meanings such as the context implies.

### SECTION C202 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.

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

**APPROVED.** Approval by the *code official* 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*.

**BUILDING.** Any structure used or intended for supporting or sheltering any use or occupancy, including any mechanical systems, service water heating systems and electric power and lighting systems located on the building site and supporting the building.

**BUILDING COMMISSIONING.** A process that verifies and documents that the selected building systems have been designed, installed, and function according to the owner’s project requirements and construction documents, and to minimum code requirements.

**BUILDING ENTRANCE.** Any door, set of doors, doorway, or other form of portal that is used to gain access to the building from the outside by the public.

**BUILDING SITE.** A contiguous area of land that is under the ownership or control of one entity.

**BUILDING THERMAL ENVELOPE.** The basement walls, exterior walls, floor, roof, and any other building elements that enclose *conditioned space* or provides a boundary between *conditioned space* and exempt or unconditioned space.

**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 ( $\text{Btu/h ft}^2 \times \text{°F}$ ) [ $\text{W}/(\text{m}^2 \times \text{K})$ ].

**CODE OFFICIAL.** The officer or other designated authority charged with the administration and enforcement of this code, or a duly authorized representative.

**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 refrigerating system or some specific portion of that system under designated operating conditions.

**COEFFICIENT OF PERFORMANCE (COP) – HEATING.** The ratio of the rate of heat removal to the rate of heat delivered to the rate of energy input, in consistent units, for a complete heat pump system, including the compressor and, if applicable, auxiliary heat, under designated operating conditions.

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

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

**CONDITIONED SPACE.** An area or room within a building being heated or cooled, containing uninsulated ducts, or with a fixed opening directly into an adjacent *conditioned space*.

## DEFINITIONS

**CONTINUOUS AIR BARRIER.** A combination of materials and assemblies that restrict or prevent the passage of air through the building thermal envelope.

**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.

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

**DEMAND RECIRCULATION WATER SYSTEM.** A water distribution system where pump(s) prime the service hot water piping with heated water upon demand for hot water.

**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.

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

**DYNAMIC GLAZING.** Any fenestration product that has the fully reversible ability to change its performance properties, including *U*-factor, SHGC, or VT.

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

**ECONOMIZER, WATER.** A system where the supply air of a cooling system is cooled indirectly with water that is itself

cooled by heat or mass transfer to the environment without the use of mechanical cooling.

**ENCLOSED SPACE.** A volume surrounded by solid surfaces such as walls, floors, roofs, and openable devices such as doors and operable windows.

**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.

**[M] ENERGY RECOVERY VENTILATION SYSTEM.** Systems that employ air-to-air heat exchangers to recover energy from exhaust air for the purpose of preheating, pre-cooling, 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.

**EQUIPMENT ROOM.** A space that contains either electrical equipment, mechanical equipment, machinery, water pumps or hydraulic pumps that are a function of the building's services.

**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.

**FENESTRATION PRODUCT, FIELD-FABRICATED.** A fenestration product whose frame is made at the construction site of standard dimensional lumber or other materials

that were not previously cut, or otherwise formed with the specific intention of being used to fabricate a fenestration product or exterior door. Field fabricated does not include site-built fenestration.

**FENESTRATION PRODUCT, SITE-BUILT.** A fenestration designed to be made up of field-glazed or field-assembled units using specific factory cut or otherwise factory-formed framing and glazing units. Examples of site-built fenestration include storefront systems, curtain walls, and atrium roof systems.

**F-FACTOR.** The perimeter heat loss factor for slab-on-grade floors ( $\text{Btu/h} \times \text{ft} \times ^\circ\text{F}$ ) [ $\text{W}/(\text{m} \times \text{K})$ ].

**FURNACE ELECTRICITY RATIO.** The ratio of furnace electricity use to total furnace energy computed as ratio =  $(3.412 \times E_{AE})/1000 \times E_F + 3.412 \times E_{AE}$  where  $E_{AE}$  (average annual auxiliary electrical consumption) and  $E_F$  (average annual fuel energy consumption) are defined in Appendix N to Subpart B of Part 430 of Title 10 of the Code of Federal Regulations and  $E_F$  is expressed in millions of Btu's per year.

**GENERAL LIGHTING.** Lighting that provides a substantially uniform level of illumination throughout an area. General lighting shall not include decorative lighting or lighting that provides a dissimilar level of illumination to serve a specialized application or feature within such area.

**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.

**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.

**HUMIDISTAT.** A regulatory device, actuated by changes in humidity, used for automatic control of relative humidity.

**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.

**INTEGRATED PART LOAD VALUE (IPLV).** A single-number figure of merit based on part-load EER, COP, or kW/ton expressing part-load efficiency for air-conditioning and heat pump equipment on the basis of weighted operation at various load capacities for equipment.

**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.

**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").

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

**NONSTANDARD PART LOAD VALUE (NPLV).** A single-number part-load efficiency figure of merit calculated and referenced to conditions other than IPLV conditions, for units that are not designed to operate at ARI standard rating conditions.

**ON-SITE RENEWABLE ENERGY.** Energy derived from solar radiation, wind, waves, tides, landfill gas, biomass, or the internal heat of the earth. The energy system providing on-site renewable energy shall be located on the project site.

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

**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").

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

**RESIDENTIAL BUILDING.** For this code, includes detached one- and two-family dwellings and multiple single-family dwellings (townhouses) as well as Group R-2, R-3 and R-4 buildings three stories or less in height above grade plane.

**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.

**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 ( $h \cdot \text{ft}^2 \cdot ^\circ\text{F}/\text{Btu}$ ) [ $(\text{m}^2 \cdot \text{K})/\text{W}$ ].

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

## DEFINITIONS

**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 less than 60 degrees (1.05 rad) from horizontal. Glazing material in skylights, including unit skylights, solariums, sunrooms, roofs and sloped walls is included in this definition.

**[B] 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.

**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.

**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, with or without mullied windows and doors.

**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.

**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.

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

**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 (Btu/h · ft<sup>2</sup> · °F) [W/(m<sup>2</sup> · K)].

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

**[M] 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.

**VISIBLE TRANSMITTANCE [VT].** The ratio of visible light entering the space through the fenestration product assembly to the incident visible light, Visible Transmittance, includes the effects of glazing material and frame and is expressed as a number between 0 and 1.

**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.

## CHAPTER 3 [CE]

# GENERAL REQUIREMENTS

### SECTION C301 CLIMATE ZONES

**C301.1 General.** Climate zones from Figure C301.1 or Table C301.1 shall be used in determining the applicable requirements from Chapter 4. Locations not in Table C301.1 (outside the United States) shall be assigned a climate zone based on Section C301.3.

**C301.2 Warm humid counties.** Warm humid counties are identified in Table C301.1 by an asterisk.

**C301.3 International climate zones.** The climate zone for any location outside the United States shall be determined by applying Table C301.3(1) and then Table C301.3(2).

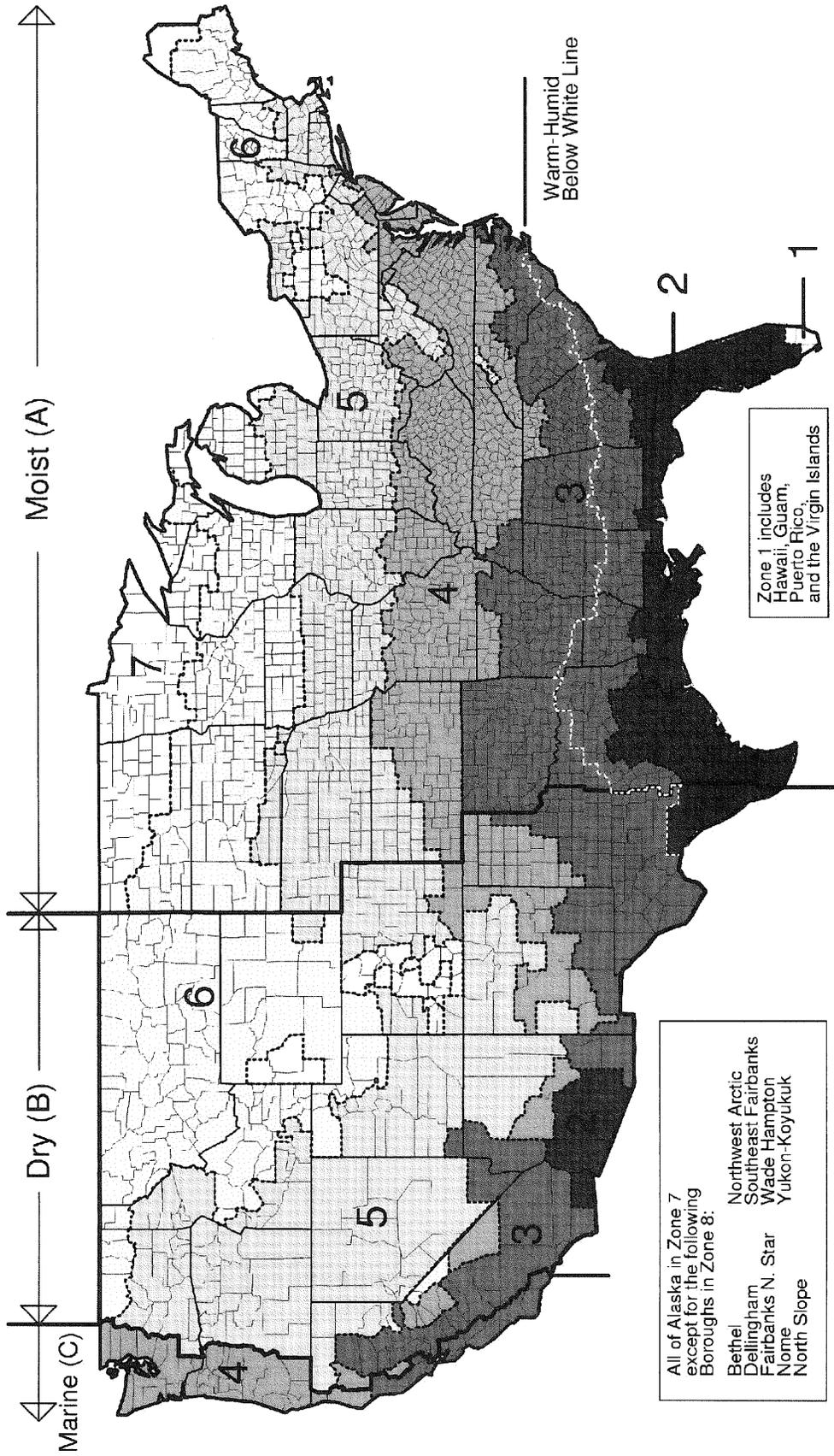


FIGURE C301.1  
CLIMATE ZONES

TABLE C301.1  
CLIMATE ZONES, MOISTURE REGIMES, AND WARM-HUMID  
DESIGNATIONS BY STATE, COUNTY AND TERRITORY

Key: A – Moist, B – Dry, C – Marine. Absence of moisture designation indicates moisture regime is irrelevant. Asterisk (\*) indicates a warm-humid location.

### US STATES

<b>ALABAMA</b>	3A Lee	7 Kodiak Island	3A Calhoun	3A Monroe
3A Autauga*	3A Limestone	7 Lake and Peninsula	4A Carroll	3A Montgomery
2A Baldwin*	3A Lowndes*	7 Matanuska-Susitna	3A Chicot	3A Nevada
3A Barbour*	3A Macon*	8 Nome	3A Clark	4A Newton
3A Bibb	3A Madison	8 North Slope	3A Clay	3A Ouachita
3A Blount	3A Marengo*	8 Northwest Arctic	3A Cleburne	3A Perry
3A Bullock*	3A Marion	7 Prince of Wales	3A Cleveland	3A Phillips
3A Butler*	3A Marshall	Outer Ketchikan	3A Columbia*	3A Pike
3A Calhoun	2A Mobile*	7 Sitka	3A Conway	3A Poinsett
3A Chambers	3A Monroe*	7 Skagway-Hoonah- Angoon	3A Craighead	3A Polk
3A Cherokee	3A Montgomery*	8 Southeast Fairbanks	3A Crawford	3A Pope
3A Chilton	3A Morgan	7 Valdez-Cordova	3A Crittenden	3A Prairie
3A Choctaw*	3A Perry*	8 Wade Hampton	3A Cross	3A Pulaski
3A Clarke*	3A Pickens	7 Wrangell-Petersburg	3A Dallas	3A Randolph
3A Clay	3A Pike*	7 Yakutat	3A Desha	3A Saline
3A Cleburne	3A Randolph	8 Yukon-Koyukuk	3A Drew	3A Scott
3A Coffee*	3A Russell*	<b>ARIZONA</b>	3A Faulkner	4A Searcy
3A Colbert	3A Shelby	5B Apache	3A Franklin	3A Sebastian
3A Conecuh*	3A St. Clair	3B Cochise	4A Fulton	3A Sevier*
3A Coosa	3A Sumter	5B Coconino	3A Garland	3A Sharp
3A Covington*	3A Talladega	4B Gila	3A Grant	3A St. Francis
3A Crenshaw*	3A Tallapoosa	3B Graham	3A Greene	4A Stone
3A Cullman	3A Tuscaloosa	3B Greenlee	3A Hempstead*	3A Union*
3A Dale*	3A Walker	2B La Paz	3A Hot Spring	3A Van Buren
3A Dallas*	3A Washington*	2B Maricopa	3A Howard	4A Washington
3A DeKalb	3A Wilcox*	3B Mohave	3A Independence	3A White
3A Elmore*	3A Winston	5B Navajo	4A IZARD	3A Woodruff
3A Escambia*	<b>ALASKA</b>	2B Pima	3A Jackson	3A Yell
3A Etowah	7 Aleutians East	2B Pinal	3A Jefferson	<b>CALIFORNIA</b>
3A Fayette	7 Aleutians West	3B Santa Cruz	3A Johnson	3C Alameda
3A Franklin	7 Anchorage	4B Yavapai	3A Lafayette*	6B Alpine
3A Geneva*	8 Bethel	2B Yuma	3A Lawrence	4B Amador
3A Greene	7 Bristol Bay	<b>ARKANSAS</b>	3A Lee	3B Butte
3A Hale	7 Denali	3A Arkansas	3A Lincoln	4B Calaveras
3A Henry*	8 Dillingham	3A Ashley	3A Little River*	3B Colusa
3A Houston*	8 Fairbanks North Star	4A Baxter	3A Logan	3B Contra Costa
3A Jackson	7 Haines	4A Benton	3A Lonoke	4C Del Norte
3A Jefferson	7 Juneau	4A Boone	4A Madison	4B El Dorado
3A Lamar	7 Kenai Peninsula	3A Bradley	3A Miller*	3B Fresno
3A Lauderdale	7 Ketchikan Gateway		3A Mississippi	3B Glenn
3A Lawrence				

(continued)

**GENERAL REQUIREMENTS**

**TABLE C301.1—continued  
CLIMATE ZONES, MOISTURE REGIMES, AND WARM-HUMID  
DESIGNATIONS BY STATE, COUNTY AND TERRITORY**

4C Humboldt	3B Yuba	5B Morgan	2A Escambia*	2A Taylor*
2B Imperial	<b>COLORADO</b>	4B Otero	2A Flagler*	2A Union*
4B Inyo	5B Adams	6B Ouray	2A Franklin*	2A Volusia*
3B Kern	6B Alamosa	7 Park	2A Gadsden*	2A Wakulla*
3B Kings	5B Arapahoe	5B Phillips	2A Gilchrist*	2A Walton*
4B Lake	6B Archuleta	7 Pitkin	2A Glades*	2A Washington*
5B Lassen	4B Baca	5B Prowers	2A Gulf*	<b>GEORGIA</b>
3B Los Angeles	5B Bent	5B Pueblo	2A Hamilton*	2A Appling*
3B Madera	5B Boulder	6B Rio Blanco	2A Hardee*	2A Atkinson*
3C Marin	6B Chaffee	7 Rio Grande	2A Hendry*	2A Bacon*
4B Mariposa	5B Cheyenne	7 Routt	2A Hernando*	2A Baker*
3C Mendocino	7 Clear Creek	6B Saguache	2A Highlands*	3A Baldwin
3B Merced	6B Conejos	7 San Juan	2A Hillsborough*	4A Banks
5B Modoc	6B Costilla	6B San Miguel	2A Holmes*	3A Barrow
6B Mono	5B Crowley	5B Sedgwick	2A Indian River*	3A Bartow
3C Monterey	6B Custer	7 Summit	2A Jackson*	3A Ben Hill*
3C Napa	5B Delta	5B Teller	2A Jefferson*	2A Berrien*
5B Nevada	5B Denver	5B Washington	2A Lafayette*	3A Bibb
3B Orange	6B Dolores	5B Weld	2A Lake*	3A Bleckley*
3B Placer	5B Douglas	5B Yuma	2A Lee*	2A Brantley*
5B Plumas	6B Eagle	<b>CONNECTICUT</b>	2A Leon*	2A Brooks*
3B Riverside	5B Elbert	5A (all)	2A Levy*	2A Bryan*
3B Sacramento	5B El Paso	<b>DELAWARE</b>	2A Liberty*	2A Bulloch*
3C San Benito	5B Fremont	4A (all)	2A Madison*	3A Burke
3B San Bernardino	5B Garfield	<b>DISTRICT OF</b>	2A Manatee*	3A Butts
3B San Diego	5B Gilpin	<b>COLUMBIA</b>	2A Marion*	3A Calhoun*
3C San Francisco	7 Grand	4A (all)	2A Martin*	2A Camden*
3B San Joaquin	7 Gunnison	<b>FLORIDA</b>	1A Miami-Dade*	3A Candler*
3C San Luis Obispo	7 Hinsdale	2A Alachua*	1A Monroe*	3A Carroll
3C San Mateo	5B Huerfano	2A Baker*	2A Nassau*	4A Catoosa
3C Santa Barbara	7 Jackson	2A Bay*	2A Okaloosa*	2A Charlton*
3C Santa Clara	5B Jefferson	2A Bradford*	2A Okeechobee*	2A Chatham*
3C Santa Cruz	5B Kiowa	2A Brevard*	2A Orange*	3A Chattahoochee*
3B Shasta	5B Kit Carson	2A Calhoun*	2A Osceola*	4A Chattooga
5B Sierra	7 Lake	1A Broward*	2A Palm Beach*	3A Cherokee
5B Siskiyou	5B La Plata	2A Charlotte*	2A Pasco*	3A Clarke
3B Solano	5B Larimer	2A Citrus*	2A Pinellas*	3A Clay*
3C Sonoma	4B Las Animas	2A Clay*	2A Polk*	3A Clayton
3B Stanislaus	5B Lincoln	2A Collier*	2A Putnam*	2A Clinch*
3B Sutter	5B Logan	2A Columbia*	2A Santa Rosa*	3A Cobb
3B Tehama	5B Mesa	2A DeSoto*	2A Sarasota*	3A Coffee*
4B Trinity	7 Mineral	2A Dixie*	2A Seminole*	2A Colquitt*
3B Tulare	6B Moffat	2A Duval*	2A St. Johns*	3A Columbia
4B Tuolumne	5B Montezuma		2A St. Lucie*	2A Cook*
3C Ventura	5B Montrose		2A Sumter*	3A Coweta
3B Yolo			2A Suwannee*	

(continued)

**TABLE C301.1—continued**  
**CLIMATE ZONES, MOISTURE REGIMES, AND WARM-HUMID**  
**DESIGNATIONS BY STATE, COUNTY AND TERRITORY**

3A Crawford	2A Lanier*	3A Taylor*	5B Cassia	4A Crawford
3A Crisp*	3A Laurens*	3A Telfair*	6B Clark	5A Cumberland
4A Dade	3A Lee*	3A Terrell*	5B Clearwater	5A DeKalb
4A Dawson	2A Liberty*	2A Thomas*	6B Custer	5A De Witt
2A Decatur*	3A Lincoln	3A Tift*	5B Elmore	5A Douglas
3A DeKalb	2A Long*	2A Toombs*	6B Franklin	5A DuPage
3A Dodge*	2A Lowndes*	4A Towns	6B Fremont	5A Edgar
3A Dooly*	4A Lumpkin	3A Treutlen*	5B Gem	4A Edwards
3A Dougherty*	3A Macon*	3A Troup	5B Gooding	4A Effingham
3A Douglas	3A Madison	3A Turner*	5B Idaho	4A Fayette
3A Early*	3A Marion*	3A Twiggs*	6B Jefferson	5A Ford
2A Echols*	3A McDuffie	4A Union	5B Jerome	4A Franklin
2A Effingham*	2A McIntosh*	3A Upson	5B Kootenai	5A Fulton
3A Elbert	3A Meriwether	4A Walker	5B Latah	4A Gallatin
3A Emanuel*	2A Miller*	3A Walton	6B Lemhi	5A Greene
2A Evans*	2A Mitchell*	2A Ware*	5B Lewis	5A Grundy
4A Fannin	3A Monroe	3A Warren	5B Lincoln	4A Hamilton
3A Fayette	3A Montgomery*	3A Washington	6B Madison	5A Hancock
4A Floyd	3A Morgan	2A Wayne*	5B Minidoka	4A Hardin
3A Forsyth	4A Murray	3A Webster*	5B Nez Perce	5A Henderson
4A Franklin	3A Muscogee	3A Wheeler*	6B Oneida	5A Henry
3A Fulton	3A Newton	4A White	5B Owyhee	5A Iroquois
4A Gilmer	3A Oconee	4A Whitfield	5B Payette	4A Jackson
3A Glascock	3A Oglethorpe	3A Wilcox*	5B Power	4A Jasper
2A Glynn*	3A Paulding	3A Wilkes	5B Shoshone	4A Jefferson
4A Gordon	3A Peach*	3A Wilkinson	6B Teton	5A Jersey
2A Grady*	4A Pickens	3A Worth*	5B Twin Falls	5A Jo Daviess
3A Greene	2A Pierce*		6B Valley	4A Johnson
3A Gwinnett	3A Pike	<b>HAWAII</b>	5B Washington	5A Kane
4A Habersham	3A Polk	1A (all)*		5A Kankakee
4A Hall	3A Pulaski*	<b>IDAHO</b>	<b>ILLINOIS</b>	5A Kendall
3A Hancock	3A Putnam	5B Ada	5A Adams	5A Knox
3A Haralson	3A Quitman*	6B Adams	4A Alexander	5A Lake
3A Harris	4A Rabun	6B Bannock	4A Bond	5A La Salle
3A Hart	3A Randolph*	6B Bear Lake	5A Boone	4A Lawrence
3A Heard	3A Richmond	5B Benewah	5A Brown	5A Lee
3A Henry	3A Rockdale	6B Bingham	5A Bureau	5A Livingston
3A Houston*	3A Schley*	6B Blaine	5A Calhoun	5A Logan
3A Irwin*	3A Screven*	6B Boise	5A Carroll	5A Macon
3A Jackson	2A Seminole*	6B Bonner	5A Cass	4A Macoupin
3A Jasper	3A Spalding	6B Bonneville	5A Champaign	4A Madison
2A Jeff Davis*	4A Stephens	6B Boundary	4A Christian	4A Marion
3A Jefferson	3A Stewart*	6B Butte	5A Clark	5A Marshall
3A Jenkins*	3A Sumter*	6B Camas	4A Clay	5A Mason
3A Johnson*	3A Talbot	5B Canyon	4A Clinton	4A Massac
3A Jones	3A Taliaferro	6B Caribou	5A Coles	5A McDonough
3A Lamar	2A Tattall*		5A Cook	5A McHenry

(continued)

GENERAL REQUIREMENTS

TABLE C301.1—continued  
CLIMATE ZONES, MOISTURE REGIMES, AND WARM-HUMID  
DESIGNATIONS BY STATE, COUNTY AND TERRITORY

5A McLean	5A Boone	5A Miami	5A Appanoose	5A Jasper
5A Menard	4A Brown	4A Monroe	5A Audubon	5A Jefferson
5A Mercer	5A Carroll	5A Montgomery	5A Benton	5A Johnson
4A Monroe	5A Cass	5A Morgan	6A Black Hawk	5A Jones
4A Montgomery	4A Clark	5A Newton	5A Boone	5A Keokuk
5A Morgan	5A Clay	5A Noble	6A Bremer	6A Kossuth
5A Moultrie	5A Clinton	4A Ohio	6A Buchanan	5A Lee
5A Ogle	4A Crawford	4A Orange	6A Buena Vista	5A Linn
5A Peoria	4A Daviess	5A Owen	6A Butler	5A Louisa
4A Perry	4A Dearborn	5A Parke	6A Calhoun	5A Lucas
5A Piatt	5A Decatur	4A Perry	5A Carroll	6A Lyon
5A Pike	5A De Kalb	4A Pike	5A Cass	5A Madison
4A Pope	5A Delaware	5A Porter	5A Cedar	5A Mahaska
4A Pulaski	4A Dubois	4A Posey	6A Cerro Gordo	5A Marion
5A Putnam	5A Elkhart	5A Pulaski	6A Cherokee	5A Marshall
4A Randolph	5A Fayette	5A Putnam	6A Chickasaw	5A Mills
4A Richland	4A Floyd	5A Randolph	5A Clarke	6A Mitchell
5A Rock Island	5A Fountain	4A Ripley	6A Clay	5A Monona
4A Saline	5A Franklin	5A Rush	6A Clayton	5A Monroe
5A Sangamon	5A Fulton	4A Scott	5A Clinton	5A Montgomery
5A Schuyler	4A Gibson	5A Shelby	5A Crawford	5A Muscatine
5A Scott	5A Grant	4A Spencer	5A Dallas	6A O'Brien
4A Shelby	4A Greene	5A Starke	5A Davis	6A Osceola
5A Stark	5A Hamilton	5A Steuben	5A Decatur	5A Page
4A St. Clair	5A Hancock	5A St. Joseph	6A Delaware	6A Palo Alto
5A Stephenson	4A Harrison	4A Sullivan	5A Des Moines	6A Plymouth
5A Tazewell	5A Hendricks	4A Switzerland	6A Dickinson	6A Pocahontas
4A Union	5A Henry	5A Tippecanoe	5A Dubuque	5A Polk
5A Vermilion	5A Howard	5A Tipton	6A Emmet	5A Pottawattamie
4A Wabash	5A Huntington	5A Union	6A Fayette	5A Poweshiek
5A Warren	4A Jackson	4A Vanderburgh	6A Floyd	5A Ringgold
4A Washington	5A Jasper	5A Vermillion	6A Franklin	6A Sac
4A Wayne	5A Jay	5A Vigo	5A Fremont	5A Scott
4A White	4A Jefferson	5A Wabash	5A Greene	5A Shelby
5A Whiteside	4A Jennings	5A Warren	6A Grundy	6A Sioux
5A Will	5A Johnson	4A Warrick	5A Guthrie	5A Story
4A Williamson	4A Knox	4A Washington	6A Hamilton	5A Tama
5A Winnebago	5A Kosciusko	5A Wayne	6A Hancock	5A Taylor
5A Woodford	5A Lagrange	5A Wells	6A Hardin	5A Union
	5A Lake	5A White	5A Harrison	5A Van Buren
	5A La Porte	5A Whitley	5A Henry	5A Wapello
	4A Lawrence		6A Howard	5A Warren
	5A Madison	<b>IOWA</b>	6A Humboldt	5A Washington
	5A Marion	5A Adair	6A Ida	5A Wayne
	5A Marshall	5A Adams	5A Iowa	6A Webster
	4A Martin	6A Allamakee	5A Jackson	6A Winnebago

(continued)

**TABLE C301.1—continued**  
**CLIMATE ZONES, MOISTURE REGIMES, AND WARM-HUMID**  
**DESIGNATIONS BY STATE, COUNTY AND TERRITORY**

6A Winneshiek	4A Haskell	4A Sedgwick	2A Iberville*	6A Cumberland
5A Woodbury	4A Hodgeman	4A Seward	3A Jackson*	6A Franklin
6A Worth	4A Jackson	4A Shawnee	2A Jefferson*	6A Hancock
6A Wright	4A Jefferson	5A Sheridan	2A Jefferson Davis*	6A Kennebec
<b>KANSAS</b>	5A Jewell	5A Sherman	2A Lafayette*	6A Knox
4A Allen	4A Johnson	5A Smith	2A Lafourche*	6A Lincoln
4A Anderson	4A Kearny	4A Stafford	3A La Salle*	6A Oxford
4A Atchison	4A Kingman	4A Stanton	3A Lincoln*	6A Penobscot
4A Barber	4A Kiowa	4A Stevens	2A Livingston*	6A Piscataquis
4A Barton	4A Labette	4A Sumner	3A Madison*	6A Sagadahoc
4A Bourbon	5A Lane	5A Thomas	3A Morehouse	6A Somerset
4A Brown	4A Leavenworth	5A Trego	3A Natchitoches*	6A Waldo
4A Butler	4A Lincoln	4A Wabaunsee	2A Orleans*	6A Washington
4A Chase	4A Linn	5A Wallace	3A Ouachita*	6A York
4A Chautauqua	5A Logan	4A Washington	2A Plaquemines*	<b>MARYLAND</b>
4A Cherokee	4A Lyon	5A Wichita	2A Pointe Coupee*	4A Allegany
5A Cheyenne	4A Marion	4A Wilson	2A Rapides*	4A Anne Arundel
4A Clark	4A Marshall	4A Woodson	3A Red River*	4A Baltimore
4A Clay	4A McPherson	4A Wyandotte	3A Richland*	4A Baltimore (city)
5A Cloud	4A Meade	<b>KENTUCKY</b>	3A Sabine*	4A Calvert
4A Coffey	4A Miami	4A (all)	2A St. Bernard*	4A Caroline
4A Comanche	5A Mitchell	<b>LOUISIANA</b>	2A St. Charles*	4A Carroll
4A Cowley	4A Montgomery	2A Acadia*	2A St. Helena*	4A Cecil
4A Crawford	4A Morris	2A Allen*	2A St. James*	4A Charles
5A Decatur	4A Morton	2A Ascension*	2A St. John the Baptist*	4A Dorchester
4A Dickinson	4A Nemaha	2A Assumption*	2A St. Landry*	4A Frederick
4A Doniphan	4A Neosho	2A Avoyelles*	2A St. Martin*	5A Garrett
4A Douglas	5A Ness	2A Beauregard*	2A St. Mary*	4A Harford
4A Edwards	5A Norton	3A Bienville*	2A St. Tammany*	4A Howard
4A Elk	4A Osage	3A Bossier*	2A Tangipahoa*	4A Kent
5A Ellis	5A Osborne	3A Caddo*	3A Tensas*	4A Montgomery
4A Ellsworth	4A Ottawa	2A Calcasieu*	2A Terrebonne*	4A Prince George's
4A Finney	4A Pawnee	3A Caldwell*	3A Union*	4A Queen Anne's
4A Ford	5A Phillips	2A Cameron*	2A Vermilion*	4A Somerset
4A Franklin	4A Pottawatomie	3A Catahoula*	3A Vernon*	4A St. Mary's
4A Geary	4A Pratt	3A Claiborne*	2A Washington*	4A Talbot
5A Gove	5A Rawlins	3A Concordia*	3A Webster*	4A Washington
5A Graham	4A Reno	3A De Soto*	2A West Baton Rouge*	4A Wicomico
4A Grant	4A Rice	2A East Baton Rouge*	3A West Carroll	4A Worcester
4A Gray	4A Riley	3A East Carroll	2A West Feliciana*	<b>MASSACHUSETTS</b>
5A Greeley	5A Rooks	2A East Feliciana*	3A Winn*	5A (all)
4A Greenwood	4A Rush	2A Evangeline*	<b>MAINE</b>	<b>MICHIGAN</b>
5A Hamilton	4A Russell	3A Franklin*	6A Androscoggin	6A Alcona
4A Harper	4A Saline	3A Grant*	7 Aroostook	6A Alger
4A Harvey	5A Scott	2A Iberia*		

(continued)

GENERAL REQUIREMENTS

TABLE C301.1—continued  
CLIMATE ZONES, MOISTURE REGIMES, AND WARM-HUMID  
DESIGNATIONS BY STATE, COUNTY AND TERRITORY

5A Allegan	7 Mackinac	6A Carver	7 Otter Tail	3A Clarke
6A Alpena	5A Macomb	7 Cass	7 Pennington	3A Clay
6A Antrim	6A Manistee	6A Chippewa	7 Pine	3A Coahoma
6A Arenac	6A Marquette	6A Chisago	6A Pipestone	3A Copiah*
7 Baraga	6A Mason	7 Clay	7 Polk	3A Covington*
5A Barry	6A Mecosta	7 Clearwater	6A Pope	3A DeSoto
5A Bay	6A Menominee	7 Cook	6A Ramsey	3A Forrest*
6A Benzie	5A Midland	6A Cottonwood	7 Red Lake	3A Franklin*
5A Berrien	6A Missaukee	7 Crow Wing	6A Redwood	3A George*
5A Branch	5A Monroe	6A Dakota	6A Renville	3A Greene*
5A Calhoun	5A Montcalm	6A Dodge	6A Rice	3A Grenada
5A Cass	6A Montmorency	6A Douglas	6A Rock	2A Hancock*
6A Charlevoix	5A Muskegon	6A Faribault	7 Roseau	2A Harrison*
6A Cheboygan	6A Newaygo	6A Fillmore	6A Scott	3A Hinds*
7 Chippewa	5A Oakland	6A Freeborn	6A Sherburne	3A Holmes
6A Clare	6A Oceana	6A Goodhue	6A Sibley	3A Humphreys
5A Clinton	6A Ogemaw	7 Grant	6A Stearns	3A Issaquena
6A Crawford	7 Ontonagon	6A Hennepin	6A Steele	3A Itawamba
6A Delta	6A Osceola	6A Houston	6A Stevens	2A Jackson*
6A Dickinson	6A Oscoda	7 Hubbard	7 St. Louis	3A Jasper
5A Eaton	6A Otsego	6A Isanti	6A Swift	3A Jefferson*
6A Emmet	5A Ottawa	7 Itasca	6A Todd	3A Jefferson Davis*
5A Genesee	6A Presque Isle	6A Jackson	6A Traverse	3A Jones*
6A Gladwin	6A Roscommon	7 Kanabec	6A Wabasha	3A Kemper
7 Gogebic	5A Saginaw	6A Kandiyohi	7 Wadena	3A Lafayette
6A Grand Traverse	6A Sanilac	7 Kittson	6A Waseca	3A Lamar*
5A Gratiot	7 Schoolcraft	7 Koochiching	6A Washington	3A Lauderdale
5A Hillsdale	5A Shiawassee	6A Lac qui Parle	6A Watonwan	3A Lawrence*
7 Houghton	5A St. Clair	7 Lake	7 Wilkin	3A Leake
6A Huron	5A St. Joseph	7 Lake of the Woods	6A Winona	3A Lee
5A Ingham	5A Tuscola	6A Le Sueur	6A Wright	3A Leflore
5A Ionia	5A Van Buren	6A Lincoln	6A Yellow	3A Lincoln*
6A Iosco	5A Washtenaw	6A Lyon	Medicine	3A Lowndes
7 Iron	5A Wayne	7 Mahanomen	<b>MISSISSIPPI</b>	3A Madison
6A Isabella	6A Wexford	7 Marshall	3A Adams*	3A Marion*
5A Jackson	<b>MINNESOTA</b>	6A Martin	3A Alcorn	3A Marshall
5A Kalamazoo	7 Aitkin	6A McLeod	3A Amite*	3A Monroe
6A Kalkaska	6A Anoka	6A Meeker	3A Attala	3A Montgomery
5A Kent	7 Becker	7 Mille Lacs	3A Benton	3A Neshoba
7 Keweenaw	7 Beltrami	6A Morrison	3A Bolivar	3A Newton
6A Lake	6A Benton	6A Mower	3A Calhoun	3A Noxubee
5A Lapeer	6A Big Stone	6A Murray	3A Carroll	3A Oktibbeha
6A Leelanau	6A Blue Earth	6A Nicollet	3A Chickasaw	3A Panola
5A Lenawee	6A Brown	6A Nobles	3A Choctaw	2A Pearl River*
5A Livingston	6A Brown	7 Norman	3A Claiborne*	3A Perry*
7 Luce	7 Carlton	6A Olmsted		3A Pike*

(continued)

TABLE C301.1—continued  
CLIMATE ZONES, MOISTURE REGIMES, AND WARM-HUMID  
DESIGNATIONS BY STATE, COUNTY AND TERRITORY

3A Pontotoc	5A Chariton	4A Mississippi	4A Webster	4A Cumberland
3A Prentiss	4A Christian	4A Moniteau	5A Worth	4A Essex
3A Quitman	5A Clark	4A Monroe	4A Wright	4A Gloucester
3A Rankin*	4A Clay	4A Montgomery	<b>MONTANA</b>	4A Hudson
3A Scott	5A Clinton	4A Morgan	6B (all)	5A Hunterdon
3A Sharkey	4A Cole	4A New Madrid	<b>NEBRASKA</b>	5A Mercer
3A Simpson*	4A Cooper	4A Newton	5A (all)	4A Middlesex
3A Smith*	4A Crawford	5A Nodaway	<b>NEVADA</b>	4A Monmouth
2A Stone*	4A Dade	4A Oregon	5B Carson City (city)	5A Morris
3A Sunflower	4A Dallas	4A Osage	5B Churchill	4A Ocean
3A Tallahatchie	5A Daviess	4A Ozark	3B Clark	5A Passaic
3A Tate	5A DeKalb	4A Pemiscot	5B Douglas	4A Salem
3A Tippah	4A Dent	4A Perry	5B Elko	5A Somerset
3A Tishomingo	4A Douglas	4A Pettis	5B Esmeralda	5A Sussex
3A Tunica	4A Dunklin	4A Phelps	5B Humboldt	4A Union
3A Union	4A Franklin	5A Pike	5B Lander	5A Warren
3A Walthall*	4A Gasconade	4A Platte	5B Lincoln	<b>NEW MEXICO</b>
3A Warren*	5A Gentry	4A Polk	5B Lyon	4B Bernalillo
3A Washington	4A Greene	4A Pulaski	5B Mineral	5B Catron
3A Wayne*	5A Grundy	5A Putnam	5B Nye	3B Chaves
3A Webster	5A Harrison	5A Ralls	5B Pershing	4B Cibola
3A Wilkinson*	4A Henry	4A Randolph	5B Storey	5B Colfax
3A Winston	4A Hickory	4A Ray	5B Washoe	4B Curry
3A Yalobusha	5A Holt	4A Reynolds	5B White Pine	4B DeBaca
3A Yazoo	4A Howard	4A Ripley	<b>NEW HAMPSHIRE</b>	3B Dona Ana
<b>MISSOURI</b>	4A Howell	4A Saline	6A Belknap	3B Eddy
5A Adair	4A Iron	5A Schuyler	6A Carroll	4B Grant
5A Andrew	4A Jackson	4A Scotland	5A Cheshire	4B Guadalupe
5A Atchison	4A Jasper	4A Scott	6A Coos	5B Harding
4A Audrain	4A Jefferson	4A Shannon	6A Grafton	3B Hidalgo
4A Barry	4A Johnson	5A Shelby	5A Hillsborough	3B Lea
4A Barton	5A Knox	4A St. Charles	6A Merrimack	4B Lincoln
4A Bates	4A Laclede	4A St. Clair	5A Rockingham	5B Los Alamos
4A Benton	4A Lafayette	4A Ste. Genevieve	5A Strafford	3B Luna
4A Bollinger	4A Lawrence	4A St. Francois	6A Sullivan	5B McKinley
4A Boone	5A Lewis	4A St. Louis	<b>NEW JERSEY</b>	5B Mora
5A Buchanan	4A Lincoln	4A St. Louis (city)	4A Atlantic	3B Otero
4A Butler	5A Linn	4A Stoddard	5A Bergen	4B Quay
5A Caldwell	5A Livingston	4A Stone	4A Burlington	5B Rio Arriba
4A Callaway	5A Macon	4A St. Louis	4A Camden	4B Roosevelt
4A Camden	4A Madison	4A Taney	4A Cape May	5B Sandoval
4A Cape Girardeau	4A Maries	4A Texas		5B San Juan
4A Carroll	5A Marion	4A Vernon		5B San Miguel
4A Carter	4A McDonald	4A Warren		5B Santa Fe
4A Cass	5A Mercer	4A Washington		4B Sierra
4A Cedar	4A Miller	4A Wayne		4B Socorro

(continued)

GENERAL REQUIREMENTS

TABLE C301.1—continued  
CLIMATE ZONES, MOISTURE REGIMES, AND WARM-HUMID  
DESIGNATIONS BY STATE, COUNTY AND TERRITORY

5B Taos	4A Queens	4A Clay	4A Orange	7 Divide
5B Torrance	5A Rensselaer	4A Cleveland	3A Pamlico	6A Dunn
4B Union	4A Richmond	3A Columbus*	3A Pasquotank	7 Eddy
4B Valencia	5A Rockland	3A Craven	3A Pender*	6A Emmons
<b>NEW YORK</b>	5A Saratoga	3A Cumberland	3A Perquimans	7 Foster
5A Albany	5A Schenectady	3A Currituck	4A Person	6A Golden Valley
6A Allegany	6A Schoharie	3A Dare	3A Pitt	7 Grand Forks
4A Bronx	6A Schuyler	3A Davidson	4A Polk	6A Grant
6A Broome	5A Seneca	4A Davie	3A Randolph	7 Griggs
6A Cattaraugus	6A Steuben	3A Duplin	3A Richmond	6A Hettinger
5A Cayuga	6A St. Lawrence	4A Durham	3A Robeson	7 Kidder
5A Chautauqua	4A Suffolk	3A Edgecombe	4A Rockingham	6A LaMoure
5A Chemung	6A Sullivan	4A Forsyth	3A Rowan	6A Logan
6A Chenango	5A Tioga	4A Franklin	4A Rutherford	7 McHenry
6A Clinton	6A Tompkins	3A Gaston	3A Sampson	6A McIntosh
5A Columbia	6A Ulster	4A Gates	3A Scotland	6A McKenzie
5A Cortland	6A Warren	4A Graham	3A Stanly	7 McLean
6A Delaware	5A Washington	4A Granville	4A Stokes	6A Mercer
5A Dutchess	5A Wayne	3A Greene	4A Surry	6A Morton
5A Erie	4A Westchester	4A Guilford	4A Swain	7 Mountrail
6A Essex	6A Wyoming	4A Halifax	4A Transylvania	7 Nelson
6A Franklin	5A Yates	4A Harnett	3A Tyrrell	6A Oliver
6A Fulton	<b>NORTH</b>	4A Haywood	3A Union	7 Pembina
5A Genesee	<b>CAROLINA</b>	4A Henderson	4A Vance	7 Pierce
5A Greene	4A Alamance	4A Hertford	4A Wake	7 Ramsey
6A Hamilton	4A Alexander	3A Hoke	4A Warren	6A Ransom
6A Herkimer	5A Alleghany	3A Hyde	3A Washington	7 Renville
6A Jefferson	3A Anson	4A Iredell	5A Watauga	6A Richland
4A Kings	5A Ashe	4A Jackson	3A Wayne	7 Rolette
6A Lewis	5A Avery	3A Johnston	4A Wilkes	6A Sargent
5A Livingston	3A Beaufort	3A Jones	3A Wilson	7 Sheridan
6A Madison	4A Bertie	4A Lee	4A Yadkin	6A Sioux
5A Monroe	3A Bladen	3A Lenoir	5A Yancey	6A Slope
6A Montgomery	3A Brunswick*	4A Lincoln	<b>NORTH DAKOTA</b>	6A Stark
4A Nassau	4A Buncombe	4A Macon	6A Adams	7 Steele
4A New York	4A Burke	4A Madison	7 Barnes	7 Stutsman
5A Niagara	3A Cabarrus	3A Martin	7 Benson	7 Towner
6A Oneida	4A Caldwell	4A McDowell	6A Billings	7 Traill
5A Onondaga	3A Camden	3A Mecklenburg	7 Bottineau	7 Walsh
5A Ontario	3A Carteret*	5A Mitchell	6A Bowman	7 Ward
5A Orange	4A Caswell	3A Montgomery	7 Burke	7 Wells
5A Orleans	4A Catawba	3A Moore	6A Burleigh	7 Williams
5A Oswego	4A Chatham	4A Nash	7 Cass	<b>OHIO</b>
6A Otsego	4A Cherokee	3A New Hanover*	7 Cavalier	4A Adams
5A Putnam	3A Chowan	4A Northampton	6A Dickey	5A Allen
		3A Onslow*		

(continued)

**TABLE C301.1—continued**  
**CLIMATE ZONES, MOISTURE REGIMES, AND WARM-HUMID**  
**DESIGNATIONS BY STATE, COUNTY AND TERRITORY**

5A Ashland	5A Mahoning	3A Bryan	3A Okfuskee	4C Linn
5A Ashtabula	5A Marion	3A Caddo	3A Oklahoma	5B Malheur
5A Athens	5A Medina	3A Canadian	3A Okmulgee	4C Marion
5A Auglaize	5A Meigs	3A Carter	3A Osage	5B Morrow
5A Belmont	5A Mercer	3A Cherokee	3A Ottawa	4C Multnomah
4A Brown	5A Miami	3A Choctaw	3A Pawnee	4C Polk
5A Butler	5A Monroe	4B Cimarron	3A Payne	5B Sherman
5A Carroll	5A Montgomery	3A Cleveland	3A Pittsburg	4C Tillamook
5A Champaign	5A Morgan	3A Coal	3A Pontotoc	5B Umatilla
5A Clark	5A Morrow	3A Comanche	3A Pottawatomie	5B Union
4A Clermont	5A Muskingum	3A Cotton	3A Pushmataha	5B Wallowa
5A Clinton	5A Noble	3A Craig	3A Roger Mills	5B Wasco
5A Columbiana	5A Ottawa	3A Creek	3A Rogers	4C Washington
5A Coshocton	5A Paulding	3A Custer	3A Seminole	5B Wheeler
5A Crawford	5A Perry	3A Delaware	3A Sequoyah	4C Yamhill
5A Cuyahoga	5A Pickaway	3A Dewey	3A Stephens	<b>PENNSYLVANIA</b>
5A Darke	4A Pike	3A Ellis	4B Texas	5A Adams
5A Defiance	5A Portage	3A Garfield	3A Tillman	5A Allegheny
5A Delaware	5A Preble	3A Garvin	3A Tulsa	5A Armstrong
5A Erie	5A Putnam	3A Grady	3A Wagoner	5A Beaver
5A Fairfield	5A Richland	3A Grant	3A Washington	5A Bedford
5A Fayette	5A Ross	3A Greer	3A Washita	5A Berks
5A Franklin	5A Sandusky	3A Harmon	3A Woods	5A Blair
5A Fulton	4A Scioto	3A Harper	3A Woodward	5A Bradford
4A Gallia	5A Seneca	3A Haskell	<b>OREGON</b>	4A Bucks
5A Geauga	5A Shelby	3A Hughes	5B Baker	5A Butler
5A Greene	5A Stark	3A Jackson	4C Benton	5A Cambria
5A Guernsey	5A Summit	3A Jefferson	4C Clackamas	6A Cameron
4A Hamilton	5A Trumbull	3A Johnston	4C Clatsop	5A Carbon
5A Hancock	5A Tuscarawas	3A Kay	4C Columbia	5A Centre
5A Hardin	5A Union	3A Kingfisher	4C Coos	4A Chester
5A Harrison	5A Van Wert	3A Kiowa	5B Crook	5A Clarion
5A Henry	5A Vinton	3A Latimer	4C Curry	6A Clearfield
5A Highland	5A Warren	3A Le Flore	5B Deschutes	5A Clinton
5A Hocking	4A Washington	3A Lincoln	4C Douglas	5A Columbia
5A Holmes	5A Wayne	3A Logan	5B Gilliam	5A Crawford
5A Huron	5A Williams	3A Love	5B Grant	5A Cumberland
5A Jackson	5A Wood	3A Major	5B Harney	5A Dauphin
5A Jefferson	5A Wyandot	3A Marshall	5B Hood River	4A Delaware
5A Knox	<b>OKLAHOMA</b>	3A Mayes	5B Hood River	6A Elk
5A Lake	3A Adair	3A McClain	4C Jackson	5A Erie
4A Lawrence	3A Alfalfa	3A McCurtain	5B Jefferson	5A Fayette
5A Licking	3A Atoka	3A McIntosh	4C Josephine	5A Forest
5A Logan	4B Beaver	3A Murray	5B Klamath	5A Franklin
5A Lorain	3A Beckham	3A Muskogee	5B Lake	5A Fulton
5A Lucas	3A Blaine	3A Noble	4C Lane	5A Greene
5A Madison		3A Nowata	4C Lincoln	

(continued)

**GENERAL REQUIREMENTS**

**TABLE C301.1—continued  
CLIMATE ZONES, MOISTURE REGIMES, AND WARM-HUMID  
DESIGNATIONS BY STATE, COUNTY AND TERRITORY**

5A Huntingdon	3A Bamberg*	5A Bennett	6A Minnehaha	4A Gibson
5A Indiana	3A Barnwell*	5A Bon Homme	6A Moody	4A Giles
5A Jefferson	3A Beaufort*	6A Brookings	6A Pennington	4A Grainger
5A Juniata	3A Berkeley*	6A Brown	6A Perkins	4A Greene
5A Lackawanna	3A Calhoun	6A Brule	6A Potter	4A Grundy
5A Lancaster	3A Charleston*	6A Buffalo	6A Roberts	4A Hamblen
5A Lawrence	3A Cherokee	6A Butte	6A Sanborn	4A Hamilton
5A Lebanon	3A Chester	6A Campbell	6A Shannon	4A Hancock
5A Lehigh	3A Chesterfield	5A Charles Mix	6A Spink	3A Hardeman
5A Luzerne	3A Clarendon	6A Clark	6A Stanley	3A Hardin
5A Lycoming	3A Colleton*	5A Clay	6A Sully	4A Hawkins
6A McKean	3A Darlington	6A Codrington	5A Todd	3A Haywood
5A Mercer	3A Dillon	6A Corson	5A Tripp	3A Henderson
5A Mifflin	3A Dorchester*	6A Custer	6A Turner	4A Henry
5A Monroe	3A Edgefield	6A Davison	5A Union	4A Hickman
4A Montgomery	3A Fairfield	6A Day	6A Walworth	4A Houston
5A Montour	3A Florence	6A Deuel	5A Yankton	4A Humphreys
5A Northampton	3A Georgetown*	6A Dewey	6A Ziebach	4A Jackson
5A Northumberland	3A Greenville	5A Douglas	<b>TENNESSEE</b>	4A Jefferson
5A Perry	3A Greenwood	6A Edmunds	4A Anderson	4A Johnson
4A Philadelphia	3A Hampton*	6A Fall River	4A Bedford	4A Knox
5A Pike	3A Horry*	6A Faulk	4A Benton	3A Lake
6A Potter	3A Jasper*	6A Grant	4A Bledsoe	3A Lauderdale
5A Schuylkill	3A Kershaw	5A Gregory	4A Blount	4A Lawrence
5A Snyder	3A Lancaster	6A Haakon	4A Bradley	4A Lewis
5A Somerset	3A Laurens	6A Hamlin	4A Campbell	4A Lincoln
5A Sullivan	3A Lee	6A Hand	4A Cannon	4A Loudon
6A Susquehanna	3A Lexington	6A Hanson	4A Carroll	4A Macon
6A Tioga	3A Marion	6A Harding	4A Carter	3A Madison
5A Union	3A Marlboro	6A Hughes	4A Cheatham	4A Marion
5A Venango	3A McCormick	5A Hutchinson	3A Chester	4A Marshall
5A Warren	3A Newberry	6A Hyde	4A Claiborne	4A Maury
5A Washington	3A Oconee	5A Jackson	4A Clay	4A McMinn
6A Wayne	3A Orangeburg	6A Jerauld	4A Coke	3A McNairy
5A Westmoreland	3A Pickens	6A Jones	4A Coffee	4A Meigs
5A Wyoming	3A Richland	6A Kingsbury	3A Crockett	4A Monroe
4A York	3A Saluda	6A Lake	4A Cumberland	4A Montgomery
<b>RHODE ISLAND</b>	3A Spartanburg	6A Lawrence	4A Davidson	4A Moore
5A (all)	3A Sumter	6A Lincoln	4A Decatur	4A Morgan
<b>SOUTH CAROLINA</b>	3A Union	6A Lyman	4A DeKalb	4A Obion
3A Abbeville	3A Williamsburg	6A Marshall	4A Dickson	4A Overton
3A Aiken	3A York	6A McCook	3A Dyer	4A Perry
3A Allendale*	<b>SOUTH DAKOTA</b>	6A McPherson	3A Fayette	4A Pickett
3A Anderson	6A Aurora	6A Meade	4A Fentress	4A Polk
	6A Beadle	5A Mellette	4A Franklin	4A Putnam
		6A Miner		4A Rhea

(continued)

TABLE C301.1—continued  
CLIMATE ZONES, MOISTURE REGIMES, AND WARM-HUMID  
DESIGNATIONS BY STATE, COUNTY AND TERRITORY

4A Roane	3B Brewster	3B Ector	3B Howard	3B McCulloch
4A Robertson	4B Briscoe	2B Edwards*	3B Hudspeth	2A McLennan*
4A Rutherford	2A Brooks*	3A Ellis*	3A Hunt*	2A McMullen*
4A Scott	3A Brown*	3B El Paso	4B Hutchinson	2B Medina*
4A Sequatchie	2A Burlison*	3A Erath*	3B Irion	3B Menard
4A Sevier	3A Burnet*	2A Falls*	3A Jack	3B Midland
3A Shelby	2A Caldwell*	3A Fannin	2A Jackson*	2A Milam*
4A Smith	2A Calhoun*	2A Fayette*	2A Jasper*	3A Mills*
4A Stewart	3B Callahan	3B Fisher	3B Jeff Davis	3B Mitchell
4A Sullivan	2A Cameron*	4B Floyd	2A Jefferson*	3A Montague
4A Sumner	3A Camp*	3B Foard	2A Jim Hogg*	2A Montgomery*
3A Tipton	4B Carson	2A Fort Bend*	2A Jim Wells*	4B Moore
4A Trousdale	3A Cass*	3A Franklin*	3A Johnson*	3A Morris*
4A Unicoi	4B Castro	2A Freestone*	3B Jones	3B Motley
4A Union	2A Chambers*	2B Frio*	2A Karnes*	3A Nacogdoches*
4A Van Buren	2A Cherokee*	3B Gaines	3A Kaufman*	3A Navarro*
4A Warren	3B Childress	2A Galveston*	3A Kendall*	2A Newton*
4A Washington	3A Clay	3B Garza	2A Kenedy*	3B Nolan
4A Wayne	4B Cochran	3A Gillespie*	3B Kent	2A Nueces*
4A Weakley	3B Coke	3B Glasscock	3B Kerr	4B Ochiltree
4A White	3B Coleman	2A Goliad*	3B Kimble	4B Oldham
4A Williamson	3A Collin*	2A Gonzales*	3B King	2A Orange*
4A Wilson	3B Collingsworth	4B Gray	2B Kinney*	3A Palo Pinto*
<b>TEXAS</b>	2A Colorado*	3A Grayson	2A Kleberg*	3A Panola*
2A Anderson*	2A Comal*	3A Gregg*	3B Knox	3A Parker*
3B Andrews	3A Comanche*	2A Grimes*	3A Lamar*	4B Parmer
2A Angelina*	3B Concho	2A Guadalupe*	4B Lamb	3B Pecos
2A Aransas*	3A Cooke	4B Hale	3A Lampasas*	2A Polk*
3A Archer	2A Coryell*	3B Hall	2B La Salle*	4B Potter
4B Armstrong	3B Cottle	3A Hamilton*	2A Lavaca*	3B Presidio
2A Atascosa*	3B Crane	4B Hansford	2A Lee*	3A Rains*
2A Austin*	3B Crockett	3B Hardeman	2A Leon*	4B Randall
4B Bailey	3B Crosby	2A Hardin*	2A Liberty*	3B Reagan
2B Bandera*	3B Culberson	2A Harris*	2A Limestone*	2B Real*
2A Bastrop*	4B Dallam	3A Harrison*	4B Lipscomb	3A Red River*
3B Baylor	3A Dallas*	4B Hartley	2A Live Oak*	3B Reeves
2A Bee*	3B Dawson	3B Haskell	3A Llano*	2A Refugio*
2A Bell*	4B Deaf Smith	2A Hays*	3B Loving	4B Roberts
2A Bexar*	3A Delta	3B Hemphill	3B Lubbock	2A Robertson*
3A Blanco*	3A Denton*	3A Henderson*	3B Lynn	3A Rockwall*
3B Borden	2A DeWitt*	2A Hidalgo*	2A Madison*	3B Runnels
2A Bosque*	3B Dickens	2A Hill*	3A Marion*	3A Rusk*
3A Bowie*	2B Dimmit*	4B Hockley	3B Martin	3A Sabine*
2A Brazoria*	4B Donley	3A Hood*	3B Mason	3A San Augustine*
2A Brazos*	2A Duval*	3A Hopkins*	2A Matagorda*	2A San Jacinto*
	3A Eastland	2A Houston*	2B Maverick*	2A San Patricio*

(continued)

**GENERAL REQUIREMENTS**

**TABLE C301.1—continued  
CLIMATE ZONES, MOISTURE REGIMES, AND WARM-HUMID  
DESIGNATIONS BY STATE, COUNTY AND TERRITORY**

3A San Saba*	3A Young	4C Clark	4A Gilmer	<b>WISCONSIN</b>
3B Schleicher	2B Zapata*	5B Columbia	5A Grant	6A Adams
3B Scurry	2B Zavala*	4C Cowlitz	5A Greenbrier	7 Ashland
3B Shackelford		5B Douglas	5A Hampshire	6A Barron
3A Shelby*	<b>UTAH</b>	6B Ferry	5A Hancock	7 Bayfield
4B Sherman	5B Beaver	5B Franklin	5A Hardy	6A Brown
3A Smith*	6B Box Elder	5B Garfield	5A Harrison	6A Buffalo
3A Somervell*	6B Cache	5B Grant	4A Jackson	7 Burnett
2A Starr*	6B Carbon	4C Grays Harbor	4A Jefferson	6A Calumet
3A Stephens	6B Daggett	4C Island	4A Kanawha	6A Chippewa
3B Sterling	5B Davis	4C Jefferson	5A Lewis	6A Clark
3B Stonewall	6B Duchesne	4C King	4A Lincoln	6A Columbia
3B Sutton	5B Emery	4C Kitsap	4A Logan	6A Crawford
4B Swisher	5B Garfield	5B Kittitas	5A Marion	6A Dane
3A Tarrant*	5B Grand	5B Klickitat	5A Marshall	6A Dodge
3B Taylor	5B Iron	4C Lewis	4A Mason	6A Door
3B Terrell	5B Juab	5B Lincoln	4A McDowell	7 Douglas
3B Terry	5B Kane	4C Mason	4A Mercer	6A Dunn
3B Throckmorton	5B Millard	6B Okanogan	5A Mineral	6A Eau Claire
3A Titus*	6B Morgan	4C Pacific	4A Mingo	7 Florence
3B Tom Green	5B Piute	6B Pend Oreille	5A Monongalia	6A Fond du Lac
2A Travis*	6B Rich	4C Pierce	4A Monroe	7 Forest
2A Trinity*	5B Salt Lake	4C San Juan	4A Morgan	6A Grant
2A Tyler*	5B San Juan	4C Skagit	5A Nicholas	6A Green
3A Upshur*	5B Sanpete	5B Skamania	5A Ohio	6A Green Lake
3B Upton	5B Sevier	4C Snohomish	5A Pendleton	6A Iowa
2B Uvalde*	6B Summit	5B Spokane	4A Pleasants	7 Iron
2B Val Verde*	5B Tooele	6B Stevens	5A Pocahontas	6A Jackson
3A Van Zandt*	6B Uintah	4C Thurston	5A Preston	6A Jefferson
2A Victoria*	5B Utah	4C Wahkiakum	4A Putnam	6A Juneau
2A Walker*	6B Wasatch	5B Walla Walla	5A Raleigh	6A Kenosha
2A Waller*	3B Washington	4C Whatcom	5A Randolph	6A Kewaunee
3B Ward	5B Wayne	5B Whitman	4A Ritchie	6A La Crosse
2A Washington*	5B Weber	5B Yakima	4A Roane	6A Lafayette
2B Webb*	<b>VERMONT</b>	<b>WEST VIRGINIA</b>	5A Summers	7 Langlade
2A Wharton*	6A (all)	5A Barbour	5A Taylor	7 Lincoln
3B Wheeler	<b>VIRGINIA</b>	4A Berkeley	5A Tucker	6A Manitowoc
3A Wichita	4A (all)	4A Boone	4A Tyler	6A Marathon
3B Wilbarger	<b>WASHINGTON</b>	4A Braxton	5A Upshur	6A Marinette
2A Willacy*	5B Adams	5A Brooke	4A Wayne	6A Marquette
2A Williamson*	5B Asotin	4A Cabell	5A Webster	6A Menominee
2A Wilson*	5B Asotin	4A Calhoun	5A Wetzel	6A Milwaukee
3B Winkler	5B Benton	4A Clay	4A Wirt	6A Monroe
3A Wise	5B Benton	5A Doddridge	4A Wood	6A Oconto
3A Wood*	5B Chelan	5A Fayette	4A Wyoming	7 Oneida
4B Yoakum	4C Clallam			6A Outagamie

(continued)

**TABLE C301.1—continued**  
**CLIMATE ZONES, MOISTURE REGIMES, AND WARM-HUMID**  
**DESIGNATIONS BY STATE, COUNTY AND TERRITORY**

6A Ozaukee	7 Taylor	6B Big Horn	6B Sheridan	<b>NORTHERN MARIANA ISLANDS</b>
6A Pepin	6A Trempealeau	6B Campbell	7 Sublette	
6A Pierce	6A Vernon	6B Carbon	6B Sweetwater	1A (all)*
6A Polk	7 Vilas	6B Converse	7 Teton	<b>PUERTO RICO</b>
6A Portage	6A Walworth	6B Crook	6B Uinta	
7 Price	7 Washburn	6B Fremont	6B Washakie	1A (all)*
6A Racine	6A Washington	5B Goshen	6B Weston	<b>VIRGIN ISLANDS</b>
6A Richland	6A Waukesha	6B Hot Springs		
6A Rock	6A Waupaca	6B Johnson	<b>US TERRITORIES</b>	1A (all)*
6A Rusk	6A Waushara	6B Laramie	<b>AMERICAN SAMOA</b>	
6A Sauk	6A Winnebago	7 Lincoln	<b>SAMOA</b>	
7 Sawyer	6A Wood	6B Natrona	1A (all)*	
6A Shawano	<b>WYOMING</b>	6B Niobrara	<b>GUAM</b>	
6A Sheboygan	6B Albany	6B Park	1A (all)*	
6A St. Croix		5B Platte		

**TABLE C301.3(1)**  
**INTERNATIONAL CLIMATE ZONE DEFINITIONS**

MAJOR CLIMATE TYPE DEFINITIONS
<p>Marine (C) Definition—Locations meeting all four criteria:</p> <ol style="list-style-type: none"> <li>1. Mean temperature of coldest month between -3°C (27°F) and 18°C (65°F).</li> <li>2. Warmest month mean &lt; 22°C (72°F).</li> <li>3. At least four months with mean temperatures over 10°C (50°F).</li> <li>4. Dry season in summer. The month with the heaviest precipitation in the cold season has at least three times as much precipitation as the month with the least precipitation in the rest of the year. The cold season is October through March in the Northern Hemisphere and April through September in the Southern Hemisphere.</li> </ol>
<p>Dry (B) Definition—Locations meeting the following criteria:</p> <p>Not marine and <math>P_m &lt; 0.44 \times (TF - 19.5)</math>    [<math>P_{cm} &lt; 2.0 \times (TC + 7)</math> in SI units]</p> <p>where:</p> <p><math>P_m</math> = Annual precipitation in inches (cm)</p> <p><math>T</math> = Annual mean temperature in °F (°C)</p>
<p>Moist (A) Definition—Locations that are not marine and not dry.</p>
<p>Warm-humid Definition—Moist (A) locations where either of the following wet-bulb temperature conditions shall occur during the warmest six consecutive months of the year:</p> <ol style="list-style-type: none"> <li>1. 67°F (19.4°C) or higher for 3,000 or more hours; or</li> <li>2. 73°F (22.8°C) or higher for 1,500 or more hours.</li> </ol>

For SI: °C = [(°F)-32]/1.8, 1 inch = 2.54 cm.

**GENERAL REQUIREMENTS**

**TABLE C301.3(2)  
INTERNATIONAL CLIMATE ZONE DEFINITIONS**

ZONE NUMBER	THERMAL CRITERIA	
	IP Units	SI Units
1	9000 < CDD50°F	5000 < CDD10°C
2	6300 < CDD50°F ≤ 9000	3500 < CDD10°C ≤ 5000
3A and 3B	4500 < CDD50°F ≤ 6300 AND HDD65°F ≤ 5400	2500 < CDD10°C ≤ 3500 AND HDD18°C ≤ 3000
4A and 4B	CDD50°F ≤ 4500 AND HDD65°F ≤ 5400	CDD10°C ≤ 2500 AND HDD18°C ≤ 3000
3C	HDD65°F ≤ 3600	HDD18°C ≤ 2000
4C	3600 < HDD65°F ≤ 5400	2000 < HDD18°C ≤ 3000
5	5400 < HDD65°F ≤ 7200	3000 < HDD18°C ≤ 4000
6	7200 < HDD65°F ≤ 9000	4000 < HDD18°C ≤ 5000
7	9000 < HDD65°F ≤ 12600	5000 < HDD18°C ≤ 7000
8	12600 < HDD65°F	7000 < HDD18°C

For SI: °C = [(°F)-32]/1.8.

**SECTION C302  
DESIGN CONDITIONS**

**C302.1 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.

**SECTION C303  
MATERIALS, SYSTEMS AND EQUIPMENT**

**C303.1 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.

**C303.1.1 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.

**C303.1.1.1 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.

**C303.1.2 Insulation mark installation.** Insulating materials shall be installed such that the manufacturer's *R*-value mark is readily observable upon inspection.

**C303.1.3 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 C303.1.3(1) or C303.1.3(2). The solar heat gain coefficient (SHGC) and *visible transmittance* (VT) of glazed fenestration products (windows, glazed doors and skylights) shall be determined in accordance with NFRC 200 by an accredited, independent laboratory, and labeled and certified by the manufacturer. Products lacking such a labeled SHGC or VT shall be assigned a default SHGC or VT from Table C303.1.3(3).

**TABLE C303.1.3(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 C303.1.3(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 C303.1.3(3)  
DEFAULT GLAZED FENESTRATION SHGC AND VT

	SINGLE GLAZED		DOUBLE GLAZED		GLAZED BLOCK
	Clear	Tinted	Clear	Tinted	
SHGC	0.8	0.7	0.7	0.6	0.6
VT	0.6	0.3	0.6	0.3	0.6

**C303.1.4 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) in units of  $h \times ft^2 \times ^\circ F/Btu$  at a mean temperature of  $75^\circ F$  ( $24^\circ C$ ).

**C303.2 Installation.** All materials, systems and equipment shall be installed in accordance with the manufacturer's installation instructions and the *International Building Code*.

**C303.2.1 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.

**C303.3 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.



## CHAPTER 4 [CE]

# COMMERCIAL ENERGY EFFICIENCY

### SECTION C401 GENERAL

**C401.1 Scope.** The requirements contained in this chapter are applicable to commercial buildings, or portions of commercial buildings.

**C401.2 Application.** Commercial buildings shall comply with one of the following:

1. The requirements of ANSI/ASHRAE/IESNA 90.1.
2. The requirements of Sections C402, C403, C404 and C405. In addition, commercial buildings shall comply with either Section C406.2, C406.3 or C406.4.
3. The requirements of Section C407, C402.4, C403.2, C404, C405.2, C405.3, C405.4, C405.6 and C405.7. The building energy cost shall be equal to or less than 85 percent of the standard reference design building.

**C401.2.1 Application to existing buildings.** Additions, alterations and repairs to existing buildings shall comply with one of the following:

1. Sections C402, C403, C404 and C405; or
2. ANSI/ASHRAE/IESNA 90.1.

### SECTION C402 BUILDING ENVELOPE REQUIREMENTS

**C402.1 General (Prescriptive).** The building thermal envelope shall comply with Section C402.1.1. Section C402.1.2 shall be permitted as an alternative to the *R*-values specified in Section C402.1.1.

**C402.1.1 Insulation and fenestration criteria.** The *building thermal envelope* shall meet the requirements of Tables C402.2 and C402.3 based on the climate zone specified in Chapter 3. Commercial buildings or portions of commercial buildings enclosing Group R occupancies shall use the *R*-values from the "Group R" column of Table C402.2. Commercial buildings or portions of commercial buildings enclosing occupancies other than Group R shall use the *R*-values from the "All other" column of Table C402.2. Buildings with a vertical fenestration area or skylight area that exceeds that allowed in Table C402.3 shall comply with the building envelope provisions of ANSI/ASHRAE/IESNA 90.1.

**C402.1.2 *U*-factor alternative.** An assembly with a *U*-factor, *C*-factor, or *F*-factor equal or less than that specified in Table C402.1.2 shall be permitted as an alternative to the *R*-value in Table C402.2. Commercial buildings or portions of commercial buildings enclosing Group R occupancies shall use the *U*-factor, *C*-factor, or *F*-factor from the "Group R" column of Table C402.1.2. Commercial buildings or portions of commercial buildings enclosing occupancies other than Group R shall use the *U*-factor, *C*-factor or *F*-factor from the "All other" column of Table C402.1.2.

**C402.2 Specific insulation requirements (Prescriptive).** Opaque assemblies shall comply with Table C402.2. Where two or more layers of continuous insulation board are used in a construction assembly, the continuous insulation boards shall be installed in accordance with Section C303.2. If the continuous insulation board manufacturer's installation instructions do not address installation of two or more layers, the edge joints between each layer of continuous insulation boards shall be staggered.

**C402.2.1 Roof assembly.** The minimum thermal resistance (*R*-value) of the insulating material installed either between the roof framing or continuously on the roof assembly shall be as specified in Table C402.2, based on construction materials used in the roof assembly. Skylight curbs shall be insulated to the level of roofs with insulation entirely above deck or R-5, whichever is less.

#### Exceptions:

1. Continuously insulated roof assemblies where the thickness of insulation varies 1 inch (25 mm) or less and where the area-weighted *U*-factor is equivalent to the same assembly with the *R*-value specified in Table C402.2.
2. Unit skylight curbs included as a component of an NFRC 100 rated assembly shall not be required to be insulated.

Insulation installed on a suspended ceiling with removable ceiling tiles shall not be considered part of the minimum thermal resistance of the roof insulation.

**C402.2.1.1 Roof solar reflectance and thermal emittance.** Low-sloped roofs, with a slope less than 2 units vertical in 12 horizontal, directly above cooled *conditioned spaces* in Climate Zones 1, 2, and 3 shall comply with one or more of the options in Table C402.2.1.1.

**Exceptions:** The following roofs and portions of roofs are exempt from the requirements in Table C402.2.1.1:

1. Portions of roofs that include or are covered by:
  - 1.1. Photovoltaic systems or components.
  - 1.2. Solar air or water heating systems or components.
  - 1.3. Roof gardens or landscaped roofs.
  - 1.4. Above-roof decks or walkways.
  - 1.5. Skylights.
  - 1.6. HVAC systems, components, and other opaque objects mounted above the roof.

2. Portions of roofs shaded during the peak sun angle on the summer solstice by permanent features of the building, or by permanent features of adjacent buildings.
3. Portions of roofs that are ballasted with a minimum stone ballast of 17 pounds per square foot (psf) (74 kg/m<sup>2</sup>) or 23 psf (117 kg/m<sup>2</sup>) pavers.
4. Roofs where a minimum of 75 percent of the roof area meets a minimum of one of the exceptions above.

**TABLE C402.2.1.1  
MINIMUM ROOF REFLECTANCE AND EMITTANCE OPTIONS<sup>a</sup>**

Three-year aged solar reflectance <sup>b</sup> of 0.55 and three-year aged thermal emittance <sup>c</sup> of 0.75
Initial solar reflectance <sup>b</sup> of 0.70 and initial thermal emittance <sup>c</sup> of 0.75
Three-year-aged solar reflectance index <sup>d</sup> of 64
Initial solar reflectance index <sup>d</sup> of 82

- a. The use of area-weighted averages to meet these requirements shall be permitted. Materials lacking initial tested values for either solar reflectance or thermal emittance, shall be assigned both an initial solar reflectance of 0.10 and an initial thermal emittance of 0.90. Materials lacking three-year aged tested values for either solar reflectance or thermal emittance shall be assigned both a three-year aged solar reflectance of 0.10 and a three-year aged thermal emittance of 0.90.
- b. Solar reflectance tested in accordance with ASTM C 1549, ASTM E 903 or ASTM E 1918.
- c. Thermal emittance tested in accordance with ASTM C 1371 or ASTM E 408.
- d. Solar reflectance index (SRI) shall be determined in accordance with ASTM E 1980 using a convection coefficient of 2.1 Btu/h × ft<sup>2</sup> × °F (12W/m<sup>2</sup> × K). Calculation of aged SRI shall be based on aged tested values of solar reflectance and thermal emittance. Calculation of initial SRI shall be based on initial tested values of solar reflectance and thermal emittance.

**C402.2.2 Classification of walls.** Walls associated with the building envelope shall be classified in accordance with Section C402.2.2.1 or C402.2.2.2.

**C402.2.2.1 Above-grade walls.** Above-grade walls are those walls covered by Section C402.2.3 on the exterior of the building and completely above grade or walls that are more than 15 percent above grade.

**C402.2.2.2 Below-grade walls.** Below-grade walls covered by Section C402.2.4 are basement or first-story walls associated with the exterior of the building that are at least 85 percent below grade.

**C402.2.3 Thermal resistance of above-grade walls.** The minimum thermal resistance (*R*-value) of the insulating materials installed in the wall cavity between the framing members and continuously on the walls shall be as specified in Table C402.2, based on framing type and construction materials used in the wall assembly. The *R*-value of integral insulation installed in concrete masonry units (CMU) shall not be used in determining compliance with Table C402.2.

“Mass walls” shall include walls weighing not less than:

1. 35 psf (170 kg/m<sup>2</sup>) of wall surface area; or

2. 25 psf (120 kg/m<sup>2</sup>) of wall surface area if the material weight is not more than 120 pounds per cubic foot (pcf) (1900 kg/m<sup>3</sup>).

**C402.2.4 Thermal resistance of below-grade walls.** The minimum thermal resistance (*R*-value) of the insulating material installed in, or continuously on, the below-grade walls shall be as specified in Table C402.2, and shall extend to a depth of 10 feet (3048 mm) below the outside finished ground level, or to the level of the floor, whichever is less.

**C402.2.5 Floors over outdoor air or unconditioned space.** The minimum thermal resistance (*R*-value) of the insulating material installed either between the floor framing or continuously on the floor assembly shall be as specified in Table C402.2, based on construction materials used in the floor assembly.

“Mass floors” shall include floors weighing not less than:

1. 35 psf (170 kg/m<sup>2</sup>) of floor surface area; or
2. 25 psf (120 kg/m<sup>2</sup>) of floor surface area if the material weight is not more than 12 pcf (1,900 kg/m<sup>3</sup>).

**C402.2.6 Slabs on grade.** Where the slab on grade is in contact with the ground, the minimum thermal resistance (*R*-value) of the insulation around the perimeter of unheated or heated slab-on-grade floors shall be as specified in Table C402.2. The insulation shall be placed on the outside of the foundation or on the inside of the foundation wall. The insulation shall extend downward from the top of the slab for a minimum distance as shown in the table or to the top of the footing, whichever is less, or downward to at least the bottom of the slab and then horizontally to the interior or exterior for the total distance shown in the table. Insulation extending away from the building shall be protected by pavement or by a minimum of 10 inches (254 mm) of soil.

**Exception:** Where the slab-on-grade floor is greater than 24 inches (61 mm) below the finished exterior grade, perimeter insulation is not required.

**C402.2.7 Opaque doors.** Opaque doors (doors having less than 50 percent glass area) shall meet the applicable requirements for doors as specified in Table C402.2 and be considered as part of the gross area of above-grade walls that are part of the building envelope.

**C402.2.8 Insulation of radiant heating systems.** Radiant panels, and associated U-bends and headers, designed for sensible heating of an indoor space through heat transfer from the thermally effective panel surfaces to the occupants or indoor space by thermal radiation and natural convection and the bottom surfaces of floor structures incorporating radiant heating shall be insulated with a minimum of R-3.5 (0.62 m<sup>2</sup>/K × W).

TABLE C402.1.2  
OPAQUE THERMAL ENVELOPE ASSEMBLY REQUIREMENTS<sup>a</sup>

CLIMATE ZONE	1		2		3		4 EXCEPT MARINE		5 AND MARINE 4		6		7		8	
	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R
<b>Roofs</b>																
Insulation entirely above deck	U-0.048	U-0.048	U-0.048	U-0.048	U-0.048	U-0.048	U-0.039	U-0.039	U-0.039	U-0.039	U-0.032	U-0.032	U-0.028	U-0.028	U-0.028	U-0.028
Metal buildings	U-0.044	U-0.035	U-0.035	U-0.035	U-0.035	U-0.035	U-0.035	U-0.035	U-0.035	U-0.031	U-0.031	U-0.029	U-0.029	U-0.029	U-0.029	U-0.029
Attic and other	U-0.027	U-0.027	U-0.027	U-0.027	U-0.027	U-0.027	U-0.027	U-0.027	U-0.027	U-0.021	U-0.021	U-0.021	U-0.021	U-0.021	U-0.021	U-0.021
<b>Walls, Above Grade</b>																
Mass	U-0.142	U-0.142	U-0.123	U-0.110	U-0.104	U-0.104	U-0.090	U-0.078	U-0.078	U-0.078	U-0.071	U-0.061	U-0.061	U-0.061	U-0.061	U-0.061
Metal building	U-0.079	U-0.079	U-0.079	U-0.079	U-0.052	U-0.052	U-0.052	U-0.052	U-0.052	U-0.052	U-0.052	U-0.052	U-0.039	U-0.039	U-0.039	U-0.039
Metal framed	U-0.077	U-0.077	U-0.064	U-0.064	U-0.064	U-0.064	U-0.064	U-0.064	U-0.064	U-0.064	U-0.057	U-0.064	U-0.052	U-0.052	U-0.045	U-0.045
Wood framed and other	U-0.064	U-0.064	U-0.064	U-0.064	U-0.064	U-0.064	U-0.064	U-0.064	U-0.064	U-0.051	U-0.051	U-0.051	U-0.051	U-0.051	U-0.036	U-0.036
<b>Walls, Below Grade</b>																
Below-grade wall <sup>b</sup>	C-1.140	C-1.140	C-1.140	C-1.140	C-1.140	C-1.140	C-0.119	C-0.119	C-0.119	C-0.119	C-0.119	C-0.119	C-0.092	C-0.092	C-0.092	C-0.092
<b>Floors</b>																
Mass	U-0.322	U-0.107	U-0.087	U-0.076	U-0.076	U-0.076	U-0.074	U-0.074	U-0.074	U-0.064	U-0.057	U-0.055	U-0.051	U-0.051	U-0.055	U-0.051
Joist/framing	U-0.066	U-0.033	U-0.033	U-0.033	U-0.033	U-0.033	U-0.033	U-0.033	U-0.033	U-0.033	U-0.033	U-0.033	U-0.033	U-0.033	U-0.033	U-0.033
<b>Slab-on-Grade Floors</b>																
Unheated slabs	F-0.73	F-0.73	F-0.73	F-0.73	F-0.73	F-0.73	F-0.54	F-0.54	F-0.54	F-0.54	F-0.52	F-0.40	F-0.40	F-0.40	F-0.40	F-0.40
Heated slabs	F-0.70	F-0.70	F-0.70	F-0.70	F-0.70	F-0.70	F-0.65	F-0.65	F-0.58	F-0.58	F-0.58	F-0.55	F-0.55	F-0.55	F-0.55	F-0.55

a. Use of opaque assembly U-factors, C-factors, and F-factors from ANSI/ASHRAE/IESNA 90.1 Appendix A shall be permitted, provided the construction complies with the applicable construction details from ANSI/ASHRAE/IESNA 90.1 Appendix A.

b. Where heated slabs are below grade, below-grade walls shall comply with the F-factor requirements for heated slabs.

TABLE C402.2  
OPAQUE THERMAL ENVELOPE REQUIREMENTS<sup>a</sup>

CLIMATE ZONE	1		2		3		4 EXCEPT MARINE		5 AND MARINE 4		6		7		8	
	All Other	Group R														
<b>Roofs</b>																
Insulation entirely above deck	R-20ci	R-20ci	R-20ci	R-20ci	R-20ci	R-20ci	R-25ci	R-25ci	R-25ci	R-25ci	R-30ci	R-35ci	R-35ci	R-35ci	R-35ci	R-35ci
Metal buildings (with R-5 thermal blocks) <sup>a,b</sup>	R-19 + R-11 LS	R-25 + R-11 LS	R-30 + R-11 LS													
Attic and other	R-38	R-49	R-49	R-49	R-49	R-49	R-49									
<b>Walls, Above Grade</b>																
Mass	R-5.7ci	R-5.7ci	R-5.7ci	R-5.7ci	R-5.7ci	R-5.7ci	R-9.5ci	R-11.4ci	R-11.4ci	R-13.3ci	R-13.3ci	R-15.2ci	R-15.2ci	R-15.2ci	R-25ci	R-25ci
Metal building	R-13 + R-6.5ci	R-13 + R-13ci														
Metal framed	R-13 + R-5ci	R-13 + R-7.5ci														
Wood framed and other	R-13 + R-3.8ci or R-20															
<b>Walls, Below Grade</b>																
Below-grade wall <sup>d</sup>	NR	NR	NR	NR	NR	NR	R-7.5ci	R-10ci	R-10ci							
Mass	NR	NR	R-6.3ci	R-8.3ci	R-10ci	R-10ci	R-10ci	R-10.4ci	R-10ci	R-12.5ci	R-12.5ci	R-12.5ci	R-12.5ci	R-12.5ci	R-15ci	R-16.7ci
Joist/framing	NR	NR	R-30													
<b>Floors</b>																
<b>Slab-on-Grade Floors</b>																
Unheated slabs	NR	NR	NR	NR	NR	NR	R-10 for 24" below	R-15 for 24" below	R-20 for 24" below							
Heated slabs <sup>d</sup>	R-7.5 for 12" below	R-10 for 24" below	R-15 for 36" below	R-20 for 48" below	R-20 for 48" below											
<b>Opaque Doors</b>																
Swinging	U-0.61	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37									
Roll-up or sliding	R-4.75															

For SI: 1 inch = 25.4 mm. ci = Continuous insulation. NR = No requirement.  
 LS = Liner System—A continuous membrane installed below the purlins and uninterrupted by framing members. Uncompressed, unfaced insulation rests on top of the membrane between the purlins.  
 a. Assembly descriptions can be found in ANSI/ASHRAE/IESNA Appendix A.  
 b. Where using R-value compliance method, a thermal spacer block shall be provided, otherwise use the U-factor compliance method in Table C402.1.2.  
 c. R-5.7ci is allowed to be substituted with concrete block walls complying with ASTM C 90, ungrouted or partially grouted at 32 inches or less on center vertically and 48 inches or less on center horizontally, with ungrouted cores filled with materials having a maximum thermal conductivity of 0.44 Btu-in/h·ft<sup>2</sup>·°F.  
 d. Where heated slabs are below grade, below-grade walls shall comply with the exterior insulation requirements for heated slabs.  
 e. Steel floor joist systems shall be insulated to R-38.

**C402.3 Fenestration (Prescriptive).** Fenestration shall comply with Table C402.3. Automatic daylighting controls specified by this section shall comply with Section C405.2.2.3.2.

**C402.3.1 Maximum area.** The vertical fenestration area (not including opaque doors and opaque spandrel panels) shall not exceed 30 percent of the gross above-grade wall area. The skylight area shall not exceed 3 percent of the gross roof area.

**C402.3.1.1 Increased vertical fenestration area with daylighting controls.** In Climate Zones 1 through 6, a maximum of 40 percent of the gross above-grade wall area shall be permitted to be vertical fenestration, provided:

1. No less than 50 percent of the conditioned floor area is within a daylight zone;
2. Automatic daylighting controls are installed in daylight zones; and
3. Visible transmittance (VT) of vertical fenestration is greater than or equal to 1.1 times solar heat gain coefficient (SHGC).

**Exception:** Fenestration that is outside the scope of NFRC 200 is not required to comply with Item 3.

**C402.3.1.2 Increased skylight area with daylighting controls.** The skylight area shall be permitted to be a maximum of 5 percent of the roof area provided automatic daylighting controls are installed in daylight zones under skylights.

**C402.3.2 Minimum skylight fenestration area.** In an enclosed space greater than 10,000 square feet (929 m<sup>2</sup>), directly under a roof with ceiling heights greater than 15 feet (4572 mm), and used as an office, lobby, atrium, concourse, corridor, storage, gymnasium/exercise center, convention center, automotive service, manufacturing, non-refrigerated warehouse, retail store, distribution/sorting area, transportation, or workshop, the total daylight zone under skylights shall be not less than half the floor area

and shall provide a minimum skylight area to daylight zone under skylights of either:

1. Not less than 3 percent with a skylight VT of at least 0.40; or
2. Provide a minimum skylight effective aperture of at least 1 percent determined in accordance with Equation 4-1.

$$\text{Skylight Effective Aperature} = \frac{0.85 \times \text{Skylight Area} \times \text{Skylight VT} \times \text{WF}}{\text{Daylight zone under skylight}}$$

(Equation 4-1)

where:

- Skylight area = Total fenestration area of skylights.
- Skylight VT = Area weighted average visible transmittance of skylights.
- WF = Area weighted average well factor, where well factor is 0.9 if light well depth is less than 2 feet (610 mm), or 0.7 if light well depth is 2 feet (610 mm) or greater.

Light well depth = Measure vertically from the underside of the lowest point of the skylight glazing to the ceiling plane under the skylight.

**Exception:** Skylights above daylight zones of enclosed spaces are not required in:

1. Buildings in climate zones 6 through 8.
2. Spaces where the designed *general lighting* power densities are less than 0.5 W/ft<sup>2</sup> (5.4 W/m<sup>2</sup>).
3. Areas where it is documented that existing structures or natural objects block direct beam sunlight on at least half of the roof over the enclosed

**TABLE C402.3  
BUILDING ENVELOPE REQUIREMENTS: FENESTRATION**

CLIMATE ZONE	1	2	3	4 EXCEPT MARINE	5 AND MARINE 4	6	7	8
<b>Vertical fenestration</b>								
<b>U-factor</b>								
Fixed fenestration	0.50	0.50	0.46	0.38	0.38	0.36	0.29	0.29
Operable fenestration	0.65	0.65	0.60	0.45	0.45	0.43	0.37	0.37
Entrance doors	1.10	0.83	0.77	0.77	0.77	0.77	0.77	0.77
<b>SHGC</b>								
SHGC	0.25	0.25	0.25	0.40	0.40	0.40	0.45	0.45
<b>Skylights</b>								
<b>U-factor</b>	0.75	0.65	0.55	0.50	0.50	0.50	0.50	0.50
<b>SHGC</b>	0.35	0.35	0.35	0.40	0.40	0.40	NR	NR

NR = No requirement.

area for more than 1,500 daytime hours per year between 8 am and 4 pm.

- Spaces where the daylight zone under rooftop monitors is greater than 50 percent of the enclosed space floor area.

**C402.3.2.1 Lighting controls in daylight zones under skylights.** All lighting in the daylight zone shall be controlled by multilevel lighting controls that comply with Section C405.2.2.3.3.

**Exception:** Skylights above daylight zones of enclosed spaces are not required in:

- Buildings in Climate Zones 6 through 8.
- Spaces where the designed *general lighting* power densities are less than 0.5 W/ft<sup>2</sup> (5.4 W/m<sup>2</sup>).
- Areas where it is documented that existing structures or natural objects block direct beam sunlight on at least half of the roof over the enclosed area for more than 1,500 daytime hours per year between 8 am and 4 pm.
- Spaces where the daylight zone under rooftop monitors is greater than 50 percent of the enclosed space floor area.

**C402.3.2.2 Haze factor.** Skylights in office, storage, automotive service, manufacturing, nonrefrigerated warehouse, retail store, and distribution/sorting area spaces shall have a glazing material or diffuser with a measured haze factor greater than 90 percent when tested in accordance with ASTM D 1003.

**Exception:** Skylights designed to exclude direct sunlight entering the occupied space by the use of fixed or automated baffles, or the geometry of skylight and light well need not comply with Section C402.3.2.2.

**C402.3.3 Maximum U-factor and SHGC.** For vertical fenestration, the maximum U-factor and solar heat gain coefficient (SHGC) shall be as specified in Table C402.3, based on the window projection factor. For skylights, the maximum U-factor and solar heat gain coefficient (SHGC) shall be as specified in Table C402.3.

The window projection factor shall be determined in accordance with Equation 4-2.

$$PF = A/B \quad \text{(Equation 4-2)}$$

where:

PF = Projection factor (decimal).

A = Distance measured horizontally from the furthest continuous extremity of any overhang, eave, or permanently attached shading device to the vertical surface of the glazing.

B = Distance measured vertically from the bottom of the glazing to the underside of the overhang, eave, or permanently attached shading device.

Where different windows or glass doors have different PF values, they shall each be evaluated separately.

**C402.3.3.1 SHGC adjustment.** Where the fenestration projection factor for a specific vertical fenestration product is greater than or equal to 0.2, the required maximum SHGC from Table C402.3 shall be adjusted by multiplying the required maximum SHGC by the multiplier specified in Table C402.3.3.1 corresponding with the orientation of the fenestration product and the projection factor.

**TABLE C402.3.3.1  
SHGC ADJUSTMENT MULTIPLIERS**

PROJECTION FACTOR	ORIENTED WITHIN 45 DEGREES OF TRUE NORTH	ALL OTHER ORIENTATION
0.2 ≤ PF < 0.5	1.1	1.2
PF ≤ 0.5	1.2	1.6

**C402.3.3.2 Increased vertical fenestration SHGC.** In Climate Zones 1, 2 and 3, vertical fenestration entirely located not less than 6 feet (1729 mm) above the finished floor shall be permitted a maximum SHGC of 0.40.

**C402.3.3.3 Increased skylight SHGC.** In Climate Zones 1 through 6, skylights shall be permitted a maximum SHGC of 0.60 where located above daylight zones provided with automated daylighting controls.

**C402.3.3.4 Increased skylight U-factor.** Where skylights are installed above daylight zones provided with automatic daylighting controls, a maximum U-factor of 0.9 shall be permitted in Climate Zones 1 through 3; and a maximum U-factor of 0.75 shall be permitted in Climate Zones 4 through 8.

**C402.3.3.5 Dynamic glazing.** For compliance with Section C402.3.3, the SHGC for dynamic glazing shall be determined using the manufacturer's lowest-rated SHGC, and the VT/SHGC ratio shall be determined using the maximum VT and maximum SHGC. Dynamic glazing shall be considered separately from other fenestration, and area-weighted averaging with other fenestration that is not dynamic glazing shall not be permitted.

**C402.3.4 Area-weighted U-factor.** An area-weighted average shall be permitted to satisfy the U-factor requirements for each fenestration product category listed in Table C402.3. Individual fenestration products from different fenestration product categories listed in Table C402.3 shall not be combined in calculating area-weighted average U-factor.

**C402.4 Air leakage (Mandatory).** The thermal envelope of buildings shall comply with Sections C402.4.1 through C402.4.8.

**C402.4.1 Air barriers.** A continuous air barrier shall be provided throughout the building thermal envelope. The air barriers shall be permitted to be located on the inside or outside of the building envelope, located within the assemblies composing the envelope, or any combination thereof. The air barrier shall comply with Sections C402.4.1.1 and C402.4.1.2.

**Exception:** Air barriers are not required in buildings located in Climate Zones 1, 2 and 3.

**C402.4.1.1 Air barrier construction.** The *continuous air barrier* shall be constructed to comply with the following:

1. The air barrier shall be continuous for all assemblies that are the thermal envelope of the building and across the joints and assemblies.
2. Air barrier joints and seams shall be sealed, including sealing transitions in places and changes in materials. Air barrier penetrations shall be sealed in accordance with Section C402.4.2. The joints and seals shall be securely installed in or on the joint for its entire length so as not to dislodge, loosen or otherwise impair its ability to resist positive and negative pressure from wind, stack effect and mechanical ventilation.
3. Recessed lighting fixtures shall comply with Section C404.2.8. Where similar objects are installed which penetrate the air barrier, provisions shall be made to maintain the integrity of the air barrier.

**Exception:** Buildings that comply with Section C402.4.1.2.3 are not required to comply with Items 1 and 3.

**C402.4.1.2 Air barrier compliance options.** A continuous air barrier for the opaque building envelope shall comply with Section C402.4.1.2.1, C402.4.1.2.2, or C402.4.1.2.3.

**C402.4.1.2.1 Materials.** Materials with an air permeability no greater than 0.004 cfm/ft<sup>2</sup> (0.02 L/s · m<sup>2</sup>) under a pressure differential of 0.3 inches water gauge (w.g.) (75 Pa) when tested in accordance with ASTM E 2178 shall comply with this section. Materials in Items 1 through 15 shall be deemed to comply with this section provided joints are sealed and materials are installed as air barriers in accordance with the manufacturer's instructions.

1. Plywood with a thickness of not less than  $\frac{3}{8}$  inch (10 mm).
2. Oriented strand board having a thickness of not less than  $\frac{3}{8}$  inch (10 mm).
3. Extruded polystyrene insulation board having a thickness of not less than  $\frac{1}{2}$  inch (12 mm).
4. Foil-back polyisocyanurate insulation board having a thickness of not less than  $\frac{1}{2}$  inch (12 mm).
5. Closed cell spray foam a minimum density of 1.5 pcf (2.4 kg/m<sup>3</sup>) having a thickness of not less than 1½ inches (36 mm).
6. Open cell spray foam with a density between 0.4 and 1.5 pcf (0.6 and 2.4 kg/m<sup>3</sup>) and having a thickness of not less than 4.5 inches (113 mm).
7. Exterior or interior gypsum board having a thickness of not less than  $\frac{1}{2}$  inch (12 mm).

8. Cement board having a thickness of not less than  $\frac{1}{2}$  inch (12 mm).
9. Built up roofing membrane.
10. Modified bituminous roof membrane.
11. Fully adhered single-ply roof membrane.
12. A Portland cement/sand parge, or gypsum plaster having a thickness of not less than  $\frac{5}{8}$  inch (16 mm).
13. Cast-in-place and precast concrete.
14. Fully grouted concrete block masonry.
15. Sheet steel or aluminum.

**C402.4.1.2.2 Assemblies.** Assemblies of materials and components with an average air leakage not to exceed 0.04 cfm/ft<sup>2</sup> (0.2 L/s · m<sup>2</sup>) under a pressure differential of 0.3 inches of water gauge (w.g.) (75 Pa) when tested in accordance with ASTM E 2357, ASTM E 1677 or ASTM E 283 shall comply with this section. Assemblies listed in Items 1 and 2 shall be deemed to comply provided joints are sealed and requirements of Section C402.4.1.1 are met.

1. Concrete masonry walls coated with one application either of block filler and two applications of a paint or sealer coating;
2. A Portland cement/sand parge, stucco or plaster minimum  $\frac{1}{2}$  inch (12 mm) in thickness.

**C402.4.1.2.3 Building test.** The completed building shall be tested and the air leakage rate of the *building envelope* shall not exceed 0.40 cfm/ft<sup>2</sup> at a pressure differential of 0.3 inches water gauge (2.0 L/s · m<sup>2</sup> at 75 Pa) in accordance with ASTM E 779 or an equivalent method approved by the code official.

**C402.4.2 Air barrier penetrations.** Penetrations of the air barrier and paths of air leakage shall be caulked, gasketed or otherwise sealed in a manner compatible with the construction materials and location. Joints and seals shall be sealed in the same manner or taped or covered with a moisture vapor-permeable wrapping material. Sealing materials shall be appropriate to the construction materials being sealed. The joints and seals shall be securely installed in or on the joint for its entire length so as not to dislodge, loosen or otherwise impair its ability to resist positive and negative pressure from wind, stack effect and mechanical ventilation.

**C402.4.3 Air leakage of fenestration.** The air leakage of fenestration assemblies shall meet the provisions of Table C402.4.3. Testing shall be in accordance with the applicable reference test standard in Table C402.4.3 by an accredited, independent testing laboratory and *labeled* by the manufacturer.

**Exceptions:**

1. Field-fabricated fenestration assemblies that are sealed in accordance with Section C402.4.1.
2. Fenestration in buildings that comply with Section C402.4.1.2.3 are not required to meet the air leakage requirements in Table C402.4.3.

**TABLE C402.4.3  
MAXIMUM AIR INFILTRATION RATE  
FOR FENESTRATION ASSEMBLIES**

FENESTRATION ASSEMBLY	MAXIMUM RATE (CFM/FT <sup>2</sup> )	TEST PROCEDURE
Windows	0.20 <sup>a</sup>	AAMA/WDMA/ CSA101/I.S.2/A440 or NFRC 400
Sliding doors	0.20 <sup>a</sup>	
Swinging doors	0.20 <sup>a</sup>	
Skylights – with condensation weepage openings	0.30	
Skylights – all other	0.20 <sup>a</sup>	NFRC 400 or ASTME 283 at 1.57 psf (75 Pa)
Curtain walls	0.06	
Storefront glazing	0.06	
Commercial glazed swinging entrance doors	1.00	
Revolving doors	1.00	ANSI/DASMA 105, NFRC 400, or ASTME 283 at 1.57 psf (75 Pa)
Garage doors	0.40	
Rolling doors	1.00	

For SI: 1 cubic foot per minute = 0.47L/s, 1 square foot = 0.093 m<sup>2</sup>.

a. The maximum rate for windows, sliding and swinging doors, and skylights is permitted to be 0.3 cfm per square foot of fenestration or door area when tested in accordance with AAMA/WDMA/CSA101/I.S.2/A440 at 6.24 psf (300 Pa).

**C402.4.4 Doors and access openings to shafts, chutes, stairways, and elevator lobbies.** Doors and access openings from conditioned space to shafts, chutes stairways and elevator lobbies shall either meet the requirements of Section C402.4.3 or shall be gasketed, weatherstripped or sealed.

**Exception:** Door openings required to comply with Section 715 or 715.4 of the *International Building Code*; or doors and door openings required by the *International Building Code* to comply with UL 1784 shall not be required to comply with Section C402.4.4.

**C402.4.5 Air intakes, exhaust openings, stairways and shafts.** Stairway enclosures and elevator shaft vents and other outdoor air intakes and exhaust openings integral to the building envelope shall be provided with dampers in accordance with Sections C402.4.5.1 and C402.4.5.2.

**C402.4.5.1 Stairway and shaft vents.** Stairway and shaft vents shall be provided with Class I motorized dampers with a maximum leakage rate of 4 cfm/ft<sup>2</sup> (20.3 L/s · m<sup>2</sup>) at 1.0 inch water gauge (w.g.) (249 Pa) when tested in accordance with AMCA 500D.

Stairway and shaft vent dampers shall be installed with controls so that they are capable of automatically opening upon:

1. The activation of any fire alarm initiating device of the building's fire alarm system; or
2. The interruption of power to the damper.

**C402.4.5.2 Outdoor air intakes and exhausts.** *Outdoor air* supply and exhaust openings shall be provided with Class IA motorized dampers with a maximum

leakage rate of 4 cfm/ft<sup>2</sup> (20.3 L/s · m<sup>2</sup>) at 1.0 inch water gauge (w.g.) (249 Pa) when tested in accordance with AMCA 500D.

**Exceptions:**

1. Gravity (nonmotorized) dampers having a maximum leakage rate of 20 cfm/ft<sup>2</sup> (101.6 L/s · m<sup>2</sup>) at 1.0 inch water gauge (w.g.) (249 Pa) when tested in accordance with AMCA 500D are permitted to be used as follows:
  - 1.1. In buildings for exhaust and relief dampers.
  - 1.2. In buildings less than three stories in height above grade.
  - 1.3. For ventilation air intakes and exhaust and relief dampers in buildings of any height located in Climate Zones 1, 2 and 3.
  - 1.4. Where the design *outdoor air* intake or exhaust capacity does not exceed 300 cfm (141 L/s).

Gravity (nonmotorized) dampers for ventilation air intakes shall be protected from direct exposure to wind.

2. Dampers smaller than 24 inches (610 mm) in either dimension shall be permitted to have a leakage of 40 cfm/ft<sup>2</sup> (203.2 L/s · m<sup>2</sup>) at 1.0 inch water gauge (w.g.) (249 Pa) when tested in accordance with AMCA 500D.

**C402.4.6 Loading dock weatherseals.** Cargo doors and loading dock doors shall be equipped with weatherseals to restrict infiltration when vehicles are parked in the doorway.

**C402.4.7 Vestibules.** All building entrances shall be protected with an enclosed vestibule, with all doors opening into and out of the vestibule equipped with self-closing devices. Vestibules shall be designed so that in passing through the vestibule it is not necessary for the interior and exterior doors to open at the same time. The installation of one or more revolving doors in the building entrance shall not eliminate the requirement that a vestibule be provided on any doors adjacent to revolving doors.

**Exceptions:**

1. Buildings in Climate Zones 1 and 2.
2. Doors not intended to be used by the public, such as doors to mechanical or electrical equipment rooms, or intended solely for employee use.
3. Doors opening directly from a *sleeping unit* or dwelling unit.
4. Doors that open directly from a space less than 3,000 square feet (298 m<sup>2</sup>) in area.
5. Revolving doors.

- Doors used primarily to facilitate vehicular movement or material handling and adjacent personnel doors.

**C402.4.8 Recessed lighting.** Recessed luminaires installed in the *building thermal envelope* shall be sealed to limit air leakage between conditioned and unconditioned spaces. All recessed luminaires shall be IC-rated and *labeled* as having an air leakage rate or not more 2.0 cfm (0.944 L/s) when tested in accordance with ASTM E 283 at a 1.57 psf (75 Pa) pressure differential. All recessed luminaires shall be sealed with a gasket or caulk between the housing and interior wall or ceiling covering.

### SECTION C403 BUILDING MECHANICAL SYSTEMS

**C403.1 General.** Mechanical systems and equipment serving the building heating, cooling or ventilating needs shall comply with Section C403.2 (referred to as the mandatory provisions) and either:

- Section C403.3 (Simple systems); or
- Section C403.4 (Complex systems).

**C403.2 Provisions applicable to all mechanical systems (Mandatory).** Mechanical systems and equipment serving the building heating, cooling or ventilating needs shall comply with Sections C403.2.1 through C403.2.11.

**C403.2.1 Calculation of heating and cooling loads.** Design loads shall be determined in accordance with the procedures described in ANSI/ASHRAE/ACCA Standard 183. The design loads shall account for the building envelope, lighting, ventilation and occupancy loads based on the project design. Heating and cooling loads shall be adjusted to account for load reductions that are achieved where energy recovery systems are utilized in the HVAC system in accordance with the ASHRAE *HVAC Systems and Equipment Handbook*. Alternatively, design loads shall be determined by an *approved* equivalent computation procedure, using the design parameters specified in Chapter 3.

**C403.2.2 Equipment and system sizing.** The output capacity of heating and cooling equipment and systems shall not exceed the loads calculated in accordance with Section C403.2.1. A single piece of equipment providing both heating and cooling shall satisfy this provision for one function with the capacity for the other function as small as possible, within available equipment options.

**Exceptions:**

- Required standby equipment and systems provided with controls and devices that allow such systems or equipment to operate automatically only when the primary equipment is not operating.
- Multiple units of the same equipment type with combined capacities exceeding the design load and provided with controls that have the capability to sequence the operation of each unit based on load.

**C403.2.3 HVAC equipment performance requirements.** Equipment shall meet the minimum efficiency requirements

of Tables C403.2.3(1), C403.2.3(2), C403.2.3(3), C403.2.3(4), C403.2.3(5), C403.2.3(6), C403.2.3(7) and C403.2.3(8) when tested and rated in accordance with the applicable test procedure. Plate-type liquid-to-liquid heat exchangers shall meet the minimum requirements of Table C403.2.3(9). The efficiency shall be verified through certification under an *approved* certification program or, if no certification program exists, the equipment efficiency ratings shall be supported by data furnished by the manufacturer. Where multiple rating conditions or performance requirements are provided, the equipment shall satisfy all stated requirements. Where components, such as indoor or outdoor coils, from different manufacturers are used, calculations and supporting data shall be furnished by the designer that demonstrates that the combined efficiency of the specified components meets the requirements herein.

**C403.2.3.1 Water-cooled centrifugal chilling packages.** Equipment not designed for operation at AHRI Standard 550/590 test conditions of 44°F (7°C) leaving chilled-water temperature and 85°F (29°C) entering condenser water temperature with 3 gpm/ton (0.054 l/s · kW) condenser water flow shall have maximum full-load kW/ton and *NPLV* ratings adjusted using Equations 4-3 and 4-4.

$$\begin{aligned} \text{Adjusted minimum full-load COP ratings} = \\ (\text{Full-load COP from Table 6.8.1C of AHRI} \\ \text{Standard 550/590}) \times K_{adj} \end{aligned} \quad \text{(Equation 4-3)}$$

$$\begin{aligned} \text{Adjusted minimum NPLV rating} = \\ (\text{IPLV from Table 6.8.1C of AHRI Standard} \\ \text{550/590}) \times K_{adj} \end{aligned} \quad \text{(Equation 4-4)}$$

where:

$$\begin{aligned} K_{adj} &= A \times B \\ A &= 0.0000015318 \times (\text{LIFT})^4 - 0.000202076 \times \\ &\quad (\text{LIFT})^3 + 0.0101800 \times (\text{LIFT})^2 - \\ &\quad 0.264958 \times \text{LIFT} + 3.930196 \\ B &= 0.0027 \times L_{vg}^{\text{Evap}} (\text{°C}) + 0.982 \\ \text{LIFT} &= L_{vg}^{\text{Cond}} - L_{vg}^{\text{Evap}} \\ L_{vg}^{\text{Cond}} &= \text{Full-load condenser leaving water} \\ &\quad \text{temperature (°C)} \\ L_{vg}^{\text{Evap}} &= \text{Full-load leaving evaporator temperature} \\ &\quad \text{(°C)} \end{aligned}$$

SI units shall be used in the  $K_{adj}$  equation.

The adjusted full-load and *NPLV* values shall only be applicable for centrifugal chillers meeting all of the following full-load design ranges:

- The leaving evaporator fluid temperature is not less than 36°F (2.2°C).
- The leaving condenser fluid temperature is not greater than 115°F (46.1°C).
- LIFT is not less than 20°F (11.1 °C) and not greater than 80°F (44.4°C).

**Exception:** Centrifugal chillers designed to operate outside of these ranges need not comply with this code.

**TABLE C403.2.3(1)  
MINIMUM EFFICIENCY REQUIREMENTS:  
ELECTRICALLY OPERATED UNITARY AIR CONDITIONERS AND CONDENSING UNITS**

EQUIPMENT TYPE	SIZE CATEGORY	HEATING SECTION TYPE	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY		TEST PROCEDURE <sup>a</sup>	
				Before 6/1/2011	As of 6/1/2011		
Air conditioners, air cooled	< 65,000 Btu/h <sup>b</sup>	All	Split System	13.0 SEER	13.0 SEER	AHRI 210/240	
			Single Package	13.0 SEER	13.0 SEER		
Through-the-wall (air cooled)	≤ 30,000 Btu/h <sup>b</sup>	All	Split system	12.0 SEER	12.0 SEER		
			Single Package	12.0 SEER	12.0 SEER		
Small-duct high-velocity (air cooled)	< 65,000 Btu/h <sup>b</sup>	All	Split System	10.0 SEER	10.0 SEER		
Air conditioners, air cooled	≥ 65,000 Btu/h and < 135,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	11.2 EER 11.4 IEER	11.2 EER 11.4 IEER	AHRI 340/360	
		All other	Split System and Single Package	11.0 EER 11.2 IEER	11.0 EER 11.2 IEER		
	≥ 135,000 Btu/h and < 240,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	11.0 EER 11.2 IEER	11.0 EER 11.2 IEER		
		All other	Split System and Single Package	10.8 EER 11.0 IEER	10.8 EER 11.0 IEER		
	≥ 240,000 Btu/h and < 760,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	10.0 EER 10.1 IEER	10.0 EER 10.1 IEER		
		All other	Split System and Single Package	9.8 EER 9.9 IEER	9.8 EER 9.9 IEER		
	≥ 760,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	9.7 EER 9.8 IEER	9.7 EER 9.8 IEER		
		All other	Split System and Single Package	9.5 EER 9.6 IEER	9.5 EER 9.6 IEER		
	Air conditioners, water cooled	< 65,000 Btu/h <sup>b</sup>	All	Split System and Single Package	12.1 EER 12.3 IEER	12.1 EER 12.3 IEER	AHRI 210/240
		≥ 65,000 Btu/h and < 135,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	11.5 EER 11.7 IEER	12.1 EER 12.3 IEER	AHRI 340/360
			All other	Split System and Single Package	11.3 EER 11.5 IEER	11.9 EER 12.1 IEER	
		≥ 135,000 Btu/h and < 240,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	11.0 EER 11.2 IEER	12.5 EER 12.7 IEER	
All other			Split System and Single Package	10.8 EER 11.0 IEER	12.3 EER 12.5 IEER		
≥ 240,000 Btu/h and < 760,000 Btu/h		Electric Resistance (or None)	Split System and Single Package	11.0 EER 11.1 IEER	12.4 EER 12.6 IEER		
		All other	Split System and Single Package	10.8 EER 10.9 IEER	12.2 EER 12.4 IEER		
≥ 760,000 Btu/h		Electric Resistance (or None)	Split System and Single Package	11.0 EER 11.1 IEER	12.0 EER 12.4 IEER		
		All other	Split System and Single Package	10.8 EER 10.9 IEER	12.0 EER 12.2 IEER		

(continued)

**TABLE C403.2.3(1)—continued  
MINIMUM EFFICIENCY REQUIREMENTS:  
ELECTRICALLY OPERATED UNITARY AIR CONDITIONERS AND CONDENSING UNITS**

EQUIPMENT TYPE	SIZE CATEGORY	HEATING SECTION TYPE	SUB-CATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY		TEST PROCEDURE <sup>a</sup>	
				Before 6/1/2011	As of 6/1/2011		
Air conditioners, evaporatively cooled	< 65,000 Btu/h <sup>b</sup>	All	Split System and Single Package	12.1 EER 12.3 IEER	12.1 EER 12.3 IEER	AHRI 210/240	
	≥ 65,000 Btu/h and < 135,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	11.5 EER 11.7 IEER	12.1 EER 12.3 IEER	AHRI 340/360	
		All other	Split System and Single Package	11.3 EER 11.5 IEER	11.9 EER 12.1 IEER		
	≥ 135,000 Btu/h and < 240,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	11.0 EER 11.2 IEER	12.0 EER 12.2 IEER		
		All other	Split System and Single Package	10.8 EER 11.0 IEER	11.8 EER 12.0 IEER		
	≥ 240,000 Btu/h and < 760,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	11.0 EER 11.1 IEER	11.9 EER 12.1 IEER		
		All other	Split System and Single Package	10.8 EER 10.9 IEER	12.2 EER 11.9 IEER		
	≥ 760,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	10.0 EER 11.1 IEER	11.7 EER 11.9 IEER		
		All other	Split System and Single Package	10.8 EER 10.9 IEER	11.5 EER 11.7 IEER		
	Condensing units, air cooled	≥ 135,000 Btu/h			10.1 EER 11.4 IEER		10.5 EER 14.0 IEER
Condensing units, water cooled	≥ 135,000 Btu/h			13.1 EER 13.6 IEER	13.5 EER 14.0 IEER		
Condensing units, evaporatively cooled	≥ 135,000 Btu/h			13.1 EER 13.6 IEER	13.5 EER 14.0 IEER		

For SI: 1 British thermal unit per hour = 0.2931 W.

- a. Chapter 6 of the referenced standard contains a complete specification of the referenced test procedure, including the reference year version of the test procedure.
- b. Single-phase, air-cooled air conditioners less than 65,000 Btu/h are regulated by NAECA. SEER values are those set by NAECA.

**TABLE C403.2.3(2)**  
**MINIMUM EFFICIENCY REQUIREMENTS:**  
**ELECTRICALLY OPERATED UNITARY AND APPLIED HEAT PUMPS**

EQUIPMENT TYPE	SIZE CATEGORY	HEATING SECTION TYPE	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY	TEST PROCEDURE <sup>a</sup>		
Air cooled (cooling mode)	< 65,000 Btu/h <sup>b</sup>	All	Split System	13.0 SEER	AHRI 210/240		
			Single Packaged	13.0 SEER			
Through-the-wall, air cooled	≤ 30,000 Btu/h <sup>b</sup>	All	Split System	13.0 SEER			
			Single Packaged	13.0 SEER			
Single-duct high-velocity air cooled	< 65,000 Btu/h <sup>b</sup>	All	Split System	10.0 SEER			
Air cooled (cooling mode)	≥ 65,000 Btu/h and < 135,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	11.0 EER 11.2 IEER		AHRI 340/360	
		All other	Split System and Single Package	10.8 EER 11.0 IEER			
	≥ 135,000 Btu/h and < 240,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	10.6 EER 10.7 IEER			
		All other	Split System and Single Package	10.4 EER 10.5 IEER			
	≥ 240,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	9.5 EER 9.6 IEER			
		All other	Split System and Single Package	9.3 EER 9.4 IEER			
	Water source (cooling mode)	< 17,000 Btu/h	All	86°F entering water	11.2 EER		ISO 13256-1
		≥ 17,000 Btu/h and < 65,000 Btu/h	All	86°F entering water	12.0 EER		
≥ 65,000 Btu/h and < 135,000 Btu/h		All	86°F entering water	12.0 EER			
Ground water source (cooling mode)	< 135,000 Btu/h	All	59°F entering water	16.2 EER			
		All	77°F entering water	13.4 EER			
Water-source water to water (cooling mode)	< 135,000 Btu/h	All	86°F entering water	10.6 EER	ISO 13256-2		
			59°F entering water	16.3 EER			
Ground water source Brine to water (cooling mode)	< 135,000 Btu/h	All	77°F entering fluid	12.1 EER			
Air cooled (heating mode)	< 65,000 Btu/h <sup>b</sup>	—	Split System	7.7 HSPF		AHRI 210/240	
		—	Single Package	7.7 HSPF			
Through-the-wall, (air cooled, heating mode)	≤ 30,000 Btu/h <sup>b</sup> (cooling capacity)	—	Split System	7.4 HSPF			
		—	Single Package	7.4 HSPF			
Small-duct high velocity (air cooled, heating mode)	< 65,000 Btu/h <sup>b</sup>	—	Split System	6.8 HSPF			

(continued)

**TABLE C403.2.3(2)—continued  
MINIMUM EFFICIENCY REQUIREMENTS:  
ELECTRICALLY OPERATED UNITARY AND APPLIED HEAT PUMPS**

EQUIPMENT TYPE	SIZE CATEGORY	HEATING SECTION TYPE	SUB-CATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY	TEST PROCEDURE <sup>a</sup>
Air cooled (heating mode)	≥ 65,000 Btu/h and < 135,000 Btu/h (cooling capacity)	—	47°F db/43°F wb Outdoor Air	3.3 COP	AHRI 340/360
			17°F db/15°F wb Outdoor Air	2.25 COP	
	≥ 135,000 Btu/h (cooling capacity)	—	47°F db/43°F wb Outdoor Air	3.2 COP	
			17°F db/15°F wb Outdoor Air	2.05 COP	
Water source (heating mode)	< 135,000 Btu/h (cooling capacity)	—	68°F entering water	4.2 COP	ISO 13256-1
Ground water source (heating mode)	< 135,000 Btu/h (cooling capacity)	—	50°F entering water	3.6 COP	
Ground source (heating mode)	< 135,000 Btu/h (cooling capacity)	—	32°F entering fluid	3.1 COP	
Water-source water to water (heating mode)	< 135,000 Btu/h (cooling capacity)	—	68°F entering water	3.7 COP	ISO 13256-2
		—	50°F entering water	3.1 COP	
Ground source brine to water (heating mode)	< 135,000 Btu/h (cooling capacity)	—	32°F entering fluid	2.5 COP	

For SI: 1 British thermal unit per hour = 0.2931 W, °C = [(°F) - 32]/1.8.

- a. Chapter 6 of the referenced standard contains a complete specification of the referenced test procedure, including the reference year version of the test procedure.
- b. Single-phase, air-cooled air conditioners less than 65,000 Btu/h are regulated by NAECA. SEER values are those set by NAECA.

**TABLE C403.2.3(3)**  
**MINIMUM EFFICIENCY REQUIREMENTS:**  
**ELECTRICALLY OPERATED PACKAGED TERMINAL AIR CONDITIONERS,**  
**PACKAGED TERMINAL HEAT PUMPS, SINGLE-PACKAGE VERTICAL AIR CONDITIONERS,**  
**SINGLE VERTICAL HEAT PUMPS, ROOM AIR CONDITIONERS AND ROOM AIR-CONDITIONER HEAT PUMPS**

EQUIPMENT TYPE	SIZE CATEGORY (INPUT)	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY		TEST PROCEDURE <sup>a</sup>
			Before 10/08/2012	As of 10/08/2012	
PTAC (cooling mode) new construction	All Capacities	95°F db outdoor air	12.5 - (0.213 × Cap/1000) EER	13.8 - (0.300 × Cap/1000) EER	AHRI 310/380
PTAC (cooling mode) replacements <sup>b</sup>	All Capacities	95°F db outdoor air	10.9 - (0.213 × Cap/1000) EER	10.9 - (0.213 × Cap/1000) EER	
PTHP (cooling mode) new construction	All Capacities	95°F db outdoor air	12.3 - (0.213 × Cap/1000) EER	14.0 - (0.300 × Cap/1000) EER	
PTHP (cooling mode) replacements <sup>b</sup>	All Capacities	95°F db outdoor air	10.8 - (0.213 × Cap/1000) EER	10.8 - (0.213 × Cap/1000) EER	
PTHP (heating mode) new construction	All Capacities	—	3.2 - (0.26 × Cap/1000) COP	3.2 - (0.26 × Cap/1000) COP	
PTHP (heating mode) replacements <sup>b</sup>	All Capacities	—	2.9 - (0.26 × Cap/1000) COP	2.9 - (0.26 × Cap/1000) COP	
SPVAC (cooling mode)	< 65,000 Btu/h	95°F db/ 75°F wb outdoor air	9.0 EER	9.0 EER	AHRI 390
	≥ 65,000 Btu/h and < 135,000 Btu/h	95°F db/ 75°F wb outdoor air	8.9 EER	8.9 EER	
	≥ 135,000 Btu/h and < 240,000 Btu/h	95°F db/ 75°F wb outdoor air	8.6 EER	8.6 EER	
SPVHP (cooling mode)	< 65,000 Btu/h	95°F db/ 75°F wb outdoor air	9.0 EER	9.0 EER	
	≥ 65,000 Btu/h and < 135,000 Btu/h	95°F db/ 75°F wb outdoor air	8.9 EER	8.9 EER	
	≥ 135,000 Btu/h and < 240,000 Btu/h	95°F db/ 75°F wb outdoor air	8.6 EER	8.6 EER	
SPVHP (heating mode)	<65,000 Btu/h	47°F db/ 43°F wb outdoor air	3.0 COP	3.0 COP	AHRI 390
	≥ 65,000 Btu/h and < 135,000 Btu/h	47°F db/ 43°F wb outdoor air	3.0 COP	3.0 COP	
	≥ 135,000 Btu/h and < 240,000 Btu/h	47°F db/ 75°F wb outdoor air	2.9 COP	2.9 COP	

*(continued)*

**TABLE C403.2.3(3)—continued  
MINIMUM EFFICIENCY REQUIREMENTS:  
ELECTRICALLY OPERATED PACKAGED TERMINAL AIR CONDITIONERS,  
PACKAGED TERMINAL HEAT PUMPS, SINGLE-PACKAGE VERTICAL AIR CONDITIONERS,  
SINGLE VERTICAL HEAT PUMPS, ROOM AIR CONDITIONERS AND ROOM AIR-CONDITIONER HEAT PUMPS**

EQUIPMENT TYPE	SIZE CATEGORY (INPUT)	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY		TEST PROCEDURE <sup>a</sup>
			Before 10/08/2012	As of 10/08/2012	
Room air conditioners, with louvered slides	< 6,000 Btu/h	—	9.7 SEER	9.7 SEER	ANSI/AHA-MRAC-1
	≥ 6,000 Btu/h and < 8,000 Btu/h	—	9.7 EER	9.7 EER	
	≥ 8,000 Btu/h and < 14,000 Btu/h	—	9.8 EER	9.8 EER	
	≥ 14,000 Btu/h and < 20,000 Btu/h	—	9.7 SEER	9.7 SEER	
	≥ 20,000 Btu/h	—	8.5 EER	8.5 EER	
Room air conditioners, with louvered slides	< 8,000 Btu/h	—	9.0 EER	9.0 EER	
	≥ 8,000 Btu/h and < 20,000 Btu/h	—	8.5 EER	8.5 EER	
	≥ 20,000 Btu/h	—	8.5 EER	8.5 EER	
Room air-conditioner heat pumps with louvered sides	< 20,000 Btu/h	—	9.0 EER	9.0 EER	
	≥ 20,000 Btu/h	—	8.5 EER	8.5 EER	
Room air-conditioner heat pumps without louvered sides	< 14,000 Btu/h	—	8.5 EER	8.5 EER	
	≥ 14,000 Btu/h	—	8.0 EER	8.0 EER	
Room air conditioner casement only	All capacities	—	8.7 EER	8.7 EER	
Room air conditioner casement-slider	All capacities	—	9.5 EER	9.5 EER	

For SI: 1 British thermal unit per hour = 0.2931 W, °C = [(°F) - 32]/1.8.

“Cap” = The rated cooling capacity of the project in Btu/h. If the unit’s capacity is less than 7000 Btu/h, use 7000 Btu/h in the calculation. If the unit’s capacity is greater than 15,000 Btu/h, use 15,000 Btu/h in the calculations.

- a. Chapter 6 of the referenced standard contains a complete specification of the referenced test procedure, including the referenced year version of the test procedure.
- b. Replacement unit shall be factory labeled as follows: “MANUFACTURED FOR REPLACEMENT APPLICATIONS ONLY; NOT TO BE INSTALLED IN NEW CONSTRUCTION PROJECTS.” Replacement efficiencies apply only to units with existing sleeves less than 16 inches (406 mm) in height and less than 42 inches (1067 mm) in width.

**TABLE 403.2.3(4)**  
**WARM AIR FURNACES AND COMBINATION WARM AIR FURNACES/AIR-CONDITIONING UNITS,**  
**WARM AIR DUCT FURNACES AND UNIT HEATERS, MINIMUM EFFICIENCY REQUIREMENTS**

EQUIPMENT TYPE	SIZE CATEGORY (INPUT)	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY <sup>d,e</sup>	TEST PROCEDURE <sup>a</sup>
Warm air furnaces, gas fired	< 225,000 Btu/h	—	78% AFUE or 80% $E_t^c$	DOE 10 CFR Part 430 or ANSI Z21.47
	≥ 225,000 Btu/h	Maximum capacity <sup>c</sup>	80% $E_t^f$	ANSI Z21.47
Warm air furnaces, oil fired	< 225,000 Btu/h	—	78% AFUE or 80% $E_t^c$	DOE 10 CFR Part 430 or UL 727
	≥ 225,000 Btu/h	Maximum capacity <sup>b</sup>	81% $E_t^g$	UL 727
Warm air duct furnaces, gas fired	All capacities	Maximum capacity <sup>b</sup>	80% $E_c$	ANSI Z83.8
Warm air unit heaters, gas fired	All capacities	Maximum capacity <sup>b</sup>	80% $E_c$	ANSI Z83.8
Warm air unit heaters, oil fired	All capacities	Maximum capacity <sup>b</sup>	80% $E_c$	UL 731

For SI: 1 British thermal unit per hour = 0.2931 W.

- a. Chapter 6 of the referenced standard contains a complete specification of the referenced test procedure, including the referenced year version of the test procedure.
- b. Minimum and maximum ratings as provided for and allowed by the unit's controls.
- c. Combination units not covered by the National Appliance Energy Conservation Act of 1987 (NAECA) (3-phase power or cooling capacity greater than or equal to 65,000 Btu/h [19 kW]) shall comply with either rating.
- d.  $E_t$  = Thermal efficiency. See test procedure for detailed discussion.
- e.  $E_c$  = Combustion efficiency (100% less flue losses). See test procedure for detailed discussion.
- f.  $E_c$  = Combustion efficiency. Units must also include an IID, have jackets not exceeding 0.75 percent of the input rating, and have either power venting or a flue damper. A vent damper is an acceptable alternative to a flue damper for those furnaces where combustion air is drawn from the conditioned space.
- g.  $E_t$  = Thermal efficiency. Units must also include an IID, have jacket losses not exceeding 0.75 percent of the input rating, and have either power venting or a flue damper. A vent damper is an acceptable alternative to a flue damper for those furnaces where combustion air is drawn from the conditioned space.

**TABLE C403.2.3(5)**  
**MINIMUM EFFICIENCY REQUIREMENTS: GAS- AND OIL-FIRED BOILERS**

EQUIPMENT TYPE <sup>a</sup>	SUBCATEGORY OR RATING CONDITION	SIZE CATEGORY (INPUT)	MINIMUM EFFICIENCY	TEST PROCEDURE
Boilers, hot water	Gas-fired	< 300,000 Btu/h	80% AFUE	10 CFR Part 430
		≥ 300,000 Btu/h and ≤ 2,500,000 Btu/h <sup>b</sup>	80% $E_t$	10CFR Part 431
		> 2,500,00 Btu/h <sup>a</sup>	82% $E_c$	
	Oil-fired <sup>c</sup>	< 300,000 Btu/h	80% AFUE	10 CFR Part 430
		≥ 300,000 Btu/h and ≤ 2,500,000 Btu/h <sup>b</sup>	82% $E_t$	10 CFR Part 431
		> 2,500,000 Btu/h <sup>a</sup>	84% $E_c$	
Boilers, steam	Gas-fired	< 300,000 Btu/h	75% AFUE	10 CFR Part 430
	Gas-fired- all, except natural draft	≥ 300,000 Btu/h and ≤ 2,500,000 Btu/h <sup>b</sup>	79% $E_t$	10CFR Part 431
		> 2,500,000 Btu/h <sup>a</sup>	79% $E_t$	
		Gas-fired-natural draft	≥ 300,000 Btu/h and ≤ 2,500,000 Btu/h <sup>b</sup>	
	> 2,500,000 Btu/h <sup>a</sup>		77% $E_t$	
	Oil-fired <sup>c</sup>	< 300,000 Btu/h	80% AFUE	10 CFR Part 430
		≥ 300,000 Btu/h and ≤ 2,500,000 Btu/h <sup>b</sup>	81% $E_t$	10CFR Part 431
		> 2,500,000 Btu/h <sup>a</sup>	81% $E_t$	

For SI: 1 British thermal unit per hour = 0.2931 W.

$E_c$  = Combustion efficiency (100 percent less flue losses).  $E_t$  = Thermal efficiency. See referenced standard document for detailed information.

- a. These requirements apply to boilers with rated input of 8,000,000 Btu/h or less that are not packaged boilers and to all packaged boilers. Minimum efficiency requirements for boilers cover all capacities of packaged boilers.
- b. Maximum capacity – minimum and maximum ratings as provided for and allowed by the unit’s controls.
- c. Includes oil-fired (residual).

**TABLE C403.2.3(6)**  
**MINIMUM EFFICIENCY REQUIREMENTS:**  
**CONDENSING UNITS, ELECTRICALLY OPERATED**

EQUIPMENT TYPE	SIZE CATEGORY	MINIMUM EFFICIENCY <sup>b</sup>	TEST PROCEDURE <sup>a</sup>
Condensing units, air cooled	≥ 135,000 Btu/h	10.1 EER 11.2 IPLV	AHRI 365
Condensing units, water or evaporatively cooled	≥ 135,000 Btu/h	13.1 EER 13.1 IPLV	

For SI: 1 British thermal unit per hour = 0.2931 W.

- a. Chapter 6 of the referenced standard contains a complete specification of the referenced test procedure, including the referenced year version of the test procedure.
- b. IPLVs are only applicable to equipment with capacity modulation.

**TABLE C403.2.3(7)  
MINIMUM EFFICIENCY REQUIREMENTS:  
WATER CHILLING PACKAGES<sup>a</sup>**

EQUIPMENT TYPE	SIZE CATEGORY	UNITS	BEFORE 1/1/2010		AS OF 1/1/2010 <sup>b</sup>				TEST PROCEDURE <sup>c</sup>
			FULL LOAD	IPLV	PATH A		PATH B		
					FULL LOAD	IPLV	FULL LOAD	IPLV	
Air-cooled chillers	< 150 tons	EER	≥ 9.562	≥ 10.4 16	≥ 9.562	≥ 12.500	NA	NA	AHRI 550/590
	≥ 150 tons	EER			≥ 9.562	≥ 12.750	NA	NA	
Air cooled without condenser, electrical operated	All capacities	EER	≥ 10.586	≥ 11.782	Air-cooled chillers without condensers shall be rated with matching condensers and comply with the air-cooled chiller efficiency requirements				
Water cooled, electrically operated, reciprocating	All capacities	kW/ton	≤ 0.837	≤ 0.696	Reciprocating units shall comply with water cooled positive displacement efficiency requirements				
Water cooled, electrically operated, positive displacement	< 75 tons	kW/ton	≤ 0.790	≤ 0.676	≤ 0.780	≤ 0.630	≤ 0.800	≤ 0.600	
	≥ 75 tons and < 150 tons	kW/ton			≤ 0.775	≤ 0.615	≤ 0.790	≤ 0.586	
	≥ 150 tons and < 300 tons	kW/ton	≤ 0.717	≤ 0.627	≤ 0.680	≤ 0.580	≤ 0.718	≤ 0.540	
	≥ 300 tons	kW/ton	≤ 0.639	≤ 0.571	≤ 0.620	≤ 0.540	≤ 0.639	≤ 0.490	
Water cooled, electrically operated, centrifugal	< 150 tons	kW/ton	≤ 0.703	≤ 0.669	≤ 0.634	≤ 0.596	≤ 0.639	≤ 0.450	
	≥ 150 tons and < 300 tons	kW/ton	≤ 0.634	≤ 0.596					
	≥ 300 tons and < 600 tons	kW/ton	≤ 0.576	≤ 0.549	≤ 0.576	≤ 0.549	≤ 0.600	≤ 0.400	
	≥ 600 tons	kW/ton	≤ 0.576	≤ 0.549	≤ 0.570	≤ 0.539	≤ 0.590	≤ 0.400	
Air cooled, absorption single effect	All capacities	COP	≥ 0.600	NR	≥ 0.600	NR	NA	NA	AHRI 560
Water cooled, absorption single effect	All capacities	COP	≥ 0.700	NR	≥ 0.700	NR	NA	NA	
Absorption double effect, indirect fired	All capacities	COP	≥ 1.000	≥ 1.050	≥ 1.000	≥ 1.050	NA	NA	
Absorption double effect, direct fired	All capacities	COP	≥ 1.000	≥ 1.000	≥ 1.000	≥ 1.000	NA	NA	

For SI: 1 ton = 3517 W, 1 British thermal unit per hour = 0.2931 W, °C = [(°F) - 32]/1.8.

NA = Not applicable, not to be used for compliance; NR = No requirement.

- a. The centrifugal chiller equipment requirements, after adjustment in accordance with Section C403.2.3.1 or Section C403.2.3.2, do not apply to chillers used in low-temperature applications where the design leaving fluid temperature is less than 36°F. The requirements do not apply to positive displacement chillers with leaving fluid temperatures less than or equal to 32°F. The requirements do not apply to absorption chillers with design leaving fluid temperatures less than 40°F.
- b. Compliance with this standard can be obtained by meeting the minimum requirements of Path A or B. However, both the full load and IPLV shall be met to fulfill the requirements of Path A or B.
- c. Chapter 6 of the referenced standard contains a complete specification of the referenced test procedure, including the referenced year version of the test procedure.

**TABLE C403.2.3(8)**  
**MINIMUM EFFICIENCY REQUIREMENTS:**  
**HEAT REJECTION EQUIPMENT**

EQUIPMENT TYPE <sup>a</sup>	TOTAL SYSTEM HEAT REJECTION CAPACITY AT RATED CONDITIONS	SUBCATEGORY OR RATING CONDITION	PERFORMANCE REQUIRED <sup>b, c, d</sup>	TEST PROCEDURE <sup>e, f</sup>
Propeller or axial fan open circuit cooling towers	All	95°F Entering Water 85°F Leaving Water 75°F Entering wb	≥ 38.2 gpm/hp	CTI ATC-105 and CTI STD-201
Centrifugal fan open circuit cooling towers	All	95°F Entering Water 85°F Leaving Water 75°F Entering wb	≥ 20.0 gpm/hp	CTI ATC-105 and CTI STD-201
Propeller or axial fan closed circuit cooling towers	All	102°F Entering Water 90°F Leaving Water 75°F Entering wb	≥ 14.0 gpm/hp	CTI ATC-105S and CTI STD-201
Centrifugal closed circuit cooling towers	All	102°F Entering Water 90°F Leaving Water 75°F Entering wb	≥ 7.0 gpm/hp	CTI ATC-105S and CTI STD-201
Air-cooled condensers	All	125°F Condensing Temperature R-22 Test Fluid 190°F Entering Gas Temperature 15°F Subcooling 95°F Entering db	≥ 176,000 Btu/h-hp	ARI 460

For SI: °C = [(°F)-32]/1.8, L/s · kW = (gpm/hp)/(11.83), COP = (Btu/h · hp)/(2550.7).

db = dry bulb temperature, °F, wb = wet bulb temperature, °F.

- The efficiencies and test procedures for both open and closed circuit cooling towers are not applicable to hybrid cooling towers that contain a combination of wet and dry heat exchange sections.
- For purposes of this table, open circuit cooling tower performance is defined as the water flow rating of the tower at the thermal rating condition listed in Table 403.2.3(8) divided by the fan nameplate rated motor power.
- For purposes of this table, closed circuit cooling tower performance is defined as the water flow rating of the tower at the thermal rating condition listed in Table 403.2.3(8) divided by the sum of the fan nameplate rated motor power and the spray pump nameplate rated motor power.
- For purposes of this table, air-cooled condenser performance is defined as the heat rejected from the refrigerant divided by the fan nameplate rated motor power.
- Chapter 6 of the referenced standard contains a complete specification of the referenced test procedure, including the referenced year version of the test procedure.
- If a certification program exists for a covered product, and it includes provisions for verification and challenge of equipment efficiency ratings, then the product shall be listed in the certification program, or, if a certification program exists for a covered product, and it includes provisions for verification and challenge of equipment efficiency ratings, but the product is not listed in the existing certification program, the ratings shall be verified by an independent laboratory test report.

**TABLE C403.2.3(9)**  
**HEAT TRANSFER EQUIPMENT**

EQUIPMENT TYPE	SUBCATEGORY	MINIMUM EFFICIENCY	TEST PROCEDURE <sup>a</sup>
Liquid-to-liquid heat exchangers	Plate type	NR	AHRI 400

NR = No Requirement

- Chapter 6 of the referenced standard contains a complete specification of the referenced test procedure, including the referenced year version of the test procedure.

**C403.2.3.2 Positive displacement (air- and water-cooled) chilling packages.** Equipment with a leaving fluid temperature higher than 32°F (0°C), shall meet the requirements of Table C403.2.3(7) when tested or certified with water at standard rating conditions, in accordance with the referenced test procedure.

**C403.2.4 HVAC system controls.** Each heating and cooling system shall be provided with thermostatic controls as specified in Section C403.2.4.1, C403.2.4.2, C403.2.4.3, C403.2.4.4, C403.4.1, C403.4.2, C403.4.3 or C403.4.4.

**C403.2.4.1 Thermostatic controls.** The supply of heating and cooling energy to each zone shall be controlled by individual thermostatic controls capable of responding to temperature within the zone. Where humidification or dehumidification or both is provided, at least one humidity control device shall be provided for each humidity control system.

**Exception:** Independent perimeter systems that are designed to offset only building envelope heat losses

or gains or both serving one or more perimeter *zones* also served by an interior system provided:

1. The perimeter system includes at least one thermostatic control *zone* for each building exposure having exterior walls facing only one orientation (within +/-45 degrees) (0.8 rad) for more than 50 contiguous feet (15 240 mm); and
2. The perimeter system heating and cooling supply is controlled by a thermostat located within the *zones* served by the system.

**C403.2.4.1.1 Heat pump supplementary heat.** Heat pumps having supplementary electric resistance heat shall have controls that, except during defrost, prevent supplementary heat operation where the heat pump can meet the heating load.

**C403.2.4.2 Set point overlap restriction.** Where used to control both heating and cooling, *zone* thermostatic controls shall provide a temperature range or deadband of at least 5°F (2.8°C) within which the supply of heating and cooling energy to the *zone* is capable of being shut off or reduced to a minimum.

**Exception:** Thermostats requiring manual change-over between heating and cooling modes.

**C403.2.4.3 Off-hour controls.** Each *zone* shall be provided with thermostatic setback controls that are controlled by either an automatic time clock or programmable control system.

**Exceptions:**

1. *Zones* that will be operated continuously.
2. *Zones* with a full HVAC load demand not exceeding 6,800 Btu/h (2 kW) and having a readily accessible manual shutoff switch.

**C403.2.4.3.1 Thermostatic setback capabilities.** Thermostatic setback controls shall have 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).

**C403.2.4.3.2 Automatic setback and shutdown capabilities.** Automatic time clock or programmable controls shall be capable of starting and stopping the system for seven different daily schedules per week and retaining their programming and time setting during a loss of power for at least 10 hours. Additionally, the controls shall have a manual override that allows temporary operation of the system for up to 2 hours; a manually operated timer capable of being adjusted to operate the system for up to 2 hours; or an occupancy sensor.

**C403.2.4.3.3 Automatic start capabilities.** Automatic start controls shall be provided for each HVAC system. The controls shall be capable of automatically adjusting the daily start time of the HVAC system in order to bring each space to the desired occupied temperature immediately prior to scheduled occupancy.

**C403.2.4.4 Shutoff damper controls.** Both outdoor air supply and exhaust ducts shall be equipped with motorized dampers that will automatically shut when the systems or spaces served are not in use.

**Exceptions:**

1. Gravity dampers shall be permitted in buildings less than three stories in height.
2. Gravity dampers shall be permitted for buildings of any height located in Climate Zones 1, 2 and 3.
3. Gravity dampers shall be permitted for outside air intake or exhaust airflows of 300 cfm (0.14 m<sup>3</sup>/s) or less.

**C403.2.4.5 Snow melt system controls.** 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 (10°C) and no precipitation is falling and an automatic or manual control that will allow shutoff when the outdoor temperature is above 40°F (4°C) so that the potential for snow or ice accumulation is negligible.

**C403.2.5 Ventilation.** Ventilation, either natural or mechanical, shall be provided in accordance with Chapter 4 of the *International Mechanical Code*. Where mechanical ventilation is provided, the system shall provide the capability to reduce the outdoor air supply to the minimum required by Chapter 4 of the *International Mechanical Code*.

**C403.2.5.1 Demand controlled ventilation.** Demand control ventilation (DCV) shall be provided for spaces larger than 500 square feet (50 m<sup>2</sup>) and with an average occupant load of 25 people per 1000 square feet (93 m<sup>2</sup>) of floor area (as established in Table 403.3 of the *International Mechanical Code*) and served by systems with one or more of the following:

1. An air-side economizer;
2. Automatic modulating control of the outdoor air damper; or
3. A design outdoor airflow greater than 3,000 cfm (1400 L/s).

**Exception:** Demand control ventilation is not required for systems and spaces as follows:

1. Systems with energy recovery complying with Section C403.2.6.
2. Multiple-*zone* systems without direct digital control of individual *zones* communicating with a central control panel.
3. System with a design outdoor airflow less than 1,200 cfm (600 L/s).
4. Spaces where the supply airflow rate minus any makeup or outgoing transfer air requirement is less than 1,200 cfm (600 L/s).
5. Ventilation provided for process loads only.

**C403.2.6 Energy recovery ventilation systems.** Where the supply airflow rate of a fan system exceeds the values specified in Table C403.2.6, the system shall include an energy recovery system. The energy recovery system shall have the capability to provide a change in the enthalpy of the outdoor air supply of not less than 50 percent of the difference between the outdoor air and return air enthalpies, at design conditions. Where an air economizer is required, the energy recovery system shall include a bypass or controls which permit operation of the economizer as required by Section C403.4

**Exception:** An energy recovery ventilation system shall not be required in any of the following conditions:

1. Where energy recovery systems are prohibited by the *International Mechanical Code*.
2. Laboratory fume hood systems that include at least one of the following features:
  - 2.1. Variable-air-volume hood exhaust and room supply systems capable of reducing exhaust and makeup air volume to 50 percent or less of design values.
  - 2.2. Direct makeup (auxiliary) air supply equal to at least 75 percent of the exhaust rate, heated no warmer than 2°F (1.1°C) above room setpoint, cooled to no cooler than 3°F (1.7°C) below room setpoint, no humidification added, and no simultaneous heating and cooling used for dehumidification control.
3. Systems serving spaces that are heated to less than 60°F (15.5°C) and are not cooled.
4. Where more than 60 percent of the outdoor heating energy is provided from site-recovered or site solar energy.
5. Heating energy recovery in Climate Zones 1 and 2.
6. Cooling energy recovery in Climate Zones 3C, 4C, 5B, 5C, 6B, 7 and 8.
7. Systems requiring dehumidification that employ energy recovery in series with the cooling coil.
8. Where the largest source of air exhausted at a single location at the building exterior is less than 75 percent of the design *outdoor air* flow rate.

9. Systems expected to operate less than 20 hours per week at the *outdoor air* percentage covered by Table C403.2.6

**C403.2.7 Duct and plenum insulation and sealing.** All supply and return air ducts and plenums shall be insulated with a minimum of R-6 insulation where located in unconditioned spaces and a minimum of R-8 insulation where located outside the building. Where located within a building envelope assembly, the duct or plenum shall be separated from the building exterior or unconditioned or exempt spaces by a minimum of R-8 insulation.

**Exceptions:**

1. Where located within equipment.
2. Where the design temperature difference between the interior and exterior of the duct or plenum does not exceed 15°F (8°C).

All ducts, air handlers and filter boxes shall be sealed. Joints and seams shall comply with Section 603.9 of the *International Mechanical Code*.

**C403.2.7.1 Duct construction.** Ductwork shall be constructed and erected in accordance with the *International Mechanical Code*.

**C403.2.7.1.1 Low-pressure duct systems.** All longitudinal and transverse joints, seams and connections of supply and return ducts operating at a static pressure less than or equal to 2 inches water gauge (w.g.) (500 Pa) shall be securely fastened and sealed with welds, gaskets, mastics (adhesives), mastic-plus-embedded-fabric systems or tapes installed in accordance with the manufacturer’s installation instructions. Pressure classifications specific to the duct system shall be clearly indicated on the construction documents in accordance with the *International Mechanical Code*.

**Exception:** Continuously welded and locking-type longitudinal joints and seams on ducts operating at static pressures less than 2 inches water gauge (w.g.) (500 Pa) pressure classification.

**C403.2.7.1.2 Medium-pressure duct systems.** All ducts and plenums designed to operate at a static pressure greater than 2 inches water gauge (w.g.) (500 Pa) but less than 3 inches w.g. (750 Pa) shall be insulated and sealed in accordance with Section C403.2.7. Pressure classifications specific to the duct system shall be

**TABLE C403.2.6  
ENERGY RECOVERY REQUIREMENT**

CLIMATE ZONE	PERCENT (%) OUTDOOR AIR AT FULL DESIGN AIRFLOW RATE					
	≥ 30% and < 40%	≥ 40% and < 50%	≥ 50% and < 60%	≥ 60% and < 70%	≥ 70% and < 80%	≥ 80%
	DESIGN SUPPLY FAN AIRFLOW RATE (cfm)					
3B, 3C, 4B, 4C, 5B	NR	NR	NR	NR	≥ 5000	≥ 5000
1B, 2B, 5C	NR	NR	≥ 26000	≥ 12000	≥ 5000	≥ 4000
6B	≥ 11000	≥ 5500	≥ 4500	≥ 3500	≥ 2500	≥ 1500
1A, 2A, 3A, 4A, 5A, 6A	≥ 5500	≥ 4500	≥ 3500	≥ 2000	≥ 1000	> 0
7, 8	≥ 2500	≥ 1000	> 0	> 0	> 0	> 0

NR = not required

clearly indicated on the construction documents in accordance with the *International Mechanical Code*.

**C403.2.7.1.3 High-pressure duct systems.** Ducts designed to operate at static pressures in excess of 3 inches water gauge (w.g.) (750 Pa) shall be insulated and sealed in accordance with Section C403.2.7. In addition, ducts and plenums shall be leak-tested in accordance with the *SMACNA HVAC Air Duct Leakage Test Manual* with the rate of air leakage (CL) less than or equal to 6.0 as determined in accordance with Equation 4-5.

$$CL = F/P^{0.65} \quad \text{(Equation 4-5)}$$

where:

*F* = The measured leakage rate in cfm per 100 square feet of duct surface.

*P* = The static pressure of the test.

Documentation shall be furnished by the designer demonstrating that representative sections totaling at least 25 percent of the duct area have been tested and that all tested sections meet the requirements of this section.

**C403.2.8 Piping insulation.** All piping serving as part of a heating or cooling system shall be thermally insulated in accordance with Table C403.2.8.

**Exceptions:**

1. Factory-installed piping within HVAC equipment tested and rated in accordance with a test procedure referenced by this code.
2. Factory-installed piping within room fan-coils and unit ventilators tested and rated according to

AHRI 440 (except that the sampling and variation provisions of Section 6.5 shall not apply) and 840, respectively.

3. Piping that conveys fluids that have a design operating temperature range between 60°F (15°C) and 105°F (41°C).
4. Piping that conveys fluids that have not been heated or cooled through the use of fossil fuels or electric power.
5. Strainers, control valves, and balancing valves associated with piping 1 inch (25 mm) or less in diameter.
6. Direct buried piping that conveys fluids at or below 60°F (15°C)

**C403.2.8.1 Protection of piping insulation.** Piping insulation exposed to weather shall be protected from damage, including that due to sunlight, moisture, equipment maintenance and wind, and shall provide shielding from solar radiation that can cause degradation of the material. Adhesives tape shall not be permitted.

**C403.2.9 Mechanical systems commissioning and completion requirements.** Mechanical systems shall be commissioned and completed in accordance with Section C408.2.

**C403.2.10 Air system design and control.** Each HVAC system having a total fan system motor nameplate horsepower (hp) exceeding 5 horsepower (hp) (3.7 kW) shall meet the provisions of Sections C403.2.10.1 through C403.2.10.2.

**C403.2.10.1 Allowable fan floor horsepower.** Each HVAC system at fan system design conditions shall not exceed the allowable *fan system motor nameplate hp*

**TABLE C403.2.8  
MINIMUM PIPE INSULATION THICKNESS (thickness in inches)<sup>a</sup>**

FLUID OPERATING TEMPERATURE RANGE AND USAGE (°F)	INSULATION CONDUCTIVITY		NOMINAL PIPE OR TUBE SIZE (inches)				
	Conductivity Btu · in./h · ft <sup>2</sup> · °F <sup>b</sup>	Mean Rating Temperature, °F	< 1	1 to < 1½	1½ to < 4	4 to < 8	≤ 8
> 350	0.32 – 0.34	250	4.5	5.0	5.0	5.0	5.0
251 – 350	0.29 – 0.32	200	3.0	4.0	4.5	4.5	4.5
201 – 250	0.27 – 0.30	150	2.5	2.5	2.5	3.0	3.0
141 – 200	0.25 – 0.29	125	1.5	1.5	2.0	2.0	2.0
105 – 140	0.21 – 0.28	100	1.0	1.0	1.5	1.5	1.5
40 – 60	0.21 – 0.27	75	0.5	0.5	1.0	1.0	1.0
< 40	0.20 – 0.26	75	0.5	1.0	1.0	1.0	1.5

a. For piping smaller than 1½ inch (38 mm) and located in partitions within *conditioned spaces*, reduction of these thicknesses by 1 inch (25 mm) shall be permitted (before thickness adjustment required in footnote b) but not to a thickness less than 1 inch (25 mm).

b. For insulation outside the stated conductivity range, the minimum thickness (*T*) shall be determined as follows:

$$T = r\{(1 + t/r)^{K/k} - 1\}$$

where:

*T* = minimum insulation thickness,

*r* = actual outside radius of pipe,

*t* = insulation thickness listed in the table for applicable fluid temperature and pipe size,

*K* = conductivity of alternate material at mean rating temperature indicated for the applicable fluid temperature (Btu × in/h × ft<sup>2</sup> × °F) and

*k* = the upper value of the conductivity range listed in the table for the applicable fluid temperature.

c. For direct-buried heating and hot water system piping, reduction of these thicknesses by 1½ inches (38 mm) shall be permitted (before thickness adjustment required in footnote b) but not to thicknesses less than 1 inch (25 mm).

(Option 1) or *fan system bhp* (Option 2) as shown in Table C403.2.10.1(1). This includes supply fans, return/relief fans, and fan-powered terminal units associated with systems providing heating or cooling capability. Single *zone* variable-air-volume systems shall comply with the constant volume fan power limitation.

**Exception:** The following fan systems are exempt from allowable fan floor horsepower requirement.

1. Hospital, vivarium and laboratory systems that utilize flow control devices on exhaust and/or return to maintain space pressure relationships necessary for occupant health and safety or environmental control shall be permitted to use variable volume fan power limitation.
2. Individual exhaust fans with motor nameplate horsepower of 1 hp or less.

**C403.2.10.2 Motor nameplate horsepower.** For each fan, the selected fan motor shall be no larger than the first available motor size greater than the brake horsepower

(bhp). The fan brake horsepower (bhp) shall be indicated on the design documents to allow for compliance verification by the *code official*.

**Exceptions:**

1. For fans less than 6 bhp (4413 W), where the first available motor larger than the brake horsepower has a nameplate rating within 50 percent of the bhp, selection of the next larger nameplate motor size is allowed.
2. For fans 6 bhp (4413 W) and larger, where the first available motor larger than the bhp has a nameplate rating within 30 percent of the bhp, selection of the next larger nameplate motor size is allowed.

**C403.2.11 Heating outside a building.** Systems installed to provide heat outside a building shall be radiant systems.

Such heating systems shall be controlled by an occupancy sensing device or a timer switch, so that the system is automatically deenergized when no occupants are present.

**TABLE C403.2.10.1(1)  
FAN POWER LIMITATION**

	LIMIT	CONSTANT VOLUME	VARIABLE VOLUME
Option 1: Fan system motor nameplate hp	Allowable nameplate motor hp	$hp \leq CFM_s \times 0.0011$	$hp \leq CFM_s \times 0.0015$
Option 2: Fan system bhp	Allowable fan system bhp	$bhp \leq CFM_s \times 0.00094 + A$	$bhp \leq CFM_s \times 0.0013 + A$

where:

- CFM<sub>s</sub> = The maximum design supply airflow rate to conditioned spaces served by the system in cubic feet per minute.
- hp = The maximum combined motor nameplate horsepower.
- Bhp = The maximum combined fan brake horsepower.
- A = Sum of  $[PD \times CFM_D / 4131]$

For SI: 1 cfm = 0.471 L/s.

where:

- PD = Each applicable pressure drop adjustment from Table C403.2.10.1(2) in. w.c.
- CFM<sub>D</sub> = The design airflow through each applicable device from Table C403.2.10.1(2) in cubic feet per minute.

For SI: 1 bhp = 735.5 W, 1 hp = 745.5 W.

**TABLE C403.2.10.1(2)  
FAN POWER LIMITATION PRESSURE DROP ADJUSTMENT**

DEVICE	ADJUSTMENT
<b>Credits</b>	
Fully ducted return and/or exhaust air systems	0.5 inch w.c. (2.15 in w.c. for laboratory and vivarium systems)
Return and/or exhaust air flow control devices	0.5 inch w.c.
Exhaust filters, scrubbers, or other exhaust treatment.	The pressure drop of device calculated at fan system design condition
Particulate filtration credit: MERV 9 thru 12	0.5 inch w.c.
Particulate filtration credit: MERV 13 thru 15	0.9 inch. w.c.
Particulate filtration credit: MERV 16 and greater and electronically enhanced filters	Pressure drop calculated at 2x clean filter pressure drop at fan system design condition.
Carbon and other gas-phase air cleaners	Clean filter pressure drop at fan system design condition.
Biosafety cabinet	Pressure drop of device at fan system design condition.
Energy recovery device, other than coil runaround loop	$(2.2 \times \text{energy recovery effectiveness}) - 0.5$ inch w.c. for each airstream
Coil runaround loop	0.6 inch w.c. for each airstream
Evaporative humidifier/cooler in series with another cooling coil	Pressure drop of device at fan system design conditions
Sound attenuation section	0.15 inch w.c.
Exhaust system serving fume hoods	0.35 inch w.c.
Laboratory and vivarium exhaust systems in high-rise buildings	0.25 inch w.c./100 feet of vertical duct exceeding 75 feet

w.c. = water column

For SI: 1 inch w.c. = 249 Pa, 1 inch = 25.4 mm.

**C403.3 Simple HVAC systems and equipment (Prescriptive).** This section applies to buildings served by unitary or packaged HVAC equipment listed in Tables C403.2.3(1) through C403.2.3(8), each serving one *zone* and controlled by a single thermostat in the *zone* served. It also applies to two-pipe heating systems serving one or more *zones*, where no cooling system is installed.

**C403.3.1 Economizers.** Each cooling system that has a fan shall include either an air or water economizer meeting the requirements of Sections C403.3.1.1 through C403.3.1.1.4.

**Exception:** Economizers are not required for the systems listed below.

1. Individual fan-cooling units with a supply capacity less than the minimum listed in Table C403.3.1(1).
2. Where more than 25 percent of the air designed to be supplied by the system is to spaces that are designed to be humidified above 35°F (1.7 °C) dew-point temperature to satisfy process needs.
3. Systems that serve *residential* spaces where the system capacity is less than five times the requirement listed in Table C403.3.1(1).
4. Systems expected to operate less than 20 hours per week.
5. Where the use of *outdoor air* for cooling will affect supermarket open refrigerated casework systems.
6. Where the cooling *efficiency* meets or exceeds the *efficiency* requirements in Table C403.3.1(2).

**TABLE C403.3.1(1)  
ECONOMIZER REQUIREMENTS**

CLIMATE ZONES	ECONOMIZER REQUIREMENT
1A, 1B	No requirement
2A, 2B, 3A, 3B, 3C, 4A, 4B, 4C, 5A, 5B, 5C, 6A, 6B, 7, 8	Economizers on all cooling systems $\geq 33,000$ Btu/h <sup>a</sup>

For SI: 1 British thermal unit per hour = 0.2931 W.

a. The total capacity of all systems without economizers shall not exceed 300,000 Btu/h per *building*, or 20 percent of its air economizer capacity, whichever is greater.

**TABLE C403.3.1(2)  
EQUIPMENT EFFICIENCY PERFORMANCE  
EXCEPTION FOR ECONOMIZERS**

CLIMATE ZONES	COOLING EQUIPMENT PERFORMANCE IMPROVEMENT (EER OR IPLV)
2B	10% Efficiency Improvement
3B	15% Efficiency Improvement
4B	20% Efficiency Improvement

**C403.3.1.1 Air economizers.** Air economizers shall comply with Sections C403.3.1.1.1 through C403.3.1.1.4.

**C403.3.1.1.1 Design capacity.** Air economizer systems shall be capable of modulating *outdoor air* and

return air dampers to provide up to 100 percent of the design supply air quantity as *outdoor air* for cooling.

**C403.3.1.1.2 Control signal.** Economizer dampers shall be capable of being sequenced with the mechanical cooling equipment and shall not be controlled by only mixed air temperature.

**Exception:** The use of mixed air temperature limit control shall be permitted for systems controlled from space temperature (such as single-*zone* systems).

**C403.3.1.1.3 High-limit shutoff.** Air economizers shall be capable of automatically reducing *outdoor air* intake to the design minimum *outdoor air* quantity when *outdoor air* intake will no longer reduce cooling energy usage. High-limit shutoff control types for specific climates shall be chosen from Table C403.3.1.1.3(1). High-limit shutoff control settings for these control types shall be those specified in Table C403.3.1.1.3(2).

**C403.3.1.1.4 Relief of excess outdoor air.** Systems shall be capable of relieving excess *outdoor air* during air economizer operation to prevent over-pressurizing the building. The relief air outlet shall be located to avoid recirculation into the building.

**C403.3.2 Hydronic system controls.** Hydronic systems of at least 300,000 Btu/h (87 930 W) design output capacity supplying heated and chilled water to comfort conditioning systems shall include controls that meet the requirements of Section C403.4.3.

**C403.4 Complex HVAC systems and equipment. (Prescriptive).** This section applies to buildings served by HVAC equipment and systems not covered in Section C403.3.

**C403.4.1 Economizers.** Economizers shall comply with Sections C403.4.1.1 through C403.4.1.4.

**C403.4.1.1 Design capacity.** Water economizer systems shall be capable of cooling supply air by indirect evaporation and providing up to 100 percent of the expected system cooling load at *outdoor air* temperatures of 50°F dry bulb (10°C dry bulb)/45°F wet bulb (7.2°C wet bulb) and below.

**Exception:** Systems in which a water economizer is used and where dehumidification requirements cannot be met using outdoor air temperatures of 50°F dry bulb (10°C dry bulb)/45°F wet bulb (7.2°C wet bulb) shall satisfy 100 percent of the expected system cooling load at 45°F dry bulb (7.2°C dry bulb)/40°F wet bulb (4.5°C wet bulb).

**C403.4.1.2 Maximum pressure drop.** Precooling coils and water-to-water heat exchangers used as part of a water economizer system shall either have a water-side pressure drop of less than 15 feet (4572 mm) of water or a secondary loop shall be created so that the coil or heat exchanger pressure drop is not seen by the circulating pumps when the system is in the normal cooling (noneconomizer) mode.

**TABLE C403.3.1.1.3(1)  
HIGH-LIMIT SHUTOFF CONTROL OPTIONS FOR AIR ECONOMIZERS**

CLIMATE ZONES	ALLOWED CONTROL TYPES	PROHIBITED CONTROL TYPES
1B, 2B, 3B, 3C, 4B, 4C, 5B, 5C, 6B, 7, 8	Fixed dry bulb Differential dry bulb Electronic enthalpy <sup>a</sup> Differential enthalpy Dew-point and dry-bulb temperatures	Fixed enthalpy
1A, 2A, 3A, 4A	Fixed dry bulb Fixed enthalpy Electronic enthalpy <sup>a</sup> Differential enthalpy Dew-point and dry-bulb temperatures	Differential dry bulb
All other climates	Fixed dry bulb Differential dry bulb Fixed enthalpy Electronic enthalpy <sup>a</sup> Differential enthalpy Dew-point and dry-bulb temperatures	—

a. Electronic enthalpy controllers are devices that use a combination of humidity and dry-bulb temperature in their switching algorithm.

**TABLE C403.3.1.1.3(2)  
HIGH-LIMIT SHUTOFF CONTROL SETTING FOR AIR ECONOMIZERS**

DEVICE TYPE	CLIMATE ZONE	REQUIRED HIGH LIMIT (ECONOMIZER OFF WHEN):	
		EQUATION	DESCRIPTION
Fixed dry bulb	1B, 2B, 3B, 3C, 4B, 4C, 5B, 5C, 6B, 7, 8	$T_{OA} > 75^{\circ}\text{F}$	Outdoor air temperature exceeds 75°F
	5A, 6A, 7A	$T_{OA} > 70^{\circ}\text{F}$	Outdoor air temperature exceeds 70°F
	All other zones	$T_{OA} > 65^{\circ}\text{F}$	Outdoor air temperature exceeds 65°F
Differential dry bulb	1B, 2B, 3B, 3C, 4B, 4C, 5A, 5B, 5C, 6A, 6B, 7, 8	$T_{OA} > T_{RA}$	Outdoor air temperature exceeds return air temperature
Fixed enthalpy	All	$h_{OA} > 28 \text{ Btu/lb}^a$	Outdoor air enthalpy exceeds 28 Btu/lb of dry air <sup>a</sup>
Electronic Enthalpy	All	$(T_{OA}, RH_{OA}) > A$	Outdoor air temperature/RH exceeds the "A" setpoint curve <sup>b</sup>
Differential enthalpy	All	$h_{OA} > h_{RA}$	Outdoor air enthalpy exceeds return air enthalpy
Dew-point and dry bulb temperatures	All	$DP_{OA} > 55^{\circ}\text{F}$ or $T_{OA} > 75^{\circ}\text{F}$	Outdoor air dry bulb exceeds 75°F or outside dew point exceeds 55°F (65 gr/lb)

For SI: °C = (°F - 32) × 5/9, 1 Btu/lb = 2.33 kJ/kg.

- a. At altitudes substantially different than sea level, the Fixed Enthalpy limit shall be set to the enthalpy value at 75°F and 50-percent relative humidity. As an example, at approximately 6,000 feet elevation the fixed enthalpy limit is approximately 30.7 Btu/lb.
- b. Setpoint "A" corresponds to a curve on the psychrometric chart that goes through a point at approximately 75°F and 40-percent relative humidity and is nearly parallel to dry-bulb lines at low humidity levels and nearly parallel to enthalpy lines at high humidity levels.

**C403.4.1.3 Integrated economizer control.** Economizer systems shall be integrated with the mechanical cooling system and be capable of providing partial cooling even where additional mechanical cooling is required to meet the remainder of the cooling load.

**Exceptions:**

1. Direct expansion systems that include controls that reduce the quantity of *outdoor air* required to prevent coil frosting at the lowest step of compressor unloading, provided this lowest step is no greater than 25 percent of the total system capacity.
2. Individual direct expansion units that have a rated cooling capacity less than 54,000 Btu/h (15 827 W) and use nonintegrated economizer controls that preclude simultaneous operation of the economizer and mechanical cooling.

**C403.4.1.4 Economizer heating system impact.** HVAC system design and economizer controls shall be such that economizer operation does not increase the building heating energy use during normal operation.

**Exception:** Economizers on VAV systems that cause *zone* level heating to increase due to a reduction in supply air temperature.

**C403.4.2 Variable air volume (VAV) fan control.** Individual VAV fans with motors of 7.5 horsepower (5.6 kW) or greater shall be:

1. Driven by a mechanical or electrical variable speed drive;
2. Driven by a vane-axial fan with variable-pitch blades; or
3. The fan shall have controls or devices that will result in fan motor demand of no more than 30 percent of their design wattage at 50 percent of design airflow when static pressure set point equals one-third of the total design static pressure, based on manufacturer's certified fan data.

**C403.4.2.1 Static pressure sensor location.** Static pressure sensors used to control VAV fans shall be placed in a position such that the controller setpoint is no greater than one-third the total design fan static pressure, except for systems with *zone* reset control complying with Section C403.4.2.2. For sensors installed down-stream of major duct splits, at least one sensor shall be located on each major branch to ensure that static pressure can be maintained in each branch.

**C403.4.2.2 Set points for direct digital control.** For systems with direct digital control of individual *zone* boxes reporting to the central control panel, the static pressure set point shall be reset based on the *zone* requiring the most pressure, i.e., the set point is reset lower until one *zone* damper is nearly wide open.

**C403.4.3 Hydronic systems controls.** The heating of fluids that have been previously mechanically cooled and the cooling of fluids that have been previously mechanically heated shall be limited in accordance with Sections

C403.4.3.1 through C403.4.3.3. Hydronic heating systems comprised of multiple-packaged boilers and designed to deliver conditioned water or steam into a common distribution system shall include automatic controls capable of sequencing operation of the boilers. Hydronic heating systems comprised of a single boiler and greater than 500,000 Btu/h (146 550 W) input design capacity shall include either a multistaged or modulating burner.

**C403.4.3.1 Three-pipe system.** Hydronic systems that use a common return system for both hot water and chilled water are prohibited.

**C403.4.3.2 Two-pipe changeover system.** Systems that use a common distribution system to supply both heated and chilled water shall be designed to allow a dead band between changeover from one mode to the other of at least 15°F (8.3°C) outside air temperatures; be designed to and provided with controls that will allow operation in one mode for at least 4 hours before changing over to the other mode; and be provided with controls that allow heating and cooling supply temperatures at the changeover point to be no more than 30°F (16.7°C) apart.

**C403.4.3.3 Hydronic (water loop) heat pump systems.** Hydronic heat pump systems shall comply with Sections C403.4.3.3.1 through C403.4.3.3.3.

**C403.4.3.3.1 Temperature dead band.** Hydronic heat pumps connected to a common heat pump water loop with central devices for heat rejection and heat addition shall have controls that are capable of providing a heat pump water supply temperature dead band of at least 20°F (11.1°C) between initiation of heat rejection and heat addition by the central devices.

**Exception:** Where a system loop temperature optimization controller is installed and can determine the most efficient operating temperature based on realtime conditions of demand and capacity, dead bands of less than 20°F (11°C) shall be permitted.

**C403.4.3.3.2 Heat rejection.** Heat rejection equipment shall comply with Sections C403.4.3.3.2.1 and C403.4.3.3.2.2.

**Exception:** Where it can be demonstrated that a heat pump system will be required to reject heat throughout the year.

**C403.4.3.3.2.1 Climate Zones 3 and 4.** For Climate Zones 3 and 4:

1. If a closed-circuit cooling tower is used directly in the heat pump loop, either an automatic valve shall be installed to bypass all but a minimal flow of water around the tower, or lower leakage positive closure dampers shall be provided.
2. If an open-circuit tower is used directly in the heat pump loop, an automatic valve shall be installed to bypass all heat pump water flow around the tower.

3. If an open- or closed-circuit cooling tower is used in conjunction with a separate heat exchanger to isolate the cooling tower from the heat pump loop, then heat loss shall be controlled by shutting down the circulation pump on the cooling tower loop.

**C403.4.3.3.2 Climate Zones 5 through 8.** For Climate Zones 5 through 8, if an open- or closed-circuit cooling tower is used, then a separate heat exchanger shall be provided to isolate the cooling tower from the heat pump loop, and heat loss shall be controlled by shutting down the circulation pump on the cooling tower loop and providing an automatic valve to stop the flow of fluid.

**C403.4.3.3.3 Two position valve.** Each hydronic heat pump on the hydronic system having a total pump system power exceeding 10 horsepower (hp) (7.5 kW) shall have a two-position valve.

**C403.4.3.4 Part load controls.** Hydronic systems greater than or equal to 300,000 Btu/h (87 930 W) in design output capacity supplying heated or chilled water to comfort conditioning systems shall include controls that have the capability to:

1. Automatically reset the supply-water temperatures using zone-return water temperature, building-return water temperature, or outside air temperature as an indicator of building heating or cooling demand. The temperature shall be capable of being reset by at least 25 percent of the design supply-to-return water temperature difference; or
2. Reduce system pump flow by at least 50 percent of design flow rate utilizing adjustable speed drive(s) on pump(s), or multiple-staged pumps where at least one-half of the total pump horsepower is capable of being automatically turned off or control valves designed to modulate or step down, and close, as a function of load, or other approved means.

**C403.4.3.5 Pump isolation.** Chilled water plants including more than one chiller shall have the capability to reduce flow automatically through the chiller plant when a chiller is shut down. Chillers piped in series for the purpose of increased temperature differential shall be considered as one chiller.

Boiler plants including more than one boiler shall have the capability to reduce flow automatically through the boiler plant when a boiler is shut down.

**C403.4.4 Heat rejection equipment fan speed control.** Each fan powered by a motor of 7.5 hp (5.6 kW) or larger shall have the capability to operate that fan at two-thirds of full speed or less, and shall have controls that automatically change the fan speed to control the leaving fluid tem-

perature or condensing temperature/pressure of the heat rejection device.

**Exception:** Factory-installed heat rejection devices within HVAC equipment tested and rated in accordance with Tables C403.2.3(6) and C403.2.3(7).

**C403.4.5 Requirements for complex mechanical systems serving multiple zones.** Sections C403.4.5.1 through C403.4.5.3 shall apply to complex mechanical systems serving multiple zones. Supply air systems serving multiple zones shall be VAV systems which, during periods of occupancy, are designed and capable of being controlled to reduce primary air supply to each zone to one of the following before reheating, recooling or mixing takes place:

1. Thirty percent of the maximum supply air to each zone.
2. Three hundred cfm (142 L/s) or less where the maximum flow rate is less than 10 percent of the total fan system supply airflow rate.
3. The minimum ventilation requirements of Chapter 4 of the *International Mechanical Code*.

**Exception:** The following define where individual zones or where entire air distribution systems are exempted from the requirement for VAV control:

1. Zones where special pressurization relationships or cross-contamination requirements are such that VAV systems are impractical.
2. Zones or supply air systems where at least 75 percent of the energy for reheating or for providing warm air in mixing systems is provided from a site-recovered or site-solar energy source.
3. Zones where special humidity levels are required to satisfy process needs.
4. Zones with a peak supply air quantity of 300 cfm (142 L/s) or less and where the flow rate is less than 10 percent of the total fan system supply airflow rate.
5. Zones where the volume of air to be reheated, re-cooled or mixed is no greater than the volume of outside air required to meet the minimum ventilation requirements of Chapter 4 of the *International Mechanical Code*.
6. Zones or supply air systems with thermostatic and humidistatic controls capable of operating in sequence the supply of heating and cooling energy to the zones and which are capable of preventing reheating, recooling, mixing or simultaneous supply of air that has been previously cooled, either mechanically or through the use of economizer systems, and air that has been previously mechanically heated.

**C404.6 Hot water system controls.** Circulating hot water system pumps or heat trace shall be arranged to be turned off either automatically or manually when there is limited hot water demand. Ready access shall be provided to the operating controls.

**C404.7 Pools and inground permanently installed spas (Mandatory).** Pools and inground permanently installed spas shall comply with Sections C404.7.1 through C404.7.3.

**C404.7.1 Heaters.** All heaters shall be equipped with a readily *accessible* on-off switch that is mounted outside of the heater to allow shutting off the heater without adjusting the thermostat setting. Gas-fired heaters shall not be equipped with constant burning pilot lights.

**C404.7.2 Time switches.** Time switches or other control method that can automatically turn off and on heaters and pumps according to a preset schedule shall be installed on all heaters and pumps. Heaters, pumps and motors that have built in timers shall be deemed in compliance with this requirement.

**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.

**C404.7.3 Covers.** Heated pools and inground permanently installed spas shall be provided with a vapor-retardant cover.

**Exception:** A vapor-retardant cover is not required for pools deriving over 70 percent of the energy for heating from site-recovered energy, such as a heat pump or solar energy source computed over an operating season.

**SECTION C405  
ELECTRICAL POWER AND LIGHTING SYSTEMS  
(MANDATORY)**

**C405.1 General (Mandatory).** This section covers lighting system controls, the connection of ballasts, the maximum lighting power for interior applications, electrical energy consumption, and minimum acceptable lighting equipment for exterior applications.

**Exception:** Dwelling units within commercial buildings shall not be required to comply with Sections C405.2 through C405.5 provided that not less than 75 percent of the permanently installed light fixtures, other than low-voltage lighting, shall be fitted for, and contain only, high efficacy lamps.

**C405.2 Lighting controls (Mandatory).** Lighting systems shall be provided with controls as specified in Sections C405.2.1, C405.2.2, C405.2.3 and C405.2.4.

**C405.2.1 Manual lighting controls.** All buildings shall include manual lighting controls that meet the requirements of Sections C405.2.1.1 and C405.2.1.2.

**C405.2.1.1 Interior lighting controls.** Each area enclosed by walls or floor-to-ceiling partitions shall have at least one manual control for the lighting serving

that area. The required controls shall be located within the area served by the controls or be a remote switch that identifies the lights served and indicates their status.

**Exceptions:**

1. Areas designated as security or emergency areas that need to be continuously lighted.
2. Lighting in stairways or corridors that are elements of the means of egress.

**C405.2.1.2 Light reduction controls.** Each area that is required to have a manual control shall also allow the occupant to reduce the connected lighting load in a reasonably uniform illumination pattern by at least 50 percent. Lighting reduction shall be achieved by one of the following or other *approved* method:

1. Controlling all lamps or luminaires;
2. Dual switching of alternate rows of luminaires, alternate luminaires or alternate lamps;
3. Switching the middle lamp luminaires independently of the outer lamps; or
4. Switching each luminaire or each lamp.

**Exception:** Light reduction controls need not be provided in the following areas and spaces:

1. Areas that have only one luminaire, with rated power less than 100 watts.
2. Areas that are controlled by an occupant-sensing device.
3. Corridors, equipment rooms, storerooms, restrooms, public lobbies, electrical or mechanical rooms.
4. *Sleeping unit* (see Section C405.2.3).
5. Spaces that use less than 0.6 watts per square foot (6.5 W/m<sup>2</sup>).
6. Daylight spaces complying with Section C405.2.2.3.2.

**C405.2.2 Additional lighting controls.** Each area that is required to have a manual control shall also have controls that meet the requirements of Sections C405.2.2.1, C405.2.2.2 and C405.2.2.3.

**Exception:** Additional lighting controls need not be provided in the following spaces:

1. *Sleeping units*.
2. Spaces where patient care is directly provided.
3. Spaces where an automatic shutoff would endanger occupant safety or security.
4. Lighting intended for continuous operation.

**C405.2.2.1 Automatic time switch control devices.** Automatic time switch controls shall be installed to control lighting in all areas of the building.

**Exceptions:**

1. Emergency egress lighting does not need to be controlled by an automatic time switch.

2. Lighting in spaces controlled by occupancy sensors does not need to be controlled by automatic time switch controls.

The automatic time switch control device shall include an override switching device that complies with the following:

1. The override switch shall be in a readily accessible location;
2. The override switch shall be located where the lights controlled by the switch are visible; or the switch shall provide a mechanism which announces the area controlled by the switch;
3. The override switch shall permit manual operation;
4. The override switch, when initiated, shall permit the controlled lighting to remain on for a maximum of 2 hours; and
5. Any individual override switch shall control the lighting for a maximum area of 5,000 square feet (465 m<sup>2</sup>).

**Exception:** Within malls, arcades, auditoriums, single tenant retail spaces, industrial facilities and arenas:

1. The time limit shall be permitted to exceed 2 hours provided the override switch is a captive key device; and
2. The area controlled by the override switch is permitted to exceed 5,000 square feet (465 m<sup>2</sup>), but shall not exceed 20,000 square feet (1860 m<sup>2</sup>).

**C405.2.2.2 Occupancy sensors.** Occupancy sensors shall be installed in all classrooms, conference/meeting rooms, employee lunch and break rooms, private offices, restrooms, storage rooms and janitorial closets, and other spaces 300 square feet (28 m<sup>2</sup>) or less enclosed by floor-to-ceiling height partitions. These automatic control devices shall be installed to automatically turn off lights within 30 minutes of all occupants leaving the space, and shall either be manual on or shall be controlled to automatically turn the lighting on to not more than 50 percent power.

**Exception:** Full automatic-on controls shall be permitted to control lighting in public corridors, stairways, restrooms, primary building entrance areas and lobbies, and areas where manual-on operation would endanger the safety or security of the room or building occupants

**C405.2.2.3 Daylight zone control.** Daylight zones shall be designed such that lights in the daylight zone are controlled independently of general area lighting and are controlled in accordance with either Section C405.2.2.3.1 or Section C405.2.2.3.2. Each daylight control zone shall not exceed 2,500 square feet (232 m<sup>2</sup>). Contiguous daylight zones adjacent to vertical fenestration are allowed to be controlled by a single con-

trolling device provided that they do not include zones facing more than two adjacent cardinal orientations (i.e., north, east, south, west). Daylight zones under skylights more than 15 feet (4572 mm) from the perimeter shall be controlled separately from daylight zones adjacent to vertical fenestration.

**Exception:** Daylight zones enclosed by walls or ceiling height partitions and containing two or fewer light fixtures are not required to have a separate switch for general area lighting.

**C405.2.2.3.1 Manual daylighting controls.** Manual controls shall be installed in daylight zones unless automatic controls are installed in accordance with Section C405.2.2.3.2.

**C405.2.2.3.2 Automatic daylighting controls.** Set-point and other controls for calibrating the lighting control device shall be readily accessible.

Daylighting controls device shall be capable of automatically reducing the lighting power in response to available daylight by either one of the following methods:

1. Continuous dimming using dimming ballasts and daylight-sensing automatic controls that are capable of reducing the power of general lighting in the daylit zone continuously to less than 35 percent of rated power at maximum light output.
2. Stepped dimming using multi-level switching and daylight-sensing controls that are capable of reducing lighting power automatically. The system shall provide a minimum of two control channels per zone and be installed in a manner such that at least one control step is between 50 percent and 70 percent of design lighting power and another control step is no greater than 35 percent of design power.

**C405.2.2.3.3 Multi-level lighting controls.** Where multi-level lighting controls are required by this code, the general lighting in the daylight zone shall be separately controlled by at least one multi-level lighting control that reduces the lighting power in response to daylight available in the space. Where the daylit illuminance in the space is greater than the rated illuminance of the general lighting of daylight zones, the general lighting shall be automatically controlled so that its power draw is no greater than 35 percent of its rated power. The multi-level lighting control shall be located so that calibration and set point adjustment controls are readily accessible and separate from the light sensor.

**C405.2.3 Specific application controls.** Specific application controls shall be provided for the following:

1. Display and accent light shall be controlled by a dedicated control which is independent of the controls for other lighting within the room or space.

2. Lighting in cases used for display case purposes shall be controlled by a dedicated control which is independent of the controls for other lighting within the room or space.
3. Hotel and motel sleeping units and guest suites shall have a master control device at the main room entry that controls all permanently installed luminaires and switched receptacles.
4. Supplemental task lighting, including permanently installed under-shelf or under-cabinet lighting, shall have a control device integral to the luminaires or be controlled by a wall-mounted control device provided the control device is readily accessible.
5. Lighting for nonvisual applications, such as plant growth and food warming, shall be controlled by a dedicated control which is independent of the controls for other lighting within the room or space.
6. Lighting equipment that is for sale or for demonstrations in lighting education shall be controlled by a dedicated control which is independent of the controls for other lighting within the room or space.

**C405.2.4 Exterior lighting controls.** Lighting not designated for dusk-to-dawn operation shall be controlled by either a combination of a photosensor and a time switch, or an astronomical time switch. Lighting designated for dusk-to-dawn operation shall be controlled by an astronomical time switch or photosensor. All time switches shall be capable of retaining programming and the time setting during loss of power for a period of at least 10 hours.

**C405.3 Tandem wiring (Mandatory).** The following luminaires located within the same area shall be tandem wired:

1. Fluorescent luminaires equipped with one, three or odd-numbered lamp configurations, that are recess-mounted within 10 feet (3048 mm) center-to-center of each other.
2. Fluorescent luminaires equipped with one, three or any odd-numbered lamp configuration, that are pendant- or surface-mounted within 1 foot (305 mm) edge-to-edge of each other.

**Exceptions:**

1. Where electronic high-frequency ballasts are used.
2. Luminaires on emergency circuits.
3. Luminaires with no available pair in the same area.

**C405.4 Exit signs (Mandatory).** Internally illuminated exit signs shall not exceed 5 watts per side.

**C405.5 Interior lighting power requirements (Prescriptive).** A building complies with this section if its total connected lighting power calculated under Section C405.5.1 is no greater than the interior lighting power calculated under Section C405.5.2.

**C405.5.1 Total connected interior lighting power.** The total connected interior lighting power (watts) shall be the sum of the watts of all interior lighting equipment as deter-

mined in accordance with Sections C405.5.1.1 through C405.5.1.4.

**Exceptions:**

1. The connected power associated with the following lighting equipment is not included in calculating total connected lighting power.
  - 1.1. Professional sports arena playing field lighting.
  - 1.2. *Sleeping unit* lighting in hotels, motels, boarding houses or similar buildings.
  - 1.3. Emergency lighting automatically off during normal building operation.
  - 1.4. Lighting in spaces specifically designed for use by occupants with special lighting needs including the visually impaired visual impairment and other medical and age-related issues.
  - 1.5. Lighting in interior spaces that have been specifically designated as a registered interior historic landmark.
  - 1.6. Casino gaming areas.
2. Lighting equipment used for the following shall be exempt provided that it is in addition to general lighting and is controlled by an independent control device:
  - 2.1. Task lighting for medical and dental purposes.
  - 2.2. Display lighting for exhibits in galleries, museums and monuments.
3. Lighting for theatrical purposes, including performance, stage, film production and video production.
4. Lighting for photographic processes.
5. Lighting integral to equipment or instrumentation and is installed by the manufacturer.
6. Task lighting for plant growth or maintenance.
7. Advertising signage or directional signage.
8. In restaurant buildings and areas, lighting for food warming or integral to food preparation equipment.
9. Lighting equipment that is for sale.
10. Lighting demonstration equipment in lighting education facilities.
11. Lighting *approved* because of safety or emergency considerations, inclusive of exit lights.
12. Lighting integral to both open and glass-enclosed refrigerator and freezer cases.

13. Lighting in retail display windows, provided the display area is enclosed by ceiling-height partitions.
14. Furniture mounted supplemental task lighting that is controlled by automatic shutoff.

**C405.5.1.1 Screw lamp holders.** The wattage shall be the maximum *labeled* wattage of the luminaire.

**C405.5.1.2 Low-voltage lighting.** The wattage shall be the specified wattage of the transformer supplying the system.

**C405.5.1.3 Other luminaires.** The wattage of all other lighting equipment shall be the wattage of the lighting equipment verified through data furnished by the manufacturer or other *approved* sources.

**C405.5.1.4 Line-voltage lighting track and plug-in busway.** The wattage shall be:

1. The specified wattage of the luminaires included in the system with a minimum of 30 W/lin ft. (98 W/lin. m);
2. The wattage limit of the system’s circuit breaker; or
3. The wattage limit of other permanent current limiting device(s) on the system.

**C405.5.2 Interior lighting power.** The total interior lighting power allowance (watts) is determined according to Table C405.5.2(1) using the Building Area Method, or Table C405.5.2(2) using the Space-by-Space Method, for all areas of the building covered in this permit. For the Building Area Method, the interior lighting power allowance is the floor area for each building area type listed in Table C405.5.2(1) times the value from Table C405.5.2(1) for that area. For the purposes of this method, an “area” shall be defined as all contiguous spaces that accommodate or are associated with a single building area type as listed in Table C405.5.2(1). Where this method is used to calculate the total interior lighting power for an entire building, each building area type shall be treated as a separate area. For the Space-by-Space Method, the interior lighting power allowance is determined by multiplying the floor area of each space times the value for the space type in Table C405.5.2(2) that most closely represents the proposed use of the space, and then summing the lighting power allowances for all spaces. Tradeoffs among spaces are permitted.

**C405.6 Exterior lighting (Mandatory).** Where the power for exterior lighting is supplied through the energy service to the building, all exterior lighting, other than low-voltage landscape lighting, shall comply with Sections C405.6.1 and C405.6.2.

**Exception:** Where *approved* because of historical, safety, signage or emergency considerations.

**C405.6.1 Exterior building grounds lighting.** All exterior building grounds luminaires that operate at greater than 100 watts shall contain lamps having a minimum efficacy of 60 lumens per watt unless the luminaire is controlled by a motion sensor or qualifies for one of the exceptions under Section C405.6.2.

**TABLE C405.5.2(1)  
INTERIOR LIGHTING POWER ALLOWANCES:  
BUILDING AREA METHOD**

BUILDING AREA TYPE	LPD (w/ft²)
Automotive facility	0.9
Convention center	1.2
Courthouse	1.2
Dining: bar lounge/leisure	1.3
Dining: cafeteria/fast food	1.4
Dining: family	1.6
Dormitory	1.0
Exercise center	1.0
Fire station	0.8
Gymnasium	1.1
Health care clinic	1.0
Hospital	1.2
Hotel	1.0
Library	1.3
Manufacturing facility	1.3
Motel	1.0
Motion picture theater	1.2
Multifamily	0.7
Museum	1.1
Office	0.9
Parking garage	0.3
Penitentiary	1.0
Performing arts theater	1.6
Police station	1.0
Post office	1.1
Religious building	1.3
Retail	1.4
School/university	1.2
Sports arena	1.1
Town hall	1.1
Transportation	1.0
Warehouse	0.6
Workshop	1.4

**TABLE C405.5.2(2)  
INTERIOR LIGHTING POWER ALLOWANCES:  
SPACE-BY-SPACE METHOD**

COMMON SPACE-BY-SPACE TYPES	LPD (w/ft <sup>2</sup> )
Atrium – First 40 feet in height	0.03 per ft. ht.
Atrium – Above 40 feet in height	0.02 per ft. ht.
Audience/seating area – permanent	
For auditorium	0.9
For performing arts theater	2.6
For motion picture theater	1.2
Classroom/lecture/training	1.30
Conference/meeting/multipurpose	1.2
Corridor/transition	0.7
Dining area	
Bar/lounge/leisure dining	1.40
Family dining area	1.40
Dressing/fitting room performing arts theater	1.1
Electrical/mechanical	1.10
Food preparation	1.20
Laboratory for classrooms	1.3
Laboratory for medical/industrial/research	1.8
Lobby	1.10
Lobby for performing arts theater	3.3
Lobby for motion picture theater	1.0
Locker room	0.80
Lounge recreation	0.8
Office – enclosed	1.1
Office – open plan	1.0
Restroom	1.0
Sales area	1.6 <sup>a</sup>
Stairway	0.70
Storage	0.8
Workshop	1.60
Courthouse/police station/penitentiary	
Courtroom	1.90
Confinement cells	1.1
Judge chambers	1.30
Penitentiary audience seating	0.5
Penitentiary classroom	1.3
Penitentiary dining	1.1
<b>BUILDING SPECIFIC SPACE-BY-SPACE TYPES</b>	
Automotive – service/repair	0.70
Bank/office – banking activity area	1.5
Dormitory living quarters	1.10
Gymnasium/fitness center	
Fitness area	0.9
Gymnasium audience/seating	0.40
Playing area	1.40

(continued)

**TABLE C405.5.2(2)—continued  
INTERIOR LIGHTING POWER ALLOWANCES:  
SPACE-BY-SPACE METHOD**

COMMON SPACE-BY-SPACE TYPES	LPD (w/ft <sup>2</sup> )
Healthcare clinic/hospital	
Corridors/transition	1.00
Exam/treatment	1.70
Emergency	2.70
Public and staff lounge	0.80
Medical supplies	1.40
Nursery	0.9
Nurse station	1.00
Physical therapy	0.90
Patient room	0.70
Pharmacy	1.20
Radiology/imaging	1.3
Operating room	2.20
Recovery	1.2
Lounge/recreation	0.8
Laundry – washing	0.60
Hotel	
Dining area	1.30
Guest rooms	1.10
Hotel lobby	2.10
Highway lodging dining	1.20
Highway lodging guest rooms	1.10
Library	
Stacks	1.70
Card file and cataloguing	1.10
Reading area	1.20
Manufacturing	
Corridors/transition	0.40
Detailed manufacturing	1.3
Equipment room	1.0
Extra high bay (> 50-foot floor-ceiling height)	1.1
High bay (25- – 50-foot floor-ceiling height)	1.20
Low bay (< 25-foot floor-ceiling height)	1.2
Museum	
General exhibition	1.00
Restoration	1.70
Parking garage – garage areas	0.2
Convention center	
Exhibit space	1.50
Audience/seating area	0.90
Fire stations	
Engine room	0.80
Sleeping quarters	0.30
Post office	
Sorting area	0.9
Religious building	
Fellowship hall	0.60
Audience seating	2.40
Worship pulpit/choir	2.40
Retail	
Dressing/fitting area	0.9
Mall concourse	1.6
Sales area	1.6 <sup>a</sup>

(continued)

**TABLE C405.5.2(2)—continued  
INTERIOR LIGHTING POWER ALLOWANCES:  
SPACE-BY-SPACE METHOD**

BUILDING SPECIFIC SPACE-BY-SPACE TYPES	LPD (w/ft <sup>2</sup> )
Sports arena	
Audience seating	0.4
Court sports area – Class 4	0.7
Court sports area – Class 3	1.2
Court sports area – Class 2	1.9
Court sports area – Class 1	3.0
Ring sports area	2.7
Transportation	
Air/train/bus baggage area	1.00
Airport concourse	0.60
Terminal – ticket counter	1.50
Warehouse	
Fine material storage	1.40
Medium/bulky material	0.60

For SI: 1 foot = 304.8 mm, 1 watt per square foot = 11 W/m<sup>2</sup>.

a. Where lighting equipment is specified to be installed to highlight specific merchandise in addition to lighting equipment specified for general lighting and is switched or dimmed on circuits different from the circuits for general lighting, the smaller of the actual wattage of the lighting equipment installed specifically for merchandise, or additional lighting power as determined below shall be added to the interior lighting power determined in accordance with this line item.

Calculate the additional lighting power as follows:

Additional Interior Lighting Power Allowance = 500 watts + (Retail Area 1 × 0.6 W/ft<sup>2</sup>) + (Retail Area 2 × 0.6 W/ft<sup>2</sup>) + (Retail Area 3 × 1.4 W/ft<sup>2</sup>) + (Retail Area 4 × 2.5 W/ft<sup>2</sup>).

where:

Retail Area 1 = The floor area for all products not listed in Retail Area 2, 3 or 4.

Retail Area 2 = The floor area used for the sale of vehicles, sporting goods and small electronics.

Retail Area 3 = The floor area used for the sale of furniture, clothing, cosmetics and artwork.

Retail Area 4 = The floor area used for the sale of jewelry, crystal and china.

**Exception:** Other merchandise categories are permitted to be included in Retail Areas 2 through 4 above, provided that justification documenting the need for additional lighting power based on visual inspection, contrast, or other critical display is *approved* by the authority having jurisdiction.

**C405.6.2 Exterior building lighting power.** The total exterior lighting power allowance for all exterior building applications is the sum of the base site allowance plus the individual allowances for areas that are to be illuminated and are permitted in Table C405.6.2(2) for the applicable lighting zone. Tradeoffs are allowed only among exterior lighting applications listed in Table C405.6.2(2), Tradable Surfaces section. The lighting zone for the building exterior is determined from Table C405.6.2(1) unless otherwise specified by the local jurisdiction. Exterior lighting for all applications (except those included in the exceptions to Section C405.6.2) shall comply with the requirements of Section C405.6.1.

**Exception:** Lighting used for the following exterior applications is exempt where equipped with a control

device independent of the control of the nonexempt lighting:

1. Specialized signal, directional and marker lighting associated with transportation;
2. Advertising signage or directional signage;
3. Integral to equipment or instrumentation and is installed by its manufacturer;
4. Theatrical purposes, including performance, stage, film production and video production;
5. Athletic playing areas;
6. Temporary lighting;
7. Industrial production, material handling, transportation sites and associated storage areas;
8. Theme elements in theme/amusement parks; and
9. Used to highlight features of public monuments and registered historic landmark structures or buildings.

**TABLE C405.6.2(1)  
EXTERIOR LIGHTING ZONES**

LIGHTING ZONE	DESCRIPTION
1	Developed areas of national parks, state parks, forest land, and rural areas
2	Areas predominantly consisting of residential zoning, neighborhood business districts, light industrial with limited nighttime use and residential mixed use areas
3	All other areas
4	High-activity commercial districts in major metropolitan areas as designated by the local land use planning authority

**C405.7 Electrical energy consumption (Mandatory).** In buildings having individual dwelling units, provisions shall be made to determine the electrical energy consumed by each tenant by separately metering individual dwelling units.

**SECTION C406  
ADDITIONAL EFFICIENCY PACKAGE OPTIONS**

**C406.1 Requirements.** Buildings shall comply with at least one of the following:

1. Efficient HVAC Performance in accordance with Section C406.2.
2. Efficient Lighting System in accordance with Section C406.3.
3. On-Site Supply of Renewable Energy in accordance with Section C406.4.

Individual tenant spaces shall comply with either Section C406.2 or Section C406.3 unless documentation can be provided that demonstrates compliance with Section C406.4 for the entire building

**TABLE C405.6.2(2)  
INDIVIDUAL LIGHTING POWER ALLOWANCES FOR BUILDING EXTERIORS**

		LIGHTING ZONES			
		Zone 1	Zone 2	Zone 3	Zone 4
Base Site Allowance (Base allowance is usable in tradable or nontradable surfaces.)		500 W	600 W	750 W	1300 W
Tradable Surfaces (Lighting power densities for uncovered parking areas, building grounds, building entrances and exits, canopies and overhangs and outdoor sales areas are tradable.)	<b>Uncovered Parking Areas</b>				
	Parking areas and drives	0.04 W/ft <sup>2</sup>	0.06 W/ft <sup>2</sup>	0.10 W/ft <sup>2</sup>	0.13 W/ft <sup>2</sup>
	<b>Building Grounds</b>				
	Walkways less than 10 feet wide	0.7 W/linear foot	0.7 W/linear foot	0.8 W/linear foot	1.0 W/linear foot
	Walkways 10 feet wide or greater, plaza areas special feature areas	0.14 W/ft <sup>2</sup>	0.14 W/ft <sup>2</sup>	0.16 W/ft <sup>2</sup>	0.2 W/ft <sup>2</sup>
	Stairways	0.75 W/ft <sup>2</sup>	1.0 W/ft <sup>2</sup>	1.0 W/ft <sup>2</sup>	1.0 W/ft <sup>2</sup>
	Pedestrian tunnels	0.15 W/ft <sup>2</sup>	0.15 W/ft <sup>2</sup>	0.2 W/ft <sup>2</sup>	0.3 W/ft <sup>2</sup>
	<b>Building Entrances and Exits</b>				
	Main entries	20 W/linear foot of door width	20 W/linear foot of door width	30 W/linear foot of door width	30 W/linear foot of door width
	Other doors	20 W/linear foot of door width	20 W/linear foot of door width	20 W/linear foot of door width	20 W/linear foot of door width
	Entry canopies	0.25 W/ft <sup>2</sup>	0.25 W/ft <sup>2</sup>	0.4 W/ft <sup>2</sup>	0.4 W/ft <sup>2</sup>
	<b>Sales Canopies</b>				
	Free-standing and attached	0.6 W/ft <sup>2</sup>	0.6 W/ft <sup>2</sup>	0.8 W/ft <sup>2</sup>	1.0 W/ft <sup>2</sup>
	<b>Outdoor Sales</b>				
	Open areas (including vehicle sales lots)	0.25 W/ft <sup>2</sup>	0.25 W/ft <sup>2</sup>	0.5 W/ft <sup>2</sup>	0.7 W/ft <sup>2</sup>
Street frontage for vehicle sales lots in addition to "open area" allowance	No allowance	10 W/linear foot	10 W/linear foot	30 W/linear foot	
Nontradable Surfaces (Lighting power density calculations for the following applications can be used only for the specific application and cannot be traded between surfaces or with other exterior lighting. The following allowances are in addition to any allowance otherwise permitted in the "Tradable Surfaces" section of this table.)	Building facades	No allowance	0.1 W/ft <sup>2</sup> for each illuminated wall or surface or 2.5 W/linear foot for each illuminated wall or surface length	0.15 W/ft <sup>2</sup> for each illuminated wall or surface or 3.75 W/linear foot for each illuminated wall or surface length	0.2 W/ft <sup>2</sup> for each illuminated wall or surface or 5.0 W/linear foot for each illuminated wall or surface length
	Automated teller machines and night depositories	270 W per location plus 90 W per additional ATM per location	270 W per location plus 90 W per additional ATM per location	270 W per location plus 90 W per additional ATM per location	270 W per location plus 90 W per additional ATM per location
	Entrances and gatehouse inspection stations at guarded facilities	0.75 W/ft <sup>2</sup> of covered and uncovered area	0.75 W/ft <sup>2</sup> of covered and uncovered area	0.75 W/ft <sup>2</sup> of covered and uncovered area	0.75 W/ft <sup>2</sup> of covered and uncovered area
	Loading areas for law enforcement, fire, ambulance and other emergency service vehicles	0.5 W/ft <sup>2</sup> of covered and uncovered area	0.5 W/ft <sup>2</sup> of covered and uncovered area	0.5 W/ft <sup>2</sup> of covered and uncovered area	0.5 W/ft <sup>2</sup> of covered and uncovered area
	Drive-up windows/doors	400 W per drive-through	400 W per drive-through	400 W per drive-through	400 W per drive-through
	Parking near 24-hour retail entrances	800 W per main entry	800 W per main entry	800 W per main entry	800 W per main entry

For SI: 1 foot = 304.8 mm, 1 watt per square foot = W/0.0929 m<sup>2</sup>.

**TABLE C406.2(1)**  
**UNITARY AIR CONDITIONERS AND CONDENSING UNITS, ELECTRICALLY OPERATED, EFFICIENCY REQUIREMENTS**

EQUIPMENT TYPE	SIZE CATEGORY	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY <sup>a</sup>	
			CLIMATE ZONES 1 - 5	CLIMATE ZONES 6 - 8
Air conditioners, air cooled	< 65,000 Btu/h	Split system	15.0 SEER 12.5 EER	14 SEER 12 EER
		Single package	15.0 SEER 12.0 EER	14.0 SEER 11.6 EER
	≥ 65,000 Btu/h and < 240,000 Btu/h	Split system and single package	12.0 EER <sup>b</sup> 12.54 IEER <sup>b</sup>	11.5 EER <sup>b</sup> 12.0 IEER <sup>b</sup>
	≥ 240,000 Btu/h and < 760,000 Btu/h	Split system and single package	10.8 EER <sup>b</sup> 11.3 IEER <sup>b</sup>	10.5 EER <sup>b</sup> 11.0 IEER <sup>b</sup>
	≥ 760,000 Btu/h	—	10.2 EER <sup>b</sup> 10.7 IEER <sup>b</sup>	9.7 EER <sup>b</sup> 10.2 IEER <sup>b</sup>
Air conditioners, water and evaporatively cooled	—	Split system and single package	14.0 EER	14.0 EER

For SI: 1 British thermal unit per hour = 0.2931 W.

a. IEERs are only applicable to equipment with capacity modulation.

b. Deduct 0.2 from the required EERs and IPLVs for units with a heating section other than electric resistance heat.

**TABLE C406.2(2)**  
**UNITARY AND APPLIED HEAT PUMPS, ELECTRICALLY OPERATED, EFFICIENCY REQUIREMENTS**

EQUIPMENT TYPE	SIZE CATEGORY	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY <sup>a</sup>	
			CLIMATE ZONES 1 - 5	CLIMATE ZONES 6 - 8
Air cooled (Cooling mode)	< 65,000 Btu/h	Split system	15.0 SEER, 12.5 EER	14.0 SEER, 12.0 EER
		Single package	15.0 SEER, 12.0 EER	14.0 SEER 11.6 EER
	≥ 65,000 Btu/h and < 240,000 Btu/h	Split system and single package	12.0 SEER, 12.4 EER	11.5 EER <sup>b</sup> , 12.0 IEER <sup>b</sup>
	≥ 240,000 Btu/h	Split system and single package	12.0 SEER, 12.4 EER	10.5 EER <sup>b</sup> , 10.5 IEER <sup>b</sup>
Water sources (Cooling mode)	< 135,000 Btu/h	85°F entering water	14.0 EER	14.0 EER
Air cooled (Heating mode)	< 65,000 Btu/h (Cooling capacity)	Split system	9.0 HSPF	8.5 HSPF
		Single package	8.5 HSPF	8.0 HSPF
	≥ 65,000 Btu/h and < 135,000 Btu/h (Cooling capacity)	47°F db/43°F wb outdoor air	3.4 COP	3.4 COP
		17°F db/15°F wb outdoor air	2.4 COP	2.4 COP
	≥ 135,000 Btu/h (Cooling capacity)	47°F db/43°F wb outdoor air	3.2 COP	3.2 COP
	77°F db/15°F wb outdoor air	2.1 COP	2.1 COP	
Water sources (Heating mode)	< 135,000 Btu/h (Cooling capacity)	70°F entering water	4.6 COP	4.6 COP

For SI: °C = [(°F) - 32] / 1.8, 1 British thermal unit per hour = 0.2931 W.

db = dry-bulb temperature, °F; wb = wet-bulb temperature, °F.

a. IEERs and Part load rating conditions are only applicable to equipment with capacity modulation.

b. Deduct 0.2 from the required EERs and IPLVs for units with a heating section other than electric resistance heat.

**TABLE C406.2(3)**  
**PACKAGED TERMINAL AIR CONDITIONERS AND PACKAGED TERMINAL HEAT PUMPS**

EQUIPMENT TYPE	SIZE CATEGORY	MINIMUM EFFICIENCY
Air conditioners and heat pumps (cooling mode)	< 7,000 Btu/h	11.9 EER
	7,000 Btu/h and < 10,000 Btu/h	11.3 EER
	10,000 Btu/h and ≤ 13,000 Btu/h	10.7 EER
	> 13,000 Btu/h	9.5 EER

**TABLE C406.2(4)**  
**WARM AIR FURNACES AND COMBINATION WARM AIR FURNACES/AIR-CONDITIONING UNITS,**  
**WARM AIR DUCT FURNACES AND UNIT HEATERS, EFFICIENCY REQUIREMENTS**

EQUIPMENT TYPE	SIZE CATEGORY (INPUT)	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY	TEST PROCEDURE
Warm air furnaces, gas fired <sup>a</sup>	< 225,000 Btu/h	—	For Climate Zones 1 and 2 NR	DOE 10 CFR Part 430 or ANSI Z21.47
			For Climate Zones 3 and 4 90 AFUE or 90 $E_t^c$	
			For Climate Zones 4 – 8 92 AFUE or 92 $E_t^c$	
	≥ 225,000 Btu/h	Maximum capacity	90% $E_c^b$	ANSI Z21.47
Warm air furnaces, oil fired <sup>a</sup>	< 225,000 Btu/h	—	For Climate Zones 1 and 2 NR	DOE 10 CFR Part 430 or UL 727
			For Climate Zones 3 – 8 85 AFUE or 85 $E_t^c$	
			≥ 225,000 Btu/h	Maximum capacity
Warm air duct furnaces, gas fired <sup>a</sup>	All capacities	Maximum capacity	90% $E_c$	ANSI Z83.8
Warm air unit heaters, gas fired	All capacities	Maximum capacity	90% $E_c$	ANSI Z83.8
Warm air unit heaters, oil fired	All capacities	Maximum capacity	90% $E_c$	UL 731

For SI: 1 British thermal unit per hour = 0.2931 W.

$E_t$  = Thermal efficiency.  $E_c$  = Combustion efficiency (100 percent less flue losses).

- a. Efficient furnace fan: Fossil fuel furnaces in climate zones 3 to 8 shall have a furnace electricity ratio not greater than 2 percent and shall include a manufacturer’s designation of the furnace electricity ratio.
- b. Units shall also include an IID (intermittent ignition device), have jacket losses not exceeding 0.75 percent of the input rating, and have either power venting or a flue damper. A vent damper is an acceptable alternative to a flue damper for those furnaces where combustion air is drawn from the conditioned space.
- c. Where there are two ratings for units not covered by NAECA (3-phase power or cooling capacity greater than or equal to 65,000 Btu/h [19 kW]), units shall be permitted to comply with either rating.

**TABLE C406.2(5)**  
**BOILER, EFFICIENCY REQUIREMENTS**

EQUIPMENT TYPE	FUEL	SIZE CATEGORY	TEST PROCEDURE	MINIMUM EFFICIENCY
Steam	Gas	< 300,000 Btu/h	DOE 10 CFR Part 430	83% AFUE
		> 300,000 Btu / h and > 2.5 m Btu/h	DOE 10 CFR Part 431	81% $E_t$
		>2.5 m Btu/h		82% $E_c$
	Oil	< 300,000 Btu/h	DOE 10 CFR Part 430	85% AFUE
		> 300,000 Btu/h and > 2.5 m Btu/h	DOE 10 CFR Part 431	83% $E_t$
		>2.5 m Btu/h		84% $E_c$
Hot water	Gas	< 300,000 Btu/h	DOE 10 CFR Part 430	97% AFUE
		> 300,000 Btu/h and > 2.5 m Btu/h	DOE 10 CFR Part 431	97% $E_t$
		>2.5 m Btu/h		94% $E_c$
	Oil	< 300,000 Btu/h	DOE 10 CFR Part 430	90% AFUE
		> 300,000 Btu/h and > 2.5 m Btu/h	DOE 10 CFR Part 431	88% $E_t$
		>2.5 m Btu/h		87% $E_c$

For SI: 1 British thermal unit per hour = 0.2931 W.

$E_t$  = Thermal efficiency.  $E_c$  = Combustion efficiency (100 percent less flue losses).

**TABLE C406.2(6)  
CHILLERS—EFFICIENCY REQUIREMENTS**

EQUIPMENT TYPE	SIZE CATEGORY	UNITS	MINIMUM EFFICIENCY <sup>a</sup> (I-P)				Test Procedure <sup>b</sup>
			Path A		Path B <sup>c</sup>		
			Full Load	IPLV	Full Load	IPLV	
Air-cooled chillers with condenser, electrically operated	< 150 tons	EER	10.000	12.500	NA	NA	AHRI 550/590 <sup>f</sup>
	≥ 150 tons	EER	10.000	12.750	NA	NA	
Air-cooled without condenser, electrical operated	All capacities	EER	Condenserless units shall be rated with matched condensers				AHRI 550/590
Water-cooled, electrically operated, positive displacement (reciprocating)	All capacities	kw/ton	Reciprocating units required to comply with water cooled positive displacement requirements				AHRI 550/590 <sup>f</sup>
Water-cooled electrically operated, positive displacement	< 75 tons	kw/ton	0.780	0.630	0.800	0.600	AHRI 550/590 <sup>f</sup>
	≥ 75 tons and < 150 tons	kw/ton	0.775	0.615	0.790	0.586	
	≥ 150 tons and < 300 tons	kw/ton	0.680	0.580	0.718	0.540	
	≥ 300 tons	kw/ton	0.620	0.540	0.639	0.490	
Water-cooled electrically operated, centrifugal <sup>d</sup>	< 150 tons	kw/ton	0.634	0.596	0.639	0.450	AHRI 550/590 <sup>f</sup>
	≥ 150 tons and < 300 tons	kw/ton	0.634	0.596	0.639	0.450	
	≥ 300 tons and < 600 tons	kw/ton	0.576	0.549	0.600	0.400	
	≥ 600 tons	kw/ton	0.570	0.539	0.590	0.400	
Air-cooled absorption single effect <sup>e</sup>	All capacities	COP	0.600	NR	NA	NA	AHRI 560
Water-cooled absorption single effect <sup>e</sup>	All capacities	COP	0.700	NR	NA	NA	
Absorption double effect indirect-fired	All capacities	COP	1.000	1.050	NA	NA	
Absorption double effect direct fired	All capacities	COP	1.000	1.000	NA	NA	

For SI: 1 Ton = 3516 W.

NA = Not applicable and cannot be used for compliance. NR = No minimum requirements.

- a. Compliance with this standard can be obtained by meeting the minimum requirements of Path A or Path B. However both the full load and IPLV shall be met to fulfill the requirements of Path A and Path B.
- b. Chapter 6 of the referenced standard contains a complete specification of the referenced test procedure, including the referenced year version of the test procedure.
- c. Path B is intended for applications with significant operating time at part load. All Path B machines shall be equipped with demand limiting capable controls.
- d. The chiller equipment requirements do not apply for chillers used in low-temperature applications where the design leaving fluid temperature is greater than 40°F.
- e. Only allowed to be used in heat recovery applications.
- f. Packages that are not designed for operation at ARI Standard 550/590 test conditions (and, thus, cannot be tested to meet the requirements of Table C-3) of 44°F leaving chilled-water temperature and 85°F entering condenser-water temperature with 3 gpm/ton condenser-water flow shall have maximum full-load kW/ton and NPLV ratings adjusted using the following equation:

$$\text{Adjusted maximum full load kW/ton rating} = (\text{full load kW/ton from Table C-3})/K_{adj}$$

$$\text{Adjusted maximum NPLV rating} = (\text{IPLV from Table C-3})/K_{adj}$$

where:

$$K_{adj} = 6.174722 - 0.303668(X) + 0.00629466(X)^2 - 0.000045780(X)^3$$

$$X = DT_{std} + \text{LIFT} \text{ (°F)}$$

$$DT_{std} = [(24 + (\text{full load kW/ton from Table C-3}) \times 6.83)]/\text{flow} \text{ (°F)}$$

$$\text{Flow} = \text{condenser-water flow (gpm)} / \text{cooling full load capacity (tons)}$$

$$\text{LIFT} = \text{CEWT} - \text{CLWT} \text{ (°F)}$$

$$\text{CEWT} = \text{full load entering condenser-water temperature (°F)}$$

$$\text{CLWT} = \text{full load leaving chilled-water temperature (°F)}$$

The adjusted full load and NPLV values are only applicable over the following full-load design ranges:

Minimum leaving chilled-water temperature: 38°F

Maximum condenser entering water temperature: 102°F

Condenser-water flow: 1 to 6 gpm/ton

$$X \geq 39^\circ\text{F and } \leq 60^\circ\text{F}$$

**TABLE C406.2(7)  
ABSORPTION CHILLERS—EFFICIENCY REQUIREMENTS**

EQUIPMENT TYPE	MINIMUM EFFICIENCY FULL LOAD COP (IPLV)
Air cooled, single effect	0.60, allowed only in heat recovery applications
Water cooled, single effect	0.70, allowed only in heat recovery applications
Double effect – direct fired	1.0 (1.05 )
Double effect – indirect fired	1.20

**C406.2 Efficient HVAC performance.** Equipment shall meet the minimum efficiency requirements of Tables C406.2(1) through C406.2(7) in addition to the requirements in Section C403. This section shall only be used where the equipment efficiencies in Tables C406.2(1) through C406.2(7) are greater than the equipment efficiencies listed in Table C403.2.3(1) through 403.2.3(7) for the equipment type.

**C406.3 Efficient lighting system.** Whole building lighting power density (Watts/sf) shall comply with the requirements of Section C406.3.1.

**C406.3.1 Reduced lighting power density.** The total interior lighting power (watts) of the building shall be determined by using the reduced whole building interior lighting power in Table C406.3 times the floor area for the building types.

**C406.4 On-site renewable energy.** Total minimum ratings of on-site renewable energy systems shall comply with one of the following:

1. Provide not less than 1.75 Btu (1850 W), or not less than 0.50 watts per square foot (5.4 W/m<sup>2</sup>) of conditioned floor area.
2. Provide not less than 3 percent of the energy used within the building for building mechanical and service water heating equipment and lighting regulated in this chapter.

**SECTION C407  
TOTAL BUILDING PERFORMANCE**

**C407.1 Scope.** This section establishes criteria for compliance using total building performance. The following systems and loads shall be included in determining the total building performance: heating systems, cooling systems, service water heating, fan systems, lighting power, receptacle loads and process loads.

**C407.2 Mandatory requirements.** Compliance with this section requires that the criteria of Sections C402.4, C403.2, C404 and C405 be met.

**C407.3 Performance-based compliance.** Compliance based on total building performance requires that a proposed building (*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*, 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. Nondepletable energy collected off site shall be treated and priced the same as purchased energy. Energy from nondepletable energy sources collected on site shall be omitted from the annual energy cost of the *proposed design*.

**Exception:** Jurisdictions that require site energy (1 kWh = 3413 Btu) rather than energy cost as the metric of comparison.

**TABLE C406.3  
REDUCED INTERIOR LIGHTING POWER**

BUILDING AREA TYPE <sup>a</sup>	LPD (w/ft <sup>2</sup> )
Automotive facility	0.82
Convention center	1.08
Courthouse	1.05
Dining: bar lounge/leisure	0.99
Dining: cafeteria/fast food	0.90
Dining: family	0.89
Dormitory	0.61
Exercise center	0.88
Fire station	0.71
Gymnasium	1.0
Health care clinic	0.87
Hospital	1.10
Library	1.18
Manufacturing facility	1.11
Hotel/motel	0.88
Motion picture theater	0.83
Museum	1.06
Multifamily	0.60
Office	0.90/0.85 <sup>b</sup>
Performing arts theater	1.39
Police station	0.96
Post office	0.87
Religious building	1.05
Retail	1.4/1.3 <sup>b</sup>
School/ university	0.99
Sports arena	0.78
Town hall	0.92
Transportation	0.77
Warehouse <sup>c</sup>	0.6
Workshop	1.2

For SI: 1 foot = 304.8 mm, 1 watt per square foot = W/0.0929 m<sup>2</sup>.

- a. In cases where both a general building area type and a more specific building area type are listed, the more specific building area type shall apply.
- b. First LPD value applies if no less than 30 percent of conditioned floor area is in daylight zones. Automatic daylighting controls shall be installed in daylight zones and shall meet the requirements of Section C405.2.2.3. In all other cases, second LPD value applies.
- c. No less than 70 percent of the floor area shall be in the daylight zone. Automatic daylighting controls shall be installed in daylight zones and shall meet the requirements of Section C405.2.2.3.

**C407.4 Documentation.** Documentation verifying that the methods and accuracy of compliance software tools conform to the provisions of this section shall be provided to the *code official*.

**C407.4.1 Compliance report.** Compliance software tools shall generate a report that documents that the *proposed design* has annual energy costs less than or equal to the annual energy costs of the *standard reference design*. The compliance documentation shall include the following information:

1. Address of the building;
2. An inspection checklist documenting the building component characteristics of the *proposed design* as listed in Table C407.5.1(1). The inspection checklist shall show the estimated annual energy cost for both the *standard reference design* and the *proposed design*;
3. Name of individual completing the compliance report; and
4. Name and version of the compliance software tool.

**C407.4.2 Additional documentation.** The *code official* shall be permitted to require the following documents:

1. Documentation of the building component characteristics of the *standard reference design*;
2. Thermal zoning diagrams consisting of floor plans showing the thermal zoning scheme for *standard reference design* and *proposed design*;
3. Input and output report(s) from the energy analysis simulation program containing the complete input and output files, as applicable. The output file shall include energy use totals and energy use by energy source and end-use served, total hours that space conditioning loads are not met and any errors or warning messages generated by the simulation tool as applicable;
4. An explanation of any error or warning messages appearing in the simulation tool output; and
5. A certification signed by the builder providing the building component characteristics of the *proposed design* as given in Table C407.5.1(1).

**C407.5 Calculation procedure.** Except as specified by this section, the *standard reference design* and *proposed design* shall be configured and analyzed using identical methods and techniques.

**C407.5.1 Building specifications.** The *standard reference design* and *proposed design* shall be configured and analyzed as specified by Table C407.5.1(1). Table C407.5.1(1) shall include by reference all notes contained in Table C402.2.

**C407.5.2 Thermal blocks.** The *standard reference design* and *proposed design* shall be analyzed using identical ther-

mal blocks as specified in Section C407.5.2.1, C407.5.2.2 or C407.5.2.3.

**C407.5.2.1 HVAC zones designed.** Where HVAC *zones* are defined on HVAC design drawings, each HVAC *zone* shall be modeled as a separate thermal block.

**Exception:** Different HVAC *zones* shall be allowed to be combined to create a single thermal block or identical thermal blocks to which multipliers are applied provided:

1. The space use classification is the same throughout the thermal block.
2. All HVAC *zones* in the thermal block that are adjacent to glazed exterior walls face the same orientation or their orientations are within 45 degrees (0.79 rad) of each other.
3. All of the *zones* are served by the same HVAC system or by the same kind of HVAC system.

**C407.5.2.2 HVAC zones not designed.** Where HVAC *zones* have not yet been designed, thermal blocks shall be defined based on similar internal load densities, occupancy, lighting, thermal and temperature schedules, and in combination with the following guidelines:

1. Separate thermal blocks shall be assumed for interior and perimeter spaces. Interior spaces shall be those located more than 15 feet (4572 mm) from an exterior wall. Perimeter spaces shall be those located closer than 15 feet (4572 mm) from an *exterior wall*.
2. Separate thermal blocks shall be assumed for spaces adjacent to glazed exterior walls: a separate *zone* shall be provided for each orientation, except orientations that differ by no more than 45 degrees (0.79 rad) shall be permitted to be considered to be the same orientation. Each *zone* shall include floor area that is 15 feet (4572 mm) or less from a glazed perimeter wall, except that floor area within 15 feet (4572 mm) of glazed perimeter walls having more than one orientation shall be divided proportionately between *zones*.
3. Separate thermal blocks shall be assumed for spaces having floors that are in contact with the ground or exposed to ambient conditions from *zones* that do not share these features.
4. Separate thermal blocks shall be assumed for spaces having exterior ceiling or roof assemblies from *zones* that do not share these features.

**C407.5.2.3 Multifamily residential buildings.** Residential spaces shall be modeled using one thermal block per space except that those facing the same orientations are permitted to be combined into one thermal block. Corner units and units with roof or floor loads shall only be combined with units sharing these features.

**TABLE C407.5.1(1)**  
**SPECIFICATIONS FOR THE STANDARD REFERENCE AND PROPOSED DESIGNS**

BUILDING COMPONENT CHARACTERISTICS	STANDARD REFERENCE DESIGN	PROPOSED DESIGN
Space use classification	Same as proposed	The space use classification shall be chosen in accordance with Table C405.5.2 for all areas of the building covered by this permit. Where the space use classification for a building is not known, the building shall be categorized as an office building.
Roofs	Type: Insulation entirely above deck Gross area: same as proposed <i>U</i> -factor: from Table C402.1.2 Solar absorptance: 0.75 Emittance: 0.90	As proposed As proposed As proposed As proposed As proposed
Walls, above-grade	Type: Mass wall if proposed wall is mass; otherwise steel-framed wall Gross area: same as proposed <i>U</i> -factor: from Table C402.1.2 Solar absorptance: 0.75 Emittance: 0.90	As proposed As proposed As proposed As proposed As proposed
Walls, below-grade	Type: Mass wall Gross area: same as proposed <i>U</i> -Factor: from Table C402.1.2 with insulation layer on interior side of walls	As proposed As proposed As proposed
Floors, above-grade	Type: joist/framed floor Gross area: same as proposed <i>U</i> -factor: from Table C402.1.2	As proposed As proposed As proposed
Floors, slab-on-grade	Type: Unheated <i>F</i> -factor: from Table C402.1.2	As proposed As proposed
Doors	Type: Swinging Area: Same as proposed <i>U</i> -factor: from Table C402.2	As proposed As proposed As proposed
Glazing	Area 1. The proposed glazing area; where the proposed glazing area is less than 40 percent of above-grade wall area. 2. 40 percent of above-grade wall area; where the proposed glazing area is 40 percent or more of the above-grade wall area. <i>U</i> -factor: from Table C402.3 SHGC: from Table C402.3 except that for climates with no requirement (NR) SHGC = 0.40 shall be used External shading and PF: None	As proposed  As proposed As proposed As proposed
Skylights	Area 1. The proposed skylight area; where the proposed skylight area is less than 3 percent of gross area of roof assembly. 2. 3 percent of gross area of roof assembly; where the proposed skylight area is 3 percent or more of gross area of roof assembly <i>U</i> -factor: from Table C402.3 SHGC: from Table C402.3 except that for climates with no requirement (NR) SHGC = 0.40 shall be used.	As proposed  As proposed As proposed
Lighting, interior	The interior lighting power shall be determined in accordance with Table C405.5.2. Where the occupancy of the building is not known, the lighting power density shall be 1.0 Watt per square foot (10.73 W/m <sup>2</sup> ) based on the categorization of buildings with unknown space classification as offices.	As proposed
Lighting, exterior	The lighting power shall be determined in accordance with Table C405.6.2(2). Areas and dimensions of tradable and nontradable surfaces shall be the same as proposed.	As proposed

(continued)

**TABLE C407.5.1(1)—continued  
SPECIFICATIONS FOR THE STANDARD REFERENCE AND PROPOSED DESIGNS**

BUILDING COMPONENT CHARACTERISTICS	STANDARD REFERENCE DESIGN	PROPOSED DESIGN
Internal gains	Same as proposed	Receptacle, motor and process loads shall be modeled and estimated based on the space use classification. All end-use load components within and associated with the building shall be modeled to include, but not be limited to, the following: exhaust fans, parking garage ventilation fans, exterior building lighting, swimming pool heaters and pumps, elevators, escalators, refrigeration equipment and cooking equipment.
Schedules	Same as proposed	Operating schedules shall include hourly profiles for daily operation and shall account for variations between weekdays, weekends, holidays and any seasonal operation. Schedules shall model the time-dependent variations in occupancy, illumination, receptacle loads, thermostat settings, mechanical ventilation, HVAC equipment availability, service hot water usage and any process loads. The schedules shall be typical of the proposed building type as determined by the designer and approved by the jurisdiction.
Mechanical ventilation	Same as proposed	As proposed, in accordance with Section C403.2.5.
Heating systems	Fuel type: same as proposed design Equipment type <sup>a</sup> : from Tables C407.5.1(2) and C407.5.1(3) Efficiency: from Tables C403.2.3(4) and C403.2.3(5) Capacity <sup>b</sup> : sized proportionally to the capacities in the proposed design based on sizing runs, and shall be established such that no smaller number of unmet heating load hours and no larger heating capacity safety factors are provided than in the proposed design.	As proposed As proposed As proposed As proposed
Cooling systems	Fuel type: same as proposed design Equipment type <sup>c</sup> : from Tables C407.5.1(2) and C407.5.1(3) Efficiency: from Tables C403.2.3(1), C403.2.3(2) and C403.2.3(3) Capacity <sup>b</sup> : sized proportionally to the capacities in the proposed design based on sizing runs, and shall be established such that no smaller number of unmet cooling load hours and no larger cooling capacity safety factors are provided than in the proposed design. Economizer <sup>d</sup> : same as proposed, in accordance with Section C403.4.1.	As proposed As proposed As proposed As proposed
Service water heating	Fuel type: same as proposed Efficiency: from Table C404.2 Capacity: same as proposed Where no service water hot water system exists or is specified in the proposed design, no service hot water heating shall be modeled.	As proposed As proposed As proposed

- a. Where no heating system exists or has been specified, the heating system shall be modeled as fossil fuel. The system characteristics shall be identical in both the standard reference design and proposed design.
- b. The ratio between the capacities used in the annual simulations and the capacities determined by sizing runs shall be the same for both the standard reference design and proposed design.
- c. Where no cooling system exists or no cooling system has been specified, the cooling system shall be modeled as an air-cooled single-zone system, one unit per thermal zone. The system characteristics shall be identical in both the standard reference design and proposed design.
- d. If an economizer is required in accordance with Table C403.3.1(1), and if no economizer exists or is specified in the proposed design, then a supply air economizer shall be provided in accordance with Section C403.4.1.

TABLE C407.5.1(2)  
HVAC SYSTEMS MAP

CONDENSER COOLING SOURCE <sup>a</sup>	HEATING SYSTEM CLASSIFICATION <sup>b</sup>	STANDARD REFERENCE DESIGN HVAC SYSTEM TYPE <sup>c</sup>		
		Single-zone Residential System	Single-zone Nonresidential System	All Other
Water/ground	Electric resistance	System 5	System 5	System 1
	Heat pump	System 6	System 6	System 6
	Fossil fuel	System 7	System 7	System 2
Air/none	Electric resistance	System 8	System 9	System 3
	Heat pump	System 8	System 9	System 3
	Fossil fuel	System 10	System 11	System 4

- a. Select "water/ground" if the proposed design system condenser is water or evaporatively cooled; select "air/none" if the condenser is air cooled. Closed-circuit dry coolers shall be considered air cooled. Systems utilizing district cooling shall be treated as if the condenser water type were "water." If no mechanical cooling is specified or the mechanical cooling system in the proposed design does not require heat rejection, the system shall be treated as if the condenser water type were "Air." For proposed designs with ground-source or groundwater-source heat pumps, the standard reference design HVAC system shall be water-source heat pump (System 6).
- b. Select the path that corresponds to the proposed design heat source: electric resistance, heat pump (including air source and water source), or fuel fired. Systems utilizing district heating (steam or hot water) and systems with no heating capability shall be treated as if the heating system type were "fossil fuel." For systems with mixed fuel heating sources, the system or systems that use the secondary heating source type (the one with the smallest total installed output capacity for the spaces served by the system) shall be modeled identically in the standard reference design and the primary heating source type shall be used to determine *standard* reference design HVAC system type.
- c. Select the standard reference design HVAC system category: The system under "single-zone residential system" shall be selected if the HVAC system in the proposed design is a single-zone system and serves a residential space. The system under "single-zone nonresidential system" shall be selected if the HVAC system in the proposed design is a single-zone system and serves other than residential spaces. The system under "all other" shall be selected for all other cases.

**TABLE C407.5.1(3)  
SPECIFICATIONS FOR THE STANDARD REFERENCE DESIGN HVAC SYSTEM DESCRIPTIONS**

SYSTEM NO.	SYSTEM TYPE	FAN CONTROL	COOLING TYPE	HEATING TYPE
1	Variable air volume with parallel fan-powered boxes <sup>a</sup>	VAV <sup>d</sup>	Chilled water <sup>e</sup>	Electric resistance
2	Variable air volume with reheat <sup>b</sup>	VAV <sup>d</sup>	Chilled water <sup>e</sup>	Hot water fossil fuel boiler <sup>f</sup>
3	Packaged variable air volume with parallel fan-powered boxes <sup>a</sup>	VAV <sup>d</sup>	Direct expansion <sup>c</sup>	Electric resistance
4	Packaged variable air volume with reheat <sup>b</sup>	VAV <sup>d</sup>	Direct expansion <sup>c</sup>	Hot water fossil fuel boiler <sup>f</sup>
5	Two-pipe fan coil	Constant volume <sup>i</sup>	Chilled water <sup>e</sup>	Electric resistance
6	Water-source heat pump	Constant volume <sup>i</sup>	Direct expansion <sup>c</sup>	Electric heat pump and boiler <sup>g</sup>
7	Four-pipe fan coil	Constant volume <sup>i</sup>	Chilled water <sup>e</sup>	Hot water fossil fuel boiler <sup>f</sup>
8	Packaged terminal heat pump	Constant volume <sup>i</sup>	Direct expansion <sup>c</sup>	Electric heat pump <sup>h</sup>
9	Packaged rooftop heat pump	Constant volume <sup>i</sup>	Direct expansion <sup>c</sup>	Electric heat pump <sup>h</sup>
10	Packaged terminal air conditioner	Constant volume <sup>i</sup>	Direct expansion	Hot water fossil fuel boiler <sup>f</sup>
11	Packaged rooftop air conditioner	Constant volume <sup>i</sup>	Direct expansion	Fossil fuel furnace

For SI: 1 foot = 304.8 mm, 1 cfm/ft<sup>2</sup> = 0.0004719, 1 Btu/h = 0.293/W, °C = [(°F) -32/1.8].

- a. **VAV with parallel boxes:** Fans in parallel VAV fan-powered boxes shall be sized for 50 percent of the peak design flow rate and shall be modeled with 0.35 W/cfm fan power. Minimum volume setpoints for fan-powered boxes shall be equal to the minimum rate for the space required for ventilation consistent with Section C403.4.5, Exception 5. Supply air temperature setpoint shall be constant at the design condition.
- b. **VAV with reheat:** Minimum volume setpoints for VAV reheat boxes shall be 0.4 cfm/ft<sup>2</sup> of floor area. Supply air temperature shall be reset based on zone demand from the design temperature difference to a 10°F temperature difference under minimum load conditions. Design airflow rates shall be sized for the reset supply air temperature, i.e., a 10°F temperature difference.
- c. **Direct expansion:** The fuel type for the cooling system shall match that of the cooling system in the proposed design.
- d. **VAV:** Constant volume can be modeled if the system qualifies for Exception 1, Section C403.4.5. When the proposed design system has a supply, return or relief fan motor 25 horsepower (hp) or larger, the corresponding fan in the VAV system of the standard reference design shall be modeled assuming a variable speed drive. For smaller fans, a forward-curved centrifugal fan with inlet vanes shall be modeled. If the proposed design's system has a direct digital control system at the zone level, static pressure setpoint reset based on zone requirements in accordance with Section C403.4.2 shall be modeled.
- e. **Chilled water:** For systems using purchased chilled water, the chillers are not explicitly modeled and chilled water costs shall be based as determined in Sections C407.3 and C407.5.2. Otherwise, the standard reference design's chiller plant shall be modeled with chillers having the number as indicated in Table C407.5.1(4) as a function of standard reference building chiller plant load and type as indicated in Table C407.5.1(5) as a function of individual chiller load. Where chiller fuel source is mixed, the system in the standard reference design shall have chillers with the same fuel types and with capacities having the same proportional capacity as the proposed design's chillers for each fuel type. Chilled water supply temperature shall be modeled at 44°F design supply temperature and 56°F return temperature. Piping losses shall not be modeled in either building model. Chilled water supply water temperature shall be reset in accordance with Section C403.4.3.4. Pump system power for each pumping system shall be the same as the proposed design; if the proposed design has no chilled water pumps, the standard reference design pump power shall be 22 W/gpm (equal to a pump operating against a 75-foot head, 65-percent combined impeller and motor efficiency). The chilled water system shall be modeled as primary-only variable flow with flow maintained at the design rate through each chiller using a bypass. Chilled water pumps shall be modeled as riding the pump curve or with variable-speed drives when required in Section C403.4.3.4. The heat rejection device shall be an axial fan cooling tower with two-speed fans if required in Section C403.4.4. Condenser water design supply temperature shall be 85°F or 10°F approach to design wet-bulb temperature, whichever is lower, with a design temperature rise of 10°F. The tower shall be controlled to maintain a 70°F leaving water temperature where weather permits, floating up to leaving water temperature at design conditions. Pump system power for each pumping system shall be the same as the proposed design; if the proposed design has no condenser water pumps, the standard reference design pump power shall be 19 W/gpm (equal to a pump operating against a 60-foot head, 60-percent combined impeller and motor efficiency). Each chiller shall be modeled with separate condenser water and chilled water pumps interlocked to operate with the associated chiller.
- f. **Fossil fuel boiler:** For systems using purchased hot water or steam, the boilers are not explicitly modeled and hot water or steam costs shall be based on actual utility rates. Otherwise, the boiler plant shall use the same fuel as the proposed design and shall be natural draft. The standard reference design boiler plant shall be modeled with a single boiler if the standard reference design plant load is 600,000 Btu/h and less and with two equally sized boilers for plant capacities exceeding 600,000 Btu/h. Boilers shall be staged as required by the load. Hot water supply temperature shall be modeled at 180°F design supply temperature and 130°F return temperature. Piping losses shall not be modeled in either building model. Hot water supply water temperature shall be reset in accordance with Section C403.4.3.4. Pump system power for each pumping system shall be the same as the proposed design; if the proposed design has no hot water pumps, the standard reference design pump power shall be 19 W/gpm (equal to a pump operating against a 60-foot head, 60-percent combined impeller and motor efficiency). The hot water system shall be modeled as primary only with continuous variable flow. Hot water pumps shall be modeled as riding the pump curve or with variable speed drives when required by Section C403.4.3.4.
- g. **Electric heat pump and boiler:** Water-source heat pumps shall be connected to a common heat pump water loop controlled to maintain temperatures between 60°F and 90°F. Heat rejection from the loop shall be provided by an axial fan closed-circuit evaporative fluid cooler with two-speed fans if required in Section C403.4.2. Heat addition to the loop shall be provided by a boiler that uses the same fuel as the proposed design and shall be natural draft. If no boilers exist in the proposed design, the standard reference building boilers shall be fossil fuel. The standard reference design boiler plant shall be modeled with a single boiler if the standard reference design plant load is 600,000 Btu/h or less and with two equally sized boilers for plant capacities exceeding 600,000 Btu/h. Boilers shall be staged as required by the load. Piping losses shall not be modeled in either building model. Pump system power shall be the same as the proposed design; if the proposed design has no pumps, the standard reference design pump power shall be 22 W/gpm, which is equal to a pump operating against a 75-foot head, with a 65-percent combined impeller and motor efficiency. Loop flow shall be variable with flow shutoff at each heat pump when its compressor cycles off as required by Section C403.4.3.3. Loop pumps shall be modeled as riding the pump curve or with variable speed drives when required by Section C403.4.3.4.
- h. **Electric heat pump:** Electric air-source heat pumps shall be modeled with electric auxiliary heat. The system shall be controlled with a multistage space thermostat and an outdoor air thermostat wired to energize auxiliary heat only on the last thermostat stage and when outdoor air temperature is less than 40°F.
- i. **Constant volume:** Fans shall be controlled in the same manner as in the proposed design; i.e., fan operation whenever the space is occupied or fan operation cycled on calls for heating and cooling. If the fan is modeled as cycling and the fan energy is included in the energy efficiency rating of the equipment, fan energy shall not be modeled explicitly.

**TABLE C407.5.1(4)  
NUMBER OF CHILLERS**

TOTAL CHILLER PLANT CAPACITY	NUMBER OF CHILLERS
≤ 300 tons	1
> 300 tons, < 600 tons	2, sized equally
≥ 600 tons	2 minimum, with chillers added so that no chiller is larger than 800 tons, all sized equally

For SI: 1 ton = 3517 W.

**TABLE C407.5.1(5)  
WATER CHILLER TYPES**

INDIVIDUAL CHILLER PLANT CAPACITY	ELECTRIC-CHILLER TYPE	FOSSIL FUEL CHILLER TYPE
≤ 100 tons	Reciprocating	Single-effect absorption, direct fired
> 100 tons, < 300 tons	Screw	Double-effect absorption, direct fired
≥ 300 tons	Centrifugal	Double-effect absorption, direct fired

For SI: 1 ton = 3517 W.

**C407.6 Calculation software tools.** 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. Building operation for a full calendar year (8,760 hours).
3. Climate data for a full calendar year (8,760 hours) and shall reflect *approved* coincident hourly data for temperature, solar radiation, humidity and wind speed for the building location.
4. Ten or more thermal zones.
5. Thermal mass effects.
6. Hourly variations in occupancy, illumination, receptacle loads, thermostat settings, mechanical ventilation, HVAC equipment availability, service hot water usage and any process loads.
7. Part-load performance curves for mechanical equipment.
8. Capacity and efficiency correction curves for mechanical heating and cooling equipment.
9. Printed *code official* inspection checklist listing each of the *proposed design* component characteristics from Table C407.5.1(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.).

**C407.6.1 Specific approval.** Performance analysis tools meeting the applicable subsections of Section C407 and tested according to ASHRAE Standard 140 shall be per-

mitted to be *approved*. Tools are permitted to be *approved* based on meeting a specified threshold for a jurisdiction. The *code official* shall be permitted to approve tools for a specified application or limited scope.

**C407.6.2 Input values.** Where calculations require input values not specified by Sections C402, C403, C404 and C405, those input values shall be taken from an *approved* source.

## SECTION C408 SYSTEM COMMISSIONING

**C408.1 General.** This section covers the commissioning of the building mechanical systems in Section C403 and electrical power and lighting systems in Section C405.

**C408.2 Mechanical systems commissioning and completion requirements.** Prior to passing the final mechanical inspection, the *registered design professional* shall provide evidence of mechanical systems *commissioning* and completion in accordance the provisions of this section.

Construction document notes shall clearly indicate provisions for *commissioning* and completion requirements in accordance with this section and are permitted to refer to specifications for further requirements. Copies of all documentation shall be given to the owner and made available to the *code official* upon request in accordance with Sections C408.2.4 and C408.2.5.

**Exception:** The following systems are exempt from the commissioning requirements:

1. Mechanical systems in buildings where the total mechanical equipment capacity is less than 480,000 Btu/h (140 690 W) cooling capacity and 600,000 Btu/h (175 860 W) heating capacity.
2. Systems included in Section C403.3 that serve dwelling units and sleeping units in hotels, motels, boarding houses or similar units.

**C408.2.1 Commissioning plan.** A *commissioning plan* shall be developed by a *registered design professional* or approved *agency* and shall include the following items:

1. A narrative description of the activities that will be accomplished during each phase of commissioning, including the personnel intended to accomplish each of the activities.
2. A listing of the specific equipment, appliances or systems to be tested and a description of the tests to be performed.
3. Functions to be tested, including, but not limited to calibrations and economizer controls.
4. Conditions under which the test will be performed. At a minimum, testing shall affirm winter and summer design conditions and full outside air conditions.
5. Measurable criteria for performance.

**C408.2.2 Systems adjusting and balancing.** HVAC systems shall be balanced in accordance with generally accepted engineering standards. Air and water flow rates shall be measured and adjusted to deliver final flow rates within the tolerances provided in the product specifications. Test and balance activities shall include air system and hydronic system balancing.

**C408.2.2.1 Air systems balancing.** Each supply air outlet and *zone* terminal device shall be equipped with means for air balancing in accordance with the requirements of Chapter 6 of the *International Mechanical Code*. Discharge dampers are prohibited on constant volume fans and variable volume fans with motors 10 hp (18.6 kW) and larger. Air systems shall be balanced in a manner to first minimize throttling losses then, for fans with system power of greater than 1 hp (0.74 kW), fan speed shall be adjusted to meet design flow conditions.

**Exception:** Fans with fan motors of 1 hp (0.74 kW) or less.

**C408.2.2.2 Hydronic systems balancing.** Individual hydronic heating and cooling coils shall be equipped with means for balancing and measuring flow. Hydronic systems shall be proportionately balanced in a manner to first minimize throttling losses, then the pump impeller shall be trimmed or pump speed shall be adjusted to meet design flow conditions. Each hydronic system shall have either the capability to measure pressure across the pump, or test ports at each side of each pump.

**Exceptions:**

1. Pumps with pump motors of 5 hp (3.7 kW) or less.
2. Where throttling results in no greater than five percent of the nameplate horsepower draw above that required if the impeller were trimmed.

**C408.2.3 Functional performance testing.** Functional performance testing specified in Sections C408.2.3.1 through C408.2.3.3 shall be conducted.

**C408.2.3.1 Equipment.** Equipment functional performance testing shall demonstrate the installation and operation of components, systems, and system-to-system interfacing relationships in accordance with approved plans and specifications such that operation, function, and maintenance serviceability for each of the commissioned systems is confirmed. Testing shall include all modes and *sequence of operation*, including under full-load, part-load and the following emergency conditions:

1. All modes as described in the *sequence of operation*;
2. Redundant or *automatic* back-up mode;
3. Performance of alarms; and
4. Mode of operation upon a loss of power and restoration of power.

**Exception:** Unitary or packaged HVAC equipment listed in Tables C403.2.3(1) through C403.2.3(3) that do not require supply air economizers.

**C408.2.3.2 Controls.** HVAC control systems shall be tested to document that control devices, components, equipment, and systems are calibrated, adjusted and operate in accordance with approved plans and specifications. Sequences of operation shall be functionally tested to document they operate in accordance with *approved* plans and specifications.

**C408.2.3.3 Economizers.** Air economizers shall undergo a functional test to determine that they operate in accordance with manufacturer's specifications.

**C408.2.4 Preliminary commissioning report.** A preliminary report of commissioning test procedures and results shall be completed and certified by the *registered design professional* or *approved agency* and provided to the building owner. The report shall be identified as "Preliminary Commissioning Report" and shall identify:

1. Itemization of deficiencies found during testing required by this section that have not been corrected at the time of report preparation.
2. Deferred tests that cannot be performed at the time of report preparation because of climatic conditions.
3. Climatic conditions required for performance of the deferred tests.

**C408.2.4.1 Acceptance of report.** *Buildings*, or portions thereof, shall not pass the final mechanical inspection until such time as the *code official* has received a letter of transmittal from the *building owner* acknowledging that the *building owner* has received the Preliminary Commissioning Report.

**C408.2.4.2 Copy of report.** The *code official* shall be permitted to require that a copy of the Preliminary

Commissioning Report be made available for review by the *code official*.

**C408.2.5 Documentation requirements.** The *construction documents* shall specify that the *documents* described in this section be provided to the *building owner* within 90 days of the date of receipt of the *certificate of occupancy*.

**C408.2.5.1 Drawings.** Construction documents shall include the location and performance data on each piece of equipment.

**C408.2.5.2 Manuals.** An operating and maintenance manual shall be provided and include all of the following:

1. Submittal data stating equipment size and selected options for each piece of equipment requiring maintenance.
2. Manufacturer’s operation manuals and maintenance manuals for each piece of equipment requiring maintenance, except equipment not furnished as part of the project. Required routine maintenance actions shall be clearly identified.
3. Name and address of at least one service agency.
4. HVAC controls system maintenance and calibration information, including wiring diagrams, schematics, and control sequence descriptions. Desired or field-determined setpoints shall be permanently recorded on control drawings at control devices or, for digital control systems, in system programming instructions.
5. A narrative of how each system is intended to operate, including recommended setpoints.

**C408.2.5.3 System balancing report.** A written report describing the activities and measurements completed in accordance with Section C408.2.2.

**C408.2.5.4 Final commissioning report.** A report of test procedures and results identified as “Final Commissioning Report” shall be delivered to the building owner and shall include:

1. Results of functional performance tests.
2. Disposition of deficiencies found during testing, including details of corrective measures used or proposed.
3. Functional performance test procedures used during the commissioning process including measurable criteria for test acceptance, provided herein for repeatability.

**Exception:** Deferred tests which cannot be performed at the time of report preparation due to climatic conditions.

**C408.3 Lighting system functional testing.** Controls for automatic lighting systems shall comply with Section C408.3.

**C408.3.1 Functional testing.** Testing shall ensure that control hardware and software are calibrated, adjusted, programmed and in proper working condition in accor-

dance with the construction documents and manufacturer’s installation instructions. The construction documents shall state the party who will conduct the required functional testing. Where required by the code official, an approved party independent from the design or construction of the project shall be responsible for the functional testing and shall provide documentation to the code official certifying that the installed lighting controls meet the provisions of Section C405.

Where occupant sensors, time switches, programmable schedule controls, photosensors or daylighting controls are installed, the following procedures shall be performed:

1. Confirm that the placement, sensitivity and time-out adjustments for occupant sensors yield acceptable performance.
2. Confirm that the time switches and programmable schedule controls are programmed to turn the lights off.
3. Confirm that the placement and sensitivity adjustments for photosensor controls reduce electric light based on the amount of usable daylight in the space as specified.

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## CHAPTER 5

# REFERENCED STANDARDS

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

### AAMA

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

Standard reference number	Title	Referenced in code section number
AAMA/WDMA/CSA 101/I.S.2/A C440—11	North American Fenestration Standard/ Specifications for Windows, Doors and Unit Skylights	Table C402.4.3

### AHAM

Association of Home Appliance Manufacturers  
1111 19th Street, NW, Suite 402  
Washington, DC 20036

Standard reference number	Title	Referenced in code section number
ANSI/AHAM RAC-1—2008	Room Air Conditioners	Table C403.2.3(3)

### 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
ISO/AHRI/ASHRAE 13256-1 (2005)	Water-source Heat Pumps—Testing and Rating for Performance— Part 1: Water-to-air and Brine-to-air Heat Pumps	Table C403.2.3(2)
ISO/AHRI/ASHRAE 13256-2 (1998)	Water-source Heat Pumps—Testing and Rating for Performance— Part 2: Water-to-water and Brine-to-water Heat Pumps	Table C403.2.3(2)
210/240—08	Unitary Air Conditioning and Air-source Heat Pump Equipment	Table C403.2.3(1), Table C403.2.3(2)
310/380—04	Standard for Packaged Terminal Air Conditioners and Heat Pumps	Table C403.2.3(3)
340/360—2007	Commercial and Industrial Unitary Air-conditioning and Heat Pump Equipment	Table C403.2.3(1), Table C403.2.3(2)
365—09	Commercial and Industrial Unitary Air-conditioning Condensing Units	Table C403.2.3(1), Table C403.2.3(6)
390—03	Performance Rating of Single Package Vertical Air Conditioners and Heat Pumps	Table C403.2.3(3)
400—01	Liquid to Liquid Heat Exchangers with Addendum 2	Table C403.2.3(9)
440—08	Room Fan Coil	C403.2.8
460—05	Performance Rating Remote Mechanical Draft Air-cooled Refrigerant Condensers	Table C403.2.3(8)
550/590—03	Water Chilling Packages Using the Vapor Compression Cycle—with Addenda	C403.2.3.1, Table C403.2.3(7), Table C406.2(6)
560—00	Absorption Water Chilling and Water-heating Packages	Table C403.2.3(7)
1160—08	Performance Rating of Heat Pump Pool Heaters	Table C404.2

**REFERENCED STANDARDS**

**AMCA**

Air Movement and Control Association International  
30 West University Drive  
Arlington Heights, IL 60004-1806

Standard reference number	Title	Referenced in code section number
500D—10	Laboratory Methods for Testing Dampers for Rating	C402.4.5.1, C402.4.5.2

**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/CSA 4.3—04	Gas Water Heaters, Volume III—Storage Water Heaters with Input Ratings Above 75,000 Btu per Hour, Circulating Tank and Instantaneous	Table C404.2
Z21.47/CSA 2.3—06	Gas-fired Central Furnaces	Table C403.2.3(4), Table C406.2.(4)
Z83.8/CSA 2.6—09	Gas Unit Heaters, Gas Packaged Heaters, Gas Utility Heaters and Gas-fired Duct Furnaces	Table C403.2.3(4), Table C406.2.(4)

**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
ANSI/ASHRAE/ACCA Standard 183—2007	Peak Cooling and Heating Load Calculations in Buildings, Except Low-rise Residential Buildings	C403.2.1
ASHRAE—2004	ASHRAE HVAC Systems and Equipment Handbook—2004	C403.2.1
ISO/AHRI/ASHRAE 13256-1 (2005)	Water-source Heat Pumps—Testing and Rating for Performance— Part 1: Water-to-air and Brine-to-air Heat Pumps	Table C403.2.3(2)
ISO/AHRI/ASHRAE 13256-2 (1998)	Water-source Heat Pumps—Testing and Rating for Performance— Part 2: Water-to-water and Brine-to-water Heat Pumps	Table C403.2.3(2)
90.1—2010	Energy Standard for Buildings Except Low-rise Residential Buildings (ANSI/ASHRAE/IESNA 90.1—2007)	C401.2, C401.2.1, C402.1.1, Table C402.1.2, Table C402.2, Table C407.6.1
119—88 (RA 2004)	Air Leakage Performance for Detached Single-family Residential Buildings	Table C405.5.2(1)
140—2010	Standard Method of Test for the Evaluation of Building Energy Analysis Computer Programs	C407.6.1
146—2006	Testing and Rating Pool Heaters	Table C404.2

**ASTM**

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

Standard reference number	Title	Referenced in code section number
C 90—08	Specification for Load-bearing Concrete Masonry Units	Table C402.2
C 1371—04	Standard Test Method for Determination of Emittance of Materials Near Room Temperature Using Portable Emisometers	Table C402.2.1.1
C 1549—04	Standard Test Method for Determination of Solar Reflectance Near Ambient Temperature Using A Portable Solar Reflectometer	Table C405.2.1.1
D 1003—07e1	Standard Test Method for Haze and Luminous Transmittance of Transparent Plastics	C402.3.2.2

**ASTM—continued**

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 . . . . .	Table C402.2.1.1, C402.4.1.2.2, Table C402.4.3, C402.4.4, C402.4.8
E 408—71(2002)	Test Methods for Total Normal Emittance of Surfaces Using Inspection-meter Techniques . . . . .	Table C402.2.1.1
E 779—03	Standard Test Method for Determining Air Leakage Rate by Fan Pressurization . . . . .	C402.4.1.2.3
E 903—96	Standard Test Method Solar Absorptance, Reflectance and Transmittance of Materials Using Integrating Spheres (Withdrawn 2005) . . . . .	Table C402.2.1.1
E 1677—05	Standard Specification for an Air-retarder (AR) Material or System for Low-rise Framed Building Walls . . . . .	C402.4.1.2.2
E 1918—97	Standard Test Method for Measuring Solar Reflectance of Horizontal or Low-sloped Surfaces in the Field . . . . .	Table C402.2.1.1
E 1980—(2001)	Standard Practice for Calculating Solar Reflectance Index of Horizontal and Low-sloped Opaque Surfaces . . . . .	Table C402.2.1.1
E 2178—03	Standard Test Method for Air Permanence of Building Materials . . . . .	C402.4.1.2.1
E 2357—05	Standard Test Method for Determining Air Leakage of Air Barriers Assemblies . . . . .	C404.1.2.2

**CSA**

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

Standard reference number	Title	Referenced in code section number
AAMA/WDMA/CSA 101/I.S.2/A440—11	North American Fenestration Standard/Specification for Windows, Doors and Unit Skylights . . . . .	Table C402.4.3

**CTI**

Cooling Technology Institute  
2611 FM 1960 West, Suite A-101  
Houston, TX 77068

Standard reference number	Title	Referenced in code section number
ATC 105 (00)	Acceptance Test Code for Water Cooling Tower . . . . .	Table C403.2.3(8)
STD 201—09	Standard for Certification of Water Cooling Towers Thermal Performances . . . . .	Table C403.2.3(8)

**DASMA**

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

Standard reference number	Title	Referenced in code section number
105—92 (R2004)	Test Method for Thermal Transmittance and Air Infiltration of Garage Doors . . . . .	Table C402.4.3

**REFERENCED STANDARDS**

**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
10 CFR, Part 430—1998	Energy Conservation Program for Consumer Products: Test Procedures and Certification and Enforcement Requirement for Plumbing Products; and Certification and Enforcement Requirements for Residential Appliances; Final Rule . . . . .	Table C403.2.3(4), Table C403.2.3(5), Table C404.2, Table C406.2(4), Table C406.2(5)
10 CFR, Part 430, Subpart B, Appendix N—1998	Uniform Test Method for Measuring the Energy Consumption of Furnaces and Boilers . . . . .	C202
10 CFR, Part 431—2004	Energy Efficiency Program for Certain Commercial and Industrial Equipment: Test Procedures and Efficiency Standards; Final Rules. . . . .	Table C403.2.3(5), Table C406.2(5)
NAECA 87—(88)	National Appliance Energy Conservation Act 1987 [(Public Law 100-12 (with Amendments of 1988-P.L. 100-357))] . . . . .	Tables C403.2.3(1), (2), (4)

**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—12	International Building Code® . . . . .	C201.3, C303.2, C402.4.4
IFC—12	International Fire Code® . . . . .	C201.3
IFGC—12	International Fuel Gas Code® . . . . .	C201.3
IMC—12	International Mechanical Code® . . . . .	C403.2.5, C403.2.5.1, C403.2.6, C403.2.7, C403.2.7.1, C403.2.7.1.1, C403.2.7.1.2, C403.2.7.1.3, C403.4.5, C408.2.2.1
IPC—12	International Plumbing Code® . . . . .	C201.3

**IESNA**

Illuminating Engineering Society of North America  
 120 Wall Street, 17th Floor  
 New York, NY 10005-4001

Standard reference number	Title	Referenced in code section number
ANSI/ASHRAE/IESNA 90.1—2007	Energy Standard for Buildings, Except Low-rise Residential Buildings . . . . .	C401.2, C401.2.1, C402.1.1, Table C402.1.2, Table C402.2

**ISO**

International Organization for Standardization  
 1, rue de Varembe, Case postale 56, CH-1211  
 Geneva, Switzerland

Standard reference number	Title	Referenced in code section number
ISO/AHRI/ASHRAE 13256-1 (2005)	Water-source Heat Pumps—Testing and Rating for Performance— Part 1: Water-to-air and Brine-to-air Heat Pumps . . . . .	C403.2.3(2)
ISO/AHRI/ASHRAE 13256-2 (1998)	Water-Source Heat Pumps—Testing and Rating for Performance— Part 2: Water-to-water and Brine-to-water Heat Pumps . . . . .	C403.2.3(2)

# NFRC

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

Standard reference number	Title	Referenced in code section number
100—2009	Procedure for Determining Fenestration Products <i>U</i> -factors—Second Edition . . . . .	C303.1.2, C402.2.1
200—2009	Procedure for Determining Fenestration Product Solar Heat Gain Coefficients and Visible Transmittance at Normal Incidence—Second Edition . . . . .	C303.1.3, C402.3.1.1
400—2009	Procedure for Determining Fenestration Product Air Leakage—Second Edition . . . . .	Table C402.4.3

# SMACNA

Sheet Metal and Air Conditioning Contractors National Association, Inc.  
4021 Lafayette Center Drive  
Chantilly, VA 20151-1209

Standard reference number	Title	Referenced in code section number
SMACNA—85	HVAC Air Duct Leakage Test Manual . . . . .	C403.2.7.1.3

# UL

Underwriters Laboratories  
333 Pfingsten Road  
Northbrook, IL 60062-2096

Standard reference number	Title	Referenced in code section number
727—06	Oil-fired Central Furnaces—with Revisions through April 2010 . . . . .	Table C403.2.3(4), Table C406.2(4)
731—95	Oil-fired Unit Heaters—with Revisions through April 2010. . . . .	Table C403.2.3(4), Table C406.2(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 (May 31, 2005)	R-value Rule . . . . .	C303.1.4

# 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/I.S.2/A440—11	North American Fenestration Standard/Specification for Windows, Doors and Unit Skylights . . . . .	Table C402.4.3



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# CHAPTER 1 [RE]

## SCOPE AND ADMINISTRATION

### PART 1—SCOPE AND APPLICATION

#### SECTION R101 SCOPE AND GENERAL REQUIREMENTS

**R101.1 Title.** This code shall be known as the *International Energy Conservation Code* of [NAME OF JURISDICTION], and shall be cited as such. It is referred to herein as “this code.”

**R101.2 Scope.** This code applies to *residential buildings* and the buildings sites and associated systems and equipment.

**R101.3 Intent.** This code shall regulate the design and construction of buildings for the effective use and conservation of energy over the useful life of each building. This code is intended to provide flexibility to permit the use of innovative approaches and techniques to achieve this objective. This code is not intended to abridge safety, health or environmental requirements contained in other applicable codes or ordinances.

**R101.4 Applicability.** Where, in any specific case, different sections of this code specify different materials, methods of construction or other requirements, the most restrictive shall govern. Where there is a conflict between a general requirement and a specific requirement, the specific requirement shall govern.

**R101.4.1 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.

**R101.4.2 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.

**R101.4.3 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 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 a space, 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.

**R101.4.4 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.

**R101.4.5 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.

**R101.4.6 Mixed occupancy.** Where a building includes both *residential* and *commercial* occupancies, each occupancy shall be separately considered and meet the applicable provisions of the IECC—Commercial and Residential Provisions.

**R101.5 Compliance.** *Residential buildings* shall meet the provisions of IECC—Residential Provisions. *Commercial buildings* shall meet the provisions of IECC—Commercial Provisions.

**R101.5.1 Compliance materials.** The *code official* shall be permitted to approve specific computer software, worksheets, compliance manuals and other similar materials that meet the intent of this code.

**R101.5.2 Low energy buildings.** The following buildings, or portions thereof, separated from the remainder of the building by *building thermal envelope* assemblies complying with this code shall be exempt from the *building thermal envelope* provisions of this code:

1. Those with a peak design rate of energy usage less than  $3.4 \text{ Btu/h} \cdot \text{ft}^2$  ( $10.7 \text{ W/m}^2$ ) or  $1.0 \text{ watt/ft}^2$  ( $10.7 \text{ W/m}^2$ ) of floor area for space conditioning purposes.
2. Those that do not contain *conditioned space*.

## SECTION R102 ALTERNATE MATERIALS—METHOD OF CONSTRUCTION, DESIGN OR INSULATING SYSTEMS

**R102.1 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* as meeting the intent of this code.

**R102.1.1 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 shall be met.

## PART 2—ADMINISTRATION AND ENFORCEMENT

### SECTION R103 CONSTRUCTION DOCUMENTS

**R103.1 General.** 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* is authorized to require necessary construction documents to be prepared by a registered design professional.

**Exception:** The *code official* is authorized to waive the requirements for construction documents or other supporting data if the *code official* determines they are not necessary to confirm compliance with this code.

**R103.2 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*. Construction documents shall be of sufficient clarity to indicate the loca-

tion, 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.

**R103.3 Examination of documents.** The *code official* 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.

**R103.3.1 Approval of construction documents.** When the *code official* 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*. 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*. 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.

**R103.3.2 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.

**R103.3.3 Phased approval.** The *code official* shall have the authority to issue a permit for the construction of part of an energy conservation system before the construction documents for the entire system have been submitted or *approved*, provided adequate information and detailed statements have been filed complying with all pertinent requirements of this code. The holders of such permit shall proceed at their own risk without assurance that the permit for the entire energy conservation system will be granted.

**R103.4 Amended construction documents.** Changes made during construction that are not in compliance with the *approved* construction documents shall be resubmitted for approval as an amended set of construction documents.

**R103.5 Retention of construction documents.** One set of *approved* construction documents shall be retained by the *code official* for a period of not less than 180 days from date of completion of the permitted work, or as required by state or local laws.

## SECTION R104 INSPECTIONS

**R104.1 General.** Construction or work for which a permit is required shall be subject to inspection by the *code official*.

**R104.2 Required approvals.** Work shall not be done beyond the point indicated in each successive inspection without first obtaining the approval of the *code official*. The *code official*, 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*.

**R104.3 Final inspection.** The building shall have a final inspection and not be occupied until *approved*.

**R104.4 Reinspection.** A building shall be reinspected when determined necessary by the *code official*.

**R104.5 Approved inspection agencies.** The *code official* is authorized to accept reports of *approved* inspection agencies, provided such agencies satisfy the requirements as to qualifications and reliability.

**R104.6 Inspection requests.** It shall be the duty of the holder of the permit or their duly authorized agent to notify the *code official* when work is ready for inspection. It shall be the duty of the permit holder to provide access to and means for inspections of such work that are required by this code.

**R104.7 Reinspection and testing.** Where any work or installation does not pass an initial test or inspection, the necessary corrections shall be made so as to achieve compliance with this code. The work or installation shall then be resubmitted to the *code official* for inspection and testing.

**R104.8 Approval.** After the prescribed tests and inspections indicate that the work complies in all respects with this code, a notice of approval shall be issued by the *code official*.

**R104.8.1 Revocation.** The *code official* is authorized to, in writing, suspend or revoke a notice of approval issued under the provisions of this code wherever the certificate is issued in error, or on the basis of incorrect information supplied, or where it is determined that the building or structure, premise, or portion thereof is in violation of any ordinance or regulation or any of the provisions of this code.

## SECTION R105 VALIDITY

**R105.1 General.** If a portion of this code is held to be illegal or void, such a decision shall not affect the validity of the remainder of this code.

## SECTION R106 REFERENCED STANDARDS

**R106.1 Referenced codes and standards.** The codes and standards referenced in this code shall be those listed in

Chapter 5, and such codes and standards shall be considered as part of the requirements of this code to the prescribed extent of each such reference and as further regulated in Sections R106.1.1 and R106.1.2.

**R106.1.1 Conflicts.** Where differences occur between provisions of this code and referenced codes and standards, the provisions of this code shall apply.

**R106.1.2 Provisions in referenced codes and standards.** Where the extent of the reference to a referenced code or standard includes subject matter that is within the scope of this code, the provisions of this code, as applicable, shall take precedence over the provisions in the referenced code or standard.

**R106.2 Conflicting requirements.** Where the provisions of this code and the referenced standards conflict, the provisions of this code shall take precedence.

**R106.3 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.

**R106.4 Other laws.** The provisions of this code shall not be deemed to nullify any provisions of local, state or federal law.

## SECTION R107 FEES

**R107.1 Fees.** A permit shall not be issued until the fees prescribed in Section R107.2 have been paid, nor shall an amendment to a permit be released until the additional fee, if any, has been paid.

**R107.2 Schedule of permit fees.** A fee for each permit shall be paid as required, in accordance with the schedule as established by the applicable governing authority.

**R107.3 Work commencing before permit issuance.** Any person who commences any work before obtaining the necessary permits shall be subject to an additional fee established by the *code official*, which shall be in addition to the required permit fees.

**R107.4 Related fees.** The payment of the fee for the construction, *alteration*, removal or demolition of work done in connection to or concurrently with the work or activity authorized by a permit shall not relieve the applicant or holder of the permit from the payment of other fees that are prescribed by law.

**R107.5 Refunds.** The *code official* is authorized to establish a refund policy.

## SECTION R108 STOP WORK ORDER

**R108.1 Authority.** Whenever the *code official* finds any work regulated by this code being performed in a manner either contrary to the provisions of this code or dangerous or unsafe, the *code official* is authorized to issue a stop work order.

## SCOPE AND ADMINISTRATION

**R108.2 Issuance.** The stop work order shall be in writing and shall be given to the owner of the property involved, or to the owner's agent, or to the person doing the work. Upon issuance of a stop work order, the cited work shall immediately cease. The stop work order shall state the reason for the order, and the conditions under which the cited work will be permitted to resume.

**R108.3 Emergencies.** Where an emergency exists, the *code official* shall not be required to give a written notice prior to stopping the work.

**R108.4 Failure to comply.** Any person who shall continue any work after having been served with a stop work order, except such work as that person is directed to perform to remove a violation or unsafe condition, shall be liable to a fine of not less than [AMOUNT] dollars or more than [AMOUNT] dollars.

## SECTION R109 BOARD OF APPEALS

**R109.1 General.** In order to hear and decide appeals of orders, decisions or determinations made by the *code official* relative to the application and interpretation of this code, there shall be and is hereby created a board of appeals. The *code official* shall be an ex officio member of said board but shall have no vote on any matter before the board. The board of appeals shall be appointed by the governing body and shall hold office at its pleasure. The board shall adopt rules of procedure for conducting its business, and shall render all decisions and findings in writing to the appellant with a duplicate copy to the *code official*.

**R109.2 Limitations on authority.** An application for appeal shall be based on a claim that the true intent of this code or the rules legally adopted thereunder have been incorrectly interpreted, the provisions of this code do not fully apply or an equally good or better form of construction is proposed. The board shall have no authority to waive requirements of this code.

**R109.3 Qualifications.** The board of appeals shall consist of members who are qualified by experience and training and are not employees of the jurisdiction.

## CHAPTER 2 [RE] DEFINITIONS

### SECTION R201 GENERAL

**R201.1 Scope.** Unless stated otherwise, the following words and terms in this code shall have the meanings indicated in this chapter.

**R201.2 Interchangeability.** Words used in the present tense include the future; words in the masculine gender include the feminine and neuter; the singular number includes the plural and the plural includes the singular.

**R201.3 Terms defined in other codes.** Terms that are not defined in this code but are defined in the *International Building Code*, *International Fire Code*, *International Fuel Gas Code*, *International Mechanical Code*, *International Plumbing Code* or the *International Residential Code* shall have the meanings ascribed to them in those codes.

**R201.4 Terms not defined.** Terms not defined by this chapter shall have ordinarily accepted meanings such as the context implies.

### SECTION R202 GENERAL DEFINITIONS

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

**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.

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

**APPROVED.** Approval by the *code official* 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*.

**BUILDING.** Any structure used or intended for supporting or sheltering any use or occupancy, including any mechanical systems, service water heating systems and electric power and lighting systems located on the building site and supporting the building.

**BUILDING SITE.** A contiguous area of land that is under the ownership or control of one entity.

**BUILDING THERMAL ENVELOPE.** The basement walls, exterior walls, floor, roof, and any other building elements that enclose *conditioned space* or provides a boundary between *conditioned space* and exempt or unconditioned space.

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

**CODE OFFICIAL.** The officer or other designated authority charged with the administration and enforcement of this code, or a duly authorized representative.

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

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

**CONDITIONED SPACE.** An area or room within a building being heated or cooled, containing uninsulated ducts, or with a fixed opening directly into an adjacent *conditioned space*.

**CONTINUOUS AIR BARRIER.** A combination of materials and assemblies that restrict or prevent the passage of air through the building thermal envelope.

**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.

**DEMAND RECIRCULATION WATER SYSTEM.** A water distribution system where pump(s) prime the service hot water piping with heated water upon demand for hot water.

**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.

## DEFINITIONS

**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.

**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 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.

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

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

**FENESTRATION PRODUCT, SITE-BUILT.** A fenestration designed to be made up of field-glazed or field-assembled units using specific factory cut or otherwise factory-formed framing and glazing units. Examples of site-built fenestration include storefront systems, curtain walls, and atrium roof systems.

**F-FACTOR.** The perimeter heat loss factor for slab-on-grade floors ( $\text{Btu/h} \times \text{ft} \times ^\circ\text{F}$ ) [ $\text{W}/(\text{m} \times \text{K})$ ].

**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.

**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.

**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.

**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").

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

**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").

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

**RESIDENTIAL BUILDING.** For this code, includes detached one- and two-family dwellings and multiple single-family dwellings (townhouses) as well as Group R-2, R-3 and R-4 buildings three stories or less in height above grade plane.

**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.

**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 ( $h \cdot \text{ft}^2 \cdot ^\circ\text{F}/\text{Btu}$ ) [ $(\text{m}^2 \cdot \text{K})/\text{W}$ ].

**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 less than 60 degrees (1.05 rad) from horizontal. Glazing material in skylights, including unit skylights, solariums, sunrooms, roofs and sloped walls is included in this definition.

**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.

**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.

**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.

**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.

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

**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 (Btu/h · ft<sup>2</sup> · °F) [W/(m<sup>2</sup> · K)].

**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.

**VISIBLE TRANSMITTANCE [VT].** The ratio of visible light entering the space through the fenestration product assembly to the incident visible light, Visible Transmittance, includes the effects of glazing material and frame and is expressed as a number between 0 and 1.

**WHOLE HOUSE MECHANICAL VENTILATION SYSTEM.** An exhaust system, supply system, or combination thereof that is designed to mechanically exchange indoor air with outdoor air when operating continuously or through a programmed intermittent schedule to satisfy the whole house ventilation rates.

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



## CHAPTER 3 [RE]

# GENERAL REQUIREMENTS

### SECTION R301 CLIMATE ZONES

**R301.1 General.** Climate zones from Figure R301.1 or Table R301.1 shall be used in determining the applicable requirements from Chapter 4. Locations not in Table R301.1 (outside the United States) shall be assigned a climate zone based on Section R301.3.

**R301.2 Warm humid counties.** Warm humid counties are identified in Table R301.1 by an asterisk.

**R301.3 International climate zones.** The climate zone for any location outside the United States shall be determined by applying Table R301.3(1) and then Table R301.3(2).

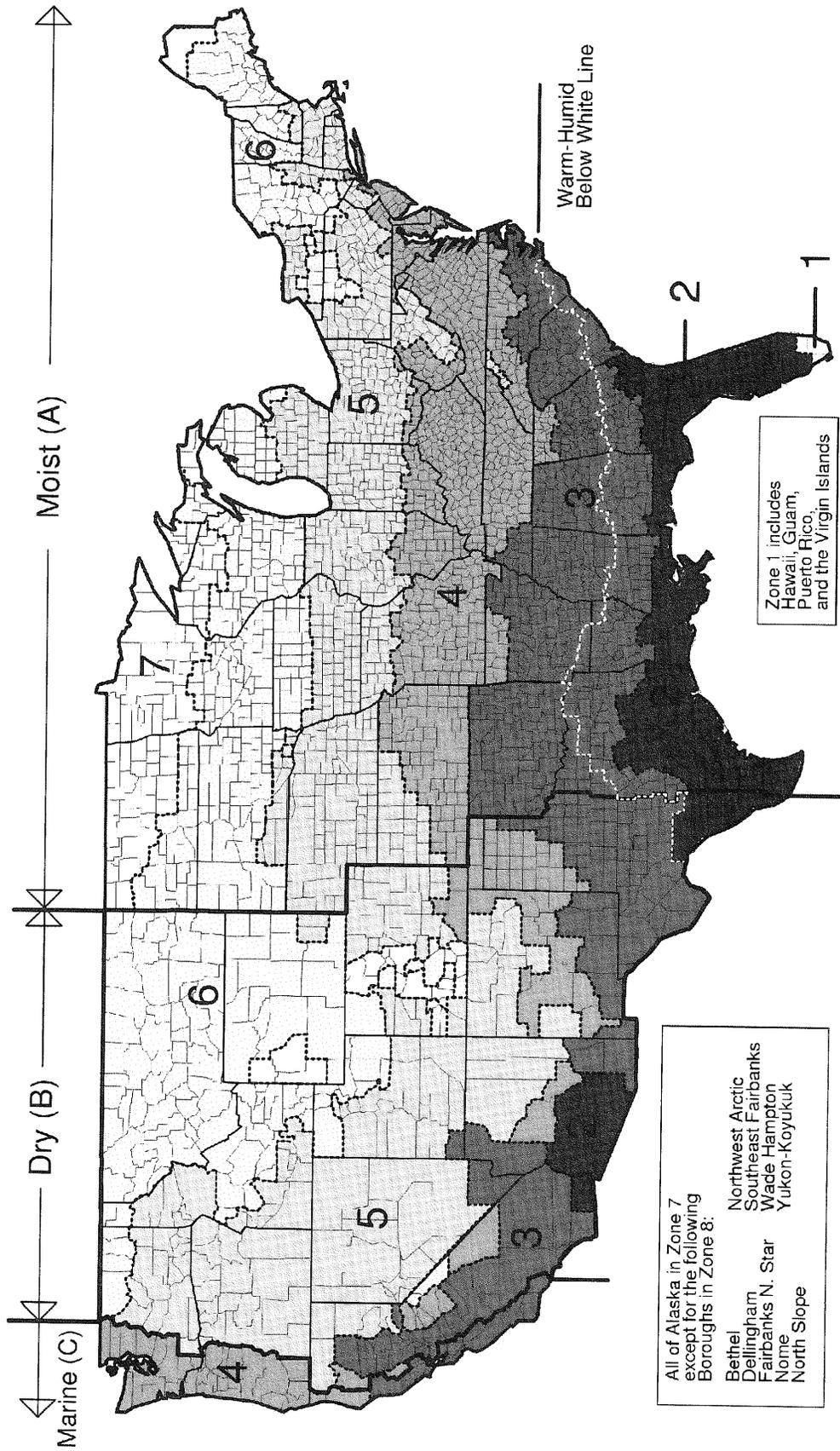


FIGURE R301.1  
CLIMATE ZONES

TABLE R301.1  
CLIMATE ZONES, MOISTURE REGIMES, AND WARM-HUMID  
DESIGNATIONS BY STATE, COUNTY AND TERRITORY

Key: A – Moist, B – Dry, C – Marine. Absence of moisture designation indicates moisture regime is irrelevant. Asterisk (\*) indicates a warm-humid location.

### US STATES

<b>ALABAMA</b>	3A Lee	7 Kodiak Island	3A Calhoun	3A Monroe
3A Autauga*	3A Limestone	7 Lake and Peninsula	4A Carroll	3A Montgomery
2A Baldwin*	3A Lowndes*	7 Matanuska-Susitna	3A Chicot	3A Nevada
3A Barbour*	3A Macon*	8 Nome	3A Clark	4A Newton
3A Bibb	3A Madison	8 North Slope	3A Clay	3A Ouachita
3A Blount	3A Marengo*	8 Northwest Arctic	3A Cleburne	3A Perry
3A Bullock*	3A Marion	7 Prince of Wales Outer Ketchikan	3A Cleveland	3A Phillips
3A Butler*	3A Marshall	7 Sitka	3A Columbia*	3A Pike
3A Calhoun	2A Mobile*	7 Skagway-Hoonah- Angoon	3A Conway	3A Poinsett
3A Chambers	3A Monroe*	8 Southeast Fairbanks	3A Craighead	3A Polk
3A Cherokee	3A Montgomery*	7 Valdez-Cordova	3A Crawford	3A Pope
3A Chilton	3A Morgan	8 Wade Hampton	3A Crittenden	3A Prairie
3A Choctaw*	3A Perry*	7 Wrangell-Petersburg	3A Cross	3A Pulaski
3A Clarke*	3A Pickens	7 Yakutat	3A Dallas	3A Randolph
3A Clay	3A Pike*	8 Yukon-Koyukuk	3A Desha	3A Saline
3A Cleburne	3A Randolph	<b>ARIZONA</b>	3A Drew	3A Scott
3A Coffee*	3A Russell*	5B Apache	3A Faulkner	4A Searcy
3A Colbert	3A Shelby	3B Cochise	3A Franklin	3A Sebastian
3A Conecuh*	3A St. Clair	5B Coconino	4A Fulton	3A Sevier*
3A Coosa	3A Sumter	4B Gila	3A Garland	3A Sharp
3A Covington*	3A Talladega	3B Graham	3A Grant	3A St. Francis
3A Crenshaw*	3A Tallapoosa	3B Greenlee	3A Greene	4A Stone
3A Cullman	3A Tuscaloosa	2B La Paz	3A Hempstead*	3A Union*
3A Dale*	3A Walker	3B Maricopa	3A Hot Spring	3A Van Buren
3A Dallas*	3A Washington*	3B Mohave	3A Howard	4A Washington
3A DeKalb	3A Wilcox*	5B Navajo	3A Independence	3A White
3A Elmore*	3A Winston	2B Pima	4A IZARD	3A Woodruff
3A Escambia*	<b>ALASKA</b>	2B Pinal	3A Jackson	3A Yell
3A Etowah	7 Aleutians East	3B Santa Cruz	3A Jefferson	<b>CALIFORNIA</b>
3A Fayette	7 Aleutians West	4B Yavapai	3A Johnson	3C Alameda
3A Franklin	7 Anchorage	2B Yuma	3A Lafayette*	6B Alpine
3A Geneva*	8 Bethel	<b>ARKANSAS</b>	3A Lawrence	4B Amador
3A Greene	7 Bristol Bay	3A Arkansas	3A Lee	3B Butte
3A Hale	7 Denali	3A Ashley	3A Lincoln	4B Calaveras
3A Henry*	8 Dillingham	4A Baxter	3A Little River*	3B Colusa
3A Houston*	8 Fairbanks North Star	4A Benton	3A Logan	3B Contra Costa
3A Jackson	7 Haines	4A Boone	3A Lonoke	4C Del Norte
3A Jefferson	7 Juneau	3A Bradley	4A Madison	4B El Dorado
3A Lamar	7 Kenai Peninsula		4A Marion	3B Fresno
3A Lauderdale	7 Ketchikan Gateway		3A Miller*	3B Glenn
3A Lawrence			3A Mississippi	

(continued)

**GENERAL REQUIREMENTS**

**TABLE R301.1—continued  
CLIMATE ZONES, MOISTURE REGIMES, AND WARM-HUMID  
DESIGNATIONS BY STATE, COUNTY AND TERRITORY**

4C Humboldt	3B Yuba	5B Morgan	2A Escambia*	2A Taylor*
2B Imperial	<b>COLORADO</b>	4B Otero	2A Flagler*	2A Union*
4B Inyo	5B Adams	6B Ouray	2A Franklin*	2A Volusia*
3B Kern	6B Alamosa	7 Park	2A Gadsden*	2A Wakulla*
3B Kings	5B Arapahoe	5B Phillips	2A Gilchrist*	2A Walton*
4B Lake	6B Archuleta	7 Pitkin	2A Glades*	2A Washington*
5B Lassen	4B Baca	5B Prowers	2A Gulf*	<b>GEORGIA</b>
3B Los Angeles	5B Bent	5B Pueblo	2A Hamilton*	2A Appling*
3B Madera	5B Boulder	6B Rio Blanco	2A Hardee*	2A Atkinson*
3C Marin	6B Chaffee	7 Rio Grande	2A Hendry*	2A Bacon*
4B Mariposa	5B Cheyenne	7 Routt	2A Hernando*	2A Baker*
3C Mendocino	7 Clear Creek	6B Saguache	2A Highlands*	3A Baldwin
3B Merced	6B Conejos	7 San Juan	2A Hillsborough*	4A Banks
5B Modoc	6B Costilla	6B San Miguel	2A Holmes*	3A Barrow
6B Mono	5B Crowley	5B Sedgwick	2A Indian River*	3A Bartow
3C Monterey	6B Custer	7 Summit	2A Jackson*	3A Ben Hill*
3C Napa	5B Delta	5B Teller	2A Jefferson*	2A Berrien*
5B Nevada	5B Denver	5B Washington	2A Lafayette*	3A Bibb
3B Orange	6B Dolores	5B Weld	2A Lake*	3A Bleckley*
3B Placer	5B Douglas	5B Yuma	2A Lee*	2A Brantley*
5B Plumas	6B Eagle	<b>CONNECTICUT</b>	2A Leon*	2A Brooks*
3B Riverside	5B Elbert	5A (all)	2A Levy*	2A Bryan*
3B Sacramento	5B El Paso	<b>DELAWARE</b>	2A Liberty*	3A Bulloch*
3C San Benito	5B Fremont	4A (all)	2A Madison*	3A Burke
3B San Bernardino	5B Garfield	<b>DISTRICT OF</b>	2A Manatee*	3A Butts
3B San Diego	5B Gilpin	<b>COLUMBIA</b>	2A Marion*	3A Calhoun*
3C San Francisco	7 Grand	4A (all)	2A Martin*	2A Camden*
3B San Joaquin	7 Gunnison	<b>FLORIDA</b>	1A Miami-Dade*	3A Candler*
3C San Luis Obispo	7 Hinsdale	2A Alachua*	1A Monroe*	3A Carroll
3C San Mateo	5B Huerfano	2A Okaloosa*	2A Nassau*	4A Catoosa
3C Santa Barbara	7 Jackson	2A Okeechobee*	2A Okaloosa*	2A Charlton*
3C Santa Clara	5B Jefferson	2A Orange*	2A Osceola*	2A Chatham*
3C Santa Cruz	5B Kiowa	2A Osceola*	2A Palm Beach*	3A Chattahoochee*
3B Shasta	5B Kit Carson	2A Pasco*	2A Palm Beach*	4A Chattooga
5B Sierra	7 Lake	2A Pinellas*	2A Pasco*	3A Cherokee
5B Siskiyou	5B La Plata	2A Polk*	2A Pinellas*	3A Clarke
3B Solano	5B Larimer	2A Putnam*	2A Polk*	3A Clay*
3C Sonoma	4B Las Animas	2A Santa Rosa*	2A Putnam*	3A Clayton
3B Stanislaus	5B Lincoln	2A Santa Rosa*	2A Santa Rosa*	2A Clinch*
3B Sutter	5B Logan	2A Sarasota*	2A Sarasota*	3A Cobb
3B Tehama	5B Mesa	2A Seminole*	2A Seminole*	3A Coffee*
4B Trinity	7 Mineral	2A St. Johns*	2A St. Johns*	2A Colquitt*
3B Tulare	6B Moffat	2A St. Lucie*	2A St. Lucie*	3A Columbia
4B Tuolumne	5B Montezuma	2A Sumter*	2A Sumter*	2A Cook*
3C Ventura	5B Montrose	2A Suwannee*	2A Suwannee*	3A Coweta
3B Yolo				

(continued)

TABLE R301.1—continued  
CLIMATE ZONES, MOISTURE REGIMES, AND WARM-HUMID  
DESIGNATIONS BY STATE, COUNTY AND TERRITORY

3A Crawford	2A Lanier*	3A Taylor*	5B Cassia	4A Crawford
3A Crisp*	3A Laurens*	3A Telfair*	6B Clark	5A Cumberland
4A Dade	3A Lee*	3A Terrell*	5B Clearwater	5A DeKalb
4A Dawson	2A Liberty*	2A Thomas*	6B Custer	5A De Witt
2A Decatur*	3A Lincoln	3A Tift*	5B Elmore	5A Douglas
3A DeKalb	2A Long*	2A Toombs*	6B Franklin	5A DuPage
3A Dodge*	2A Lowndes*	4A Towns	6B Fremont	5A Edgar
3A Dooly*	4A Lumpkin	3A Treutlen*	5B Gem	4A Edwards
3A Dougherty*	3A Macon*	3A Troup	5B Gooding	4A Effingham
3A Douglas	3A Madison	3A Turner*	5B Idaho	4A Fayette
3A Early*	3A Marion*	3A Twiggs*	6B Jefferson	5A Ford
2A Echols*	3A McDuffie	4A Union	5B Jerome	4A Franklin
2A Effingham*	2A McIntosh*	3A Upson	5B Kootenai	5A Fulton
3A Elbert	3A Meriwether	4A Walker	5B Latah	4A Gallatin
3A Emanuel*	2A Miller*	3A Walton	6B Lemhi	5A Greene
2A Evans*	2A Mitchell*	2A Ware*	5B Lewis	5A Grundy
4A Fannin	3A Monroe	3A Warren	5B Lincoln	4A Hamilton
3A Fayette	3A Montgomery*	3A Washington	6B Madison	5A Hancock
4A Floyd	3A Morgan	2A Wayne*	5B Minidoka	4A Hardin
3A Forsyth	4A Murray	3A Webster*	5B Nez Perce	5A Henderson
4A Franklin	3A Muscogee	3A Wheeler*	6B Oneida	5A Henry
3A Fulton	3A Newton	4A White	5B Owyhee	5A Iroquois
4A Gilmer	3A Oconee	4A Whitfield	5B Payette	4A Jackson
3A Glascock	3A Oglethorpe	3A Wilcox*	5B Power	4A Jasper
2A Glynn*	3A Paulding	3A Wilkes	5B Shoshone	4A Jefferson
4A Gordon	3A Peach*	3A Wilkinson	6B Teton	5A Jersey
2A Grady*	4A Pickens	3A Worth*	5B Twin Falls	5A Jo Daviess
3A Greene	2A Pierce*		6B Valley	4A Johnson
3A Gwinnett	3A Pike	<b>HAWAII</b>	5B Washington	5A Kane
4A Habersham	3A Polk	1A (all)*		5A Kankakee
4A Hall	3A Pulaski*	<b>IDAHO</b>	<b>ILLINOIS</b>	5A Kendall
3A Hancock	3A Putnam	5B Ada	5A Adams	5A Knox
3A Haralson	3A Quitman*	6B Adams	4A Alexander	5A Lake
3A Harris	4A Rabun	6B Bannock	4A Bond	5A La Salle
3A Hart	3A Randolph*	6B Bear Lake	5A Boone	4A Lawrence
3A Heard	3A Richmond	5B Benewah	5A Brown	5A Lee
3A Henry	3A Rockdale	6B Bingham	5A Bureau	5A Livingston
3A Houston*	3A Schley*	6B Blaine	5A Calhoun	5A Logan
3A Irwin*	3A Screven*	6B Boise	5A Carroll	5A Macon
3A Jackson	2A Seminole*	6B Bonner	5A Cass	4A Macoupin
3A Jasper	3A Spalding	6B Bonneville	5A Champaign	4A Madison
2A Jeff Davis*	4A Stephens	6B Boundary	4A Christian	4A Marion
3A Jefferson	3A Stewart*	6B Butte	5A Clark	5A Marshall
3A Jenkins*	3A Sumter*	6B Camas	4A Clay	5A Mason
3A Johnson*	3A Talbot	5B Canyon	4A Clinton	4A Massac
3A Jones	3A Taliaferro	6B Caribou	5A Coles	5A McDonough
3A Lamar	2A Tattnell*		5A Cook	5A McHenry

(continued)

**GENERAL REQUIREMENTS**

**TABLE R301.1—continued  
CLIMATE ZONES, MOISTURE REGIMES, AND WARM-HUMID  
DESIGNATIONS BY STATE, COUNTY AND TERRITORY**

5A McLean	5A Boone	5A Miami	5A Appanoose	5A Jasper
5A Menard	4A Brown	4A Monroe	5A Audubon	5A Jefferson
5A Mercer	5A Carroll	5A Montgomery	5A Benton	5A Johnson
4A Monroe	5A Cass	5A Morgan	6A Black Hawk	5A Jones
4A Montgomery	4A Clark	5A Newton	5A Boone	5A Keokuk
5A Morgan	5A Clay	5A Noble	6A Bremer	6A Kossuth
5A Moultrie	5A Clinton	4A Ohio	6A Buchanan	5A Lee
5A Ogle	4A Crawford	4A Orange	6A Buena Vista	5A Linn
5A Peoria	4A Daviess	5A Owen	6A Butler	5A Louisa
4A Perry	4A Dearborn	5A Parke	6A Calhoun	5A Lucas
5A Piatt	5A Decatur	4A Perry	5A Carroll	6A Lyon
5A Pike	5A De Kalb	4A Pike	5A Cass	5A Madison
4A Pope	5A Delaware	5A Porter	5A Cedar	5A Mahaska
4A Pulaski	4A Dubois	4A Posey	6A Cerro Gordo	5A Marion
5A Putnam	5A Elkhart	5A Pulaski	6A Cherokee	5A Marshall
4A Randolph	5A Fayette	5A Putnam	6A Chickasaw	5A Mills
4A Richland	4A Floyd	5A Randolph	5A Clarke	6A Mitchell
5A Rock Island	5A Fountain	4A Ripley	6A Clay	5A Monona
4A Saline	5A Franklin	5A Rush	6A Clayton	5A Monroe
5A Sangamon	5A Fulton	4A Scott	5A Clinton	5A Montgomery
5A Schuyler	4A Gibson	5A Shelby	5A Crawford	5A Muscatine
5A Scott	5A Grant	4A Spencer	5A Dallas	6A O'Brien
4A Shelby	4A Greene	5A Starke	5A Davis	6A Osceola
5A Stark	5A Hamilton	5A Steuben	5A Decatur	5A Page
4A St. Clair	5A Hancock	5A St. Joseph	6A Delaware	6A Palo Alto
5A Stephenson	4A Harrison	4A Sullivan	5A Des Moines	6A Plymouth
5A Tazewell	5A Hendricks	4A Switzerland	6A Dickinson	6A Pocahontas
4A Union	5A Henry	5A Tippecanoe	5A Dubuque	5A Polk
5A Vermilion	5A Howard	5A Tipton	6A Emmet	5A Pottawattamie
4A Wabash	5A Huntington	5A Union	6A Fayette	5A Poweshiek
5A Warren	4A Jackson	4A Vanderburgh	6A Floyd	5A Ringgold
4A Washington	5A Jasper	5A Vermillion	6A Franklin	6A Sac
4A Wayne	5A Jay	5A Vigo	5A Fremont	5A Scott
4A White	4A Jefferson	5A Wabash	5A Greene	5A Shelby
5A Whiteside	4A Jennings	5A Warren	6A Grundy	6A Sioux
5A Will	5A Johnson	4A Warrick	5A Guthrie	5A Story
4A Williamson	4A Knox	4A Washington	6A Hamilton	5A Tama
5A Winnebago	5A Kosciusko	5A Wayne	6A Hancock	5A Taylor
5A Woodford	5A Lagrange	5A Wells	6A Hardin	5A Union
<b>INDIANA</b>	5A Lake	5A White	5A Harrison	5A Van Buren
5A Adams	5A La Porte	5A Whitley	5A Henry	5A Wapello
5A Allen	4A Lawrence	<b>IOWA</b>	6A Howard	5A Warren
5A Bartholomew	5A Madison	5A Adair	6A Humboldt	5A Washington
5A Benton	5A Marion	5A Adams	6A Ida	5A Wayne
5A Blackford	5A Marshall	6A Allamakee	5A Iowa	6A Webster
	4A Martin		5A Jackson	6A Winnebago

(continued)

**TABLE R301.1—continued**  
**CLIMATE ZONES, MOISTURE REGIMES, AND WARM-HUMID**  
**DESIGNATIONS BY STATE, COUNTY AND TERRITORY**

6A Winneshiek	4A Haskell	4A Sedgwick	2A Iberville*	6A Cumberland
5A Woodbury	4A Hodgeman	4A Seward	3A Jackson*	6A Franklin
6A Worth	4A Jackson	4A Shawnee	2A Jefferson*	6A Hancock
6A Wright	4A Jefferson	5A Sheridan	2A Jefferson Davis*	6A Kennebec
<b>KANSAS</b>	5A Jewell	5A Sherman	2A Lafayette*	6A Knox
4A Allen	4A Johnson	5A Smith	2A Lafourche*	6A Lincoln
4A Anderson	4A Kearny	4A Stafford	3A La Salle*	6A Oxford
4A Atchison	4A Kingman	4A Stanton	3A Lincoln*	6A Penobscot
4A Barber	4A Kiowa	4A Stevens	2A Livingston*	6A Piscataquis
4A Barton	4A Labette	4A Sumner	3A Madison*	6A Sagadahoc
4A Bourbon	5A Lane	5A Thomas	3A Morehouse	6A Somerset
4A Brown	4A Leavenworth	5A Trego	3A Natchitoches*	6A Waldo
4A Butler	4A Lincoln	4A Wabaunsee	2A Orleans*	6A Washington
4A Chase	4A Linn	5A Wallace	3A Ouachita*	6A York
4A Chautauqua	5A Logan	4A Washington	2A Plaquemines*	<b>MARYLAND</b>
4A Cherokee	4A Lyon	5A Wichita	2A Pointe Coupee*	4A Allegany
5A Cheyenne	4A Marion	4A Wilson	2A Rapides*	4A Anne Arundel
4A Clark	4A Marshall	4A Woodson	3A Red River*	4A Baltimore
4A Clay	4A McPherson	4A Wyandotte	3A Richland*	4A Baltimore (city)
5A Cloud	4A Meade	<b>KENTUCKY</b>	3A Sabine*	4A Calvert
4A Coffey	4A Miami	4A (all)	2A St. Bernard*	4A Caroline
4A Comanche	5A Mitchell	<b>LOUISIANA</b>	2A St. Charles*	4A Carroll
4A Cowley	4A Montgomery	2A Acadia*	2A St. Helena*	4A Cecil
4A Crawford	4A Morris	2A Allen*	2A St. James*	4A Charles
5A Decatur	4A Morton	2A Ascension*	2A St. John the Baptist*	4A Dorchester
4A Dickinson	4A Nemaha	2A Assumption*	2A St. Landry*	4A Frederick
4A Doniphan	4A Neosho	2A Avoyelles*	2A St. Martin*	5A Garrett
4A Douglas	5A Ness	2A Beauregard*	2A St. Mary*	4A Harford
4A Edwards	5A Norton	3A Bienville*	2A St. Tammany*	4A Howard
4A Elk	4A Osage	3A Bossier*	2A Tangipahoa*	4A Kent
5A Ellis	5A Osborne	3A Caddo*	3A Tensas*	4A Montgomery
4A Ellsworth	4A Ottawa	2A Calcasieu*	2A Terrebonne*	4A Prince George's
4A Finney	4A Pawnee	3A Caldwell*	3A Union*	4A Queen Anne's
4A Ford	5A Phillips	2A Cameron*	2A Vermilion*	4A Somerset
4A Franklin	4A Pottawatomie	3A Catahoula*	3A Vernon*	4A St. Mary's
4A Geary	4A Pratt	3A Claiborne*	2A Washington*	4A Talbot
5A Gove	5A Rawlins	3A Concordia*	3A Webster*	4A Washington
5A Graham	4A Reno	3A De Soto*	2A West Baton Rouge*	4A Wicomico
4A Grant	5A Republic	2A East Baton Rouge*	3A West Carroll	4A Worcester
4A Gray	4A Rice	3A East Carroll	2A West Feliciana*	<b>MASSACHUSETTS</b>
5A Greeley	4A Riley	2A East Feliciana*	3A Winn*	5A (all)
4A Greenwood	5A Rooks	2A Evangeline*	<b>MAINE</b>	<b>MICHIGAN</b>
5A Hamilton	4A Rush	3A Franklin*	6A Androscoggin	6A Alcona
4A Harper	4A Russell	3A Grant*	7 Aroostook	6A Alger
4A Harvey	4A Saline	2A Iberia*		
	5A Scott			

(continued)

GENERAL REQUIREMENTS

TABLE R301.1—continued  
CLIMATE ZONES, MOISTURE REGIMES, AND WARM-HUMID  
DESIGNATIONS BY STATE, COUNTY AND TERRITORY

5A Allegan	7 Mackinac	6A Carver	7 Otter Tail	3A Clarke
6A Alpena	5A Macomb	7 Cass	7 Pennington	3A Clay
6A Antrim	6A Manistee	6A Chippewa	7 Pine	3A Coahoma
6A Arenac	6A Marquette	6A Chisago	6A Pipestone	3A Copiah*
7 Baraga	6A Mason	7 Clay	7 Polk	3A Covington*
5A Barry	6A Mecosta	7 Clearwater	6A Pope	3A DeSoto
5A Bay	6A Menominee	7 Cook	6A Ramsey	3A Forrest*
6A Benzie	5A Midland	6A Cottonwood	7 Red Lake	3A Franklin*
5A Berrien	6A Missaukee	7 Crow Wing	6A Redwood	3A George*
5A Branch	5A Monroe	6A Dakota	6A Renville	3A Greene*
5A Calhoun	5A Montcalm	6A Dodge	6A Rice	3A Grenada
5A Cass	6A Montmorency	6A Douglas	6A Rock	2A Hancock*
6A Charlevoix	5A Muskegon	6A Faribault	7 Roseau	2A Harrison*
6A Cheboygan	6A Newaygo	6A Fillmore	6A Scott	3A Hinds*
7 Chippewa	5A Oakland	6A Freeborn	6A Sherburne	3A Holmes
6A Clare	6A Oceana	6A Goodhue	6A Sibley	3A Humphreys
5A Clinton	6A Ogemaw	7 Grant	6A Stearns	3A Issaquena
6A Crawford	7 Ontonagon	6A Hennepin	6A Steele	3A Itawamba
6A Delta	6A Osceola	6A Houston	6A Stevens	2A Jackson*
6A Dickinson	6A Oscoda	7 Hubbard	7 St. Louis	3A Jasper
5A Eaton	6A Otsego	6A Isanti	6A Swift	3A Jefferson*
6A Emmet	5A Ottawa	7 Itasca	6A Todd	3A Jefferson Davis*
5A Genesee	6A Presque Isle	6A Jackson	6A Traverse	3A Jones*
6A Gladwin	6A Roscommon	7 Kanabec	6A Wabasha	3A Kemper
7 Gogebic	5A Saginaw	6A Kandiyohi	7 Wadena	3A Lafayette
6A Grand Traverse	6A Sanilac	7 Kittson	6A Waseca	3A Lamar*
5A Gratiot	7 Schoolcraft	7 Koochiching	6A Washington	3A Lauderdale
5A Hillsdale	5A Shiawassee	6A Lac qui Parle	6A Watonwan	3A Lawrence*
7 Houghton	5A St. Clair	7 Lake	7 Wilkin	3A Leake
6A Huron	5A St. Joseph	7 Lake of the Woods	6A Winona	3A Lee
5A Ingham	5A Tuscola	6A Le Sueur	6A Wright	3A Leflore
5A Ionia	5A Van Buren	6A Lincoln	6A Yellow	3A Lincoln*
6A Iosco	5A Washtenaw	6A Lyon	Medicine	3A Lowndes
7 Iron	5A Wayne	7 Mahanomen		3A Madison
6A Isabella	6A Wexford	7 Marshall	<b>MISSISSIPPI</b>	3A Marion*
5A Jackson	<b>MINNESOTA</b>	6A Martin	3A Adams*	3A Marshall
5A Kalamazoo	7 Aitkin	6A McLeod	3A Alcorn	3A Monroe
6A Kalkaska	6A Anoka	6A Meeker	3A Amite*	3A Montgomery
5A Kent	7 Becker	7 Mille Lacs	3A Attala	3A Neshoba
7 Keweenaw	7 Beltrami	6A Morrison	3A Benton	3A Newton
6A Lake	6A Benton	6A Mower	3A Bolivar	3A Noxubee
5A Lapeer	6A Big Stone	6A Murray	3A Calhoun	3A Oktibbeha
6A Leelanau	6A Blue Earth	6A Nicollet	3A Carroll	3A Panola
5A Lenawee	6A Brown	6A Nobles	3A Chickasaw	2A Pearl River*
5A Livingston	7 Carlton	7 Norman	3A Choctaw	3A Perry*
7 Luce		6A Olmsted	3A Claiborne*	3A Pike*

(continued)

TABLE R301.1—continued  
CLIMATE ZONES, MOISTURE REGIMES, AND WARM-HUMID  
DESIGNATIONS BY STATE, COUNTY AND TERRITORY

3A Pontotoc	5A Chariton	4A Mississippi	4A Webster	4A Cumberland
3A Prentiss	4A Christian	4A Moniteau	5A Worth	4A Essex
3A Quitman	5A Clark	4A Monroe	4A Wright	4A Gloucester
3A Rankin*	4A Clay	4A Montgomery	<b>MONTANA</b>	4A Hudson
3A Scott	5A Clinton	4A Morgan	6B (all)	5A Hunterdon
3A Sharkey	4A Cole	4A New Madrid	<b>NEBRASKA</b>	5A Mercer
3A Simpson*	4A Cooper	4A Newton	5A (all)	4A Middlesex
3A Smith*	4A Crawford	5A Nodaway	<b>NEVADA</b>	4A Monmouth
2A Stone*	4A Dade	4A Oregon	5B Carson City (city)	5A Morris
3A Sunflower	4A Dallas	4A Osage	5B Churchill	4A Ocean
3A Tallahatchie	5A Daviess	4A Ozark	3B Clark	5A Passaic
3A Tate	5A DeKalb	4A Pemiscot	5B Douglas	4A Salem
3A Tippah	4A Dent	4A Perry	5B Elko	5A Somerset
3A Tishomingo	4A Douglas	4A Pettis	5B Esmeralda	5A Sussex
3A Tunica	4A Dunklin	4A Phelps	5B Eureka	4A Union
3A Union	4A Franklin	5A Pike	5B Humboldt	5A Warren
3A Walthall*	4A Gasconade	4A Platte	5B Lander	<b>NEW MEXICO</b>
3A Warren*	5A Gentry	4A Polk	5B Lincoln	4B Bernalillo
3A Washington	4A Greene	4A Pulaski	5B Lyon	5B Catron
3A Wayne*	5A Grundy	5A Putnam	5B Mineral	3B Chaves
3A Webster	5A Harrison	5A Ralls	5B Nye	4B Cibola
3A Wilkinson*	4A Henry	4A Randolph	5B Pershing	5B Colfax
3A Winston	4A Hickory	4A Ray	5B Storey	4B Curry
3A Yalobusha	5A Holt	4A Reynolds	5B Washoe	4B DeBaca
3A Yazoo	4A Howard	4A Ripley	5B White Pine	3B Dona Ana
<b>MISSOURI</b>	4A Howell	4A Saline	<b>NEW HAMPSHIRE</b>	3B Eddy
5A Adair	4A Iron	5A Schuyler	6A Belknap	4B Grant
5A Andrew	4A Jackson	5A Scotland	6A Carroll	4B Guadalupe
5A Atchison	4A Jasper	4A Scott	5A Cheshire	5B Harding
4A Audrain	4A Jefferson	4A Shannon	6A Coos	3B Hidalgo
4A Barry	4A Johnson	5A Shelby	6A Grafton	3B Lea
4A Barton	5A Knox	4A St. Charles	5A Hillsborough	4B Lincoln
4A Bates	4A Laclede	4A St. Clair	6A Merrimack	5B Los Alamos
4A Benton	4A Lafayette	4A Ste. Genevieve	5A Rockingham	3B Luna
4A Bollinger	4A Lawrence	4A St. Francois	5A Strafford	5B McKinley
4A Boone	5A Lewis	4A St. Louis	6A Sullivan	5B Mora
5A Buchanan	4A Lincoln	4A St. Louis (city)	<b>NEW JERSEY</b>	3B Otero
4A Butler	5A Linn	4A Stoddard	4A Atlantic	4B Quay
5A Caldwell	5A Livingston	4A Stone	5A Bergen	5B Rio Arriba
4A Callaway	5A Macon	5A Sullivan	4A Burlington	4B Roosevelt
4A Camden	4A Madison	4A Taney	4A Camden	5B Sandoval
4A Cape Girardeau	4A Maries	4A Texas	4A Cape May	5B San Juan
4A Carroll	5A Marion	4A Vernon		5B San Miguel
4A Carter	4A McDonald	4A Warren		5B Santa Fe
4A Cass	5A Mercer	4A Washington		4B Sierra
4A Cedar	4A Miller	4A Wayne		4B Socorro

(continued)

GENERAL REQUIREMENTS

TABLE R301.1—continued  
CLIMATE ZONES, MOISTURE REGIMES, AND WARM-HUMID  
DESIGNATIONS BY STATE, COUNTY AND TERRITORY

5B Taos	4A Queens	4A Clay	4A Orange	7 Divide
5B Torrance	5A Rensselaer	4A Cleveland	3A Pamlico	6A Dunn
4B Union	4A Richmond	3A Columbus*	3A Pasquotank	7 Eddy
4B Valencia	5A Rockland	3A Craven	3A Pender*	6A Emmons
<b>NEW YORK</b>	5A Saratoga	3A Cumberland	3A Perquimans	7 Foster
5A Albany	5A Schenectady	3A Currituck	4A Person	6A Golden Valley
6A Allegany	6A Schoharie	3A Dare	3A Pitt	7 Grand Forks
4A Bronx	6A Schuylar	3A Davidson	4A Polk	6A Grant
6A Broome	5A Seneca	4A Davie	3A Randolph	7 Griggs
6A Cattaraugus	6A Steuben	3A Duplin	3A Richmond	6A Hettinger
5A Cayuga	6A St. Lawrence	4A Durham	3A Robeson	7 Kidder
5A Chautauqua	4A Suffolk	3A Edgecombe	4A Rockingham	6A LaMoure
5A Chemung	6A Sullivan	4A Forsyth	3A Rowan	6A Logan
6A Chenango	5A Tioga	4A Franklin	4A Rutherford	7 McHenry
6A Clinton	6A Tompkins	3A Gaston	3A Sampson	6A McIntosh
5A Columbia	6A Ulster	4A Gates	3A Scotland	6A McKenzie
5A Cortland	6A Warren	4A Graham	3A Stanly	7 McLean
6A Delaware	5A Washington	4A Granville	4A Stokes	6A Mercer
5A Dutchess	5A Wayne	3A Greene	4A Surry	6A Morton
5A Erie	4A Westchester	4A Guilford	4A Swain	7 Mountrail
6A Essex	6A Wyoming	4A Halifax	4A Transylvania	7 Nelson
6A Franklin	5A Yates	4A Harnett	3A Tyrrell	6A Oliver
6A Fulton	<b>NORTH</b>	4A Haywood	3A Union	7 Pembina
5A Genesee	<b>CAROLINA</b>	4A Henderson	4A Vance	7 Pierce
5A Greene	4A Alamance	4A Hertford	4A Wake	7 Ramsey
6A Hamilton	4A Alexander	3A Hoke	4A Warren	6A Ransom
6A Herkimer	5A Alleghany	3A Hyde	3A Washington	7 Renville
6A Jefferson	3A Anson	4A Iredell	5A Watauga	6A Richland
4A Kings	5A Ashe	4A Jackson	3A Wayne	7 Rolette
6A Lewis	5A Avery	3A Johnston	4A Wilkes	6A Sargent
5A Livingston	3A Beaufort	3A Jones	3A Wilson	7 Sheridan
6A Madison	4A Bertie	4A Lee	4A Yadkin	6A Sioux
5A Monroe	3A Bladen	3A Lenoir	5A Yancey	6A Slope
6A Montgomery	3A Brunswick*	4A Lincoln	<b>NORTH DAKOTA</b>	6A Stark
4A Nassau	4A Buncombe	4A Macon	6A Adams	7 Steele
4A New York	4A Burke	4A Madison	7 Barnes	7 Stutsman
5A Niagara	3A Cabarrus	3A Martin	7 Benson	7 Towner
6A Oneida	4A Caldwell	4A McDowell	6A Billings	7 Traill
5A Onondaga	3A Camden	3A Mecklenburg	7 Bottineau	7 Walsh
5A Ontario	3A Carteret*	5A Mitchell	6A Bowman	7 Ward
5A Orange	4A Caswell	3A Montgomery	7 Burke	7 Wells
5A Orleans	4A Catawba	3A Moore	6A Burleigh	7 Williams
5A Oswego	4A Chatham	4A Nash	7 Cass	<b>OHIO</b>
6A Otsego	4A Cherokee	3A New Hanover*	7 Cavalier	4A Adams
5A Putnam	3A Chowan	4A Northampton	6A Dickey	5A Allen
		3A Onslow*		

(continued)

TABLE R301.1—continued  
 CLIMATE ZONES, MOISTURE REGIMES, AND WARM-HUMID  
 DESIGNATIONS BY STATE, COUNTY AND TERRITORY

5A Ashland	5A Mahoning	3A Bryan	3A Okfuskee	4C Linn
5A Ashtabula	5A Marion	3A Caddo	3A Oklahoma	5B Malheur
5A Athens	5A Medina	3A Canadian	3A Okmulgee	4C Marion
5A Auglaize	5A Meigs	3A Carter	3A Osage	5B Morrow
5A Belmont	5A Mercer	3A Cherokee	3A Ottawa	4C Multnomah
4A Brown	5A Miami	3A Choctaw	3A Pawnee	4C Polk
5A Butler	5A Monroe	4B Cimarron	3A Payne	5B Sherman
5A Carroll	5A Montgomery	3A Cleveland	3A Pittsburg	4C Tillamook
5A Champaign	5A Morgan	3A Coal	3A Pontotoc	5B Umatilla
5A Clark	5A Morrow	3A Comanche	3A Pottawatomie	5B Union
4A Clermont	5A Muskingum	3A Cotton	3A Pushmataha	5B Wallowa
5A Clinton	5A Noble	3A Craig	3A Roger Mills	5B Wasco
5A Columbiana	5A Ottawa	3A Creek	3A Rogers	4C Washington
5A Coshocton	5A Paulding	3A Custer	3A Seminole	5B Wheeler
5A Crawford	5A Perry	3A Delaware	3A Sequoyah	4C Yamhill
5A Cuyahoga	5A Pickaway	3A Dewey	3A Stephens	<b>PENNSYLVANIA</b>
5A Darke	4A Pike	3A Ellis	4B Texas	5A Adams
5A Defiance	5A Portage	3A Garfield	3A Tillman	5A Allegheny
5A Delaware	5A Preble	3A Garvin	3A Tulsa	5A Armstrong
5A Erie	5A Putnam	3A Grady	3A Wagoner	5A Beaver
5A Fairfield	5A Richland	3A Grant	3A Washington	5A Bedford
5A Fayette	5A Ross	3A Greer	3A Washita	5A Berks
5A Franklin	5A Sandusky	3A Harmon	3A Woods	5A Blair
5A Fulton	4A Scioto	3A Harper	3A Woodward	5A Bradford
4A Gallia	5A Seneca	3A Haskell	<b>OREGON</b>	4A Bucks
5A Geauga	5A Shelby	3A Hughes	5B Baker	5A Butler
5A Greene	5A Stark	3A Jackson	4C Benton	5A Cambria
5A Guernsey	5A Summit	3A Jefferson	4C Clackamas	6A Cameron
4A Hamilton	5A Trumbull	3A Johnston	4C Clatsop	5A Carbon
5A Hancock	5A Tuscarawas	3A Kay	4C Columbia	5A Centre
5A Hardin	5A Union	3A Kingfisher	4C Coos	4A Chester
5A Harrison	5A Van Wert	3A Kiowa	5B Crook	5A Clarion
5A Henry	5A Vinton	3A Latimer	4C Curry	6A Clearfield
5A Highland	5A Warren	3A Le Flore	5B Deschutes	5A Clinton
5A Hocking	4A Washington	3A Lincoln	4C Douglas	5A Columbia
5A Holmes	5A Wayne	3A Logan	5B Gilliam	5A Crawford
5A Huron	5A Williams	3A Love	5B Grant	5A Cumberland
5A Jackson	5A Wood	3A Major	5B Harney	5A Dauphin
5A Jefferson	5A Wyandot	3A Marshall	5B Hood River	4A Delaware
5A Knox	<b>OKLAHOMA</b>	3A Mayes	4C Jackson	6A Elk
5A Lake	3A Adair	3A McClain	5B Jefferson	5A Erie
4A Lawrence	3A Alfalfa	3A McCurtain	4C Josephine	5A Fayette
5A Licking	3A Atoka	3A McIntosh	5B Klamath	5A Forest
5A Logan	4B Beaver	3A Murray	5B Lake	5A Franklin
5A Lorain	3A Beckham	3A Muskogee	4C Lane	5A Fulton
5A Lucas	3A Blaine	3A Noble	4C Lincoln	5A Greene
5A Madison		3A Nowata		

(continued)

**GENERAL REQUIREMENTS**

**TABLE R301.1—continued  
CLIMATE ZONES, MOISTURE REGIMES, AND WARM-HUMID  
DESIGNATIONS BY STATE, COUNTY AND TERRITORY**

5A Huntingdon	3A Bamberg*	5A Bennett	6A Minnehaha	4A Gibson
5A Indiana	3A Barnwell*	5A Bon Homme	6A Moody	4A Giles
5A Jefferson	3A Beaufort*	6A Brookings	6A Pennington	4A Grainger
5A Juniata	3A Berkeley*	6A Brown	6A Perkins	4A Greene
5A Lackawanna	3A Calhoun	6A Brule	6A Potter	4A Grundy
5A Lancaster	3A Charleston*	6A Buffalo	6A Roberts	4A Hamblen
5A Lawrence	3A Cherokee	6A Butte	6A Sanborn	4A Hamilton
5A Lebanon	3A Chester	6A Campbell	6A Shannon	4A Hancock
5A Lehigh	3A Chesterfield	5A Charles Mix	6A Spink	3A Hardeman
5A Luzerne	3A Clarendon	6A Clark	6A Stanley	3A Hardin
5A Lycoming	3A Colleton*	5A Clay	6A Sully	4A Hawkins
6A McKean	3A Darlington	6A Codrington	5A Todd	3A Haywood
5A Mercer	3A Dillon	6A Corson	5A Tripp	3A Henderson
5A Mifflin	3A Dorchester*	6A Custer	6A Turner	4A Henry
5A Monroe	3A Edgefield	6A Davison	5A Union	4A Hickman
4A Montgomery	3A Fairfield	6A Day	6A Walworth	4A Houston
5A Montour	3A Florence	6A Deuel	5A Yankton	4A Humphreys
5A Northampton	3A Georgetown*	6A Dewey	6A Ziebach	4A Jackson
5A Northumberland	3A Greenville	5A Douglas	<b>TENNESSEE</b>	4A Jefferson
5A Perry	3A Greenwood	6A Edmunds	4A Anderson	4A Johnson
4A Philadelphia	3A Hampton*	6A Fall River	4A Bedford	4A Knox
5A Pike	3A Horry*	6A Faulk	4A Benton	3A Lake
6A Potter	3A Jasper*	6A Grant	4A Bledsoe	3A Lauderdale
5A Schuylkill	3A Kershaw	5A Gregory	4A Blount	4A Lawrence
5A Snyder	3A Lancaster	6A Haakon	4A Bradley	4A Lewis
5A Somerset	3A Laurens	6A Hamlin	4A Campbell	4A Lincoln
5A Sullivan	3A Lee	6A Hand	4A Cannon	4A Loudon
6A Susquehanna	3A Lexington	6A Hanson	4A Carroll	4A Macon
6A Tioga	3A Marion	6A Harding	4A Carter	3A Madison
5A Union	3A Marlboro	6A Hughes	4A Cheatham	4A Marion
5A Venango	3A McCormick	5A Hutchinson	3A Chester	4A Marshall
5A Warren	3A Newberry	6A Hyde	4A Claiborne	4A Maury
5A Washington	3A Oconee	5A Jackson	4A Clay	4A McMinn
6A Wayne	3A Orangeburg	6A Jerauld	4A Coker	3A McNairy
5A Westmoreland	3A Pickens	6A Jones	4A Coffee	4A Meigs
5A Wyoming	3A Richland	6A Kingsbury	3A Crockett	4A Monroe
4A York	3A Saluda	6A Lake	4A Cumberland	4A Montgomery
<b>RHODE ISLAND</b>	3A Spartanburg	6A Lawrence	4A Davidson	4A Moore
5A (all)	3A Sumter	6A Lincoln	4A Decatur	4A Morgan
<b>SOUTH CAROLINA</b>	3A Union	6A Lyman	4A DeKalb	4A Obion
3A Abbeville	3A Williamsburg	6A Marshall	4A Dickson	4A Overton
3A Aiken	3A York	6A McCook	3A Dyer	4A Perry
3A Allendale*	<b>SOUTH DAKOTA</b>	6A McPherson	3A Fayette	4A Pickett
3A Anderson	6A Aurora	6A Meade	4A Fentress	4A Polk
	6A Beadle	5A Mellette	4A Franklin	4A Putnam
		6A Miner		4A Rhea

(continued)

TABLE R301.1—continued  
CLIMATE ZONES, MOISTURE REGIMES, AND WARM-HUMID  
DESIGNATIONS BY STATE, COUNTY AND TERRITORY

4A Roane	3B Brewster	3B Ector	3B Howard	3B McCulloch
4A Robertson	4B Briscoe	2B Edwards*	3B Hudspeth	2A McLennan*
4A Rutherford	2A Brooks*	3A Ellis*	3A Hunt*	2A McMullen*
4A Scott	3A Brown*	3B El Paso	4B Hutchinson	2B Medina*
4A Sequatchie	2A Burlison*	3A Erath*	3B Irion	3B Menard
4A Sevier	3A Burnet*	2A Falls*	3A Jack	3B Midland
3A Shelby	2A Caldwell*	3A Fannin	2A Jackson*	2A Milam*
4A Smith	2A Calhoun*	2A Fayette*	2A Jasper*	3A Mills*
4A Stewart	3B Callahan	3B Fisher	3B Jeff Davis	3B Mitchell
4A Sullivan	2A Cameron*	4B Floyd	2A Jefferson*	3A Montague
4A Sumner	3A Camp*	3B Foard	2A Jim Hogg*	2A Montgomery*
3A Tipton	4B Carson	2A Fort Bend*	2A Jim Wells*	4B Moore
4A Troup	3A Cass*	3A Franklin*	3A Johnson*	3A Morris*
4A Unicoi	4B Castro	2A Freestone*	3B Jones	3B Motley
4A Union	2A Chambers*	2B Frio*	2A Karnes*	3A Nacogdoches*
4A Van Buren	2A Cherokee*	3B Gaines	3A Kaufman*	3A Navarro*
4A Warren	3B Childress	2A Galveston*	3A Kendall*	2A Newton*
4A Washington	3A Clay	3B Garza	2A Kenedy*	3B Nolan
4A Wayne	4B Cochran	3A Gillespie*	3B Kent	2A Nueces*
4A Weakley	3B Coke	3B Glasscock	3B Kerr	4B Ochiltree
4A White	3B Coleman	2A Goliad*	3B Kimble	4B Oldham
4A Williamson	3A Collin*	2A Gonzales*	3B King	2A Orange*
4A Wilson	3B Collingsworth	4B Gray	2B Kinney*	3A Palo Pinto*
<b>TEXAS</b>	2A Colorado*	3A Grayson	2A Kleberg*	3A Panola*
2A Anderson*	2A Comal*	3A Gregg*	3B Knox	3A Parker*
3B Andrews	3A Comanche*	2A Grimes*	3A Lamar*	4B Parmer
2A Angelina*	3B Concho	2A Guadalupe*	4B Lamb	3B Pecos
2A Aransas*	3A Cooke	4B Hale	3A Lampasas*	2A Polk*
2A Archer	2A Coryell*	3B Hall	2B La Salle*	4B Potter
4B Armstrong	3B Cottle	3A Hamilton*	2A Lavaca*	3B Presidio
2A Atascosa*	3B Crane	4B Hansford	2A Lee*	3A Rains*
2A Austin*	3B Crockett	3B Hardeman	2A Leon*	4B Randall
4B Bailey	3B Crosby	2A Hardin*	2A Liberty*	3B Reagan
2B Bandera*	3B Culberson	2A Harris*	2A Limestone*	2B Real*
2A Bastrop*	4B Dallam	3A Harrison*	4B Lipscomb	3A Red River*
3B Baylor	3A Dallas*	4B Hartley	2A Live Oak*	3B Reeves
2A Bee*	3B Dawson	3B Haskell	3A Llano*	2A Refugio*
2A Bell*	4B Deaf Smith	2A Hays*	3B Loving	4B Roberts
2A Bexar*	3A Delta	3B Hemphill	3B Lubbock	2A Robertson*
3A Blanco*	3A Denton*	3A Henderson*	3B Lynn	3A Rockwall*
3B Borden	2A DeWitt*	2A Hidalgo*	2A Madison*	3B Runnels
2A Bosque*	3B Dickens	2A Hill*	3A Marion*	3A Rusk*
3A Bowie*	2B Dimmit*	4B Hockley	3B Martin	3A Sabine*
2A Brazoria*	4B Donley	3A Hood*	3B Mason	3A San Augustine*
2A Brazos*	2A Duval*	3A Hopkins*	2A Matagorda*	2A San Jacinto*
	3A Eastland	2A Houston*	2B Maverick*	2A San Patricio*

(continued)

**GENERAL REQUIREMENTS**

**TABLE R301.1—continued  
CLIMATE ZONES, MOISTURE REGIMES, AND WARM-HUMID  
DESIGNATIONS BY STATE, COUNTY AND TERRITORY**

3A San Saba*	3A Young	4C Clark	4A Gilmer	<b>WISCONSIN</b>
3B Schleicher	2B Zapata*	5B Columbia	5A Grant	
3B Scurry	2B Zavala*	4C Cowlitz	5A Greenbrier	
3B Shackelford		5B Douglas	5A Hampshire	
3A Shelby*	<b>UTAH</b>	6B Ferry	5A Hancock	
4B Sherman	5B Beaver	5B Franklin	5A Hardy	
3A Smith*	6B Box Elder	5B Garfield	5A Harrison	
3A Somervell*	6B Cache	5B Grant	4A Jackson	
2A Starr*	6B Carbon	4C Grays Harbor	4A Jefferson	
3A Stephens	6B Daggett	4C Island	4A Kanawha	
3B Sterling	5B Davis	4C Jefferson	5A Lewis	
3B Stonewall	6B Duchesne	4C King	4A Lincoln	
3B Sutton	5B Emery	4C Kitsap	4A Logan	
4B Swisher	5B Garfield	5B Kittitas	5A Marion	
3A Tarrant*	5B Grand	5B Klickitat	5A Marshall	
3B Taylor	5B Iron	4C Lewis	4A Mason	
3B Terrell	5B Juab	5B Lincoln	4A McDowell	
3B Terry	5B Kane	4C Mason	4A Mercer	
3B Throckmorton	5B Millard	6B Okanogan	5A Mineral	
3A Titus*	6B Morgan	4C Pacific	4A Mingo	
3B Tom Green	5B Piute	6B Pend Oreille	5A Monongalia	
2A Travis*	6B Rich	4C Pierce	4A Monroe	
2A Trinity*	5B Salt Lake	4C San Juan	4A Morgan	
2A Tyler*	5B San Juan	4C Skagit	5A Nicholas	
3A Upshur*	5B Sanpete	5B Skamania	5A Ohio	
3B Upton	5B Sevier	4C Snohomish	5A Pendleton	
2B Uvalde*	6B Summit	5B Spokane	4A Pleasants	
2B Val Verde*	5B Tooele	6B Stevens	5A Pocahontas	
3A Van Zandt*	6B Uintah	4C Thurston	5A Preston	
2A Victoria*	5B Utah	4C Wahkiakum	4A Putnam	
2A Walker*	6B Wasatch	5B Walla Walla	5A Raleigh	
2A Waller*	3B Washington	4C Whatcom	5A Randolph	
3B Ward	5B Wayne	5B Whitman	4A Ritchie	
2A Washington*	5B Weber	5B Yakima	4A Roane	
2B Webb*	<b>VERMONT</b>	<b>WEST VIRGINIA</b>	5A Summers	
2A Wharton*	6A (all)	5A Barbour	5A Taylor	
3B Wheeler	<b>VIRGINIA</b>	4A Berkeley	5A Tucker	
3A Wichita	4A (all)	4A Boone	4A Tyler	
3B Wilbarger	<b>WASHINGTON</b>	4A Braxton	5A Upshur	
2A Willacy*	5B Adams	5A Brooke	4A Wayne	
2A Williamson*	5B Asotin	4A Cabell	5A Webster	
2A Wilson*	5B Benton	4A Calhoun	5A Wetzal	
3B Winkler	5B Benton	4A Clay	4A Wirt	
3A Wise	5B Chelan	5A Doddridge	4A Wood	
3A Wood*	4C Clallam	5A Fayette	4A Wyoming	
4B Yoakum				

(continued)

**TABLE R301.1—continued  
CLIMATE ZONES, MOISTURE REGIMES, AND WARM-HUMID  
DESIGNATIONS BY STATE, COUNTY AND TERRITORY**

6A Ozaukee	7 Taylor	6B Big Horn	6B Sheridan	<b>NORTHERN MARIANA ISLANDS</b>
6A Pepin	6A Trempealeau	6B Campbell	7 Sublette	
6A Pierce	6A Vernon	6B Carbon	6B Sweetwater	1A (all)*
6A Polk	7 Vilas	6B Converse	7 Teton	<b>PUERTO RICO</b>
6A Portage	6A Walworth	6B Crook	6B Uinta	
7 Price	7 Washburn	6B Fremont	6B Washakie	1A (all)*
6A Racine	6A Washington	5B Goshen	6B Weston	<b>VIRGIN ISLANDS</b>
6A Richland	6A Waukesha	6B Hot Springs	<b>US TERRITORIES</b>	
6A Rock	6A Waupaca	6B Johnson	<b>AMERICAN</b>	1A (all)*
6A Rusk	6A Waushara	6B Laramie	<b>SAMOA</b>	
6A Sauk	6A Winnebago	7 Lincoln	1A (all)*	
7 Sawyer	6A Wood	6B Natrona	<b>GUAM</b>	
6A Shawano	<b>WYOMING</b>	6B Niobrara	1A (all)*	
6A Sheboygan	6B Albany	6B Park		
6A St. Croix		5B Platte		

**TABLE R301.3(1)  
INTERNATIONAL CLIMATE ZONE DEFINITIONS**

MAJOR CLIMATE TYPE DEFINITIONS
<p>Marine (C) Definition—Locations meeting all four criteria:</p> <ol style="list-style-type: none"> <li>1. Mean temperature of coldest month between -3°C (27°F) and 18°C (65°F).</li> <li>2. Warmest month mean &lt; 22°C (72°F).</li> <li>3. At least four months with mean temperatures over 10°C (50°F).</li> <li>4. Dry season in summer. The month with the heaviest precipitation in the cold season has at least three times as much precipitation as the month with the least precipitation in the rest of the year. The cold season is October through March in the Northern Hemisphere and April through September in the Southern Hemisphere.</li> </ol>
<p>Dry (B) Definition—Locations meeting the following criteria:</p> <p>Not marine and <math>P_{in} &lt; 0.44 \times (TF - 19.5)</math> [<math>P_{cm} &lt; 2.0 \times (TC + 7)</math> in SI units]</p> <p>where:</p> <p><math>P_{in}</math> = Annual precipitation in inches (cm)</p> <p><math>T</math> = Annual mean temperature in °F (°C)</p>
<p>Moist (A) Definition—Locations that are not marine and not dry.</p>
<p>Warm-humid Definition—Moist (A) locations where either of the following wet-bulb temperature conditions shall occur during the warmest six consecutive months of the year:</p> <ol style="list-style-type: none"> <li>1. 67°F (19.4°C) or higher for 3,000 or more hours; or</li> <li>2. 73°F (22.8°C) or higher for 1,500 or more hours.</li> </ol>

For SI: °C = [(°F)-32]/1.8, 1 inch = 2.54 cm.

**GENERAL REQUIREMENTS**

**TABLE R301.3(2)  
INTERNATIONAL CLIMATE ZONE DEFINITIONS**

ZONE NUMBER	THERMAL CRITERIA	
	IP Units	SI Units
1	9000 < CDD50°F	5000 < CDD10°C
2	6300 < CDD50°F ≤ 9000	3500 < CDD10°C ≤ 5000
3A and 3B	4500 < CDD50°F ≤ 6300 AND HDD65°F ≤ 5400	2500 < CDD10°C ≤ 3500 AND HDD18°C ≤ 3000
4A and 4B	CDD50°F ≤ 4500 AND HDD65°F ≤ 5400	CDD10°C ≤ 2500 AND HDD18°C ≤ 3000
3C	HDD65°F ≤ 3600	HDD18°C ≤ 2000
4C	3600 < HDD65°F ≤ 5400	2000 < HDD18°C ≤ 3000
5	5400 < HDD65°F ≤ 7200	3000 < HDD18°C ≤ 4000
6	7200 < HDD65°F ≤ 9000	4000 < HDD18°C ≤ 5000
7	9000 < HDD65°F ≤ 12600	5000 < HDD18°C ≤ 7000
8	12600 < HDD65°F	7000 < HDD18°C

For SI: °C = [(°F)-32]/1.8.

**SECTION R302  
DESIGN CONDITIONS**

**R302.1 Interior design conditions.** The interior design temperatures used for heating and cooling load calculations shall be a maximum of 72°F (22°C) for heating and minimum of 75°F (24°C) for cooling.

**SECTION R303  
MATERIALS, SYSTEMS AND EQUIPMENT**

**R303.1 Identification.** Materials, systems and equipment shall be identified in a manner that will allow a determination of compliance with the applicable provisions of this code.

**R303.1.1 Building thermal envelope insulation.** An *R*-value identification mark shall be applied by the manufacturer to each piece of *building thermal envelope* insulation 12 inches (305 mm) or greater in width. Alternately, the insulation installers shall provide a certification listing the type, manufacturer and *R*-value of insulation installed in each element of the *building thermal envelope*. For blown or sprayed insulation (fiberglass and cellulose), the initial installed thickness, settled thickness, settled *R*-value, installed density, coverage area and number of bags installed shall be *listed* on the certification. For sprayed polyurethane foam (SPF) insulation, the installed thickness of the areas covered and *R*-value of installed thickness shall be *listed* on the certification. The insulation installer shall sign, date and post the certification in a conspicuous location on the job site.

**R303.1.1.1 Blown or sprayed roof/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.

**R303.1.2 Insulation mark installation.** Insulating materials shall be installed such that the manufacturer’s *R*-value mark is readily observable upon inspection.

**R303.1.3 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 R303.1.3(1) or R303.1.3(2). The solar heat gain coefficient (SHGC) and *visible transmittance* (VT) of glazed fenestration products (windows, glazed doors and skylights) shall be determined in accordance with NFRC 200 by an accredited, independent laboratory, and labeled and certified by the manufacturer. Products lacking such a labeled SHGC or VT shall be assigned a default SHGC or VT from Table R303.1.3(3).

**TABLE R303.1.3(1)  
DEFAULT GLAZED 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 R303.1.3(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 R303.1.3(3)**  
**DEFAULT GLAZED FENESTRATION SHGC AND VT**

	SINGLE GLAZED		DOUBLE GLAZED		GLAZED BLOCK
	Clear	Tinted	Clear	Tinted	
SHGC	0.8	0.7	0.7	0.6	0.6
VT	0.6	0.3	0.6	0.3	0.6

**R303.1.4 Insulation product rating.** The thermal resistance ( $R$ -value) of insulation shall be determined in accordance with the U.S. Federal Trade Commission  $R$ -value rule (CFR Title 16, Part 460) in units of  $\text{h} \times \text{ft}^2 \times ^\circ\text{F}/\text{Btu}$  at a mean temperature of  $75^\circ\text{F}$  ( $24^\circ\text{C}$ ).

**R303.2 Installation.** All materials, systems and equipment shall be installed in accordance with the manufacturer's installation instructions and the *International Building Code* or *International Residential Code*, as applicable.

**R303.2.1 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.

**R303.3 Maintenance information.** Maintenance instructions shall be furnished for equipment and systems that require preventive maintenance. Required regular maintenance actions shall be clearly stated and incorporated on a readily accessible label. The label shall include the title or publication number for the operation and maintenance manual for that particular model and type of product.



## CHAPTER 4 [RE]

# RESIDENTIAL ENERGY EFFICIENCY

### SECTION R401 GENERAL

**R401.1 Scope.** This chapter applies to residential buildings.

**R401.2 Compliance.** Projects shall comply with Sections identified as “mandatory” and with either sections identified as “prescriptive” or the performance approach in Section R405.

**R401.3 Certificate (Mandatory).** A permanent certificate shall be completed and posted on or in the electrical distribution panel by the builder or registered design professional. The certificate shall not cover or obstruct the visibility of the circuit directory label, service disconnect label or other required labels. The certificate shall list the predominant *R*-values of insulation installed in or on ceiling/roof, walls, foundation (slab, *basement wall*, crawlspace wall and/or floor) and ducts outside conditioned spaces; *U*-factors for fenestration and the solar heat gain coefficient (SHGC) of fenestration, and the results from any required duct system and building envelope air leakage testing done on the building. Where there is more than one value for each component, the certificate shall list the value covering the largest area. The certificate shall list the types and efficiencies of heating,

cooling and service water heating equipment. Where a gas-fired unvented room heater, electric furnace, or baseboard electric heater is installed in the residence, the certificate shall list “gas-fired unvented room heater,” “electric furnace” or “baseboard electric heater,” as appropriate. An efficiency shall not be *listed* for gas-fired unvented room heaters, electric furnaces or electric baseboard heaters.

### SECTION R402 BUILDING THERMAL ENVELOPE

**R402.1 General (Prescriptive).** The *building thermal envelope* shall meet the requirements of Sections R402.1.1 through R402.1.4.

**R402.1.1 Insulation and fenestration criteria.** The *building thermal envelope* shall meet the requirements of Table R402.1.1 based on the climate zone specified in Chapter 3.

**R402.1.2 *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

**TABLE R402.1.1  
INSULATION AND FENESTRATION REQUIREMENTS BY COMPONENT<sup>a</sup>**

CLIMATE ZONE	FENESTRATION <i>U</i> -FACTOR <sup>b</sup>	SKYLIGHT <sup>b</sup> <i>U</i> -FACTOR	GLAZED FENESTRATION SHGC <sup>b,e</sup>	CEILING <i>R</i> -VALUE	WOOD FRAME WALL <i>R</i> -VALUE	MASS WALL <i>R</i> -VALUE <sup>i</sup>	FLOOR <i>R</i> -VALUE	BASEMENT <sup>c</sup> WALL <i>R</i> -VALUE	SLAB <sup>d</sup> <i>R</i> -VALUE & DEPTH	CRAWL SPACE <sup>e</sup> WALL <i>R</i> -VALUE
1	NR	0.75	0.25	30	13	3/4	13	0	0	0
2	0.40	0.65	0.25	38	13	4/6	13	0	0	0
3	0.35	0.55	0.25	38	20 or 13+5 <sup>h</sup>	8/13	19	5/13 <sup>f</sup>	0	5/13
4 except Marine	0.35	0.55	0.40	49	20 or 13+5 <sup>h</sup>	8/13	19	10/13	10, 2 ft	10/13
5 and Marine 4	0.32	0.55	NR	49	20 or 13+5 <sup>h</sup>	13/17	30 <sup>g</sup>	15/19	10, 2 ft	15/19
6	0.32	0.55	NR	49	20+5 or 13+10 <sup>h</sup>	15/20	30 <sup>g</sup>	15/19	10, 4 ft	15/19
7 and 8	0.32	0.55	NR	49	20+5 or 13+10 <sup>h</sup>	19/21	38 <sup>g</sup>	15/19	10, 4 ft	15/19

For SI: 1 foot = 304.8 mm.

- a. *R*-values are minimums. *U*-factors and SHGC are maximums. When insulation is installed in a cavity which is less than the label or design thickness of the insulation, the installed *R*-value of the insulation shall not be less than the *R*-value specified in the table.
- b. The fenestration *U*-factor column excludes skylights. The SHGC column applies to all glazed fenestration. Exception: Skylights may be excluded from glazed fenestration SHGC requirements in Climate Zones 1 through 3 where the SHGC for such skylights does not exceed 0.30.
- c. “15/19” means R-15 continuous insulation on the interior or exterior of the home or R-19 cavity insulation at the interior of the basement wall. “15/19” shall be permitted to be met with R-13 cavity insulation on the interior of the basement wall plus R-5 continuous insulation on the interior or exterior of the home. “10/13” means R-10 continuous insulation on the interior or exterior of the home or R-13 cavity insulation at the interior of the basement wall.
- d. R-5 shall be added to the required slab edge *R*-values for heated slabs. Insulation depth shall be the depth of the footing or 2 feet, whichever is less in Climate Zones 1 through 3 for heated slabs.
- e. There are no SHGC requirements in the Marine Zone.
- f. Basement wall insulation is not required in warm-humid locations as defined by Figure R301.1 and Table R301.1.
- g. Or insulation sufficient to fill the framing cavity, R-19 minimum.
- h. First value is cavity insulation, second is continuous insulation or insulated siding, so “13+5” means R-13 cavity insulation plus R-5 continuous insulation or insulated siding. If structural sheathing covers 40 percent or less of the exterior, continuous insulation *R*-value shall be permitted to be reduced by no more than R-3 in the locations where structural sheathing is used – to maintain a consistent total sheathing thickness.
- i. The second *R*-value applies when more than half the insulation is on the interior of the mass wall.

TABLE R402.1.3  
EQUIVALENT *U*-FACTORS<sup>a</sup>

CLIMATE ZONE	FENESTRATION <i>U</i> -FACTOR	SKYLIGHT <i>U</i> -FACTOR	CEILING <i>U</i> -FACTOR	FRAME WALL <i>U</i> -FACTOR	MASS WALL <i>U</i> -FACTOR <sup>b</sup>	FLOOR <i>U</i> -FACTOR	BASEMENT WALL <i>U</i> -FACTOR	CRAWL SPACE WALL <i>U</i> -FACTOR
1	0.50	0.75	0.035	0.082	0.197	0.064	0.360	0.477
2	0.40	0.65	0.030	0.082	0.165	0.064	0.360	0.477
3	0.35	0.55	0.030	0.057	0.098	0.047	0.091 <sup>c</sup>	0.136
4 except Marine	0.35	0.55	0.026	0.057	0.098	0.047	0.059	0.065
5 and Marine 4	0.32	0.55	0.026	0.057	0.082	0.033	0.050	0.055
6	0.32	0.55	0.026	0.048	0.060	0.033	0.050	0.055
7 and 8	0.32	0.55	0.026	0.048	0.057	0.028	0.050	0.055

- a. Nonfenestration *U*-factors shall be obtained from measurement, calculation or an approved source.
- b. When more than half the insulation is on the interior, the mass wall *U*-factors shall be a maximum of 0.17 in Climate Zone 1, 0.14 in Climate Zone 2, 0.12 in Climate Zone 3, 0.087 in Climate Zone 4 except Marine, 0.065 in Climate Zone 5 and Marine 4, and 0.057 in Climate Zones 6 through 8.
- c. Basement wall *U*-factor of 0.360 in warm-humid locations as defined by Figure R301.1 and Table R301.1.

blown insulation. Computed *R*-values shall not include an *R*-value for other building materials or air films.

**R402.1.3 *U*-factor alternative.** An assembly with a *U*-factor equal to or less than that specified in Table R402.1.3 shall be permitted as an alternative to the *R*-value in Table R402.1.1.

**R402.1.4 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 R402.1.3 (multiplied by the same assembly area as in the proposed building), the building shall be considered in compliance with Table R402.1.1. 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.

**R402.2 Specific insulation requirements (Prescriptive).** In addition to the requirements of Section R402.1, insulation shall meet the specific requirements of Sections R402.2.1 through R402.2.12.

**R402.2.1 Ceilings with attic spaces.** When Section R402.1.1 would require R-38 in the ceiling, R-30 shall be deemed to satisfy the requirement for R-38 wherever the full height of uncompressed R-30 insulation extends over the wall top plate at the eaves. Similarly, 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 R402.1.3 and the total UA alternative in Section R402.1.4.

**R402.2.2 Ceilings without attic spaces.** Where Section R402.1.1 would require insulation levels above R-30 and the design of the roof/ceiling assembly does not allow sufficient space for the required insulation, the minimum required insulation for such roof/ceiling assemblies shall be R-30. This reduction of insulation from the requirements of Section R402.1.1 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 R402.1.3 and the total UA alternative in Section R402.1.4.

**R402.2.3 Eave baffle.** For air permeable insulations in vented attics, a baffle shall be installed adjacent to soffit and eave vents. Baffles shall maintain an opening equal or greater than the size of the vent. The baffle shall extend over the top of the attic insulation. The baffle shall be permitted to be any solid material.

**R402.2.4 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.

**R402.2.5 Mass walls.** Mass walls for the purposes of this chapter shall be considered above-grade walls of concrete block, concrete, insulated concrete form (ICF), masonry cavity, brick (other than brick veneer), earth (adobe, compressed earth block, rammed earth) and solid timber/logs.

**R402.2.6 Steel-frame ceilings, walls, and floors.** Steel-frame ceilings, walls, and floors shall meet the insulation requirements of Table R402.2.6 or shall meet the *U*-factor requirements of Table R402.1.3. The calculation of the *U*-factor for a steel-frame envelope assembly shall use a series-parallel path calculation method.

**R402.2.7 Floors.** Floor insulation shall be installed to maintain permanent contact with the underside of the sub-floor decking.

**R402.2.8 Basement walls.** Walls associated with conditioned basements shall be insulated from the top of the *basement wall* down to 10 feet (3048 mm) below grade or to the basement floor, whichever is less. Walls associated with unconditioned basements shall meet this requirement unless the floor overhead is insulated in accordance with Sections R402.1.1 and R402.2.7.

**TABLE R402.2.6**  
**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 16" O.C.</b>	
R-13	R-13 + 4.2 or R-19 + 2.1 or R-21 + 2.8 or R-0 + 9.3 or R-15 + 3.8 or R-21 + 3.1
R-13 + 3	R-0 + 11.2 or R-13 + 6.1 or R-15 + 5.7 or R-19 + 5.0 or R-21 + 4.7
R-20	R-0 + 14.0 or R-13 + 8.9 or R-15 + 8.5 or R-19 + 7.8 or R-19 + 6.2 or R-21 + 7.5
R-20 + 5	R-13 + 12.7 or R-15 + 12.3 or R-19 + 11.6 or R-21 + 11.3 or R-25 + 10.9
R-21	R-0 + 14.6 or R-13 + 9.5 or R-15 + 9.1 or R-19 + 8.4 or R-21 + 8.1 or R-25 + 7.7
<b>Steel Framed Wall, 24" O.C.</b>	
R-13	R-0 + 9.3 or R-13 + 3.0 or R-15 + 2.4
R-13 + 3	R-0 + 11.2 or R-13 + 4.9 or R-15 + 4.3 or R-19 + 3.5 or R-21 + 3.1
R-20	R-0 + 14.0 or R-13 + 7.7 or R-15 + 7.1 or R-19 + 6.3 or R-21 + 5.9
R-20 + 5	R-13 + 11.5 or R-15 + 10.9 or R-19 + 10.1 or R-21 + 9.7 or R-25 + 9.1
R-21	R-0 + 14.6 or R-13 + 8.3 or R-15 + 7.7 or R-19 + 6.9 or R-21 + 6.5 or R-25 + 5.9
<b>Steel Joist Floor</b>	
R-13	R-19 in 2 × 6, or R-19 + 6 in 2 × 8 or 2 × 10
R-19	R-19 + 6 in 2 × 6, or R-19 + 12 in 2 × 8 or 2 × 10

a. 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.

**R402.2.9 Slab-on-grade floors.** Slab-on-grade floors with a floor surface less than 12 inches (305 mm) below grade shall be insulated in accordance with Table R402.1.1. The insulation shall extend downward from the top of the slab on the outside or inside of the foundation wall. Insulation located below grade shall be extended the distance provided in Table R402.1.1 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* as having a very heavy termite infestation.

**R402.2.10 Crawl space walls.** As an alternative to insulating floors over crawl spaces, crawl space walls shall be permitted to be insulated when the crawl space is not vented to the outside. Crawl space wall insulation shall be permanently fastened to the wall and extend downward from the floor to the finished grade level and then vertically and/or horizontally for at least an additional 24 inches (610 mm). Exposed earth in unvented crawl space foundations shall be covered with a continuous Class I vapor retarder in accordance with the *International Building Code* or *International Residential Code*, as applicable. All joints of the vapor retarder shall overlap by 6 inches (153 mm) and be sealed or taped. The edges of the vapor retarder shall extend at least 6 inches (153 mm) up the stem wall and shall be attached to the stem wall.

**R402.2.11 Masonry veneer.** Insulation shall not be required on the horizontal portion of the foundation that supports a masonry veneer.

**R402.2.12 Sunroom insulation.** All *sunrooms* enclosing conditioned space shall meet the insulation requirements of this code.

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

1. The minimum ceiling insulation *R*-values shall be R-19 in Climate Zones 1 through 4 and R-24 in Climate Zones 5 through 8; and
2. The minimum wall *R*-value shall be R-13 in all climate zones. Wall(s) separating a *sunroom* with a *thermal isolation* from *conditioned space* shall meet the *building thermal envelope* requirements of this code.

**R402.3 Fenestration (Prescriptive).** In addition to the requirements of Section R402, fenestration shall comply with Sections R402.3.1 through R402.3.6.

**R402.3.1 U-factor.** An area-weighted average of fenestration products shall be permitted to satisfy the *U*-factor requirements.

**R402.3.2 Glazed fenestration SHGC.** An area-weighted average of fenestration products more than 50-percent glazed shall be permitted to satisfy the SHGC requirements.

**R402.3.3 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 R402.1.1. This exemption shall not apply to the *U*-factor alternative approach in Section R402.1.3 and the Total UA alternative in Section R402.1.4.

**R402.3.4 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 R402.1.1. This exemption shall not apply to the *U*-factor alternative approach in Section R402.1.3 and the total UA alternative in Section R402.1.4.

**R402.3.5 Sunroom U-factor.** All *sunrooms* enclosing conditioned space shall meet the fenestration requirements of this code.

**Exception:** For *sunrooms* with *thermal isolation* and enclosing conditioned space, in Climate Zones 4 through 8, 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 0.70. New fenestration separating the *sunroom* with *thermal isolation* from *conditioned space* shall meet the *building thermal envelope* requirements of this code.

**R402.3.6 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 R402.1.1.

**TABLE R402.4.1.1  
AIR BARRIER AND INSULATION INSTALLATION**

COMPONENT	CRITERIA <sup>a</sup>
Air barrier and thermal barrier	A continuous air barrier shall be installed in the building envelope. Exterior thermal envelope contains a continuous air barrier. Breaks or joints in the air barrier shall be sealed. Air-permeable insulation shall not be used as a sealing material.
Ceiling/attic	The air barrier in any dropped ceiling/soffit shall be aligned with the insulation and any gaps in the air barrier sealed. Access openings, drop down stair or knee wall doors to unconditioned attic spaces shall be sealed.
Walls	Corners and headers shall be insulated and the junction of the foundation and sill plate shall be sealed. The junction of the top plate and top of exterior walls shall be sealed. Exterior thermal envelope insulation for framed walls shall be installed in substantial contact and continuous alignment with the air barrier. Knee walls shall be sealed.
Windows, skylights and doors	The space between window/door jambs and framing and skylights and framing shall be sealed.
Rim joists	Rim joists shall be insulated and include the air barrier.
Floors (including above-garage and cantilevered floors)	Insulation shall be installed to maintain permanent contact with underside of subfloor decking. The 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 the crawlspace walls. Exposed earth in unvented crawl spaces shall be covered with a 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 sealed.
Narrow cavities	Batts in narrow cavities shall be cut to fit, or narrow cavities shall be filled by insulation that on installation readily conforms to the available cavity space.
Garage separation	Air sealing shall be provided between the garage and conditioned spaces.
Recessed lighting	Recessed light fixtures installed in the building thermal envelope shall be air tight, IC rated, and sealed to the drywall.
Plumbing and wiring	Batt insulation shall be cut neatly to fit around wiring and plumbing in exterior walls, or insulation that on installation readily conforms to available space shall extend behind piping and wiring.
Shower/tub on exterior wall	Exterior walls adjacent to showers and tubs shall be insulated and the air barrier installed separating them from the showers and tubs.
Electrical/phone box on exterior walls	The air barrier shall be installed behind electrical or communication boxes or air sealed boxes shall be installed.
HVAC register boots	HVAC register boots that penetrate building thermal envelope shall be sealed to the sub-floor or drywall.
Fireplace	An air barrier shall be installed on fireplace walls. Fireplaces shall have gasketed doors.

a. In addition, inspection of log walls shall be in accordance with the provisions of ICC-400.

**R402.4 Air leakage (Mandatory).** The building thermal envelope shall be constructed to limit air leakage in accordance with the requirements of Sections R402.4.1 through R402.4.4.

**R402.4.1 Building thermal envelope.** The *building thermal envelope* shall comply with Sections R402.4.1.1 and R402.4.1.2. The sealing methods between dissimilar materials shall allow for differential expansion and contraction.

**R402.4.1.1 Installation.** The components of the *building thermal envelope* as listed in Table R402.4.1.1 shall be installed in accordance with the manufacturer's instructions and the criteria listed in Table R402.4.1.1, as applicable to the method of construction. Where required by the *code official*, an *approved* third party shall inspect all components and verify compliance.

**R402.4.1.2 Testing.** The building or dwelling unit shall be tested and verified as having an air leakage rate of not exceeding 5 air changes per hour in Climate Zones 1 and 2, and 3 air changes per hour in Climate Zones 3 through 8. Testing shall be conducted with a blower door at a pressure of 0.2 inches w.g. (50 Pascals). Where required by the *code official*, testing shall be conducted by an *approved* third party. A written report of the results of the test shall be signed by the party conducting the test and provided to the *code official*. Testing shall be performed at any time after creation of all penetrations of the *building thermal envelope*.

During testing:

1. Exterior windows and doors, fireplace and stove doors shall be closed, but not sealed, beyond the intended weatherstripping or other infiltration control measures;
2. Dampers including exhaust, intake, makeup air, backdraft and flue dampers shall be closed, but not sealed beyond intended infiltration control measures;
3. Interior doors, if installed at the time of the test, shall be open;
4. Exterior doors for continuous ventilation systems and heat recovery ventilators shall be closed and sealed;
5. Heating and cooling systems, if installed at the time of the test, shall be turned off; and
6. Supply and return registers, if installed at the time of the test, shall be fully open.

**R402.4.2 Fireplaces.** New wood-burning fireplaces shall have tight-fitting flue dampers and outdoor combustion air.

**R402.4.3 Fenestration air leakage.** Windows, skylights and sliding glass doors shall have an air infiltration rate of no more than 0.3 cfm per square foot (1.5 L/s/m<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.

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

**R402.4.4 Recessed lighting.** Recessed luminaires installed in the *building thermal envelope* shall be sealed to limit air leakage between conditioned and unconditioned spaces. All recessed luminaires shall be IC-rated and *labeled* as having an air leakage rate not more than 2.0 cfm (0.944 L/s) when tested in accordance with ASTM E 283 at a 1.57 psf (75 Pa) pressure differential. All recessed luminaires shall be sealed with a gasket or caulk between the housing and the interior wall or ceiling covering.

**R402.5 Maximum fenestration U-factor and SHGC (Mandatory).** The area-weighted average maximum fenestration U-factor permitted using tradeoffs from Section R402.1.4 or R405 shall be 0.48 in Climate Zones 4 and 5 and 0.40 in Climate Zones 6 through 8 for vertical fenestration, and 0.75 in Climate Zones 4 through 8 for skylights. The area-weighted average maximum fenestration SHGC permitted using tradeoffs from Section R405 in Climate Zones 1 through 3 shall be 0.50.

## SECTION R403 SYSTEMS

**R403.1 Controls (Mandatory).** At least one thermostat shall be provided for each separate heating and cooling system.

**R403.1.1 Programmable thermostat.** Where the primary heating system is a forced-air furnace, 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).

**R403.1.2 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.

**R403.2 Ducts.** Ducts and air handlers shall be in accordance with Sections R403.2.1 through R403.2.3.

**R403.2.1 Insulation (Prescriptive).** Supply ducts in attics shall be insulated to a minimum of R-8. All other ducts shall be insulated to a minimum of R-6.

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

**R403.2.2 Sealing (Mandatory).** Ducts, air handlers, and filter boxes shall be sealed. Joints and seams shall comply

with either the *International Mechanical Code* or *International Residential Code*, as applicable.

**Exceptions:**

1. Air-impermeable spray foam products shall be permitted to be applied without additional joint seals.
2. Where a duct connection is made that is partially inaccessible, three screws or rivets shall be equally spaced on the exposed portion of the joint so as to prevent a hinge effect.
3. Continuously welded and locking-type longitudinal joints and seams in ducts operating at static pressures less than 2 inches of water column (500 Pa) pressure classification shall not require additional closure systems.

Duct tightness shall be verified by either of the following:

1. Postconstruction test: Total leakage shall be less than or equal to 4 cfm (113.3 L/min) per 100 square feet (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 4 cfm (113.3 L/min) per 100 square feet (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 system, including the manufacturer's air handler enclosure. All registers 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 3 cfm (85 L/min) per 100 square feet (9.29 m<sup>2</sup>) of conditioned floor area.

**Exception:** The total leakage test is not required for ducts and air handlers located entirely within the building thermal envelope.

**R403.2.2.1 Sealed air handler.** Air handlers shall have a manufacturer's designation for an air leakage of no more than 2 percent of the design air flow rate when tested in accordance with ASHRAE 193.

**R403.2.3 Building cavities (Mandatory).** Building framing cavities shall not be used as ducts or plenums.

**R403.3 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.

**R403.3.1 Protection of piping insulation.** Piping insulation exposed to weather shall be protected from damage, including that caused by sunlight, moisture, equipment maintenance, and wind, and shall provide shielding from solar radiation that can cause degradation of the material. Adhesive tape shall not be permitted.

**R403.4 Service hot water systems.** Energy conservation measures for service hot water systems shall be in accordance with Sections R403.4.1 and R403.4.2.

**R403.4.1 Circulating hot water systems (Mandatory).** Circulating hot water systems shall be provided with an automatic or readily *accessible* manual switch that can turn off the hot-water circulating pump when the system is not in use.

**R403.4.2 Hot water pipe insulation (Prescriptive).** Insulation for hot water pipe with a minimum thermal resistance (*R*-value) of R-3 shall be applied to the following:

1. Piping larger than 3/4 inch nominal diameter.
2. Piping serving more than one dwelling unit.
3. Piping from the water heater to kitchen outlets.
4. Piping located outside the conditioned space.
5. Piping from the water heater to a distribution manifold.
6. Piping located under a floor slab.
7. Buried piping.
8. Supply and return piping in recirculation systems other than demand recirculation systems.
9. Piping with run lengths greater than the maximum run lengths for the nominal pipe diameter given in Table R403.4.2.

All remaining piping shall be insulated to at least R-3 or meet the run length requirements of Table R403.4.2.

**TABLE R403.4.2  
MAXIMUM RUN LENGTH (feet)<sup>a</sup>**

Nominal Pipe Diameter of Largest Diameter Pipe in the Run (inch)	3/8	1/2	3/4	> 3/4
Maximum Run Length	30	20	10	5

For SI: 1 inch = 25.4 mm, 1 foot 304.8 mm.

a. Total length of all piping from the distribution manifold or the recirculation loop to a point of use.

**R403.5 Mechanical ventilation (Mandatory).** The building shall be provided with ventilation that meets the requirements

**TABLE R403.5.1  
MECHANICAL VENTILATION SYSTEM FAN EFFICACY**

FAN LOCATION	AIR FLOW RATE MINIMUM (CFM)	MINIMUM EFFICACY (CFM/WATT)	AIR FLOW RATE MAXIMUM (CFM)
Range hoods	Any	2.8 cfm/watt	Any
In-line fan	Any	2.8 cfm/watt	Any
Bathroom, utility room	10	1.4 cfm/watt	< 90
Bathroom, utility room	90	2.8 cfm/watt	Any

For SI: 1 cfm = 28.3 L/min.

of the *International Residential Code* or *International Mechanical Code*, as applicable, or with other approved means of ventilation. Outdoor air intakes and exhausts shall have automatic or gravity dampers that close when the ventilation system is not operating.

**R403.5.1 Whole-house mechanical ventilation system fan efficacy.** Mechanical ventilation system fans shall meet the efficacy requirements of Table R403.5.1.

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

**R403.6 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.

**R403.7 Systems serving multiple dwelling units (Mandatory).** Systems serving multiple dwelling units shall comply with Sections C403 and C404 of the IECC—Commercial Provisions in lieu of Section R403.

**R403.8 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.

**R403.9 Pools and inground permanently installed spas (Mandatory).** Pools and inground permanently installed spas shall comply with Sections R403.9.1 through R403.9.3.

**R403.9.1 Heaters.** All heaters shall be equipped with a readily *accessible* on-off switch that is mounted outside of the heater to allow shutting off the heater without adjusting the thermostat setting. Gas-fired heaters shall not be equipped with constant burning pilot lights.

**R403.9.2 Time switches.** Time switches or other control method that can automatically turn off and on heaters and pumps according to a preset schedule shall be installed on all heaters and pumps. Heaters, pumps and motors that have built in timers shall be deemed in compliance with this requirement.

**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.

**R403.9.3 Covers.** Heated pools and inground permanently installed spas shall be provided with a vapor-retardant cover.

**Exception:** Pools deriving over 70 percent of the energy for heating from site-recovered energy, such as a heat pump or solar energy source computed over an operating season.

## SECTION R404 ELECTRICAL POWER AND LIGHTING SYSTEMS (MANDATORY)

**R404.1 Lighting equipment (Mandatory).** A minimum of 75 percent of the lamps in permanently installed lighting fixtures shall be high-efficacy lamps or a minimum of 75 percent of the permanently installed lighting fixtures shall contain only high efficacy lamps.

**Exception:** Low-voltage lighting shall not be required to utilize high-efficiency lamps.

**R404.1.1 Lighting equipment (Mandatory).** Fuel gas lighting systems shall not have continuously burning pilot lights.

## SECTION R405 SIMULATED PERFORMANCE ALTERNATIVE (PERFORMANCE)

**R405.1 Scope.** This section establishes criteria for compliance using simulated energy performance analysis. Such analysis shall include heating, cooling, and service water heating energy only.

**R405.2 Mandatory requirements.** Compliance with this section requires that the mandatory provisions identified in Section R401.2 be met. All supply and return ducts not completely inside the *building thermal envelope* shall be insulated to a minimum of R-6.

**R405.3 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*, 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.

**R405.4 Documentation.** Documentation of the software used for the performance design and the parameters for the building shall be in accordance with Sections R405.4.1 through R405.4.3.

**R405.4.1 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*.

**R405.4.2 Compliance report.** Compliance software tools shall generate a report that documents that the *proposed*

*design* complies with Section R405.3. 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 R405.5.2(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.

**R405.4.3 Additional documentation.** The *code official* 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 R405.5.2(1).
3. Documentation of the actual values used in the software calculations for the *proposed design*.

**R405.5 Calculation procedure.** Calculations of the performance design shall be in accordance with Sections R405.5.1 and R405.5.2.

**R405.5.1 General.** Except as specified by this section, the *standard reference design* and *proposed design* shall be configured and analyzed using identical methods and techniques.

**R405.5.2 Residence specifications.** The *standard reference design* and *proposed design* shall be configured and analyzed as specified by Table R405.5.2(1). Table R405.5.2(1) shall include by reference all notes contained in Table R402.1.1.

**R405.6 Calculation software tools.** Calculation software, where used, shall be in accordance with Sections R405.6.1 through R405.6.3.

**R405.6.1 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 R403.6.
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* inspection checklist listing each of the *proposed design* component characteristics from Table R405.5.2(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.).

**R405.6.2 Specific approval.** Performance analysis tools meeting the applicable sections of Section R405 shall be permitted to be *approved*. Tools are permitted to be *approved* based on meeting a specified threshold for a jurisdiction. The *code official* shall be permitted to approve tools for a specified application or limited scope.

**R405.6.3 Input values.** When calculations require input values not specified by Sections R402, R403, R404 and R405, those input values shall be taken from an *approved* source.

**TABLE R405.5.2(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 <i>U</i> -factor: from Table R402.1.3 Solar absorptance = 0.75 Remittance = 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 <i>U</i> -factor: from Table R402.1.3, 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 <i>U</i> -factor: from Table R402.1.3	As proposed As proposed As proposed
Ceilings	Type: wood frame Gross area: same as proposed <i>U</i> -factor: from Table R402.1.3	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 <i>U</i> -factor: same as fenestration from Table R402.1.3.	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). <i>U</i> -factor: from Table R402.1.3  SHGC: From Table R402.1.1 except that for climates with no requirement (NR) SHGC = 0.40 shall be used. Interior shade fraction: 0.92-(0.21 × SHGC for the standard reference design) External shading: none	As proposed  As proposed  As proposed 0.92-(0.21 × SHGC as proposed) As proposed
Skylights	None	As proposed
Thermally isolated sunrooms	None	As proposed

(continued)

**TABLE R405.5.2(1)—continued**  
**SPECIFICATIONS FOR THE STANDARD REFERENCE AND PROPOSED DESIGNS**

BUILDING COMPONENT	STANDARD REFERENCE DESIGN	PROPOSED DESIGN
Air exchange rate	Air leakage rate of 5 air changes per hour in Climate Zones 1 and 2, and 3 air changes per hour in Climate Zones 3 through 8 at a pressure of 0.2 inches w.g (50 Pa). The mechanical ventilation rate shall be in addition to the air leakage rate and the same as in the proposed design, but no greater than $0.01 \times CFA + 7.5 \times (N_{br} + 1)$ where: $CFA$ = conditioned floor area $N_{br}$ = number of bedrooms Energy recovery shall not be assumed for mechanical ventilation.	For residences that are not tested, the same air leakage rate as the standard reference design. For tested residences, the measured air exchange rate <sup>c</sup> . The mechanical ventilation rate <sup>d</sup> shall be in addition to the air leakage rate and shall be as proposed.
Mechanical ventilation	None, except where mechanical ventilation is specified by the proposed design, in which case: Annual vent fan energy use: $kWh/yr = 0.03942 \times CFA + 29.565 \times (N_{br} + 1)$ where: $CFA$ = conditioned floor area $N_{br}$ = number of bedrooms	As proposed
Internal gains	$IGain = 17,900 + 23.8 \times CFA + 4104 \times N_{br}$ (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 <sup>e</sup> but not integral to the building envelope or structure.
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. For masonry basement walls, as proposed, but with insulation required by Table R402.1.3 located on the interior side of the walls For other walls, for ceilings, floors, and interior walls, wood frame construction	As proposed As proposed As proposed
Heating systems <sup>f, g</sup>	As proposed for other than electric heating without a heat pump. Where the proposed design utilizes electric heating without a heat pump the standard reference design shall be an air source heat pump meeting the requirements of Section R403 of the IECC—Commercial Provisions. Capacity: sized in accordance with Section R403.6	As proposed
Cooling systems <sup>f, h</sup>	As proposed Capacity: sized in accordance with Section R403.6.	As proposed
Service water Heating <sup>f, g, h, i</sup>	As proposed Use: same as proposed design	As proposed $gal/day = 30 + (10 \times N_{br})$
Thermal distribution systems		Thermal distribution system efficiency shall be as tested or as specified in Table R405.5.2(2) if not tested. Duct insulation shall be as proposed.
Thermostat	Type: Manual, cooling temperature setpoint = 75°F; Heating temperature setpoint = 72°F	Same as standard reference

(continued)

**TABLE R405.5.2(1)—continued  
SPECIFICATIONS FOR THE STANDARD REFERENCE AND PROPOSED DESIGNS**

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.  
 $L$  and  $CFA$  are in the same units.
- c. Where required by the *code official*, testing shall be conducted by an *approved party*. Hourly calculations as specified in the ASHRAE *Handbook of Fundamentals*, or the equivalent shall be used to determine the energy loads resulting from infiltration.
- d. 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.
- e. 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.
- f. 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.
- g. 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.
- h. 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.
- i. 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 R405.5.2(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

# REFERENCED STANDARDS

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

### AAMA

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

Standard reference number	Title	Referenced in code section number
AAMA/WDMA/CSA 101/I.S.2/A C440—11	North American Fenestration Standard/ Specifications for Windows, Doors and Unit Skylights .....	R402.4.3

### ACCA

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

Standard reference number	Title	Referenced in code section number
Manual J—11	Residential Load Calculation Eighth Edition.....	R403.6
Manual S—10	Residential Equipment Selection .....	R403.6

### 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
ASHRAE—2009	ASHRAE Handbook of Fundamentals .....	R402.1.4, Table R405.5.2(1)
ASHRAE 193—2010	Method of Test for Determining the Airtightness of HVAC Equipment .....	R403.2.2.1

### 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 .....	R402.4.4

**REFERENCED STANDARDS**

**CSA**

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

Standard reference number	Title	Referenced in code section number
AAMA/WDMA/CSA 101/I.S.2/A440—11	North American Fenestration Standard/Specification for Windows, Doors and Unit Skylights	R402.4.3

**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—12	International Building Code®	R201.3, R303.2, R402.2.10
ICC 400—12	Standard on the Design and Construction of Log Structures	Table R402.4.1.1
IFC—12	International Fire Code®	R201.3
IFGC—12	International Fuel Gas Code®	R201.3
IMC—12	International Mechanical Code®	R201.3, R403.2.2, R403.5
IPC—12	International Plumbing Code®	R201.3
IRC—12	International Residential Code®	R201.3, R303.2, R402.2.10, R403.2.2, R403.5

**NFRC**

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

Standard reference number	Title	Referenced in code section number
100—2009	Procedure for Determining Fenestration Products <i>U</i> -factors—Second Edition	R303.1.3
200—2009	Procedure for Determining Fenestration Product Solar Heat Gain Coefficients and Visible Transmittance at Normal Incidence—Second Edition	R303.1.3
400—2009	Procedure for Determining Fenestration Product Air Leakage—Second Edition	R402.4.3

**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 (May 31, 2005)	R-value Rule	R303.1.4

**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/I.S.2/A440—11	North American Fenestration Standard/Specification for Windows, Doors and Unit Skylights	R402.4.3

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# 2012 International Energy Conservation Code Errata

(Portions of text and tables not shown are unaffected by the errata)

1<sup>st</sup> and 2<sup>nd</sup> PRINTINGS (Posted: 09-27-13)

## CHAPTER 1 [CE] SCOPE AND ADMINISTRATION

**C106.1.1 Conflicts.** Where differences conflicts occur between provisions of this code and referenced codes and standards, the provisions of this code shall apply.

# 2012 International Energy Conservation Code Errata

(Portions of text and tables not shown are unaffected by the errata)

1<sup>st</sup> and 2<sup>nd</sup> PRINTINGS (Posted: 09-27-13)

## CHAPTER 2 [CE] 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.~~

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

**COEFFICIENT OF PERFORMANCE (COP) – HEATING.** The ratio of the rate of heat ~~removal to the rate of heat~~ delivered to the rate of energy input, in consistent units, for a complete heat pump system, including the compressor and, if applicable, auxiliary heat, under designated operating conditions.

# 2012 International Energy Conservation Code Errata

(Portions of text and tables not shown are unaffected by the errata)

1<sup>st</sup> through 4<sup>th</sup> PRINTING (Posted: 12-09-13)

## CHAPTER 4[CE] COMMERCIAL ENERGY EFFICIENCY

**C403.2.8 Piping insulation.** All piping serving as part of a heating or cooling system shall be thermally insulated in accordance with Table C403.2.8.

**Exception:**

2. Factory-installed piping within room fan-coils and unit ventilators tested and rated according to AHRI 440 (except that the sampling and variation provisions of Section 6.5 shall not apply) and [AHRI 840](#).

# 2012 International Energy Conservation Code Errata

(Portions of text and tables not shown are unaffected by the errata)

1<sup>st</sup> PRINTING ONLY – CORRECTED IN 2<sup>nd</sup> PRINTING (Posted: 09-27-13)

## CHAPTER 4 [CE] COMMERCIAL ENERGY EFFICIENCY

### C402.2.5 Floors over outdoor air or unconditioned space.

2. 25 psf (120 kg/m<sup>2</sup>) of floor surface area if the material weight is not more than ~~42~~ 120 pcf (1,900 kg/m<sup>3</sup>).

**TABLE C402.3.3.1  
SHGC ADJUSTMENT MULTIPLIERS**

Projection Factor	Oriented Within 45 Degrees of True North	All Other Orientation
$0.2 \leq PF < 0.5$	1.1	1.2
$PF < \geq 0.5$	1.2	1.6

**TABLE C403.2.3(3)**

### Electrically Operated Packaged Terminal Air Conditioners, Packaged Terminal Heat Pumps, Single-Package Vertical Air Conditioners, Single Vertical Heat Pumps, Room Air Conditioners, And Room Air-Conditioner Heat Pumps – Minimum Efficiency Requirements

Equipment Type	Size Category (Input)	Subcategory or Rating Condition	Minimum Efficiency		Test procedure <sup>a</sup>
			Before 10/08/2012	As of 10/08/2012	
PTHP (heating mode) New construction	All Capacities		3.2- <del>(0.26</del> <u>0.026</u> x Cap/1000) COP	3.2- <del>(0.26</del> <u>0.026</u> x cap/1000) COP	AHRI 310/380
PTHP (heating mode) replacements <sup>b</sup>	All Capacities		2.9- <del>(0.26</del> <u>0.026</u> x Cap/1000) COP	2.9- <del>(0.26</del> <u>0.026</u> x Cap/1000) COP	AHRI 310/380

**C403.4.5 Requirements for complex mechanical systems serving multiple zones.** Sections C403.4.5.1 through ~~C403.4.5.3~~ C403.4.5.4 shall apply to complex mechanical systems serving multiple zones.

# 2012 International Energy Conservation Code Errata

(Portions of text and tables not shown are unaffected by the errata)

1<sup>st</sup> and 2<sup>nd</sup> PRINTINGS (Posted: 09-27-13)

## CHAPTER 4 [CE] COMMERCIAL ENERGY EFFICIENCY

TABLE C402.2  
OPAQUE THERMAL ENVELOPE REQUIREMENTS<sup>a</sup>

CLIMATE ZONE	1		2		3		4 EXCEPT MARINE		5 AND MARINE 4		6		7		8	
	All Other	Group R	All Other	Group R	All Other	Group R	All Other	Group R	All Other	Group R	All Other	Group R	All Other	Group R	All Other	Group R
Walls, Above Grade																
Mass <sup>c</sup> ←	R-5.7ci <sup>e</sup>	R-5.7ci <sup>e</sup>	R-5.7ci <sup>e</sup>	R-7.6ci	R-7.6ci	R-9.5ci	R-9.5ci	R-11.4ci	R-11.4ci	R-13.3ci	R-13.3ci	R-15.2ci	R-15.2ci	R-15.2ci	R-25ci	R-25ci

**C402.3.2 Minimum skylight fenestration area.** In an enclosed space greater than 10,000 square feet (929 m<sup>2</sup>), directly under a roof with ceiling heights greater than 15 feet (4572 mm), and used as an office, lobby, atrium, concourse, corridor, storage, gymnasium/exercise center, convention center, automotive service, manufacturing, non-refrigerated warehouse, retail store, distributing/sorting area, transportation, or workshop, the total daylight zone under skylights shall be not less than half the floor area and shall provide a minimum skylight area to daylight zone under skylights of either:

2. Provide a minimum skylight effective aperture of at least 1 percent determined in accordance with Equation C4-1.

$$\text{Skylight Effective Aperture} = \frac{0.85 \times \text{Skylight Area} \times \text{Skylight VT} \times \text{WF}}{\text{Daylight zone under skylight}}$$

(Equation C4-1)

**C402.3.3 Maximum U-factor and SHGC.** For vertical fenestration, the maximum U-factor and solar heat gain coefficient (SHGC) shall be as specified in Table C402.3, based on the window projection factor. For skylights, the maximum U-factor and solar heat gain coefficient (SHGC) shall be as specified in Table C402.3.

The window projection factor shall be determined in accordance with Equation C4-2.

$$PF = A/B$$

(Equation C4-2)

**C402.4.1.1 Air barrier construction.** The continuous air barrier shall be constructed to comply with the following:

1. The air barrier shall be continuous for all assemblies that are the thermal envelope of the building and across the joints and assemblies.
2. Air barrier joints and seams shall be sealed, including sealing transitions in places and changes in materials. Air barrier penetrations shall be sealed in accordance with Section C402.4.2. The joints and seals shall be securely installed in or on the joint for its entire length so as not to dislodge, loosen or otherwise impair its ability to resist positive and negative pressure from wind, stack effect and mechanical ventilation.
3. Recessed lighting fixtures shall comply with Section ~~C4042.8~~ C402.4.8. Where similar objects are installed which penetrate the air barrier, provisions shall be made to maintain the integrity of the air barrier.

**Exception:** Buildings that comply with Section C402.4.1.2.3 are not required to comply with Items 1 and 3.

**C402.4.8 Recessed lighting.** Recessed luminaires installed in the *building thermal envelope* shall be sealed to limit air leakage between conditioned and unconditioned spaces. All recessed luminaires shall be IC-rated and *labeled* as having an air leakage rate ~~of~~ of not more than 2.0 cfm (0.944 L/s) when tested in accordance with ASTM E 283 at a 1.57 psf (75 Pa)

# 2012 International Energy Conservation Code Errata

(Portions of text and tables not shown are unaffected by the errata)

pressure differential. All recessed luminaires shall be sealed with a gasket or caulk between the housing and interior wall or ceiling covering.

**TABLE C403.2.3(1)**  
**MINIMUM EFFICIENCY REQUIREMENTS:**  
**ELECTRICALLY OPERATED UNITARY AIR CONDITIONERS AND CONDENSING UNITS**

EQUIPMENT TYPE	SIZE CATEGORY	HEATING SECTION TYPE	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY		TEST PROCEDURE <sup>a</sup>		
				Before 6/1/2011	As of 6/1/2011			
Air conditioners, water cooled	< 65,000 Btu/h <sup>b</sup>	All	Split System and Single Package	12.1 EER 12.3 IEER	12.1 EER 12.3 IEER	AHRI 210/240		
	≥ 65,000 Btu/h and < 135,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	11.5 EER 11.7 IEER	12.1 EER 12.3 IEER	AHRI 340/360		
		All other	Split System and Single Package	11.3 EER 11.5 IEER	11.9 EER 12.1 IEER			
	≥ 135,000 Btu/h and < 240,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	11.0 EER 11.2 IEER	12.5 EER 12.7 IEER			
		All other	Split System and Single Package	10.8 EER 11.0 IEER	12.3 EER 12.5 IEER			
	≥ 240,000 Btu/h and < 760,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	11.0 EER 11.1 <del>IEER</del> <del>EER</del>	12.4 EER 12.6 <del>IEER</del> <del>EER</del>			
		All other	Split System and Single Package	10.8 EER 10.9 <del>IEER</del> <del>EER</del>	12.2 EER 12.4 <del>IEER</del> <del>EER</del>			
	≥ 760,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	11.0 EER 11.1 <del>IEER</del> <del>EER</del>	12.0 EER 12.4 <del>IEER</del> <del>EER</del>			
		All other	Split System and Single Package	10.8 EER 10.9 <del>IEER</del> <del>EER</del>	12.0 EER 12.2 <del>IEER</del> <del>EER</del>			
	EQUIPMENT TYPE	SIZE CATEGORY	HEATING SECTION TYPE	SUB-CATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY		TEST PROCEDURE <sup>a</sup>	
	Air conditioners, evaporatively cooled	< 65,000 Btu/h <sup>b</sup>	All	Split System and Single Package	12.1 EER 12.3 IEER		12.1 EER 12.3 IEER	AHRI 210/240
		≥ 65,000 Btu/h and < 135,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	11.5 EER 11.7 IEER		12.1 EER 12.3 IEER	AHRI 340/360
			All other	Split System and Single Package	11.3 EER 11.5 IEER		11.9 EER 12.1 IEER	
≥ 135,000 Btu/h and < 240,000 Btu/h		Electric Resistance (or None)	Split System and Single Package	11.0 EER 11.2 IEER	12.0 EER 12.2 IEER			
		All other	Split System and Single Package	10.8 EER 11.0 IEER	11.8 EER 12.0 IEER			
≥ 240,000 Btu/h and < 760,000 Btu/h		Electric Resistance (or None)	Split System and Single Package	11.0 EER 11.1 <del>IEER</del> <del>EER</del>	11.9 EER 12.1 <del>IEER</del> <del>EER</del>			
		All other	Split System and Single Package	10.8 EER 10.9 <del>IEER</del> <del>EER</del>	12.2 EER 11.9 <del>IEER</del> <del>EER</del>			
≥ 760,000 Btu/h		Electric Resistance (or None)	Split System and Single Package	11.0 EER 11.1 EER	11.7 EER 11.9 EER			

# 2012 International Energy Conservation Code Errata

(Portions of text and tables not shown are unaffected by the errata)

		All other	Split System and Single Package	10.8 EER 10.9 EER	11.5 EER 11.7 EER	
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For SI: 1 British thermal unit per hour = 0.2931 W.

- a. Chapter 6 of the referenced standard contains a complete specification of the referenced test procedure, including the reference year version of the test procedure.
- b. Single-phase, air-cooled air conditioners less than 65,000 Btu/h are regulated by NAECA. SEER values are those set by NAECA.

**TABLE C403.2.3(3)**

**Electrically Operated Packaged Terminal Air Conditioners, Packaged Terminal Heat Pumps, Single-Package Vertical Air Conditioners, Single Vertical Heat Pumps, Room Air Conditioners, And Room Air-Conditioner Heat Pumps – Minimum Efficiency Requirements**

Equipment Type	Size Category (Input)	Subcategory or Rating Condition	Minimum Efficiency		Test procedure <sup>a</sup>
			Before 10/08/2012	As of 10/08/2012	
Room air conditioners, <b>without</b> louvered slides	< 8,000 Btu/h	-	9.0 EER	9.0 EER	ANSI/AHAM RAC-1
	≥ 8,000 Btu/h and < 20,000 Btu/h	-	8.5 EER	8.5 EER	
	≥ 20,000 Btu/h	-	8.5 EER	8.5 EER	

**C403.2.3.1 Water-cooled centrifugal chilling packages.** Equipment not designed for operation at AHRI Standard 550/590 test conditions of 44°F (7°C) leaving chilled-water temperature and 85°F (29°C) entering condenser water temperature with 3 gpm/ton (0.054 l/s x kW) condenser water flow shall have a maximum full-load kW/ton and *NPLV* ratings adjusted using Equations [C4-3](#) and [C4-4](#).

$$\text{Adjusted minimum full-load COP ratings} = (\text{Full-load COP from Table 6.8.1C of AHRI Standard 550/590}) \times K_{adj}$$

**(Equation [C4-3](#))**

$$\text{Adjusted minimum } NPLV \text{ rating} = (\text{IPLV from Table 6.8.1C of AHRI Standard 550/590}) \times K_{adj}$$

**(Equation [C4-4](#))**

**C403.2.7.1.3 High-pressure duct systems.** Ducts designed to operate at static pressures in excess of 3 inches water gauge (w.g.) (750 Pa) shall be insulated and sealed in accordance with Section C403.2.7. In addition, ducts and plenums shall be leak-tested in accordance with the SMACNA *HVAC Air Duct Leakage Test Manual* with the rate of air leakage (CL) less than or equal to 6.0 as determined in accordance with Equation [C4-5](#).

$$CL = F/P^{0.65}$$

**(Equation [C4-5](#))**

**TABLE C406.3**  
**REDUCED INTERIOR LIGHTING POWER**

BUILDING TYPE	LPD (w/ft <sup>2</sup> )
<b>Automotive Automotive facility</b>	<b>0.82</b>

**TABLE C407.5.1(1)**  
**SPECIFICATIONS FOR THE STANDARD REFERENCE AND PROPOSED DESIGNS**

BUILDING COMPONENT CHARACTERISTICS	STANDARD REFERENCE DESIGN	PROPOSED DESIGN
Space use classification	Same as proposed	The space use classification shall be chosen in accordance with Table C405.5.2 for all areas of the building covered by this permit. Where the space use classification for a building is not known, the building shall be categorized as an office building.
Lighting, interior	The interior lighting power shall be determined in accordance with <a href="#">Table Section C405.5.2</a> . Where the occupancy of the building is not known, the lighting power density shall be 1.0 Watt per square foot (10.73 W/m <sup>2</sup> ) based on the categorization of buildings with unknown space classification as offices.	As proposed

# 2012 International Energy Conservation Code Errata

(Portions of text and tables not shown are unaffected by the errata)

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1<sup>st</sup> thru 3<sup>rd</sup> PRINTINGS (Posted: 09-27-13)

## CHAPTER 4 [CE] COMMERCIAL ENERGY EFFICIENCY

**C402.3.2 Minimum skylight fenestration area.** In an enclosed space greater than 10,000 square feet (929 m<sup>2</sup>), directly under a roof with ceiling heights greater than 15 feet (4572 mm), and used as an office, lobby, atrium, concourse, corridor, storage, gymnasium/exercise center, convention center, automotive service, manufacturing, non-refrigerated warehouse, retail store, distributing/sorting area, transportation, or workshop, the total daylight zone under skylights shall be not less than half the floor area and shall provide a minimum skylight area to daylight zone under skylights of either:

2. Provide a minimum skylight effective aperture of at least 1 percent determined in accordance with Equation **C4-1**.

# 2012 International Energy Conservation Code Errata

(Portions of text and tables not shown are unaffected by the errata)

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3rd PRINTING ONLY (Posted: 09-27-13)

## CHAPTER 4 [CE] COMMERCIAL ENERGY EFFICIENCY

**C405.5.1.1 Screw lamp holders.** The wattage shall be the maximum *labeled* wattage of the luminaire.

**C405.5.1.2 Low-voltage lighting.** The wattage shall be the specified wattage of the transformer supplying the system.

**C405.5.1.3 Other luminaires.** The wattage of all other lighting equipment shall be the wattage of the lighting equipment verified through data furnished by the manufacturer or other *approved* sources.

**C405.5.1.4 Line-voltage lighting track and plug-in busway.** The wattage shall be:

1. The specified wattage of the luminaires included in the system with a minimum of 30 W/lin ft. (98 W/lin. m);
2. The wattage limit of the system's circuit breaker; or
3. The wattage limit of other permanent current limiting device(s) on the system.

# 2012 International Energy Conservation Code Errata

(Portions of text and tables not shown are unaffected by the errata)

1<sup>st</sup> through 4<sup>th</sup> PRINTING (Posted: 12-09-13)

## CHAPTER 5[CE] REFERENCED STANDARDS

### AHRI

Standard reference number	Title	Referenced in code Section number
<u>840-1998</u>	<u>Unit Ventilators</u>	<u>403.2.8</u>

# 2012 International Energy Conservation Code Errata

(Portions of text and tables not shown are unaffected by the errata)

1<sup>st</sup> PRINTING ONLY – CORRECTED IN 2<sup>nd</sup> PRINTING (Posted: 09-27-13)

## CHAPTER 5 [CE] 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 [C106](#).

**IESNA** Illuminating Engineering Society of North America  
120 Wall Street, 17th Floor  
New York, NY 10005-4001

Standard reference number	Title	Referenced in code section number
ANSI/ASHRAE/IESNA 90.1— <del>2007</del> <u>2010</u>	Energy Standard for Buildings, Except Low-rise Residential Buildings . . . . .	C401.2, C401.2.1, C402.1.1, Table C402.1.2, Table C402.2

# 2012 International Energy Conservation Code Errata

(Portions of text and tables not shown are unaffected by the errata)

1<sup>st</sup> thru 3<sup>rd</sup> PRINTINGS (Posted: 09-27-13)

## CHAPTER 5 **[CE]** 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 **C**106.

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

Standard

reference number	Title	Referenced in code section number
100- 2010	Procedure for Determining Fenestration Products U-factors... <del>Second Edition</del> .....	C303.1.2, C402.2.1
200- 2010	Procedure for Determining Fenestration Product Solar Heat Gain Coefficients And Visible Transmittance at Normal Incidence - <del>Second Edition</del> .....	C303.1.3, C402.3.1.1
400 -2010	Procedure for Determining Fenestration Product Air Leakage.... <del>Second Edition</del> ...	Table C402.4.3

# 2012 International Energy Conservation Code Errata

(Portions of text and tables not shown are unaffected by the errata)

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1<sup>st</sup> thru 3<sup>rd</sup> PRINTINGS (Posted: 09-27-13)

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# 2012 International Energy Conservation Code Errata

(Portions of text and tables not shown are unaffected by the errata)

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1<sup>st</sup> thru 3rd PRINTINGS (Posted: 09-27-13)

## CHAPTER 1 [RE] SCOPE AND ADMINISTRATION

**R106.1.1 Conflicts.** Where ~~differences~~ **conflicts** occur between provisions of this code and referenced codes and standards, the provisions of this code shall apply.

# 2012 International Energy Conservation Code Errata

(Portions of text and tables not shown are unaffected by the errata)

1<sup>st</sup> thru 3rd PRINTINGS (Posted: 09-27-13)

**TABLE R402.1.1  
INSULATION AND FENESTRATION REQUIREMENTS BY COMPONENT<sup>a</sup>**

CLIMATE ZONE	FENESTRATION U-FACTOR	SKYLIGHT U-FACTOR	GLAZED FENESTRATION SHGC <sup>be</sup>	CEILING R-VALUE	WOOD FRAME-WALL R-VALUE	MASS WALL R-VALUE	FLOOR R-VALUE
1	NR	0.75	0.25	30	13	3/4	13
2	0.40	0.65	0.25	38	13	4/6	13
3	0.35	0.55	0.25	38	20 or 13 + 5 <sup>d</sup> ←	8/13	19

# 2012 International Energy Conservation Code Errata

(Portions of text and tables not shown are unaffected by the errata)

2<sup>nd</sup> PRINTING ONLY (Posted: 09-27-13)

TABLE R402.1.1  
INSULATION AND FENESTRATION REQUIREMENTS BY COMPONENT<sup>a</sup>

CLIMATE ZONE	FENESTRATION U-FACTOR	SKYLIGHT U-FACTOR	GLAZED FENESTRATION SHGC <sup>be</sup>	CEILING R-VALUE	WOOD FRAME-WALL R-VALUE	MASS WALL R-VALUE	FLOOR R-VALUE
1	NR	0.75	0.25	30	13	3/4	13
2	0.40	0.65	0.25	38	13	4/6	13
3	0.35	0.55	0.25	38	<del>13</del> <u>20 or 13 + 5<sup>n</sup></u>	8/13	19

# 2012 International Energy Conservation Code Errata

(Portions of text and tables not shown are unaffected by the errata)

1<sup>st</sup> and 2<sup>nd</sup> PRINTINGS (Posted: 09-27-13)

## CHAPTER 4 [RE] RESIDENTIAL ENERGY EFFICIENCY

Note: Move the two entries marked with red arrows in the "Proposed Design" column down to line up with the adjacent entries in the "Standard Reference Design" column as shown:

**TABLE R405.5.2(1)  
SPECIFICATIONS FOR THE STANDARD REFERENCE AND PROPOSED DESIGNS**

BUILDING COMPONENT	STANDARD REFERENCE DESIGN	PROPOSED DESIGN
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 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 R402.1.3  SHGC: From Table R402.1.1 except that for climates with no requirement (NR) SHGC = 0.40 shall be used. Interior shade fraction: 0.92-(0.21 x SHGC for the standard reference design) External shading: none	As proposed   As proposed  As proposed  As proposed 0.92-(0.21 x SHGC as proposed) As proposed  

The portion of the Table will appear as shown below:

	SHGC: From Table R402.1.1 except that for climates with no requirement (NR) SHGC = 0.40 shall be used. Interior shade fraction: 0.92-(0.21 x SHGC for the standard reference design) External shading: none	As proposed  0.92-(0.21 x SHGC as proposed) As proposed
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# 2012 International Energy Conservation Code Errata

(Portions of text and tables not shown are unaffected by the errata)

1<sup>st</sup> thru 3rd PRINTINGS (Posted: 09-27-13)

## CHAPTER 5 [RE] 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 [R106](#).

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

reference number	Title	Referenced in code section number
100- <del>2009</del> <a href="#">2010</a>	Procedure for Determining Fenestration Products <i>U</i> -factors... <del>Second Edition</del> .....	R303.1.3
200- <del>2009</del> <a href="#">2010</a>	Procedure for Determining Fenestration Product Solar Heat Gain Coefficients And Visible Transmittance at Normal Incidence <del>Second Edition</del> .....	R303.1.3
400- <del>2009</del> <a href="#">2010</a>	Procedure for Determining Fenestration Product Air Leakage..... <del>Second Edition</del> ...	R402.4.3

# 2012 International Energy Conservation Code Errata

(Portions of text and tables not shown are unaffected by the errata)

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1<sup>st</sup> thru 3rd PRINTINGS (Posted: 09-27-13)

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