



## **CARICOM REGIONAL STANDARD**

**CARICOM Application Document for  
CARICOM Regional Energy Efficiency  
Building Code (Revision)**

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**CREEBC 2024**

Public Comments: 03 Nov 2025 to 06 Feb 2026

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PREFACE

Public Comments: 03 Nov 2025 to 06 Feb 2026

## EFFECTIVE USE OF THE CARICOM REGIONAL ENERGY EFFICIENCY BUILDING CODE

The CARICOM Regional Energy Efficiency Building Code (CREEBC) is a model code that regulates minimum energy conservation requirements for new buildings. The CREEBC 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 CREEBC 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 CREEBC 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 CREEBC 2024

The CREEBC contains two separate sets of provisions—one for commercial buildings and one for residential buildings. Each set of provisions is applied separately to buildings within their scope. The CREEBC—Commercial Provisions apply to all buildings except for residential buildings three stories or less in height. The CREEBC—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 CREEBC Commercial Provisions therefore contain provisions for residential buildings four stories or greater in height. Each set of provisions is divided into five different parts:

Chapters	Subjects
1-2	Administration and definitions
3	Climate zones and general materials requirements
4	Energy efficiency requirements
5	Existing buildings
6	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 Scope and 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 this code. Only through careful observation of the administrative provisions can the code official reasonably expect to demonstrate that “equal protection under the law” has been provided.

**Chapter 2 Definitions.** Chapter 2 is the repository of the definitions of terms used in the body of the code. Codes are technical documents and every word, term and punctuation mark can impact the meaning of the code text and the intended results. The code often uses terms that have a unique meaning in the code and the code meaning can differ substantially from the ordinarily understood meaning of the term as used outside of the code.

The terms defined in Chapter 2 are deemed to be of prime importance in establishing the meaning and intent of the code text. The user of the code should be familiar with and consult this chapter because the definitions are essential to the correct interpretation of the code and the user may not be aware that a term is defined.

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. 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 (U-factors) and provisions that affect the mechanical systems based on the climate where the building 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 or eliminating 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 CREEBC—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. 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. In addition to energy conservation requirements for the building envelope, this chapter contains requirements that impact energy efficiency for the HVAC systems, the electrical systems and the plumbing systems. It should be noted, however, that requirements are contained in other codes that have an impact on energy conservation. For instance, requirements for water flow rates are regulated by the International Plumbing Code.

**Residential Energy Efficiency.** Chapter 4 of the CREEBC—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 buildings 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 CREEBC—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 Existing Buildings.** Chapter 5 of each set of provisions contains the technical energy efficiency requirements for existing buildings. Chapter 5 provisions address the maintenance of buildings in compliance with the code as well as how additions, alterations, repairs and changes of occupancy need to be addressed from the standpoint of energy efficiency. Specific provisions are provided for historic buildings.

**Chapter 6 Referenced Standards.** The code contains numerous references to standards that are used to regulate materials and methods of construction. Chapter 6 contains a comprehensive list of all standards that are referenced in the code. The standards are part of the code to the extent of the reference to the standard. Compliance with the referenced standard is necessary for compliance with this code. By providing specifically adopted standards, the construction and installation requirements necessary for compliance with the code can be readily determined. The basis for code compliance is, therefore, established and available on an equal basis to the code official, contractor, designer and owner.

Chapter 6 is organized in a manner that makes it easy to locate specific standards. It lists all of the referenced standards, alphabetically, by acronym of the promulgating agency of the standard. Each agency's standards

are then listed in either alphabetical or numeric order based on 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.

## How to Read This Document

This document uses **colour coding** to distinguish between different types of content and edits made during the review process. Please refer to the guide below when reading:

- **Black** – This is considered same as **IECC 2018** text, presented exactly as it appears in 2018 version.
- **Orange** – This is considered same as **IECC 2024** text, presented exactly as it appears in 2024 version.
- **Blue** – Rationale / Suggestion, providing reasoning, clarifications, or recommendations.
- **Green** – Modified **IECC 2024** text, reflecting tailored adjustments, edits, or proposed changes.

This structure allows the reader to clearly see:

1. What has been carried forward from IECC 2018 to be considered in CREEBC 2024
2. What has been excluded in proposed CREEBC 2024
3. The exact text from IECC 2024 proposed in CREEBC 2024
4. The rationale or suggestions behind decisions (either 1 or 2 or 3)

The final modified version of IECC 2024 for adoption proposed to be considered in CREEBC 2024

## IECC 2024

The IECC 2024 can be found at: <https://codes.iccsafe.org/content/IECC2024P1>

## Abbreviations and Notations

The following is a list of common abbreviations and units of measurement used in this code. Some of the abbreviations are for terms defined in Chapter 2. Others are terms used in various tables and text of the code.

AFUE	Annual fuel utilization efficiency
bhp	Brake horsepower (fans)
Btu	British thermal unit
Btu/h-ft <sup>2</sup>	Btu per hour per square foot
C-factor	See Chapter 2—Definitions
CDD	Cooling degree days
cfm	Cubic feet per minute
cfm/ft <sup>2</sup>	Cubic feet per minute per square foot
ci	Continuous insulation
COP	Coefficient of performance
DCV	Demand control ventilation
°C	Degrees Celsius
°F	Degrees Fahrenheit
DWHR	Drain water heat recovery
DX	Direct expansion
<i>Ec</i>	Combustion efficiency
<i>Ev</i>	Ventilation efficiency
<i>Et</i>	Thermal efficiency
EER	Energy efficiency ratio
EF	Energy factor
ERI	Energy rating index
F-factor	See Chapter 2—Definitions
FDD	Fault detection and diagnostics
FEG	Fan efficiency grade
FL	Full load
ft <sup>2</sup>	Square foot

gpm	Gallons per minute
HDD	Heating degree days
hp	Horsepower
HSPF	Heating seasonal performance factor
HVAC	Heating, ventilating and air conditioning
IEER	Integrated energy efficiency ratio
IPLV	Integrated Part Load Value
Kg/m <sup>2</sup>	Kilograms per square meter
kW	Kilowatt
LPD	Light power density (lighting power allowance)
L/s	Liters per second
Ls	Liner system
m <sup>2</sup>	Square meters
MERV	Minimum efficiency reporting value
NAECA	National Appliance Energy Conservation Act
NPLV	Nonstandard Part Load Value
Pa	Pascal
PF	Projection factor
pcf	Pounds per cubic foot
psf	Pounds per square foot
PTAC	Packaged terminal air conditioner
PTHP	Packaged terminal heat pump
R-value	See Chapter 2—Definitions
SCOP	Sensible coefficient of performance
SEER	Seasonal energy efficiency ratio
SHGC	Solar Heat Gain Coefficient
SPVAC	Single packaged vertical air conditioner
SPVHP	Single packaged vertical heat pump
SRI	Solar reflectance index
SWHF	Service water heat recovery factor
U-factor	See Chapter 2—Definitions
VAV	Variable air volume
VRF	Variable refrigerant flow
VT	Visible transmittance
W	Watts
w.c.	Water column
w.g.	Water gauge

## UNITS CONVERSION TABLE

SI Unit		I-P Unit	Conversion Factor
1 COP	=	3.412969283 EER	0.293
1 EJ	=	0.947867299 quad (10 <sup>15</sup> Btu)	1.055
1 g	=	15.43209877 grain (1/7000 lb)	0.0648
1 g	=	0.035273369 ounce (mass, avoirdupois)	28.35
1 g	=	0.002204624 lb (avoirdupois, mass)	453.592
1 g/kg	=	6.993006993 gr/lb	0.143
1 g/m <sup>3</sup>	=	0.058479532 gr/gal	17.1
1 ha	=	2.470966148 acre (43,560 ft <sup>2</sup> )	0.4047
1 J	=	0.000947817 Btu (International Table)	1055.056
1 J	=	0.000948452 Btu (thermochemical)	1054.35
1 J	=	0.239005736 calorie (thermochemical)	4.184
1 J	=	0.737463127 ft·lb <sub>f</sub> (work)	1.356
1 J/kg	=	0.334448161 ft·lb <sub>f</sub> /lb (specific energy)	2.99
1 J/m <sup>2</sup>	=	8.80551E-05 Btu/ft <sup>2</sup> (International Table)	11,356.53
1 J/m <sup>3</sup>	=	2.68392E-05 Btu/ft <sup>3</sup> (International Table)	37,258.95
1 J/m <sup>3</sup>	=	3.58787E-06 Btu/gal	278,717.18
1 kg	=	2.20462442 lb (avoirdupois, mass)	0.453592
1 kg/(Pa·s·m)	=	6.87938E+11 perm inch (permeability at 32°F)	1.45E-12
1 kg/(Pa·s·m <sup>2</sup> )	=	17478392337 perm (permeance at 32°F)	5.7214E-11
1 kg/m <sup>2</sup>	=	0.204918033 lb/ft <sup>2</sup>	4.88
1 kg/m <sup>3</sup>	=	0.133526466 ounce (avoirdupois) per gallon	7.489152
1 kg/m <sup>3</sup>	=	0.0625 lb/ft <sup>3</sup> (density r)	16
1 kg/m <sup>3</sup>	=	0.0083333333 lb/gallon	120
1 kg/s	=	7936.507937 lb/h	0.000126
1 kg/s	=	132.2926313 lb/min	0.007559
1 kJ/(kg·K)	=	0.238845897 Btu/lb·°F (specific heat c <sub>p</sub> )	4.1868
1 kJ/kg	=	0.429922614 Btu/lb	2.326
1 kJ/m <sup>3</sup>	=	0.471947444 kW/1000 cfm	2.11888
1 km	=	0.62150404 mile	1.609
1 kN	=	0.224719101 kip (1000 lb <sub>f</sub> )	4.45
1 kPa	=	0.009869233 atmosphere (standard)	101.325
1 kPa	=	0.01 bar	100
1 kPa	=	0.295298842 in. of mercury (60°F)	3.3864
1 kPa	=	10 millibar	0.1
1 kPa	=	7.518796992 mm of mercury (60°F)	0.133
1 kPa	=	0.145032632 psi	6.895
1 kW	=	0.101936799 horsepower (boiler) (33, 470 Btu/h)	9.81
1 kW	=	1.341021859 horsepower (550 ft·lb <sub>f</sub> /s)	0.7457
1 kW	=	3.517411185 lb/h [steam at 212°F (100°C)]	0.2843
1 kW	=	0.284333239 ton, refrigeration (12,000 Btu/h)	3.517

SI Unit		I-P Unit	Conversion Factor
1 L	=	0.006289308 barrel (42 U.S. gal, petroleum)	159
1 L	=	0.035314667 ft <sup>3</sup>	28.316846
1 L	=	0.264172037 gallon (U.S., 231 in <sup>3</sup> )	3.785412
1 L	=	1.056747332 quart (liquid, U.S.)	0.9463
1 L/(s·m <sup>2</sup> )	=	1.472537182 gpm/ft <sup>2</sup>	0.6791
1 L/s	=	2.118881993 ft <sup>3</sup> /min, cfm	0.471947
1 L/s	=	0.035314669 ft <sup>3</sup> /s, cfs	28.316845
1 L/s	=	15.84786054 gpm	0.0631
1 lx	=	0.092903044 footcandle	10.76391
1 m	=	3.280839895 ft	0.3048
1 m <sup>2</sup>	=	10.76391505 ft <sup>2</sup>	0.092903
1 m <sup>2</sup>	=	0.107639151 square (100 ft <sup>2</sup> )	9.2903
1 m <sup>2</sup>	=	1.196029183 yd <sup>2</sup>	0.8361
1 m <sup>2</sup>	=	0.000247104 acre (43,560 ft <sup>2</sup> )	4046.873
1 (m <sup>2</sup> ·K)/W	=	6.451612903 clo	0.155
1 (m <sup>2</sup> ·K)/W	=	5.678269264 ft <sup>2</sup> ·h·°F/Btu (thermal resistance R)	0.17611
1 m <sup>3</sup>	=	6.325162699 barrel (42 U.S. gal, petroleum)	0.1580987
1 m <sup>3</sup>	=	28.37732765 bushel (dry, U.S.)	0.0352394
1 m <sup>3</sup>	=	35.31073446 ft <sup>3</sup>	0.02832
1 m <sup>3</sup>	=	1000 litre	0.001
1 m <sup>3</sup>	=	2113.378531 pint (liquid, U.S.)	4.73E-04
1 m <sup>3</sup>	=	1.307873398 yd <sup>3</sup>	0.7646
1 Mg	=	0.984207408 ton, long (2240 lb)	1.016046
1 mg/kg	=	1 ppm (by mass)	1
1 Mg; t (tonne)	=	1.10231221 ton, short (2000 lb)	0.907184
1 MJ	=	0.277777778 kWh	3.6
1 MJ	=	0.009478673 therm (U.S.)	105.5
1 mL	=	0.061022493 in <sup>3</sup> (volume)	16.3874
1 mL	=	0.033783784 ounce (liquid, U.S.)	29.6
1 mL	=	0.066666667 tablespoon (approximately)	15
1 mL	=	0.2 teaspoon (approximately)	5
1 mL/J	=	55.86592179 gpm/ton refrigeration	0.0179
1 mL/s	=	0.952380952 gph	1.05
1 mL/s	=	3.661434477 in <sup>3</sup> /min (SCIM)	0.273117
1 mm	=	0.00328084 ft	304.8
1 mm	=	0.039370079 inch	25.4
1 mm/m	=	1.200480192 in/100 ft, thermal expansion coefficient	0.833
1 mm <sup>2</sup>	=	0.001550003 in <sup>2</sup>	645.16
1 mPa	=	0.007518797 micron (mm) of mercury (60°F)	133
1 mPa·s	=	1 centipoise (dynamic viscosity m)	1
1 mPa·s	=	2.418964683 lb/ft·h (dynamic viscosity m)	0.4134

SI Unit		I-P Unit	Conversion Factor
1 mPa·s	=	0.000671141 lb/ft·s (dynamic viscosity m)	1490
1 N	=	100000 dyne	1.00E-05
1 N	=	0.101936799 kilopond (kg force)	9.81
1 N	=	3.597122302 ounce (force or thrust)	0.278
1 N	=	0.224808924 lbf (force or thrust)	4.448222
1 N/m	=	0.06852178 lbf/ft (uniform load)	14.5939
1 N·m	=	0.737562121 ft·lbf (torque or moment)	1.355818
1 Pa	=	10 dyne/cm <sup>2</sup>	0.1
1 Pa	=	0.00033456 ft of water	2989
1 Pa	=	0.004018647 in. of water (60°F)	248.84
1 Pa	=	0.102040816 mm of water (60°F)	9.8
1 Pa	=	0.020876827 lbf/ft <sup>2</sup>	47.9
1 Pa	=	0.007518797 torr (1 mm Hg at 0°C)	133
1 Pa/m	=	0.01019368 ft of water per 100 ft pipe	98.1
1 Pa·s	=	0.020885434 lbf·s/ft <sup>2</sup> (dynamic viscosity m)	47.88026
1 W	=	3.412141286 Btu/h	0.2930711
1 W	=	0.022747642 EDR hot water (150 Btu/h)	43.9606
1 W	=	0.014217256 EDR steam (240 Btu/h)	70.33706
1 W	=	44.24778761 ft·lbf/min (power)	0.0226
1 W/(m·K)	=	0.577789205 Btu·ft/h·ft <sup>2</sup> ·°F	1.730735
1 W/(m·K)	=	6.933471263 Btu·in/h·ft <sup>2</sup> ·°F (thermal conductivity <i>k</i> )	0.1442279
1 W/(m <sup>2</sup> ·K)	=	0.176110194 Btu/h·ft <sup>2</sup> ·°F (overall heat transfer coefficient <i>U</i> )	5.678263
1 W/m <sup>2</sup>	=	0.316998305 Btu/h·ft <sup>2</sup>	3.154591
1 W/m <sup>2</sup>	=	0.017196905 met	58.15
1 W/m <sup>2</sup>	=	0.092936803 watt per square foot	10.76

## 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 2025 CARICOM Regional Energy Efficiency Building Code and shall be cited as such. It is referred to herein as “this code.”

1. C101.2 Scope. 2024 IECC shall apply.

##### **C101.2.1 Appendices.**

Provisions in the appendices shall not apply unless specifically adopted.

2. C101.3 Intent. 2024 IECC shall apply

**C101.4 Compliance.** 2024 IECC shall apply.

C101.4.1 Mixed occupancy. 2018 IECC shall apply.

##### **C101.4.1 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 Compliance.** 2018 IECC shall apply.

**C101.5.1 Compliance materials.** 2018 IECC shall apply.

#### SECTION C102 APPLICABILITY

**C102.1 Applicability.** 2024 IECC shall apply.

**C102.1.1 Mixed residential and commercial buildings.** 2024 IECC shall apply.

##### **C102.2 Other laws.**

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

##### **C102.3 Applications 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.

##### **C102.4 Referenced codes and standards.**

The codes and standards referenced in this code shall be those listed in Chapter 6, and such codes and standards shall be considered as part of the requirements of this code to the prescribed extent of each such reference and as further regulated in Sections C102.4.1 and C102.4.2.

##### **C102.4.1 Conflicts.**

Where conflicts occur between provisions of this code and referenced codes and standards, the provisions of this code shall apply.

##### **C102.4.2 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.

##### **C102.5 Partial invalidity.**

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.

### PART 2 - ADMINISTRATION AND ENFORCEMENT

#### SECTION C103 CODE COMPLIANCE AGENCY

C103.1 Creation of enforcement agency. 2024 IECC shall apply

**C103.2 Appointment.** 2024 IECC shall apply

**C103.3 Deputies.** 2024 IECC shall apply

#### SECTION C104 ALTERNATIVE MATERIALS, DESIGN AND METHODS OF CONSTRUCTION AND EQUIPMENT

C104.1 General.

The provisions of this code are not intended to prevent the installation of any material or to prohibit any design or method of construction not specifically prescribed by this code, provided that any such alternative has been *approved*. The *code official* shall have the authority to approve an alternative material, design or method of construction upon the written application of the *owner* or the *owner's* authorized agent. The *code official* shall first find that the proposed design is satisfactory and complies with the intent of the provisions of this code, and that the material, method or work offered is, for the purpose intended, not less than the equivalent of that prescribed in this code in quality, strength, effectiveness, *fire resistance*, durability, energy conservation and safety. The *code official* shall respond to the applicant, in writing, stating the reasons why the alternative was *approved* or was not *approved*.

**C104.1.1 Above code programs.** 2024 IECC shall apply.

#### SECTION C105 CONSTRUCTION DOCUMENTS

**C105.1 General.**

*Construction documents* and other supporting data shall be submitted, as required by the competent code authority having jurisdiction in a digital format allowed by the *code official*, with each application for a permit.

*Construction documents* and supporting data shall be submitted with each permit application, in the number of copies required by the authority having jurisdiction, or in digital format if permitted by the

code official.

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.

**C105.2 Information on construction documents.** 2024 IECC shall apply.

**C105.2.1 Building thermal envelope depiction.** 2024 IECC shall apply.

**C105.3 Examination of documents.** 2024 IECC shall apply.

**C105.3.1 Approval of construction documents.** 2024 IECC shall apply.

**C105.3.2 Previous approvals.** 2024 IECC shall apply

**C105.3.3 Phased approval.** 2024 IECC shall apply.

**C105.4 Amended construction documents.** 2024 IECC shall apply.

**C105.5 Retention of construction documents.** 2024 IECC shall apply.

**C105.6 Building documentation and closeout submittal requirements.** 2024 IECC shall apply.

**C105.6.1 Record documents.** 2024 IECC shall apply.

**C105.6.2 Compliance documentation.** 2024 IECC shall apply.

**C105.6.3 Systems operation control.** 2024 IECC shall apply.

## SECTION C106 FEES

**C106.1 Fees.** 2024 IECC shall apply.

**C106.2 Schedule of permit fees.** 2024 IECC shall apply.

**C106.3 Valuation of work.** 2024 IECC shall apply.

**C106.4 Work commencing before permit issuance.** 2024 IECC shall apply.

**C106.5 Related fees.** 2024 IECC shall apply.

**C106.6 Refunds.** 2024 IECC shall apply.

## SECTION C107 INSPECTIONS

### C107.1 General.

Construction or work for which a permit is required shall be subject to inspection by the *code official*, his or her designated agent or an *approved agency*, and such construction or work shall remain visible and able to be accessed for inspection purposes until *approved*. Approval as a result of an inspection

shall not be construed to be an approval of a violation of the provisions of this code or of other ordinances of the jurisdiction. Inspections presuming to give authority to violate or cancel the provisions of this code or of other ordinances of the jurisdiction shall not be valid. It shall be the duty of the permit applicant to cause the work to remain visible and able to be accessed for inspection purposes. Neither the *code official* nor the jurisdiction shall be liable for expense entailed in the removal or replacement of any material, product, system or building component required to allow inspection to validate compliance with this code.

**C107.2 Required inspections.** 2024 IECC shall apply.

**C107.2.1 Footing and foundation insulation.** 2024 IECC shall apply.

**C107.2.2 Building thermal envelope.** 2024 IECC shall apply.

**C107.2.3 Plumbing system.** 2024 IECC shall apply.

**C107.2.4 Mechanical system.** 2024 IECC shall apply.

**C107.2.5 Electrical system.** 2024 IECC shall apply.

**C107.2.6 Final inspection.** 2024 IECC shall apply.

**C107.3 Reinspection.** 2024 IECC shall apply.

**C107.4 Approved inspection agencies.** 2024 IECC shall apply.

**C107.5 Inspection requests.** 2024 IECC shall apply.

**C107.6 Reinspection and testing.** 2024 IECC shall apply.

## SECTION C108 NOTICE OF APPROVAL

**C108.1 Approval.** 2024 IECC shall apply.

**C108.2 Revocation.** 2024 IECC shall apply.

## SECTION C109 MEANS 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 board of appeals shall be appointed by the governing authority 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.** 2024 IECC shall apply.

**C109.3 Qualifications.** 2024 IECC shall apply.

**C109.4 Administration.** 2024 IECC shall apply.

## SECTION C110 STOP WORK ORDER

**C110.1 Authority.** 2024 IECC shall apply.

**C110.2 Issuance.** 2024 IECC shall apply.

**C110.3 Emergencies.** 2024 IECC shall apply.

**C110.4 Failure to comply.** 2024 IECC shall apply.

CHAPTER 2[CE]  
DEFINITIONSSECTION C201  
GENERAL

**C201.1 Scope.** 2024 IECC shall apply.

**C201.2 Interchangeability.** 2024 IECC shall apply.

**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.** 2018 IECC shall apply.

SECTION C202  
GENERAL DEFINITIONS

In addition to the definitions provided by IECC, the following shall be included.

**AUTHORITY HAVING JURISDICTION.** An organization, office, individual or local government agency responsible for enforcing the requirements of a code or standard, appointing code officials, or for approving equipment, materials, an installation, or a procedure.

**INTEGRATED COEFFICIENT OF PERFORMANCE (ICOP<sub>c</sub>).** A single-number figure of merit expressing cooling part-load COP efficiency for commercial unitary air-conditioning and heat pump equipment based on weighted operation at various load capacities. It is similar to IEER, but in SI or other consistent units.

**SEASONAL COEFFICIENT OF PERFORMANCE—COOLING (SCOP<sub>c</sub>).** The total cooling output of an air conditioner during its normal annual usage period for cooling divided by the total electric energy input during the same period in consistent units. These ratings are used to assess long-term performance and are analogous to SEER but in SI or other consistent units).

**SEASONAL COEFFICIENT OF PERFORMANCE—HEATING (SCOP<sub>H</sub>).** The total heating output of a heat pump during its normal annual usage period for heating divided by the total electric energy input during the same period in consistent units (analogous to HSPF but in SI or other consistent units).

**ABOVE-GRADE WALL.**

See "Wall, above-grade."

**ACCESS (TO).** That which enables a device, appliance or equipment to be reached by ready access or by a means that first requires the removal or movement of a panel or similar obstruction.

**ADDITION.**

An extension or increase in the conditioned space floor area, number of stories or height of a building or structure.

**AIR BARRIER.**

One or more materials joined together in a continuous manner to restrict or prevent the passage of air through the building thermal envelope and its assemblies.

**AIR CURTAIN UNIT.**

A device installed at building entrance that generates and discharges a laminar airstream intended to prevent the infiltration of external, unconditioned air into the conditioned spaces or the loss of interior, conditioned air to the outside.

**AIR LEAKAGE.**

The uncontrolled airflow through the building thermal envelope caused by pressure differences across the building thermal envelope. Air leakage can be inward (infiltration) or outward (exfiltration) through the building thermal envelope.

**ALTERATION.**

Any construction, retrofit or renovation to an existing structure other than repair or addition. Also, a change in a

building, electrical, gas, mechanical or plumbing system that involves an extension, addition or change to the arrangement, type or purpose of the original installation.

**APPROVED.**

Acceptable to the code official.

**APPROVED AGENCY.**

An established and recognized agency that is regularly engaged in conducting tests or furnishing inspection services, or furnishing product certification, where such agency has been approved by the code official.

**APPROVED PARTY.**

An individual or organization recognized by the authority having jurisdiction to complete compliance documentation. This may include a trained local inspector, certified energy auditor, or qualified builder who can accurately certify the building thermal envelope.

**APPROVED SOURCE.**

An independent person, firm or corporation approved by the code official, who is competent and experienced in the application of engineering principles to materials, methods or systems analyses.

**ASHRAE 90.1-2024:** Energy Standard for Buildings Except Low-Rise Residential Buildings (primary energy-efficiency baseline).

**ASHRAE 170-2021:** Ventilation of Health-Care Facilities (specific to health-care occupancies and infection-control requirements).

**ASHRAE 90.4-2022:** Energy Standard for Data Centers (specific to data-center power and cooling systems).

**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").

**BELOW-GRADE WALL.**

See "Wall, below-grade."

**BEST EFFICIENCY POINT (BEP).**

The pump hydraulic power operating point (consisting of both flow and head conditions) that results in the maximum efficiency.

**BIOGAS.** A mixture of hydrocarbons that is a gas at 60°F (15.5°C) and 1 atmosphere of pressure that is produced through the anaerobic digestion of organic matter.

**BIOMASS WASTE.**

Organic non fossil material of biological origin that is a byproduct or a discarded product. Biomass waste includes municipal solid waste from biogenic sources; landfill gas; sludge waste; agricultural crop byproducts; straw; and other biomass solids, liquids and biogases, but excludes wood and wood-derived fuels (including black liquor), biofuel feedstock, biodiesel and fuel ethanol.

**BOILER, MODULATING.**

A boiler that is capable of more than a single firing rate in response to a varying temperature or heating load.

**BOILER SYSTEM.**

One or more boilers, their piping and controls that work together to supply steam or hot water to heat output devices remote from the boiler.

**BUBBLE POINT.** The refrigerant liquid saturation temperature at a specified pressure.

**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, floors, ceilings, roofs and any other building element assemblies that enclose conditioned space or provide a boundary between conditioned space and exempt or unconditioned space.

**CAPTIVE KEY OVERRIDE.**

A lighting control that will not release the key that activates the override when the lighting is on.

**CAVITY INSULATION.**

Insulating material located between framing members.

**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)].

**CHANGE OF OCCUPANCY.**

A change in the use of a building or a portion of a building that results in any of the following:

1. A change of occupancy classification.
2. A change from one group to another group within an occupancy classification.
3. Any change in use within a group for which there is a change in the application of the requirements of this code.

**CHI-FACTOR (χ-FACTOR).**

The heat loss factor for a single thermal bridge characterized as a point element of a building thermal envelope (Btu/h × °F) [W/k].

**CIRCULATING HOT WATER SYSTEM.**

A specifically designed water distribution system where one or more pumps are operated in the service hot water piping to circulate heated water from the water-heating equipment to the fixture supply and back to the water-heating equipment.

**CLEAN WATER PUMP.**

A device that is designed for use in pumping water with a maximum nonabsorbent free solid content of 0.016 lb/ft<sup>3</sup> (0.256 kg/m<sup>3</sup>) and with a maximum dissolved solid content of 3.1 lb/ft<sup>3</sup> (49.66 kg/m<sup>3</sup>), provided that the total gas content of the water does not exceed the saturation volume, and disregarding any additives necessary to prevent the water from freezing at a minimum of 14°F (-10°C).

**CLIMATE ZONE.**

A geographical region based on climatic criteria as specified in this code.

**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 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 building.”

**COMMON AREAS.**

All conditioned spaces within Group R occupancy buildings that are not dwelling units or sleeping units.

**COMMUNITY RENEWABLE ENERGY FACILITY.**

A facility that produces energy harvested from renewable energy resources and is qualified as a community energy facility under applicable jurisdictional statutes and rules.

**COMPUTER ROOM.**

A room whose primary function is to house equipment for the processing and storage of electronic data which has a design total information technology equipment (ITE) equipment power density less than or equal to 20 watts per square foot (20 watts per 0.092 m<sup>2</sup>) of conditioned area or a design total ITE equipment load less than or equal to 10 kW.

**CONDENSING UNIT.**

A factory-made assembly of refrigeration components designed to compress and liquefy a specific refrigerant. The unit consists of one or more refrigerant compressors, refrigerant condensers (air-cooled, evaporatively cooled or water-cooled), condenser fans and motors (where used) and factory-supplied accessories.

**CONDITIONED FLOOR AREA.**

The horizontal projection of the floors associated with the conditioned space.

**CONDITIONED SPACE.**

An area, room or space that is enclosed within the building thermal envelope and is directly or indirectly heated or cooled. Spaces are indirectly heated or cooled where they communicate through openings with conditioned spaces, where they are separated from conditioned spaces by uninsulated walls, floors or ceilings, or where they contain uninsulated ducts, piping or other sources of heating or cooling.

**CONGREGATE LIVING FACILITIES.**

A building or part thereof that contains sleeping

units where residents share bathroom or kitchen facilities, or both.

**CONSTRUCTION DOCUMENTS.**

Written, graphic and pictorial documents prepared or assembled for describing the design, location and physical characteristics of the elements of a project necessary for obtaining a building permit.

**CONTINUOUS INSULATION (ci).**

Insulating material that is continuous across all structural members without thermal bridges other than fasteners and service openings. It is installed on the interior or exterior or is integral to any opaque surface of the building 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.

**DATA CENTER.**

A room or series of rooms that share data center systems, whose primary function is to house equipment for the processing and storage of electronic data and that has a design total ITE equipment power density exceeding 20 watts per square foot (20 watts per 0.092 m<sup>2</sup>) of conditioned area and a total design ITE equipment load greater than 10 kW.

**DATA CENTER SYSTEMS.**

HVAC systems and equipment, or portions thereof, used to provide cooling or ventilation in a data center.

**DAYLIGHT RESPONSIVE CONTROL.**

A device or system that provides automatic control of electric light levels based on the amount of daylight in a space.

**DAYLIGHT ZONE.**

That portion of a building's interior floor area that is illuminated by natural light.

**DEDICATED OUTDOOR AIR SYSTEM (DOAS).**

A ventilation system that supplies 100 percent outdoor air primarily for the purpose of ventilation and that is a separate system from the zone space-conditioning system.

**DEHUMIDIFIER.**

A self-contained, electrically operated and mechanically encased product with the sole purpose of dehumidifying the space consisting of the following:

1. A refrigerated surface (evaporator) that condenses moisture from the atmosphere.
2. A refrigerating system, including an electric motor.
3. An air-circulating fan.
4. A means for collecting or disposing of the condensate.

A dehumidifier does not include a portable air conditioner, room air conditioner or packaged terminal air conditioner.

**DEMAND CONTROL KITCHEN VENTILATION (DCKV).**

A system that provides automatic, continuous control over exhaust hood and makeup air fan speed in response to temperature, optical or infrared (IR) sensors that monitor cooking activity or through direct communication with cooking appliances.

**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 one or more pumps prime the service hot water piping with heated water upon a demand for hot water.

**DEMAND RESPONSE SIGNAL.**

A signal that indicates a price or a request to modify electricity consumption for a limited time period.

**DEMAND RESPONSIVE CONTROL.**

A control capable of receiving and automatically responding to a demand response signal.

**DESSICANT DEHUMIDIFICATION SYSTEM.**

A mechanical dehumidification technology that uses a solid or liquid material to remove moisture from the air.

**DIRECT DIGITAL CONTROL (DDC).**

A type of control where controlled and monitored analog or binary data, such as temperature and contact closures, are converted to digital format for manipulation and calculations by a digital computer or microprocessor, then converted back to analog or binary form to control physical devices.

**DUCT.**

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

**DUCT SYSTEM.**

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

**DWELLING UNIT.**

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

**DX DEDICATED OUTDOOR AIR SYSTEM UNIT (DX-DOAS UNIT).**

A type of air-cooled, water-cooled or water source factory-assembled product that dehumidifies 100 percent outdoor air to a low dew point and includes reheat that is capable of controlling the supply dry-bulb temperature of the dehumidified air to the designated supply air temperature. It may precondition outdoor air with an energy recovery ventilation system.

**DYNAMIC GLAZING.**

Any fenestration product that has the fully reversible ability to change its performance properties, including U-factor, solar heat gain coefficient (SHGC) or visible transmittance (VT).

**EAST-ORIENTED.**

Facing within 45 degrees of true east to the south and within less than 22.5 degrees of true east to the north in the northern hemisphere or facing within 45 degrees of true east to the north and within less than 22.5 degrees of true east to the south in the southern hemisphere.

**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.

**EMITTANCE.**

The ratio of the radiant heat flux emitted by a specimen measured on a scale from 0 to 1, where a value of 1 indicates perfect release of thermal radiation.

**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.

**ENERGY RECOVERY, SERIES.**

A three-step process in which the first step is to remove energy from a single airstream without the use of mechanical cooling. In the second step, the airstream is mechanically cooled for the purpose of dehumidification. In the third step, the energy removed in the first step is reintroduced to the airstream.

**ENERGY RECOVERY RATIO, SERIES (SERR).**

The difference between the dry-bulb air temperatures leaving the series energy recovery unit and leaving the dehumidifying coil divided by the difference between 75°F (24°C) and the dry-bulb temperature of the air leaving the dehumidifying cooling coil.

**ENERGY RECOVERY VENTILATION SYSTEM.**

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

**ENERGY SIMULATION TOOL.**

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

**ENERGY STORAGE SYSTEM (ESS).**

One or more devices, assembled together, capable of storing energy in order to supply electrical energy at a future time.

**ENERGY USE INTENSITY (EUI).**

The metric indicating the total amount of energy consumed by a building in 1 year divided by the gross floor area of the building.

**ENTHALPY RECOVERY RATIO (ERR).**

Change in the enthalpy of the outdoor air supply divided by the difference between the outdoor air and entering exhaust air enthalpy, expressed as a percentage.

**ENTRANCE DOOR.**

A vertical fenestration product used for occupant ingress, egress and access in nonresidential buildings, including, but not limited to, exterior entrances utilizing latching hardware and automatic closers and containing over 50 percent glazing specifically designed to withstand heavy-duty usage.

**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.

**EXTERIOR WALL ENVELOPE.**

A system or assembly of exterior wall components, including exterior wall finish materials, that provides protection of the building structural members, including framing and sheathing materials, and conditioned interior space from the detrimental effects of the exterior environment.

**FAN, EMBEDDED.**

A fan that is part of a manufactured assembly where the assembly includes functions other than air movement.

**FAN ARRAY.**

Multiple fans in parallel between two plenum sections in an air distribution system.

**FAN BRAKE HORSEPOWER (BHP).**

The horsepower delivered to the fan's shaft. Brake horsepower does not include the mechanical drive losses, such as that from belts and gears.

**FAN ELECTRICAL INPUT POWER.**

The electrical input power in kilowatts required to operate an individual fan or fan array at design conditions. It includes the power consumption of motor controllers, where present.

**FAN ENERGY INDEX (FEI).**

The ratio of the electric input power of a reference fan to the electric input power of the actual fan as calculated in accordance with AMCA 208.

**FAN NAMEPLATE ELECTRICAL INPUT POWER.**

The nominal electrical input power rating stamped on a fan assembly nameplate.

**FAN SYSTEM.**

All the fans that contribute to the movement of air serving spaces that pass through a point of a common duct, plenum or cabinet.

**FAN SYSTEM, COMPLEX.**

A fan system that combines a single-cabinet fan system with other supply fans, exhaust fans or both.

**FAN SYSTEM, EXHAUST OR RELIEF.**

A fan system dedicated to the removal of air from interior spaces to the outdoors.

**FAN SYSTEM, RETURN.**

A fan system dedicated to removing air from the interior where some or all the air is to be recirculated except during economizer operation.

**FAN SYSTEM, SINGLE-CABINET.**

A fan system that supplies air to a space and recirculates the air, wherein a single cabinet houses a single fan, a single fan array, a single set of fans operating in parallel or fans or fan arrays in series.

**FAN SYSTEM, TRANSFER.**

A fan system that exclusively moves air from one occupied space to another.

**FAN SYSTEM AIRFLOW.**

The sum of the airflow of all fans with fan electrical input power greater than 1 kW at fan system design conditions, excluding the airflow that passes through downstream fans with fan electrical input power less than 1 kW.

**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 spaces 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, other than during air economizer operation.

**FAN SYSTEM ELECTRICAL INPUT POWER.**

The sum of the fan electrical power 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 spaces and/or return it to the source or exhaust it to the outdoors.

**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 spaces and return it to the source or exhaust it to the outdoors.

**FAULT DETECTION AND DIAGNOSTICS (FDD) SYSTEM.**

A software platform that utilizes building analytic algorithms to convert data provided by sensors and devices to automatically identify faults in building

systems and provide a prioritized list of actionable resolutions to those faults based on cost or energy avoidance, comfort and maintenance impact.

#### **FENESTRATION.**

Products classified as either skylights or vertical fenestration.

#### **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 is 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 per unit perimeter length of slab-on-grade floors ( $\text{Btu/h} \times \text{ft} \times ^\circ\text{F}$ ) [ $\text{W}/(\text{m} \times \text{K})$ ].

#### **FINANCIAL RENEWABLE ENERGY POWER PURCHASE AGREEMENT.**

A financial arrangement between a renewable electricity generator and a purchaser wherein the purchaser pays or guarantees a price to the generator for the project's renewable generation. Also known as a "financial power purchase agreement" and "virtual power purchase agreement."

#### **FLOOR AREA, NET.**

The actual occupied area not including unoccupied accessory areas such as corridors, stairways, toilet rooms, mechanical rooms and closets.

#### **GENERAL LIGHTING.**

Interior lighting that provides a substantially uniform level of illumination throughout a space.

#### **GREEN RETAIL TARIFF**

An electricity-rate structure qualified under applicable statutes or rules contracted by an electricity service provider to the building project owner to provide electricity generated with 100 percent renewable energy resources without the purchase of unbundled renewable energy certificates (RECs).

#### **GREENHOUSE.**

A structure or a thermally isolated area of a building that maintains a specialized sunlit environment with a skylight roof ratio of 50 percent or more above the growing area exclusively used for, and essential to, the cultivation, protection or maintenance of plants. Greenhouses are those that are erected for a period of 180 days or more.

#### **GROUP R.**

Buildings or portions of buildings that contain any of

the following occupancies as established in the International Building Code:

1. Group R-1.
2. Group R-2 where located more than three stories in height above grade plane.
3. Group R-4 where located more than three stories in height above grade plane.

#### **HEAT TRAP.**

An arrangement of piping and fittings, such as elbows, or a commercially available heat trap that prevents thermosyphoning 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 SPEED DOOR.**

A nonswinging door used primarily to facilitate vehicular access or material transportation, with a minimum opening rate of 32 inches (813 mm) per second, a minimum closing rate of 24 inches (610 mm) per second and that includes an automatic-closing device.

#### **HIGH-CAPACITY GAS-FIRED WATER HEATER.**

Gas-fired instantaneous water heaters with a rated input greater than 200,000 Btu/h (58.6 kW) and not less than 4,000 Btu/h per gallon (310 W per liter) of stored water. Also, gas-fired storage water heaters with a rated input both greater than 105,000 Btu/h (30.8 kW) and less than 4,000 Btu/h per gallon (310 W per liter) of stored water.

#### **HIGH-END TRIM.**

A lighting control setting that limits the maximum power to individual luminaries or groups of luminaries in a space.

#### **HISTORIC BUILDING.**

Any building or structure that is one or more of the following:

1. Listed, or certified as eligible for listing, by the State Historic Preservation Officer or the Keeper of the National Register of Historic Places, in the National Register of Historic Places.
2. Designated as historic under an applicable state or local law.
3. Certified as a contributing resource within a National Register-listed, state-designated or locally designated historic district.

#### **HORTICULTURAL LIGHTING.**

Electric lighting used for horticultural production, cultivation or maintenance.

#### **HUMIDISTATIC CONTROLS.**

Automatic controls used to maintain humidity at a setpoint.

#### **HVAC TOTAL SYSTEM PERFORMANCE RATIO (HVAC TSPR).**

The ratio of the sum of a building's annual heating and cooling load in thousands of Btu's to the sum of annual site energy consumption of the building

HVAC systems in Btu.

**IEC DESIGN H MOTOR.**

An electric motor that meets all of the following:

1. It is an induction motor designed for use with three-phase power.
2. It contains a cage rotor.
3. It is capable of direct-on-line starting.
4. It has four, six or eight poles.
5. It is rated from 0.4 kW to 1600 kW at a frequency of 60 hertz.

**IEC DESIGN N MOTOR.**

An electric motor that meets all of the following:

1. It is an induction motor designed for use with three-phase power.
2. It contains a cage rotor.
3. It is capable of direct-on-line starting.
4. It has two, four, six or eight poles.
5. It is rated from 0.4 kW to 1600 kW at a frequency of 60 hertz.

**INDOOR GROW.**

A space, other than a greenhouse, used exclusively for and essential to horticultural production, cultivation or maintenance.

**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.

**INFORMATION TECHNOLOGY EQUIPMENT (ITE).**

Items including computers, data storage devices, servers and network and communication equipment.

**INTEGRATED HVAC SYSTEM.**

An HVAC system designed to handle both sensible and latent heat removal. Integrated HVAC systems include, but are not limited to, HVAC systems with a sensible heat ratio of 0.65 or less and the capability of providing cooling, dedicated outdoor air systems, single-package air conditioners with at least one refrigerant circuit providing hot gas reheat, and dehumidifiers modified to allow external heat rejection.

**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.

**INTERNAL CURTAIN SYSTEM.**

A system consisting of movable panels of fabric or plastic film used to cover and uncover the space enclosed in a greenhouse on a daily basis.

**ISOLATION DEVICES.**

Devices that isolate HVAC zones so that they can be operated independently of one another. Isolation devices include separate systems, isolation dampers and controls providing shutoff at terminal boxes.

**LABELED.**

Equipment, materials or products to which have been affixed a label, seal, symbol or other identifying mark of a nationally recognized testing laboratory, approved agency or other organization concerned with product evaluation that maintains periodic inspection of the production of the 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.

**LARGE-DIAMETER CEILING FAN.**

A ceiling fan that is greater than or equal to 84 1/2 inches (2.15 m) in diameter. These fans are sometimes referred to as High-Volume, Low-Speed (HVLS) fans.

**LINER SYSTEM (Ls).**

A system that includes the following:

1. A continuous vapor barrier liner membrane that is installed below the purlins and that is uninterrupted by framing members.
2. An uncompressed, unfaced insulation resting on top of the liner membrane and located between the purlins.

For multilayer installations, the last rated R-value of insulation is for unfaced insulation draped over purlins and then compressed when the metal roof panels are attached.

**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 SLOPE.**

A slope less than 2 units vertical in 12 units horizontal (17 percent slope) as applied to roofs.

**LOW-VOLTAGE DRY-TYPE DISTRIBUTION TRANSFORMER.**

A transformer that is air-cooled, does not use oil as a coolant, has an input voltage less than or equal to 600 volts and is rated for operation at a frequency of 60 hertz.

**LUMINAIRE-LEVEL LIGHTING CONTROLS.**

A lighting system consisting of one or more luminaires with embedded lighting control logic, occupancy and ambient light sensors, wireless networking capabilities and local override switching capability, where required.

**MANUAL.**

Capable of being operated by personal intervention (see "Automatic").

**NAMEPLATE HORSEPOWER.**

The nominal motor output power rating stamped on the motor nameplate.

**NEMA DESIGN A MOTOR.**

A squirrel-cage motor that meets all of the following:

1. It is designed to withstand full-voltage starting and develop locked-rotor torque as shown in paragraph 12.38.1 of NEMA MG 1.
2. It has pull-up torque not less than the values shown in paragraph 12.40.1 of NEMA MG 1.
3. It has breakdown torque not less than the values shown in paragraph 12.39.1 of NEMA MG 1.
4. It has a locked-rotor current higher than the values shown in paragraph 12.35.1 of NEMA MG 1 for 60 hertz and paragraph 12.35.2 of NEMA MG 1 for 50 hertz.
5. It has a slip at rated load of less than 5 percent for motors with fewer than 10 poles.

**NEMA DESIGN B MOTOR.**

A squirrel-cage motor that meets all of the following:

1. It is designed to withstand full-voltage starting.
2. It develops locked-rotor, breakdown and pull-up torques adequate for general application as specified in Sections 12.38, 12.39 and 12.40 of NEMA MG1.
3. It draws locked-rotor current not to exceed the values shown in Section 12.35.1 for 60 hertz and Section 12.35.2 for 50 hertz of NEMA MG1.
4. It has a slip at rated load of less than 5 percent for motors with fewer than 10 poles.

**NEMA DESIGN C MOTOR.**

A squirrel-cage motor that meets all of the following:

1. Designed to withstand full-voltage starting and develop locked-rotor torque for high-torque applications up to the values shown in paragraph 12.38.2 of NEMA MG1 (incorporated by reference, see A\$431.15).
2. It has pull-up torque not less than the values shown in paragraph 12.40.2 of NEMA MG1.
3. It has breakdown torque not less than the values shown in paragraph 12.39.2 of NEMA MG1.
4. It has a locked-rotor current not to exceed the values shown in paragraph 12.35.1 of NEMA MG1 for 60 hertz and paragraph 12.35.2 for 50 hertz.
5. It has a slip at rated load of less than 5 percent.

**NETWORKED GUESTROOM CONTROL SYSTEM.**

A control system, with access from the front desk or other central location associated with a Group R-1 building, that is capable of identifying the rented and unrented status of each guestroom according to a timed schedule, and is capable of controlling HVAC in each hotel and motel guestroom separately.

**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 AHRI standard rating conditions.

**NORTH-ORIENTED.**

Facing within 67.5 degrees of true north in the northern hemisphere or facing within 67.5 degrees of true south in the southern hemisphere.

**OCCUPANT SENSOR CONTROL.**

An automatic control device or system that detects the presence or absence of people within an area and causes lighting, equipment or appliances to be regulated accordingly.

**OCCUPIED-STANDBY MODE.**

Mode of operation when an HVAC zone is scheduled to be occupied and an occupant sensor indicates no occupants are within the zone.

**ON-SITE RENEWABLE ENERGY.**

Energy from renewable energy resources harvested at the building project site.

**OPAQUE DOOR.**

A door that is not less than 50 percent opaque in surface area.

**Optimum Start and Stop:**

A building automation control strategy that automatically adjusts the startup and shutdown time of HVAC systems to achieve desired indoor conditions (temperature, humidity, and ventilation) at the beginning of occupancy and maintain energy efficiency. The system learns from past performance and external factors (such as outdoor weather, building thermal mass, and load conditions) to start equipment only as early as necessary and stop it as late as possible without compromising occupant comfort.

**OWNER.**

Any person, agent, operator, entity, firm or corporation having any legal or equitable interest in the property; or recorded in the official records of the state, county or municipality as holding an interest or title to the property; or otherwise having possession or control of the property, including the guardian of the estate of any such person, and the executor or administrator of the estate of such person if ordered to take possession of real property by a court.

**PARKING AREA, EXTERIOR.**

Parking spaces, drive aisles and ramps that are not located within a building, or that are located on a roof.

**PARKING AREA, INTERIOR.**

Parking spaces, drive aisles and ramps located within a building.

**PARKING GARAGE SECTION.**

A part of an enclosed parking garage that is separated from all other parts of the garage by full-height solid walls or operable openings that are intended to remain closed during normal operation and where vehicles cannot pass to other parts of the garage. A parking garage can have one or more

parking garage sections, and parking garage sections can include multiple floors.

**PHOTOSYNTHETIC PHOTON EFFICACY (PPE).**

Photosynthetic photon flux emitted by a light source divided by its electrical input power in units of micromoles per second per watt, or micromoles per joule ( $\mu\text{mol}/\text{J}$ ) between 400–700 nm as defined by ANSI/ASABE S640.

**PHYSICAL RENEWABLE ENERGY POWER PURCHASE AGREEMENT.**

A contract for the purchase of renewable electricity from a specific renewable electricity generator to a purchaser of renewable electricity.

**POWERED ROOF/WALL VENTILATORS.**

A fan consisting of a centrifugal or axial impeller with an integral driver in a weather-resistant housing and with a base designed to fit, usually by means of a curb, over a wall or roof opening.

**PROCESS APPLICATION.**

A manufacturing, industrial or commercial procedure or activity where the primary purpose is other than conditioning spaces and maintaining comfort and amenities for the occupants of a building.

**PROPOSED DESIGN.**

A description of the proposed building used to estimate annual energy use for determining compliance based on simulated building performance and HVAC total system performance ratio.

**PSI-FACTOR ( $\Psi$ -FACTOR).**

The heat loss factor per unit length of a thermal bridge characterized as a linear element of a building thermal envelope ( $\text{Btu}/\text{h} \times \text{ft} \times ^\circ\text{F}$ ) [ $\text{W}/(\text{m} \times \text{K})$ ].

**PUMP ENERGY INDEX (PEI).**

The ratio of a pump's energy rating divided by the energy rating of a minimally compliant pump. For pumps with the constant load operating mode, the relevant PEI is  $\text{PEI}_{\text{CL}}$ . For pumps with the variable load operating mode, the relevant PEI is  $\text{PEI}_{\text{VL}}$ .

**PURCHASED ENERGY.**

Energy or power purchased for consumption and delivered to the building site.

**RADIANT HEATING SYSTEM.**

A heating system that transfers heat to objects and surfaces within a conditioned space, primarily by infrared radiation.

**READY ACCESS (TO).**

That which enables a device, appliance or equipment to be directly reached without requiring the removal or movement of any panel or similar obstruction.

**REFRIGERANT DEW POINT.**

The refrigerant vapor saturation temperature at a specified pressure.

**REFRIGERATED WAREHOUSE COOLER.**

An enclosed storage space capable of being refrigerated to temperatures above 32°F (0°C) that can be walked into and has a total chilled storage

area of not less than 3,000 square feet (279 m<sup>2</sup>).

**REFRIGERATED WAREHOUSE FREEZER.**

An enclosed storage space capable of being refrigerated to temperatures at or below 32°F (0°C) that can be walked into and has a total chilled storage area of not less than 3,000 square feet (279 m<sup>2</sup>).

**REFRIGERATION SYSTEM, LOW TEMPERATURE.**

Systems for maintaining food product in a frozen state in refrigeration applications.

**REFRIGERATION SYSTEM, MEDIUM TEMPERATURE.**

Systems for maintaining food product above freezing in refrigeration applications.

**REGISTERED DESIGN PROFESSIONAL.**

An individual who is registered or licensed to practice their respective design profession as defined by the statutory requirements of the professional registration laws of the state or jurisdiction in which the project is to be constructed.

**RENEWABLE ENERGY CERTIFICATE (REC).**

A market-based instrument that represents and conveys the environmental, social and other nonpower attributes of 1 megawatt hour of renewable electricity generation and could be sold separately from the underlying physical electricity associated with renewable energy resources, also known as energy attribute and energy attribute certificate (EAC).

**RENEWABLE ENERGY INVESTMENT FUND (REIF).**

A fund established by a jurisdiction to accept payment from building project owners to construct or acquire interests in qualifying renewable energy systems, together with their associated RECs, on the building project owners' behalf.

**RENEWABLE ENERGY RESOURCES.**

Energy derived from solar radiation, wind, waves, tides, biomass waste or extracted from hot fluid or steam heated within the earth.

**REPAIR.**

The reconstruction or renewal of any part of an existing building for the purpose of its maintenance or to correct damage.

**REROOFING.**

The process of recovering or replacing an existing roof covering. See "[Roof recover](#)" and "[Roof replacement](#)."

**RESIDENTIAL BUILDING.**

For this code, includes detached one- and two-family dwellings and multiple single-family dwellings (townhouses) and 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.

**ROOF RECOVER.**

The process of installing an additional roof covering over an existing roof covering without removing the existing roof covering.

**ROOF REPAIR.**

Reconstruction or renewal of any part of an existing roof for the purpose of its maintenance.

**ROOF REPLACEMENT.**

An alteration that includes the removal of all existing layers of roof assembly materials down to the roof deck and the installation of replacement materials above the existing roof deck.

**ROOFTOP MONITOR.**

A raised section of a roof containing vertical fenestration along one or more sides.

**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 ( $h \times ft^2 \times ^\circ F/Btu$ ) [ $(m^2 \times K)/W$ ].

**SATURATED CONDENSING TEMPERATURE.**

The saturation temperature corresponding to the measured refrigerant pressure at the condenser inlet for single component and azeotropic refrigerants, and the arithmetic average of the dew point and bubble point temperatures corresponding to the refrigerant pressure at the condenser entrance for zeotropic refrigerants.

**SENSIBLE ENERGY RECOVERY RATIO.**

Change in the dry-bulb temperature of the outdoor air supply divided by the difference between the outdoor air and entering exhaust air dry-bulb temperatures, expressed as a percentage.

**SERVICE WATER HEATING.**

Supply of hot water for purposes other than comfort heating.

**SIMULATED BUILDING PERFORMANCE.**

A process in which the proposed building design is compared to a standard reference design for the purposes of estimating relative energy use against a baseline to determine code compliance.

**SLEEPING UNIT.**

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

**SMALL ELECTRIC MOTOR.**

A general purpose alternating-current single-speed induction motor

**SOLAR HEAT GAIN COEFFICIENT (SHGC).**

The ratio of the solar heat gain entering the space through the fenestration assembly to the incident solar radiation. Solar heat gain includes directly transmitted solar heat and absorbed solar radiation that is then reradiated, conducted or convected into

the space.

**SOUTH-ORIENTED.**

Facing within 45 degrees of true south in the northern hemisphere or facing within 45 degrees of true north in the southern hemisphere.

**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 simulated building performance and HVAC total system performance ratio.

**STOREFRONT.**

A system of doors and windows mullled 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 mullled windows and doors.

**SUBSTANTIAL IMPROVEMENT.**

Any repair, reconstruction, rehabilitation, alteration, addition or other improvement of a building or structure, the cost of which equals or is more than 50 percent of the market value of the structure before the improvement. Where the structure has sustained substantial damage, as defined in the International Building Code, any repairs are considered substantial improvement regardless of the actual repair work performed. Substantial improvement does not include the following:

1. Improvement of a building ordered by the code official to correct health, sanitary or safety code violations.
2. Alteration of a historic building where the alteration will not affect the designation as a historic building.

**TESTING UNIT ENCLOSURE AREA.**

The area sum of all the boundary surfaces that define the dwelling unit, sleeping unit or conditioned enclosed space, including top/ceiling, bottom/floor and all side walls. This does not include interior partition walls within the dwelling unit, sleeping unit or conditioned enclosed space. Wall height shall be measured from the finished floor of the conditioned space to the finished floor or roof/ceiling air barrier above.

**THERMAL BLOCK.**

A generic concept used in energy simulation. It can include one or more thermal zones. It represents a whole building or portion of a building with the same use type served by the same HVAC system type.

**THERMAL BRIDGE.**

An element or interface of elements within the building thermal envelope that has higher thermal conductivity than surrounding materials, creating a path of least resistance for heat transfer and thereby reducing the effectiveness of insulation and overall energy performance.

**THERMAL DISTRIBUTION EFFICIENCY (TDE).**

The resistance to changes in air heat as air is conveyed through a distance of air duct. TDE is a heat loss calculation evaluating the difference in the heat of the air between the air duct inlet and outlet caused by differences in temperatures between the air in the duct and the duct material. TDE is expressed as a percent difference between the inlet and outlet heat in the duct.

**THERMOSTAT.**

An automatic control device used to maintain temperature at a fixed or adjustable setpoint.

**TIME-SWITCH CONTROL.**

An automatic control device or system that controls lighting or other loads, including switching off, based on time schedules.

**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)].

**VARIABLE REFRIGERANT FLOW SYSTEM.**

An engineered direct-expansion (DX) refrigerant system that incorporates a common condensing unit, at least one variable-capacity compressor, a distributed refrigerant piping network to multiple indoor fan heating and cooling units each capable of individual zone temperature control, through integral zone temperature control devices and a common communications network. Variable refrigerant flow utilizes three or more steps of control on common interconnecting piping.

**VEGETATIVE ROOF.**

An assembly of interacting components designed to waterproof a building's top surface that includes, by design, vegetation and related landscape elements.

**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.

**VISIBLE TRANSMITTANCE, ANNUAL (VT<sub>annual</sub>).**

The ratio of visible light entering the space through the fenestration product assembly to the incident visible light during the course of a year, which includes the effects of glazing material, frame, and light well or tubular conduit, and is expressed as a number between 0 and 1.

**VOLTAGE DROP.**

A decrease in voltage caused by losses in the wiring systems that connect the power source to the load.

**WALK-IN COOLER.**

An enclosed storage space capable of being refrigerated to temperatures above 32°F (0°C) and less than 55°F (12.8°C) that can be walked into, has a ceiling height of not less than 7 feet (2134 mm) and has a total chilled storage area of less than 3,000 square feet (279 m<sup>2</sup>).

**WALK-IN FREEZER.**

An enclosed storage space capable of being refrigerated to temperatures at or below 32°F (0°C) that can be walked into, has a ceiling height of not less than 7 feet (2134 mm) and has a total chilled storage area of less than 3,000 square feet (279 m<sup>2</sup>).

**WALL, ABOVE-GRADE.**

A wall associated with the building thermal envelope that is more than 15 percent above grade and is on the exterior of the building or any wall that is associated with the building thermal envelope that is not on the exterior of the building. This includes, but is not limited to, between-floor spandrels, peripheral edges of floors, roof knee walls, dormer walls, gable end walls, walls enclosing a mansard roof, mechanical equipment penetrations and skylight shafts.

**WALL, BELOW-GRADE.**

A wall associated with the basement or first story of the building that is part of the building thermal envelope, is not less than 85 percent below grade and is on the exterior of the building.

**WATER HEATER.**

Any heating appliance or equipment that heats potable water and supplies such water to the potable hot water distribution system.

**WEST-ORIENTED.**

Facing within 45 degrees of true west to the south and within less than 22.5 degrees of true west to the north in the northern hemisphere or facing within 45 degrees of true west to the north and within less than 22.5 degrees of true west to the south in the southern hemisphere.

**WORK AREA.**

That portion or portions of a building consisting of all reconfigured spaces as indicated on the construction documents. Work area excludes other portions of the building where incidental work entailed by the intended work must be performed and portions of the building where work not initially intended by the owner is specifically required by this code.

**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 Table C301.1 shall be used in determining the applicable requirements from Chapter 4 [CE]. Locations not in Table C301.1 shall be assigned a climate zone based on Section C301.3.

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

**C301.3 Unstated climate zones.** The climate zone for any location not listed in Table C301.1 shall be determined by applying Table C301.3(1) and then Table C301.3(2).

**C301.4 Tropical climate zone.** The tropical climate zone shall be defined as:

1. Anguilla, Antigua and Barbuda, Bahamas, Barbados, Belize, Bermuda, British Virgin Islands, Cayman Islands, Dominica, Grenada, Guyana, Haiti, Jamaica, Montserrat, Saint Lucia, St. Kitts and Nevis, St. Vincent and the Grenadines, Suriname, Trinidad and Tobago, Turks and Caicos Islands; and
2. Islands in the area between the Tropic of Cancer and the Tropic of Capricorn.

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

Key: A – Moist, B – Dry, C – Marine. Absence of moisture designation indicates moisture regime is irrelevant.

COUNTRY	LOCATION	WMO#	CZ	SI			I-P				
				Elev (m)	CDD10	HDD18	Precip (mm)	Elev (ft)	CDD50	HDD65	Precip (in)
Anguilla (AIA) <sup>a</sup>	WALLBLAKE	-	0A	10 <sup>c</sup>	6691	0 <sup>c</sup>	617 <sup>c</sup>	33 <sup>c</sup>	10450 <sup>c</sup>	0 <sup>c</sup>	24 <sup>c</sup>
Antigua and Barbuda (ATG) <sup>b</sup>	VC BIRD INTL AIRPORT	788620	0A	10	6249	0	883	33	11248	0	35
Bahamas (BHS) <sup>b</sup>	LYNDEN PINDLING INTL AIRPORT	780730	1A	7	5643	9	1334	23	10157	16	53
	SETTLEMENT POINT	994390	1A	3	5322	19	1281	10	9580	34	50
Barbados (BRB) <sup>b</sup>	GRANTLEY ADAMS	789540	0A	56	6308	0	1155	184	11354	0	45
Belize (BLZ) <sup>b</sup>	BELIZE/PHILLIP GOLD	785830	0A	5	6145	0	1944	16	11061	0	77
Bermuda (BMU) <sup>b</sup>	BERMUDA INTL	780160	2A	6	4596	88	1456	20	8273	158	57
British Virgin Islands (VGB) <sup>a</sup>	TERRANCE B. LETTSOME INTL AIRPORT		0A	10 <sup>c</sup>	6453	0 <sup>c</sup>	841 <sup>c</sup>	33 <sup>c</sup>	10445 <sup>c</sup>	0 <sup>c</sup>	33 <sup>c</sup>
Cayman Islands (CYM) <sup>a</sup>	OWEN ROBERTS AIRPORT		0A	10 <sup>c</sup>	6620	0 <sup>c</sup>	1037 <sup>c</sup>	33 <sup>c</sup>	10889 <sup>c</sup>	0 <sup>c</sup>	41 <sup>c</sup>
Dominica (DMA) <sup>a</sup>	DOUGLAS-CHARLES AIRPORT		0A	10 <sup>c</sup>	6288	0 <sup>c</sup>	878 <sup>c</sup>	33 <sup>c</sup>	10631 <sup>c</sup>	0 <sup>c</sup>	35 <sup>c</sup>
Grenada (GRD) <sup>b</sup>	MAURICE BISHOP INTL AIRPORT	789580	0A	7	6378	0	1197	23	11480	0	47
Guyana (GUY) <sup>b</sup>	TIMEHRICHEDDI JAG	810020	0A	29	6136	0	2234	95	11045	0	88
Haiti (HTI) <sup>a</sup>	PORT-AU-PRINCE AEROPORT INTL		0A	10 <sup>c</sup>	6848	0 <sup>c</sup>	1404 <sup>c</sup>	33 <sup>c</sup>	10278 <sup>c</sup>	0 <sup>c</sup>	55 <sup>c</sup>
Jamaica (JAM) <sup>b</sup>	KINGSTON/NORMAN MAN	783970	0A	14	6608	0	730	46	11894	0	29
	MONTEGO BAY/SANGSTE	783880	0A	8	6336	0	1184	26	11405	0	47
Montserrat (MSR) <sup>a</sup>	JOHN OSBORNE AIRPORT	-	1A	10 <sup>c</sup>	5946	0 <sup>c</sup>	702 <sup>c</sup>	33 <sup>c</sup>	10615 <sup>c</sup>	0 <sup>c</sup>	28 <sup>c</sup>
Saint Lucia (LCA) <sup>b</sup>	HEWANORRA INTL AIRP	789480	0A	10	6429	0	1128	33	11572	0	44
St. Kitts and Nevis (KNA) <sup>a</sup>	ROBERT L. BRADSHAW INTL AIRPORT	-	0A	10 <sup>c</sup>	6388	0 <sup>c</sup>	696 <sup>c</sup>	33 <sup>c</sup>	10516 <sup>c</sup>	0 <sup>c</sup>	27 <sup>c</sup>

COUNTRY	LOCATION	WMO#	CZ	SI			I-P				
				Elev (m)	CDD10	HDD18	Precip (mm)	Elev (ft)	CDD50	HDD65	Precip (in)
<b>St. Vincent and the Grenadines (VCT)<sup>a</sup></b>	ARGYLE INTERNATIONAL AIRPORT	-	0A	10 <sup>c</sup>	6647	0 <sup>c</sup>	582 <sup>c</sup>	33 <sup>c</sup>	10729 <sup>c</sup>	0 <sup>c</sup>	23 <sup>c</sup>
<b>Suriname (SUR)<sup>a</sup></b>	JOHAN A. PENDEL INTL AIRPORT at Zanderij	812250	0A	9	6264	0	2249	30	11275	0	89
	Paramaribo	-	-	10 <sup>c</sup>	6361	0 <sup>c</sup>	2293 <sup>c</sup>	33 <sup>c</sup>	10688 <sup>c</sup>	0 <sup>c</sup>	90 <sup>c</sup>
<b>Trinidad and Tobago (TTO)<sup>b</sup></b>	ARTHUR NAPOLEON RAYMOND ROBINSON INTL AIRPORT	789620	0A	6	6307	0	1452	20	11353	0	57
	PIARCO INT. AIRPORT	789700	0A	15	6274	0	1781	49	11293	0	70
	PROVIDENCIALES INTL AIRPORT	-	0A	10 <sup>c</sup>	6439	0 <sup>c</sup>	673 <sup>c</sup>	33 <sup>c</sup>	10331 <sup>c</sup>	0 <sup>c</sup>	27 <sup>c</sup>

a. Calculated CARICOM Member State or Associate

b. CARICOM Member State or Associate

(continued)

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

*Degree-day*: the difference in temperature between the out- door mean temperature over a 24-hour period and a given base temperature. For the purposes of determining building envelope requirements, the classifications are defined as follows:

*Cooling degree-day base 10°C, CDD10 (50°F, CDD50)*: for any one day, when the mean temperature is more than 10°C (50°F), there are as many degree-days as degrees Fahrenheit or Celsius temperature difference between the mean temperature for the day and 10°C (50°F) (mean temperature 10°C (50°F)). Annual cooling degree- days (CDDs) are the sum of the degree-days over a calendar year.

*Heating degree-day base 18°C, HDD18 (65°F, HDD65)*: for any one day, when the mean temperature is less than 18°C (65°F), there are as many degree-days as degrees Fahrenheit or Celsius temperature difference between and 18°C (65°F) and the mean temperature for the day (18°C (65°F) minus the mean temperature). Annual heating degree-days (HDDs) are the sum of the degree-days over a calendar year.

Public Comments: 03 Nov 2025 to 06 Feb 2026

**Table C301.3(1)  
UNSTATED CLIMATE ZONE DEFINITIONS**

MAJOR CLIMATE TYPE DEFINITIONS	
<p><i>Marine (C) Definition</i>—Locations meeting all four criteria:</p> <ol style="list-style-type: none"> <li>1. Mean temperature of coldest month between <math>-3^{\circ}\text{C}</math> (<math>27^{\circ}\text{F}</math>) and <math>18^{\circ}\text{C}</math> (<math>65^{\circ}\text{F}</math>)</li> <li>2. Warmest month mean <math>&lt; 22^{\circ}\text{C}</math> (<math>72^{\circ}\text{F}</math>)</li> <li>3. At least four months with mean temperatures over <math>10^{\circ}\text{C}</math> (<math>50^{\circ}\text{F}</math>)</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><i>Dry (B) Definition</i>—Locations meeting the following criteria:</p> <ol style="list-style-type: none"> <li>1. Not Marine (C)</li> <li>2. If 70% or more of the precipitation, <math>P</math>, occurs during the high sun period, then the dry/humid threshold is <math>P_{mm} &lt; 20.0 \times (T + 14)</math> (SI) [<math>P_{in} &lt; 0.44 \times (T - 7)</math> (I-P)]</li> <li>3. If between 30% and 70% of the precipitation, <math>P</math>, occurs during the high sun period, then the dry/humid threshold is <math>P_{mm} &lt; 20.0 \times (T + 7)</math> (SI) [<math>P_{in} &lt; 0.44 \times (T - 19.5)</math> (I-P)]</li> <li>4. If 30% or less of the precipitation, <math>P</math>, occurs during the high sun period, then the dry/humid threshold is <math>P_{mm} &lt; 20 \times T</math> (SI) [<math>P_{in} &lt; 0.44 \times (T - 32)</math> (I-P)] where: <ul style="list-style-type: none"> <li><math>\frac{P}{T}</math> =</li> <li>annual precipitation, in. (mm)</li> <li><math>T</math> =</li> <li>annual mean temperature, <math>^{\circ}\text{F}</math> (<math>^{\circ}\text{C}</math>)</li> <li>Summer or high sun = April</li> <li>through September in the Northern Hemisphere and</li> <li>October</li> <li>through March period in the Southern Hemisphere</li> <li>Winter or cold season =</li> <li>October through March in the Northern Hemisphere and April</li> <li>through September</li> <li>in the Southern Hemisphere</li> </ul> </li> </ol>	
<p><i>Humid (A) Definition</i>—Locations that are not marine and not dry.</p>	
<p><i>Warm-humid Definition</i>—Humid (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. <math>19.4^{\circ}\text{C}</math> (<math>67^{\circ}\text{F}</math>) or higher for 3,000 or more hours; or</li> <li>2. <math>22.8^{\circ}\text{C}</math> (<math>73^{\circ}\text{F}</math>) or higher for 1,500 or more hours.</li> </ol>	

For IP:  $^{\circ}\text{F} = [ (^{\circ}\text{F} - 32) \times 5/9 ]$ , 1 mm = 0.03937 in..

**Table 301.3(2)  
UNSTATED CLIMATE ZONE DEFINITIONS  
[Source: ASHRAE STANDARD 169-2013]**

Thermal Zone	Name	SI Units	I-P Units
0	Tropical <sup>1</sup>	6000 < CDD10°C	10,800 < CDD50°F
1	Very hot	5000 < CDD10°C ≤ 6000	9000 < CDD50°F ≤ 10,800
2	Hot	3500 < CDD10°C ≤ 5000	6300 < CDD50°F ≤ 9000
3	Warm	CDD10°C ≤ 3500 and HDD18°C ≤ 2000	CDD50°F ≤ 6300 and HDD65°F ≤ 3600

<sup>1</sup> ASHRAE Standard 169-2013 uses the term "Extremely hot"

**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 305 mm (12 in) 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. For insulated siding, the R-value shall be labelled on the product's pack- age and shall be listed on the certification. The insulation installer shall sign, date and post the certification in a conspicuous location on the job site.

**Exception:** For roof insulation installed above the deck, the R-value shall be labeled as required by the material standards specified in Table 1508.2 of the International Building Code.

**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 mm (in.) on markers that are installed at least one for every 28 m<sup>2</sup> (300 square feet) throughout the attic space. The markers shall be affixed to the trusses or joists and marked with the minimum initial installed thickness with numbers not less than 25 mm (1 inch) 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.** 2024 IECC shall apply.

**C303.1.3 Fenestration product rating.** 2024 IECC shall apply.

**TABLE C303.1.3(1)  
DEFAULT OPAQUE DOOR U-FACTORS**

FRAME TYPE	SINGLE PANE	DOUBLE PANE	SKYLIGHT	
			Single	Double
Metal	6.81 W/m <sup>2</sup> ·K	4.54 W/m <sup>2</sup> ·K	11.36 W/m <sup>2</sup> ·K	7.38 W/m <sup>2</sup> ·K
	(1.20 Btu/h·ft <sup>2</sup> ·°F)	(0.80 Btu/h·ft <sup>2</sup> ·°F)	(2.00 Btu/h·ft <sup>2</sup> ·°F)	(1.30 Btu/h·ft <sup>2</sup> ·°F)
Metal with Thermal Break	6.25 W/m <sup>2</sup> ·K	3.69 W/m <sup>2</sup> ·K	10.79 W/m <sup>2</sup> ·K	6.25 W/m <sup>2</sup> ·K
	(1.10 Btu/h·ft <sup>2</sup> ·°F)	(0.65 Btu/h·ft <sup>2</sup> ·°F)	(1.90 Btu/h·ft <sup>2</sup> ·°F)	(1.10 Btu/h·ft <sup>2</sup> ·°F)
Nonmetal or Metal Clad	5.39 W/m <sup>2</sup> ·K	3.12 W/m <sup>2</sup> ·K	9.94 W/m <sup>2</sup> ·K	5.96 W/m <sup>2</sup> ·K
	(0.95 Btu/h·ft <sup>2</sup> ·°F)	(0.55 Btu/h·ft <sup>2</sup> ·°F)	(1.75 Btu/h·ft <sup>2</sup> ·°F)	(1.05 Btu/h·ft <sup>2</sup> ·°F)
Glazed Block	3.41 W/m <sup>2</sup> ·K			
	(0.60 Btu/h·ft <sup>2</sup> ·°F)			

**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 · ft<sup>2</sup> · °F/Btu at a mean temperature of 24°C (75°F).

**TABLE C303.1.3(2)  
DEFAULT DOOR U-FACTORS**

DOOR TYPE	U-FACTOR
Uninsulated Metal	6.81 W/m <sup>2</sup> ·K
	(1.20 Btu/h·ft <sup>2</sup> ·°F)
Insulated Metal (Rolling)	5.11 W/m <sup>2</sup> ·K
	(0.90 Btu/h·ft <sup>2</sup> ·°F)
Insulated Metal (Other)	3.41 W/m <sup>2</sup> ·K
	(0.60 Btu/h·ft <sup>2</sup> ·°F)
Wood	2.84 W/m <sup>2</sup> ·K
	(0.50 Btu/h·ft <sup>2</sup> ·°F)
Insulated, nonmetal edge, max 45% glazing, any glazing double pane	1.99 W/m <sup>2</sup> ·K
	(0.35 Btu/h·ft <sup>2</sup> ·°F)

**TABLE C303.1.3(3)**  
**DEFAULT GLAZED FENESTRATION SHGC**  
**AND VT 2024 IECC shall apply.**

**C303.1.4.1 Insulated siding.** 2024 IECC shall apply.

**C303.2 Installation.** 2024 IECC shall apply.

**C303.2.1 Protection of exposed foundation insulation.** Insulation applied to the exterior of basement walls, crawlspace walls and the perimeter of slab-on-grade floors shall have a

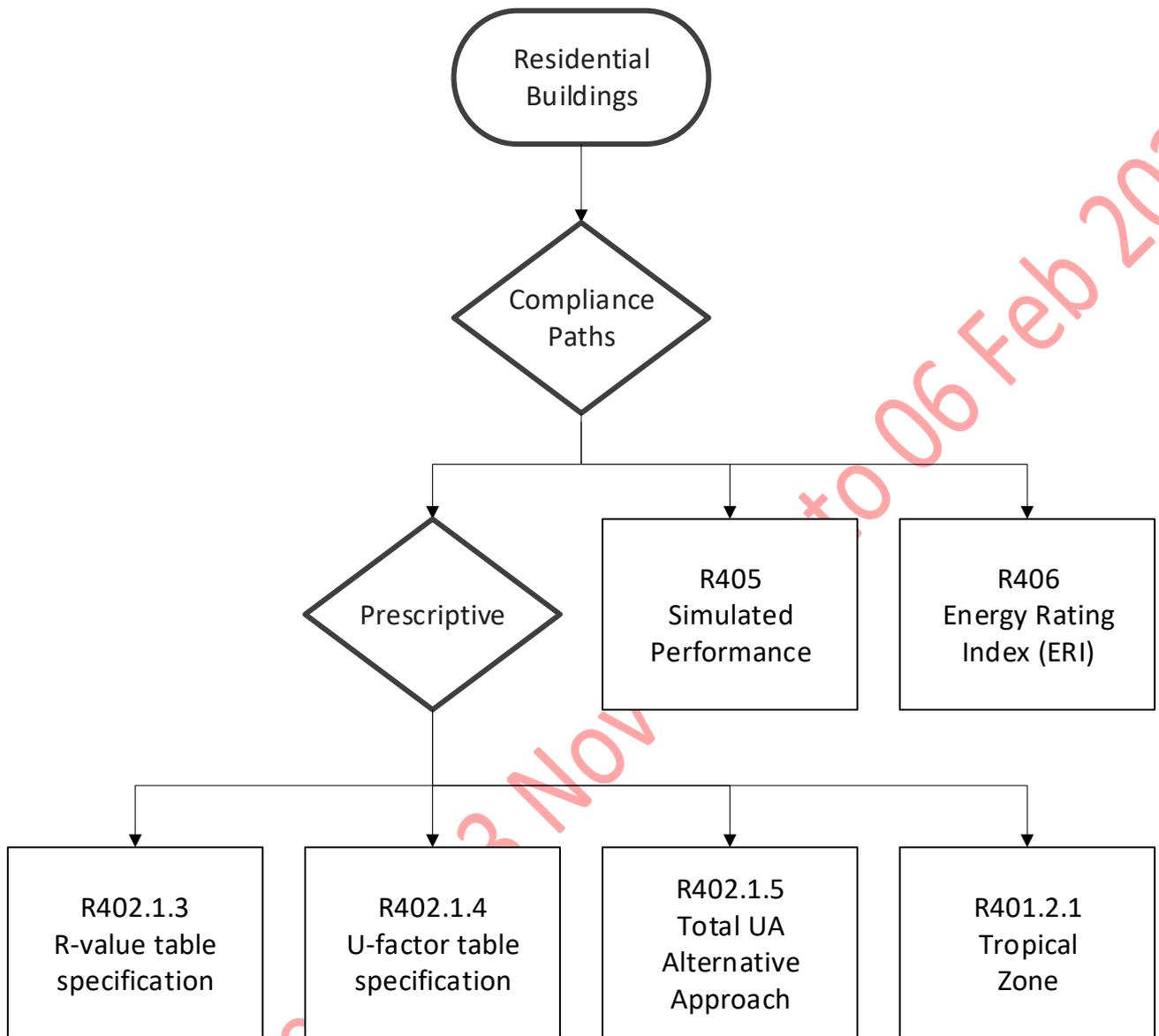
rigid, opaque and weather-resistant protective covering to prevent the degradation of the insulation's thermal performance. The protective covering shall cover the exposed exterior insulation and extend not less than 153 mm (6 inches) below grade.

**C303.2.2 Multiple layers of continuous insulation board.** 2024 IECC shall apply.

**C303.3 Maintenance information.** 2024 IECC shall apply.

Public Comments: 03 Nov 2025 to 06 Feb 2026

RESIDENTIAL PROVISIONS



**CREEBC—RESIDENTIAL PROVISIONS**  
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 20XX Regional Energy Efficiency Building Code, and shall be cited as such. It is referred to herein as “this code.”

**R101.2 Scope.** 2024 IECC shall apply.

**R101.2.1 Appendices.**

Provisions in the appendices shall not apply unless specifically adopted.

**R101.3 Intent.** 2024 IECC shall apply.

**R101.4 Compliance.** 2024 IECC shall apply.

**R101.4.1 Compliance materials.** 2024 IECC shall apply.

**SECTION R102  
APPLICABILITY**

**R102.1 Applicability.** 2024 IECC shall apply.

**R102.1.1 Mixed residential and commercial buildings.** 2024 IECC shall apply.

**R102.2 Other laws.** 2024 IECC shall apply.

**R102.3 Application of references.** 2024 IECC shall apply.

**R102.4 Referenced codes and standards.** The codes and standards referenced in this code shall be those indicated in [Chapter 6](#), and such codes and standards shall be considered as part of the requirements of this code to the prescribed extent of each such reference and as further regulated in [Sections R102.4.1](#) and [R102.4.2](#).

**R102.4.1 Conflicts.** 2024 IECC shall apply.

**R102.4.2 Provisions in referenced codes and standards.** 2024 IECC shall apply.

**R102.5 Partial invalidity.**

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.

**PART 2 - ADMINISTRATION AND****ENFORCEMENT****SECTION R103  
CODE COMPLIANCE AGENCY**

**R103.1 Creation of enforcement agency.** 2024 IECC shall apply.

**R103.2 Appointment.** 2024 IECC shall apply.

**R103.3 Deputies.** 2024 IECC shall apply.

**SECTION R104  
ALTERNATIVE MATERIALS, DESIGN  
AND METHODS OF CONSTRUCTION  
AND EQUIPMENT****R104.1 General.**

The provisions of this code are not intended to prevent the installation of any material or to prohibit any design or method of construction not specifically prescribed by this code, provided that any such alternative has been *approved*. The *code official* shall have the authority to approve an alternative material, design or method of construction upon the written application of the owner or the owner's authorized agent. The *code official* shall first find that the proposed design is satisfactory and complies with the intent of the provisions of this code, and that the material, method or work offered is, for the purpose intended, not less than the equivalent of that prescribed in this code for strength, effectiveness, fire resistance, durability, energy conservation and safety. The *code official* shall respond to the applicant, in writing, stating the reasons why the alternative was *approved* or was not *approved*.

**R104.1.1 Above code programs.** 2024 IECC shall apply.

**SECTION R105  
CONSTRUCTION DOCUMENTS****R105.1 General.**

*Construction documents*, technical reports and other supporting data shall be submitted in one or more sets, or in a digital format where allowed by the *code official*, with each application for a permit. The *construction documents* and technical reports 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.

**R105.2 Information on construction documents.** 2024 IECC shall apply.

**R105.2.1 Building thermal envelope depiction.** 2024 IECC shall apply.

**R105.2.2 Solar-ready system.** Where a *solar-ready zone* is provided, the *construction documents* shall indicate details for a dedicated roof area for the *solar-ready zone*, roof dead load, roof live load and the routing of conduit or prewiring from the *solar-ready zone* to an electrical service panel or plumbing from the *solar-ready zone* to a *service water heating system*.

**R105.3 Examination of documents.** 2024 IECC shall apply.

**R105.3.1 Approval of construction documents.** 2024 IECC shall apply.

**R105.3.2 Previous approvals.** 2024 IECC shall apply.

**R105.3.3 Phased approval.** 2024 IECC shall apply.

**R105.4 Amended construction documents.** 2024 IECC shall apply.

**R105.5 Retention of construction documents.** 2024 IECC shall apply.

## SECTION R106 FEES

**R106.1 Payment of fees.**

A permit shall not be *valid* until the fees prescribed by *law* have been paid. *Nor* shall an amendment to a permit be released until the additional fee, if any, has been paid.

**R106.2 Schedule of permit fees.** 2024 IECC shall apply.

**R106.3 Permit valuation.** 2024 IECC shall apply.

**R106.4 Work commencing before permit issuance.** 2024 IECC shall apply.

**R106.5 Related fees.** 2024 IECC shall apply.

**R106.6 Refunds.** 2024 IECC shall apply.

## SECTION R107 INSPECTIONS

**R107.1 General.**

Construction or work for which a permit is required shall be subject to inspection by the *code official* his or her designated agent, and such construction or work shall remain visible and able to be accessed for inspection purposes until *approved*. It shall be the duty of the permit applicant to cause the work to remain visible and able to be accessed for inspection purposes. Neither the *code official* nor the jurisdiction shall be liable for expense entailed in the removal or replacement of any material, product, system or building component required to allow inspection to validate compliance with this code.

**R107.2 Required inspections.** 2024 IECC shall apply.

**R107.2.1 Footing and foundation inspection.** 2024 IECC shall apply.

**R107.2.2 Framing and air barrier rough-in inspection.** 2024 IECC shall apply.

**R107.2.3 Plumbing rough-in inspection.**

Inspections at plumbing rough-in shall verify compliance as required by the code and *approved* plans and specifications as to types of insulation and corresponding *R*-values and protection and required controls. Where a *solar-ready zone* is provided for a solar thermal system, inspections shall verify pathways for routing of plumbing from *solar-ready zone* to *service water heating system*.

**R107.2.4 Mechanical rough-in inspection.** 2024 IECC shall apply.

**R107.2.5 Electrical rough-in inspection.** 2024 IECC shall apply.

Inspections at electrical rough-in shall verify compliance as required by the code and the *approved* plans and specifications as to the locations, distribution and capacity of the electrical system. Where the *solar-ready zone* is installed for electricity generation, inspections shall verify conduit or prewiring from *solar-ready zone* to electrical panel.

**R107.2.6 Insulation and fenestration rough-in inspection.** Inspections at insulation and *fenestration* rough-in shall be made before the application of interior finish. Inspections shall be used to verify compliance with this code as to types of insulation, corresponding *R*-values and their correct location and proper installation; and *fenestration* properties such as *U*-factors, SHGC and proper installation.

**R107.2.7 Final inspection.** 2024 IECC shall

apply.

**R107.3 Reinspection.** 2024 IECC shall apply.

**R107.4 Approved third-party inspection agencies.**

The *code official* is authorized to accept reports of third-party inspection agencies not affiliated with the *building* design or construction, provided that such agencies are *approved* as to qualifications and reliability relevant to the *building* components and systems that they are inspecting or testing, and approval is granted prior to issuance of the building permit.

**R107.4.1 Authorization of approved third-party inspection agency.**

An *approved* third-party inspection agency shall provide all requested information for the *code official* to determine that the agency meets the applicable requirements specified in Sections

R107.4.1.1 through R107.4.1.3 and to authorize its work in the jurisdiction.

**R107.4.1.1 Independence.**

An *approved* third-party inspection agency shall be an independent business identity. The agency shall perform its duties in accordance with the scope of delegated responsibilities established by the *code official*. The agency shall disclose to the *code official* any conflicts of interest, including where fees for service are derived. The agency shall acknowledge in writing that it is authorized to work only within the scope of delegated responsibilities.

**R107.4.1.2 Equipment.**

An *approved* third-party inspection agency shall have adequate equipment to perform inspections and tests required by the *code official* and this code. All testing equipment shall be periodically calibrated as required by the manufacturer, testing standards used in this code or certifications held by the *approved* third-party inspection agency.

**R107.4.1.3 Personnel.**

Personnel assigned by an *approved* third-party inspection agency to perform inspections and testing shall be trained or credentialed, and documentation of training or credentials shall be available to the *code official* upon request.

**R107.4.1.4 Delegated authority.**

Where *approved*, a third-party inspection agency shall have the authority to perform delegated inspections and determine

compliance or noncompliance of work with *approved construction documents*.

**R107.4.2 Approved third-party inspection agency reporting.**

An *approved* third-party inspection agency shall keep records of delegated inspections, tests and compliance documentation required by this code. The agency shall submit reports of delegated inspections and tests to the *code official* and to the owner or owner's representative. Reports shall indicate the compliance determination for the inspected or tested work based on *approved construction documents*. A final report documenting required delegated inspections and tests, and correction of any discrepancies noted in the inspections or tests, shall be submitted with other required compliance documentation at a time required by the *code official*.

**R107.5 Inspection requests.** 2024 IECC shall apply.

**R107.6 Reinspection and testing.** 2024 IECC shall apply.

**SECTION R108  
NOTICE OF APPROVAL**

**R108.1 Approval.** 2024 IECC shall apply.

**R108.2 Revocation.** 2024 IECC shall apply.

**SECTION R109  
MEANS 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 board of appeals shall be appointed by the applicable governing authority 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.** 2024 IECC shall apply.

**R109.3 Qualifications.**

The board of appeals shall consist of members who are qualified by experience and training on matters pertaining to the provisions of this code and are not employees of the jurisdiction.

**R109.4 Administration.**

The code official shall take action in accordance with the decision of the board.

**SECTION R110  
STOP WORK ORDER**

**R110.1 Authority.** 2024 IECC shall apply.

**R110.2 Issuance.** 2024 IECC shall apply.

**R110.3 Emergencies.** 2024 IECC shall apply.

**R110.4 Failure to comply.** 2024 IECC shall apply.

Public Comments: 03 Nov 2025 to 06 Feb 2026

## CHAPTER 2[RE] DEFINITIONS

### SECTION R201 GENERAL

**R201.1 Scope.** 2024 IECC shall apply.

**R201.2 Interchangeability.** 2024 IECC shall apply.

**R201.3 Terms defined in other codes.** 2024 IECC shall apply.

**R201.4 Terms not defined.** 2024 IECC shall apply.

### SECTION R202 GENERAL DEFINITIONS

**AUTHORITY HAVING JURISDICTION.** An organization, office, or individual responsible for enforcing the requirements of a code or standard, appointing code officials, or for approving equipment, materials, an installation, or a procedure.

**ENERGY USE INTENSITY.** Energy-use intensity (EUI): an expression of building energy use per year in terms of net energy divided by gross floor area.

**ENERGY USE INTENSITY (EUI):** A measure of a building's annual energy use, expressed as the total net energy consumed per year divided by the building's gross floor area

**EUI = Annual Net Energy Use (kWh)/Gross Floor Area (m<sup>2</sup>)** **ADDITION.** An extension or increase in the floor area, number of stories or height of a *building* or structure.

**AIR-HANDLING UNIT.** A blower or fan used for the purpose of distributing supply air to a room, space or area.

**APPROVED SOURCE.** An independent person, firm or corporation *approved* by the *code official*, who is competent and experienced in the application of engineering principles to materials, methods or system analyses.

**AUTOMATIC SHUTOFF CONTROL.** A device capable of automatically turning loads off without *manual* intervention. *Automatic shutoff controls* include devices such as, but not limited to, occupancy sensors, vacancy sensors, door switches, programmable time switches (i.e., timeclocks), or count-down timers.

**BALANCED VENTILATION SYSTEM.** A *ventilation* system that simultaneously supplies outdoor air to and exhausts air from a space, where the mechanical supply airflow rate and the mechanical exhaust airflow rate are each within 10 percent of the average of the two airflow rates.

**BIODIESEL BLEND.** A homogeneous mixture of hydrocarbon oils and mono alkyl esters of long chain fatty acids.

**COMMON AREAS.** All conditioned spaces within Group R occupancy buildings that are not *dwelling units* or *sleeping units*.

**CONSTRUCTION DOCUMENTS.** Written, graphic

and pictorial documents prepared or assembled for describing the design, location and physical characteristics of the elements of a project necessary for obtaining a building permit.

**CONTINUOUS INSULATION (ci).** Insulating material that is continuous across all structural members without thermal bridges other than fasteners and service openings. It is installed on the interior or exterior, or is integral to any opaque surface, of the *building thermal* envelope.

**CONTINUOUS PILOT.** A pilot which, once placed in operation, is intended to remain ignited continuously until it is manually interrupted.

**DAMPER.** A manually or automatically controlled device to regulate draft or the rate of flow of air or combustion gases.

**DEMAND RESPONSE SIGNAL.** A signal that indicates a price or a request to modify electricity consumption for a limited time period.

**DEMAND RESPONSIVE CONTROL.** A control capable of receiving and automatically responding to a *demand response signal*.

**DISTRIBUTION SYSTEM EFFICIENCY (DSE).** A factor that adjusts for the energy losses associated with delivery of energy from the equipment to the source of the load.

**DUCT SYSTEM.** A system that consists of *space conditioning equipment* and *ductwork*, and includes any apparatus installed in connection therewith.

**DUCTWORK.** The assemblies of connected *ducts*, plenums, boots, fittings, *dampers*, supply registers, return grilles, and filter grilles through which air is supplied to or returned from the space to be heated, cooled, or ventilated. Supply *ductwork* delivers air to the spaces from the *space conditioning equipment*. Return *ductwork* conveys air from the spaces back to the *space conditioning equipment*. *Ventilation ductwork* conveys air to or from any space.

**EMITTANCE.** The ratio of the radiant heat flux emitted by a specimen measured on a scale from 0 to 1, where a value of 1 indicates perfect release of thermal radiation.

**ENCLOSED REFLECTIVE AIRSPACE.** An unventilated cavity with a low-*emittance* surface bounded on all sides by building components.

**ENERGY RATING INDEX (ERI).** A numerical integer value that represents the relative energy performance of a *rated design* or constructed *dwelling unit* as compared with the energy performance of the *ERI Reference Design*, where an ERI value of 100 represents the energy performance of the *ERI Reference Design* and an ERI value of 0 represents a *rated design* or constructed *dwelling unit* with zero net energy performance.

**EXISTING BUILDING.** A *building* erected prior to the date of adoption of the appropriate code, or one for which a legal building permit has been issued.

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

**FUEL GAS.** A natural gas, manufactured gas, liquified petroleum gas or a mixture of these.

**FUEL OIL.** Kerosene or any hydrocarbon oil having a flash point not less than 100°F (38°C).

**GRADE PLANE.** A reference plane representing the average of the finished ground level adjoining the *building* at all *exterior walls*. Where the finished ground level slopes away from the *exterior wall*, the reference plane is established by the lowest points within the area between the *building* and the lot line or, where the lot line is more than 6 feet (1829 mm) from the *building* between the structure and a point 6 feet (1829 mm) from the *building*.

**HEAT EXCHANGER.** A device that transfers heat from one medium to another.

**INTERMITTENT IGNITION.** Type of ignition that is energized when an appliance is called on to operate and that remains continuously energized during each period of main burner operation and where the ignition is deenergized when the main burner operating cycle is completed.

**INTERRUPTED IGNITION.** Type of ignition that is energized prior to the admission of fuel to the main burner and that is deenergized when the main flame is established.

**KNEE WALL.** An *above-grade wall* assembly, or wall defined by vertical truss members, of any height that separates *conditioned space* from unconditioned buffer spaces, such as ventilated attics and entry porch roofs, rather than ambient outdoors.

**LIQUID FUEL.** A *fuel oil* or *biodiesel blend*.

**LIVING SPACE.** Space within a *dwelling unit* utilized for living, sleeping, eating, cooking, bathing, washing and sanitation purposes.

**LOW SLOPE.** A roof slope less than 2 units vertical in 12 units horizontal (17 percent slope).

**OCCUPIABLE SPACE.** An enclosed space intended for human activities, excluding those spaces intended primarily for other purposes, such as storage rooms and equipment rooms, that are only intended to be occupied occasionally and for short periods of time.

**ON-DEMAND PILOT.** A pilot that, once placed into operation, is intended to remain ignited for a predetermined period of time following an *automatic* or *manual* operation of the main burner gas valve, after which the pilot is automatically extinguished when no *automatic* or *manual* operation of the main burner gas valve occurs during the predetermined period of time.

**PLENUM.** An enclosed portion of the *building* structure, other than an *occupiable*

*space* being conditioned, that is designed to allow air movement and thereby serve as part of the supply or return *ductwork*.

**RADIANT BARRIER.** A material having a low *emittance* surface of 0.1 or less installed in building assemblies.

**RATED DESIGN.** A description of the proposed *dwelling unit* used to determine the *energy rating index*.

**REFLECTIVE INSULATION.** A material with a surface *emittance* of 0.1 or less in an assembly consisting of one or more *enclosed reflective airspaces*.

**RENEWABLE ENERGY CERTIFICATE (REC).** A market-based instrument that represents and conveys the environmental attributes of 1 megawatt hour of renewable electricity generation and could be sold separately from the underlying physical electricity associated with *renewable energy resources*; also known as an energy attribute certificate (EAC).

**ROOF REPLACEMENT.** An *alteration* that includes the removal of all existing layers of *roof assembly* materials down to the roof deck and the installation of replacement materials above the existing roof deck.

**SIMULATED BUILDING PERFORMANCE.** A process in which the proposed building design is compared to a *standard reference design* for the purposes of estimating relative energy use to determine code compliance.

**SLEEPING UNIT.** A single unit that provides rooms or spaces for one or more persons, includes permanent provisions for sleeping and can include provisions for living, eating and either sanitation or kitchen facilities but not both. Such rooms and spaces that are part of a *dwelling unit* are not *sleeping units*.

**SOLAR-READY ZONE.** A designated area of a building or property reserved for the future installation of a solar photovoltaic or solar thermal system.

**SPACE CONDITIONING.** The treatment of air so as to control the temperature, humidity, filtration or distribution of the air to meet the requirements of a *conditioned space*.

**SPACE CONDITIONING EQUIPMENT.** The *heat exchangers*, *air-handling units*, filter boxes and any apparatus installed in connection therewith used to provide *space conditioning*.

**STEEP SLOPE.** A roof slope 2 units vertical in 12 units horizontal (17 percent slope) or greater.

**SUBSTANTIAL IMPROVEMENT.** Any *repair*, reconstruction, rehabilitation, *alteration*, *addition* or other improvement of a *building* or structure, the cost of which equals or is more than 50 percent of the market value of the structure before the improvement. Where the structure has sustained substantial damage as defined in the *International Building Code*, any repairs are

considered *substantial improvement* regardless of the actual *repair* work performed. *Substantial improvement* does not include the following:

1. Improvement of a *building* ordered by the code official to correct health, sanitary or safety code violations.
2. *Alteration* of a historic building where the *alteration* will not affect the designation as a historic building.

**TESTING UNIT ENCLOSURE AREA.** The sum of the area of ceiling, floors, and walls separating a *dwelling unit's* or *sleeping unit's* conditioned space from the exterior or from adjacent conditioned or unconditioned spaces. Wall height shall be measured from the finished floor of the *dwelling unit* or *sleeping unit* to the underside of the floor above.

**WORK AREA.** That portion or portions of a *building* consisting of all reconfigured spaces as indicated on the *construction documents*. *Work area* excludes other portions of the *building* where

incidental work entailed by the intended work must be performed and portions of the *building* where work not initially intended by the owner is specifically required by this code.

## CHAPTER 3[RE] GENERAL REQUIREMENTS

### SECTION R301 CLIMATE ZONES

**R301.1 General.** Climate zones from Table R301.1 shall be used in determining the applicable requirements from Chapter 4 [RE]. Locations not in Table R301.1 shall be assigned a climate zone based on Section R301.3.

**R301.2 Warm humid counties.** Warm humid locations are identified in Table R301.1 by an asterisk.

**R301.3 Unstated climate zones.** The climate zone for any location not listed in Table R301.1 shall be determined by applying Table R301.3 and then Table R301.3(2).

**R301.4 Tropical climate zone.** The tropical climate zone shall be defined as:

1. Islands in the area between the Tropic of Cancer and the Tropic of Capricorn.
2. Anguilla, Antigua and Barbuda, Bahamas, Barbados, Belize, Bermuda, British Virgin Islands, Cayman Islands, Dominica, Grenada, Guyana, Haiti, Jamaica, Montserrat, Saint Lucia, St. Kitts and Nevis, St. Vincent and the Grenadines, Suriname, Trinidad and Tobago, Turks and Caicos Islands;

### SECTION R302 DESIGN CONDITIONS

R302.1 Interior design conditions. 2024 IECC shall apply

### SECTION R303 MATERIALS, SYSTEMS AND EQUIPMENT

**R303.1 Identification.** 2024 IECC shall apply.

**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 305 mm (12 inches) 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. *For reflective insulation, the number of reflective sheets, the number and thickness of the enclosed reflective airspaces and the R-value for the installed assembly determined in accordance with Section R303.1.6 shall be listed on the certification.* For insulated siding, the R-value shall be labelled on the product's package and 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 mm (inches) on markers that are installed at least one for every 28 m<sup>2</sup> (300 square feet) throughout the attic space. The markers shall be affixed to the trusses or joists and marked with the minimum initial installed thickness with numbers not less than 25 mm (1 inch) 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. 2024 IECC shall apply.

R303.1.3 Fenestration product rating. 2024 IECC shall apply.

**TABLE R303.1.3(1)  
DEFAULT GLAZED FENESTRATION U-FACTORS**

FRAME TYPE	SINGLE PANE	DOUBLE PANE	SKYLIGHT	
			Single	Double
Metal	6.81 W/m <sup>2</sup> ·K (1.20 Btu/h·ft <sup>2</sup> ·°F)	4.54 W/m <sup>2</sup> ·K (0.80 Btu/h·ft <sup>2</sup> ·°F)	11.36 W/m <sup>2</sup> ·K (2.00 Btu/h·ft <sup>2</sup> ·°F)	7.38 W/m <sup>2</sup> ·K (1.30 Btu/h·ft <sup>2</sup> ·°F)
	6.25 W/m <sup>2</sup> ·K (1.10 Btu/h·ft <sup>2</sup> ·°F)	3.69 W/m <sup>2</sup> ·K (0.65 Btu/h·ft <sup>2</sup> ·°F)	10.79 W/m <sup>2</sup> ·K (1.90 Btu/h·ft <sup>2</sup> ·°F)	6.25 W/m <sup>2</sup> ·K (1.10 Btu/h·ft <sup>2</sup> ·°F)
Metal with Thermal Break	5.39 W/m <sup>2</sup> ·K (0.95 Btu/h·ft <sup>2</sup> ·°F)	3.12 W/m <sup>2</sup> ·K (0.55 Btu/h·ft <sup>2</sup> ·°F)	9.94 W/m <sup>2</sup> ·K (1.75 Btu/h·ft <sup>2</sup> ·°F)	5.96 W/m <sup>2</sup> ·K (1.05 Btu/h·ft <sup>2</sup> ·°F)
	3.41 W/m <sup>2</sup> ·K (0.60 Btu/h·ft <sup>2</sup> ·°F)			
Nonmetal or Metal Clad				
Glazed Block				

**TABLE R303.1.3(2)  
DEFAULT DOOR U-FACTORS**

DOOR TYPE	U-FACTOR
Uninsulated Metal	6.81 W/m <sup>2</sup> ·K (1.20 Btu/h·ft <sup>2</sup> ·°F)
	3.41 W/m <sup>2</sup> ·K (0.60 Btu/h·ft <sup>2</sup> ·°F)
Insulated Metal	2.84 W/m <sup>2</sup> ·K (0.50 Btu/h·ft <sup>2</sup> ·°F)
	1.99 W/m <sup>2</sup> ·K (0.35 Btu/h·ft <sup>2</sup> ·°F)
Wood	
Insulated, nonmetal edge, max 45% glazing, any glazing double pane	

**TABLE R303.1.3(3)  
DEFAULT GLAZED FENESTRATION SHGC AND VT**

2024 IECC shall apply.

**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 m<sup>2</sup>·K/W (h·ft<sup>2</sup>·°F/Btu) at a mean temperature of 24°C (75°F).

**R303.1.4.1 Insulated siding.** 2024 IECC shall apply.  
**R303.1.5 Air-impermeable insulation.** 2024 IECC shall apply.

**R303.1.6 Airspaces.** 2024 IECC shall apply.

**R303.2 Installation.** 2024 IECC shall apply.

**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 not less than 153 mm (6 inches) below grade.

**R303.2.2 Radiant barrier.** 2024 IECC shall apply.

**R303.3 Maintenance information.** 2024 IECC shall apply.

Public Comments: 03 Nov 2025 to 06 Feb 2026

**TABLE R301.1  
CLIMATE ZONES, MOISTURE REGIMES, AND WARM-HUMID DESIGNATIONS BY COUNTRY AND TERRITORY**

Key: A – Moist, B – Dry, C – Marine. Absence of moisture designation indicates moisture regime is irrelevant.

COUNTRY	LOCATION	WMO#	CZ	SI			I-P				
				Elev (m)	CDD10	HDD18	Precip (mm)	Elev (ft)	CDD50	HDD65	Precip (in)
Anguilla (AIA) <sup>a</sup>	WALLBLAKE		0A		6691						
Antigua and Barbuda (ATG) <sup>b</sup>	VC BIRD INTL AIRPORT	788620	0A	10	6249	0	883	33	11248	0	35
Bahamas (BHS) <sup>b</sup>	LYNDEN PINDLING INTL AIRPORT	780730	1A	7	5643	9	1334	23	10157	16	53
	SETTLEMENT POINT	994390	1A	3	5322	19	1281	10	9580	34	50
	GRANTLEY ADAMS	789540	0A	56	6308	0	1155	184	11354	0	45
Barbados (BRB) <sup>b</sup>	GRANTLEY ADAMS	789540	0A	56	6308	0	1155	184	11354	0	45
Belize (BLZ) <sup>b</sup>	BELIZE/PHILLIP GOLD	785830	0A	5	6145	0	1944	16	11061	0	77
Bermuda (BMU) <sup>b</sup>	BERMUDA INTL	780160	2A	6	4596	88	1456	20	8273	158	57
British Virgin Islands (VGB) <sup>a</sup>	TERRANCE B. LETTSOME INTL AIRPORT		0A		6453						
Cayman Islands (CYM) <sup>a</sup>	OWEN ROBERTS AIRPORT		0A		6620						
Dominica (DMA) <sup>a</sup>	DOUGLAS-CHARLES AIRPORT		0A		6288						
Grenada (GRD) <sup>b</sup>	MAURICE BISHOP INTL AIRPORT	789580	0A	7	6378	0	1197	23	11480	0	47
Guyana (GUY) <sup>b</sup>	TIMEHRI\CHEDDI JAG	810020	0A	29	6136	0	2234	95	11045	0	88
Haiti (HTI) <sup>a</sup>	Port-Au-Prince Aeroport Intl		0A		6848						
Jamaica (JAM) <sup>b</sup>	KINGSTON/NORMAN MAN	783970	0A	14	6608	0	730	46	11894	0	29
	MONTEGO BAY/SANGSTE	783880	0A	8	6336	0	1184	26	11405	0	47
	JOHN OSBORNE AIRPORT		1A		5946						
Montserrat (MSR) <sup>a</sup>	JOHN OSBORNE AIRPORT		1A		5946						
Saint Lucia (LCA) <sup>b</sup>	HEWANORRA INTL AIRP	789480	0A	10	6429	0	1128	33	11572	0	44
St. Kitts and Nevis (KNA) <sup>a</sup>			0A		6388						

<b>St. Vincent and the Grenadines (VCT)<sup>a</sup></b>	ARGYLE INTERNATIONAL AIRPORT		0A		6647						
<b>Suriname (SUR)</b>	JOHAN A. PENDEL INTL AIRPORT at Zanderij Paramaribo <sup>a</sup>	812250	0A	9	6264 6361	0	2249	30	11275	0	89
<b>Trinidad and Tobago (TTO)<sup>b</sup></b>	ARTHUR NAPOLEON RAYMOND ROBINSON INTL AIRPORT	789620	0A	6	6307	0	1452	20	11353	0	57
	PIARCO INT. AIRPORT	789700	0A	15	6274	0	1781	49	11293	0	70
<b>Turks and Caicos Islands (TCA)<sup>a</sup></b>			0A		6439						

a. Calculated CARICOM Member State or Associate

b. CARICOM Member State or Associate

(continued)

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**TABLE R301.1 continued**  
**CLIMATE ZONES, MOISTURE REGIMES, AND WARM-HUMID DESIGNATIONS BY COUNTRY AND TERRITORY**

*Degree-day*: the difference in temperature between the out- door mean temperature over a 24-hour period and a given base temperature. For the purposes of determining building envelope requirements, the classifications are defined as follows:  
*Cooling degree-day base 10°C, CDD10 (50°F, CDD50)*: for any one day, when the mean temperature is more than 10°C (50°F), there are as many degree-days as degrees Fahrenheit or Celsius temperature difference between the mean temperature for the day and 10°C (50°F) (mean temperature 10°C (50°F)). Annual cooling degree- days (CDDs) are the sum of the degree-days over a calendar year.

*Heating degree-day base 18°C, HDD18 (65°F, HDD65)*: for any one day, when the mean temperature is less than 18°C (65°F), there are as many degree-days as degrees Fahrenheit or Celsius temperature difference between and 18°C (65°F) and the mean temperature for the day (18°C (65°F) minus the mean temperature). Annual heating degree-days (HDDs) are the sum of the degree-days over a calendar year.

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**TABLE R 301.3(1)  
UNSTATED CLIMATE ZONE DEFINITIONS**

MAJOR CLIMATE TYPE DEFINITIONS	
<i>Marine (C) Definition</i> —Locations meeting all four criteria:	
5. Mean temperature of coldest month between 27°F (−3°C) and 65°F (18°C)	
6. Warmest month mean < 72°F (22°C)	
7. At least four months with mean temperatures over 50°F (10°C)	
8. 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.	
<i>Dry (B) Definition</i> —Locations meeting the following criteria:	
5. Not Marine (C)	
6. If 70% or more of the precipitation, <i>P</i> , occurs during the high sun period, then the dry/humid threshold is $P_{in} < 0.44 \times (T - 7)$ (I-P) [ $P_{mm} < 20.0 \times (T + 14)$ (SI)]	
7. If between 30% and 70% of the precipitation, <i>P</i> , occurs during the high sun period, then the dry/humid threshold is $P_{in} < 0.44 \times (T - 19.5)$ (I-P) [ $P_{mm} < 20.0 \times (T + 7)$ (SI)]	
8. If 30% or less of the precipitation, <i>P</i> , occurs during the high sun period, then the dry/humid threshold is $P_{in} < 0.44 \times (T - 32)$ (I-P) [ $P_{mm} < 20 \times T$ (SI)] where:	
<i>P</i>	= annual precipitation, in. (mm)
<i>T</i>	= annual mean temperature, °F (°C)
Summer or high sun	= April through September in the Northern Hemisphere and October through March period in the Southern Hemisphere
Winter or cold season	= October through March in the Northern Hemisphere and April through September in the Southern Hemisphere
<i>Humid (A) Definition</i> —Locations that are not marine and not dry.	
<i>Warm-humid Definition</i> —Humid (A) locations where either of the following wet-bulb temperature conditions shall occur during the warmest six consecutive months of the year:	
1. 67°F (19.4°C) or higher for 3,000 or more hours; or	
2. 73°F (22.8°C) or higher for 1,500 or more hours.	

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

**Table 301.3(2)  
UNSTATED CLIMATE ZONE DEFINITIONS [Source: ASHRAE STANDARD 169-2013]**

Thermal Zone	Name	SI Units	I-P Units
0	Tropical <sup>1</sup>	6000 < CDD10°C	10,800 < CDD50°F
1	Very hot	5000 < CDD10°C ≤ 6000	9000 < CDD50°F ≤ 10,800
2	Hot	3500 < CDD10°C ≤ 5000	6300 < CDD50°F ≤ 9000
3	Warm	CDD10°C ≤ 3500 and HDD18°C ≤ 2000	CDD50°F ≤ 6300 and HDD65°F ≤ 3600

<sup>1</sup> ASHRAE Standard 169-2013 uses the term "Extremely hot"

## CHAPTER [CE] 4 COMMERCIAL ENERGY EFFICIENCY

**SECTION C401 GENERAL****C401.1 Scope.**

The provisions in this chapter are applicable to commercial *buildings* and their *building sites*.

**C401.2 Application.**

Commercial buildings shall comply with Section C401.2.1 or C401.2.2.

**C401.2.1 International Energy Conservation Code.**

Commercial buildings shall comply with one of the following:

1. Prescriptive Compliance. The Prescriptive Compliance option requires compliance with all applicable mandatory provisions of this code, in addition to Sections C402 through C406 and Section

C408. Dwelling units and sleeping units in Group R-2 buildings shall be deemed to be in compliance with this chapter, provided that they comply with Section R406.

2. Simulated Building Performance. The Simulated Building Performance option requires compliance with Section C407.

**Exception:** Additions, alterations, repairs and changes of occupancy to existing buildings complying with Chapter 5.

Table below the compliance options and its relevance in Caribbean and Prescriptive and Mandatory compliance as per IECC 2024.

Table 1: IECC 2024 compliance option and its relevance in Caribbean

Building Type	IECC 2024 Compliance Methods	Recommendation for CREEBC 2024 (Caribbean Context)	Rationale for recommendation
Commercial	<ul style="list-style-type: none"> <li>• <b>Prescriptive Path</b> (mandatory + prescriptive envelope, mechanical, lighting, service water heating requirements)</li> <li>• <b>Performance Path (C407)</b> – modelled energy cost/use ≤ reference design</li> <li>• <b>ASHRAE 90.1-2022</b></li> <li>3. <b>Appendix G (ECB Method)</b> as alternative</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Adopt Prescriptive + Performance Path (C407)</b></li> <li>• <b>Allow ASHRAE 90.1-2022 as alternative</b></li> </ul>	<ul style="list-style-type: none"> <li>• Prescriptive path gives clear baselines; performance path provides flexibility for large projects.</li> <li>• ASHRAE 90.1-2022 aligns with global best practice and supports complex buildings (airports, hospitals, hotels).</li> </ul>
Residential (Low-rise R-2, R-3, R-4)	<ul style="list-style-type: none"> <li>• <b>Prescriptive Path</b> (mandatory + prescriptive envelope, HVAC, lighting, etc.)</li> <li>• <b>UA Trade-off (R402.1.5)</b> – envelope flexibility</li> <li>• <b>Performance Path (R405)</b> – modelled energy use ≤ reference design</li> <li>• <b>ERI Path (R406)</b> – HERS or equivalent rating index</li> <li>• <b>ASHRAE 90.2-2020</b> as alternative</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Adopt Prescriptive Path</b></li> <li>• <b>Allow UA Trade-off + Performance Path (R405)</b></li> <li>• <b>Defer ERI Path until infrastructure exists</b></li> <li>• <b>Keep ASHRAE 90.2 optional</b></li> </ul>	<ul style="list-style-type: none"> <li>• Prescriptive path is easiest for enforcement; UA Trade-off gives limited flexibility; Performance path enables innovation in larger developments; ERI is not practical now due to lack of rating systems;</li> <li>• ASHRAE 90.2-2020 can be retained for high-performance projects.</li> </ul>

Table 2: Prescriptive and Mandatory compliance as per IECC 2024

Category	Commercial Buildings	Residential Buildings
<b>Mandatory Provisions</b> (apply regardless of compliance path)	<ul style="list-style-type: none"> <li>• <b>C401.2</b> Compliance paths (must meet mandatory + chosen path)</li> <li>• <b>C402.5</b> Air leakage (envelope sealing &amp; testing)</li> <li>• <b>C403.2</b> General mechanical provisions (controls, insulation, economizers, efficiency)</li> <li>• <b>C404.2</b> Service hot water (controls, piping insulation)</li> <li>• <b>C405.2</b> Basic lighting controls</li> <li>• <b>C405.10</b> Functional testing of lighting controls</li> <li>• <b>C408</b> Commissioning of HVAC, lighting, SWH, refrigeration</li> <li>• <b>C409</b> Energy metering</li> </ul>	<ul style="list-style-type: none"> <li>• <b>R401.2</b> Compliance paths (must meet mandatory + chosen path)</li> <li>• <b>R401.3 Certificate</b> – permanent energy certificate posted in the home listing envelope values, equipment, and test results</li> <li>• <b>R402.4</b> Air leakage (envelope sealing &amp; testing)</li> <li>• <b>R403.1–R403.5</b> Mechanical system controls, duct/piping insulation, hot water controls</li> <li>• <b>R404</b> Basic electrical &amp; lighting requirements</li> <li>• <b>R405.3</b> Performance path mandatory requirements (before trade-offs)</li> </ul>
<b>Prescriptive Provisions</b> (default compliance path if no trade-	<ul style="list-style-type: none"> <li>• <b>C402</b> Envelope (insulation, fenestration, SHGC, roof reflectance)</li> <li>• <b>C403</b> Mechanical (equipment efficiencies, ventilation, advanced controls)</li> </ul>	<ul style="list-style-type: none"> <li>• <b>R402</b> Envelope (insulation, fenestration, U-factor, SHGC)</li> <li>• <b>R403</b> Systems (HVAC and water heating efficiencies)</li> <li>• <b>R404</b> Lighting (high-efficacy lamps, controls)</li> </ul>

Category	Commercial Buildings	Residential Buildings
off/performance path)	<ul style="list-style-type: none"> <li>• <b>C404</b> Service water heating (equipment efficiencies, recirculation, pool/spa heating)</li> <li>• <b>C405</b> Lighting power allowances, daylighting, advanced controls</li> <li>• <b>C406</b> Additional efficiency options (renewables, high-performance HVAC, etc.)</li> <li>• <b>C410</b> Refrigeration systems (walk-ins, supermarkets)</li> </ul>	<ul style="list-style-type: none"> <li>• <b>R406</b> ERI compliance path (prescriptive baseline + performance flexibility)</li> </ul>

#### C401.2.2 ASHRAE 90.1-2022

Commercial buildings shall comply with the requirements of [ANSI/ASHRAE/IES 90.1](#).

#### C401.3 Building thermal envelope certificate.

A permanent building thermal envelope certificate shall be completed by an approved third party inspection agency or individual. Such certificate shall be posted in the utility room or near the HVAC equipment. The certificate should be stored properly to prevent being damaged due to water or any other weather change.

If located on an electrical panel, the certificate shall not cover or obstruct the visibility of the circuit directory label, service disconnect label or other required labels. A copy of the certificate shall also be included in the construction files for the project, which may be digital or physical for simplified compliance.

Also, certificate must explicitly indicate where air-barrier continuity is not provided and explain the basis for exemption.

Consider requiring **limited testing or alternative compliance documentation** where alterations affect a significant proportion of the envelope or where the space is mechanically cooled/dehumidified, as these conditions increase the importance of airtightness for comfort and moisture control.

The certificate shall include the following:

R-values of insulation for main envelope elements only: ceilings, roofs, external walls, and floors. Minor components such as doors, windows, skylights, hatches, access panels, and localized thermal bridges may be omitted.

1. U-factors and SHGC for major fenestrations: windows and doors only.
2. Air leakage testing is optional; where testing is required, default regional envelope performance values may be used.
3. Where there is more than one value for any component of the building thermal envelope, the certificate shall indicate the area-weighted averages of that specific component type (e.g., walls, roofs, floors, ceilings) where available. If area-weighted averages are unavailable, list only those assemblies covering at least 25% of the total

area of that component type, not the total building area..

#### SECTION C402 BUILDING THERMAL ENVELOPE REQUIREMENTS

##### C402.1 General.

Building thermal envelope assemblies for buildings that are intended to comply with the code on a prescriptive basis in accordance with the compliance path described in Item 1 of [Section C401.2.1](#) shall comply with the following:

1. The opaque portions of the building thermal envelope shall comply with the specific insulation requirements of [Section C402.2](#) and the thermal requirements of [Section C402.1.2](#), [C402.1.3](#) or [C402.1.4](#). Where the total area of through penetrations of mechanical equipment is greater than 1 percent of the opaque above-grade wall area, the building thermal envelope shall comply with [Section C402.1.2.1.8](#).
2. Wall solar reflectance and thermal emittance shall comply with [Section C402.3](#).
3. Roof solar reflectance and thermal emittance shall comply with [Section C402.4](#).
4. Fenestration in the building thermal envelope shall comply with [Section C402.5](#). Where buildings have a vertical fenestration area or skylight area greater than that allowed in [Section C402.5](#), the building and building thermal envelope shall comply with Item 2 of [Section C401.2.1](#), [C401.2.2](#) or [C402.1.4](#).
5. Air leakage of building thermal envelope shall comply with [Section C402.6](#).
6. Thermal bridges in above-grade walls shall comply with [Section C402.7](#).

7. Walk-in coolers, walk-in freezers, refrigerated warehouse coolers and refrigerated warehouse freezers shall comply with Section C403.12.

#### **C402.1.1 Low-energy buildings and greenhouses.**

The following low-energy buildings, or portions thereof separated from the remainder of the building by building thermal envelope assemblies complying with this section, shall be exempt from the building thermal envelope provisions of Section C402.

##### **C402.1.1.1 Low-energy buildings.**

Buildings that comply with either of the following:

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

##### **C402.1.1.2 Greenhouses.**

Greenhouse structures or areas that are mechanically heated or cooled and that comply with all of the following shall be exempt from the building thermal envelope requirements of this code:

1. Exterior opaque envelope assemblies comply with Sections C402.2 and C402.5.5.

Exception: Low energy greenhouses that comply with Section C402.1.1.

2. Interior partition building thermal envelope assemblies that separate the greenhouse from conditioned space comply with Sections C402.2, C402.5.3 and C402.5.5.
3. Fenestration assemblies that comply with the building thermal envelope requirements in Table C402.1.1.2. The U-factor for a roof shall be for the roof assembly or a roof that includes the assembly and an internal curtain system.

Exception: Unconditioned greenhouses.

TABLE C402.1.1.2 FENESTRATION BUILDING THERMAL ENVELOPE	MAXIMUM REQUIREMENTS
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##### **C402.1.1.3 Equipment buildings.**

Buildings that comply with the following shall be exempt from the building thermal envelope provisions of this code:

1. Are separate buildings with floor area not more than  $111 \text{ m}^2$  (1,200 square feet).

2. Are intended to house electric equipment with installed equipment power totalling not less than  $75 \text{ W/m}^2$  (7 watts per square foot) and not intended for human occupancy.

3. Have a heating system capacity not greater than 6 kW (20,000 Btu/h) and a heating thermostat setpoint that is restricted to not more than  $10 \text{ }^\circ\text{C}$  ( $50 \text{ }^\circ\text{F}$ )

4. Have an average wall and roof U-factor less than 0.2 in Climate Zones 1 through 5 and less than 0.12 in Climate Zones 6 through 8.

5. Comply with the roof solar reflectance and thermal emittance provisions for Climate Zone 1.

#### **C402.1.2 Assembly U-factor, C-factor or F-factor method.**

Building thermal envelope opaque assemblies shall have a U-, C- or F-factor not greater than that specified in Table C402.1.2. Commercial buildings or portions of commercial buildings enclosing Group R occupancies shall use the U-, C- 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-, C- or F-factor from the "All other" column of Table C402.1.2.

#### **TABLE C402.1.2 OPAQUE BUILDING THERMAL ENVELOPE ASSEMBLY MAXIMUM REQUIREMENTS, U-FACTOR METHOD<sup>a, b</sup>**

##### **C402.1.2.1 Methods of determining U-, C- and F-factors.**

Where assembly U-factors, C-factors and F-factors and calculation procedures are established in ANSI/ASHRAE/IES 90.1-2022 Appendix A for opaque assemblies, such opaque assemblies shall be a compliance alternative provided they meet the criteria of Table C402.1.2 and the construction, excluding cladding system on walls, complies with the applicable construction details from ANSI/ASHRAE/IES 90.1-2022 Appendix A. Where U-factors have been established by testing in accordance with ASTM C1363, such opaque assemblies shall be a compliance alternative provided they meet the criteria of Table C402.1.4. The R-value of continuous insulation shall be permitted to be added to, or subtracted from the original tested design. Airspaces used for assembly evaluations shall comply with Section C402.2.7.

##### **C402.1.2.1.1 Tapered, above-deck insulation based on thickness.**

For tapered, above-deck roof insulation, area-weighted U-factors of non-uniform insulation thickness shall be determined by an approved method.

Exception: The area-weighted U-factor shall be permitted to be determined by using the inverse of the average R-value determined in accordance with the exception to [Section C402.1.3.2](#).

#### **C402.1.2.1.2 Suspended ceilings.**

Insulation installed on suspended ceilings having removable ceiling tiles shall not be considered part of the assembly U-factor of the roof-ceiling construction.

#### **C402.1.2.1.3 Concrete masonry units, integral insulation.**

In determining compliance with [Table C402.1.2](#), the U-factor of concrete masonry units with integral insulation shall be permitted to be used.

#### **C402.1.2.1.4 Mass walls and floors.**

Compliance with required maximum U-factors for mass walls and mass floors in accordance with [Table C402.1.2](#) shall be permitted for assemblies complying with [Section C402.1.3.4](#).

#### **C402.1.2.1.5 Area-weighted averaging of above-grade wall U-factors.**

Where above-grade walls include more than one assembly type or a penetration of the opaque wall area, the area-weighted U-factor of the above-grade wall is permitted to be determined by an approved method.

#### **C402.1.2.1.6 Cold-formed steel assemblies.**

U-factors for building thermal envelopes containing cold-formed steel-framed ceilings and walls shall be permitted to be determined in accordance with [AISI S250](#) as modified herein.

1. Where the steel-framed wall contains no cavity insulation and uses continuous insulation to satisfy the U-factor maximum, the steel-framed wall member spacing is permitted to be installed at any on-center spacing.
2. Where the steel-framed wall contains framing at 610 mm (24 inches) on center with a 23 percent framing factor or framing at 406 mm (16 inches) on center with a 25 percent framing factor, the next lower framing member spacing input values shall be used when calculating using [AISI S250](#).
3. Where the steel-framed wall contains less than 23 percent framing factors, the [AISI S250](#) shall be used without any modifications.
4. Where the steel-framed wall contains other than standard C-shape framing members, the [AISI S250](#) calculation option for other than standard C-shape framing is permitted to be used.

#### **C402.1.2.1.7 Spandrel panels.**

U-factors of opaque assemblies within fenestration framing systems shall be determined in accordance with the default values in [Table C402.1.2.1.7](#), [ASTM C1363](#) or [ANSI/NFRC 100](#).

#### **TABLE C402.1.2.1.7 EFFECTIVE U-FACTORS FOR SPANDREL PANELS<sup>a</sup>**

##### **C402.1.2.1.8 Mechanical equipment penetrations.**

Where the total area of through penetrations of mechanical equipment is greater than 1 percent of the opaque above-grade wall area, such area shall be calculated as a separate wall assembly, in accordance with either [Section C402.1.2.1.5](#) or [Section C402.1.4](#) using a published and approved U-factor for that equipment or a default U-factor of 0.5.

#### **C402.1.3 Insulation component R-value method.**

For opaque portions of the building thermal envelope the R-values for cavity insulation and continuous insulation shall be not less than that specified in [Table C402.1.3](#). Group R occupancy buildings or portions of commercial buildings enclosing Group R occupancies shall use the R-values from the "Group R" column of [Table C402.1.3](#). 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 C402.1.3](#).

#### **TABLE C402.1.3 OPAQUE BUILDING THERMAL ENVELOPE INSULATION COMPONENT MINIMUM REQUIREMENTS, R-VALUE METHOD<sup>a</sup>**

##### **C402.1.3.1 R-value of multi-layered insulation components.**

Where cavity insulation is installed in multiple layers, the cavity insulation R-values shall be summed to determine compliance with the cavity insulation R-value requirements. Where continuous insulation is installed in multiple layers, the continuous insulation R-values shall be summed to determine compliance with the continuous insulation R-value requirements. Cavity insulation R-values shall not be used to determine compliance with the continuous insulation R-value requirements in [Table C402.1.3](#).

##### **C402.1.3.2 Area-weighted averaging of R-values.**

Area-weighted averaging shall not be permitted for R-value compliance.

Exception: For tapered above-deck roof insulation, compliance with the R-values required in [Table C402.1.3](#) shall be permitted to be demonstrated by multiplying the rated R-value per inch of the insulation material by the average thickness of the roof insulation. The average thickness of the roof insulation shall equal the total volume of the roof insulation divided by the area of the roof.

##### **C402.1.3.3 Suspended ceilings.**

Insulation installed on suspended ceilings having

removable ceiling tiles shall not be considered part of the minimum thermal resistance (R-value) of roof insulation in roof-ceiling construction.

**C402.1.3.4 Mass walls and mass floors.**

Compliance with required maximum U-factors for mass walls and mass floors in accordance with Table C402.1.2 and minimum R-values for insulation components applied to mass walls and mass floors in accordance with Table C402.1.3 shall be permitted for assemblies complying with the following:

1. Where used as a component of the building thermal envelope, mass walls shall comply with one of the following:
  - 1.1 Weigh not less than 171 kg/m<sup>2</sup> (35 pounds per square foot) of wall surface area.
  - 1.2. Weigh not less than 122 kg/m<sup>2</sup> 25 pounds per square foot of wall surface area where the material weight is not more than 1922 kg/m<sup>3</sup> (120 pounds per cubic foot [pcf]).
  - 1.3. Have a heat capacity exceeding 144 kJ/m<sup>2</sup> × K (7 Btu/ft<sup>2</sup> × °F).
  - 1.4. Have a heat capacity exceeding 103 kJ/m<sup>2</sup>·K (5 Btu/ft<sup>2</sup>·°F) where the material weight is not more than 1922 kg/m<sup>3</sup> (120 pcf).
2. Where used as a component of the building thermal envelope, the minimum weight of mass floors shall comply with one of the following:
  - 2.1. 171 kg/m<sup>2</sup> (Thirty-five pounds per square foot) of floor surface area.
  - 2.2. 122 kg/m<sup>2</sup> (Twenty-five pounds per square foot) of floor surface area where the material weight is not more than 120 pcf (1922 kg/m<sup>3</sup>).

**C402.1.4 Component performance method.**

Building thermal envelope values and fenestration areas determined in accordance with Equation 4-1 shall be an alternative to compliance with the U-, F-, psi-, chi-, and C-factors in Tables C402.1.2, C402.1.2.1.7, C402.1.4 and C402.5 and the maximum allowable fenestration areas in Section C402.5.1. Fenestration shall meet the applicable SHGC requirements of Section C402.5.3.

$$A_P + B_P + C_P + T_P \leq A_T + B_T + C_T + T_T - V_F - V_S$$

Equation 4-1

Where,

$A_P$  = Sum of the (area × U-factor) for each proposed building thermal envelope assembly, other than slab-on-grade or below-grade wall assemblies.

$B_P$  = Sum of the (length × F-factor) for each proposed slab-on-grade edge condition.

$C_P$  =Sum of the (area × C-factor) for each proposed below-grade wall assembly.

$T_P$  =Sum of the ( $\Psi LP$ ) and ( $\chi NP$ ) values for each type of thermal bridge condition of the building thermal envelope as identified in Section C402.7 in the proposed building. For the purposes of this section, the ( $\Psi LP$ ) and ( $\chi NP$ ) values for thermal bridges caused by materials with a thermal conductivity less than or equal to 3.0 Btu × in/h × ft<sup>2</sup> × °F shall be assigned as zero. For buildings or structures located in Climate Zones 0 through 3, the value of  $T_P$  shall be assigned as zero.

$\Psi LP$  =Psi-factor × length of the thermal bridge elements in the proposed building thermal envelope.

$\chi NP$  =Chi-factor × number of the thermal bridge point elements other than fasteners, ties or brackets in the proposed building thermal envelope.

$A_T$  =Sum of the (area × U-factor permitted by Tables C402.1.2 and C402.5) for each proposed building thermal envelope assembly, other than slab-on-grade or below-grade wall assemblies.

$B_T$  =Sum of the (length × F-factor permitted by Table C402.1.2) for each proposed slab-on-grade edge condition.

$C_T$  =Sum of the (area × C-factor permitted by Table C402.1.2) for each proposed below-grade wall assembly.

$T_T$  =Sum of the ( $\Psi LT$ ) and ( $\chi NT$ ) values for each type of thermal bridge condition in the proposed building thermal envelope as identified in Section C402.7 with values specified as “compliant” in Table C402.1.4. For the purposes of this section, the ( $\Psi LT$ ) and ( $\chi NT$ ) values for thermal bridges caused by materials with a thermal conductivity less than or equal to 3.0 Btu × in/h × ft<sup>2</sup> × °F shall be assigned as zero. For buildings or structures located in Climate Zones 0 through 3, the value of  $T_T$  shall be assigned as zero.

$\Psi LT$  =Psi-factor specified as “compliant” in Table C402.1.4 × length of the thermal bridge elements in the proposed building thermal envelope.

$\chi NT$  =(Chi-factor specified as “compliant” in Table C402.1.4) × number of the thermal bridge point elements other than fasteners, ties or brackets in the proposed building thermal envelope.

$P_F$  =Maximum vertical fenestration area allowable by Section C402.5.1, C402.5.1.1 or C402.5.1.2.

$Q_F$  =Proposed vertical fenestration area.

$R_F$  =  $Q_F - P_F$ , but not less than zero (excess vertical fenestration area).

$S_F$  =Area-weighted average U-factor permitted by Table C402.5 of all vertical fenestration assemblies.

$T_F$  =Area-weighted average U-factor permitted by Table C402.1.2 of all exterior opaque wall assemblies.

$U_F$  = $S_F - T_F$  (excess U-factor for excess vertical fenestration area).

$V_F$  = $R_F \times U_F$  (excess U × A due to excess vertical

fenestration area).

$P_S$  = Maximum skylight area allowable by Section C402.1.2.

$Q_S$  = Actual skylight area.

$R_S$  =  $Q_S - P_S$ , but not less than zero (excess skylight area).

$S_S$  = Area-weighted average  $U$ -factor permitted by Table C402.5 of all skylights.

$T_S$  = Area-weighted average  $U$ -factor permitted by Table C402.1.2 of all opaque roof assemblies.

$U_S$  =  $S_S - T_S$  (excess  $U$ -factor for excess skylight area).

$V_S$  =  $R_S \times U_S$  (excess  $U \times A$  due to excess skylight area).

A proposed psi- or *chi*-factor for each thermal bridge shall comply with one of the following, as applicable:

1. Where the proposed mitigation of a thermal bridge is compliant with the requirements of Section C402.7, the “compliant” values in Table C402.1.4 shall be used for the proposed psi- or chi-factors.
2. Where a thermal bridge is not mitigated in a manner at least equivalent to Section C402.7, the “noncompliant” values in Table C402.1.4 shall be used for the proposed psi- or chi-factors.
3. Where the proposed mitigation of a thermal bridge provides a psi- or chi-factor less than the “compliant” values in Table C402.1.4, the proposed psi- or chi-factor shall be determined by thermal analysis, testing or other approved sources.

**TABLE C402.1.4 PSI- and CHI-FACTORS TO DETERMINE THERMAL BRIDGES FOR THE COMPONENT PERFORMANCE METHOD**

**C402.2 Specific insulation and installation requirements.**

Insulation in building thermal envelope opaque assemblies shall be installed in accordance with Section C303.2 and Sections C402.2.1 through C402.2.7, or an approved design.

**C402.2.1 Roof-ceiling construction.**

Insulation materials in the roof-ceiling construction shall be installed between the roof or ceiling framing, continuously below the ceiling framing, continuously above, below, or within the roof deck or in any approved combination thereof. Insulation installed above the roof deck shall comply with Sections C402.2.1.1 through C402.2.1.3.

**C402.2.1.1 Joints staggered.**

Continuous, above-deck insulation board located above the roof deck shall be installed in not less than two layers and the edge joints between each layer of insulation shall be staggered, except where insulation tapers to the roof deck at a gutter edge,

roof drain or scupper.

**C402.2.1.2 Skylight curbs.**

Skylight curbs shall be insulated to the level of the above-deck roof insulation or R-5, whichever is less.

Exception: Unit skylight curbs included as a component of a skylight listed and labelled in accordance with NFRC 100 shall not be required to be insulated.

**C402.2.1.3 Minimum thickness of tapered insulation.**

The thickness of tapered above-deck roof insulation at its lowest point, gutter edge, roof drain or scupper, shall be not less than 25 mm (1 inch).

**C402.2.2 Above-grade walls.**

Above-grade wall insulation materials shall be installed between the wall framing, be integral to the wall assembly, be continuous on the wall assembly, or be any combination of these insulation methods. Where continuous insulation is layered on the exterior side of a wall assembly, the joints shall be staggered.

**C402.2.3 Floors over outdoor air or unconditioned space.**

Floor insulation shall be installed between floor framing, be integral to the floor assembly, be continuous on the floor assembly, or be any combination of these insulation methods. Where continuous insulation is layered on the exterior side of a floor assembly, the joints shall be staggered. Floor framing cavity insulation or structural slab insulation shall be installed to maintain permanent contact with the underside of the subfloor decking or structural slabs.

Exceptions:

1. The floor framing cavity insulation or structural slab insulation shall be permitted to be installed in contact with the top side of sheathing or continuous insulation installed on the bottom side of floor assemblies. Floor framing or structural slab members at the perimeter of the floor assembly shall be insulated vertically for their full depth with insulation equivalent to that required for the above-grade wall construction.
2. Insulation applied to the underside of concrete floor slabs shall be permitted an airspace of not more than 1 inch (25 mm) where it turns up and is in contact with the underside of the floor under walls associated with the building thermal envelope.

**C402.2.4 Slabs-on-grade.**

Where installed, the perimeter insulation for slab-on-grade shall be placed on the outside of the foundation or on the inside of the foundation wall. For installations complying with Table C402.1.3, the

perimeter insulation shall extend downward from the top of the slab for the minimum distance shown in the table or to the top of the footing, whichever is less, or downward to not less than the bottom of the slab and then horizontally to the interior or exterior for the total distance shown in the table. Where installed, full slab insulation shall be continuous under the entire area of the slab-on-grade floor, except at structural column locations and service penetrations. Insulation required at the heated slab perimeter shall not be required to extend below the bottom of the heated slab and shall be continuous with the full slab insulation.

Exception: Where the slab-on-grade floor is greater than 24 inches (610 mm) below the finished exterior grade, perimeter insulation is not required.

#### **C402.2.5 Below-grade walls.**

Below-grade wall insulation shall be installed between framing members, be integral to the wall assembly, be continuous on the wall assembly, or be any combination of these insulation methods. For installations complying with [Section C401.2.1](#), insulation shall extend to a depth of not less than 10 feet (3048 mm) below the outside finished ground level or to the level of the lowest floor of the conditioned space enclosed by the below-grade wall, whichever is less.

#### **C402.2.6 Insulation of radiant heating system panels.**

Radiant heating system panels, and their associated components that are installed in interior or exterior assemblies, shall be insulated to an R-value of not less than R-3.5 on all surfaces not facing the space being heated. Radiant heating system panels that are installed in the building thermal envelope shall be separated from the exterior of the building or unconditioned or exempt spaces by not less than the R-value of insulation installed in the opaque assembly in which they are installed or the assembly shall comply with [Section C402.1.2](#).

#### **C402.2.7 Airspaces.**

Where the R-value of an airspace is used for compliance in accordance with [Section C402.1](#), the airspace shall be enclosed in a cavity bounded on all sides by building components and constructed to minimize airflow into and out of the enclosed airspace. Airflow shall be deemed minimized where one of the following conditions occur:

1. The enclosed airspace is unventilated.
2. The enclosed airspace is bounded on at least one side by an anchored masonry veneer, constructed in accordance with [Chapter 14](#) of the International Building Code and vented by

veneer weep holes located only at the bottom of the airspace and spaced not less than 15 inches (381 mm) on center with top of the cavity airspace closed.

Exception: For ventilated cavities, the effect of the ventilation of airspaces located on the exterior side of the continuous air barrier and adjacent to and behind the exterior wall-covering material shall be determined in accordance with ASTM C1363 modified<sup>1</sup> with an airflow entering the bottom and exiting the top of the airspace at an air movement rate of not less than 70 mm/second.

#### **C402.3 Above-grade wall solar reflectance.**

For Climate Zone 0, above-grade east-oriented, south-oriented and west-oriented walls shall comply with either of the following:

1. Not less than 75 percent of the opaque above-grade wall area shall have an area-weighted initial solar reflectance of not less than 0.30 where tested in accordance with ASTM C1549 with AM1.5GV output or ASTM E903 with AM1.5GV output or determined in accordance with an approved source. This above-grade wall area shall have an emittance or emissivity of not less than 0.75 where tested in accordance with ASTM C835, ASTM C1371, ASTM E408 or determined in accordance with an approved source. For the portion of the above-grade wall that is glass spandrel area, a solar reflectance of not less than 0.29, as determined in accordance with [NFRC 300](#) or [ISO 9050](#), shall be permitted. Area-weighted averaging is permitted using only south-, east- and west-oriented walls enclosing the same occupancy classification.
2. Not less than 30 percent of the opaque above-grade wall area shall be shaded by manmade structures, existing buildings, hillsides, permanent building projections, on-site renewable energy systems or a combination of these. Shade coverage shall be calculated by projecting the shading surface downward on the above-grade wall at an angle of 45 degrees.

Exception: Above-grade walls of low-energy buildings complying with [Section C402.1.1.1](#), greenhouses complying with [Section C402.1.1.2](#) and equipment buildings complying with [Section C402.1.1.3](#).

<sup>1</sup> Please note: These calculation methods ASTM C1363 or ASHRAE Appendix A) require specialized knowledge and tools. Caribbean building professionals may require capacity-

building workshops or simplified lookup tables for implementation.

**C402.4 Roof solar reflectance and thermal emittance.**

Low slope roofs directly above cooled conditioned spaces in Climate Zones 0 through 3 shall comply with one or more of the options in Table C402.4.

Exceptions: The following roofs and portions of roofs are exempt from the requirements of Table C402.4:

1. Portions of the roof that include or are covered by the following:
  - 1.1. Photovoltaic systems or components.
  - 1.2. Solar air or water-heating systems or components.
  - 1.3. Vegetative roofs or landscaped roofs.
  - 1.4. Above-roof decks or walkways.
  - 1.5. Skylights.
  - 1.6. HVAC systems and components, and other opaque objects mounted above the roof.
2. Portions of the roof 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 (74 kg/m<sup>2</sup>) or 23 psf (117 kg/m<sup>2</sup>) pavers.
4. Roofs where not less than 75 percent of the roof area complies with one or more of the exceptions to this section.

**TABLE C402.4 MINIMUM ROOF REFLECTANCE AND EMITTANCE OPTIONS<sup>a</sup>**

Three-year-aged solar reflectance<sup>b</sup> of 0.55 and 3-year aged thermal emittance <sup>c</sup>of 0.75

Three-year-aged solar reflectance index<sup>d</sup> of 64

- a. The use of area-weighted averages to comply with these requirements shall be permitted. Materials lacking 3-year-aged tested values for either solar reflectance or thermal emittance shall be assigned both a 3-year-aged solar reflectance in accordance with Section C402.4.1 and a 3-year-aged thermal emittance of 0.90.
- b. Aged solar reflectance tested in accordance with ASTM C1549, ASTM E903 or ASTM E1918 or CRRC-S100.
- c. Aged thermal emittance tested in accordance with ASTM C1371 or ASTM E408 or CRRC-S100.
- d. Solar reflectance index (SRI) shall be determined in accordance with ASTM E1980 using a convection coefficient of 12 W/m<sup>2</sup>× K (2.1 Btu/h × ft<sup>2</sup> × °F )Calculation of aged SRI shall be based on aged, tested values of solar reflectance and thermal emittance.

**C402.4.4 C402.3.1 Aged roof solar reflectance.**

Where an aged solar reflectance required by Section C402.4 is not available, it shall be determined in accordance with Equation 4-2.

$$R_{aged} = [0.2 + 0.7(R_{initial} - 0.2)]$$

Equation 4-2

where:

$R_{aged}$  = The aged solar reflectance.

$R_{initial}$  = The initial solar reflectance determined in accordance with CRRC-S100.

**C402.5 Fenestration.**

Fenestration shall comply with Sections C402.5.1 through C402.5.5 and Table C402.5. Daylight responsive controls shall comply with this section and Section C405.2.4.

**TABLE C402.5 Table****C402.4 BUILDING THERMAL ENVELOPE FENESTRATION MAXIMUM U-FACTOR AND SHGC REQUIREMENTS (IECC 2018)****C402.5.1 Maximum area.**

The vertical fenestration area, not including opaque doors and opaque spandrel panels, shall be not greater than 30 percent of the gross above-grade wall area. The skylight area shall be not greater than 3 percent of the gross roof area.

**C402.5.1.1 Increased vertical fenestration area with daylight responsive controls.**

In Climate Zones 0 through 6, not more than 40 percent of the gross above-grade wall area shall be vertical fenestration, provided that all of the following requirements are met:

1. In buildings not greater than two stories above grade, not less than 50 percent of the net floor area is within a primary sidelit daylight zone or a toplit daylight zone.
2. In buildings three or more stories above grade, not less than 25 percent of the net floor area is within a primary sidelit daylight zone or a toplit daylight zone.
3. Daylight responsive controls are installed in daylight zones.
4. Visible transmittance (VT) of vertical fenestration is not less than 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 4.

**C402.5.1.2 Increased skylight area with daylight responsive controls.**

The skylight area shall be not more than 6 percent of the roof area provided that daylight responsive controls are installed in toplit daylight zones.

**C402.5.2 Minimum skylight fenestration area.**

Skylights shall be provided in enclosed spaces greater than 232 m<sup>2</sup> (2,500 square feet) in floor area, directly under a roof with not less than 75 percent of the ceiling area with a ceiling height greater than 4572 mm (15 feet), and used as an office, lobby, atrium, concourse, corridor, storage space, gymnasium/exercise center, convention center, automotive service area, space where manufacturing occurs, nonrefrigerated warehouse, retail store, distribution/sorting area, transportation

depot or workshop. The total toplit daylight zone shall be not less than half the floor area and shall comply with one of the following:

1. A minimum skylight area to toplit daylight zone of not less than 3 percent where all skylights have a VT of not less than 0.40, or VT<sub>annual</sub> of not less than 0.26, as determined in accordance with Section C303.1.3.
2. A minimum skylight effective aperture, determined in accordance with Equation 4-3, of:
  - 2.1. Not less than 1 percent using a skylight's VT rating; or
  - 2.2. Not less than 0.66 percent using a Tubular Daylight Device's VT<sub>annual</sub> rating.

*Skylight Effective Aperture*

$$= 0.85 \times \text{Skylight Area} \times \text{Skylight VT} \times \text{WFToplit}$$

Equation 4-3

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, or 1.0 for Tubular Daylighting Devices with VT<sub>annual</sub> ratings.

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

Exceptions: 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 not less than half of the roof over the enclosed area for more than 1,500 daytime hours per year between 8 a.m. and 4 p.m.
4. Spaces where the daylight zone under rooftop monitors is greater than 50 percent of the enclosed space floor area.
5. Spaces where the total area minus the area of sidelit daylight zones is less than 232 m<sup>2</sup> (2,500 square feet, and where the lighting is

controlled in accordance with Section C405.2.3.

6. Spaces designed as storm shelters complying with ICC 500.

**C402.5.2.1 Lighting controls in toplit daylight zones.**

Daylight responsive controls shall be provided in toplit daylight zones.

**C402.5.2.2 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 haze factor greater than 90 percent when tested in accordance with ASTM D1003.

Exception: Skylights and tubular daylighting devices designed and installed to exclude direct sunlight entering the occupied space by the use of fixed or automated baffles, the geometry of skylight and light well or the use of optical diffuser components.

**C402.5.3 Maximum U-factor and SHGC.**

The maximum U-factor and solar heat gain coefficient (SHGC) for fenestration shall be as specified in Table C402.5.

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

$$PF = A/B$$

Equation 4-4

where:

PF = Projection factor (decimal).

A = Distance measured horizontally from the farthest 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.

**C402.5.3.1 Increased skylight SHGC.**

In Climate Zones 0 through 6, skylights shall be permitted a maximum SHGC of 0.60 where located above daylight zones provided with daylight responsive controls.

**C402.5.3.2 Increased skylight U-factor.**

Where skylights are installed above daylight zones provided with daylight responsive controls, a maximum U-factor of 0.9 shall be permitted in Climate Zones 0 through 3 and a maximum U-factor of 0.75 shall be permitted in Climate Zones 4 through 8.

**C402.5.3.3 Dynamic glazing.**

Where dynamic glazing is intended to satisfy the SHGC and VT requirements of Table C402.5, the

ratio of the higher to lower labelled SHGC shall be greater than or equal to 2.4, and the dynamic glazing shall be automatically controlled to modulate the amount of solar gain into the space in multiple steps. 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.

Exception: Dynamic glazing is not required to comply with this section where both the lower and higher labelled SHGC already comply with the requirements of [Table C402.5](#).

#### **C402.5.3.4 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 C402.5](#). Individual fenestration products from different fenestration product categories listed in [Table C402.5](#) shall not be combined in calculating area-weighted average U-factor.

#### **C402.5.4 Daylight zones.**

Daylight zones referenced in [Sections C402.5.1.1](#) through [C402.5.3.2](#) shall comply with [Sections C405.2.4.2](#) and [C405.2.4.3](#), as applicable. Daylight zones shall include toplit daylight zones and sidelit daylight zones.

#### **C402.5.5 Doors.**

Opaque swinging doors shall comply with [Table C402.1.2](#). Opaque non-swinging doors shall comply with [Table C402.1.2](#). Opaque doors shall be considered as part of the gross area of above-grade walls that are part of the building thermal envelope. Opaque doors shall comply with [Section C402.5.5.1](#) or [C402.5.5.2](#). Other doors shall comply with the provisions of [Section C402.5.3](#) for vertical fenestration.

##### **C402.5.5.1 Opaque swinging doors.**

Opaque swinging doors shall comply with [Table C402.1.2](#).

##### **C402.5.5.2 non-swinging doors.**

Opaque non-swinging doors that are horizontally hinged sectional doors with a single row of fenestration shall have an assembly U-factor less than or equal to 0.440 in Climate Zones 0 through 6 and less than or equal to 0.360 in Climate Zones 7 and 8, provided that the fenestration area is not less than 14 percent and not more than 25 percent of the total door area.

Exception: Other doors shall comply with the provisions of [Section C402.5.3](#) for vertical fenestration.

#### **C402.6 Air leakage—building thermal envelope.**

The building thermal envelope shall comply with [Sections C402.6.1](#) through [C402.6.7](#).

##### **C402.6.1 Air barriers.**

A continuous air barrier shall be provided throughout the building thermal envelope. The air barrier is permitted to be located at any combination of inside, outside or within the building thermal envelope. The air barrier shall comply with [Sections](#)

[C402.6.1.1](#) and [C402.6.1.2](#). The air leakage performance of the air barrier shall be verified in accordance with [Section C402.6.2](#).

Exception: Air barriers are not required in buildings located in Climate Zone 2B.

##### **C402.6.1.1 Air barrier design and documentation requirements.**

Design of the continuous air barrier shall be documented as follows:

1. Components comprising the continuous air barrier and their position within each building thermal envelope assembly shall be identified.
2. Joints, interconnections and penetrations of the continuous air barrier components shall be detailed.
3. The continuity of the air barrier building element assemblies that enclose conditioned space or provide a boundary between conditioned space and unconditioned space shall be identified.
4. Documentation of the continuous air barrier shall detail methods of sealing the air barrier, such as wrapping, caulking, gasketing, taping or other approved methods at the following locations:
  - 4.1. Joints around fenestration and door frames.
  - 4.2. Joints between walls and floors; between walls at building corners; between walls and roofs, including parapets and copings; where above-grade walls meet foundations; and at similar intersections.
  - 4.3. Penetrations or attachments through the continuous air barrier.
  - 4.4. Building assemblies used as ducts or plenums.
  - 4.5. Changes in continuous air barrier materials and assemblies.

5. Identify where testing will or will not be performed in accordance with [Section C402.6.2](#). Where testing will not be performed, a plan for field inspections required by [Section C402.6.2.3](#) shall be provided that includes the following:
  - 5.1. A schedule for periodic inspection.
  - 5.2. The continuous air barrier scope of work.
  - 5.3. A list of critical inspection items.
  - 5.4. Inspection documentation requirements.
  - 5.5. Provisions for corrective actions where needed.

**C402.6.1.2 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 compromise the building thermal envelope and across the joints and assemblies.
2. Air barrier joints and seams shall be sealed, including sealing transitions in places and changes in materials. 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 differentials such as those from wind, stack effect and mechanical ventilation.
3. Penetrations of the air barrier shall be caulked, gasketed or otherwise sealed in a manner compatible with the construction materials and location. Sealing shall allow for expansion, contraction and mechanical vibration. Sealing materials shall be securely installed around the penetration so as not to dislodge, loosen or otherwise impair the penetrations' ability to resist positive and negative pressure. Sealing of concealed fire sprinklers, where required, shall be in a manner that is recommended by the fire sprinkler manufacturer. Caulking or other adhesive sealants shall not be used to fill voids between fire sprinkler cover plates and walls or ceilings.
4. Recessed lighting fixtures shall comply with Section C402.6.1.2.1. Where similar objects are installed that penetrate the air barrier, provisions shall be made to maintain the integrity of the air barrier.
5. Electrical and communication boxes shall comply with Section C402.6.1.2.2.

**C402.6.1.2.1 Recessed lighting.**

Recessed luminaires installed in the building thermal envelope shall be all of the following:

1. IC-rated.
2. Labelled as having an air leakage rate of not greater than 2.0 cfm (0.944 L/s) when tested in accordance with ASTM E283 at a 1.57 psf (75 Pa) pressure differential.
3. Sealed with a gasket or caulk between the housing and interior wall or ceiling covering.

**C402.6.1.2.2 Electrical and communication boxes.**

Electrical and communication boxes that penetrate the air barrier of the building thermal envelope, and that do not comply with Section C402.6.1.2.2.1, shall be caulked, taped, gasketed or otherwise sealed to the air barrier element being penetrated. All openings on the concealed portion of the box shall be sealed. Where present, insulation shall rest against all concealed portions of the box.

**C402.6.1.2.2.1 Air-sealed boxes.**

Where air-sealed boxes are installed, they shall be marked in accordance with NEMA OS 4. Air-sealed boxes shall be installed in accordance with the manufacturer's instructions.

**C402.6.2 Air leakage compliance.**

Air leakage of the building thermal envelope shall be tested by an approved third party in accordance with Section C402.6.2.1. The measured air leakage shall not be greater than 0.35 cubic feet per minute per square foot (1.8 L/s x m<sup>2</sup>) of the building thermal envelope area at a pressure differential of 75 Pawater gauge (0.3 inch) with the calculated building thermal envelope surface area being the sum of the above- and below-grade building thermal envelope.

Exceptions:

1. Where the measured air leakage rate is greater than 1.8 L/s·m<sup>2</sup> (0.35 cfm/ft<sup>2</sup>) but not greater than 2.3 L/s·m<sup>2</sup> (0.45 cfm/ft<sup>2</sup>) the approved third party shall perform a diagnostic evaluation using a smoke tracer or infrared imaging. The evaluation shall be conducted while the building is pressurized or depressurized along with a visual inspection of the air barrier in accordance with ASTM E1186. All identified leaks shall be sealed where such sealing can be made without damaging existing building components. A report specifying the corrective actions taken to seal leaks shall be deemed to establish compliance with the requirements of this section where submitted to the code official and the building owner. Where the measured air leakage rate is greater than 2.3 L/s·m<sup>2</sup> (0.45 cfm/ft<sup>2</sup>), corrective actions must be made to the building and an additional test completed for which the results are 2.3 L/s·m<sup>2</sup> (0.45 cfm/ft<sup>2</sup>) or less.
2. Buildings in Climate Zone 2B.
3. Buildings larger than 25,000 square feet (2323 m<sup>2</sup>) floor area in Climate Zones 0 through 4, other than Group I and R occupancies, that comply with Section C402.6.2.3.

4. As an alternative, buildings or portions of buildings containing Group I-1 and R-2 occupancies shall be permitted to be tested by an approved third party in accordance with Section C402.6.2.2. The reported air leakage of the building thermal envelope shall not be greater than 1.4 L/s·m<sup>2</sup> (0.27 cfm/ft<sup>2</sup>) of the testing unit enclosure area at a pressure differential of 0.2 inch water gauge (50 Pa).

#### **C402.6.2.1 Whole building test method and reporting.**

The building thermal envelope shall be tested by an approved third party in accordance with ASTM E3158 or an equivalent approved method. A report that includes the tested surface area, floor area, air by volume, stories above grade, and air leakage rates shall be submitted to the code official and the building owner.

Exceptions:

For buildings less than 929 m<sup>2</sup> (10,000 square feet), the entire building thermal envelope shall be permitted to be tested in accordance with ASTM E779, ASTM E3158, ASTM E1827 or an equivalent approved method.

1. For buildings greater than 4645 m<sup>2</sup> (50,000 square feet), portions of the building shall be permitted to be tested, and the measured air leakage shall be area weighted by the surface areas of the building thermal envelope in each portion. The weighted-average tested air leakage shall not be greater than the whole building air leakage limit. The following portions of the building shall be tested:
  - 2.1. The entire building thermal envelope area of stories that have any conditioned spaces directly under a roof.
  - 2.2. The entire building thermal envelope area of stories that have a building entrance, have a floor over unconditioned space, have a loading dock or that are below grade.
  - 2.3. Representative above-grade portions of the building totalling not less than 25 percent of the wall area enclosing the remaining conditioned space.

Exception: Corridors, stairwells, and enclosed spaces having a conditioned floor area not greater than 139 m<sup>2</sup> (1,500 square feet) shall be permitted to comply with Section C402.6.2.3 and either Section C402.6.2.3.1 or Section C402.6.2.3.2.

dwelling units or sleeping units or other spaces are contained within one building thermal envelope, each shall be considered an individual testing unit, and the building air leakage shall be the weighted average of all tested unit results, weighted by each testing unit enclosure area. Units shall be tested without simultaneously testing adjacent units and shall be separately tested as follows:

1. Where buildings have less than eight total dwelling or sleeping units, each testing unit shall be tested.
2. Where buildings have eight or more dwelling or sleeping units, the greater of seven units or 20 percent of the units in the building shall be tested, including a top floor unit, a middle floor unit, a ground floor unit and a unit with the largest testing unit enclosure area. For each tested unit that exceeds the maximum air leakage rate, an additional three units shall be tested, including a mixture of testing unit types and locations.
3. Enclosed spaces with not less than one exterior wall in the building thermal envelope shall be tested in accordance with Section C402.6.2.1.

Exception: Corridors, stairwells, and enclosed spaces having a conditioned floor area not greater than 139 m<sup>2</sup> (1,500 square feet) shall be permitted to comply with Section C402.6.2.3 and either Section C402.6.2.3.1 or Section C402.6.2.3.2.

#### **C402.6.2.3.1 Materials.**

Materials with an air permeability not greater than 0.02 L/s·m<sup>2</sup> (0.004 cfm/ft<sup>2</sup>) under a pressure differential of 75 Pa (0.3-inch) water gauge) when tested in accordance with ASTM E2178 shall comply with this section. Materials in Items 1 through 16 shall be deemed to comply with this section, provided that 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 10 mm (3/8 inch).
2. Oriented strand board having a thickness of not less than 10 mm (3/8 inch).
3. Extruded polystyrene insulation board having a thickness of not less than 12.7 mm (1/2 inch).
4. Foil-back polyisocyanurate insulation board having a thickness of not less than 12.7 mm (1/2 inch).

#### **C402.6.2.2 Dwelling and sleeping unit enclosure method and reporting.**

The building thermal envelope shall be tested for air leakage in accordance with ASTM E779, ANSI/RESNET/ICC 380, ASTM E1827 or an equivalent approved method. Where multiple

5. Closed-cell spray foam having a minimum density of 2.4 kg/m<sup>3</sup> (1.5 pcf) and having a thickness of not less than 38 mm (1 1/2 inches).
6. Open-cell spray foam with a density between 0.6 and 2.4 kg/m<sup>3</sup> (0.4 and 1.5 pcf) and having a thickness of not less than 113 mm (4.5 inches).
7. Exterior or interior gypsum board having a thickness of not less than 12.7 mm (1/2 inch).
8. Cement board having a thickness of not less than 12.7 mm (1/2 inch).
9. Built-up roofing membrane.
10. Modified bituminous roof membrane.
11. Single-ply roof membrane.
12. A Portland cement/sand parge, or gypsum plaster having a thickness of not less than 15.9 mm (5/8 inch).
13. Cast-in-place and precast concrete.
14. Fully grouted concrete block masonry.
15. Sheet steel or aluminium.
16. Solid or hollow masonry constructed of clay or shale masonry units.

#### **C402.6.2.3.2 Assemblies.**

Assemblies of materials and components with an average air leakage not greater than 0.2 L/s·m<sup>2</sup> (0.04 cfm/ft<sup>2</sup>) under a pressure differential of 75 Pa (0.3 inch) of water gauge where tested in accordance with ASTM E2357, ASTM E1677, ASTM D8052 or ASTM E283 shall comply with this section. Assemblies listed in Items 1 through 3 below shall be deemed to comply, provided that joints are sealed and the requirements of [Section C402.6.1.2](#) are met.

1. Concrete masonry walls coated with either one application of block filler or two applications of a paint or sealer coating.
2. Masonry walls constructed of clay or shale masonry units with a nominal width greater than or equal to 102 mm (4 inches).
3. A Portland cement/sand parge, stucco or plaster not less than 12.7 mm (1/2 inch) in thickness.

#### **C402.6.3 Air leakage of fenestration and opaque**

#### **doors.**

The air leakage of fenestration and opaque door assemblies shall comply with [Table C402.6.3](#). Testing shall be conducted by an accredited, independent testing laboratory in accordance with applicable reference test standards in [Table C402.6.3](#) and labelled by the manufacturer.

Exceptions:

1. Field-fabricated fenestration assemblies that are sealed in accordance with [Section C402.6.1](#).
2. Fenestration in buildings that is tested in accordance with [Section C402.6.2](#) is not required to meet the air leakage requirements in [Table C402.6.3](#).

#### **TABLE C402.6.3 MAXIMUM AIR LEAKAGE RATE FOR FENESTRATION ASSEMBLIES**

#### **C402.6.4 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 not within the scope of the fenestration assemblies covered by [Section C402.6.3](#) shall be gasketed, weather-stripped or sealed.

Exceptions:

1. Door openings required to comply with [Section 716](#) of the International Building Code.
2. Doors and door openings required by the International Building Code to comply with [UL 1784](#).

#### **C402.6.5 Air intakes, exhaust openings, stairways and shafts.**

Stairway enclosures, elevator shaft vents and other outdoor air intakes and exhaust openings integral to the building thermal envelope shall be provided with dampers in accordance with [Section C403.7.7](#).

#### **C402.6.6 Vestibules.**

Building entrances shall be protected with an enclosed vestibule. 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: Vestibules are optional for the following:

1. Buildings in Climate Zones 0 through 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 298 m<sup>2</sup> (3,000 square feet) in area.
5. Revolving doors.
6. Doors used primarily to facilitate vehicular movement or material handling and adjacent personnel doors.
7. Doors that have an air curtain unit with a velocity of not less than 2 m/s (6.56 feet per second) at 152 mm (6 inches) above the floor that has been tested in accordance with ANSI/AMCA 220 or ISO 27327-1 and installed in accordance with the manufacturer's instructions. Manual or automatic controls shall be provided that will operate the air curtain unit with the opening and closing of the door and comply with Section C403.4.1.5. Air curtain units and their controls shall comply with Section C408.2.3.

#### **C402.6.7 Loading dock weather seals.**

Cargo door openings and loading door openings shall be equipped with weather seals that restrict air leakage and provide direct contact along the top and sides of vehicles that are parked in the doorway.

### **SECTION C403 BUILDING MECHANICAL SYSTEMS**

#### **C403.1 General.**

Mechanical systems and equipment serving the building heating, cooling, ventilating or refrigerating needs shall comply with one of the following:

1. Section C403.1.1 and Sections C403.2 through C403.17.
2. *Data Centers* shall comply with Section C403.1.1, Section C403.1.2 and Sections C403.6 through C403.17.
3. Section C409.

#### **C403.1.1 Calculation of heating and cooling loads.**

Design loads associated with heating, ventilating and air conditioning of the building shall be determined in accordance with ANSI/ASHRAE/ACCA Standard 183 or by

an *approved* equivalent computational procedure using the design parameters specified in Chapter 3. 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 by an approved equivalent computational procedure.

#### **C403.1.2 Data centers.**

*Data center systems* shall comply with Sections 6 and 8 of ASHRAE 90.4-2022.

#### **C403.2 System design.**

Mechanical systems shall be designed to comply with Sections C403.2.1 through C403.2.3. Where elements of a building's mechanical systems are addressed in Sections C403.3 through C403.14, such elements shall comply with the applicable provisions of those sections.

#### **C403.2.1 Zone isolation required.**

HVAC systems serving *zones* that are over 2,323 m<sup>2</sup> (25,000 square feet) in floor area or that span more than one floor and are designed to operate or be occupied not simultaneously shall be divided into isolation areas. Each isolation area shall be equipped with *isolation devices* and controls configured to automatically shut off the supply of conditioned air and outdoor air to and exhaust air from the isolation area. Each isolation area shall be controlled independently by a device meeting the requirements of Section C403.4.2.2. Central systems and plants shall be provided with controls and devices that will allow system and equipment operation for any length of time while serving only the smallest isolation area served by the system or plant.

#### **Exceptions:**

1. Exhaust air and outdoor air connections to isolation areas where the *fan system* to which they connect is not greater than 2,360 L/s (5,000 cfm).
2. Exhaust airflow from a single isolation area of less than 10 percent of the design airflow of the exhaust system to which it connects.
3. Isolation areas intended to operate continuously or intended to be inoperative only when all other isolation areas in a *zone* are inoperative.

#### **C403.2.2 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*.

#### **C403.3 Heating and cooling equipment efficiencies.**

Heating and cooling equipment installed in mechanical systems shall be sized in accordance with Section C403.3.1 and shall be not less efficient

in the use of energy than as specified in Section C403.3.2

#### **C403.3.1 Equipment sizing.**

The output capacity of heating and cooling equipment shall be not greater than that of the smallest available equipment size that exceeds the loads calculated in accordance with Section C403.1.1. 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:**

1. 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.
2. Multiple units of the same equipment type with combined capacities exceeding the design load and provided with controls that are configured to sequence the operation of each unit based on load.

#### **C403.3.2 HVAC equipment performance requirements.**

Equipment shall meet the minimum efficiency requirements of Tables C403.3.2(1) through C403.3.2(16) when tested and rated in accordance with the applicable test procedure. Plate-type liquid-to-liquid heat exchangers shall meet the minimum requirements of AHRI 400. The efficiency shall be verified through certification under an *approved* certification program or, where a certification program does not exist, 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.

#### **TABLE C403.3.2(1) MINIMUM EFFICIENCY REQUIREMENTS: ELECTRICALLY OPERATED UNITARY AIR CONDITIONERS AND CONDENSING UNITS**

#### **TABLE C403.3.2(2) MINIMUM EFFICIENCY REQUIREMENTS: ELECTRICALLY OPERATED UNITARY AND APPLIED HEAT PUMPS**

#### **TABLE C403.3.2(7) C403.3.2(3) WATER CHILLING PACKAGES — EFFICIENCY REQUIREMENTS<sup>a, b, d</sup>**

#### **TABLE C403.3.2(3) C403.3.2(4) 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**

#### **TABLE C403.3.2(4) C403.3.2(5) WARM-AIR FURNACES AND COMBINATION WARM-AIR FURNACES/AIR-CONDITIONING UNITS, WARM-AIR DUCT FURNACES AND UNIT HEATERS, MINIMUM EFFICIENCY REQUIREMENTS**

#### **TABLE C403.3.2(5) C403.3.2(6) MINIMUM EFFICIENCY REQUIREMENTS: GAS- AND OIL-FIRED BOILERS**

#### **TABLE C403.3.2(8) C403.3.2(7) MINIMUM EFFICIENCY REQUIREMENTS: HEAT REJECTION EQUIPMENT**

#### **TABLE C403.3.2(8) ELECTRICALLY OPERATED VARIABLE-REFRIGERANT-FLOW AIR CONDITIONERS—MINIMUM EFFICIENCY REQUIREMENTS**

#### **TABLE C403.3.2(9) ELECTRICALLY OPERATED VARIABLE-REFRIGERANT-FLOW AND APPLIED HEAT PUMPS—MINIMUM EFFICIENCY REQUIREMENTS**

#### **TABLE C403.3.2 (10) FLOOR-MOUNTED AIR CONDITIONERS AND CONDENSING UNITS SERVING COMPUTER ROOMS—MINIMUM EFFICIENCY REQUIREMENTS**

#### **TABLE C403.3.2 (11) VAPOR-COMPRESSION-BASED INDOOR POOL DEHUMIDIFIERS—MINIMUM EFFICIENCY REQUIREMENTS** <https://www.ahrinet.org/search-standards/ahri-910-i-p-and-911-si-performance-rating-indoor-pool-dehumidifiers>.

#### **TABLE C403.3.2(12) ELECTRICALLY OPERATED DX-DOAS UNITS, SINGLE-PACKAGE AND REMOTE CONDENSER, WITHOUT ENERGY RECOVERY—MINIMUM EFFICIENCY REQUIREMENTS**

#### **TABLE C403.3.2(13) ELECTRICALLY OPERATED DX-DOAS UNITS, SINGLE-PACKAGE AND REMOTE CONDENSER, WITH ENERGY RECOVERY—MINIMUM EFFICIENCY REQUIREMENTS**

#### **TABLE C403.3.2(14) ELECTRICALLY OPERATED WATER-SOURCE HEAT PUMPS—MINIMUM EFFICIENCY REQUIREMENTS<sup>b</sup>**

#### **TABLE C403.3.2(15) HEAT-PUMP AND HEAT RECOVERY CHILLER PACKAGES—MINIMUM EFFICIENCY REQUIREMENTS<sup>9, °</sup>**

#### **TABLE C403.3.2(16) CEILING-MOUNTED COMPUTER ROOM AIR CONDITIONERS—MINIMUM EFFICIENCY REQUIREMENTS**

#### **C403.3.2.1 Water-cooled centrifugal chilling packages.**

Equipment not designed for operation at AHRI Standard 550/590 test conditions of 44.00°F leaving and 54.00°F entering chilled-fluid temperatures,

and with 85.00°F entering and 94.30°F leaving condenser-fluid temperatures, shall have maximum full-load kW/ton (FL) and part-load rating requirements adjusted using the following equations:

$$FL_{adj} = FL/K_{adj}$$

Equation 4-5

$$PLV_{adj} = IPLV.IP/K_{adj}$$

Equation 4-6

where:

$$K_{adj} = A \times B$$

$FL$  = Full-load kW/ton value from [Table C403.3.2\(3\)](#).

$FL_{adj}$  = Maximum full-load kW/ton rating, adjusted for nonstandard conditions.

$IPLV.IP$  =  $IPLV.IP$  value from [Table C403.3.2\(3\)](#).

$PLV_{adj}$  = Maximum  $NPLV$  rating, adjusted for nonstandard conditions.

$$A = 0.00000014592 \times (LIFT)^4 - 0.0000346496 \times (LIFT)^3 + 0.00314196 \times (LIFT)^2 - 0.147199 \times (LIFT) + 3.93073$$

$$B = 0.0015 \times L_{vg}E_{vap} + 0.934$$

$$LIFT = L_{vg}Cond - L_{vg}E_{vap}$$

$L_{vg}Cond$  = Full-load condenser leaving fluid temperature (°F).

$L_{vg}E_{vap}$  = Full-load evaporator leaving temperature (°F).

The  $FL_{adj}$  and  $PLV_{adj}$  values are applicable only for centrifugal chillers meeting all of the following full-load design ranges:

- 36.00°F ≤  $L_{vg}E_{vap}$  ≤ 60.00°F
- $L_{vg}Cond$  ≤ 115.00°F
- 20.00°F ≤  $LIFT$  ≤ 80.00°F

Manufacturers shall calculate the  $FL_{adj}$  and  $PLV_{adj}$  before determining whether to label the chiller. Centrifugal chillers designed to operate outside of these ranges are not covered by this code.

#### **C403.3.2.2 Positive displacement (air- and water-cooled) chilling packages.**

Equipment with a leaving fluid temperature higher than 0 °C (32 °F) and water-cooled positive displacement chilling packages with a condenser leaving fluid temperature below 46 °C (115 °F) shall meet the requirements of the tables in [Section C403.3.2](#) when tested or certified with water at standard rating conditions, in accordance with the referenced test procedure.

#### **C403.3.3 Hot gas bypass limitation.**

Cooling systems shall not use hot gas bypass or other evaporator pressure control systems unless the system is designed with multiple steps of unloading or continuous capacity modulation. The

capacity of the hot gas bypass shall be limited as indicated in [Table C403.3.3](#), as limited by [Section C403.5.1](#).

### **TABLE C403.3.3 MAXIMUM HOT GAS BYPASS CAPACITY**

#### **C403.3.4 Boilers.**

**Boiler systems shall comply with the following:**

1. Combustion air positive shutoff shall be provided on all newly installed boiler systems that meet one or more of the following conditions:
  1. The total input capacity is not less than 733 kW (2,500,000 Btu/h) and one or more of the boilers are designed to operate with a nonpositive vent static pressure.
  2. Any stack serving the boiler system is connected to two or more boilers with a total combined input capacity of not less than 733 kW (2,500,000 Btu/h).
2. Newly installed boilers or boiler systems with a combustion air fan motor *nameplate* horsepower rating of 7.46 kW (10 horsepower) or more shall comply with one of the following:
  1. The fan motor shall be variable speed.
  2. The fan motor shall include controls that modulate fan airflow as a function of the load to a speed 50 percent or less of design air volume.

#### **C403.3.4.1 Boiler oxygen concentration controls.**

Newly installed boilers with an input capacity of 1465 kW (5,000,000 Btu/h) and steady state full-load less than 90 percent shall maintain stack-gas oxygen concentrations not greater than the values specified in [Table C403.3.4.1](#). Combustion air volume shall be controlled with respect to measured flue gas oxygen concentration. The use of a common gas and combustion air control linkage or jack shaft is not permitted.

Exception: These concentration limits do not apply where 50 percent or more of the boiler system capacity serves Group R-2 occupancies.

### **TABLE C403.3.4.1 BOILER OXYGEN CONCENTRATIONS**

#### **C403.3.4.2 Boiler turndown.**

Boiler systems with design input of greater than 293 kW (1,000,000 Btu/h) shall comply with the turndown ratio specified in [Table C403.3.4.2](#).

The system turndown requirement shall be met through the use of multiple single-input boilers, one or more *modulating boilers* or a combination of

single-input and *modulating boilers*.

**TABLE C403.3.4.2 BOILER TURNDOWN**

**C403.4 Heating and cooling system controls.**

Heating and cooling system shall be provided with controls in accordance with Sections C403.4.1 through C403.4.8

**C403.4.1 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, not fewer than one humidity control device shall be provided for each humidity control system.

Exception: Independent perimeter systems that are designed to offset only *building thermal envelope* heat losses, gains or both serving one or more perimeter *zones* also served by an interior system provided that both of the following conditions are met:

1. The perimeter system includes not fewer than one thermostatic control *zone* for each *building exposure* having *exterior walls* facing only one orientation (within  $\pm 45$  degrees) (0.8 rad) for more than **15,240 mm (50 contiguous feet)**.
2. The perimeter system heating and cooling supply is controlled by *thermostats* located within the *zones* served by the system.

**C403.4.1.1 Heat pump supplementary heat.**

Heat pumps having supplementary electric resistance heat shall have controls that limit supplemental heat operation to only those times when one of the following applies:

1. The vapor compression cycle cannot provide the necessary heating energy to satisfy the *thermostat* setting.
2. The heat pump is operating in defrost mode.
3. The vapor compression cycle malfunctions.
4. The *thermostat* malfunctions.

**C403.4.1.2 Deadband.**

Where used to control both heating and cooling, *zone* thermostatic controls shall:

1. Have separate setpoints for heating and cooling, each individually adjustable.
2. Be capable of and initially configured to provide a temperature range or deadband between the two setpoints of not less than  $3\text{ }^{\circ}\text{C}$  ( $5\text{ }^{\circ}\text{F}$ ) within which the supply of heating and cooling energy to the *zone* is shut off or reduced to a minimum.

3. Have a minimum deadband of not less than  $0.56\text{ }^{\circ}\text{C}$  ( $1\text{ }^{\circ}\text{F}$ ) when setpoints are adjusted.

**Exceptions:**

1. *Thermostats* requiring *manual* changeover between heating and cooling modes.
2. Occupancies or applications where applicable codes or accreditation standards requiring precision in indoor temperature control shall be permitted to be initially configured to not less than  $0.56\text{ }^{\circ}\text{C}$  ( $1\text{ }^{\circ}\text{F}$ ) deadband.

**C403.4.1.3 Setpoint adjustment and display.**

Where thermostatic control setpoints are capable of being adjusted by occupants or HVAC system operators, the adjustment shall be independent for the heating setpoint and the cooling setpoint; when one setpoint is changed, the other shall not change except as needed to maintain the minimum deadband required by Section C403.4.1.2. For thermostatic controls that display setpoints, both the heating and cooling setpoints shall be displayed simultaneously, or the setpoint of the currently active mode (heating or cooling) shall be displayed along with an indication of that mode.

**C403.4.1.4 Setpoint overlap restriction.**

Where heating and cooling to a *zone* are controlled by separate *zone* thermostatic controls located within the *zone*, mechanical or software means shall be provided to prevent the heating setpoint from exceeding the cooling setpoint, minus the deadband required by Section C403.4.1.2.

**C403.4.1.5 Heated or cooled vestibules.**

The heating system for heated vestibules and air curtains with integral heating shall be provided with controls configured to shut off the source of heating when the outdoor air temperature is greater than  $7\text{ }^{\circ}\text{C}$  ( $45\text{ }^{\circ}\text{F}$ ). Vestibule heating and cooling systems shall be controlled by a *thermostat* located in the vestibule configured to limit heating to a temperature not greater than  $60^{\circ}\text{F}$  ( $16^{\circ}\text{C}$ ) and cooling to a temperature not less than  $29\text{ }^{\circ}\text{C}$  ( $85\text{ }^{\circ}\text{F}$ ).

**Exception:** Control of heating or cooling provided by site-recovered energy or transfer air that would otherwise be exhausted

**C403.4.1.6 Hot water boiler outdoor temperature setback control.**

Hot water boilers that supply heat to the building through one- or two-pipe heating systems shall have an outdoor setback control that lowers the boiler water temperature based on the outdoor temperature.

**C403.4.2 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 2 kW (6,800 Btu/h) and having a *manual* shutoff switch located with *ready access*.

#### **C403.4.2.1 Thermostatic setback.**

Thermostatic setback controls shall be configured to set back or temporarily operate the system to maintain *zone* temperatures down to 13 °C (55 °F) or up to 29 °C (85 °F).

#### **C403.4.2.2 Automatic setback and shutdown.**

*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 not fewer than 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 configured to operate the system for up to 2 hours; or an occupancy sensor.

#### **C403.4.2.3 Optimum start and stop.**

Optimum start and stop controls shall be provided for each heating and cooling system with direct control of individual *zones*. The optimum start controls shall be configured to automatically adjust the daily start time of the heating and cooling system in order to bring each space to the desired occupied temperature immediately prior to scheduled occupancy. The optimum stop controls shall be configured to reduce the heating and cooling system's heating temperature setpoint and increase the cooling temperature setpoint by not less than 1.11 °C (2 °F) before scheduled unoccupied periods based on the thermal lag and acceptable drift in space temperature that is within comfort limits.

**Exception:** *Dwelling units* and *sleeping units* are not required to have optimum start controls.

#### **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 configured to sequence operation of the boilers. Hydronic heating systems composed of a single boiler and greater than 146.5 kW (500,000 Btu/h) input design capacity shall include either a multistage 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 deadband between changeover

from one mode to the other of not less than 8.3 °C (15 °F) outside air temperatures; be designed to and provided with controls that will allow operation in one mode for not less than 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 not more than 16.7 °C (30 °F) 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 deadband.**

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 configured to provide a heat pump water supply temperature deadband of not less than 11 °C (20 °F) 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 real-time conditions of demand and capacity, deadbands of less than 11 °C (20 °F) shall be permitted.

###### **C403.4.3.3.2 Heat rejection.**

The following shall apply to hydronic water loop heat pump systems in Climate Zones 3 through 8:

1. Where a closed-circuit cooling tower is used directly in the heat pump loop, either an *automatic* valve shall be installed to bypass the flow of water around the closed-circuit cooling tower, except for any flow necessary for freeze protection, or low-leakage positive-closure dampers shall be provided.
2. Where an open-circuit cooling tower is used directly in the heat pump loop, an *automatic* valve shall be installed to bypass all heat pump water flow around the open-circuit cooling tower.
3. Where an open-circuit or closed-circuit cooling tower is used in conjunction with a separate heat exchanger to isolate the open-circuit cooling tower from the heat pump loop, heat loss shall be controlled by shutting down the circulation pump on the cooling tower loop.

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

###### **C403.4.3.3.3 Two-position valve.**

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

##### **C403.4.4 Part-load controls.**

Hydronic systems greater than or equal to 87.9 kW (300,000 Btu/h) in design output capacity supplying heated or chilled water to comfort conditioning systems shall include controls that are configured to do all of the following:

1. Automatically reset the supply-water temperatures in response to varying *building* heating and cooling demand using coil valve position, zone-return water temperature, building-return water temperature or outside air temperature. The temperature shall be reset by not less than 25 percent of the design supply-to-return water temperature difference.
2. Automatically vary fluid flow for hydronic systems with a combined pump motor capacity of 1.5 kW (2 hp) or larger with three or more control valves or other devices by reducing the system design flow rate by not less than 50 percent or the maximum reduction allowed by the equipment manufacturer for proper operation of equipment by valves that modulate or step open and close, or pumps that modulate or turn on and off as a function of load.
3. Automatically vary pump flow on heating-water systems, chilled-water systems and heat rejection loops serving water-cooled unitary air conditioners as follows:
  - a) Where pumps operate continuously or operate based on a time schedule, pumps with nominal output motor power of 2 hp or more shall have a variable speed drive.
  - b) Where pumps have *automatic direct digital control* configured to operate pumps only when zone heating or cooling is required, a variable speed drive shall be provided for pumps with motors having the same or greater nominal output power indicated in Table C403.4.4 based on the *climate zone* and system served.
4. Where a variable speed drive is required by Item 3 of this section, pump motor power input shall be not more than 30 percent of design wattage at 50 percent of the design water flow. Pump flow shall be controlled to maintain one control valve nearly wide open or to satisfy the minimum differential pressure.

**Exceptions:**

1. Supply-water temperature reset is not required for chilled-water systems supplied

by off-site district chilled water or chilled water from ice storage systems.

2. Variable pump flow is not required on dedicated coil circulation pumps where needed for freeze protection.
3. Variable pump flow is not required on dedicated equipment circulation pumps where configured in primary/secondary design to provide the minimum flow requirements of the equipment manufacturer for proper operation of equipment.
4. Variable speed drives are not required on heating water pumps where more than 50 percent of annual heat is generated by an electric boiler.

**TABLE C403.4.4 VARIABLE SPEED DRIVE (VSD) REQUIREMENTS FOR DEMAND-CONTROLLED PUMPS**

**C403.4.5 Pump isolation.**

Chilled water plants including more than one chiller shall be capable of and configured 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 systems including more than one boiler shall be capable of and configured to reduce flow automatically through the *boiler system* when a boiler is shut down.

**C403.4.6 Reserved.**

Rationale: "Reserved" means the section number is held but has no active requirements in this edition of the code.

**C403.4.7 Heating and cooling system controls for operable openings to the outdoors.**

All doors from a conditioned space to the outdoors and operable openings from a conditioned space to the outdoors that are larger than 9.3 m<sup>2</sup> (100 square feet) when fully open shall have automatic controls interlocked with the heating and cooling system, unless exempted.

The controls shall be configured to disable mechanical heating or reset the space heating temperature setpoint to 12.5 °C (55 °F) or less and disable mechanical cooling or reset the space cooling temperature setpoint to 32 °C (90 °F) or more, within 10–15 minutes of opening. Mechanical cooling may remain enabled if the outdoor air temperature is below the space temperature.

**Exceptions:**

1. Building entrances with automatic closing devices.
2. Emergency exits with an automatic alarm that sounds when open.
3. Operable openings and doors serving enclosed spaces without a thermostat or heating/cooling sensor.
4. Separately zoned areas associated with food preparation with heat-generating appliances.
5. Warehouses that utilize operable openings for operational purposes, approved by the code official.
6. First entrance doors located in exterior walls that are part of a vestibule system.
7. Operable openings into spaces served by radiant heating and cooling systems.
8. Alterations where walls would have to be opened solely to meet this requirement, approved by the code official.
9. Doors served by air curtains meeting Section C402.6.6.
10. Small commercial, residential, or low-occupancy spaces where impacts on HVAC load are minimal.

**C403.4.8 Humidification and dehumidification controls.** Humidification and dehumidification controls shall be in accordance with this section.

**C403.4.8.1 Dehumidification.**

*Humid static controls* shall not use mechanical cooling to reduce the humidity below the lower of a dew point of 13 °C (55 °F) or relative humidity of 60 percent in the coldest *zone* served by the system. Lower humidity shall be permitted where mechanical cooling is being used for temperature control.

**Exceptions:**

1. Where approved, systems serving zones where specific humidity levels are required, such as museums and hospitals, and where *humid static controls* are capable of and configured to maintain a dead band of at least 10 percent relative humidity where no active humidification or dehumidification takes place.
2. Systems serving zones where humidity levels are required to be maintained with precision of not more than ±5 percent relative humidity to comply with applicable codes or accreditation standards or as *approved* by the authority having jurisdiction.

**C403.4.8.2 Humidification.**

*Humid static controls* shall not use fossil fuels or electricity to produce relative humidity above 30 percent in the warmest *zone* served by the system.

**Exceptions:**

1. Where *approved*, systems serving zones where specific humidity levels are required, such as museums and hospitals, and where *humid static controls* are capable of and configured to maintain a deadband of at least 10 percent relative humidity where no active humidification or dehumidification takes place.
2. Systems serving zones where humidity levels are required to be maintained with precision of not more than ±5 percent relative humidity to comply with applicable codes or accreditation standards or as *approved* by the authority having jurisdiction.

**C403.4.8.3 Control interlock.**

Where a *zone* is served by a system or systems with both humidification and dehumidification capability, means such as limit switches, mechanical stops, or for DDC systems, software programming, shall be provided capable of and configured to prevent simultaneous operation of humidification and dehumidification equipment.

**Exception:** Systems serving zones where humidity levels are required to be maintained with precision of not more than ±5 percent relative humidity to comply with applicable codes or accreditation standards or as *approved* by the authority having jurisdiction.

**C403.5 Economizers.**

Economizers shall comply with [Sections C403.5.1](#) through [C403.5.5](#).

An air or water *economizer* shall be provided for the following cooling systems:

1. Chilled water systems with a total cooling capacity, less cooling capacity provided with air economizers, as specified in [Table C403.5\(1\)](#).
2. Individual *fan* systems with cooling capacity greater than or equal to 15.8 kW (54,000 Btu/h) in *buildings* having other than a *Group R* occupancy.

The total supply capacity of all fan cooling units not provided with economizers shall not exceed 20 percent of the total supply capacity of all fan cooling units in the *building* or 88 kW (300,000 Btu/h) , whichever is greater.

- Individual *fan systems* with cooling capacity greater than or equal to 79.1 kW (270,000 Btu/h) in *buildings* having a *Group R* occupancy.

The total supply capacity of all fan cooling units not provided with economizers shall not exceed 20 percent of the total supply capacity of all fan cooling units in the *building* or 440 kW (1,500,000 Btu/h), whichever is greater.

**Exceptions:** Economizers are optional for the following systems.

- Individual *fan systems* not served by chilled water for *buildings* located in Climate Zones 0A, 0B, 1A and 1B.
- 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 1.7 °C (35 °F) dew-point temperature to satisfy process needs.
- Systems expected to operate less than 20 hours per week.
- Systems serving supermarket areas with open refrigerated casework.
- Where the cooling efficiency is greater than or equal to the efficiency requirements in Table C403.5(2).
- Systems that include a heat recovery system in accordance with Section C403.11.5.
- Direct-expansion fan coils or unitary equipment with a capacity less than 15.8 kW (54,000 Btu/h) and multiple stages of compressor capacity installed with a dedicated outdoor air system.

**TABLE C403.5(1) MINIMUM CHILLED-WATER SYSTEM COOLING CAPACITY FOR DETERMINING ECONOMIZER COOLING REQUIREMENTS**

**TABLE C403.5(2) EQUIPMENT EFFICIENCY PERFORMANCE EXCEPTION FOR ECONOMIZERS**

**C403.5.1 Integrated economizer control.**

Economizer systems shall be integrated with the mechanical cooling system and be configured to provide partial cooling even where additional mechanical cooling is required to provide the remainder of the cooling load. Controls shall not be capable of creating a false load in the mechanical cooling systems by limiting or disabling the economizer or any other means, such as hot gas bypass, except at the lowest stage of mechanical cooling.

Units that include an *air economizer* shall comply with the following:

- Unit controls shall have the mechanical cooling capacity control interlocked with the *air economizer* controls such that the outdoor air damper is at the 100 percent open position when mechanical cooling is on, and the outdoor air damper does not

begin to close to prevent coil freezing due to minimum compressor run time until the leaving air temperature is less than 7 °C (45 °F).

- Direct expansion (DX) units that control 22 kW (75,000 Btu/h) or greater of rated capacity of the capacity of the mechanical cooling directly based on occupied space temperature shall have not fewer than two stages of mechanical cooling capacity.
- Other DX units, including those that control space temperature by modulating the airflow to the space, shall be in accordance with Table C403.5.1.

**TABLE C403.5.1 DX COOLING STAGE REQUIREMENTS FOR MODULATING AIRFLOW UNITS**

**C403.5.2 Economizer heating system impact.**

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

Exception: Economizers on variable air volume (VAV) systems that cause *zone* level heating to increase because of a reduction in supply air temperature.

**C403.5.3 Air economizers.**

Where economizers are required by Section C403.5, air economizers shall comply with Sections C403.5.3.1 through C403.5.3.5.

**C403.5.3.1 Design capacity.**

*Air economizer* systems shall be configured to modulate outdoor air and return air dampers to provide up to 100 percent of the design supply air quantity as outdoor air for cooling.

**C403.5.3.2 Control signal.**

Economizer controls and dampers shall be configured to sequence the dampers 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).

**C403.5.3.3 High-limit shutoff.**

Air economizers shall be configured to automatically reduce outdoor air intake to the design minimum outdoor air quantity when outdoor air intake will not reduce cooling energy usage. High-limit shutoff control types for specific climates shall be chosen from Table C403.5.3.3. High-limit shutoff control settings for these control types shall be those specified in Table C403.5.3.3.

**TABLE C403.5.3.3 HIGH-LIMIT SHUTOFF CONTROL SETTING FOR AIR ECONOMIZERS<sup>b</sup>**

**C403.5.3.4 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

#### **C403.5.3.5 Economizer dampers.**

Return, exhaust/relief and outdoor air dampers used in economizers shall comply with Section C403.7.7.

#### **C403.5.4 Water-side economizers.**

Where economizers are required by Section C403.5, water-side economizers shall comply with Sections C403.5.4.1 and C403.5.4.2.

##### **C403.5.4.1 Design capacity.**

Water economizer systems shall be configured to cool supply air by indirect evaporation and providing up to 100 percent of the expected system cooling load at *outdoor air* temperatures of not greater than 10 °C (50 °F) dry bulb/7 °C (45 °F) wet bulb.

##### **Exceptions:**

1. Systems primarily serving computer rooms in which 100 percent of the expected system cooling load at 4 °C (40 °F) dry bulb/1.7 °C (35 °F) wet bulb is met with evaporative water economizers.
2. Systems primarily serving computer rooms with dry cooler water economizers that satisfy 100 percent of the expected system cooling load at 1.7 °C (35 °F) dry bulb.
3. Systems where dehumidification requirements cannot be met using outdoor air temperatures of 10 °C (50 °F) dry bulb/7 °C (45 °F) wet bulb and where 100 percent of the expected system cooling load at 7 °C (45 °F) dry bulb/4 °C (40 °F) wet bulb is met with evaporative water economizers.

##### **C403.5.4.2 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 45 kPa (15 feet) 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 (non-economizer) mode.

#### **C403.5.5 Economizer fault detection and diagnostics (Mandatory).**

Air-cooled unitary direct-expansion units listed in Tables C403.3.2(1) through C403.3.2(3) and variable refrigerant flow (VRF) units that are equipped with an economizer in accordance with Sections C403.5 through C403.5.4 shall include a fault detection and diagnostics system complying with the following:

1. The following temperature sensors shall be permanently installed to monitor system operation:

1. Outside air.
2. Supply air.
3. Return air.

2. Temperature sensors shall have an accuracy of  $\pm 1.1$  °C (2 °F) over the range of 4 °C to 26.7 °C (40 °F to 80 °F).
3. Refrigerant pressure sensors, where used, shall have an accuracy of  $\pm 3$  percent of full scale.
4. The unit controller shall be configured to provide system status by indicating the following:

1. Free cooling available.
2. Economizer enabled.
3. Compressor enabled.
4. Heating enabled.
5. Mixed air low limit cycle active.
6. The current value of each sensor.

5. The unit controller shall be capable of manually initiating each operating mode so that the operation of compressors, economizers, fans and the heating system can be independently tested and verified.
6. The unit shall be configured to report faults to a fault management application available for access by day-to-day operating or service personnel or annunciated locally on zone thermostats.
7. The fault detection and diagnostics system shall be configured to detect the following faults:

1. Air temperature sensor failure/fault.
2. Not economizing when the unit should be economizing.
3. Economizing when the unit should not be economizing.
4. Damper not modulating.
5. Excess outdoor air.

#### **C403.6 Requirements for mechanical systems serving multiple zones.**

Sections C403.6.1 through C403.6.9 shall apply to mechanical systems serving multiple zones

##### **C403.6.1 Variable air volume and multiple-zone systems.**

Supply air systems serving multiple zones shall be variable air volume (VAV) systems that have zone controls configured to reduce the volume of air that is reheated, recooled or mixed in each zone to one of the following:

1. Thirty percent of the zone design peak supply for systems with *direct digital control* (DDC).
2. Systems with DDC where all of the following apply:

- 2.1. The airflow rate in the deadband between heating and cooling does not exceed the

highest of the allowed rates under Items 3, 4, 5 or 6 of this section.

2.2. The first stage of heating modulates the zone supply air temperature setpoint up to a maximum setpoint while the airflow is maintained at the deadband flow rate.

2.3. The second stage of heating modulates the airflow rate from the deadband flow rate up to the heating maximum flow rate that is less than 50 percent of the zone design peak supply rate.

3. The outdoor airflow rate required to meet the minimum ventilation requirements of Chapter 4 of the *International Mechanical Code*.
4. The minimum primary airflow rate required to meet the Simplified Procedure ventilation requirements of ASHRAE 62.1-2019 for the zone and is permitted to be the average airflow rate as allowed by ASHRAE 62.1-2019.
5. Any higher rate that can be demonstrated to reduce overall system annual energy use by offsetting reheat/recool energy losses through a reduction in outdoor air intake for the system as approved by the code official.
6. The airflow rate required to comply with applicable codes or accreditation standards such as pressure relationships or minimum air change rates.

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

1. Zones or supply air systems where not less than 75 percent of the energy for reheating or for providing warm air in mixing systems is provided from a site-recovered, including condenser heat, or site-solar energy source.
2. Systems that prevent 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.

#### **C403.6.2 Single-duct VAV systems, terminal devices.**

Single-duct VAV systems shall use terminal devices capable of and configured to reduce the supply of primary supply air before reheating or recooling takes place.

#### **C403.6.3 Dual-duct and mixing VAV systems, terminal devices.**

Systems that have one warm air duct and one cool air duct shall use terminal devices that are configured to reduce the flow from one duct to a minimum before mixing of air from the other duct takes place.

#### **C403.6.4 Single-fan dual-duct and mixing VAV systems, economizers.**

Individual dual-duct or mixing heating and cooling systems with a single fan and with total capacities greater than 26.4 kW [(90,000 Btu/h) 7.5 tons] shall not be equipped with air economizers.

#### **C403.6.5 Supply-air temperature reset controls.**

Multiple-zone HVAC systems shall include controls that automatically reset the supply-air temperature in response to representative building loads, or to outdoor air temperature. The controls shall be configured to reset the supply air temperature not less than 25 percent of the difference between the design supply-air temperature and the design room air temperature.

#### **Exceptions:**

1. Systems that prevent reheating, recooling or mixing of heated and cooled supply air.
2. Seventy-five percent of the energy for reheating is from site-recovered or site-solar energy sources.
3. Zones with peak supply air quantities of 142 L/s (300 cfm) or less.

#### **C403.6.5.1 Dehumidification control interaction.**

In Climate Zones 0A, 1A, 2A, and 3A, the system design should allow partial supply-air temperature to reset during dehumidification. When dehumidification control is active, air economizers may operate if outdoor air conditions are suitable, rather than being fully locked out.

#### **C403.6.6 Multiple-zone VAV system ventilation optimization control.**

Multiple-zone VAV systems with direct digital control of individual zone boxes reporting to a central control panel shall have automatic controls configured to reduce outdoor air intake flow below design rates in response to changes in system ventilation efficiency ( $E_v$ ) as defined by the *International Mechanical Code*.

#### **Exceptions:**

1. VAV systems with zonal transfer fans that recirculate air from other zones without directly mixing it with outdoor air, dual-duct dual-fan VAV systems, and VAV systems with fan-powered terminal units.
2. Systems where total design exhaust airflow is more than 70 percent of total design outdoor air intake flow requirements.

#### **C403.6.7 Parallel-flow fan-powered VAV air terminal control.**

Parallel-flow fan-powered VAV air terminals shall

have *automatic* controls configured to:

1. Turn off the terminal fan except when space heating is required or where required for *ventilation*.
2. Turn on the terminal fan as the first stage of heating before the heating coil is activated.
3. During heating for warmup or setback temperature control, either:
  - 3.1. Operate the terminal fan and heating coil without primary air.
  - 3.2. Reverse the terminal damper logic and provide heating from the central air handler by primary air.

#### **C403.6.8 Setpoints for direct digital control.**

For systems with *direct digital control* of individual *zones* reporting to the central control panel, the static pressure setpoint shall be reset based on the *zone* requiring the most pressure. In such case, the setpoint is reset lower until one *zone* damper is nearly wide open. The *direct digital controls* shall be capable of monitoring zone damper positions or shall have an alternative method of indicating the need for static pressure that is configured to provide all of the following:

1. *Automatic* detection of any *zone* that excessively drives the reset logic.
2. Generation of an alarm to the system operational location.
3. Allowance for an operator to readily remove one or more *zones* from the reset algorithm.

#### **C403.6.9 Static pressure sensor location.**

Static pressure sensors used to control VAV fans shall be located such that the controller setpoint is not greater than 1.2 inches w.c. (299 Pa). Where this results in one or more sensors being located downstream of major duct splits, not less than one sensor shall be located on each major branch to ensure that static pressure can be maintained in each branch.

#### **C403.7 Ventilation and exhaust systems.**

In addition to other requirements of [Section C403](#) applicable to the provision of *ventilation* air or the exhaust of air, *ventilation* and exhaust systems shall be in accordance with [Sections C403.7.1](#) through [C403.7.9](#).

##### **C403.7.1 Demand control ventilation**

Demand control ventilation (DCV) shall be provided for the following:

1. Spaces with ventilation provided by single-zone systems where an air-side economizer is provided in accordance with Section C403.5.
2. Spaces larger than **23 m<sup>2</sup> (250 square feet)** in Climate Zones 5A, 6, 7, and 8, and spaces larger than **46.5 m<sup>2</sup> (500 square feet)** in other climate zones that have a design occupant load of 15 people or greater per **93 m<sup>2</sup> (1,000 square feet)** of floor area, as established in Table 403.3.1.1 of the

International Mechanical Code, and are served by systems with one or more of the following:

- 2.1. An air-side economizer.
- 2.2. Automatic modulating control of the outdoor air damper.
- 2.3. A design outdoor airflow greater than 3,000 cfm (1416 L/s).

Exceptions:

1. Spaces served by systems with energy recovery in accordance with Section C403.7.4.2 and that have a floor area less than:

- 1.1. 6,000 square feet (557 m<sup>2</sup>) in Climate Zone 3C.
- 1.2. 2,000 square feet (186 m<sup>2</sup>) in Climate Zones 1A, 3B and 4B.
- 1.3. 1,000 square feet (93 m<sup>2</sup>) in Climate Zones 2A, 2B, 3A, 4A, 4C, 5 and 6.
- 1.4. 400 square feet (37 m<sup>2</sup>) in Climate Zones 7 and 8.

2. Multiple-zone systems without direct digital control of individual *zones* communicating with a central control panel.

3. Spaces served by multiple-zone systems with a design outdoor airflow less than 750 cfm (354 L/s).

4. Spaces where more than 75 percent of the space design outdoor airflow is required for makeup air that is exhausted from the space or transfer air that is required for makeup air that is exhausted from other spaces.

5. Spaces with one of the following occupancy classifications as defined in Table 403.3.1.1 of the International Mechanical Code: correctional cells, education laboratories, barber, beauty and nail salons, and bowling alley seating areas.

6. Spaces where the registered design professional demonstrates an engineered ventilation system design that:

- 6.1. Prevents the maximum concentration of contaminants from being more than that obtainable by the required rate of outdoor air ventilation.
- 6.2. Allows the required minimum design rate of outdoor air to be reduced by not less than 15 percent.

##### **C403.7.2 Parking garage ventilation controls.**

Enclosed parking garages used for storing or handling automobiles operating under their own power shall employ contamination-sensing devices and automatic controls configured to stage fans or modulate fan average airflow rates to 50 percent or less of design capacity, or intermittently operate fans less than 20 percent of the occupied time or as required to maintain acceptable contaminant levels in accordance with [International Mechanical Code](#) provisions. Failure of contamination-sensing devices shall cause the exhaust fans to operate continuously at design airflow.

**Exceptions:**

1. Garages with a total exhaust capacity less than 10,620 L/s (22,500 cfm) with ventilation systems that do not utilize heating or mechanical cooling.
2. Garages that have a garage area to ventilation system motor nameplate power ratio that exceeds 710 L/s/kW (1125 cfm/hp) and do not utilize heating or mechanical cooling.

**C403.7.3 Ventilation air heating control.**

Units that provide *ventilation* air to multiple *zones* and operate in conjunction with *zone* heating and cooling systems shall not use heating or heat recovery to warm supply air to a temperature greater than 60°F (16°C) when representative *building* loads or outdoor air temperatures indicate that the majority of *zones* require cooling.

**Exception:** Units that heat the airstream using only *series energy recovery* when representative *building* loads or outdoor air temperature indicates that the majority of *zones* require cooling in Climate Zones 0A, 1A, 2A, 3A and 4A.

**C403.7.4 Energy recovery systems.**

Energy recovery ventilation systems shall be provided as specified in either Section C403.7.4.1 or C403.7.4.2, as applicable.

**C403.7.4.1 Non-transient dwelling units.**

Non-transient dwelling units shall be provided with outdoor air energy recovery ventilation systems complying with not less than one of the following:

1. The system shall have an *enthalpy recovery ratio* of not less than 50 percent at cooling design condition and not less than 60 percent at heating design condition.
2. The system shall have a sensible recovery efficiency (SRE) that is not less than 65 percent at 32°F (0°C) and in Climate Zones 0A, 1A, 2A and 3A shall have a net moisture transfer (NMT) that is not less than 40 percent at 95°F (35°C). SRE and NMT shall be determined from a *listed* value or from interpolation of *listed* values at an airflow not less than the design airflow, based on testing in accordance with [CAN/CSA C439](#).

**Exceptions:**

1. Non-transient dwelling units in Climate Zone 3C.
2. Non-transient dwelling units with not more than 500 square feet (46 m<sup>2</sup>) of *conditioned floor area* in Climate Zones 0, 1, 2, 3, 4C and 5C.

3. *Enthalpy recovery ratio* requirements at heating design condition in Climate Zones 0, 1 and 2.
4. *Enthalpy recovery ratio* requirements at cooling design condition in Climate Zones 4, 5, 6, 7 and 8.

**C403.7.4.2 Spaces other than non-transient dwelling units.**

Where the supply airflow rate of a *fan system* serving a space other than a non-transient dwelling unit exceeds the values specified in Tables C403.7.4.2(1) and C403.7.4.2(2), the system shall include an energy recovery system. The energy recovery system shall provide an *enthalpy recovery ratio* of not less than 50 percent at design conditions. Where an *air economizer* is required, the energy recovery system shall include a bypass or controls that permit operation of the economizer as required by Section C403.5.

**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 not fewer than one of the following features:
  - 2.1. Variable-air-volume hood exhaust and room supply systems configured to reduce exhaust and makeup air volume to 50 percent or less of design values.
  - 2.2. Direct makeup (auxiliary) air supply equal to or greater than 75 percent of the exhaust rate, heated not warmer than 2°F (1.1°C) above room setpoint, cooled to not cooler than 3°F (1.7°C) below room setpoint, with 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 that are not cooled.
4. Heating energy recovery where more than 60 percent of the outdoor heating energy is provided from site-recovered or site-solar energy in Climate Zones 5 through 8.
5. *Enthalpy recovery ratio* requirements at heating design condition in Climate Zones 0, 1 and 2.
6. *Enthalpy recovery ratio* requirements at cooling design condition in Climate Zones 3C, 4C, 5B, 5C, 6B, 7 and 8.
7. Systems in Climate Zones 0 through 4 requiring dehumidification that

employ series energy recovery and have a minimum SERR of 0.40.

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 airflow rate.
9. Systems expected to operate less than 20 hours per week at the *outdoor air* percentage covered by Table C403.7.4.2(1).
10. Systems exhausting toxic, flammable, paint or corrosive fumes or dust.
11. Commercial kitchen hoods used for collecting and removing grease vapours and smoke.

**TABLE C403.7.4.2(1) ENERGY RECOVERY REQUIREMENT (Ventilation systems operating less than 8,000 hours per year)**

**TABLE C403.7.4(2) ENERGY RECOVERY REQUIREMENT (Ventilation systems operating not less than 8,000 hours per year)**

**C403.7.5 Kitchen exhaust systems.**

Replacement air introduced directly into the exhaust hood cavity shall not be greater than 10 percent of the hood exhaust airflow rate. Conditioned supply air delivered to any space shall not exceed the greater of the following:

1. The ventilation rate required to meet the space heating or cooling load.
2. The hood exhaust flow minus the available transfer air from adjacent space where available transfer air is considered to be that portion of outdoor *ventilation* air not required to satisfy other exhaust needs, such as restrooms, and not required to maintain pressurization of adjacent spaces.

Kitchen exhaust hood systems serving Type I exhaust hoods shall be provided with *demand control kitchen ventilation* (DCKV) controls where a kitchen or kitchen/dining facility has a total Type I kitchen hood exhaust airflow rate greater than 5,000 cubic feet per minute (2360 L/s). DCKV systems shall be configured to provide a minimum of 50 percent reduction in exhaust and replacement air system airflow rates. Systems shall include controls necessary to modulate exhaust and replacement air system airflows in response to appliance operation and to maintain full capture and containment of smoke, effluent and combustion products during cooking and idle operation. Each hood shall be a factory-built commercial exhaust hood *listed* by a nationally recognized testing laboratory and shall have a maximum exhaust rate as specified in Table C403.7.5.

Where a single hood, or hood section, is installed over appliances with different duty ratings, the

maximum allowable flow rate for the hood or hood section shall be based on the requirements for the highest appliance duty rating under the hood or hood section.

Exceptions:

1. UL 710 listed exhaust hoods that have a design maximum exhaust flow rate not greater than 118 L/s per linear foot (305 mm) (250 cubic feet per minute per linear foot) of hood that serve kitchen or kitchen/dining facilities with a total kitchen hood exhaust airflow rate less than 2,360 L/s (5,000 cfm).
2. Where allowed by the International Mechanical Code, an *energy recovery ventilation system* is installed on the kitchen exhaust with a sensible heat recovery effectiveness of not less than 40 percent on not less than 50 percent of the total exhaust hood airflow.

**TABLE C403.7.5 MAXIMUM NET EXHAUST FLOW RATE, CFM PER LINEAR FOOT OF HOOD LENGTH**

**C403.7.6 Automatic control of HVAC systems serving guestrooms.**

In Group R-1 *buildings* containing more than 50 guestrooms, each guestroom shall be provided with controls complying with the provisions of Sections C403.7.6.1 and C403.7.6.2.

**C403.7.6.1 Temperature setpoint controls.**

Controls shall be provided on each HVAC system that are capable of and configured to automatically raise the cooling setpoint and lower the heating setpoint by not less than 4°F (2°C) from the occupant setpoint within 30 minutes after the occupants have left the guestroom. The controls shall be capable of and configured to automatically raise the cooling setpoint to not lower than 80°F (27°C) and lower the heating setpoint to not higher than 60°F (16°C) when the guestroom is unrented or has not been continuously occupied for more than 16 hours or a *networked guestroom control system* indicates that the guestroom is unrented and the guestroom is unoccupied for more than 30 minutes. A *networked guestroom control system* that is capable of returning the thermostat setpoints to default occupied setpoints 60 minutes prior to the time a guestroom is scheduled to be occupied is not precluded by this section. Cooling that is capable of limiting relative humidity with a setpoint not lower than 65-percent relative humidity during unoccupied periods is not precluded by this section.

**C403.7.6.2 Ventilation controls.**

Controls shall be provided on each HVAC system that are capable of and configured to automatically turn off the *ventilation* and exhaust fans within 20 minutes of the occupants leaving the guestroom, or *isolation devices* shall be provided to each guestroom that are capable of automatically

shutting off the supply of outdoor air to and exhaust air from the guestroom.

**Exception:** Guestroom ventilation systems are not precluded from having an *automatic* daily pre-occupancy purge cycle that provides daily outdoor air *ventilation* during unrented periods at the design ventilation rate for 60 minutes, or at a rate and duration equivalent to one air change.

#### C403.7.7 Shutoff dampers.

Outdoor air intake and exhaust openings and stairway and shaft vents shall be provided with Class I motorized dampers. The dampers shall have an *air leakage* rate not greater than **20.3 L/s × m<sup>2</sup> (4 cfm/ft<sup>2</sup>) of damper surface area at 249 Pa (1.0 inch water gauge)** and shall be *labelled* by an *approved agency* when tested in accordance with AMCA 500D for such purpose.

Outdoor air intake and exhaust dampers shall be installed with *automatic* controls configured to close when the systems or spaces served are not in use or during unoccupied period warm-up and setback operation, unless the systems served require outdoor or exhaust air in accordance with the International Mechanical Code or the dampers are opened to provide intentional economizer cooling.

Stairway and elevator shaft vent dampers shall be installed with *automatic* controls configured to open upon the activation of any fire alarm initiating device of the *building's* fire alarm system, the interruption of power to the damper, or by thermostatic control systems.

**Exception:** Nonmotorized gravity dampers shall be an alternative to motorized dampers for exhaust and relief openings as follows:

1. In *buildings* less than three stories in height above grade plane.
2. In *buildings* of any height located in Climate Zones 0, 1, 2 or 3.
3. Where the design exhaust capacity is not greater than 142 L/s (300 cfm).

Nonmotorized gravity dampers shall have an *air leakage* rate not greater than 101.6 L/s × m<sup>2</sup> (20 cfm/ft<sup>2</sup>) where not less than 610 mm (24 inches) in either dimension and 203.2 L/s × m<sup>2</sup> (40 cfm/ft<sup>2</sup>) where less than 249 Pa 610 mm (24 inches) in either dimension. The rate of *air leakage* shall be determined at water gauge 1.0 inch when tested in accordance with AMCA 500D for such purpose. The dampers shall be *labelled* by an *approved agency*.

#### C403.7.8 Occupied standby controls.

The following spaces shall be equipped with occupied standby controls in accordance with Section C403.7.8.1 for each ventilation zone:

1. Postsecondary classrooms, lecture rooms and training rooms.
2. Conference/meeting/multipurpose rooms.
3. Lounges/breakrooms.
4. Enclosed offices.
5. Open-plan office areas.
6. Corridors.

**Exception:** Zones that are part of a multiple-zone system without *automatic* zone flow control dampers.

##### C403.7.8.1 Occupied-standby zone controls.

Within 5 minutes of all spaces in that *zone* entering *occupied-standby mode*, the *zone* control shall operate as follows:

1. The active heating setpoint shall be set back by not less than 0.55°C (1°F).
2. The active cooling setpoint shall be set up by not less than 0.55°C (1°F).
3. All airflow supplied to the *zone* shall be shut off whenever the space temperature is between the active heating and cooling setpoints.
4. Multiple-zone systems shall comply with Section C403.7.8.1.1.

##### C403.7.8.1.1 Multiple-zone system controls.

Multiple-zone systems required to automatically reset the effective minimum outdoor air setpoint, per Section C403.6.6, shall reset the effective minimum outdoor air setpoint based on a *zone* outdoor air requirement of zero for all *zones* in *occupied-standby mode*. Sequences of operation for system outside air reset shall comply with an *approved* method.

##### C403.7.9 Dwelling unit ventilation system.

A fan that is the air mover for a heating or cooling system that serves an individual *dwelling unit* shall not be used to provide outdoor air.

**Exception:** Where the fan efficacy is not less than 1.2 cubic feet per minute (0.56 L/s) of outdoor airflow per watt when there is no demand for heating or cooling.

##### C403.8 Fans and fan controls.

Fans in HVAC systems shall comply with Sections C403.8.1 through C403.8.5.1.

##### C403.8.1 Allowable fan horsepower.

Where the summed fan system motor *nameplate horsepower* on an HVAC *fan system* is greater than 5 hp (3.7 kW) at *fan system design conditions*, it shall not be greater than the allowable total *fan system motor nameplate hp* (Option 1) or *fan system bhp* (Option 2), as specified in Table C403.8.1(1). Such summed HVAC fan system motor *nameplate horsepower* shall include supply fans, exhaust fans, return or 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.

**Exceptions:**

1. Hospital, vivarium and laboratory systems that utilize flow control devices on exhaust 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 0.746 kW (1 hp) or less are exempt from the allowable fan horsepower requirement.

**TABLE C403.8.1(1) FAN POWER LIMITATION**

**TABLE C403.8.1(2) FAN POWER LIMITATION PRESSURE DROP ADJUSTMENT**

**C403.8.2 Motor nameplate horsepower.**

For each fan, the *fan brake horsepower* (bhp) shall be indicated on the *construction documents* and the selected motor shall be not larger than the first available motor size greater than the following:

1. For fans less than 4,476 W (6 bhp) 1.5 times the *fan brake horsepower*.
2. For fans 4,476 W (6 bhp) and larger, 1.3 times the *fan brake horsepower*.

**Exceptions:**

1. Fans equipped with electronic speed control devices to vary the fan airflow as a function of load.
2. Fans with a *fan nameplate electrical input power* of less than 0.89 kW.
3. Systems complying with Section C403.8.1 fan system motor nameplate hp (Option 1).
4. Fans with *motor nameplate horsepower* less than **746 W (1 hp)**.

**C403.8.3 Fan efficiency**

Fans shall have a fan efficiency grade (FEG) of not less than 67, as determined in accordance with AMCA 205 by an *approved*, independent testing laboratory and labelled by the manufacturer. The total efficiency of the fan at the design point of operation shall be within 15 percentage points of the maximum total efficiency of the fan.

**Exception:** The following fans are not required to have a fan efficiency grade:

1. Fans of 5 hp (3.7 kW) or less as follows:
  - 1.1. Individual fans with a motor nameplate horsepower of 5 hp (3.7 kW) or less, unless Exception 1.2 applies.
  - 1.2. Multiple fans in series or parallel that have a combined motor nameplate horsepower of 5 hp (3.7 kW) or less and are operated as the functional equivalent of a single fan.

2. Fans that are part of equipment covered in Section C403.3.2.
3. Fans included in an equipment package certified by an *approved agency* for air or energy performance.
4. Powered wall/roof ventilators.
5. Fans outside the scope of AMCA 205.
6. Fans that are intended to operate only during emergency conditions.

**C403.8.4 Fractional hp fan motors.**

Motors for fans that are not less than 1/12 hp (0.062 kW) and are less than 1 hp (0.746 kW) shall be electronically commutated motors or shall have a minimum motor efficiency of 70 percent, rated in accordance with DOE 10 CFR 431. These motors shall have the means to adjust motor speed for either balancing or remote control. The use of belt-driven fans to sheave adjustments for airflow balancing instead of a varying motor speed shall be permitted.

**Exceptions:** The following motors are not required to comply with this section

1. Motors in the airstream within fan coils and terminal units that only provide heating to the space served.
2. Motors in space-conditioning equipment that comply with Section C403.3.2 or Sections C403.8.1 through C403.8.3.
3. Motors that comply with Section C405.8.

**C403.8.5 Low-capacity ventilation fans.**

Mechanical ventilation system fans with motors less than 1/12 hp (0.062 kW) in capacity shall meet the efficacy requirements of Table C403.8.5 at one or more rating points. Airflow shall be tested in accordance with the test procedure referenced in Table C403.8.5 and *listed*. The airflow shall be reported in the product listing or on the label. Fan efficacy shall be reported in the product listing or shall be derived from the input power and airflow values reported in the product listing or on the label. Fan efficacy for fully ducted HRV, ERV, balanced and in-line fans shall be determined at a static pressure not less than 0.2-inch w.c. (49.8 Pa). Fan efficacy for ducted range hoods, bathroom and utility room fans shall be determined at a static pressure not less than 0.1-inch w.c. (24.9 Pa).

**Exceptions:**

1. Where ventilation fans are a component of a *listed* heating or cooling appliance.
2. Dryer exhaust duct power ventilators, domestic range hoods and domestic range booster fans that operate intermittently.
3. Fans in radon mitigation systems.
4. Fans not covered within the scope of the test methods referenced in Table C403.8.5.

- Ceiling fans regulated under [10 CFR 430, Appendix U](#).

#### **TABLE C403.8.5 LOW-CAPACITY VENTILATION FAN EFFICACY<sup>a</sup>**

##### **C403.8.5-C 403.8.6 Fan control.**

Controls shall be provided for fans in accordance with [Section C403.8.6.1](#) and as required for specific systems provided in [Section C403](#).

##### **C403.8.6.1 Fan airflow control.**

Each cooling system listed in [Table C403.8.6.1](#) shall be designed to vary the indoor fan airflow as a function of load and shall comply with the following requirements:

- Direct expansion (DX) and chilled water-cooling units that control the capacity of the mechanical cooling directly based on space temperature shall have not fewer than two stages of fan control. Low or minimum speed shall not be greater than 66 percent of full speed. At low or minimum speed, the *fan system* shall draw not more than 40 percent of the fan power at full fan speed. Low or minimum speed shall be used during periods of low cooling load and ventilation-only operation.
- Other units including DX cooling units and chilled water units that control the space temperature by modulating the airflow to the space shall have modulating fan control. Minimum speed shall be not greater than 50 percent of full speed. At minimum speed the *fan system* shall draw not more than 30 percent of the power at full fan speed. Low or minimum speed shall be used during periods of low cooling load and ventilation-only operation.
- Units that include an air-side economizer in accordance with [Section C403.5](#) shall have not fewer than two speeds of fan control during economizer operation.

##### **Exceptions:**

- Modulating fan control is not required for chilled water and evaporative cooling units with fan motors of less than 1 hp (0.746 kW) where the units are not used to provide *ventilation air* and the indoor fan cycles with the load.
- Where the volume of outdoor air required to comply with the ventilation requirements of the [International Mechanical Code](#) at low speed exceeds the air that would be delivered at the speed defined in [Section C403.8.6](#), the minimum speed shall be selected to provide the required *ventilation air*.

#### **TABLE C403.8.5.1 C403.8.6.1 COOLING SYSTEMS**

##### **C403.8.6.2 Intermittent exhaust control for bathrooms and toilet rooms**

Where an exhaust system serving a bathroom or toilet room is designed for intermittent operation, the exhaust system **should be provided** with manual-on capability and **one or more of the following controls, or equivalent manufacturer settings:**

- Timer control: minimum setpoint up to **45 minutes**.
- Occupant sensor control: automatically turns off exhaust fans **within 45 minutes** after all occupants leave the space.
- Humidity control: manual or automatic adjustment from a minimum setpoint **not greater than 40–50%** to a maximum setpoint up to **85%** relative humidity.
- Contaminant control: responds to particle or gaseous concentration.

Exception: Bathroom and toilet room exhaust systems serving as an integral component of an outdoor air ventilation system in Group R-2, R-3, and R-4 occupancies **may rely on manual-on or manufacturer-provided factory settings**. Note: An off setpoint may be used to comply with minimum setpoint requirements in low-use or low-occupancy spaces.

##### **C403.9 Large-diameter ceiling fans.**

Where provided, *large-diameter ceiling fans* shall be tested and *labelled* in accordance with [AMCA 230](#) and shall meet the efficiency requirements of [Table C403.9](#) and [Section C403.9.1](#).

#### **TABLE C403.9 CEILING FAN EFFICIENCY REQUIREMENTS<sup>a</sup>**

##### **C403.9.1 Ceiling Fan Energy Index (CFEI).**

The Ceiling Fan Energy Index shall be calculated as the ratio of the electric input power of a reference *large-diameter ceiling fan* to the electric input power of the actual *large-diameter ceiling fan* as calculated in accordance with [AMCA 208](#) with the following modifications to the calculations for the reference fan: Using an airflow constant (Q) of **12.5 m<sup>3</sup>/s (26,500 cfm)**, a pressure constant (P) of **0.6719 Pa (0.0027 inch of water)**, and fan efficiency constant ( $\eta$ ) of 42 percent.

##### **C403.10 Buildings with high-capacity space-heating gas boiler systems.**

Gas hot water boiler systems for space heating with system input capacities of not less than **234 kW (800,000 Btu/h)** and not greater than **3,517 kW (12,000,000 Btu/h)** in new buildings shall comply with [Sections C403.10.1](#) and [C403.10.2](#).

##### **Exceptions:**

- Where **20 percent** of the annual space heating requirement is provided by *on-site renewable energy*, site-recovered energy or heat recovery chillers.
- Space heating boilers installed in individual *dwelling units*.

- Where **40 percent** or more of the design heating load is served using perimeter convective heating, radiant ceiling panels or both.
- Individual gas boilers with input capacity less than **102 kW (350,000 Btu/h)** shall not be included in the calculations of the total system input or total system efficiency.

#### C403.10.1 Boiler efficiency

Gas hot water boilers shall have a thermal efficiency ( $E_t$ ) of not less than **85 percent** where rated in accordance with the test procedures in Table C403.3.2(6). Systems with multiple boilers are allowed to meet this requirement where the space heating input provided by equipment with  $E_t$  above or below **85 percent provides an input capacity-weighted average  $E_t$  of not less than 85 percent**. For boilers rated only for combustion efficiency, the calculation for the input capacity-weighted average  $E_t$  shall use the combustion efficiency value.

#### C403.10.2 Hot water distribution system design.

The hot water distribution system shall be designed to meet the following:

- Coils and other heat exchangers shall be selected so that at design conditions the hot water return temperature entering the boilers is 120°F (49°C) or less.
- Under all operating conditions, the water temperature entering the boiler is not greater than 120°F (49°C) or the flow rate of supply hot water that recirculates directly into the return system, such as by three-way valves or minimum flow bypass controls, shall be not greater than **30 percent of the design flow of the boilers**.

#### ~~C403.9.~~ C403.11 Heat rejection equipment.

Heat rejection equipment, including air-cooled condensers, dry coolers, open-circuit cooling towers, closed-circuit cooling towers and evaporative condensers, shall comply with this section.

**Exception:** Heat rejection devices where energy usage is included in the equipment efficiency ratings listed in Tables C403.3.2(6) and C403.3.2(7).

#### ~~C403.9.1~~ C403.11.1 Fan speed control.

Each fan system powered by an individual motor or array of motors with connected power, including the motor service factor, totalling 5 hp (3.7 kW) or more shall have controls and devices configured to automatically modulate the fan speed to control the leaving fluid temperature or condensing temperature and pressure of the heat rejection device. Fan motor power input shall be not more than 30 percent of design wattage at 50 percent of the design airflow.

**Exceptions:**

- Fans serving multiple refrigerant or fluid cooling circuits.
- Condenser fans serving flooded condensers.

#### ~~C403.9.2~~ C403.11.2 Multiple-cell heat rejection equipment.

Multiple-cell heat rejection equipment with variable speed fan drives shall be controlled to operate the maximum number of fans allowed that comply with the manufacturer's requirements for all system components and so that all fans operate at the same fan speed required for the instantaneous cooling duty, as opposed to staged on and off operation. The minimum fan speed shall be the minimum allowable speed of the fan drive system in accordance with the manufacturer's recommendations.

#### ~~C403.9.3~~ C403.11.3 Limitation on centrifugal fan open-circuit cooling towers.

Centrifugal fan open-circuit cooling towers with a combined rated capacity of 1,100 gpm (4164 L/m) or greater at 95°F (35°C) condenser water return, 85°F (29°C) condenser water supply, and 75°F (24°C) outdoor air wet-bulb temperature shall meet the energy efficiency requirement for axial fan open-circuit cooling towers listed in Table C403.3.2(7).

**Exception:** Centrifugal open-circuit cooling towers that are designed with inlet or discharge ducts or require external sound attenuation.

#### ~~C403.9.4~~ C403.11.4 Tower flow turndown.

Open-circuit cooling towers used on water-cooled chiller systems that are configured with multiple- or variable-speed condenser water pumps shall be designed so that all open-circuit cooling tower cells can be run in parallel with the larger of the flow that is produced by the smallest pump at its minimum expected flow rate or at 50 percent of the design flow for the cell.

#### ~~C403.9.5~~ C403.11.5 Heat recovery for service water heating.

Condenser heat recovery shall be installed for heating or reheating of service hot water provided that the facility operates 24 hours a day, the total installed heat capacity of water-cooled systems exceeds 1,758 kW (6,000,000 Btu/h) of heat rejection, and the design service water heating load exceeds 293 kW (1,000,000 Btu/h).

The required heat recovery system shall have the capacity to provide the smaller of the following:

- Sixty percent of the peak heat rejection load at design conditions.
- The preheating required to raise the peak service hot water draw to 85°F (29°C).

**Exceptions:**

- Facilities that employ condenser heat recovery for space heating or reheat

purposes with a heat recovery design exceeding 30 percent of the peak water-cooled condenser load at design conditions.

2. Facilities that provide 60 percent of their service water heating from site solar or site recovered energy or from other sources.

#### **C403.12 Refrigeration equipment performance.**

Refrigeration equipment performance shall be determined in accordance with Sections C403.12.1 and C403.12.2 for commercial refrigerators, freezers, refrigerator-freezers, *walk-in coolers*, *walk-in freezers* and refrigeration equipment. The energy use shall be verified through certification under an *approved* certification program or, where a certification program does not exist, the energy use shall be supported by data furnished by the equipment manufacturer.

**Exception:** *Walk-in coolers* and *walk-in freezers* regulated under federal law in accordance with Subpart R of DOE 10 CFR 431.

#### **C403.12.1 Commercial refrigerators, refrigerator-freezers and refrigeration.**

Refrigeration equipment, defined in DOE 10 CFR Part 431.62, shall have an energy use in kWh/day not greater than the values of Table C403.12.1 when tested and rated in accordance with AHRI 1200.

#### **TABLE C403.12.1 MINIMUM EFFICIENCY REQUIREMENTS: COMMERCIAL REFRIGERATORS AND FREEZERS AND REFRIGERATION**

#### **C403.12.2 Walk-in coolers and walk-in freezers.**

*Walk-in cooler* and *walk-in freezer* refrigeration systems, except for walk-in process cooling refrigeration systems as defined in DOE 10 CFR 431.302, shall meet the requirements of Tables C403.12.2.1(1), C403.12.2.1(2) and C403.12.2.1(3).

#### **C403.12.2.1 Performance standards.**

*Walk-in coolers* and *walk-in freezers* shall meet the requirements of Tables C403.12.2.1(1), C403.12.2.1(2) and C403.12.2.1(3).

#### **TABLE C403.12.2.1(1) WALK-IN COOLER AND FREEZER DISPLAY DOOR EFFICIENCY REQUIREMENTS<sup>a</sup>**

#### **TABLE C403.10.2.1(2) WALK-IN COOLER AND FREEZER NONDISPLAY DOOR EFFICIENCY REQUIREMENTS<sup>a</sup>**

#### **TABLE C403.10.2.1(3) WALK-IN COOLER AND FREEZER REFRIGERATION SYSTEM EFFICIENCY REQUIREMENTS**

#### **C403.12.3 Refrigeration systems.**

Refrigerated display cases, *walk-in coolers* or *walk-in freezers* that are served by remote compressors and remote condensers not located in a condensing unit, shall comply with Sections

#### C403.12.3.1 and C403.12.3.2.

Exception: Systems where the working fluid in the refrigeration cycle goes through both subcritical and super-critical states (transcritical) or that use ammonia refrigerant are exempt.

#### C403.10.4.4 **C403.12.3.1 Condensers serving refrigeration systems.**

Fan-powered condensers shall comply with the following:

1. The design *saturated condensing temperatures* for air-cooled condensers shall not exceed the design dry-bulb temperature plus 10°F (5.6°C) for *low-temperature refrigeration systems*, and the design dry-bulb temperature plus 15°F (8°C) for *medium temperature refrigeration systems* where the *saturated condensing temperature* for blend refrigerants shall be determined using the average of liquid and vapor temperatures as converted from the condenser drain pressure.
2. Condenser fan motors that are less than **0.75 kW (1 hp)** shall use electronically commutated motors, permanent split-capacitor-type motors or 3-phase motors.
3. Condenser fans for air-cooled condensers, evaporatively cooled condensers, air- or water-cooled fluid coolers or cooling towers shall reduce fan motor demand to not more than 30 percent of design wattage at 50 percent of design air volume, and incorporate one of the following continuous variable speed fan control approaches:
  - 3.1. Refrigeration system condenser control for air-cooled condensers shall use variable setpoint control logic to reset the condensing temperature setpoint in response to ambient dry-bulb temperature.
  - 3.2. Refrigeration system condenser control for evaporatively cooled condensers shall use variable setpoint control logic to reset the condensing temperature setpoint in response to ambient wet-bulb temperature.
4. Multiple fan condensers shall be controlled in unison.
5. The minimum condensing temperature setpoint shall be not greater than 70°F (21°C).

#### C403.10.4.2 **C403.12.3.2 Compressor systems.**

Refrigeration compressor systems shall comply

with the following:

1. Compressors and multiple-compressor system suction groups shall include control systems that use floating suction pressure control logic to reset the target suction pressure temperature based on the temperature requirements of the attached refrigeration display cases or walk-ins.

Exception: Controls are not required for the following:

1. Single-compressor systems that do not have variable capacity capability.
2. Suction groups that have a design saturated suction temperature of 30°F (-1.1°C) or higher, suction groups that comprise the high stage of a two-stage or cascade system, or suction groups that primarily serve chillers for secondary cooling fluids.
2. Liquid subcooling shall be provided for all low-temperature compressor systems with a design cooling capacity equal to or greater than 29.3 kW (100,000 Btu) with a design-saturated suction temperature of -10°F (-23°C) or lower. The subcooled liquid temperature shall be controlled at a maximum temperature setpoint of 50°F (10°C) at the exit of the subcooler using either compressor economizer (interstage) ports or a separate compressor suction group operating at a saturated suction temperature of 18°F (-7.8°C) or higher.

2.1. Insulation for liquid lines with a fluid operating temperature less than 60°F (15.6°C) shall comply with Table C403.13.3(1) or C403.13.3(2).

3. Compressors that incorporate internal or external crankcase heaters shall provide a means to cycle the heaters off during compressor operation.

**C403.13 Construction of HVAC system elements.**  
*Ducts*, plenums, piping and other elements that are part of an HVAC system shall be constructed and insulated in accordance with Sections C403.13.1 through C403.13.3.1.

**C403.11.4 C403.13.1 Duct and plenum insulation and sealing.**

Supply and return air *ducts* and plenums shall be insulated with not less than R-6 insulation where located in unconditioned spaces and where located outside the *building* with not less than R-8 insulation in Climate Zones 0 through 4 and not less than R-12 insulation in Climate Zones 5 through 8. *Ducts* located underground beneath *buildings* shall be insulated as required in this section or have an equivalent *thermal distribution efficiency*. Underground *ducts* utilizing the *thermal distribution efficiency* method shall be *listed* and *labelled* to indicate the *R-value* equivalency. Where located within a *building thermal envelope* assembly, the *duct* or plenum shall be separated from the *building* exterior or unconditioned or exempt spaces by not less than R-8 insulation in Climate Zones 0 through 4 and not less than R-12 insulation in Climate Zones 5 through 8.

Exceptions:

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

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

**C403.13.2 Duct construction.**

Ductwork shall be constructed and erected in accordance with the *International Mechanical Code*.

**C403.13.2.1 Low-pressure duct systems.**

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.) (498 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 instructions. Pressure classifications specific to the duct system shall be clearly indicated on the construction documents in accordance with the *International Mechanical Code*.

Exception: Locking-type longitudinal joints and seams, other than the snap-lock and button-lock types, need not be sealed as specified in this section.

**C403.13.2.2 Medium-pressure duct systems.**

*Ducts* and plenums designed to operate at a static pressure greater than 498 Pa (2 inches water gauge (w.g.)) but less than 747 Pa (3 inches w.g.) shall be insulated and sealed in accordance with Section C403.13.1. Pressure classifications specific to the *duct system* shall be clearly indicated on

the *construction documents* in accordance with the *International Mechanical Code*.

#### C403.13.2.3 High-pressure duct systems.

*Ducts* and plenums designed to operate at static pressures equal to or greater than 747 Pa (3 inches water gauge) shall be insulated and sealed in accordance with [Section C403.13.1](#). In addition, *ducts* and plenums shall be leak tested in accordance with the [SMACNA HVAC Air Duct Leakage Test Manual](#) and shown to have a rate of *air leakage* (CL) less than or equal to 4.0 as determined in accordance with [Equation 4-7](#).

$$CL = F/P^{0.65}$$

Equation 4-7

where:

*F* = The measured leakage rate in cfm per **9.3 m<sup>2</sup> (100 square feet)** of duct surface..

*P* = The static pressure of the test.

Documentation shall be furnished demonstrating that representative sections totalling not less than 25 percent of the *duct* area have been tested and that all tested sections comply with the requirements of this section.

#### C403.13.3 Piping insulation.

Piping serving as part of a heating or cooling system shall be thermally insulated in accordance with [Table C403.13.3\(1\)](#) or [C403.13.3\(2\)](#).

##### 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 [AHRI 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 25 mm (1 inch) or less in diameter.
6. Direct buried piping that conveys fluids at or below 60°F (15°C).

7. In radiant heating systems, sections of piping intended by design to radiate heat.

**TABLE C403.13.3(1) MINIMUM PIPE INSULATION THICKNESS (in inches or R-value)<sup>a, c</sup>**

**TABLE C403.13.3(2) MINIMUM PIPE INSULATION R-VALUE<sup>a</sup>**

#### C403.13.3.1 Protection of piping insulation.

Piping insulation exposed to the weather shall be protected from damage, including that caused by sunlight, moisture, equipment maintenance and wind. The protection shall provide shielding from solar radiation that can cause degradation of the material. The protection shall be removable and reuseable for not less than 152 mm (6 inches) from the connection to the equipment piping for maintenance. Adhesive tape shall not be permitted as a means of insulation protection.

#### C403.14 Mechanical systems located outside of the building thermal envelope.

Mechanical systems, providing heat outside of the *building thermal envelope* of a *building* shall comply with [Sections C403.14.1](#) through [C403.14.4](#).

#### C403.12.3

#### C403.15 Dehumidification in spaces for plant growth and maintenance.

Equipment that dehumidifies *indoor grow* and *greenhouse* spaces shall be one or more of the following:

1. *Dehumidifiers* tested in accordance with the test procedure *listed* in [DOE 10 CFR 430](#) and [DOE 10 CFR 430](#), Subpart B, Appendix X or X1.
2. An integrated HVAC system with on-site heat recovery designed to fulfill not less than **50-60%** percent of the annual energy for dehumidification reheat.
3. A chilled water system with on-site heat recovery designed to fulfill not less than **50-60%** percent of the annual energy for dehumidification reheat.
4. A solid or liquid desiccant dehumidification system for system designs that require a dewpoint of not more than **55°F (13°C)**.

#### C403.16 Service water pressure-booster systems.

Service water pressure-booster systems shall be designed such that the following apply:

1. One or more pressure sensors shall be used to vary pump speed and/or start and stop pumps. The sensors shall either be located near the critical fixtures that determine the pressure required or logic shall be employed

that adjusts the setpoint to simulate the operation of remote sensors.

2. No devices shall be installed for the purpose of reducing the pressure of all of the water supplied by any booster system pump or booster system, except for safety devices.

3. No booster system pumps shall operate when there is no service water flow.

#### **C403.17 Clean water pumps.**

*Clean water pumps* meeting all the following criteria shall achieve a PEI rating not greater than 1.0:

1. Shaft input power is greater than or equal to 0.75 kW (1.0 hp) and less than or equal to 149.1 kW (200 hp) at its best efficiency point (BEP). Designated as either an end-suction close-coupled, end-suction frame-mounted, in-line, radially split vertical or submersible turbine pump.
2. A flow rate of 1.58 L/s (25 gallons per minute) or greater at its BEP at full impeller diameter.
3. Maximum head of 139.9 m (459 feet) at its BEP at full impeller diameter and the number of stages required for testing.
4. Design temperature range from -10°C (14°F) to 120°C (248°F).
5. Designed to operate with one of the following. Note that for either Item 6.1 or 6.2, the driver and impeller must rotate at the same speed.
  - 6.1 A 2- or 4-pole induction motor.
  - 6.2 A non-induction motor with a speed of rotation operating range that includes speeds of rotation between 2,880 and 4,320 rpm and/or 1,440 and 2,160 rpm.
6. For submersible turbine pumps, a 152 mm (6-inch) or smaller bowl diameter.
7. For end-suction close-coupled pumps and end-suction frame-mounted/own bearings pumps, specific speeds less than or equal to 5,000 rpm when calculated using US customary units.

**Exceptions:** The following pumps are exempt from these requirements:

1. Fire pumps.
2. Self-priming pumps.
3. Prime-assisted pumps.
4. Magnet-driven pumps.
5. Pumps designed to be used in a nuclear facility subject to [10 CFR 50](#).

6. Pumps meeting the design and construction requirements set forth in US Military Specification MIL-P-17639F (1996), "Pumps, Centrifugal, Miscellaneous Service Naval Shipboard Use" (as amended); MIL-P-17840C (1986), "Pump, Centrifugal, Close Coupled, Navy Standard for Use on Naval Ships" (as amended); MIL-P-17881D (1972), "Pump, Centrifugal, Boiler Feed, (Multi Stage)" (as amended); MIL-P-18472G (1989), "Pumps, Centrifugal, Condensate, Feed Booster, Waste Heat Boiler, and Distilling Plant" (as amended); MIL-P-18682D (1984), "Pump, Centrifugal, Main Condenser Circulating, Naval Shipboard" (as amended).

## **SECTION C404 SERVICE WATER HEATING**

### **C404.1 General.**

This section covers the minimum efficiency of, and controls for, service water-heating equipment and insulation of service hot water piping.

### **C404.2 Service water-heating equipment performance efficiency.**

Water-heating equipment and hot water storage tanks shall meet the requirements of [Table C404.2](#). The efficiency shall be verified through data furnished by the manufacturer of the equipment or through certification under a certification program. Water-heating equipment intended to be used to provide space heating shall meet the applicable provisions of [Table C404.2](#).

### **TABLE C404.2 MINIMUM PERFORMANCE OF WATER-HEATING EQUIPMENT**

#### **C404.2.1 High input service water-heating systems.**

Gas-fired water-heating equipment installed in new buildings shall be in compliance with this section. Where a singular piece of water-heating equipment serves the entire building and the input rating of the equipment is 293 kW (1,000,000 Btu/h) or greater, such equipment shall have a thermal efficiency,  $E_t$ , of not less than 90 percent. Where multiple pieces of water-heating equipment serve the building and the combined input rating of the water-heating equipment is 293 kW (1,000,000 Btu/h) or greater, the combined input-capacity-weighted-average thermal efficiency,  $E_t$ , shall be not less than 90 percent.

Exceptions:

1. Where not less than 25 percent of the annual *service water-heating* requirement is provided by *on-site renewable energy* or

site-recovered energy, the minimum thermal efficiency requirements of this section shall not apply.

2. The input rating of water heaters installed in individual dwelling units shall not be required to be included in the total input rating of *service water-heating* equipment for a building.
3. The input rating of water heaters with an input rating of not greater than 100,000 Btu/h (29.3 kW) shall not be required to be included in the total input rating of *service water-heating* equipment for a building.

#### **C404.3 Heat traps for hot water storage tanks.**

Storage tank-type *water heaters* and hot water storage tanks that have vertical water pipes connecting to the inlet and outlet of the tank shall be provided with integral *heat traps* at those inlets and outlets or shall have pipe-configured *heat traps* in the piping connected to those inlets and outlets. Tank inlets and outlets associated with solar water-heating system circulation loops shall not be required to have *heat traps*.

#### **C404.4 Insulation of piping.**

Piping from a water heater to the termination of the heated water fixture supply pipe shall be insulated in accordance with Table C403.11.3. On both the inlet and outlet piping of a storage water heater or heated water storage tank, the piping to a heat trap or the first 2438 mm (8 feet) of piping, whichever is less, shall be insulated. Piping that is heat traced shall be insulated in accordance with Table C403.11.3 or the heat trace manufacturer's instructions. Tubular pipe insulation shall be installed in accordance with the insulation manufacturer's instructions. Pipe insulation shall be continuous except where the piping passes through a framing member. The minimum insulation thickness requirements of this section shall not supersede any greater insulation thickness requirements necessary for the protection of piping from freezing temperatures or the protection of personnel against external surface temperatures on the insulation.

Exception: Tubular pipe insulation shall not be required on the following:

1. The tubing from the connection at the termination of the fixture supply piping to a plumbing fixture or plumbing appliance.
2. Valves, pumps, strainers and threaded

unions in piping that is 25 mm (1 inch) or less in nominal diameter.

3. Piping from user-controlled shower and bath mixing valves to the water outlets.
4. Cold-water piping of a demand recirculation water system.
5. Tubing from a hot drinking-water heating unit to the water outlet.
6. Piping at locations where a vertical support of the piping is installed.
7. Piping surrounded by building insulation with a thermal resistance (R-value) of not less than R-3.

#### **C404.5 Heated water supply piping.**

Heated water supply piping shall be in accordance with Section C404.5.1 or C404.5.2. The flow rate through 6.4 mm (1/4-inch) piping shall be not greater than 1.9 L/m (0.5 gpm). The flow rate through 5/16-inch (7.9 mm) piping shall be not greater than 1 gpm (3.8 L/m). The flow rate through 7.9 mm (5/16-inch) piping shall be not greater than 3.8 L/m (1 gpm). The flow rate through 9.5 mm (3/8-inch) piping shall be not greater than 5.7 L/m (1.5 gpm).

##### **C404.5.1 Maximum allowable pipe length method.**

The maximum allowable piping length from the nearest source of heated water to the termination of the fixture supply pipe shall be in accordance with the following. Where the piping contains more than one size of pipe, the largest size of pipe within the piping shall be used for determining the maximum allowable length of the piping in Table C404.5.1.

1. For a public lavatory faucet, use the "Public lavatory faucets" column in Table C404.5.1.
2. For all other plumbing fixtures and plumbing appliances, use the "Other fixtures and appliances" column in Table C404.5.1.

##### **TABLE C404.5.1 PIPING VOLUME AND MAXIMUM PIPING LENGTHS**

##### **C404.5.2 Maximum allowable pipe volume method.**

The water volume in the piping shall be calculated in accordance with Section C404.5.2.1. *Water heaters*, circulating water systems and heat trace temperature maintenance systems shall be considered to be sources of heated water.

The volume from the nearest source of heated water to the termination of the fixture supply pipe shall be as follows:

1. For a public lavatory faucet: not more than 0.06 L (2 ounces)
2. For other plumbing fixtures or plumbing appliances; not more than 1.89 L (0.5 gallon).

**C404.5.2.1 Water volume determination.**

The volume shall be the sum of the internal volumes of pipe, fittings, valves, meters and manifolds between the nearest source of heated water and the termination of the fixture supply pipe. The volume in the piping shall be determined from the "Volume" column in [Table C404.5.1](#) or from [Table C404.5.2.1](#). The volume contained within fixture shutoff valves, within flexible water supply connectors to a fixture fitting and within a fixture fitting shall not be included in the water volume determination. Where heated water is supplied by a recirculating system or heat-traced piping, the volume shall include the portion of the fitting on the branch pipe that supplies water to the fixture.

**TABLE C404.5.2.1 INTERNAL VOLUME OF VARIOUS WATER DISTRIBUTION TUBING****C404.6 Heated-water circulating and temperature maintenance systems.**

Heated-water circulation systems shall be in accordance with [Section C404.6.1](#). Heat trace temperature maintenance systems shall be in accordance with [Section C404.6.2](#). Controls for hot water storage shall be in accordance with [Section C404.6.3](#). *Automatic* controls, temperature sensors and pumps shall be in a location with *access*. *Manual* controls shall be in a location with *ready access*.

**C404.6.1 Circulation systems.**

Heated-water circulation systems shall be provided with a circulation pump. The system return pipe shall be a dedicated return pipe or a cold-water supply pipe. Gravity and thermo-syphon circulation systems shall be prohibited. Controls for circulating hot water system pumps shall start the pump based on the identification of a demand for hot water within the occupancy. The controls shall automatically turn off the pump when the water in the circulation loop is at the desired temperature and when there is not a demand for hot water.

**C404.6.1.1 Demand recirculation controls.**

Demand recirculation water systems shall have controls that start the pump upon receiving a signal from the action of a user of a fixture or appliance, sensing the presence of a user of a fixture, or sensing the flow of hot or tempered water to a fixture fitting or appliance.

**C404.6.2 Heat trace systems.**

Electric heat trace systems shall comply with [IEEE 515.1](#). Controls for such systems shall be able to automatically adjust the energy input to the heat tracing to maintain the desired water temperature in the piping in accordance with the times when heated water is used in the occupancy. Heat trace shall be arranged to be turned off automatically when there is not a demand for hot water.

**C404.6.3 Controls for hot water storage.**

The controls on pumps that circulate water between a *water heater* and a heated-water storage tank shall limit operation of the pump from heating cycle

startup to not greater than 5 minutes after the end of the cycle.

**C404.7 Drain water heat recovery units.**

Drain water heat recovery units shall comply with [CSA B55.2](#). Potable water-side pressure loss shall be less than 10 psi (69 kPa) at maximum design flow. For *Group R* occupancies, the efficiency of drain water heat recovery unit efficiency shall be in accordance with [CSA B55.1](#).

**C404.8 Energy consumption of pools and permanent spas.**

The energy consumption of pools and permanent spas shall be controlled by the requirements in [Sections C404.8.1](#) through [C404.8.3](#).

**C404.8.1 Heaters.**

The electric power to all heaters shall be controlled by an on-off switch that is an integral part of the heater, mounted on the exterior of the heater, or external to and within 914 mm (3 feet) of the heater in a location with *ready access*. Operation of such switch shall not change the setting of the heater *thermostat*. Such switches shall be in addition to a circuit breaker for the power to the heater. Gas-fired heaters shall not be equipped with continuously burning ignition pilots.

**C404.8.2 Time switches.**

Time switches or other control methods that can automatically turn off and on heaters and pump motors according to a preset schedule shall be installed for heaters and pump motors. Heaters and pump motors that have built-in time switches shall be in compliance with this section.

**Exceptions:**

1. Where public health standards require 24-hour pump operation.
2. Pumps that operate solar- and waste-heat-recovery pool heating systems.

**C404.8.3 Covers.**

Outdoor heated pools and outdoor permanent spas shall be provided with a vapour-retardant cover or other *approved* vapour-retardant means.

**Exception:** Where more than 75 percent of the energy for heating, computed over an operating season of not fewer than 3 calendar months, is from a heat pump or an on-site renewable energy system, covers or other vapor-retardant means shall not be required. *On-site renewable energy* used to meet [Section C405.15.1](#) or [C406.3.1](#) shall not be used to meet this exception.

**C404.9 Portable spas.**

The energy consumption of electric-powered portable spas shall be controlled by the requirements of [APSP 14](#).

## SECTION C405 ELECTRICAL POWER AND LIGHTING SYSTEMS

### C405.1 General.

Electrical power and lighting systems and generation shall comply with this section. General lighting shall consist of all lighting included when calculating the total connected interior lighting power in accordance with Section C405.3.1 and which does not require specific application controls in accordance with Section C405.2.5.

**Exception:** *Dwelling units and sleeping units* that comply with Sections C405.2.10, C405.3.3 and C405.6.

### C405.2 Lighting Controls.

Lighting systems in interior parking areas shall be provided with controls that comply with Section C405.2.9. However, for personal and occupant's safety, an explicit exception or alternative compliance path should be considered allowing constant illumination where local security conditions warrant, while still promoting energy efficiency

All other lighting systems powered through the energy service for the building and building site lighting for which the building owner is responsible shall be provided with controls that comply with Sections C405.2.1 through C405.2.8.

Exceptions (Caribbean Context):

Lighting controls are not required for the following:

1. Spaces where an automatic shutoff could endanger occupant safety or security, including parking areas, guard stations, exterior walkways, and public corridors.
2. Interior exit stairways, interior exit ramps and exit passageways.
3. Emergency lighting that is automatically off during normal operations.
4. Emergency lighting required by the International Building Code in exit access components that are not provided with fire alarm systems.
5. 0.43 W/m<sup>2</sup> (0.04 watts per square foot) of lighting in exit access components that are provided with fire alarm systems.
6. Buildings with a gross floor area less than 1000 m<sup>2</sup>, where manual or scheduled shutoff is permitted in lieu of automatic controls.

#### C405.2.1 Occupant Sensor Controls.

Occupant *sensor controls* shall be installed to control lights in the following space types:

1. Classrooms/lecture/training rooms.
2. Computer room, data center.
3. Conference/meeting/multipurpose rooms.

4. Copy/print rooms.
5. Lounges/breakrooms.
6. Medical supply room in a health care facility.
7. Enclosed offices.
8. Laundry/washing area.
9. Open plan office areas.
10. Restrooms.
11. Storage rooms.
12. Telemedicine room in a health care facility.
13. Locker rooms.
14. Corridors.
15. Warehouse storage areas.
16. Other spaces 28 m<sup>2</sup> (300 square feet) or less that are enclosed by floor-to-ceiling height partitions.

**Exception:** Luminaires that are required to have specific application controls in accordance with Section C405.2.5.

#### C405.2.1.1 Occupant sensor control function.

Occupant sensor controls in warehouse storage areas shall comply with Section C405.2.1.2. Occupant sensor controls in open plan office areas shall comply with Section C405.2.1.3. Occupant sensor controls in corridors shall comply with Section C405.2.1.4. Occupant sensor controls for all other spaces specified in Section C405.2.1 shall comply with the following:

1. They shall automatically turn off lights within 20 minutes after all occupants have left the space.
2. Occupant sensors shall automatically reduce lighting power within each controlled area to an unoccupied setpoint of not more than 70 percent of full power within 30 minutes after all occupants have left the controlled area.
3. They shall incorporate a manual control to allow occupants to turn off lights.

**Exception:** Full automatic-on controls with no manual control shall be permitted in *interior parking areas*, stairways, restrooms, locker rooms, lobbies, library stacks and areas where *manual* operation would endanger occupant safety or security.

#### C405.2.1.2 Occupant sensor control function in warehouse storage areas.

Lighting in warehouse storage areas shall be controlled as follows:

1. Lighting in each aisleway shall be controlled independently of lighting in all other aisleways and open areas.
2. Occupant sensors shall automatically reduce lighting power within each controlled area to an unoccupied setpoint of not more than 70 percent of full power within 30 minutes after all occupants have left the controlled area.
3. Lights that are not turned off by occupant sensors shall be turned off by *time-switch control* complying with Section C405.2.2.1.
4. A *manual control* shall be provided to allow occupants to turn off lights in the space.

#### **C405.2.1.3 Occupant sensor control function in open plan office areas.**

Occupant sensor controls in open plan office spaces less than 300 square feet (28 m<sup>2</sup>) in area shall comply with Section C405.2.1.1. Occupant sensor controls in all other open plan office spaces shall comply with all of the following:

1. The controls shall be configured so that *general lighting* can be controlled separately in control zones with floor areas not greater than 55 m<sup>2</sup> (600 square feet) within the open plan office space.
2. *General lighting* in each control zone shall be permitted to automatically turn on upon occupancy within the control zone. *General lighting* in other unoccupied zones within the open plan office space shall be permitted to turn on to not more than 20 percent of full power or remain unaffected.
3. The controls shall automatically turn off *general lighting* in all control zones within 20 minutes after all occupants have left the open plan office space.

**Exception:** Where general lighting is turned off by *time-switch control* complying with Section C405.2.2.1.

4. General lighting in each control zone shall turn off or uniformly reduce lighting power to an unoccupied setpoint of not more than 20 percent of full power within 20 minutes after all occupants have left the control zone.

#### **C405.2.1.4 Occupant sensor control function in corridors.**

Occupant sensor controls in corridors shall uniformly reduce lighting power to an unoccupied

setpoint not more than 70 percent of full power within 30 minutes after all occupants have left the space.

Exception: Corridors provided with less than two footcandles (~21.52 Lux) of illumination on the floor at the darkest point with all lights on.

#### **C405.2.2 Time-switch controls.**

Each area of the *building* that is not provided with *occupant sensor controls* complying with Section C405.2.1.1 shall be provided with *time-switch controls* complying with Section C405.2.2.1.

##### **Exceptions:**

1. Luminaires that are required to have specific application controls in accordance with Section C405.2.4.
2. Spaces where patient care is directly provided.

#### **C405.2.2.1 Time-switch control function.**

*Time-switch controls* shall comply with all of the following:

1. Programmed to automatically turn off lights when the space is scheduled to be unoccupied.
2. Have a minimum 7-day clock.
3. Be capable of being set for seven different day types per week.
4. Incorporate an automatic holiday "shutoff" feature, which turns off all controlled lighting loads for not fewer than 24 hours and then resumes normally scheduled operations.
5. Have program backup capabilities, which prevent the loss of program and time settings for not fewer than 10 hours, if power is interrupted.
6. Include an override switch that complies with the following:
  - 6.1. The override switch shall be a *manual control*.
  - 6.2. The override switch, when initiated, shall permit the controlled lighting to remain on for not more than 2 hours.
  - 6.3. Any individual override switch shall control the lighting for an area not larger than 465 m<sup>2</sup> (5,000 square feet)
7. For spaces where schedules are not available, *time switch controls* are

programmed to a schedule that turns off lights not less than 12 hours per day.

**Exception:** Within mall concourses, auditoriums, sales areas, manufacturing facilities and sports arenas:

1. The time limit shall be permitted to be greater than 2 hours, provided that the switch is a captive key device.
2. The area controlled by the override switch shall not be limited to 465 m<sup>2</sup> (5,000 square feet) provided that such area is less than 1,860 m<sup>2</sup> (20,000 square feet)

**C405.2.3 Dimming controls.**

Dimming controls complying with Section C405.2.3.1 are required for general lighting in the following space types:

1. Classroom/lecture hall/training room.\
2. Conference/multipurpose/meeting room.
3. In a dining area for bar/lounge or leisure, family dining.
4. Laboratory.
5. Lobby.
6. Lounge/break room.
7. Offices.
8. Gymnasium/fitness center.
9. Library reading room.
10. In a health care facility for imaging rooms, exam rooms, nursery and nurses' station.
11. Spaces not provided with occupant sensor controls complying with Section C405.2.1.1.

**Exception:** Luminaires controlled by special application controls complying with Section C405.2.5.

**C405.2.3.1 Dimming control function.**

Spaces required to have dimming control shall be provided with manual controls that allow lights to be dimmed from full output to at least one intermediate level (such as 50%) or continuously down to 20 percent of full power, as well as turning off lights. Manual control shall be provided within each room or via centralized/digital controls to dim lights.

Exceptions:

1. Manual dimming control is not required in spaces where high-end trim lighting controls are provided that comply with the following:
4. a) The calibration adjustment equipment is located for ready access only by authorized personnel.

5. b) Lighting controls with ready access for users cannot increase the lighting power above the maximum level established by the high-end trim controls.

Additional exceptions for Caribbean context:

1. Small spaces less than 25 m<sup>2</sup> (250 sq ft)
2. Utility areas such as storage rooms, mechanical rooms, and back-of-house spaces.
3. Spaces with lighting power density below 2 W/m<sup>2</sup> (0.2 W/ft<sup>2</sup>)

**C405.2.4 Daylight responsive controls.**

*Daylight responsive controls* complying with Section C405.2.4.1 shall be provided to control the *general lighting* within *daylight zones* in the following spaces:

1. Spaces with a total of more than 75 watts of *general lighting* within primary *sidelit daylight zones* complying with Section C405.2.4.2.
2. Spaces with a total of more than 150 watts of *general lighting* within *sidelit daylight zones* complying with Section C405.2.4.2.
3. Spaces with a total of more than 75 watts of *general lighting* within *toplit daylight zones* complying with Section C405.2.4.3.

**Exceptions:** *Daylight responsive controls* are not required for the following:

1. Spaces in health care facilities where patient care is directly provided.
2. *Sidelit daylight zones* on the first floor above grade in Group A-2 and Group M occupancies.
3. Enclosed office spaces less than 23.2 m<sup>2</sup> (250 square feet).

**C405.2.4.1 Daylight responsive control function.**

Where required, *daylight responsive controls* shall be provided within each space for control of lights in that space and shall comply with the following, with regional adaptations:

1. Lights in *toplit daylight zones* in accordance with Section C405.2.4.3 shall be controlled independently of lights in *sidelit daylight zones* in accordance with Section C405.2.4.2.
2. Lights in the primary *sidelit daylight zone* shall be controlled independently of lights in the secondary *sidelit daylight zone*, unless the total connected load in the combined zone is ≤ 300 watts.

3. Daylight responsive controls within each space shall be capable of being calibrated from within that space by authorized personnel, but remote or centralized digital calibration may be permitted where manual calibration is not practical.
4. Calibration mechanisms shall be in a location with ready access.
5. Daylight responsive controls shall dim lights continuously or in stepped increments (e.g., 3–4 steps) from full light output down to 20 percent of full light output, as well as turning lights off.
6. Daylight responsive controls shall be configured to completely shut off all controlled lights unless safety, security, or functional requirements prevent shutoff.
7. When occupant sensor controls have reduced the lighting power to an unoccupied setpoint in accordance with Sections C405.2.1.2 through C405.2.1.4, daylight responsive controls shall continue to adjust electric light levels in response to available daylight but shall not increase the lighting power above the specified unoccupied setpoint.
8. Lights in sidelit daylight zones in accordance with Section C405.2.4.2 facing different cardinal orientations [within 45 degrees (0.79 rad) of due north, east, south, west] shall be controlled independently of each other, except in spaces with total connected load  $\leq$  600 watts, where grouped control is permitted.

Exceptions (expanded for Caribbean context):

1. Within each space, up to 250 watts (instead of 150 watts) of lighting within the primary sidelit daylight zone is permitted to be controlled together with lighting in a primary sidelit daylight zone facing a different cardinal orientation.
2. Within each space, up to 250 watts (instead of 150 watts) of lighting within the secondary sidelit daylight zone is permitted to be controlled together with lighting in a secondary sidelit daylight zone facing a different cardinal orientation.

3. Spaces under 500 sq ft (50 m<sup>2</sup>), or with daylight glazing below 10% of wall area, are exempt

#### C405.2.4.2 Sidelit daylight zone.

The sidelit *daylight zone* is the floor area adjacent to vertical *fenestration* that complies with all of the following:

1. Reduce strictness of zone dimensions
  - Primary sidelit daylight zone: instead of extending laterally  $1.0 \times$  window height, reduce to  $0.75 \times$  window height (for practical sensor coverage and reduced wiring complexity).
  - Secondary sidelit daylight zone: instead of  $2.0 \times$  window height, reduce to  $1.5 \times$  window height, since secondary zones capture less daylight and controls there often underperform.
2. Minimum fenestration area requirement
  - Lower from 2.23 m<sup>2</sup> to 1.4 m<sup>2</sup> (24 ft<sup>2</sup> to 15 ft<sup>2</sup>) to include smaller windows in compliance (common in schools, housing, small offices in the Caribbean).
3. Obstruction requirement
  - Instead of requiring  $0.5 \times$  window height clearance, allow  $0.25 \times$  window height clearance (since tropical climates often have external shading elements like verandas or vegetation).
4. Visible transmittance (VT) requirement
  - Keep minimum VT 0.20 but allow a compliance path if daylight-responsive controls are installed and calibrated — since in hot climates, lower-VT glazing is sometimes chosen for solar control. or change the VLT to 0.30 as minimum for compliance
5. Projection factor requirement
  - Relax to:  $\leq 1.25$  for north-facing,  $\leq 2.0$  for all other orientations.

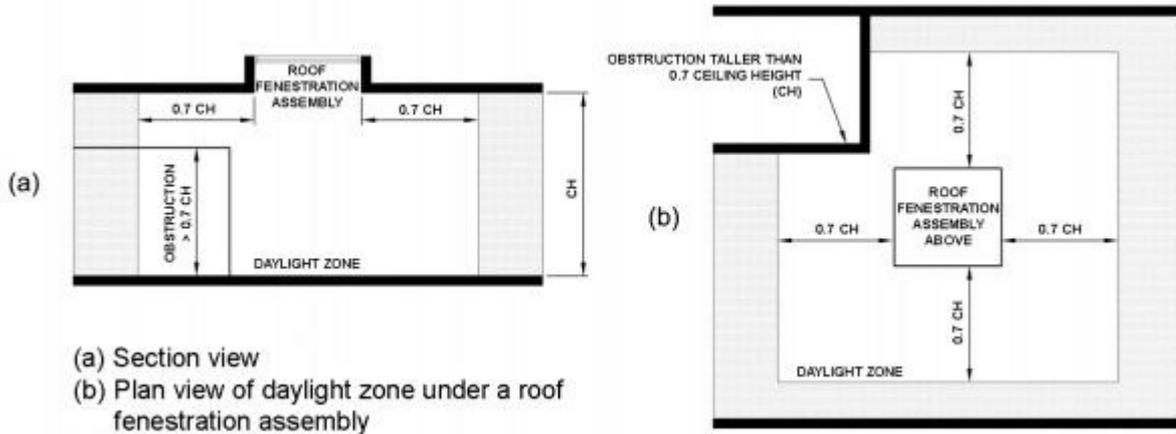


FIGURE C405.2.4.2(1) PRIMARY AND SECONDARY SIDELIT DAYLIGHT ZONES

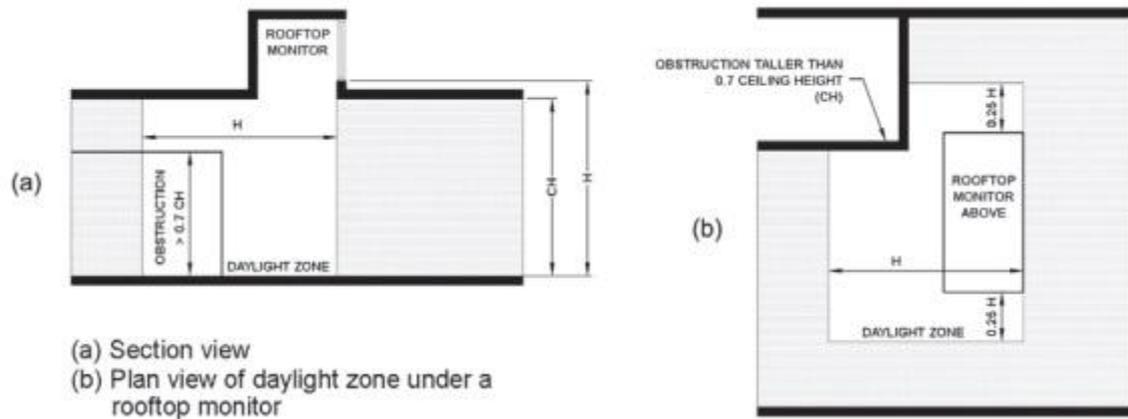


FIGURE C405.2.4.2(2) DAYLIGHT ZONE UNDER A ROOFTOP MONITOR

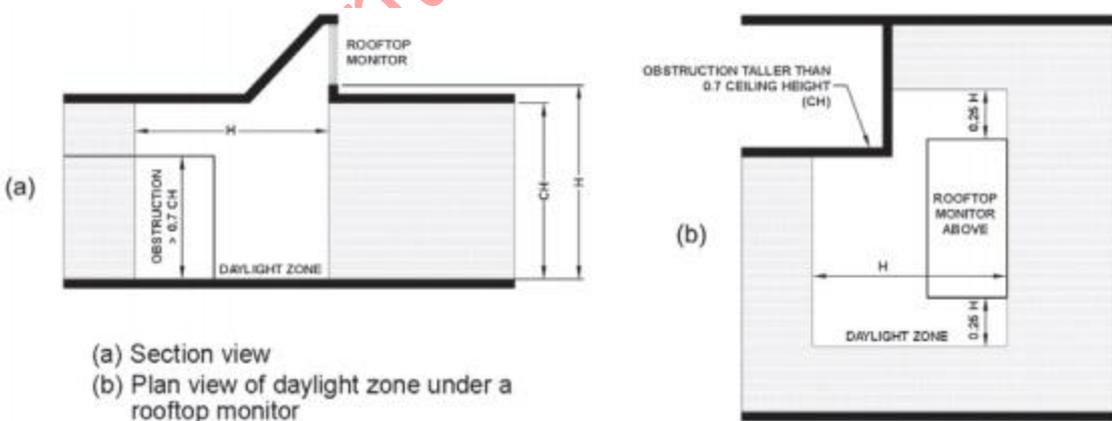


FIGURE C405.2.4.2(3) DAYLIGHT ZONE UNDER A SLOPED ROOFTOP MONITOR

**C405.2.4.3 Toplit daylight zone.**

The *toplit daylight zone* is the floor area underneath a roof fenestration assembly that complies with all of the following:

1. The toplit daylight zone shall extend laterally and longitudinally beyond the edge of the roof fenestration assembly to the nearest obstruction that is taller than 0.6 times the ceiling height, or up to 1 times the ceiling height, whichever is less, as indicated in Figure C405.2.4.3.
2. Direct sunlight is not blocked from hitting the roof fenestration assembly at the peak solar angle on the summer solstice by buildings or geological formations.
3. The product of the visible transmittance of the roof fenestration assembly and the area of the rough opening of the roof fenestration assembly divided by the area of the toplit zone is not less than 0.010.(raised from 0.008 for stronger daylight contribution — aligns with advanced daylighting standards like LEED / WELL).

**FIGURE C405.2.4.4 DAYLIGHT ZONES AT A MULTISTORY ATRIUM**

**C405.2.4.4 Atriums.**

*Daylight zones* at atrium spaces shall be established at the top floor surrounding the atrium and at the floor of the atrium space and not on intermediate floors, as indicated in Figure C405.2.4.4.

**FIGURE C405.2.4.4 DAYLIGHT ZONES AT A MULTISTORY ATRIUM**

**C405.2.5 Specific application controls.**

Specific application controls shall be provided for the following:

1. The following lighting shall be controlled by an occupant sensor complying with Section C405.2.1.1 or a *time-switch control* complying with Section C405.2.2.1. In addition, a *manual* control shall be provided to control such lighting separately from the *general lighting* in the space:
  - 1.1. Luminaires for which additional lighting power is claimed in accordance with Section C405.3.2.2.1.

- 1.2. Display and accent, including lighting in display cases.
- 1.3. Supplemental task lighting, including permanently installed under-shelf or under-cabinet lighting.
- 1.4. Lighting equipment that is for sale or demonstration in lighting education.

2. Lighting for nonvisual applications, such as plant growth and food warming, shall be controlled by a *time switch control* complying with Section C405.2.2.1 that is independent of the controls for other lighting within the room or space.
3. Task lighting for medical and dental purposes that is in addition to *general lighting* shall be provided with a *manual* control.
4. Lighting integrated into range hoods and exhaust fans shall be controlled independently of fans.

**C405.2.6 Manual controls.**

Where required by this code, *manual* controls for lights shall comply with the following:

1. They shall be in a location with *ready access* to occupants.
2. They shall be located where the controlled lights are visible, or shall identify the area served by the lights and indicate their status.

**405.2.7 Exterior lighting controls.**

Exterior lighting systems shall be provided with controls that comply with Sections C405.2.7.1 through C405.2.7.4.

**Exceptions:**

1. Lighting for covered vehicle entrances to *buildings* where required for eye adaptation.
2. Lighting controlled from within *dwelling units*.

**C405.2.7.1 Daylight shutoff.**

Lights shall be automatically turned off when daylight is present and satisfies the lighting needs.

**C405.2.7.2 Building facade and landscape**

**lighting.**

*Building facade* and landscape lighting shall automatically shut off from not later than 1 hour after *building* or business closing to not earlier than 1 hour before *building* or business opening.

**C405.2.7.3 Lighting setback.**

Lighting that is not controlled in accordance with Section C405.2.7.2 shall comply with the following:

1. Be controlled so that the total wattage of such lighting is automatically reduced by not less than 50 percent by selectively switching off or dimming luminaires at one of the following times:
  - 1.1. From not later than midnight to not earlier than 6 a.m.
  - 1.2. From not later than 1 hour after *building* or business closing to not earlier than 1 hour before *building* or business opening.
  - 1.3. During any time where activity has not been detected for 15 minutes or more.
2. Luminaires serving exterior parking areas and having a rated input wattage of greater than 30 watts and a mounting height of 7,315 mm (24 feet) or less above the ground shall be controlled so that the total wattage of such lighting is automatically reduced by not less than 70 percent during any time where activity has not been detected for 10 minutes or more. Not more than 1,500 watts of lighting power shall be controlled together.

**C405.2.7.4 Exterior time-switch control function.**

*Time-switch controls* for exterior lighting shall comply with the following:

1. They shall have a clock capable of being programmed for not fewer than 7 days.
2. They shall be capable of being set for seven different day types per week.
3. They shall incorporate an automatic holiday setback feature.
4. They shall have program backup capabilities that prevent the loss of program and time settings for a period of not less than 10 hours in the event that power is interrupted.

**C405.2.8 Reserved.****C405.2.8.1 Demand responsive lighting controls function.**

Demand responsive controls for lighting shall be capable of the following:

1. Automatically reducing the output of controlled lighting to 80 percent or less of full power or light output upon receipt of a *demand response signal*.
2. Where *high-end trim* has been set, automatically reducing the output of controlled lighting to 80 percent or less of the *high-end trim* setpoint upon receipt of a *demand response signal*.
3. Dimming controlled lights gradually and continuously over a period of not longer than 30 minutes to achieve their demand response setpoint.
4. Returning controlled lighting to its normal operational settings at the end of the demand response period.

**Exception:** *Storage rooms and warehouse storage areas* shall be permitted to switch off 25 percent or more of general lighting power rather than dimming.

**C405.2.9 Interior parking area lighting control.**

Interior parking area lighting shall be controlled by an *occupant sensor* complying with Section C405.2.1.1 or a *time-switch control* complying with Section C405.2.2.1. Additional lighting controls shall be provided as follows:

1. Lighting power of each luminaire shall be automatically reduced by not less than 30 percent when there is no activity detected within a lighting zone for 20 minutes. Lighting zones for this requirement shall be not larger than 334.5 m<sup>2</sup> (3,600 square feet).

**Exception:** Lighting zones provided with less than 1.5 footcandles of illumination on the floor at the darkest point with all lights on are not required to have *automatic* light-reduction controls.

2. Where lighting for eye adaptation is provided at vehicle entrances to *buildings*, such lighting shall be separately controlled by a device that automatically reduces lighting power by at least 50 percent from sunset to sunrise.
3. The power to luminaires within 6,096 mm (20 feet) of perimeter wall openings shall automatically reduce in response to daylight by at least 50 percent.

**Exceptions:**

1. Where the opening-to-wall ratio is less than 40 percent as viewed from the interior and encompassing the vertical distance from the driving surface to the lowest structural element.
2. Where the distance from the opening to any exterior daylight blocking obstruction is less than one-half the height from the bottom of the opening or *fenestration* to the top of the obstruction.
3. Where openings are obstructed by permanent screens or architectural elements restricting daylight entering the interior space.

**C405.2.10 Sleeping unit and dwelling unit lighting and switched receptacle controls.**

*Sleeping units* and *dwelling units* shall be provided with lighting controls and switched receptacles as specified in Sections C405.2.10.1 and C405.2.10.2.

**C405.2.10.1 Sleeping units and dwelling units in hotels, motels and vacation timeshare properties.**

*Sleeping units* and *dwelling units* in hotels, motels and vacation timeshare properties shall be provided with the following:

1. Not less than two 125V, 15- and 20-amp switched receptacles in each room, except for bathrooms, kitchens, foyers, hallways and closets.
2. Lighting controls that automatically turn off all lighting and switched receptacles within 20 minutes after all occupants have left the unit.

**Exception:** *Automatic* shutoff is not required where *captive key override* controls all lighting and switched receptacles in units with five or fewer permanently installed lights and switched receptacles.

**C405.2.10.2 Sleeping units in congregate living facilities.**

*Sleeping units* in *congregate living facilities* shall be provided with the following controls:

1. Lighting in bathrooms shall be controlled by an *occupant sensor control* that automatically turns off lights within 20 minutes after all occupants have left the space.
2. Each unit shall have a *manual* control by the entrance that turns off all lighting and

switched receptacles in the unit, except for lighting in bathrooms and kitchens. The *manual* control shall be marked to indicate its function.

**C405.3 Interior lighting power requirements.**

A *building* complies with this section where its total connected interior lighting power calculated under Section C405.3.1 is not greater than the interior lighting power allowance calculated under Section C405.3.2. *Sleeping units* and *dwelling units* shall comply with Section C405.3.3.

**C405.3.1 Total connected interior lighting power.**

The total connected interior lighting power shall be determined in accordance with Equation 4-9.

$$TCLP = [LVL + BLL + LED + TRK + Other]$$

**Equation 4-9**

where:

TCLP = Total connected lighting power (watts).

LVL = For luminaires with lamps connected directly to building power, such as line voltage lamps, the rated wattage of the lamp.

BLL = For luminaires incorporating a ballast or transformer, the rated input wattage of the ballast or transformer when operating that lamp.

LED = For light-emitting diode luminaires with either integral or remote drivers, the rated wattage of the luminaire.

TRK = For lighting track, cable conductor, rail conductor, and plug-in busway systems that allow the addition and relocation of luminaires without rewiring, the wattage shall be one of the following:

1. The specified wattage of the luminaires, but not less than 8 W per linear foot (25 W/lin m).
2. The wattage limit of the permanent current-limiting devices protecting the system.
3. The wattage limit of the transformer supplying the system.

Other = The wattage of all other luminaires and lighting sources not covered previously and associated with interior lighting verified by data supplied by the manufacturer or other approved sources.

The connected power associated with the following lighting equipment and applications is not included in calculating total connected lighting power.

1. Emergency lighting automatically off during normal building operation.

2. Lighting in spaces specifically designed for use by occupants with special lighting needs, including those with visual impairment and other medical and age-related issues.
3. Mirror lighting in makeup or dressing areas used for video broadcasting, video or film recording, or live theatrical and music performance.
4. Task lighting for medical and dental purposes that is in addition to *general lighting*.
5. Display lighting for exhibits in galleries, museums and monuments that is in addition to *general lighting*.
6. Lighting in any location that is specifically used for video broadcasting, video or film recording, or live theatrical and music performance.
7. Lighting for photographic processes.
8. Lighting integral to equipment or instrumentation and installed by the manufacturer.
9. Task lighting for plant growth or maintenance.
10. Advertising signage or directional signage.
11. Lighting for food warming.
12. Lighting equipment that is for sale.
13. Lighting demonstration equipment in lighting education facilities.
14. Lighting approved because of safety considerations.
15. Lighting in retail display windows, provided that the display area is enclosed by ceiling-height partitions.
16. Furniture-mounted supplemental task lighting that is controlled by automatic shutoff.
17. Exit signs.
18. Antimicrobial lighting used for the sole purpose of disinfecting a space.
19. Lighting in *sleeping units* and *dwelling units*.
20. For exit access and exit stairways, including landings, where the applicable code requires an illuminance of 10 footcandles or more on the walking surface,

the power in excess of the allowed power calculated according to Section C405.3.2.2 is not included.

#### **C405.3.2 Interior lighting power allowance.**

The total interior lighting power allowance (watts) for an entire *building* shall be determined according to Table C405.3.2(1) using the Building Area Method or Table C405.3.2(2) using the Space-by-Space Method. The interior lighting power allowance for projects that involve only portions of a *building* shall be determined according to Table C405.3.2(2) using the Space-by-Space Method. *Buildings* with unfinished spaces shall use the Space-by-Space Method.

#### **TABLE C405.3.2(1) INTERIOR LIGHTING POWER ALLOWANCES: BUILDING AREA METHOD**

#### **TABLE C405.3.2(2) INTERIOR LIGHTING POWER ALLOWANCES: SPACE-BY-SPACE METHOD**

##### **C405.3.2.1 Building Area Method.**

For the Building Area Method, the interior lighting power allowance is calculated as follows:

1. For each building area type inside the *building*, determine the applicable building area type and the allowed lighting power density for that type from Table C405.3.2(1). For building area types not listed, select the building area type that most closely represents the use of 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.
2. Determine the floor area for each building area type listed in Table C405.3.2(1) and multiply this area by the applicable value from Table C405.3.2(1) to determine the lighting power (watts) for each building area type. *Sleeping units* and *dwelling units* are excluded from lighting power allowance calculations by application of Section C405.3.3. The area of *sleeping units* and *dwelling units* is not included in the calculation.
3. The total interior lighting power allowance (watts) for the entire *building* is the sum of the lighting power from each building area type.

##### **C405.3.2.2 Space-by-Space Method.**

Where a *building* has unfinished spaces, the lighting power allowance for the unfinished spaces

shall be the total connected lighting power for those spaces, or 0.1 watts per square foot (1.08 w/m<sup>2</sup>), whichever is less. For the Space-by-Space Method, the interior lighting power allowance is calculated as follows:

1. For each space enclosed by partitions that are not less than 80 percent of the ceiling height, determine the applicable space type from [Table C405.3.2\(2\)](#). For space types not listed, select the space type that most closely represents the proposed use of the space. Where a space has multiple functions, that space may be divided into separate spaces.
2. Determine the total floor area of all the spaces of each space type and multiply by the value for the space type in [Table C405.3.2\(2\)](#) to determine the allowed lighting power (watts) for each space type. *Sleeping units* and *dwelling units* are excluded from lighting power allowance calculations by application of [Section C405.3.3](#). The area of *sleeping units* and *dwelling units* is not included in the calculation.
3. The total interior lighting power allowance (watts) shall be the sum of the lighting power allowances for all space types.

#### C405.3.2.2.1 Additional interior lighting power.

Where using the Space-by-Space Method, an increase in the interior lighting power allowance is permitted for specific lighting functions. Additional power shall be permitted only where the specified lighting is installed and controlled in accordance with [Section C405.2.5](#). These additional power allowances shall be used only for the luminaires serving the specific lighting function and shall not be used for any other purpose. An increase in the interior lighting power allowance is permitted in the following cases:

1. For lighting equipment to be installed in sales areas specifically to highlight merchandise, the additional lighting power allowance shall be the connected lighting power of the luminaires specifically highlighting merchandise, calculated in accordance with [Equation 4-9](#), or the additional power allowance calculated in accordance with [Equation 4-10](#), whichever is less.

$$\begin{aligned} \text{Additional lighting power allowance} &= 750\text{W} \\ &+ (\text{Retail Area 1} \times 0.40\text{W/ft}^2) \\ &+ (\text{Retail Area 2} \times 0.40\text{W/ft}^2) \\ &+ (\text{Retail Area 3} \times 0.70\text{W/ft}^2) \\ &+ (\text{Retail Area 4} \times 1.00\text{W/ft}^2) \end{aligned}$$

#### Equation 4-10

For SI units:

$$\text{Additional lighting power allowance} = 750\text{W} + (\text{Retail Area 1} \times 4.3\text{W/m}^2) + (\text{Retail Area 2} \times 4.3\text{W/m}^2) + (\text{Retail Area 3} \times 7.5\text{W/m}^2) + (\text{Retail Area 4} \times 10.8\text{W/m}^2)$$

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, provided that justification documenting the need for additional lighting power based on visual inspection, contrast or other critical display is approved by the code official.

2. For spaces in which lighting is specified to be installed in addition to the *general lighting* for the purpose of decorative appearance or for highlighting art or exhibits, the additional lighting power allowance for that space shall be the smallest of the following:

2.17.1 W/m<sup>2</sup> (0.66 W/ft<sup>2</sup>) in lobbies,

2.2. 5.9 W/m<sup>2</sup> (0.55 W/ft<sup>2</sup>) in other spaces, or

2.3. The connected lighting power of the luminaires specifically for decorative appearance or for highlighting art or exhibits, calculated according to [Equation 4-9](#).

#### C405.3.3 Lighting power for sleeping units and dwelling units.

*Sleeping units* in Group I-2 occupancies that are patient rooms shall comply with [Sections C405.3.1](#) and [C405.3.2](#). For all other *sleeping units* and *dwelling units*, permanently installed lighting, including lighting integrated into range hoods and exhaust fans, shall be provided by lamps

capable of operating with an efficacy of not less than 65 lumens per watt or luminaires capable of operating with an efficacy of not less than 45 lumens per watt.

**Exceptions:**

1. Lighting integral to other appliances.
2. Antimicrobial lighting used for the sole purpose of disinfecting.
3. Luminaires with an input rating of less than 3 watts.

**C405.4 Horticultural lighting.**

Permanently installed luminaires shall have a *photosynthetic photon efficacy* of not less than 1.7 micromoles per joule ( $\mu\text{mol/J}$ ) for *horticultural lighting* in greenhouses and not less than 1.9  $\mu\text{mol/J}$  for all other *horticultural lighting*. Luminaires for *horticultural lighting* in greenhouses shall be controlled by a device that automatically turns off the luminaire when sufficient daylight is available. Luminaires for *horticultural lighting* shall be controlled by a device that automatically turns off the luminaire at specific programmed times.

**C405.5 Exterior lighting power requirements.**

The total connected exterior lighting power calculated in accordance with Section C405.5.1 shall be not greater than the exterior lighting power allowance calculated in accordance with Section C405.5.2.

**C405.5.1 Total connected exterior lighting power.**

The total exterior connected lighting power shall be the total maximum rated wattage of all exterior lighting that is powered through the energy service for the *building* and *building site lighting* for which the *building owner* is responsible.

**Exception:** Lighting used for the following applications shall not be included.

1. *Lighting approved* because of safety considerations.
2. Emergency lighting automatically off during normal business operation.
3. Exit signs.
4. Specialized signal, directional and marker lighting associated with transportation.
5. Advertising signage or directional signage.
6. Integral to equipment or instrumentation and installed by its manufacturer.
7. Lighting in any location that is specifically used for video broadcasting, video or film recording, or live theatrical and music performances.

8. Athletic playing areas.
9. Temporary lighting.
10. Industrial production, material handling, transportation sites and associated storage areas.
11. Theme elements in theme/amusement parks.
12. Used to highlight features of art, public monuments and the national flag.
13. Lighting for water features and swimming pools.
14. Lighting controlled from within *sleeping units* and *dwelling units*.
15. Lighting of the exterior means of egress as required by the International Building Code.

**C405.5.2 Exterior lighting power allowance.**

The exterior lighting power allowance (watts) is calculated as follows:

1. Determine the Lighting Zone (LZ) for the *building* according to Table C405.5.2(1), unless otherwise specified by the *code official*.
2. For each exterior area that is to be illuminated by lighting that is powered through the energy service for the *building* and *building site lighting* for which the *building owner* is responsible, determine the applicable area type from Table C405.5.2(2). For area types not listed, select the area type that most closely represents the proposed use of the area.
3. Determine the total area or length of each area type and multiply by the value for the area type in Table C405.5.2(2) to determine the lighting power (watts) allowed for each area type.
4. The total exterior lighting power allowance (watts) is the sum of the base site allowance determined according to Table C405.5.2(2), plus the watts from each area type.

**TABLE C405.5.2(1) EXTERIOR LIGHTING ZONES**

**TABLE C405.5.2(2) LIGHTING POWER ALLOWANCES FOR BUILDING EXTERIORS**

**TABLE C405.5.2(3) INDIVIDUAL LIGHTING POWER ALLOWANCES FOR BUILDING EXTERIORS**

**C405.5.2.1 Additional exterior lighting power.**

Additional exterior lighting power allowances are available for the specific lighting applications listed in [Table C405.5.2\(3\)](#). These additional power allowances shall be used only for the luminaires serving these specific applications and shall not be used to increase any other lighting power allowance.

**C405.5.3 Gas lighting.**

Gas-fired lighting appliances shall not be equipped with continuously burning pilot ignition systems.

**C405.6 Dwelling electrical meter.**

Each *dwelling unit* located in a Group R-2 *building* shall have a separate electrical meter.

**C405.7 Electrical transformers.**

Low-voltage dry-type distribution electric transformers shall meet the minimum efficiency requirements of [Table C405.7](#) as tested and rated in accordance with the test procedure listed in [DOE 10 CFR 431](#). The efficiency shall be verified through certification under an *approved* certification program or, where a certification program does not exist, the equipment efficiency ratings shall be supported by data furnished by the transformer manufacturer.

Exceptions: The following transformers are exempt in accordance with the DOE definition of Distribution Transformers found in 10 CFR 431.192:

1. Transformers with a tap range of 20 percent or more.
2. Drive (*isolation*) transformers.
3. Rectifier transformers.
4. Auto-transformers.
5. Uninterruptible power system transformers.
6. *Special impedance* transformers.
7. Regulating transformers.
8. Sealed transformers.
9. Machine tool (*control*) transformers.
10. Welding transformers.
11. Grounding transformers.
12. Testing transformers.
13. Nonventilated transformers.

**TABLE C405.7 MINIMUM NOMINAL EFFICIENCY LEVELS FOR DOE 10 CFR 431 LOW-VOLTAGE DRY-TYPE DISTRIBUTION TRANSFORMERS**

**C405.8 Electric motors.**

Electric motors shall meet the minimum efficiency requirements of [Tables C405.8\(1\)](#) through [C405.8\(4\)](#) when tested and

rated in accordance with the [DOE 10 CFR 431](#). The efficiency shall be verified through certification under an *approved* certification program or, where a certification program does not exist, the equipment efficiency ratings shall be supported by data furnished by the motor manufacturer.

**Exception:** The standards in this section shall not apply to the following exempt electric motors:

1. Air-over electric motors.
2. Component sets of an electric motor.
3. Liquid-cooled electric motors.
4. Submersible electric motors.
5. Inverter-only electric motors.
6. Definite-purpose machines within the scope of [ANSI/NEMA MG 1, Part 18](#).

**TABLE C405.8(1) MINIMUM NOMINAL FULL-LOAD EFFICIENCY FOR NEMA DESIGN A, NEMA DESIGN B, and IEC DESIGN N MOTORS (EXCLUDING FIRE PUMP) ELECTRIC MOTORS AT 60 HZ<sup>a, b</sup>**

**TABLE C405.8(2) MINIMUM NOMINAL FULL-LOAD EFFICIENCY FOR NEMA DESIGN C AND IEC DESIGN H MOTORS AT 60 HZ<sup>a, b</sup>**

**TABLE C405.8(3) MINIMUM AVERAGE FULL-LOAD EFFICIENCY POLYPHASE SMALL ELECTRIC MOTORS<sup>a</sup>**

**TABLE C405.8(4) MINIMUM AVERAGE FULL-LOAD EFFICIENCY FOR CAPACITOR-START CAPACITOR-RUN AND CAPACITOR-START INDUCTION-RUN SMALL ELECTRIC MOTORS<sup>a</sup>**

**C405.9 Data centers and computer rooms.**

Electrical equipment in *data centers* and *computer rooms* shall comply with this section.

**C405.9.1 Data centers.**

Transformers, uninterruptible power supplies, motors and electrical power processing equipment in *data centers* shall comply with Section 8 of [ASHRAE 90.4-2022](#) in addition to this code.

**C405.9.2 Computer rooms.**

Uninterruptible power supplies in *computer rooms* shall comply with the requirements in Tables 8.5 and 8.6 of [ASHRAE 90.4-2022](#) in addition to this code.

**Exception:** AC-output UPS that utilizes standardized NEMA 1-15P or NEMA 5-15P input plug, as specified in [ANSI/NEMA WD-6](#).

**C405.10 Vertical and horizontal transportation systems and equipment.**

Vertical and horizontal transportation systems and equipment shall comply with this section.

**C405.10.1 Elevator cabs.**

For the luminaires in each elevator cab, not including signals and displays, the sum of the lumens divided by the sum of the watts shall be not less than 35 lumens per watt. Ventilation fans in elevators that do not have their own air-conditioning system shall not consume more than 0.33 watts/cfm at the maximum rated speed of the fan. Controls shall be provided that will de-energize ventilation fans and lighting systems when the elevator is stopped, unoccupied and with its doors closed for over 15 minutes.

#### **C405.10.2 Escalators and moving walks.**

Escalators and moving walks shall comply with [ASME A17.1/CSA B44](#) and shall have *automatic* controls that reduce speed as permitted in accordance with [ASME A17.1/CSA B44](#) and applicable local code.

**Exception:** A variable voltage drive system that reduces operating voltage in response to light loading conditions is an alternative to the reduced speed function.

##### **C405.10.2.1 Energy recovery.**

Escalators shall be designed to recover electrical energy when resisting overspeed in the down direction.

##### **C405.11 Voltage drop.**

The total *voltage drop* across the combination of customer-owned service conductors, feeder conductors and branch circuit conductors shall not exceed 5 percent.

##### **C405.12 Automatic receptacle control.**

The following shall have *automatic* receptacle control complying with [Section C405.12.1](#):

1. At least 50 percent of all 125V, 15- and 20-amp receptacles installed in enclosed offices, conference rooms, rooms used primarily for copy or print functions, breakrooms, classrooms and individual workstations, including those installed in modular partitions and module office workstation systems.
2. At least 25 percent of branch circuit feeders installed for modular furniture not shown on the *construction documents*.

##### **C405.12.1 Automatic receptacle control function.**

*Automatic* receptacle controls shall comply with the following:

1. Either split controlled receptacles shall be provided with the top receptacle controlled, or a controlled receptacle shall be located within 12 inches (304.8 mm) of each uncontrolled receptacle.

2. One of the following methods shall be used to provide control:

2.1. A scheduled basis using a time-of-day operated control device that turns receptacle power off at specific programmed times and can be programmed separately for each day of the week. The control device shall be configured to provide an independent schedule for each portion of the *building* of not more than 464.5 m<sup>2</sup> (5,000 square feet) and not more than one floor. The occupant shall be able to manually override an area for not more than 2 hours. Any individual override switch shall control the receptacles of not more than 1,524 m (5,000 feet).

2.2. An *occupant sensor control* that shall turn off receptacles within 20 minutes of all occupants leaving a space.

2.3. An automated signal from another control or alarm system that shall turn off receptacles within 20 minutes after determining that the area is unoccupied.

3. All controlled receptacles shall be permanently marked in accordance with [NFPA 70](#) and be uniformly distributed throughout the space.
4. Plug-in devices shall not comply.

**Exceptions:** *Automatic* receptacle controls are not required for the following:

1. Receptacles specifically designated for equipment requiring continuous operation (24 hours per day, 365 days per year).
2. Spaces where an *automatic* control would endanger the safety or security of the room or building occupants.
3. Within a single modular office workstation, noncontrolled receptacles are permitted to be located more than 12 inches (304.8 mm), but not more than 72 inches (1828 mm) from the controlled receptacles serving that workstation.

##### **C405.13 Energy monitoring.**

New *buildings* with a gross conditioned floor area of not less than 929 m<sup>2</sup> (10,000 square feet) shall be equipped to measure, monitor, record and report energy consumption in accordance with [Sections C405.13.1](#) through [C405.13.6](#) for load categories indicated in [Table C405.13.2](#) and [Sections C405.13.7](#) through [C405.13.11](#) for end-use categories indicated in [Table C405.13.8](#).

**Exceptions:**

1. *Dwelling units* in R-2 occupancies.
2. Individual tenant spaces are not required to comply with this section provided that the space has its own utility services and meters and has less than 464.5 m<sup>2</sup> (5,000 square feet) of *conditioned floor area*.

**C405.13.1 Electrical energy metering.**

For electrical energy supplied to the *building* and its associated site, including but not limited to site lighting, parking, recreational facilities and other areas that serve the *building* and its occupants, meters or other measurement devices shall be provided to collect energy consumption data for each end-use category required by Section C405.13.2.

**C405.13.2 End-use electric metering categories.**

Meters or other *approved* measurement devices shall be provided to collect energy use data for each end-use category indicated in Table C405.13.2. Where multiple meters are used to measure any end-use category, the data acquisition system shall total all of the energy used by that category. Not more than 5 percent of the design load for each of the end-use categories indicated in Table C405.13.2 shall be permitted to be from a load that is not within that category.

**Exceptions:**

1. HVAC and water-heating equipment serving only an individual *dwelling unit* shall not require end-use metering.
2. End-use metering shall not be required for fire pumps, stairwell pressurization fans or any system that operates only during testing or emergency.
3. End-use metering shall not be required for an individual tenant space having a floor area not greater than 232 m<sup>2</sup> (2,500 square feet) where a dedicated source meter complying with Section C405.13.3 is provided.

**TABLE C405.13.2 ELECTRICAL ENERGY USE CATEGORIES****C405.13.3 Electrical meters.**

Meters or other measurement devices required by this section shall be configured to automatically communicate energy consumption data to the data acquisition system required by Section C405.13.4. Source meters shall be allowed to be any digital-type meter. Lighting, HVAC or other building systems that can self-monitor their energy consumption shall be permitted instead of meters.

Current sensors shall be permitted, provided that they have a tested accuracy of  $\pm 2$  percent. Required metering systems and equipment shall have the capability to provide at least hourly data that is fully integrated into the data acquisition system and graphical energy report in accordance with Sections

C405.13.4 and C405.13.5. Nonintrusive load monitoring (NILM) packages that extract energy consumption data from detailed electric waveform analysis shall be permitted to substitute for individual meters if the equivalent data is available for collection in Section C405.13.4 and reporting in Section C405.13.5.

**C405.13.4 Electrical energy data acquisition system.**

A data acquisition system shall have the capability to store the data from the required meters and other sensing devices for a minimum of 36 months. The data acquisition system shall have the capability to store real-time energy consumption data and provide hourly, daily, monthly and yearly logged data for each end-use category required by Section C405.13.2. The data acquisition system shall have the capability of providing *building* total peak electric demand and the time(s) of day and time(s) per month at which the peak occurs. Peak demand shall be integrated over the same time period as the underlying whole-building meter reading rate.

**C405.13.5 Graphical energy report.**

A permanent and readily available reporting mechanism shall be provided in the *building* for access by *building* operation and management personnel. The reporting mechanism shall have the capability to graphically provide the energy consumption for each end-use category required by Section C405.13.2 not less than every hour, day, month and year for the previous 36 months.

**C405.13.6 Renewable energy.**

On-site renewable energy sources shall be metered with no less frequency than nonrenewable energy systems in accordance with Section C405.13.3.

**C405.13.7 Nonelectrical energy submetering.**

For all nonelectrical energy supplied to the *building* and its associated site that serves the *building* and its occupants, submeters or other measurement devices shall be provided to collect energy consumption data for each end-use category required by Section C405.13.8.

**Exceptions:**

1. HVAC and water-heating equipment serving only an individual *dwelling unit* shall not require end-use submetering.
2. End-use submetering shall not be required for fire pumps, stairwell pressurization fans

or any system that operates only during testing or emergency.

3. End-use submetering shall not be required for an individual tenant space having a floor area not greater than 232 m<sup>2</sup> (2,500 square feet) where a dedicated source meter complying with Section C405.13.9 is provided.
4. Equipment powered primarily by solid fuels serving loads other than *building* heating and service water heating loads.

#### **C405.13.8 End-use nonelectrical submetering categories.**

Submeters or other *approved* measurement devices shall be provided to collect energy use data for each end-use category indicated in Table C405.13.8. Where multiple submeters are used to measure any end-use category, the data acquisition system shall total all of the energy used by that category. Not more than 5 percent of the design load for each of the end-use categories indicated in Table C405.13.8 shall be permitted to be from a load that is not within that category.

#### **TABLE C405.13.8 NONELECTRICAL ENERGY USE CATEGORIES**

##### **C405.13.9 Nonelectrical submeters.**

Submeters or other measurement devices required by this section shall be configured to automatically communicate energy consumption data to the data acquisition system required by Section C405.13.10. Source submeters shall be allowed to be any digital-type meter that can provide a digital output to the data acquisition system. Required submetering systems and equipment shall be fully integrated into the data acquisition system and graphical energy report that updates at least hourly in accordance with Sections C405.13.10 and C405.13.11.

##### **C405.13.10 Nonelectrical energy data acquisition system.**

A data acquisition system shall have the capability to store the data from the required submeters and other sensing devices for not less than 36 months. The data acquisition system shall have the capability to store real-time energy consumption data and provide hourly, daily, monthly and yearly logged data for each end-use category required by Section C405.13.8. The data acquisition system shall have the capability of providing building total nonelectrical peak demand and the time(s) of day and time(s) per month at which the peak occurs. Where applicable as determined by the authority having jurisdiction (AHJ), peak demand shall be integrated over the same time period as the underlying whole-building meter reading rate.

##### **C405.13.11 Graphical energy report.**

A permanent and readily accessible reporting mechanism shall be provided in the *building* that is accessible by building operation and management personnel. The reporting mechanism shall have the capability to graphically provide the nonelectrical energy consumption for each end-use category required by Section C405.13.8 not less than every hour, day, month and year for the previous 36 months. The graphical report shall incorporate natural gas interval data from the submeter or the ability to enter gas utility bills into the report.

##### **C405.14 Reserved.**

##### **C405.15 Renewable energy systems.**

*Buildings* in Climate Zones 0 through 7 shall comply with Sections C405.15.1 through C405.15.4.

##### **C405.15.1 On-site renewable energy systems.**

*Buildings* shall be provided with on-site renewable electricity generation systems with a direct current (DC) nameplate power rating of not less than 0.75 watts per square foot (8.1 W/m<sup>2</sup>) multiplied by the sum of the gross *conditioned floor area* of all floors, not to exceed the combined gross *conditioned floor area* of the three largest floors.

**Exceptions:** The following *buildings* or building sites shall comply with Section C405.15.2:

1. A *building site* located where an unshaded flat plate collector oriented toward the equator and tilted at an angle from horizontal equal to the latitude receives an annual daily average incident solar radiation less than **3.5 kWh/m<sup>2</sup>/day (1.1 kBtu/ft<sup>2</sup>/day)**
2. A *building* where more than 80 percent of the roof area is covered by any combination of permanent obstructions such as, but not limited to, mechanical equipment, vegetated space, access pathways or occupied roof terrace.
3. Any *building* where more than 50 percent of the roof area is shaded from direct-beam sunlight by natural objects or by structures that are not part of the *building* for more than 2,500 annual hours between 8:00 a.m. and 4:00 p.m.
4. A *building* with gross *conditioned floor area* less than 465 m<sup>2</sup> (5,000 square feet).

##### **C405.15.2 Off-site renewable energy.**

*Buildings* that qualify for one or more of the exceptions to Section C405.15.1 or do not meet the requirements of Section C405.15.1 with an on-site renewable energy system shall procure off-site renewable electrical energy, in accordance with Sections C405.15.2.1 and C405.15.2.2, that

shall be not less than the total off-site renewable electrical energy determined in accordance with [Equation 4-11](#).

$$TRE_{off} = (REN_{off} \times 0.75W/ft^2 \times FLRA - IRE_{on}) \times 15$$

#### Equation 4-11

where:

$TRE_{off}$  = Total off-site renewable electrical energy in kilowatt-hours (kWh) to be procured in accordance with [Table C405.15.2](#).

$REN_{off}$  = Annual off-site renewable electrical energy from [Table C405.15.2](#), in units of kilowatt-hours per watt of array capacity.

$FLRA$  = The sum of the gross conditioned floor area of all floors not to exceed the combined floor area of the three largest floors.

$IRE_{on}$  = Annual on-site renewable electrical energy generation of a new on-site renewable energy system, to be installed as part of the building project, whose rated capacity is less than the rated capacity required in [Section C405.15.1](#).

#### **TABLE C405.15.2 ANNUAL OFF-SITE RENEWABLE ENERGY REQUIREMENTS**

##### **C405.15.2.1 Off-site procurement.**

The *building owner*, as defined in the *International Building Code*, shall procure and be credited for the total amount of off-site renewable electrical energy, not less than required in accordance with [Equation 4-11](#), with one or more of the following:

1. *Physical renewable energy power purchase agreement.*
2. *Financial renewable energy power purchase agreement.*
3. *Community renewable energy facility.*
4. Off-site renewable energy system owned by the *building property owner*.
5. *Renewable energy investment fund.*
6. *Green retail tariff.*

The generation source shall be located where the energy can be delivered to the *building site* by any of the following:

1. Direct connection to the off-site renewable energy facility.
2. The local utility or distribution entity.
3. An interconnected electrical network where energy delivery capacity between the generator and the *building site* is available.

##### **C405.15.2.2 Off-site contract.**

The renewable energy shall be delivered or credited to the *building site* under an energy contract with a

duration of not less than 10 years. The contract shall be structured to survive a partial or full transfer of ownership of the building property.

##### **C405.15.3 Renewable energy certificate (REC) documentation.**

The *property owner* or owner's authorized agent shall demonstrate that where *renewable energy certificates (RECs)* or *energy attribute certificates (EACs)* are associated with on-site and off-site renewable energy production required by [Sections C405.15.1](#) and [C405.15.2](#), all of the following criteria for RECs and EACs shall be met:

1. The RECs and EACs are retained and retired by or on behalf of the *property owner* or tenant for a period of not less than 15 years or the duration of the contract in [Section C405.15.2.2](#), whichever is less.
2. The RECs and EACs are created within a 12-month period of the use of the REC.
3. The RECs and EACs are from a generating asset placed in service not more than 5 years before the issuance of the certificate of occupancy.

##### **C405.15.4 Renewable energy certificate purchase.**

A *building* that qualifies for one or more of the exceptions to [Section C405.15.1](#), and where it can be demonstrated to the *code official* that the requirements of [Section C405.15.2](#) cannot be met, the *building owner* shall contract the purchase of renewable electricity products before the certificate of occupancy is issued. The purchase of renewable electricity products shall comply with the Green-e Energy National Standard for renewable electricity products equivalent to five times the amount of total off-site renewable energy calculated in accordance with [Equation 4-11](#).

##### **C405.16 Inverters.**

Direct-current-to-alternating-current inverters serving on-site renewable energy systems or on-site electrical energy storage systems (ESS) shall be compliant with [IEEE 1547](#) and [UL 1741](#).

#### **SECTION C406 ADDITIONAL EFFICIENCY, RENEWABLE AND LOAD MANAGEMENT REQUIREMENTS**

##### **C406.1 Compliance.**

*Buildings* shall comply as follows:

1. *Buildings* with greater than 2,000 square feet (186 m<sup>2</sup>) of *conditioned floor area* shall comply with Section C406.1.1.
2. *Buildings* with greater than 5,000 square feet (465 m<sup>2</sup>) of *conditioned floor area* shall comply with Sections C406.1.1 and C406.1.2.
3. Build-out construction greater than 1,000 square feet (93 m<sup>2</sup>) of *conditioned floor area* that does not have final lighting or final HVAC systems installed under a prior building permit shall comply with Section C406.1.1.2.

**Exceptions:** Core and shell *buildings* where not less than 20 percent of the net floor area is without final lighting or final HVAC that comply with all of the following:

1. *Buildings* with greater than 5,000 square feet (465 m<sup>2</sup>) of *conditioned floor area* shall comply with Section C406.1.2.
2. Portions of the *building* where the net floor area is without final lighting or final HVAC shall comply with Section C406.1.1.2.
3. Portions of the *building* where the net floor area has final lighting and final HVAC systems shall comply with Section C406.1.1.

**C406.1.1 Additional energy efficiency credit requirements.**

*Buildings* shall comply with measures from Section C406.2 to achieve not less than the number of required efficiency credits from Table C406.1.1(1) based on building occupancy group and *climate zone*. Where a project contains multiple occupancies, the total required energy credits from each building occupancy shall be weighted by the gross *conditioned floor area* to determine the weighted-average project energy credits required. Accessory occupancies shall be included with the primary occupancy group for the purposes of Section C406.

**Exceptions:**

1. Portions of *buildings* devoted to manufacturing or industrial use.
2. Where a *building* achieves more renewable and load management credits in Section C406.3 than are required in Section C406.1.2, surplus credits shall be permitted to reduce the required energy efficiency credits as follows:

$$EEC_{red} = EEC_{tbl} - \{the\ lesser\ of:\ [SLRM_{lim}, SLRM_{adj} \times (RLM_{ach} - RLM_{req})]\}$$

**Equation 4-12**

where:

$EEC_{red}$  = Reduced required energy efficiency credits.

$EEC_{tbl}$  = Required energy efficiency credits from Table C406.1.1(1).

$SLRM_{lim}$  = Surplus renewable and load management credit limit from Table C406.1.1(2).

$SLRM_{adj}$  = 1.0 for all-electric or all-renewable buildings (excluding emergency generation); 0.7 for buildings with fossil fuel equipment (excluding emergency generation).

$RLM_{ach}$  = Achieved renewable and load management credits from Section C406.3.

$RLM_{req}$  = Required renewable and load management credits from Section C406.1.2.

**TABLE C406.1.1(1) ENERGY CREDIT REQUIREMENTS BY BUILDING OCCUPANCY GROUP**

**TABLE C406.1.1(2) LIMIT TO ENERGY EFFICIENCY CREDIT CARRYOVER FROM RENEWABLE AND LOAD MANAGEMENT CREDITS**

**C406.1.1.1 Reserved.**

**C406.1.1.2 Building core/shell and build-out construction.**

Where separate permits are issued for core and shell *buildings* and build-out construction, compliance shall be in accordance with the following requirements.

1. Core and shell *buildings* or portions of *buildings* shall comply with one of the following:

1.1. Where the permit includes a central HVAC system or *service water heating* system with chillers, heat pumps, boilers, *service water heating* equipment or loop pumping systems with heat rejection, the project shall achieve not less than 50 percent of the energy credits required by Section C406.1.1 in accordance with Section C406.2.

1.2. Alternatively, the project shall achieve not less than 33 percent of the energy credits required by Section C406.1.1.

2. For core and shell buildings or portions of buildings, the energy credits achieved shall be subject to the following adjustments:

2.1. Lighting measure credits shall be determined only for areas with final

lighting installed.

2.2. Where HVAC or *service water heating* systems are designed to serve the entire *building*, full HVAC or *service water heating* measure credits shall be achieved.

2.3. Where HVAC or *service water heating* systems are designed to serve individual areas, HVAC or *service water heating* measure credits achieved shall be reduced in proportion to the floor area with final HVAC systems or final *service water heating* systems installed.

3. Build-out construction shall be deemed to comply with Section C406.1 where one of the following applies:

3.1. Where heating and cooling generation is provided by a previously installed central system, the energy credits achieved in accordance with Section C406.2 under the build-out project are not less than 33 percent of the credits required by Section C406.1.1.

3.2. Where heating and cooling generation is provided by an HVAC system installed in the build-out, the energy credits achieved in accordance with Section C406.2 under the build-out project are not less than 50 percent of the credits required by Section C406.1.1.

3.3. Where the core and shell *building* is *approved* in accordance with Section C407 under the 2021 IECC or later.

#### **C406.1.2 Additional renewable and load management credit requirements.**

Buildings shall comply with measures from Section C406.3 to achieve not less than the number of required renewable and load management credits from Table C406.1.2 based on building occupancy group and *climate zone*. Where a project contains multiple occupancies, credits in Table C406.1.2 from each building occupancy shall be weighted by the gross floor area to determine the weighted-average project energy credits required. Accessory occupancies shall be included with the primary occupancy group for the purposes of Section C406.

**Exception:** Where a *building* achieves more energy efficiency credits in Section C406.2 than are required in Section C406.1.1, the renewable and load management credits required in Table C406.1.2 shall be permitted to be reduced by the amount of surplus energy efficiency credits.

#### **TABLE C406.1.2 RENEWABLE AND LOAD MANAGEMENT CREDIT REQUIREMENTS BY BUILDING OCCUPANCY GROUP**

**C406.2 Additional energy efficiency credits achieved.**

Each energy efficiency credit measure used to meet credit requirements for the project shall have efficiency that is greater than the requirements in Sections C402 through C405. Measures installed in the project that meet the requirements in Sections C406.2.1 through C406.2.6 shall achieve the base credits listed for the measure and occupancy type in Tables C406.2(1) through C406.2(9) or, where calculations required by Sections C406.2.1 through C406.2.6 create or modify the table credits, the credits achieved shall be based on the calculations.

Energy credits achieved for measures shall be determined by one of the following, as applicable:

1. The measure's energy credit shall be the base energy credit from Tables C406.2(1) through C406.2(9) for the measure where no adjustment factor or calculation is included in the description of the measure in Section C406.2.
2. The measure's energy credit shall be the base energy credit for the measure adjusted by a factor or equation as stated in the description of the measure in Section C406.2. Where adjustments are applied, each measure's energy credit shall be rounded to the nearest whole number.
3. The measure's energy credit shall be calculated as stated in the measure's description in Section C406.2, where each individual measure credit shall be rounded to the nearest whole number.

Energy credits achieved for the project shall be the sum of the individual measure's energy credits. Credits are available for the measures listed in this section. Where a project contains multiple building occupancy groups:

1. Credits achieved for each occupancy group shall be summed and then weighted by the *conditioned floor area* of each occupancy group to determine the weighted average project energy credits achieved.
2. Improved envelope efficiency (E01 through E06), HVAC performance (H01) and lighting reduction (L06) measure credits shall be determined for the *building* or permitted *conditioned floor area* as a whole. Credits for other measures shall be determined for each occupancy separately. Credits shall be taken from applicable

tables or calculations for each occupancy and weighted by the building occupancy group floor area.

**TABLE C406.2(1) BASE ENERGY CREDITS FOR GROUP R-2, R-4 AND I-1 OCCUPANCIES<sup>a</sup>**

**TABLE C406.2(2) BASE ENERGY CREDITS FOR GROUP I-2 OCCUPANCIES<sup>a</sup>**

**TABLE C406.2(3) BASE ENERGY CREDITS FOR GROUP R-1 OCCUPANCIES<sup>a</sup>**

**TABLE C406.2(4) BASE ENERGY CREDITS FOR GROUP B OCCUPANCIES<sup>a</sup>**

**TABLE C406.2(5) BASE ENERGY CREDITS FOR GROUP A-2 OCCUPANCIES<sup>a</sup>**

**TABLE C406.2(6) BASE ENERGY CREDITS FOR GROUP M OCCUPANCIES<sup>a</sup>**

**TABLE C406.2(7) BASE ENERGY CREDITS FOR GROUP E OCCUPANCIES<sup>a</sup>**

**TABLE C406.2(8) BASE ENERGY CREDITS FOR GROUP S-1 AND S-2 OCCUPANCIES<sup>a</sup>**

**TABLE C406.2(9) BASE ENERGY CREDITS FOR OTHER OCCUPANCIES<sup>a, b</sup>**

**C406.2.1 More efficient building thermal envelope.**

A project shall achieve credits for improved envelope performance by complying with one of the following measures:

1. [Section C406.2.1.1](#): E01.
2. [Section C406.2.1.2](#): E02.
3. [Section C406.2.1.3](#): E03.
4. Both [E02](#) and [E03](#).
5. Any combination of:
  - 5.1. [Section C406.2.1.3](#): E03.
  - 5.2. [Section C406.2.1.4](#): E04.
  - 5.3. [Section C406.2.1.5](#): E05.
  - 5.4. [Section C406.2.1.6](#): E06.

**C406.2.1.1 E01 Improved envelope performance ASHRAE 90.1-2022 Appendix C.**

*Building thermal envelope* measures shall be installed to improve the energy performance of the project. The achieved energy credits shall be determined using [Equation 4-13](#).

$$EC_{ENV} = 1,000 \times (EPFB - EPFP) / EPFB$$

**Equation 4-13**

where:

$EC_{ENV}$  = E01 measure energy credits.

$EPFB$  = base envelope performance factor calculated in accordance with [ASHRAE 90.1-2022 Appendix C](#).

$EPFP$  = proposed envelope performance factor calculated in accordance with [ASHRAE 90.1-2022 Appendix C](#).

**C406.2.1.2 E02 Component performance envelope reduction.**

Energy credits shall be achieved where the component performance of the *building thermal*

*envelope* as designed is not less than 15 percent below the component performance of the *building thermal envelope* in accordance with [Section C402.1.4](#).

**C406.2.1.3 E03 Reduced air leakage.**

Energy credits shall be achieved where tested *building air leakage* is not less than 10 percent of the maximum leakage permitted by [Section C402.6.2](#), provided that the *building* is tested in accordance with the applicable method in [Section C402.6.2](#). Energy credits achieved for measure E03 shall be determined as follows:

$$EC_{E03} = EC_B \times EC_{adj}$$

**Equation 4-14**

where:

$EC_{E03}$  = Energy efficiency credits achieved for envelope leakage reduction.

$EC_B$  = [Section C406.2.1.3](#) credits from [Tables C406.2\(1\)](#) through [C406.2\(9\)](#).

$EC_{adj}$  =  $L_s / EC_a$

$L_s$  = Leakage savings fraction: the lesser of  $[(L_r - L_m) / L_r]$  or 0.8.

$L_r$  = Maximum leakage permitted for tested buildings, by occupancy group, in accordance with [Section C402.6.2](#).

$L_m$  = Measured leakage in accordance with [Section C402.6.2.1](#) or [C402.6.2.2](#).

$EC_a$  = Energy credit alignment factor: 0.37 for whole-building tests in accordance with [Section C402.6.2.1](#) or 0.25 for dwelling and sleeping unit enclosure tests in accordance with [Section C402.6.2.2](#).

**C406.2.1.4 E04 Added roof insulation.**

Energy credits shall be achieved for insulation that is in addition to the required insulation in [Table C402.1.3](#). All roof areas in the project shall have additional R-10 *continuous insulation* included in the roof assembly. For attics, this is permitted to be achieved with fill or batt insulation rated at R-10 that is continuous and not interrupted by ceiling or roof joists. Where interrupted by joists, the added insulation shall be not less than R-13. Alternatively, one-half of the base credits shall be achieved where the added *R-value* is one-half of the additional *R-value* required by this section.

**C406.2.1.5 E05 Added wall insulation.**

Energy credits shall be achieved for insulation applied to not less than 90 percent of all opaque wall area in the project that is in addition to the required insulation in [Table C402.1.3](#). Opaque walls shall have additional R-5 *continuous insulation* included in the wall assembly. Alternatively, one-half of the base credits shall be achieved where the added *R-value* is R-2.5.

**C406.2.1.6 E06 Improve fenestration.**

Energy credits shall be achieved for improved energy characteristics of all vertical *fenestration* in the project meeting the requirements in [Table C406.2.1.6](#). The area-weighted average *U-factor* and SHGC of all vertical *fenestration* shall be

equal to or less than the value shown in the table. Where vertical *fenestration* is located under a permanently attached shading projection with a projection factor (PF) not less than 0.2 as determined in accordance with [Section C402.5.3](#), the SHGC for that *fenestration* shall be permitted to be divided by 1.2. The area-weighted average *visible transmittance* (VT) of all vertical *fenestration* shall be equal to or greater than the value shown in the table.

**TABLE C406.2.1.6 VERTICAL FENESTRATION REQUIREMENTS FOR ENERGY CREDIT E06**

**C406.2.2 More efficient HVAC equipment performance.**

All heating and cooling systems shall meet the minimum requirements of [Section C403](#) and efficiency improvements shall be referenced to minimum efficiencies listed in tables referenced by [Section C403.3.2](#). Where multiple efficiency requirements are listed, equipment shall meet the seasonal or part-load efficiencies including SEER, integrated energy efficiency ratio (IEER), *integrated part load value* (IPLV) or AFUE. Equipment that is larger than the maximum capacity range indicated in tables referenced by [Section C403.3.2](#) shall utilize the values listed for the largest capacity equipment for the associated equipment type shown in the table. Where multiple individual heating or cooling systems serve the project, the improvement shall be the weighted-average improvement based on individual system capacity. Systems are permitted to achieve HVAC energy credits by meeting the requirements of one of the following:

1. [C406.2.2.1](#) H01.
2. [C406.2.2.2](#) H02.
3. [C406.2.2.3](#) H03.
4. [C406.2.2.4](#) H04.
5. [C406.2.2.5](#) H05.
6. Any combination of [H02](#), [H03](#), [H04](#) and [H05](#).
7. The combination of [H01](#) and [H04](#).

**C406.2.2.1 H01 HVAC Total System Performance Ratio (TSPR).**

[H01](#) energy credits shall be earned where systems are permitted to use [Section C409](#) and where the savings (TSPRs) based on the proposed TSPR (TSPRp) compared to the target TSPR is 5 percent or more. If savings are greater than 5 percent, determine H01 earned credits using [Equation 4-15](#). Energy credits for H01 shall not be combined with energy credits from HVAC measures H02, H03 or H05.

$$EC_{TSPR} = EC_{BASE} \times AREA_{TSPR} \times TSPR_s / 0.05$$

**Equation 4-15**

$EC_{TSPR}$  = Energy credits achieved for [H01](#).

$EC_{BASE}$  = [H01](#) base energy credits from [Tables C406.2\(1\)](#) through [C406.2\(9\)](#).

$TSPR_s$  = The lesser of 0.20 and  $[1 - (TSPR_t / TSPR_p)]$ .

where:

$AREA_{TSPR}$  = (floor area served by systems included in TSPR)/(total building conditioned floor area)

$TSPR_p$  = HVAC TSPR of the proposed design calculated in accordance with [Sections C409.4](#), [C409.5](#) and [C409.6](#).

$TSPR_t$  = TSPRr /MPF.

$TSPR_r$  = VAC TSPR of the reference building design calculated in accordance with [Sections C409.4](#), [C409.5](#) and [C409.6](#).

MPF = Mechanical performance factor from [Table C409.4](#) based on climate zone and building use type. Where a building has multiple building use types, MPF shall be area weighted in accordance with [Section C409.4](#).

**C406.2.2.2 H02 More efficient HVAC equipment heating performance.**

In accordance with [Section C406.1.1](#), not less than 90 percent of the total HVAC heating capacity serving the total conditioned floor area of the entire building or tenant space shall comply with the requirements of this section.

1. Equipment installed shall be types that have their efficiency listed in tables referenced by [Section C403.3.2](#). Electric resistance heating capacity shall be limited to 20 percent of system capacity, with the exception of heat pump supplemental heating.
2. Equipment shall exceed the minimum heating efficiency requirements listed in tables referenced by [Section C403.3.2](#) by not less than 5 percent. Where equipment exceeds the minimum annual heating efficiency requirements by more than 5 percent, energy efficiency credits for heating shall be determined using [Equation 4-16](#), rounded to the nearest whole number.

$$EEC_{HEH} = EEC_{H5} \times \left( \frac{HEI}{0.05} \right)$$

Equation 4-16

where:

$EEC_{HEH}$  = Energy efficiency credits for heating efficiency improvement.

$EEC_{H5}$  = [Section C406.2.2.2](#) credits from [Tables C406.2\(1\)](#) through [C406.2\(9\)](#).

HEI = The lesser of the improvement above minimum heating efficiency requirements,

expressed as a fraction or 20 percent (0.20). Where heating equipment with different minimum efficiencies is included in the building, a heating capacity weighted-average improvement shall be used. Where electric resistance primary heating or reheat is included in the building, it shall be included in the weighted-average improvement with an HEI of 0. Supplemental gas and electric heat for heat pump systems shall be excluded from the weighted HEI. For heat pumps rated at multiple ambient temperatures, the efficiency at 47°F (8.3°C) shall be used. For metrics that increase as efficiency increases, HEI shall be calculated as follows:

$$HEI = \left( \frac{HM_{DES}}{HM_{MIN}} \right) - 1$$

where:

- $HM_{DES}$  = Design heating efficiency metric, part-load or annualized where available.
- $HM_{MIN}$  = Minimum required heating efficiency metric, part-load or annualized where available from [Section C403.3.2](#).

Exception: In low-energy spaces complying with [Section C402.1.1](#), not less than 90 percent of the installed heating capacity is provided by electric infrared or gas-fired radiant heating equipment for localized heating applications. Such spaces shall achieve base energy credits only for  $EECH_5$ .

#### **C406.2.2.3 H03 More efficient HVAC cooling equipment and fan performance.**

In accordance with [Section C406.1.1](#), not less than 90 percent of the total HVAC cooling capacity serving the total *conditioned floor area* of the entire *building* or tenant space shall comply with all of the requirements of this section.

1. Equipment installed shall be types that are listed in tables referenced by [Section C403.3.2](#).
2. Equipment shall exceed the minimum cooling efficiency requirements listed in tables referenced by [Section C403.3.2](#) by not less than 5 percent. For water-cooled chiller plants, heat-rejection equipment performance in [Table C403.3.2\(7\)](#) shall also be increased by at least the chiller efficiency improvement. Where equipment exceeds both the minimum annual cooling efficiency and heat-rejection efficiency requirements by more than 5 percent, energy efficiency credits for cooling shall be determined using [Equation 4-17](#), rounded to the nearest whole number.

Where fan energy is not included in the packaged equipment rating or it is and the fan size has been increased from the as rated equipment condition,

fan power or horsepower shall be less than 95 percent of the allowed fan power in [Section C403.8.1](#).

$$EEC_{HEH} = EEC_{H_5} \times (CEI/0.05)$$

Equation 4-17

where:

$EEC_{HEC}$  = Energy efficiency credits for cooling efficiency improvement.

$EEC_5$  = [Section C406.2.2.3](#) base energy credits from [Tables C406.2\(1\)](#) through [C406.2\(9\)](#).

$CEI$  = The lesser of the improvement above minimum cooling efficiency and heat-rejection performance requirements, expressed as a fraction or 20 percent (0.20). Where cooling equipment with different minimum efficiencies is included in the building, a cooling capacity weighted-average improvement shall be used. Where multiple cooling efficiency or performance requirements are provided, the equipment shall exceed the annualized energy or part-load requirement. Meeting both part-load and full-load efficiencies is not required.

For metrics that increase as efficiency increases,  $CEI$  shall be calculated as follows:

$$CEI = (CM_{DES}/CM_{MIN}) - 1$$

$$CEI = (CM_{DES}/CM_{MIN}) - 1.$$

For metrics that decrease as efficiency increases,  $CEI$  shall be calculated as follows:

$$CEI = (CM_{MIN}/CM_{DES}) - 1.$$

where:

$CM_{DES}$  = Design cooling efficiency metric, part-load or annualized where available.

$CM_{MIN}$  = Minimum required cooling efficiency metric, part-load or annualized where available from [Section C403.3.2](#).

For data centers using [ASHRAE Standard 90.4-2022](#),  $CEI$  shall be calculated as follows:

$$CEI = (AMLC_{MAX}/AMLC_{DES}) - 1$$

where:

$AMLC_{DES}$  = As-designed annualized mechanical load component calculated in accordance with [ASHRAE Standard 90.4-2022](#), Section 6.5.

$AMLC_{MAX}$  = Maximum annualized mechanical load component from [ASHRAE Standard 90.4-2022](#), Table 6.5.

#### **C406.2.2.4 H04 Residential HVAC control.**

HVAC systems serving *dwelling units* or *sleeping units* shall be controlled to automatically activate a setback at least 5°F (3°C) for both heating and cooling. The temperature controller shall be configured to provide setback during occupied sleep periods. The unoccupied setback mode shall

be configured to operate in conjunction with one of the following:

1. A *manual* main control device by each *dwelling unit* main entrance that initiates setback and non-ventilation mode for all HVAC units in the *dwelling unit* and is clearly identified as "Heating/Cooling Master Setback."
2. Occupancy sensors in each room of the *dwelling unit* combined with a door switch to initiate setback and non-ventilation mode for all HVAC units in the dwelling within 20 minutes of all spaces being vacant immediately after a door switch operation. Where separate room HVAC units are used, an individual occupancy sensor on each unit that is configured to provide setback shall meet this requirement.
3. An advanced learning *thermostat* or controller that recognizes occupant presence and automatically creates a schedule for occupancy and provides a dynamic setback schedule based on when the spaces are generally unoccupied.
4. An automated control and sensing system that uses geographic fencing connected to the *dwelling unit* occupants' cell phones and initiates the setback condition when all occupants are away from the *building*.

#### **C406.2.2.5 H05 Dedicated outdoor air system.**

Credits for this measure are allowed only where single-zone HVAC units are not required to have multispeed or variable-speed fan control in accordance with Section C403.8.6.1. HVAC controls and ventilation systems shall include all of the following:

1. Zone controls shall cycle the heating/cooling unit fans off when not providing required heating and cooling or shall limit fan power to 0.056 W/(L/s) (0.12 W/cfm) of zone supply air.
2. Outdoor air shall be supplied by an independent ventilation system designed to provide not more than 130 percent of the minimum outdoor air to each individual occupied zone, as specified by the *International Mechanical Code*.

**Exception:** Outdoor airflow is permitted to increase

during emergency or economizer operation, implemented as described in Item 4.

3. The ventilation system shall have energy recovery with an *enthalpy recovery ratio* of 65 percent or more at heating design conditions in Climate Zones 3 through 8 and an *enthalpy recovery ratio* of 65 percent or more at cooling design conditions in Climate Zones 0, 1, 2, 3A, 3B, 4A, 4B, 5A and 6A. In "A" climate zones, energy recovery shall include latent recovery. Where no humidification is provided, heating energy recovery effectiveness is permitted to be based on *sensible energy recovery ratio*. Where energy recovery effectiveness is less than the 65 percent required for full credit, adjust the credits from Section C406.2 by the factors in Table C406.2.2.5.
4. Where the ventilation system serves multiple zones and the system is not in a latent recovery outside air dehumidification mode, partial economizer cooling through an outdoor air bypass or wheel speed control shall automatically do one of the following:
  - 4.1. Set the energy recovery leaving-air temperature 55°F (13°C) or 100 percent outdoor air bypass when a majority of zones require cooling and outdoor air temperature is below 70°F (21°C).
  - 4.2. The HVAC ventilation system shall include supply-air temperature controls that automatically reset the supply-air temperature in response to representative *building* loads or to outdoor air temperatures. The controls shall reset the supply-air temperature not less than 25 percent of the difference between the design supply-air temperature and the design room-air temperature.
5. Ventilation systems providing mechanical dehumidification shall use recovered energy for reheat within the limits of Item 4. This shall not limit the use of latent energy recovery for dehumidification.

Where only a portion of the *building* is permitted to be served by constant air volume units or

the *enthalpy recovery ratio* or *sensible energy recovery ratio* is less than 65 percent, the base energy credits shown in Section C406.2 shall be prorated as follows:

$$EC_{DOAS} = EC_{BASE} \times FLOOR_{CAV} \times ERE_{ADJ}$$

#### Equation 4-18

where:

$EC_{DOAS}$  = Energy credits achieved for H05.

$EC_{BASE}$  = H05 base energy credits in Section C406.2.

$FLOOR_{CAV}$  = Fraction of whole-project gross conditioned floor area not required to have variable-speed or multi-speed fan airflow control in accordance with Section C403.8.6.

$ERE_{adj}$  = The energy recovery adjustment from Table C406.2.2.5 based on the lower of actual cooling or heating enthalpy recovery ratio or sensible energy recovery ratio where required for the climate zone. Where recovery ratios vary, use a weighted average by supply airflow.

#### **TABLE C406.2.2.5 DOAS ENERGY RECOVERY ADJUSTMENTS**

##### **C406.2.3 Reduced energy use in service water heating.**

For projects with service water heating equipment that serves the whole *building*, a *building addition* or a tenant space shall achieve credits through compliance with the requirements of this section. Systems are permitted to achieve energy credits by meeting the requirements of one of the following:

1. Section C406.2.3.1 by selecting one allowed measure W01, W02, W03 or a combination in accordance with Section C406.2.3.1.4.
2. Section C406.2.3.2 W04.
3. Section C406.2.3.3 by selecting one allowed measure: W05, W06 or W07.
4. Section C406.2.3.4 W08.
5. Section C406.2.3.5 W09.
6. Section C406.2.3.6 W10.
7. Any combination of measures in Sections C406.2.3.1 through C406.2.3.6 as long as not more than one allowed measure from Sections C406.2.3.1 and C406.2.3.3 are selected.

##### **C406.2.3.1 Service water heating system efficiency.**

A project is allowed to achieve energy credits from only one of Sections C406.2.3.1.1 through C406.2.3.1.4.

##### **C406.2.3.1.1 W01 Recovered or renewable water heating.**

The *building service water-heating system* shall have one or more of the following that are sized to provide not less than 30 percent of the *building's* annual hot water requirements, or sized to provide not less than 70 percent of the *building's* annual hot water requirements if the *building* is required to comply with Section C403.11.5:

1. Waste heat recovery from service hot water, heat recovery chillers, *building* equipment or process equipment.
2. A water-to-water heat pump that precools chilled water return for *building* cooling while heating SHW.
3. On-site renewable energy water-heating systems.

##### **C406.2.3.1.2 W02 Heat pump water heater.**

Air-source heat pump *water heaters* shall be installed according to the manufacturer's instructions and at least 30 percent of design end-use *service water heating* requirements shall be met using only heat pump heating at an ambient condition of 67.5°F (19.7°C), db without supplemental electric resistance or fossil fuel heating. For a heat pump water heater with supplemental electric resistance heating, the heat pump-only capacity shall be deemed at 40 percent of first-hour draw. Where the heat pump-only capacity exceeds 50 percent of the design end-use load, excluding recirculating system losses, the credits from the Section C406.2 tables shall be prorated as follows:

$$EC_{HPWH} = (EC_{BASE}/0.5) \times (CAP_{HPWH}) / (\text{Endload}) [\text{not greater than } 2]$$

#### Equation 4-19

where:

$EC_{HPWH}$  = Energy credits achieved for W02.

$EC_{BASE}$  = W02 base energy credits from Tables C406.2(1) through C406.2(9).

Endload = End-use peak hot water load, excluding load for heat trace or recirculation, Btu/h or kW.

$CAP_{HPWH}$  = The heat pump-only capacity at 50°F (10°C) entering air and 70°F (21°C) entering potable water without supplemental electric resistance or fossil fuel heat, Btu/h or kW.

The heat pump service water heating system shall comply with the following requirements:

1. For systems with an installed total output capacity of more than 29 kW (100,000 Btu/h) at an ambient condition of 67.5°F (19.7°C) db, a preheat storage tank with greater than or equal to 0.75 gallons per 1,000 Btu/h ( $\geq 9.7$  L/kW) of design end-use service water-heating requirements shall be heated only with a heat pump heating

when the ambient temperature is greater than 45°F (7.2°C).

2. For systems with piping temperature maintenance, either a heat trace system or a separate water heater in series for recirculating system and final heating shall be installed.
3. Heat pump water heater efficiency shall meet or exceed one of the following:
  - 3.1. Output-capacity-weighted-average UEF of 3.0 in accordance with 10 CFR 430 Appendix E.
  - 3.2. Output-capacity-weighted-average COP of not less than 4.0 tested at 50°F (10°C) entering air and 70°F (21°C) entering potable water in accordance with ANSI/AHRI 1300.

Where the heat pump capacity at 50°F (10°C) entering air and 70°F (21°C) entering water exceeds 50 percent of the design end-use load, excluding recirculating system losses, the base credits from Section C406.2 shall be prorated based on Equation 4-20.

$W02 \text{ credit} = \text{base } W02 \text{ table credit} \times HP_{if}/50\%$

**Equation 4-20**

where:

$HP_{if}$  = Heat pump capacity as a fraction of the design end-use SHW requirements, excluding recirculating system losses, not to exceed 80 percent.

**C406.2.3.1.3 W03 Efficient fossil fuel water heater.**

The combined input-capacity-weighted-average equipment rating of all gas water heating equipment in the *building* shall be not less than 95 percent  $E_t$  or 0.93 UEF. Adjustments shall apply as follows:

1. Where the *service water heating* system is required to comply with Section C404.2.1, this measure shall achieve 30 percent of the listed base W03 energy credits in Tables C406.2(1) through C406.2(9).
2. Where the installed *building service water heating* capacity is less than 59 kW (200,000 Btu/h) and weighted UEF is less than 0.93 UEF and not less than 0.82, this measure shall achieve 25 percent of the base W03 credit in Tables C406.2(1) through C406.2(9).

**C406.2.3.1.4 Combination service water heating systems.**

Combination *service water heating* systems shall achieve credits using one of the measure combinations as follows:

1. (W01 + W02) Where *service water heating* employs both energy recovery and heat pump water heating, W01 may be combined with W02 and receive the sum of both credits.
2. (W01 + W03) Where *service water heating* employs both energy recovery and efficient gas water heating, W01 may be combined with W03 and receive the sum of the W01 credit and the portion of the W03 credit based on Item 4.
3. (W02 + W03) Where *service water heating* employs both heat pump water heating and efficient gas water heating, W02 may be combined with W03 and receive the sum of the W02 credit and the portion of the W03 credit based on Item 4.
4. For Items 2 and 3, the achieved W03 credit shall be the Section C406.2.3.1.3 W03 credit multiplied by the fractional share of total water-heating installed capacity served by gas water heating that is not less than 95 percent  $E_t$  or 0.93 UEF. In no case shall the achieved W03 credit exceed 60 percent of the W03 credit in the Section C406.2 tables. In buildings that have a service water heating design generating capacity greater than 900,000 Btu/h (264 kW), that proportioned W03 credit shall be further multiplied by 30 percent.

**C406.2.3.2 W04 Service hot water piping insulation increase.**

Where service hot water is provided by a central water heating system, the hot water pipe insulation thickness shall be at least 1.5 times the thickness required in Section C404.4. All service hot water piping shall be insulated from the hot water source to the fixture shutoff. Where 50 percent or more of hot water piping does not have increased insulation due to installation in partitions, the credit shall be prorated as a percentage of lineal feet of piping with increased insulation.

**C406.2.3.3 Service water-heating distribution temperature maintenance.**

A project is allowed to claim energy credits from only one of the following SHW distribution temperature maintenance measures.

1. **W05 Point of use water heaters.** Credits are available for Group B or

E buildings larger than 5,000 square feet (465 m<sup>2</sup>) where *service water heating* systems meet the following requirements:

1.1. Fixtures requiring hot water shall be supplied from a local *water heater* with no recirculating system or heat trace piping.

**Exception:** Commercial kitchens or showers in locker rooms shall be permitted to have a local recirculating system or heat trace piping where *water heaters* are located not more than 50 lineal feet (15 m) from the farthest fixture served.

1.2. Supply piping from the *water heater* to the termination of the fixture supply pipe shall be insulated to the levels shown in Table C404.4.1.

**Exceptions:**

1. Piping at locations where a vertical support of the piping is installed.
2. Where piping passes through a framing member and insulation requires increasing the size of the framing member.

1.3. The water volume in the piping from the *water heater* to the termination of any individual fixture shall be limited as follows:

1.3.1. Nonresidential public lavatory faucets that are available for use by members of the general public: not more than 2 ounces (59 mL).

1.3.2. Commercial kitchens or showers in locker rooms with recirculating systems or heat trace piping: not more than 24 ounces (710 mL) from the recirculating system or heat trace piping.

1.3.3. All other plumbing fixtures or appliances: not more than 16 ounces (473 mL).

2. **W06 Thermostatic balancing valves.** Credits are available where *service water heating* is provided centrally and distributed throughout the *building* with a recirculating system. Each recirculating

system branch return connection to the main SHW supply piping shall have an *automatic* thermostatic balancing valve set to a minimal return water flow when the branch return temperature is greater than 120°F (49°C).

3. **W07 Heat trace system.** Credits are available for projects with gross floor area greater than 929 m<sup>2</sup> (10,000 square feet) and a central water heating system. The energy credits achieved shall be from Tables C406.2(1) through C406.2(9). This system shall include self-regulating electric heat cables, connection kits and electronic controls. The cable shall be installed directly on the hot water supply pipes underneath the insulation to replace standby losses.

**C406.2.3.4 W08 Water-heating system submeters.**

Each individual *dwelling unit* in a Group R-2 occupancy served by a central service water heating system shall be provided with a service hot water meter connected to a reporting system that provides individual *dwelling unit* reporting of actual domestic hot water use. Preheated water serving the cold-water inlet to showers need not be metered.

**C406.2.3.5 W09 Service hot water flow reduction.**

Dwelling unit, sleeping unit and guestroom plumbing fixtures that are connected to the service water-heating system shall have a flow or consumption rating less than or equal to the values shown in Table C406.2.3.5.

**TABLE C406.2.3.5 MAXIMUM FLOW RATING FOR RESIDENTIAL PLUMBING FIXTURES WITH HEATED WATER**

**C406.2.3.6 W10 Shower drain heat recovery.**

Cold water serving *building* showers shall be preheated by shower drain heat recovery units that comply with Section C404.7. The efficiency of drain heat recovery units shall be 54 percent or greater measured in accordance with CSA B55.1. Full credits are applicable to the following *building* uses: I-2, I-4, R-1, R-2 and also Group E where there are more than eight showers. Partial credits are applicable to *buildings* where all but ground floor showers are served where the base energy credit from Section C406.2 is adjusted by Equation 4-21.

**Equation 4-21** W10 credit = W10 base energy credit × (showers with drain heat recovery/total showers in building)

**C406.2.4 P01 Energy monitoring.**

A project not required to comply with Section C405.13 can achieve energy credits for installing an

energy monitoring system that complies with all the requirements of Sections C405.13.1 through C405.13.5.

**C406.2.5 Energy savings in lighting systems.**

Projects are permitted to achieve energy credits for increased lighting system performance by meeting the requirements of one of the following:

1. Section C406.2.5.2 L02.
2. Section C406.2.5.3 L03.
3. Section C406.2.5.4 L04.
4. Section C406.2.5.5 L05.
5. Section C406.2.5.6 L06.
6. Any combination of L03, L04, L05 and L06.
7. Any combination of L02, L03 and L04.

**C406.2.5.1 L01 Lighting system performance (reserved).**

Reserved for future use.

**C406.2.5.2 L02 High-end trim lighting controls.**

Measure credits shall be achieved where qualifying spaces are not less than 50 percent of the project interior floor area exclusive of *dwelling* and *sleeping units*. Qualifying spaces are those where *general lighting* is controlled by *high-end trim* lighting controls complying with the following:

1. The calibration adjustment equipment is located for ready access only by authorized personnel.
2. Lighting controls with ready access for users cannot increase the lighting power above the maximum level established by the *high-end trim* controls.
3. Construction documents shall state that maximum light output or power of general lighting in spaces contributing to the qualifying floor area shall be not greater than 85 percent of full power or light output.
4. *High-end trim* lighting controls shall be tested in accordance with Section C408.3.1.5.

The base credits from Tables C406.2(1) through C406.2(9) shall be prorated as follows:

$HET \times [\text{Base energy credits for } \underline{C406.2.5.2}]/50\%$   
where:

$HET =$  Floor area of qualifying spaces where general lighting is provided with high-end trim lighting controls complying with this section, expressed as a percentage of total interior floor

area, excluding dwelling and sleeping units.

**C406.2.5.3 L03 Increase occupancy sensor.**

Lighting controls shall comply with Sections C406.2.5.3.1, C406.2.5.3.2 and C406.2.5.3.3.

**C406.2.5.3.1 Occupant sensor controls.**

Occupant sensor controls shall be installed to control lights in the following space types:

1. Food preparation area.
2. Laboratory.
3. Elevator lobby.
4. Pharmacy area.
5. Vehicular maintenance area.
6. Workshop.
7. Recreation room in a facility for the visually impaired.
8. Exercise area in a fitness center.
9. Playing area in a fitness center.
10. Exam/treatment room in a health care facility.
11. Imaging room in a health care facility.
12. Physical therapy room in a health care facility.
13. Library reading area.
14. Library stacks.
15. Detailed manufacturing area.
16. *Equipment room* in a manufacturing facility.
17. Low-bay area in a manufacturing facility.
18. Post office sorting area.
19. Religious fellowship hall.
20. Hair salon.
21. Nail salon.
22. Banking activity area.
23. Museum restoration room.

**C406.2.5.3.2 Occupant sensor control function.**

Occupant sensors in library stacks and laboratories shall comply with Section C405.2.1.2. Occupant sensors in elevator lobbies shall comply with Section C405.2.1.4. All other occupant sensors required by Section C406.2.5.3.1 shall comply with Section C405.2.1.1.

**Exception:** In spaces where an automatic shutoff could endanger occupant safety or security, occupant sensor controls shall uniformly reduce lighting power to not more than 20 percent of full power within 10 minutes after all occupants have left the space. Time-switch controls complying with Section C405.2.2.1 shall automatically turn off lights.

#### **C406.2.5.3.3 Occupant sensor time delay and setpoint.**

Occupant sensor controls installed in accordance with Sections

C405.2.1.1, C405.2.1.2, C405.2.1.3 and C405.2.1.4 shall automatically turn off lights or reduce lighting power within 10 minutes after all occupants have left the space. Occupant sensor controls installed in accordance with Section C405.2.1.2 shall have an unoccupied setpoint of not greater than 20 percent of full power.

#### **C406.2.5.4 L04 Increased daylight area.**

The total daylight area of the *building* ( $DLA_{BLDG}$ ) determined by Equation 4-22 shall be at least 5 percent greater than the typical daylight area ( $DLA_{TYP}$ ) from Table C406.2.5.4. Credits for measure L04 shall be determined by Equation 4-23 or Equation 4-24, whichever is less:

$$DLA_{BLDG} = DLZ/LFA$$

#### **Equation 4-22**

where:

$DLZ$  = The total building floor area located within sidelit and toplit daylight zones complying with Section C405.2.4.2 or C405.2.4.3 and provided with daylight responsive controls complying with Section C405.2.4.1, ft<sup>2</sup> or m<sup>2</sup>.

$LFA$  = The total building floor area used to determine the lighting power allowance in Section C405.3.2, ft<sup>2</sup> or m<sup>2</sup>.

$$EC_{DL} = EC_{DL5} \times 20 \times (DLA_{BLDG} - DLA_{TYP})$$

#### **Equation 4-23**

where:

$EC_{DL}$  = The lesser of actual area of daylight zones in the building with continuous daylight dimming, ft<sup>2</sup> or m<sup>2</sup> and ( $GLFA \times DLA$ ); see Table C406.2.5.4. Daylight zones shall meet the criteria in Sections C405.2.4.2 and C405.2.4.3 for primary sidelit daylight zones, secondary sidelit daylight zones and toplit daylight zones.

$DLA_{TYP}$  = Typical percent of building area with daylight control (as a fraction) from Table C406.2.5.4.

$EC_{DL5}$  = Section C406.2.5.4 L04 base energy credits from Section C406.2.

$$EC_{DL} = EC_{DL5} \times 20 \times (DLA_{MAX} - DLA_{TYP})$$

#### **Equation 4-24**

where:

$EC_{DL}$  = The lesser of actual area of daylight zones in the building with continuous daylight dimming, ft<sup>2</sup> or m<sup>2</sup> and ( $GLFA \times DLA$ ); see Table C406.2.5.4. Daylight zones shall meet the criteria in Sections C405.2.4.2 and C405.2.4.3 for primary sidelit

daylight zones, secondary sidelit daylight zones and toplit daylight zones.

$EC_{DL5}$  = Section C406.2.5.4 L04 base energy credits from Section C406.2 and Tables C406.2(4), C406.2(6), C406.2(7) and C406.2(8).

$DLA_{TYP}$  = Typical percent of building floor area with daylight control (as a fraction) from Table C406.2.5.4.

$DLA_{MAX}$  = Maximum percent of building floor area with daylight control that can be counted for compliance with this measure, from Table C406.2.5.4.

#### **TABLE C406.2.5.4 ADDED DAYLIGHTING PARAMETERS**

##### **C406.2.5.5 L05 Residential light control.**

In *buildings* with Group R-2 occupancy spaces, interior lighting systems shall comply with the following:

1. In common areas, the following space types shall have occupant sensor controls that comply with the requirements of Section C405.2.1.1:
  - 1.1. Laundry/washing areas.
  - 1.2. Dining areas.
  - 1.3. Food preparation areas.
  - 1.4. Seating areas.
  - 1.5. Exercise areas.
  - 1.6. Massage spaces.
2. In *dwelling units*, not less than one receptacle in each living room and each sleeping room shall be controlled by a switch in that room.
3. Lights and switched receptacles in bathrooms and kitchens shall be controlled by an occupant sensor complying with Section C405.2.1.1. All other lights and switched receptacles in each *dwelling unit* shall be controlled by a switch at the main entrance. The switch shall be marked to indicate its function.

**Exception:** Lighting and switched receptacles controlled by an occupant sensor complying with Section C405.2.1.1 are not required to be controlled by the switch at the main entrance.

##### **C406.2.5.6 L06 Reduced lighting power.**

Interior lighting within all *building* areas shall comply with this section.

1. The connected interior lighting power (LP) determined in accordance with Section C405.3.1 shall be 95 percent or less than the interior lighting power allowance (LPA) determined in accordance with Section C405.3.2 using the same method used to comply with Section C405.3. Energy

credits shall not be greater than four times the L06 base credit from Section C406.2 and shall be determined using Equation 4-25.

2. All permanently installed lighting serving *dwelling units* and *sleeping units*, including ceiling fan light kits and lighting integrated into range hoods and exhaust fans shall be provided by lamps with an efficacy of not less than 90 lumens per watt or by luminaires that have an efficacy of not less than 65 lumens per watt.

**Exceptions:**

1. Lighting integral to other appliances.
2. Antimicrobial lighting used for the sole purpose of disinfecting.

$$EC_{LPA} = EC_5 \times 20 \times (LPA - LP) / LPA$$

**Equation 4-25**

where:

$EC_{LPA}$  = Additional energy credit for lighting power reduction.

$LP$  = Connected interior lighting power calculated in accordance with Section C405.3.1, watts.

$LPA$  = Interior lighting power allowance calculated in accordance with the requirements of Section C405.3.2, watts.

$EC_5$  = L06 base credit from Section C406.2.

**406.2.6 Efficient equipment credits.**

Projects are permitted to achieve energy credits using any combination of Efficient Equipment Credits Q01 through Q04.

**C406.2.6.1 Q01 Efficient elevator equipment.**

Qualifying elevators in the *building* shall be energy efficiency class A per ISO 25745-2, Table 7. Only *buildings* three or more floors above grade may use this credit. Credits shall be prorated based on Equation 4-26, rounded to the nearest whole credit. Projects with a compliance ratio below 0.5 do not qualify for this credit.

$$EC_e = EC_t \times CR_e$$

**Equation 4-26**

where:

$EC_e$  = Elevator energy credit achieved for the building.

$EC_t$  = Q01 base energy credit from applicable Table C406.2(1) through Table C406.2(9).

$CR_e$  = Compliance ratio = FA/FB.

$FA$  = Sum of floors served by class A elevators.

$FB$  = Sum of floors served by all building elevators and escalators.

**C406.2.6.2 Q02 Efficient commercial kitchen equipment.**

For *buildings* and spaces designated as Group A-2 or facilities whose primary business type involves

the use of a commercial kitchen where at least one gas or electric fryer is installed before the issuance of the certificate of occupancy, all fryers, dishwashers, steam cookers and ovens installed before the issuance of the certificate of occupancy shall comply with all of the following:

1. Achieve performance levels in accordance with the equipment specifications listed in Tables C406.2.6.2(1) through C406.2.6.2(4) where rated in accordance with the applicable test procedure.
2. Have associated performance levels listed on the construction documents submitted for permitting.

**TABLE C406.2.6.2(1) MINIMUM EFFICIENCY REQUIREMENTS: COMMERCIAL FRYERS**

**TABLE C406.2.6.2(3) MINIMUM EFFICIENCY REQUIREMENTS: COMMERCIAL DISHWASHERS**

**TABLE C406.2.6.2(4) MINIMUM EFFICIENCY REQUIREMENTS: COMMERCIAL OVENS**

**C406.2.6.3 Q03 Efficient residential kitchen equipment.**

For projects with Group R-1 and R-2 occupancies, energy credits shall be achieved where all dishwashers, refrigerators and freezers comply with all of the following:

1. Achieve the Energy Star Most Efficient 2021 label in accordance with the specifications current as of:
  - 1.1. Refrigerators and freezers 5.0, 9/15/2014.
  - 1.2. Dishwashers 6.0, 1/29/2016.
2. Be installed before the issuance of the certificate of occupancy.

For Group R-1 where only some guestrooms are equipped with both refrigerators and dishwashers, the table credits shall be prorated as follows:

Equation 4-27 [Section C406.2 base credits] × [floor area of guestrooms with kitchens]/[total guestroom floor area]

**C406.2.6.4 Q04 Fault detection and diagnostics system.**

A project not required to comply with Section C403.2.3 can achieve energy credits for installing a fault detection and diagnostics system to monitor the HVAC system's performance and automatically identify faults. The installed system shall comply with Items 1 through 6 in Section C403.2.3.

**C406.3 Renewable and load management credits achieved.**

Renewable energy and load management measures shall achieve credits as follows:

1. General measure requirements. Credits are achieved for measures installed in the building that comply with Sections C406.3.1 through C406.3.8.
2. Achieved credits are determined as follows:
  - 2.1. Measure credits achieved shall be determined in one of two ways, depending on the measure:
    - 2.1.1. The measure credit shall be the base credit listed by occupancy group and climate zone for the measure in Tables C406.3(1) through C406.3(9) where no adjustment factor or formula is shown in the description of the measure in Section C406.3.
    - 2.1.2. The measure credit shall be the base energy credit for the measure adjusted by a factor or formula as stated in the description of the measure in Section C406.3. Where adjustments are applied, each energy credit shall be rounded to the nearest whole number.
  - 2.2. Load management and renewable credits achieved for the project shall be the sum of credits for individual measures included in the project. Credits are available for the measures listed in this section.
  - 2.3. Where a project contains multiple building use groups, credits achieved for each building use group shall be summed and then weighted by the gross floor area of each building use group to determine the weighted-average project energy credits achieved.
3. Load management control requirements. The load management measures in Sections C406.3.2 (G01) through C406.3.7 (G06) require load management control sequences that are capable of and configured to automatically provide the load management operation specified based on indication of a peak period related to high short-term electric prices, grid condition or peak building load. Such a peak period shall, where possible, be initiated by a *demand response signal* from the controlling entity, such as a utility or service operator. Where communications are disabled or unavailable, all demand-responsive

controls shall continue backup demand response based on a local schedule or building-demand monitoring. The local building schedule shall be adjustable without programming and reflect the electric rate peak period dates and times. The load management control sequences shall be activated for peak period control by one of the following:

3.1. A certified OpenADR 2.0a or OpenADR 2.0b Virtual End Node (VEN), as specified under Clause 11, Conformance, in the applicable OpenADR 2.0 Specification.

3.2. A device certified by the manufacturer as being capable of responding to a *demand response signal* from a certified OpenADR 2.0b VEN by automatically implementing the control functions requested by the VEN for the equipment it controls.

3.3. The physical configuration and communication protocol of ANSI/CTA-2045-A or ANSI/CTA-2045-B.

3.4. For air conditioners and heat pumps with two or more stages of control and cooling capacity of less than 65,000 Btu/h (19 kW), *thermostats* with a *demand responsive control* that complies with the communication and performance requirements of AHRI 1380.

3.5. A device that complies with IEC 62746-10-1, an international standard for the open automated demand response system interface between the appliance, system, or energy management system and the controlling entity.

3.6. An interface that complies with the communication protocol required by a controlling entity to participate in an automated demand response program.

3.7. Where the controlling entity does not have a demand response signal available for the building type and size, local load management control shall be provided based on either:

3.7.1. *Building* demand management controls that monitor *building* electrical demand and initiate controls to minimize monthly or peak time period demand charges.

3.7.2. A local *building* schedule that reflects the electric rate peak period dates and times where buildings are less than 25,000 gross square feet (2322 m<sup>2</sup>).

In this case, a binary input to the control system shall be provided that activates the demand response sequence.

**TABLE C406.3(1) RENEWABLE AND LOAD MANAGEMENT CREDITS FOR GROUP R-2, R-4 AND I-1 OCCUPANCIES**

**TABLE C406.3(2) RENEWABLE AND LOAD MANAGEMENT CREDITS FOR GROUP I-2 OCCUPANCIES**

**TABLE C406.3(3) RENEWABLE AND LOAD MANAGEMENT CREDITS FOR GROUP R-1 OCCUPANCIES**

**TABLE C406.3(4) RENEWABLE AND LOAD MANAGEMENT CREDITS FOR GROUP B OCCUPANCIES**

**TABLE C406.3(5) RENEWABLE AND LOAD MANAGEMENT CREDITS FOR GROUP A-2 OCCUPANCIES**

**TABLE C406.3(6) RENEWABLE AND LOAD MANAGEMENT CREDITS FOR GROUP M OCCUPANCIES**

**TABLE C406.3(7) RENEWABLE AND LOAD MANAGEMENT CREDITS FOR GROUP E OCCUPANCIES**

**TABLE C406.3(8) RENEWABLE AND LOAD MANAGEMENT CREDITS FOR GROUP S-1 AND S-2 OCCUPANCIES**

**TABLE C406.3(9) RENEWABLE AND LOAD MANAGEMENT CREDITS FOR OTHERa OCCUPANCIES**

**C406.3.1 R01 Renewable energy.**

Projects installing on-site renewable energy systems with a capacity of at least 0.1 watts per gross square foot (1.08 W/m<sup>2</sup>) of *building area* or securing off-site renewable energy shall achieve energy credits for this measure calculated as follows:

$$EC_R = EC_{0.1} \times (R_t + R_{off} - R_{ex}) / (0.1 \times PGFA)$$

**Equation 4-28**

where:

$EC_R$  = Section C406.3.1 R01 energy credits achieved for this project.

$EC_{0.1}$  = Section C406.3.1 R01 base credits from Tables C406.3(1) through C406.3(9).

$R_t$  = Actual total rating of on-site renewable energy systems (W).

$R_{off}$  = Actual total equivalent rating of off-site renewable energy contracts (W), calculated as follows:

$$R_{off} = TRE / (REN \times 20)$$

where:

$TRE$  = Total off-site renewable electrical energy in kilowatt-hours (kWh) that is procured in accordance with Sections C405.15.2.1 through C405.15.4.

$REN$  = Annual off-site renewable electrical energy from Table C405.15.2, in units of kilowatt-hours per watt of array capacity.

$R_{ex}$  = Rating (W) of renewable energy resources

capacity excluded from credit calculated as follows:

$$R_{ex} = RR_r + RR_x + RR_c$$

where:

- $RR_r$  = Rating of on-site renewable energy systems required by Section C405.15.1, without exception (W).
- $RR_x$  = Rating of renewable energy resources used to meet any exceptions of this code (W).
- $RR_c$  = Rating of renewable energy resources used to achieve other energy credits in Section C406 (W).

$PGFA$  = Project gross floor area, ft<sup>2</sup>. Where renewable requirements, exceptions or credits are expressed in annual kWh or Btu rather than watts of output capacity, they shall be converted as 3413 Btu = 1 kWh and converted to W equivalent capacity as follows:

$RR_w$  = Actual total equivalent rating of renewable energy capacity (W), calculated as follows:

$$RR_w = TRE_x / (REN \times PGFA)$$

where:

$TRE_x$  = Total renewable energy in kilowatt-hours (kWh) that is excluded from R01 energy credits.

**C406.3.2 G01 Lighting load management.**

A project not required to comply with Section C405.2.8 can achieve energy credits for installing demand-responsive lighting controls for interior *general lighting* that comply with Section C405.2.8.1. The demand-responsive lighting controls shall automatically reduce the light output or power of controlled lighting to not more than 80 percent of full output, or 80 percent of the *high-end trim* setpoint, whichever is less. Energy credits can be earned where demand-responsive lighting controls are installed for the following:

1. Not less than 10 percent of the interior floor area in Group R or I occupancies.
2. Not less than 50 percent of the interior floor area in all other occupancies.

G01 credits shall be prorated using Equation 4-29 with not more than 75 percent of the interior floor area being counted.

**Equation 4-29** [interior floor area with lighting load management, %] × [table credits for Section C406.3.2] / 75%

**C406.3.3 G02 HVAC load management.**

*Automatic* load management controls shall be configured as follows:

1. Cooling temperature shift: Where electric cooling is in use, controls shall gradually increase the cooling setpoint by at least 3°F (1.7°C) over a minimum of 3 hours or reduce effective cooling capacity to 60 percent of installed capacity during the peak period or adjust the cooling temperature setpoint as described in Section C403.6.1.
2. Heating temperature shift: Where electric heating is in use, controls shall gradually decrease the heating setpoint by at least 3°F (1.7°C) over a minimum of 3 hours or reduce effective heating capacity to 60 percent of installed capacity during the peak period or adjust the heating temperature setpoint as described in Section C403.6.1.
3. Ventilation shift: Where HVAC systems serve multiple zones and have less than 70 percent outdoor air required, include controls that provide excess outdoor air preceding the peak period and reduce outdoor air by at least 30 percent during the peak period, in accordance with ASHRAE Standard 62.1-2019 Section 6.2.5.2 or provisions for approved engineering analysis in Section 403.3.1.1 of the International Mechanical Code.

Credits achieved for measure G02 shall be calculated as follows:

$$EC_{G02\_ach} = EC_{G02\_base} \times EC_{G02\_adj}$$

**Equation 4-30**

where:

$EC_{G02\_ach}$  = Demand responsive control credit achieved for project.

$EC_{G02\_base}$  = G02 Base energy credit from Section C406.3.

$EC_{G02\_adj}$  = Energy credit adjustment factor from Table C406.3.3.

**TABLE C406.3.3 ENERGY CREDIT ADJUSTMENT BASED ON USE OF VENTILATION SHIFT OR DEMAND RESPONSE**

**C406.3.4 G03 Automated shading load management.**

Where *fenestration* on east, south and west exposures is greater than 20 percent of the wall area, load management credits shall be achieved as follows:

1. *Automatic* exterior shading devices or *dynamic glazing* that is capable of reducing solar gain through sunlit *fenestration* by not less than 50 percent when fully closed shall receive the

full credits in Tables C406.3(1) through C406.3(9). The exterior shades shall have fully open and fully closed *solar heat gain coefficient* (SHGC) determined in accordance with AERC 1.

2. *Automatic* interior shading devices with a solar reflectance of not less than 0.50 for the surface facing the *fenestration* shall receive 40 percent of the credits in Tables C406.3(1) through C406.3(9).

3. All shading devices, *dynamic glazing* or shading attachments shall:
  - 3.1. Provide not less than 90 percent coverage of the total *fenestration* on east, south and west exposures in the *building* to achieve the credits determined in Item 1 or 2. Alternatively, provide not less than 70 percent coverage of the total *fenestration* on the south and west exposures in the *building* to achieve 50 percent of the credits determined in Item 1 or 2.
  - 3.2. Be automatically controlled and shall modulate in multiple steps or continuously the amount of solar gain and light transmitted into the space in response to peak periods and either daylight levels or solar intensity.
  - 3.3. Include a *manual* override located in the same enclosed space as the shaded vertical *fenestration* that shall override operation of *automatic* controls for not longer than 4 hours. Such override shall be locked out during peak periods.

For this section, directional exposures shall exclude *fenestration* that has an orientation deviating by more than 45 degrees of facing the cardinal direction. In the southern hemisphere, where the south exposure is referred to, it shall be replaced by the north exposure.

**C406.3.5 G04 Electric energy storage.**

Electric storage devices shall be charged and discharged by *automatic* load management controls to store energy during nonpeak periods and use stored energy during peak periods to reduce *building* demand. Electric storage devices shall have a minimum capacity of 16 Wh/m<sup>2</sup> (1.5 Wh/ft<sup>2</sup>) of gross building area. Base credits in Tables C406.3(1) through C406.3(9) are based on installed electric storage of 54 Wh/m<sup>2</sup> (5 Wh/ft<sup>2</sup>) and shall be prorated for actual installed storage capacity between 1.5 and 15 Wh/ft<sup>2</sup> (16 to 161 Wh/m<sup>2</sup>), as follows:

**Equation 4-31** [installed electric storage capacity, Wh/ft<sup>2</sup>(Wh/m<sup>2</sup>)]/5(54)×[table credits for Section C406.3.5]

Larger energy storage shall be permitted; however, credits are limited to the range of 1.5 to 15 Wh/ft<sup>2</sup> (16 to 161 Wh/m<sup>2</sup>).

#### C406.3.6 G05 Cooling energy storage.

*Automatic* load management controls shall be capable of activating ice or chilled water storage equipment to reduce demand during summer peak periods. Storage tank standby loss shall be demonstrated through analysis to be not more than 2 percent of storage capacity over a 24-hour period for the cooling design day. Base credits in [Section C406.3](#) are based on storage capacity of the design peak hour cooling load with a 1.15 sizing factor. Credits shall be prorated for installed storage systems sized between 0.5 and 4.0 times the design day peak hour cooling load, rounded to the nearest whole credit. Larger storage shall be permitted but the associated credits are limited to the range provided in this section. Energy credits shall be determined as follows:

$$EC_s = EC_{1.0} \times (1.44 \times SR + 0.71) / 2.15$$

#### Equation 4-32

here:

$EC_s$  = Cooling storage credit achieved for project.

$EC_{1.0}$  = G05 base energy credit for building use type and climate zone based on 1.0 ton-hours storage per design day ton (kWh/kW) of cooling load.

$SR$  = Storage ratio in ton-hours storage per design day ton (kWh/kW) of cooling load where  $0.5 \leq SR \leq 4.0$ .

#### C406.3.7 G06 Service hot water energy storage.

Where service hot water (SHW) is heated by electricity, *automatic* load management controls complying with [ANSI/CTA-2045-B](#) shall preheat stored SHW before the peak period and suspend electric water heating during the peak period. Storage capacity shall be provided by either:

1. Preheating water above 140°F (60°C) delivery temperature with at least 1.34 kWh of energy storage per kW of water-heating capacity. Tempering valves shall be provided at the water heater delivery location.
2. Providing additional heated water tank storage capacity above peak SHW demand with equivalent peak storage capacity to item 1.

Credits earned for measure G06 shall be calculated using [Equation 4-33](#):

$$EC_{G06\_ach} = EC_{G06\_base} \times EC_{G06\_adj}$$

#### Equation 4-33

where:

$EC_{G06\_ach}$  = SWH energy storage credit achieved for project.

$EC_{G06\_base}$  = G06 Base energy credit from [Section C406.3](#).

$EC_{G06\_adj}$  = Energy credit adjustment factor from [Table C406.3.7](#).

#### TABLE C406.3.7 ENERGY CREDIT ADJUSTMENT BASED ON USE OF HEAT PUMP WATER HEATER OR DEMAND RESPONSE

##### C406.3.8 G07 Building thermal mass.

The project shall have additional passive interior mass and a night flush control of the HVAC system. The credit is available to projects that have at least 80 percent of gross floor area unoccupied between midnight and 6:00 a.m. The project shall meet the following requirements:

1. Interior to the *building thermal envelope* insulation, provide 10 pounds per foot (15 kg/m) of project conditioned floor area of passive thermal mass in the *building interior wall*, the inside of the exterior wall or the interior floor construction. Mass construction shall have mass surfaces directly contacting the air in *conditioned spaces* with directly attached gypsum panels allowed. Mass with carpet or furred gypsum panels or exterior wall mass that is on the exterior of the insulation layer [e.g., the portion of concrete masonry unit (CMU) block on the exterior of insulation-filled cell cavities] shall not be included toward the *building mass* required.
2. HVAC units for 80 percent or more of the supply airflow in the project shall be equipped with outdoor air economizers and fans that have variable or low speed capable of operating at 66 percent or lower airflow and be included in the night flush control sequence.
3. Night flush controls shall be configured with the following sequence, or another night flush strategy shall be permitted where demonstrated to be effective, avoids added morning heating and is approved by the authority having jurisdiction.
  - 3.1. Summer mode shall be activated when outdoor air temperature exceeds 70°F (21°C) and shall continue uninterrupted until deactivated when outdoor air temperature falls below 45°F (7°C). During summer mode, the occupied cooling setpoint shall be set 1°F (0.6°C) higher than normal and the occupied heating setpoint shall be reset 2°F (1.1°C) lower than normal.
  - 3.2. Where all the following conditions

exist, night flush shall be activated:

3.2.1. Summer mode is active in accordance with Item 3.1.

3.2.2. Outdoor air temperature is 5°F (2.8°C) or more below indoor average zone temperature.

3.2.3. Indoor average zone temperature is greater than morning occupied heating setpoint.

3.2.4. In Climate Zones 0A, 1A, 2A and 3A, outdoor dewpoint is below 50°F (10°C) or outdoor air enthalpy is less than indoor air enthalpy.

3.2.5. Local time is between 10:00 p.m. and 6:00 a.m.

3.3. When night flush is active, automatic night flush controls shall operate outdoor air economizers at low fan speed not exceeding 66 percent during the unoccupied period with mechanical cooling and heating locked out.

cost. The amount of renewable energy purchased from off-site sources shall be the same in the *standard reference design* and the *proposed design*.

$$PAEC = 100 \times (0.80 + 0.025 - EC_r) / 1000$$

**Equation 4-34**

where:

PAEC = The percentage of the annual energy cost of the standard reference design.

EC<sub>r</sub> = Energy efficiency credits required for the building in accordance with [Section C406.1](#) (do not include load management and renewable credits).

**Exceptions:**

1. Jurisdictions that require site energy (1 kWh = 3413 Btu) rather than *energy cost* as the metric of comparison.
2. Where energy use based on source energy expressed in Btu or Btu per square foot of *conditioned floor area* is substituted for the *energy cost*, the energy use shall be calculated using source energy factors from [Table C407.2\(2\)](#). For electricity, US locations shall use values from eGRID subregions. Locations outside the United States shall use the value for "All other electricity" or locally derived values.

**SECTION C407 SIMULATED BUILDING PERFORMANCE**

**C407.1 Scope.**

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

**Exception:** Energy used to recharge or refuel vehicles that are used for on-road and off-site transportation purposes.

**C407.2 Mandatory Requirements.**

Compliance based on *simulated building performance* requires that a *proposed design* meet all of the following:

1. The requirements of the sections indicated within [Table C407.2\(1\)](#).
2. An annual *energy cost* that is less than or equal to the percentage of the annual *energy cost* (PAEC) of the *standard reference design* calculated in [Equation 4-34](#). 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 Data System Prices and Expenditures reports. *Code officials* shall be permitted to require time-of-use pricing in *energy cost* calculations. The reduction in *energy cost* of the *proposed design* associated with *on-site renewable energy* shall be not more than 5 percent of the total *energy*

**TABLE C407.2(1) REQUIREMENTS FOR SIMULATED BUILDING PERFORMANCE**  
**TABLE C407.2(2) SOURCE ENERGY CONVERSION FACTORS FOR ELECTRICITY**

**C407.3 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*.

**C407.3.1 Compliance Report.**

Permit submittals shall include a report documenting 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 specified in [Table C407.4.1\(1\)](#). 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.

4. Name and version of the compliance software tool.

#### **C407.3.2 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 reports 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.
5. A certification signed by the builder providing the building component characteristics of the *proposed design* as given in Table C407.4.1(1).
6. Documentation of the reduction in energy use associated with *on-site renewable energy*.

#### **C407.4 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.

##### **C407.4.1 Building Specifications.**

The *standard reference design* and *proposed design* shall be configured and analyzed as specified by Table C407.4.1(1). Table C407.4.1(1) shall include by reference all notes contained in Table C402.1.2.

##### **TABLE C407.4.1(1) SPECIFICATIONS FOR THE STANDARD REFERENCE AND PROPOSED DESIGNS**

##### **TABLE C407.4.1(2) HVAC SYSTEMS MAP**

##### **TABLE C407.4.1(3) SPECIFICATIONS FOR THE STANDARD REFERENCE DESIGN HVAC SYSTEM DESCRIPTIONS**

##### **TABLE C407.4.1(4) NUMBER OF CHILLER**

##### **TABLE C407.4.1(5) WATER CHILLER TYPES**

##### **C407.4.2 Thermal blocks.**

The *standard reference design* and *proposed design* shall be analyzed using identical *thermal blocks* as specified in Section C407.4.2.1, C407.4.2.2 or C407.4.2.3.

##### **C407.4.2.1 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 that:

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.

##### **C407.4.2.2 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 4572 mm (15 feet) 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 not 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 4572 mm (15 feet) or less from a glazed perimeter wall, except that floor area within 4572 mm (15 feet) 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.

#### **C407.4.2.3 Group R-2 occupancy buildings.**

Group R-2 occupancy 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.

#### **C407.5 Calculation software tools.**

Energy modelling shall be conducted using software approved by the code official. The software shall be capable of simulating local climate conditions and generating annual energy use results for comparison with the standard reference design

#### **C407.5 Calculation software tools.**

Calculation procedures used to comply with Section C407 shall apply an *approved* version of a performance analysis software tool capable of calculating the annual energy consumption of all building elements that differ between the *standard reference design* and the *proposed design*. The same *approved* version of the performance analysis tool shall be used to calculate the *proposed design* and *standard reference design*.

#### **C407.5.1 Software tool approval.**

Any version of a performance analysis tool meeting the requirements of Sections C407.5.1.1 and C407.5.1.2 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.

#### **C407.5.1.1 Software tool capabilities.**

*Approved* software tools shall include the following capabilities:

1. *Building* operation for a full calendar year (8,760 hours).
2. 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.
3. Ten or more thermal zones.
4. 4Thermal mass effects.

5. Hourly variations in occupancy, illumination, receptacle loads, *thermostat* settings, mechanical ventilation, HVAC equipment availability, service hot water usage and any process loads.
6. Part-load performance curves for mechanical equipment.
7. Capacity and efficiency correction curves for mechanical heating and cooling equipment.
8. Printed *code official* inspection checklist listing each of the *proposed design* component characteristics from Table C407.4.1(1) determined by the analysis to provide compliance, along with their respective performance ratings, including but not limited to *R-value*, *U-factor*, SHGC, HSPF, AFUE, SEER and EF.

#### **C407.5.1.2 Testing required by software vendors.**

Prior to approval, software tools shall be tested by the software vendor in accordance with ASHRAE Standard 140-2020, except Sections 7 and 8. During testing, hidden inputs that are not normally available to the user shall be permitted to avoid introducing source code changes strictly used for testing. Software vendors shall publish, on a publicly available website, the following ASHRAE Standard 140-2020 test results, input files and modeler reports for each tested version of a software tool:

1. Test results that demonstrate the software tool was tested in accordance with ASHRAE Standard 140-2020 and that meet or exceed the values for "The Minimum Number of Range Cases within the Test Group to Pass" for all test groups in ASHRAE Standard 140, Table A3-14.
2. Test results of the performance analysis tool and input files used for generating the ASHRAE Standard 140-2020 test cases along with the results of the other performance analysis tools included in ASHRAE Standard 140-2020, Annexes B8 and B16.
3. The modeler report in ASHRAE Standard 140, Annex A2, Attachment A2.7, Report Blocks A and G shall be completed for

results exceeding the maximum or falling below the minimum of the reference values shown in ASHRAE Standard 140-2020, Tables A3-1 through A3-13 and Report Blocks A and E shall be completed for any omitted results.

#### **C407.5.2 Algorithms not tested.**

Algorithms not tested in accordance with Section C407.5.1.2, including algorithms that are alternatives to those that were tested and numerical settings not tested, such as time steps and tolerances, shall be permitted to be used where modeling the *proposed design* and *standard reference design*.

#### **C407.5.3 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.

#### **C407.5.4 Exceptional calculation methods.**

Where the simulation program does not model a design, material or device of the *proposed design*, an exceptional calculation method shall be used where *approved* by the *code official*. Where there are multiple designs, materials or devices that the simulation program does not model, each shall be calculated separately, and exceptional savings determined for each. The total exceptional savings shall not constitute more than half of the difference between the baseline *simulated building performance* and the proposed *simulated building performance*. Applications for approval of an exceptional method shall include all of the following:

1. Step-by-step documentation of the exceptional calculation method performed, detailed enough to reproduce the results.
2. Copies of all spreadsheets used to perform the calculations.
3. A sensitivity analysis of energy consumption where each of the input parameters is varied from half to double the value assumed.
4. The calculations shall be performed on a time step basis consistent with the simulation program used.
5. The performance rating calculated with and without the exceptional calculation method.

### **SECTION C408 MAINTENANCE INFORMATION AND SYSTEM COMMISSIONING**

#### **C408.1 General.**

Section C408 (Maintenance Information and

System Commissioning) shall be considered a recommended best practice under CREEBC 2024. Mandatory application may be required by the competent authority for:

- Government or donor-funded projects;
- Large commercial or institutional buildings with gross conditioned floor area greater than 10,000 m<sup>2</sup>;
- Projects specifically targeting high-performance building certification or financial incentives.
- Broader application may be phased in once sufficient local capacity for commissioning services is established."

#### **C408.1.1 Building operations and maintenance information.**

The *building* operations and maintenance documents shall be provided to the *owner* and shall consist of manufacturers' information, specifications and recommendations; programming procedures and data points; narratives; and other means of illustrating to the *owner* how the *building*, equipment and systems are intended to be installed, maintained and operated. Required regular maintenance actions for equipment and systems shall be clearly stated on a readily visible label. The label shall include the title or publication number for the operation and maintenance manual for that particular model and type of product.

#### **C408.2 Mechanical systems and service water-heating systems commissioning and completion requirements.**

Prior to the final mechanical and plumbing inspections, the *registered design professional or approved agency* shall provide evidence of mechanical systems *commissioning* and completion in accordance with 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* or owner's authorized agent and made available to the *code official* upon request in accordance with Sections C408.2.4 and C408.2.5.

**Exceptions:** The following systems are exempt:

1. *Buildings* with less than 10,000 square feet (929 m<sup>2</sup>) gross *conditioned floor area* and combined heating, cooling and service water heating capacity of less than 960,000 Btu/h (281 kW).
2. Components within *dwelling units* and *sleeping units* served by one of the following systems:

2.1. Simple unitary or packaged HVAC equipment listed in Table C403.3.2(1), C403.3.2(2), C403.3.2(4) or C403.3.2(5), each serving one *zone* and controlled by a single *thermostat* in the *zone* served.

2.2. Two-pipe heating systems installed in the dwelling, serving one or more *zones*.

#### **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. 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 used for air-system balancing 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 (0.746 kW), fan speed shall be adjusted to meet design flow conditions.

**Exception:** Fans with fan motors of 1 hp (0.74 kW) or less are not required to be provided with a means for air balancing.

##### **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.

**Exception:** The following equipment is not required to be equipped with a means for balancing or measuring flow:

1. Pumps with pump motors of 3.7 kW (5 hp) or less.
2. Where throttling results in not greater than 5 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 are 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.
4. Mode of operation upon a loss of power and restoration of power.

**Exception:** Unitary or packaged HVAC equipment listed in the tables in Section C403.3.2 that do not require supply air economizers.

##### **C408.2.3.2 Controls.**

HVAC and service water-heating control systems shall be tested to document that control devices, components, equipment and systems are calibrated and 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* or owner's authorized agent. The report shall be organized with mechanical and service hot water findings in separate sections to allow independent review. The report shall be identified as "Preliminary Commissioning Report," shall include the completed Commissioning Compliance Checklist, [Figure C408.2.4](#) 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.
4. Results of functional performance tests.
5. Functional performance test procedures used during the commissioning process, including measurable criteria for test acceptance.

#### **FIGURE C408.2.4 COMMISSIONING COMPLIANCE CHECKLIST**

##### **C408.2.4.1 Acceptance of report.**

*Buildings* or portions thereof, shall not be considered as acceptable for a final inspection pursuant to [Section C107.2.6](#) until the *code official* has received the Preliminary Commissioning Report from the *building owner* or owner's authorized agent.

##### **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* or owner's authorized agent within 90 days of the date of receipt of the *certificate of occupancy*.

##### **C408.2.5.1 System balancing report.**

A written report describing the activities and measurements completed in accordance with [Section C408.2.2](#).

##### **C408.2.5.2 Final commissioning report.**

A report of test procedures and results identified as

"Final Commissioning Report" shall be delivered to the *building owner* or owner's authorized agent. The report shall be organized with mechanical system and service hot water system findings in separate sections to allow independent review. The report shall include the following:

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 that cannot be performed at the time of report preparation due to climatic conditions.

#### **C408.3 Functional testing of lighting and receptacle controls.**

*Automatic* lighting and receptacle controls required by this code shall comply with this section.

##### **C408.3.1 Functional testing.**

Prior to passing final inspection, the *registered design professional* or *approved agency* shall provide evidence that the lighting and receptacle control systems have been tested to ensure that control hardware and software are calibrated, adjusted, programmed and in proper working condition in accordance with the *construction documents* and manufacturer's instructions. Functional testing shall be in accordance with [Sections C408.3.1.1](#) through [C408.3.1.3](#) for the applicable control type.

##### **C408.3.1.1 Occupant sensor controls.**

Where *occupant sensor controls* are provided, the following procedures shall be performed:

1. Certify that the *occupant sensor* has been located and aimed in accordance with manufacturer recommendations.
2. For projects with seven or fewer *occupant sensors*, each sensor shall be tested.
3. For projects with more than seven *occupant sensors*, testing shall be done for each unique combination of sensor type and space geometry. Where multiples of each unique combination of sensor type and space geometry are provided, not less than 10 percent and in no case fewer than one of each combination shall be tested unless the *code official* or design professional requires a higher percentage to be tested. Where 30 percent or more of the tested controls fail, all remaining identical combinations shall be tested.

For *occupant sensor controls* to be tested, verify the following:

3.1. Where *occupant sensor controls* include status indicators, verify correct operation.

3.2. The lights and receptacles controlled by *occupant sensor controls* turn off or down to the permitted level within the required time upon vacancy of the space.

3.3. For auto-on *occupant sensor controls*, the lights and receptacles controlled by *occupant sensor controls* turn on to the permitted level when an occupant enters the space.

3.4. For manual-on *occupant sensor controls*, the lights and receptacles controlled by *occupant sensor controls* turn on only when manually activated.

3.5. The lights are not incorrectly turned on by movement in adjacent areas or by HVAC operation.

#### **C408.3.1.2 Time-switch controls.**

Where *time-switch controls* are provided, Items 1 through 5 shall be performed for all *time-switch controls*. For projects with more than seven spaces where lighting or receptacles are controlled by *time-switch controls*, not less than 10 percent of spaces and in no case fewer than one space shall be tested according to Items 6 and 7 unless the *code official* or *registered design professional* requires a higher percentage to be tested. Where 30 percent or more of the tested spaces fail any of the requirements in Items 6 and 7, all remaining spaces shall be tested.

1. Confirm that the *time-switch control* is programmed with accurate weekday, weekend and holiday schedules.
2. Provide documentation to the *owner* of *time-switch controls* programming including weekday, weekend, holiday schedules and set-up and preference program settings.
3. Verify the correct time and date in the time switch.
4. Verify that any battery back-up is installed and energized.
5. Verify that the override time limit is set to not more than 2 hours.
6. Simulate occupied condition. Verify and document the following:

6.1. All lights can be turned on and off by their respective area control switch.

6.2. The switch only operates lighting in the *enclosed space* in which the switch is located.

6.3. Receptacles in the space

controlled by the *time-switch controls* turn on.

7. Simulate unoccupied condition. Verify and document the following:

7.1. Nonexempt lighting turns off.

7.2. *Manual* override switch allows only the lights and receptacles controlled by the time-switch controls in the *enclosed space* where the override switch is located to turn on controlled lighting and receptacles for more than 2 hours.

7.3. Receptacles controlled by the *time-switch controls* turn off.

8. Additional testing as specified by the *registered design professional*.

#### **C408.3.1.3 Daylight responsive controls.**

Where *daylight responsive controls* are provided, the following shall be verified:

1. Control devices have been properly located, field calibrated and set for accurate setpoints and threshold light levels.
2. Daylight controlled lighting loads adjust to light level setpoints in response to available daylight.
3. The calibration adjustment equipment is located for *ready access* only by authorized personnel.

#### **C408.3.1.4 High-end trim controls.**

Where lighting controls are configured for *high-end trim*, verify the following:

1. *High-end trim* maximum level has been set.
2. The calibration adjustment equipment is located for *ready access* only by authorized personnel.
3. Lighting controls with *ready access* for users cannot increase the lighting power above the maximum level established by the *high-end trim* controls.

#### **C408.3.1.5 High-end trim lighting control verification for L02 Additional Efficiency Credit.**

For the qualifying spaces associated with the project receiving the additional efficiency credits in Section C406.2.5.2, the following shall be documented while daylight responsive controls are not reducing lighting power:

1. The maximum setting for power or light output for each control group of general lighting luminaires.

2. The *high-end trim* setting for power or light output for each control group of general lighting luminaires.
3. For projects with seven or fewer claimed qualifying spaces, the reduction in light output or reduction in power due to *high-end trim* shall be tested in all spaces and shown to reduce the general lighting power or light output to not greater than 85 percent of full power or light output. For projects with more than seven claimed qualifying spaces, the reduction in light output or reduction in power due to *high-end trim* shall be tested in not less than 10 percent of spaces and not less than seven spaces and be shown to reduce general lighting power or light output to not greater than 85 percent of full power or light output. Where more than 30 percent of the tested spaces fail, the remaining qualifying spaces shall be tested.
4. Summarize the reduction in general lighting power or light output resulting from the *high-end trim* setting for each qualifying space and the floor area of each qualifying space.
5. Summarize the fraction of total floor area for spaces where *high-end trim* reduces general lighting power or light output to not greater than 85 percent of full power or light output.

**C408.3.1.6 Demand responsive lighting controls G01.**

For spaces associated with the project receiving renewable and load management credits in Section C406.3.2, the following procedures shall be performed:

1. Confirm the maximum setpoint upon receipt of the *demand response signal* has been established for each space.
2. For projects with seven or fewer spaces with controls, each space shall be tested.
3. For projects with more than seven spaces with controls, testing shall be done for each unique space type. Where multiple spaces of each space type exist, not less than 10 percent of each space type and in no case fewer than one space, shall

be tested unless the *code official* requires a higher percentage to be tested. Where 30 percent or more of the tested controls fail in a space type, all remaining identical space types shall be tested.

4. For demand responsive controls to be tested, verify the following:
  - 4.1. Where *high-end trim* controls are used, the *high-end trim* shall be set before testing.
  - 4.2. Turn off all non-general lighting in the space.
  - 4.3. Set *general lighting* to its maximum illumination level. Where *high-end trim* is set, this will be the maximum illumination level at the *high-end trim* setpoint.
  - 4.4. An illumination measurement shall be taken in an area of the space not controlled by daylight responsive controlled lighting. If there is not an area without *daylight responsive controls*, the *daylight responsive controls* shall be overridden from reducing the lighting level during the test.
  - 4.5. Measure and document the maximum illumination level of the space.
5. Simulate a *demand response signal* and measure the illumination level at the same location as for the measurement in Section C408.3.1.6, Item 4.5. Verify the illumination level has been reduced to not greater than 80 percent of the maximum illumination level documented in Section C408.3.1.6, Item 4.5.
6. Simulate the end of a demand event by turning off the *demand response signal*; confirm controls automatically return to their normal operational settings at the end of the demand response event.

**C408.3.2 Documentation requirements.**

The *construction documents* shall specify that the documents described in this section be provided to the *building owner* or owner's authorized agent within 90 days of the date of receipt of the *certificate of occupancy*.

**C408.3.2.1 Drawings.**

*Construction documents* shall include the location and catalogue number of each piece of equipment.

**C408.3.2.2 Manuals.**

An operating and maintenance manual shall be provided and include the following:

1. Name and address of not less than one service agency for installed equipment.

2. A narrative of how each system is intended to operate, including recommended setpoints.
3. Submittal data indicating all selected options for each piece of lighting equipment and lighting controls.
4. Operation and maintenance manuals for each piece of lighting equipment. Required routine maintenance actions, cleaning and recommended relamping shall be clearly identified.
5. A schedule for inspecting and recalibrating all lighting controls.

#### C408.3.2.3 Report.

A report of test results shall be provided and include the following:

1. Results of functional performance tests.
2. Disposition of deficiencies found during testing, including details of corrective measures used or proposed.

### SECTION C409 CALCULATION OF THE HVAC TOTAL SYSTEM PERFORMANCE RATIO

#### C409.1 Applicability

Section C409 should be considered as optional in CREEBC 2024, with the following approach:

- Encourage voluntary adoption of TSPR for larger, complex, or government-led demonstration projects.
- Retain C409 in the code text as an appendix or optional compliance path, allowing early market players to use it.
- Defer mandatory enforcement until supporting infrastructure (simulation tools, reference baselines, trained code officials) is established.

#### C409.2 Permitted uses.

Only HVAC systems that serve building occupancies and uses in [Table C409.4](#) and are not excluded by [Section C409.2.1](#) shall be permitted to use the TSPR method.

##### C409.2.1 Systems not permitted.

The following HVAC systems are not permitted to use [Section C403.1](#), Item 3:

1. HVAC systems using:
  - 1.1. District heating water, chilled water or steam.
  - 1.2. Small-duct high-velocity air-cooled, space-constrained air-cooled, or single-package vertical air conditioner; single-package

vertical heat pump; or double-duct air conditioner or double-duct heat pump, as defined in subpart F to [10 CFR Part 431](#).

1.3. Packaged terminal air conditioners and packaged terminal heat pumps that have a cooling capacity greater than 12,000 Btu/h (3.5 kW).

1.4. A common heating source serving both HVAC and *service water heating* equipment.

2. HVAC systems that provide recovered heat for *service water heating*.
3. HVAC systems not specified in [Table C409.6.1.10.1](#).
4. HVAC systems specified in [Table C409.6.1.10.1](#) with characteristics or parameters in [Table C409.6.1.10.2\(1\)](#), not identified as applicable to that HVAC system type.
5. HVAC systems with chilled water supplied by absorption chillers, heat recovery chillers, water-to-water heat pumps, air-to-water heat pumps, or a combination of air- and water-cooled chillers on the same chilled water loop.
6. HVAC systems served by heating water systems that include air-to-water or water-to-water heat pumps.
7. Underfloor air distribution and displacement ventilation HVAC systems.
8. Space-conditioning systems that do not include mechanical cooling.
9. HVAC systems serving laundry rooms, elevator rooms, mechanical rooms, electrical rooms, *data centers* and *computer rooms*.
10. *Buildings* or areas of medical office buildings required to use [ASHRAE Standard 170-2021](#).
11. *Buildings* or areas that are required by regulation to have continuous air-handling unit operation.
12. HVAC systems serving laboratories with fume hoods.
13. Locker rooms with more than two showers.
14. Natatoriums and rooms with saunas.
15. Restaurants and commercial kitchens with a total cooking capacity greater than 100,000 Btu/h (29 kW).
16. Areas of *buildings* with commercial refrigeration equipment exceeding 100 kW of power input.

17. Cafeterias and dining rooms.

#### **C409.3 HVAC TSPR compliance.**

HVAC systems permitted to use TSPR shall comply with Section C409.4 and the following:

1. HVAC systems shall comply with applicable requirements of Section C403 as follows:
  - 1.1. Air economizers shall meet the requirements of Sections C403.5.3.4 and C403.5.5.
  - 1.2. Variable-air-volume systems shall meet the requirements of Sections C403.6.5, C403.6.6 and C403.6.9.
  - 1.3. Hydronic systems shall meet the requirements of Section C403.4.4.
  - 1.4. Plants with multiple chillers or boilers shall meet the requirements of Section C403.4.5.
  - 1.5. Hydronic (water loop) heat pumps and water-cooled unitary air conditioners shall meet the requirements of Section C403.4.3.3.
  - 1.6. Cooling tower turndown shall meet the requirements of Section C403.11.4.
  - 1.7. Heating of unenclosed spaces shall meet the requirements of Section C403.14.1.
  - 1.8. Hot-gas bypass shall meet the requirements of Section C403.3.3.
  - 1.9. Systems shall meet the operable openings interlock requirements of Section C403.4.7. Refrigeration systems shall meet the requirements of Section C403.12.
2. Systems shall comply with the applicable provisions of Section C403 required by Table C407.2.

#### **C409.4 Performance target.**

For HVAC systems serving uses or portions of uses listed in Section C409.2 that are not served by systems listed in Section C409.2.1, the HVAC TSPR of the *proposed design* shall be greater than or equal to the HVAC TSPR of the *standard reference design* divided by the mechanical performance factor (MPF) using Equation 4-35.

$$TSPR_p > TSPR_r / MPF$$

#### **Equation 4-35**

where:

$TSPR_p$  = HVAC TSPR of the proposed design calculated in accordance with Sections C409.4, C409.5 and C409.6.

$TSPR_r$  = HVAC TSPR of the reference building

design calculated in accordance with Sections C409.4, C409.5 and C409.6.

MPF = Mechanical performance factor from Table C409.4 based on climate zone and building use type.

$$MPF = (A_1 \times MPF_1 + A_2 \times MPF_2 + \dots + A_n \times MPF_n) / (A_1 + A_2 + \dots + A_n)$$

#### **Equation 4-36**

where:

$MPF_1, MPF_2$  through  $MPF_n$  = Mechanical performance factors from Table C409.4 based on climate zone and building use types 1, 2 through  $n$ .  
 $A_1, A_2$  through  $A_n$  = Conditioned floor areas for building use types 1, 2 through  $n$ .

#### **TABLE C409.4 MECHANICAL PERFORMANCE FACTORS**

##### **C409.4.1 HVAC TSPR.**

HVAC TSPR is calculated according to Equation 4-37.

**Equation 4-37** HVAC TSPR = heating and cooling load/building HVAC system energy

where:

Building HVAC system energy = Sum of the annual site energy consumption for heating, cooling, fans, energy recovery, pumps and heat rejection in thousands of Btu (kWh).

Heating and cooling load = Sum of the annual heating and cooling loads met by the building HVAC system in thousands of Btu (kWh).

##### **C409.5 General.**

Projects shall use the procedures of this section when calculating compliance using HVAC total system performance ratio.

##### **C409.5.1 Simulation program.**

Simulation tools used to calculate the HVAC TSPR of the *standard reference design* shall comply with the following:

1. The simulation program shall calculate the HVAC TSPR based only on the input for the *proposed design* and the requirements of Section C409. The calculation procedure shall not allow the user to directly modify the building component characteristics of the *standard reference design*.
2. Performance analysis tools shall meet the applicable subsections of Section C409 and be tested in accordance with ASHRAE Standard 140-2020, except for Sections 7 and 8. The required tests shall include the *building thermal envelope* and fabric load test (Sections 5.2.1, 5.2.2 and 5.2.3), ground-coupled slab-on-grade analytical verification tests

(Section 5.2.4), space-cooling equipment performance tests (Section 5.3), space heating equipment performance tests (Section 5.4), and air-side HVAC equipment analytical verification test (Section 5.5), along with the associated reporting (Section 6).

3. The test results and modeler reports shall be publicly available and shall include the test results of the simulation programs and input files used for generating the results along with the results of the other simulation programs included in ASHRAE Standard 140-2020, Annexes B8 and B16. The modeler report in ASHRAE Standard 140-2020 Annex A2 Attachment A2.7 shall be completed for results exceeding the maximum or falling below the minimum of the reference values and for omitted results.
4. The simulation program shall have the ability to model part-load performance curves or other part-load adjustment methods based on manufacturer's part-load performance data for mechanical equipment.
5. The *code official* shall be permitted to approve specific software deemed to meet these requirements in accordance with Section C101.4.1.

#### **C409.5.2 Climatic data.**

The simulation program shall perform the simulation using hourly values of climatic 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.

#### **C409.5.3 Documentation.**

Documentation or web links to documentation conforming to the provisions of this section shall be provided to the *code official*.

##### **C409.5.3.1 Compliance report.**

Building permit submittals shall include:

1. A report produced by the simulation software that includes the following:
  - 1.1. Address of the *building*.
  - 1.2. Name of the individual completing the compliance report.
  - 1.3. Name and version of the compliance software tool.
  - 1.4. The dimensions, floor heights and number of floors for each *thermal block*.
  - 1.5. By *thermal block*, the *U*-factor, *C*-factor or *F*-factor for each simulated opaque envelope component and the *U*-

factor and SHGC for each *fenestration* component.

1.6. By *thermal block* or by surface for each *thermal block*, the *fenestration* area.

1.7. By *thermal block*, a list of the HVAC equipment simulated in the *proposed design*, including the equipment type, fuel type, equipment efficiencies and system controls.

1.8. Annual site HVAC energy use by end use for the proposed and baseline building.

1.9. Annual sum of heating and cooling loads for the baseline building.

1.10. The HVAC *TSPR* for both the *standard reference design* and the *proposed design*.

2. A mapping of the actual *building* HVAC component characteristics and those simulated in the *proposed design* showing how individual pieces of HVAC equipment identified in Item 1 have been combined into average inputs as required by Section C409.6.1.10, including:
  - 2.1. Fans.
  - 2.2. Hydronic pumps.
  - 2.3. Air handlers.
  - 2.4. Packaged cooling equipment.
  - 2.5. Furnaces.
  - 2.6. Heat pumps.
  - 2.7. Boilers.
  - 2.8. Chillers.
  - 2.9. Heat rejection equipment (open- and closed-circuit cooling towers, dry coolers).
  - 2.10. Electric resistance coils.
  - 2.11. Condensing units.
  - 2.12. Motors for fans and pumps.
  - 2.13. Energy recovery devices.
3. For each piece of equipment identified in Item 2, include the following, as applicable:
  - 3.1. Equipment name or tag consistent with that found on the design documents.
  - 3.2. Rated efficiency level.
  - 3.3. Rated capacity.
  - 3.4. Where not provided by the simulation program report in Item 1, documentation of the calculation of any weighted equipment efficiencies input into the program.
  - 3.5. Electrical input power for fans and pumps (before any speed or frequency control device) at design condition and calculation of input value (W/cfm or W/gpm) or W/gpm (W/Lps).
4. Floor plan of the *building*, identifying:
  - 4.1. How portions of the *buildings* are

assigned to the simulated thermal blocks.  
4.2. Areas of the *building* that are not covered under the requirements of Section C403.1.1.

#### **C409.6 Calculation procedures.**

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

#### **C409.6.1 Simulation of the proposed building design.**

The *proposed design* shall be configured and analyzed as specified in this section.

##### **C409.6.1.1 Thermal block geometry.**

The geometry of *buildings* shall be configured using one or more thermal blocks. Each *thermal block* shall define attributes, including *thermal block* dimensions, number of floors, floor-to-floor height and floor-to-ceiling height. Simulation software may allow the use of simplified shapes (such as rectangle, L-shaped, H-shaped, U-shaped or T-shaped) to represent thermal blocks. Where actual building shape does not match these predefined shapes, simplifications are permitted, provided that the following requirements are met:

1. The *conditioned floor area* and volume of each *thermal block* shall match the *proposed design* within 10 percent.
2. The area of each exterior envelope component from Table C402.1.4 is accounted for within 10 percent of the actual design.
3. The area of vertical *fenestration* and skylights is accounted for within 10 percent of the actual design.
4. The orientation of each component in Items 2 and 3 is accounted for within 45 degrees of the actual design.

The creation of additional *thermal blocks* may be necessary to meet these requirements. A more complex zoning of the *building* shall be allowed where all *thermal zones* in the reference and proposed models are the same, and rules related to thermal block geometry and HVAC system assignment to *thermal blocks* are met with appropriate assignment to thermal zones.

**Exception:** Portions of the *building* that are unconditioned or served by systems not covered by the requirements of Section C403.1.1 shall be omitted.

##### **C409.6.1.1.1 Number of thermal blocks.**

One or more *thermal blocks* may be required per *building* based on the following restrictions:

1. Each *thermal block* shall have not more than one building use.
2. Each *thermal block* shall be served by not more than one type of HVAC system.

A single block shall be created for each unique HVAC system and building use combination, and multiple HVAC units or components of the same type shall be combined in accordance with Section C409.6.1.10.2.

3. Each *thermal block* shall have not more than a single defined floor-to-floor or floor-to-ceiling height. Where floor heights differ by more than 2 feet, separate *thermal blocks* shall be created.
4. Each block shall include either above-grade or below-grade stories. For *buildings* with both above-grade and below-grade stories, separate blocks shall be created for each. Where blocks have *exterior walls* partially below grade, if greater than 50 percent of the exterior wall surface is below grade, then simulate the block as below grade; otherwise, simulate as above grade.
5. Where a block includes multiple stories, separate blocks shall be created, if needed, to comply with both the following *fenestration* modeling requirements:
  - 5.1. The product of the *proposed design* *U-factor* times the area of windows ( $U \times A$ ) on a given story of each facade shall not differ by more than 15 percent of the average  $U \times A$  for that modeled facade in each block.
  - 5.2. The product of the *proposed design* SHGC times the area of windows ( $SHGC \times A$ ) on a given story of each facade shall not differ by more than 15 percent of the average  $SHGC \times A$  for that modeled facade in each block.
6. For a building model with multiple blocks, the blocks shall be configured together to have the same adjacencies as the actual building design.

##### **C409.6.1.2 Thermal zoning.**

Each story in a *thermal block* shall be modeled as follows:

1. Below-grade stories shall be modeled as a single thermal zone.
2. Where any facade in the block is less than 13.7 m (45 feet) in length, it shall be modeled as a single thermal zone per story.
3. For stories not covered by Item 1 or Item 2, each story shall be modeled with five thermal zones. A perimeter zone shall be created, extending from each facade to a

depth of 4572 mm 15 feet. Where facades intersect, the zone boundary shall be formed by a 45-degree angle with the two facades. The remaining area of each story shall be modeled as a core zone with no exterior walls.

#### **C409.6.1.2.1 Core and shell, build-out and future system construction analysis.**

Where the building permit applies to only a portion of the HVAC system in a *building* and the remaining components will be designed under a future building permit or were previously installed, such components shall be modeled as follows:

1. Blocks including existing or future HVAC zone served by independent systems and not part of the construction project shall not be modeled.
2. Where the HVAC zones that do not include complete HVAC systems in the permit are intended to receive HVAC services from systems that are part of the construction project, their proposed zonal systems shall be modeled with equipment that meets, but does not exceed, the requirements of [Section C403](#).
3. Where existing HVAC systems serve permitted zone equipment, the existing systems shall be modeled with equipment matching the manufacturer's stated efficiency for the installed equipment or equipment that meets, but does not exceed, the requirements of [Section C403](#).
4. Where the central plant heating and cooling equipment is completely replaced and HVAC zones with existing systems receive HVAC services from systems in the permit, their proposed zonal systems shall be modeled with equipment that meets, but does not exceed, the requirements of [Section C403](#).

#### **C409.6.1.3 Occupancy.**

Building occupancies modeled in the *standard reference design* and the *proposed design* shall comply with the following requirements.

##### **C409.6.1.3.1 Occupancy type.**

The occupancy type for each thermal block shall be consistent with the building occupancy and uses specified in [Table C409.4](#). Portions of the building occupancy and uses other than those specified in [Table C409.4](#) shall not be included in the simulation. Surfaces adjacent to such excluded *building* portions shall be modeled as adiabatic in the simulation program.

##### **C409.6.1.3.2 Occupancy schedule, density and heat gain.**

The occupant density, heat gain and schedule shall be for multifamily, offices, retail spaces, libraries, hotels/motels or schools as specified by [ANSI/ASHRAE/IES 90.1-2022](#), Normative Appendix C.

#### **C409.6.1.4 Building thermal envelope components.**

*Building thermal envelope* components modeled in the *standard reference design* and the *proposed design* shall comply with the requirements of this section.

##### **C409.6.1.4.1 Roofs.**

The roof *U-factor* and area shall be modeled as in the *proposed design*. If different roof thermal properties are present in a single *thermal block*, an area-weighted *U-factor* shall be used. Roofs shall be modeled with insulation above a steel roof deck, with a solar reflectance of 0.25 and an *emittance* of 0.90.

**Exception:** For Climate Zones 0, 1, 2 and 3, solar reflectance and *emittance* shall be as specified in [Section C402.4](#) and [Table C402.4](#).

##### **C409.6.1.4.2 Above-grade walls.**

The *U-factor* and area of *above-grade walls* shall be modeled as in the *proposed design*. If different wall constructions exist on the facade of a thermal block, an area-weighted *U-factor* shall be used. Walls will be modeled as steel-frame construction.

##### **C409.6.1.4.3 Below-grade walls.**

The *C-factor* and area of *below-grade walls* shall be modeled as in the *proposed design*. If different *below-grade wall* constructions exist in a *thermal block*, an area-weighted *C-factor* shall be used.

##### **C409.6.1.4.4 Above-grade exterior floors.**

The *U-factor* and area of floors shall be modeled as in the *proposed design*. If different floor constructions exist in the *thermal block*, an area-weighted *U-factor* shall be used. Exterior floors shall be modeled as steel frame.

##### **C409.6.1.4.5 Slab-on-grade floors.**

The *F-factor* and perimeter of slab-on-grade floors shall be modeled as in the *proposed design*. If different slab-on-grade floor constructions exist in a *thermal block*, a perimeter-weighted *F-factor* shall be used.

##### **C409.6.1.4.6 Vertical fenestration.**

The window area and area-weighted *U-factor* and SHGC shall be modeled for each facade based on the *proposed design*. Each exterior surface in a *thermal block* must comply with [Section C409.6.1.1.1](#), Item 5. Windows shall be combined into a single window centered on each facade based on the area and sill height input by the user. Where different *U-values*, SHGC or sill heights exist on a single facade in a block, the area-weighted average for each shall be input by the user.

##### **C409.6.1.4.7 Skylights.**

The skylight area and area-weighted *U-factor* and SHGC shall be modeled for each roof based on the *proposed design*. Skylights shall be combined into a single skylight centered on the roof of each zone based on the area input by the user.

#### **C409.6.1.4.8 Exterior shading.**

Permanent window overhangs shall be modeled. Where windows with and without overhangs or windows with different overhang projection factors exist on a facade, window width-weighted projection factors shall be input by the user as follows:

$$P_{avg} = (A_1 \times L_{o1} + A_2 \times L_{o2..} + A_n \times L_{on}) / (L_{w1} + L_{w2..} + L_{wn})$$

#### **Equation 4-38**

where:

$P_{avg}$  = Average overhang projection modeled in the simulation tool.

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

$L_o$  = Length off the overhang.

$L_w$  = Length of the window.

#### **C409.6.1.5 Lighting.**

Interior lighting power density shall be equal to the allowance in Table C405.3.2(1) for multifamily buildings, offices, retail spaces, libraries or schools. The lighting schedule shall be for multifamily buildings, offices, retail spaces, libraries or schools as specified by ANSI/ASHRAE/IES 90.1-2022, Normative Appendix C. The impact of lighting controls is assumed to be captured by the lighting schedule and no explicit controls shall be modeled. Exterior lighting shall not be modeled.

#### **C409.6.1.6 Miscellaneous equipment.**

The miscellaneous equipment schedule and power shall be for multifamily buildings, offices, retail spaces, libraries or schools as specified by ANSI/ASHRAE/IES 90.1-2022, Normative Appendix C. The impact of miscellaneous equipment controls is assumed to be captured by the equipment schedule and no explicit controls shall be modeled.

#### **Exceptions:**

1. Multiple-family dwelling units shall have a miscellaneous load density of 0.42 watts per square foot.
2. Multiple-family *common areas* shall have a miscellaneous load density of 0 watts per square foot.

#### **C409.6.1.7 Elevators.**

Elevators shall not be modeled.

#### **C409.6.1.8 Service water heating equipment.**

*Service water heating* shall not be modeled.

#### **C409.6.1.9 On-site renewable energy systems.**

On-site renewable energy systems shall not be modeled.

#### **C409.6.1.10 HVAC equipment.**

Where proposed or where reference system parameters are not specified in Section C409, HVAC systems shall be modeled to meet the minimum requirements of Section C403.

#### **C409.6.1.10.1 Supported HVAC systems.**

At a minimum, the HVAC systems shown in Table C409.6.1.10.1 shall be supported by the simulation program.

#### **TABLE C409.6.1.10.1 PROPOSED BUILDING HVAC SYSTEMS SUPPORTED BY HVAC TSPR SIMULATION SOFTWARE**

#### **C409.6.1.10.2 Proposed building HVAC system simulation.**

The HVAC systems shall be modeled as in the *proposed design* at design conditions unless otherwise stated, with clarifications and simplifications as described in Tables C409.6.1.10.2(1) and C409.6.1.10.2(2). System parameters not described in the following sections shall be simulated to meet the minimum requirements of Section C403. All zones within a thermal block shall be served by the same HVAC system type as described in Section C409.6.1.1.1, Item 2. Heat loss from *ducts* and pipes shall not be modeled. The proposed building system parameters in Table C409.6.1.10.2(1) are based on input of full-load equipment efficiencies with adjustments using part-load curves integrated into the simulation program. Where other approaches to part-load adjustments are used, it is permitted for specific input parameters to vary. The simulation program shall model part-load HVAC equipment performance using one of the following:

1. Full-load efficiency adjusted for fan power input that is modeled separately and typical part-load performance adjustments for the proposed equipment.
2. Part-load adjustments based on input of both full-load and part-load metrics.
3. Equipment-specific adjustments based on performance data provided by the equipment manufacturer for the proposed equipment.

Where multiple system components serve a thermal block, average values weighted by the appropriate metric as described in this section shall be used.

1. Where multiple *fan systems* serve a single thermal block, fan power shall be based on a weighted average using the design supply air (cfm).
2. Where multiple cooling systems serve a single thermal block, the coefficient of performance (COP) shall be based on a weighted average using cooling capacity. Direct expansion (DX) coils shall be

entered as multistage if more than 50 percent of coil capacity serving the thermal block is multistage with staged controls.

3. Where multiple heating systems serve a single thermal block, thermal efficiency or heating COP shall be based on a weighted average using heating capacity.
4. Where multiple boilers or chillers serve a heating water or chilled water loop, efficiency shall be based on a weighted average for using heating or cooling capacity.
5. Where multiple cooling towers serving a condenser water loop are combined, the cooling tower efficiency, cooling tower design approach and design range are based on a weighted average of the design water flow rate through each cooling tower.
6. Where multiple pumps serve a heating water, chilled water or condenser water loop, pump power shall be based on a weighted average for using design water flow rate.
7. Where multiple system types with and without economizers are combined, the economizer maximum outside air fraction of the combined system shall be based on the weighted average of 100 percent supply air for systems with economizers and design outdoor air for systems without economizers.
8. Multiple systems with and without ERVs cannot be combined.
9. Systems with and without supply-air temperature reset controls cannot be combined.
10. Systems with different fan controls (constant volume, multispeed or VAV) for supply fans cannot be combined.

**TABLE C409.6.1.10.2(1) PROPOSED BUILDING SYSTEM PARAMETERS**

**TABLE C409.6.1.10.2(2) FAN AND PUMP POWER CURVE COEFFICIENTS**

**C409.6.1.10.3 Demand control ventilation.**

Demand control ventilation (DCV) shall be modeled using a simplified approach that adjusts the design outdoor supply airflow rate based on the floor area of the *building* that is covered by DCV. The simplified method shall accommodate both variable DCV and on/off DCV, giving on/off DCV one third of the effective floor control area of the variable DCV. Outdoor air reduction coefficients shall be as stated

in [Table C409.6.1.10.3](#).

**Exception:** On/off DCV shall receive full effective area adjustment for R-1 and R-2 occupancies.

**TABLE C409.6.1.10.3 DCV OUTDOOR AIR REDUCTION CURVE COEFFICIENTS**

**C409.6.2 Simulation of the standard reference design.**

The *standard reference design* shall be configured and analyzed as specified in this section.

**C409.6.2.1 Utility rates.**

Same as the *proposed design*.

**C409.6.2.2 Thermal blocks.**

Same as the *proposed design*.

**C409.6.2.3 Thermal zoning.**

Same as the *proposed design*.

**C409.6.2.4 Occupancy type, schedule, density and heat gain.**

Same as the *proposed design*.

**C409.6.2.5 Envelope components.**

Same as the *proposed design*.

**C409.6.2.6 Lighting.**

Same as the *proposed design*.

**C409.6.2.7 Miscellaneous equipment.**

Same as the *proposed design*.

**C409.6.2.8 Elevators.**

Not modeled. Same as the *proposed design*.

**C409.6.2.9 Service water heating equipment.**

Not modeled. Same as the *proposed design*.

**C409.6.2.10 On-site renewable energy systems.**

Not modeled. Same as the *proposed design*.

**C409.6.2.11 HVAC equipment.**

The reference building design HVAC equipment consists of separate space conditioning systems as described in [Tables C409.6.2.11\(1\)](#) through [C409.6.2.11\(3\)](#) for the appropriate building use types. In these tables, “warm” refers to Climate Zones 0 through 2 and 3A, and “cold” refers to Climate Zones 3B, 3C and 4 through 8.

**TABLE C409.6.2.11(1) REFERENCE BUILDING DESIGN HVAC COMPLEX SYSTEMS**

**TABLE C409.6.2.11(2) TSPR REFERENCE BUILDING DESIGN HVAC SIMPLE SYSTEMS**

**TABLE C409.6.2.11(3) TSPR REFERENCE BUILDING DESIGN HVAC SIMPLE SYSTEMS**

**C409.7 Target design HVAC systems.**

Target system descriptions in [Tables C409.7\(1\)](#) through [C409.7\(3\)](#) are provided as reference. The target systems are used for developing mechanical performance factors and do not need to be programmed into TSPR software.

**TABLE C409.7(1) TARGET BUILDING DESIGN CRITERIA HVAC COMPLEX SYSTEMS**

**TABLE C409.7(2) TARGET BUILDING DESIGN CRITERIA HVAC SIMPLE SYSTEMS**

**TABLE C409.7(3) TARGET BUILDING DESIGN CRITERIA HVAC SIMPLE SYSTEMS**

## CHAPTER [RE] 4 RESIDENTIAL ENERGY EFFICIENCY

### SECTION R401 GENERAL

#### R401.1 Scope.

This chapter applies to residential buildings.

#### R401.2 Application.

Residential buildings shall comply with Section R401.2.1, R401.2.2, R401.2.3 or R401.2.4.

**Exception:** *Additions, alterations, repairs and changes of occupancy to existing buildings* complying with Chapter 5.

#### R401.2.1 Prescriptive Compliance Option.

The Prescriptive Compliance Option requires compliance with Sections

R401 through R404 and R408.

#### R401.2.2 Simulated Building Performance Option.

The Simulated Building Performance Option requires compliance with Section R405.

#### R401.2.3 Energy Rating Index Option.

The *Energy Rating Index* (ERI) Option requires compliance with Section R406.

#### R401.2.4 Tropical Climate Region Option.

The Tropical Climate Region Option requires compliance with Section R407.

#### R401.3 Certificate. (Not Mandatory)

A permanent certificate shall be completed by the builder or other approved party and posted on a wall in the space where the furnace is located, a utility room or an approved location inside the building. Where located on an electrical panel, the certificate shall not cover or obstruct the visibility of the circuit directory label, service disconnect label or other required labels. The certificate shall indicate the following:

1. The predominant R-values of insulation installed in or on ceilings, roofs, walls, foundation components such as slabs, basement walls, crawl space walls and floors and ducts outside conditioned spaces.
2. U-factors of fenestration and the solar heat gain coefficient (SHGC) of fenestration. Where there is more than one value for any component of the building thermal envelope, the certificate shall indicate both the value covering the largest area and the area weighted average value if available.
3. The results from any required duct system and building thermal envelope air leakage testing performed on the building.
4. The types, sizes 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 indicate "gas-fired unvented room heater," "electric furnace" or "baseboard electric heater," as appropriate. An efficiency shall not be indicated for gas-fired unvented room heaters, electric furnaces and electric baseboard heaters.

5. Where on-site photovoltaic panel systems have been installed, the array capacity, inverter efficiency, panel tilt and orientation shall be noted on the certificate.
6. For buildings where an Energy Rating Index score is determined in accordance with Section R406, the Energy Rating Index score, both with and without any on-site generation, shall be listed on the certificate.
7. The code edition under which the structure was permitted, the compliance path used and, where applicable, the additional efficiency measures selected for compliance with Section R408.
8. The location and dimensions of a solar-ready zone where one is provided.

### SECTION R402 BUILDING THERMAL ENVELOPE

#### R402.1 General.

The building thermal envelope shall comply with the requirements of one of the following:

1. Sections R402.1.1 through R402.1.4 and Section R402.1.6.
2. Sections R402.1.1, R402.1.5 and R402.1.6.

#### Exceptions:

1. The following low-energy *buildings*, or portions thereof, separated from the remainder of the building by *building thermal envelope* assemblies complying with this section shall be exempt from the *building thermal envelope* provisions of Section R402.
  1. Those with a peak design rate of energy usage less than  $3.4 \text{ Btu/h} \times \text{ft}^2$  ( $10.7 \text{ W/m}^2$ ) or  $1.0 \text{ watt/ft}^2$  of floor area for space-conditioning purposes.
  2. Those that do not contain *conditioned space*.

2. Log homes designed in accordance with ICC 400.

#### **R402.1.2 Insulation and fenestration criteria.**

The *building thermal envelope* shall meet the requirements of Table R402.1.2, based on the *climate zone* specified in Chapter 3. Assemblies shall have a *U-factor* or *F-factor* equal to or less than that specified in Table R402.1.2. *Fenestration* shall have a *U-factor* and glazed fenestration SHGC equal to or less than that specified in Table R402.1.2.

#### **TABLE R402.1.2 MAXIMUM ASSEMBLY U-FACTORS<sup>a</sup> AND FENESTRATION REQUIREMENTS**

#### **R402.1.3 R-value alternative.**

Assemblies with an *R-value* of insulation materials equal to or greater than that specified in Table R402.1.3 shall be an alternative to the *U-factor* or *F-factor* in Table R402.1.2.

#### **TABLE R402.1.3 INSULATION MINIMUM R-VALUES AND FENESTRATION REQUIREMENTS BY COMPONENT<sup>a</sup>**

#### **R402.1.4 R-value computation.**

*Cavity insulation* alone shall be used to determine compliance with the *cavity insulation R-value* requirements in Table R402.1.3. Where *cavity insulation* is installed in multiple layers, the *R-values* of the *cavity insulation* layers shall be summed to determine compliance with the *cavity insulation R-value* requirements. The manufacturer's settled *R-value* shall be used for blown-in insulation. *Continuous insulation* (ci) alone shall be used to determine compliance with the *continuous insulation R-value* requirements in Table R402.1.3. Where *continuous insulation* is installed in multiple layers, the *R-values* of the *continuous insulation* layers shall be summed to determine compliance with the *continuous insulation R-value* requirements. *Cavity insulation R-values* shall not be used to determine compliance with the *continuous insulation R-value* requirements in Table R402.1.3. Computed *R-values* shall not include an *R-value* for other building materials or air films. Where *insulated siding* is used for the purpose of complying with the *continuous insulation* requirements of Table R402.1.3, the manufacturer's *labelled R-value* for the *insulated siding* shall be reduced by R-0.6.

#### **R402.1.5 Component performance alternative.**

Where the proposed total *building thermal envelope* thermal conductance ( $TC_p$ ) is less than or equal to the total *building thermal envelope* thermal conductance ( $TC_r$ ) using factors in Table R402.1.2, the *building* shall be considered to be in compliance with Table R402.1.2. The total thermal conductance ( $TC$ ) shall be determined in accordance with Equation 4-1. Proposed *U-factors* and slab-on-grade *F-factors*

shall be taken from ANSI/ASHRAE/IES Standard 90.1-2022 Appendix A or determined using a method consistent with the ASHRAE Handbook of Fundamentals and shall include the thermal bridging effects of framing materials. In addition to  $TC$  compliance, the SHGC requirements of Table R402.1.2 and the maximum *fenestration U-factors* of Section R402.6 shall be met.

$$TC_p \leq TC_r$$

#### **Equation 4-1**

where:

$$TC_p = U_pA + F_pP$$

$$TC_r = U_rA + F_rP$$

$U_pA$  = the sum of proposed *U-factors* times the assembly areas in the proposed building.

$F_pP$  = the sum of the proposed *F-factors* times the slab-on-grade perimeter lengths in the proposed building.

$U_rA$  = the sum of *U-factors* in Table R402.1.2 times the same assembly areas as in the proposed building.

$F_rP$  = the sum of *F-factors* in Table R402.1.2 times the same slab-on-grade perimeter lengths as in the proposed building.

**Exception:** For Climate Zones 0, 1 and 2, the value of  $F_rP$  shall equal the value of  $F_pP$ .

#### **R402.1.6 Rooms containing fuel-burning appliances.**

In Climate Zones 3 through 8, where open combustion air *ducts* provide combustion air to open combustion fuel-burning appliances, the appliances and combustion air opening shall be located outside the *building thermal envelope* or enclosed in a room that is isolated from inside the *building thermal envelope*. Such rooms shall be sealed and insulated in accordance with the *building thermal envelope* requirements of Table R402.1.3, where the walls, floors and ceilings shall meet a minimum of the *basement wall R-value* requirement. The door into the room shall be fully gasketed and any water lines and *ducts* in the room insulated in accordance with Section R403. The combustion air *duct* shall be insulated where it passes through *conditioned space* to an *R-value* of not less than R-8.

#### **Exceptions:**

1. Direct vent appliances with both intake and exhaust pipes installed continuous to the outside.
2. Fireplaces and stoves complying with Section R402.5.2 and Section R1006 of the International Residential Code.

#### **R402.2 Specific insulation requirements.**

In addition to the requirements of Section R402.1, insulation shall meet the specific requirements

of Sections R402.2.1 through R402.2.13.

#### **R402.2.1 Ceilings with attics.**

Where Section R402.1.3 requires R-38 insulation in the ceiling or attic, installing R-30 over 100 percent of the ceiling or attic area requiring insulation shall satisfy the requirement for R-38 insulation wherever the full height of uncompressed R-30 insulation extends over the wall top plate at the eaves. Where Section R402.1.3 requires R-49 insulation in the ceiling or attic, installing R-38 over 100 percent of the ceiling or attic area requiring insulation shall satisfy the requirement for R-49 insulation wherever the full height of uncompressed R-38 insulation extends over the wall top plate at the eaves. This reduction shall not apply to the insulation and fenestration criteria in Section R402.1.2 and the component performance alternative in Section R402.1.5.

Recommendation: R30 everywhere as long as it covers the full attic uniformly to the top plate. Instead of R49, use R 38 as long as it covers the full attic uniformly to the top table

#### **R402.2.2 Ceilings without attics.**

Where Section R402.1.3 requires insulation *R*-values greater than R-30 in the interstitial space above a ceiling and below the structural roof deck, and the design of the roof/ceiling assembly does not allow sufficient space for the required insulation, the minimum required insulation *R*-value for such roof/ceiling assemblies shall be R-30. Insulation shall extend over the top of the wall plate to the outer edge of such plate and shall not be compressed. This reduction of insulation from the requirements of Section R402.1.3 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 component performance alternative in Section R402.1.5.

#### **R402.2.3 Attic knee wall.**

Wood attic knee wall assemblies that separate conditioned space from unconditioned attic spaces shall comply with Table R402.1.3 for wood-framed walls. Steel attic knee wall assemblies shall comply with Section R402.2.7. Such knee walls shall have an air barrier between conditioned and unconditioned space.

#### **R402.2.3.1 Roof truss framing separating conditioned and unconditioned space.**

Where wood vertical roof truss framing members are used to separate conditioned space and unconditioned space, they shall comply with Table R402.1.3 for wood-framed walls. Steel frame vertical roof truss framing members used to separate conditioned space and unconditioned space shall comply with Section R402.2.7.

#### **R402.2.4 Eave baffle.**

For air-permeable insulation in vented attics, a baffle shall be installed adjacent to soffit and eave vents. Baffles shall maintain a net free area opening

equal to 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. The baffle shall be installed to the outer edge of the exterior wall top plate so as to provide maximum space for attic insulation coverage over the top plate. Where soffit venting is not continuous, baffles shall be installed continuously to prevent ventilation air in the eave soffit from bypassing the baffle.

#### **R402.2.5 Access hatches and doors.**

Access hatches and doors from conditioned to unconditioned spaces such as attics and crawl spaces shall be insulated to the same *R*-value required by Table R402.1.3 for the wall or ceiling in which they are installed.

#### **Exceptions:**

1. Vertical doors providing access from conditioned spaces to unconditioned spaces that comply with the fenestration requirements of Table R402.1.3 based on the applicable climate zone specified in Chapter 3.
2. Horizontal pull-down, stair-type access hatches in ceiling assemblies that provide access from conditioned to unconditioned spaces in Climate Zones 0 through 4 shall not be required to comply with the insulation level of the surrounding surfaces provided the hatch meets all of the following:
  - 2.1. The average *U*-factor of the hatch shall be less than or equal to U-0.10 or have an average insulation *R*-value of R-10 or greater.
  - 2.2. Not less than 75 percent of the panel area shall have an insulation *R*-value of R-13 or greater.
  - 2.3. The net area of the framed opening shall be less than or equal to 13.5 square feet (1.25 m<sup>2</sup>).
  - 2.4. The perimeter of the hatch edge shall be weather-stripped.

The reduction shall not apply to the component performance alternative in Section R402.1.5.

#### **R402.2.5.1 Access hatches and door insulation installation and retention.**

Vertical or horizontal access hatches and doors from conditioned spaces to unconditioned spaces such as attics and crawl spaces shall be weather-stripped. Access that prevents damaging or compressing the insulation shall be provided to all equipment. Where loose-fill insulation is installed, a wood-framed or equivalent baffle, retainer or dam shall be installed to prevent loose-fill insulation from spilling into living space from higher to lower sections of the attic and from attics covering conditioned spaces to unconditioned spaces. The baffle or retainer shall provide a permanent means of maintaining the installed *R*-

value of the loose-fill insulation.

#### R402.2.6 Mass walls.

Mass walls where used as a component of the *building thermal envelope* shall be one of the following:

1. Above-ground walls of concrete block, concrete, insulated concrete form, masonry cavity, brick but not brick veneer, adobe, compressed earth block, rammed earth, solid timber, mass timber or solid logs.
2. Any wall having a heat capacity greater than or equal to 6 Btu/ft<sup>2</sup> × °F (123 kJ/m<sup>2</sup> × K).

#### R402.2.7 Steel-frame ceilings, walls and floors.

Steel-frame ceilings, walls, and floors shall comply with the *U-factor* requirements of [Table R402.1.2](#). The calculation of the *U-factor* for steel-framed ceilings and walls in a *building thermal envelope* assembly shall be determined in accordance with [AISI S250](#), modified as follows:

1. Where the steel-framed wall contains no *cavity insulation* and uses *continuous insulation* to satisfy the *U-factor* maximum, the steel-framed wall member spacing is permitted to be installed at any on-center spacing.
2. Where the steel-framed wall contains framing spaced at 610 mm (24 inches) on center with a 23 percent framing factor or framing spaced at 400 mm (16 inches) on center with a 25 percent framing factor, the next lower framing member spacing input values shall be used when calculating using [AISI S250](#).
3. Where the steel-framed wall contains less than 23 percent framing factors [AISI S250](#) shall be used without any modifications.
4. Where the steel-framed wall contains other than standard C-shaped framing members the [AISI S250](#) calculation option for other than standard C-shaped framing is permitted to be used.

#### R402.2.8 Floors.

Floor *insulation* shall be installed in accordance with all of the following:

1. [Table R402.1.2](#) or [R402.1.3](#) and manufacturer's instructions.
2. Floor framing members that are part of the *building thermal envelope* shall be air sealed to maintain a *continuous air barrier*.

3. One of the following methods:

3.1. *Cavity insulation* shall be installed to maintain permanent contact with the underside of the subfloor decking.

3.2. *Cavity insulation* shall be installed to maintain contact with the top side of sheathing separating the cavity and the unconditioned space below. Insulation shall extend from the bottom to the top of all perimeter floor framing members.

3.3. A combination of *cavity insulation* and *continuous insulation* shall be installed such that the *cavity insulation* maintains contact with the top side of the *continuous insulation* and the *continuous insulation* maintains contact with the underside of the structural floor system. Insulation shall extend from the bottom to the top of all perimeter floor framing members.

3.4. *Continuous insulation* shall be installed to maintain contact with the underside of the structural floor system. Insulation shall extend from the bottom to the top of all perimeter floor framing members.

#### R402.2.9 Basement walls.

*Basement walls* shall be insulated in accordance with [Table R402.1.3](#).

**Exception:** *Basement walls* associated with unconditioned basements where the following requirements are met:

1. The floor overhead, including the underside stairway stringer leading to the basement, is insulated in accordance with [Section R402.1.3](#) and applicable provisions of [Sections R402.2](#) and [R402.2.8](#).
2. There are no uninsulated ductwork, domestic hot water piping, or hydronic heating surfaces exposed to the basement.
3. There is no HVAC supply or return diffusers serving the basement.
4. The walls surrounding the stairway and adjacent to *conditioned space* are insulated in accordance with [Section R402.1.3](#) and applicable provisions of [Section R402.2](#).
5. The door(s) leading to the basement from *conditioned spaces* are insulated in accordance with [Section R402.1.3](#) and applicable provisions of [Section R402.2](#), and weather-stripped in accordance with [Section R402.5](#).

6. The *building thermal envelope* separating the basement from adjacent *conditioned spaces* complies with Section R402.5.

#### **R402.2.9.1 Basement wall insulation installation.**

Where *basement walls* are insulated, the insulation shall be installed from the top of the *basement wall* down to 10 feet (3048 mm) below grade or to the basement floor, whichever is less, or in accordance with the *proposed design* or the *rated design*, as applicable.

#### **R402.2.10 Slab-on-grade floors.**

Slab-on-grade floors with a floor surface within 610 mm (24 inches) above or below grade shall be insulated in accordance with Section R402.2.10.1 or R402.2.10.2.

**Exception:** Slab-edge insulation is not required in jurisdictions designated by the *code official* as having a very heavy termite infestation probability.

#### **R402.2.10.1 Slab-on-grade floor insulation installation.**

For buildings complying with Section R401.2.1, the slab edge *continuous insulation* shall extend downward from the top of the slab on the outside or inside of the foundation wall. Insulation located below grade shall extend the vertical distance provided in Table R402.1.3, but need not exceed the footing depth in accordance with Section R403.1.4 of the *International Residential Code*. Where a proposed design includes insulation extending away from the *building*, it shall be protected by pavement or by not less than 254 mm (10 inches) 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*. Full-slab insulation shall be continuous under the entire area of the slab-on-grade floor, except at structural column locations and service penetrations. Slab edge insulation required at the *heated slab* perimeter shall not be required to extend below the bottom of the *heated slab* and shall be continuous with the full slab insulation.

#### **R402.2.10.2 Alternative slab-on-grade insulation configurations.**

For *buildings* complying with Section R405 or R406, slab-on-grade insulation shall be installed in accordance with the *proposed design* or *rated design*.

#### **R402.2.11 Crawl space walls.**

*Crawl space walls* shall be insulated in accordance with Section R402.2.11.1 or R402.2.11.2.

**Exception:** *Crawl space walls* associated with a crawl space that is vented to the outdoors and the floor overhead is insulated in accordance with Table R402.1.3 and Section R402.2.8.

#### **R402.2.11.1 Crawl space wall insulation installations.**

Where installed, *crawl space wall* insulation shall be secured to the wall and extend downward from the sill plate to not less than the top of the foundation wall footing.

**Exception:** Where the *crawl space wall* insulation is installed on the interior side of the wall and the crawl space floor is more than 24 inches (610 mm) below the exterior grade, the crawl space wall insulation shall be permitted to extend downward from the sill plate at the top of the foundation wall to not less than the interior floor of the crawl space. Exposed earth in 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. 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 not less than 6 inches (153 mm) up stem walls and shall be attached to the stem walls.

#### **R402.2.11.2 Alternative crawl space wall insulation configurations.**

For *buildings* complying with Section R405 or R406, *crawl space wall* insulation shall be installed in accordance with the *proposed design* or *rated design*.

#### **R402.2.12 Masonry veneer.**

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

#### **R402.2.13 Sunroom and heated garage insulation.**

*Sunrooms* enclosing *conditioned space* and heated garages shall meet the insulation requirements of this code.

**Exception:** For *sunrooms* and heated garages provided 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* 0 through 4 and R-24 in *Climate Zones* 5 through 8.
2. The minimum wall insulation *R-value* shall be R-13 in all *climate zones*. Walls separating a *sunroom* or heated garage with *thermal isolation* from *conditioned space* shall comply with the *building thermal envelope* requirements of this code.

#### **R402.3 Radiant barriers.**

Where installed, radiant barriers shall be installed in accordance with ASTM C1743.

#### **R402.4 Fenestration.**

In addition to the requirements of Section R402, *fenestration* shall comply with Sections R402.4.1 through R402.4.5.

**R402.4.1 U-factor.**

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

**R402.4.2 Glazed fenestration SHGC.**

An area-weighted average of *fenestration* products more than 50 percent glazed shall be permitted to satisfy the SHGC requirements.

Dynamic glazing shall be permitted to satisfy the SHGC requirements of Table R402.1.2 provided that the ratio of the higher to lower *labeled SHGC* is greater than or equal to 2.4, and the dynamic glazing is automatically controlled to modulate the amount of solar gain into the space in multiple steps. Dynamic glazing shall be considered separately from other *fenestration*, and area-weighted averaging with other *fenestration* that is not dynamic glazing shall be prohibited.

**Exception:** Dynamic glazing shall not be required to comply with this section where both the lower and higher *labeled SHGC* comply with the requirements of Table R402.1.2.

**R402.4.3 Glazed fenestration exemption.**

Not greater than 15 square feet (1.4 m<sup>2</sup>) of glazed *fenestration* per *dwelling unit* shall be exempt from the *U-factor* and SHGC requirements in Section R402.1.2. This exemption shall not apply to the component performance alternative in Section R402.1.5.

**R402.4.4 Opaque door exemption.**

One side-hinged *opaque door* assembly not greater than 24 square feet (2.22 m<sup>2</sup>) in area shall be exempt from the *U-factor* requirement in Section R402.1.2. This exemption shall not apply to the component performance alternative in Section R402.1.5.

**R402.4.5 Sunroom and heated garage fenestration.**

*Sunrooms* and heated garages enclosing *conditioned space* shall comply with the *fenestration* requirements of this code.

**Exception:** In Climate Zones 2 through 8, for *sunrooms* and heated garages with *thermal isolation* and enclosing *conditioned space*, the *fenestration U-factor* shall not exceed 0.45 and the skylight *U-factor* shall not exceed 0.70.

New *fenestration* separating a *sunroom* or heated garage with *thermal isolation* from *conditioned space* shall comply with the *building thermal envelope* requirements of this code.

**R402.5 Air leakage.**

The *building thermal envelope* shall be constructed to limit air leakage in accordance with the requirements of Sections R402.5.1 through R402.5.4.

**R402.5.1 Building thermal envelope.**

The *building thermal envelope* shall comply with Sections R402.5.1.1 through R402.5.1.3. The sealing methods between dissimilar materials shall allow for differential expansion and contraction.

**R402.5.1.1 Installation.**

The components of the *building thermal envelope* as indicated in Table R402.5.1.1 shall be installed in accordance with the manufacturer's instructions and the criteria indicated in Table R402.5.1.1, as applicable to the method of construction. Where required by the *code official*, an *approved* third party shall inspect all components and verify compliance.

**TABLE R402.5.1.1 AIR BARRIER, AIR SEALING AND INSULATION INSTALLATION<sup>a</sup>****R402.5.1.2 Air leakage testing.**

The *building* or each *dwelling unit* or *sleeping unit* in the *building* shall be tested for air leakage. Testing shall be conducted in accordance with ANSI/RESNET/ICC 380, ASTM E779, ASTM E1827 or ASTM E3158 and reported at a pressure differential of 0.2 inch water gauge (50 Pa). 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* have been sealed.

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, where installed at the time of the test, shall be open.
4. Exterior or interior terminations for continuous *ventilation* systems shall be sealed.
5. Heating and cooling systems, where installed at the time of the test, shall be turned off.
6. Supply and return registers, where installed at the time of the test, shall be fully open.

**Exceptions:**

1. For heated, attached private garages and heated, detached private garages accessory to one- and two-family dwellings and townhouses not more than three

stories above *grade plane* in height, *building thermal envelope* tightness and insulation installation shall be considered acceptable where the items in Table R402.5.1.1, applicable to the method of construction, are field verified. Where required by the *code official*, an *approved* third party independent from the installer shall inspect both *air barrier* and insulation installation criteria. Heated, attached private garage space and heated, detached private garage space shall be thermally isolated from all other habitable, *conditioned spaces* in accordance with Sections R402.2.13 and R402.4.5, as applicable.

2. Where tested in accordance with Section R402.5.1.2.1, testing of each *dwelling unit* or *sleeping unit* is not required.

Recommendation: Section C402.5.1.2 can be considered as Not mandatory to follow for residential

#### **R402.5.1.2.1 Unit sampling.**

For *buildings* with eight or more *dwelling units* or *sleeping units*, seven or 20 percent of the *dwelling units* or *sleeping units*, whichever is greater, shall be tested. Tested units shall include a top-floor unit, a ground-floor unit, a middle-floor unit and the *dwelling unit* or *sleeping unit* with the largest *testing unit enclosure area*. Where the air leakage rate of a tested unit is greater than the maximum permitted rate, corrective actions shall be taken, and the unit retested until it passes. For each tested *dwelling unit* or *sleeping unit* with an air leakage rate greater than the maximum permitted rate, three additional units, including the corrected unit, shall be tested. Where *buildings* have fewer than eight *dwelling units* or *sleeping units*, each unit shall be tested.

#### **R402.5.1.3 Maximum air leakage rate.**

Where tested in accordance with Section R402.5.1.2, the air leakage rate for *buildings*, *dwelling units* or *sleeping units* shall be as follows:

1. Where complying with Section R401.2.1, the *building* or the *dwelling units* or *sleeping units* in the *building* shall have an air leakage rate not greater than

4.0 air changes per hour in Climate Zones 0, 1 and 2; 3.0 air changes per hour in Climate Zones 3 through 5; and 2.5 air changes per hour in Climate Zones 6 through 8.

2. Where complying with Section R401.2.2 or R401.2.3, the *building* or the *dwelling units* or *sleeping units* in the *building* shall have an air leakage rate not greater than 4.0 air changes per hour, or 0.22 cubic feet per minute per square foot [ $1.1 \text{ L}/(\text{s} \times \text{m}^2)$ ] of the *building thermal envelope area* or the *dwelling testing unit enclosure area*, as applicable.

#### **Exceptions:**

1. Where *dwelling units* or *sleeping units* are attached or located in an R-2 occupancy and are tested without simultaneously testing adjacent *dwelling units* or *sleeping units*, the air leakage rate is permitted to be not greater than 0.27 cubic feet per minute per square foot [ $1.4 \text{ L}/(\text{s} \times \text{m}^2)$ ] of the *testing unit enclosure area*. Where adjacent *dwelling units* are simultaneously tested in accordance with ASTM E779, the air leakage rate is permitted to be not greater than 0.27 cubic feet per minute per square foot [ $1.4 \text{ L}/(\text{s} \times \text{m}^2)$ ] of the *testing unit enclosure area* that separates *conditioned space* from the exterior.
2. Where *buildings* have 1,500 square feet ( $139.4 \text{ m}^2$ ) or less of *conditioned floor area*, the air leakage rate is permitted to be not greater than 0.27 cubic feet per minute per square foot [ $1.4 \text{ L}/(\text{s} \cdot \text{m}^2)$ ].

#### **R402.5.2 Fireplaces.**

New wood-burning fireplaces shall have tight-fitting flue *dampers* or doors, and outdoor combustion air. Where using tight-fitting doors on factory-built fireplaces *listed* and *labeled* in accordance with UL 127, the doors shall be tested and *listed* for the fireplace.

#### **R402.5.3 Fenestration air leakage.**

Windows, *skylights* and sliding glass doors shall have an air *infiltration* rate of not greater than 0.3 cubic feet per minute per square foot ( $1.5 \text{ L}/\text{s} \cdot \text{m}^2$ ), and for swinging doors, not greater than 0.5 cubic feet per minute per square foot ( $2.6 \text{ L}/\text{s} \cdot \text{m}^2$ ) when tested in accordance with 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.

#### R402.5.4 Recessed lighting.

Recessed luminaires installed in the *building thermal envelope* shall be sealed to limit air leakage between conditioned and *unconditioned spaces*. Recessed luminaires shall be IC-rated and *labeled* as having an air leakage rate of not greater than 2.0 cfm (0.944 L/s) when tested in accordance with ASTM E283 at a pressure differential of 1.57 psf (75 Pa). Recessed luminaires shall be sealed with a gasket or caulked between the housing and the interior wall or ceiling covering.

#### R402.5.5 Air-sealed electrical and communication outlet boxes.

Air-sealed electrical and communication outlet boxes that penetrated the *air barrier* of the *building thermal envelope* shall be caulked, taped, gasketed or otherwise sealed to the *air barrier* element being penetrated. Air-sealed boxes shall be buried in or surrounded by insulation. Air-sealed boxes shall be tested and marked in accordance with NEMA OS 4. Air-sealed boxes shall be installed in accordance with the manufacturer's instructions.

#### R402.6 Maximum fenestration U-factor and SHGC.

The area-weighted average maximum *fenestration U-factor* permitted using tradeoffs from Section R402.1.5 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 0 through 3 shall be 0.40.

**Exception:** The maximum *U-factor* and *SHGC* for *fenestration* shall not be required in storm shelters complying with ICC 500.

### SECTION R403 SYSTEMS

#### R403.1 Controls.

Not less than one *thermostat* shall be provided for each separate heating and cooling system.

##### R403.1.1 Programmable thermostat.

The *thermostat* controlling the primary heating or cooling system of the *dwelling unit* shall be capable of controlling the heating and cooling system on a daily schedule to maintain different temperature set points at different times of day and different days of the week. This *thermostat* shall include the capability to set back or temporarily operate the system to maintain *zone* temperatures of not less than 55°F (13°C) to not greater than 85°F (29°C). The *thermostat* shall be programmed initially by the manufacturer with a heating temperature setpoint of not greater than 70°F (21°C) and a cooling

temperature setpoint of not less than 78°F (26°C).

#### R403.1.2 Heat pump supplementary heat.

Heat pumps having supplementary electric-resistance, *fuel gas* or *liquid fuel* heating systems shall have controls that are configured to prevent supplemental heat operation when the capacity of the heat pump compressor can meet the heating load. Supplemental heat operation shall be limited to only where one of the following applies:

1. The vapor compression cycle cannot provide the necessary heating energy to satisfy the *thermostat* setting.
2. The heat pump is operating in defrost mode.
3. The vapor compression cycle malfunctions.
4. The *thermostat* malfunctions.

#### R403.2 Hot water boiler temperature reset.

Other than where equipped with tankless domestic water heating coils, the manufacturer shall equip each *gas, liquid fuel* and electric boiler with *automatic* means of adjusting the water temperature supplied by the boiler so that incremental change of the inferred heat load will cause an incremental change in the temperature of the water supplied by the boiler. This can be accomplished with outdoor reset, indoor reset or water temperature sensing.

#### R403.3 Duct systems.

*Duct systems* shall be installed in accordance with Sections R403.3.1 through R403.3.9.

**Exception:** *Ventilation ductwork* that is not integrated with *duct systems* serving heating or cooling systems.

##### R403.3.1 Duct system design.

*Duct systems* serving one or two *dwelling units* or *sleeping units* shall be designed and sized in accordance with ANSI/ACCA Manual D. *Duct systems* serving more than two *dwelling units* or *sleeping units* shall be sized in accordance with the ASHRAE Handbook of Fundamentals, ANSI/ACCA Manual D or other equivalent computation procedure.

##### R403.3.2 Building cavities.

*Building framing cavities* shall not be used as ductwork or plenums.

##### R403.3.3 Ductwork located outside conditioned space.

Supply and return *ductwork* located outside *conditioned space* shall be insulated to an *R-value* of not less than R-8 for *ducts* 76 mm (3 inches) in diameter and larger and not less than R-6 for *ducts* smaller than 3 inches (76 mm) in diameter. *Ductwork* buried beneath a *building* shall be insulated as required per this section or have an equivalent *thermal distribution efficiency*.

Underground *ductwork* utilizing the *thermal distribution efficiency* method shall be listed and labeled to indicate the *R-value* equivalency.

#### **R403.3.4 Duct systems located in conditioned space.**

For *duct systems* to be considered inside a *conditioned space*, the *space conditioning equipment* shall be located completely on the conditioned side of the *building thermal envelope*. The *ductwork* shall comply with the following, as applicable:

1. The *ductwork* shall be located completely on the conditioned side of the *building thermal envelope*.
2. *Ductwork* in ventilated attic spaces or unvented attics with vapor diffusion ports shall be buried within ceiling insulation in accordance with Section R403.3.5 and shall comply with the following:

2.1 The ductwork leakage, as measured either by a rough-in test of the supply and return *ductwork* or a post-construction *duct system* leakage test to outside the *building thermal envelope* in accordance with Section R403.3.7, is not greater than 1.5 cubic feet per minute (42.5 L/min) per 100 square feet (9.29 m<sup>2</sup>) of *conditioned floor area* served by the *duct system*.

2.2. The ceiling insulation *R-value* installed against and above the insulated *ductwork* is greater than or equal to the proposed ceiling insulation *R-value*, less the *R-value* of the insulation on the *ductwork*.

3. *Ductwork* contained within wall or floor assemblies separating unconditioned from *conditioned space* shall comply with the following:

3.1. A *continuous air barrier* shall be installed as part of the building assembly between the *ductwork* and the unconditioned space.

3.2. *Ductwork* shall be installed in accordance with Section R403.3.3.

**Exception:** Where the building assembly cavities containing *ductwork* have been air sealed in accordance with Section R402.5.1 and insulated in accordance with Item 3.3, duct insulation is not required.

3.3 Not less than R-10 insulation, or not less than 50 percent of the required

insulation *R-value* specified in Table R402.1.3, whichever is greater, shall be located between the *ductwork* and the unconditioned space.

3.4. Segments of *ductwork* contained within these building assemblies shall not be considered completely inside *conditioned space* for compliance with Section R405 or R406.

#### **R403.3.5 Ductwork buried within ceiling insulation.**

Where supply and return *ductwork* is partially or completely buried in ceiling insulation, such *ductwork* shall comply with the following:

1. The supply and return *ductwork* shall be insulated with not less than R-8 insulation.
2. At all points along the *ductwork*, the sum of the ceiling insulation *R-value* against and above the top of the *ductwork*, and against and below the bottom of the *ductwork*, shall be not less than R-19, excluding the *R-value* of the duct insulation.

3. In Climate Zones 0A, 1A, 2A and 3A, the supply *ductwork* shall be completely buried within ceiling insulation, insulated to an *R-value* of not less than R-13 and in compliance with the vapor retarder requirements of Section 604.11 of the *International Mechanical Code* or Section M1601.4.6 of the *International Residential Code*, as applicable.

**Exception:** Sections of the supply *ductwork* that are less than 3 feet (914 mm) from the supply outlet.

4. In Climate Zones 0A, 1A, 2A and 3A where installed in an unvented attic with vapor diffusion ports, the supply *ductwork* shall be completely buried within the insulation in the ceiling assembly at the floor of the attic, insulated to an *R-value* of not less than R-8 and in compliance with the vapor retarder requirements of Section 604.11 of the *International Mechanical Code* or Section M1601.4.6 of the *International Residential Code*, as applicable.

**Exception:** Sections of the supply *ductwork* that are less than 3 feet (914 mm) from the supply outlet.

- 4.1. Air permeable insulation installed in unvented attics shall comply with Section R806.5 of the *International Residential Code*.

**R403.3.5.1 Effective R-value of deeply buried ducts.**

Where complying using Section R405, sections of *ductwork* that are installed in accordance with Section R403.3.5 surrounded with blown-in attic insulation having an *R-value* of R-30 or greater and located such that the top of the *ductwork* is not less than 3.5 inches (89 mm) below the top of the insulation shall be considered as having

**R403.3.6 Sealing.**

*Ductwork*, *air-handling units* and filter boxes shall be sealed. Joints and seams shall comply with the International Mechanical Code or the International Residential Code, as applicable.

**R403.3.6.1 Sealed air-handling unit.**

Air-handling units shall have a manufacturer's designation for an air leakage of not greater than 2 percent of the design airflow rate when tested in accordance with ASHRAE 193-2014.

**R403.4 Mechanical system piping insulation.**

Mechanical system piping capable of carrying fluids greater than 105°F (41°C) or less than 55°F (13°C) shall be insulated to an *R-value* of not less than R-3.

**R403.4.1 Protection of piping insulation.**

Piping insulation exposed to weather shall be protected from damage, including that caused by sunlight, moisture, physical contact and wind. The protection shall provide shielding from solar radiation that can cause degradation of the material and shall be removable not less than 6 feet (1828 mm) from the equipment for maintenance. Adhesive tape shall be prohibited.

**R403.5 Service hot water systems.**

Energy conservation measures for service hot water systems shall be in accordance with Sections R403.5.1 through R403.5.3.

**R403.5.1 Heated water circulation and temperature maintenance systems.**

Heated water circulation systems shall be in accordance with Section R403.5.1.1. Heat trace temperature maintenance systems shall be in accordance with Section R403.5.1.2. *Automatic* controls, temperature sensors and pumps shall be in a location with access. *Manual* controls shall be in a location with *ready access*.

**R403.5.1.1 Circulation systems.**

Heated water circulation systems shall be provided with a circulation pump. Gravity and thermosiphon circulation systems shall be prohibited. Controls for *circulating hot water system* pumps shall automatically turn off the pump when the water in the circulation loop is at the desired temperature and when there is no demand for hot water. The system return pipe shall be a dedicated return pipe or a cold water supply pipe. Where a cold-water supply pipe is used as the return pipe, a temperature sensor connected to the controls shall

be located on the hot water supply not more than two feet (305 mm) from the connection to the cold-water supply pipe. The controls shall limit the temperature of the water entering the cold-water piping to not greater than 104°F (40°C).

**R403.5.1.1.1 Demand recirculation water systems.**

*Demand recirculation water systems* shall have controls that start the pump upon receiving a signal from the action of a user of a fixture or appliance, sensing the presence of a user of a fixture or sensing the flow of hot or tempered water to a fixture fitting or appliance. The controls shall limit pump operation by:

1. Shutting off the pump when the temperature sensor detects one of the following:
  - 1.1. An increase in the water temperature of not more than 10°F (5.6°C) above the initial temperature of the water in the pipe.
  - 1.2. The temperature of the water in the pipe reaches 104°F (40°C).
2. Limiting pump operation to a maximum of 5 minutes following activation.
3. Not activating the pump for at least 5 minutes following shutoff or when the temperature of the water in the pipe exceeds 104°F (40°C).

**R403.5.1.2 Heat trace systems.**

Electric heat trace systems shall comply with IEEE 515.1 or UL 515. Controls for such systems shall automatically adjust the energy input to the heat tracing to maintain the desired water temperature in the piping in accordance with the times when heated water is used in the occupancy.

**R403.5.2 Hot water pipe insulation.**

Insulation for service hot water piping shall comply with Table R403.5.2 and be applied to the following:

1. Piping  $\frac{3}{4}$  inch (19.1 mm) and larger in nominal diameter located inside the *conditioned space*.
2. Piping located outside the *conditioned space*.
3. Piping from the water heater to a distribution manifold.
4. Piping located under a floor slab.
5. Buried piping.
6. Supply and return piping in circulating hot water systems.

**Exception:** Cold water returns in *demand*

recirculation water systems.

**TABLE R403.5.2 MINIMUM PIPE INSULATION THICKNESS**

**R403.5.3 Drain water heat recovery units.**

Where installed, drain water heat recovery units shall comply with CSA B55.2. Drain water heat recovery units shall be tested in accordance with CSA B55.1. Potable water-side pressure loss of drain water heat recovery units shall be less than 3 psi (20.7 kPa) for individual units connected to one or two showers. Potable water-side pressure loss of drain water heat recovery units shall be less than 2 psi (13.8 kPa) for individual units connected to three or more showers.

**R403.6 Mechanical ventilation.**

The *buildings and dwelling units* complying with Section R402.5.1.1 shall be provided with mechanical *ventilation* that complies with the requirements of Section M1505 of the *International Residential Code* or the *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.

**R403.6.2 Fan efficacy for whole-house mechanical ventilation systems and outdoor air ventilation systems.**

Fans used to provide whole-dwelling mechanical *ventilation* shall meet the efficacy requirements of Table R403.6.2 at one or more rating points. Fans shall be tested in accordance with the test procedure referenced by Table R403.6.2 and *listed*. The airflow shall be reported in the product listing or on the label. Fan efficacy shall be reported in the product listing or shall be derived from the input power and airflow values reported in the product listing or on the label. Fan efficacy for fully ducted HRV, ERV, balanced *ventilation* systems and in-line fans shall be determined at a static pressure of not less than 0.2 inch water gauge (50 Pa). Fan efficacy for ducted range hoods, bathroom and utility room fans shall be determined at a static pressure of not less than 0.1 inch water gauge (25 Pa).

**TABLE R403.6.2 FAN EFFICACY FOR WHOLE-HOUSE MECHANICAL VENTILATION SYSTEMS AND OUTDOOR AIR VENTILATION SYSTEMS<sup>a</sup>**

**R403.6.3 Testing.**

Mechanical *ventilation* systems shall be tested and verified to provide the minimum *ventilation* flow rates required by Section R403.6, in accordance with ANSI/RESNET/ICC 380. 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*.

**Exceptions:**

1. Kitchen range hoods that are ducted to the outside with ducting having a diameter of 6 inches (152 mm) or larger, a length of 10 feet (3028 mm) or less, and not more than two 90-degree (1.57 rad) elbows or equivalent shall not require testing.
2. A third-party test shall not be required where the ventilation system has an integrated diagnostic tool used for airflow measurement, and a user interface that communicates the installed airflow rate.
3. Where tested in accordance with Section R403.6.4, testing of each mechanical ventilation system is not required.

**R403.6.4 Unit sampling.**

For *buildings* with eight or more *dwelling units* or *sleeping units*, the mechanical *ventilation* systems in the greater of seven units or 20 percent of the total units shall be tested. Tested systems shall include systems in a top floor unit, systems in a ground floor unit, systems in a middle floor unit, and the systems in the *dwelling unit* or *sleeping unit* with the largest *conditioned floor area*. Where *buildings* have fewer than eight *dwelling units* or *sleeping units*, the mechanical *ventilation* systems in each unit shall be tested. Where the *ventilation* flow rate of a mechanical *ventilation* system is less than the minimum permitted rate, corrective actions shall be taken, and the system retested until it passes. For each tested *dwelling unit* or *sleeping unit* system with a *ventilation* flow rate lower than the minimum permitted, three additional systems, including the corrected system, shall be tested.

**R403.6.5 Intermittent exhaust control for bathrooms and toilet rooms.**

Where an exhaust system serving a bathroom or toilet room is designed for intermittent operation, the exhaust system controls shall include one or more of the following:

1. A timer control with one or more delay setpoints that automatically turns off exhaust fans when the selected setpoint is reached. Not fewer than one delay-off setpoint shall be 30 minutes or less.
2. An *occupant sensor control* with one or more delay setpoints that automatically turns off exhaust fans in accordance with the selected delay setpoint after all occupants have vacated the space. Not fewer than one delay-off setpoint shall be 30 minutes or less.
3. A humidity control with an adjustable setpoint ranging between 50 percent or

more and 80 percent or less relative humidity that automatically turns off exhaust fans when the selected setpoint is reached.

4. A contaminant control that responds to a particle or gaseous concentration and automatically turns off exhaust fans when a design setpoint is reached.

*Manual* off functionality shall not be used in lieu of the minimum setpoint functionality required by this section.

**Exception:** Bathroom and toilet room exhaust systems serving as an integral component of an outdoor air *ventilation* system or a whole-house mechanical *ventilation* system.

**R403.7 Equipment sizing and efficiency rating.**

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. New or replacement heating and cooling equipment shall have an efficiency rating equal to or greater than the minimum required by federal law for the geographic location where the equipment is installed.

**R403.7.1 Electric-resistance space heating.**

Detached one- and two-family dwellings and townhouses in Climate Zones 4 through 8 using electric-resistance space heating shall limit the total installed heating capacity of all electric-resistance space heating serving the *dwelling unit* to not more than 2.0 kW or shall install a heat pump in the largest space that is not used as a bedroom.

**R403.8 Systems serving multiple dwelling units.**

Except for systems complying with Section R403.9, systems serving multiple *dwelling units* shall comply with Sections C403 and C404 of the *International Energy Conservation Code*—Commercial Provisions instead of Section R403.

**R403.9 Mechanical systems located outside of the building thermal envelope.**

Mechanical systems providing heat outside of the *building thermal envelope* of a *building* shall comply with Sections R403.9.1 through R403.9.4.

**R403.9.1 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 de-energized when occupants are not present.

**R403.9.2 Snow melt and ice 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 greater than 50°F (10°C) and precipitation is not falling, and an *automatic* or *manual* control that will allow shutoff when the outdoor temperature is

greater than 40°F (4.8°C).

**R403.9.3 Roof and gutter deicing controls.**

Roof and gutter deicing systems, including but not limited to self-regulating cable, shall include *automatic* controls that are configured to shut off the system when the outdoor temperature is above 40°F (4.4°C) and shall include one of the following:

1. A moisture sensor configured to shut off the system in the absence of moisture.
2. A daylight sensor or other means configured to shut off the system between sunset and sunrise.

**R403.9.4 Freeze protection system controls.**

Freeze protection systems, such as heat tracing of outdoor piping and *heat exchangers*, including self-regulating heat tracing, shall include *automatic* controls configured to shut off the systems when outdoor air temperatures are above 40°F (4.4°C) or when the conditions of the protected fluid will prevent freezing.

**R403.10 Energy consumption of pools and spas.**

The energy consumption of pools and permanent spas shall be controlled by the requirements in Sections R403.10.1 through R403.10.3.

**R403.10.1 Heaters.**

The electric power to heaters shall be controlled by an on-off switch that is an integral part of the heater mounted on the exterior of the heater in a location with *ready access*, or external to and within 3 feet (914 mm) of the heater. Operation of such switch shall not change the setting of the heater *thermostat*. Such switches shall be in addition to a circuit breaker for the power to the heater. Gas-fired heaters shall not be equipped with continuously burning ignition pilots.

**R403.10.2 Time switches.**

Time switches or other control methods that can automatically turn heaters and pump motors off and on according to a preset schedule shall be installed for heaters and pump motors. Heaters and pump motors that have built-in time switches shall be in compliance with this section.

**Exceptions:**

1. Where public health standards require 24-hour pump operation.
2. Pumps that operate *on-site renewable energy* and waste-heat-recovery pool heating systems.

**R403.10.3 Covers.**

Outdoor heated pools and outdoor permanent spas shall be provided with a vapor-retardant cover or other *approved* vapor-retardant means.

**Exception:** Where more than 75 percent of the energy for heating, computed over an operation season of not fewer than 3 calendar months, is from a heat pump or an *on-site renewable*

energy system, covers or other vapor-retardant means shall not be required.

#### **R403.11 Portable spas.**

The energy consumption of electric-powered portable spas shall be controlled by the requirements of APSP 14.

#### **R403.12 Residential pools and permanent residential spas.**

Where installed, the energy consumption of residential swimming pools and permanent residential spas shall be controlled in accordance with the requirements of APSP 15.

### **SECTION R404 ELECTRICAL POWER, LIGHTING AND RENEWABLE ENERGY SYSTEMS**

#### **R404.1 Lighting equipment.**

All permanently installed luminaires in residential buildings shall use high-efficacy lighting with a minimum efficacy of  $\geq 45$  lumens per watt, or lamps with a minimum efficacy of  $\geq 60$  lumens per watt, in line with the availability of LED technologies in the Caribbean market.

Exceptions:

1. Appliance lamps (e.g., refrigerator, oven, microwave lighting).
2. Antimicrobial lighting used solely for disinfection.
3. Decorative fixtures or specialty lamps not intended for general illumination.
4. Luminaires with a rated electric input  $\leq 5.0$  watts (raised from 3.0 watts to reflect practical Caribbean market availability).

#### **TABLE R404.1 LIGHTING POWER ALLOWANCES FOR BUILDING EXTERIORS**

##### **R404.1.1 Exterior lighting.**

Connected exterior lighting for Group R-2, R-3 and R-4 *residential buildings* shall comply with Sections R404.1.2 through R404.1.5.

Exceptions:

1. Detached one- and two-family dwellings.
2. Townhouses.
3. Group R-3 *buildings* that do not contain more than two *dwelling units*.
4. Solar-powered lamps not connected to any electrical service.
5. Luminaires controlled by a motion sensor.
6. Lamps and luminaires that comply with Section R404.1.

##### **R404.1.2 Exterior lighting power requirements.**

The total exterior connected lighting power shall be not greater than the exterior lighting power allowance calculated in accordance with Section R404.1.3. The total exterior connected lighting power shall be the total maximum rated wattage of all lighting that is powered through the energy service for the *building*.

**Exceptions:** Lighting used for the following applications shall not be included.

1. Lighting *approved* for safety reasons.
2. Emergency lighting that is automatically off during normal operations.
3. Exit signs.
4. Specialized signal, directional and marker lighting associated with transportation.
5. Lighting for athletic playing areas.
6. Temporary lighting.
7. Lighting used to highlight features of art, public monuments and the national flag.
8. Lighting for water features and swimming pools.
9. Lighting controlled from within *sleeping units and dwelling units*.
10. Lighting of the exterior means of egress as required by the International Building Code.

**Recommendation:** The total exterior connected lighting power for residential buildings shall be limited to high-efficacy lighting ( $\geq 45$  lumens per watt) and controlled through automatic switching (e.g., timers, photocells, or motion sensors) for non-essential lighting. A prescriptive power allowance calculation method (as in R404.1.3) shall be considered optional for large-scale multi-family projects only.

Compliance can be optional for small homes and mandatory for the large projects. like apartments, gated society, housing developments, multi storey

Rationale: In the Caribbean, exterior lighting is widely used for safety and security, making efficiency critical. High-efficacy lighting ( $\geq 45$  lm/W) with automatic controls reduces waste while ensuring performance. Flexibility is provided by keeping compliance optional for small homes but mandatory for large projects like apartments and gated communities, where cumulative savings are significant. The prescriptive allowance method remains optional only for complex, multi-family developments.

##### **R404.1.3 Exterior lighting power allowance.**

**Recommendation:** Make the values mentioned in table R404.1 discounted by 10% for higher adoptability

##### **R404.1.4 Additional exterior lighting power.**

Additional exterior lighting power allowances shall be available for the building facades at  $0.075$  W/ft<sup>2</sup> ( $0.807$  w/m<sup>2</sup>) of gross *above-grade wall area*. These additional power allowances shall be used only for the luminaires serving the facade and shall not be used to increase any other lighting power allowance.

##### **R404.1.5 Gas lighting.**

Gas-fired lighting appliances shall not be equipped with a *continuous pilot* and shall be equipped with an *on-demand pilot, intermittent ignition or interrupted ignition* as defined by ANSI Z21.20.

##### **R404.2 Interior lighting controls.**

All permanently installed luminaires shall be controlled as required in Sections R404.2.1 and R404.2.2.

**Exception:** Lighting controls shall not be required for safety or security lighting.

#### **R404.2.1 Habitable spaces.**

All permanently installed luminaires in habitable spaces shall be controlled with a *manual dimmer* or with an *automatic* shutoff control that automatically turns off lights within 20 minutes after all occupants have left the space and shall incorporate a *manual* control to allow occupants to turn the lights on or off.

#### **R404.2.2 Specific locations.**

All permanently installed luminaires in garages, unfinished basements, laundry rooms and utility rooms shall be controlled by an *automatic* shutoff control that automatically turns off lights within 20 minutes after all occupants have left the space and shall incorporate a *manual* control to allow occupants to turn the lights on or off.

#### **R404.3 Exterior lighting controls.**

Exterior lighting controls shall comply with Section R404.3.1.

##### **R404.3.1 Controls for individual dwelling units.**

Where the total permanently installed exterior lighting power is greater than 40 watts, the permanently installed exterior lighting shall comply with the following:

1. Lighting shall be controlled by a manual on and off switch which permits automatic shut-off actions.
2. Lighting shall be automatically shut off when daylight is present and satisfies the lighting needs.
3. Controls that override automatic shut-off actions shall not be allowed unless the override automatically returns automatic control to its normal operation within 24 hours.

##### **R404.4 Renewable energy certificate (REC) documentation.**

Where renewable energy generation is used to comply with this code, the property owner or their authorized agent shall provide documentation to the code official confirming that the renewable energy produced on-site is dedicated to the building's own consumption. In cases where renewable energy certificates (RECs) or energy attribution certificates (EACs) are issued, they shall be retained or retired on behalf of the property owner. For small-scale residential systems, submission of system installation details and utility interconnection approval shall be deemed sufficient documentation.

## **SECTION R405 SIMULATED BUILDING PERFORMANCE**

### **R405.1 Scope.**

This section establishes criteria for compliance using *simulated building performance* analysis. Such analysis shall include heating, cooling, mechanical *ventilation* and service water-heating

energy only. Such analysis shall be limited to *dwelling units*. Spaces other than *dwelling units* in Group R-2, R-3 or R-4 buildings shall comply with Sections R402 through R404.

### **R405.2 Simulated building performance compliance.**

Compliance based on simulated building performance requires that a building comply with the following:

1. The requirements of the sections indicated within Table R405.2.
2. The proposed total building thermal envelope thermal conductance (TC) shall be less than or equal to the required total building thermal envelope TC using the prescriptive U-factors and F-factors from Table R402.1.2 multiplied by 1.08 in Climate Zones 0, 1 and 2, and 1.15 in Climate Zones 3 through 8, in accordance with Equation 4-2 and Section R402.1.5. The area-weighted maximum fenestration SHGC permitted in Climate Zones 0 through 3 shall be 0.30.

For Climate Zones 0–2:  $TC_{Proposed\ design} \leq 1.08 \times TC_{Prescriptive\ reference\ design}$

For Climate Zones 3–8:  $TC_{Proposed\ design} \leq 1.15 \times TC_{Prescriptive\ reference\ design}$

Equation 4-2

3. For each dwelling unit with one or more fuel-burning appliances for space heating, water heating, or both, the annual energy cost of the dwelling unit shall be less than or equal to 80 percent of the annual energy cost of the standard reference design. For all other dwelling units, the annual energy cost of the proposed design shall be less than or equal to 85 percent of the annual energy cost of the standard reference design. For each dwelling unit with greater than 5,000 square feet (465 m<sup>2</sup>) of living space located above grade plane, the annual energy cost of the dwelling unit shall be reduced by an additional 5 percent of annual energy cost of the standard reference design. Energy prices shall be taken from an approved source, such as the US Energy Information Administration's State Energy Data System prices and expenditures reports. Code officials shall be permitted to require time-of-use pricing in energy cost calculations.

Exceptions:

1. 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 2.51. The source energy multipliers shall be 1.09 for natural gas, 1.15 for propane, 1.19 for fuel oil, and 1.30 for imported liquefied natural gas.
2. The energy use based on site energy expressed in Btu or Btu per square foot of conditioned floor area shall be permitted to be substituted for the energy cost.

### **TABLE R405.2 REQUIREMENTS FOR SIMULATED BUILDING PERFORMANCE**

#### **R405.3 Compliance documentation.**

The following compliance reports, which document that the performance of the *proposed design* and the performance of the as-built *dwelling unit* comply with the requirements of Section R405, shall be submitted to the *code official*.

1.A compliance report in accordance with Section R405.5.4.1 shall be submitted with the application for the building permit.

2.A compliance report in accordance with Section R405.5.4.2 shall be submitted before a certificate of occupancy is issued.

#### **R405.4 Calculation procedure.**

Performance calculations shall be in accordance with Sections R405.4.1 through R405.4.3. Except as specified by this section, the *standard reference design* and *proposed design* shall be configured and analyzed using identical methods and techniques.

##### **R405.4.1 General.**

Calculation procedures used to comply with Section R405 shall use a software tool, *approved* in accordance with Section R405.5, capable of calculating the annual energy consumption of all building elements that differ between the *standard reference design* and the *proposed design*.

##### **R405.4.2 Residence specifications.**

The *standard reference design*, *proposed design* and as-built *dwelling unit* shall be configured and analyzed as specified by Table R405.4.2(1). Table R405.4.2(1) shall include, by reference, all notes contained in Table R402.1.3. Proposed *U*-factors and slab-on-grade *F*-factors shall be taken from Appendix RF, ANSI/ASHRAE/IES Standard 90.1-2022 Appendix A, or determined using a method consistent with the ASHRAE Handbook of Fundamentals and shall include the thermal bridging effects of framing materials.

#### **TABLE R405.4.2(1) SPECIFICATIONS FOR THE STANDARD REFERENCE AND PROPOSED DESIGNS**

#### **TABLE R405.4.2(2) DEFAULT DISTRIBUTION SYSTEM EFFICIENCIES FOR PROPOSED DESIGNS<sup>a</sup>**

##### **R405.4.3 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.

#### **R405.5 Calculation software tools.**

Performance analysis tools meeting the applicable provisions of Sections R405.5.1 through R405.5.4 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 such tools for a specified application or limited scope.

##### **R405.5.1 Minimum capabilities.**

*Approved* software tools 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-dwelling unit (as a single *zone*) sizing for the heating and cooling equipment in the *standard reference design* residence in accordance with Section R403.7.

3.Hourly calculations of building operation for a full calendar year (8,760 hours).

4.Calculations that account for hourly variations 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.

5.Printing of a *code official* inspection checklist listing each of the *proposed design* component characteristics from Table R405.4.2(1) determined by the analysis to provide compliance, along with their respective performance ratings such as *R-value*, *U-factor*, SHGC, HSPF2, AFUE, SEER2 and UEF.

##### **R405.5.2 Testing required by software vendors.**

Prior to approval, software tools shall be tested by the software vendor in accordance with ANSI/ASHRAE 140-2020 Class II, Tier 1 test procedures. During testing, hidden inputs that are not normally available to the user shall be permitted to avoid introducing source code changes strictly used for testing. Software vendors shall publish, on a publicly available website, the following ANSI/ASHRAE 140-2020 test results, input files and modeler reports for each tested version of a software tool:

1.Test results demonstrating the software tool was tested in accordance with ANSI/ASHRAE 140-2020.

2.The modeler report in ANSI/ASHRAE 140-2020, Annex A2, Attachment A2.7.

##### **R405.5.3 Algorithms not tested.**

Algorithms not tested in accordance with Section R405.5.2 shall be permitted in accordance with ANSI/RESNET/ICC 301. Numerical settings not tested, such as timestep duration and tolerances, shall be permitted where they represent a higher resolution than the numerical settings used for testing.

##### **R405.5.4 Compliance reports.**

*Approved* software tools shall generate compliance reports in accordance with Sections R405.5.4.1 and R405.5.4.2.

##### **R405.5.4.1 Compliance report for permit application.**

A compliance report generated for submission with the application for building permit shall include the following:

1. Building street address or other *building site* identification.
2. The name of the individual performing the analysis and generating the compliance report.
3. The name and version of the compliance software tool.
4. Documentation of all inputs to the software used to produce the results for the *standard reference design* and the *proposed design*.
5. A certificate indicating that the *proposed design* complies with Section R405.2. The certificate shall document the building components' energy specifications that are included in the calculation including: component-level insulation *R-values* or *U-factors*; *duct system* and *building thermal envelope* air leakage testing assumptions; and the type and rated efficiencies of proposed heating, cooling, mechanical *ventilation* and service water-heating equipment to be installed. Where *on-site renewable energy* systems will be installed, the certificate shall report the type and production size of the proposed system.
6. Where a site-specific report is not generated, the *proposed design* shall be based on the worst-case orientation and configuration of the rated *dwelling unit*.

#### **R405.5.4.2 Compliance report for certificate of occupancy.**

A compliance report generated for submission prior to obtaining the certificate of occupancy shall include the following:

1. Building street address, or other *building site* identification.
2. Declaration of the *simulated building performance* path on the title page of the energy report and the title page of the building plans.
3. A statement, bearing the name of the individual performing the analysis and generating the report, indicating that the as-built *building* complies with Section R405.2.
4. The name and version of the compliance software tool.
5. A site-specific *energy analysis* report that is in compliance with the requirements of Section R405.4, where all inputs for the *proposed design* have been replaced in the simulation with confirmed energy features of the as-built *dwelling unit*.
6. A final confirmed certificate indicating compliance based on inspection, and a statement indicating that the as-built *building* complies with Section R405.2. The certificate shall report the energy features that were confirmed to be in the *building*, including component-level insulation *R-values* or *U-factors*; results from

- any required *duct system* and *building thermal envelope* air leakage testing; and the type and rated efficiencies of the heating, cooling, mechanical *ventilation* and service water-heating equipment installed.
7. When *on-site renewable energy* systems have been installed, the certificate shall report the type and production size of the installed system.

### **SECTION R406 ENERGY RATING INDEX COMPLIANCE ALTERNATIVE**

#### **R406.1 Scope.**

This section establishes criteria for compliance using an *Energy Rating Index* (ERI) analysis. Such analysis shall be limited to *dwelling units*. Spaces other than *dwelling units* in Group R-2, R-3 or R-4 buildings shall comply with Sections R402 through R404.

#### **R406.2 ERI compliance.**

Compliance based on the *ERI* requires that the *rated design* and as-built *dwelling unit* meet all of the following:

1. The requirements of the sections indicated within Table R406.2.
2. Maximum *ERI* values indicated in Table R406.5.

### **TABLE R406.2 REQUIREMENTS FOR ENERGY RATING INDEX**

#### **R406.3 Building thermal envelope.**

The proposed total *building thermal envelope* thermal conductance (TC) shall be less than or equal to the required total *building thermal envelope* TC using the prescriptive *U-factors* and *F-factors* from Table R402.1.2 multiplied by 1.08 in Climate Zones 0, 1 and 2, and by 1.15 in Climate Zones 3 through 8, in accordance with Equation 4-2 and Section R402.1.5. The area-weighted maximum fenestration SHGC permitted in Climate Zones 0 through 3 shall be 0.30.

#### **R406.4 Energy Rating Index.**

The *Energy Rating Index* (ERI) shall be determined in accordance with ANSI/RESNET/ICC 301. The mechanical *ventilation* rates used for the purpose of determining the *ERI* shall not be construed to establish minimum *ventilation* requirements for compliance with this code.

Energy used to recharge or refuel a vehicle used for transportation on roads that are not on the *building site* shall not be included in the *ERI reference design* or the *rated design*.

#### **R406.5 ERI-based compliance.**

Compliance based on an *ERI* analysis requires that the *rated design* and each confirmed as-built *dwelling unit* be shown to have an *ERI* less than or equal to the appropriate value indicated in Table R406.5 where compared to the *ERI*

*reference design* as follows:

1. Where on-site renewables are not installed, the values under ENERGY RATING INDEX NOT INCLUDING OPP apply.
2. Where on-site renewables are installed, the values under ENERGY RATING INDEX WITH OPP apply.

**Exceptions:**

1. Where the *ERI* analysis excludes on-site power production (OPP), the values under ENERGY RATING INDEX NOT INCLUDING OPP shall be permitted to be applied.
2. For buildings with 20 or more *dwelling units*, where *approved* by the *code official*, compliance shall be permitted using the Average Dwelling Unit *Energy Rating Index*, as calculated in accordance with ANSI/RESNET/ICC 301.

**TABLE R406.5 MAXIMUM ENERGY RATING INDEX**

**R406.6 Verification by approved agency.**

Verification of compliance with Section R406 as outlined in Sections R406.5 and R406.7 shall be completed by an *approved* third party. Verification of compliance with Section R406.2 shall be completed by the authority having jurisdiction or an *approved* third-party inspection agency in accordance with Section R107.4.

**R406.7 Documentation.**

Documentation of the software used to determine the *ERI* and the parameters for the *ERI reference design* shall be in accordance with Sections R406.7.1 through R406.7.4.

**R406.7.1 Compliance software tools.**

Software tools used for determining *ERI* shall be *approved* software rating tools as defined by ANSI/RESNET/ICC 301. Software vendors shall publish, on a publicly available website, documentation that the software tool has been validated using the Class II, Tier 1 test procedure in ANSI/ASHRAE 140-2020.

**R406.7.2 Compliance report.**

Compliance software tools shall generate a report that documents that the *ERI* of the *rated design* and as-built *dwelling unit* complies with Sections R406.2 through R406.5.

Compliance documentation shall be created for the proposed design and shall be submitted with the application for the building permit. Confirmed compliance documents of the as-built *dwelling unit* shall be created and submitted to the *code official* for review before a certificate of occupancy is issued. Compliance reports shall include information in accordance with Sections R406.7.2.1 and R406.7.2.2.

**R406.7.2.1 Proposed compliance report for permit application.**

Compliance reports submitted with the application for a building permit shall include the following:

1. Building street address, or other *building site* identification.
2. Declare *ERI* on title page and building plans.
3. The name of the individual performing the analysis and generating the compliance report.
4. The name and version of the compliance software tool.
5. Documentation of all inputs entered into the software used to produce the results for the *ERI reference design* and the *rated design*.
6. A certificate indicating that the proposed design has an *ERI* less than or equal to the appropriate score indicated in Table R406.5 when compared to the *ERI reference design*. The certificate shall document the building component energy specifications that are included in the calculation, including: component level insulation *R-values* or *U-factors*; assumed *duct system* and *building thermal envelope* air leakage testing results; and the type and rated efficiencies of proposed heating, cooling, mechanical *ventilation* and service water-heating equipment to be installed. Where *on-site renewable energy* systems will be installed, the certificate shall report the type and production size of the proposed system.
7. When a site-specific report is not generated, the proposed design shall be based on the worst-case orientation and configuration of the *rated dwelling unit*.

**R406.7.2.2 Confirmed compliance report for a certificate of occupancy.**

A confirmed compliance report submitted for obtaining the certificate of occupancy shall be made site and address specific and include the following:

1. Building street address or other *building site* identification.
2. Declaration of *ERI* on title page and on building plans.
3. The name of the individual performing the analysis and generating the report.
4. The name and version of the compliance software tool.
5. Documentation of all inputs entered into the software used to produce the results for the *ERI reference design* and the as-built *dwelling unit*.
6. A final confirmed certificate indicating that the as-built *building* complies with Sections R406.2, R406.4 and R406.5. The certificate shall report the energy features that were confirmed to be in the *building*, including: component-level insulation *R-values* or *U-factors*; results from any required *duct system* and *building thermal envelope* air leakage testing; and the type and rated efficiencies of the heating, cooling,

mechanical *ventilation*, and service water-heating equipment installed. Where *on-site renewable energy* systems have been installed on or in the *building*, the certificate shall report the type and production size of the installed system.

**R406.7.3 Renewable energy certificate (REC) documentation.**

Where renewable energy power production is included in the calculation of an *ERI*, documentation shall comply with Section R404.4.

**R406.7.4 Additional documentation.**

The *code official* shall be permitted to require the following documents:

- 1.Documentation of the building component characteristics of the *ERI reference design*.
- 2.A certification signed by the builder providing the building component characteristics of

the *rated design*.

3.Documentation of the actual values used in the software calculations for the *rated design*.

**R406.7.5 Specific approval.**

Performance analysis tools meeting the applicable subsections of Section R406 shall be *approved*. Documentation demonstrating the approval of performance analysis tools in accordance with Section R406.7.1 shall be provided.

**R406.7.6 Input values.**

Where calculations require input values not specified by Sections R402, R403, R404 and R405, those input values shall be taken from ANSI/RESNET/ICC 301.

Public Comments: 03 Nov 2025 to 06 Feb 2026

## CHAPTER [CE] 5 EXISTING BUILDINGS

### SECTION C501 GENERAL

#### C501.1 Scope.

The provisions of this chapter shall control the *alteration, repair, addition and change of occupancy* of existing buildings and structures.

#### C501.1.1 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.

#### C501.2 Compliance.

*Alterations, repairs, additions and changes of occupancy to, or relocation of, existing buildings and structures shall comply with the provisions for alterations, repairs, additions and changes of occupancy or relocation, respectively, in this code and in the International Building Code, International Existing Building Code, International Fire Code, International Fuel Gas Code, International Mechanical Code, International Plumbing Code, International Property Maintenance Code, International Private Sewage Disposal Code and NFPA 70.*

#### C501.3 Maintenance.

*Buildings and structures, and parts thereof, shall be maintained in a safe and sanitary condition. Devices and systems required by this code shall be maintained in conformance to the code edition under which they were installed. The owner or the owner's authorized agent shall be responsible for the maintenance of buildings and structures. The requirements of this chapter shall not provide the basis for removal or abrogation of energy conservation, fire protection and safety systems and devices in existing structures.*

#### C501.4 New and replacement materials.

Except as otherwise required or permitted by this code, materials permitted by the applicable code for new construction shall be used. Like materials shall be permitted for *repairs*, provided that hazards to life, health or property are not created. Hazardous materials shall not be used where the code for new construction would not allow use of these materials in buildings of similar occupancy, purpose and location.

#### C501.5 Historic buildings.

Provisions of this code relating to the construction, *repair, alteration, restoration and movement of structures, and change of occupancy* shall not be mandatory for *historic buildings* provided that a report has been submitted to the *code official* and signed by a *registered design professional*, or a representative of the State Historic Preservation Office or the historic

preservation authority having jurisdiction, demonstrating that compliance with that provision would threaten, degrade or destroy the historic form, fabric or function of the *building*.

### SECTION C502 ADDITIONS

#### C502.1 General.

*Additions* to an existing building, building system or portion thereof shall conform to the provisions of this code as those provisions relate to new construction without requiring the unaltered portion of the existing building or building system to comply with this code. *Additions* 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*.

#### C502.2 Change in space conditioning.

Any nonconditioned or low-energy space that is altered to *become conditioned space* shall be required to comply with Section C502.

#### Exceptions:

1. Where the component performance alternative in Section C402.1.4 is used to comply with this section, the proposed UA shall be not greater than 110 percent of the target UA.
2. Where the simulated building performance option in Section C407 is used to comply with this section, the annual *energy cost* of the *proposed design* shall be not greater than 110 percent of the annual *energy cost* otherwise permitted by Section C407.2.

#### C502.3 Compliance.

*Additions* shall comply with Sections C502.3.1 through C502.3.8.

#### C502.3.1 Vertical fenestration area.

New *vertical fenestration* area that results in a total building *fenestration* area less than or equal to that specified in Section C402.4.1 shall comply with Section C402.1.5, C402.4.3 or C407. *Additions* with *vertical fenestration* that result in a total building *fenestration* area greater than Section C402.4.1 or *additions* that exceed the fenestration area greater than Section C402.4.1 shall comply with Section C402.4.1.1 for the *addition* only. *Additions* that result in a total building vertical fenestration area exceeding that specified in Section C402.4.1.1 shall comply with Section C402.1.5 or C407.

#### C502.3.2 Skylight area.

New *skylight* area that results in a total building *fenestration* area less than or equal to that specified in Section C402.4.1 shall comply with Section

C402.1.5 or C407. *Additions* with *skylight* area that result in a total building *skylight* area greater than C402.4.1 or additions that exceed the *skylight* area shall comply with Section C402.4.1.2 for the *addition* only. *Additions* that result in a total building *skylight* area exceeding that specified in Section C402.4.1.2 shall comply with Section C402.1.5 or C407.

#### **C502.3.3 Building mechanical systems.**

New mechanical systems and equipment that are part of the *addition* and serve the building heating, cooling and *ventilation* needs shall comply with Sections C403 and C408.

#### **C502.3.4 Service water-heating systems.**

New service water-heating equipment, controls and service water-heating piping shall comply with Section C404.

#### **C502.3.6 Lighting power and systems.**

New lighting systems that are installed as part of the *addition* shall comply with Sections C405 and C408.

##### **C502.3.6.1 Interior lighting power.**

The total interior lighting power for the *addition* shall comply with Section C405.3.2 for the *addition* alone, or the existing building and the *addition* shall comply as a single *building*.

##### **C502.3.6.2 Exterior lighting power.**

The total exterior lighting power for the *addition* shall comply with Section C405.5.2 for the *addition* alone, or the existing building and the *addition* shall comply as a single *building*.

#### **C502.3.7 Additional energy efficiency credit requirements.**

*Additions* shall comply with sufficient measures from Sections C406.2 and C406.3 to achieve not less than 50 percent of the number of required efficiency credits from Table C406.1.1(1) based on building occupancy group and *climate zone*. Where a project contains multiple occupancies, credits from Table C406.1.1(1) for each building occupancy shall be weighted by the gross floor area to determine the project weighted average energy credits required. Accessory occupancies shall be included with the primary occupancy group for purposes of this section. *Alterations* to the existing building that are not part of the *addition*, but are permitted with an *addition*, shall be permitted to be used to achieve the required credits.

#### **Exceptions:**

1. Buildings in Group U (Utility and Miscellaneous), Group S (Storage), Group F (Factory), Group H (High-Hazard).
2. *Additions* less than 1,000 square feet (93 m<sup>2</sup>) and less than 50 percent of existing floor area.
3. *Additions* that do not include the *addition* or replacement of equipment covered by Tables

C403.3.2(1) through C403.3.2(16) or Section C404.2.

4. *Additions* that do not increase *conditioned space*.
5. Where the *addition* alone or the existing building and *addition* together comply with Section C407.

#### **C502.3.8 Renewable energy systems.**

*Additions* shall comply with Section C405.15 for the *addition* alone.

## **SECTION C503 ALTERATIONS**

### **C503.1 General.**

*Alterations* to any *building* or structure shall comply with the requirements of Section C503. *Alterations* shall be such that the existing building or structure is not less conforming to the provisions of this code than the existing *building* or structure was prior to the *alteration*. *Alterations* to an existing *building*, *building* system or portion thereof shall conform to the provisions of this code as those provisions relate to new construction without requiring the unaltered portions of the existing *building* or *building* system to comply with this code. *Alterations* shall not create an unsafe or hazardous condition or overload existing building systems.

Exception: The following *alterations* need not comply with the requirements for new construction, provided that the energy use of the *building* is not increased:

1. Storm windows installed over existing *fenestration*.
2. Surface-applied window film installed on existing single-pane *fenestration* assemblies reducing solar heat gain, provided that the code does not require the glazing or *fenestration* to be replaced.
3. *Roof recover*.
4. *Roof replacement* where roof assembly insulation is integral to or located below the structural roof deck.
5. *Air barriers* shall not be required for *roof recover* and *roof replacement* where the *alterations* or renovations to the *building* do not include *alterations*, renovations or *repairs* to the remainder of the *building thermal envelope*.

6. An existing building undergoing alterations that complies with Section C407.

#### C503.2 Building thermal envelope.

Alterations of existing building thermal envelope assemblies shall comply with this section. New building thermal envelope assemblies that are part of the alteration shall comply with Section C402. An area-weighted average *U-factor* for new and altered portions of the building thermal envelope shall be permitted to satisfy the *U-factor* requirements in Table C402.1.4. The existing *R-value* of insulation shall not be reduced or the *U-factor* of a building thermal envelope assembly be increased as part of a building thermal envelope alteration except where complying with Section C407.

Exception: Where the existing building exceeds the fenestration area limitations of Section C402.5.1 prior to alteration, the building is exempt from Section C402.5.1 provided that there is no increase in fenestration area.

#### C503.2.1 Roof, ceiling and attic alterations.

Insulation complying with Sections C402.1 and C402.2.1, or an approved design that minimizes deviation from the insulation requirements, shall be provided for the following alterations:

1. An alteration of roof/ceiling construction other than reroofing where existing insulation located below the roof deck or on an attic floor above conditioned space does not comply with Table C402.1.2.
2. Roof replacement or a roof alteration that includes removing and replacing the roof covering, where the roof assembly includes insulation entirely above the roof deck.

Exceptions: Where compliance with Section C402.1 cannot be met due to limiting conditions on an existing roof, an approved design shall be submitted with the following:

1. Construction documents that include a report by a registered design professional or an approved source documenting details of the limiting conditions affecting compliance with the insulation requirements.
2. Construction documents that include a roof design by a registered design professional or an approved source that minimizes deviation from the insulation requirements.
3. Conversion of unconditioned attic space into conditioned space.
4. Replacement of ceiling finishes exposing cavities or surfaces of the roof/ceiling construction.

#### C503.2.2 Vertical fenestration.

The addition of vertical fenestration that results in a

total building fenestration area less than or equal to that specified in Section C402.5.1 shall be permitted without additional restrictions, provided that glazing meets the *U-factor* and *SHGC* requirements of Section C402.1.4 or the performance path in Section C407.

The addition of vertical fenestration that results in a total building fenestration area greater than Section C402.5.1 shall not be required to fully comply with Section C402.5.1.1, provided that:

The fenestration area does not exceed 10% more than the existing building's fenestration-to-wall ratio prior to alteration.

Where new fenestration is added, shading devices, orientation strategies, or low-e glazing are incorporated to minimize solar heat gain.

In energy modelling, the existing fenestration area prior to alteration may be used in the standard reference design as an alternative to the prescriptive limits in Table C407.4.1(1).

#### C503.2.2.1 Application to replacement fenestration products.

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 C402.5.

Exception: An area-weighted average of the *U-factor* of replacement fenestration products being installed in the building for each fenestration product category listed in Table C402.5 shall be permitted to satisfy the *U-factor* requirements for each fenestration product category listed in Table C402.5. Individual fenestration products from different product categories listed in Table C402.5 shall not be combined in calculating the area-weighted average *U-factor*.

#### C503.2.3 Skylight area.

New skylight additions resulting in total building skylight area  $\leq$  Section C402.5.1 shall comply with Section C402.1.4, C402.5 or C407.

New skylight additions resulting in total skylight area  $>$  Section C402.5.1: comply with C402.5.1.2 only for the floor area directly beneath the new skylights, instead of the entire floor area. Alterations exceeding C402.5.1.2: comply with C402.1.4 or C407. Alternative: If skylight area remains unchanged, use the same skylight area in the reference design as the building prior to alteration.

#### C503.2.4 Above-grade wall alterations.

Above-grade wall alterations shall comply with the following:

1. Where wall cavities are exposed, the cavity shall be filled with cavity insulation complying with Section C303.1.4. New cavities created may be insulated with an *R-value* up to 20% lower than Section C402.1, or an approved design that minimizes deviation from the insulation requirements.

2. Where exterior wall coverings and fenestration are added or replaced for the full extent of any exterior wall assembly on one or more elevations of the building, insulation shall be provided **only on walls directly exposed to the exterior climate**, in accordance with one of the following:

2.1. **An R-value of continuous insulation not less than 80% of that designated in Table C402.1.3** for the applicable above-grade wall type and existing cavity insulation R-value, if any;

2.2. **An R-value of not less than 80% of that required to bring the above-grade wall into compliance with Table C402.1.2**; or

2.3. An approved design that minimizes deviation from the insulation requirements of Section C402.1. Where Items 1 and 2 apply, **the insulation may be partially omitted in non-critical areas, while still complying with Section C402.1** to the extent practical.

Where any of the above requirements are applicable, the above-grade wall alteration shall comply with Sections 1402.2 and 1404.3 of the International Building Code.

#### **C503.2.5 Floor alterations.**

Where an alteration to a floor or floor overhang exposes cavities or surfaces to which insulation can be applied, and the floor or floor overhang is part of the building thermal envelope, **insulation shall be provided to at least 80% of the R-value specified in Section C402.1 or an approved design that minimizes deviation from the insulation requirements.** This requirement applies to floor alterations where the floor cavities or surfaces are exposed and unobstructed prior to construction. **Insulation may be omitted in non-critical or internal floor areas not directly exposed to conditioned spaces.**

#### **C503.2.6 Below-grade wall alterations.**

Where unconditioned below-grade space is changed to conditioned space, walls enclosing such conditioned space shall be insulated **to at least 70–80% of the R-value specified in Section C402.1 or an approved design that minimizes deviation from the insulation requirements.** Where the below-grade space is already conditioned and walls enclosing such space are altered, **insulation shall be provided as above only for walls directly affecting occupied spaces; walls in non-critical areas may be exempted.**

#### **C503.2.7 Air barrier.**

Altered building thermal envelope assemblies shall be provided with an air barrier in accordance with Section C402.6.1. **The air barrier may be discontinuous and need not connect with unaltered portions of the building thermal envelope. Mandatory air barrier testing per Section C402.6.1.2 is not required.**

#### **C503.3 Heating and cooling systems.**

New heating, cooling and *duct systems* that are part of the *alteration* shall comply with [Section](#)

#### [C403.](#)

##### **C503.3.1 Economizers.**

New cooling systems that are part of an alteration shall comply with Section C403.5 **where technically feasible. For systems in small buildings or with low outdoor air-cooling potential, economizer installation may be exempted if demonstrated to have minimal energy savings.**

##### **C503.3.2 Mechanical system acceptance testing.**

Where an alteration requires compliance with Section C403 or any of its subsections, mechanical systems that serve the alteration shall comply with Sections C408.2.2, C408.2.3 and C408.2.5, **except for small buildings or systems where compliance is demonstrated to be technically impractical.**

Exceptions:

**1. Buildings with less than 15,000 square feet (1,394 m<sup>2</sup>) or a combined heating, cooling, and service water-heating capacity of less than 1,200,000 Btu/h (351 kW).**

**2. Systems included in Section C403.5 that serve individual dwelling units and sleeping units.**

**3. Buildings in CARICOM climates where testing would not significantly impact energy performance due to predominantly natural ventilation or low cooling/heating loads.**

##### **C503.3.3 Duct testing.**

Ducts and plenums designed to operate at static pressures not less than 3 inches water gauge (747 Pa) that serve an alteration shall be tested **only if the alteration significantly affects system performance, including any of the following:**

**1. Thirty-five percent or more of the total length of the ducts in the system are relocated.**

The total length of all ducts in the system is increased by 35 percent or more.

Ducts and plenums shall be leak tested in accordance with the SMACNA HVAC Air Duct Leakage Test Manual and shown to have a rate of **air leakage (CL) less than or equal to 15.0** as determined in accordance with Equation 4-7 of Section C403.13.2.3. Documentation shall be available demonstrating that representative sections totalling not less than **20 percent of the duct area have been tested and that all tested sections comply with the requirements of this section.**

##### **C503.3.4 Controls.**

New heating and cooling equipment that is part of the alteration shall be provided with controls that comply with the control requirements in Sections C403.4 and C403.5, **except that compliance with Sections C403.4.3.3, C403.4.4, and C403.5.1.1 is not mandatory.**

Exceptions:

**1. Systems with direct digital control of individual zones reporting to a central control panel.**

2.The replacement of individual components of multiple-zone VAV systems.

**3.Single-zone systems or systems in buildings with total conditioned area less than 929 m<sup>2</sup> (10,000 sq. ft.).**

**C503.3.5 System sizing.**

New heating and cooling equipment that is part of an alteration shall **preferably** be sized in accordance with Section C403.3.1 based on the existing building features as modified by the alteration.

Exceptions:

1.Where it has been demonstrated to the code official that compliance with this section would result in heating or cooling equipment that is incompatible with the rest of the heating or cooling system.

2.Where it has been demonstrated to the code official that the additional capacity will be needed in the future.

**3.Where local climate conditions (high ambient temperatures and humidity typical of CARICOM) make strict compliance uneconomical or unnecessary for comfort.**

**C503.3.6 Replacement or added roof-mounted mechanical equipment.**

For roofs with insulation entirely above the roof deck and where existing roof-mounted mechanical equipment is replaced or new equipment is added, and the existing roof does not comply with the insulation requirements for new construction in accordance with Sections C402.1 and C402.2.1, curbs for added or replaced equipment **shall be of a height sufficient to allow practical insulation retrofitting in the future.** Alternatively, the curb height may comply with Table C503.3.6. Curb height measurements may be reduced by up to 25% for small-scale equipment typical in CARICOM buildings.

**TABLE C503.3.6**

**C503.4 Service hot water systems.**

New service hot water systems that are part of the *alteration* shall comply with [Section C404](#).

**C503.4.1 Service hot water system acceptance testing.**

Where an alteration requires compliance with Section C404 or any of its subsections, service hot water systems that serve the alteration shall **generally** comply with Sections C408.2.3 and C408.2.5.

Exceptions:

1. Buildings with less than 1394 m<sup>2</sup> (15,000 square feet) or a combined heating, cooling, and service water-heating capacity of less than 352 kW (1,200,000 Btu/h)
2. Systems included in Section C403.5 that serve individual dwelling units and sleeping units.
3. **Systems where full acceptance testing is technically impractical due to site constraints, provided alternative**

**verification of proper operation is documented.**

**C503.5 Lighting systems.**

New lighting systems that are part of the *alteration* shall comply with [Section C405](#).

Exception. *Alterations* that replace less than 10 percent of the luminaires in a space, provided that such *alterations* do not increase the installed interior lighting power.

**C503.5.1 Interior lighting and controls.**

Alterations to interior spaces, lighting or controls shall comply with the following:

1.Where an alteration of an interior space includes the addition or relocation of full height partitions, the space shall comply with Sections C405.2, C405.3 and C408.3.

2.Where the lighting within interior spaces is altered, those spaces shall comply with Sections C405.2, C405.3 and C408.3.

3.Where the lighting controls within interior spaces are altered, those spaces shall comply with Sections C405.2 and C408.3.

Exception:

Compliance with Section C405.2.8 is not required for alterations.

**Spaces with lighting retrofits using high-efficiency LED or CFL replacements that do not increase installed wattage are exempt from full compliance.**

**Spaces where architectural or structural constraints make full compliance impractical may use alternate lighting control strategies approved by a design professional.**

**C503.5.2 Exterior lighting and controls.**

Alterations to exterior lighting and controls shall comply with the following:

1.Where the connected exterior lighting power is increased by more than 400 watts, all exterior lighting, including lighting that is not proposed to be altered, shall comply with Section C405.5.

2.Where the combined power of added and replacement luminaires is more than 400 watts, all lighting that is added or altered shall be controlled in accordance with Sections C405.2 and C408.3.

Exception:

1. Individual luminaires less than 50 watts provided they pass functional tests verifying automatic shut off where daylight is present.

**2. Lighting retrofits using high-efficiency LED luminaires that do not increase overall connected load may follow simplified control compliance.**

**3. Partial control alterations in existing systems may comply using alternate approved control strategies without full retrofitting.**

**C503.6 Additional energy efficiency credit requirements for alterations.**

*Alterations that are substantial improvements* shall comply with measures from [Sections C406.2, C406.3](#) or both to earn the number of

required credits specified in [Table C406.1.1\(1\)](#) based on building occupancy group and *climate zone*. Where a project contains multiple occupancies, credits specified in [Table C406.1.1\(1\)](#) for each building occupancy shall be weighted by the gross *conditioned floor area* to determine the weighted average credits required. Accessory occupancies, other than Group F or H, shall be included with the primary occupancy group for the purposes of this section.

Exceptions:

1. *Alterations* that do not contain *conditioned space*.
  2. Portions of *buildings* devoted to manufacturing or industrial use.
  3. *Alterations* to *buildings* where the *building* after the *alteration* complies with [Section C407](#).
  4. *Alterations* that are permitted with an *addition* complying with [Section C502.3.7](#).
  - 5.
1. Glass-only replacements in an existing sash and frame.
  2. *Roof repairs*.
  3. *Air barriers* shall not be required for *roof repair* where the *repairs* to the *building* do not include *alterations*, renovations or *repairs* to the remainder of the *building thermal envelope*.
  4. Replacement of existing doors that separate *conditioned space* from the exterior shall not require the installation of a vestibule or revolving door, provided that an existing vestibule that separates a *conditioned space* from the exterior shall not be removed.
  5. *Repairs* where only the bulb, the ballast or both within the existing luminaires in a space are replaced, provided that the replacement does not increase the installed interior lighting power.

#### SECTION C504 REPAIRS

##### C504.1 General.

*Buildings* and structures, and parts thereof, shall be repaired in compliance with [Section C501.3](#) and this section. Work on nondamaged components that is necessary for the required *repair* of damaged components shall be considered to be part of the *repair* and shall not be subject to the requirements for *alterations* in this chapter. Routine maintenance required by [Section C501.3](#), ordinary *repairs* exempt from *permit* and abatement of wear due to normal service conditions shall not be subject to the requirements for *repairs* in this section.

Where a *building* was constructed to comply with [ANSI/ASHRAE/IES 90.1-2022](#), *repairs* shall comply with the standard and need not comply with [Sections C402](#), [C403](#), [C404](#) and [C405](#).

##### C504.2 Application.

For the purposes of this code, the following shall be considered to be *repairs*:

#### SECTION C505

#### CHANGE OF OCCUPANCY OR USE

##### C505.1 General.

Spaces undergoing a change in occupancy from Group F, H, S or U occupancy classification shall comply with [Section C503](#). *Buildings* or portions of *buildings* undergoing a *change of occupancy* without *alterations* shall comply with [Section C505.2](#).

##### Exception:

1. Where the simulated building performance option in [Section C407](#) is used to comply with this section, the annual *energy cost* of the *proposed design* shall be not greater than 110 percent of the annual *energy cost* otherwise permitted by [Section C407.3](#).

## CHAPTER [RE] 5 EXISTING BUILDINGS

### SECTION R501 GENERAL

#### R501.1 Scope.

The provisions of this chapter shall control the *alteration, repair, addition* and change of occupancy of existing *buildings* and structures.

#### R501.1.1 General.

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. Unaltered portions of the *existing building* or *building* supply system shall not be required to comply with this code.

#### R501.2 Compliance.

*Additions, alterations, repairs* or changes of occupancy to, or relocation of, an existing *building*, building system or portion thereof shall comply with Section R502, R503, R504 or R505, respectively, in this code and the provisions for alterations, repairs, additions and changes of occupancy or relocation, respectively, in the *International Building Code, International Existing Building Code, International Fire Code, International Fuel Gas Code, International Mechanical Code, International Plumbing Code, International Property Maintenance Code, International Private Sewage Disposal Code, International Residential Code* and NFPA 70, as applicable. Changes where unconditioned space is changed to *conditioned space* shall comply with Section R501.6.

#### R501.3 Maintenance.

*Buildings* and structures, and parts thereof, shall be maintained in a safe and sanitary condition. Devices and systems that are required by this code shall be maintained in conformance to the code edition under which installed. The owner or the owner's authorized agent shall be responsible for the maintenance of *buildings* and structures. The requirements of this chapter shall not provide the basis for removal or abrogation of energy conservation, fire protection and safety systems and devices in existing structures.

#### R501.5 R501.4 New and replacement materials.

Except as otherwise required or permitted by this code, materials permitted by the applicable code for new construction shall be used. Like materials shall be permitted for *repairs*, provided that hazards to life, health or property are not created. Hazardous materials shall not be used where the code for new construction would not allow their use in *buildings* of similar occupancy, purpose and location.

#### R501.6 R501.5 Historic buildings.

Provisions of this code relating to the construction, *repair, alteration*, restoration and movement of structures, and *change of occupancy* shall not be mandatory for *historic buildings* provided that a report has been submitted to the *code official* and signed by the owner, a *registered design professional*, or a representative of the State Historic Preservation Office or the historic preservation authority having jurisdiction, demonstrating that compliance with that provision would threaten, degrade or destroy the historic form, fabric or function of the *building*.

#### R501.6 Change in space conditioning.

Any unconditioned or low-energy space that is altered to become *conditioned space* shall be required to be brought into full compliance with Section R502.

**Exception:** Where the simulated performance option in Section R405 is used to comply with this section, the annual *energy cost* of the *proposed design* is permitted to be 110 percent of the annual *energy cost* otherwise allowed by Section R405.2.

### SECTION R502 ADDITIONS

#### R502.1 General.

*Additions* to an existing *building, building* system or portion thereof shall conform to the provisions of this code as those provisions relate to new construction without requiring the unaltered portion of the existing *building* or *building* system to comply with this code. **Additions** shall not create an unsafe or hazardous condition or overload existing *building* systems. An *addition* shall be deemed to comply with this code where the *addition* alone complies, where the existing *building* and *addition* comply with this code as a single building, or where the *building* with the *addition* does not use more energy than the existing *building*. *Additions* shall be in accordance with Section R502.1.1 or R502.1.2.

#### R502.2 Prescriptive compliance.

*Additions* shall comply with Sections R502.2.1 through R502.2.5.

#### R502.2.1 Building thermal envelope.

New building thermal envelope assemblies that are part of the addition shall comply with Sections R402.1, R402.2, R402.4.1 through R402.4.5, and R402.5.

Exception: New building thermal envelope assemblies are exempt from the requirements of Section R402.5.1.2.

#### R502.2.2 Heating and cooling systems.

HVAC *ductwork* newly installed as part of

an *addition* shall comply with Section R403.

**Exception:** Where *ductwork* from an existing heating and cooling system is extended to an *addition*, Sections R403.3.7 and R403.3.8 shall not be required.

#### **R502.2.3 Service hot water systems.**

New service hot water systems that are part of the *addition* shall comply with Section R403.5.

#### **R502.1.1.4 R502.2.4 Lighting.**

New lighting systems that are part of the *addition* shall comply with Section R404.1.

#### **R502.2.5 Additional energy efficiency credit requirements for additions.**

*Additions* shall comply with sufficient measures from Table R408.2 to achieve not less than **three credits**. *Alterations* to the *existing building* that are not part of the *addition* but are permitted with an *addition* shall be permitted to be used to achieve this requirement.

#### **Exceptions:**

1. *Additions* that increase the *building's* total conditioned floor area by less than 25 percent.
2. *Additions* that do not include the addition or replacement of equipment covered in Section R403.5 or R403.7.
3. *Additions* that do not increase conditioned space.
4. Where the *addition* alone or the *existing building* and *addition* together comply with Section R405 or R406.

## **SECTION R503 ALTERATIONS**

### **R503.1 General.**

*Alterations* to any *building* or structure shall comply with the requirements of the code for new construction, without requiring the unaltered portions of the *existing building* or building system to comply with this code. *Alterations* shall be such that the *existing building* or structure is not less conforming to the provisions of this code than the *existing building* or structure was prior to the *alteration*.

*Alterations* shall not create an unsafe or hazardous condition or overload *existing building* systems. *Alterations* shall be such that the *existing building* or structure does not use more energy than the *existing building* or structure prior to the *alteration*. *Alterations* to *existing buildings* shall comply with Sections R503.1.1 through R503.1.5.

#### **R503.1.1 Building thermal envelope.**

*Alterations* of *existing building thermal envelope* assemblies shall comply with this section. New *building thermal envelope* assemblies that are

part of the *alteration* shall comply with Section R402. The *R-value* of insulation shall not be reduced, nor the *U-factor* of a *building thermal envelope* assembly increased as part of a *building thermal envelope alteration* except where the *building* after the alteration complies with Section R405 or R406.

**Exception:** The following alterations shall not be required to comply with the requirements for new construction provided that the energy use of the building is not increased:

1. Storm windows installed over existing *fenestration*.
2. *Roof recover*.
3. Surface-applied window film installed on existing single pane *fenestration* assemblies to reduce solar heat gain provided that the code does not require the glazing or *fenestration* assembly to be replaced.
4. *Roof replacement* where *roof assembly* insulation is integral to or located below the structural roof deck.

#### **R503.1.1.1 Fenestration alterations.**

Where new *fenestration* area is added to an *existing building*, the new *fenestration* shall comply with Section R402.4. 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 *solar heat gain coefficient* (SHGC) as specified in Table R402.1.3. Where more than one replacement *fenestration* unit is to be installed, an area-weighted average of the *U-factor*, SHGC or both of all replacement *fenestration* units shall be an alternative that can be used to show compliance.

#### **R503.1.1.2 Roof, ceiling and attic alterations.**

Roof, ceiling and attic insulation shall comply with Section R402.1. Alternatively, where limiting conditions prevent compliance with Section R402.1, an approved design that minimizes deviation from Section R402.1 shall be provided for the following alterations:

1. An alteration to roof/ceiling construction other than reroofing where existing insulation located below the roof deck, or an attic floor above conditioned space does not comply with Table R402.1.3.
2. Roof replacements or a roof alteration that includes removing and replacing the roof covering where the roof assembly includes insulation entirely above the roof deck. Where limiting conditions require use of an approved design to minimize deviation from Section R402.1 for a Group R-2 building, a registered design professional or other approved source shall provide construction

documents that identify the limiting conditions and the means to address them.

3. Conversion of an unconditioned attic space into conditioned space.

4. Replacement of ceiling finishes exposing cavities or surfaces of the roof/ceiling.

#### **R503.1.1.3 Above-grade wall alterations.**

*Above-grade wall alterations* shall comply with the following as applicable:

1. Where wall cavities are exposed, the exposed cavities shall be filled with insulation complying with Section R303.1.4. New cavities created shall be insulated in accordance with Section R402.1 or an *approved design* that minimizes deviation from Section R402.1. An interior vapor retarder shall be provided where required in accordance with Section R702.7 of the *International Residential Code* or Section 1404.3 of the *International Building Code*, as applicable.
2. Where exterior wall coverings and *fenestration* are added or replaced for the full extent of any exterior facade of one or more elevations of the *building*, *continuous insulation* shall be provided where required in accordance with Section R402.1 or the wall insulation shall be in accordance with an *approved design* that minimizes deviation from Section R402.1. Where specified, the *continuous insulation* requirement also shall comply with Section R702.7 of the *International Residential Code*. Replacement exterior wall coverings shall comply with the water-resistance requirements of Section R703.1.1 of the *International Residential Code* or Section 1402.2 of the *International Building Code*, as applicable, and manufacturers' instructions.
3. Where new interior finishes or exterior wall coverings are applied to the full extent of any exterior wall assembly of mass construction, insulation shall be provided in accordance with Section R402.1 or an *approved design* that minimizes deviation from Section R402.1.

#### **R503.1.1.4 Floor alterations.**

Where cavities in a floor or floor overhang are exposed and the floor or floor overhang is part of the building thermal envelope:

The floor or floor overhang shall comply with **Section R402.1** where practical and feasible.

Where **site conditions, structural limitations, or local climate make full compliance impractical, an approved alternative design shall be**

permitted.

**Acceptable alternatives include:**

**1. Partial insulation upgrades (minimum 50–70% of R-value in Table R402.1.3).**

**2. Use of reflective barriers or ventilation strategies in lieu of full insulation in tropical climates.**

**3. Exemptions for minor repairs (<25 m<sup>2</sup> / ~270 ft<sup>2</sup> exposed area) or non-conditioned spaces (e.g., storage, utility).**

#### **R503.1.1.5 Below-grade wall alterations.**

Where an unconditioned below-grade space is changed to conditioned space, or where building thermal envelope walls enclosing such below-grade space are altered:

1. The walls shall comply with **Section R402.1** where practical and feasible.
2. Where climate conditions, construction type, or site limitations make full compliance impractical, an approved alternative design shall be permitted.

**Acceptable alternatives include:**

1. Partial insulation upgrades (minimum 50–70% of R-value in Table R402.1.3).
2. Use of waterproofing, reflective coatings, or ventilation in lieu of full insulation, recognizing limited thermal load impact of below-grade walls in tropical climates.
3. Exemptions for minor repairs (<25% of wall area altered) or non-habitable spaces (e.g., storage rooms, utility areas).

#### **R503.1.1.6 Air barrier.**

Altered building thermal envelope assemblies shall be provided with an air barrier in accordance with Section R402.5, to the extent practical.

The air barrier need not be continuous with unaltered portions of the building thermal envelope. Testing requirements of Section R402.5.1.2 shall not apply. In tropical CARICOM climates, where natural ventilation is widely used, alternative measures such as sealing of visible cracks, joints, and penetrations shall be deemed acceptable compliance.

**Exemptions:**

**1. Minor alterations that do not expose envelope cavities (e.g., window/door replacement only).**

**2. Structures designed primarily for natural ventilation where airtightness provides little efficiency benefit.**

#### **R503.1.2 Heating and cooling systems.**

New heating and cooling systems and *ductwork* that are part of the *alteration* shall comply with Section R403 and this section. *Alterations* to existing heating and cooling systems and *ductwork* shall comply with this section.

**Exception:** Where *ductwork* from an existing heating and cooling system is extended.

#### R503.1.2.1 Ductwork.

HVAC *ductwork* newly installed as part of an *alteration* shall comply with [Section R403](#).

**Exception:** Where *ductwork* from an existing heating and cooling system is extended.

#### R503.1.2.2 System sizing.

New heating and cooling equipment that is part of an *alteration* shall be sized in accordance with [Section R403.7](#) based on the *existing building* features as modified by the *alteration*.

**Exception:** Where it has been demonstrated to the *code official* that compliance with this section would result in heating or cooling equipment that is incompatible with the remaining portions of the existing heating or cooling system.

#### R503.1.2.3 Duct system leakage.

Where an *alteration* includes any of the following, *duct systems* shall be tested in accordance with [Section R403.3.7](#) and shall have a total leakage less than or equal to 12.0 cubic feet per minute (339.9 L/min) per 100 square feet (9.29 m<sup>2</sup>) of *conditioned floor area*:

1. 1.Twenty-five percent or more of the registers that are part of the *duct system* are relocated.
2. 2.Twenty-five percent or more of the total length of all *ductworks* in the *duct system* is relocated.
3. 3.The total length of all *ductworks* in the *duct system* is increased by 25 percent or more.

**Exception:** *Duct systems* located entirely inside a *conditioned space* in accordance with [Section R403.3.4](#).

#### R503.1.2.4 Controls.

New heating and cooling equipment that is part of the *alteration* shall comply with [Sections R403.1](#) and [R403.2](#).

#### R503.1.3 Service hot water systems.

New service hot water systems that are part of the *alteration* shall comply with [Section R403.5](#).

#### R503.1.4 Lighting.

New lighting systems that are part of the *alteration* shall comply with [Section R404.1](#).

**Exception:** *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.

**R503.1.5 Additional efficiency credit requirements for substantial improvements.**

*Substantial improvements* shall comply with sufficient measures from [Table R408.2](#) to achieve not less than three credits.

#### Exceptions:

1. *Alterations* that are permitted with an *addition* complying with [Section R502.2.5](#).
2. *Alterations* that comply with [Section R405](#) or [R406](#).
3. *Substantial improvements* that do not include the *addition* or replacement of equipment covered in either [Section R403.5](#) or [R403.7](#).

## SECTION R504 REPAIRS

### R504.1 General.

*Buildings*, structures and parts thereof shall be repaired in compliance with [Section R501.3](#) and this section. Work on nondamaged components necessary for the required *repair* of damaged components shall be considered to be part of the *repair* and shall not be subject to the requirements for *alterations* in this chapter. Routine maintenance required by [Section R501.3](#), ordinary *repairs* exempt from *permit*, and abatement of wear due to normal service conditions shall not be subject to the requirements for *repairs* in this section.

### R504.2 Application.

For the purposes of this code, the following shall be considered to be *repairs*:

1. Glass-only replacements in an existing sash and frame.
2. Roof *repairs*.
3. *Repairs* where only the bulb, ballast or both within the existing luminaires in a space are replaced provided that the replacement does not increase the installed interior lighting power

## SECTION R505 CHANGE OF OCCUPANCY OR USE

### R505.1 General.

Any space that is converted to a *dwelling unit* or portion thereof from another use or occupancy shall comply with this chapter.

#### Exception:

Where the *simulated building performance* option in [Section R405](#) is used to comply with this section, the annual *energy cost* of the *proposed design* is permitted to be 110 percent of the annual *energy cost* allowed by [Section R405.2](#).

#### R505.1.1 Unconditioned space.

Any unconditioned or low-energy space that is altered to become a *conditioned space* shall comply with [Section R501.6](#).

## CHAPTER [CE] 6 REFERENCED STANDARDS

2024 IECC shall apply.

Public Comments: 03 Nov 2025 to 06 Feb 2026

## CHAPTER [RE] 6 REFERENCED STANDARDS

2024 IECC shall apply.

END OF DOCUMENT

Public Comments: 03 Nov 2025 to 06 Feb 2026



## **CARICOM REGIONAL ORGANISATION FOR STANDARDS AND QUALITY**

The CARICOM Regional Organisation for Standards and Quality (CROSQ) was created as an Inter-Governmental Organisation by the signing of an agreement among fourteen Member States of the Caribbean Community (CARICOM). CROSQ is the regional centre for promoting efficiency and competitive production in goods and services, through the process of standardization and the verification of quality. It is the successor to the Caribbean Common Market Standards Council (CCMSC), and supports the CARICOM mandate in the expansion of intra-regional and extra-regional trade in goods and services.

CROSQ is mandated to represent the interest of the region in international and hemispheric standards work, to promote the harmonization of metrology systems and standards, and to increase the pace of development of regional standards for the sustainable production of goods and services in the CARICOM Single Market and Economy (CSME), and the enhancement of social and economic development.

### **CROSQ VISION:**

Transforming and Empowering Lives Through Standards and Quality

### **CROSQ MISSION:**

Working together to facilitate the growth, resilience and sustainable development of CARICOM through the advancement of an internationally recognised Regional Quality Infrastructure