



**The 2018 International Green Construction Code as Amended and Adopted by  
Montgomery County, Maryland  
Department of Permitting Services**

## Effective Use of the International Green Construction Code

**Informative Note:** Corresponding ASHRAE 189.1 section numbers have not been included in this Effective Use section but have been included throughout the chapters and appendices of this code.

The *International Green Construction Code*® (IgCC®) is a model code that provides minimum requirements to safeguard the environment, public health, safety and general welfare through the establishment of requirements that are intended to reduce the negative impacts and increase the positive impacts of the built environment on the natural environment and building occupants. The IgCC is fully compatible with the ICC family of codes, including the *International Building Code*® (IBC), the *International Code Council Performance Code*® (ICPCP<sup>3</sup>), the *International Energy Conservation Code*® (IECC<sup>3</sup>), the *International Existing Building Code*® (IEBC<sup>6</sup>), the *International Fire Code*® (WV), the *International Fuel Gas Code*® (IFGC<sup>3</sup>), the *International Mechanical Code*® (IMC<sup>3</sup>), the *International Plumbing Code*® (IPC<sup>3</sup>), the *International Private Sewage Disposal Code*® (IPSDC<sup>3</sup>), the *International Property Maintenance Code*® (IPMC), the *International Residential Code*® (IRC), the *International Swimming Pool and Spa Code*® (ISPSC<sup>9</sup>), the *International Wildland-Urban Interface Code*® (IWUIC<sup>3</sup>), and the *International Zoning Code*® (IZC<sup>3</sup>).

The IgCC addresses site sustainability, water and energy efficiency, indoor environmental quality, materials, and resources, building commissioning, construction and plans for operations and maintenance for new and certain types of existing buildings, building sites and building materials, components, equipment and systems (see Section 101.3.1). The code will be promulgated on a 3-year cycle to allow for new construction methods and technologies to be incorporated into the code. Innovative approaches and alternative materials, designs, and methods not specifically addressed in this code can be approved by the code official where the proposed innovative approaches or materials, designs or methods comply with the intent of the provisions of the code (see Section 105.4).

The IgCC applies to all occupancies other than single-family dwellings and multifamily dwellings that are three stories or less in height (see Section 101.3.2). See discussion below for additional information in Appendix J for residential construction.

## Arrangement and Format of the 2018 IgCC

Before applying the requirements of the IgCC, it is beneficial to understand its arrangement and format.

Chapter	Subjects
1	Scope and Administration
2	Reserved
3	Definitions, Abbreviations and Acronyms
4	Reserved
5	Site Sustainability
6	Reserved
7	Energy Efficiency
8	Indoor Environmental Quality (IEQ)
9	Materials and Resources
10	Construction and Plans for Operation
11	Normative References
Normative Appendix A	Climate zones and prescriptive building envelope and duct insulation tables.
Normative Appendix B	Prescriptive equipment efficiency tables for the alternate reduced renewables and increased equipment efficiency approach in Section 701.4.1.1.2 (7.4.1.1.2)
Normative Appendix C	Performance option for energy efficiency
Normative Appendix D	Building concentrations
Informative Appendix E	Building Envelope Tables
Informative Appendix F	Integrated Design
Informative Appendix G	Informative References
Informative Appendix H	Option for energy efficiency using the IECC prescriptive compliance path
Informative Appendix I	Additional guidance for functional and performance testing (FPT) and the commissioning (Cx) process
Informative Appendix J	Option for residential compliance using the National Green Building Standard.
Annex 1	Referenced standard reproduction annex – ASHRAE Standard 169

The following is a chapter-by-chapter synopsis of the scope and intent of the provisions of the *International Green Construction Code*:

**Chapter 1 Scope and Administration.** Chapter 1 of the IgCC establishes the limits of applicability of the code and describes the manner in which the code is to be applied and enforced. Chapter 1 is divided into two parts: Part 1— Scope and Application (Sections 101 and 102); and Part 2— Administration and Enforcement (Sections 103 — 109).

Section 101 identifies which buildings and structures come under its purview and Section 102 references other adopted I-Codes as applicable. Section 103 establishes the duties and powers of the code official, including enforcement and the authority granted to the code official to make inspections. Section 105 provides guidance to the code official in the approval of materials, methods of construction, designs, systems, and innovative approaches where they are not specifically prescribed in the IgCC. Section 106 identifies the permitting process.

The provisions of Chapter 1 also establish the rights and privileges of the design professional, contractor and property owner.

The IgCC is intended to be adopted as a legally enforceable document and it cannot be effective without adequate provisions for its administration and enforcement.

## **Chapter 2 Reserved.**

**Chapter 3 Definitions, Abbreviations and Acronyms.** All terms that are defined in the code are listed alphabetically in Chapter 3. 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 that code meaning can differ substantially from the ordinarily understood meaning of the term as used outside of the code. Where a definition is provided for understanding a particular code provision, the term is shown in italics wherever it appears in the code. 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.

Definitions are deemed to be of prime importance in establishing the meaning and intent of the code text that uses code-defined terms. 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 because the user may not be aware that a term is defined in a manner that is not commonly understood.

## **Chapter 4 Reserved.**

**Chapter 5 Site Sustainability.** Chapter 5 contains requirements related to the selection and development of sites and the mitigation of heat island effect, light pollution and transportation impact.

Section 501.3 limits the type of sites that can be built upon and the type of development that can occur.

Section 501.3.1.1 limits building sites to within the envelope of an existing building, brownfield sites, greyfield sites and certain limited types of greenfield sites.

Section 501.3.5 requires the mitigation of heat island effect.

## **Chapter 6 Reserved.**

**Chapter 7 Energy Efficiency.** Chapter 7 contains requirements related to the effective use of energy in buildings and appliances and to on-site renewable energy systems. Chapter 7 references ANSI/ASHRAE/IES Standard 90.1 and contains many provisions that exceed those in Standard 90.1. It should also be noted that Appendix H is an alternative prescriptive energy compliance path that is built on the prescriptive provisions of the *International Energy Conservation Code*.

Section 701.2 requires that building projects comply with the mandatory provisions of Section 701.3 and either the prescriptive provisions of Section 701.4 or the performance provisions of Section 701.5.

Section 701.3 contains mandatory provisions that are applicable to both the prescriptive and performance compliance paths. It includes provisions related to air barriers, on-site renewable energy systems, energy consumption management and automated demand response systems.

Section 701.4 contains the prescriptive-based energy compliance path. It includes provisions related to renewable energy systems, the building envelope, HVAC systems, service water heating, power, lighting and various other equipment.

Section 701.5 contains the performance-based energy compliance path. It is based on an annual energy cost concept that builds on Normative Appendix G of ANSI/ASHRAE/IES Standard 90.1. Compliance with Normative Appendix C of this code is also required for on-site renewable energy systems in the proposed design. Section 701.5.2 sets maximum annual carbon dioxide equivalent requirements.

**Chapter 8 Indoor Environmental Quality (IEQ).** Chapter 8 is intended to ensure that the building's interior environment is conducive to the health of building occupants.

Section 801.2 requires compliance with the mandatory provisions of Section 801.3 and either the prescriptive-based provisions of Section 801.4 or the performance-based provisions of Section 801.5.

Section 801.3 contains mandatory provisions related to indoor air quality, thermal environmental conditions, acoustical control, soil gas control, lighting quality, moisture control and glare control.

Section 801.4 contains prescriptive-based provisions related to indoor environmental quality. It includes requirements for daylighting, material volatile organic compound emissions and contents and lighting for presentations.

Section 801.5 contains performance-based provisions related to indoor environmental quality. It includes requirements for daylight simulation, material VOC emissions and lighting for presentations.

**Chapter 9 Materials and Resources.** Chapter 9 addresses the human health and environmental impacts of materials.

Section 901.2 requires that buildings comply with the mandatory provisions of Section 901.3 and either the prescriptive-based provisions of Section 901.4 or the performance-based provisions of Section 901.5,

Section 901.3 contains mandatory provisions related to the human health and environmental impacts of materials. It includes requirements for construction waste management; the extracting, harvesting, and manufacturing of materials; refrigerants; the storage and collection of recyclables and discarded goods and the mercury content levels of lamps.

Section 901.4 contains prescriptive-based requirements related to the human health and environmental impacts of materials. It includes provisions for recycled and salvaged material content, regional materials, biobased products, and multiple-attribute product declaration/certification.

Section 901.5 contains performance-based requirements related to the health and environmental impacts of materials. It includes provisions for life-cycle assessment that address performance metrics, procedures, and reporting.

**Chapter 10 Construction and Plans for Operation.** Chapter 10 addresses building commissioning and functional and performance testing during construction and requires plans for the subsequent operation and maintenance of building projects.

Section 1001.3.1.1 regulates the functional and performance testing of building systems.

Section 1001.3.1.2 regulates the building commissioning process.

Section 1001.3.1.3 regulates the documentation of the commissioning process.

Section 1001.3.1.4 regulates erosion and sedimentation control during construction.

Section 1001.3.1.5 regulates indoor air quality during construction.

Section 1001.3.1.6 regulates moisture control during construction.

Section 1001.3.1.8 addresses contaminant entry into buildings during construction.

Section 1001.3.2 requires plans for building project operation. These plans are intended to help and encourage building owners and facility management staff to operate and maintain building projects in a manner, and at a performance level, as was originally intended by this code.

Section 1001.3.2.3 requires that a service life plan be developed for the building project.

**Chapter 11 Normative References.** The code contains numerous references to standards that are used to regulate materials and methods of construction. Chapter 11 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 (see Sections 102.4, 102.4.1 and 102.4.2). 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 11 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 of the IgCC; and the section or sections of this code that reference the standard.

**Appendices. User note: Appendices in this edition of the IgCC are treated differently than the appendices in the other I-Codes (see Sections 101.4.3 and 101.4.4).**

In the IgCC, the technical content is based on Standard 189.1, including the appendices. These appendices are identified in two categories:

- Normative appendices. As noted in Section 101.4.3, where a normative appendix is referenced in the code, it is considered part of the mandatory provisions of the code.
- Informative appendices. As noted in Section 101.4.4, these appendices provide additional information but are not mandatory provisions and therefore are not part of the code.

**Normative Appendix A Climate Zones and Prescriptive Building Envelope and Duct Insulation Tables.** This appendix is referenced in the definition of "climate zone" and Sections 701.4.2.1, 701.4.2.2 and 701.4.3.9. This appendix includes a mandatory reference to ANSI/ASHRAE Standard 169 to determine the applicable climate zone to be used in conjunction with Chapter 7 and includes minimum roof and duct insulation values.

**Normative Appendix B Prescriptive Equipment Efficiency Tables for the Alternate Reduced Renewables and Increased Equipment Efficiency Approach in Section 701.4.1.1.2.** This appendix is referenced in Sections 701.4.1.1.2, 701.4.3.1, 701.4.4.1, 701.4.7.1 and 701.4.7.3.2. This appendix provides mandatory equipment efficiency information for the different types of mechanical equipment utilized for heating and cooling.

**Normative Appendix C Performance Option for Energy Efficiency.** This appendix is referenced in Section 701.5.1. This appendix provides a mandatory reference to ANSI/ASHRAE/IES Standard 90.1 for modeling requirements for on-site renewable energy systems and the required information to perform building performance calculations.

**Normative Appendix D Building Concentrations.** This appendix is referenced in Section 801.5.2. This appendix provides mandatory criteria to estimate building concentrations of materials for individual VOC concentrations.

**Informative Appendix E Building Envelope Tables.** As an informative appendix, this appendix is not referenced in the body of the code and is therefore not part of the code. This appendix provides R-values for

common building assemblies such as roofs, walls, floors and doors. It also includes common fenestration values for glazed areas.

**Informative Appendix F Integrated Design.** As an informative appendix, this appendix is not referenced in the body of the code and is therefore not part of the code. This appendix provides details and concepts on the need for early collaboration in order to increase the predictability of project outcomes as early as possible in the design phase of the project. See Chapter 3 definition for "integrated design process."

**Informative Appendix G Informative References.** Even though this is an informative appendix, it is cited in Sections 101.4.2, 701.5.1 and 701.5.2, as well as Appendices B and C. However, as an informative appendix, it is not part of the code. This appendix includes potentially useful source documents that may be consulted.

**Informative Appendix H Option for Energy Efficiency Using the IECC Prescriptive Compliance Path.** As an informative appendix, this appendix is not referenced in the body of the code and is therefore not part of the code. This appendix provides an option for prescriptive energy compliance that is based on requirements in the *International Energy Conservation Code* (IECC). This approach allows the use of the prescriptive provisions of the IECC without directly relying on the energy provisions of ANSI/ASHRAE/IES Standard 90.1.

Appendix H includes provisions related to renewable energy systems, the building envelope, HVAC systems, service water heating, power, lighting, and various other equipment.

**Informative Appendix I Additional Guidance for Functional and Performance Testing (FPT) and the Commissioning (Cx) Process.** As an informative appendix, this appendix is not referenced in the body of the code and is therefore not part of the code. This appendix provides guidance on best practices for performance testing and commissioning. See Chapter 3 definitions for "functional and performance testing (FPT)" and "commissioning (Cx) process."

**Informative Appendix J Option for Residential Compliance Using the National Green Building Standard.** This appendix is cited in an informative note in Section 101.3. As an informative appendix, this appendix is not referenced in the body of the code and is therefore not part of the code. This appendix provides an option for residential compliance using the *National Green Building Standard*. The provisions in the appendix are mandatory only when specifically adopted. The provisions can be adopted in total or by individual section(s) at the discretion of the authority having jurisdiction.

**Informative Appendix K Addenda Description Information.** As an informative appendix, this appendix is not referenced in the body of the code and is therefore not part of the code. This appendix provides the roadmap of approved addenda to the 2014 edition of Standard 189.1 which resulted in the 2017 edition of Standard 189.1 which forms the technical content for this code. As can be seen by the list, there were 75 addenda to the 2014 edition.

**Informative Appendix L for roofs and, vegetated terraces and roofs. (Adopted as Policy)** While it does not apply to our climate zone (4A), inclusion of Sections 501.3.5.3-501.3.5.5 provides guidance pertaining to roofs, vegetated terraces, and roofing systems to help further mitigate the heat island effects associated with conventional roofs to provide shade, remove heat from the air and reduce temperatures of the roof and surrounding air. Green roofs can reduce building energy use by 0.7% compared to conventional roofs, reducing peak electricity demand, and leading to an annual savings of \$0.23 per square foot of the roof's surface.

**Annex 1 Referenced Standard Reproduction Annex ASHRAE Standard 169.** This annex contains pertinent information from ASHRAE Standard 169 for assessing climate zones. See also Normative Appendix A.

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# CHAPTER 1

## SCOPE AND ADMINISTRATION

### PART 1—SCOPE AND APPLICATION

#### SECTION 101 GENERAL

**101.1 Title.** These regulations shall be known as the Green Construction Code of Montgomery County, Maryland hereinafter referred to as "this code."

#### 101.2 Purpose.

**101.2.1 (1.1)** The purpose of this code is to provide minimum requirements for the siting, design, construction, and plans for operation of *high-performance green buildings* to: reduce emissions from buildings and building systems; enhance building occupant health and comfort; conserve water resources; protect local biodiversity and ecosystem services; promote sustainable and regenerative materials cycles; enhance building quality; enhance resilience to natural, technological, and human-caused hazards; and support the goal of development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

**101.2.2** This code is intended to provide the technical basis of mandatory building codes and regulations for *high-performance green buildings* that are broadly adoptable by national and local jurisdictions.

#### 101.3 Scope.

**101.3.1** This code contains requirements that address *site* sustainability, water use efficiency, energy efficiency, indoor environmental quality (IEQ), materials and resources, and construction and plans for operation. This code applies only to the following *building projects*:

1. New buildings greater than 5000 square feet in gross aggregate area and their systems.
2. New portions of buildings exceeding 5000 square feet in gross aggregate area and their systems.

**101.3.2** The provisions of this code do not apply to the following:

1. Single-family dwellings.
2. Multifamily dwellings of three stories or fewer above grade.
3. Manufactured houses (mobile homes).
4. Manufactured houses (modular).
5. Building projects that use none of the following:
  1. Electricity.
  2. Fossil fuels.
  3. Water.

6. Group R-4 occupancy buildings not exceeding 16 residents.

**101.3.3** The requirements in this code shall not be used to circumvent any applicable safety, health, or environmental requirements.

#### 101.4 Application.

**101.4.1 General.** *Building projects* shall comply with Chapters 5 through 11. Within each of these chapters, *building projects* shall comply with all mandatory provisions (x.3) and, where offered, either the:

1. Prescriptive Option (x.4) or
2. Performance Option (x.5).

**101.4.2 Referenced Standards.** The standards referenced in this code and listed in Chapter 11 shall be considered to be part of the requirements of this code to the prescribed extent of such reference. Where differences exist between provisions of this code and a referenced standard, the provisions of this code shall apply. Informative references in Informative Appendix G are cited to acknowledge sources and are not part of this code.

**101.4.3 Normative Appendices.** The normative appendices to this code are considered to be integral parts of the mandatory requirements of this code, which for reasons of convenience are placed apart from all other normative elements.

**101.4.4 Informative Appendices.** The informative appendices to this code, and informative notes located within this code, contain additional information and are not mandatory or part of this code.

**101.4.5 Referenced Standard Reproduction Annexes.** The referenced standard reproduction annexes contain material that is cited in this code but that is contained in another standard. The reference standard reproduction annexes are not part of this code but are included in its publication to facilitate its use.

## SECTION 102 APPLICABILITY

**102.1 Code conflicts.** Where there is a conflict between a general requirement and a specific requirement of this code, the specific requirement shall be applicable. Where, in any specific case, different sections of the code specify different materials, methods of construction or other requirements, the most practical requirement to meet the intent of the code shall govern.

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

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

**102.4 Referenced codes and standards.** Where adopted by the authority having jurisdiction, the following codes shall be considered to be part of the requirements of this code: *International Building Code, International Code Council Performance Code, International Energy Conservation Code, International Existing Building Code, International Fire Code, International Fuel Gas Code, International Mechanical Code, International Plumbing Code, International Property Maintenance Code, and International Residential Code.*

**102.4.1 Conflicting provisions.** Where the extent of the reference to a referenced code or standard includes subject matter that is within the scope of this code or the International Codes as adopted by the authority having jurisdiction listed in Section 102.4, the provisions of this code or the International Codes listed in Section 102.4, as applicable, shall take precedence over the provisions in the referenced code or standard.

**102.4.2 Application of referenced standards.** The standards referenced in this code and listed in Chapter 11 shall be considered to be part of the requirements of this code to the prescribed extent of such reference. Where differences exist between the provisions of this code and a referenced standard, the provisions of this code shall apply.

**102.5 Partial invalidity.** In the event that any part or provision of this code is held to be illegal or void, this shall not have the effect of making void or illegal any of the other parts or provisions.

**102.7 Mixed occupancy buildings.** In mixed occupancy buildings, each portion of a building shall comply with the specific requirements of this code applicable to each specific occupancy.

## PART 2— ADMINISTRATION AND ENFORCEMENT

### SECTION 103 DUTIES AND POWERS OF THE AUTHORITY HAVING JURISDICTION

**103.1 General.** The authority having jurisdiction is hereby authorized and directed to enforce the provisions of this code. The authority having jurisdiction shall have the authority to render interpretations of this code and to adopt policies and procedures in order to clarify the application of its provisions and how this code relates to other applicable codes and ordinances. Such interpretations, policies and procedures shall be in compliance with the intent and purpose of this code and other applicable codes and ordinances. Such policies and procedures shall not have the effect of waiving requirements specifically provided for in this code or other applicable codes and ordinances.

**103.2 Applications and permits.** The authority having jurisdiction shall enforce compliance with the provisions of this code as part of the enforcement of other applicable codes and regulations, including the referenced codes listed in Section 102.4.

**103.3 Notices and orders.** The authority having jurisdiction shall issue all necessary notices or orders to ensure compliance with this code.

**103.4 Inspections.** The authority having jurisdiction shall make inspections, as required, to determine code compliance, or the authority having jurisdiction shall have the authority to accept reports of inspection by approved agencies or individuals. The authority having jurisdiction is authorized to engage such expert opinion as deemed necessary to report on unusual technical issues that arise, subject to the approval of the appointing authority.

### SECTION 104 CONSTRUCTION DOCUMENTS

**104.1 Information on construction documents.** Where adopted by the authority having jurisdiction, the content and format of construction documents shall comply with the *International Building Code*.

### SECTION 105 APPROVAL

**105.1 General.** This code is not intended to prevent the use of any material, method of construction, design, system, or innovative approach not specifically prescribed herein, provided that such construction, design, system, or innovative approach has been approved by the authority having jurisdiction as meeting the intent of this code and all other applicable laws, codes and ordinances.

**105.2 Approved materials and equipment.** Materials, equipment, devices, and innovative approaches *approved* by the authority having jurisdiction shall be constructed, installed, and maintained in accordance with such approval.

**105.2.1 Used materials, products, and equipment.**

Used materials, products and equipment that are to be reused shall meet the requirements of this code for new materials. Used equipment and devices that are to be reused are subject to the approval of the authority having jurisdiction.

**105.3 Modifications.** Where there are practical difficulties involved in carrying out the provisions of this code, the authority having jurisdiction shall have the authority to grant modifications for individual cases, upon application of the owner or the owner's authorized agent, provided the authority having jurisdiction shall first *find* that special individual reason makes the strict letter of this code impractical and that the modification is in compliance with the intent and purpose of this code and that such modification does not lessen the minimum requirements of this code. The details of granting modifications shall be recorded and entered in the files of the department.

**105.4 Innovative approaches and alternative materials, design, and methods of construction and equipment.**

The provisions of this code are not intended to prevent the installation of any material or to prohibit any design, innovative approach, or method of construction not specifically prescribed by this code, provided that any such alternative has been *approved*. An alternative material, design, innovative approach or method of construction shall be reviewed and *approved* where the authority having jurisdiction finds that the proposed design is satisfactory and complies with the intent of the provisions of this code, and that the material, design, method or work offered is, for the purpose intended, at least the equivalent of that prescribed in this code. The details of granting the use of alternative materials, designs, innovative approach and methods of construction shall be recorded and entered in the files of the department. Where the alternative material, design or method of construction is not approved, the building official shall respond in writing, stating the reasons the alternative was not approved.

**105.4.1 Research reports.** Supporting data, where necessary to assist in the approval of materials or assemblies not specifically provided for in this code, shall consist of valid research reports from *approved* sources.

**105.4.2 Tests.** Where there is insufficient evidence of compliance with the provisions of this code, or evidence that a material or method does not conform to the requirements of this code, or in order to substantiate claims for alternative materials or methods, the authority having jurisdiction shall have the authority to require tests as evidence of compliance to be made at no expense to the jurisdiction. Test methods shall be as specified in this code or by other recognized test shall

be retained by the authority having jurisdiction for the period required for retention of public records.

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

**105.6 Approved programs.** The authority having jurisdiction shall have the authority to deem a national, state or local program as meeting or exceeding this code. Buildings *approved* in writing by such a program shall be considered to be in compliance with this code.

**105.6.1 Specific approval.** The authority having jurisdiction shall have the authority to approve programs or compliance tools for a specified application, limited scope or specific locale, including approval that is applicable to a specific section or chapter of this code.

## **SECTION 106 PERMITS**

**106.1 Required.** Any owner or owner's authorized agent who intends to construct, enlarge, alter, repair, move, demolish, or change the occupancy of a building or structure, or to erect, install, enlarge, alter, repair, remove, convert or replace any energy, electrical, gas, mechanical or plumbing system, the installation of which is regulated by this code, Or to cause any such work to be done, shall first make application to the authority having jurisdiction and obtain the required permit under the applicable adopted code (*Informative Note:* e.g., *International Building Code*) or regulation relevant to the intended work. Separate permits shall not be issued under this code. Exemptions from permit requirements shall not be deemed to grant authorization for any work to be done in any manner in violation of the provisions of this code or any other applicable laws, codes, or ordinances of this jurisdiction.

## **SECTION 107 INSPECTIONS**

**107.1 General.** Construction or work for which a permit is required shall be subject to inspection by the authority having jurisdiction 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 owner or the owner's authorized agent to cause the work to remain accessible and exposed for inspection purposes. Neither the authority having jurisdiction, nor the jurisdiction shall be liable for the expense entailed in the removal or replacement of any material required to allow inspection.

**SECTION 109**  
**CERTIFICATE OF OCCUPANCY**

**109.1 Violations.** Issuance of a certificate of occupancy shall not be construed as an approval of a violation of the provisions of this code or of other ordinances of the jurisdiction.

**CHAPTER 2**  
**RESERVED**

## CHAPTER 3

# DEFINITIONS, ABBREVIATIONS AND ACRONYMS

**301.1 General.** Certain terms, abbreviations, and acronyms are defined in this chapter for the purposes of this code. These definitions are applicable to all chapters of this code.

Terms that are not defined herein, but that are defined in standards that are referenced herein (*Informative Note:* e.g., ANSI/ASHRAE/IES Standard 90.1), shall have the meanings as defined in those standards.

Other terms that are not defined shall have their ordinarily accepted meanings within the context in which they are used. Ordinarily accepted meanings shall be based on American standard English language usage, as documented in an unabridged dictionary accepted by the *authority having jurisdiction*.

### 301.2 Definitions.

**agricultural land:** land that is, or was, within ten years prior to the date of the building permit application for the *building project*, primarily devoted to the commercial production of horticultural, viticultural, floricultural, dairy, apiary, vegetable, or animal products or of berries, grain, hay, straw, turf, seed, finfish in upland hatcheries, or livestock, and that has long-term commercial significance for agricultural production. Land that meets this definition is *agricultural land* regardless of how the land is zoned by the local government with zoning jurisdiction over that land.

**air, makeup:** see ANSI/ASHRAE Standard 62.1.

**air, outdoor:** see ANSI/ASHRAE Standard 62.1.

**air, transfer:** see ANSI/ASHRAE Standard 62.1.

**airflow, minimum outdoor:** the outdoor airflow provided by a ventilation system to meet requirements for indoor air quality, excluding any additional outdoor air intake to reduce or eliminate the need for mechanical cooling.

**alternative daily cover:** cover material, other than earthen material, placed on the surface of the active face of a municipal solid-waste landfill at the end of each operating day to control vectors, fires, odors, blowing litter, and scavenging.

**annual sunlight exposure (ASE):** the percent of an analysis area that exceeds a specified direct-sunlight illuminance level for more than a specified number of hours per year (Source: IES LM 83). Annual sunlight exposure is a metric that quantifies the potential for excessive sunlight in interior work environments.

**attic and other roofs:** see ANSI/ASHRAE/IES Standard 90.1.

**authority having jurisdiction (AHJ):** the agency or agent responsible for enforcing this code.

**automatic:** see ANSI/ASHRAE/IES Standard 90.1.

**baseline building design:** see ANSI/ASHRAE/IES Standard 90.1.

**baseline building performance:** see ANSI/ASHRAE/IES Standard 90.1.

**Basis of Design (BoD):** a document that records the concepts, calculations, decisions, and product selections used to meet the owner's project requirements and to satisfy applicable regulatory requirements, standards, and guidelines. The document includes both narrative descriptions and lists of individual items that support the design process. (See *owner's project requirements*.)

**bilevel lighting control:** lighting control in a *space* that provides at least one intermediate level of lighting power in addition to fully ON and fully OFF. Continuous dimming systems are covered by this definition.

**biobased product:** a commercial or industrial product (other than food or feed) that comprises, in whole or in significant part, biological products or renewable agricultural materials (including plant, animal, and marine materials) or forestry materials.

**biodiverse plantings:** nonhomogeneous, multiple-species plantings.

**breathing zone:** see ANSI/ASHRAE Standard 62.1.

**brownfield:** a *site* documented as contaminated by means of an ASTM E1903 Phase II Environmental Site Assessment or a site classified as a brownfield by a local, state, or federal government agency.

**building entrance:** see ANSI/ASHRAE/IES Standard 90.1.

**building envelope:** see ANSI/ASHRAE/IES Standard 90.1.

**building project:** a building, or group of buildings, and site that utilize a single submittal for a construction permit or that are within the boundary of contiguous properties under single ownership or effective control. (See *owner*.)

**carbon dioxide equivalent (CO<sub>2</sub>e):** a measure used to compare the impact of various greenhouse gases based on their global warming potential (GWP). CO<sub>2</sub>e approximates the time-integrated warming effect of a unit mass of a given greenhouse gas relative to that of carbon dioxide (CO<sub>2</sub>). GWP is an index for estimating the relative global warming contribution of atmospheric emissions of 1 kg of a particular greenhouse gas compared to emissions of 1 kg of CO<sub>2</sub>. The following GWP values are used based on a 100-year time horizon: 1 for CO<sub>2</sub>, 25 for methane (CH<sub>4</sub>), and 298 for nitrous oxide (N<sub>2</sub>O).

**classroom:** a space primarily used for scheduled instructional activities.

**climate zone:** see Normative Appendix A.

**combined energy efficiency ratio (CEER [I-P]) (CCOP<sub>c</sub> [SI]) :** the combined energy efficiency is a ratio of the total cooling in one year divided by the total energy from active, stand-by, and OFF modes as defined in AHAM Standard RAC-1; Btu/h/W (W/W).

**commissioning (Cx) plan:** a document that outlines the organization, schedule, allocation of resources, and documentation requirements of the building commissioning process. [See commissioning (Cx) process.]

**commissioning (Cx) process:** a quality-focused process for enhancing the delivery of a project. The process focuses on verifying and documenting that the facility and all of its systems and assemblies are planned, designed, installed, tested, operated, and maintained to meet the *owner's project requirements*. (See *owner's project requirements*.)

**commissioning (Cx) provider:** an entity, identified by the owner and approved by the AHJ, who manages the commissioning team to implement the building commissioning process. [See *commissioning (Cx) process*.]

**Informative Note:** This entity is sometimes known as a "commissioning authority," "CxA," or "approved agency." [See *commissioning (Cx) process*.]

**conditioned space:** see ANSI/ASHRAE/IES Standard 90.1.

**construction documents:** see ANSI/ASHRAE/IES Standard 90.1.

**contaminant:** see ANSI/ASHRAE Standard 62.1.

**continuous air barrier:** see ANSI/ASHRAE/IES Standard 90.1.

**cycles of concentration:** the ratio of makeup rate to the sum of the blowdown and drift rates.

**daylight area:** area in an enclosed space that is in the primary sidelighted area, daylight area under roof monitors, or daylight area under skylights.

**daylight area under roof monitors:** see ANSI/ASHRAE/IES Standard 90.1.

**daylight area under skylights:** see ANSI/ASHRAE/IES Standard 90.1.

**daylight hours:** the period from 30 minutes after sunrise to 30 minutes before sunset.

**demand control ventilation (DCV):** see ANSI/ASHRAE/IES Standard 90.1.

**densely occupied space:** those spaces with a design occupant density greater than or equal to 25 people per 1000 ft<sup>2</sup>.

**design professional:** see ANSI/ASHRAE/IES Standard 90.1.

**designated park land:** federal-, state-, or local-government-owned land that is formally designated and set aside as park land or a wildlife preserve.

**dwelling unit:** see ANSI/ASHRAE/IES Standard 90.1.

**dynamic glazing:** see ANSI/ASHRAE/IES Standard 90.1.

**electronics:** computers and accessories; monitors; printers; and other equipment, such as scanners, fax machines, electric typewriters, cell phones, telephones, answering machines, shredders, postage machines, televisions, VHS/DVD players, portable cassette/CD players with radio devices, and stereo equipment.

**emergency ride home:** access to transportation home in the case of a personal emergency or unscheduled overtime for employees who commute via transit, carpool, or vanpool.

**enclosed space:** see ANSI/ASHRAE/IES Standard 90.1.

**evapotranspiration (ET):** the sum of evaporation from soil and *plant* surfaces and transpiration of water through leaf stomata.

**ET<sub>c</sub>:** evapotranspiration of the plant material derived by multiplying ET<sub>o</sub> by the appropriate plant factor or coefficient.

**ET<sub>o</sub>:** reference *evapotranspiration* for a cool-season grass as calculated by the standardized Penman-Monteith equation based on weather-station data.

**fenestration:** see ANSI/ASHRAE/IES Standard 90.1.

**fenestration area:** see ANSI/ASHRAE/IES Standard 90.1.

**fish and wildlife habitat conservation area:** areas with which state or federally designated endangered, threatened, or sensitive species have a primary association.

**forest land:** all designated state forests, national forests, and all land that is, or was, within ten years prior to the date of the building permit for the building project, primarily devoted to growing trees for long-term commercial timber production.

**functional and performance testing (FPT):** testing performed to ensure that designated systems of the project meet the intended design performance requirements.

**functional and performance testing provider (FPT provider):** an entity identified by the *owner* who manages the activities needed to implement the building functional and performance testing (FPT) activities.

**generally accepted engineering standard:** see ANSI/ASHRAE/IES Standard 90.1.

**geothermal energy:** heat extracted from the Earth's interior that is used to produce electricity or mechanical power or to provide thermal energy for heating buildings or processes. Geothermal energy does not include systems such as heat pumps that use energy independent of the geothermal source to raise the temperature of the extracted heat.

**greenfield:** a site of which 20% or less has been previously developed with impervious surfaces.

**greyfield:** a *site* of which more than 20% is currently or has been previously developed with impervious surfaces.

**gross aggregate area:** means the sum of the floor areas of all the spaces within the building with no deductions for floor penetrations. Gross Aggregate Area is measured from the exterior faces of exterior walls or from the centerline of walls separating buildings. Gross Aggregate Area includes covered walkways, open roofed-over areas, porches and similar spaces, exterior terraces or steps, roof overhangs, parking garages, surface parking, and similar features.

**gross roof area:** see ANSI/ASHRAE/IES Standard 90.1.

**gross wall area:** see ANSI/ASHRAE/IES Standard 90.1.

**ground cover:** plantings other than turfgrass that are low-growing and form dense vegetation over the soil area.

**hardscape:** site paved areas, including roads, driveways, parking lots, walkways, courtyards, and plazas.

**heat island effect:** the tendency of urban areas to be at a warmer temperature than surrounding rural areas.

**high-performance green building:** a building designed, constructed, and capable of being operated in a manner that increases environmental performance and economic value over time, seeks to establish an indoor environment that supports the health of occupants, and enhances satisfaction and productivity of occupants through integration of environmentally preferable building materials and water-efficient and energy-efficient systems.

**high-speed door:** a nonswinging door used primarily to facilitate vehicular access or material transportation, and having an *automatic* closing device with an opening rate of not less than 32 in./s (810 mm/s) and a closing rate of not less than 24 in./s.

**hourly average sound pressure level ( $L_{eq}$ ):** time-mean-square frequency-weighted sound pressure level for one hour

**hydrozone:** an irrigated area of landscape in which the plants have similar water needs and are irrigated by the same type of emission devices.

**improved landscape:** any disturbed area of the site where new plant and/or grass materials are to be used, including green roofs, plantings for stormwater controls, planting boxes, and similar vegetative use. Improved landscape shall not include hardscape areas such as sidewalks, driveways, other paved areas, and swimming pools or decking.

**institutional tuning:** the process, by authorized personnel, of adjusting the maximum light output of individual luminaires, groups of luminaires, or entire lighting systems to support visual needs or to save energy. Institutional tuning is also known as "high-end trim control."

**integrated design process:** a design process using early collaboration among representatives of each stakeholder and participating consultant on the project. Unlike the conventional, or linear, design process, integrated design requires broad stakeholder/consultant participation.

**integrated project delivery:** see *integrated design process*.

**interior projection factor (PF):** see *projection factor, interior*,

**irrigation adequacy:** a representation of how well irrigation meets the needs of the plant material. This reflects the percentage of required water for turf or *plant* material supplied by rainfall and controller-scheduled irrigations.

**irrigation excess:** a representation of the amount of irrigation water applied beyond the needs of the plant material. This reflects the percentage of water applied in excess of 100% of required water.

**irrigation station:** a set of irrigation emission devices supplied water by a single control valve. Also referred to as an "irrigation zone."

**isolation devices:** see ANSI/ASHRAE/IES Standard 90.1.

**landscape establishment period:** a time period, beginning on the date of completion of permanent plantings and not exceeding 18 months, intended to allow the permanent landscape to become sufficiently established to remain viable.

**Life-cycle assessment (LCA):** a compilation and evaluation of the inputs, outputs, and potential environmental impacts of a building system throughout its life cycle. LCA addresses the environmental aspects and potential environmental impacts, (e.g., use of resources and environmental consequences of releases) throughout a building's life cycle, from raw material acquisition through manufacturing, construction, use, operation, end-of-life treatment, recycling, and

final disposal (end of life). The purpose is to identify opportunities to improve the environmental performance of buildings throughout their life cycles.

**lighting power allowance:** see ANSI/ASHRAE/IES Standard 90.1.

**lighting quality:** the degree to which the luminous environment in a space supports the requirements of the occupants.

**lighting zone (LZ):** an area defining limitations for outdoor lighting.

**LZO:** undeveloped areas within national parks, state parks, forest land, rural areas, and other undeveloped areas as defined by the AHJ.

**LZ1:** developed areas of national parks, state parks, forest land, and rural areas.

**LZ2:** areas predominantly consisting of residential zoning, neighborhood business districts, light industrial with limited night time use, and residential mixed-use.

**LZ3:** all areas not included in LZO, LZ1, LZ2, or LZ4.

**LZ4:** high-activity commercial districts in major metropolitan areas as designated by the local jurisdiction.

**liner system (Ls):** an insulation system for a metal building roof that includes the following components. A continuous membrane is installed below the purlins and uninterrupted by framing members. Uncompressed, unfaced insulation rests on acquisition through manufacturing, construction, use, operation, end-of-life treatment, recycling, and final disposal (end of life). The purpose is to identify opportunities to improve the environmental performance of buildings throughout their life cycles.

**low-impact trail:** erosion-stabilized pathway or track that uses natural groundcover or installed system greater than 50% pervious. The pathway or track is designed and used only for pedestrian and nonmotorized vehicles (excluding power-assisted conveyances for individuals with disabilities).

**maintenance plan:** see *maintenance program* in ANSI/ASHRAE/ACCA Standard 180.

**maximum sound pressure level ( $L_{max}$ ):** greatest frequency-weighted and exponential-time-weighted sound level within a stated time interval.

**mechanical cooling:** see ANSI/ASHRAE/IES Standard 90.1.

**multilevel lighting control:** lighting control in a *space* that provides at least two intermediate levels of lighting power in addition to fully ON and fully OFF. Continuous dimming systems are covered by this definition.

**networked guest-room control system:** an energy management control system, accessible from the hotel/motel front desk or other central location, that is capable of identifying reserved rooms according to a timed schedule and is capable of controlling each hotel/motel guest room separately.

**nonresidential:** see ANSI/ASHRAE/IES Standard 90.1.

**nonstandard part-load value (NPLV):** see ANSI/ASHRAE/IES Standard 90.1.

**north-oriented:** facing within 45 degrees of true north within the northern hemisphere (however, facing within 45 degrees of true south in the southern hemisphere).



**occupant load:** the number of persons for which the means of egress of a building or portion thereof is designed.

**occupiable space:** see ANSI/ASHRAE Standard 62.1.

**office furniture system:** either a panel-based workstation comprising modular interconnecting panels, hang-on components, and drawer/filing components, or a freestanding grouping of furniture items and their components that have been designed to work in concert.

**once-through cooling:** the use of water as a cooling medium, where the water is passed through a heat exchanger one time and is then discharged to the drainage system. This also includes the use of water to reduce the temperature of condensate or process water before discharging it to the drainage system.

**on-site renewable energy system:** photovoltaic, solar thermal, geothermal energy, and wind systems used to generate energy and located on the building project.

**open-graded (uniform-sized) aggregate:** materials such as crushed stone or decomposed granite that provide 30% to 40% void spaces.

**outdoor air fault condition:** a situation in which the measured minimum outdoor airflow of a ventilation system is 10% or more below the set-point value that corresponds to the occupancy and operation conditions at the time of the measurement.

**owner:** the party in responsible control of development, construction, or operation of a project at any given time.

**owner's project requirements (OPR):** a document that specifies the functional requirements of a project and the expectations of how it will be used and operated, including project goals, measurable performance criteria, cost considerations, benchmarks, success criteria, training requirements, documentation requirements, and supporting information. All information in the OPR document shall certify that the items identified in the plans are constructed, installed and operate as intended in the approved plans and specifications.

**permanently installed:** see ANSI/ASHRAE/IES Standard 90.1.

**permeable pavement:** pervious concrete or porous asphalt that allows the movement of water and air through the paving material and which is primarily used as paving for roads, parking lots, and walkways. Permeable paving materials have an open-graded coarse aggregate with interconnected voids.

**permeable pavers:** units that present a solid surface but allow natural drainage and migration of water into the base below by permitting water to drain through the spaces between the pavers.

**plants:**

- a. **adapted plants:** plants that reliably grow well in a given habitat with minimal attention from humans in the form of winter protection, pest protection, water irrigation, or fertilization once root systems are established in the soil. Adapted plants are considered to be low maintenance but not invasive.
- b. **invasive plants:** species of plants that are not native to the building project site and that cause or are likely to cause environmental harm. At a minimum, the list of invasive species for a building project site includes plants included in city, county, and regional lists and state and federal noxious weeds laws.

- c. **native plants:** plants that adapted to a given area during a defined time period and are not invasive. In America, the term often refers to *plants* growing in a region prior to the time of settlement by people of European descent.

- d. **rainfall-ET<sub>c</sub> compatible plants:** plants with documented ET<sub>c</sub> rates and having all of the following characteristics: (1) not native or invasive to the local geographic area of the site; (2) after the landscape establishment period, do not require supplemental annual irrigation, based on the ten-year average annual rainfall of the local climate and based on 80% of the plant's ET<sub>c</sub>.

**porous pavers (open-grid pavers):** units where at least 40% of the surface area consists of holes or openings that are filled with sand, gravel, other porous material, or vegetation.

**postconsumer recycled content:** proportion of recycled material in a product generated by households or by commercial, industrial, and institutional facilities in their role as end-users of the product, which can no longer be used for its intended purpose. This includes returns of material from the distribution chain. (See *recycled material*.)

**preconsumer recycled content:** proportion of recycled material in a product diverted from the waste stream during the manufacturing process. Content that shall not be considered preconsumer recycled includes the reutilization of materials such as rework, regrind, or scrap generated in a process and capable of being reclaimed within the same process that generated it. (See *recycled material*.)

**primary sidelighted area:** see ANSI/ASHRAE/IES Standard 90.1.

**projection factor (PI):** see ANSI/ASHRAE/IES Standard 90.1.

**projection factor (PF), interior:** the ratio of the horizontal depth of the interior shading projection divided by the sum of the height of the fenestration above the interior shading projection and, if the interior projection is below the bottom of the fenestration, the vertical distance from the bottom of the fenestration to the top of the farthest point of the interior shading projection, in consistent units.

**proposed building performance:** see ANSI/ASHRAE/IES Standard 90.1.

**proposed design:** see ANSI/ASHRAE/IES Standard 90.1.

**public way:** a street, alley, transit right of way, or other parcel of land open to the outdoors and leading to a street or transit right of way that has been deeded, dedicated, or otherwise permanently appropriated for public use and that has a clear width and height of not less than 10 ft (3 m).

**REC:** see *renewable energy certificate (REC)*.

**recovered material:** material that would have otherwise been disposed of as waste or used for energy recovery (**Informative Note:** e.g., incinerated for power generation) but has instead been collected and recovered as a material input, in lieu of new primary material, for a recycling or a manufacturing process.

**recycled content:** proportion by mass of recycled material in a product or packaging. Only preconsumer and postconsumer materials shall be considered as recycled content. (See *recycled material*.)

**recycled material:** material that has been reprocessed from recovered (reclaimed) material by means of a manufacturing process and made into a final product or into a component for incorporation into a product. (See *recovered material*.)

**regulated energy use:** see ANSI/ASHRAE/IES Standard 90.1.

**renewable energy certificate (REC):** a tradable instrument that represents the environmental attributes of one megawatt-hour of renewable electricity generation and is transacted separately from the electricity generated by the renewable energy source.

**residential:** see ANSI/ASHRAE/IES Standard 90.1.

**roof:** see ANSI/ASHRAE/IES Standard 90.1.

**roof area, gross:** see ANSI/ASHRAE/IES Standard 90.1.

**roof monitor:** see ANSI/ASHRAE/IES Standard 90.1.

**salvaged material:** material, component, or assembly removed in a whole form from a structure or site in which it was permanently installed and subsequently reused in the building project.

**seating:** task and guest chairs used with office furniture systems.

**secondary sidelighted area:** see ANSI/ASHRAE/IES Standard 90.1.

**semiheated space:** see ANSI/ASHRAE/IES Standard 90.1.

**service water heating:** see ANSI/ASHRAE/IES Standard 90.1.

**sidelighting:** daylighting provided by vertical fenestration mounted below the ceiling plane.

**sidelighting effective aperture:** the relationship of daylight transmitted through vertical fenestration to the primary side-lighted areas. The sidelighting effective aperture is calculated according to the following formula:

$$\frac{\sum \text{Vertical fenestration area} \times \text{Vertical fenestration VT}}{\text{Area of primary sidelighted area}}$$

where Vertical fenestration VT is the visible transmittance of vertical fenestration as determined in accordance with NFRC 200. For products outside the scope of NFRC 200, VT is the solar photometric transmittance of the glazing materials as determined in accordance with ASTM E972.

**single-rafter roof:** see ANSI/ASHRAE/IES Standard 90.1.

**site:** a contiguous area of land that is under the ownership or control of one entity.

**skylight:** see ANSI/ASHRAE/IES Standard 90.1.

**skylight effective aperture:** see ANSI/ASHRAE/IES Standard 90.1.

**smart controller (weather-based irrigation controller):** a device that estimates or measures depletion of water from the soil moisture reservoir and operates an irrigation system to replenish water as needed while minimizing excess.

**soil-gas retarder system:** a combination of measures that retard vapors in the soil from entering the occupied space.

**solar energy system:** any device or combination of devices or elements that rely on direct sunlight as an energy source, including, but not limited to, any substance or device that collects sunlight for use in

- a. heating or cooling of a structure or building;
- b. heating or pumping of water;
- c. industrial, commercial, or agricultural processes; and

- d. generation of electricity.

**solar heat gain coefficient (SHGC):** see ANSI/ASHRAE/IES Standard 90.1.

**solar reflectance index (SRI):** a measure of a constructed surface's ability to reflect solar heat, as shown by a small temperature rise. A standard black surface (reflectance 0.05, emittance 0.90) is 0, and a standard white surface (reflectance 0.80, emittance 0.90) is 100.

**space:** see ANSI/ASHRAE/IES Standard 90.1.

**spatial daylight autonomy (sDA):** the percent of an analysis area that meets a minimum daylight illuminance level for a specified fraction of the hours per year (Source: IES LM 83). Spatial daylight autonomy is a metric quantifying annual sufficiency of ambient daylight levels in interior spaces.

**specular visible transmittance:** the fraction of incident flux (lumens) that passes directly through a surface or medium without scattering.

**SWAT:** smart water application technology as defined by the Irrigation Association.

**task lighting:** see ANSI/ASHRAE/IES Standard 90.1.

**tubular daylighting device:** a means to capture sunlight from a rooftop. Sunlight is then redirected down from a highly reflective shaft and diffused throughout interior space.

**turfgrass:** grasses that are regularly mowed and, as a consequence, form a dense growth of leaf blades, shoots, and roots.

**unregulated energy use:** see ANSI/ASHRAE/IES Standard 90.1.

**variable-air-volume (VAV) system:** see ANSI/ASHRAE/IES Standard 90.1.

**vendor:** a company that furnishes products to project contractors and/or subcontractors for on-site installation.

**verification:** the process by which specific documents, components, equipment, assemblies, systems, and interfaces among systems are confirmed to comply with the criteria described in the *owner's project requirements*. (See *owner's project requirements*.)

**vertical fenestration:** see ANSI/ASHRAE/IES Standard 90.1.

**view fenestration:** fenestration that complies with all of the following:

- a. It provides building occupants with a view to the outdoors or to an interior daylight atrium.
- b. It has undiffused glazing with a haze value less than 3%, as determined in accordance with ASTM D1003.
- c. It has a center-of-glass visible transmittance (VT) of not less than 20%.
- d. The product of the center-of-glass VT and the openness factor of screens, patterned films, and ceramic frits is not less than 20%.
- e. Where dynamic glazing is provided, such glazing has a center-of-glass VT of not less than 20% at the highest end of its range.
- f. Where nonoperable opaque window treatments are provided, such as blinds, shades, and louvers, such treatments do not obstruct more than 40% of the *fenestration glazing area*.

**wall:** see ANSI/ASHRAE/IES Standard 90.1.

**wall area, gross:** see ANSI/ASHRAE/IES Standard 90.1.

**water, alternate on-site sources of alternate on-site sources of water** include, but are not limited to:

- a. rainwater or stormwater harvesting,
- b. air conditioner condensate,
- c. grey water from interior applications and treated as required,
- d. swimming-pool filter backwash water,
- e. cooling-tower blowdown water,
- f. foundation drain water,
- g. industrial process water, and
- h. on-site wastewater treatment plant effluent.

**water, nonpotable:** water that is not potable water. (See *water, potable*.)

**water, potable:** water from public drinking water systems or from natural freshwater sources, such as lakes, streams, and aquifers, where water from such natural sources would or could meet drinking water standards.

**water, reclaimed:** nonpotable water derived from the treatment of waste water by a facility or system licensed or permitted to produce water meeting the jurisdiction's water requirements for its intended uses, including, but not limited to, above-surface landscape irrigation.

**water-bottle filling station:** a plumbing fixture or fixture fitting that is controlled by the user for the sole intended purpose of dispensing potable water into a personal drinking water bottle. Such fixtures and fittings are connected to the potable water distribution system of the premises and can be stand-alone fixtures or integrated with another fixture.

**water factor (WF):**

- a. **clothes washer (residential and commercial):** the quantity of water in gallons (litres) used to wash each cubic foot (cubic metre) of machine capacity.
- b. **residential dishwasher:** the quantity of water use in gallons (litres) per full machine wash and rinse cycle.

**weatherproofing system:** a group of components, including associated adhesives and primers, that when installed create a protective envelope against water and wind.

**wetlands:** those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation adapted for life in saturated soil conditions. This definition incorporates all areas that would meet the definition of "wetlands" under applicable federal or state guidance—regardless of whether they are officially designated, delineated, or mapped—including man-made areas that are designed, constructed, or restored to include the ecological functions of natural *wetlands*.

### 301.3 (3.3) Abbreviations and Acronyms

µg	microgram
AC	alternating current
AHJ	authority having jurisdiction

AHRI	Air-Conditioning, Heating, and Refrigeration Institute
ANSI	American National Standards Institute
ASE	annual sunlight exposure
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials International
BIFMA	The Business and Institutional Furniture Manufacturer's Association
BMS	building management system
BoD	Basis of Design
BPF	building performance factor
Btu	British thermal unit
Btu/h	British thermal unit per hour
BUG	backlight, uplight, and glare
CAC	ceiling attenuation class
CCOP	combined coefficient of performance
CDPH	California Department of Public Health
CEER	combined energy efficiency ratio
CFC	Chlorofluorocarbon
cfm	cubic feet per minute (ft <sup>3</sup> /min)
CH <sub>4</sub>	methane
c.i.	continuous insulation
CIE	Commission Internationale de L'Eclairage (International Commission on Illumination)
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CO <sub>2</sub>	carbon dioxide
CO <sub>2</sub> e	carbon dioxide equivalent
CSA	Canadian Standards Association
cSTC	composite sound transmission class
Cx	commissioning
dB	decibel
db	dry bulb
dBA	decibel, A-weighting
dB(C)	decibel, C-weighting
DC	direct current
DCV	demand control ventilation
DR	demand response
EISA	Energy Independence and Security Act
EMS	Energy Management System
EPAct	U.S. Energy Policy Act

EPD	environmental product declaration	LZ	lighting zone
ESC	erosion and sedimentation control	m	metre
ET <sub>c</sub>	evapotranspiration	MDF	medium density fiberboard
ET <sub>o</sub>	maximum evapotranspiration	MERV	minimum efficiency reporting value
ETS	environmental tobacco smoke	mg	milligram
fc	footcandle	mi	mile
FF&E	furniture, fixtures, and equipment	min	minute
FPT	functional and performance testing	mm	millimetre
ft	foot	mph	miles per hour
gal	gallon	M&V	measurement and verification
gpm	gallons per minute	N <sub>2</sub> O	nitrous oxide
GWP	global warming potential	NA	not applicable
h	hour	NAECA	National Appliance Energy Conservation Act
ha	hectare	NIC	noise isolation class
HCFC	hydrochlorofluorocarbon	NISR	normalized impact sound rating
HID	high-intensity discharge	NNIC	normalized noise isolation class
HVAC	heating, ventilation, and air conditioning	NPLV	nonstandard part-load value
HVAC&R	heating, ventilation, air conditioning, and refrigeration	NR	not required
Hz	hertz	OITC	outdoor-indoor transmission class
IA	Irrigation Association	O&M	operations and maintenance
IAPMO	International Association of Plumbing and Mechanical Officials	OPR	owner's project requirements
IAQ	indoor air quality	Pa	Pascal
IECC	International Energy Conservation Code	PCI	Performance Cost Index
IEQ	indoor environmental quality	PF	projection factor
IES	Illuminating Engineering Society	ppm	parts per million
IIC	impact insulation class	RCR	room cavity ratio
in.	inch	REC	renewable energy certificate
I-P	inch-pound	s	second
ISR	impact sound rating	SCAQMD	South Coast Air Quality Management District
kg	kilogram	sDA	spatial daylight autonomy
km	kilometre	SHGC	solar heat gain coefficient
kVA	kilovolt-ampere	SMACNA	Sheet Metal and Air Conditioning Contractors National Association
kW	kilowatt	SRI	solar reflectance index
kWh	kilowatt-hour	STC	sound transmission class
L	litre	SWAT	smart water application technology
lb	pound	T <sub>60</sub>	reverberation time in seconds
LCA	life-cycle assessment	UL	Underwriters Laboratory
LCI	life-cycle inventory	USDA	United States Department of Agriculture
L <sub>eq</sub>	hourly average sound pressure level	USEPA	United States Environmental Protection Agency
L <sub>max</sub>	maximum sound pressure level	USFEMA	United States Federal Emergency Management Agency
LPD	lighting power density	USGBC	United States Green Building Council
Ls	liner system	VAV	variable air volume

VOC	volatile organic compound
VRF	variable refrigerant flow system
VT	visible transmittance
wb	wet bulb
WF	water factor
yr	year

**CHAPTER 4**  
**RESERVED**

## CHAPTER 5

# SITE SUSTAINABILITY

**501.1 Scope.** This section addresses requirements for *building projects* that pertain to *site* selection, *site* development, mitigation of *heat island effect*, light pollution reduction, and mitigation of transportation impacts.

**501.2 Compliance.** All of the provisions of Chapter 5 (Section 5) are mandatory provisions.

### 501.3 Mandatory Provisions.

**501.3.1 Site Selection.** The *building project* shall comply with Sections 501.3.1.1.

**501.3.1.1 Allowable Sites.** The *building project* shall take place in or on one of the following:

- a. An existing *building envelope*.
- b. A *brownfield*.
- c. A *greyfield*.
- d. A *greenfield* that is within 1/2 mi (800 m) of *residential* land that is developed, or that has one or more buildings under construction, with an average density of ten *dwelling units* per acre (4 units per ha) unless that *site is agricultural land or forest land*. Proximity is determined by drawing a circle with a 1/2 mi radius around the center of the proposed *site*.
- e. A *greenfield* where the proposed building complies with ASTM E2843, unless that *site is agricultural land or forest land*.
- f. A *greenfield* where the proposed building complies with ASTM E2844, unless that *site is agricultural land or forest land*.
- g. A *greenfield* that is *agricultural land*, and the purpose of the proposed building is related to the agricultural use of the land.
- h. A *greenfield* that is *forest land*, and the purpose of the proposed building is related to the forestry use of the land.
- i. A *greenfield* that is *designated park land*, and the purpose of the proposed building is related to the use of the land as a park.

### 501.3.5 Mitigation of Heat Island Effect.

**501.3.5.1 Site Hardscape.** At least 50% of the *site hardscape* that is not covered by *solar energy systems* shall be provided with one or any combination of the following:

- a. Existing trees and vegetation or new *biodiverse plantings* of *native plants* and *adapted plants*,

which shall be planted either prior to the final approval by the *AHJ* or in accordance with a contract established to require planting no later than 12 months after the final approval by the *AHJ* so as to provide the required shade no later than ten years after the final approval. The effective shade coverage on the *hardscape* shall be the arithmetic mean of the shade coverage calculated at 10 a.m., noon, and 3 p.m. on the summer solstice.

- b. Paving materials with a minimum initial *solar reflectance index (SRI)* of 29. A default *SRI* value of 35 for new concrete without added color pigment is allowed to be used instead of measurements.
- c. *Open-graded (uniform-sized) aggregate, permeable pavement, permeable pavers, and porous pavers (open-grid pavers)*. *Permeable pavement* and *permeable pavers* shall have a percolation rate of not less than 2 gal/min-ft<sup>2</sup>.
- d. Shading through the use of structures, provided that the top surface of the shading structure complies with the provisions of Section 501.3.5.3.
- e. Parking under a building, provided that the *roof* of the building complies with the provisions of Section 501.3.5.3.
- f. Buildings or structures that provide shade to the *site hardscape*. The effective shade coverage on the *hardscape* shall be the arithmetic mean of the shade coverage calculated at 10 a.m., noon, and 3 p.m. on the summer solstice.

**Exception:** Section 501.3.5.1 shall not apply to *building projects* in *Climate Zones* 6, 7, and 8.

**501.3.5.2 Walls.** Above-grade building *walls* and retaining *walls* shall be shaded in accordance with this section. The building is allowed to be rotated up to 45 degrees to the nearest cardinal orientation for purposes of calculations and showing compliance. Compliance with this section shall be achieved through the use of shade-providing *plants*, man-made structures, existing buildings, hillsides, permanent *building projections*, *on-site renewable energy systems*, or a combination of these, using the following criteria:

- a. Shade shall be provided on at least 30% of the east and west above-grade *walls* and retaining *walls* from grade level to a height of 20 ft above grade, or the top of the exterior *wall*, whichever is less. Shade coverage shall be calculated at 10 a.m. for the east *walls* and 3 p.m. for the west *walls* on the summer solstice.

- b. Where shading is provided by vegetation, such vegetation shall be existing trees and vegetation or new *biodiverse plantings* of *native plants* and *adapted plants*. Such planting shall occur prior to the final approval by the *AHJ* or in accordance with a contract established to require planting no later than 12 months after the final approval by the *AHJ* so as to provide the required shade no later than ten years after the final approval. Vegetation shall be appropriately sized, selected, planted, and maintained so that it does not interfere with overhead or underground utilities. Trees shall be placed a minimum of 5 ft from and within 50 ft of the building or retaining *wall*.

**Exceptions:**

1. The requirements of this section are satisfied if 75% or more of the opaque *wall* surfaces on the east and west have a minimum *SRI* of 29. Each *wall* is allowed to be considered separately for this exception.
2. East *wall* shading is not required for buildings located in *Climate Zones* 5, 6, 7, and 8. West *wall* shading is not required for buildings located in *Climate Zones* 7 and 8.



**CHAPTER 6**  
**RESERVED**

## CHAPTER 7

# ENERGY EFFICIENCY

**701.1 Scope.** This section specifies requirements for energy efficiency for buildings and appliances, for *on-site renewable energy systems*, and for energy measuring.

**701.2 Compliance.** The energy systems shall comply with Section 701.3, "Mandatory Provisions," and either

- Section 701.4, "Prescriptive Option," or
- Section 701.5, "Performance Option."

### 701.3 Mandatory Provisions.

**701.3.1 General.** *Building projects* shall be designed to comply with Sections 5.4, 6.4, 7.4, 8.4, 9.4, and 10.4 of ANSI/ASHRAE/IES Standard 90.1.

**701.3.1.1 Continuous Air Barrier.** The exceptions to the requirement for a *continuous air barrier* in ANSI/ASHRAE/IES Standard 90.1, Section 5.4.3.1, for specific *climate zones* and constructions shall not apply. The testing criteria of Section 1001.3.1.5(a) shall supersede ANSI/ASHRAE/IES Standard 90.1, Section 5.4.3.1.3(a).

**701.3.2 On-Site Renewable Energy Systems.** *Building project* design shall show allocated *space* and pathways for future installation of *on-site renewable energy systems* and associated infrastructure that provide the annual energy production equivalent of not less than 6.0 kBtu/ft<sup>2</sup> for single-story buildings and not less than 10.0 kBtu/ft<sup>2</sup> multiplied by the *gross roof area* in feet squared for all other buildings.

#### Exceptions:

- Building projects* that have an annual daily average incident solar radiation available to a flat plate collector oriented due south at an angle from horizontal equal to the latitude of the collector location less than 1.2 kBtu/ft<sup>2</sup>•day, accounting for existing buildings, permanent infrastructure that is not part of the *building project*, topography, or trees.
- Building projects* that comply with Section 701.4.1.1.

### 701.3.3 Energy Consumption Management.

**701.3.3.1 Consumption Management.** Measurement devices with remote communication capability shall be provided to collect energy consumption data for each energy supply source to the building (including gas, electricity, and district energy) that exceeds the thresholds listed in Table 701.3.3.1A. The measurement devices shall have the capability to automatically communicate the energy consumption data to a data acquisition system.

For all buildings that exceed the threshold in Table 701.3.3.1A, subsystem measurement devices with remote capability (including current sensors or flowmeters) shall be provided to measure energy consumption data of each subsystem for each use

category that exceeds the thresholds listed in Table 701.3.3.1B.

The energy consumption data from the subsystem measurement devices shall be automatically communicated to the data acquisition system.

**TABLE 701.3.3.1A  
ENERGY SOURCE THRESHOLDS**

ENERGY SOURCE	THRESHOLD
Electrical service	> 200 kVA
On-site renewable electric power	All systems > 1 kVA (peak)
Gas and district services	> 1,000,000 Btu/h (300 kW)
<i>Geothermal energy</i>	> 1,000,000 Btu/h (300 kW) heating
On-site renewable thermal energy	> 100,000 Btu/h (30 kW)

**TABLE 701.3.3.1B  
SYSTEM ENERGY USE THRESHOLDS**

USE (TOTAL OF ALL LOADS)	SUBSYSTEM THRESHOLD
HVAC system	Connected electric load > 100kVA
	Connected gas or district services load > 500,000 Btu/h (150 kW)
People moving	Sum of all feeders > 50 kVA
Lighting	Connected load > 50 kVA
Process and plug process	Connected load > 50 kVA
	Connected gas or district services load > 250,000 Btu/h (75 kW)

**701.3.3.2 Energy Consumption Data Collection and Display.** All building measurement devices shall be configured to automatically communicate the energy data to the data acquisition system. Measurement devices shall provide daily data and shall record hourly energy profiles. Such hourly energy profiles shall be capable of being used to assess building performance at least monthly. The hourly energy profiles shall be displayed.

**701.3.3.3 Data Storage and Retrieval.** The data acquisition system shall be capable of electronically storing the data from the measurement devices and other sensing devices for a minimum of 36 months and creating user reports showing hourly, daily, monthly, and annual energy consumption.

**Exception:** Portions of buildings used as *residential*.

**701.3.4 Automated Demand Response.** *Building projects* shall contain *automatic* control systems that

have the capability to reduce building equipment loads to lower electric peak demand of the building.

The building controls shall be designed with automated demand-response (DR) infrastructure capable of receiving DR requests from the utility, electrical system operator, or third-party DR program provider and automatically implementing load adjustments to the HVAC and lighting systems.

**701.3.4.1 HVAC Systems Zone Set Points.** *The building project's* HVAC systems shall be programmed to allow centralized demand reduction in response to a signal from a centralized contact or software point in accordance with the following:

- a. The controls shall be programmed to automatically adjust upward the zone operating cooling set points by a minimum of 3°F.
- b. The controls shall be programmed to automatically adjust downward the zone operating heating set points by a minimum of 3°F.
- c. The controls shall be programmed to automatically adjust downward the zone operating cooling set points by a minimum of 2°F.
- d. The automated DR strategy shall include both ramp-up and ramp-down logic to prevent the building peak demand from exceeding that expected without the DR implementation.

**Exception:** Systems serving areas deemed by the *owner* to be critical in nature.

**701.3.4.2 Variable-Speed Equipment.** For HVAC equipment with variable-speed control, the controls shall be programmed to allow *automatic* adjustment of the maximum speed of the equipment to 90% of design speed during automated DR events. Airflow adjustments shall not decrease the supply airflow rate below the level that would result in outdoor airflow being below the *minimum outdoor airflow rates* specified in Section 801.3.1.1, or that would cause adverse building pressurization problems.

**701.3.4.3 Lighting.** For *building projects* with interior lighting control systems controlled at a central point, such systems shall be programmed to allow automated DR. The programming shall reduce the total connected lighting power demand during a DR event by not less than 15% but no more than 50% of the baseline power level. The baseline lighting power shall be determined in accordance with Section 701.4.6.1.1. For *building projects* without central lighting controls, DR capabilities for lighting systems shall not be required.

For *spaces* not in the *daylight area* and not connected to automated daylighting control, the lighting levels shall be uniformly reduced throughout the *space*.

**Exceptions:**

1. Luminaires or signage on emergency circuits Luminaires or signage on emergency circuits

2. Luminaires located within a *daylight area* that are dimmable and connected to automated daylighting control systems.
3. Lighting systems, including dimming systems, claiming a *lighting power allowance* for *institutional tuning* in accordance with Section 701.4.6.1.1(f).

**701.4 Prescriptive Option.**

**701.4.1 General Comprehensive Prescriptive Requirements.** When a requirement is provided below, it supersedes the requirement in ANSI/ASHRAE/IES Standard 90.1. For all other criteria, the *building project* shall comply with the requirements of ANSI/ASHRAE/IES Standard 90.1.

**701.4.1.1 On-Site Renewable Energy Systems.** *Building projects* shall comply with either the Standard Renewables Approach in Section 701.4.1.1.1 or the Alternate Renewables Approach in Section 701.4.1.1.2.

**701.4.1.1.1 Standard Renewables Approach: Baseline On-Site Renewable Energy Systems.** *Building projects* shall contain *on-site renewable energy systems* that provide the annual energy production equivalent of not less than 6.0 kBtu/ft<sup>2</sup> multiplied by the horizontal projection of the *gross roof area* in feet squared (metres squared) for single-story buildings, and not less than 10.0 kBtu/ft<sup>2</sup> multiplied by the horizontal projection of the *gross roof area* in feet squared for all other buildings. The annual energy production shall be the combined sum of all *on-site renewable energy systems*. Documentation shall be provided to the *AHJ* that indicates that the *renewable energy certificates (RECs)* associated with the *on-site renewable energy system* will be retained and retired by the *owner*. Where the building *owner* does not have ownership of the *RECs* associated with the *on-site renewable energy system*, the *owner* shall obtain and retire an equal or greater quantity of *RECs*.

All RECs obtained must be sourced within the PJM Interconnection region. Documentation pertaining to retention and retirement of RECs must be available to the authority having jurisdiction, for review upon request. Note: PJM Interconnection is a regional transmission organization that coordinates the movement of wholesale electricity in all or parts of 13 states including Maryland and DC.

**Exceptions:** Buildings that demonstrate compliance with both of the following are not required to contain *on-site renewable energy systems*:

1. An annual daily average incident solar radiation available to a flat plate collector oriented due south at an angle from horizontal equal to the latitude of the collector location less than 4.0 kWh/m<sup>2</sup>.day (1.2 kBtu/ft<sup>2</sup>/ day), accounting for existing buildings, permanent infrastructure that is not part of the *building project*, topography, and trees.

2. A commitment to purchase renewable electricity products complying with the Greene Energy National Standard for Renewable Electricity Products, of at least 7 kWh/ft<sup>2</sup> of *conditioned space* each year until the cumulative purchase totals 70 kWh/ft<sup>2</sup> of *conditioned space*.

**701.4.1.1.2 Alternate Renewables Approach: Reduced On-Site Renewable Energy Systems and Higher-Efficiency Equipment.** *Building projects* complying with this approach shall comply with the applicable equipment efficiency requirements in Normative Appendix B, the water-heating efficiency requirements in Section 701.4.4.1, equipment efficiency requirements in Section 701.4.7.1, and the applicable ENERGY STAR® requirements in Section 701.4.7.3.2, and shall contain *on-site renewable energy systems* that provide the annual energy production equivalent of not less than 4.0 kBtu/ft<sup>2</sup> multiplied by the horizontal projection of the *gross roof area* in feet squared for single-story buildings, and not less than 7.0 kBtu/ft<sup>2</sup> multiplied by the horizontal projection of the *gross roof area* in feet squared for all other buildings. The annual energy production shall be the combined sum of *all on-site renewable energy systems*. For equipment listed in Section 701.4.7.3.2 that are also contained in Normative Appendix B, the installed equipment shall comply by meeting or exceeding both requirements.

Documentation shall be provided to the *AHJ* that indicates that the *RECs* associated with the *on-site renewable energy system* will be retained and retired by the *owner*. Where the building owner does not have ownership of the *RECs* associated with the *on-site renewable energy system*, the *owner* shall obtain and retire an equal or greater quantity of *RECs*.

**701.4.2 Building Envelope.** The *building envelope* shall comply with ANSI/ASHRAE/IES Standard 90.1, Section 5, with the following modifications and additions.

**701.4.2.1 Building Envelope Requirements.** The *building envelope* shall comply with the requirements in ANSI/ASHRAE/IES Standard 90.1, Tables 5.5-0 through 5.5-8, with the following modifications to values in each table. For the opaque elements, each U-factor, C-factor, and F-factor in Tables 5.5-4 through 5.5-8 shall be reduced by 5%. The "Insulation Min. R-Value" column in ANSI/ASHRAE/IES Standard 90.1, Tables 5.5-4 through 5.5-8, shall not apply. For *vertical fenestration* and *skylights*, each U-factor shall be reduced by 5%. For *skylights* and east- and west-oriented *vertical fenestration*, each *solar heat gain coefficient (SHGC)* in Tables 5.5-0 through 5.5-8 shall be reduced by 5%.

**Exceptions:**

1. The U-factor, C-factor, or F-factor shall not be modified where the corresponding R-value requirement is designated as "NR" (no requirement) in ANSI/ASHRAE/IES Standard 90.1, Tables 5.5-4 through 5.5-8.
2. The *SHGC* shall not be modified where the *SHGC* requirement is designated as "NR" (no

requirement) in ANSI/ASHRAE/IES Standard 90.1, Tables 5.5-0 through 5.5-8.

3. *Spaces* that meet the requirements of Section 801.4.1, regardless of *space area*, are exempt from the *SHGC* criteria for *skylights*.

**Informative Notes:**

1. U-factors, C-factors, and F-factors for many common assemblies are provided in ANSI/ASHRAE/IES Standard 90.1, Normative Appendix A.
2. Section 501.3.5.3 of this code includes additional provisions related to *roofs*.

**701.4.2.2 Single-Rafter Roof Insulation.** *Single-rafter roofs* shall comply with the requirements in Normative Appendix A, Table A101.1. These requirements supersede the requirements in ANSI/ASHRAE/IES Standard 90.1, Section A2.4.2.4. ANSI/ASHRAE/IES Standard 90.1, Section A2.4.2.4 and Table A2.4.2, shall not apply.

**701.4.2.3 High-Speed Doors.** *High-speed doors* that are intended to operate on average at least 75 cycles per day shall not exceed a maximum U-factor of 1.20 Btu/h-ft<sup>2</sup>-°F. Opening rate, closing rate, and average cycles per day shall be included in construction drawings. ANSI/ASHRAE/IES Standard 90.1, Sections 5.5.3.6 and 5.5.4.3, shall not apply for *high-speed doors* complying with all criteria in this section.

**701.4.2.4 Air Curtains.** Where air curtains are provided at *building entrances* or *building entrance vestibules*, for the distance from the air-curtain discharge nozzle to the floor, the air-curtain unit shall produce a minimum velocity of 6.6 ft/s, in accordance with ANSI/AMCA 220, and be installed in accordance with manufacturer's instructions. *Automatic* controls shall be provided that will operate the air curtain with the opening and closing of the door. Air curtains and their controls shall comply with Section 1001.3.1.2.1.

**701.4.2.5 Vertical Fenestration Area.** The total *vertical fenestration area* shall be less than 40% of the *gross wall area*. This requirement supersedes the requirement in ANSI/ASHRAE/IES Standard 90.1, Section 5.5.4.2.1.

**701.4.2.6 Permanent Projections. NOT APPLICABLE TO OUR ZONE.** For *Climate Zones* 0 through 3 and *Climate Zones* 4B and 4C, the *vertical fenestration* on the west, south, and east shall be shaded by permanent projections that have an area-weighted average *projection factor (PF)* of not less than 0.50 for the first story above grade and 0.25 for other above-grade stories. The building is allowed to be rotated up to 45 degrees to the nearest cardinal orientation for purposes of calculations and showing compliance. Where different windows or glass doors have different *PF* values, each shall be evaluated separately, or an area-weighted *PF* value shall be calculated and used for all windows and glass doors. Horizontal projections shall extend over the full width of the glazing.

**Exceptions:** Permanent projections are not required for the following buildings and fenestrations:

1. Where *vertical fenestration* is located within 18 in. (450 mm) of the lot line.
2. Where equivalent shading of the *vertical fenestration* is provided by buildings, structures, geological formations, or permanent exterior projections that are not horizontal, as determined by sun-angle studies at the peak solar altitude on the summer solstice and three hours before and after the peak solar altitude on the summer solstice.
3. *Vertical fenestration* with automatically controlled shading devices capable of modulating in multiple steps the amount of solar gain and light transmitted into the *space* in response to daylight levels or solar intensity that comply with all of the following:
  - a. Exterior shading devices shall be capable of providing at least 90% coverage of the *fenestration* in the closed position.
  - b. Interior shading devices shall be capable of providing at least 90% coverage of the *fenestration* in the closed position and have a minimum solar reflectance of 0.50 for the surface facing the *fenestration*.
  - c. A manual override located in the same *enclosed space* as the *vertical fenestration* shall override operation of *automatic* controls no longer than four hours.
  - d. Acceptance testing and commissioning shall be conducted as required by Chapter 10 (Section 10) to verify that *automatic* controls for shading devices respond to changes in illumination or radiation intensity.
4. *Vertical fenestration* with automatically controlled *dynamic glazing* capable of modulating in multiple steps the amount of solar gain and light transmitted into the *space* in response to daylight levels or solar intensity that comply with all of the following:
  - a. *Dynamic glazing* shall have a lower labeled *SHGC* equal to or less than 0.12, lowest labeled visible transmittance (VT) no greater than 0.05, and highest labeled VT no less than 0.40.
  - b. A manual override located in the same *enclosed space* as the *vertical fenestration* shall override operation of *automatic* controls no longer than 4 hours.
    - c. Acceptance testing and commissioning shall be conducted as required by Chapter 10 (Section 10) to verify that *automatic* controls for *dynamic glazing* respond to changes in illumination or radiation intensity.
5. Existing buildings undergoing alteration, repair, relocation, or a change of occupancy.

**701.4.2.7 SHGC of Vertical Fenestration.** For *SHGC* compliance, the methodology in ANSI/

ASHRAE/IES Standard 90.1, Section 5.5.4.4.1, Exception 2, is allowed, provided that the *SHGC* multipliers in Table 701.4.2.7 of this standard are used. This requirement supersedes the requirement in ANSI/ASHRAE/IES Standard 90.1, Table 5.5.4.4.1; that table shall not apply. *Vertical fenestration* that is *north oriented* shall be allowed to have a maximum *SHGC* of 0.10 greater than that specified in ANSI/ASHRAE/IES Standard 90.1, Tables 5.5-1 through 5.5-8. When this provision is used, separate calculations shall be performed for these sections of the *building envelope*, and these values shall not be averaged with any others for compliance purposes.

**TABLE 701.4.2.7  
SHGC MULTIPLIERS FOR PERMANENT PROJECTIONS**

PF	SHGC MULTIPLIER	SHGC MULTIPLIER
	(ALL OTHER ORIENTATIONS)	(NORTH-ORIENTED)
0 to 0.60	1.00	1.00
> 0.60 to 0.70	0.92	0.96
>0.70 to 0.80	0.84	0.94
> 0.80 to 0.90	0.77	0.93
> 0.90 to 1.00	0.72	0.90

**701.4.2.8 Building Envelope Trade-Off Option.** The *building envelope* trade-off option in ANSI/ASHRAE/IES Standard 90.1, Section 5.6, shall not apply unless the procedure incorporates the modifications and additions to ANSI/ASHRAE/IES Standard 90.1 noted in Section 701.4.2.

**701.4.2.9 Orientation.** The *vertical fenestration* shall comply with either (a) or (b):

- a.  $A_w \leq (A_N + 4S)/4$  and  $A_E \leq (A_N + A_S)/4$
- b.  $A_w \times SHGC_w (A_N \times SHGC_C + A_S \times SHGC_C)/6$  and  
 $A_E \times SHGC_E \leq (A_N \times SHGC_C + A_S \times SHGC_C)/6$   
 where:  
 $SHGC_X$  = the *SHGC* for orientation x that complies with Section 701.4.2.7 (7.4.2.7).  
 $SHGC_C$  = the *SHGC* criteria for each *climate zone* from Section 701.4.2.1 (7.4.2.1).  
 $A_X$  = *fenestration area* for orientation x.  
 $N$  = north (oriented less than 45 degrees of true north).  
 $S$  = south (oriented less than 45 degrees of true south).  
 $E$  = east (oriented less than or equal to 45 degrees of true east).  
 $W$  = west (oriented less than or equal to 45 degrees of true west).

### Exceptions:

1. *Vertical fenestration* that complies with ANSI/ASHRAE/IES Standard 90.1, Section 5.5.4.4.1, Exception (3).
2. Buildings with shade on 75% of the west- and east-oriented *vertical fenestration areas* from permanent projections, existing buildings, existing permanent infrastructure, or topography at 9 a.m. and 3 p.m. on the summer solstice (June 21 in the northern hemisphere).
3. Alterations and additions with no increase in *vertical fenestration area*.
4. Buildings where the west- and east-oriented *vertical fenestration areas* do not exceed 20% of the *gross wall area* for each of those façades, and the *SHGC* on those façades is not greater than 90% of the criteria in Section 701.4.2.1.
5. Buildings in *Climate Zone 8*.

**701.4.3 Heating, Ventilating, and Air Conditioning.** The heating, ventilating, and air conditioning shall comply with ANSI/ASHRAE/IES Standard 90.1, Section (6), with the following modifications and additions.

**701.4.3.1 Minimum Equipment Efficiencies for the Alternate Renewables Approach.** All *building projects* complying with the Alternate Renewables Approach in Section 701.4.1.1.2 shall comply with the applicable equipment efficiency requirements in Normative Appendix B and the applicable ENERGY STAR requirements in Section 701.4.7.3.2. Where equipment efficiency is not defined/listed in Normative Appendix B or in Section 701.4.7.3.2, the equipment shall meet the minimum efficiency requirements defined/listed in ANSI/ASHRAE/IES Standard 90.1. Specifically, this applies to the following products in ANSI/ASHRAE/IES Standard 90.1:

- a. Table 6.8.1.3, "Water-Chilling Packages—Minimum Efficiency Requirements."
- b. Table 6.8.1-11, "Air Conditioners and Condensing Units Serving Computer Rooms—Minimum Efficiency Requirements."
- c. Table 6.8.1-12, "Commercial Refrigerator and Freezers—Minimum Efficiency Requirements."
- d. Table 6.8.1-13, "Commercial Refrigeration—Minimum Efficiency Requirements."
- e. Table 6.8.1-14, "Vapor Compression Based Indoor Pool Dehumidifiers—Minimum Efficiency Requirements."
- f. Table 6.8.1-15, "Electrically Operated DX-DOAS Units, Single-Package and Remote Condenser, without Energy Recovery—Minimum Efficiency Requirements."
- g. Table 6.8.1-16, "Electrically Operated DX-DOAS Units, Single Package and Remote Condenser, with Energy Recovery—Minimum Efficiency Requirements."

h. Table 10.8-1, "Minimum Nominal Full-Load Efficiency for NEMA Design A, NEMA Design B, and WC Design N Motors (Excluding Fire Pump Electric Motors) at 60 Hz" (NEMA MG 1).

i. Table 10.8-2, "Minimum Nominal Full-Load Efficiency for NEMA Design C and IEC Design H Motors at 60 Hz" (NEMA MG 1).

Table 10.8-3, "Minimum Average Full-Load Efficiency for Polyphase Small Electric Motors."

k. Table 10.8-4, "Minimum Average Full-Load Efficiency for Capacitor-Start Capacitor-Run and Capacitor-Start Induction-Run Small Electric Motors."

l. Table 10.8-5, "Minimum Nominal Full-Load Efficiency for Fire Pump Electric Motors."

### 701.4.3.1.1 Water-Cooled Centrifugal Chiller Packages Efficiency Adjustment.

a. **For Water-Cooled Centrifugal Units Rated per AHRI Standard 550/590 (1-P).** 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 (FL) kW/ton and part-load rating requirements adjusted using the following equations:

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

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

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

Where:

FL = full-load kW/ton value from ANSI/ASHRAE/IES Standard 90.1, Table 6.8.1-3.

FL<sub>adj</sub> = maximum full-load kW/ton rating, adjusted for nonstandard conditions.

IPLV = IPLV value from ANSI/ASHRAE/IES Standard 90.1, Table 6.8.1-3.

PLV = maximum NPLV rating, adjusted for nonstandard conditions.

$$A = 0.000000145920 \times (LIFT)^4 - 0.0000346496 \times (LIFT)^3 + 0.00314196 \times (LIFT)^2 - 0.147199 \times (LIFT) + 3.93073.$$

$$B = 0.0015 \times LvgEvap + 0.934.$$

$$LIFT = LvgCond - LvgEvap.$$

LvgCond = full-load condenser leaving fluid temperature, °F.

LvgEvap = full-load evaporator leaving temperature, °F.

The FL<sub>adj</sub> and PLV<sub>adj</sub> values are only applicable for centrifugal chillers meeting all of the following full-load design ranges:

- $36.00^{\circ}\text{F} \leq \text{LvgEvap} \leq 60.00^{\circ}\text{F}$ .
- $\text{LvgCond} \leq 115.00^{\circ}\text{F}$ .
- $20.00^{\circ}\text{F} \leq \text{LIFT} \leq 80.00^{\circ}\text{F}$ .

Centrifugal chillers designed to operate outside of these ranges are not covered by this code.

- b. For Water-Cooled Centrifugal Units Rated per AHRI Standard 551/591 (SI).** Equipment not designed for operation at AHRI Standard 551/591 test conditions of  $7.00^{\circ}\text{C}$  leaving and  $12.00^{\circ}\text{C}$  entering chilled-fluid temperatures, and with  $30.00^{\circ}\text{C}$  entering and  $35.00^{\circ}\text{C}$  leaving condenser-fluid temperatures, shall have maximum full-load (FL) COP and part-load rating requirements adjusted using the following code:

$$\text{FL}_{\text{adj}} = \text{FL} \times K_{\text{adj}}$$

$$\text{PLV}_{\text{adj}} = \text{IPLV} \times K_{\text{adj}}$$

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

where:

**FL** = full-load COP value from ANSI/ASHRAE/IES Standard 90.1, Table 6.8.1-3.

**FL<sub>adj</sub>** = minimum full-load COP rating, adjusted for nonstandard conditions.

**IPLV** = IPLV value from ANSI/ASHRAE/IES Standard 90.1, Table 6.8.1-3.

**PLV<sub>adj</sub>** = minimum *NPLV* rating, adjusted for nonstandard conditions.

$$\begin{aligned} A &= 0.00000153181 \times (\text{LIFT})^4 - \\ &\quad 0.000202076 \times (\text{LIFT})^3 + \\ &\quad 0.0101800 \times (\text{LIFT})^2 - 0.264958 \\ &\quad \times \text{LIFT} + 3.93073. \\ &= 0.0027 \times \text{LvgEvap} + 0.982. \end{aligned}$$

**LIFT** =  $\text{LvgCond} - \text{LvgEvap}$ .

**LvgCond** = full-load condenser leaving fluid temperature,  $^{\circ}\text{C}$ .

**LvgEvap** = full-load evaporator leaving temperature,  $^{\circ}\text{C}$ .

The **FL<sub>adj</sub>** and **PLV<sub>adj</sub>** values are only applicable for centrifugal chillers meeting all of the following full-load design ranges:

- $2.20^{\circ}\text{C} \leq \text{LvgEvap} \leq 15.60^{\circ}\text{C}$ .
- $\text{LvgCond} \leq 46.00^{\circ}\text{C}$ .
- $11.00^{\circ}\text{C} \leq \text{LIFT} \leq 44.00^{\circ}\text{C}$ .

Centrifugal chillers designed to operate outside of these ranges are not covered by this code.

- 701.4.3.2 Ventilation Controls for Densely Occupied Spaces.** The requirements in this section supersede those in ANSI/ASHRAE/IES Standard 90.1, Section 6.4.3.8. *Demand control ventilation (DCV)* shall be provided for *densely occupied spaces* served by systems with one or more of the following:

- An air-side economizer.
- Automatic* modulating control of the *outdoor air* dampers.
- A design outdoor airflow greater than 1000 cfm.

**Exceptions:**

- Systems with exhaust air energy recovery complying with Section 701.4.3.7.
- Systems with a design outdoor airflow less than 750 cfm.
- Spaces* where more than 75% of the *space* design outdoor airflow is used as *makeup air* or *transfer air* to provide *makeup air* for other *spaces*.
- Spaces* with one of the following occupancy categories as listed in ANSFASHRAE Standard 62.1: cells in correctional facilities; daycare sickrooms; science laboratories; barbershops; beauty and nail salons; and bowling alleys (seating).

The *DCV* system shall be designed to be in compliance with ASHRAE Standard 62.1, Section 6.2.7.1. Occupancy assumptions shall be shown in the design documents for *spaces* provided with *DCV*. All  $\text{CO}_2$  sensors used as part of a *DCV* system or any other system that dynamically controls *outdoor air* shall meet the following requirements:

- Spaces* with  $\text{CO}_2$  sensors or air-sampling probes leading to a central  $\text{CO}_2$  monitoring station shall be provided with at least one sensor or probe for each 10,000  $\text{ft}^2$  of floor *space*. Sensors or probes shall be installed between 3 and 6 ft above the floor.
- $\text{CO}_2$  sensors shall have a rated accuracy of  $\pm 50$  ppm at 1000 ppm.
- Outdoor air*  $\text{CO}_2$  concentrations shall be determined by one of the following:
  - Outdoor air*  $\text{CO}_2$  concentrations shall be dynamically measured using one or multiple  $\text{CO}_2$  sensors. The  $\text{CO}_2$  sensor locations shall be identified on the *construction documents*.
  - When documented statistical data on the local ambient  $\text{CO}_2$  concentrations are available, a fixed value typical of the location where the building is located shall be allowed in lieu of an outdoor sensor.
- Occupant  $\text{CO}_2$  generation rate assumptions shall be shown in the design documents.

**701.4.3.3 Duct Leakage Tests.** Leakage tests shall comply with the requirements in ANSI/ASHRAE/IES Standard 90.1, Section 6.4.4.2.2, with the following modification. Ductwork that is designed to operate at static pressures in excess of 2 in. of water (500 Pa), and all ductwork located outdoors, shall be leak-tested according to industry-accepted test procedures.

**701.4.3.4 Economizers.** Systems shall include economizers meeting the requirements in ANSI/ASHRAE/IES Standard 90.1, Section 6.5.1, except as modified by the following:

- a. The minimum size requirements for economizers for comfort cooling and for computer rooms are defined in Table 701.4.3.4 and supersede the requirements in ANSI/ASHRAE/IES Standard 90.1, Tables 6.5.1-1 and 6.5.1-2.
- b. Rooftop units with a capacity of less than 54,000 Btu/h shall have two stages of capacity control, with the first stage controlling the economizer and the second stage controlling *mechanical cooling*. Units with a capacity equal to or greater than 54,000 Btu/h shall comply with the staging requirements defined in ANSI/ASHRAE/IES Standard 90.1, Section 6.5.3.1
- c. For systems that control to a fixed leaving air temperature (i.e., *variable-air-volume [VAV]* systems), the system shall be capable of resetting the supply air temperature up at least 5°F during economizer operation.

All the exceptions in ANSI/ASHRAE/IES Standard 90.1, Section 6.5.1, shall apply except as modified by the following:

- a. Where the reduced renewable approach defined in Section 701.4.1.1.1 is used, ANSI/ASHRAE/IES Standard 90.1, Section 6.5.1, Exception (9), shall be permitted to eliminate the economizer requirement, provided the requirements in ANSI/ASHRAE/IES Standard 90.1, Table 6.5.1-3, are applied to the efficiency requirements required by Section 701.4.1.1.2. If the standard renewable approach is chosen as defined in Section 701.4.1.1.1 then the requirements in ANSI/ASHRAE/IES Standard 90.1, Table 6.5.1-3, shall be applied to the efficiency requirements in ANSI/ASHRAE/IES Standard 90.1, Tables 6.8.1-1 through 6.8.1-11.

- b. For water-cooled units with a capacity less than 54,000 Btu/h (16 kW) that are used in systems where heating and cooling loads are transferred within the building (i.e., water-source heat-pump systems), the requirement for an air or water economizer can be eliminated if the condenser-water temperature controls are capable of being set to maintain full-load heat-rejection capacity down to a 55°F condenser-water supply temperature, and the HVAC equipment is capable of operating with a 55°F condenser-water supply temperature.

**701.4.3.5 Zone Controls.** The exceptions to ANSI/ASHRAE/IES Standard 90.1, Section (6.5.2.1), shall be modified as follows:

- a. Exception (1) shall not be used.
- b. Exception (2)(a)(2) shall be replaced by the following text: "the design outdoor airflow rate for the zone."

#### **701.4.3.6 Fan System Power and Efficiency.**

**701.4.3.6.1 Fan System Power Limitation.** Systems shall have fan power limitations 10% below limitations specified in ANSI/ASHRAE/IES Standard 90.1, Table 6.5.3.1-1. This requirement supersedes the requirement in ANSI/ASHRAE/IES Standard 90.1, Section (6.5.3.1) and Table. All exceptions in ANSI/ASHRAE/IES Standard 90.1, Section 6.5.3.1, shall apply.

**701.4.3.6.2 Fan Efficiency.** The fan efficiency requirements defined in ANSI/ASHRAE/IES Standard 90.1, Section 6.5.3.1.3, shall be used, except that the total efficiency of the fan at the design point of operation shall be within ten percentage points of the maximum total efficiency of the fan. All exceptions in ANSI/ASHRAE/IES Standard 90.1, Section 6.5.3.1.3, shall apply.

**TABLE 701.4.3.4**

#### **MINIMUM SYSTEM SIZE FOR WHICH AN ECONOMIZER IS REQUIRED**

CLIMATE ZONES	COOLING CAPACITY FOR WHICH AN ECONOMIZER IS REQUIRED <sup>a</sup>
OA, OB, 1A, 1B	No economizer requirement
2A, 2B, 3A, 3B, 3C, 4A, 4B, 4C, 5A, 5B, 5C, 6A, 6B, 7, 8	≥33,000 Btu/h (9.7 kW) <sup>a</sup>

a. Where economizers are required, the total capacity of all systems without economizers shall not exceed 480,000 Btu/h (140 kW) per building or 20% of the building's air economizer capacity, whichever is greater.



**701.4.3.7 Exhaust Air Energy Recovery.** The exhaust air energy recovery requirements defined in ANSI/ASHRAE/IES Standard 90.1, Section 6.5.6.1, including the requirements in Tables 6.5.6.1-1 and 6.5.6.1-2, shall be used except that the energy recovery effectiveness shall not be less than 60%, superseding the 50% effectiveness requirement in ANSI/ASHRAE/IES Standard 90.1, Section 6.5.6.1.

**701.4.3.8 Kitchen Exhaust Systems.** The requirements in ANSI/ASHRAE/IES Standard 90.1, Section 6.5.7.2 shall apply, except as follows: Sections 701.4.3.8.1 and 701.4.3.8.2 supersede the requirements in ANSI/ASHRAE/IES Standard 90.1, Sections 6.5.7.2.2 and 6.5.7.2.3.

**701.4.3.8.1** For kitchen/dining facilities with total kitchen hood exhaust airflow rate greater than 2000 cfm (950 L/s), the maximum exhaust flow rate for each hood shall be determined in accordance with Table 701.4.3.8.1. For single hoods, or hood sections installed over appliances with different duty ratings, the maximum allowable exhaust flow rate for the hood or hood section shall be determined in accordance with Table 701.4.3.8.1 for the highest appliance duty rating under the hood or hood section. Refer to ANSI/ASHRAE Standard 154 for definitions of hood type, appliance duty, and net exhaust flow rate.

**Exception:** When at least 75% of all the replacement air is *transfer air* that would otherwise be exhausted.

**701.4.3.8.2** Kitchen/dining facilities with total kitchen hood exhaust airflow rate greater than 2000 cfm shall comply with at least one of the following:

- At least 50% of all replacement air must be *transfer air* that would otherwise be exhausted.
- At least 75% of kitchen hood exhaust air shall be controlled by demand ventilation system, which shall:
  - Be capable of reducing exhaust and replacement air system airflow rates by no more than the larger of:
    - 50% of total design exhaust and replacement air system airflow rate; or
    - The outdoor airflow and exhaust rates required to meet the ventilation and exhaust requirements of Sections 6.2 and 6.5 of ASHRAE Standard 62.1 for the zone.

- Include controls to modulate airflow in response to appliance operation and to maintain full capture and containment of smoke, effluent, and combustion products during cooking and idle;
- Include controls that result in full flow when the demand ventilation systems fail to modulate airflow in response to appliance operation; and
- Allow occupants to temporarily override the systems to full flow.

c. Listed energy recovery devices with a sensible heat recovery effectiveness of not less than 40% shall be applied on at least 50% of the total exhaust airflow.

d. In *Climate Zones* OB, 1B, 2B, 3B, 4B, 5B, 6B, 7B, and 8B, when *makeup air* is uncooled or cooled without the use of *mechanical cooling*, the capacity of any nonmechanical *cooling* systems (*Informative Note:* e.g., natural cooling or evaporative cooling) shall be demonstrated to be no less than the system capacity of a *mechanical cooling* system necessary to meet the same loads under design conditions.

**701.4.3.9 Duct Insulation.** Duct insulation shall comply with the minimum requirements in Normative Appendix A, Tables A-2 and A-3. These requirements supersede the requirements in ANSI/ASHRAE/IES Standard 90.1, Table 6.8.2.

**701.4.3.10 Automatic Control of HVAC and Lights in Hotel/Motel Guest Rooms.** In hotels and motels with over 50 guest rooms, *automatic controls* for the lighting, switched outlets, television, and HVAC equipment serving each guest room shall be configured according to the following requirements.

**TABLE 701.4.3.8.1  
MAXIMUM NET EXHAUST FLOW RATE PER LENGTH OF HOOD**

TYPE OF HOOD	LIGHT-DUTY EQUIPMENT		MEDIUM-DUTY EQUIPMENT		HEAVY-DUTY EQUIPMENT		EXTRA-HEAVY-DUTY EQUIPMENT	
	cfm per linear foot	L/s per linear metre	cfm per linear foot	L/s per linear metre	cfm per linear foot	L/s per linear metre	cfm per linear foot	L/s per linear metre
Wall-mounted canopy	140	217	210	325	280	433	385	596
Single island	280	433	350	541	420	650	490	758
Double Island (per side)	175	271	210	325	280	433	385	596
Eye brow	175	271	175	271	Not allowed	Not allowed	Not allowed	Not allowed
Backshelf/Passover	210	325	210	325	280	433	Not allowed	Not allowed

- a. The total exhaust flow rate for all single-island hoods in a kitchen/dining facility shall be no more than 5000 cfm (2360 L/s)

**701.4.3.10.1 Lighting and Switched Outlet Control.** Within 30 minutes of all occupants leaving the guest room, power for lighting and switched outlets shall be automatically turned off.

**701.4.3.10.2 Television Control.** Within 30 minutes of all occupants leaving the guest room, televisions shall be automatically turned off or placed in sleep or standby mode.

**701.4.3.10.3 HVAC Set-Point Control.** Within 30 minutes of all occupants leaving the guest room, HVAC set points shall be automatically raised by at least 5°F from the occupant set point in the cooling mode and automatically lowered by at least 5°F from the occupant set point in the heating mode. When the guest room is unrented and unoccupied, HVAC set points shall be automatically reset to 80°F or higher in the cooling mode and to 60°F or lower in the heating mode. Unrented and unoccupied guest rooms shall be determined by either of the following criteria:

- a. The guest room has been continuously unoccupied for up to 16 hours.
- b. A *networked guest-room control system indicates* the guest room is unrented and the guest room is unoccupied for no more than 30 minutes.

**Exceptions:**

1. A *networked guest-room control system* may return the thermostat set points to their default set points 60 minutes prior to the time the room is scheduled to be occupied.
2. Cooling for humidity control shall be permitted during unoccupied periods.

**701.4.3.10.4 Ventilation Control.** Within 30 minutes of all occupants leaving the guest room, ventilation and exhaust fans shall be automatically turned off, or *isolation devices* serving each guest room shall automatically shut off the supply of *outdoor air* to the room and shut off exhaust air from the guest room. In conjunction with the *automatic* ventilation shutoff, an *automatic* preoccupancy purge cycle shall provide *outdoor air* ventilation as specified in Section 801.3.1.6.

**701.4.3.10.5 Automatic Control.** Captive keycard systems shall not be used to comply with Section 701.4.3.10.

**701.4.4 Service Water Heating.** The *service water heating* shall comply with ANSI/ASHRAE/IES Standard 90.1, Section 7, with the following modifications and additions.

**701.4.4.1 Equipment Efficiency for the Alternate Renewables Approach.** All *building projects* complying with the Alternate Renewables Approach in Section 701.4.1.1.2 shall comply with the applicable equipment efficiency requirements in Normative Appendix B, Table B101.9, and with the applicable ENERGY STAR requirements in Section 701.4.7.3.2.

These requirements supersede the requirements in ANSI/ASHRAE/IES Standard 90.1, Table 7.8.

**701.4.4.2 Insulation for Spa Pools.** Pools heated to more than 90°F shall have side and bottom surfaces insulated on the exterior with a minimum insulation value of R-12.

**701.4.5 Power.** The power shall comply with ANSI/ASHRAE/IES Standard 90.1, Section 8.

**701.4.6 Lighting.** The lighting shall comply with ANSI/ASHRAE/IES Standard 90.1, Section 9, with the following modifications and additions.

**701.4.6.1 Lighting Power Allowance**

**701.4.6.1.1 Interior Lighting Power Densities (LPDs).** The interior *lighting power allowance* shall be determined using ANSI/ASHRAE/IES Standard 90.1, either Section 9.5 or 9.6, with the following modifications:

- a. For those areas where the Building Area Method is used, the LPD from ANSI/ASHRAE/IES Standard 90.1, Table 9.5.1, shall be replaced with the corresponding LPD in Table 701.4.6.1A.
- b. For those areas where the Space-by-Space Method is used, the LPD from ANSI/ASHRAE/IES Standard 90.1, Table 9.6.1, shall be replaced with the corresponding LPD in Table 701.4.6.1B.
- c. Room geometry adjustment when using the Space-by-Space Method: ANSI/ASHRAE/IES Standard 90.1, Section 9.6.4, shall be replaced with the following. For corridor/transition *spaces* less than 8 ft wide, or individual *spaces* where room cavity ratio (RCR) calculated for the empty room is documented to be greater than the RCR threshold for that *space* type shown in Table 701.4.6.1B, the allowed LPD shall be 1.2 times the LPD in Table 701.4.6.1B. RCR shall be calculated as described in ANSI/ASHRAE/IES Standard 90.1, Section 9.6.4.
- d. Additional lighting power when using the Space-by-Space Method: For those areas where the Space-by-Space Method is used, the additional increase in the interior lighting power allowed by ANSI/ASHRAE/IES Standard 90.1, Section 9.6.2, for specific lighting functions shall be replaced by the requirements and allowances of this section. Additional power shall be allowed only if the specified lighting is installed and automatically controlled separately from the general lighting and is designed and installed to be turned off during nonbusiness hours. This additional power shall be used only for the specified

**TABLE 701.4.6.1A  
LIGHTING POWER DENSITIES USING THE  
BUILDING AREA METHOD**

BUILDING AREA TYPE	LPD, W/ft <sup>2</sup>	LPD, W/m <sup>2</sup>
Automotive facility	0.64	6.9
Convention center	0.51	5.5
Courthouse	0.74	8.0
Dining: Bar lounge/leisure	0.69	7.4
Dining: Cafeteria/fast food	0.66	7.1
Dining: Family	0.61	6.6
Dormitory	0.52	5.6
Exercise center	0.61	6.6
Fire station	0.50	5.4
Gymnasium	0.67	7.2
Health care clinic	0.68	7.3
Hospital	0.86	9.3
Hotel/Motel	0.70	7.5
Library	0.72	7.8
Manufacturing facility	0.60	6.5
Motion picture theater	0.62	6.7
Multifamily	0.49	5.3
Museum	0.68	7.3
Office	0.69	7.4
Parking garage	0.12	1.3
Penitentiary	0.67	7.2
Performing arts theater	0.85	9.1
Police station	0.68	7.3
Post office	0.62	6.7
Religious facility	0.70	7.5
Retail	0.91	9.8
School/university	0.67	7.2
Sports arena	0.76	8.2
Town hall	0.72	7.8
Transportation	0.51	5.5
Warehouse	0.41	4.4
Workshop	0.83	8.9

a. In cases where both a general building area type and a specific building area type are listed, the specific building area type shall apply.

luminaires 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 *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, provided that the additional lighting power shall not exceed  $0.5 \text{ W/ft}^2$  ( $5.4 \text{ W/m}^2$ ) of such *spaces*.

2. For lighting equipment installed in sales areas and specifically designed and directed to highlight merchandise, calculate the additional lighting power as follows:

Additional interior *lighting power allowance* =  
750 W

+ [Retail Area 1 x 0.40 W/ft<sup>2</sup>]  
+ [Retail Area 2 x 0.40 W/ft<sup>2</sup>]  
+ [Retail Area 3 x 1.00 W/ft<sup>2</sup>]  
+ [Retail Area 4 x 1.50 W/ft<sup>2</sup>]

where:

Retail Area 1 = the floor area for all products not listed in Retail Areas 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 included in Retail Areas 2 through 4 where the *authority having jurisdiction* has approved the documented need for additional lighting power based on visual inspection, contrast, or other critical display.

- e. Any of the control factors from ANSI/ASHRAE/IES Standard 90.1, Table 9.6.3, shall be permitted to be applied, provided that the corresponding control method is not required by ANSI/ASHRAE/ICC/USGBC/ IES Standard 189.1.
- f. An additional *lighting power allowance* shall be credited for *institutional tuning* of dimmable lighting systems that meet all of the following requirements:
  1. *Institutional tuning* controls shall be accessible only to authorized personnel.
  2. *Construction documents* shall state that maximum light output or power of controlled lighting shall be reduced by at least 15% from full output.
  3. The maximum light output or power of the controlled lighting shall be measured without *institutional tuning* and with *institutional tuning* to verify reduction of light output or power by at least 15% when tuned. In daylighted areas these measurements shall be conducted at night.

For controlled lighting in daylighted areas, the additional *lighting power allowance* shall be 0.05 times the controlled lighting power. In nonday-lighted areas, the additional *lighting power allowance* shall be 0.10 times the controlled lighting power.

**TABLE 701.4.6.1B  
LIGHTING POWER DENSITY (LPD) ALLOWANCES AND ROOM CAVITY RATIO (RCR)  
THRESHOLDS USING THE SPACE-BY-SPACE METHOD**

**Informative Note:** This table is divided into two sections. The first section covers *space* types that can be commonly found in multiple-building types. The second part covers *space* types that are typically found in a single-building type.

Common Space Types <sup>a</sup>	LPD, W/ft <sup>2</sup>	LPD, W/m <sup>2</sup>	RCR THRESHOLD
<b>Atrium</b>			
< 20 ft (6.1 m) in height	0.023/ft total height	0.81/m total height	NA
≥ 20 ft (6.1 m) and ≤ 40 ft (12.2 m) in height	0.023/ft total height	0.81/m total height	NA
> 40 ft (12.2 m) height	0.30 + 0.015/ft total height	3.2 + 0.53/m total height	NA
<b>Audience Seating Area</b>			
Auditorium	0.65	7.2	6
Convention Center	0.65	7.0	4
Gymnasium	0.43	4.6	6
Motion Picture theater	0.64	6.9	4
Penitentiary	0.44	4.7	4
Performing arts theater	1.34	14.4	8
Religious building	0.98	10.5	4
Sports arena	0.42	4.5	4
All other audience <i>seating</i> areas	0.40	4.3	4
<b>Banking Activity Area</b>	0.79	8.5	6
<b>Breakroom (see Lounge/Breakroom)</b>			
<b>Classroom/Lecture Hall/Training Room</b>			
Penitentiary	1.06	11.4	4
All other <i>classrooms/lecture</i> halls/training rooms	0.74	8.0	4
<b>Conference/Meeting/Multipurpose Room</b>	0.93	10.0	6
<b>Confinement Cells</b>	0.52	5.6	6
<b>Copy/Print Room</b>	0.50	5.4	6
<b>Corridor</b>			
Facility for the visually impaired (and not used primarily by the staff) <sup>c</sup>	0.81	8.7	width < 8 ft (2.4 m)
Hospital	0.81	8.7	width < 8 ft (2.4 m)
Manufacturing facility	0.28	3.0	width < 8 ft (2.4 m)
All other corridors	0.58	6.2	width < 8 ft (2.4 m)
<b>Courtroom</b>	0.98	10.5	6
<b>Computer Room</b>	1.16	12.5	4

- In cases where both a common *space* type and a building area specific *space* type are listed, the building area specific *space* type shall apply.
- In corridors, the extra LPD allowance is permitted when the width of the corridor is less than 8 ft (2.4 m) and is not based on the RCR, see Section 701.4.6.1.1(c).
- A "Facility for the visually impaired" is a facility that can be documented as being designed to comply with the light levels in ANSI/IES RP-28 and is licensed or will be licensed by local/state authorities for either senior long-term care, adult daycare, senior support, and/or people with special visual needs.
- For accent lighting, see Section 701.4.6.1.1(d).
- Sometimes referred to as a "picking area."
- Not used to keep footnote numbering consistent with ANSI/ASHRAE/IES Standard 90.1.
- Electrical/mechanical rooms. An additional 0.50 W/ft<sup>2</sup> shall be allowed, provided that the additional lighting is controlled separately from the base allowance of 0.39 W/ft<sup>2</sup>. The additional 0.50 W/ft<sup>2</sup> allowance shall not be used for any other purpose.
- Class of play as defined by IES RP-6.

(continued)

**TABLE 701.4.6.1B**  
**LIGHTING POWER DENSITY (LPD) ALLOWANCES AND ROOM CAVITY RATIO (RCR)**  
**THRESHOLDS USING THE SPACE-BY-SPACE METHOD (Continued)**

**Informative Note:** This table is divided into two sections. The first section covers *space* types that can be commonly found in multiple-building types. The second part covers *space* types that are typically found in a single-building type.

Common Space Types <sup>a</sup>	LPD, W/ft <sup>2</sup>	LPD, W/m <sup>2</sup>	RCR THRESHOLD
<b>Dining Area</b>			
Penitentiary	0.72	7.8	6
Facility for the visually impaired (and not used primarily by staff) <sup>c</sup>	1.48	15.9	4
Bar/lounge or leisure dining	0.62	6.7	4
Cafeteria or fast-food dining	0.53	5.7	4
Family dining	0.54	5.8	4
All other dining areas	0.53	5.7	4
<b>Electrical/Mechanical Room<sup>g</sup></b>	0.39	4.2	6
<b>Emergency Vehicle Garage</b>	0.53	5.7	4
<b>Food Preparation Area</b>	0.92	9.9	6
<b>Guest Room</b>	0.75	8.1	6
<b>Laboratory</b>			
In or as a classroom	1.04	11.2	6
All other laboratories	1.24	13.3	6
<b>Laundry/Washing Area</b>	0.43	4.6	4
<b>Loading Dock, Interior</b>	0.51	5.5	6
<b>Lobby</b>			
Facility for the visually impaired (and not used primarily by the staff) <sup>c</sup>	1.30	14.0	4
Elevator	0.52	5.6	6
Hotel	0.68	7.3	4
Motion picture theater	0.38	4.1	4
Performing arts theater	0.82	8.8	6
All other lobbies	0.86	9.3	4
<b>Locker Room</b>	0.45	4.8	6
<b>Lounge/Breakroom</b>			
Healthcare facility	0.53	5.7	6
All other lounges/breakrooms	0.44	4.7	4

- a. In cases where both a common *space* type and a building area specific *space* type are listed, the building area specific *space* type shall apply.
- b. In corridors, the extra LPD allowance is permitted when the width of the corridor is less than 8 ft and is not based on the RCR, see Section 701.4.6.1.1(c).
- c. A "Facility for the visually impaired" is a facility that can be documented as being designed to comply with the light levels in ANSVIES RP-28 and is licensed or will be licensed by local/state authorities for either senior long-term care, adult daycare, senior support, and/or people with special visual needs.
- d. For accent lighting, see Section 701.4.6.1.1(d).
- e. Sometimes referred to as a "picking area."
- f. Not used to keep footnote numbering consistent with ANSI/ASHRAE/IES Standard 90.1.
- g. Electrical/mechanical rooms. An additional 0.50 W/ft<sup>2</sup> shall be allowed, provided that the additional lighting is controlled separately from the base allowance of 0.39 W/ft<sup>2</sup> (4.2 W/m<sup>2</sup>). The additional 0.50 W/ft<sup>2</sup> allowance shall not be used for any other purpose.
- h. Class of play as defined by IES RP-6.

(continued)

**TABLE 701.4.6.1B  
LIGHTING POWER DENSITY (LPD) ALLOWANCES AND ROOM CAVITY RATIO (RCR)  
THRESHOLDS USING THE SPACE-BY-SPACE METHOD (Continued)**

**Informative Note:** This table is divided into two sections. The first section covers *space* types that can be commonly found in multiple-building types. The second part covers *space* types that are typically found in a single-building type.

Common Space Types <sup>a</sup>	LPD, W/ft <sup>2</sup>	LPD, W/m <sup>2</sup>	RCR THRESHOLD
<b>Office</b>			
Enclosed and ≤ 250 ft <sup>2</sup>	0.85	9.1	8
Enclosed and > 250 ft <sup>2</sup>	0.85	9.1	8
Open Plan	0.78	8.4	4
<b>Parking Area, Interior</b>	0.11	1.2	4
<b>Pharmacy Area</b>	1.23	13.2	6
<b>Restroom</b>			
Facility for the visually impaired (and not used primarily by the staff) <sup>c</sup>	0.81	8.7	8
All other restrooms	0.75	8.1	8
<b>Sales Area<sup>d</sup></b>	1.06	11.4	6
<b>Seating Area, General</b>	0.38	4.1	4
<b>Stairway</b>	This space containing the stairway shall determine the LPD requirements for the stairway.		
Stairwell	0.50	5.4	10
<b>Storage Room</b>			
< 50 ft <sup>2</sup>	0.86	9.3	6
≥ 50 ft <sup>2</sup> and ≤ 1000 ft <sup>2</sup>	0.43	4.6	6
All other storage rooms	0.43	4.6	6
<b>Vehicular Maintenance Area</b>	0.53	5.7	4
<b>Workshop</b>	1.09	11.7	6
BUILDING TYPE SPECIFIC SPACE TYPES <sup>a</sup>	LPD, W/ft <sup>2</sup>	LPD, W/m <sup>2</sup>	RCR THRESHOLD
<b>Facility for the Visually Impaired<sup>e</sup></b>			
Chapel (used primarily by residents)	0.89	8.9	4
Recreation room/common living room (and not used primarily by staff)	1.53	15.3	6
<b>Automotive (see Vehicular Maintenance Area)</b>			
<b>Convention Center-Exhibit Space</b>	0.69	7.43	4
<b>Dormitory-Living Quarters</b>	0.46	4.95	8
<b>Fire Station-Sleeping Quarters</b>	0.19	2.05	6

- In cases where both a common *space* type and a building area specific *space* type are listed, the building area specific *space* type shall apply.
- In corridors, the extra LPD allowance is permitted when the width of the corridor is less than 8 ft and is not based on the RCR, see Section 701.4.6.1.1(c).
- A "Facility for the visually impaired" is a facility that can be documented as being designed to comply with the light levels in ANSI/IES RP-28 and is licensed or will be licensed by local/state authorities for either senior long-term care, adult daycare, senior support, and/or people with special visual needs.
- For accent lighting, see Section 701.4.6.1.1(d).
- Sometimes referred to as a "picking area."
- Not used to keep footnote numbering consistent with ANSI/ASHRAE/IES Standard 90.1.
- Electrical/mechanical rooms. An additional 0.50 W/ft<sup>2</sup> shall be allowed, provided that the additional lighting is controlled separately from the base allowance of 0.39 W/ft<sup>2</sup>. The additional 0.50 W/ft<sup>2</sup> allowance shall not be used for any other purpose.
- Class of play as defined by IES RP-6.

(continued)

**TABLE 701.4.6.1B  
LIGHTING POWER DENSITY (LPD) ALLOWANCES AND ROOM CAVITY RATIO (RCR)  
THRESHOLDS USING THE SPACE-BY-SPACE METHOD (Continued)**

**Informative Note:** This table is divided into two sections. The first section covers *space* types that can be commonly found in multiple-building types. The second part covers *space* types that are typically found in a single-building type.

BUILDING TYPE SPECIFIC SPACE TYPES <sup>a</sup>	LPD, W/ft <sup>2</sup>	LPD, W/m <sup>2</sup>	RCR THRESHOLD
<b>Gymnasium/Fitness Center</b>			
Exercise area	0.50	5.4	4
Playing area	0.75	8.1	4
<b>Healthcare Facility</b>			
Exam/treatment room	1.16	12.5	8
Imaging room	0.98	10.5	6
Medical supply room	0.54	5.8	6
Nursery	0.94	10.1	6
Nurse's station	0.75	8.1	6
Operating room	1.87	20.1	6
Patient room	0.45	4.8	6
Physical therapy room	0.85	9.1	6
Recovery room	0.89	9.6	6
<b>Library</b>			
Reading area	0.77	8.3	4
Stacks	1.08	11.6	4
<b>Manufacturing Facility</b>			
Detailed manufacturing area	0.86	9.3	4
Equipment room	0.61	6.6	6
Extra high bay area (> 50 ft floor-to-ceiling height)	0.73	7.9	4
High bay area (25 ft to 50 ft floor-to-ceiling height)	0.58	6.2	4
Low bay area (< 25 ft floor-to-ceiling height)	0.61	6.6	4
<b>Museum</b>			
General exhibition area	0.61	6.6	6
Restoration room	0.77	8.3	6
<b>Performing Arts Theater-Dressing Room</b>	0.35	3.8	6
<b>Post Office-Sorting Area</b>	0.66	7.1	4
<b>Religious Buildings</b>			
Fellowship hall	0.42	4.5	4
Worship/pulpit/choir area	0.98	10.5	4

- In cases where both a common *space* type and a building area specific *space* type are listed, the building area specific *space* type shall apply.
- In corridors, the extra LPD allowance is permitted when the width of the corridor is less than 8 ft (2.4 m) and is not based on the RCR, see Section 701.4.6.1.1(c).
- A "Facility for the visually impaired" is a facility that can be documented as being designed to comply with the light levels in ANSI/IES RP-28 and is licensed or will be licensed by local/state authorities for either senior long-term care, adult daycare, senior support, and/or people with special visual needs.
- For accent lighting, see Section 701.4.6.1.1(d).
- Sometimes referred to as a "picking area."
- Not used to keep footnote numbering consistent with ANSI/ASHRAE/IES Standard 90.1.
- Electrical/mechanical rooms. An additional 0.50 W/ft<sup>2</sup> shall be allowed, provided that the additional lighting is controlled separately from the base allowance of 0.39 W/ft<sup>2</sup>. The additional 0.50 W/ft<sup>2</sup> allowance shall not be used for any other purpose.
- Class of play as defined by IES RP-6.

(continued)

**TABLE 701.4.6.1B  
LIGHTING POWER DENSITY (LPD) ALLOWANCES AND ROOM CAVITY RATIO (RCR)  
THRESHOLDS USING THE SPACE-BY-SPACE METHOD (Continued)**

**Informative Note:** This table is divided into two sections. The first section covers *space* types that can be commonly found in multiple-building types. The second part covers *space* types that are typically found in a single-building type.

BUILDING TYPE SPECIFIC SPACE TYPES <sup>a</sup>	LPD, W/ft <sup>2</sup>	LPD, W/m <sup>2</sup>	RCR THRESHOLD
<b>Retail Facilities</b>			
Dressing/fitting room	0.49	5.3	8
Mall concourse	0.79	8.5	4
<b>Sports Arena-Playing Area<sup>b</sup></b>			
Class I facility	2.26	24.3	4
Class II facility	1.45	15.6	4
Class III facility	1.08	11.6	4
Class IV facility	0.72	7.8	4
<b>Transportation Facility</b>			
Baggage/carousel area	0.40	4.3	4
Airport concourse	0.22	2.4	4
Terminal ticket counter	0.48	5.2	4
<b>Warehouse-Storage Area</b>			
Medium-to-bulky, palletized items	0.27	2.9	4
Smaller, hand-carried items <sup>c</sup>	0.65	7.0	6

a. In cases where both a common *space* type and a building area specific *space* type are listed, the building area specific *space* type shall apply.

b. In corridors, the extra LPD allowance is permitted when the width of the corridor is less than 8 ft (2.4 m) and is not based on the RCR, see Section 701.4.6.1.1(c).

c. A "Facility for the visually impaired" is a facility that can be documented as being designed to comply with the light levels in ANSI/IES RP-28 and is licensed or will be licensed by local/state authorities for either senior long-term care, adult daycare, senior support, and/or people with special visual needs.

d. For accent lighting, see Section 701.4.6.1.1(d).

e. Sometimes referred to as a "picking area."

f. Not used to keep footnote numbering consistent with ANSI/ASHRAE/IES Standard 90.1.

g. Electrical/mechanical rooms. An additional 0.50 W/ft<sup>2</sup> (5.4 W/m<sup>2</sup>) shall be allowed, provided that the additional lighting is controlled separately from the base allowance of 0.39 W/ft<sup>2</sup>. The additional 0.50 W/ft<sup>2</sup> allowance shall not be used for any other purpose.

h. Class of play as defined by IES RP-6

**701.4.6.1.2 Exterior LPDs.** The exterior *lighting power allowance* shall be determined using ANSI/ASHRAE/IES Standard 90.1, Section 9.4.3, with the following modification. The LPDs from ANSI/ASHRAE/IES Standard 90.1, Table 9.4.2-2, shall be multiplied by the appropriate LPD factor from Table 701.4.6.1.2.

**701.4.6.2 Occupancy Sensor Controls with Multilevel Switching or Dimming.** The lighting in commercial and industrial storage stack areas shall be controlled by an occupant sensor with multilevel switching or dimming system that reduces lighting power a minimum of 50% within 20 minutes of all occupants leaving the stack area.

**Exception:** Storage stack areas illuminated by high-intensity discharge (HID) lighting with an LPD of 0.8 W/ft<sup>2</sup> (8.6 W/m<sup>2</sup>) or less.

**701.4.6.3 Automatic Controls for Egress and Security Lighting.** Lighting in any area within a

building that is required to be continuously illuminated for reasons of building security or emergency egress shall not exceed 0.1 W/ft<sup>2</sup> (1 W/m<sup>2</sup>). Additional egress and security lighting shall be allowed, provided it is controlled by an *automatic* control device that turns off the additional lighting.

**701.4.6.4 Controls for Exterior Sign Lighting.** This section supersedes ANSI/ASHRAE/IES Standard 90.1, Section 9.4.1.4, for all exterior sign lighting. All exterior sign lighting, including internally illuminated signs and lighting on externally illuminated signs, shall comply with the requirements of Sections 701.4.6.4.1 or 701.4.6.4.2.

**Exceptions:**

1. Sign lighting that is specifically required by a health or life safety statute, ordinance, or regulation.
2. Signs in tunnels.



**TABLE 701.4.6.1.2  
LIGHTING POWER ALLOWANCE FACTORS**

	LIGHTING ZONE				
	LZ0	LZ1	LZ2	LZ3	LZ4
For tradable areas, uncovered parking areas: parking areas and drives with measured <i>SRI</i> <29 or without <i>SRI</i> measurement	Not allowed	1	0.75	0.83	0.63
For tradable areas, uncovered parking areas: parking areas and drives with new concrete without added color pigment or with measured <i>SRI</i> ≥ 29	Not allowed	1	1	1	1
For tradable areas, other	1.00	0.90	0.90	0.95	0.95
For nontradable areas	1.00	0.95	0.95	0.95	0.95

**701.4.6.4.1** All sign lighting that operates more than one hour per day during *daylight hours* shall include controls to automatically reduce the input power to a maximum of 35% of full power for a period from one hour after sunset to one hour before sunrise.

**Exception:** Sign lighting using neon lamps with controls to automatically reduce the input power to a maximum of 70% of full power for a period from one hour after sunset to one hour before sunrise.

**701.4.6.4.2** All other sign lighting shall include the following:

- a. Controls to automatically reduce the input power to a maximum of 50% of full power for a period from midnight or within one hour of the end of business operations, whichever is later, until 6:00 am or business opening, whichever is earlier.
- b. Controls to automatically turn off during *daylight hours*.

**701.4.6.5 Parking and Outdoor Sales Lighting.** This section supersedes ANSI/ASHRAE/IES Standard 90.1, Section 9.4.1.4, for lighting serving uncovered parking areas and open areas in outdoor sales lots. Outdoor luminaires serving uncovered parking areas and open areas in outdoor sales lots shall be controlled by all of the following:

- a. Luminaires shall be controlled by a device that automatically turns off the luminaire during *daylight hours*.
- b. Luminaires shall be controlled by a timeclock or other control that automatically turns off the luminaire according to a timed schedule.
- c. For luminaires having a rated input wattage of more than 50 W and where the bottom of the luminaire is mounted 24 ft or less above the ground, the luminaires shall be controlled by one or more devices that automatically reduce lighting power of each luminaire by a minimum of 50% when there is no activity detected in the controlled zone for a period no longer than 15 minutes. No more than 1500 input watts of lighting power shall be controlled together.

**Exceptions:**

1. Lighting serving street frontage for vehicle sales lots.
2. Lighting for covered vehicle entrances or exits from buildings or parking structures where required for safety, security, or eye adaptation.

**701.4.7 Other Equipment.** The other equipment shall comply with ANSI/ASHRAE/IES Standard 90.1, Section 10, with the following modifications and additions.

**701.4.7.1 Equipment Efficiency for the Alternate Renewables Approach.** All *building projects* complying with the Alternate Renewables Approach in Section 701.4.1.1.2 shall comply with the applicable equipment efficiency requirements in Normative Appendix B and the applicable ENERGY STAR requirements in Section 701.4.7.3.2.

**701.4.7.2 Supermarket Heat Recovery.** Supermarkets with a floor area of 25,000 ft or greater shall recover waste heat from the condenser heat rejection on *permanently installed* refrigeration equipment meeting one of the following criteria:

- a. Twenty-five percent (25%) of the refrigeration system full-load total heat rejection.
- b. Eighty percent (80%) of the *space heat, service water heating, and dehumidification reheat*.

If a recovery system is used that is installed in the refrigeration system, the system shall not increase the saturated condensing temperature at design conditions by more than 5°F and shall not impair other head pressure control/energy reduction strategies.

**701.4.7.3 ENERGY STAR Equipment.** All *building projects* shall comply with the requirements in Section 701.4.7.3.1 and all *building projects* complying with the Alternate Renewables Approach in Section 701.4.1.1.2 shall also comply with Section 701.4.7.3.2.

**701.4.7.3.1 ENERGY STAR Requirements for Equipment not Covered by Federal Appliance Efficiency Regulations (All Building Projects).** The following equipment within the scope of the applicable ENERGY STAR program shall comply with the equivalent criteria required to achieve the ENERGY STAR label if installed prior to the issuance of the certificate of occupancy:

a. Appliances:

1. Room air cleaners: ENERGY STAR Program Requirements for Room Air Cleaners.
2. Water coolers: ENERGY STAR Program Requirements for Water Coolers.

b. Heating and Cooling:

1. Programmable thermostats: ENERGY STAR Program Requirements for Programmable Thermostats.
2. Ventilating fans: ENERGY STAR Program Requirements for *Residential* Ventilating Fans.

c. Electronics:

1. Cordless phones: ENERGY STAR Program Requirements for Telephony.
2. Audio and video: ENERGY STAR Program Requirements for Audio and Video.
3. Televisions: ENERGY STAR Program Requirements for Televisions.
4. Set-top boxes: ENERGY STAR Program Requirements for Set-Top Boxes.

d. Office Equipment:

1. Computers: ENERGY STAR Program Requirements for Computers.
2. Copiers: ENERGY STAR Program Requirements for Imaging Equipment.
3. Fax machines: ENERGY STAR Program Requirements for Imaging Equipment.
4. Laptops: ENERGY STAR Program Requirements for Computers.
5. Mailing machines: ENERGY STAR Program Requirements for Imaging Equipment.
6. Monitors: ENERGY STAR Program Requirements for Displays.
7. Multifunction devices (printer/fax/ scanner): Program Requirements for Imaging Equipment.
8. Printers: ENERGY STAR Program Requirements for Imaging Equipment.
9. Scanners: ENERGY STAR Program Requirements for Imaging Equipment.
10. Computer servers: ENERGY Star Program Requirements for Computer Servers.

e. Lighting:

1. Integral LED lamps: ENERGY STAR Program Requirements for Integral LED Lamps.

f. Commercial Food Service:

1. Commercial fryers: ENERGY STAR Program Requirements for Commercial Fryers.
2. Commercial hot food holding cabinets: ENERGY STAR Program Requirements for Hot Food Holding Cabinets.
3. Commercial steam cookers: ENERGY STAR Program Requirements for Commercial Steam Cookers [see also water efficiency requirements in Section 601.3.2.5].
4. Commercial dishwashers: ENERGY STAR Program Requirements for Commercial Dishwashers.
5. Commercial griddles: ENERGY STAR Program Requirements for Commercial Griddles.
6. Commercial ovens: ENERGY STAR Program Requirements for Commercial Ovens [see also water efficiency requirements in Section 601.3.2.5].

**Exception:** Products with minimum efficiencies addressed in the Energy Policy Act (EPA) and the Energy Independence and Security Act (EISA) when complying with Section 701.4.1.1.2.

**701.4.7.3.2 ENERGY STAR Requirements for Equipment Covered by Federal Appliance Efficiency Regulations (Alternate Renewables Approach).** For all *building projects* complying with the Alternate Renewables Approach in Section 701.4.1.1.2, the following equipment within the scope of the applicable ENERGY STAR program shall comply with the equivalent criteria required to achieve the ENERGY STAR label if installed prior to the issuance of the certificate of occupancy. For those products listed below that are also contained in Normative Appendix B, the installed equipment shall comply by meeting or exceeding both the requirements in this section and in Normative Appendix B.

a. Appliances:

1. Clothes washers: ENERGY STAR Program Requirements for Clothes Washers [see also the water efficiency requirements in Section 601.3.2.2].
2. Dehumidifiers: ENERGY STAR Program Requirements for Dehumidifiers.
3. Dishwashers: ENERGY STAR Program Requirements Product Specifications for *Residential Dishwashers* [see also the water efficiency requirements in Section 601.3.2.2].
4. Refrigerators and freezers: ENERGY STAR Program Requirements for Refrigerators and Freezers.
5. Room air conditioners: ENERGY STAR Program Requirements and Criteria for Room Air Conditioners.

b. Heating and Cooling:

1. *Residential* air-source heat pumps: ENERGY STAR Program Requirements for ASHPs and Central Air Conditioners [see also the energy efficiency requirements in Section 701.4.1].
2. *Residential* boilers: ENERGY STAR Program Requirements for Boilers [see also the energy efficiency requirements in Section 701.4.1].
3. *Residential* central air conditioners: ENERGY STAR Program Requirements for ASHPs and Central Air Conditioners [see also the energy efficiency requirements in Section 701.4.1].
4. *Residential* ceiling fans: ENERGY STAR Program Requirements for *Residential* Ceiling Fans.
5. Dehumidifiers: ENERGY STAR Program Requirements for Dehumidifiers.
6. *Residential* warm air furnaces: ENERGY STAR Program Requirements for Furnaces.
7. *Residential* geothermal heat pumps: ENERGY STAR Program Requirements for Geothermal Heat Pumps.

c. Water Heaters: ENERGY STAR Program Requirements for *Residential* Water Heaters.

d. Lighting:

1. Lamps: ENERGY STAR Program Requirements for Lamps (Light Bulbs).
2. Luminaires: ENERGY STAR Program Requirements for Luminaires.
3. *Residential* light fixtures: ENERGY STAR Program Requirements for *Residential* Light Fixtures.

e. Commercial Food Service:

1. Commercial refrigerators and freezers: ENERGY STAR Program Requirements for Commercial Refrigerators and Freezers.
2. Commercial ice machines: ENERGY STAR Program Requirements for Commercial Ice Machines.

f. Other Products:

1. Battery charging systems: ENERGY STAR Program Requirements for Products with Battery Charger Systems (BCSs).
2. External power adapters: ENERGY STAR Program Requirements for Single-Voltage AC-DC and AC-AC Power Supplies.
3. Vending machines: ENERGY STAR Program Requirements for Refrigerated Beverage Vending Machines.

**701.4.7.4 Programmable Thermostats.** *Residential* programmable thermostats shall meet the requirements of NEMA Standards Publication DC 3, Annex A, "Energy-Efficiency Requirements for Programmable Thermostats."

**701.4.7.5 Refrigerated Display Cases.** All open refrigerated display cases shall be covered by using field-installed strips, curtains, or doors.

**701.4.8 Energy Cost Budget.** The Energy Cost Budget option in ANSI/ASHRAE/IES Standard 90.1, Section 11, shall not be used.

Performance-based compliance. Compliance for buildings and their sites to be designed on a performance basis must be determined by predictive modeling of both energy performance and CO<sub>2</sub>e emissions. Predictive energy modeling must use source energy kBtu unit measure based on compliance with Section 701.5.1.1. Predictive CO<sub>2</sub>e emissions modeling must comply with Section 701.5.2.

**701.5 Performance-based compliance.** Compliance for buildings and their sites to be designed on a performance basis must be determined by predictive modeling of both energy performance and CO<sub>2</sub>e emissions. Predictive energy modeling must use source energy kBtu unit measure based on compliance with Section 701.5.1.1. Predictive CO<sub>2</sub>e emissions modeling must comply with Section 701.5.2.

**701.5.1 zEPI.** Demonstrate zEPI target using the methodology in 701.5.1.1 through 701.5.1.2.

**701.5.1.1 Energy performance modeling.** Performance-based designs must demonstrate a zEPI of not more than the zEPI target for the building type as shown in Table 701.5.1. zEPI must be determined under the following: Equation: (Equation)  $zEPI = M \times (\text{Proposed building performance} / \text{Baseline building performance})$  Where: zEPI = zero energy performance index of the proposed building zEPI Target = zero energy performance index target for compliance with this section Proposed Building Performance (PBF) = The proposed building performance in source kBtu for the proposed design of the building and its site calculated under Section 701.5.1.2 Baseline Building Performance (BBF) = The baseline building performance in source kBtu for a baseline building and its site calculated under Section 701.5.1.2  $M = zEPI$  conversion factors from a 90.1 Appendix G baseline to a CBECS 2003 baseline for the building type as shown in Table 701.5.1.

**Table 701.5.1 Building Type zEPI score calculation inputs**

BUILDING TYPE	M	zEPI <sub>target</sub>
Multifamily	78	42
Health	83	45
Hotel/motel	92	50
Office	71	39
Restaurant	92	50
School	81	44
Semi-heated storage	61	37
Other	78	42

**701.5.1.2 Modeling methodology.** The proposed building performance and the baseline building performance of the building and building site must be calculated under Appendix G to ASHRAE 90.1, as modified by Sections 701.5.1.3 and 701.5.1.4. The energy use modeling must include all energy used for building and site functions and anticipated occupancy.

**701.5.1.3 Energy units.** The building performance calculations in Section G3 of ASHRAE 90.1 must be based on energy use instead of energy cost. Energy use must be converted to consistent units by multiplying the nonrenewable energy fossil fuel use at the utility meter or measured point of delivery to Btus and multiplying by the conversion factor in Table 701.5.1.3.

**701.5.1.4 Site to source electric power conversion.** In calculating the proposed building performance and the baseline building performance, electric energy used must be calculated in source energy by multiplying the electric power use at the utility meter or measured point of delivery in Btus by the conversion factor in Tables 701.5.1.3 and 701.5.1.4.

**TABLE 701.5.1.3 ELECTRICITY GENERATION ENERGY CONVERSION FACTORS BY EPA eGRID SUB-REGION**

eGRID 2018 SUB-REGION ACRONYM	eGRID 2018 SUB-REGION NAME	ENERGY CONVERSION FACTOR
RFCE	RFC East	2.86

**TABLE 701.5.1.4 U.S. AVERAGE BUILDING FUELS ENERGY CONVERSION FACTORS BY FUEL TYPE**

FUEL TYPE	ENERGY CONVERSION FACTOR
Natural Gas	1.09
Fuel Oil	1.19
LPG	1.15
Purchased District Heating-Hot Water	1.73

**701.5.2 Annual Carbon Dioxide Equivalent (CO<sub>2</sub>e).** The *proposed design* shall have an annual CO<sub>2</sub>e equal to or less than the annual CO<sub>2</sub>e of the *baseline building design* multiplied by the building performance factor (BPF) target determined from Table 701.5.2A using the

Performance Rating Method in ANSFASHRAE/IES Standard 90.1, Normative Appendix G. To determine the annual CO<sub>2</sub>e for each energy source in the *baseline building design* and *proposed design*, the energy consumption shall be multiplied by the CO<sub>2</sub>e emission factors from Table 701.5.2B.

**TABLE 701.5.2A ENERGY COST AND CO<sub>2</sub>e BUILDING PERFORMANCE FACTORS (BPF)**

BUILDING TYPE	BUILDING PERFORMANCE FACTOR (BPF)
Multifamily	0.66
Healthcare/hospital	0.51
Hotel/motel	0.48
Office	0.47
Restaurant	0.61
Retail	0.48
School	0.36
Semiheated warehouse	0.42
all others	0.5

**TABLE 701.5.2B CO<sub>2</sub>e EMISSION FACTORS**

Energy Form	CO <sub>2</sub> e, lb/kBtu	CO <sub>2</sub> e, kg/MWh
Grid-delivered electricity and other fuels not specified in this table	1156	524
LP or propane	651	295
Fuel oil (residual)	738	335
Fuel oil (distillate)	715	324
Coal	892	405
Gasoline	744	337
Natural gas	681	309
District chilled water	339	154
District steam	1145	519
District hot water	1081	491

## CHAPTER 8

# INDOOR ENVIRONMENTAL QUALITY (IEQ)

**801.1 Scope.** This section specifies requirements for indoor environmental quality, including indoor air quality, environmental tobacco smoke control, *outdoor air* delivery monitoring, thermal comfort, *building entrances*, acoustic control, *lighting quality*, daylighting, and low-emitting materials.

**801.2 Compliance.** The indoor environmental quality shall comply with Section 801.3, "Mandatory Provisions," and either

- a. Section 801.4, "Prescriptive Option," or
- b. Section 801.5, "Performance Option."

Daylighting and low-emitting materials are not required to use the same option, i.e., prescriptive or performance, for demonstrating compliance.

### 801.3 Mandatory Provisions

**801.3.1 Indoor Air Quality.** Buildings shall comply with the design requirements of ANSI/ASHRAE Standard 62.1, Sections 4 through 6, including applicable normative appendices, with the modifications and additions indicated herein. Health care facilities shall comply with the design requirements of ANSI/ASHRAE/ASHE Standard 170, including applicable normative appendices, with the modifications and additions indicated herein. *Residential dwelling units* shall comply with the design requirements of ANSI/ASHRAE Standard 62.2, Sections 4 through 8, with the modifications and additions indicated herein.

Requirements provided in Sections 801.3.1.1 through 801.3.1.7 supersede such requirements in ASHRAE Standard 62.1, ASHRAE Standard 62.2, and ASHRAE/ASHE Standard 170.

**801.3.1.1 Minimum Ventilation Rates.** In health care facilities, the ventilation requirements of ASHRAE/ASHE Standard 170 shall apply. In *residential dwelling units*, the *dwelling unit* ventilation rates and local exhaust airflow rates as required by ASHRAE Standard 62.2 shall apply. ASHRAE Standard 62.2, Section 4.1.2, shall not apply. In all other cases, ASHRAE Standard 62.1, Sections 6.1.1 and 6.2, shall be used to determine minimum zone and intake outdoor airflow rates. ASHRAE Standard 62.1, Sections 6.1.2 and 6.1.3, shall not apply.

**Informative Note:** ASHRAE Standard 62.1, Sections 6.1.1 and 6.2, define the Ventilation Rate Procedure for determining ventilation rates.

#### 801.3.1.2 Outdoor Air Delivery Monitoring.

**801.3.1.2.1 System Design for Outdoor Air Intake Measurement.** Each mechanical ventilation system shall be configured to allow for the

measurement of the *outdoor air* intake for use in testing and balancing, recommissioning, and *outdoor air* monitoring as required in Section 801.3.1.2.2.

**801.3.1.2.2 Monitoring Requirements.** Each mechanical ventilation system shall have a *permanently installed* device to measure the *minimum outdoor airflow* that meets the following requirements:

- a. The device shall employ methods described in ANSI/ASHRAE Standard 111.
- b. The device shall have an accuracy of  $\pm 10\%$  of the *minimum outdoor airflow*. Where the *minimum outdoor airflow* varies, as in *demand control ventilation (DCV)* systems, the device shall maintain this accuracy over the entire range of occupancy and system operation.
- c. The device shall be capable of notifying the building operator, either by activating a local indicator or sending a signal to a building monitoring system, whenever an *outdoor air fault condition* exists. This notification shall require manual reset.

**Exception:** Constant-volume air supply systems that do not employ *DCV* and that use an indicator to confirm that the intake damper is open to the position needed to maintain the design *minimum outdoor airflow* as determined during system startup and balancing.

#### 801.3.1.3 Filtration and Air Cleaner Requirements.

**a. Particulate Matter.** The following requirements shall apply in all buildings.

**Exceptions:** In health care facilities, the particulate filter requirements of ASHRAE/ ASHE Standard 170 shall apply.

1. **Wetted Surfaces.** Particulate matter filters or air cleaners having a minimum efficiency reporting value (MERV) of not less than 8 when rated in accordance with ANSI/ASHRAE Standard 52.2 shall be provided upstream of all cooling coils or other devices with wetted surfaces through which air is supplied to an *occupiable space*. These requirements supersede the requirements in ASHRAE Standard 62.1, Section 5.8.
2. **Particulate Matter Smaller than 10 Micrometers (PM<sub>10</sub>).** Particulate matter filters or air cleaners shall be provided in accordance with Standard 62.1, Section 6.2.1.1, with the following modification. Such filters or air cleaners shall have a MERV of not less than 8 when rated in accordance with ASHRAE Standard 52.2.

3. **Particulate Matter Smaller than 2.5 Micrometers (PM<sub>2.5</sub>).** Particulate matter filters or air cleaners shall be provided in accordance with Standard 62.1, Section 6.2.1.2, with the following modification. Such filters or air cleaners shall have a MERV of not less than 13 when rated in accordance with ASHRAE Standard 52.2.

- b. Ozone.** Air cleaning devices for ozone shall be provided for buildings located in an area that is designated "non-attainment" in an area that exceeds the National Ambient Air Quality Standards (NAAQS) for ozone, as determined by the *authority having jurisdiction (AHJ)*. Such air cleaning devices shall have an ozone removal efficiency of no less than 40% where installed, operated, and maintained in accordance with the manufacturer's recommendations. Such air cleaning devices shall be operated whenever the outdoor ozone level is expected to exceed the NAAQS. This requirement supersedes the requirements of ASHRAE Standard 62.1, Section 6.2.1.3. This requirement applies to all buildings, including health care facilities covered by ASHRAE/ASHE Standard 170.
- c. Sealing.** Where particulate matter filters or air cleaners are required by Section 801.3.1.3, filter tracks, filter supports, filters, and access doors shall be sealed in accordance with the following:
1. Where filter track and filter support systems incorporate multiple filters, the gap between each filter shall be sealed with a gasket, and the gap between the filter and its track or support shall be sealed using gaskets that expand when the filter is removed. Filter support systems shall include a filter-to-support gasket *permanently installed* on the filter support, except for filter track and filter support systems that seal around the filter by means of a friction fit.
  2. Filter tracks and filter supports shall be sealed to the HVAC equipment housing and ducts by a sealant or other sealing method.
  3. Filter access doors shall be sealed to minimize filter bypass and air leakage into or out of the system.
  4. Gaskets and seals used to comply with the requirements of this section shall be capable of effecting a seal for the anticipated life of the equipment, and the system shall be designed such that the seals are readily accessible.
  5. Field- or shop-fabricated *spacers* shall not be installed for the purpose of replacing the intended-size filter with a smaller-size filter.

**801.3.1.4 Building Pressure.** The requirements in Section 801.3.1.4 supersede the requirements in ASHRAE Standard 62.1, Section 5.9.2. *Building projects* shall be designed in accordance with the following subsections.

**801.3.1.4.1 Mechanical Exhaust.** Mechanical systems shall include controls capable of disabling exhaust fans and closing exhaust dampers whenever mechanical intake airflow is discontinued.

**801.3.1.4.2 Exfiltration.** Mechanical air-conditioning systems with dehumidification capability shall include system controls capable of maintaining static pressure inside the building, at the top floor, equal to or greater than the static pressure outside of the building during *mechanical cooling* operation.

**Exceptions:**

1. Where excess exhaust is required by process considerations, such as certain industrial or healthcare facilities.
2. Warehouse facilities.
3. Buildings in *Climate Zones* OB, 1B, 2B, 3B, 3C, 4B, 4C, 5, 6, 7 and 8.

**801.3.1.5 Venting of Combustion Products.**

**801.3.1.5.1 Vented Combustion.** *Permanently installed* appliances shall have products of combustion vented to the outdoors.

**Exceptions:**

1. Ovens and ranges in *residential spaces*.
2. Heaters certified to ANSI Z83.19/CSA 2,35, mounted greater than or equal to 10 ft above the occupied floor.
3. Heaters certified to ANSI Z83.4/CAN 3.7.
4. Heaters certified to ANSI Z21.11.2, provided that the aggregate input rating of all such appliances does not exceed 1000 Btu/ h per 1500 ft<sup>3</sup> of *space* volume.

**801.3.1.5.2 Ranges in Residential Spaces.** Gas and electric ranges in *residential spaces* shall comply with ASHRAE Standard 62.2, Section 5.1, using a range hood.

**801.3.1.6 Humidity Control.** The requirements in this section supersede the requirements in ASHRAE Standard 62.1, Section 5.9.1. Mechanical air-conditioning and evaporative cooling systems shall be designed in accordance with Sections 801.3.1.4.1 and 801.3.1.4.2, as applicable.

**Exceptions:**

1. Systems serving *HVAC zones* with construction, furnishings, and fixtures that manage liquid water and high humidity using impervious or moisture-retardant surfaces and other means.
2. Systems where performance simulation demonstrates that *HVAC zone* relative humidity levels during cooling do not exceed 65% rh for more than 48 consecutive hours.

**801.3.1.6.1 Cooling Coils.** *HVAC systems* with dehumidification capability in *Climate Zones* OA, 1A, 2A, 3A, 4A, and 4C shall be designed in accordance with one of the following:

- a. Where recirculating systems do not include means for *HVAC zone* humidity sensing, such systems shall include controls capable of maintaining the average cooling-coil leaving air temperature at 53°F (12°C) or lower and shall include devices and controls capable of maintaining each *HVAC zone* sensible temperature set point using one of the following approaches:

1. Variable *HVAC zone* supply airflow rate.
2. Variable return-air bypass flow around each cooling coil serving one or more *HVAC zones*.
3. Variable *HVAC zone* supply air reheat using site-recovered energy or *site* solar energy.

- b. Where a 100% *outdoor air* system provides preconditioned *outdoor air* for ventilation, and where such systems do not include means for *HVAC zone* humidity sensing, the 100% *outdoor air* system shall include devices and controls capable of maintaining the average cooling-coil leaving air temperature at 53°F (12°C) or lower.

- c. Where systems include means for *HVAC zone* relative humidity sensing, such systems shall include devices and controls capable of limiting *HVAC zone* relative humidity to not exceed 65% rh for more than 48 consecutive hours.

**801.3.1.6.2 Direct Evaporative Cooling.** Direct evaporative cooling systems shall include devices and controls capable of limiting *HVAC zone* relative humidity to not exceed 65% rh for more than 48 consecutive hours.

**801.3.1.8 Building Entrances.** All *building entrances* shall employ an entryway floor system comprising a scraper surface, an absorption surface, and a finishing surface, in that order, in the direction of travel entering the building and in accordance with Sections 801.3.1.8.1, 801.3.1.8.2, and 801.3.1.8.3. Each surface shall be at least as wide as the entrance. The length shall be measured in the primary direction of travel.

**Exceptions:**

1. Entrances to individual *dwelling units*.
2. Entrances that employ an entryway floor system that is not less than 4 ft in length to provide access to *spaces* that are less than 3000 ft<sup>2</sup> in area and that are not used as a pass-through to other parts of the building.

3. Doors the purpose of which is to meet code requirements (**Informative Note:** e.g., *International Building Code*) for means of egress and not entry into the building.

4. Entrances that are locked for use by limited authorized personnel.

**801.3.1.8.1 Scraper Surface.** The scraper surface shall be:

- a. immediately outside, inside, or spanning the entry;
- b. a minimum of 3 ft long; and
- c. constructed using materials that scrape away snow, dirt, and debris.

**801.3.1.8.2 Absorption Surface.** The absorption surface shall be:

- a. inside,
- b. a minimum of 3 ft long, and
- c. constructed using materials that perform both a scraping action and a moisture wicking action.

**801.3.1.8.3 Finishing Surface.** The finishing surface shall be:

- a. a minimum of 4 ft long and
- b. constructed using materials that capture particles and moisture.

**801.3.1.9 Guest Room Preoccupancy Outdoor Air Purge Cycle.** Guest room ventilation systems controlled according to Section 701.4.3.9.4 shall have an *automatic* preoccupancy purge cycle that shall provide *outdoor air* ventilation at the design ventilation rate for 60 minutes, or at a rate and duration equivalent to one air change. In guest rooms with a *networked guest room control system*, the purge cycle shall be completed within 60 minutes prior to the time the room is scheduled to be occupied. Where guest rooms are not connected to a *networked guest room control system*, the preoccupancy purge cycle shall occur daily.

**801.3.1.10 Preoccupancy Ventilation Control.** Ventilation systems serving zones that are not continuously occupied shall have controls designed to automatically provide *outdoor air* to the zones, prior to their scheduled occupancy, where the zones served by the ventilation system have been unoccupied for 24 hours or longer. This preoccupancy ventilation shall be provided continuously at the system design *minimum outdoor airflow* for a period of one hour prior to the expected occupancy, or at an *outdoor air* rate and for a time period that provides the same number of air changes as the design *minimum outdoor airflow* for one hour.

If the preoccupancy ventilation period requires ventilation earlier than as required by ANSI/ASHRAE/IES Standard 90.1, Section 6.4.3, the preoccupancy ventilation start time of Section 801.3.1.7 shall take precedence.

**Exception:** Hotel and motel guest rooms subject to *automatic* control of HVAC and lighting as required in Chapters 7 and 8 (Sections 7 and 8).

**801.3.2 Thermal Environmental Conditions for Human Occupancy.** The building shall be designed in compliance with ANSI/ASHRAE Standard 55, Sections 6.1, "Design," and 6.2, "Documentation."

**Exception:** *Spaces* with special requirements for processes, activities, or contents that require a thermal environment outside that which humans find thermally acceptable, such as food storage, natatoriums, shower rooms, saunas, and drying rooms.

**801.3.3 Acoustical Control.** The provisions of this section shall govern acoustical control for the *building envelope*, the interior *spaces* within the building or structure, and the design of the related mechanical equipment and systems. School *spaces* identified in ANSI/ASA S12.60 shall comply with ANSI/ASA S12.60. Healthcare *spaces*, as defined in the FGI Guidelines, shall comply with the FGI Guidelines. All other *spaces* shall be designed in accordance with Sections 801.3.3.1 through 801.3.3.5.

**801.3.3.1 Documentation.** *Construction documents* and supplemental information necessary to verify compliance with this code, such as calculations, worksheets, laboratory test reports, field test reports, compliance forms, *vendor* literature, or other data, shall be reviewed by a person experienced in the field of acoustics and who shall report compliance or noncompliance with the required acoustical performance. The *construction documents* and any reports shall show all the pertinent data and features of the building, equipment, and systems in sufficient detail to permit a determination of compliance by the *authority having jurisdiction (AHJ)* and to indicate compliance with the requirements of this code.

**801.3.3.1.1 Test Methods.** The laboratory tested performance for sound transmission class (STC) for *wall*, partition, window, and ceiling/floor assemblies shall be tested in accordance with ASTM E90, and the laboratory tested performance for impact insulation class (HC) for floor/ceiling assemblies shall be tested in accordance with ASTM E492. All assemblies shall be sealed according to ASTM C919 and in accordance with the laboratory tested

assembly details and materials. Field tested assemblies used in the analysis shall be tested in accordance with ASTM E336 and ASTM E1007.

**801.3.3.2 Interior Background Noise Requirements.** The *building envelope*; interior *spaces* within the building; and building systems, including mechanical, electrical, and plumbing systems, shall be designed and constructed such that the interior sound pressure levels created by the combination of building systems noise and exterior sound sources, under normal operation with windows closed and no active sound masking systems, do not exceed the values specified in Table 801.3.3.2. The *hourly average sound pressure level  $L_{\text{eq}}$*  and *maximum sound pressure level  $L$*  shall not exceed the values listed in Table 801.3.3.2. Outdoor noise levels used in the design shall be provided in the *construction documents*.

**801.3.3.2.1 High-Noise Exterior Events.** *Hourly average sound pressure levels  $L_{\text{eq}}$*  shall be permitted to exceed the values specified in Table 801.3.3.2 by not more than 5 dB where the excess sound pressure is attributed to high-noise exterior events that occur more than ten times per day, and by not more than 10 dB where the excess sound pressure is attributed to high-noise exterior events that occur ten times or fewer per day. *Maximum sound pressure levels  $L$*  shall be permitted to exceed the values specified in Table 801.3.3.2 by not more than 10 dB where the excess sound pressure is attributed to high-noise exterior events that occur more than ten times per day. *Maximum sound pressure levels  $L$*  shall be permitted to exceed the values specified in Table 801.3.3.2, without limitation, where the excess sound pressure is attributed to high-noise exterior events that occur ten times or fewer per day.

**801.3.3.2.2 Conformance.** Conformance to the requirements in Section 801.3.3.2 shall be demonstrated either through the design requirements of Section 801.3.3.2.3 or the testing requirements of Section 801.3.3.2.4.

**801.3.3.2.3 Interior Background Noise—Design.** Conformance with the provisions of this section shall be demonstrated.



**TABLE 801.3.3.2**  
**MAXIMUM INTERIOR BACKGROUND SOUND PRESSURE LEVELS FROM BUILDING SYSTEMS AND EXTERIOR SOUND SOURCES<sup>a</sup>**

ROOM TYPE	HOURLY AVERAGE SOUND PRESSURE LEVEL (L <sub>eq</sub> )		MAXIMUM SOUND PRESSURE LEVEL (L <sub>max</sub> (slow time weighting))	
	dBA	dB C	dBA	dB C
Residential sleeping areas (night-time <sup>b</sup> )	35	60	45	70
Residential living and sleeping areas (daytime)	40	60	50	70
Hotel and motel guest rooms or suites and dormitories	40	60	50	70
Meeting and banquet rooms	35	60	45	70
Corridors and lobbies	45	65	60	75
Service and support areas	45	65	60	75
Enclosed offices	35	60	45	70
Conference rooms	35	60	45	70
Teleconference rooms	30	55	40	65
Open-plan offices	45	65	55	75
Courtrooms—unamplified speech	35	60	45	70
Courtrooms—amplified speech	40	60	50	70
Laboratories—minimal speech communication	55	75	65	85
Laboratories—extensive phone use and speech communication	50	70	60	80
Laboratories—group teaching	40	60	50	70
Religious—general assembly with music program	30	55	40	65
Library study and reading areas	35	60	45	70
Gymnasiums and natatoriums without speech amplification	50	70	60	80
Gymnasiums and natatoriums with speech amplification	55	75	65	85

a. For high-noise exterior events, refer to Section 801.3.3.2.1.

b. "Night-time" is defined as the time between 10 p.m. and 7 a.m.

**801.3.3.2.3.1 Building Envelope.** The composite sound transmission class (cSTC) for the *building envelope* shall be calculated and used in determining the maximum interior background sound pressure levels for room types listed in Table 801.3.3.2.

**801.3.3.2.3.2 Interior Systems.** Interior noise from HVAC systems shall be calculated for room types listed in Table 801.3.3.2 and used in determining the maximum interior background sound pressure levels for the room types listed in Table 801.3.3.2.

**801.3.3.2.3.3 Penetrations and Fenestrations.** All penetrations through, and fenestrations within, sound rated assemblies shall be sealed in accordance with ASTM C919 and installed per the manufacturer's recommendations.

**801.3.3.2.3.4 Inspection.** Construction of acoustical items required in Sections 801.3.3.2.3 through 801.3.3.2.3.3 shall be visually inspected by an approved agency.

**801.3.3.2.4 Interior Background Noise—Testing.** Acceptance testing shall be performed in accordance with Section 1001.3.1.1.5. Noise from construction activities, emergency vehicles, and sirens need not be considered.

**801.3.3.3 Interior Sound Transmission.** Interior *wall* and floor-ceiling assemblies separating adjacent interior *spaces* shall be designed and constructed to provide airborne sound isolation that complies with the minimum cSTC values specified in Table 801.3.3.3. For *wall* and floor-ceiling assemblies separating different room types, the greater of the two cSTC values shall apply. Floor-ceiling assemblies separating adjacent interior *spaces* shall be designed and constructed to provide impact sound isolation that complies

with the minimum IIC values specified in Table 801.3.3.3. For floor-ceiling assemblies separating different room types, the IIC value associated with the room on the story below shall apply.

**801.3.3.3.1 Conformance.** Conformance to the requirements in Section 801.3.3.3 shall be demonstrated either through the design requirements of Section 801.3.3.3.2 or testing requirements of Section 801.3.3.3.3.

**801.3.3.3.2 Interior Sound Transmission—Design.** *Wall* and floor-ceiling assemblies shall comply with the following:

- Assemblies shall be required to provide sound isolation in accordance with this section and shall adjoin other intersecting sound isolating assemblies along all perimeter edges so as to provide continuity of sound isolation.
- All partitions between *spaces* with different uses shall be full-height partitions or shall extend to a ceiling system with a ceiling attenuation class (CAC) rating equal to or greater than the *wall* cSTC rating, and all floor-ceiling assemblies shall be full-span assemblies connected to the walls/partitions.
- Assemblies shall be sealed at all potential flanking paths and around all penetrations according to ASTM C919 and installed in accordance with the sealant manufacturer's recommendations to achieve the assembly's required performance rating.

**801.3.3.3.2.1 Inspection.** Construction of acoustical items required in Section 801.3.3.3.2 shall be visually inspected by an approved agency.

**801.3.3.3.3 Interior Sound Transmission—Testing.** Acceptance testing shall be performed in accordance with Section 1001.3.1.1.5.

**801.3.3.4 Interior Sound Reverberation.** The reverberation time  $T_{60}$  for designated *spaces* shall be calculated in accordance with ANSI/ASA S12.60-2010, Part 1, Annex A, for the octave bands 500, 1000, and 2000 Hz and shall not exceed the values specified in Table 801.3.3.4 for fully furnished rooms.

**TABLE 801.3.3.3  
MINIMUM SOUND AND IMPACT SOUND RATINGS**

ROOM TYPE	cSTC <sup>c,d</sup>	IIC
Dwelling unit (apartment, condominium, duplex, hotel guest room, etc.)	55	55
Retail or restaurant	50	45
Exercise, gym or pool <sup>b</sup>	55	50 <sup>a</sup>
Mechanical, electrical, and elevator machinery	60	N/A <sup>e</sup>
Conference and teleconference rooms	50	50
Enclosed offices	45	45
Open offices	N/A <sup>e</sup>	45

- The IIC value listed addresses footfall noise but not exercise-related vibration-borne sound. Exercise-related vibration-borne sound shall comply with the requirements of Section 801.3.3.2.
- Minimum cSTC and IIC values are not required between adjacent rooms of the same room type.
- For operable partitions and *walls* containing doors, windows, or both, the minimum cSTC ratings shall be 5 less than the values listed in Table 801.3.3.3.
- The minimum cSTC values shall be 5 less than the cSTC values in Table 801.3.3.3 for *walls* between *spaces* and corridors and between *spaces* and open offices. The minimum cSTC values shall be 15 less than the cSTC values specified in Table 801.3.3.3 for *walls* having doors that open to corridors or open offices.
- Not applicable.

**801.3.4 Soil-Gas Control.** Soil-gas entry into *enclosed spaces* that are immediately above crawlspaces, slabs-on-grade, and basement slabs shall be controlled in accordance with Sections 801.3.4.1 or 801.3.4.2.

**Exceptions:**

- Buildings or portions thereof that are not routinely occupied, such as warehouses and parking structures.
- Ventilated garages that comply with ANSI/ASHRAE Standard 62.1, Sections 5.15 and 6.5.

**801.3.4.1 Soil-Gas Control Systems.**

**801.3.4.1.1 Soil-Gas Barriers.** Soil-gas retarder systems shall be provided and shall comply with all of the following:

- Earthen floors in basements and enclosed crawlspaces shall be covered with a soil-gas

retarder membrane. Such membrane shall be sealed to the foundation at the edges. Soil-gas retarder membranes or systems shall be placed between slab floors and the base course gas-permeable layer required by Section 801.3.4.1.2. Soil-gas retarder materials shall meet or exceed the durability requirements of ASTM E1745, and the installation shall comply with ASTM E1643. Damp-proofing or waterproofing materials shall be installed on the exterior surface of foundation *walls* and shall extend from the top of the footing to above grade.

- Joints in concrete around the perimeter of each poured slab section shall be permanently sealed with closed-cell gasket materials or equivalent methods that retain closure after the slab has cured.
- Openings in slab floors; below-grade masonry *walls*; and membranes, such as those for plumbing, ground water control systems, soil vent pipes, electrical, mechanical piping, and structural supports, shall be sealed at the penetration with caulk that complies with ASTM C920 class 25 or higher equivalent closed-cell gasket materials or other equivalent method.
- Sumps shall be covered with a rigid lid that is mechanically fastened and sealed with a gasket or caulk that will allow removal of the lid for maintenance.
- Hollow masonry unit *walls* shall be designed and constructed as follows:
  - The first course of masonry units bearing on a footing shall be laid with a mortar bedding and shall be solid units or fully grouted masonry units.
  - Where portions of masonry units are below grade and in contact with earth, the course of masonry units that is at or partially below grade shall be made of solid masonry units or fully grouted masonry units. Such course of masonry units need not change elevation to compensate for lower-grade elevations along the building perimeter. Openings in *walls* that are below such course of solid or fully grouted masonry units, such as window and door openings, shall be surrounded by solid or fully grouted masonry units.

**TABLE 801.3.3.4  
MAXIMUM REVERBERATION TIME**

ROOM TYPES	T <sub>60</sub> , sec
Meeting and banquet rooms < 3000 ft <sup>3</sup>	0.8
Meeting and banquet rooms 3000 ft <sup>3</sup> up to 8000 ft <sup>3</sup>	1.0
Meeting and banquet rooms > 8000 ft <sup>3</sup> up to 30,000 ft <sup>3</sup>	1.2
Meeting and banquet rooms > 30,000 ft <sup>3</sup>	1.5
Enclosed offices	0.6
Conference/teleconference rooms	0.6
Open-plan offices	0.6
Courtrooms—unamplified speech	0.7
Courtrooms—amplified speech	1.0
Testing/research labs (little speech communication)	1.0
Labs (extensive phone use and speech communication)	0.6
Library study and reading areas	1.0
Gymnasiums and natatoriums	2.0

**TABLE 801.3.3.5.1  
PROPERTY LINE MAXIMUM SOUND LEVELS—PRESCRIPTIVE OPTION**

INITIATING PROPERTY	RECEIVING PROPERTY	HOURLY AVERAGE SOUND PRESSURE LEVEL L <sub>eq</sub>
All, except factory or industrial	All, except factory or industrial	50
Factory or industrial	All, except factory or industrial	55
Factory or industrial	Factory or industrial	75

**TABLE 801.3.3.5.2  
PROPERTY LINE MAXIMUM SOUND LEVELS—TESTED PERFORMANCE OPTION**

INITIATING PROPERTY	RECEIVING PROPERTY	HOURLY AVERAGE SOUND PRESSURE LEVEL L <sub>eq</sub>	
		DAYTIME	NIGHTTIME
		7:00 A.M. TO 10:00 P.M.	10:00 P.M. TO 7:00 A.M.
All, except factory or industrial	All, except factory or industrial	60	50
Factory or industrial	All, except factory or industrial	65	55
Factory or industrial	Factory or industrial	75	75

**801.3.4.1.2 Gas-Permeable Layer and Soil-Gas Conveyance.** There shall be a continuous gas-permeable layer under each slab-on-grade and basement slab for the entire area of the slab and under each membrane installed over earth for the entire area of the membrane. Perforated pipe, geo-textile matting, or soil-gas collection pits shall be installed below the slab or membrane and shall be connected to exhaust vent pipe as specified in Section 801.3.4.1.3. The gas-permeable layer and soil-gas conveyance pipe shall comply with Table 801.3.4.1.2 and (a), (b), or (c) as applicable.

- a. **Stone Aggregate Layer.** The gas-permeable layer shall be a uniform layer not less than 4 in. in depth and shall consist of gravel or crushed stone that meets ASTM C33 requirements for size numbers 5, 56, 57, or 6. Vent pipe openings to unobstructed interstices between stones within the gas-permeable layer shall not be less than the equivalent values indicated in Table 801.3.4.1.2.

- b. **Small Stone, Sand, and Soil.** The gas-permeable layer shall be a uniform layer not less than 4 in. in depth that consists of any of the following:

1. Small stone aggregates classified in ASTM C33 as size numbers 46, 67, 7, or 8.
2. Sand classified in ASTM C33 as size number 9.
3. Soil that contains less than 35% sand, rock fragment fines, clay, and silt. Such clay and silt shall consist of not more than 10% high-plasticity clay or silt.

Perforated pipe or geotextile drainage matting shall be placed at distances not farther than 20 ft apart and not farther than 10 ft away from foundation *walls* or other surfaces that surround the gas-permeable layer. Perforated pipe shall be surrounded by not less than 4 in. of gas-permeable aggregates that meet ASTM C33 requirements for size numbers 5, 56, 57,

or 6. The minimum length and soil-gas inlet openings in the perforated pipe and geotextile matting shall not be less than equivalent values indicated in Table 801.3.4.1.2.

- c. **Crawlspace Membranes.** Perforated pipe or equivalent material not less than 10 ft in length and 3 in. in nominal diameter shall be provided under the membrane. The configuration shall allow air movement under the entire area of the membrane.

**801.3.4.1.2.1 Soil-Gas Conveyance Clearance and Dimension.** Geotextile mats and perforated pipe shall not be less than 12 in. and not farther than 10 ft from foundation *walls* or other surfaces that surround the gas-permeable layer. Soil-gas inlet openings into the geotextile mats and perforated pipe shall have an area of not less than 1.0 in.<sup>2</sup>/ft of length. The airway path within geotextile mats and perforated pipe shall not be less than the nominal equivalent area of 3 in. pipe inner diameter. Pipe materials below slabs and membranes shall be configured to drain collected water within piping.

**801.3.4.1.2.2 Connections to Exhaust Vent Pipes.** Exhaust vent piping, as specified in Section 801.3.4.1.3, shall connect to soil-gas inlet configurations within the gas-permeable layer and extend not less than 2 ft (0.6 m) above the top of the slab or membrane. Such pipes shall be temporarily capped or otherwise closed during construction to prevent debris from entering the pipes. The pipe that extends above the slab or membrane shall be labeled with the words "radon vent" or "soil-gas vent" in the prevailing language at the location.

**TABLE 801.3.4.1.2  
SOIL-GAS CONVEYANCE COMPONENTS**

SYSTEM VENT PIPE NOMINAL DIAMETER	MINIMUM DIAMETER OF PITS <sup>a</sup>	MINIMUM LENGTH OF PERFORATED PIPE OR GEOTEXTILE MATTING <sup>b</sup>
3 in.	12 in diameter pit	18 ft
4 in.	16 in. diameter pit	32 ft
6 in.	24 in. diameter pit	71 ft

- a. Pits shall not be less than 4 in. in depth.
- b. Openings in perforated pipe and geotextile matting shall not be less than 1.0 in<sup>2</sup>/ft of pipe or matting length.

**801.3.4.1.3 Soil-Gas Exhaust Vent Pipe.** Soil-gas exhaust vent piping shall be provided as follows:

- a. **Pipe Placement.** Nonperforated Schedule 40 pipe, as defined by ASTM D1785, shall extend from within the gas-permeable layers to the point of exhaust above the *roof*. The vent pipe size shall not be reduced at any point between its connection to the gas permeable layers and the exhaust terminal above the *roof*. Such piping shall be labeled on each floor level of the building with the words "radon vent" or "soil-gas vent" in the prevailing language at the location.

- b. **Multiple Vented Areas.** Where interior footings divide a gas-permeable layer into two or more unconnected areas, such areas shall be interconnected by piping below the slab or membrane or above the slab or membrane. Such piping shall be nonperforated and of a size indicated in Table 801.3.4.1.3.
- c. **Provision for Fan.** Soil-gas venting systems shall include a fan or a dedicated *space* for the future installation of a fan. The fan and soil-gas vent piping on the discharge side of the fan shall not be installed within or under occupied *spaces*. A dedicated *space* having a vertical height of not less than 48 in. and a diameter of not less than 21 in. shall be provided in the *attic* or other interior area to accommodate the installation of a fan. The fan inlet and outlet vent pipes shall be centered in such dedicated *space*. An electrical supply for the fan shall be provided within 6 ft of the fan location.
- d. **Vented Area.** The maximum foundation area served by a soil-gas exhaust vent pipe shall be determined in accordance with Table 801.3.4.1.3.

**Exception:** Where inspections verify compliance with Sections 801.3.4.1.1 through 801.3.4.1.3, the maximum vented area per vent pipe indicated in Table 801.3.4.1 shall be increased by 40%. Where the soil-gas barrier consists of a spray-applied vapor barrier or a geomembrane that provides a homogeneous closure, the maximum vented area per vent pipe shall be increased by an additional 20%.

**TABLE 801.3.4.1.3  
VENT PIPE DIAMETER PER VENTED AREA**

VENT PIPE DIAMETER	MAXIMUM VENTED AREA PER VENT PIPE
3 in.	2500 ft <sup>2</sup>
4 in.	4500 ft <sup>2</sup>
6 in.	10,000 ft <sup>2</sup>

**801.3.4.2 Alternative Methods of Soil-Gas Control.** A soil-gas control system shall be provided, and such system shall be clearly identified or otherwise noted on *construction documents* and shall be approved by a qualified soil-gas professional and the *building project FPT provider*.

**801.3.5 Lighting Quality.** The interior lighting and lighting controls shall be installed to meet the requirements of Sections 801.3.5.1 and 801.3.5.2.

**801.3.5.1 Enclosed Office Spaces.** Lighting for at least 90% of enclosed office *spaces* with less than 250 ft<sup>2</sup> of floor area shall comply with at least one of the following:

- a. Provide *multilevel lighting control*.
- b. Provide *bilevel lighting control* and separate *task lighting*.

**801.3.5.2 Multioccupant Spaces.** Lighting for conference rooms, meeting rooms, multipurpose rooms, gymnasiums, auditoriums, ballrooms, cafeterias, *classrooms*, and other training or lecture rooms shall be provided with *multilevel lighting control*. Lighting settings or the lighting controlled by each manual control shall be labeled at the control devices. The lighting in gymnasiums, auditoriums, ballrooms, and cafeterias shall also consist of at least two separately controlled groups of luminaires.

**801.3.6 Moisture Control** Either a dynamic heat and moisture analysis, in accordance with ANSI/ ASHRAE Standard 160, or steady-state water vapor transmission analysis, in accordance with Sections 801.3.6.1 and 801.3.6.2, shall be performed on above-grade portions of the *building envelope* and on interior partitions as described in Section 801.3.6.2. Conditions conducive to condensate formation, as demonstrated by analysis, shall not occur at any location within the *building envelope* or partition components or on the interior side of surfaces not specifically designed and constructed to manage moisture.

**Exception:** Where analysis indicates that incidental condensate occurs in components engineered to allow or manage such condensate without damage to the *building envelope* components.

**801.3.6.1 Exterior Building Envelope.** The analysis shall be conducted using the average of at least ten consecutive years of weather data for the *outdoor air* temperature for the warmest three months of the year (summer condition) and the *outdoor air* temperature for the coldest three months of the year (winter condition). The analysis shall include all *building envelope* components, including interior wall finishes of the exterior walls.

**801.3.6.2 Humid Spaces.** A separate analysis shall be performed in *spaces* where process or occupancy requirements dictate dew-point conditions that are unique with respect to other *spaces* in the building, such as kitchens, water therapy rooms, swimming-pool enclosures, ice rink enclosures, shower rooms, locker rooms, operating rooms in health care facilities, and exhibit areas in museums.

**801.3.6.2.1** For exterior *building envelope* components of humid *spaces*, the analysis shall use the *outdoor air* temperature conditions described in Section 801.3.6.1.

**801.3.6.2.2** For walls, floors, and ceilings between occupied *spaces* and adjacent *spaces*, the analysis shall be performed using design summer (cooling) conditions and design winter (heating) conditions of both types of *conditioned space*.

**Exception:** *Spaces* and their individual mechanical systems that are designed to control condensation and moisture accumulation in the *adjacent building envelope*, walls, or ceilings.

**801.3.6.3 Flashing of Fenestration, Door Assemblies, Mechanical Equipment, and Other Penetrations of Building Envelope.** Flashing or sealants shall be installed around *fenestration*, door assemblies, and penetrations associated with mechanical equipment and utility services, except where there is a mechanism for drainage to the outdoors or where the materials are designed for long-term contact with water.

**801.3.7 Glare Control.** *View fenestration* for the *spaces* listed in Table 801.4.1.2A shall comply with this section.

*View fenestration* shall have one or more operable glare control devices capable of reducing the *specular visible transmittance* of the *fenestration* assembly to 3% or less. Such glare control devices shall allow an occupant or control system to change the device's position or light transmission level in order to address glare in the *space*. Operable glare control devices include movable interior window blinds, curtains, and shades; movable exterior louvers, screens, awnings, shades, and blinds; and *dynamic glazing*. Where fabric shades are used, the openness factor, also known as "direct-direct transmittance," shall be tested according to Standard EN14500.

**Exceptions:**

1. For buildings located greater than 20 degrees latitude north or south of the equator, *view fenestration* oriented within 10 degrees of true north in northern hemisphere locations or within 10 degrees of true south in southern hemisphere location.
2. Where permanent interior or exterior obstructions, such as buildings, structures, overhangs, and fins, have a *specular visible transmittance* of not greater than 3% and block a direct beam of sunlight from passing through the *view fenestration* at a point in the middle of the *view fenestration* both horizontally and vertically, at the peak solar altitude and four hours before and after the peak solar altitude on the summer solstice and the spring equinox as determined by sun-angle studies.
3. *Spaces* that have an *annual sunlight exposure* of not more than 93 fc of direct sunlight illumination for more than 250 hours per year for less than 3% of the floor area.

**801.3.8 Occupant Override.** Occupants shall have the capability to temporarily override *automatic* methods of glare control for periods not exceeding two hours.

## **801.4 Prescriptive Option.**

### **801.4.1 Daylighting.**

**801.4.1.1 Daylighting in Large Spaces Directly under a Roof and Having High Ceilings.** *Enclosed spaces*, including conditioned and unconditioned *spaces*, meeting all of the following criteria, shall comply with Sections 801.4.1.1.1, 801.4.1.1.2 and 801.4.1.1.3:

- a. The *space* is in a building with three stories or fewer above grade.
- b. The *space area* is greater than 2500 ft<sup>2</sup>.
- c. The *space* is located directly under a *roof* and average ceiling heights are greater than 15 ft.

#### **Exceptions:**

1. *Spaces* in buildings located in *Climate Zones* 7 or 8.
2. Auditoria, motion picture theaters, performing arts theaters, museums, places of worship, and refrigerated warehouses.
3. *Enclosed spaces* where documentation shows that existing structures or natural objects block direct sunlight on at least 50% of the *roof* over the *enclosed space* at all three of the following times on the date of the spring equinox: three hours before solar noon (peak solar altitude), at solar noon, and three hours after solar noon.

**801.4.1.1.1 Minimum Daylight Area.** Not less than 50% of the floor area shall be in the *daylight area* as defined in Chapter 3. For the purposes of Section 801.4.1.1.1, the definition of *daylight area* shall be modified such that partitions and other obstructions that are less than the ceiling height are disregarded. *Daylight areas* shall be under *skylights*, under *roof monitors*, or in the primary or secondary *sidelighted areas* and shall meet not less than one of the following requirements:

- a. The combined area of the *skylights* within the *space* shall not be less than 3% of the calculated *daylight area under skylights*.
- b. The *space* shall have a *skylight effective aperture* of not less than 1%.
- c. The combined area within the *space* of any *vertical fenestration in roof monitors* shall not be less than 20% of the calculated *daylight area under roof monitors*.
- d. *Primary sidelighted areas* shall have a *side-lighting effective aperture* of not less than 0.15.
- e. *Secondary sidelighted areas* shall have a *side-lighting effective aperture* of not less than 0.30.

**801.4.1.1.2 Visible Transmittance (VT) of Skylights and Roof Monitors.** The visible transmittance of *skylights* and *roof monitors* for *daylight areas* used to

comply with Section 801.4.1.1.1 shall not be less than 0.40. For *dynamic glazing*, the highest-labeled VT shall be used for compliance with this section.

**Exception:** *Enclosed spaces* that have a *skylight effective aperture* of not less than 1%.

### **801.4.1.1.3 Skylight Optical Diffusion**

**Characteristics.** *Skylights* used to comply with Section 801.4.1.1.1 shall have a glazing material or diffuser that has a measured haze value greater than 90% when tested according to ASTM D1003 or other test method approved by the *AHJ*.

#### **Exceptions:**

1. *Skylights* with a measured haze value less than or equal to 90% and having a combined area not in excess of 5% of the total *skylight area*.
2. *Tubular daylighting devices* having a diffuser.
3. *Skylights* designed to prevent direct sunlight from entering the occupied *space* below during occupied hours.
4. *Skylights* in transportation terminals and concourses, sports arenas, convention centers, atria, and shopping malls.

**801.4.1.2 Minimum Sidelighting Effective Aperture for Office Spaces and Classrooms.** The *spaces* listed in Table 801.4.1.2A shall comply with items (a), (b) and (c).

- a. The north-, south-, and east-facing *façades* shall have a minimum *sidelighting effective aperture* as prescribed in Table 801.4.1.2B.
- b. For all *façades*, the combined width of the *primary sidelighted areas* shall not be less than 75% of the length of the *façade wall*.
- c. Opaque interior surfaces in *daylight areas* shall have average visible light reflectances greater than or equal to 80% for ceilings, 40% for partitions higher than 60 in., and 60% for *walls*.

#### **Exceptions:**

1. *Spaces* not adjacent to an exterior *wall*.
2. A *space* that would have tasks or activities requiring routine dark conditions for more than four daytime hours per day.
3. *Spaces* covered by and in compliance with Section 801.4.1.1 (8.4.1.1) without the use of any exception.
4. *Daylight areas* where the height of existing adjacent structures above the window is not less than twice the distance between the window and the adjacent structures, measured from the top of the glazing.
5. Existing buildings undergoing alteration, repair, relocation, or a change in occupancy.

**801.4.1.3 Shading for Offices.** For office *spaces* 250 ft<sup>2</sup> and larger, each façade shall be designed with a shading *projection factor* (*PO*). The *PF* shall not be less than 0.5 for the first story above grade and 0.25 for other above-grade stories. Shading is allowed to be external or internal using the *interior PF*. Shading devices shall be limited to the following:

- a. Louvers, sun shades, light shelves, and any other permanent device. Any *vertical fenestration* that employs a combination of interior and external shading is allowed to be separated into multiple segments for compliance purposes. Each segment shall comply with the requirements for either external or *interior PF*.
- b. Building self-shading through *roof* overhangs or recessed windows.

**Exceptions:**

1. Facades facing within 45 degrees of true north in the northern hemisphere or facades facing 45 degrees from true south in the southern hemisphere.
2. Translucent panels and glazing systems with a measured haze value greater than 90% when tested according to ASTM D1003 or other test method approved by the AHJ, and that are entirely 8 ft above the floor do not require external shading devices.
3. Where equivalent shading of the *vertical fenestration* is provided by buildings, structures, geological formations, or permanent exterior projections that are not horizontal, as determined by sun-angle studies at the peak solar altitude on the summer solstice and three hours before and after the peak solar altitude on the summer solstice.
4. *Vertical fenestration* with automatically controlled shading devices in compliance with Exception (2) of Section 701.4.2.5.
5. *Vertical fenestration* with automatically controlled *dynamic glazing* in compliance with Exception (3) of Section 701.4.2.5.
6. Existing buildings undergoing alteration, repair, relocation, or a change in occupancy.

**TABLE 801.4.1.2A  
DAYLIT SPACES**

Classroom/training room
Conference/meeting/multipurpose room except in convention centers
Lounge/breakroom
Enclosed office and open plan office
Library reading area
Patient rooms and physical therapy rooms within a healthcare facility

**TABLE 801.4.1.2B  
MINIMUM SIDELIGHTING EFFECTIVE APERTURE**

CLIMATE ZONE	MINIMUM SIDELIGHTING EFFECTIVE APERTURE
0, 1, 2, 3A, 3B	0.10
3C, 4, 5, 6, 7, 8	0.15

**801.4.2 Materials.** Reported emissions or volatile organic compound (VOC) contents specified in the following subsections shall be from a representative product sample and determined with each product reformulation or at a minimum of every three years. Products certified under third-party certification programs as meeting the specific emission or VOC content requirements listed in the following subsections are exempted from this three-year testing requirement but shall meet all the other requirements as listed.

**801.4.2.1 Adhesives and Sealants.** Products in this category include carpet, resilient, and wood flooring adhesives; base cove adhesives; ceramic tile adhesives; drywall and panel adhesives; aerosol adhesives; adhesive primers; acoustical sealants; firestop sealants; HVAC air duct sealants; sealant primers; and caulks. All adhesives and sealants used on the interior of the building (defined as inside of the *weatherproofing system* and applied on-site) shall comply with the requirements of either Section 801.4.2.1.1 or 801.4.2.1.2.

**801.4.2.1.1 Emissions Requirements.** Emissions shall be determined according to CDPH/EHLB/Standard Method V1.1 (commonly known as California Section 01350) and shall comply with the limit requirements for either office or *classroom spaces*, regardless of the *space* type. The emissions testing shall be performed by an ISO/IEC 17025 accredited laboratory that has CDPH/EHLB/Standard Method V.1.1, USEPA Method TO-17, and ASTM Standard Method D5197 within the scope of its accreditation. Third-party certifiers shall be accredited to ISO/IEC 17065 and have the relevant certification program in the scope of accreditation.

**801.4.2.1.2 VOC Content Requirements.** The VOC content of adhesives, sealants, and sealant primers shall be determined and limited in accordance with SCAQMD Rule 1168. HVAC duct sealants shall be classified as "Other" category within the SCAQMD Rule 1168 sealants table.

The VOC content of aerosol adhesives shall be determined and limited in accordance with Green Seal Standard GS-36, Section 3.

**Exceptions:** The following solvent welding and sealant products are not required to meet the emissions or VOC content requirements.

1. Cleaners, solvent cements, and primers used with plastic piping and conduit in plumbing, fire suppression, and electrical systems.
2. HVAC air-duct sealants when the air temperature of the *space* in which they are applied is less than 40°F.

**801.4.2.2 Paints and Coatings.** Products in this category include anticorrosive coatings, basement specialty coatings, concrete/masonry sealers, concrete curing compounds, dry fog coatings, faux-finishing coatings, fire-resistive coatings, flat and nonflat topcoats, floor coatings, graphic arts (sign) coatings, high-temperature coatings, industrial maintenance coatings, low-solids coatings, mastic texture coatings, metallic pigmented coatings, multicolor coatings, pretreatment wash primers, primers, reactive penetrating sealers, recycled coatings, shellacs (clear and opaque), specialty primers, stains, stone consolidants, swimming-pool coatings, tub- and tile-refining coatings, under-coaters, waterproofing membranes, wood coatings (clear wood finishes), wood preservatives, and zinc primers. Paints and coatings used on the interior of the building (defined as inside of the *weatherproofing system* and applied on-site) shall comply with either Section 801.4.2.2.1 or 801.4.2.2.2.

**801.4.2.2.1 Emissions Requirements.** Emissions shall be determined according to CDPH/EHLB/Standard Method V1.1 (commonly known as California Section 01350) and shall comply with the limit requirements for either office or *classroom spaces*, regardless of the *space* type. The emissions testing shall be performed by an ISO/IEC 17025 accredited laboratory that has CDPH/EHLB/Standard Method V.1.1, USEPA Method TO-17, and ASTM Standard Method D5197 within the scope of its accreditation. Third-party certifiers shall be accredited to ISO/MC 17065 and have the relevant certification program in the scope of accreditation.

**801.4.2.2.2 VOC Content Requirements.**

- a. The VOC content for flat and nonflat coatings, nonflat high-gloss coatings, specialty coatings, basement specialty coatings, concrete/ masonry sealers, fire-resistive coatings, floor coatings, low-solids coatings, primers, sealers and undercoaters, rust preventative coatings, shellacs (clear and opaque), stains, wood coatings, reflective *wall* coatings, varnishes, conjugated oil varnish, lacquer, and clear brushing lacquer shall be determined and limited in accordance with Green Seal Standard GS-11.
- b. The VOC content for concrete curing compounds, dry fog coatings, faux finishing coatings, graphic arts coatings (sign paints), industrial maintenance coatings, mastic texture coatings, metallic pigmented coatings, multicolor coatings, pretreatment wash primers, reactive penetrating sealers, recycled coat-

ings, specialty primers, wood preservatives, and zinc primers shall be determined and limited in accordance with the California Air Resources Board Suggested Control Measure for Architectural Coatings or SCAQMD Rule 1113r.

- c. The VOC content for high-temperature coatings, stone consolidants, swimming-pool coatings, tub- and tile-refinishing coatings, and waterproofing membranes shall be determined and limited in accordance with the California Air Resources Board Suggested Control Measure for Architectural Coatings.

**801.4.2.3 Floor Covering Materials.** Emissions of floor covering materials installed in the building interior, and each product layer within a flooring system containing more than one distinct product layer, shall be individually determined according to CDPH/EHLB/Standard Method V1.1 (commonly known as California Section 01350) and shall comply with the limit requirements for either office or *classroom spaces*, regardless of the *space* type. The emissions testing shall be performed by an ISO/IEC 17025 accredited laboratory that has CDPH/EHLB/Standard Method V.1.1, USEPA TO-17, and ASTM Standard Method D5197 within the scope of its accreditation. Third-party certifiers shall be accredited to ISO/TEC 17065 and have the relevant certification program in the scope of accreditation.

**801.4.2.3.1 Deemed to Comply.** Floor covering materials that are composed of materials listed in Table 801.4.2.3.1 shall be deemed to comply with the requirements of Section 801.4.2.3. Where these products include integral organic-based surface coatings, binders, or sealants, or are installed using adhesives, sealants, paints, or coatings, those products shall be subject to other requirements of Section 801.4.2.

**TABLE 801.4.2.3.1  
FLOOR COVERING DEEMED TO COMPLY  
WITH VOC EMISSION LIMITS**

Ceramic and concrete tile
Natural stone
Gypsum plaster
Clay masonry
Concrete masonry
Concrete
Metal

**801.4.2.4 Composite Wood, Wood Structural Panel, and Agrifiber Products.** Composite wood, wood structural panel, and agrifiber



products used on the interior of the building (defined as inside of the *weatherproofing system*) shall contain no added urea-formaldehyde resins. Laminating adhesives used to fabricate on-site and shop-applied composite wood and agrifiber assemblies shall contain no added urea-formaldehyde resins. Composite wood and agrifiber products are defined as follows: particleboard, medium density fiberboard (MDF), wheatboard, strawboard, panel substrates, and door cores. Materials considered furniture, fixtures, and equipment (FF&E) are not considered base building elements and are not included in this requirement.

Emissions for products covered by this section shall be determined according to, and shall comply with, one of the following:

- a. Third-party certification shall be submitted indicating compliance with the California Air Resource Board's (CARB) regulation, *Airborne Toxic Control Measure to Reduce Formaldehyde Emissions from Composite Wood Products*. Third-party certifier shall be approved by CARB.
- b. CDPH/EHLB/Standard Method V1.1 (commonly referred to as California Section 01350) and shall comply with the limit requirements for either office or *classroom spaces*, regardless of the *space* type.

**Exceptions:** Structural panel components such as plywood, particle board, wafer board, and oriented strand board identified as "EXPOSURE 1," "EXTERIOR," or "HUD-APPROVED" are considered acceptable for interior use.

**801.4.2.5 Office Furniture Systems and Seating.** *Office furniture systems* and *seating* installed prior to occupancy shall comply with the requirements of both Sections 801.4.2.5.1 and 801.4.2.5.2, based on testing according to ANSI/BIFMA M7.1.

**801.4.2.5.1** At least 95% of the total number of installed *office furniture system* workstations, and at least 95% of the total number of *seating* units installed, shall comply with ANSI/ BIFMA X7.1.

**801.4.2.5.2** At least 50% of the total number of installed *office furniture system* workstations, and at least 50% of the total number of *seating* units installed, shall comply with Section 7.6.2 of ANSUBIFMA e3.

**801.4.2.6 Ceiling and Wall Assemblies and Systems.** Ceiling and wall assemblies and systems include acoustical treatments, ceiling panels and tiles, gypsum panel products, tackable *wall* panels and coverings, *wall* coverings, and *wall* and ceiling paneling and planking. Emissions from these assemblies and systems shall be determined according to CDPH/EHLB/Standard Method V1.1 (commonly known as California Section 01350) and shall comply with the limit

requirements for either office or *classroom spaces*, regardless of the *space* type. The emissions testing shall be performed by an ISO/ IEC 17025 accredited laboratory that has CDPH/ EHLB/Standard Method V.1.1, USEPA TO-17, and ASTM Standard Method D5197 within the scope of its accreditation. Third-party certifiers shall be accredited to ISO/IEC 17065 and have the relevant certification program in the scope of accreditation.

**801.4.2.6.1 Deemed to Comply.** Ceiling and *wall* assemblies and systems that are composed of materials listed in Table 801.4.2.6.1 shall be deemed to comply with the requirements of Section 801.4.2.6. Where these products include integral organic-based surface coatings, binders, or sealants, or are installed using adhesives, sealants, paints, or coatings, those products shall be subject to other requirements of Section 801.4.2.

**TABLE 801.4.2.6.1  
CEILING AND WALL PRODUCTS DEEMED TO  
COMPLY WITH VOC EMISSION LIMITS**

Ceramic and concrete
Natural stone
Gypsum plaster
Clay masonry
Concrete masonry
Concrete
Metal

**801.4.2.7 Insulation.** Emissions shall be determined according - to CDPH/EHLB/Standard Method V1.1 (commonly known as California Section 01350) and shall comply with the limit requirements for either office or *classroom spaces*, regardless of the *space* type. The emissions testing shall be performed by an ISO/IEC 17025 accredited laboratory that has CDPH/EHLB/Standard Method V.1.1, USEPA TO-17, and ASTM Standard Method D5197 within the scope of its accreditation. Third-party certifiers shall be accredited to ISO/IEC 17065 and have the relevant certification program in the scope of accreditation.

**801.4.3 Lighting for Presentations.** Luminaires that are located entirely or partially within 3 ft horizontally of any *permanently installed* presentation surfaces, including whiteboards, blackboards, chalkboards, and screens for projection units, shall be controlled separately from all other luminaires in the *space* and be capable of being turned off. Control settings for these luminaires shall be labeled at the control device. At least one luminaire shall be located entirely or partially within 3 ft horizontally of *each permanently installed* whiteboard, blackboard, or chalkboard that is not self-illuminated.

## 801.5 Performance Option.

**801.5.1 Daylight Simulation.** For the *spaces* listed in Table 801.4.1.2A, and any *spaces* required to have daylighting in accordance with Section 801.4.1.1, the total floor area shall be calculated, and computer modeling shall be used to determine that the requirements specified in Sections 801.5.1.1 and 801.5.1.2 are met. Computer models shall use an hourly simulation and shall adhere to the modeling protocols described in IES LM 83 for *spatial daylight autonomy (sDA)* calculations in Section 801.5.1.1 and *annual sunlight exposure (ASE)* calculations in Section 801.5.1.2.

**801.5.1.1 Minimum Daylight.** The computed area-weighted *sDA* shall not be less than 40%.

The *sDA* within each *space* shall be calculated in accordance with the methodology of IES LM 83. Calculations shall be made on the basis of 28 fc (300 lux) for all *spaces*, with the exception of the following *space* types, which shall be calculated on the basis of 14 fc: health-care patient rooms, post-office sorting areas, gymnasias, big box retail, transportation facility terminal ticket counters, airport concourses, and nonrefrigerated warehouses.

### Exceptions:

1. A *space* used for tasks or activities requiring routine dark conditions for more than 4 daytime hours per day.
2. A *space* where the height of existing facing structures above the *vertical fenestration* is not less than twice the distance between the *vertical fenestration* and facing structures, measured from the top of the glazing.

**801.5.1.2 Excessive Sunlight.** The *ASE*, calculated with a threshold of 93 fc and 250 hours, shall not exceed 20% of the floor area.

### Exceptions:

1. Spaces less than 250 ft<sup>2</sup>.
2. *Vertical fenestration* with automatically controlled shading devices in compliance with Section 701.4.2.5, Exception (2).
3. *Vertical fenestration* with automatically controlled *dynamic glazing* in compliance with Section 701.4.2.5, Exception (3).

**801.5.2 Materials.** The emissions of all the materials listed below and used within the building (defined as inside of the *weatherproofing system* and applied on-site) shall be modeled for individual VOC concentrations. The sum of each individual VOC concentration from the materials listed below shall be shown to be in compliance with the limits as listed in CDPH/EHLB/Standard Method V1.1 (commonly referred to as California Section 01350), Section 4.3, and shall be compared to 100% of its corresponding listed limit. In addition, the modeling for the building shall include, at a minimum, the criteria listed in Normative Appendix D of this code. Emissions of materials used for modeling VOC concentrations shall be obtained in accordance with the testing procedures of

CDPH/EHLB/Standard Method V1.1 unless otherwise noted below.

- a. Tile, strip, panel, and plank products, including vinyl composition tile, resilient floor tile, linoleum tile, wood floor strips, parquet flooring, laminated flooring, and modular carpet tile.
- b. Sheet and roll goods, including broadloom carpet, sheet vinyl, sheet linoleum, carpet cushion, wallcovering, and other fabric
- c. Rigid panel products, including gypsum board, other *wall* paneling, insulation board, oriented strand board, medium density fiber board, wood structural panel, acoustical ceiling tiles, and particleboard.
- d. Insulation products.
- e. Containerized products, including adhesives, sealants, paints, other coatings, primers, and other "wet" products.
- f. Cabinets, shelves, and worksurfaces that are permanently attached to the building before occupancy. Emissions of these items shall be obtained in accordance with the ANSI/BIFMA M7.1.
- g. *Office furniture systems* and *seating* installed prior to initial occupancy. Emissions of these items shall be obtained in accordance with the BIFMA M7.1.

**Exception:** *Salvaged materials* that have not been refurbished or refinished within one year prior to installation.

**801.5.3 Lighting for Presentations.** Lighting systems shall be provided and shall be controllable by the occupants so as to meet the illuminance and uniformity requirements specified in items (a) through (c) for each *permanently installed* presentation system. Lighting control settings required to meet each of the specified levels shall be labeled at the control device.

- a. Lighting system and controls shall be capable of illuminating *permanently installed* white boards to at least an average of 28 fc vertical illuminance, and the ratio of average-to-minimum illuminance over the full area of the whiteboard shall be equal to or less than 3:1.
- b. Lighting system and controls shall be capable of illuminating *permanently installed* screens for front-screen projection units to no greater than 5 fc vertical illuminance, and the ratio of maximum-to-average illuminance over the full area of the projection screen shall be equal to or less than 2:1. Compliance with this provision shall not be met by turning off all the luminaires in the *space*.
- c. Lighting system and controls shall be capable of illuminating *permanently installed* screens for rear-screen projection units at a level no greater than 14 fc vertical illuminance, and the ratio of maximum-to-average illuminance over the full area of the projection screen shall be equal to or less than 2:1. Compliance with this provision shall not be met by turning off all the luminaires in the *space*.

## CHAPTER 9

# MATERIALS AND RESOURCES

**901.1 Scope.** This section specifies requirements related to the environmental and human health impacts of materials, including resource conservation, reduced life-cycle impacts of building materials, impacts on the atmosphere, product transparency, and waste management.

**901.2 Compliance.** The building materials shall comply with Section 901.3, "Mandatory Provisions," and either

- a. Section 901.4, "Prescriptive Option," or
- b. Section 901.5, "Performance Option."

### 901.3 Mandatory Provisions.

**901.3.2 Extracting, Harvesting, and/or Manufacturing.** This section applies to all materials, products, and/or assemblies installed prior to the issuance of the final certificate of occupancy.

Materials shall be harvested and/or extracted, and products and/or assemblies shall be manufactured, according to the laws and regulations of the country of origin.

Wood products in the project, other than recovered or reused wood, shall not contain wood from endangered wood species unless the trade of such wood conforms with the requirements of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).

**901.3.3 Refrigerants.** Chlorofluorocarbon (CFC) based refrigerants in HVAC&R systems shall not be used. Fire suppression systems shall not contain ozone-depleting substances (CFCs, hydrochlorofluorocarbons [HCFCs], or halons).

**901.3.4 Areas for Storage and Collection of Recyclables and Discarded Goods.** Areas for recyclables and discarded goods shall be provided as described in this section. These areas shall be coordinated with the anticipated collection services to maximize the effectiveness of the dedicated areas. Instructions regarding the identification and handling of recyclables and discarded goods in these areas shall be posted in or adjacent to each dedicated area.

**901.3.4.1 Recyclables.** There shall be areas that serve the entire building and are dedicated to the collection and storage of nonhazardous materials for recycling, including paper, corrugated cardboard, glass, plastics, and metals.

**901.3.4.2 Reusable Goods.** For *building projects* with *residential spaces*, there shall be an area that serves the entire building and is designed for the collection and storage of discarded but clean items in good condition. Charitable organizations or others to

arrange for periodic pickups shall be identified and posted.

**901.3.4.3 Fluorescent and High-Intensity Discharge (HID) Lamps and Ballasts.** An area shall be provided that serves the entire building, is designed for the collection and storage of fluorescent and HID lamps and ballasts, and facilitates proper disposal and/or recycling according to jurisdictional hazardous waste requirements.

**901.3.4.4 Electronics and Batteries.** Separate containers or areas shall be provided that serve the entire building; are designed for the collection and storage of *electronics*, alkaline batteries, and rechargeable batteries; and facilitate disposal and/or recycling according to jurisdictional requirements.

**901.3.5 Mercury Content Levels of Lamps.** Electric lamps used in the *building project* shall not contain mercury in an amount exceeding, per lamp, the maximum mercury content levels of Table 901.3.5.

#### Exceptions:

1. Eight-foot models of straight fluorescent T8 lamps.
2. High-output and very-high-output, straight fluorescent lamps greater than 1.25 in. in diameter.
3. Mogul bi-pin-based lamps.
4. Preheat straight fluorescent lamps of any size.
5. U-bend and circline fluorescent lamps.
6. HID lamps.
7. Induction lamps.
8. Special-purpose lamps: appliance, black light, germicidal, bug, colored, grow, straight fluorescent reflector, reprographic, shatter resistant, cold temperature, and three-way lamps.

### 901.4 Prescriptive Option.

**901.4.1 Reduced Impact Materials.** The *building project* shall comply with any two of the following: Sections 901.4.1.1, 901.4.1.2, 901.4.1.3, or 901.4.1.4. Calculations shall only include materials *permanently installed* in the project. A value of 45% of the total construction cost shall be permitted to be used in lieu of the actual total cost of materials.

**901.4.1.1 Recycled Content and Salvaged Material Content.** The sum of the *recycled content* and the *salvaged material* content shall constitute a minimum of 10%, based on cost, of the total materials in the *building project*.

**901.4.1.1.1 Recycled Content.** The *recycled content* of a material shall be the *postconsumer recycled content* plus one-half of the *preconsumer recycled content*, determined by weight (mass). The recycled fraction of the material in a product or an assembly shall then be multiplied by the cost of the product or assembly to determine its contribution to the 10% requirement.

The annual average industry values, by country of production, for the *recycled content* of steel products manufactured in basic oxygen furnaces and electric arc furnaces shall be permitted to be used as the *recycled content* of the steel. For the purpose of calculating the *recycled content* contribution of concrete, the constituent materials in concrete (**Informative Note:** e.g., the cementitious materials, aggregates, and water) shall be permitted to be treated as separate components and calculated separately.

**901.4.1.1.2 Salvaged Material Content.** The *salvaged material* content shall be determined based on the actual cost of the *salvaged material* or the cost of a comparable alternative component material.

**901.4.1.2 Regional Materials.** A minimum of 15% of building materials or products used, based on cost, shall be regionally extracted/harvested/recovered or manufactured within a radius of 500 mi of the project *site*. If only a fraction of a product or material is extracted/harvested/recovered or manufactured locally, then only that percentage (by weight) shall contribute to the regional value.

**Exception:** For building materials or products shipped in part by rail or water, the total distance to the project shall be determined by weighted average, whereby that portion of the distance shipped by rail or water shall be multiplied by 0.25 and added to that portion not shipped by rail or water, provided that the total does not exceed 500 mi.

**901.4.1.3 Biobased Products.** A minimum of 5% of building materials used, based on cost, shall be *biobased products*. *Biobased products* shall:

- comply with the minimum biobased contents of the USDA's BioPreferred Program;
- contain the "USDA Certified *Biobased Product*" label; or
- be composed of solid wood, engineered wood, bamboo, wool, cotton, cork, agricultural fibers, or other biobased materials with at least 50% biobased content.

**901.4.1.3.1 Wood Building Components.** Wood building components, including but not limited to structural framing, sheathing, flooring, subflooring, wood window sash and frames, doors, and architectural millwork, used to comply with this requirement shall contain not less than 60% certified wood content tracked through a chain of custody process, either by physical separation or percentage-based approaches, or wood that qualifies as a *salvaged material*. Certified wood content documentation shall be provided by sources certified through a forest certification system with principles, criteria, and standards developed using ISO/IEC Guide 59 or the WTO Technical Barriers to Trade. Wood building components from a *vendor* shall be permitted to comply when the annual average amount of certified wood products purchased by the *vendor*, for which they have chain of custody *verification* not older than two years, is 60% or greater of their total annual wood products purchased.

**901.4.1.4 Multiple-Attribute Product Declaration or Certification.** A minimum of ten different products installed in the *building project* at the time of issuance of certificate of occupancy shall comply with one of the following subsections. Declarations, reports, and assessments shall be submitted to the *authority having jurisdiction (AHJ)* and shall contain documentation of the critical peer review by an independent third party, results from the review, the reviewer's name, company name, contact information, and date of the review or certification.

**TABLE 901.3.5  
MAXIMUM MERCURY CONTENT FOR ELECTRIC LAMPS**

LAMP	MAXIMUM MERCURY CONTENT
Screw-base compact fluorescent lamps <25 W	4 mg
Screw-base compact fluorescent lamps ≥ 25 W and < 40 W	5 mg
Pin-base compact fluorescent lamps, all wattages	5 mg
Straight fluorescent T5 normal lifetime lamps <sup>a</sup>	3 mg
Straight fluorescent T8 normal lifetime lamps <sup>a</sup>	4 mg
Straight fluorescent T5 and T8 long lifetime lamps <sup>b</sup>	5 mg
T12 eight-foot straight fluorescent lamps	15 mg

- Electric lamps with a rated lifetime less than 25,000 hours when tested on an electronic fluorescent ballast, including T8 instant-start ballasts and T5 programmed-start ballasts, and turned OFF and ON every three hours.
- Electric lamps with a rated lifetime equal to or greater than 25,000 hours when tested on an electronic fluorescent ballast, including T8 instant-start ballasts and T5 programmed-start ballasts, and turned OFF and ON every three hours.

**901.4.1.4.1 Industry-Wide Declaration.** A Type HI industry-wide environmental product declaration (EPD) shall be submitted for each product. Where the program operator explicitly recognizes the EPD as fully representative of the product group on a national level, it is considered industrywide. In the case where an industry-wide EPD represents only a subset of an industry group, as opposed to being industry-wide, the manufacturer shall be explicitly recognized as a participant by the EPD program operator. All EPD shall be consistent with ISO Standards 14025 and 21930, with at least a cradle-to-gate scope. Each product complying with this section shall be counted as one product for compliance with Section 901.4.1.4.

**901.4.1.4.2 Product-Specific Declaration.** A product-specific Type III EPD shall be submitted for each product. The product-specific declaration shall be manufacturer-specific for a product family. Type III EPDs shall be certified as complying with the goal and scope for the cradle-to-gate requirements in accordance with ISO Standards 14025 and 21930. Each product complying with this section shall be counted as two products for compliance with Section 901.4.1.4.

**901.4.1.4.3 Third-Party Multiattribute Certification.** A material-specific assessment shall be submitted for each product in accordance with one of the following standards, where applicable. The assessment shall be certified as meeting the minimum performance level specified in each standard. Each product complying with this section shall be counted as two products for compliance with Section 901.4.1.4.

- a. ANSI/BIFMA e3
- b. NSF/ANSI 140
- c. NSF/ANSI 332
- d. NSF/ANSI 336
- e. NSF/ANSI 342
- f. NSF/ANSI 347
- g. NSC 373
- h. ANSI A138.1
- i. UL 100
- j. UL 102

**901.4.1.4.4 Product Life Cycle.** A report by a third-party that has critically reviewed the *life-cycle assessment (LCA)* of a product, based on ISO Standards 14040 and 14044, shall be submitted. The report shall demonstrate compliance with the goal and scope for the cradle-to-gate requirements. Each product complying with this section shall be counted as two products for compliance with Section 901.4.1.4.

## **901.5 Performance Option**

**901.5.1 Life-Cycle Assessment (LCA).** An *LCA* shall be performed in accordance with ASTM E2921 and ISO Standard 14044, as modified by this section, for a minimum of two building alternatives, both of which shall conform to the *owner's project requirements (OPR)*.

**901.5.1.1 LCA Performance Metric.** The *LCA* shall demonstrate that the final building design achieves one of the following minimum improvements over the reference building design assessed in the *LCA*:

- a. Ten percent (10%) improvement in a minimum of each of two impact categories, one of which must be global warming.
- b. Five percent (5%) improvement in a minimum of each of three impact categories, one of which must be global warming.

The following impact categories shall be used to determine compliance with this section and shall be included in the report described in Section 901.5.1.3: land use, resource use, global warming, ozone layer depletion, human health effects, ecotoxicity, smog, acidification, and eutrophication.

**901.5.1.2 Procedure.** The *LCA* shall be performed in accordance with the service lives, life-cycle stages, study boundaries, and comparison methodologies of ASTM E2921 with the following modifications:

- a. Each building alternative shall comply with Chapters 6, 7 and 8 (Sections 6, 7, and 8) of this code.
- b. The service life of the buildings shall not be less than that determined using Table 1001.3.2.3, except that the service life of long-life buildings shall be no less than 75 years.
- c. Operating energy consumption shall be included or excluded at the discretion of the project team.
- d. The *LCA* tool (or tools) or software shall include a published third-party impact indicator method.
- e. The estimate of structural system material quantities shall be verified by a *design professional* or other approved source.

**901.5.1.3 Reporting.** A report that includes a description of the building alternatives and their physical differences shall be prepared and shall comply with the reporting requirements stated in ASTM E2921. The name and address of the *design professional* or other approved source verifying structural system material quantities shall be included. A critical review shall be performed by an external expert independent of those performing the *LCA*.

The report shall be submitted to the *AHJ* and include documentation of critical peer review by a third party, results from the review, and the reviewer's name and contact information.

## CHAPTER 10

# CONSTRUCTION AND PLANS FOR OPERATION

**1001.1 Scope.** This section specifies requirements for construction and plans for operation, including the *commissioning (Cx) process*, building *functional and performance testing (FPT)*, measurement and verification (M&V), energy use reporting, durability, transportation management, erosion and sediment control, construction, and indoor air quality (IAQ) during construction.

**1001.2 Compliance.** All of the provisions of Chapter 10 are mandatory provisions.

### 1001.3 Mandatory Provisions.

#### 1001.3.1 Construction.

**1001.3.1.1 Building Systems FPT.** *Functional and performance testing* shall be performed on all building systems specifically referenced in this section using *generally accepted engineering standards* acceptable to the *authority having jurisdiction (AHJ)*.

An *FPT* process and system performance requirements shall be incorporated into *construction documents* and construction schedule of the *building project* to verify system performance.

**1001.3.1.1.1 FPT Requirements.** An *FPT* process shall be performed for the following:

- a. Heating, ventilating, air conditioning, and refrigeration systems (mechanical and passive) and associated controls that exceed total system capacities of 180,000 Btu/h for cooling, 300,000 Btu/h for heating, or 10,000 cfm for ventilation.
- b. Lighting systems over 5 kW in total capacity, including *automatic* and daylighting controls, manual daylighting controls, occupancy-sensing devices, time switching, and *automatic* shut-off controls.
- c. Domestic water-heating systems rated at over 50,000 Btu/h.
- d. Water pumping and mixing systems over 5 hp.
- e. Irrigation systems that use more than 1000 gal per day.

**1001.3.1.1.1.1 Activities Prior to Building Permit for Facilities Using the FPT Process.** The following activities shall be completed before a permit is issued for any system requiring *FPT*:

- a. Designate *FPT providers*. For systems that are required to comply with Section 1001.3.1.1.1, *FPT providers* shall be *owner's* qualified

employees, independent commissioning (*Cx*) providers, or qualified designers experienced with *FPT* on the designated systems. *FPT providers* shall be independent of the building system design and construction function and shall possess the necessary experience and testing equipment.

- b. *FPT providers* shall review the *construction documents* to verify that the relevant sensor locations, devices, and control sequences are properly specified; performance and testing criteria are included; and equipment to be tested is accessible for testing and maintenance.

**1001.3.1.1.1.2 Activities Prior to Building Occupancy for Facilities Using the FPT Process.** Before issuance of a certificate of occupancy, the *FPT providers* shall complete the following activities:

- a. Installation and startup of the specified systems shall be verified.
- b. *FPT* of systems shall be verified.

**Exception:** Systems for which operation is seasonally dependent, and which cannot be fully commissioned in accordance with the *commissioning (Cx) plan* at the time of occupancy, shall be commissioned at the earliest operation time, postoccupancy, as determined by the *FPT providers*.

- c. The preparation of operation and maintenance (O&M) documentation and warranty information shall be verified. O&M documentation, including the information needed to understand, operate, and maintain the building systems, shall be provided to the AHJ, with copies also being provided to building *owner* and facility manager.

**1001.3.1.1.1.3 Documentation.** The completed project design and *FPT* documentation shall be provided to the AHJ, with copies also being provided to the *owner* and shall be retained with the project records.

#### 1001.3.1.1.2 Acoustical Control.

**1001.3.1.1.2.1 Acoustical Field Measurement.** Where required by Chapter 8, the *FPT* specified in Sections 1001.3.1.1.2.1.1 through 1001.3.1.1.2.1.2 shall be completed.

**1001.3.1.1.2.1.1 Interior Background Sound Levels.** The interior sound level shall be measured in accordance with ANSI S12.72 using a sound

level meter in slow-response setting as defined in ANSI/ ASA S1.4. The testing shall include not less than 10% of the rooms of each type specified in Table 801.33.2 that has a prescribed maximum *hourly average sound pressure level*  $L_{eq}$  dBA of 40 or less. The measured performance of the *spaces* shall not exceed the values specified in Table 801.3.3.2 by greater than 5 dBA or 5 dBC.

#### **1001.3.1.1.2.1.2 Interior Sound Transmission.**

The testing of interior sound transmission shall be in accordance with ASTM E336 with respect to noise isolation class (MC) and ASTM E1007 with respect to impact sound rating (ISR). Tested MC values shall not be more than five less than the composite sound transmission class (cSTC) values, and the ISR values shall not exceed 5 less than the impact insulation class (IIC) values in Table 801.3.3.3. Testing shall be performed on not less than 10% of the partitions between rooms of each type in Table 801.3.3.3 that has a prescribed cSTC or IIC of 50 or higher.

#### **1001.3.1.2 Building Project Commissioning (Cx) Process.**

The *Cx process* shall be performed in accordance with this section using ANSI/ASHRAE/ IES Standard 202 or other *generally accepted engineering standards* acceptable to the *AHJ*. The *Cx provider* shall verify that a *Cx process* has been incorporated into the design phases of the project and that commissioning shall be incorporated into the *construction documents*. The *Cx process* documents that the building and its commissioned components, assemblies, and systems comply with the *owner 's project requirements (OPR)*. The project requirements, including *OPR*, *BoD*, design and construction record documentation, training plans and records, O&M plans and procedures, and Cx reports shall be assembled in a systems manual that provides information for building operating and maintenance staff.

**1001.3.1.2.1 Systems to be Commissioned.** For buildings that exceed 10,000 ft<sup>2</sup> of gross floor area, the *Cx process* shall be included in the design and construction of the *building project*. The following systems and associated controls, where included in the *building project*, shall be commissioned:

- a. Heating, ventilating, air-conditioning, and refrigeration systems (mechanical and/or passive) and associated controls.
- b. Air-curtain systems.
- c. Lighting systems: *automatic* and manual daylighting controls, occupancy sensing devices, *automatic* shut-off controls, time switching, and other lighting control devices, and dimming systems claiming a lighting power allowance for institutional tuning according to Section 701.4.6.1.1(f).
- d. Domestic hot-water systems and controls.
- e. Water pumping and mixing systems over 5 hp and purification systems.

f. Irrigation system performance that uses more than 1000 gal per day.

g. Renewable energy systems and energy storage systems.

h. Energy and building management and demand-control systems.

**1001.3.1.2.2 Cx Activities Prior to Building Permit.** The following activities shall be completed prior to issuance of a building permit:

- a. A copy of the *Cx plan* in accordance with ANSI/ASHRAE/IES Standard 202 shall be submitted for review with the-building permit application.
- b. An *approved Cx provider* shall be designated by the *owner* to manage *Cx process* activities prior to completion of *construction documents*. The *Cx provider* shall have the necessary training, experience, and equipment and be independent from the design team and the contractor responsible for the work being commissioned. The *Cx provider* shall disclose possible conflicts of interest so that objectivity can be confirmed. The Cx team shall include an *FPT provider* who may also be the *Cx provider*.
- c. Construction phase Cx requirements shall be incorporated into project specifications and other *construction documents* developed by the design team.

**1001.3.1.2.3 Cx Activities Prior to Building Occupancy.** The following activities shall be completed prior to issuance of a certificate of occupancy:

- a. For the systems being commissioned, verify that commissioning has been completed, installation has been verified, *FPT* has been performed, and that reporting includes documentation of test results.

**Exception:** Systems for which operation is seasonally dependent and which cannot be fully commissioned in accordance with the *Cx plan* at the time of occupancy shall be commissioned at the earliest operation time, postoccupancy, as determined by the *Cx provider*.

- b. The *owner* shall be provided with a preliminary Cx report per compliance with Section 1001.3.1.3 (10.3.1.3). A copy of the Cx preliminary report shall be submitted to the *AHJ* upon request.
- c. The *Cx provider* shall verify that the *owner* has been provided with a systems manual that includes the information needed to understand and operate the commissioned systems as designed, including warranty information for the commissioned systems. The systems manual with design and operational information shall be available for building operator and maintenance training.

**1001.3.1.2.4 Postoccupancy Cx Activities.** The *Cx plan* shall contain postoccupancy Cx requirements in accordance with ANSI/ASHRAE/IES Standard 202. The *Cx provider* shall provide the *owner* with a complete systems manual, all record documents, and a complete final Cx report in accordance with Standard 202.

#### 1001.3.1.3 Project Cx Documents

**1001.3.1.3.1 Cx Plan.** A *Cx plan* shall be developed by a *Cx provider* in accordance with ANSI/ASHRAE/IES Standard 202 for all systems to be commissioned and/or tested.

**1001.3.1.3.2 Design Review Report.** The *Cx provider* shall provide to the *owner* and design teams a Cx design review report that complies with ANSI/ASHRAE/IES Standard 202 and details compliance with the *OPR*. This Cx design review shall not be considered a design peer review or a code or regulatory review.

**1001.3.1.3.3 Preliminary Cx Report.** The *Cx provider* shall provide a preliminary Cx report that includes the following information:

- a. Performance of commissioned equipment, systems, and assemblies;
- b. Issue and resolution logs, including itemization of deficiencies found during testing and commissioning that have not been corrected at the time of report preparation;
- c. Deferred tests that cannot be performed at the time of report preparation;
- d. Documentation of the training of operating personnel and building occupants on commissioned systems and a plan for the completion of any deferred trainings that were unable to be fully commissioned at the time of report preparation; and
- e. A plan for the completion of commissioning, including climatic and other conditions required for performance of the deferred tests.

**1001.3.1.3.4 Final Cx Report.** The *Cx provider* shall provide to the *owner*, prior to project completion, a final Cx report that complies with ANSI/ASHRAE/IES Standard 202.

**1001.3.1.3.5 Building Envelope Airtightness.** *Building envelope* airtightness shall comply with ANSI/ASHRAE/IES Standard 90.1, with the following modifications and additions. Air leakage *verification* shall be determined in accordance with ANSI/ASHRAE/IES Standard 90.1, Section 5.9.2.2:

- a. When implementing the testing option in ANSI/ASHRAE/IES Standard 90.1, Sections 5.9.2.2(b) and 5.4.3.1.3(a), whole-building pressurization testing shall meet the following requirements:

1. It shall be conducted in accordance with ASTM E779, ASTM E1827, CAN/

CGSB-149.10, CAN/CGSB-149.15, ISO 9972, or equivalent standard by an independent third party.

2. The measured air leakage rate of the *building envelope* shall not exceed 0.25 cfm/ft<sup>2</sup> under a pressure differential of 0.3 in. of water (75 Pa), with this air leakage rate normalized by the sum of the above- and below-grade *building envelope* areas of the *conditioned* and *semiheated space*.
3. Section 501.4.3.1.3(a), Exception (1), is not allowed.
4. Section 501.4.3.1.3(a), Exception (2), is allowed where the measured air leakage rate exceeds 0.25 cfm/ft<sup>2</sup> but does not exceed 0.40 cfm/ft<sup>2</sup>.
- b. When implementing the *verification* program option in ANSI/ASHRAE/IES Standard 90.1, Section 5.9.2.2(a), the air barrier design review shall be performed by an independent third party.

**1001.3.1.3.6 Documentation.** *Owner* shall retain the systems manual and final Cx report.

**1001.3.1.5 IAQ Construction Management.** Develop and implement an IAQ construction management plan to include the following:

- a. Air conveyance materials shall be stored and covered so that they remain clean. All filters and controls shall be in place and operational when HVAC systems are operated during building flush-out or baseline IAQ monitoring. Except for system startup, testing, balancing, and commissioning, permanent HVAC systems shall not be used during construction.
- b. After construction ends, prior to occupancy and with all interior finishes installed, a post construction, preoccupancy building flush-out as described under Section 1001.3.1.5(b)(1), or postconstruction, preoccupancy baseline IAQ monitoring as described under Section 1001.3.1.5(b)(2), shall be performed:

1. **Postconstruction, preoccupancy flush-out.** A total air volume of *outdoor air* in total air changes as defined by Equation 101 shall be supplied while maintaining an internal temperature of a minimum of 60°F and relative humidity no higher than 60%. For buildings located in nonattainment areas, filtration and/or air cleaning as described in Section 801.3.1.3 shall be supplied when the Air Quality Index forecast exceeds 100 (category orange, red, purple, or maroon). One of the following options shall be followed:

- i. **Continuous postconstruction, preoccupancy flush-out.** The flush-out shall be continuous and supplied at an



outdoor airflow rate no less than that determined in Section 801.3.1.1.

- ii. **Continuous postconstruction, preoccupancy/post occupancy flush-out.** If occupancy is desired prior to completion of the flush-out, the *space* is allowed to be occupied following delivery to the *space* of half of the total air changes calculated from Equation 10-1. The *space* shall be ventilated at a minimum rate of 0.30 cfm per ft<sup>2</sup> of *outdoor air*, or the outdoor airflow rate determined in 801.3.1.1, whichever is greater. These conditions shall be maintained until the total air changes calculated according to Equation 10-1 have been delivered to the *space*. The flush-out shall be continuous.

$$TAC = V_{ot} \times \frac{1}{A} \times \frac{1}{H} \times 60 \text{ min/h} \\ \times 24 \text{ h/day} \times 14 \text{ days (I-P)}$$

$$TAC = V_{ot} \times 1 \frac{m^3}{100L} \times \frac{1}{A} \times \frac{1}{H} \times 3600 \text{ s/h} \\ \times 24 \text{ h/day} \times 14 \text{ days (SI)}$$

(Equation 10-1)

where:

TAC = total air changes.

$V_{ot}$  = system design *outdoor air* intake flow, cfm (L/s) (according to ANSI/ASHRAE Standard 62.1).

A = floor area, ft<sup>2</sup>

H = ceiling height, ft

**2. Postconstruction, preoccupancy baseline IAQ monitoring.** Baseline IAQ testing shall be conducted after construction ends and prior to occupancy. The ventilation system shall be operated continuously, within +10% of the outdoor airflow rate provided by the ventilation system at design occupancy, for a minimum of 24 hours prior to IAQ monitoring. Testing shall be performed using protocols consistent with the USEPA Compendium of Methods for the Determination of Toxic Organic Pollutants in Ambient Air, TO-1, TO-11, TO-17, and ASTM Standard Method D 5197. The testing shall demonstrate that the *contaminant* maximum concentrations listed in Table 1001.3.1.5 are not exceeded in the return airstreams of the HVAC systems that serve the *space* intended for occupancy. If the return airstream of the HVAC system serving the *space* intended for occupancy cannot be separated from other *spaces*, then for each portion of the building served by a separate ventilation system, the testing shall demonstrate that the *contaminant* maximum concentrations at *breathing zone* listed in Table 1001.3.1.5 are not exceeded in the larger of the following number of

**TABLE 1001.3.1.5  
MAXIMUM CONCENTRATION OF  
AIR POLLUTANTS RELEVANT TO IAQ**

CONTAMINANT	MAXIMUM CONCENTRATION, µg/m <sup>3</sup> (UNLESS OTHERWISE NOTED)
<b>Nonvolatile Organic Compounds</b>	
Carbon monoxide (CO)	9ppm and no greater than 2 ppm above outdoor levels
Ozone	0.075 ppm (8-h)
Particulates (PM2.5)	35 (24 h)
Particulates (PM10)	150 (24 h)
<b>Volatile Organic Compounds</b>	
Acetaldehyde	140
Acrylonitrile	5
Benzene	60
1,3-butadiene	20
t-butyl methyl ether (methyl-t-butyl ether)	8000
Carbon disulfide	800
Caprolactam <sup>a</sup>	100
Carbon tetrachloride	40
Chlorobenzene	1000
Chloroform	300
1, 4-dichlorobenzene	800
Dichloromethane (methylene chloride)	400
1, 4-Dioxane	3000
Ethylbenzene	2000
Ethylene glycol	400
Formaldehyde	33
2-Ethylhexanoic acid <sup>a</sup>	25
n-Hexane	7000
1-methyl-2-pyrrolidinone <sup>a</sup>	160
Naphthalene	9
Nonanal <sup>a</sup>	13
Octanal <sup>a</sup>	7.2
Phenol	200
4-phenylcyclohexene (4 PCH) <sup>a</sup>	2.5
2-propanol (isopropanol)	7000
Styrene	900
Tetrachloroethene (tetrachloroethylene, perchloroethylene)	35
Toluene	300
1, 1, 1-trichloroethane (methyl chloroform)	1000
Trichloroethene (trichloroethylene)	600
Xylene isomers	700
Total volatile organic compounds (TVOC)	<sup>b</sup> —

a. This test is only required if carpets and fabrics with styrene butadiene rubber (SBR) latex backing material are installed as part of the base building systems.

b. TVOC reporting shall be in accordance with CDPH/EHLB/Standard Method V1.1 and shall be in conjunction with the individual VOCs listed.

locations: (i) no fewer than one location per 25,000 ft<sup>2</sup> or (ii) in each contiguous floor area. For each sampling point where the maximum concentration limits are exceeded, conduct additional flush-out with *outdoor air*, and retest the specific parameters exceeded to demonstrate that the requirements are achieved. Repeat procedure until all requirements have been met. When retesting noncomplying building areas, take samples from the same locations as in the first test.

**1001.3.1.6 Moisture Control.** The following items to control moisture shall be implemented during construction:

- a. Materials stored on-site, or materials installed that are absorptive, shall be protected from moisture damage.
- b. Building construction materials that show visual evidence of biological growth due to the presence of moisture shall not be installed on the *building project*.

**1001.3.1.8 Construction Activity Pollution Prevention: Protection of Occupied Areas.** The *construction documents* shall identify operable windows, doors, and air intake openings that serve occupied *spaces*, including those not associated with the *building project*, that are in the area of construction activity or within 35 ft of the limits of construction activity. Such windows, doors, and air intake openings that are under control of the *owner* shall be closed, or other measures shall be taken to limit *contaminant* entry.

Management of the affected buildings not under the control of the *building project owner* shall be notified in writing of planned construction activity and possible entry of *contaminants* into their buildings.

**1001.3.2 Plans for Operation.** This section specifies the items to be included in plans for operation of a *building project* that falls under the requirements of this code.

**1001.3.2.1 High-Performance Building Operation Plan.** A master building plan for operation shall be developed that meets the requirements specified in Sections 1001.3.2.1.1 through 1001.3.2.1.4.

**1001.3.2.1.1 Site Sustainability.** A *site sustainability* portion of the plan for operation shall be developed and shall contain the following provisions:

- a. Where trees and vegetation are used to comply with the shade requirements of Section 501.3.5, the plan for operation shall include the maintenance procedures needed to maintain healthy vegetation growth. The plan shall also outline the procedures for replacing any vegetation used to comply with the provisions in Chapter 5 (Section 5).
- b. For *roof* surface materials selected to comply with the requirements of Section 501.3.5.3, the plan for operation shall include the maintenance procedures for keeping the *roof*

surfaces cleaned in accordance with manufacturer's recommendations.

- c. For vegetated terrace and roofing systems selected to comply with Section 501.3.5.5, the plan for operation shall include the maintenance procedures needed to maintain healthy vegetation growth and *roof* membrane system. The plan shall also outline the procedures for replacing any vegetation used to comply with the provisions in Chapter 5.

**1001.3.2.1.3 Energy Efficiency.** The plan for operation shall specify energy performance *verification* activities for *building projects* to track and assess building energy performance. The plan must describe the procedures needed to use the energy measurement devices and collection/storage infrastructure, and the procedures for tracking and assessing energy consumption.

The indoor air quality plan must describe the procedures needed to implement a regular outdoor airflow monitoring program after building occupancy; the procedures for operating ventilation systems during occupancy; the procedures needed for maintaining and monitoring IAQ after building occupancy; a green cleaning plan; and the procedures for implementing a regular humidity sensor monitoring program after building occupancy.

**1001.3.2.2 Maintenance Plan.** A *maintenance plan* shall be developed for mechanical, electrical, plumbing, and fire protection systems. The plan shall include the following:

- a. The plan shall be in accordance with ANSI/ASHRAE/ACCA Standard 180 for HVAC systems in buildings that meet the definition of commercial buildings in ASHRAE/ACCA Standard 180.
- b. The plan shall address all elements of ASHRAE/ACCA Standard 180, Section 4, and shall develop required inspection and maintenance tasks similar to ASHRAE/ACCA Standard 180, Section 5, for electrical and plumbing systems in buildings that meet the definition of commercial buildings in ASHRAE/ACCA Standard 180.
- c. *Outdoor air* delivery monitors required by Section 801.3.1.2 shall be visually inspected at least once each quarter and cleaned or repaired, as necessary, and calibrated at the manufacturer's recommended interval or not less than once per year, whichever is more frequent.
- d. For systems with a damper indicator and with less than 2000 cfm of supply air, the system components that control the *minimum outdoor airflow* shall be visually inspected every two years. Records of this inspection shall be maintained on-site either in electronic or written form.
- e. Documentation of the plan and of completed maintenance procedures shall be maintained on the building *site* at all times in:

1. electronic format for storage on the building energy management system (EMS), building management system (BMS), computerized maintenance management system (CMMS), or other computer storage means, or
2. maintenance manuals specifically developed and maintained for documenting completed maintenance activities.

**1001.3.2.3 Service Life Plan.** A service life plan that is consistent with the *OPR* shall be developed to estimate to what extent structural, *building envelope* (not mechanical and electrical), and *hardscape* materials will need to be repaired or replaced during the service life of the building. The design service life of the building shall be no less than that determined using Table 1001.3.2.3. The estimated service life shall be documented for building assemblies, products, and materials that will need to be inspected, repaired, and/or replaced during the service life of the building. *Site* improvements and *hardscape* shall also be

included. Documentation in the service life plan shall include the *building project* design service life and basis for determination, and the following for each assembly or component:

- a. Building assembly description.
- b. Materials or products.
- c. Design or estimated service life in years.
- d. Maintenance frequency.
- e. Maintenance access for components with an estimated service life less than the service life of the building.

Provide a service life plan at the completion of design development. The *owner* shall retain a copy of the service life plan for use during the life of building.

**TABLE 1001.3.2.3  
MINIMUM DESIGN SERVICE LIFE FOR BUILDINGS**

CATEGORY	MINIMUM SERVICE LIFE	BUILDING TYPES
Temporary	Up to 10 years	Nonpermanent construction buildings (sales offices, bunkhouses) Temporary exhibition buildings
Medium life	25 years	Industrial buildings Stand-alone parking structures
Long life	50 years	All building not temporary or medium life, including the parking structures below buildings designed for long life category

## CHAPTER 11

# NORMATIVE REFERENCES

Section numbers indicate where the reference occurs in this document.

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### AARST

American Association of Radon Scientists and Technologists  
475 South Church Street, Suite 600  
Hendersonville, NC

**ANSI/AARST RMS-LB-2014: Radon Mitigation Standards for Schools and Large Buildings**  
1001.3.1.9, 1001.3.2.1.4.4.

**ANSI/AARST MALB-2014: Protocols for Measuring Radon and Radon Decay Products in School and Large Buildings**  
1001.3.1.9, 1001.3.2.1.4.4

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### AHAM

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

**ANSI/AHAM RAC-1-R2015: Room Air Conditioners**  
Appendix B

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### AHRI

Air-Conditioning, Heating, and Refrigeration Institute  
2111 Wilson Blvd, Suite 500  
Arlington, VA 22201

**ANSI/AHRI 210/240-2008 (with Addenda 1 and 2): Performance Rating of Unitary Air-Conditioning and Air-Source Heat Pump Equipment**  
Appendix B

**ANSI/AHRI 310/380-2014: Standard for Packaged Terminal Air-Conditioners and Heat Pumps (CSA-C744-14)**  
Appendix B

**AHRI 340/360-2015 (14): Performance Rating of Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment**  
Appendix B

**ANSI/AHRI 365-2009: Performance Rating of Commercial and Industrial Unitary Air-Conditioning Condensing Units**  
Appendix B

**ANSI/ABM 460-2005: Performance Rating of Remote Mechanical-Draft Air-Cooled Refrigerant Condensers**  
Appendix B

**ANSI/AHRI 1230-2010 (with Addendum 2): Performance Rating of Variable Refrigerant Flow (VRF) Multi-Split Air-Conditioning and Heat Pump Equipment**  
Appendix B

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### AMCA

Air Movement and Control Association International, Inc.  
30 West University Drive  
Arlington Heights, IL 6004-1893

**ANSI/AMCA 220-05 (R2012): Laboratory Methods of Testing Air Curtain Units for Aerodynamic Performance Rating**  
701.4.2.4

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## ANSI

American National Standards Institute  
25 West 43<sup>rd</sup> Street  
New York, NY 20036

**ANSI Z21.10.3-2015: Gas Water Heaters, Volume 3, Storage Water Heaters with Input Ratings above 75,000 Btu/h, Circulating and Instantaneous**

Appendix B

**ANSI Z21.11.2-2013: Gas-fired room heaters, volume II, unvented room heaters**

801.3.1.5

**ANSI Z21.47-2012: Gas-Fired Central Furnaces**

Appendix B

**ANSI Z83.4-2015/CSA 3.7-2015: Non-recirculating direct gas-fired industrial air heaters**

801.3.1.5

**ANSI Z83.8-2013: Gas Unit Heaters, Gas Packaged Heaters, Gas Utility Heaters, and Gas-Fired Duct Furnaces**

Appendix B

**ANSI Z83.19-2009/CSA 2.35-2009: Gas-fired high-intensity infrared heaters**

801.3.1.5

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## ASA

Acoustical Society of America  
1305 Walt Whitman Road, Suite 300  
Melville, NY 11747-4300

**ANSI/ASA S1.13-2005 (R2010): Measurement of Sound Pressure Levels in Air**

1001.3.1.1.2

**ANSUASA S1.4-2014: Sound Level Meters**

1001.3.1.1.2

**ANSI/ASA S12.60-2009: Acoustical Performance Criteria, Design Requirements, and Guidelines for Schools, Part 2: Relocatable Classroom Factors**

801.3.3, 801.3.3.4

**ANSI/ASA S12.60-2010: Acoustical Performance Criteria, Design Requirements, and Guidelines for Schools, Part 1: Permanent Schools**

801.3.3

**ANSI/ASA 12.72-2015: Measuring the Ambient Noise Level in a Room**

1001.3.1.1.2

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## ASABE

American Society of Agricultural and Biological Engineers  
2950 Niles Road  
Saint Joseph, MI 49085

**ASA13E/ICC 802-2014: Landscape Irrigation Sprinkler and Emitter Standard**

601.3.1.2.1

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## ASHE

American Society for Healthcare Engineering of the American Hospital Association  
155 N. Wacker Drive, Suite 400  
Chicago, IL 60606

**2014 FGI Guidelines: Hospitals and Outpatient Facilities: Guidelines for Design and Construction of Hospitals and Outpatient Facilities**

801.3.3

**2014 FGI Guidelines: Residential Health, Care and Support Facilities: Guidelines for Design and Construction of Residential Health, Care, and Support Facilities**

801.3.3

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## ASHRAE

ASHRAE  
1791 Tullie Circle NE  
Atlanta, GA 30329

**ANSI/ASHRAE Standard 52.2-2017: Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size**

801.3.1.3

**ANSI/ASHRAE Standard 55-2017: Thermal Environmental Conditions for Human Occupancy**

801.3.2

**ANSI/ASHRAE Standard 62.1-2016: Ventilation for Acceptable Indoor Air Quality**

301.2, 701.4.3.2, 701.4.3.8, 801.3, 1001.3.1.5, 1001.3.2.1.4

**ANSI/ASHRAE Standard 62.2-2016: Ventilation and Acceptable Indoor Air Quality in Residential Buildings**

801.3.1, 801.3.1.1, 801.3.1.5

**ANSI/ASHRAE/IES Standard 90.1-2016: Energy Standard for Buildings Except Low-Rise Residential Buildings**

301.1, 301.2, 701.3.1, 701.4.1, 701.4.2, 701.4.3, 701.4.4, 701.4.5, 701.4.6, 701.4.7, 701.4.8, 801.3.1.10, 1001.3.1.3.5, Appendix A, Appendix B, Appendix C

**ANSI/ASHRAE Standard 111-2008: Measurement, Testing, Adjusting, and Balancing of Building HVAC Systems**

801.3.1.2.2, 1001.3.2.1.4, 1001.3.2.1.4.6

**ANSI/ASHRAE Standard 146-2011: Method of Testing and Rating Pool Heaters**

Appendix B

**ANSI/ASHRAE Standard 154-2011: Ventilation for Commercial Cooking Operations**

701.4.3.8.1

**ANSUASHRAE Standard 160-2016: Criteria for Moisture-Control Design Analysis in Buildings**

801.3.6

**ANSI/ASHRAE Standard 169-2013: Climatic Data for Building Design Standards**

Appendix A

**ANSI/ASHRAE/ASHE Standard 170-2013: Ventilation of Health Care Facilities**

801.3.1

**ANSUASHRAE/ACCA Standard 180-2012: Standard Practice for Inspection and Maintenance of Commercial Building HVAC Systems**

301.2, 1001.3.2.2

**ANSUASHRAE/IES Standard 202-2013: Commissioning Process for Buildings and Systems**

1001.3.1.2, 1001.3.1.3

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## ASME

American Society of Mechanical Engineers  
Three Park Avenue  
New York, NY 10016-5990

**ASME A112.18.1-2012/CSA B125.1-12: Plumbing Supply Fittings**

601.3.2.1

**ASME A112.19.2-2013/CSA B45.1-13: Ceramic Plumbing Fixtures**

601.3.2.1

**ASME A112.19.14-2013: Six-Liter Water Closets Equipped with a Dual Flushing Device**

601.3.2.1

**ASME A112.19.19-2006: Vitreous China Nonwater Urinals**

601.3.2.1

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## ASTM

ASTM International

**ASTM C33: Standard Specification for Concrete Aggregates**  
801.3.4.1.2

**ASTM C518-15: Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus**  
Appendix A

**ASTM C919-12: Standard Practice for Use of Sealants in Acoustical Applications.**  
801.3.3.1.1, 801.3.3.2.3.3, 801.3.3.3.2

**ASTM C920-14: Standard Specification for Elastomeric Joint Sealants**  
801.3.4.1.1

**ASTM C1371-15: Standard Test Method for Determination of Emittance of Materials Near Room Temperature Using Portable Emissometers**  
501.3.5.4

**ASTM C1549-09(2014): Standard Test Method for Determination of Solar Reflectance Near Ambient Temperature Using a Portable Solar Reflectometer**  
501.3.5.4

**ASTM D1003-13: Standard Test Method for Haze and Luminous Transmittance of Transparent Plastics**  
301.2, 801.4, 801.4.1.1.3, 801.4.1.3

**ASTM D1785-15: Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40,80, and 120**  
801.3.4.1.3

**ASTM D5197-09e1: Standard Test Method for Determination of Formaldehyde and Other Carbonyl Compounds in Air (Active Sampler Methodology)**  
801.4.2, 1001.3.1.5

**ASTM E90-09: Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements**  
801.3.3.1.1

**ASTM E336-14: Standard Test Method for Measurement of Airborne Sound Attenuation Between Rooms in Buildings**  
801.3.3.1.1, 1001.3.1.1.5.1.2

**ASTM E408-13: Standard Test Methods for Total Normal Emittance of Surfaces Using Inspection-Meter Techniques**  
501.3.5.4

**ASTM E492-09s: Standard Test Method for Laboratory Measurement of Impact Sound Transmission through Floor-Ceiling Assemblies Using the Tapping Machine**  
801.3.3.1.1

**ASTM E779-10: Standard Test Method for Determining Air Leakage Rate by Fan Pressurization**  
1001.3.1.3.5

**ASTM E972-96 (2013): Standard Test Method for Solar Photometric Transmittance of Sheet Materials Using Sunlight**  
301.2

**ASTM E1007-14: Standard Test Method for Field Measurement of Tapping Machine Impact Sound Transmission through Floor-Ceiling Assemblies and Associated Support Structures**  
801.3.3.1.1

**ASTM E1643-11: Standard Practice for Selection, Design, Installation, and Inspection of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs**  
801.3.4.1.1

## **ASTM - Continued**

**ASTM E1745-11: Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs**

801.3.4.1.1

**ASTM E1827-11: Standard Test Methods for Determining Airtightness of Buildings Using an Orifice Blower Door**

1001.3.1.3.5

**ASTM E1903-11: Standard Practice for Environmental Site Assessments: Phase II Environmental Site Assessment Process**

301.2

**ASTM E1918-06(2015): Standard Test Method for Measuring Solar Reflectance of Horizontal and Low-Sloped Surfaces in the Field**

501.3.5.4

**ASTM E1980-11: Standard Practice for Calculating Solar Reflectance Index of Horizontal and Low-Sloped Opaque Surfaces**

501.3.5.4

**ASTM E2399-11: Standard Test Method for Maximum Media Density for Dead Load Analysis of Vegetative (Green) Roof Systems**

501.3.5.5

**ASTM E2843-17: Standard Specification for Demonstrating that a Building is in Walkable Proximity to Neighborhood Assets**

501.3.1.1

**ASTM E2844-15e1: Standard Specification for Demonstrating That a Building's Location Provides Access to Public Transit**

501.3.1.1

**ASTM E2921-16: Standard Practice for Minimum Criteria for Comparing Whole Building Life Cycle Assessments for Use with Building Codes and Rating Systems**

901.5.1

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## **BIFMA**

Business and Institutional Furniture Manufacturer's Association  
678 Front Avenue NW, Suite 150  
Grand Rapids, MI 49504-5368

**ANSI/BIFMA e3-2014: Furniture Sustainability Standard**

801.4.2.5, 901.4.1.4.3

**ANSI/BIFMA M7.1-2011 (R2016): Standard Test Method For Determining VOC Emissions From Office Furniture Systems, Components and Seating**

801.4.2.5, 801.5.2

**ANSI/BIFMA X7.1-2011 (R2016): Standard for Formaldehyde and TVOC Emissions of Low-Emitting Office Furniture Systems and Seating**

801.4.2.5

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## **CARB**

California Air Resources Board  
1001 "I" Street  
P.O. Box 2815  
Sacramento, CA 95812

**CARB SCM for Architectural Coatings-2007: California Air Resources Board (ARB) Suggested Control Measure for Architectural Coatings**

801.4.2.2.2

**No-Added Formaldehyde Based Resins: Airborne Toxic Control Measure to Reduce Formaldehyde Emissions from Composite Wood Products. California Code of Regulations, Title 17, Sections 93120-93120.12**

801.4.2.4



<b>CDPH</b>	California Department of Public Health, Indoor Air Quality Section 850 Marina Bay Parkway Richmond, CA 94804
<b>CDPH/EHLB/Standard Method V1.1 (2010): Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers—Version 1.1</b> 801.4.2, 801.5.2, Table 1001.3.1.5, Appendix D	
<b>CEN</b>	European Committee for Standardization Avenue Marnix 17--B-1000 Brussels, Belgium
<b>EN14500:2008: Blinds and shutters—Thermal and visual comfort—Test and calculation methods</b> 801.3.8	
<b>CGSB</b>	Canadian General Standards Board Place du Portage III, 6B1 11 Laurier Street Gatineau, Quebec K1A 1G6, Canada
<b>CAN/CGSB 149.10-M86: Determination of the Airtightness of Building Envelopes by the Fan Depressurization Method</b> 1001.3.1.3.5	
<b>CAN/CGSB 149.15-96: Determination of the Overall Envelope Airtightness of Buildings by the Fan Pressurization Method Using the Building's Air Handling Systems</b> 1001.3.1.3.5	
<b>CITES</b>	Convention on International Trade in Endangered Species of Wild Fauna Flora International Environment House 11 Chemin des Anémones CH-1219 Châtelaine, Geneva, Switzerland
<b>CRRC</b>	Cooling Roof Rating Council 449 15th Street, Suite 400 Oakland, CA 94612
<b>ANSI/CRRC 8100-2016: Standard Test Methods for Determining Radiative Properties of Materials</b> 501.3.5.4	
<b>CTI</b>	Cooling Technology Institute PO Box 681807 Houston, TX 77268
<b>CTI ATC-105 (00): Acceptance Test Code for Water Cooling Towers</b> Appendix B	
<b>CTI ATC-105S (11): Acceptance Test Code for Closed-Circuit Cooling Towers</b> Appendix B	
<b>CTI ATC-106 (11): Acceptance Test Code for Mechanical Draft Evaporative Vapor Condensers</b> Appendix B	
<b>CTI STD-201RS (15): Standard for the Certification of Water Cooling Tower Thermal Performance</b> Appendix B	
<b>Green-e</b>	Green-e c/o Center for Resource Solutions 1012 Torney Ave., Second Floor San Francisco, CA 94129
<b>Version 2.8, April 1,2016: Green-e Energy National Standard for Renewable Electricity Products</b> 701.4.1.1.1	

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## GS

Green Seal  
1001 Connecticut Avenue, NW, Suite 827  
Washington, DC 20036-5525

**GS-11, 32.2, October 26, 2016: Green Seal Standard for Paints, Coatings, Stains, and Sealers, Section 3.0: “Product-Specific Health and Environmental Requirements”**

801.4.2.2.2

**GS-36, 2.1, July 12, 2013: Standard for Adhesives for Commercial Use**

801.4.2.1.2

**GS-42, July 7, 2015: Standard for Commercial and Institutional Cleaning Services**

1001.3.2.1.4.5

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## IA

Irrigation Association  
8280 Willow Oaks Corporate Drive, Suite 400  
Fairfax, VA 22031

**Smart Water Application Technologies (SWAT) Climatologically Based Controllers, 8th Testing Protocol—September 2008:  
Smart Water Application Technologies (SWAT), Turf and Landscape Irrigation System Smart Controllers, Climatologically  
Based Controllers**

301.2

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## IAPMO

International Association of Plumbing and Mechanical Officials  
5001 East Philadelphia Street  
Ontario, CA 91761

**Z124.9-2004: Plastic Urinal Fixtures**

601.3.2.1

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## ICC

International Code Council  
500 New Jersey Ave., NW #300  
Washington, DC 20001

**2018 IBC: International Building Code®**

102.4, 102.6, 104.1

**2018 IECC: International Energy Conservation Code®**

102.4

**2018 IEBC: International Existing Building Code®**

102.4, 102.6

**2018 IFC: International Fire Code®**

102.4, 102.6, 501.3.5.5

**2018 IFGC: International Fuel Gas Code®**

102.4

**2018 IMC: International Mechanical Code®**

102.4

**2018 IPC: International Plumbing Code®**

102.4

**2018 IPMC: International Property Maintenance Code®**

102.4, 102.6

**2018 IRC: International Residential Code®**

101.3.2, 102.4

**2018 ICC PC: Performance Code for Buildings and Facilities®**

102.4

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## **IES**

Illuminating Engineering Society  
120 Wall Street, Floor 17  
New York, NY 10005-4001

**TM-15-2011 including addendum a: Luminaire Classification System for Outdoor Luminaires**  
501.3.6.2

**LM-83-12: Approved Method: IES Spatial Daylight Autonomy (sDA) and Annual Sunlight Exposure**  
(ASE) 301.2, 801.5.1

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## **ISO**

International Organization for Standardization  
ISO Central Secretariat, 1 rue Varembee, Case postale 56  
CH-1211 Geneva 20, Switzerland

**ISO-9972-2015: Thermal Performance of Buildings—Determination of Air Permeability of Buildings—Fan Pressurization Method**  
1001.3.1.3.5

**ISO-13256-1-1998: Water-Source Heat Pumps—Testing and Rating for Performance—Part 1: Water-to-Air and Brine-to-Air Heat Pumps**  
Appendix B

**ISO-13256-2-1998: Water-Source Heat Pumps—Testing and Rating for Performance—Part 2: Water-to-Water and Brine-to-Water Heat Pumps**  
Appendix B

**ISO 14025-2006: Environmental Labels and Declarations—Type III Environmental Declarations—Principles and Procedures**  
901.4.1.4

**ISO 14040-2006: Environmental Management—Life Cycle Assessment—Principles and Framework**  
901.4.1.4

**ISO 14044-2006: Environmental Management—Life Cycle Assessment— Requirements and Guidelines**  
901.5.1, 901.5.1.2

**ISO 21930-2017: Sustainability in Building Construction—Environmental Declaration of Building Products**  
901.4.1.4

**ISCO/IEC 17025-2005 (Reviewed 2010): General Requirements for the Competence of Testing and Calibration Laboratories**  
801.4.2

**ISO/IEC 17065-2012: Conformity Assessment—Requirements for Bodies Certifying Products, Processes, and Services**  
801.4.2

**ISO/IEC Guide 59-1994: Code of Good Practice for Standardization**  
901.4.1.3.1

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## **NEMA**

National Electrical Manufacturers Association  
1300 North 17<sup>th</sup> Street, Suite 900  
Rosslyn, VA 22209

**ANSI/NEMA MG 1-2009: Motors and Generators**  
701.4.3.1

**NEMA DC 3, Annex A-2013: Energy-Efficiency Requirements for Programmable Thermostats**  
701.4.7.4

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## **NFPA**

National Fire Protection Association  
1 Battery March Park  
Quincy, MA 02169-7471

**NFPA 70-2014: National Electrical Code**  
501.3.6.3

<b>NFRC</b>	National Fenestration Rating Council 6305 Ivy Lane, Suite 140 Greenbelt, MD 20770-6323
<b>ANSI/NFRC 200-2014: Procedure for Determining Fenestration Product Solar Heat Gain Coefficients and Visible Transmittance at Normal Incidence</b> 301.2	
<b>NSC</b>	Natural Stone Council P.O. Box 539 Hollis, NH 03049
<b>NSC 373-2013: Sustainable Production of Natural Dimension Stone</b> 901.4.1.4	
<b>NSF</b>	NSF International 789 Dixboro Road Ann Arbor, MI 48105
<b>NSF/ANSI 44-2016: Residential Cation Exchange Water Softeners</b> 601.3.5	
<b>NSF/ANSI 58-2016: Reverse Osmosis Drinking Water Treatment Systems</b> 601.3.6	
<b>NSF/ANSI 140-2015: Sustainability Assessment for Carpet</b> 901.4.1.4	
<b>NSF/ANSI 332-2015: Sustainability Assessment for Resilient Floor Coverings</b> 901.4.1.4	
<b>NSF/ANSI 336-2011: Sustainability Assessment for Commercial Furnishings Fabric</b> 901.4.1.4	
<b>NSF/ANSI 342-2014: Sustainability Assessment for Wallcovering Products</b> 901.4.1.4	
<b>NSF/ANSI 347-2012: Sustainability Assessment for Single Ply Roofing Membranes</b> 901.4.1.4	
<b>NSF/ANSI 350-2017: On-Site Residential and Commercial Water Reuse Systems</b> 601.3.7	
<b>SCAQMD</b>	South Coast Air Quality Management District California Air Resources Board 1001 "I" Street; P.O. Box 2815 Sacramento, CA 95812
<b>SCAQMD Rule 1113r, Amended February 5, 2016: Architectural Coatings</b> 801.4.2.2	
<b>SCAQMD Rule 1168, Amended January 7, 2005: Adhesive and Sealant Applications</b> 801.4.2.1	
<b>TCNA</b>	Tile Council of North America 100 Clemson Research Boulevard Anderson, SC 29625
<b>ANSI A138.1-2011: Standard Specifications for Sustainable Ceramic Tiles, Glass Tiles, and Tile Installation Materials</b> 901.4.1.4	

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## **UL**

Underwriters Laboratories Inc.  
333 Pfingsten Road  
Northbrook, IL 60062

### **UL 100-2012: Standard for Sustainability for Gypsum Boards and Panels**

901.4.1.4

### **UL 102-2012: Standard for Sustainability for Door Leafs**

901.4.1.4

### **UL 727-2006: Standard for Oil-Fired Central Furnaces**

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### **UL 731-2012: Standard for Oil-Fired Unit Heaters**

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## **U.S. Congress**

United States Congress  
Washington, DC 20515

### **EPAct 2005 HR6 Public Law 109-58: The Energy Policy Act (EPAct) of 2005**

701.4.7.3

### **EISA 2007 HR6 Public Law 110-140: The Energy Independence and Security Act of 2007**

701.4.7

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## **USDA**

United States Department of Agriculture  
BioPreferred Program  
1400 Independence Avenue, SW  
Washington, DC 20250

### **7 CFR Part 3201 Subpart B, (Includes Rounds 1-7) August 29, 2011; Round 8, April 4,2012; Round 9, November 19,2012; Round 10, June 11, 2013: Guidelines for Designating Biobased Products for Federal Procurement; Designated Items**

901.4.1.3

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## **USDOE**

United State Department of Energy  
Energy Information Administration  
Washington, DC 20585

### **10 CFR Part 430, App N: Uniform Test Method for Measuring the Energy Consumption of Furnaces**

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## **USEPA**

United State Environmental Protection Agency  
Ariel Rios Building  
1200 Pennsylvania Avenue, NW  
Washington, DC 20460

### **Code of Federal Regulations, Title 40 Part 50 (40 CFR 50), as amended July 1, 2004: National Primary and Secondary Ambient Air Quality Standards**

801.3.1.3

### **EPA 420-F-07-063, November 2007: Green Vehicle Guide: Consider a SmartWay Vehicle Program—Requirements for Certified Passenger Vehicles**

501.3.7

### **EPA 625/R-96/0106, January 1999: Compendium of Methods for the Determination of Toxic Organic Pollutants in Ambient Air, Sections TO-1, TO-11, TO-17**

1001.3.1.5

### **February 16, 2012: NPDES General Permit for Stormwater Discharges From Construction Activities**

1001.3.1.4

## **USEPA – Continued**

**USEPA Method TO-17 (1999): Determination of Volatile Organic Compounds in Ambient Air Using Active Sampling Onto Sorbent Tubes**

801.4.2

**Version 1.0, August 1, 2012: ENERGY STAR Program Requirements for Uninterruptible Power Supplies**

701.4.7

**Version 1.0, August 14, 2009: WaterSense Specification for Flushing Urinals**

601.3.2.1

**Version 1.0, March 4, 2010: WaterSense Specification for Showerheads**

601.3.2.1

**Version 1.0, October 1, 2007: WaterSense Tank-Type High-Efficiency Lavatory Faucet Specification**

601.3.2.1

**Version 1.0, November 3, 2011: WaterSense Specification for Weather-Based Irrigation Controllers**

601.3.1.2

**Version 1.2, August 1, 2003: ENERGY STAR Program Requirements for Commercial Steam Cookers**

701.4.7

**Version 1.2, July 1, 2004: ENERGY STAR Program Requirements for Room Air Cleaners**

701.4.7

**Version 1.2, June 2, 2014: WaterSense Tank-Type High-Efficiency Toilet Specification**

601.3.2.1

**Version 1.2, May 8, 2009: ENERGY STAR Program Requirements for Commercial Griddles**

701.4.7

**Version 2.0, April 22, 2011: ENERGY STAR Program Requirements for Commercial Fryers**

701.4.7

**Version 2.0 December 31, 2015: ENERGY STAR Program Requirements for Lamps (Light Bulbs)**

701.4.7

**Version 2.0, February 1, 2013: ENERGY STAR Program Requirements for Commercial Ice Makers**

701.4.7

**Version 2.0, June 25, 2012: ENERGY STAR Program Requirements for Commercial Dishwashers**

701.4.7

**Version 2.0, June 26, 2013: ENERGY STAR Program Requirements for Imaging Equipment**

701.4.7

**Version 2.0, May 9, 2013: ENERGY STAR Program Requirements for Water Coolers**

701.4.7

**Version 2.0, May 29, 2015: ENERGY STAR Program Requirements for Luminaires**

701.4.7.3

**Version 2.0, October 1, 2011: ENERGY STAR Program Requirements for Hot Food Holding Cabinets**

701.4.7

**Version 2.2, October 7, 2015: ENERGY STAR Program Requirements for Commercial Ovens**

701.4.7

**Version 3.0, April 1, 2012: ENERGY STAR Program Requirements for Residential Ceiling Fans**

701.4.7

**Version 3.0, December 20, 2013: ENERGY STAR Program Requirements for Boilers**

701.4.7

## USEPA – Continued

- Version 3.0, July 18, 2014: ENERGY STAR Program Requirements for Residential Water Heaters**  
701.4.7
- Version 3.0, May 1, 2013: ENERGY STAR Program Requirements for Audio and Video**  
701.4.7
- Version 3.0, October 1, 2012: ENERGY STAR Program Requirements for Dehumidifiers**  
701.4.7
- Version 3.0, October 1, 2014: ENERGY STAR Program Requirements for Commercial Refrigerators and Freezers**  
701.4.7
- Version 3.0, October 1, 2014: ENERGY STAR Program Requirements for Telephony**  
701.4.7
- Version 3.1, January 1, 2012: ENERGY STAR Program Requirements for Geothermal Heat Pumps**  
701.4.7
- Version 3.1, March 1, 2013: ENERGY STAR Program Requirements for Refrigerated Beverage Vending Machines**  
701.4.7
- Version 3.2, April 1, 2012: ENERGY STAR Program Requirements for Residential Ventilating Fans**  
701.4.7
- Version 4.0, February 20, 2015: ENERGY STAR Program Requirements and Criteria for Room Air Conditioners**  
701.4.7
- Version 4.0, June 13, 2011: ENERGY STAR Program Requirements for Furnaces**  
701.4.7
- Version 5.0, May 13, 2016: ENERGY STAR Program Requirements for Set-Top Boxes**  
701.4.7
- Version 5.0, September 15, 2014: ENERGY STAR Program Requirements for Refrigerators and Freezers**  
701.4.7
- Version 5.0, September 15, 2015: ENERGY STAR Program Requirements for ASHPs and Central Air Conditioners**  
701.4.7
- Version 6.0, April 29, 2015: ENERGY STAR Program Requirements Product Specification for Residential Dishwashers**  
701.4.7
- Version 6.1, August 12, 2014: ENERGY STAR Program Requirements for Computers**  
701.4.7
- Version 7.0, May 2016: ENERGY STAR Program Requirements for Displays**  
701.4.7
- Version 7.0, October 30, 2015: ENERGY STAR Program Requirements for Televisions**  
701.4.7
- Version 7.1, May 20, 2015: ENERGY STAR Program Requirements for Clothes Washers**  
701.4.7

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## WTO

World Trade Organization  
Centre William Rappard  
Rue de Lausanne 154,  
CH-1211 Geneva 21, Switzerland

- WTO TBT-1994: WTO Technical Barriers to Trade (TBT) Agreement Annex 3 Code of Good Practice for the Preparation, Adoption and Application of Standards**  
901.4.1.3.1

## NORMATIVE APPENDIX A

# CLIMATE ZONES AND PRESCRIPTIVE BUILDING ENVELOPE AND DUCT INSULATION TABLES

*(This is a normative appendix and is part of this code.)*

Tables A101.1 (A-1) through A101.3 (A-3) appear twice in this appendix. The three tables are shown first with I-P units, followed by three tables with SI units.

For *climate zones*, see ANSI/ASHRAE/IES Standard 90.1, Section 5.1.4, and ANSI/ASHRAE Standard 169.

- a. For locations in the United States and its territories, use ANSI/ASHRAE Standard 169, Table B-1, "U.S. States by State and County," to determine the assigned climate zone and, where required, the assigned climate zone letter. **Informative Note:** Referenced Standard Reproduction Annex ASHRAE Standard 169 (included at the end of this document) contains an extraction of ANSI/ASHRAE Standard 169, Figure B-1, "Climate Zone for United States Counties," (which is informative for Standards 90.1 and 189.1). ANSI/ASHRAE/IES Standard 90.1 Referenced Standard Reproduction Annex ASHRAE Standard 169 (included at the end of ANSI/ASHRAEMS Standard 90.1) contains an extraction of ANSI/ASHRAE Standard 169, Table B-1, "U.S. States by State and County."
- b. For locations in Canada that are listed in ASHRAE Standard 169, Table A-5, "Canada Stations and Climate Zones," use this table to determine the assigned

*climate zone* number and, where required, the assigned *climate zone* letter. For locations in other international countries that are listed in ASHRAE Standard 169, Table A-6, "International Stations and Climate Zones," use this table to determine the required *climate zone* number and, where required, the assigned *climate zone* letter. For all international locations that are not listed either in ASHRAE Standard 169, Table A-5 or Table A-6, use ASHRAE Standard 169, Section A3, "Climate Zone Definitions," and Table A-3, "Thermal Climate Zone Definitions," to determine both the *climate zone* number and letter. **Informative Note:** Reference Standard Reproduction Annex ASHRAE Standard 169 (included at the end of this document) contains an extraction of ASHRAE Standard 169, Section A3, "Climate Zone Definitions," and Table A-3, "Thermal Climate Zone Definitions." ANSI/ASHRAE/IES Standard 90.1 Referenced Standard Reproduction Annex ASHRAE Standard 169 (included at the end of ANSI/ASHRAE/IES Standard 90.1) contains an extraction of ASHRAE Standard 169, Table A-5, "Canada Stations and Climate Zones," and Table A-6, "International Stations and Climate Zones."



**TABLE A101.1**  
**(SUPERSEDES TABLE A2.4.2 IN ANSI/ASHRAE/IES STANDARD 90.1)**  
**SINGLE-RAFTER ROOF REQUIREMENTS (I-P)**

CLIMATE ZONE	MINIMUM INSULATION R-VALUE OR MAXIMUM ASSEMBLY U-FACTOR		
	NONRESIDENTIAL	RESIDENTIAL	SEMIHEATED
0.1	R-38 U-0.029	R-38 + R10 ci U-0.022	R-19 U-0.055
2	R-38 + R10 ci U-0.022	R-38 + R10 ci U-0.022	R-19 U-0.055
3, 4, 5	R-38 + R10 ci U-0.022	R-38 + R10 ci U-0.022	R-30 U-0.036
6	R-38 + R10 ci U-0.022	R-38 + R10 ci U-0.022	R-38 U-0.029
7, 8	R-38 + R10 ci U-0.022	R-38 + R10 ci U-0.022	R-38 U-0.029

**TABLE A101.2**  
**(SUPERSEDES TABLE 6.8.2 IN ANSI/ASHRAE/IES STANDARD 90.1)**  
**MINIMUM DUCT INSULATION R-VALUE<sup>a</sup> HEATING- AND COOLING-ONLY SUPPLY DUCTS AND RETURN DUCTS (I-P)**

CLIMATE ZONE	DUCT LOCATION						
	EXTERIOR	VENTILATED ATTIC	UNVENTED ATTIC ABOVE INSULATED CEILING	UNVENTED ATTIC WITH ROOF INSULATION <sup>a</sup>	UNCONDITIONED SPACE <sup>b</sup>	INDIRECTLY CONDITIONED SPACE <sup>c</sup>	BURIED
<b>Heating-Only Ducts</b>							
0, 1, 2	None	None	None	None	None	None	None
3	R-6	None	None	None	R-6	None	None
4	R-6	None	None	None	R-6	None	None
5	R-8	R-6	None	None	R-6	None	R-8
6	R-8	R-8	R-6	None	R-6	None	R-6
7	R-10	R-8	R-8	None	R-6	None	R-6
8	R-10	R-10	R-8	None	R-8	None	R-8
<b>Cooling-Only Ducts</b>							
0, 1	R-6	R-8	R-10	R-6	R-6	None	R-6
2	R-6	R-8	R-10	R-6	R-6	None	R-6
3	R-6	R-8	R-8	R-6	R-3.5	None	None
4	R-3.5	R-6	R-8	R-3.5	R-3.5	None	None
5, 6	R-3.5	R-3.5	R-6	R-3.5	R-3.5	None	None
7, 8	R-1.9	R-3.5	R-3.5	R-3.5	R-3.5	None	None
<b>Return Ducts</b>							
0 to 8	R-6	R-6	R-6	None	None	None	R-6

- Insulation R-values, measured in (h·ft<sup>2</sup>·°F)/Btu, are for the insulation as installed and do not include film resistance. The required minimum thicknesses do not consider water vapor transmission and possible surface condensation. Where exterior walls are used as plenum walls, wall insulation shall be as required by the most restrictive condition of this table or Section 701.4.2 (7.4.2). Insulation resistance is measured on a horizontal plane in accordance with ASTM C518 at a mean temperature of 75°F at the installed thickness.
- Includes crawlspaces, both ventilated and nonventilated.
- Includes return air plenums with or without exposed roofs above.

**TABLE A101.3**  
**(SUPERSEDES TABLE 6.8.2 IN ANSI/ASHRAE/IES STANDARD 90.1)**  
**MINIMUM DUCT INSULATION R-VALUE<sup>a</sup> COMBINED HEATING AND COOLING SUPPLY DUCTS AND RETURN DUCTS (I-P)**

CLIMATE ZONE	DUCT LOCATION						
	EXTERIOR	VENTILATED ATTIC	UNVENTED ATTIC ABOVE INSULATED CEILING	UNVENTED ATTIC WITH ROOF INSULATION <sup>a</sup>	UNCONDITIONED SPACE <sup>b</sup>	INDIRECTLY CONDITIONED SPACE <sup>c</sup>	BURIED
<b>Supply Ducts</b>							
0, 1	R-8	R-8	R-10	R-6	R-6	None	R-6
2	R-8	R-8	R-8	R-6	R-8	None	R-6
3	R-8	R-8	R-8	R-6	R-8	None	R-6
4	R-8	R-8	R-8	R-6	R-8	None	R-6
5	R-8	R-8	R-8	R-3.5	R-8	None	R-6
6	R-10	R-8	R-8	R-3.5	R-8	None	R-6
7	R-10	R-8	R-8	R-3.5	R-8	None	R-6
8	R-10	R-11	R-11	R-3.5	R-8	None	R-8
<b>Return Ducts</b>							
0 to 8	R-6	R-6	R-6	None	None	None	None

- a. Insulation R-values, measured in (h·ft<sup>2</sup>·°F)/Btu, are for the insulation as installed and do not include film resistance. The required minimum thicknesses do not consider water vapor transmission and possible surface condensation. Where exterior *walls* are used as plenum *walls*, *wall* insulation shall be as required by the most restrictive condition of this table or Section 701.4.2 (7.4.2). Insulation resistance is measured on a horizontal plane in accordance with ASTM C518 at a mean temperature of 75°F at the installed thickness.
- b. Includes crawlspaces, both ventilated and nonventilated.
- c. Includes return air plenums with or without exposed *roofs* above.

**TABLE A101.1**  
**(SUPERSEDES TABLE A2.4.2 IN ANSI/ASHRAE/IES STANDARD 90.1)**  
**SINGLE-RAFTER ROOF REQUIREMENTS (SI)**

CLIMATE ZONE	MINIMUM INSULATION R-VALUE OR MAXIMUM ASSEMBLY U-FACTOR		
	NONRESIDENTIAL	RESIDENTIAL	SEMIHEATED
0, 1	R-6.7 U-0.165	R-6.7 + R-1.8 ci U-0.112	R-3.3 U-0.312
2	R-6.7 + R-1.8 ci U-0.112	R-6.7 + R-1.8 ci U-0.112	R-3.3 U-0.312
3, 4, 5	R-6.7 + R-1.8 ci U-0.112	R-6.7 + R-1.8 ci U-0.112	R-5.3 U-0.204
6	R-6.7 + R-1.8 ci U-0.112	R-6.7 + R-1.8 ci U-0.112	R-6.7 U-0.165
7, 8	R-6.7 + R-2.6 ci U-0.111	R-6.7 + R-2.6 ci U-0.111	R-6.7 U-0.165

**TABLE A101.2**  
**(SUPERSEDES TABLE 6.8.2 IN ANSI/ASHRAE/IES STANDARD 90.1)**  
**MINIMUM DUCT INSULATION R-VALUE<sup>a</sup> HEATING AND COOLING ONLY SUPPLY DUCTS AND RETURN DUCTS (SI)**

CLIMATE ZONE	DUCT LOCATION						
	EXTERIOR	VENTILATED ATTIC	UNVENTED ATTIC ABOVE INSULATED CEILING	UNVENTED ATTIC WITH ROOF INSULATION <sup>a</sup>	UNCONDITIONED SPACE <sup>b</sup>	INDIRECTLY CONDITIONED SPACE <sup>c</sup>	BURIED
<b>Heating-Only Ducts</b>							
0, 1, 2	None	None	None	None	None	None	None
3	R-1.06	None	None	None	R-1.06	None	None
4	R-1.06	None	None	None	R-1.06	None	None
5	R-1.41	R-1.06	None	None	R-1.06	None	R-1.06
6	R-1.41	R-1.41	R-1.06	None	R-1.06	None	R-1.06
7	R-1.76	R-1.41	R-1.41	None	R-1.06	None	R-1.06
8	R-1.76	R-1.76	R-1.41	None	R-1.41	None	R-1.41
<b>Cooling-Only Ducts</b>							
0, 1	R-1.06	R-1.41	R-10	R-1.06	R-1.06	None	R-1.06
2	R-1.06	R-1.41	R-10	R-1.06	R-1.06	None	R-1.06
3	R-1.06	R-1.41	R-1.41	R-1.06	R-0.62	None	None
4	R-0.62	R-1.06	R-1.41	R-0.62	R-0.62	None	None
5, 6	R-0.62	R-0.62	R-1.06	R-0.62	R-0.62	None	None
7, 8	R-1.9	R-0.62	R-0.62	R-0.62	R-0.62	None	None
<b>Return Ducts</b>							
0 to 8	R-1.06	R-1.06	R-1.06	None	None	None	None

a. Insulation R-values, measured in m<sup>2</sup>.k/kW, are for the insulation as installed and do not include film resistance. The required minimum thicknesses do not consider water vapor transmission and possible surface condensation. Where exterior *walls* are used as plenum *walls*, *wall* insulation shall be as required by the most restrictive condition of this table or Section 701.4.2 (7.4.2). Insulation resistance measured on a horizontal plane in accordance with ASTM C518 at a mean temperature of 23.8 C at the installed thickness."

b. Includes crawlspaces, both ventilated and non-ventilated.

c. Includes return air plenums with or without exposed *roofs* above

**TABLE A101.3**  
**(SUPERSEDES TABLE 6.8.2 IN ANSI/ASHRAMS STANDARD 90.1)**  
**MINIMUM DUCT INSULATION R-VALUE<sup>a</sup> COMBINED HEATING AND COOLING SUPPLY DUCTS AND RETURN DUCTS (SI)**

CLIMATE ZONE	DUCT LOCATION						
	EXTERIOR	VENTILATED ATTIC	UNVENTED ATTIC ABOVE INSULATED CEILING	UNVENTED ATTIC WITH ROOF INSULATION <sup>a</sup>	UNCONDITIONED SPACE <sup>b</sup>	INDIRECTLY CONDITIONED SPACE <sup>c</sup>	BURIED
<b>Supply Ducts</b>							
0, 1	R-1.41	R-1.41	R-1.76	R-1.06	R-1.06	None	R-1.06
2	R-1.41	R-1.41	R-1.41	R-1.06	R-1.41	None	R-1.06
3	R-1.41	R-1.41	R-1.41	R-1.06	R-1.41	None	R-1.06
4	R-1.41	R-1.41	R-1.41	R-1.06	R-1.41	None	R-1.06
5	R-1.41	R-1.41	R-1.41	R-0.62	R-1.41	None	R-1.06
6	R-1.76	R-1.41	R-1.41	R-0.62	R-1.41	None	R-1.06
7	R-1.76	R-1.41	R-1.41	R-0.62	R-1.41	None	R-1.06
8	R-1.76	R-1.94	R-1.94	R-0.62	R-1.41	None	R-1.41
<b>Return Ducts</b>							
0 to 8	R-1.06	R-1.06	R-1.06	None	None	None	None

a. Insulation R-values, measured in m<sup>2</sup>.k/kW, are for the insulation as installed and do not include film resistance. The required minimum thicknesses do not consider water vapor transmission and possible surface condensation. Where exterior *walls* are used as plenum *walls*, *wall* insulation shall be as required by the most restrictive condition of this table or Section 701.4.2 (7.4.2). Insulation resistance measured on a horizontal plane in accordance with ASTM C518 at a mean temperature of 23.8 C at the installed thickness."

b. Includes crawlspaces, both ventilated and non-ventilated.

c. Includes return air plenums with or without exposed *roofs* above

## NORMATIVE APPENDIX B

# PRESCRIPTIVE EQUIPMENT EFFICIENCY TABLES FOR THE ALTERNATE REDUCED RENEWABLES AND INCREASED EQUIPMENT EFFICIENCY APPROACH IN SECTION 701.4.1.1.2

*(This is a normative appendix and is part of this code.)*

**Informative Note:** The first 11 tables appear in I-P units and are followed by 11 tables in SI units.

**TABLE 8101.1  
(SUPERSEDES TABLE 6.8.1-1 IN ANSI/ASHRAES STANDARD 90.1)  
ELECTRICALLY OPERATED UNITARY AIR CONDITIONERS AND  
CONDENSING UNITS—MINIMUM EFFICIENCY REQUIREMENTS (I-P)**

EQUIPMENT TYPE	SIZE CATEGORY	HEATING SECTION TYPE	SUBCATEGORY OR RATING CONDITIONS	MINIMUM EFFICIENCY	TEST PROCEDURE <sup>a</sup>
Air conditioners, air cooled	<65,000 Btu/h (one phase)	All	Split systems	15.0 SEER 12.5 EER	AHRI 210/240
			Single packaged	15.0 SEER 12.0 EER	
	< 65,000 Btu/h (three phase)	All	Split systems	15.0 SEER 12.5 EER	
			Single packaged	15.0 SEER 12.0 EER	
Through-the-wall, air cooled	< 30,000 Btu/h	All	Split systems	12.0 SEER	
			Single packaged	12.0 SEER	
Small duct, high velocity, air cooled	< 65,000 Btu/h (one phase)	All	Split systems	12.0 SEER	AHRI 340/360
Small duct, high velocity, air cooled	< 65,000 Btu/h (three phase)	All	Split systems	12.0 SEER	
Air conditioners, air cooled	≥ 65,000 Btu/h and < 135,000 Btu/h	Electric resistance (or none)	Split systems and single package	14.0 IEER	
		All other	Split systems and single package	12.0 EER 13.8 IEER	
	≥ 135,000 Btu/h and < 240,000 Btu/h	Electric resistance (or none)	Split systems and single package	13.2 IEER	
		All other	Split systems and single package	12.0 EER 13.0 IEER	
	240,000 Btu/h and < 760,000 Btu/h	Electric resistance (or none)	Split systems and single package	10.8 EER 12.3 IEER	
		All other	Split systems and single package	10.6 EER 12.1 IEER	
	≥ 760,000 Btu/h	Electric resistance (or none)	Split systems and single package	10.4 EER 11.6 IEER	
		All other	Split systems and single package	10.2 EER 11.4 IEER	
Air conditioners, water cooled	< 65,000 Btu/h	All	Split systems and single package	14.0 EER 15.3 IEER	AHRI 210/240
	≥ 65,000 Btu/h and < 135,000 Btu/h	Electric resistance (or none)	Split systems and single package	14.0 EER 15.3 IEER	AHRI 340/360
		All other	Split systems and single package	13.8 EER 15.1 JEER	
	≥ 135,000 Btu/h and < 240,000 Btu/h	Electric resistance (or none)	Split systems and single package	14.0 EER 14.8 IEER	
		All other	Split systems and single package	13.8 EER 14.6 JEER	
	≥ 240,000 Btu/h and < 760,000 Btu/h	Electric resistance (or none)	Split systems and single package	14.0 EER 14.8 IEER	
		All other	Split systems and single package	13.8 EER 14.6 JEER	
	≥ 760,000 Btu/h	Electric resistance (or none)	Split systems and single package	14.0 EER 14.8 IEER	
		All other	Split systems and single package	13.8 EER 14.6 JEER	

a. Chapter 11 (Section 11) contains a detail on the referenced test procedures, including year and version of the test procedure.

*(continued)*

**TABLE 8101.1**  
**(SUPERSEDES TABLE 6.8.1-1 IN ANSI/ASHRAE STANDARD 90.1)**  
**ELECTRICALLY OPERATED UNITARY AIR CONDITIONERS AND**  
**CONDENSING UNITS—MINIMUM EFFICIENCY REQUIREMENTS (I-P) (Continued)**

EQUIPMENT TYPE	SIZE CATEGORY	HEATING SECTION TYPE	SUBCATEGORY OR RATING CONDITIONS	MINIMUM EFFICIENCY	TEST PROCEDURE <sup>a</sup>
Air conditioners, evaporatively cooled	< 65,000 Btu/h	All	Split systems and single package	14.0 EER 15.3 IEER	AHRI 210/240
	≥ 65,000 Btu/h and < 135,000 Btu/h	Electric resistance (or none)	Split systems and single package	14.0 EER 15.3 IEER	AHRI 340/360
		All other	Split systems and single package	13.8 EER 15.1 IEER	
	≥ 135,000 Btu/h and < 240,000 Btu/h	Electric resistance (or none)	Split systems and single package	14.0 EER 14.8 IEER	
		All other	Split systems and single package	13.8 EER 14.6 IEER	
	≥ 240,000 Btu/h and < 760,000 Btu/h	Electric resistance (or none)	Split systems and single package	14.0 EER 14.8 PEER	
		All other	Split systems and single package	13.8 EER 14.6 IEER	
	≥ 760,000 Btu/h	Electric resistance (or none)	Split systems and single package	14.0 EER 14.8 IEER	
		All other	Split systems and single package	13.8 EER 14.6 IEER	
Condensing units, air cooled	< 135,000 Btu/h			Not applicable match with indoor coil	AHRI 365
Condensing, water or evaporatively cooled	< 135,000 Btu/h			Not applicable match with indoor coil	

a. Chapter 11 contains a detail on the referenced test procedures, including year and version of the test procedure.

**TABLE B101.2**  
**(SUPERSEDES TABLE 6.8.1-2 IN ANSI/ASHRAE STANDARD 90.1)**  
**ELECTRICALLY OPERATED UNITARY AND APPLIED HEAT PUMPS-MINIMUM EFFICIENCY REQUIREMENTS (I-P)**

EQUIPMENT TYPE	SIZE CATEGORY	HEATING SECTION TYPE	SUBCATEGORY OR RATING CONDITIONS	MINIMUM EFFICIENCY	TEST PROCEDURE <sup>a</sup>
Air conditioners, air cooled (cooling mode)	< 65,000 Btu/h (one phase)	All	Split systems	15.0 SEER 12.5 EER	AHRI 210/240
			Single packaged	15.0 SEER 12.0 EER	
	< 65,000 Btu/h (three phase)	All	Split systems	15.0 SEER 12.5 EER	
			Single packaged	15.0 SEER 12.0 EER	
Through-the-wall, air cooled (cooling mode)	< 30,000 Btu/h	All	Split systems	12.0 SEER	
			Single packaged	12.0 SEER	
Small duct high velocity, air cooled (cooling mode)	< 65,000 Btu/h (one phase)	All	Split systems	12.0 SEER	AHRI 340/360
	< 65,000 Btu/h (three phase)	All	Split systems	12.0 SEER	
Air conditioners, air cooled (cooling mode)	≥ 65,000 Btu/h and < 135,000 Btu/h	Electric resistance (or none)	Split systems and single package	11.3 EER 12.3 IEER	
		All other	Split systems and single package	11.1 EER 12.1 IEER	
	≥ 135,000 Btu/h and < 240,000 Btu/h	Electric resistance (or none)	Split systems and single package	10.9 EER 11.9 IEER	
		All other	Split systems and single package	10.7 EER 11.7 IEER	
	≥ 240,000 Btu/h	Electric resistance (or none)	Split systems and single package	10.3 EER 10.9 IEER	
		All other	Split systems and single package	10.1 EER 10.7 IEER	
Water-to-air water loop (cooling mode)	< 17,000 Btu/h	All	86°F entering water	14.0 EER	ISO-13256-1
	≥ 17,000 Btu/h and < 65,000 Btu/h	All	86°F entering water	14.0 EER	
	≥ 65,000 Btu/h and < 135,000 Btu/h	All	86°F entering water	14.0 EER	
Water-to-air ground water (cooling mode)	< 135,000 Btu/h	All	59°F entering water	18.0 EER	
Water-to-air ground loop (cooling mode)	< 135,000 Btu/h	All	77°F entering water	14.1 EER	
Water-to-water water loop (cooling mode)	< 135,000 Btu/h	All	86°F entering water	10.6 EER	ISO-13256-2
Water-to-water groundwater (cooling mode)	< 135,000 Btu/h	All	59°F entering water	16.3 EER	
Brine-to-water ground loop (cooling mode)	< 135,000 Btu/h	All	77°F entering water	12.1 EER	
Air conditioners, air cooled (heating mode)	< 65,000 Btu/h (cooling capacity) (one phase)	All	Split systems	9.00 HSPF	AHRI 210/240
			Single packaged	8.50 HSPF	
	< 65,000 Btu/h (cooling capacity) (three phase)	All	Split systems	9.00 HSPF	AHRI 210/240
			Single packaged	8.50 HSPF	
Through-the-wall, air cooled (heating mode)	< 30,000 Btu/h (cooling capacity)	All	Split systems	7.40 HSPF	AHRI 210/240
			Single packaged	7.40 HSPF	
Small-duct high velocity, air cooled (heating mode)	< 65,000 Btu/h (cooling capacity) (one phase)	All	Split systems	7.20 HSPF	
	< 65,000 Btu/h (cooling capacity) (three phase)	All	Split systems	7.20 HSPF	

a. Chapter 11 contains a detail on the referenced test procedures, including year and version of the test procedure.

*(continued)*

**TABLE B101.2**  
**(SUPERSEDES TABLE 6.8.1-2 IN ANSI/ASHRAE STANDARD 90.1)**  
**ELECTRICALLY OPERATED UNITARY AND APPLIED HEAT PUMPS-MINIMUM EFFICIENCY REQUIREMENTS (I-P) (Continued)**

EQUIPMENT TYPE	SIZE CATEGORY	HEATING SECTION TYPE	SUBCATEGORY OR RATING CONDITIONS	MINIMUM EFFICIENCY	TEST PROCEDURE <sup>a</sup>
Air cooled (heating mode)	65,000 Btu/h and <135,000 Btu/h (cooling capacity)		47°F db/43°F wb <i>outdoor air</i>	3.40 COP <sub>H</sub>	AHRI 340/360
			17°F db/15°F wb <i>outdoor air</i>	2.40 COP <sub>H</sub>	
	135,000 Btu/h (cooling capacity)		47°F db/43°F wb <i>outdoor air</i>	3.20 COP <sub>H</sub>	
			17°F db/15°F wb <i>outdoor air</i>	2.10 COP <sub>H</sub>	
Water-to-air Water loop (heating mode)	<135,000 Btu/h (cooling capacity)		68°F entering water	4.60 COP <sub>H</sub>	ISO-13256-1
Water-to-air ground water (heating mode)	<135,000 Btu/h (cooling capacity)		50°F entering water	3.70 COP <sub>H</sub>	
Water-to-air ground loop (heating mode)	<135,000 Btu/h (cooling capacity)		32°F entering fluid	3.20 COP <sub>H</sub>	
Water-to-air water loop (heating mode)	<135,000 Btu/h (cooling capacity)		68°F entering water	3.70 COP <sub>H</sub>	ISO-13256-2
Water-to-air ground water (heating mode)	<135,000 Btu/h (cooling capacity)		50°F entering water	3.10 COP <sub>H</sub>	
Water-to-air ground loop (heating mode)	<135,000 Btu/h (cooling capacity)		32°F entering fluid	2.50 OP <sub>H</sub>	

a. Chapter 11 contains a detail on the referenced test procedures, including year and version of the test procedure.

**TABLE B101.3**  
**(SUPERSEDES TABLE 6.8.1-4 IN ANSUSHRAVIES STANDARD 90.1)**  
**ELECTRICALLY OPERATED SINGLE-PACKAGED VERTICAL AIR CONDITIONERS AND SINGLE-PACKAGED**  
**VERTICAL HEAT PUMPS AIR-CONDITIONER HEAT PUMPS—MINIMUM EFFICIENCY REQUIREMENTS (I-P)**

EQUIPMENT TYPE	SIZE CATEGORY	SUBCATEGORY OR RATING CONDITIONS	MINIMUM EFFICIENCY	TEST PROCEDURE <sup>a</sup>
PTAC (cooling mode) standard size	All capacities	95°F db <i>outdoor air</i>	14.4 - (0.300 x Cap/1000) <sup>c</sup> EER	AHRI 310/380
PTAC (cooling mode) nonstandard size <sup>b</sup>	All capacities	95°F db <i>outdoor air</i>	10.9 - (0.213 x Cap/1000) <sup>c</sup> EER	AHRI 310/380
PTHP (cooling mode) standard size	All capacities	95°F db <i>outdoor air</i>	14.4 - (0.300 x Cap/1000) <sup>c</sup> EER	ARI 310/380
PTHP (cooling mode) nonstandard size <sup>b</sup>	< 7000 Btu/h	95°F db <i>outdoor air</i>	10.8 - (0.213 x Cap/1000) <sup>c</sup> EER	ARI 310/380
PTHP (heating mode) new constructions	All capacities	47°F db/43°F wb <i>outdoor air</i>	3.7 - (0.052 x Cap/1000) <sup>c</sup> COP <sub>H</sub>	ARI 310/380
PTHP (heating mode) nonstandard size <sup>b</sup>	All capacities	47°F db/43°F wb <i>outdoor air</i>	2.9 - (0.026 x Cap/1000) <sup>c</sup> COP <sub>H</sub>	ARI 310/380

a. Chapter 11 (Section 11) contains a complete specification of the referenced test procedures including year version of the test procedure.

b. Replacement units shall be factory labeled as follows: "MANUFACTURED FOR REPLACEMENT APPLICATIONS ONLY; NOT TO BE INSTALLED IN NEW CONSTRUCTION PROJECTS." Replacement efficiencies apply only to units with existing sleeves less than 16 *in.* high and less than 42 *in.* wide and having a cross-sectional area less than 670 *in*<sup>2</sup>

c. "Cap" means the rated cooling capacity of the product in Btu/h. If the unit's capacity is less than 7000 Btu/h, use 7000 Btu/h in the calculation. If the unit's capacity is greater than 15,000 Btu/h, use 15,000 Btu/h in the calculation.



**TABLE B101.4**  
**(SUPERSEDES TABLE 6.8.1-4 IN ANSWASHRAVIES STANDARD 90.1)**  
**SINGLE-PACKAGED VERTICAL AIR CONDITIONERS, SINGLE-PACKAGED VERTICAL HEAT PUMPS, ROOM AIR CONDITIONERS,**  
**AND ROOM AIR-CONDITIONER HEAT PUMPS-MINIMUM EFFICIENCY REQUIREMENTS (I-P)**

EQUIPMENT TYPE	SIZE CATEGORY (INPUT)	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY BASE	MINIMUM EFFICIENCY CONNECTED <sup>b</sup>	TEST PROCEDURE <sup>a</sup>
SPVAC (cooling mode)	< 65,000 Btu/h	95°F db/75°F wb <i>outdoor air</i>	14.0 SEER		AHRI 210/240
	≥ 65,000 Btu/h and < 135,000 Btu/h	95°F db/75°F wb <i>outdoor air</i>	11.2 EER 12.9 IEER		AHRI 340/360
	≥ 135,000 Btu/h and < 240,000 Btu/h	95°F db/75°F wb <i>outdoor air</i>	11.0 EER 12.4 IEER		
SPVHP (cooling mode)	< 65,000 Btu/h	95°F db/75°F wb <i>outdoor air</i>	14.0 SEER		AHRI 210/240
	≥ 65,000 Btu/h and < 135,000 Btu/h	95°F db/75°F wb <i>outdoor air</i>	11.0 EER 12.2 IEER		AHRI 340/360
	≥ 135,000 Btu/h and < 240,000 Btu/h	95°F db/75°F wb <i>outdoor air</i>	10.6 EER 11.6 IEER		
SPVHP (heating mode)	< 65,000 Btu/h	47°F db/43°F wb <i>outdoor air</i>	8.0 HSPF		AHRI 210/240
	≥ 65,000 Btu/h and < 135,000 Btu/h	47°F db/43°F wb <i>outdoor air</i>	3.3 COP <sub>H</sub>		AHRI 340/360
	≥ 135,000 Btu/h and < 240,000 Btu/h	47°F db/43°F wb <i>outdoor air</i>	3.2 COP <sub>H</sub>		
Room air conditioners, with louvered sides	< 6,000 Btu/h		12.1 <i>CEER</i>	11.5 <i>CEER</i>	ANSI/AHAM RAC-1
	≥ 6,000 Btu/h and < 8,000 Btu/h		12.1 <i>CEER</i>	11.5 <i>CEER</i>	
	≥ 8,000 Btu/h and < 14,000 Btu/h		12.0 <i>CEER</i>	11.5 <i>CEER</i>	
	≥ 14,000 Btu/h and < 20,000 Btu/h		11.8 <i>CEER</i>	11.2 <i>CEER</i>	
	≥ 20,000 Btu/h and < 28,000 Btu/h		10.3 <i>CEER</i>	9.8 <i>CEER</i>	
	≥ 28,000 Btu/h		9.9 <i>CEER</i>	9.4 <i>CEER</i>	
Room air conditioners, without louvered sides	< 6,000 Btu/h		11.0 <i>CEER</i>	10.5 <i>CEER</i>	
	≥ 6,000 Btu/h and < 8,000 Btu/h		11.0 <i>CEER</i>	10.5 <i>CEER</i>	
	≥ 8,000 Btu/h and < 11,000 Btu/h		10.6 <i>CEER</i>	10.1 <i>CEER</i>	
	≥ 11,000 Btu/h and < 14,000 Btu/h		10.5 <i>CEER</i>	10.0 <i>CEER</i>	
	≥ 14,000 Btu/h and < 20,000 Btu/h		10.2 <i>CEER</i>	9.7 <i>CEER</i>	
	≥ 20,000 Btu/h		10.3 <i>CEER</i>	9.8 <i>CEER</i>	
Room air conditioner heat pump, with louvered sides	< 20,000 Btu/h		10.8 <i>CEER</i>	10.3 <i>CEER</i>	
	≥ 20,000 Btu/h		10.2 <i>CEER</i>	9.7 <i>CEER</i>	
Room air conditioner heat pump, without louvered sides	< 14,000 Btu/h		10.2 <i>CEER</i>	9.7 <i>CEER</i>	
	≥ 14,000 Btu/h		9.6 <i>CEER</i>	9.1 <i>CEER</i>	
Room air conditioner, casement only	All capacities		10.5 <i>CEER</i>	10.0 <i>CEER</i>	
Room air conditioner, casement-slider	All capacities		11.4 <i>CEER</i>	10.8 <i>CEER</i>	

a. Chapter 11 (Section 11) contains details for the referenced test procedure, including the referenced year version of the test procedure.

b. Connected room air conditioners that are connected to utility programs are allowed a lower *CEER* value but must be in compliance with and certified per EnergyStar version 4.0 requirements for connected equipment.

**TABLE B101.5**  
**(SUPERSEDES TABLE 6.8.1-5 IN ANSI/ASHRAE STANDARD 90.1)**  
**WARM-AIR FURNACES AND COMBINATION WARM-AIR FURNACES/AIR-CONDITIONING UNITS, WARM-AIR DUCT FURNACES, AND UNIT HEATERS—MINIMUM EFFICIENCY REQUIREMENTS (I-P)**

EQUIPMENT TYPE	SIZE CATEGORY (INPUT)	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY	TEST PROCEDURE <sup>a</sup>
Warm-air furnace, gas fired (weatherized)	< 225,000 Btu/h	Maximum capacity <sup>c</sup>	81% AFUE <sup>b</sup>	DOE 10 CFR Part 430 or Section 2.39, Thermal Efficiency, ANSI Z21.47
	≥ 225,000 Btu/h		80% E <sub>t</sub> <sup>d</sup>	Section 2.39, Thermal Efficiency, ANSI Z21.47
Warm-air furnace, gas fired (nonweatherized)	< 225,000 Btu/h	Maximum capacity <sup>c</sup>	90% AFUE or 92% E <sub>t</sub> <sup>b,d</sup>	DOE 10 CFR Part 430 or Section 2.39, Thermal Efficiency, ANSI Z21.47
	≥ 225,000 Btu/h		92% E <sub>t</sub> <sup>d</sup>	Section 2.39, Thermal Efficiency, ANSI Z21.47
Warm-air furnace, oil fired (weatherized)	< 225,000 Btu/h	Maximum capacity <sup>c</sup>	78% AFUE <sup>b,d</sup>	DOE 10 CFR Part 430 or Section 42, Combustion, UL 727
	> 225,000 Btu/h		81% E <sub>t</sub> <sup>d</sup>	Section 42, Combustion, UL 727
Warm-air furnaces, oil fired (nonweatherized)	< 225,000 Btu/h	Maximum capacity <sup>c</sup>	85% AFUE or 87% E <sub>t</sub> <sup>b,d</sup>	DOE 10 CFR Part 430 or Section 42, Combustion, UL 727
	≥ 225,000 Btu/h		87% E <sub>t</sub> <sup>d</sup>	Section 42, Combustion, UL 727
Warm-air duct furnace, gas fired (weatherized)	All capacities	Maximum capacity <sup>c</sup>	80% E <sub>c</sub> <sup>e</sup>	Section 2.10, Efficiency, ANSI Z83.8
Warm-air duct furnace, gas fired (nonweatherized)	All capacities	Maximum capacity <sup>c</sup>	90% E <sub>c</sub> <sup>e</sup>	Section 2.10, Efficiency, ANSI Z83.8
Warm-air unit heater, gas fired (nonweatherized)	All capacities	Maximum capacity <sup>c</sup>	80% E <sub>c</sub> <sup>e,f</sup>	Section 2.10, Efficiency, ANSI Z83.8
Warm-air unit heater, oil fired (weatherized)	All capacities	Maximum capacity <sup>c</sup>	90% E <sub>c</sub> <sup>e,f</sup>	Section 40, Combustion, UL 731

- a. Chapter 11 (Section 11) contains a complete specification of the referenced test procedure, including the referenced year version of the test procedure.
- b. Combination units not covered by the U.S. Department of Energy Code of Federal Regulations 10 CFR 430 (three-phase power or cooling capacity greater than or equal to 65,000 Btu/h) may comply with either rating.
- c. Compliance of multiple firing rate units shall be at the maximum firing rate.
- d. E<sub>t</sub> = thermal efficiency. Units must also include an interrupted or intermittent ignition device (IID), have jacket losses not exceeding 0.75% of the input rating, and have either power venting or flue damper. A vent damper is an acceptable alternative to a flue damper for those furnaces where combustion air is drawn from the conditioned space.
- d. k = combustion efficiency (100% less flue losses). See test procedure for detailed discussion.
- d. As of August 8, 2008, according to the Energy Policy Act of 2005, units must also include an interrupted or intermittent ignition device (IID) and have either power venting or an automatic flue damper.

**TABLE B101.6**  
**(SUPERSEDES TABLE 6.8.1-6 IN ANSI/ASHRAE/IES STANDARD 90.1)**  
**GAS- AND OIL-FIRED BOILERS—MINIMUM EFFICIENCY REQUIREMENTS (I-P)**

EQUIPMENT TYPE <sup>a</sup>	SUBCATEGORY OR RATING CONDITION	SIZE CATEGORY (INPUT)	MINIMUM EFFICIENCY <sup>hc</sup>	TEST PROCEDURE <sup>g</sup>
Boilers, hot water	Gas fired	< 300,000 Btu/h <sup>hi</sup>	89% AFUE <sup>th</sup>	10 CFR Part 430
		≥ 300,000 Btu/h and ≤ 2,500,000 Btu/h <sup>d</sup>	89% E <sub>t</sub> <sup>f</sup>	10 CFR Part 431
		> 2,500,000 Btu/h <sup>a</sup>	91% E <sub>c</sub> <sup>f</sup>	
	Oil fired <sup>c</sup>	< 300,000 Btu/h	89% AFUE <sup>f</sup>	10 CFR Part 430
		≥ 300,000 Btu/h and ≤ 2,500,000 Btu/h <sup>d</sup>	85% E <sub>t</sub> <sup>f</sup>	10 CFR Part 431
		> 2,500,000 Btu/h <sup>a</sup>	86% E <sub>c</sub> <sup>f</sup>	
Boilers, steam	Gas fired	< 300,000 Btu/h <sup>i</sup>	80% AFUE	10 CFR Part 430
	Gas fired all except natural draft	≥ 300,000 Btu/h and ≤ 2,500,000 Btu/h <sup>d</sup>	79% E <sub>t</sub>	10 CFR Part 431
		> 2,500,000 Btu/h <sup>a</sup>	79% E <sub>t</sub>	
	Gas fired natural draft	≥ 300,000 Btu/h and ≤ 2,500,000 Btu/h <sup>d</sup>	77% E <sub>t</sub>	
		> 2,500,000 Btu/h <sup>a</sup>	77% E <sub>t</sub>	
	Oil fired <sup>c</sup>	< 300,000 Btu/h	82% AFUE	10 CFR Part 430
		≥ 300,000 Btu/h and ≤ 2,500,000 Btu/h <sup>d</sup>	81% E <sub>t</sub>	10 CFR Part 431
		> 2,500,000 Btu/h <sup>a</sup>	81% E <sub>t</sub>	

- These requirements apply to boilers with rated input of 8,000,000 Btu/h or less that are not packaged boilers and to all packaged boilers. Minimum efficiency requirements for boilers cover all capacities of packaged boilers.
- E<sub>c</sub> = thermal efficiency (100% less flue losses). See reference document for detailed information.
- E<sub>t</sub> = thermal efficiency. See reference document for detailed information.
- Maximum capacity—minimum and maximum ratings as provided for and allowed by the units controls.
- Includes oil fired (residual).
- Systems shall be designed with lower operating return hot-water temperatures (<130°F) and use hot-water reset to take advantage of the much higher efficiencies of condensing boilers.
- Chapter 11 (Section 11) contains details for the referenced test procedure, including the referenced year version of the test procedure.
- A boiler not equipped with a tankless domestic water-heating coil shall be equipped with an *automatic* means for adjusting the temperature of the water such that an incremental change in inferred heat load produces a corresponding incremental change in the temperature of the water supplied.
- Boilers shall not be equipped with a continuous pilot ignition system.

**TABLE B101.7**  
**(SUPERSEDES TABLE 6.8.1-7 IN ANSI/ASHRAE/IES STANDARD 90.1)**  
**PERFORMANCE REQUIREMENTS FOR HEAT REJECTION EQUIPMENT—MINIMUM EFFICIENCY REQUIREMENTS (I-P)**

EQUIPMENT TYPE	TOTAL SYSTEM HEAT REJECTION CAPACITY AT RATED CONDITIONS	SUBCATEGORY OR RATING CONDITION <sup>a</sup>	PERFORMANCE REQUIRED <sup>a,b,c,d,e,f,i</sup>	TEST PROCEDURE <sup>h</sup>
Propeller or axial fan open-circuit cooling towers	All	95° entering water 85° leaving water 75° entering wb	≥ 42.1 gpm/hp	CTI ATC-105 and CTI STD-201RS
Centrifugal fan open-circuit cooling towers	All	95°F entering water 85°F leaving water 75°F entering wb	≥ 22.0 gpm/hp	CTI ATC-105 and CTI STD-201RS
Propeller or axial fan closed-circuit cooling towers	All	102°F entering water 90°F leaving water 75°F entering wb	≥ 16.1 gpm/hp	CTI ATC-105S and CTI STD-201RS
Centrifugal fan closed-circuit cooling towers	All	102°F entering water 90°F leaving water 75°F entering wb	≥ 8.0 gpm/hp	CTI ATC-105S and CTI STD-201RS
Propeller or axial fan evaporative condensers	All	Ammonia test fluid 140°F entering gas temperature 96.3°F condensing temperature 75°F entering wb	≥ 134,000 Btu/h•hp	CTI ATC-106
Centrifugal fan evaporative condensers	All	Ammonia test fluid 140°F entering gas temperature 96.3°F condensing temperature 75°F entering wb	≥ 110,000 Btu/h•hp	CTI ATC-106
Propeller or axial fan evaporative condensers	All	R-507A test fluid 165°F entering gas temperature 105°F condensing temperature 75°F entering wb	≥ 157,000 Btu/h•hp	CTI ATC-106
Centrifugal fan evaporative condensers	All	R-507A test fluid 165°F entering gas temperature 105°F condensing temperature 75°F entering wb	≥ 135,000 Btu/h•hp	CTI ATC-106
Air-cooled condensers	All	190°F entering gas Temperature 125°F condensing temperature 15°F subcooling 95°F entering wb	≥ 176,000 Btu/h•hp	AHRI 460

- a. For purposes of this table, *open-circuit cooling tower performance* is defined as the water flow rating of the tower at the thermal rating condition listed in Table B101.7 (B-7) divided by the fan motor nameplate power.
- b. For purposes of this table, *closed-circuit cooling tower performance* is defined as the process water flow rating of the tower at the thermal rating condition listed in Table B101.7 (B-7) divided by the sum of the fan motor nameplate power and the integral spray pump motor nameplate power.
- c. For purposes of this table, *evaporative condenser performance* is defined as the heat rejected at the specified rating condition in the table divided by the sum of the fan motor nameplate power and the integral spray pump nameplate power.
- d. For purposes of this table, *air-cooled condenser performance* is defined as the heat rejected from the refrigerant divided by the fan motor nameplate power.
- e. The efficiencies and test procedures for both *open-* and *closed-circuit cooling towers* are not applicable to hybrid cooling towers that contain a combination of separate wet and dry heat exchange sections. The certification requirements do not apply to field erected cooling towers.
- f. All cooling towers, closed-circuit coolers, evaporative condensers, and air-cooled condensers shall comply with the minimum efficiency listed in the table for that specific type of equipment with the capacity effect of any project specific accessories and/or options included with the equipment.
- g. Requirements for evaporative condensers are listed with ammonia (R-717) and R-507A as test fluids in the table. Evaporative condensers intended for use with halocarbon refrigerants other than R-507A must meet the minimum efficiency requirements listed for R-507A as the test fluid.
- h. Informative Appendix G contains information on the referenced test procedures.
- i. Not applicable for air-cooled condensers applied to condenserless chillers. The air-cooled condenser and condenserless chiller shall comply with the requirements for air-cooled chillers as defined in ANSI/ASHRAE/IES Standard 90.1, Table 6.8.1-3.

**TABLE B101.8**  
**(SUPERSEDES TABLE 7.8 IN ANSVASHRAE/IES STANDARD 90.1)**  
**PERFORMANCE REQUIREMENTS FOR SERVICE WATER HEATING EQUIPMENT (I-P)**

EQUIPMENT TYPE	SIZE CATEGORY (INPUT)	RATED STORAGE VOLUME AND INPUT RATING (IF APPLICABLE)	DRAW PATTERN	PERFORMANCE REQUIRED <sup>a</sup>	TEST PROCEDURE <sup>b</sup>
Electric table-top water heaters <sup>c</sup>	≤ 12 kW	≥ 20 gal and ≤ 120 gal	Very small	UEF ≥ 0.6323 - 0.0058 $V$	DOE 10 CFR Part 430
			Low	UEF ≥ 0.9188 - 0.0031 $V$	
			Medium	UEF ≥ 0.9577 - 0.0023 $V$	
			High	UEF ≥ 0.9844 - 0.0016 $V$	
Electric resistance storage water heaters		≥ 20 gal and ≤ 55 gal	Very small	UEF ≥ 0.8808 - 0.0008 $V$	DOE 10 CFR Part 430
			Low	UEF ≥ 0.9254 - 0.0003 $V$	
			Medium	UEF ≥ 0.9307 - 0.0002 $V$	
			High	UEF ≥ 0.9349 - 0.0001 $V$	
		> 55 gal		Must use heat-pump water heater	
Electric resistance grid-enabled water heaters		> 75 gal	Very small	UEF ≥ 1.0136 - 0.0028 $V$	DOE 10 CFR Part 430
			Low	UEF ≥ 0.09984 - 0.0014 $V$	
			Medium	UEF ≥ 0.9853 - 0.0010 $V$	
			High	UEF ≥ 0.9720 - 0.0007 $V$	
Heat-pump water heaters		55 gal		EF ≥ 2.00, FHR ≥ 50 gal	DOE 10 CFR Part 430
		> 55 gal		EF ≥ 2.20, FHR ≥ 50 gal	
Gas-fired storage water heaters	75,000 Btu/h	55 gal		EF ≥ 0.67, FHR ≥ 67 gal	DOE 10 CFR Part 430
		> 55 gal		EF ≥ 0.77, FHR ≥ 67 gal	
	> 75,000 Btu/h	140 gal		$E_t$ ≥ 0.94 or EF ≥ 0.93 and SL ≥ 0.84 x ( $Q/800 + 110\sqrt{V}$ ), Btu/h	ANSI Z21.10.3
Gas instantaneous water heaters	> 50,000 Btu/h and < 200,000 Btu/h <sup>d</sup>	≥ 4,000 (Btu/h)/gal and < 2 gal		EF ≥ 0.90 and GPM ≥ 2.5 over a 77°F rise	DOE 10 CFR Part 430
	> 75,000 Btu/h <sup>c</sup>	≤ 140 gal and ≥ 4,000 (Btu/h)/gal		$E_t$ ≥ 0.94 or EF ≥ 0.93 SL = 0.84 x ( $Q/800 + 110\sqrt{V}$ ), Btu/h	ANSI Z21.10.3
Oil storage water heaters	≤ 105,000 Btu/h	≤ 50 gal	Very small	EF = 0.2509 - 0.0012V	DOE 10 CFR Part 430
			Low	EF = 0.5330 - 0.0016V	
			Medium	EF = 0.6078 - 0.0016V	
			High	EF = 0.6815 - 0.0014V	
	> 105,000 Btu/h	< 4,000 (Btu/h)/gal		$E_t$ ≥ 80% and SL ≤ ( $Q/800 + 110\sqrt{V}$ ), Btu/h	ANSI Z21.10.3
Oil instantaneous water heaters	≤ 210,000 Btu/h	≤ 50 gal		EF ≥ 0.59- 0.0019V	DOE 10 CFR Part 430
	> 210,000 Btu/h	≥ 4,000 (Btu/h)/gal and < 10 gal		$E_t$ ≥ 80%	ANSI Z21.10.3
	> 210,000 Btu/h	≥ 4,000 (Btu/h)/gal and ≥ 10 gal		$E_t$ ≥ 78% and SL ≤ ( $Q/800 + 110\sqrt{V}$ ), Btu/h	
Solar water heater		Electric backup		SEF ≥ 1.8	ANSI Z21.10.3
		Gas backup		SEF ≥ 1.2	
Hot-water supply boilers, gas and oil	> 300,000 Btu/h and ≤ 12,500,000 Btu/h	≥ 4,000 (Btu/h)/gal and < 10 gal		$E_t$ ≥ 80%	ANSI Z21.10.3
Hot-water supply boilers, gas		≥ 4,000 (Btu/h)/gal and ≥ 10 gal		$E_t$ ≥ 80% and SL ≤ ( $Q/800 + 110\sqrt{V}$ ), Btu/h	ANSI Z21.10.3
Hot-water supply boilers, oil		≥ 4,000 (Btu/h)/gal and ≥ 10 gal		$E_t$ ≥ 78% and SL ≤ ( $Q/800 + 110\sqrt{V}$ ), Btu/h	
Pool heaters, gas	All sizes			$E_t$ ≥ 82%	ASHRAE 146
Pool heaters, oil	All sizes			$E_t$ ≥ 78%	ASHRAE 146
Heat-pump pool heaters	All sizes	50°F db 44.2°F wb outdoor air 80.0°F entering water		≥ 4.0 COP	AHRI 1180
Unfired storage tanks	All sizes			≥ R-12.5	None

a. Energy factor (EF) and thermal efficiency (E) are minimum requirements, while standby loss (SL) is maximum Btu/h based on a 70°F temperature difference between stored water and ambient requirements. In the EF equation, V is the rated volume in gallons. In the SL equation, V is the rated volume in gallons and Q is the nameplate input rate in Btu/h.

b. Chapter 11 (Section 11) contains details on the referenced test procedures, including the year/version of the referenced test procedure.

c. Section G.1 is titled "Test Method for Measuring Thermal Efficiency," and Section G.2 is titled "Test Method for Measuring Standby Loss."

d. UEF is the Uniform Energy Factor and is a dimensionless number that is calculated per DOE 10 CFR Part 430 test procedures.

**TABLE B101.9**  
**COMMERCIAL CLOTHES WASHERS (I-F)**

PRODUCT	MEF <sup>a</sup>	WF <sup>b</sup> , gal/ft <sup>3</sup>
All commercial clothes washers	1.72	4.0

a. MEF = modified energy factor, a combination of energy factor and remaining moisture content. MEF measures energy consumption of the total laundry cycle (washing and drying). It indicates how many cubic feet of laundry can be washed and dried with one kWh of electricity: the higher the number, the greater the efficiency.

b. WF = water factor (in gal/W).

**TABLE B101.10**  
**(SUPERSEDES TABLE 6.8.1-9 IN ANSI/ASHRAE STANDARD 90.1)**  
**ELECTRICALLY OPERATED VARIABLE-REFRIGERANT-FLOW (VRF) AIR**  
**CONDITIONERS—MINIMUM EFFICIENCY REQUIREMENTS (I-P)**

EQUIPMENT TYPE	SIZE CATEGORY	HEATING SECTION TYPE	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY	TEST PROCEDURE <sup>a</sup>
VRF air conditioners, air cooled	< 65,000 Btu/h	All	VRF multisplit system	15.0 SEER 12.5 EER	AHRI 1230
	≥ 65,000 Btu/h and < 135,000 Btu/h	Electric resistance (or none)	VRF multisplit system	11.7 EER 14.9 IEER	
	≥ 135,000 Btu/h and < 240,000 Btu/h	Electric resistance (or none)	VRF multisplit system	11.7 EER 14.4 IEER	
	≥ 240,000 Btu/h	Electric resistance (or none)	VRF multisplit system	10.5 EER 13.0 IEER	

a. Chapter 11 (Section 11) contains details for the referenced test procedure, including year version of the test procedure.

**TABLE B101.11**  
**(SUPERSEDES TABLE 6.8.1-10 IN ANSI/ASHRAE STANDARD 90.1)**  
**ELECTRICALLY OPERATED VARIABLE-REFRIGERANT-FLOW AND APPLIED**  
**HEAT PUMP—MINIMUM EFFICIENCY REQUIREMENTS (I-P)**

EQUIPMENT TYPE	SIZE CATEGORY	HEATING SECTION TYPE	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY	TEST PROCEDURE <sup>a</sup>
VRF air cooled (cooling mode)	<65,000 Btu/h	All	VRF multisplit system	15.0 SEER 12.5 EER	AHRI 1230
	≥ 65,000 Btu/h and <135,000 Btu/h	Electric resistance (or none)	VRF multisplit system	11.3 EER 14.6 IEER	
	≥ 65,000 Btu/h and < 135,000 Btu/h	Electric resistance (or none)	VRF multisplit system with heat recovery	11.1 EER 14.4 IEER	
	≥ 135,000 Btu/h and < 240,000 Btu/h	Electric resistance (or none)	VRF multisplit system	10.9 EER 13.9 IEER	
	≥ 135,000 Btu/h and < 240,000 Btu/h	Electric resistance (or none)	VRF multisplit system with heat recovery	10.7 EER 13.7 IEER	
	≥ 240,000 Btu/h	Electric resistance (or none)	VRF multisplit system	10.3 EER 12.7 IEER	
	≥ 240,000 Btu/h	Electric resistance (or none)	VRF multisplit system with heat recovery	10.1 EER 12.5 IEER	
VRF water source (cooling mode)	< 65,000 Btu/h	All	VRF multisplit systems 86°F entering water	14.0 EER 16.0 IEER	AHRI 1230
	< 65,000 Btu/h	All	VRF multisplit systems with heat recovery 86°F entering water	13.8 EER 15.8 IEER	
	≥ 65,000 Btu/h and <135,000 Btu/h	All	VRF multisplit system 86°F entering water	14.0 EER 16.0 IEER	
	≥ 65,000 Btu/h and < 135,000 Btu/h	All	VRF multisplit system with heat recovery 86°F entering water	13.8 EER 15.8 IEER	
	≥ 135,000 Btu/h	All	VRF multisplit system 86°F entering water	11.6 EER 14.0 IEER	
	≥ 135,000 Btu/h	All	VRF multisplit system with heat recovery 86°F entering water	11.2 EER 13.8 IEER	

a. Chapter 11 (Section 11) contains details for the referenced test procedure, including year version of the test procedure.

(Continued)

**TABLE B101.11**  
**(SUPERSEDES TABLE 6.8.1-10 IN ANSI/ASHRAMS STANDARD 90.1)**  
**ELECTRICALLY OPERATED VARIABLE-REFRIGERANT-FLOW AND APPLIED**  
**HEAT PUMP-MINIMUM EFFICIENCY REQUIREMENTS (I-P) (Continued)**

EQUIPMENT TYPE	SIZE CATEGORY	HEATING SECTION TYPE	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY	TEST PROCEDURE <sup>a</sup>
VRF groundwater source (cooling mode)	< 135,000 Btu/h	All	VRF multisplit system 59°F entering water	16.2 EER	AHRI 1230
	< 135,000 Btu/h	All	VRF multisplit system with heat recovery 59°F entering water	16.0 EER	
	≥ 135,000 Btu/h	All	VRF multisplit system 59°F entering water	13.8 EER	
	≥ 135,000 Btu/h	All	VRF multisplit system with heat recovery 59°F entering water	13.6 EER	
VRF groundwater source (cooling mode)	< 135,000 Btu/h	All	VRF multisplit system 77°F entering water	114 EER	AHRI 1230
	< 135,000 Btu/h	All	VRF multisplit system with heat recovery 77°F entering water	13.2 EER	
	≥ 135,000 Btu/h	All	VRF multisplit system 77°F entering water	11.0 EER	
	≥ 135,000 Btu/h	All	VRF multisplit system with heat recovery 77°F entering water	10.8 EER	
VRF air cooled (heating mode)	< 65,000 Btu/h (cooling capacity)		VRF multisplit system	8.5 HSPF	AHRI 1230
	≥ 65,000 Btu/h and <135,000 Btu/h (cooling capacity)		VRF multisplit system 47°F db/43°F wb <i>outdoor air</i>	3.40 COP <sub>H</sub>	
			17°F db/15°F wb <i>outdoor air</i>	2.40 COP <sub>H</sub>	
	≥ 135,000 Btu/h (cooling capacity)		VRF multisplit system 47°F db/43°F wb <i>outdoor air</i>	3.20 COP <sub>H</sub>	
			17°F db/15°F wb <i>outdoor air</i>	2.10 COP <sub>H</sub>	
VRF water source (heating mode)	< 135,000 Btu/h (cooling capacity)		VRF multisplit system 68°F entering water	4.60 COP <sub>H</sub>	AHRI 1230
	≥ 135,000 Btu/h (cooling capacity)		VRF multisplit system 68°F entering water	4.20 COP <sub>H</sub>	
VRF groundwater source (heating mode)	< 135,000 Btu/h (cooling capacity)		VRF multisplit system 50°F entering water	3.60 COP <sub>H</sub>	AHRI 1230
	≥ 135,000 Btu/h (cooling capacity)		VRF multisplit system 50°F entering water	3.30 COP <sub>H</sub>	
VRF ground source (heating mode)	< 135,000 Btu/h (cooling capacity)		VRF multisplit system 32°F entering fluid	3.10 COP <sub>H</sub>	AHRI 1230
	≥ 135,000 Btu/h (cooling capacity)		VRF multisplit system 32°F entering fluid	2.80 COP <sub>H</sub>	

a. Chapter 11 (Section 11) contains details for the referenced test procedure, including year version of the test procedure.

**TABLE B101.1**  
**(SUPERSEDES TABLE 6.8.1-1 IN ANSWASHRAVIES STANDARD 90.1)**  
**ELECTRICALLY OPERATED UNITARY AIR CONDITIONERS AND**  
**CONDENSING UNITS—MINIMUM EFFICIENCY REQUIREMENTS (SI)**

EQUIPMENT TYPE	SIZE CATEGORY	HEATING SECTION TYPE	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY	TEST PROCEDURE <sup>a</sup>
Air conditioners, air cooled	< 19 kW (one phase)	All	Split systems	4.40 SCOP <sub>c</sub> 3.66 COP <sub>c</sub>	AMU 210/240
			Single packaged	4.40 SCOP <sub>c</sub> 3.52 COP <sub>c</sub>	
	< 19 kW (three phase)	All	Split systems	4.40 SCOP <sub>c</sub> 3.52 COP <sub>c</sub>	
			Single packaged	4.10 SCOP <sub>c</sub> 3.40 COP <sub>c</sub>	
Through-the-wall, air cooled	< 9 kW	All	Split systems	3.52 SCOP <sub>c</sub>	
			Single packaged	3.52 SCOP <sub>c</sub>	
Small duct, high velocity, air cooled	< 19 kW (one phase)	All	Split systems	3.52 SCOP <sub>c</sub>	ARI 340/360
	< 19 kW (three phase)	All	Split systems	3.52 SCOP <sub>c</sub>	
Air conditioners air cooled	≥ 19 kW and < 40 kW	Electric resistance (or none)	Split systems and single package	4.10 ICO <sub>c</sub>	
		All other	Split systems and single package	3.52 COP <sub>c</sub> 4.04 ICOP <sub>c</sub>	
	≥ 40 kW and < 70 kW	Electric resistance (or none)	Split systems and single package	3.87 ICOP <sub>c</sub>	
		All other	Split systems' and single package	3.52 COP <sub>c</sub> 3.81 ICOP <sub>c</sub>	
	≥ 70 kW and < 223 kW	Electric resistance (or none)	Split systems and single package	3.17 COP <sub>c</sub> 3.60 ICOP <sub>c</sub>	
		All other	Split systems and single package	3.11 COP <sub>c</sub> 3.55 ICOP <sub>c</sub>	
	≥ 223 kW	Electric resistance (or none)	Split systems and single package	3.05 COP <sub>c</sub> 3.40 ICOP <sub>c</sub>	
		All other	Split systems and single package	2.99 COP <sub>c</sub> 3.34 ICOP <sub>c</sub>	

a. Chapter 11 (Section 11) contains details for the referenced test procedure, including year version of the test procedure.

*(Continued)*



**TABLE B101.1**  
**(SUPERSEDES TABLE 6.8.1-1 IN ANSI/ASHRAE STANDARD 90.1)**  
**ELECTRICALLY OPERATED UNITARY AIR CONDITIONERS AND**  
**CONDENSING UNITS—MINIMUM EFFICIENCY REQUIREMENTS (SI) (Continued)**

EQUIPMENT TYPE	SIZE CATEGORY	HEATING SECTION TYPE	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY	TEST PROCEDURE <sup>a</sup>
Air conditioners, water cooled	< 19 kW	All	Split systems and single package	4.10 COP <sub>e</sub>	AHRI 210/240
			Split systems and single package	4.48 ICOP <sub>e</sub>	
	≥ 19 kW and < 140 kW	Electric resistance (or none)	Split systems and single package	4.10 COP <sub>e</sub> 4.48 ICOP <sub>e</sub>	AHRI 340/360
		All other	Split systems and single package	4.04 COP <sub>e</sub> 4.43 ICOP <sub>e</sub>	
	≥ 40 kW and < 70 kW	Electric resistance (or none)	Split systems and single package	4.10 COP <sub>e</sub> 4.34 ICOP <sub>e</sub>	
		All other All	Split systems and single package	4.04 COP <sub>e</sub> 4.28 ICOP <sub>e</sub>	
	≥ 70 kW and < 223 kW	Electric resistance (or none)	Split systems and single package	4.10 COP <sub>e</sub> 4.34 ICOP <sub>e</sub>	
		All other	Split systems and single package	3.99 COP <sub>e</sub> 4.28 ICOP <sub>e</sub>	
	≥ 223 kW	Electric resistance (or none)	Split systems and single package	4.10 COP <sub>e</sub> 4.34 ICOP <sub>e</sub>	
		All other	Split systems and single package	4.04 COP <sub>e</sub> 4.28 ICOP <sub>e</sub>	
Air conditioners, evaporatively cooled	< 19 kW	All	Split systems and single package	4.10 COP <sub>e</sub> 4.48 ICOP <sub>e</sub>	AHRI 210/240
	≥ 19 kW and < 140 kW	Electric resistance (or none)	Split systems and single package	4.10 COP <sub>e</sub> 4.48 ICOP <sub>e</sub>	AHRI 340/360
		All other	Split systems and single package	4.04 COP <sub>e</sub> 4.43 ICOP <sub>e</sub>	
	≥ 40 kW and < 70 kW	Electric resistance (or none)	Split systems and single package	3.96 COP <sub>e</sub> 4.19 ICOP <sub>e</sub>	
		All other All	Split systems and single package	3.90 COP <sub>e</sub> 4.13 ICOP <sub>e</sub>	
	≥ 70 kW and < 223 kW	Electric resistance (or none)	Split systems and single package	3.96 COP <sub>e</sub> 4.19 ICOP <sub>e</sub>	
		All other	Split systems and single package	3.90 COP <sub>e</sub> 4.13 ICOP <sub>e</sub>	
	≥ 223 kW	Electric resistance (or none)	Split systems and single package	3.96 COP <sub>e</sub> 4.19 ICOP <sub>e</sub>	
		All other	Split systems and single package	3.90 COP <sub>e</sub> 4.13 ICOP <sub>e</sub>	
Condensing units, air cooled	≥ 40 kW			Not applicable match with indoor coil	AHRI 365
Condensing, water or evaporatively cooled	40 kW			Not applicable match with indoor coil	

a. Chapter 11 (Section 11) contains details for the referenced test procedure, including year version of the test procedure.

**TABLE B101.2**  
**(SUPERSEDES TABLE 6.8.1-2 IN ANSWASHRAEJIES STANDARD 90.1)**  
**ELECTRICALLY OPERATED UNITARY AND APPLIED HEAT PUMPS-MINIMUM EFFICIENCY REQUIREMENTS (SI)**

EQUIPMENT TYPE	SIZE CATEGORY	HEATING SECTION TYPE	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY	TEST PROCEDURE <sup>a</sup>
Air conditioners, air cooled (cooling mode)	< 19 kW (one phase)	All	Split systems	4.40 SCOP <sub>C</sub> 3.66 COP <sub>C</sub>	AHRI 210/240
			Single packaged	4.40 SCOP <sub>C</sub> 3.52 COP <sub>C</sub>	
	< 19 kW (three phase)	All	Split systems	4.40 SCOP <sub>C</sub> 3.66 COP <sub>C</sub>	
			Single packaged	4.40 SCOP <sub>C</sub> 3.52 COP <sub>C</sub>	
Through-the-wall, air cooled (cooling mode)	< 9 kW	All	Split systems	3.52 SCOP <sub>C</sub>	
			Single packaged	3.52 SCOP <sub>C</sub>	
Small duct high velocity, air cooled (cooling mode)	< 19 kW (one phase)	All	Split systems	3.52 SCOP <sub>C</sub>	AHRI 340/360
	< 19 kW (three phase)	All	Split systems	3.52 SCOP <sub>C</sub>	
Air conditioners, air cooled (cooling mode)	≥ 19 kW and < 40 kW	Electric resistance (or none)	Split systems and single package	3.31 COP <sub>C</sub> 3.60 ICOP <sub>C</sub>	
		All other	Split systems and single package	3.25 COP <sub>C</sub> 3.55 ICOP <sub>C</sub>	
	≥ 40 kW and < 70 kW	Electric resistance (or none)	Split systems and single package	3.19 COP <sub>C</sub> 3.40 ICOP <sub>C</sub>	
		All other	Split systems and single package	3.14 COP <sub>C</sub> 3.34 ICOP <sub>C</sub>	
	≥ 70 kW	Electric resistance (or none)	Split systems and single package	3.02 COP <sub>C</sub> 3.11 ICOP <sub>C</sub>	
		All other	Split systems and single package	2.96 COP <sub>C</sub> 3.05 ICOP <sub>C</sub>	
Water-to-air water loop (cooling mode)	< 5 kW	All	30°C entering water	4.10 COP <sub>C</sub>	ISO-13256-1
	≥ 5 kW and < 19 kW	All	30°C entering water	4.10 COP <sub>C</sub>	
	> 19 kW and < 40 kW	All	30°C entering water	4.10 COP <sub>C</sub>	
Water-to-air ground water (cooling mode)	<40 kW	All	15°C entering water	5.28 COP <sub>C</sub>	
Water-to-air ground loop (cooling mode)	<40 kW	All	25°C entering water	4.13 COP <sub>C</sub>	
Water-to-water water loop (cooling mode)	<40 kW	All	30°C entering water	3.11 COP <sub>C</sub>	ISO-13256-2
Water-to-water groundwater (cooling mode)	<40 kW	All	15°C entering water	4.78 COP <sub>C</sub>	
Brine-to-water ground loop (cooling mode)	<40 kW	All	30° C entering water	3.55 COP <sub>C</sub>	
Air conditioners, air cooled (heating mode)	< 19 kW (cooling capacity) (one phase)	All	Split systems	2.49 COP <sub>H</sub>	AHRI 210/240
			Single packaged	2.40 COP <sub>H</sub>	
	< 19 kW (cooling capacity) (three phase)	All	Split systems	2.49 COP <sub>H</sub>	
			Single packaged	2.40 COP <sub>H</sub>	

a. Chapter 11 (Section 11) contains details for the referenced test procedure, including year version of the test procedure.

*(continued)*

**TABLE B101.2**  
**(SUPERSEDES TABLE 6.8.1-2 IN ANSVASHRAES STANDARD 90.1)**  
**ELECTRICALLY OPERATED UNITARY AND APPLIED HEAT PUMPS—MINIMUM EFFICIENCY REQUIREMENTS (SI) (Continued)**

EQUIPMENT TYPE	SIZE CATEGORY	HEATING SECTION TYPE	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY	TEST PROCEDURE <sup>a</sup>
Through-the-wall, air cooled (heating mode)	< 9kW (cooling capacity)	All	Split systems	2.17 COP <sub>H</sub>	AHRI 210/240
			Single packaged	2.17 COP <sub>H</sub>	
Small duct high velocity, air cooled (heating mode)	< 19kW (cooling capacity) (one phase)	All	Split systems	2.11 COP <sub>H</sub>	
	< 19kW (cooling capacity) (three phase)	All	Split systems	2.11 COP <sub>H</sub>	
Air cooled (heating mode)	≥ 19kW and < 40 kW (cooling capacity)		8.3°C db/6.1°C wb <i>outdoor air</i>	3.40 COP <sub>H</sub>	AHRI 340/360
			-8.3°C db/9.4°C wb <i>outdoor air</i>	2.40 COP <sub>H</sub>	
	≥ 40kW (cooling capacity)		8.3°C db/6.1°C wb <i>outdoor air</i>	3.20 COP <sub>H</sub>	
			-8.3°C db/9.4°C wb <i>outdoor air</i>	2.10 COP <sub>H</sub>	
Water-to-air water loop (heating mode)	< 40kW (cooling capacity)		20°C entering water	4.60 COP <sub>H</sub>	ISO-13256-1
Water-to-air groundwater (heating mode)	< 40kW (cooling capacity)		10°C entering water	3.70 COP <sub>H</sub>	
Brine-to-water ground loop (heating mode)	< 40kW (cooling capacity)		0°C entering fluid	3.20 COP <sub>H</sub>	
Water-to-water water loop (heating mode)	< 40kW (cooling capacity)		20°C entering water	3.70 COP <sub>H</sub>	ISO-13256-2
Water-to-water groundwater (heating mode)	< 40kW (cooling capacity)		10°C entering water	3.10 COP <sub>H</sub>	
Brine-to-water ground loop (heating mode)	< 40kW (cooling capacity)		0°C entering fluid	2.50 COP <sub>H</sub>	

a. Chapter 11 (Section 11) contains details for the referenced test procedure, including year version of the test procedure.

**TABLE B101.3**  
**(SUPERSEDES TABLE 6.8.1-4 IN ANSVASHRAES STANDARD 90.1)**  
**ELECTRICALLY OPERATED SINGLE-PACKAGED VERTICAL AIR CONDITIONERS AND SINGLE-PACKAGED VERTICAL HEAT PUMPS AIR-CONDITIONER HEAT PUMPS—MINIMUM EFFICIENCY REQUIREMENTS (SI)**

EQUIPMENT TYPE	SIZE CATEGORY (INPUT)	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY	TEST PROCEDURE <sup>a</sup>
PTAC (cooling mode) standard size	All capacities	35°C db <i>outdoor air</i>	4.22— (0.300 x Cap/1000) <sup>c</sup> COP <sub>C</sub>	AHRI 310/380
PTAC (cooling mode) nonstandard size <sup>b</sup>	All capacities	35°C db <i>outdoor air</i>	3.19— (0.213 x Cap/1000) <sup>c</sup> COP <sub>C</sub>	AHRI 310/380
PTHP (cooling mode) standard size	All capacities	35°C db <i>outdoor air</i>	4.22 — (0.300 x Cap/1000) <sup>c</sup> COP <sub>C</sub>	ARI 310/380
PTHP (cooling mode) nonstandard size <sup>b</sup>	< 7,000 Btu/h	35°C db <i>outdoor air</i>	3.16 — (0.213 x Cap/1000) <sup>c</sup> COP <sub>C</sub>	ARI 310/380
PTHP (heating mode) new constructions	All capacities	8.3°C db/6.1°C wb <i>outdoor air</i>	3.7 — (0.052 x Cap/1000) <sup>c</sup> COP <sub>H</sub>	ARI 310/380
PTHP (heating mode) nonstandard size <sup>b</sup>	All capacities	8.3°C db/6.1°C wb <i>outdoor air</i>	2.9— (0.026 x Cap/1000) <sup>c</sup> COP <sub>H</sub>	ARI 310/380

a. Chapter 11 (Section 11) contains a complete specification of the referenced test procedures, including year version of the test procedure.

b. Replacement units shall be factory labeled as follows: "MANUFACTURED FOR REPLACEMENT APPLICATIONS ONLY; NOT TO BE INSTALLED IN NEW CONSTRUCTION PROJECTS." Replacement efficiencies apply only to units with existing sleeves less than 0.45 m. high and less than 1.0 m. wide and having a cross-sectional area less than 0.43 m<sup>2</sup>.

c. "Cap" means the rated cooling capacity of the product in Btu/h. If the unit's capacity is less than 2.1 kW, use 2.1 kW in the calculation. If the unit's capacity is greater than 4.4 kW, use 4.4 kW in the calculation.

**TABLE B101.4**  
**(SUPERSEDES TABLE 6.8.1-4 IN ANSVASHRAE/IES STANDARD 90.1)**  
**SINGLE-PACKAGED VERTICAL AIR CONDITIONERS, SINGLE-PACKAGED VERTICAL HEAT PUMPS, ROOM AIR**  
**CONDITIONERS, AND ROOM AIR-CONDITIONER HEAT PUMPS-MINIMUM EFFICIENCY REQUIREMENTS (SI)**

EQUIPMENT TYPE	SIZE CATEGORY (INPUT)	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY BASE	MINIMUM EFFICIENCY CONNECTED <sup>b</sup>	TEST PROCEDURE <sup>a</sup>
SPVAC (cooling mode)	<19 kW	35°C db/23.9°C wb <i>outdoor air</i>	4.10 SCOP <sub>C</sub>		AHRI 210/240
	≥ 19 kW and < 40 kW	35°C db/23.9°C wb <i>outdoor air</i>	3.28 COP <sub>C</sub> 3.78 ICOP <sub>C</sub>		AHRI 340/360
	≥ 40 kW and < 70 kW	35°C db/23.9°C wb <i>outdoor air</i>	3.22 COP <sub>C</sub> 3.63 ICOP <sub>C</sub>		
SPVHP (cooling mode)	< 19 kW	35°C db/23.9°C wb <i>outdoor air</i>	4.10 SCOP <sub>C</sub>		AIM 210/240
	≥ 19 kW and < 40 kW	35°C db/23.9°C wb <i>outdoor air</i>	3.22 COP <sub>C</sub> 3.58 ICOP <sub>C</sub>		AHRI 340/360
	≥ 40 kW and < 70 kW	35°C db/23.9°C wb <i>outdoor air</i>	3.11 COP <sub>C</sub> 3.40 ICOP <sub>C</sub>		
SPVHP (heating mode)	< 19 kW	8.3°C db/6.1°C wb <i>outdoor air</i>	2.34 SCOP <sub>H</sub>		AHRI 210/240
	≥ 19 kW and < 40 kW	8.3°C db/6.1°C wb <i>outdoor air</i>	3.30 COP <sub>H</sub>		AHRI 340/360
	≥ 40 kW and < 70 kW	8.3°C db/6.1°C wb <i>outdoor air</i>	3.2 COP <sub>H</sub>		
Room air conditioners, with louvered sides	< 1.8 kW		3.55 CCOP <sub>C</sub>	3.37 CCOP <sub>C</sub>	ANSI/AHAM RAC-1
	≥ 1.8 kW and < 2.3 kW		3.55 CCOP <sub>C</sub>	3.37 CCOP <sub>C</sub>	
	≥ 2.3 kW and < 4.1 kW		3.52 CCOP <sub>C</sub>	3.37 CCOP <sub>C</sub>	
	≥ 4.1 kW and < 5.9 kW		3.46 CCOP <sub>C</sub>	3.28 CCOP <sub>C</sub>	
	≥ 5.9 kW and < 8.2 kW		3.02 CCOP <sub>C</sub>	2.87 CCOP <sub>C</sub>	
	≥ 8.2 kW		2.90 CCOP <sub>C</sub>	2.75 CCOP <sub>C</sub>	
Room air conditioners, without louvered sides	< 1.8 kW		3.22 CCOP <sub>C</sub>	3.08 CCOP <sub>C</sub>	
	≥ 1.8 kW and < 2.3 kW		3.22 CCOP <sub>C</sub>	3.08 CCOP <sub>C</sub>	
	≥ 2.3 kW and < 3.2 kW		3.11 CCOP <sub>C</sub>	2.96 CCOP <sub>C</sub>	
	≥ 3.2 kW and < 4.1 kW		3.08 CCOP <sub>C</sub>	2.93 CCOP <sub>C</sub>	
	≥ 4.1 kW and < 5.9 kW		2.99 CCOP <sub>C</sub>	2.84 CCOP <sub>C</sub>	
	≥ 5.9 kW		3.02 CCOP <sub>C</sub>	2.87 CCOP <sub>C</sub>	
Room air conditioner heat pump, with louvered sides	< 5.9 kW		3.17 CCOP <sub>C</sub>	3.02 CCOP <sub>C</sub>	
	≥ 5.9 kW		2.99 CCOP <sub>C</sub>	2.84 CCOP <sub>C</sub>	
Room air conditioner heat pump, without louvered sides	< 4.1 kW		2.99 CCOP <sub>C</sub>	2.84 CCOP <sub>C</sub>	
	≥ 4.1 kW		2.81 CCOP <sub>C</sub>	2.67 CCOP <sub>C</sub>	
Room air conditioner, casement only	All capacities		3.08 CCOP <sub>C</sub>	2.93 CCOP <sub>C</sub>	
Room air conditioner, casement-slider	All capacities		3.34 CCOP <sub>C</sub>	3.17 CCOP <sub>C</sub>	

a. Chapter 11 (Section 11) contains details for the referenced test procedure, including the referenced year version of the test procedure.

b. Connected room air conditioners that are connected to utility programs are allowed a lower *CEER* value but must be in compliance with and certified per ENERGY STAR version 4.0 requirements for connected equipment.

**TABLE B101.5**  
**(SUPERSEDES TABLE 6.8.1-5 IN ANSVASHRAE/IES STANDARD 90.1)**  
**WARM-AIR FURNACES AND COMBINATION WARM-AIR FURNACES/AIR-CONDITIONING UNITS, WARM-AIR DUCT**  
**FURNACES, AND UNIT HEATERS—MINIMUM EFFICIENCY REQUIREMENTS (SI)**

EQUIPMENT TYPE	SIZE CATEGORY (INPUT)	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY	TEST PROCEDURE <sup>a</sup>
Warm-air furnace, gas fired (weatherized)	< 65.9 kW	Maximum capacity <sup>c</sup>	78% AFUE or 80% E <sub>t</sub> <sup>b,d</sup>	DOE 10 CFR Part 430 or Section 2.39, Thermal Efficiency, ANSI Z21.47
	65.9 kW		80% E <sub>t</sub> <sup>d</sup>	Section 2.39, Thermal Efficiency, ANSI Z21.47
Warm-air furnace, gas fired (nonweatherized)	< 65.9 kW	Maximum capacity <sup>c</sup>	90% AFUE or 92% E <sub>t</sub> <sup>b,d</sup>	DOE 10 CFR Part 430 or Section 2.39, Thermal Efficiency, ANSI Z21.47
	65.9 kW		92% E <sub>t</sub> <sup>d</sup>	Section 2.39, Thermal Efficiency, ANSI Z21.47
Warm-air furnace, oil fired (weatherized)	< 65.9 kW	Maximum capacity <sup>c</sup>	78% AFUE or 80% E <sub>t</sub> <sup>b,d</sup>	DOE 10 CFR Part 430 or Section 42, Combustion, UL 727
	> 65.9 kW		81% E <sub>t</sub> <sup>d</sup>	Section 42, Combustion, UL 727
Warm-air furnace, oil fired (nonweatherized)	< 65.9 kW	Maximum capacity <sup>c</sup>	85% AFUE or 87% E <sub>t</sub> <sup>b,d</sup>	DOE 10 CFR Part 430 or Section 42, Combustion, UL 727
	65.9 kW		87% E <sub>t</sub> <sup>d</sup>	Section 42, Combustion, UL 727
Warm-air duct furnaces, gas fired (weatherized)	All capacities	Maximum capacity <sup>c</sup>	80% E <sub>c</sub> <sup>e</sup>	Section 2.10, Efficiency, ANSI Z83.8
Warm-air duct furnaces, gas fired (nonweatherized)	All capacities	Maximum capacity <sup>c</sup>	90% E <sub>c</sub> <sup>e</sup>	Section 2.10, Efficiency, ANSI Z83.8
Warm-air unit heaters, gas fired (nonweatherized)	All capacities	Maximum capacity <sup>c</sup>	80% E <sub>c</sub> <sup>e,f</sup>	Section 2.10, Efficiency, ANSI Z83.8
Warm-air unit heaters, oil fired (weatherized)	All capacities	Maximum capacity <sup>c</sup>	90% E <sub>c</sub> <sup>e,f</sup>	Section 40, Combustion, UL 731

a. Chapter 11 (Section 11) contains a complete specification of the referenced test procedure, including the referenced year version of the test procedure.

b. Combination units not covered by the U.S. Department of Energy Code of Federal Regulations 10 CFR 430 (three-phase power or cooling capacity greater than or equal to 19 kW) may comply with either rating.

c. Compliance of multiple firing rate units shall be at the maximum firing rate.

d. E<sub>t</sub> = thermal efficiency. Units must also include an interrupted or intermittent ignition device (IID), have jacket losses not exceeding 0.75% of the input rating, and have either power venting or flue damper. A vent damper is an acceptable alternative to a flue damper for those furnaces where combustion air is drawn from the conditioned space.

e. E<sub>c</sub> = combustion efficiency (100% less flue losses). See test procedure for detailed discussion.

f. As of August 8, 2008, according to the Energy Policy Act of 2005, units must also include an interrupted or intermittent ignition device (IID) and have either power venting or an automatic flue damper.

**TABLE B101.6**  
**(SUPERSEDES TABLE 6.8.1-6 IN ANSI/ASHRAE/IES STANDARD 90.1)**  
**GAS- AND OIL-FIRED BOILERS—MINIMUM EFFICIENCY REQUIREMENTS (SI)**

EQUIPMENT TYPE <sup>a</sup>	SUBCATEGORY OR RATING CONDITION	SIZE CATEGORY (INPUT)	MINIMUM EFFICIENCY <sup>b,c</sup>	TEST PROCEDURE <sup>g</sup>
Boilers, hot water	Gas fired	< 87.9 kW <sup>h,i</sup>	89% AFUE <sup>f</sup>	10 CFR Part 430
		≥ 87.9 kW and < 732.7 kW <sup>d</sup>	89% E <sub>t</sub> <sup>f</sup>	10 CFR Part 431
		≥ 732.7 kW <sup>a</sup>	91% E <sub>c</sub> <sup>f</sup>	
	Oil fired <sup>e</sup>	< 87.9 kW	89% AFUE <sup>f</sup>	10 CFR Part 430
		≥ 87.9 kW and < 732.7 kW <sup>d</sup>	85% E <sub>t</sub> <sup>f</sup>	10 CFR Part 431
		≥ 732.7 kW <sup>a</sup>	86% E <sub>c</sub> <sup>f</sup>	
Boilers, steam	Gas fired	< 87.9 kW <sup>i</sup>	80% AFUE	10 CFR Part 430
	Gas fired all except natural draft	≥ 87.9 kW and < 732.7 kW <sup>d</sup>	79% E <sub>t</sub>	10 CFR Part 431
		≥ 732.7 kW <sup>a</sup>	79% E <sub>t</sub>	
	Gas fired natural draft	≥ 87.9 kW and < 732.7 kW <sup>d</sup>	77% E <sub>t</sub>	
		≥ 732.7 kW <sup>a</sup>	77% E <sub>t</sub>	
	Oil fired <sup>e</sup>	< 87.9 kW	82% AFUE	10 CFR Part 430
		≥ 87.9 kW and < 732.7 kW <sup>d</sup>	81% E <sub>t</sub>	10 CFR Part 431
		≥ 732.7 kW <sup>a</sup>	81% E <sub>t</sub>	

- These requirements apply to boilers with rated input of 2344 kW or less that are not packaged boilers, and to all packaged boilers. Minimum efficiency requirements for boilers cover all capacities of packaged boilers.
- E<sub>c</sub> = thermal efficiency (100% less flue losses). See reference document for detailed information.
- E<sub>t</sub> = thermal efficiency. See reference document for detailed information.
- Maximum capacity—minimum and ITIBX/ITIIITI ratings as provided for and allowed by the unit's controls.
- Includes oil fired (residual).
- Systems shall be designed with lower operating return hot-water temperatures (< 55°C) and use hot-water reset to take advantage of the higher efficiencies of condensing boilers.
- Chapter 11 (Section 11) contains details for the referenced test procedure, including the referenced year version of the test procedure.
- A boiler not equipped with a tankless domestic water-heating coil shall be equipped with an *automatic* means for adjusting the temperature of the water such that an incremental change in inferred heat load produces a corresponding incremental change in the temperature of the water supplied.
- Boilers shall not be equipped with a continuous pilot ignition system.

**TABLE B101.7**  
**(SUPERSEDES TABLE 6.8.1-7 IN ANSVASHRAE/IES STANDARD 90.1)**  
**PERFORMANCE REQUIREMENTS FOR HEAT REJECTION EQUIPMENT—MINIMUM EFFICIENCY REQUIREMENTS (SI)**

EQUIPMENT TYPE	TOTAL SYSTEM HEAT REJECTION CAPACITY AT RATED CONDITIONS	SUBCATEGORY OR RATING CONDITION <sup>a</sup>	PERFORMANCE REQUIRED <sup>a,b,c,d,e,f,i</sup>	TEST PROCEDURE <sup>h</sup>
Propeller or axial fan open-circuit cooling towers	All	35.0°C entering water 29.4°C leaving water 23.9°C entering wb	$\geq 3.56$ L/s kW	CTI ATC-105 and CTI STD-201RS
Centrifugal fan open-circuit cooling towers	All	35.0°C entering water 29.4°C leaving water 23.9°C entering wb	$\geq 1.86$ L/s kW	CTI ATC-105 and CTI STD-201RS
Propeller or axial fan closed-circuit cooling towers	All	38.9°C entering water 32.2°C leaving water 23.9°C entering wb	$\geq 1.36$ L/s kW	CTI ATC-105S and CTI STD-201RS
Centrifugal fan closed-circuit cooling towers	All	38.9°C entering water 32.2°C leaving water 23.9°C entering wb	$\geq 0.68$ L/s kW	CTI ATC-105S and CTI STD-201RS
Propeller or axial fan evaporative condensers	All	Ammonia test fluid 60.0°C entering gas temperature 35.7°C condensing temperature 23.9°C entering wb	$\geq 52.6$ COP	CTI ATC-106
Centrifugal fan evaporative condensers	All	Ammonia test fluid 60.0°C entering gas temperature 35.7°C condensing temperature 23.9°C entering wb	$\geq 43.2$ COP	CTI ATC-106
Propeller or axial fan evaporative condensers	All	R-507A test fluid 73.9°C entering gas temperature 40.6°C condensing temperature 23.9°C entering wb	$\geq 61.7$ COP	CTI ATC-106
Centrifugal fan evaporative condensers	All	R-507A test fluid 73.9°C entering gas temperature 40.6°C condensing temperature 23.9°C entering wb	$\geq 53.1$ COP	CTI ATC-106
Air-cooled condensers	All	88°C entering gas temperature 52°C condensing temperature 8°C subcooling 35°C entering wb	$\geq 69$ COP	AHRI 460

- For purposes of this table, *open-circuit cooling tower performance* is defined as the water flow rating of the tower at the thermal rating condition listed in Table B101.8 (B-8) divided by the fan motor nameplate power.
- For purposes of this table, *closed-circuit cooling tower performance* is defined as the process water flow rating of the tower at the thermal rating condition listed in Table B101.8 (B-8) divided by the sum of the fan motor nameplate power and the integral spray pump motor nameplate power.
- For purposes of this table, *evaporative condenser performance* is defined as the heat rejected at the specified rating condition in the table divided by the sum of the fan motor nameplate power and the integral spray pump nameplate power.
- For purposes of this table, *air-cooled condenser performance* is defined as the heat rejected from the refrigerant divided by the fan motor nameplate power.
- The efficiencies and test procedures for both *open-* and *closed-circuit cooling towers* are not applicable to hybrid cooling towers that contain a combination of separate wet and dry heat exchange sections. The certification requirements do not apply to field erected cooling towers.
- All cooling towers, closed-circuit coolers, evaporative condensers and air-cooled condensers shall comply with the minimum efficiency listed in the table for that specific type of equipment with the capacity effect of any project specific accessories and/or options included with the equipment.
- Requirements for evaporative condensers are listed with ammonia (R-717) and R-507A as test fluids in the table. Evaporative condensers intended for use with halocarbon refrigerants other than R-507A must meet the minimum efficiency requirements listed for R-507A as the test fluid.
- Informative Appendix G contains information on the referenced test procedures.
- Not applicable for air-cooled condensers applied to condenserless chillers. The air-cooled condenser and condenserless chiller shall comply with the requirements for air-cooled chillers as defined in ANSI/ASHRAE/IES Standard 90.1, Table 6.8.1-3.

**TABLE B101.8**  
**(SUPERSEDES TABLE 7.8 IN ANSWASHRAE/IES STANDARD 90.1)**  
**PERFORMANCE REQUIREMENTS FOR SERVICE WATER HEATING EQUIPMENT (SI)**

EQUIPMENT TYPE	SIZE CATEGORY (INPUT)	RATED STORAGE VOLUME AND INPUT RATING (IF APPLICABLE)	DRAW PATTERN	PERFORMANCE REQUIRED <sup>a,d</sup>	TESTED PROCEDURE <sup>b</sup>
Electric table-top water heaters'	≤12 kW	≥75.7 L and ≤454 L	Very small	UEF ≥ 0.6323 - 0.0015V	DOE 10 CFR Part 430
			Low	UEF ≥ 0.9188 - 0.00082V	
			Medium	UEF ≥ 0.9577 - 0.00061 V	
			High	UEF ≥ 0.9844 - 0.00042V	
Electric resistance storage water heaters		≥75.7 L and ≤208 L	Very small	UEF ≥ 0.8808 - 0.00021 V	DOE 10 CFR Part 430
			Low	UEF ≥ 0.9254 - 0.000079V	
			Medium	UEF ≥ 0.9307 - 0.000053 V	
			High	UEF ≥ 0.9349 - 0.000026 V	
		>208 L		Must use heat-pump water heater	
Electric resistance grid-enabled water heaters		≥ 284 L	Very small	UEF ≥ 1.0136 - 0.00074V	DOE 10 CFR Part 430
			Low	UEF ≥ 0.09984 - 0.00037 V	
			Medium	UEF ≥ 0.9853 - 0.00026 V	
			High	UEF ≥ 0.9720 - 0.00018 V	
Heat-pump water heaters		≤ 208 L		EF ≥ 2.00, FHR ≥ 190 L	DOE 10 CFR Part 430
		> 208 L		EF ≥ 2.20, FHR ≥ 190 L	
Gas-fired storage water heaters	≤22.0kW	≤ 208 L		EF ≥ 0.67, FHR ≥ 250 L	ANSI Z21.10.3
		> 208 L		EF ≥ 0.77, FHR ≥ 250 L	
	> 22.0kW	≤ 530 L		E <sub>t</sub> ≥ 0.94 or EF ≥ 0.93 and SL ≤ 0.84 x (Q/234 + 56.5√V), W	ANSI Z21.10.3
Gas instantaneous water heaters	>14.6kW and <58.6kW	≥ 309.7W/L and < 7.6 L		EF ≥ 0.90 and GPM ≥ 2.5 over a 25°C rise	DOE 10 CFR Part 430
	≥22.0kW	≤ 530 L and ≥ 309.7W/L		E <sub>t</sub> ≥ 0.94 or EF ≥ 0.93 SL = 0.84 x (Q/234 + 56.5√V), W	ANSI Z21.10.3
Oil storage water heaters	≤30.7kW	≤ 190 L	Very small	EF = 0.2509 - 0.00032V	DOE 10 CFR Part 430
			Low	EF = 0.5330 - 0.00042V	
			Medium	EF = 0.6078 - 0.00042V	
			High	EF = 0.6815 - 0.0037V	
	>30.7kW	< 309.7 W/L		E <sub>t</sub> ≥ 80% and SL ≤ (Q/234 + 56.5√V), W	ANSI Z21.10.3
Oil instantaneous water heaters	≤61.5kW	≤ 190L		EF ≥ 0.59 - 0.00050V	DOE 10 CFR Part 430
	>61.5kW	≥ 309.7 W/L and < 38 L		E <sub>t</sub> ≥ 80%	ANSI Z21.10.3
	>61.5kW	≥ 309.7 W/L and ≥ 30 L		E <sub>t</sub> ≥ 78% and SL ≤ (Q/234 + 56.5√V), W	
Solar water heater		Electric backup		SEF ≥ 1.8	ANSI Z21.10.3
		Gas backup		SEF ≥ 1.2	
Hot-water supply boilers, gas and oil	>88 kW and ≤3660kW	≥ 309.7 W/L and < 30 L		E <sub>t</sub> ≥ 80%	ANSI Z21.10.3
Hot-water supply boilers, gas		≥ 309.7 W/L and ≥ 30 L		E <sub>t</sub> ≥ 80% SL ≤ (Q/234 + 56.5√V), W	ANSI Z21.10.3
Hot-water supply boilers, oil		≥309.7 W/L and ≥30 L		E <sub>t</sub> ≥ 78% SL ≤ (Q/234 + 56.5√V), W	ANSI Z21.10.3
Pool heaters, gas	All sizes			E <sub>t</sub> ≥ 82%	ASHRAE 146
Pool heaters, oil	All sizes			E <sub>t</sub> ≥ 78%	ASHRAE 146
Heat-pump pool heaters	All sizes	10°C db 6.8°C wb outdoor air 26.7°C entering water		≥4.0 COP	ASHRAE 146
Unfired storage tanks	All sizes			≥R-2.2°C • m <sup>2</sup> /W	None

a. Energy factor (EF) and thermal efficiency (*E<sub>t</sub>*) are minimum requirements, while standby loss (SL) is maximum W based on a 21°C temperature difference between stored water and ambient requirements. In the EF equation, *V* is the rated volume in litres. In the SL equation, *V* is the rated volume in litres and *Q* is the nameplate input rate in Kw.

b. Chapter 11 (Section 11) contains details on the referenced test procedures, including the year/version of the referenced test procedure.

c. Section G.1 is titled "Test Method for Measuring Thermal Efficiency," and Section G.2 is titled "Test Method for Measuring Standby Loss."

d. UEF is the Uniform Energy Factor and is a dimensionless number that is calculated per DOE 10 CFR Part 430 test procedures.



**TABLE B101.9**  
**COMMERCIAL CLOTHES WASHERS (SI)**

PRODUCT	MEF <sup>a</sup>	WF <sup>b</sup> , L/L
All commercial clothes washers	48.7	0.53

a. MEF = modified energy factor, a combination of energy factor and remaining moisture content. MEF measures energy consumption of the total laundry cycle (washing and drying). It indicates how many liters of laundry can be washed and dried with one kWh of electricity; the higher the number, the greater the efficiency

b. WF = *water factor* (in L/L)

**TABLE B101.10**  
**(SUPERSEDES TABLE 6.8.1-9 IN ANSWASHRAE/IES STANDARD 90.1)**  
**ELECTRICALLY OPERATED VARIABLE-REFRIGERANT-FLOW (VRF) AIR**  
**CONDITIONERS—MINIMUM EFFICIENCY REQUIREMENTS (SI)**

EQUIPMENT TYPE	SIZE CATEGORY	HEATING SECTION TYPE	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY	TEST PROCEDURE <sup>a</sup>
VRF air conditioners, air cooled	< 19 kW	All	VRF multisplit system	4.40 SCOP <sub>c</sub> 3.36 COP <sub>c</sub>	AHRI 1230
	≥ 19 kW and < 40 kW	Electric resistance (or none)	VRF multisplit system	3.43 COP <sub>c</sub> 4.37 ICOP <sub>c</sub>	
	≥ 40 kW and < 70 kW	Electric resistance (or none)	VRF multisplit system	3.43 COP <sub>c</sub> 4.22 ICOP <sub>c</sub>	
	≥ 70 kW	Electric resistance (or none)	VRF multisplit system	3.08 COP <sub>c</sub> 3.81 ICOP <sub>c</sub>	

a. Chapter 11 (Section 11) contains details for the referenced test procedure, including year version of the test procedure.

**TABLE B101.11**  
**(SUPERSEDES TABLE 6.8.1-10 IN ANSWASHRAVIES STANDARD 90.1)**  
**ELECTRICALLY OPERATED VARIABLE-REFRIGERANT-FLOW AND APPLIED**  
**HEAT PUMP-MINIMUM EFFICIENCY REQUIREMENTS (SI)**

<b>EQUIPMENT TYPE</b>	<b>SIZE CATEGORY</b>	<b>HEATING SECTION TYPE</b>	<b>SUBCATEGORY OR RATING CONDITION</b>	<b>MINIMUM EFFICIENCY</b>	<b>TEST PROCEDURE<sup>a</sup></b>
VRF air cooled (cooling mode)	< 19 kW	All	VRF multisplit system	4.40 SCOP <sub>C</sub> 3.66 COP <sub>C</sub>	AHRI 1230
	≥ 19 kW and < 40 kW	Electric resistance (or none)	VRF multisplit system	3.31 COP <sub>C</sub> 4.28 ICOP <sub>C</sub>	
	≥ 19 kW and < 40 kW	Electric resistance (or none)	VRF multisplit system with heat recovery	3.25 COP <sub>C</sub> 4.22 ICOP <sub>C</sub>	
	≥ 40 kW and < 70 kW	Electric resistance (or none)	VRF multisplit system	3.19 COP <sub>C</sub> 4.07 ICOP <sub>C</sub>	
	≥ 40 kW and < 70 kW	Electric resistance (or none)	VRF multisplit system with heat recovery	3.14 COP <sub>C</sub> 4.02 ICOP <sub>C</sub>	
	≥ 70 kW	Electric resistance (or none)	VRF multisplit system	3.02 COP <sub>C</sub> 4.02 ICOP <sub>C</sub>	
	≥ 70 kW	Electric resistance (or none)	VRF multisplit system with heat recovery	2.96 COP <sub>C</sub> 3.66 ICOP <sub>C</sub>	
VRF water source (cooling mode)	< 19 kW	All	VRF multisplit systems 30°C entering water	4.10 COP <sub>C</sub> 4.69 ICOP <sub>C</sub>	AHRI 1230
	< 19 kW	All	VRF multisplit systems with heat recovery 30°C entering water	4.04 COP <sub>C</sub> 4.63 ICOP <sub>C</sub>	
	≥ 19 kW and < 40 kW	All	VRF multisplit system 30°C entering water	4.10 COP <sub>C</sub> 4.69 ICOP <sub>C</sub>	
	≥ 19 kW and < 40 kW	All	VRF multisplit system with heat recovery 30°C entering water	4.04 COP <sub>C</sub> 4.63 ICOP <sub>C</sub>	
	≥ 40 kW	All	VRF multisplit system 30°C entering water	3.40 COP <sub>C</sub> 4.10 ICOP <sub>C</sub>	
	≥ 40 kW	All	VRF multisplit system with heat recovery 30°C entering water	3.28 COP <sub>C</sub> 4.04 ICOP <sub>C</sub>	
VRF groundwater source (cooling mode)	< 40 kW	All	VRF multisplit system 15°C entering water	4.75 COP <sub>C</sub>	AHRI 1230
	< 40 kW	All	VRF multisplit system with heat recovery 15°C entering water	4.69 COP <sub>C</sub>	
	≥ 40 kW	All	VRF multisplit system 15°C entering water	4.04 COP <sub>C</sub>	
	≥ 40 kW	All	VRF multisplit system with heat recovery 15°C entering	3.99 COP <sub>C</sub>	

a. Chapter 11 (Section 11) contains details for the referenced test procedure, including year version of the test procedure.

*(continued)*

**TABLE B101.11**  
**(SUPERSEDES TABLE 6.8.1-10 IN ANSWASHRAEJIES STANDARD 90.1)**  
**ELECTRICALLY OPERATED VARIABLE-REFRIGERANT-FLOW AND APPLIED**  
**HEAT PUMP—MINIMUM EFFICIENCY REQUIREMENTS (SI) (Continued)**

EQUIPMENT TYPE	SIZE CATEGORY	HEATING SECTION TYPE	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY	TEST PROCEDURE <sup>a</sup>
VRF ground source (cooling mode)	< 40 kW	All	VRF multisplit system 25°C entering water	3.93 COP <sub>C</sub>	AHRI 1230
	< 40 kW	All	VRF multisplit system with heat recovery 25°C entering water	3.87 COP <sub>C</sub>	
	40 kW	All	VRF multisplit system 25°C entering water	3.22 COP <sub>C</sub>	
	40 kW	All	VRF multisplit system with heat recovery 25°C entering water	3.17 COP <sub>C</sub>	
VRF air cooled (heating mode)	< 19 kW (cooling capacity)		VRF multisplit system	2.49 SCOP <sub>H</sub>	AHRI 1230
	≥ 19 kW and < 40 kW (cooling capacity)		VRF multisplit system 8.3°C db/6.1°C wb <i>outdoor air</i>	3.40 COP <sub>H</sub>	
			-8.3°C db/-9.4°C wb <i>outdoor air</i>	2.40 COP <sub>H</sub>	
	≥ 40 kW (cooling capacity)		VRF multisplit system 8.3°C db/6.1°C wb <i>outdoor air</i>	3.20 COP <sub>H</sub>	
			-8.3°C db/-9.4°C wb <i>outdoor air</i>	2.10 COP <sub>H</sub>	
VRF water source (heating mode)	< 40 kW (cooling capacity)		VRF multisplit system 20°C entering water	4.60 COP <sub>H</sub>	AHRI 1230
	≥ 40 kW (cooling capacity)		VRF multisplit system 20°C entering water	4.20 COP <sub>H</sub>	
VRF groundwater source (heating mode)	< 40 kW (cooling capacity)		VRF multisplit system 10°C entering water	3.60 COP <sub>H</sub>	AHRI 1230
	≥ 40 kW (cooling capacity)		VRF multisplit system 10°C entering water	3.30 COP <sub>H</sub>	
VRF ground source (heating mode)	< 40 kW (cooling capacity)		VRF multisplit system 0°C entering water	3.10 COP <sub>H</sub>	AHRI 1230
	≥ 40 kW (cooling capacity)		VRF multisplit system 0°C entering water	2.80 COP <sub>H</sub>	

a. Chapter 11 (Section 11) contains details for the referenced test procedure, including year version of the test procedure.

## NORMATIVE APPENDIX C

# PERFORMANCE OPTION FOR ENERGY EFFICIENCY

*(This is a normative appendix and is part of this code.)*

### SECTION C101 GENERAL

**C101.1 Renewable, Recovered, and Purchased Energy.**

*On-site renewable energy systems* and *site recovered energy*: The modeling requirements for *on-site renewable energy systems* in the *proposed building performance* in ANSI/ASHRAE/IES Standard 90.1, Section G2.4.1, shall not apply and are superseded by Table C101.1, Section 15, "Renewable Energy Systems."

**C101.2 Building Performance Calculations.** In addition to the requirements of ANSI/ASHRAE/IES Standard 90.1, Table G3.1, the *proposed design* shall comply with all modifications and additions in Table C101.1. All references to Table G3.1 in Table C101.1 refer to ANSI/ASHRAE/IES Standard 90.1, Appendix G, Table G3.1.

**TABLE C101.1**  
**MODIFICATIONS AND ADDITIONS TO ANSI/ASHRAE/IES STANDARD 90.1, APPENDIX G, TABLE G3.1**

PROPOSED BUILDING PERFORMANCE	BASELINE BUILDING PERFORMANCE
<b>1. Design Model</b> No modifications	No Modifications
<b>2. Additions and Alterations</b> No modifications	No modifications
<b>3. Space Use Classification</b> No modifications	No modifications
<b>4. Schedules</b> No modifications	No modifications
<b>5. Building Envelope</b> No modifications	No modifications
<b>6. Lighting</b> No modifications	No modifications
<b>7. Thermal Blocks—H VAC Zones Designed</b> No modifications	No modifications
<b>8. Thermal Blocks—HVAC Zones Not Designed</b> No modifications	No modifications
<b>9. Thermal Blocks—Multifamily Residential Buildings</b> No modifications	No modifications
<b>10. HVAC Systems</b> No modifications	No modifications
<b>11. Service Hot-Water Systems</b> No modifications	No modifications
<b>12. Receptacle and Other Loads</b> No modifications	No modifications
<b>13. Modeling Limitations to the Simulation</b> Program No modifications	No modifications
<b>14. Exterior Conditions</b> No modifications	No modifications
<b>15. On-Site Renewable Energy Systems</b> The reduction in the <i>proposed building performance</i> and annual <i>CO<sub>2</sub>e</i> of the <i>proposed design</i> due to energy generated by <i>on-site renewable energy systems</i> shall be calculated as follows:  a. <b>Annual Energy Cost.</b> The annual energy cost of the <i>proposed design</i> with an <i>on-site renewable energy system</i> shall be calculated on an hourly basis and adjusted as follows: 1. <b>Thermal Energy Performance Calculation.</b> The hourly thermal loads of the <i>proposed design</i> shall be reduced by the hourly thermal energy production of the <i>on-site renewable energy system</i> (but thermal loads shall not be reduced to less than zero). When the on-site renewable thermal energy production exceeds the applicable thermal demands of the building for any hour, the excess generated energy may be used to displace thermal loads at other times, provided the system has the storage capability and storage losses are included in the calculation. The approved energy rate structure shall be applied to the reduced energy consumption.	

(continued)

**TABLE C101.1**  
**MODIFICATIONS AND ADDITIONS TO ANSI/ASHRAE/IES STANDARD 90.1, APPENDIX G, TABLE G3.1 (Continued)**

PROPOSED BUILDING PERFORMANCE	BASELINE BUILDING PERFORMANCE
<p><b>2. Electric Energy Performance Calculation.</b> The total electrical energy production of the <i>on-site renewable energy system</i> shall be calculated on an hourly basis, and the energy cost of the <i>proposed building performance</i> shall be calculated by applying the approved electrical rate structure to each hour's electrical usage, including any reduction from hourly electrical energy production of the <i>on-site renewable energy system</i>.</p> <p><b>Exception:</b> For <i>building projects</i> with no net metering agreement, feed-in tariff, or other electrical rate structure for net generated electricity, the cost of imported electricity from the grid is calculated by applying the approved electrical rate structure to each hour's electrical loads minus the hourly electrical energy production of the <i>on-site renewable energy system</i>, but the cost of imported electricity shall not be less than zero on a monthly basis.</p> <p>Electricity production of the <i>on-site renewable energy system</i> that has a retail value in excess of the retail cost of electricity consumption on a monthly basis shall be credited as a reduction in energy costs to the <i>building performance</i> at the wholesale rate as follows:</p> $\text{Credit} = \frac{\text{EXRR} - \text{IMRR}}{\text{EXRR}} \times \text{ExkWh} \times \text{WR}$ <p>where:</p> <p>Credit = cost reduction credit for month where retail value of exported electricity is greater than retail value of imported electricity.</p> <p>ExRR = month's value of exported electricity at retail rate.</p> <p>ImRR = month's value of imported electricity at retail rate.</p> <p>ExkWh = total kilowatt-hours exported in month.</p> <p>WR = Average monthly wholesale rate for the region where the building located.</p> <p><b>b. Annual CO<sub>2</sub>e.</b> The annual CO<sub>2</sub>e of the proposed building that includes an <i>on-site renewable energy system</i> shall be equal to the annual CO<sub>2</sub>e of the imported energy to serve the proposed building (with reduced loads due to the <i>on-site renewable energy system</i>) minus the annual exported electricity produced by the <i>on-site renewable energy system</i> multiplied by the electrical CO<sub>2</sub>e emission factor.</p> <p><b>Documentation:</b> The documentation required in ANSI/ASHRAE/IES Standard 90.1, Section G2.5 (a), (b), and (e), shall be made available to the AHJ, upon request, for all <i>on-site renewable energy systems</i> in the <i>proposed design</i>.</p>	

## NORMATIVE APPENDIX D

# BUILDING CONCENTRATIONS

*(This is a normative appendix and is part of this code.)*

### SECTION D101 BUILDING CONCENTRATIONS

Building concentrations shall be estimated based on the following parameters and criteria:

- a. Laboratory-measured volatile organic compound (VOC) emission factors and actual surface area of all materials as described in (b) below.
- b. At minimum, those materials listed in Section 801.5.2(a) through (g) [8.5.2(a) through (g)] to be installed shall be modeled.
- c. The actual building parameters for volume, average weekly minimum ventilation rate, and ventilated volume fraction for the building being modeled shall be used.
- d. Standard building scenarios or modeling from similar buildings shall not be allowed.
- e. Average weekly minimum air change rates shall be calculated based on the *minimum outdoor airflow* and hours of operation for the specific building being modeled.
- f. Steady-state conditions with respect to emission rates and building ventilation may be assumed.
- g. Zero *outdoor air* concentrations, perfect mixing within the building, and no net losses of VOCs from air due

to other effects such as irreversible or net sorption on surfaces (i.e., net sink effects) and chemical reactions may be assumed.

- h. All assumptions shall be clearly stated in the design documents.
- i. The estimated building concentration  $C_{Bi}$  ( $\mu\text{g}/\text{m}^3$ ) of each target VOC shall be calculated using Equation 2 of CDPH/EHLB/Standard Method V1.1 (commonly referred to as California Section 01350), as shown below. Estimated building concentrations of individual target VOCs with multiple sources shall be added to establish a single total estimated building concentration for individual target VOCs.

$$C_{Bi} = (EF_{Ai} \times A_B) / (V_B \times a_B \times 0.9)$$

where:

$EF_{Ai}$  = area specific emission rate or emission factor at 96 hours after placing a test specimen in the chamber (14 days total exposure time),  $\mu\text{g}/\text{m}^2\cdot\text{h}$ .

$A_B$  = exposed surface area of the installed material in the building,  $\text{m}^2$ .

$V_B$  = building volume,  $\text{m}^3$ .

$a_B$  = average weekly minimum air change rate, 1/h.

## INFORMATIVE APPENDIX E

### BUILDING ENVELOPE TABLES

*(This appendix is not part of this code. It is merely informative and does not contain requirements necessary for conformance to the code. It has not been processed according to the ANSI requirements for a code and may contain material that has not been subject to public review or a consensus process. Unresolved objectors on informative material are not offered the right to appeal at ASHRAE or ANSI)*

The first nine tables are in I-P units, followed by nine tables in SI units. U-factors, C-factors, F-factors, and *SHGC* in these tables meet the requirements of Section 701.4.2.1, although the R-values in most cases provide more insulation than is required in Section 701.4.2.1. These R-values represent common assemblies in building construction. Assemblies with lower R-values are allowed to be used to meet the criteria of Section 701.4.2.1 when they meet the appropriate U-factor, C-factor, or F-factor criteria.



**TABLE E101.0**  
**(SUPERSEDES TABLE 5.5-0 IN ANSI/ASHRAE/IES STANDARD 90.1)**  
**BUILDING ENVELOPE REQUIREMENTS FOR CLIMATE ZONE 0 (A,B)\* (I-P)**

OPAQUE ELEMENTS	NONRESIDENTIAL			RESIDENTIAL			SEMIHEATED		
	ASSEMBLY MAXIMUM	INSULATION MIN. R-VALUE**		ASSEMBLY MAXIMUM	INSULATION MIN. R-VALUE**		ASSEMBLY MAXIMUM	INSULATION MIN. R-VALUE**	
Roofs									
Insulation entirely above deck	U-0.039	R-25 c.i.		U-0.032	R-30 c.i.		U-0.218	R-3.8 c.i.	
Metal building <sup>a</sup>	U-0.041	R-10 + R-19 FC		U-0.041	R-10 + R-19 FC		U-0.115	R-10	
Attic and other roofs	U-0.027	R-38		U-0.027	R-38		U-0.081	R-13	
Walls, above grade									
Mass <sup>b</sup>	U-0.580	NR		U-0.151	R-5.7 c.i.		U-0.580	NR	
Metal building	U-0.094	R-0 + R-9.8 ci		U-0.094	R-0 + R-9.8 ci		U-0.352	NR	
Steel framed	U-0.124	R-13		U-0.124	R-13		U-0.352	NR	
Wall, below grade									
Below-grade wall	C-1.140	NR		C-1.140	NR		C-1.140	NR	
Floors									
Mass	U-0.322	NR		U-0.322	NR		U-0.322	NR	
Steel joist	U-0.350	NR		U-0.350	NR		U-0.350	NR	
Wood framed and other	U-0.282	NR		U-0.282	NR		U-0.282	NR	
Slab-on-grade floors									
Unheated	F-0.730	NR		F-0.730	NR		F-0.730	NR	
Heated	F-1.020	R-7.5 for 12 in.		F-1.020	R-7.5 for 12 in.		F-1.020	R-7.5 for 12 in.	
Opaque doors									
Swinging	U-0.370			U-0.370			U-0.700		
Nonswinging	U-0.310			U-0.310			U-1.450		
FENESTRATION	ASSEMBLY MAX. U	ASSEMBLY MAX. SHGC	ASSEMBLY MIN. VT/SHGC	ASSEMBLY MAX. U	ASSEMBLY MAX. SHGC	ASSEMBLY MIN. VT/SHGC	ASSEMBLY MAX. U	ASSEMBLY MAX. SHGC	ASSEMBLY MIN. VT/SHGC
Vertical glazing, 0% to 40% of wall		(for all frame types)			(for all frame types)			(for all frame types)	
Nonmetal framing (all)	U-0.30	E&W-0.21, N&S-0.22	1.10	U-0.30	E&W-0.21, N&S-0.22	1.10	U-0.88	NR	NR
Metal framing, fixed	U-0.48			U-0.48			U-1.14		
Metal framing, operable	U-0.62			U-0.62			U-1.14		
Metal framing, entrance door	U-0.79			U-0.79			U-1.05		
Skylight, 0% to 3% of roof									
All types	U-0.71	0.33	NR	U-0.71	0.33	NR	U-1.71	NR	NR

\* The following definitions apply: c.i. = continuous insulation (see ANSI/ASHRAE/IES Standard 90.1, Section 3.2); NR = no (insulation) requirement; FC = filled cavity (see ANSI/ASHRAE/IES Standard 90.1, Section A2.3.2.5).

\*\* The insulation minimum R-value criteria in this table meet the criteria in Section 701.4.2.1, but it is possible that some assemblies with slightly less insulation minimum R-value will also meet the criteria of Section 701.4.2.1.

- a. When using the R-value compliance method for metal building *roofs*, a thermal spacer block is required (see ANSI/ASHRAE/IES Standard 90.1, Section 3.2).
- b. Exception applies for mass *walls* above grade where the requirement is for a maximum assembly U-0.151 (see ANSI/ASHRAE/IES Standard 90.1, Section 5.5.3.2).

**TABLE E101.1**  
**(SUPERSEDES TABLE 5.5-1 IN ANSI/ASHRAE/IES STANDARD 90.1)**  
**BUILDING ENVELOPE REQUIREMENTS FOR CLIMATE ZONE 1 (A,B)\* (I-P)**

OPAQUE ELEMENTS	NONRESIDENTIAL			RESIDENTIAL			SEMIHEATED		
	ASSEMBLY MAXIMUM	INSULATION MIN. R-VALUE**		ASSEMBLY MAXIMUM	INSULATION MIN. R-VALUE**		ASSEMBLY MAXIMUM	INSULATION MIN. R-VALUE**	
Roofs									
Insulation entirely above deck	U-0.039	R-25 c.i.		U-0.039	R-25 c.i.		U-0.173	R-5 c.i.	
Metal building <sup>a</sup>	U-0.041	R-10 +R-19 FC		U-0.041	R-10 + R-19 FC		U-0.096	R-16	
Attic and other roofs	U-0.027	R-38		U-0.027	R-38		U-0.053	R-19	
Walls, above grade									
Mass <sup>b</sup>	U-0.151	R-5.7 c.i.		U-0.123	R-7.6 c.i.		U-0.580	NR	
Metal building	U-0.094	R-0 + R-9.8 c.i.		U-0.094	R-0 + R-9.8. c.i.		U-0.162	R-13	
Steel framed	U-0.084	R-13 + R-3.8 c.i.		U-0.064	R-13 + R-7.5 c.i.		U-0.124	R-13	
Wood framed and other	U-0.089	R-13		U-0.089	R-13		U-0.089	R-13	
Wall, below grade									
Below-grade wall	C-1.140	NR		C-1.140	NR		C-1.140	NR	
Floors									
Mass	U-0.107	R-6.3 c.i.		U-0.087	R-8.3 c.i.		U-0.322	NR	
Steel joist	U-0.038	R-30		U-0.038	R-30		U-0.069	R-13	
Wood framed and other	U-0.033	R-30		U-0.033	R-30		U-0.066	R-13	
Slab-on-grade floors									
Unheated	F-0.730	NR		F-0.730	NR		F-0.730	NR	
Heated	F-1.020	R-7.5 for 12 in.		F-1.020	R-7.5 for 12 in.		F-1.020	R-7.5 for 12 in.	
Opaque doors									
Swinging	U-0.370			U-0.370			U-0.700		
Nonswinging	U-0.310			U-0.310			U-1.450		
FENESTRATION	ASSEMBLY MAX. U	ASSEMBLY MAX. SHGC	ASSEMBLY MIN. VT/SHGC	ASSEMBLY MAX. U	ASSEMBLY MAX. SHGC	ASSEMBLY MIN. VT/SHGC	ASSEMBLY MAX. U	ASSEMBLY MAX. SHGC	ASSEMBLY MIN. VT/SHGC
Vertical glazing, 0% to 40% of wall		(for all frame types)			(for all frame types)			(for all frame types)	
Nonmetal framing, all	U-0.48	E&W-0.24, S-0.25, N-0.35	1.10	U-0.48	E&W-0.24, S-0.25, N-0.35	1.10	U-0.88	NR	NR
Metal framing, fixed	U-0.54			U-0.54			U-1.14		
Metal framing, operable	U-0.62			U-0.62			U-1.14		
Metal framing, entrance door	U-1.05			U-1.05			U-1.05		
Skylight, 0% to 3% of roof									
All types	U-0.71	0.33	NR	U-0.71	0.33	NR	U-1.71	NR	NR

\* The following definitions apply: c.i. = continuous insulation (see ANSI/ASHRAE/IES Standard 90.1, Section 3.2); NR = no (insulation) requirement; FC = filled cavity (see ANSI/ASHRAE/IES Standard 90.1, Section A2.3.2.5).

\*\*The insulation minimum R-value criteria in this table meet the criteria in Section 701.4.2.1, but it is possible that some assemblies with slightly less insulation minimum R-value will also meet the criteria of Section 701.4.2.1.

- When using the R-value compliance method for metal building *roofs*, a thermal spacer block is required (see ANSI/ASHRAE/IES Standard 90.1, Section 3.2).
- Exception applies for mass *walls* above grade where the requirement is for a maximum assembly U-0.151 (see ANSI/ASHRAE/IES Standard 90.1, Section 5.5.3.2).

**TABLE E101.2**  
**(SUPERSEDES TABLE 5.5-2 IN ANSI/ASHRAE/IES STANDARD 90.1)**  
**BUILDING ENVELOPE REQUIREMENTS FOR CLIMATE ZONE 2 (A,B)\* (I-P)**

OPAQUE ELEMENTS	NONRESIDENTIAL			RESIDENTIAL			SEMIHEATED		
	ASSEMBLY MAXIMUM	INSULATION MIN. R-VALUE**		ASSEMBLY MAXIMUM	INSULATION MIN. R-VALUE**		ASSEMBLY MAXIMUM	INSULATION MIN. R-VALUE**	
Roofs									
Insulation entirely above deck	U-0.039	R-25 c.i.		U-0.039	R-25 c.i.		U-0.173	R-5 c.i.	
Metal building <sup>a</sup>	U-0.041	R-10 + R-19 FC		U-0.041	R-10 + R-19 FC		U-0.096	R-16	
Attic and other roofs	U-0.027	R-38		U-0.027	R-38		U-0.053	R-19	
Walls, above grade									
Mass <sup>b</sup>	U-0.151	R-5.7 c.i.		U-0.123	R-7.6 c.i.		U-0.580	NR	
Metal building	U-0.094	R-0 + R-9.8 c.i.		U-0.094	R-0 + R-9.8 c.i.		U-0.162	R-13	
Steel framed	U-0.084	R-13 + R-3.8 c.i.		U-0.064	R-13 + R-7.5 c.i.		U-0.124	R-13	
Wood framed and other	U-0.089	R-13		U-0.089	R-13		U-0.089	R-13	
Wall, below grade									
Below-grade wall	C-1.140	NR		C-1.140	NR		C-1.140	NR	
Floors									
Mass	U-0.107	R-6.3 c.i.		U-0.087	R-8.3 c.i.		U-0.322	NR	
Steel joist	U-0.038	R-30		U-0.038	R-30		U-0.069	R-13	
Wood framed and other	U-0.033	R-30		U-0.033	R-30		U-0.066	R-13	
Slab-on-grade floors									
Unheated	F-0.730	NR		F-0.730	NR		F-0.730	NR	
Heated	F-0.900	R-10 for 24 in.		F-0.860	R-15 for 24 in.		F-1.020	R-7.5 for 12 in.	
Opaque doors									
Swinging	U-0.370			U-0.370			U-0.700		
Nonswinging	U-0.310			U-0.310			U-1.450		
FENESTRATION	ASSEMBLY MAX. U	ASSEMBLY MAX. SHGC	ASSEMBLY MIN. VT/SHGC	ASSEMBLY MAX. U	ASSEMBLY MAX. SHGC	ASSEMBLY MIN. VT/SHGC	ASSEMBLY MAX. U	ASSEMBLY MAX. SHGC	ASSEMBLY MIN. VT/SHGC
Vertical glazing, 0% to 40% of wall		(for all frame types)			(for all frame types)			(for all frame types)	
Nonmetal framing, all	U-0.35	E&W-0.24, S-0.25, N-0.35	1.10	U-0.35	E&W-0.24, S-0.25, N-0.35	1.10	U-0.88	NR	NR
Metal framing, fixed	U-0.51			U-0.51			U-1.14		
Metal framing, operable	U-0.62			U-0.62			U-1.14		
Metal framing, entrance door	U-0.79			U-0.73			U-0.79		
Skylight, 0% to 3% of roof									
All types	U-0.62	0.33	NR	U-0.62	0.33	NR	U-1.71	NR	NR

\* The following definitions apply: c.i. = continuous insulation (see ANSI/ASHRAE/IES Standard 90.1, Section 3.2); NR = no (insulation) requirement; FC = filled cavity (see ANSI/ASHRAE/IES Standard 90.1, Section A2.3.2.5).

\*\*The insulation minimum R-value criteria in this table meet the criteria in Section 701.4.2.1, but it is possible that some assemblies with slightly less insulation minimum R-value will also meet the criteria of Section 701.4.2.1.

a. When using the R-value compliance method for metal building *roofs*, a thermal spacer block is required (see ANSI/ASHRAE/IES Standard 90.1, Section 3.2).

b. Exception applies for mass *walls* above grade where the requirement is for a maximum assembly U-0.151 (see ANSI/ASHRAE/IES Standard 90.1, Section 5.5.3.2).

**TABLE E101.3**  
**(SUPERSEDES TABLE 5.5-3 IN ANSI/ASHRAE/IES STANDARD 90.1)**  
**BUILDING ENVELOPE REQUIREMENTS FOR CLIMATE ZONE 3 (A,B,C)\* (I-P)**

OPAQUE ELEMENTS	NONRESIDENTIAL			RESIDENTIAL			SEMIHEATED		
	ASSEMBLY MAXIMUM	INSULATION MIN. R-VALUE**		ASSEMBLY MAXIMUM	INSULATION MIN. R-VALUE**		ASSEMBLY MAXIMUM	INSULATION MIN. R-VALUE**	
Roofs									
Insulation entirely above deck	U-0.039	R-25 c.i.		U-0.039	R-25 c.i.		U-0.119	R-7.6 c.i.	
Metal building <sup>a</sup>	U-0.041	R-10 + R-19 FC		U-0.041	R-10 + R-19 FC		U-0.096	R-16	
Attic and other roofs	U-0.027	R-38		U-0.027	R-38		U-0.053	R-19	
Walls, above grade									
Mass	U-0.123	R-7.6 c.i.		U-0.104	R-9.5 c.i.		U-0.580	NR	
Metal building	U-0.094	R-0 + R-9.8 c.i.		U-0.072	R-0 + R-13 c.i.		U-0.162	R-13	
Steel framed	U-0.077	R-13 + R-5 c.i.		U-0.064	R-13 + R-7.5 c.i.		U-0.124	R-13	
Wood framed and other	U-0.089	R-13		U-0.064	R-13 + R-3.8 c.i.		U-0.089	R-13	
Wall, below grade									
Below-grade wall	C-1.140	NR		C-1.140	NR		C-1.140	NR	
Floors									
Mass	U-0.074	R-10 c.i.		U-0.074	R-10 c.i.		U-0.137	R-4.2 c.i.	
Steel joist	U-0.038	R-30		U-0.038	R-30		U-0.052	R-19	
Wood framed and other	U-0.033	R-30		U-0.033	R-30		U-0.051	R-19	
Slab-on-grade floors									
Unheated	F-0.730	NR		F-0.540	R-10 for 24 in.		F-0.730	NR	
Heated	F-0.860	R-15 for 24 in.		F-0.860	R-15 for 24 in.		F-1.020	R-7.5 for 12 in.	
Opaque doors									
Swinging	U-0.370			U-0.370			U-0.370		
Nonswinging	U-0.310			U-0.310			U-0.360		
FENESTRATION	ASSEMBLY MAX. U	ASSEMBLY MAX. SHGC	ASSEMBLY MIN. VT/SHGC	ASSEMBLY MAX. U	ASSEMBLY MAX. SHGC	ASSEMBLY MIN. VT/SHGC	ASSEMBLY MAX. U	ASSEMBLY MAX. SHGC	ASSEMBLY MIN. VT/SHGC
Vertical glazing, 0% to 40% of wall		(for all frame types)			(for all frame types)			(for all frame types)	
Nonmetal framing, all	U-0.31	E&W-0.24, S-0.25, N-0.35	1.10	U-0.33	E&W-0.24, S-0.25, N-0.35	1.10	U-0.83	NR	NR
Metal framing, fixed	U-0.43			U-0.47			U-1.14		
Metal framing, operable	U-0.57			U-0.57			U-1.14		
Metal framing, entrance door	U-0.73			U-0.65			U-0.73		
Skylight, 0% to 3% of roof									
All types	U-0.52	0.33	NR	U-0.52	0.33	NR	U-1.62	NR	NR

\* The following definitions apply: c.i. = continuous insulation (see ANSI/ASHRAE/IES Standard 90.1, Section 3.2); NR = no (insulation) requirement; FC = filled cavity (see ANSI/ASHRAE/IES Standard 90.1, Section A2.3.2.5).

\*\* The insulation minimum R-value criteria in this table meet the criteria in Section 701.4.2.1, but it is possible that some assemblies with slightly less insulation minimum R-value will also meet the criteria of Section 701.4.2.1.

a. When using the R-value compliance method for metal building *roofs*, a thermal spacer block is required (see ANSI/ASHRAE/IES Standard 90.1, Section 3.2).

**TABLE E101.4**  
**(SUPERSEDES TABLE 5.5-4 IN ANSI/ASHRAE/IES STANDARD 90.1)**  
**BUILDING ENVELOPE REQUIREMENTS FOR CLIMATE ZONE 4 (A,B,C)\* (I-P)**

OPAQUE ELEMENTS	NONRESIDENTIAL			RESIDENTIAL			SEMIHEATED		
	ASSEMBLY MAXIMUM	INSULATION MIN. R-VALUE**		ASSEMBLY MAXIMUM	INSULATION MIN. R-VALUE**		ASSEMBLY MAXIMUM	INSULATION MIN. R-VALUE**	
Roofs									
Insulation entirely above deck	U-0.030	R-35 c.i.		U-0.030	R-35 c.i.		U-0.088	R-11 c.i.	
Metal building <sup>a</sup>	U-0.035	R-11 + R-19 c.i.		U-0.035	R-11 + R-19 c.i.		U-0.078	R-19 + R-6.5 c.i.	
Attic and other roofs	U-0.020	R-60		U-0.020	R-60		U-0.032	R-38	
Walls, above grade									
Mass	U-0.099	R-11.4 c.i.		U-0.086	R-13.3 c.i.		U-0.580	NR	
Metal building	U-0.057	R-11 + R-13 c.i.		U-0.048	R-11 + R-15.8 c.i.		U-0.154	R19	
Steel framed	U-0.061	R-13 +R-12.5 c.i.		U-0.061	R-13 +R-12.5 c.i.		U-0.118	R-13 +R-3.8 c.i.	
Wood framed and other	U-0.061	R-13 + R-7.5 c.i.		U-0.061	R-13 + R-7.5 c.i.		U-0.085	R-13 + R-3.8 c.i.	
Wall, below grade									
Below-grade wall	C-0.113	R-10.0 c.i.		C-0.087	R-12.5 c.i.		C-1.140	NR	
Floors									
Mass	U-0.054	R-16.7 c.i.		U-0.048	R-18.7 c.i.		U-0.102	R-8.3 c.i.	
Steel joist	U-0.036	R-38		U-0.036	R-38		U-0.049	R-30	
Wood framed and other	U-0.031	R-38		U-0.031	R-38		U-0.048	R-30	
Slab-on-grade floors									
Unheated	F-0.494	R-20 for 48 in.		F-0.494	R-20 for 48 in.		F-0.730	NR	
Heated	F-0.801	R-20 for 48 in.		F-0.654	R-20 full slab		F-0.855	R-20 for 24 in.	
Opaque doors									
Swinging	U-0.352			U-0.352			U-0.352		
Nonswinging	U-0.295			U-0.295			U-0.342		
FENESTRATION	ASSEMBLY MAX. U	ASSEMBLY MAX. SHGC	ASSEMBLY MIN. VT/SHGC	ASSEMBLY MAX. U	ASSEMBLY MAX. SHGC	ASSEMBLY MIN. VT/SHGC	ASSEMBLY MAX. U	ASSEMBLY MAX. SHGC	ASSEMBLY MIN. VT/SHGC
Vertical glazing, 0% to 40% of wall		(for all frame types)			(for all frame types)			(for all frame types)	
Nonmetal framing, all	U-0.29	E&W-0.34, S-0.36, N-0.46	1.10	U-0.29	E&W-0.34, S-0.36, N-0.46	1.10	U-0.48	NR	NR
Metal framing, fixed	U-0.36			U-0.36			U-0.69		
Metal framing, operable	U-0.44			U-0.44			U-0.77		
Metal framing, entrance door	U-0.65			U-0.65			U-0.73		
Skylight, 0% to 3% of roof									
All types	U-0.48	0.38	NR	U-0.48	0.38	NR	U-1.09	NR	NR

\* The following definitions apply: c.i. = continuous insulation (see ANSI/ASHRAE/IES Standard 90.1, Section 3.2); NR = no (insulation) requirement.

The insulation minimum R-value criteria in this table meet the criteria in Section 701.4.2.1, but it is possible that some assemblies with slightly less insulation minimum R-value will also meet the criteria of Section 701.4.2.1.

a. When using the R-value compliance method for metal building roofs, a thermal spacer block is required (see ANSI/ASHRAE/IES Standard 90.1, Section 3.2).

**TABLE E101.5**  
**(SUPERSEDES TABLE 5.5-5 IN ANSVASHRAE/IES STANDARD 90.1)**  
**BUILDING ENVELOPE REQUIREMENTS FOR CLIMATE ZONE 5 (A,B,C)\* (I-P)**

OPAQUE ELEMENTS	NONRESIDENTIAL			RESIDENTIAL			SEMIHEATED		
	ASSEMBLY MAXIMUM	INSULATION MIN. R-VALUE**		ASSEMBLY MAXIMUM	INSULATION MIN. R-VALUE**		ASSEMBLY MAXIMUM	INSULATION MIN. R-VALUE**	
Roofs									
Insulation entirely above deck	U-0.030	R-35 c.i.		U-0.030	R-35 c.i.		U-0.060	R-17 c.i.	
Metal building <sup>a</sup>	U-0.035	R-11 + R-19 c.i.		U-0.035	R-11 + R-19 c.i.		U-0.078	R-19 + R-6.5 c.i.	
Attic and other roofs	U-0.020	R-60		U-0.020	R-60		U-0.032	R-38	
Walls, above grade									
Mass	U-0.086	R-13.3 c.i.		U-0.076	R-15.0 c.i.		U-0.143	R-7.5 c.i.	
Metal building	U-0.048	R-11 + R-15.8 c.i.		U-0.048	R-11 + R-15.8 c.i.		U-0.089	R-11 + R-6.5 c.i.	
Steel framed	U-0.052	R-13 + R-12.5 c.i.		U-0.052	R-13 + R-12.5 c.i.		U-0.080	R-13 + R-5.0 c.i.	
Wood framed and other	U-0.048	R-13 + R-12.5 c.i.		U-0.048	R-13 + R-12.5 c.i.		U-0.085	R-13 + R-3.8 c.i.	
Wall, below grade									
Below-grade wall	C-0.113	R-10.0 c.i.		C-0.087	R-12.5 c.i.		C-1.140	NR	
Floors									
Mass	U-0.054	R-16.7 c.i.		U-0.048	R-18.7 c.i.		U-0.102	R-8.3 c.i.	
Steel joist	U-0.036	R-38		U-0.036	R-38		U-0.049	R-30	
Wood framed and other	U-0.031	R-38		U-0.031	R-38		U-0.048	R-30	
Slab-on-grade floors									
Unheated	F-0.494	R-20 for 48 in.		F-0.485	R-20 for 48 in.		F-0.730	NR	
Heated	F-0.654	R-20 full slab		F-0.654	R-20 full slab		F-0.855	R-20 for 24 in.	
Opaque doors									
Swinging	U-0.352			U-0.352			U-0.352		
Nonswinging	U-0.295			U-0.295			U-0.342		
FENESTRATION	ASSEMBLY MAX. U	ASSEMBLY MAX. SHGC	ASSEMBLY MIN. VT/SHGC	ASSEMBLY MAX. U	ASSEMBLY MAX. SHGC	ASSEMBLY MIN. VT/SHGC	ASSEMBLY MAX. U	ASSEMBLY MAX. SHGC	ASSEMBLY MIN. VT/SHGC
Vertical glazing, 0% to 40% of wall		(for all frame types)			(for all frame types)			(for all frame types)	
Nonmetal framing, all	U-0.29	E&W-0.36, S-0.38, N-0.48	1.10	U-0.29	E&W-0.36, S-0.38, N-0.48	1.10	U-0.43	NR	NR
Metal framing, fixed	U-0.36			U-0.36			U-0.59		
Metal framing, operable	U-0.44			U-0.44			U-0.67		
Metal framing, entrance door	U-0.65			U-0.65			U-0.73		
Skylight, 0% to 3% of roof									
All types	U-0.48	0.38	NR	U-0.48	0.38	NR	U-0.93	NR	NR

\* The following definitions apply: c.i. = continuous insulation (see ANSI/ASHRAE/IES Standard 90.1, Section 3.2); NR = no (insulation) requirement

\*\*The insulation minimum R-value criteria in this table meet the criteria in Section 701.4.2.1, but it is possible that some assemblies with slightly less insulation minimum R-value will also meet the criteria of Section 701.4.2.1.

a. When using the R-value compliance method for metal building *roofs*, a thermal spacer block is required (see ANSI/ASHRAE/IES Standard 90.1, Section 3.2).

**TABLE E101.6**  
**(SUPERSEDES TABLE 5.5-6 IN ANSI/ASHRAE/IES STANDARD 90.1)**  
**BUILDING ENVELOPE REQUIREMENTS FOR CLIMATE ZONE 6 (A,B)\* (I-P)**

OPAQUE ELEMENTS	NONRESIDENTIAL			RESIDENTIAL			SEMIHEATED		
	ASSEMBLY MAXIMUM	INSULATION MIN. R-VALUE**		ASSEMBLY MAXIMUM	INSULATION MIN. R-VALUE**		ASSEMBLY MAXIMUM	INSULATION MIN. R-VALUE**	
Roofs									
Insulation entirely above deck	U-0.030	R-35 c.i.		U-0.030	R-35 c.i.		U-0.060	R-17 c.i.	
Metal building <sup>a</sup>	U-0.029	R-30 + R-11 <i>Ls</i>		U-0.028	R-10 + R-19 + R-13 c.i.		U-0.057	R-10 + R-10 + R-6.5 c.i.	
Attic and other roofs	U-0.020	R-60		U-0.020	R-60		U-0.032	R-38	
Walls, above grade									
Mass	U-0.076	R-15.0 c.i.		U-0.067	R-17.5 c.i.		U-0.143	R-7.5 c.i.	
Metal building	U-0.048	R-11 + R-15.8 c.i.		U-0.048	R-11 + R-15.8 c.i.		U-0.089	R-11 + R-6.5 c.i.	
Steel framed	U-0.047	R-13 + R-15.6 c.i.		U-0.047	R-13 + R-15.6 c.i.		U-0.080	R-13 + R-5 c.i.	
Wood framed and other	U-0.048	R-13 + R-12.5 c.i.		U-0.048	R-13 + R-12.5 c.i.		U-0.085	R-13 + R-3.8 c.i.	
Wall, below grade									
Below-grade wall	C-0.087	R-12.5 c.i.		C-0.060	R-17.5 c.i.		C-0.113	R-10.0 c.i.	
Floors									
Mass	U-0.048	R-18.7 c.i.		U-0.048	R-18.7 c.i.		U-0.083	R-10 c.i.	
Steel joist	U-0.030	R-49.0		U-0.030	R-49		U-0.049	R-30	
Wood framed and other	U-0.026	R-38+ R-7.5 c.i.		U-0.026	R-38 + R-7.5 c.i.		U-0.048	R-30	
Slab-on-grade floors									
Unheated	F-0.485	R-20 for 48 in.		F-0.412	R-15 full slab		F-0.730	NR	
Heated	F-0.654	R-20 full slab		F-0.637	R-20 full slab		F-0.817	R-20 for 48 in.	
Opaque doors									
Swinging	U-0.352			U-0.352			U-0.352		
Nonswinging	U-0.295			U-0.295			U-0.342		
FENESTRATION	ASSEMBLY MAX. U	ASSEMBLY MAX. SHGC	ASSEMBLY MIN. VT/SHGC	ASSEMBLY MAX. U	ASSEMBLY MAX. SHGC	ASSEMBLY MIN. VT/SHGC	ASSEMBLY MAX. U	ASSEMBLY MAX. SHGC	ASSEMBLY MIN. VT/SHGC
Vertical glazing, 0% to 40% of wall		(for all frame types)			(for all frame types)			(for all frame types)	
Nonmetal framing, all	U-0.29	E&W-0.38, S-0.40, N-0.50	1.10	U-0.29	E&W-0.38, S-0.40, N-0.50	1.10	U-0.43	NR	NR
Metal framing, fixed	U-0.34			U-0.34			U-0.48		
Metal framing, operable	U-0.43			U-0.43			U-0.56		
Metal framing, entrance door	U-0.65			U-0.65			U-0.73		
Skylight, 0% to 3% of roof									
All types	U-0.48	0.38	NR	U-0.48	0.38	NR	U-0.81	NR	NR

\* The following definitions apply: c.i. = continuous insulation (see ANSI/ASHRAE/IES Standard 90.1, Section 3.2); NR = no (insulation) requirement; *Ls* = liner system (see ANSI/ASHRAE/IES Standard 90.1, Section A2.3.2.4).

\*\* The insulation minimum R-value criteria in this table meet the criteria in Section 701.4.2.1, but it is possible that some assemblies with slightly less insulation minimum R-value will also meet the criteria of Section 701.4.2.1.

a. When using the R-value compliance method for metal building roofs, a thermal spacer block is required (see ANSI/ASHRAE/IES Standard 90.1, Section 3.2).

**TABLE E101.7**  
**(SUPERSEDES TABLE 5.5-7 IN ANSI/ASHRAE/IES STANDARD 90.1)**  
**BUILDING ENVELOPE REQUIREMENTS FOR CLIMATE ZONE 7\* (1-P)**

OPAQUE ELEMENTS	NONRESIDENTIAL			RESIDENTIAL			SEMIHEATED		
	ASSEMBLY MAXIMUM	INSULATION MIN. R-VALUE**		ASSEMBLY MAXIMUM	INSULATION MIN. R-VALUE**		ASSEMBLY MAXIMUM	INSULATION MIN. R-VALUE**	
Roofs									
Insulation entirely above deck	U-0.027	R-40 c.i.		U-0.027	R-40 c.i.		U-0.037	R-26 c.i.	
Metal building <sup>a</sup>	U-0.028	R-10 + R-19 + R-13 c.i.		U-0.028	R-10 + R-19 + R-13 c.i.		U-0.035	R-11 + R-19 c.i.	
Attic and other roofs	U-0.016	R-71		U-0.016	R-71		U-0.026	R-49	
Walls, above grade									
Mass	U-0.067	R-17.5 c.i.		U-0.067	R-17.5 c.i.		U-0.117	R-9.5 c.i.	
Metal building	U-0.042	R-11 + R-19 c.i.		U-0.042	R-11 + R-19 c.i.		U-0.068	R-11 + R-9.8 c.i.	
Steel framed	U-0.047	R-13 + R-15.6 c.i.		U-0.040	R-13 + R-18.8 c.i.		U-0.061	R-13 + R-12.5 c.i.	
Wood framed and other	U-0.048	R-13 + R-12.5 c.i.		U-0.048	R-13 + R-12.5 c.i.		U-0.061	R-13 + R-7.5 c.i.	
Wall, below grade									
Below-grade wall	C-0.060	R-17.5 c.i.		C-0.060	R-17.5 c.i.		C-0.113	R-10.0 c.i.	
Floors									
Mass	U-0.040	R-23 c.i.		U-0.040	R-23 c.i.		U-0.070	R-12.5 c.i.	
Steel joist	U-0.030	R-49		U-0.030	R-49		U-0.049	R-30	
Wood framed and other	U-0.026	R-38 + R-7.5 c.i.		U-0.026	R-38 + R-7.5 c.i.		U-0.048	R-30	
Slab-on-grade floors									
Unheated	F-0.485	R-20 for 48 in.		F-0.412	R-15 full slab		F-0.730	NR	
Heated	F-0.637	R-20 full slab		F-0.637	R-20 full slab		F-0.817	R-20 for 48 in.	
Opaque doors									
Swinging	U-0.352			U-0.352			U-0.352		
Nonswinging	U-0.295			U-0.295			U-0.295		
FENESTRATION	ASSEMBLY MAX. U	ASSEMBLY MAX. SHGC	ASSEMBLY MIN. VT/SHGC	ASSEMBLY MAX. U	ASSEMBLY MAX. SHGC	ASSEMBLY MIN. VT/SHGC	ASSEMBLY MAX. U	ASSEMBLY MAX. SHGC	ASSEMBLY MIN. VT/SHGC
Vertical glazing, 0% to 40% of wall		(for all frame types)			(for all frame types)			(for all frame types)	
Nonmetal framing, all	U-0.27	E&W-0.43, S-0.45, N-0.55	1.10	U-0.27	E&W-0.43, S-0.45, N-0.55	1.10	U-0.30	NR	NR
Metal framing, fixed	U-0.31			U-0.31			U-0.36		
Metal framing, operable	U-0.38			U-0.38			U-0.42		
Metal framing, entrance door	U-0.65			U-0.65			U-0.73		
Skylight, 0% to 3% of roof									
All types	U-0.48	NR	NR	U-0.48	NR	NR	U-0.81	NR	NR

\* The following definitions apply: c.i. = continuous insulation (see ANSI/ASHRAE/IES Standard 90.1, Section 3.2); NR = no (insulation) requirement.

\*\*The insulation minimum R-value criteria in this table meet the criteria in Section 701.4.2.1, but it is possible that some assemblies with slightly less insulation minimum R-value will also meet the criteria of Section 701.4.2.1.

a. When using the R-value compliance method for metal building roofs, a thermal spacer block is required (see ANSI/ASHRAE/IES Standard 90.1, Section 3.2).



**TABLE E101.8**  
**(SUPERSEDES TABLE 5.5-8 IN ANSWASHRAVIES STANDARD 90.1)**  
**BUILDING ENVELOPE REQUIREMENTS FOR CLIMATE ZONE 8\* (I-P)**

OPAQUE ELEMENTS	NONRESIDENTIAL			RESIDENTIAL			SEMIHEATED		
	ASSEMBLY MAXIMUM	INSULATION MIN. R-VALUE**		ASSEMBLY MAXIMUM	INSULATION MIN. R-VALUE**		ASSEMBLY MAXIMUM	INSULATION MIN. R-VALUE**	
Roofs									
Insulation entirely above deck	U-0.027	R-40 c.i.		U-0.027	R-40 c.i.		U-0.037	R-26 c.i.	
Metal building <sup>a</sup>	U-0.025	R-19 + R-19 + R-25 c.i.		U-0.025	R-19 + R-19 + R-25 c.i.		U-0.035	R-11 + R-19 c.i.	
Attic and other roofs	U-0.016	R-71		U-0.016	R-71		U-0.026	R-49	
Walls, above grade									
Mass	U-0.046	R-21.0 c.i.		U-0.046	R-21.0 c.i.		U-0.099	R-11.4 c.i.	
Metal building	U-0.037	R-11 + R-22.1 c.i.		U-0.037	R-11 + R-22.1 c.i.		U-0.057	R-11 + R-13 c.i.	
Steel framed	U-0.035	R-13 + R-21.9 c.i.		U-0.035	R-13 + R-21.9 c.i.		U-0.061	R-13 + R-12.5 c.i.	
Wood framed and other	U-0.030	R-13 + R-21.9 c.i.		U-0.030	R-13 + R-21.9 c.i.		U-0.048	R-13 + R-12.5 c.i.	
Wall, below grade									
Below-grade wall	C-0.060	R-17.5 c.i.		C-0.060	R-17.5 c.i.		C-0.113	R-10.0 c.i.	
Floors									
Mass	U-0.036	R-25.1 c.i.		U-0.036	R-25.1 c.i.		U-0.061	R-14.6 c.i.	
Steel joist	U-0.030	R-49		U-0.030	R-49		U-0.049	R-30	
Wood framed and other	U-0.026	R-38 + R-7.5 c.i.		U-0.026	R-38 + R-7.5 c.i.		U-0.031	R-38	
Slab-on-grade floors									
Unheated	F-0.412	R-15 full slab		F-0.403	R-15 full slab		F-0.513	R-20 for 24 in.	
Heated	F-0.637	R-20 full slab		F-0.354	R-25 full slab		F-0.817	R-20 for 48 in.	
Opaque doors									
Swinging	U-0.352			U-0.352			U-0.352		
Nonswinging	U-0.295			U-0.295			U-0.295		
FENESTRATION	ASSEMBLY MAX. U	ASSEMBLY MAX. SHGC	ASSEMBLY MIN. VT/SHGC	ASSEMBLY MAX. U	ASSEMBLY MAX. SHGC	ASSEMBLY MIN. VT/SHGC	ASSEMBLY MAX. U	ASSEMBLY MAX. SHGC	ASSEMBLY MIN. VT/SHGC
Vertical glazing, 0% to 40% of wall		(for all frame types)			(for all frame types)			(for all frame types)	
Nonmetal framing, all	U-0.24	E&W-0.43, S-0.45, N-0.55	1.10	U-0.24	E&W-0.43, S-0.45, N-0.55	1.10	U-0.30	NR	NR
Metal framing, fixed	U-0.28			U-0.28			U-0.36		
Metal framing, operable	U-0.33			U-0.33			U-0.42		
Metal framing, entrance door	U-0.65			U-0.65			U-0.73		
Skylight, 0% to 3% of roof									
All types	U-0.39	NR	NR	U-0.39	NR	NR	U-0.81	NR	NR

\* The following definitions apply: c.i. = continuous insulation (see ANSI/ASHRAE/IES Standard 90.1, Section 3.2); NR = no (insulation) requirement.

\*\* The insulation minimum R-value criteria in this table meet the criteria in Section 701.4.2.1, but it is possible that some assemblies with slightly less insulation minimum R-value will also meet the criteria of Section 701.4.2.1.

a. When using the R-value compliance method for metal building roofs, a thermal spacer block is required (see ANSI/ASHRAE/IES Standard 90.1, Section 3.2).

**TABLE E101.0**  
**(SUPERSEDES TABLE 5.5-0 IN ANSI/ASHRAE/IES STANDARD 90.1)**  
**BUILDING ENVELOPE REQUIREMENTS FOR CLIMATE ZONE 0 (A,B)\* (SI)**

OPAQUE ELEMENTS	NONRESIDENTIAL			RESIDENTIAL			SEMIHEATED		
	ASSEMBLY MAXIMUM	INSULATION MIN. R-VALUE**		ASSEMBLY MAXIMUM	INSULATION MIN. R-VALUE**		ASSEMBLY MAXIMUM	INSULATION MIN. R-VALUE**	
Roofs									
Insulation entirely above deck	U-0.222	R-4.4 c.i.		U-0.184	R-5.3 c.i.		U-1.240	R-0.7 c.i.	
Metal building <sup>a</sup>	U-0.233	R-1.8 + R-3.3 FC		U-0.233	R-1.8 + R-3.3 FC		U-0.653	R-1.8	
Attic and other roofs	U-0.153	R-6.7		U-0.153	R-6.7		U-0.459	R-2.3	
Walls, above grade									
Mass <sup>b</sup>	U-3.293	NR		U-0.857	R-1.0 c.i.		U-3.293	NR	
Metal building	U-0.533	R-0 + R-1.7 ci		U-0.533	R-0 + R-1.7 ci		U-1.998	NR	
Steel framed	U-0.705	R-2.3		U-0.705	R-2.3		U-1.998	NR	
Wood framed and other	U-0.504	R-2.3		U-0.504	R-2.3		U4.660	NR	
Wall, below grade									
Below-grade wall	C-6.473	NR		C-6.473	NR		C-6.473	NR	
Floors									
Mass	U-1.825	NR		U-1.825	NX		U-1.825	NR	
Steel joist	U-1.986	NR		U-1.986	NR		U-1.986	NR	
Wood framed and other	U-1.599	NR		U-1.599	NR		U-1.599	NR	
Slab-on-grade floors									
Unheated	F-1.264	NR		F-1.264	NR		F-1.264	NR	
Heated	F-1.766	R-1.3 for 300 mm		F-1.766	R-1.3 for 300 mm		F-1.766	R-1.3 for 300 mm	
Opaque doors									
Swinging	U-2.101			U-2.101			U-3.975		
Nonswinging	U-1.760			U-1.760			U-8.233		
FENESTRATION	ASSEMBLY MAX. U	ASSEMBLY MAX. SHGC	ASSEMBLY MIN. VT/SHGC	ASSEMBLY MAX. U	ASSEMBLY MAX. SHGC	ASSEMBLY MIN. VT/SHGC	ASSEMBLY MAX. U	ASSEMBLY MAX. SHGC	ASSEMBLY MIN. VT/SHGC
Vertical glazing, 0% to 40% of wall		(for all frame types)			(for all frame types)			(for all frame types)	
Nonmetal framing, all	U-1.73	E&W-0.21, N&S-0.22	1.10	U-1.73	E&W-0.21, N&S-0.22	1.10	U-5.02	NR	NR
Metal framing, fixed	U-2.70			U-2.70			U-6.48		
Metal framing, operable	U-3.51			U-3.51			U-6.48		
Metal framing, entrance door	U-4.48			U-4.48			U-5.94		
Skylight, 0% to 3% of roof									
All types	U-4.05	0.33	NR	U-4.05	0.33	NR	U-9.71	NR	NR

\* The following definitions apply: c.i. = continuous insulation (see ANSI/ASHRAE/IES Standard 90.1, Section 3.2); NR = no (insulation) requirement; FC - filled cavity (see ANSI/ASHRAE/IES Standard 90.1, Section A2.3.2.5).

\*\*The insulation minimum R-value criteria in this table meet the criteria in Section 701.4.2.1, but it is possible that some assemblies with slightly less insulation minimum R-value will also meet the criteria of Section 701.4.2.1.

a. When using the R-value compliance method for metal building *roofs*, a thermal spacer block is required (see ANSI/ASHRAE/IES Standard 90.1, Section 3.2).

b. Exception applies for mass *walls* above grade where the requirement is for a maximum assembly U-0.151 (see ANSI/ASHRAE/IES Standard 90.1, Section 5.5.3.2).

**TABLE E101.1**  
**(SUPERSEDES TABLE 5.5-1 IN ANSI/ASHRAE/IES STANDARD 90.1)**  
**BUILDING ENVELOPE REQUIREMENTS FOR CLIMATE ZONE 1 (A,B)\* (SI)**

OPAQUE ELEMENTS	NONRESIDENTIAL			RESIDENTIAL			SEMIHEATED		
	ASSEMBLY MAXIMUM	INSULATION MIN. R-VALUE**		ASSEMBLY MAXIMUM	INSULATION MIN. R-VALUE**		ASSEMBLY MAXIMUM	INSULATION MIN. R-VALUE**	
Roofs									
Insulation entirely above deck	U-0.273	R-3.5 c.i.		U-0.220	R-4.4 c.i.		U-1.240	R-0.7 c.i.	
Metal building <sup>a</sup>	U-0.233	R-1.8 + R-3.3 FC		U-0.233	R-1.8 + R-3.3 FC		U-0.653	R-1.8	
Attic and other roofs	U-0.153	R-6.7		U-0.153	R-6.7		U-0.459	R-2.3	
Walls, above grade									
Mass <sup>b</sup>	U-3.293	NR		U-0.857	R-1.0 c.i.		U-3.293	NR	
Metal building	U-0.533	R-0 + R-1.7 c.i.		U-0.533	R-0 + R-1.7 c.i.		U-1.998	NR	
Steel framed	U-0.705	R-2.3		U-0.705	R-2.3		U-1.998	NR	
Wood framed and other	U-0.504	R-2.3		U-0.504	R-2.3		U-1.660	NR	
Wall, below grade									
Below-grade wall	C-6.473	NR		C-6.473	NR		C-6.473	NR	
Floors									
Mass	U-1.825	NR		U-1.825	NR		U-1.825	NR	
Steel joist	U-1.986	NR		U-1.986	NR		U-1.986	NR	
Wood framed and other	U-1.599	NR		U-1.599	NR		U-1.599	NR	
Slab-on-grade floors									
Unheated	F-1.264	NR		F-1.264	NR		F-1.264	NR	
Heated	F-1.766	R-1.3 for 300 mm		F-1.766	R-1.3 for 300 mm		F-1.766	R-1.3 for 300 mm	
Opaque doors									
Swinging	U-2.101			U-2.101			U-3.975		
Nonswinging	U-1.760			U-1.760			U-8.233		
FENESTRATION	ASSEMBLY MAX. U	ASSEMBLY MAX. SHGC	ASSEMBLY MIN. VT/SHGC	ASSEMBLY MAX. U	ASSEMBLY MAX. SHGC	ASSEMBLY MIN. VT/SHGC	ASSEMBLY MAX. U	ASSEMBLY MAX. SHGC	ASSEMBLY MIN. VT/SHGC
Vertical glazing, 0% to 40% of wall		(for all frame types)			(for all frame types)			(for all frame types)	
Nonmetal framing, all	U-2.70	E&W-0.24, S-0.25, N-0.35	1.10	U-2.70	E&W-0.24, S-0.25, N-0.35	1.10	U-5.02	NR	NR
Metal framing, fixed	U-3.08			U-3.08			U-6.48		
Metal framing, operable	U-3.51			U-3.51			U-6.48		
Metal framing, entrance door	U-5.94			U-5.94			U-5.94		
Skylight, 0% to 3% of roof									
All types	U-4.05	0.33	NR	U-4.05	0.33	NR	U-9.71	NR	NR

\* The following definitions apply: el. = continuous insulation (see ANSI/ASHRAE/IES Standard 90.1, Section 3.2); NR = no (insulation) requirement; FC = filled cavity (see ANSI/ASHRAE/IES Standard 90.1, Section A2.3.2.5).

\*\* The insulation minimum R-value criteria in this table meet the criteria in Section 701.4.2.1, but it is possible that some assemblies with slightly less insulation minimum R-value will also meet the criteria of Section 701.4.2.1.

a. When using the R-value compliance method for metal building *roofs*, a thermal spacer block is required (see ANSI/ASHRAE/IES Standard 90.1, Section 3.2).

b. Exception applies for mass *walls* above grade where the requirement is for a maximum assembly U-0.151 (see ANSI/ASHRAE/IES Standard 90.1, Section 5.5.3.2).

**TABLE E101.2**  
**(SUPERSEDES TABLE 5.5-2 IN ANSI/ASHRAE/IES STANDARD 90.1)**  
**BUILDING ENVELOPE REQUIREMENTS FOR CLIMATE ZONE 2 (A,B)\* (SI)**

OPAQUE ELEMENTS	NONRESIDENTIAL			RESIDENTIAL			SEMIHEATED		
	ASSEMBLY MAXIMUM	INSULATION MIN. R-VALUE**		ASSEMBLY MAXIMUM	INSULATION MIN. R-VALUE**		ASSEMBLY MAXIMUM	INSULATION MIN. R-VALUE**	
Roofs									
Insulation entirely above deck	U-0.220	R-4.4 c.i.		U-0.220	R-4.4 c.i.		U-0.982	R-0.9 c.i.	
Metal building <sup>a</sup>	U-0.233	R-1.8 + R-3.3 FC		U-0.233	R-1.8 + R-3.3 FC		U-0.545	R-2.8	
Attic and other roofs	U-0.153	R-6.7		U-0.153	R-6.7		U-0.300	R-3.3	
Walls, above grade									
Mass <sup>b</sup>	U-0.857	R-1.0 c.i.		U-0.701	R-1.3 c.i.		U-3.293	NR	
Metal building	U-0.533	R-0 + R-1.7 c.i.		U-0.533	R-0 + R-1.7 c.i.		U-0.920	R-2.3	
Steel framed	U-0.479	R-2.3 + R-0.7 c.i.		U-0.365	R-2.3 + R-1.3 c.i.		U-0.705	R-2.3	
Wood framed and other	U-0.504	R-2.3		U-0.504	R-2.3		U-0.504	R-2.3	
Wall, below grade									
Below-grade wall	C-6.473	NR		C-6.473	NR		C-6.473	NR	
Floors									
Mass	U-0.606	R-1.1		U-0.496	R-1.5		U-1.825	NR	
Steel joist	U-0.214	R-5.3		U-0.214	R-5.3		U-0.390	R-2.3	
Wood framed and other	U-0.188	R-5.3		U-0.188	R-5.3		U-0.376	R-2.3	
Slab-on-grade floors									
Unheated	F-1.264	NR		F-1.264	NR		F-1.264	NR	
Heated	F-1.558	R-1.8 for 600 mm		F-1.489	R-2.6 for 600 mm		F-1.766	R-1.3 for 300 mm	
Opaque doors									
Swinging	U-2.101			U-2.101			U-3.975		
Nonswinging	U-1.760			U-1.760			U-8.233		
FENESTRATION	ASSEMBLY MAX. U	ASSEMBLY MAX. SHGC	ASSEMBLY MIN. VT/SHGC	ASSEMBLY MAX. U	ASSEMBLY MAX. SHGC	ASSEMBLY MIN. VT/SHGC	ASSEMBLY MAX. U	ASSEMBLY MAX. SHGC	ASSEMBLY MIN. VT/SHGC
Vertical glazing, 0% to 40% of wall		(for all frame types)			(for all frame types)			(for all frame types)	
Nonmetal framing, all	U-2.00	E&W-0.24, S-0.25, N-0.35	1.10	U-2.00	E&W-0.24, S-0.25, N-0.35	1.10	U-5.02	NR	NR
Metal framing, fixed	U-2.91			U-2.91			U-6.48		
Metal framing, operable	U-3.51			U-3.51			U-6.48		
Metal framing, entrance door	U-4.48			U-4.15			U-4.48		
Skylight, 0% to 3% of roof									
All types	U-3.51	0.35	NR	U-3.51	0.33	NR	U-9.71	NR	NR

\* The following definitions apply: c.i. = continuous insulation (see ANSI/ASHRAE/IES Standard 90.1, Section 3.2); NR = no (insulation) requirement; FC = filled cavity (see ANSI/ASHRAE/IES Standard 90.1, Section A2.3.2.5).

\*\*The insulation minimum R-value criteria in this table meet the criteria in Section 701.4.2.1, but it is possible that some assemblies with slightly less insulation minimum R-value will also meet the criteria of Section 701.4.2.1.

a. When using the R-value compliance method for metal building *roofs*, a thermal spacer block is required (see ANSI/ASHRAE/IES Standard 90.1, Section 3.2).

b. Exception applies for mass *walls* above grade where the requirement is for a maximum assembly U-0.151 (see ANSI/ASHRAE/IES Standard 90.1, Section 5.5.3.2).

**TABLE E101.3**  
**(SUPERSEDES TABLE 5.5-3 IN ANSI/ASHRAE/IES STANDARD 90.1)**  
**BUILDING ENVELOPE REQUIREMENTS FOR CLIMATE ZONE 3 (A,B,C)\* (SI)**

OPAQUE ELEMENTS	NONRESIDENTIAL			RESIDENTIAL			SEMIHEATED		
	ASSEMBLY MAXIMUM	INSULATION MIN. R-VALUE**		ASSEMBLY MAXIMUM	INSULATION MIN. R-VALUE**		ASSEMBLY MAXIMUM	INSULATION MIN. R-VALUE**	
Roofs									
Insulation entirely above deck	U-0.220	R-4.4 c.i.		U-0.220	R-4.4 c.i.		U-0.677	R-1.3 c.i.	
Metal building <sup>a</sup>	U-0.233	R-1.8 + R-3.3 FC		U-0.233	R-1.8 + R-3.3 FC		U-0.545	R-2.8	
Attic and other roofs	U-0.153	R-6.7		U-0.153	R-6.7		U-0.300	R-3.3	
Walls, above grade									
Mass <sup>b</sup>	U-0.701	R-1.3 c.i.		U-0.592	R-1.7 c.i.		U-3.293	NR	
Metal building	U-0.533	R-0 + R-1.7 c.i.		U-0.409	R-0 + R-2.3 c.i.		U-0.920	R-2.3	
Steel framed	U-0.435	R-2.3 + R-0.9 c.i.		U-0.365	R-2.3 + R-1.3 c.i.		U-0.705	R-2.3	
Wood framed and other	U-0.504	R-2.3		U-0.365	R-2.3 + R-0.7 c.i.		U-0.504	R-2.3	
Wall, below grade									
Below-grade wall	C-6.473	NR		C-6.473	NR		C-6.473	NR	
Floors									
Mass	U-0.420	R-1.8 c.i.		U-0.420	R-1.8 c.i.		U-0.780	R-0.7 c.i.	
Steel joist	U-0.214	R-5.3		U-0.214	R-5.3		U-0.296	R-3.3	
Wood framed and other	U-0.188	R-5.3		U-0.188	R-5.3		U-0.288	R-3.3	
Slab-on-grade floors									
Unheated	F-1.264	NR		F-0.935	R-1.8 for 600 mm		<sup>1</sup> F-1.264	NR	
Heated	F-1.489	R-2.6 for 600 mm		F-1.489	R-2.6 for 600 mm		F-1.766	R-1.3 for 300 mm	
Opaque doors									
Swinging	U-2.101			U-2.101			U-2.101		
Nonswinging	U-1.760			U-1.760			U-2.044		
FENESTRATION	ASSEMBLY MAX. U	ASSEMBLY MAX. SHGC	ASSEMBLY MIN. VT/SHGC	ASSEMBLY MAX. U	ASSEMBLY MAX. SHGC	ASSEMBLY MIN. VT/SHGC	ASSEMBLY MAX. U	ASSEMBLY MAX. SHGC	ASSEMBLY MIN. VT/SHGC
Vertical glazing, 0% to 40% of wall		(for all frame types)			(for all frame types)			(for all frame types)	
Nonmetal framing, all	U-1.78	E&W-0.24, S-0.25, N-0.35	1.10	U-1.89	E&W-0.24, S-0.25, N-0.35	1.10	U-4.69	NR	NR
Metal framing, fixed	U-2.43			U-2.64			U-6.48		
Metal framing, operable	U-3.24			U-3.24			U-6.48		
Metal framing, entrance door	U-4.15			U-3.67			U-4.15		
Skylight, 0% to 3% of roof									
All types	U-2.97	0.33	NR	U-2.97	0.33	NR	U-9.17	NR	NR

\* The following definitions apply: c.i. = continuous insulation (see ANSI/ASHRAE/IES Standard 90.1, Section 3.2); NR = no (insulation) requirement; FC = filled cavity (see ANSI/ASHRAE/IES Standard 90.1, Section A2.3.2.5).

\*\* The insulation minimum R-value criteria in this table meet the criteria in Section 701.4.2.1, but it is possible that some assemblies with slightly less insulation minimum R-value will also meet the criteria of Section 701.4.2.1.

a. When using the R-value compliance method for metal building *roofs*, a thermal spacer block is required (see ANSI/ASHRAE/IES Standard 90.1, Section 3.2).

**TABLE E101.4**  
**(SUPERSEDES TABLE 5.5-4 IN ANSVASHRAVIES STANDARD 90.1)**  
**BUILDING ENVELOPE REQUIREMENTS FOR CLIMATE ZONE 4 (A,B,C)\* (SI)**

OPAQUE ELEMENTS	NONRESIDENTIAL			RESIDENTIAL			SEMIHEATED		
	ASSEMBLY MAXIMUM	INSULATION MIN. R-VALUE**		ASSEMBLY MAXIMUM	INSULATION MIN. R-VALUE**		ASSEMBLY MAXIMUM	INSULATION MIN. R-VALUE**	
Roofs									
Insulation entirely above deck	U-0.173	R-6.2 c.i.		U-0.173	R-6.2 c.i.		U-0.502	R-1.9 c.i.	
Metal building <sup>a</sup>	U-0.200	R-1.9 + R-3.3 c.i.		U-0.200	R-1.9 + R-3.3 c.i.		U-0.442	R-3.3 + R-1.1 c.i.	
Attic and other roofs	U-0.113	R-10.6		U-0.113	R-10.6		U-0.183	R-6.7	
Walls, above grade									
Mass <sup>b</sup>	U-0.561	R-2.0 c.i.		U-0.486	R-2.3 c.i.		U-3.294	NR	
Metal building	U-0.324	R-1.9 + R-2.3 c.i.		U-0.270	R-1.9 + R-2.8 c.i.		U-0.874	R-3.3	
Steel framed	U-0.345	R-2.3 + R-2.2 c.i.		U-0.345	R-2.3 + R-2.2 c.i.		U-0.669	R-2.3 + R-0.7 c.i.	
Wood framed and other	U-0.345	R-2.3 + R-1.3 c.i.		U-0.345	R-2.3 + R-1.3 c.i.		U-0.480	R-2.3 + R-0.7 c.i.	
Wall, below grade									
Below-grade wall	C-0.642	R-1.8 c.i.		C-0.496	R-2.2 c.i.		C-6.475	NR	
Floors									
Mass	U-0.308	R-2.9 c.i.		U-0.275	R-3.3 c.i.		U-0.577	R-1.5 c.i.	
Steel joist	U-0.205	R-6.7		U-0.205	R-6.7		U-0.281	R-5.3	
Wood framed and other	U-0.178	R-6.7		U-0.178	R-6.7		U-0.275	R-5.3	
Slab-on-grade floors									
Unheated	F-0.855	R-3.5 for 1200 nun		F-0.855	R-3.5 for 1200 mm		F-1.264	NR	
Heated	F-1.386	R-3.5 for 1200 mm		F-1.131	R-3.5 full slab		F-1.480	R-3.5 for 600 mm	
Opaque doors									
Swinging	U-1.997			U-1.997			U-1.997		
Nonswinging	U-1.673			U-1.673			U-1.943		
FENESTRATION	ASSEMBLY MAX. U	ASSEMBLY MAX. SHGC	ASSEMBLY MIN. VT/SHGC	ASSEMBLY MAX. U	ASSEMBLY MAX. SHGC	ASSEMBLY MIN. VT/SHGC	ASSEMBLY MAX. U	ASSEMBLY MAX. SHGC	ASSEMBLY MIN. VT/SHGC
Vertical glazing, 0% to 40% of wall		(for all frame types)			(for all frame types)			(for all frame types)	
Nonmetal framing, all	U-1.67	E&W-0.34, S-0.36, N-0.46	1.10	U-1.67	E&W-0.34, S-0.36, N-0.46	1.10	U-2.75	NR	NR
Metal framing, fixed	U-2.05			U-2.05			U-3.94		
Metal framing, operable	U-2.48			U-2.48			U-4.37		
Metal framing, entrance door	U-3.67			U-3.67			U-4.15		
Skylight, 0% to 3% of roof									
All types	U-2.70	0.38	NR	U-2.70	0.38	NR	U-6.21	NR	NR

\* The following definitions apply: c.i. = continuous insulation (see ANSI/ASHRAE/IES Standard 90.1, Section 3.2); NR = no (insulation) requirement.

\*\*The insulation minimum R-value criteria in this table meet the criteria in Section 701.4.2.1, but it is possible that some assemblies with slightly less insulation minimum R-value will also meet the criteria of Section 701.4.2.1.

a. When using the R-value compliance method for metal building *roofs*, a thermal spacer block is required (see ANSI/ASHRAE/IES Standard 90.1, Section 3.2).

**TABLE E101.5**  
**(SUPERSEDES TABLE 5.5-5 IN ANSWASHRAVIES STANDARD 90.1)**  
**BUILDING ENVELOPE REQUIREMENTS FOR CLIMATE ZONE 5 (A, B, C)\* (SI)**

OPAQUE ELEMENTS	NONRESIDENTIAL			RESIDENTIAL			SEMIHEATED		
	ASSEMBLY MAXIMUM	INSULATION MIN. R-VALUE**		ASSEMBLY MAXIMUM	INSULATION MIN. R-VALUE**		ASSEMBLY MAXIMUM	INSULATION MIN. R-VALUE**	
Roofs									
Insulation entirely above deck	U-0.173	R-6.2 c.i.		U-0.173	R-6.2 c.i.		U-0.340	R-3.0 c.i.	
Metal building <sup>a</sup>	U-0.200	R-1.9 + R-3.3 c.i.		U-0.200	R-1.9 + R-3.3 c.i.		U-0.442	R-3.3 + R-1.1 c.i.	
Attic and other roofs	U-0.113	R-10.6		U-0.113	R-10.6		U-0.183	R-6.7	
Walls, above grade									
Mass <sup>b</sup>	U-0.486	R-2.3 c.i.		U-0.432	R-2.6 c.i.		U-0.815	R-1.3 c.i.	
Metal building	U-0.270	R-1.9 + R-2.8 c.i.		U-0.270	R-1.9 + R-2.8 c.i.		U-0.507	R-1.9 + R-1.1 c.i.	
Steel framed	U-0.297	R-2.3 + R-2.2 c.i.		U-0.297	R-2.3 + R-2.2 c.i.		U-0.453	R-2.3 + R-0.9 c.i.	
Wood framed and other	U-0.275	R-2.3 + R-2.2 c.i.		U-0.275	R-2.3 + R-2.2 c.i.		U-0.480	R-2.3 + R-0.7 c.i.	
Wall, below grade									
Below-grade wall	C-0.642	R-1.8 c.i.		C-0.496	R-2.2 c.i.		C-6.475	NR	
Floors									
Mass	U-0.308	R-2.9 c.i.		U-0.275	R-3.3 c.i.		U-0.577	R-1.5 c.i.	
Steel joist	U-0.205	R-6.7		U-0.205	R-6.7		U-0.281	R-5.3	
Wood framed and other	U-0.178	R-6.7		U-0.178	R-6.7		U-0.275	R-5.3	
Slab-on-grade floors									
Unheated	F-0.855	R-3.5 for 1200 mm		F-0.839	R-3.5 for 1200 mm		F-1.264	NR	
Heated	F-1.131	R-3.5 full slab		F-1.131	R-3.5 full slab		F-1.480	R-3.5 for 600 mm	
Opaque doors									
Swinging	U-1.997			U-1.997			U-1.997		
Nonswinging	U-1.673			U-1.673			U-1.943		
FENESTRATION	ASSEMBLY MAX. U	ASSEMBLY MAX. SHGC	ASSEMBLY MIN. VT/SHGC	ASSEMBLY MAX. U	ASSEMBLY MAX. SHGC	ASSEMBLY MIN. VT/SHGC	ASSEMBLY MAX. U	ASSEMBLY MAX. SHGC	ASSEMBLY MIN. VT/SHGC
Vertical glazing, 0% to 40% of wall		(for all frame types)			(for all frame types)			(for all frame types)	
Nonmetal framing, all	U-1.67	E&W-0.36, S-0.38, N-0.48	1.10	U-1.67	E&W-0.36, S-0.38, N-0.48	1.10	U-2.43	NR	NR
Metal framing, fixed	U-2.05			U-2.05			U-3.35		
Metal framing, operable	U-2.48			U-2.48			U-3.78		
Metal framing, entrance door	U-3.67			U-3.67			U-4.15		
Skylight, 0% to 3% of roof									
All types	U-2.70	0.38	NR	U-2.70	0.38	NR	U-5.29	NR	NR

\* The following definitions apply: c.i. = continuous insulation (see ANSI/ASHRAE/IES Standard 90.1, Section 3.2); NR = no (insulation) requirement.

\*\* The insulation minimum R-value criteria in this table meet the criteria in Section 701.4.2.1, but it is possible that some assemblies with slightly less insulation minimum R-value will also meet the criteria of Section 701.4.2.1.

a. When using the R-value compliance method for metal building roofs, a thermal spacer block is required (see ANSI/ASHRAE/IES Standard 90.1, Section 3.2).

**TABLE E101.6**  
**(SUPERSEDES TABLE 5.5-6 IN ANSI/ASHRAE/IES STANDARD 90.1)**  
**BUILDING ENVELOPE REQUIREMENTS FOR CLIMATE ZONE 6 (A,B)\* (SI)**

OPAQUE ELEMENTS	NONRESIDENTIAL			RESIDENTIAL		SEMIHEATED			
	ASSEMBLY MAXIMUM	INSULATION MIN. R-VALUE**		ASSEMBLY MAXIMUM	INSULATION MIN. R-VALUE**		ASSEMBLY MAXIMUM	INSULATION MIN. R-VALUE**	
Roofs									
Insulation entirely above deck	U-0.173	R-6.2 c.i.		U-0.173	R-6.2 c.i.		U-0.340	R-3.0 c.i.	
Metal building <sup>a</sup>	U-0.167	R-5.3 + R-1.9 <i>Ls</i>		U-0.156	R-1.8 + R-3.3 + R-2.3 c.i.		U-0.324	R-1.8 + R-1.8 + R-1.1 c.i.	
Attic and other roofs	U-0.113	R-10.6		U-0.113	R-10.6		U-0.183	R-6.7	
Walls, above grade									
Mass	U-0.432	R-2.6 c.i.		U-0.383	R-3.1 c.i.		U-0.815	R-1.3 c.i.	
Metal building	U-0.270	R-1.9 + R-2.8 c.i.		U-0.270	R-1.9 + R-2.8 c.i.		U-0.507	R-1.9 + R-1.1 c.i.	
Steel framed	U-0.264	R-2.3 + R-2.7 c.i.		U-0.264	R-2.3 + R-2.7 c.i.		U-0.453	R-2.3 + R-0.9 c.i.	
Wood framed and other	U-0.275	R-2.3 + R-2.2 c.i.		U-0.275	R-2.3 + R-2.2 c.i.		U-0.480	R-2.3 + R-0.7 c.i.	
Wall, below grade									
Below-grade wall	C-0.496	R-2.2 c.i.		C-0.340	R-3.1 c.i.		C-0.642	R-1.8 c.i.	
Floors									
Mass	U-0.275	R-3.3 c.i.		U-0.275	R-3.3 c.i.		U-0.469	R-1.8 c.i.	
Steel joist	U-0.173	R-8.6		U-0.173	R-8.6		U-0.281	R-5.3	
Wood framed and other	U-0.146	R-6.7 + R-1.3 c.i.		U-0.146	R-6.7 + R-1.3 c.i.		U-0.275	R-5.3	
Slab-on-grade floors									
Unheated	F-0.839	R-3.5 for 1200 mm		F-0.714	R-2.6 full slab		F-1.264	NR	
Heated	F-1.131	R-3.5 full slab		F-1.103	R-3.5 full slab		F-1.414	R-3.5 for 1200 mm	
Opaque doors									
Swinging	U-1.997			U-1.997			U-1.997		
Nonswinging	U-1.673			U-1.673			U-1.943		
FENESTRATION	ASSEMBLY MAX. U	ASSEMBLY MAX. SHGC	ASSEMBLY MIN. VT/SHGC	ASSEMBLY MAX. U	ASSEMBLY MAX. SHGC	ASSEMBLY MIN. VT/SHGC	ASSEMBLY MAX. U	ASSEMBLY MAX. SHGC	ASSEMBLY MIN. VT/SHGC
Vertical glazing, 0% to 40% of wall		(for all frame types)			(for all frame types)			(for all frame types)	
Nonmetal framing, all	U-1.62	E&W-0.38, S-0.40, N-0.50	1.10	U-1.62	E&W-0.38, S-0.40, N-0.50	1.10	U-2.43	NR	NR
Metal framing, fixed	U-1.94			U-1.94			U-2.75		
Metal framing, operable	U-2.43			U-2.43			U-3.18		
Metal framing, entrance door	U-3.67			U-3.67			U-4.15		
Skylight, 0% to 3% of roof									
All types	U-2.70	0.38	NR	U-2.70	0.38	NR	U-4.59	NR	NR

\* The following definitions apply: c.i. = continuous insulation (ANSI/ASHRAE/IES Standard 90.1, see Section 3.2); NR = no (insulation) requirement; *Ls* = liner system (see ANSI/ASHRAE/IES Standard 90.1, Section A2.3.2.4).

\*\*The insulation minimum R-value criteria in this table meet the criteria in Section 701.4.2.1, but it is possible that some assemblies with slightly less insulation minimum R-value will also meet the criteria of Section 701.4.2.1.

a. When using the R-value compliance method for metal building *roofs*, a thermal spacer block is required (see ANSI/ASHRAE/IES Standard 90.1, Section 3.2).



**TABLE E101.7**  
**(SUPERSEDES TABLE 5.5-7 IN ANSI/ASHRAE/IES STANDARD 90.1)**  
**BUILDING ENVELOPE REQUIREMENTS FOR CLIMATE ZONE 7\* (SI)**

OPAQUE ELEMENTS	NONRESIDENTIAL			RESIDENTIAL			SEMIHEATED		
	ASSEMBLY MAXIMUM	INSULATION MIN. R-VALUE**		ASSEMBLY MAXIMUM	INSULATION MIN. R-VALUE**		ASSEMBLY MAXIMUM	INSULATION MIN. R-VALUE**	
Roofs									
Insulation entirely above deck	U-0.151	R-7.0 c.i.		U-0.151	R-7.0 c.i.		U-0.210	R-4.6 c.i.	
Metal building <sup>a</sup>	U-0.156	R-1.8 + R-3.3 + R-2.3 c.i.		U-0.156	R-1.8 + R-3.3 + R-2.3 c.i.		U-0.200	R-1.9 + R-3.3 c.i.	
Attic and other roofs	U-0.092	R-12.5		U-0.092	R-12.5		U-0.146	R-8.6	
Walls, above grade									
Mass	U-0.383	R-3.1 c.i		U-0.383	R-3.1 c.i.		U-0.664	R-1.7 c.i.	
Metal building	U-0.237	R-1.9 + R-3.3 c.i.		U-0.237	R-1.9 + R-3.3 c.i.		U-0.389	R-1.9 + R-1.7 c.i.	
Steel framed	U-0.264	R-2.3 + R-2.7 c.i.		U-0.227	R-2.3 + R-3.3 c.i.		U-0.345	R-2.3 + R-2.2 c.i.	
Wood framed and other	U-0.275	R-2.3 + R-2.2 c.i.		U-0.275	R-2.3 + R-2.2 c.i.		U-0.345	R-2.3 + R-1.3 c.i.	
Wall, below grade									
Below-grade wall	C-0.340	R-3.1 c.i.		C-0.340	R-3.1 c.i.		C-0.642	R-1.8 c.i.	
Floors									
Mass	U-0.227	R-4.1 c.i.		U-0.227	R-4.1 c.i.		U-0.399	R-2.2 c.i.	
Steel joist	U-0.173	R-8.6		U-0.173	R-8.6		U-0.281	R-5.3	
Wood framed and other	U-0.146	R-6.7+ R-1.3 c.i.		U-0.146	R-6.7 + R-1.3 c.i.		U-0.275	R-5.3	
Slab-on-grade floors									
Unheated	F-0.839	R-3.5 for 1200 mm		F-0.714	R-2.6 full slab		F-1.264	NR	
Heated	F-1.103	R-3.5 full slab		F-1.103	R-3.5 full slab		F-1.414	R-3.5 for 1200 mm	
Opaque doors									
Swinging	U-1.997			U-1.997			U-1.997		
Nonswinging	U-1.673			U-1.673			U-1.673		
FENESTRATION	ASSEMBLY MAX. U	ASSEMBLY MAX. SHGC	ASSEMBLY MIN. VT/SHGC	ASSEMBLY MAX. U	ASSEMBLY MAX. SHGC	ASSEMBLY MIN. VT/SHGC	ASSEMBLY MAX. U	ASSEMBLY MAX. SHGC	ASSEMBLY MIN. VT/SHGC
Vertical glazing, 0% to 40% of wall		(for all frame types)			(for all frame types)			(for all frame types)	
Nonmetal framing, all	U-1.51	E&W-0.43, S-0.45, N-0.55	1.10	U-1.51	E&W-0.43, S-0.45, N-0.55	1.10	U-1.73	NR	NR
Metal framing, fixed	U-1.78			U-1.78			U-2.05		
Metal framing, operable	U-2.16			U-2.16			U-2.37		
Metal framing, entrance door	U-3.67			U-3.67			U-4.15		
Skylight, 0% to 3% of roof									
All types	U-2.70	NR	NR	U-2.70	NR	NR	U-4.59	NR	NR

\* The following definitions apply: c.i. = continuous insulation (see ANSI/ASHRAE/IES Standard 90.1, Section 3.2), NR = no (insulation) requirement.

\*\*The insulation minimum R-value criteria in this table meet the criteria in Section 701.4.2.1, but it is possible that some assemblies with slightly less insulation minimum R-value will also meet the criteria of Section 701.4.2.1.

a. When using the R-value compliance method for metal building roofs, a thermal spacer block is required (see ANSI/ASHRAE/IES Standard 90.1, Section 3.2).

**TABLE E101.8**  
**(SUPERSEDES TABLE 5.5-8 IN ANSWASHRAERES STANDARD 90.1)**  
**BUILDING ENVELOPE REQUIREMENTS FOR CLIMATE ZONE 8\* (SI)**

OPAQUE ELEMENTS	NONRESIDENTIAL			RESIDENTIAL			SEMIHEATED		
	ASSEMBLY MAXIMUM	INSULATION MIN. R-VALUE**		ASSEMBLY MAXIMUM	INSULATION MIN. R-VALUE**		ASSEMBLY MAXIMUM	INSULATION MIN. R-VALUE**	
Roofs									
Insulation entirely above deck	U-0.151	R-7.0 c.i.		U-0.151	R-7.0 c.i.		U-0.210	R-4.6 c.i.	
Metal building <sup>a</sup>	U-0.140	R-3.3 + R-3.3 + R-4.4 c.i.		U-0.140	R-3.3 + R-3.3 + R-4.4 c.i.		U-0.200	R-1.9 + R-3.3 c.i.	
Attic and other roofs	U-0.092	R-12.5		U-0.092	R-12.5		U-0.146	R-8.6	
Walls, above grade									
Mass	U-0.259	R-3.7 c.i.		U-0.259	R-3.7 c.i.		U-0.561	R-2.0 c.i.	
Metal building	U-0.210	R-1.9 + R-3.9 c.i.		U-0.210	R-1.9 + R-3.9 c.i.		U-0.324	R-1.9 + R-2.3 c.i.	
Steel framed	U-0.200	R-2.3 + R-3.9 c.i.		U-0.200	R-2.3 + R-3.9 c.i.		U-0.345	R-2.3 + R-2.2 c.i.	
Wood framed and other	U-0.173	R-2.3 + R-3.9 c.i.		U-0.173	R-2.3 + R-3.9 c.i.		U-0.275	R-2.3 + R-2.2 c.i.	
Wall, below grade									
Below-grade wall	C-0.340	R-3.1 c.i.		C-0.340	R-3.1 c.i.		C-0.642	R-1.8 c.i.	
Floors									
Mass	U-0.205	R-4.4 c.i.		U-0.205	R-4.4 c.i.		U-0.345	R-2.6 c.i.	
Steel joist	U-0.173	R-8.6		U-0.173	R-8.6		U-0.281	R-5.3	
Wood framed and other	U-0.146	R-6.7 + R-1.3 c.i.		U-0.146	R-6.7 + R-1.3 c.i.		U-0.178	R-6.7	
Slab-on-grade floors									
Unheated	F-0.714	R-2.6 full slab		F-0.697	R-2.6 full slab		F-0.888	R-3.5 for 600 mm	
Heated	F-1.103	R-3.5 full slab		F-0.613	R-4.4 full slab		F-1.414	R-3.5 for 1200 mm	
Opaque doors									
Swinging	U-1.997			U-1.997			U-1.997		
Nonswinging	U-1.673			U-1.673			U-1.673		
FENESTRATION	ASSEMBLY MAX. U	ASSEMBLY MAX. SHGC	ASSEMBLY MIN. VT/SHGC	ASSEMBLY MAX. U	ASSEMBLY MAX. SHGC	ASSEMBLY MIN. VT/SHGC	ASSEMBLY MAX. U	ASSEMBLY MAX. SHGC	ASSEMBLY MIN. VT/SHGC
Vertical glazing, 0% to 40% of wall		(for all frame types)			(for all frame types)			(for all frame types)	
Nonmetal framing, all	U-1.35	E&W-0.43, S-0.45, N-0.55	1.10	U-1.35	E&W-0.43, S-0.45, N-0.55	1.10	U-1.73	NR	NR
Metal framing, fixed	U-1.56			U-1.56			U-2.05		
Metal framing, operable	U-1.89			U-1.89			U-2.37		
Metal framing, entrance door	U-3.67			U-3.67			U-4.15		
Skylight, 0% to 3% of roof									
All types	U-2.21	NR	NR	U-2.21	NR	NR	U-4.59	NR	NR

\* The following definitions apply: c.i. = continuous insulation (see ANSI/ASHRAE/IES Standard 90.1, Section 3.2); NR = no (insulation) requirement

\*\*The insulation minimum R-value criteria in this table meet the criteria in Section 701.4.2.1, but it is possible that some assemblies with slightly less insulation minimum R-value will also meet the criteria of Section 701.4.2.1.

a. When using the A-value compliance method for metal building *roofs*, a thermal spacer block is required (see ANSI/ASHRAE/IES Standard 90.1, Section 3.2).

## INFORMATIVE APPENDIX F

# INTEGRATED DESIGN

*This appendix is not part of this code. It is merely informative and does not contain requirements necessary for conformance to the code. It has not been processed according to the ANSI requirements for a code and may contain material that has not been subject to public review or a consensus process. Unresolved objectors on informative material are not offered the right to appeal at ASHRAE or ANSI.)*

### SECTION F101 Integrated Design Process/Integrated Project Delivery

Integrated design, and related concepts such as *integrated project delivery* and integrative design, leverages early stakeholder collaboration, through the sharing of knowledge, and expertise among project team members, to develop stronger, more balanced design solutions. This *integrated design process* stands in contrast to traditional design methods, where there is limited use of the skills and knowledge of all stakeholders. An *integrated design process* provides increased predictability of project outcomes earlier and enables the construction of *high-performance green buildings* that consume fewer resources and provide better comfort and functionality.

Integrated design introduces major issues and key participants into the project early, where more opportunities occur for creative problem solving. The complex interactions of sophisticated building systems require early coordination to maximize their effectiveness and output. Early team building and goal setting may also reduce total project costs. The collaborative process can inform *building envelope*, mechanical, electrical, plumbing, and other building system design. The later in the design process that systems are introduced, the more expensive their implementation will be. Information technology can also be a valuable asset in increasing predictability of outcomes earlier in the project and is recommended for all integrated teams.

In contrast with a linear design process, which addresses problems sequentially, an integrated process approaches each problem with input from the various viewpoints of the participants and the domains they represent, circling back after each design decision to collectively evaluate the impact on all stakeholders. This process acknowledges the complex interdependency of building systems and their relationship to resource consumption and occupant well being.

Several existing, and currently evolving, models for collaboration should be considered, including *ASHRAE Handbook—HVAC Applications*, Chapter 57; the MTS 1.0 WSIP Guide, *Whole Systems Integrated Process Guide for Sustainable Buildings and Communities*; and *Integrated Project Delivery: A Guide* by the AIA and AIA California Council.

Project-specific integrated design and/or *integrated project delivery* processes should be determined with full participation of the stakeholder team. What works for one project may not be the best approach for the next. Additionally, the team should collectively identify the performance standards and the associated metrics by which project success will be evaluated. Design charrettes of varying duration may be an effective tool to consider, though ultimately it is the

responsibility of the stakeholder team to determine the process that will best fit a specific problem or project.

**F101.1 Design Charrette.** The following outlines one type of design charrette process that resulted in a successful integrated design. A charrette process can be initiated at the initial stages of building design, and the members of the process should include all stakeholders.

**F101.1.1 Charrette Process.** Experienced personnel representing each specialty should participate in the charrette process. A discussion of all systems and all items that affect the *integrated design* should be discussed. Stakeholders should be able to decide and vote on the best integrated system.

The integrative team process should entail the following steps of design optimization:

- a. The original goals and budget of the project should be revisited to see whether the overall intentions of the project are intact.
- b. The project should be compared with this code or at least one existing green rating system.
- c. Each of the building and *site* components should be scrutinized to help ensure that natural systems for energy conservation, lighting, ventilation, and passive heating and cooling are maximized before mechanical systems are engaged.
- d. The appropriateness and integration logic of the building's primary systems should be confirmed.
- e. The impact of the design on the *site* and its larger context should be evaluated, including the environmental impact on a life-cycle cost basis.
- f. Building information modeling (BIM) software, design tools, and the experience of the design team should be used, where practical, to help optimize the design.
- g. All members of the design team should be included when making design decisions.
- h. Commissioning and consideration of future operation and maintenance (O&M) requirements should be included within the design optimization process.

**F101.1.2 Design Charrette Matrix.** At the end of the charrette process, a matrix for each proposed build ing scheme can be developed and evaluated to summarize the impact on the *site*, water, energy, materials, and indoor environmental quality and to help in deciding on the best integrated system. The matrix contains cells indicating the high-performance value, grading a particular building system to its appropriate high-performance criteria. Each high-

performance value is qualitatively rated from 1 to 10, with 1 being the lowest (minimal energy savings, low air quality, low water efficiency, high cost) and 10 being the highest (high energy savings, high air quality, high water efficiency, low cost). The average of the high-performance values for each building system is the aggregate index. Selection of the best system should be based on a comparison of the aggregate indices for each matrix.

**Scheme #1** – with Atrium, maximum exposure on the south, three-story office building.

BUILDING SYSTEM	HIGH-PERFORMANCE CRITERIA						
	SITE	IAQ	1EQ	ENERGY	COMM. M&V	INITIAL COST	O & M
Arch	8	7	6	1	6	1	6
HVAC	—	5	6	2	6	2	7
Plumbing	NA	—	—	—	—	2	7
Structural	—	—	—	—	—	2	—
Aggregate index	8	6	6	1.5	6	2	6.8

Result:

Least numbers under energy and cost column defines consumption of substantial energy with high initial cost.

**Scheme #1** – without Atrium, three-story, minimum exposure on the south and west side.

BUILDING SYSTEM	HIGH-PERFORMANCE CRITERIA						
	SITE	IAQ	1EQ	ENERGY	COMM. M&V	INITIAL COST	O & M
Arch	6	7	7	7	7	7	6
HVAC	NA	5	7	7	7	7	7
Plumbing	NA	—	—	—	7	7	7
Structural	—	—	—	—	—	—	—
Aggregate index	6	6	7	7	7	7	6.8

Result:

High numbers on all columns indicate the building is conceived optimally.

**FIGURE F101.1 (FIGURE F-1)  
SAMPLE CHARRETTE DESIGN MATRICES.**

## INFORMATIVE APPENDIX G

# INFORMATIVE REFERENCES

*This appendix is not part of this code. It is merely informative and does not contain requirements necessary for conformance to the code. It has not been processed according to the ANSI requirements for a code and may contain material that has not been subject to public review or a consensus process. Unresolved objections on informative material are not offered the right to appeal at ASHRAE or ANSI.)*

This appendix contains informative references for the convenience of users of this code and to acknowledge source documents when appropriate. Section numbers indicate where the reference occurs in this document.

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### AIA

American Institute of Architects  
1735 New York Avenue NW  
Washington, DC 20006

**AIA National/AIA California Council: Integrated Project Delivery: A Guide, v. 1-2007**  
Appendix F

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### AISC

American Institute of Steel Construction  
130 East Randolph, Suite 2000  
Chicago, Illinois 60601

**Brochure: Steel Takes LEED® with Recycled Content**  
901.4.1.1

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### ASHRAE

1791 Tullie Circle NE  
Atlanta, GA 30329

**ASHRAE Guideline 0-2013: The Commissioning Process**  
1001.3.1.1

**ASHRAE Guideline 1.1-2007 : HVAC&R Technical Requirements for the Commissioning Process**  
1001.3.1.1

**ASHRAE Guideline 4-2008 (RA 2013): Preparation of Operating and Maintenance Documentation for Building System**  
1001.3.1.1

**ASHRAE Handbook, 2017: Fundamentals**  
Appendix C

**ASHRAE Handbook, 2015: HVAC Applications**  
Appendix F

**ASHRAE Standard 62.1-2016 (Appendix C): Ventilation for Acceptable Indoor Air Quality**  
Table 1001.3.1.4

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### APBP

Association of Pedestrian and Bicycle Professionals  
201 East Main Street, Suite 1405  
Lexington, KY 40507

**Bicycle Parking Guidelines, 2nd Edition, 2010**  
501.3.7.2

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## ASTM

ASTM International  
100 Barr Harbor Dr.  
West Conshohocken, PA 19428-2959

**ASTM C755-10 (2015): Standard Practice for Selection of Water Vapor Retarders for Thermal Insulation, Appendix X1 Problem Analysis**

801.3.6

**ASTM E1331-15: Standard Test Method for Reflectance Factor and Color by Spectrophotometry Using Hemispherical Geometry**

801.4.1

**ASTM E1477 - 98a (2013): Standard Test Method for Luminous Reflectance Factor of Acoustical Materials by Use of Integrating-Sphere Reflectometers**

801.4.1

**ASTM E2813-12e1: Standard Practice for Building Enclosure Commissioning**

1001.3.1.3.5

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## BSI

British Standards Institute  
389 Chiswick High Road  
London, W4 4AL, United Kingdom

**BS 8493:2008+A1:2010: Light reflectance value (LRV) of a surface. Method of test.**

801.4.1

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## calEPA

California Environmental Protection Agency  
Office of Environmental Health Hazard Assessment  
Post Office Box 4010  
Sacramento, CA 95812-4010

**<http://www.oehha.org/air/allrels.html>: All OEHHA Acute, 8-hour and Chronic Reference Exposure Levels (chRELs) as of June 2014**

801.4.2, 801.5.2

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## CBE

Center for the Built Environment  
University of California, 390 Wurster Hall #1839  
Berkeley, CA 94720-1839

**<http://www.cbe.berkeley.edu/research/survey.htm>: Indoor Environmental Quality (IEQ) Survey™**

1001.3.2.1.5

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## CRI

Carpet and Rug Institute  
100 South Hamilton Street  
Dalton, Georgia 30720

801.4.2.3

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## CSA

Canadian Standards Association 5060  
Spectrum Way, Suite 100 Mississauga,  
Ontario, L4W 5N6, Canada

**CSA S478-95 (R2007): Guideline on Durability for Buildings**

901.4.1, 1001.3.2.3

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## DGS

State of California, Department of General Services, Procurement Division  
Ziggurat Building  
707 Third Street  
West Sacramento, CA 95605-2811

**RFP DGS-56275: Section 5.7, "Indoor Air Quality Requirements for Open Office Panel Systems"**

Appendix D

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## DHHS ATSDR

United States Department of Health and Human  
Services Agency for Toxic Substances and  
Disease Registry 4770 Buford Hwy NE  
Atlanta, GA 30341

**[www.atsdr.cdc.gov/mrls](http://www.atsdr.cdc.gov/mrls): Minimal Risk Levels (MRLs)**

Table 1001.3.1.5

<b>EPA</b>  <b>Portfolio Manager</b>  1001.3.2.1.3.2	United States Environmental Protection Agency 1200 Pennsylvania Ave NW Washington, DC 20460
<b>FSC</b>  901.4.1.3.1	Forest Stewardship Council 1155 30th Street NW, Suite 300 Washington, DC 20007
<b>GSA</b>  <b>U.S. GSA-2005: The Building Commissioning Guide</b> 1001.3.1	United States General Services Administration 1800 F Street, NW Washington, DC 20405
<b>ICC</b>  <b>IBC-2018: International Building Code®</b> 106.1, 801.3.1.8, 1201.1 <b>IECC-2018: International Energy Conservation Code®</b> Appendix H <b>IFC-2018: International Fire Code®</b> IPC-2018: International Plumbing Code® <b>IPC-2018: International Plumbing Code®</b> 601.3.1.2.1 <b>ICC/ASHRAE 700-2015: National Green Building Standard</b> J101.1.1, J101.1.2, J101.1.3, J101.1.4, J101.1.5	International Code Council 500 New Jersey Ave NW # 300 Washington, DC 20001
<b>IES</b>  <b>IDA/IES Model Lighting Ordinance: Model Lighting Ordinance (MLO)</b> 501.3.6	Illuminating Engineering Society 120 Wall Street, Floor 17 New York, NY 10005-4001
<b>ITE</b>  <b>4th Edition, 2004: Parking Generation</b> 1001.3.2.4	Institute of Transportation Engineers 1627 Eye Street, NW, Suite 600 Washington, DC 20006
<b>MTS</b>  <b>MTS 1.0 WSIP Guide-2007: Whole Systems Integrated Process Guide for Sustainable Buildings and Communities</b> Appendix F	The Institute for Market Transformation to Sustainability 1511 Wisconsin Avenue, N.W. Washington, D.C. 20007
<b>NIBS</b>  <b>NIBS Guideline 3-2012: Building Enclosure Commissioning Process BECx</b> 1001.3.1.3.5	National Institute of Building Sciences 1090 Vermont Avenue, NW, Suite 700 Washington, DC 20005-4905
<b>NREL</b>  <b>NREL/TP-550-38617: Source Energy and Emissions Factors for Energy Use in Buildings</b> Table 701.5.2B	National Renewable Energy Laboratory 1617 Cole Blvd. Golden, CO 80401-3393



<b>RFCI</b>	Resilient Floor Covering Institute 115 Broad Street, Suite 201 LaGrange, GA 30240
801.4.2.3	
<b>SFI</b>	Sustainable Forestry Initiative, Inc. 1600 Wilson Blvd, Suite 810 Arlington, VA 22209
901.4.1.3.1	
<b>SMACNA</b>	Sheet Metal and Air Conditioning Contractors National Association 4201 Lafayette Center Drive Chantilly, VA 20151
<b>ANSI/SMACNA 008-2008: IAQ Guidelines for Occupied Buildings under Construction, Second Edition</b>	
1001.3.1.5	
<b>SRI</b>	Steel Recycling Institute 680 Andersen Drive Pittsburgh, PA 15220
<b>Brochure: Steel Takes LEED® With Recycled Content</b>	
901.4.1.1	
<b>UBT</b>	Usable Buildings Trust
<b>Occupant Satisfaction Evaluation Survey:</b> <a href="http://www.busmethodology.org.uk">http://www.busmethodology.org.uk</a> ; <a href="mailto:info@busmethodology.org.uk">info@busmethodology.org.uk</a>	
1001.3.2.1.5	
<b>UL</b>	UL Environment 2211 Newmarket Parkway, #110 Marietta, GA 30067
<b>UL2818-2013: Greenguard Certification Program for Chemical Emissions for Building Materials, Finishes and Furnishing</b>	
801.4.2, 801.5.2	
<b>UL2821-2013: Greenguard Certification Program Method for Measuring and Evaluating Chemical Emissions from Building Materials, Finishes and Furnishings</b>	
801.4.2, 801.5.2	

## INFORMATIVE APPENDIX H

(Adopted in its entirety)

# OPTION FOR ENERGY EFFICIENCY USING THE IECC PRESCRIPTIVE COMPLIANCE PATH

The purpose of this appendix is to provide users of the prescriptive energy path of the IECC a correlated version of ANSI/ASHRAE/ICC/USGBC/IES Standard 189.1, Chapter 7, that facilitates the use of the prescriptive provisions of the IECC without directly relying on the energy provisions of ANSI/ASHRAE/IES Standard 90.1. Section numbers in this appendix, unless otherwise specified, refer to Standard 189.1. Where ASHRAE standards are referenced in this appendix, ASHRAE provides free online access to read-only versions of the standards. See <https://www.ashrae.org/standards-research--technology/standards--guidelines/other-ASHRAE-standards-referenced-in-code>.

### SECTION H101 DEFINITIONS APPLICABLE TO THIS APPENDIX

**air, outdoor:** see ANSI/ASHRAE Standard 62.1.

**building envelope:** see ANSI/ASHRAE/IES Standard 90.1.

**dynamic glazing:** see ANSI/ASHRAE/IES Standard 90.1.

**enclosed space:** see ANSI/ASHRAE/IES Standard 90.1.

**fenestration:** see ANSI/ASHRAE/IES Standard 90.1.

**vertical fenestration:** see ANSI/ASHRAE/IES Standard 90.1.

**fenestration area:** see ANSI/ASHRAE/IES Standard 90.1.

**gross wall area:** see ANSI/ASHRAE/IES Standard 90.1.

**lighting power allowance:** see ANSI/ASHRAE/IES Standard 90.1.

**roof:** see ANSI/ASHRAE/IES Standard 90.1.

**service water heating:** see ANSI/ASHRAE/IES Standard 90.1.

**single-rafter roof:** see ANSI/ASHRAE/IES Standard 90.1.

**skylight:** see ANSI/ASHRAE/IES Standard 90.1.

**space:** see ANSI/ASHRAE/IES Standard 90.1.

**semiheated space:** see ANSI/ASHRAE/IES Standard 90.1.

### SECTION H201 GENERAL

**H201.1 Scope.** This section specifies prescriptive requirements for energy efficiency for buildings and appliances, for *on-site renewable energy systems*, and for energy measuring.

### SECTION H301 COMPLIANCE

**H301.1 Compliance.** The energy systems shall comply with Sections 701.3.2 through 701.3.4 and with the *International Energy Conservation Code* (IECC), Sections C402 through C405. In addition, commercial buildings shall comply with the IECC, Section C406, and tenant spaces shall comply with the IECC, Section C406.1.1.

Where requirements are provided below, they shall supersede the requirements of the IECC. For all other criteria, the *building project* shall comply with the requirements of the IECC.

### SECTION H401 PRESCRIPTIVE REQUIREMENTS

**H401.1 On-Site Renewable Energy Systems.** *Building projects* shall comply with either the standard renewables approach in Section 701.4.1.1.1 or the Alternate Renewables Approach in Section 701.4.1.1.2.

**H401.2 Building Envelope.** The *building envelope* shall comply with the IECC, Sections C301 and C402, with the following modifications and additions.

**H401.2.1 Continuous Air Barrier.** The exceptions to the requirement for a *continuous air barrier* in the IECC, Section C402.5.1, for specific *climate zones* and constructions shall not apply.

**11401.2.2 Building Envelope Requirements.** The *building envelope* shall comply with the requirements in the IECC, Table C402.1.4, with the following modifications to values in the table.

For the opaque elements, each U-factor, C-factor, and F-factor in the table shall be reduced by 5%. For *vertical fenestration* and *skylights*, each U-factor in the IECC, Table C402.4, shall be reduced by 5%. For *skylights* and east-oriented and west-oriented *vertical fenestration*, each *solar heat gain coefficient (SHGC)* in the IECC, Table C402.4, shall be reduced by 5%. These adjustments shall also be applicable where the intent is to comply with the component performance alternative of the IECC, Section C402.1.5.

#### Exceptions:

1. The U-factor, C-factor, or F-factor shall not be modified where the corresponding R-value requirement is designated as "NR" (no requirement) in the IECC, Table C402.4.
2. The *SHGC* shall not be modified where the *SHGC* requirement is designated as "NR" (no requirement) in the IECC, Table C402.4.

3. *Spaces* that meet the requirements of Section 801.4.1, regardless of *space area*, are exempt from the *SHGC* criteria for *skylights*.

**Notes:**

1. U-factors, C-factors, and F-factors for many common assemblies are provided in ANSI/ASHRAE/IES Standard 90.1, Normative Appendix A.
2. Section 501.3.5.3 includes additional provisions related to *roofs*.

**H401.2.3 Single-Rafter Roof Insulation.** *Single-rafter roofs* shall comply with the requirements in Normative Appendix A, Table A101.1 (A-1). These requirements supersede the requirements in the IECC, Tables C402.1.3 and C402.1.4.

**H401.2.4 Air Curtains.** Where provided, air curtains shall comply with Section 701.4.2.4.

**H401.2.5 High-Speed Doors.** *High-speed doors* that are intended to operate, on average, at least 75 cycles per day shall not exceed a maximum U-factor of 1.20 Btu/h·ft<sup>2</sup>·°F (6.81 W/m<sup>2</sup>K). Opening rate, closing rate, and average cycles per day shall be included in the construction drawings. IECC, Table C402.1.3, shall not apply for *high-speed doors* complying with all criteria in this section.

**H401.2.6 Vertical Fenestration Area.** *Vertical fenestration area* shall comply with the IECC, Sections C402.4.1 and C402.4.1.1.

**H401.2.7 Permanent Projections.** *Vertical fenestration* shall comply with Section 701.4.2.6.

**H401.2.8 SHGC of Vertical Fenestration.** *Vertical fenestration* shall comply with the IECC, Table C402.4.

**H401.2.9 Building Envelope Trade-Off Option.** The *building envelope* component performance alternative of the IECC, Section C402.1.5, shall not apply except where the modifications and additions of Section H401.2 are incorporated.

**H401.2.10 Orientation.** The *vertical fenestration* shall comply with either (a) or (b):

- a.  $A_W \leq (A_N + A_S)/4$  and  $A_E \leq (A_N + A_S)/4$
- b.  $A_W \times SHGC_W \leq (A_N \times SHGC_C + A_S \times SHGC_C)/6$  and  $A_E \times SHGC_E \leq (A_N \times SHGC_C + A_S \times SHGC_C)/6$

Where:

$SHGC_X$  = the SHGC for orientation  $x$  that complies with Section H401.2.7 (H4.2.7).

$SHGC_C$  = the SHGC criteria for each *climate zone* from Section H401.2.2 (H4.2.2).

$A_X$  = *fenestration area* for orientation  $x$ .

N = north (oriented less than 45 degrees of true north).

S = south (oriented less than 45 degrees of true south).

E = east (oriented less than or equal to 45 degrees of true east).

W = west (oriented less than or equal to 45 degrees of true west).

**Exceptions:**

1. Buildings with shade on 75% of the west- and east-oriented *vertical fenestration areas* from permanent projections, existing buildings, existing permanent infrastructure, or topography at 9 a.m. and 3 p.m. on the summer solstice (June 21 in the northern hemisphere).
2. Alterations and additions with no increase in *vertical fenestration area*.
3. Buildings where the west- and east-oriented *vertical fenestration areas* do not exceed 20% of the *gross wall area* for each of those façades, and the *SHGC* on those façades is not greater than 90% of the criteria in Section H401.2.2.
4. Buildings in *Climate Zone 8*.

**H401.3 Heating, Ventilating, and Air Conditioning.** The heating, ventilating, and air conditioning shall comply with the IECC, Sections C301 and C403, with the following modifications and additions.

**H401.3.1 Minimum Equipment Efficiencies for the Alternate Renewables Approach.** *Building projects* complying with the Alternate Renewables Approach in Section 701.4.1.1.2 shall comply with Section 701.4.3.1.

**H401.3.2 Ventilation Controls for Densely Occupied Spaces.** The requirements in this section supersede those in the IECC, Section C403.7.1. *Demand control ventilation (DCV)* shall be provided for *densely occupied spaces* served by systems with one or more of the following:

- a. An air-side economizer
- b. *Automatic* modulating control of the *outdoor air dampers*
- c. A design outdoor airflow greater than 1000 cfm (500 L/s)

The *DCV* system shall be designed to be in compliance with ANSI/ASHRAE Standard 62.1, Section 6.2.7. Occupancy assumptions shall be shown in the design documents for *spaces* provided with *DCV*. All CO<sub>2</sub> sensors used as part of a *DCV* system or any other system that dynamically controls *outdoor air* shall meet the following requirements:

- a. *Spaces* with CO<sub>2</sub> sensors or air-sampling probes leading to a central CO<sub>2</sub> monitoring station shall be provided with at least one sensor or probe for each 10,000 ft<sup>2</sup> of floor *space*. Sensors or probes shall be installed between 3 and 6 ft above the floor.
- b. CO<sub>2</sub> sensors shall have a rated accuracy of ± 50 ppm at 1000 ppm.
- c. *Outdoor air* CO<sub>2</sub> concentrations shall be determined by one of the following:
  1. *Outdoor air* CO<sub>2</sub> concentrations shall be dynamically measured using one or multiple

CO<sub>2</sub> sensors. The CO<sub>2</sub> sensor locations shall be identified on the *construction documents*.

2. When documented statistical data are available on the local ambient CO<sub>2</sub> concentrations, a fixed value typical of the location where the building is located shall be allowed in lieu of an outdoor sensor.
- d. Occupant CO<sub>2</sub> generation rate assumptions shall be shown in the design documents.

**Exceptions:**

1. Systems with exhaust air energy recovery complying with Section H401.3.6.
2. Systems with a design outdoor airflow less than 750 cfm (350 L/s).
3. *Spaces* where more than 75% of the *space* design outdoor airflow is used as *makeup air* or *transfer air* to provide *makeup air* for other *spaces*.
4. *Spaces* with one of the following occupancy categories as defined in ASHRAE Standard 62.1: cells in correctional facilities; daycare sickrooms; science laboratories; barbershops; beauty and nail salons; and bowling alleys (seating).

**H401.3.3 Duct Leakage Tests.** Leakage tests shall be performed in compliance with the requirements in ANSI/ASHRAE/IES Standard 90.1, Section 6.4.4.2.2, with the following modification. Ductwork that is designed to operate at static pressures in excess of 2 in. of water (500 Pa), and all ductwork located outdoors, shall be leak-tested according to industry-accepted test procedures.

**H401.3.4 Economizers.** Where economizers are required by Section 701.4.3.4, economizers shall meet the requirements in the IECC, Section C403.5, except as modified by the following:

- a. Rooftop units with a capacity of less than 54,000 Btu/h (16 kW) shall have two stages of capacity control, with the first stage controlling the economizer and the second stage controlling *mechanical cooling*. Units with a capacity equal to or greater than 54,000 Btu/h (16 kW) shall comply with the staging requirements defined in the IECC, Section C403.8.
- b. For systems that control to a fixed leaving air temperature (i.e., *variable-air-volume [VAV]* systems), the system shall be capable of resetting the supply air temperature up at least 5°F (3°C) during economizer operation.

All of the exceptions in the IECC, Section C403.5, shall apply except as modified by the following.

- a. Where the reduced renewable approach defined in Section 701.4.1.1.2 is used, the IECC, Section C403.5, Exception 5, shall be permitted to eliminate the economizer requirement, provided the requirements in the IECC, Table C403.5(2), are applied to the efficiency requirements required

by Section 701.4.1.1.2. If the standard renewable approach is chosen, as defined in Section 701.4.1.1.2, then the requirements in the IECC, Table C403.5(2), shall be applied to the efficiency requirements in the IECC, Tables C403.3.2(1) through C403.3.2(10).

- b. For water-cooled units with a capacity less than 54,000 Btu/h (16 kW) that are used in systems where heating and cooling loads are transferred within the building (i.e., water-source heat pump systems), the requirement for an air or water economizer can be eliminated if the condenser-water temperature controls are capable of being set to maintain full-load heat rejection capacity down to a 55°F (12°C) condenser-water supply temperature, and the HVAC equipment is capable of operating with a 55°F (12°C) condenser-water supply temperature.

**H401.3.5 Fan System Power and Efficiency**

**H401.3.5.1 Fan System Power Limitation.**

Systems shall have fan power limitations 10% below the limitations specified in the IECC, Table C403.8.1(1). This requirement supersedes the requirement in the IECC, Section C403.8, and the IECC, Table C403.8.1(2). All exceptions in the IECC, Section C403.8, shall apply.

**H401.3.5.2 Fan Efficiency.** The fan efficiency requirements defined in the IECC, Section C403.8.3, shall be used, except that the total efficiency of the fan at the design point of operation shall be within ten percentage points of the maximum total efficiency of the fan. All exceptions in the IECC, Section C403.8.3, shall apply.

**H401.3.6 Exhaust Air Energy Recovery.** The exhaust air energy recovery shall comply with the requirements defined in the IECC, Section C403.7.4, including the requirements in Tables C403.7.4(1) and C403.7.4(2). The energy recovery effectiveness shall not be less than 60%, and this shall supersede the requirement of the IECC.

**H401.3.7 Kitchen Exhaust Systems.** The requirements in the IECC, Section C403.7.5, shall apply, except as modified by Sections 701.4.3.8.1 and 701.4.3.8.2.

**H401.3.8 Duct Insulation.** Duct insulation shall comply with the minimum requirements in Normative Appendix A, Tables A101.2 (A-2) and A101.3 (A-3). These requirements supersede the requirements in the IECC, Section C403.11.1.

**H401.3.9 Automatic Control of HVAC and Lights in Hotel/Motel Guest Rooms.** Controls in hotel and motel guest rooms shall comply with Section 701.4.3.10.

**H401.3.10 HVAC Equipment Performance Requirements.** Equipment shall meet the minimum efficiency requirements of ANSI/ASHRAE/IES Standard 90.1, Section 6.4.1, or of the IECC, Section C403.3.2.

**Note:** Some 2018 IECC minimum efficiency requirements are below Federal minimum standards. Users may want to verify applicable requirements.

**H401.4 Service Water Heating.** The *service water heating* shall comply with the IECC, Section C404, with the following modifications and additions.

**H401.4.1 Equipment Efficiency for the Alternate Renewables Approach.** *Building projects* complying with the Alternate Renewables Approach in Section 701.4.1.1.2 shall comply with the applicable equipment efficiency requirements in Normative Appendix B, Table B101.9, and the applicable ENERGY STAR® requirements in Section 701.4.7.3. These requirements supersede the requirements in the IECC, Table C404.2.

**H401.4.2 Insulation for Spa Pools.** Insulation for spa pools shall comply with Section 701.4.4.2.

**H401.5 Lighting.** The lighting shall comply with the IECC, Sections C405.2 through C405.4, with the following modifications and additions.

#### **H401.5.1 Lighting Power Allowance**

**H401.5.1.1 Interior Lighting Power Densities (LPDs).** The interior *lighting power allowance* shall comply with Section 701.4.6.1.1.

**H401.5.1.2 Exterior LPDs.** The exterior *lighting power allowance* shall be determined using the IECC, Section C405.4.1, with the following modification. The LPDs from the IECC, Table C405.4.2(2), shall be multiplied by the applicable LPD Factor from Table 701.4.6.1.2.

**H401.5.2 Occupancy Sensor Controls with Multilevel Switching or Dimming.** Lighting in commercial and industrial storage stack areas shall comply with Section 701.4.6.2.

**H401.5.3 Automatic Controls for Egress and Security Lighting.** *Automatic* controls for egress and security lighting shall comply with Section 701.4.6.3.

**H401.5.4 Controls for Exterior Sign Lighting.** Controls for exterior sign lighting shall comply with Section 701.4.6.4.

**H401.5.5 Parking and Outdoor Sales Lighting.** This section supersedes the IECC, Section C.405.4.2, for lighting serving uncovered parking areas. Outdoor luminaires serving uncovered parking areas and open areas in outdoor sales lots shall be controlled by all of the following:

- a. Luminaires shall be controlled by a device that automatically turns off the luminaire during *daylight hours*.

- b Luminaires shall be controlled by a timeclock or other control that automatically turns off the luminaire according to a timed schedule.

- c. For luminaires having a rated input wattage of more than 50 W and where the bottom of the luminaire is mounted 24 ft or less above the ground, the luminaires shall be controlled by one or more devices that automatically reduce lighting power of each luminaire by a minimum of 50% when there is no activity detected in the controlled zone for a period no longer than 15 minutes. No more than 1500 input watts of lighting power shall be controlled together.

#### **Exceptions:**

1. Lighting serving street frontage for vehicle sales lots.
2. Lighting for covered vehicle entrances or exits from buildings or parking structures where required for safety, security, or eye adaptation.

**H401.5.6 Other Equipment.** The other equipment shall comply with the IECC, Sections C405.5 through C405.9, with the following additions.

**H401.5.6.1 Equipment Efficiency for the Alternate Renewables Approach.** *Building projects* complying with the Alternate Renewables Approach in Section 701.4.1.1.2 shall comply with the applicable equipment efficiency requirements in Normative Appendix B and the applicable ENERGY STAR requirements in Section 701.4.7.3.2.

**H401.5.6.2 Supermarket Heat Recovery.** Supermarkets shall comply with Section 701.4.7.2, as applicable.

**H401.5.6.3 ENERGY STAR Equipment.** All *building projects* shall comply with Section 701.4.7.3.

**H401.5.6.4 Programmable Thermostats.** Residential programmable thermostats shall comply with Section 701.4.7.4.

**H401.5.6.5 Refrigerated Display Cases.** Refrigerated display cases shall comply with Section 701.4.7.5.

## INFORMATIVE APPENDIX I

# ADDITIONAL GUIDANCE FOR FUNCTIONAL AND PERFORMANCE TESTING (FPT) AND THE COMMISSIONING (Cx) PROCESS

*(Adopted As Policy)*

This appendix provides guidance on best practices for *functional and performance testing (FPT)* and the *commissioning (Cx) process* that relate to Section 1001.3.1.1.

### SECTION 1101 PROVIDER QUALIFICATIONS

**1101.1 Recommended Minimum Qualifications and Independence of a Commissioning (Cx) Provider and a Functional and Performance Testing (FPT) Provider.** A *commissioning (Cx) provider* or an *FPT provider* should have the following qualities to ensure the needed qualifications and independence for *building project testing* or *commissioning*:

- a. **Equipment.** A *Cx provider* or *FPT provider* should use equipment necessary to carry out the *commissioning (Cx) process* and *FPT*. Equipment should be calibrated in accordance with the manufacturer's specifications.
- b. **Personnel Experience.** The *Cx provider* or *FPT provider* should provide personnel experienced in conducting, supervising, or evaluating *functional and performance testing*, inspections, and, where applicable, performing commissioning activities prior to and subsequent to the tests. Where possible, the *Cx provider* should have completed the *Cx process* on not fewer than two projects of equal or greater scope and complexity, or should be able to demonstrate adequate experience and training in the fundamentals and application of the *Cx process*.
- c. **Independence.** The *Cx provider* and the *FPT provider* should be independent of the building system design and construction functions of the systems being commissioned. The *Cx provider* and *FPT provider* should disclose possible conflicts of interest to ensure objectivity.
- d. **Registration, Licensure, or Certification of a Cx Provider.** Where available, a *Cx provider* should be registered or licensed in a relevant discipline or certified according to the provisions of ISO 17024 or an equivalent certification process.

**1101.2 Overview of the Cx Process.** Table 1101.2 provides an overview of activities, documentation, and responsibilities that should be included in the *Cx process*.

### SECTION 1201 Cx DOCUMENTATION

The *Cx process* should result in the following deliverables.

**1201.1 Typical Elements Included in Owner's Project Requirements (OPR).** The *OPR* is a document developed by the *owner* with assistance from the design and *Cx* teams that details the requirements of a project and the expectations for how it will be used and operated. The *OPR* should include project goals, measurable performance criteria, cost considerations, benchmarks, success criteria, and supporting information. The term "project intent" or "design intent" is used by some *owners* for their *Cx process OPR*.

The *OPR* document should address the following for the commissioned systems:

- a. Facility objectives, size, location, user requirements, and *owner* directives, including *space* use and occupancy/operations schedules and special project requirements.
- b. Applicable codes and standards, in addition to local building codes (**Informative note:** e.g., *International Building Code*), and environmental, sustainability, and efficiency goals and benchmarks.
- c. Indoor environment requirements, including temperature, humidity, and ventilation.
- d. *Cx process* scope and requirements; listing of equipment; systems and assemblies requiring commissioning, including installation, evaluation, and testing requirements; and *commissioning (Cx) plan* and report formats and distribution requirements. Sampling procedures, if permitted, for all reviews, evaluations, and testing should be detailed.
- e. Equipment, systems, and assemblies requirements, expectations, and warranty provisions.
- f. Maintainability, access, and operational performance requirements.
- g. Project documentation requirements, including formats and delivery schedules for *Basis of Design (BoD)*, *Cx* specifications, *Cx plan* and reports, equipment submittals, and the systems manual; documentation reviews, approvals, and distribution during design and construction phases.
- h. Training requirements for *owner's* operation and maintenance personnel and occupants.

**TABLE I101.2**  
**TYPICAL CX PROCESS ACTIVITIES, DELIVERABLES, AND RESPONSIBILITIES**

ITEM	ACTIVITY	DELIVERABLE	NORMALLY PROVIDED BY
1	<i>Owner's project requirements</i>	<i>OPR</i> document	<i>Owner</i> with assistance from design and Cx teams
2	<i>Basis of Design</i>	<i>BoD</i> document	Design team
3	<i>Cx plan</i>	<i>Cx plan</i> document	<i>Cx provider</i> with input from <i>owner</i> , design team, and contractor
4	Contractor Cx requirements	Cx specifications	Design team and <i>Cx provider</i>
5	Design review	Cx design review report	<i>Cx provider</i>
6	Submittal review	Submittal review report	<i>Cx provider</i>
7	Commissioning designated systems inspections, <i>functional and performance testing</i>	Installation, inspection, functional test reports, performance test reports	Contractors, manufacturers, <i>Cx provider</i> and team
8	Issue and resolution log	Issue and resolution logs	<i>Cx provider</i> and team
9	Systems manual	Systems manual	Contractors with review by <i>Cx provider</i>
10	Training	Training plan and reports	Contractor and manufacturers with review by <i>Cx provider</i>
11	Preliminary Cx report	Preliminary Cx report	<i>Cx provider</i>
12	Cx activities during occupancy	Additional information and updates to reports	<i>Cx provider</i> and building operations
13	Final Cx report	Final Cx report	<i>Cx provider</i>

**I201.2 Basis of Design (BoD).** The *BoD* is a document developed by the design team that records the concepts, calculations, decisions, and product selections used to meet the *OPR* and to satisfy applicable regulatory requirements, standards, and guidelines. The document should include both narrative descriptions and lists of individual items that support the design process, including the following:

- a. A detailed description of the design team's technical approach to, and assumptions about, the *OPR*.
- b. A platform for the review of the design and for changes as the project progresses.
- c. A detailed description addressing coordination of applicable technical and code requirements.

**I201.3 Cx Plan.** A *Cx plan* is a document developed by a *Cx provider* that should include the following:

- a. An overview of the *Cx process* developed specifically for the project.
- b. The roles and responsibilities of the *Cx provider* and the Cx team through final commissioning activities.
- c. Documentation of communication channels and processes, including distribution of the *Cx plan*, logs, testing documents, and reports during the design and construction processes.
- d. A detailed description and schedule of *Cx process* activities and the list of operations, systems, and assemblies that will be commissioned, and a

description of performance criteria where not shown on the *construction documents*.

- e. The project design documentation and submittal review procedures and reports.
- f. Inspection checklists and testing forms, issues and resolution log, and Cx progress reports to be used during the project to communicate and track commissioning and inspection process information, including format, approvals, and distribution.
- g. The procedures to follow for resolution where the Cx evaluation does not meet the *OPR*.

**I201.4 Cx Specifications.** For construction or renovation projects requiring contract documents, the *owner* should require by agreement that the design/construction team include Cx specifications in the project contract documents. The Cx specification should require compliance with the *OPR* and with the *Cx process* contained in the project's *Cx plan* as detailed in this code.

**I201.5 Cx Design Review Report.** The *Cx provider* should provide a design review (Cx Design Review Report) to the *owner* and design teams to report compliance with the *OPR* and *BoD*. This Cx design review is not intended to replace a design peer review or a code or regulatory review.

**I201.6 Record Documents.** Record documents should be provided to the *owner* upon project completion. The record documents should be accessible to the building operations

and maintenance personnel, be included in the systems manual, and include all of the following:

- a. Approved *construction documents*, including record plans and specifications.
- b. Approved submittals and coordination drawings. This documentation should show the actual locations of equipment, systems, and assemblies, such as piping, ductwork, valves, controls, access panels, electrical equipment, plumbing equipment, lighting and other operating components and systems. The record documents should particularly note equipment locations that are concealed or are installed in locations other than those indicated on the approved *construction documents*.
- c. Engineering and institutional control information for *sites* that have previously been a *brownfield* or that have required environmental corrective action, remediation, or restoration at the federal, state, or local level.

**I201.7 Systems Manual.** A systems manual should be provided by an *owner* for use in building operations training. The systems manual should be made accessible to building operations and maintenance (O&M) personnel and should be updated and maintained by an *owner* for the life of the building.

A systems manual should include the following:

- a. Facility design and *construction documents*, including the following:
  - 1. *OPR* and *BoD*.
  - 2. Construction record documents, including drawings, specifications, and approved submittals.
- b. Facility systems and assemblies information, including the following:
  - 1. Manufacturer's O&M data for installed equipment systems and assemblies.
  - 2. Warranties and certificate of occupancy.
  - 3. Contractor and supplier listing and contact information.
- c. A facility operations guide, including an operating plan, building and equipment operating schedules, set points and ranges, verified sequences of operation, system and equipment limitations, and emergency procedures.
- d. Where training is provided, training plans, materials, and records.
- e. A final commissioning report.

**I201.8 Preliminary Cx Report.** A preliminary Cx report should be provided by the *Cx provider* and should include the following information:

- a. Performance of commissioned equipment, systems, and assemblies.
- b. Issue and resolution logs, including itemization of deficiencies found during testing and commissioning that have not been corrected at the time of report preparation.
- c. Deferred tests that cannot be performed at the time of report preparation.
- d. A plan for the completion of Cx activities and training, including climatic and other conditions required for performance of the deferred tests.

**I201.9 Final Cx Report.** A final Cx report should be provided by the *Cx provider* and should include the following information:

- a. A copy of the final *Cx plan*, including *FPT* procedures used during the *Cx process*, including measurable criteria for test acceptance.
- b. A copy of the final *OPR*, *BoD*, and design and submittal reviews as required by the *Cx plan* if not included in the submitted systems manual.
- c. Results of all evaluations, startup data, *FPT*, and reports by suppliers, contractors, observers, and *Cx providers*.
- d. Issue logs and disposition of all deficiencies found during testing, including details of corrective measures used or proposed.
- e. Equipment, systems, and assemblies repaired or replaced and adjustments to calibration.
- f. Documentation of equipment and systems sequences and settings, which are typically submitted in the final sequence of operation and in the systems manual.
- g. A resolution plan identifying all of the issues unresolved and incomplete at the end of the project.



## INFORMATIVE APPENDIX J

# OPTION FOR RESIDENTIAL COMPLIANCE USING THE NATIONAL GREEN BUILDING STANDARD

*(The provisions contained in this appendix are mandatory. The National Green Building Standard is a voluntary consensus standard which applies to the design and construction of residential portions of buildings. The Standard establishes criteria for rating the environmental impact of design and construction practices to achieve conformance with specified performance levels for green residential buildings.)*

### SECTION J101 GENERAL

**J101.1 Residential requirements determined by the authority having jurisdiction.** The authority having jurisdiction shall determine if one or more of the following sections apply.

**J101.1.3.** Group R-2 and R-4 residential buildings three stories or less in height above grade plane, their accessory structures, and the site or lot upon which these buildings are located shall comply with this code ICC/ASHRAE 700-2015 - 700-2020 *National Green Building Standard*.

**J101.1.4.** Group R-2 and R-4 residential buildings four stories or more in height above grade plane, their accessory structures, and the site or lot upon which these buildings are located shall comply with the provisions of this code or ICC/ASHRAE 700-2015 – 700-2020 *National Green Building Standard*.

**J101.1.5.** Group R-2 and R-4 portions of mixed use buildings shall comply with the provisions of this code or ICC/ASHRAE 700-2015 – 700-2020 *National Green Building Standard*. The remainder of the building and the site upon which the building is located shall comply with the provisions of this code.

## INFORMATIVE APPENDIX K

### ADDENDA DESCRIPTION INFORMATION

*(This appendix is not part of this code. It is merely informative and does not contain requirements necessary for conformance to the code. It has not been processed according to the ANSI requirements for a code and may contain material that has not been subject to public review or a consensus process. Unresolved objectors on informative material are not offered the right to appeal at ASHRAE or ANSI)*

ANSFASHRAMCC/USGBC/IES Standard 189.1-2017 incorporates ANSI/ASHRAE/USGBC/IES Standard 189.12014 and Addenda a, b, c, d, e, f, g, i, j, k, l, m, n, o, p, q, r, s, t, u, y, w, x, y, z, aa, ab, ac, ad, ae, ag, ah, ai, aj, ak, al, am, ap, aq, as, au, ay, aw, ax, ay, az, ba, bb, bd, be, bh, bi, bj, bk, bl, bn, bo, bp, bq, br, bs, bt, bu, by, bw, bx, by, bz, cd, ce, cf, cg, ch, cj, and cl to ANSPASHRAE/USGBC/IES Standard 189.1-2014. Table K101.1 (J-1) lists each addendum and describes the way in which the code is affected by the change. It also lists the ASHRAE, and ANSI approval dates for each addendum.

**TABLE K101.1 (TABLE J-1)**  
**ADDENDA TO ANSWASHRAE/USGBC/IES STANDARD 189.1-2014**

ADDENDUM	SECTIONS AFFECTED	DESCRIPTION OF CHANGES*	ASHRAE STANDARDS COMMITTEE APPROVAL	COSPONSOR APPROVAL (USGBC, IES, ICC)	ASHRAE BOD APPROVAL	ANSI APPROVAL
a	Section 701.4.3.2 (7.4.3.2)	This addendum clarifies the location of a CO <sub>2</sub> sensor to determine the outdoor air concentration.	Jan. 23, 2016	Jan. 11, 2016 Dec. 31, 2015 Dec. 22, 2015	Jan. 27, 2016	Jan. 28, 2016
b	Section 701.3.4 (7.3.4)	This addendum replaces the mandatory requirement for peak load reduction in Section 701.3.4 (7.3.4) that was introduced in addendum ce to the code.	June 27, 2015	May 12, 2015 June 29, 2015 N/A	July 1, 2015	July 2, 2015
c	Section 1001.3.1.2 (10.3.1.2) and Chapter 11 (Section 11)	This addendum is intended to incorporate ANSI/ASHRAE/IES Standard 202, Commissioning Process for Buildings and Systems, into Standard 189.1, thereby basing commissioning on an industry standard.	Oct. 13, 2015	Sept. 30, 2015 Sept. 28, 2015 Oct. 8, 2015	Oct 19, 2015	Nov. 2, 2015
d	Section 701.4.6.1.1 (7.4.6.1.1)	This addendum corrects and clarifies a potentially confusing sentence in the standard that could cause some designers to believe that the bonus lighting power control factors from ASHRAE Standard 90.1, Table 9.6.3, cannot be used in Standard 189.1	Jan. 23, 2016	Jan. 11, 2016 Dec. 31, 2015 Dec. 22, 2015	Jan. 27, 2016	Jan. 28, 2016
e	Sections 301.2 (3.2), 701.4.6.1.1 (7.4.6.1.1), 1001.3.1.1.3 (10.3.1.1.3), and 1001.3.1.2.4 (10.3.1.2.4)	This new Section 701.4.6.1.1(d) [7.4.6.1.1(d)] to Standard 189.1 provides control credits for institutional tuning that are in additions to the control factors that already exist in Standard 90.1-2013, Section 9.6.3.	Jan. 23, 2016	Jan. 11, 2016 Dec. 31, 2015 Dec. 22, 2015	Jan. 27, 2016	Jan. 28, 2016
f	Table 601.3.2.1 (6.3.2.1)	This addendum modifies Table 601.3.2.1 (6.3.2.1) to make it consistent with the text of Section 601.3.2.1(b) [6.3.2.1(b)].	June 25, 2016	July 4, 2016 June 27, 2016 June 9, 2016	June 29, 2016	June 30, 2016
g	Sections 801.3.1.4 (8.3.1.4) and 1001.3.2.1.4.7 (10.3.2.1.4.7)	This addendum to Standard 189.1 provides a higher level of indoor moisture control than is currently required by reference to Standard 62.1.	Jan. 23, 2016	Jan. 11, 2016 Dec. 31, 2015 Dec. 22, 2015	Jan. 27, 2016	Jan. 28, 2016
i	Sections 501.3.5.3 (5.3.5.3), 501.3.5.5 (5.3.5.5), 1001.3.2.1.1 (10.3.2.1.1), and Chapter 11 (Section 11)	This addendum reorganizes the roof heat island mitigation section and adds new provisions for vegetated terrace and roofing systems.	Jan. 28, 2017	Feb. 11, 2017 Jan. 31, 2017 Jan. 12, 2017	Feb. 1, 2017	Feb. 13, 2017
j	Sections 501.3.1.2 (5.3.1.2)	This addendum clarifies the exceptions contained under Section 501.3.1.2 (5.3.1.2), "Prohibited Development Activity," which includes provisions for fish/wildlife habitat conservation areas and wetlands.	Aug. 24, 2016	July 4, 2016 June 27, 2016 June 9, 2016	Aug. 29, 2016	Aug. 30, 2016

\* These descriptions may not be complete and are provided for information only.

*(continued)*

**TABLE K101.1 (TABLE J-1)**  
**ADDENDA TO ANSWASHRAE/USGBC/IES STANDARD 189.1-2014 (Continued)**

ADDENDUM	SECTIONS AFFECTED	DESCRIPTION OF CHANGES*	ASHRAE STANDARDS COMMITTEE APPROVAL	COSPONSOR APPROVAL (USGBC, IES, ICC)	ASHRAE BOD APPROVAL	ANSI APPROVAL
k	Section 701.4.2.1 (7.4.2.1)	This addendum is based in part on a comparison of 189.1 with the 2015 <i>International Green Construction Code</i> (IgCC). The change from 10% to 5% in the U-, C-and F- factors and in the SHGC is based on it being more practical to design and build, while having only a limited impact on energy use.	Feb. 1, 2017	Feb. 11, 2017 Jan. 31, 2017 Jan. 12, 2017	Feb. 1, 2017	March 2, 2017
l	Chapter 9 (Section 9) and Section 901.1 (9.1)	This addendum revises the title and scope of Chapter 9 (Section 9) in order to improve clarity and more accurately describe the content of the section.	Feb. 1, 2017	Feb. 11, 2017 Jan. 31, 2017 Jan. 12, 2017	Feb. 1, 2017	March 2, 2017
m	Section 501.3.7.1.1 (5.3.7.1.1)	This addendum augments provisions for connection of on-site walkways and bicycle paths to street sidewalks and bicycle paths.	Aug. 24, 2016	July 4, 2016 June 27, 2016 June 9, 2016	Aug. 29, 2016	Aug. 30, 2016
n	Section 901.3.5 (9.3.5)	This addendum clarifies footnote b to Table 7.5.2A of Standard 189.1-2014. This footnote provides a method to adjust the percent reduction for buildings with unregulated energy cost exceeding 35% of the total energy cost	Jan. 28, 2017	Feb. 11, 2017 Jan. 31, 2017 Jan. 12, 2017	Feb. 1, 2017	Feb. 13, 2017
o	Chapters 1 and 2 (Sections 1 and 2)	This addendum revises the existing purpose and scope of the standard to clarify the intended purposes of the standard and its application and to better reflect revisions to the standard that are being considered by the committee.	April 6, 2017	April 13, 2017 March 28, 2017 March 31, 2017	April 17, 2017	May 20, 2017
p	Chapter 3 (Section 3) and Section 601.3.2.1 (6.3.2.1)	This addendum adds requirements for water-bottle filling stations, which are intended to improve water efficiency and sanitation of public drinking water and reduce the environmental effects of plastic bottles.	Jan. 28, 2017	Feb. 11, 2017 Jan. 31, 2017 Jan. 12, 2017	Feb. 1, 2017	Feb. 13, 2017
g	Sections 401.1.4 (4.1.4), 501.3.5.3 (5.3.5.3), 701.4.2.1 (7.4.2.1), 701.4.2.5 (7.4.2.5), 701.4.3.7.2 (7.4.3.7.2), and Chapter 11 (Section 11); Tables 701.4.3.3 (7.4.3.3) and 801.4.1.2 (8.4.1.2); Appendix A	This addendum Standard 189.1 was developed in response to the update of ASHRAE Standard 169-2013, Climatic Data for Building Design Standards. Standard 189.1 now references ANSI/ASHRAE/IES Standard 90.1 and Standard 169 for climatic data and includes criteria for Climate Zone 0.	Aug. 24, 2016	July 4, 2016 June 27, 2016 June 9, 2016	Aug. 29, 2016	Aug. 30, 2016
r	Section 701.4.3.3 (7.4.3.3)	This addendum lowers the threshold for duct leakage testing to include 2 in. pressure class ducts, which are common upstream of VAV boxes.	June 28, 2017	June 14, 2017 June 13, 2017 June 12, 2017	June 28, 2017	Aug. 1, 2017
s	Chapter 6 (Section 6)	This addendum removes the performance option for water use and moves the prescriptive option into the mandatory section.	April 6, 2017	April 13, 2017 March 28, 2017 March 31, 2017	April 17, 2017	May 20, 2017
t	Sections 601.3.4 (6.3.4) and 601.3.5 (6.3.5)	This addendum adds new requirements for reverse osmosis and on-site reclaim water systems in order reduce the likelihood of excessive water use due to poor design of water treatment and filter systems.	Jan. 28, 2017	Feb. 11, 2017 Jan. 31, 2017 Jan. 12, 2017	Feb. 1, 2017	Feb. 13, 2017

\* These descriptions may not be complete and are provided for information only.

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**TABLE K101.1 (TABLE J-1)**  
**ADDENDA TO ANSWASHRAE/USGBC/IES STANDARD 189.1-2014 (Continued)**

ADDENDUM	SECTIONS AFFECTED	DESCRIPTION OF CHANGES*	ASHRAE STANDARDS COMMITTEE APPROVAL	COSPONSOR APPROVAL (USGBC, IES, ICC)	ASHRAE BOD APPROVAL	ANSI APPROVAL
u	Section 601.3.4 (6.3.4)	This addendum adds new requirements for water softeners to reduce water consumption, given the impact of their design and efficiency on water discharge water rates.	Jan. 28, 2017	Feb. 11, 2017 Jan. 31, 2017 Jan. 12, 2017	Feb. 1, 2017	Feb. 13, 2017
v	Sections 301.2 (3.2), 501.3.1.1 (5.3.1.1), and Chapter 11 (Section 11)	This addendum revises two paragraphs in Section 501.3.1.1 (5.3.1.1), "Allowable Sites." The revisions reference ASTM standards that provide more precision than the requirements that currently exist in Standard 189.1.	April 6, 2017	April 13, 2017 March 28, 2017 March 31, 2017	April 17, 2013	May 1, 2017
w	Section 701.5.2 (7.5.2)	This addendum updates Performance Option A of Section 701.5.2 (7.5.2) to be consistent with recent changes to the Performance Rating Method as published in Standard 90.1-2016.	April 6, 2017	April 13, 2017 March 28, 2017 March 31, 2017	April 17, 2013	May 1, 2017
x	Section 701.5 (7.5); Appendix C	This addendum deletes Performance Path B and sections of Appendix C, motivated in part by changes to the Performance Rating Method published in Standard 90.1-2016, which made significant structural changes to the performance compliance path on which the requirements in Standard 189.1 are heavily based.	Jan. 28, 2017	Feb. 11, 2017 Jan. 31, 2017 Jan. 12, 2017	Feb. 1, 2017	Feb. 13, 2017
y	Sections 1001.3.2.1 (10.3.2.1), 1001.3.2.1.4 (10.3.2.1.4); Appendix G	This addendum adds a requirement for an Indoor Environmental Quality (IEQ) occupant satisfaction survey to be included in the post occupancy plan for operation.	Jan. 28, 2017	Feb. 11, 2017 Jan. 31, 2017 Jan. 12, 2017	Feb. 1, 2017	Feb. 13, 2017
z	Tables 701.4.6.1A (7.4.6.1A) and 701.4.6.1B (7.4.6.1B)	This addendum revises the lighting power density (LPD) requirements in Standard 189_1 to include parking structures.	Jan. 28, 2017	Feb. 11, 2017 Jan. 31, 2017 Jan. 12, 2017	Feb. 1, 2017	Feb. 13, 2017
aa	Sections 301.2 (3.2), 701.4.1.1 (7.4.1.1), and Chapter 11 (Section 11)	This addendum revises current requirements for renewable energy systems and related exceptions. It requires that renewable energy certificates (RECs) be retained and retired by the building owner for all compliance options.	July 24, 2017	July 24, 2017 July 26, 2017 July 24, 2017	Aug. 1, 2017	Aug. 23, 2017
ab	Section 701.4.3.7 (7.4.3.7)	This addendum adds SI values to the requirements for kitchen hood exhausts. The SI values were extracted from Standard 90.1-2016, Table 6.5.7.2.2, which has the same table content as Table 701.4.3.7 (7.4.3.7).	Jan. 28, 2017	Feb. 11, 2017 Jan. 31, 2017 Jan. 12, 2017	Feb. 1, 2017	Feb. 13, 2017
ac	Section 701.3.4 (7.3.4)	This addendum deletes the existing Section 701.3.4 (7.3.4) and replaces with new text that is based in part on concepts that are included in the 2015 <i>International Green Construction Code</i> .	June 23, 2017	June 14, 2017 June 13, 2017 June 12, 2017	June 28, 2017	June 29, 2017
ad	Section 701.4.2.5 (7.4.2.5) and 801.4.1.3 (8A.13)	This addendum changes the requirements for permanent projections (such as balconies, overhangs, or shading devices). It deletes the prescriptive requirements for permanent projections in Climate Zones 4A and 5, retaining the requirements in Climate Zones 0 through 3, 4B, and 4C.	June 23, 2017	June 14, 2017 June 13, 2017 June 12, 2017	June 28, 2017	June 29, 2017

\* These descriptions may not be complete and are provided for information only.

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**TABLE K101.1 (TABLE J-1)**  
**ADDENDA TO ANSWASHRAE/USGBC/IES STANDARD 189.1-2014 (Continued)**

ADDENDUM	SECTIONS AFFECTED	DESCRIPTION OF CHANGES*	ASHRAE STANDARDS COMMITTEE APPROVAL	COSPONSOR APPROVAL (USGBC, IES, ICC)	ASHRAE BOD APPROVAL	ANSI APPROVAL
ae	Section 501.3.8 (5.3.8)	This addendum adds a new Section 501.3.8 (5.3.8), which addresses plans for the treatment of waste materials originating from the development of a building project site.	June 23, 2017	June 14, 2017 June 13, 2017 June 12, 2017	June 28, 2017	June 29, 2017
ag	Section 701.4.2 (7.4.2)	This addendum makes creates a new definition for plants that are suitable for inclusion in this code. It replaces "adapted plants" in Chapter 6 (Section 6) to better define the desired vegetation and to avoid conflicting with the term's use in Chapter 5 (Section 5).	June 23, 2017	June 14, 2017 June 13, 2017 June 12, 2017	June 28, 2017	June 29, 2017
ah	Table 701.5.3 (7.5.3)	This addendum revises the lighting power density (LPD) requirements in Standard 189.1 for exterior parking areas using the same methodology employed in Standard 90.1 but targeting a high level of performance.	April 6, 2017	April 13, 2017 March 28, 2017 March 31, 2017	April 17, 2013	May 1, 2017
ai	Sections 701.4.2.4 (7.4.2.4), 1001.3.1.2.4 (10.3.1.2.4), and Chapter 11 (Section 11)	This addendum adds requirements for testing, installing, and commissioning air curtains in building entrances. These requirements are intended to ensure that air curtains function and operate as intended.	June 28, 2017	June 14, 2017 June 13, 2017 June 12, 2017	June 28, 2017	Aug. 1, 2017
aj	Sections 701.4.6.4 (7.4.6.4) and 701.4.6.5 (7.4.6.5)	This addendum revises the bilevel motion control requirements to better align with the requirements of Standard 90.1-2016, which increased the lighting power reduction from 30% to 50% for signs and most exterior lighting (except facade and land-scape lighting) after business hours.	April 6, 2017	April 13, 2017 March 28, 2017 March 31, 2017	April 17, 2013	May 1, 2017
ak	Sections 901.5 (9.5) and Chapter 11 (Section 11)	This addendum revises Section 901.5 (9.5) to reflect advancements in the implementation of life-cycle assessment and to reference ASTM E2921, Standard Practice for Minimum Criteria for Comparing Whole Building Life Cycle Assessments for Use with Building Codes and Rating Systems.	July 24, 2017	July 24, 2017 July 26, 2017 July 24, 2017	Aug 1, 2017	Aug. 23, 2017
al	Section 501.3.7.3 (5.3.7.3)	This addendum modifies the provisions for electric-vehicle charging infrastructure to include an additional option to provide electric conduit from electric service panels to parking lot spaces during new-building construction	July 24, 2017	July 24, 2017 July 26, 2017 July 24, 2017	July 26, 2017	July 27, 2017
am	Section 501.3.5.3 (5.3.5.3)	This addendum modifies the roof heat island mitigation section that was previously changed via addendum i. The only change is to adjust the steep-slope roof SRI from 15 to 25, which matches the 2015 IgCC and is slightly less than the LEED V4 SRI of 32.	June 23, 2017	June 14, 2017 June 13, 2017 June 12, 2017	June 28, 2017	June 29, 2017
ap	Chapter 11 (Section 11) and Appendix G	This addendum to Standard 189.1-2014 updates the normative references in Chapter 11 (Section 11) and the informative references in Appendix G.	April 6, 2017	April 13, 2017 March 28, 2017 March 31, 2017	April 17, 2013	May 1, 2017
aq	Chapters 3 and 10 (Sections 3 and 10)	This addendum updates requirements in Standard 189.1 for functional and performance testing and for building systems commissioning. These changes are intended to harmonize the standard with requirements and methods included in the 2015 <i>International Green Construction Code</i> and to update the standard with respect to trends and terminology in the evolving commissioning industry.	July 24, 2017	July 24, 2017 July 26, 2017 July 24, 2017	Aug 1, 2017	Aug. 23, 2017

\* These descriptions may not be complete and are provided for information only.

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**TABLE K101.1 (TABLE J-1)**  
**ADDENDA TO ANSWASHRAE/USGBC/IES STANDARD 189.1-2014 (Continued)**

ADDENDUM	SECTIONS AFFECTED	DESCRIPTION OF CHANGES*	ASHRAE STANDARDS COMMITTEE APPROVAL	COSPONSOR APPROVAL (USGBC, IES, ICC)	ASHRAE BOD APPROVAL	ANSI APPROVAL
as	Sections 301.2 (3.2), 301.3 (3.3), 801.3.3 (8.3.3), Chapters 10 and 11 (Sections 10 and 11)	This addendum updates the acoustical requirements of Standard 189.1. Its development included comparison with the <i>International Green Construction Code</i> , Acoustical Society of America, Facilities Guideline Institute, and LEED, and benefited from the participation of ASHRAE TC 2.6, Sound and Vibration Control.	July 24, 2017	July 24, 2017 July 26, 2017 July 24, 2017	Aug 1, 2017	Sept. 12, 2017
au	Sections 301.2 (3.2), Chapters 6 and 11 (Sections 6 and 11)	This addendum provides additional requirements for irrigation systems to improve water use efficiency, based in part on consideration of requirements included in the IgCC.	June 23, 2017	June 14, 2017 June 13, 2017 June 12, 2017	June 28, 2017	June 29, 2017
av	Section 701.4.6.1.1 (7.4.6.1.1); Tables 701.4.6.1A (7.4.6.1A) and 701.4.6.1B (7.4.6.1B)	This addendum simplifies the application of lighting power allowances in ASHRAE/USGBC/IES Standard 189.1 and increases their stringency, while maintaining the same provisions for illuminance.	June 23, 2017	June 14, 2017 June 13, 2017 June 12, 2017	June 28, 2017	June 29, 2017
aw	Sections 301.2 (3.2), 801.3.8 (8.3.8) and 801.3.9 (8.3.9); Table 801.4.1.2A (8.4.1.2A)	This addendum adds two new mandatory requirements to Chapter 8 (Section 8), "Indoor Environmental Quality," with regard to occupant control of operable methods of glare control and of automatic daylight-responsive controls.	July 24, 2017	July 24, 2017 July 26, 2017 July 24, 2017	Aug 1, 2017	Aug. 23, 2017
ax	Section 601.4.3 (6.4.3)	This addendum modifies the existing requirements on water features by focusing on those circumstances, malfunctioning automatic water refilling valves, which are most likely to use excessive water.	April 6, 2017	April 13, 2017 March 28, 2017 March 31, 2017	April 17, 2013	May 1, 2017
ay	Sections 601.4.4 (6.4.4)	This addendum adds requirements for dual plumbing in new buildings so that non-potable waters (when available) can be used to flush toilets and urinals.	July 24, 2017	July 24, 2017 July 26, 2017 July 24, 2017	Aug 1, 2017	Aug. 23, 2017
az	Section 501.3.3.2 (5.3.3.2)	This addendum adds exceptions to the calculation of the area of greenfields that must consist of biodiverse plantings other than turfgrass.	July 24, 2017	July 24, 2017 July 26, 2017 July 24, 2017	Aug 1, 2017	Aug. 23, 2017
ba	Sections 801.3 (8.3) and Chapter 11 (Section 11)	This addendum updates the broad reference in Section 801.3.1 (8.3.1) to a wide range of requirements in both Standard 62.1 and Standard 170 to more narrowly cite the specific sections of those standards that are relevant to Standard 189.1.	April 6, 2017	April 13, 2017 March 28, 2017 March 31, 2017	April 17, 2013	May 1, 2017
bb	Section 701.3.3.2 (7.3.3.2)	This addendum adds a new requirement to Chapter 7 (Section 7) to display energy use in support of existing requirements in Section 1001.3.2.1.3.2 (10.3.2.1.3.2), "Track and Assess Energy Consumption."	June 23, 2017	June 14, 2017 June 13, 2017 June 12, 2017	June 28, 2017	June 29, 2017
bd	Table 701.5.2B (7.5.2B)	This addendum updates carbon dioxide equivalent values in Table 701.5.2B (7.5.2B).	July 24, 2017	July 24, 2017 July 26, 2017 July 24, 2017	July 26, 2017	July 27, 2017
be	Sections 801.3.1 (8.3.1) and Chapter 11 (Section 11)	This addendum requires that the products of combustion from any equipment or system that is permanently installed indoors be vented to the outside.	June 23, 2017	June 14, 2017 June 13, 2017 June 12, 2017	June 28, 2017	Aug. 3, 2017

\* These descriptions may not be complete and are provided for information only.

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**TABLE K101.1 (TABLE J-1)**  
**ADDENDA TO ANSWASHRAE/USGBC/IES STANDARD 189.1-2014 (Continued)**

ADDENDUM	SECTIONS AFFECTED	DESCRIPTION OF CHANGES*	ASHRAE STANDARDS COMMITTEE APPROVAL	COSPONSOR APPROVAL (USGBC, IES, ICC)	ASHRAE BOD APPROVAL	ANSI APPROVAL
bh	Appendix B; Table B101.1 (B-1)	This addendum revises the requirements in ASHRAE/USGBC/ IES Standard 189.1, Table B-1, Electrical-Operated Unitary Air Conditioners and Condensing Units, to adjust the efficiency metrics for industry improvements for these products.	June 23,2017	June 14, 2017 June 13, 2017 June 12, 2017	June 28, 2017	June 29,2017
bi	Chapter 3 (Section 3); Appendix B; Table B101.5 (B-5)	This addendum modifies Table B101.5 (B-5), which defines the requirements for single packaged vertical air conditioners, single packaged vertical heat pumps, room air conditioners, and room air-conditioner heat pumps.	June 23, 2017	June 14,2017 June 13, 2017 June 12, 2017	June 28, 2017	June 29, 2017
bj	Appendix B; Table B101.6 (B-6)	This addendum updates requirements in ASHRAE/USGBC/IES Standard 189.1, Table B-6, "Warm Air Furnace and Combination Warm Air Furnaces/Air-Conditioning Units, Warm Air Duct Furnaces, and Unit Heaters."	June 23, 2017	June 14, 2017 June 13, 2017 June 12, 2017	June 28, 2017	June 29, 2017
bk	Appendix B; Tables B101.12 (B-12) and B101.13 (B-13)	This addendum modifies Tables B101.12 (B-12), Electrically Operated Variable-Refrigerant-Flow (VRF) Air Conditioners Minimum Efficiency, and Table B101.13 (B-13), Electrically Operated Variable-Refrigerant-Flow (VRF) Heat-Pump Air Conditioners Minimum Efficiency.	June 23, 2017	June 14, 2017 June 13,2017 June 12, 2017	June 28, 2017	June 29, 2017
bl	Appendix B; Table B101.9 (B-9)	This addendum updates the efficiency requirements in Table B101.9 (B-9) to reflect changes in efficiency metrics.	June 23, 2017	June 14, 2017 June 13,2017 June 12, 2017	June 28, 2017	June 29, 2017
bn	Section 801.3 (8.3)	This addendum updates the soil-gas control requirements in Chapter 8 (Section 8) to increase the protection of building occupants against radon exposure, specifying the key elements of effective soil-gas control.	July 24,2017	July 24, 2017 July 26,2017 July 24, 2017	July 26,2017	July 27, 2017
ho	Chapters 3 and 11 (Sections 3 and 11)	This addendum broadens and simplifies the existing definition of "sidelighting effective aperture" in ASHRAE/USGBC/IES Standard 189.1 in order to clarify its application in the prescriptive daylighting requirements in Section 801.4.1.2 (8.4.1.2).	June 23, 2017	June 14, 2017 June 13,2017 June 12, 2017	June 28, 2017	June 29, 2017
bp	Sections 801.4.2.1 (8.4.2.1) and Chapter 11 (Section 11)	This addendum updates existing requirements for the emissions or VOC content in adhesives and sealants by updating references, adding accreditation requirements for testing laboratories and clarifying language related to the VOC content requirements.	June 23, 2017	June 14, 2017 June 13, 2017 June 12, 2017	June 28, 2017	June 29, 2017
bq	Sections 801.4.4.2 (8.4.4.2) and Chapter 11 (Section 11)	This addendum updates the existing requirements for the emissions or VOC content for paints and coating materials by adding accreditation requirements for testing laboratories, clarifying the language related to the VOC contents requirements, and updating references.	June 23, 2017	June 14, 2017 June 13, 2017 June 12, 2017	June 28, 2017	June 29, 2017
br	Sections 801.4.2.3 (8.4.2.3) and Chapter 11 (Section 11)	This addendum updates the existing requirements for the emissions for floor covering materials by adding accreditation requirements for testing laboratories, updating product categories to be consistent with CDPH/EHLB v1.1, adding a list of materials that are deemed to comply, and updating references.	June 23, 2017	June 14, 2017 June 13, 2017 June 12, 2017	June 28, 2017	June 29, 2017

\* These descriptions may not be complete and are provided for information only.

(continued)



**TABLE K101.1 (TABLE J-1)**  
**ADDENDA TO ANSWASHRAE/USGBC/IES STANDARD 189.1-2014 (Continued)**

ADDENDUM	SECTIONS AFFECTED	DESCRIPTION OF CHANGES*	ASHRAE STANDARDS COMMITTEE APPROVAL	COSPONSOR APPROVAL (USGBC, IES, ICC)	ASHRAE BOD APPROVAL	ANSI APPROVAL
bs	Sections 801.4.2.6 (8.4.2.6) and Chapter 11 (Section 11)	This addendum updates the existing requirements for the emissions for ceiling and wall assemblies by modifying the list of materials covered, adding a separate subsection on insulation, adding a list of materials that are deemed to comply, adding accreditation requirements for testing laboratories, and updating references.	June 23, 2017	June 14, 2017 June 13, 2017 June 12, 2017	June 28, 2017	June 29, 2017
bt	Sections 701.3.1.1 (7.3.1.1), 1001.3.1.2.5 (10.3.1.2.5), and Chapter 11 (Section 11)	This addendum updates requirements for building envelope airtightness testing in ASHRAE/USGBC/IES Standard 189.1 based on changes in ANSI/ASHRAE/IES Standard 90.1-2016.	June 23, 2017	June 14, 2017 June 13, 2017 June 12, 2017	June 28, 2017	June 29, 2017
bu	Appendix B; Table B101.2 (B-2)	This addendum revises the efficiency requirements in ASHRAE/USGBC/IES Standard 189.1, Table B-2, Electrically Operated Unitary and Applied Heat Pumps Minimum Efficiency Requirements (I-P), to adjust the efficiency metrics for industry improvements for these products.	June 23, 2017	June 14, 2017 June 13, 2017 June 12, 2017	June 28, 2017	June 29, 2017
by	Appendix B; Table B101.3 (B-3)	This addendum updates the centrifugal chiller requirement for K <sub>int</sub> , which currently exists as a footnote to Table B101.3 (B-3), to reflect changes to AHRI Standards 550/590 and 551/591. The revised requirement is in alignment with ANSI/ASHRAE/IES Standard 90.1.	June 28, 2017	June 14, 2017 June 13, 2017 June 12, 2017	June 28, 2017	June 29, 2017
bw	Appendix B; Table B101.4 (B-4)	This addendum updates the requirements in Table B101.4 (B-4) for electrically operated packaged-terminal air conditioners and packaged-terminal heat pumps.	July 24, 2017	July 24, 2017 July 26, 2017 July 24, 2017	July 26, 2017	July 27, 2017
bx	Appendix B; Table B101.8 (B-8)	This addendum makes changes to Table B101.8 (B-8), "Performance Requirements for Heat-Rejection Equipment," to update some of the efficiency requirements to align with changes in the industry.	July 24, 2017	July 24, 2017 July 26, 2017 July 24, 2017	July 26, 2017	July 27, 2017
by	Section 801.3.1.4 (8.3.1.4)	This addendum provides a higher level of indoor moisture control (primarily to reduce the likelihood of microbial growth on interior surfaces and within the building envelope) than is currently required by Standard 189.1's reference to Standard 62.1.	June 27, 2015	May 12, 2015 June 29, 2015 N/A	July 1, 2015	July 2, 2015
bz	Appendix B; Tables B101.3 (B-3), B101.10 (B-10), B101.14 (B-14) and B101.15 (B-15)	This addendum updates tables for Water-Chilling Packages, Commercial Refrigerator and Freezers, Commercial Refrigeration Minimum Efficiency Requirements and low-Voltage Dry-Type Distribution Transformers in Appendix B.	June 23, 2017	June 14, 2017 June 13, 2017 June 12, 2017	June 28, 2017	June 29, 2017
cd	Sections 301.2 (3.2), 801.4.1 (8.4.1), 801.5.1 (8.5.1) and Chapter 11 (Section 11)	This addendum revises the daylight requirements in Section 801.4 (8.4), "Prescriptive Compliance Path," and Section 801.5 (8.5), "Performance Option."	June 23, 2017	June 14, 2017 June 13, 2017 June 12, 2017	June 28, 2017	June 29, 2017

\* These descriptions may not be complete and are provided for information only.

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**TABLE K101.1 (TABLE J-1)**  
**ADDENDA TO ANSWASHRAE/USGBC/IES STANDARD 189.1-2014 (Continued)**

ADDENDUM	SECTIONS AFFECTED	DESCRIPTION OF CHANGES*	ASHRAE STANDARDS COMMITTEE APPROVAL	COSPONSOR APPROVAL (USGBC, IES, ICC)	ASHRAE BOD APPROVAL	ANSI APPROVAL
cc	Chapter 7 (Section 7)	This addendum revises contains modifications to the mandatory and prescriptive requirements for peak load reduction in Chapter 7 (Section 7). The existing prescriptive requirement in Section 701.4.5.1 (7.4.5.1) is deleted, and a mandatory requirement is added in Section 701.3.4 (7.3.4).	June 27, 2015	May 12, 2015 June 29, 2015 N/A	July 1, 2015	July 2, 2015
cf	Appendix E	This addendum updates Informative Appendix E to make it consistent with changes approved by addendum k, which changed the building envelope requirements in Section 701.4.2.1 (7.4.2.1). It also adds tables for Climate Zone 0, consistent with addendum q.	May 22, 2017 May 15, 2017	May 12, 2017 May 11, 2017	N/A	N/A
cg	Appendix I	This addendum adds a new informative appendix to aid in understanding and adoption of the functional and performance testing (FPT) and commissioning (Cx) processes of Chapter 10 (Section 10).	May 22, 2017	May 15, 2017 May 12, 2017 May 11, 2017	N/A	N/A
ch	Chapters 5 and 11 (Sections 5 and 11)	This addendum to ASHRAE Standard 189.1 contains updates to references.	July 24, 2017	July 24, 2017 July 26, 2017 July 24, 2017	July 26, 2017	July 27, 2017
cj	Appendix H	This addendum adds an informative appendix for use in correlating the prescriptive energy path provisions of this standard with those of the <i>International Energy Conservation Code</i> (IECC).	May 22, 2017	May 15, 2017 May 12, 2017 May 11, 2017	N/A	N/A
cl	Table 701.5.2A (7.5.2A)	This addendum updates Table 701.5.2A (7.5.2A) to provide consistency with changes to ASHRAE Standard 90.1-2016, which is referenced by Standard 189.1, and to changes in the stringency of the prescriptive requirements in Standard 189.1, Chapter 7 (Section 7).	July 24, 2017	July 24, 2017 July 26, 2017 July 24, 2017	July 26, 2017	July 27, 2017

\* These descriptions may not be complete and are provided for information only.

**NOTE**

**Approved addenda, errata, or interpretations for this standard can be downloaded free of charge from the ASHRAE website at <http://www.ashrae.org/technology>.**

## INFORMATIVE APPENDIX L

# ADDITIONAL GUIDANCE FOR ROOFS AND, VEGETATED TERRACES AND ROOFING SYSTEMS

*(Adopted As Policy)*

This appendix provides guidance on best practices for high-performance roofs and, vegetated terraces and roofing systems.

**501.3.5.3 Roofs.** This section applies to the building and covered parking roof surfaces for new building and addition projects. A minimum of 75% of the roof surface shall be covered with products that:

- a. have a minimum three-year-aged *SRI* of 64 in accordance with Section 501.3.5.4 for roofs with a slope of less than or equal to 2:12.
- b. have a minimum three-year-aged *SRI* of 25 in accordance with Section 501.3.5.4 for roofs with a slope of more than 2:12.

The area occupied by one or more of the following shall be excluded from the calculation to determine the roof surface area required to comply with this section:

- a. Roof penetrations and associated equipment.
- b. On-site renewable energy systems, including photovoltaics, solar thermal energy collectors, and required access around the panels or collectors.
- c. Portions of the roof used to capture heat for building energy technologies.
- d. Roof decks and rooftop walkways.
- e. Vegetated terrace and roofing systems complying with Section 501.3.5.5.

**Exceptions:**

1. Building projects where an annual energy analysis simulation demonstrates that the total annual building energy cost and total annual  $CO_2e$ , as calculated in accordance with Section 701.5.2, are both a minimum of 2% less for the proposed roof than for a roof material complying with the *SRI* requirements of Section 501.3.5.3.
2. Roofs used to shade or cover parking and roofs over semiheated spaces, provided that they have a minimum initial *SRI* of 29. A default *SRI* value of 35 for new concrete without added color pigment is allowed to be used instead of measurements

**501.3.5.4 (5.3.5.4) Solar Reflectance Index (SRI).** The *SRI* shall be calculated in accordance with ASTM E1 980 for medium-speed wind conditions using a convection coefficient of 2.1 Btu/hft<sup>2</sup>°F (11.9 W/m<sup>2</sup>°C) for the following conditions:

- a. For materials other than roofs, the *SRI* shall be based on solar reflectance, as measured in accordance with ASTM E1918 or ASTM C1549, and the thermal emittance, as measured in accordance with ASTM E408 or ASTM C1371. The values for solar reflectance and thermal emittance shall be determined and certified by an independent third party.

For roofing products, the *SRI* values shall be based on a minimum three-year-aged solar reflectance and thermal emittance, as measured in accordance with CRRC S100, and shall be certified by the manufacturer.

# ANNEX 1

## REFERENCED STANDARD REPRODUCTION ANNEX

### ASHRAE STANDARD 169

*(This annex contains normative material from an existing ASHRAE standard that is cited in this code. This annex is not part of this code; its inclusion is merely informative. It is included here to facilitate use of this code.)*

Annex 1 contains extractions of material from ASHRAE Standard 169. The table below lists where in Standard 189.1 this material is referenced and whether it is referenced normatively or informatively.

STANDARD 189.1 SECTION	ANNEX 1 FIGURE/TABLE/SECTION	ASHRAE STANDARD 169 MATERIAL	STATUS IN STANDARD 189.1
Appendix A	Figure Annex 1-1	Figure B-1, Climate Zones for United States Counties	Informative
Appendix A	Section Annex 1-1	Section A3 Climate Zone Definitions	Normative
Appendix A	Table Annex 1-1	Table A-3 Thermal Climate Zone Definitions	Normative

**Informative Note:** Section references that appear in this annex are references to sections or appendices in ANSI/ASHRAE Standard 169.

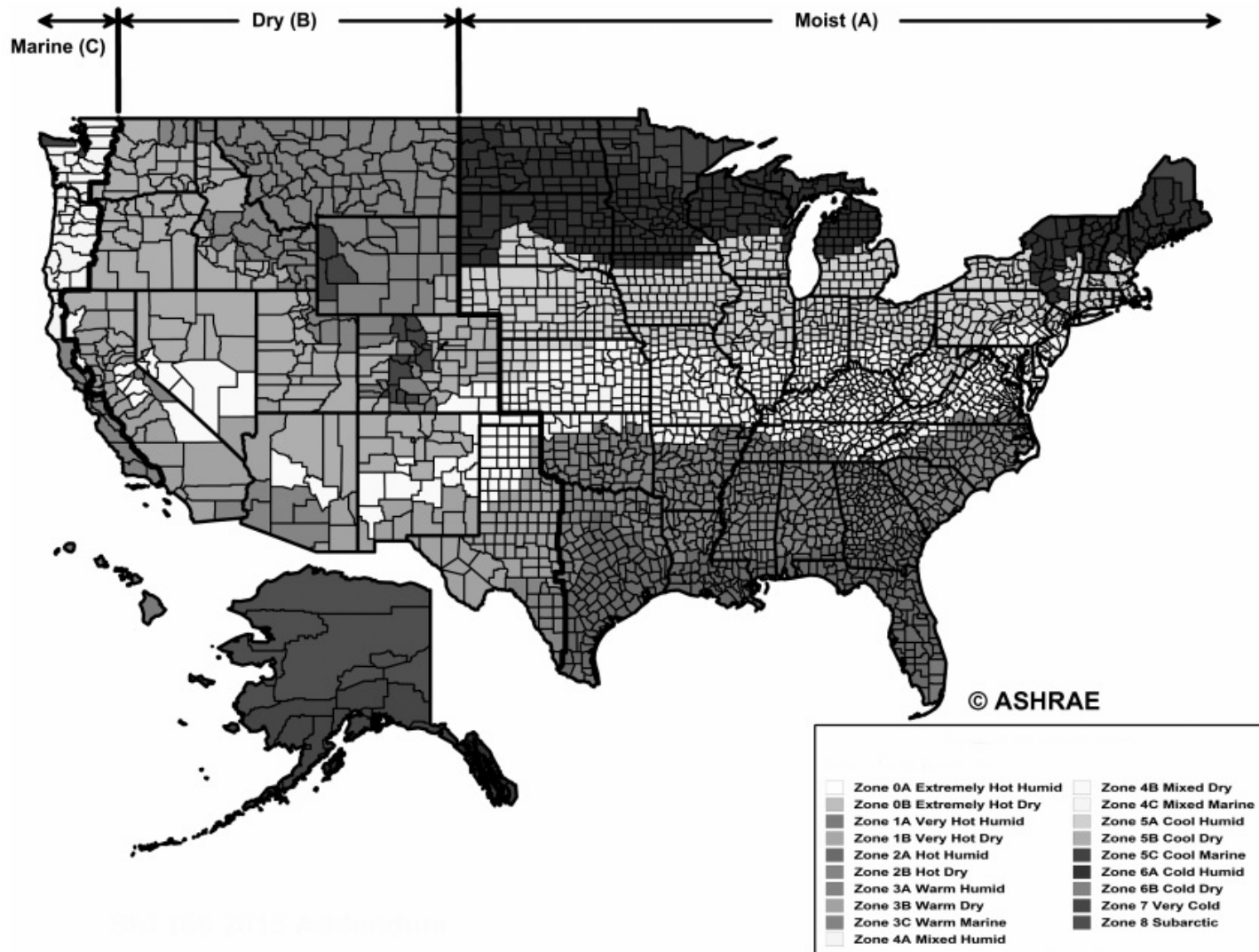


FIGURE ANNEX 101.1  
ASHRAE STANDARD 169-2013, FIGURE B-1: CLIMATE ZONES FOR UNITED STATES COUNTIES.

**SECTION ANNEX 101**  
**ASHRAE STANDARD 169-2013, SECTION A3:**  
**CLIMATE ZONE DEFINITIONS**

**SECTION A301**  
**CLIMATE ZONE DEFINITIONS**

To determine the climate zones for locations not listed in this code, use the following information to determine climate zone numbers and letters.

Determine the thermal climate zone, 0-8, from Table Annex 101.1(1-1), using the heating and cooling degree-days for the location.

Determine the moisture zone (Marine, Dry or Humid):

- a. If monthly average temperature and precipitation data are available, use the Marine, Dry, and Humid definitions below to determine the moisture zone (C, B, or A).
- b. If annual average temperature information (including degree-days) and annual precipitation (i.e. annual mean) are available, use the following to determine the moisture zone:
  1. If thermal climate zone is 3 and  $CDD_{50^{\circ}F} \leq 4500$  ( $CDD_{10^{\circ}C} \leq 2500$ ), climate zone is Marine (3C).
  2. If thermal climate zone is 4 and  $CDD_{50^{\circ}F} \leq 2700$  ( $CDD_{10^{\circ}C} \leq 1500$ ), climate zone is Marine (4C).
  3. If thermal climate zone is 5 and  $CDD_{50^{\circ}F} \leq 1800$  ( $CDD_{10^{\circ}C} \leq 1000$ ), climate zone is Marine (5C).

Use the third criteria below for determining the Dry/ Humid threshold if not Marine (C).

- c. If only degree-day information is available, use the following to determine the moisture zone:
  1. If thermal climate zone is 3 and  $CDD_{50^{\circ}F} \leq 4500$  ( $CDD_{10^{\circ}C} \leq 2500$ ), climate zone is Marine (3C).
  2. If thermal climate zone is 4 and  $CDD_{50^{\circ}F} \leq 2700$  ( $CDD_{10^{\circ}C} \leq 1500$ ), climate zone is Marine (4C).
  3. If thermal climate zone is 5 and  $CDD_{50^{\circ}F} \leq 1800$  ( $CDD_{10^{\circ}C} \leq 1000$ ), climate zone is Marine (5C).

It is not possible to assign Dry/Humid splits in this case.

*Marine (C) Zone Definition*—Locations meeting all four of the following criteria:

- a. Mean temperature of coldest month between 27°F (-3°C) and 65°F (18°C);
- b. Warmest month mean < 72°F (22°C);
- c. At least four months with mean temperatures over 50°F (10°C); and
- d. 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.

*Dry (B) Definition*—Locations meeting the following criteria:

- a. Not Marine (C);
- b. If 70% or more of the precipitation,  $P$ , occurs during the high sun period, then the dry/humid threshold is:
 
$$P < 0.44 \times (T - 7) \quad (I-P)$$

$$P < 20.0 \times (T + 14) \quad (SI)$$
- c. If between 30% and 70% of the precipitation,  $P$ , occurs during the high sun period, then the dry/humid threshold is:
 
$$P < 0.44 \times (T - 19.5) \quad (I-P)$$

$$P < 20.0 \times (T + 7) \quad (SI)$$
- d. If 30% or less of the precipitation,  $P$ , occurs during the high sun period, then the dry/humid threshold is:
 
$$P < 0.44 \times (T - 32) \quad (I-P)$$

$$P < 20 \times T \quad (SI)$$

where:

$P$	= annual precipitation, in. (mm).
$T$	= annual mean temperature, °F (°C).
Summer or high sun period	= April through September in the Northern Hemisphere and October through March in the Southern Hemisphere.
Winter or cold season	= October through March in the Northern Hemisphere and April through September in the Southern Hemisphere.

*Humid (A) Definition*—Locations that are not Marine (C) and not Dry (B).

**TABLE ANNEX 101.1**  
**ASHRAE STANDARD 169-2013, TABLE A-3: THERMAL CLIMATE ZONE DEFINITIONS**

THERMAL ZONE	NAME	I-P UNITS	SI UNITS
0	Extremely hot	$10,800 < \text{CDD}_{50^{\circ}\text{F}}$	$6000 < \text{CDD}_{10^{\circ}\text{C}}$
1	Very hot	$9000 < \text{CDD}_{50^{\circ}\text{F}} \leq 10,800$	$5000 < \text{CDD}_{10^{\circ}\text{C}} \leq 6000$
2	Hot	$6300 < \text{CDD}_{50^{\circ}\text{F}} \leq 9000$	$3500 < \text{CDD}_{10^{\circ}\text{C}} \leq 5000$
3	Warm	$\text{CDD}_{50^{\circ}\text{F}} \leq 6300$ and $\text{HDD}_{65^{\circ}\text{F}} \leq 3600$	$\text{CDD}_{10^{\circ}\text{C}} < 3500$ and $\text{HDD}_{18^{\circ}\text{C}} \leq 2000$
4	Mixed	$\text{CDD}_{50^{\circ}\text{F}} \leq 6300$ and $3600 < \text{HDD}_{65^{\circ}\text{F}} \leq 5400$	$\text{CDD}_{10^{\circ}\text{C}} < 3500$ and $2000 < \text{HDD}_{18^{\circ}\text{C}} \leq 3000$
5	Cool	$\text{CDD}_{50^{\circ}\text{F}} \leq 6300$ and $5400 < \text{HDD}_{65^{\circ}\text{F}} \leq 7200$	$\text{CDD}_{10^{\circ}\text{C}} \leq 3500$ and $3000 < \text{HDD}_{18^{\circ}\text{C}} \leq 4000$
6	Cold	$7200 < \text{HDD}_{65^{\circ}\text{F}} \leq 9000$	$4000 < \text{HDD}_{18^{\circ}\text{C}} \leq 5000$
7	Very cold	$9000 < \text{HDD}_{65^{\circ}\text{F}} \leq 12600$	$5000 < \text{HDD}_{18^{\circ}\text{C}} \leq 7000$
8	Subarctic/arctic	$12600 < \text{HDD}_{65^{\circ}\text{F}}$	$7000 < \text{HDD}_{18^{\circ}\text{C}}$