

2019 Denver Green Code
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PREFACE

The *Denver Green Code* is based on the *International Green Construction Code*[®] (IgCC[®]).

USER NOTE: The code is formatted utilizing ICC’s code format for chapter and section number designations. However, in order to provide the requisite road map to the technical provisions of Standard 189.1, the Standard 189.1 section number is included in parentheses following the Denver Green Code section number – e.g., “Section 101.2 (1.) Purpose.” The Denver Green Code section number is 101.2 and the corresponding section number/title in Standard 189.1 is “Section 1 Purpose.” In some cases where the text of the Denver Green Code is based on Standard 189.1, the text has been edited to be consistent with ICC’s publication style guidelines.

Italicized Terms

Words and terms that are defined in Chapter 3, Definitions, Abbreviations, and Acronyms are italicized where they appear in code text. Where such words and terms are not italicized, common-use definitions apply. The words and terms selected have code-specific definitions that the user should read carefully to facilitate better understanding of the code.

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Marginal Markings

The following margin symbols are used to differentiate between the *International Green Construction Code* text and Denver amendments:

|| This symbol indicates a revision to the *International Green Construction Code* by Denver.

> This symbol indicates deletion of the *International Green Construction Code* language by Denver.

Effective Use of the 2019 Denver Green Code (DGC)

Arrangement and Format of the 2019 DGC

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

Chapter	Subjects
1	Scope and administration
2	Reserved
3	Definitions, abbreviations and acronyms
4	Residential energy efficiency
5	Site sustainability
6	Water use efficiency
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 increased equipment efficiency approach
Normative Appendix C	Reserved
Normative Appendix D	Building concentrations
Informative Appendix E	Reserved
Informative Appendix F	Integrated design
Informative Appendix G	Informative references
Informative Appendix H	Reserved
Informative Appendix I	Additional guidance for functional and performance testing (FPT) and the commissioning (Cx) process
Informative Appendix J	Reserved
Informative Appendix K	Addenda description information
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 *Denver Green Code*:

Chapter 1 Scope and Administration. Chapter 1 of the DGC 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 (Section 105).

Section 101 identifies which buildings and structures come under its purview and Section 102 references other adopted I-Codes as applicable. Section 105 provides guidance to the building official in the approval of materials, methods of construction, designs, systems and innovative approaches where they are not specifically prescribed in the DGC.

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

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 Residential Energy Efficiency. Chapter 4 contains provisions for energy efficiency for residential buildings and appliances.

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 501.3.2 requires predesign site inventory and assessment.

Section 501.3.3 regulates plantings on the site.

Section 501.3.4 contains requirements for stormwater management systems.

Section 501.3.5 requires the mitigation of heat island effect.

Section 501.3.6 addresses light pollution.

Section 501.3.7 addresses transportation impacts.

Section 501.3.8.1 addresses building site waste management.

Section 501.3.9 addresses requirements for soil amendment.

Chapter 6 Water Use Efficiency. Chapter 6 provides requirements that are intended to conserve potable and nonpotable water.

Section 601.3.1 reduces water use on sites by means of requirements related to landscape design and irrigation system design.

Section 601.3.2 regulates water consumption through limitations of fixture and fitting flow rates and by means of requirements related to specific equipment, appliances and HVAC systems and equipment.

Section 601.3.3 regulates water use in ornamental fountains and water features.

Section 601.3.4 requires water metering/monitoring and data collection.

Sections 601.3.6 and 601.3.7 regulate, reverse osmosis water treatment systems and on-site reclaimed water treatment systems, respectively.

Where a reclaimed water supply is available or is planned to be available within 5 years, Section 601.3.8 requires the installation of a dual water supply plumbing system wherein reclaimed water is supplied to urinals and water closets.

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 Sections 701.5, 701.6 or 701.7.

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.

Sections 701.5 through 701.7 contains the performance-based energy compliance paths.

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 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 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 and lighting for presentations.

Section 801.5 contains performance-based provisions related to indoor environmental quality. It includes requirements for daylight simulation 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 1001.3.1.7 addresses pollution from the idling of construction vehicles during construction.

Section 1001.3.1.8 addresses contaminant entry into buildings during construction.

Section 1001.3.1.9 requires post-construction testing for radon in buildings.

Section 1001.3.1.10 requires construction waste management 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 1001.3.3 requires that a transportation management plan be developed.

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 building 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 DGC; and the section or sections of this code that reference the standard.

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

In the DGC, 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. 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 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. Reserved.

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 Section 101.4.2 and Appendix B. 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. Reserved.

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. Reserved.

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.

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 2019 *Denver Green Code* hereinafter referred to as “this code.”

101.2 (1.) 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 (1.2) 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 (2.) Scope.

101.3.1 (2.1) 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 and their systems.
2. New portions of buildings and their systems.
3. New systems and equipment in existing buildings.
4. Relocated existing buildings and temporary structures where specified in this code.

101.3.2 (2.2) The provisions of this code do not apply to the following:

1. Manufactured houses (mobile homes).
2. Manufactured houses (modular).
3. *Building projects* that use none of the following:
 1. Electricity.
 2. Fossil fuels.
 3. Water.

101.3.3 (2.3) The requirements in this code shall not be used to circumvent any applicable safety, health, or environmental requirements.

101.4 (4.) Application.

101.4.1 (4.1) General. *Building projects* shall comply with Chapters 1, 3 and 11 and with one of the following:

1. The *building project* shall achieve Platinum Certification using the most current version of the US Green Building Council’s (USGBC) Leadership in Energy and Environmental (LEED) program that is administered and supported by the USGBC. *Residential* and Group-R *buildings* may achieve certification with the LEED for Homes program. All other *building projects* shall achieve certification with the Building Design and Construction (BD +C) program.
2. The *building project* shall achieve Zero Net Energy in accordance with Section 401.5 (4.5) for *residential building projects* or 701.6 (7.6) for all other *building projects*.
3. The *building project* shall comply with Chapters 5 through 10. Within each of these chapters, *building projects* shall comply with all mandatory provisions and with a minimum number of elective provisions in accordance with Table 101.4.1.

Exception: *Residential buildings* complying with Chapter 4 shall not be required to comply with Chapter 7.

101.4.2 (4.1.1) 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. All NFPA 70 code references within this code shall refer to the *National Electrical Code* as adopted by the State of Colorado. 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 (4.1.2) 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 (4.1.3) 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 (4.1.4) 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.

**TABLE 101.4.1
MANDATORY AND ELECTIVE REQUIREMENTS**

CHAPTER	MANDATORY	PROJECT ELECTIVES
Chapter 4	401.3	No less than one of the following sections: 401.4, 401.5, 401.6
Chapter 5	All of the following sections: 501.3.3.1 501.3.3.4 501.3.4 501.3.4.6 501.3.7	No less than four of the following sections: 501.3.2 501.3.3.2 501.3.3.3 501.3.4.1 501.3.5 501.3.6 501.3.8 501.3.9
Chapter 6	All of the following sections: 601.3.1 601.3.2 601.3.3	No less than one of the following sections: 601.3.1.2.3 601.3.4 601.3.6 601.3.7 601.3.8
Chapter 7	701.3	No less than one of the following sections: 701.4, 701.5, 701.6, 701.7
Chapter 8	All of the following sections: 801.3.1 801.3.1.1 801.3.1.2 801.3.2 801.3.3 801.3.4 801.3.5 801.3.9 801.3.10	No less than four of the following sections: 801.3.1.3 801.3.1.4 801.3.1.6 801.3.1.8 801.3.6 801.3.7 801.3.8
Chapter 9	All of the following sections: 901.3.1 901.3.3 901.3.4 901.3.5 901.3.6	NA
Chapter 10	All of the following sections: 1001.3.1.1 1001.3.1.1.1 1001.3.1.2 1001.3.1.3 1001.3.1.4 1001.3.3	No less than four of the following sections: 1001.3.1.1.2 1001.3.1.5 1001.3.1.6 1001.3.1.7 1001.3.1.8 1001.3.1.9 1001.3.1.10 1001.3.2

**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 as determined by the *building official* 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 Adopted codes and standards. Where adopted by the *authority having jurisdiction (AHJ)*, the following codes, as amended by the *AHJ*, shall be considered to be part of the requirements of this code: *International Building Code*, *International Energy Conservation Code*, *International Existing Building Code*, *International Fire Code*, *International Fuel Gas Code*, *International Mechanical Code*, *International Plumbing 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. Where there is a conflict between the provisions of this chapter and the provisions of the *Administration of the 2019 Denver Building Code*, the provisions of the *Administration of the 2019 Denver Building Code* shall govern.

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.

102.6 Existing structures. The legal occupancy of any structure existing on the date of adoption of this code shall be permitted to continue without change, except as is specifically covered in this code, and where adopted by the *authority having jurisdiction*, the *International Building Code*, the *International Existing Building Code* or the *International Fire Code*.

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

Sections 103 through 109 are deleted in their entirety. The 2019 Administration of the *Denver Building Code* shall govern.

CHAPTER 2
RESERVED

CHAPTER 3

DEFINITIONS, ABBREVIATIONS AND ACRONYMS

301.1 (3.1) 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 (3.2) 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 Building Permitting and Inspections Services Agency of the City and County of Denver.

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

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 (CO₂e): a measure used to compare the impact of various greenhouse gases based on their global warming potential (GWP). CO₂e approximates the time-integrated warming effect of a unit mass of a given greenhouse gas relative to that of carbon dioxide (CO₂). 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 CO₂. The following GWP values are used based on a 100-year time horizon: 1 for CO₂, 25 for methane (CH₄), and 298 for nitrous oxide (N₂O).

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

DEFINITIONS, ABBREVIATIONS AND ACRONYMS

climate zone: see Normative Appendix A.

combined energy efficiency ratio (CEER [I-P]) (CCOP_C [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 ft² (100 m²).

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_c: *evapotranspiration* of the *plant* material derived by multiplying *ET_o* by the appropriate *plant* factor or coefficient.

ET_o: 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 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 (610 mm/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.

LZ0: 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 *LZ0*, *LZ1*, *LZ2*, or *LZ4*.

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 top of the membrane between the purlins. For multilayer installations, the last rated R-value of insulation is for unfaced insulation draped over purlins and then compressed when the metal *roof* panels are attached. A minimum R-3 (R-0.5) thermal spacer block between the purlins and the metal *roof* panels is required unless compliance is shown by the overall assembly U-factor or otherwise noted.

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

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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.

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_c compatible plants:** *plants* with documented ET_c 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_c.

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 (PF): 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 building:** detached one- and two-family dwellings, multiple single-family dwellings (townhouses), and Group R-3 and R-4 buildings three stories or less in height above grade plane.

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 sidelighted areas*. The *sidelighting effective aperture* is calculated according to the following formula:

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

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.

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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	<i>authority having jurisdiction</i>
AHRI	Air-Conditioning, Heating, and Refrigeration Institute
ANSI	American National Standards Institute
ASE	<i>annual sunlight exposure</i>
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	<i>Basis of Design</i>
BPF	building performance factor
Btu	British thermal unit
Btu/h	British thermal unit per hour
BUG	backlight, upright, and glare
CAC	ceiling attenuation class
CCOP	<i>combined coefficient of performance</i>
CDPH	California Department of Public Health
CEER	<i>combined energy efficiency ratio</i>

CFC	Chlorofluorocarbon	IAPMO	International Association of Plumbing and Mechanical Officials
cfm	cubic feet per minute (ft ³ /min)	IAQ	indoor air quality
CH ₄	methane	IECC	International Energy Conservation Code
c.i.	continuous insulation	IEQ	indoor environmental quality
CIE	Commission Internationale de L'Éclairage (International Commission on Illumination)	IES	Illuminating Engineering Society
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora	IIC	impact insulation class
CO ₂	carbon dioxide	in.	inch
CO ₂ e	<i>carbon dioxide equivalent</i>	I-P	inch-pound
CSA	Canadian Standards Association	ISR	impact sound rating
cSTC	composite sound transmission class	kg	kilogram
Cx	commissioning	km	kilometre
dB	decibel	kVA	kilovolt-ampere
db	dry bulb	kW	kilowatt
dBA	decibel, A-weighting	kWh	kilowatt-hour
dBC	decibel, C-weighting	L	litre
DC	direct current	lb	pound
DCV	<i>demand control ventilation</i>	LCA	<i>life-cycle assessment</i>
DR	demand response	LCI	life-cycle inventory
EISA	Energy Independence and Security Act	L _{eq}	hourly average sound pressure level
EMS	Energy Management System	L _{max}	<i>maximum sound pressure level</i>
EPAct	U.S. Energy Policy Act	LPD	lighting power density
EPD	environmental product declaration	Ls	<i>liner system</i>
ESC	erosion and sedimentation control	LZ	<i>lighting zone</i>
ET _c	<i>evapotranspiration</i>	m	metre
ET _o	<i>maximum evapotranspiration</i>	MDF	medium density fiberboard
ETS	environmental tobacco smoke	MERV	minimum efficiency reporting value
fc	footcandle	mg	milligram
FF&E	furniture, fixtures, and equipment	mi	mile
FPT	<i>functional and performance testing</i>	min	minute
ft	foot	mm	millimetre
gal	gallon	mph	miles per hour
gpm	gallons per minute	M&V	measurement and <i>verification</i>
GWP	global warming potential	N ₂ O	nitrous oxide
h	hour	NA	not applicable
ha	hectare	NAECA	National Appliance Energy Conservation Act
HCFC	hydrochlorofluorocarbon	NIC	noise isolation class
HID	high-intensity discharge	NISR	normalized impact sound rating
HVAC	heating, ventilation, and air conditioning	NNIC	normalized noise isolation class
HVAC&R	heating, ventilation, air conditioning, and refrigeration	NPLV	nonstandard part-load value
Hz	hertz	NR	not required
IA	Irrigation Association	OITC	outdoor-indoor transmission class
		O&M	operations and maintenance
		OPR	<i>owner's project requirements</i>

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Pa	Pascal
PCI	Performance Cost Index
<i>PF</i>	<i>projection factor</i>
ppm	parts per million
RCR	room cavity ratio
<i>REC</i>	<i>renewable energy certificate</i>
s	second
SCAQMD	South Coast Air Quality Management District
<i>sDA</i>	<i>spatial daylight autonomy</i>
<i>SHGC</i>	<i>solar heat gain coefficient</i>
SMACNA	Sheet Metal and Air Conditioning Contractors National Association
<i>SRI</i>	<i>solar reflectance index</i>
STC	sound transmission class
<i>SWAT</i>	smart water application technology
T_{60}	reverberation time in seconds
UL	Underwriters Laboratory
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
USFEMA	United States Federal Emergency Management Agency
USGBC	United States Green Building Council
<i>VAV</i>	<i>variable air volume</i>
VOC	volatile organic compound
VRF	variable refrigerant flow system
VT	visible transmittance
wb	wet bulb
<i>WF</i>	<i>water factor</i>
yr	year

CHAPTER 4

RESIDENTIAL ENERGY EFFICIENCY

401.1 (4.1) Scope. This section specifies requirements for energy efficiency for *residential buildings* and appliances, and for *on-site renewable energy systems*.

401.2 (4.2) Compliance. The energy systems shall comply with Section 401.3 and one of the following Project Electives:

1. Section 401.4, “Passive House Approach.”
2. Section 401.5, “Net Zero Approach.”
3. Section 401.6, “Energy Rating Approach.”

401.3 (4.3) Electric-vehicle charging (Mandatory). The building shall be provided with electric charging in accordance with this section and the *National Electrical Code* (NFPA 70). New one- and two-family dwellings and townhouses with attached and detached private garages shall be provided with one *EV Ready Space*. When parking spaces are added or modified without an increase in building size, only the new parking spaces are subject to this requirement.

Exception: Detached private garages without electrical service.

401.4 (4.4) Energy Rating Approach (Project Elective). The rated design of the *building project* shall have an Energy Rating Index score of less than or equal to 50 when compared to the *ERI reference design* determined in accordance with RESNET/ICC 301. The ERI value shall include onsite power production calculated in accordance with RESNET/ICC 301. All space heating and cooling systems, water heating, cooking equipment and clothes dryers shall be electric.

401.4.1 (4.4.1) Verification by approved agency. Verification of compliance with this section shall be completed by an *approved* third party.

401.4.2 (4.4.2) Documentation. Documentation showing how the ERI for the *residential building* was determined shall be in accordance with Sections 401.4.2.1 and 401.4.2.2. Additional documentation shall be provided in accordance with Section 401.4.2.3.

401.4.2.1 (4.4.2.1) Compliance software tools. Software tools used for determining ERI shall be Approved Software Rating Tools in accordance with RESNET/ICC 301.

401.4.2.2 (4.4.2.2) Compliance report. Compliance software tools shall generate a report documenting that the ERI of the rated design complies with Section 401.4 or 401.5. The compliance documentation shall include the following information:

1. Address or other identification of the residential building.
2. An inspection checklist documenting the building component characteristics of the rated design. The inspection checklist shall show results for both the *ERI reference design* and the

rated design, and shall document all inputs entered by the user necessary to reproduce the results.

401.4.2.3 (4.4.2.3) Additional documentation. The *building official* may require the following documents:

1. Documentation of the building component characteristics of the *ERI reference design*.
2. A certification signed by the builder providing the building component characteristics of the rated design.
3. Documentation of the actual values used in the software calculations for the rated design.
4. Within 24 months of occupancy, documentation that on an annual basis, the energy consumed on site by the *building project* is equal to or less than that which was calculated for the rated design to comply with Section 401.4 or 401.5.

401.5 (4.5) Net Zero Approach (Project Elective). The rated design of the *building project* shall have an Energy Rating Index score of less than or equal to 0 when compared to the *ERI reference design* determined in accordance with RESNET/ICC 301. The ERI value shall include onsite power production calculated in accordance with RESNET/ICC 301. The following conditions shall also be met:

- a. All space heating and cooling systems, water heating, cooking and clothes dryers shall be electric.
- b. The *building* or dwelling unit shall be tested and verified as having an air leakage rate not exceeding two air changes per hour. Testing shall be conducted in accordance with RESNET/ICC 380, ASTM E779 or ASTM E1827 and reported at a pressure of 0.2 inch w.g.
- c. The building shall be provided with a heat recovery or energy recovery ventilation system. The system shall be balanced with a minimum sensible heat recovery efficiency of 65% at 32°F and at rated air-flow.

401.5.1 (4.5.1) Documentation and verification. Buildings shall comply with Sections 401.4.1 through 401.4.2.3.

401.6 (4.6.) Passive House Approach (Project Elective). New *residential buildings* shall achieve Passive House certification in accordance with Section 401.6.1 or 401.6.2.

401.6.1 (4.6.1) Passive House Institute US (PHIUS) Certification. Achieve certification with the PHIUS+ 2018 Passive Building Standard and provide documentation in accordance with Section 401.6.1.1.

401.6.1.1 (4.6.1.1) Documentation. Provide documentation to the *building official* demonstrating the following.

1. Prior to the issuance of a building permit, documentation of a PHIUS+ 2018 Certification Con-

tract from PHIUS and a list of compliance features.

2. Prior to the issuance of a certificate of occupancy, a copy of the final report submitted on a form that is approved by PHIUS to document compliance with the PHIUS+ 2018 Standard.

401.6.2 (4.6.2) Passive House Institute (PHI) Certification. Achieve certification with the PHI Passive House Standard and provide documentation in accordance with Section 401.6.2.1.

401.6.2.1 (4.6.2.1) Documentation. Provide documentation to the *building official* demonstrating the following.

1. Prior to the issuance of a building permit, signed documentation from a PHI accredited Passive House Certifier of intent to certify the building and a list of compliance features.
2. Prior to the issuance of a certificate of occupancy, a copy of the final report submitted on a form that is approved by PHI to document compliance with the Passive House Standard.

CHAPTER 5

SITE SUSTAINABILITY

501.1 (5.1) 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 (5.2) Compliance. *Building projects* shall comply with Section 501.3 (5.3) in accordance with Section 101.4.1.

501.3 (5.3) Mandatory and Elective Provisions.

501.3.1 (5.3.1) Reserved.

501.3.1.1 Reserved.

501.3.1.2 Reserved.

501.3.2 (5.3.2) Predesign Site Inventory and Assessment (Project Elective). A predesign inventory and assessment of the natural resources of the *building project site* shall be submitted with the *site* design and *construction documents*. The inventory and assessment shall include all of the following:

- a. Location of land having an elevation lower than 2 feet above the elevation of the 100 year flood, as defined by U.S. FEMA that are located on or adjacent to the *building project site*.
- b. Identification of *invasive plant* species on the *site*.
- c. Identification of *native plant* species on the *site*.
- d. Identification of *site* features designated for preservation.

501.3.3 (5.3.3) Plants.

501.3.3.1 (5.3.3.1) Invasive Plants (Mandatory). *Invasive plants* and noxious weed species that appear on the Colorado Department of Agriculture's Noxious Weed List shall be removed from the *building project site* and destroyed or disposed of in a land fill. *Invasive plants* shall not be planted on the *building project site*.

501.3.3.2 (5.3.3.2) Existing Native or Adapted Plants (Project Elective).

- a. **More than 20% existing native or adapted plants:** Where more than 20% of the area of the predevelopment *site* has existing *native plants* or *adapted plants*, a minimum area of 10% the building or addition's gross floor area, or 20% of the area of *native plants* or *adapted plants* shall be retained.
- b. **Less than 20% existing native or adapted plants:** Where 20% or less of the area of the predevelopment *site* has existing *native plants* or *adapted plants*, a minimum area of 10% of the building or addition's gross floor area shall be developed or retained as at-grade green space as defined by Denver's Green Building Ordinance.

501.3.3.3 (5.3.3.3) Minimum Vegetative Area (Project Elective). A minimum of 20% of the *site* shall be developed or retained as vegetated area. Such vegetated areas include bioretention facilities, rain gardens, filter strips, grass swales, vegetated level spreaders, constructed *wetlands*, planters, and open *space* with plantings

501.3.3.4 (5.3.3.4) Mulching of Shrub Bed/Planting Areas (Mandatory). Shrub bed/planting areas shall be mulched to a depth of 2-4 in. Perennials and ground-cover areas shall be mulched with a 3 in. layer. No weed barrier shall be installed over top of tree root balls or in planting beds. The mulch shall meet the following requirements:

1. Be an organic shredded wood mulch that is certified pathogen-free and chemical-free.
2. Surface coverage shall be a minimum 3 foot radius from the trunk where there are no obstructions.
3. Mulch shall be kept a minimum of 4-6 inches away from tree trunks and shall not be in contact with the base of other woody landscape plants.

501.3.4 (5.3.4) Stormwater Management (Mandatory). Stormwater management systems shall be provided on the *building site*.

501.3.4.1 (5.3.4.1) Projects on Greenfields (Project Elective). Projects on *greenfields* shall comply with at least one of the following:

- a. Stormwater management systems shall retain on *site* no less than the volume of precipitation during a single 24 h period equal to the 95th percentile precipitation event. *Building projects* with stormwater management systems that are designed to retain volumes greater than that of the 98th percentile precipitation event shall conduct a hydrologic analysis of the *building site* to determine the water balance of the *site* prior to its development, clearing, and filling and to demonstrate that the stormwater management system will not cause ecological impairment by starving receiving waters downstream of the *site*.
- b. The stormwater management system design shall maintain *site* water balance (the combined runoff, infiltration, and *evapotranspiration*) based on a hydrologic analysis of the *site's* conditions prior to development, clearing, and filling. Postconstruction runoff rate, volume, and duration shall not exceed rates preceding development, clearing, or filling of the *site*.

501.3.4.2 (5.3.4.2) Reserved.

501.3.4.3 (5.3.4.3) Reserved.

501.3.4.4 (5.3.4.4) Reserved.

501.3.4.5 (5.3.4.5) Reserved.

501.3.4.6 (5.3.4.6) Coal Tar Sealants (Mandatory).

The use of tar sealants shall be prohibited in any application exposed to stormwater, wash waters, condensates, irrigation water, snowmelt, or icemelt.

501.3.5 (5.3.5) Mitigation of Heat Island Effect (Project Elective).

501.3.5.1 (5.3.5.1) 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·ft² (100 L/min·m²).
- 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 (5.3.5.3).
- e. Parking under a building, provided that the *roof* of the building complies with the provisions of Section 501.3.5.3 (5.3.5.3).
- 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.

501.3.5.2 (5.3.5.2) Reserved.

501.3.5.3 (5.3.5.3) Reserved.

501.3.5.4 (5.3.5.4) Reserved.

501.3.6 (5.3.6) Reduction of Light Pollution (Project Elective).

501.3.6.1 (5.3.6.1) General. Exterior lighting systems shall comply with ANSI/ASHRAE/IES Standard 90.1,

Sections 9.1, 9.4.1.4, 9.4.2, 9.4.3, and 9.7, and with Sections 501.3.6.2 (5.3.6.2) and 501.3.6.3 (5.3.6.3) of this code.

501.3.6.2 (5.3.6.2) Backlight and Glare.

- a. All building-mounted luminaires located less than two mounting heights from any property line shall meet the maximum allowable glare ratings in Table 501.3.6.2A (5.3.6.2A).
- b. All other luminaires shall meet the maximum allowable backlight and glare ratings in Table 501.3.6.2B (5.3.6.2B).

Exceptions:

- 1. Specialized signal, directional, and marker lighting associated with transportation.
- 2. Advertising signage or directional signage.
- 3. Lighting integral to equipment or instrumentation and installed by its manufacturer.
- 4. Lighting for theatrical purposes, including performance, stage, film production, and video production.
- 5. Lighting for athletic playing areas.
- 6. Lighting that is in use for no more than 60 continuous days and is not reinstalled any sooner than 60 days after being uninstalled.
- 7. Lighting for industrial production, material handling, transportation *sites*, and associated storage areas.
- 8. Theme elements in theme/amusement parks.
- 9. Roadway lighting required by governmental authorities.
- 10. Lighting classified for and used in hazardous locations as specified in NFPA 70.
- 11. Lighting for swimming pools and water features.

**TABLE 501.3.6.2A (TABLE 5.3.6.2A)
MAXIMUM ALLOWABLE GLARE RATINGS FOR
BUILDING-MOUNTED LUMINAIRES WITHIN TWO MOUNTING
HEIGHTS OF ANY PROPERTY LINE^{a,b}**

DISTANCE IN MOUNTING HEIGHTS TO NEAREST PROPERTY LINE	LZ0	LZ1	LZ2	LZ3
≥ 1 and < 2	G0	G0	G1	G1
≥ 0.5 and < 1	G0	G0	G0	G1
< 0.5	G0	G0	G0	G0

- a. For property lines that abut public walkways, bikeways, plazas, and parking lots, the property line may be considered to be 5 ft (1.5 m) beyond the actual property line for the purpose of determining compliance with this section. For property lines that abut public roadways and public transit corridors, the property line may be considered to be the centerline of the public roadway or public transit corridor for the purpose of determining compliance with this section.
- b. Backlight, uplight, and glare ratings are defined based on specific lumen limits per IES TM-15 Addendum A.

**TABLE 501.3.6.2B (TABLE 5.3.6.2B)
MAXIMUM ALLOWABLE BACKLIGHT, UPLIGHT,
AND GLARE (BUG) RATINGS^{a,b,c,d}**

	LZ0	LZ1	LZ2	LZ3
Allowed Backlight Rating				
> 2 mounting heights from property line	B1	B3	B4	B5
1 to 2 mounting heights from property line	B1	B1	B2	B3
0.5 to 1 mounting height to property line	B0	B1	B1	B2
< 0.5 mounting height to property line	B0	B0	B0	B1
Allowed Uplight Rating - Luminaires ≥ 3,500 lumens	U0	U0	U0	U0
Allowed Uplight Rating - Luminaires < 3,500 lumens	U0	U0	U1	U2
Allowed Glare Rating	G0	G1	G2	G3

- Except where installed on a building surface, luminaires that are located at a distance of two times the mounting height of the luminaire or less from a property line shall have the backlight of the luminaire aimed toward and perpendicular to the nearest property line. Backlight is that part of the luminaire’s lumen output that was used to determine the backlight rating in its final angular position.
- For property lines that abut public walkways, bikeways, plazas, and parking lots, the property line may be considered to be 5 ft (1.5 m) beyond the actual property line for the purpose of determining compliance with this section. For property lines that abut public roadways and public transit corridors, the property line may be considered to be the centerline of the public roadway or public transit corridor for the purpose of determining compliance with this section.
- If the luminaire is installed in other than the intended manner, or is an adjustable luminaire for which the aiming is specified, the rating shall be determined by the actual photometric geometry in the aimed orientation.
- Backlight, uplight, and glare ratings are defined based on specific lumen limits per IES TM-15 Addendum A.

**TABLE 501.3.6.3 (TABLE 5.3.6.3)
MAXIMUM ALLOWABLE UPLIGHT FOR FAÇADE LIGHTING**

	LZ0	LZ1	LZ2	LZ3
Total fixture lumens per square foot of façade used for façade lighting that is allowed to be emitted above 90 degrees or higher from nadir (straight down)	0	0	0.15	0.25

501.3.6.3 (5.3.6.3) Uplight. All exterior lighting shall meet one of the following uplight requirements:

- Exterior luminaires shall meet the maximum allowable Uplight Ratings of Table 501.3.6.2B (5.3.6.2B).
- Exterior lighting shall meet the uplight requirements of Table 501.3.6.3 (5.3.6.3).

Exceptions:

- Specialized signal, directional, and marker lighting associated with transportation.
- Advertising signage or directional signage.
- Lighting integral to equipment or instrumentation and installed by its manufacturer.

- Lighting for theatrical purposes, including performance, stage, film production, and video production.
- Lighting for athletic playing areas.
- Lighting that is in use for no more than 60 continuous days and is not reinstalled any sooner than 60 days after being uninstalled.
- Lighting for industrial production, material handling, transportation *sites*, and associated storage areas.
- Theme elements in theme/amusement parks.
- Roadway lighting required by governmental authorities.
- Lighting classified for and used in hazardous locations as specified in NFPA 70.
- Lighting for swimming pools and water features.

501.3.7 (5.3.7) Mitigation of Transportation Impacts (Mandatory).

501.3.7.1 (5.3.7.1) Pedestrian and Bicycle Connectivity.

501.3.7.1.1 (5.3.7.1.1) Pedestrian Walkways. Each *primary building entrance* shall be provided with a pedestrian walkway that extends to either a *public way* or a transit stop. Walkways shall not be less than 5 ft (1.5 m) in width and shall be clearly delineated.

A public-use walkway shall be provided along the length of the adjoining public-way frontage of the *building project site*, and such walkways shall connect to adjacent public-use walkways.

Exception: Walkways extending from *residential buildings* shall not be less than 3 feet (1 m) in width.

501.3.7.1.2 (5.3.7.1.2) Bicycle Paths. On-site bicycle paths shall be designed to connect bicycle parking areas to existing and planned off-site bicycle paths adjacent to the *building project*.

501.3.7.2 (5.3.7.2) Bicycle Parking.

501.3.7.2.1 (5.3.7.2.1) Minimum Number of Spaces. Bicycle parking *spaces* shall be provided for at least 5% of the *occupant load* of each building but not less than two parking *spaces*. Occupants who are nonambulatory, under restraint, or under custodial care need not be included in the total *occupant load* for the building. *Building projects* with *dwelling units* shall be provided with at least 0.5 bicycle parking *spaces* per bedroom for each building but not less than two parking *spaces*.

Exceptions:

- Building projects* with *dwelling units* that provide each unit with a private garage or private, locked storage *space* of sufficient size to store a bicycle.

2. The number of bicycle parking *spaces* shall be allowed to be reduced subject to *AHJ* approval of a transportation plan, prepared by a *design professional*, that demonstrates the likelihood that building occupants will use public transportation and/or walk to the *building project site*.

501.3.7.2.2 (5.3.7.2.2) Location. Not fewer than two bicycle parking *spaces* shall be located within 50 ft (15.2 m) of, and be visible from, the *building entrance* being served. All other bicycle parking *spaces* shall be located inside the building, or the nearest point of the bicycle parking areas shall be within 50 ft (15.2 m) of the *building entrance* being served. Bicycle parking shall not obstruct pedestrian access to the building.

501.3.7.2.3 (5.3.7.2.3) Horizontal Parking Racks. Horizontal bicycle parking racks shall provide a *space* for each bicycle that is not less than 18 in. (305 mm) in width and not less than 72 in. (1829 mm) in length. Each *space* shall provide at least two points of contact between the bicycle frame and rack. Each *space* shall have access to a clear exit pathway not less than 36 in. (914 mm) in width.

501.3.7.2.4 (5.3.7.2.4) Ability to Lock. Each bicycle parking *space* shall be provided with a securely mounted rack or other facilities for locking or securing a bicycle. A rack shall allow the locking of the frame and the front or rear wheel of the bicycle to the rack using a U-shaped shackle lock.

501.3.7.2.5 (5.3.7.2.5) Security and Visibility. All bicycle parking *spaces* shall be visible from the entrance being served; secured in a locker, cage, or room; or provided with valet service or security cameras. Signage shall be provided to identify parking that is not visible from the *building entrance*.

501.3.7.2.6 (5.3.7.2.6) Documentation. *Construction documents* shall include plans and details showing compliance with Sections 501.3.7.2.1 (5.3.7.2.1) through 501.3.7.2.5 (5.3.7.2.5).

501.3.7.3 (5.3.7.3) Electric Vehicle Charging Provisions. The building shall be provided with electric charging in accordance with this section and the *National Electrical Code* (NFPA 70). When parking spaces are added or modified without an increase in building size, only the new parking spaces are subject to this requirement.

Exception: Parking spaces for *residential buildings* shall comply with Section 401.3.

501.3.7.3.1 (5.3.7.3.1) Provisions for electric-vehicle charging infrastructure. The *building project* shall be provided with *electric vehicle* charging in accordance with Table 501.3.7.3 (5.3.7.3). Calculations for the number of spaces shall be rounded up to the nearest whole number. All *EVSE Installed*, *EV Ready* and *EV Capable Spaces* are to be included in

the calculation for the number of minimum vehicle spaces required, as provided by the applicable article of the *Denver Zoning Code*.

501.3.8 (5.3.8) Building Site Waste Management (Project Elective).

501.3.8.1 (5.3.8.1) Building Site Waste Management Plan. A building *site* waste management plan shall be developed and implemented for excavated soil, rock, and land-clearing debris. Land-clearing debris is limited to tree limbs, stumps, trunks, logs and vegetation. Diverted land-clearing debris and removed rock and soil shall not be sent to *greenfields* other than those being used for agricultural purposes or being developed as part of a *building project*.

Not less than 90% of the land-clearing debris, excluding *invasive plant* materials, shall be diverted from disposal in landfills and incinerators other than waste-to-energy systems with an energy-recovery efficiency rate higher than 60%. Land-clearing debris calculations shall be based on either weight or volume but not both. Receipts or other documentation related to diversion shall be maintained through the course of construction.

The plan shall address all of the following:

- a. Land-clearing debris, rock, and soil to be diverted from disposal by composting, recycling, or reuse.
- b. Waste materials that will be diverted on-site.
- c. The locations to which waste materials will be diverted off-site.
- d. Soils to be stockpiled for future use at any location.
- e. The destruction and disposal of *invasive plant* materials.
- f. The methods of removal of any contaminated soils.
- g. The treatment of vegetation to comply with the rules of government-designated quarantine zones for invasive insect species.

501.3.9 (5.3.9) Soil Amendment (Project Elective). Soil amendment shall be applied to all permeable areas of the *site*, prior to the installation of plant material, including sod, and incorporated or rototilled to a depth of 4 to 6 inches.

All permeable areas shall apply a minimum of 4 cubic yards per 1,000 square feet of permeable areas.

A minimum application rate of 12 cubic yards per 1,000 square feet is required for amended topsoil.

Exceptions:

1. Native grass seeded areas with an application rate of 2 cubic yards per 1,000 square feet of seeded area. The site must be raked smooth and finish grades must be established. Rock and debris over

1-inch in diameter that interfere with planting and maintenance operations must be removed from the site.

2. Green roof plant medium and engineered storm-water quality structures where a geotechnical engineer provides recommendations on soil conditions.

**TABLE 501.3.7.3 (TABLE 5.3.7.3)
NUMBER OF EV SPACES REQUIRED**

TOTAL NUMBER OF PARKING SPACES PROVIDED	NUMBER OF DC FAST CHARGING SPACES	NUMBER OF EV READY SPACES	NUMBER OF EV CAPABLE SPACES	NUMBER OF EVSE INSTALLED SPACES
1 Space	None	1	None	None
2 to 9 Spaces	None	1	1	None
10 to 200 Spaces	None	10% of spaces	10% of spaces	15% of spaces
200 or more Spaces	1	20% of spaces	10% of spaces	15% of spaces

CHAPTER 6

WATER USE EFFICIENCY

601.1 (6.1) Scope. This section specifies requirements for *potable water* and *nonpotable water* use efficiency, both for the *site* and for the building, and water monitoring.

601.2 (6.2) Compliance. *Building projects* shall comply with Section 601.3 (6.3) in accordance with Section 101.4.1.

601.3 (6.3) Mandatory and Elective Provisions.

601.3.1 (6.3.1) Site Water Use Reduction (Mandatory).

The building *site* shall comply with Sections 601.3.1.1 and 601.3.1.2.

Exception: Provide a landscape site plan that is at 10 gallons per square foot or less water budget of potable water used per year. Alternative sources of water may be substituted to increase yearly water supply. Alternative sources shall be calculated in conjunction and approved by Denver Water and Denver Public Works. Site plans and water budgets require the following:

- a. Irrigation zones shall be based on *hydrozones* that are determined by high, medium or low water use.
- b. Irrigation type including spray heads, rotors or drip, and micro spray.
- c. Nonpotable water source contribution by zone.
- d. Monthly irrigation run times by zone, post *landscape establishment period*. Irrigation run times by zones to be posted next to the irrigation controller.
- e. Monthly maintenance calendar based on plant type. Monthly maintenance calendar to be posted next to the irrigation controller.

601.3.1.1 (6.3.1.1) Landscape Design. A minimum of 60% of the area of the *improved landscape* shall be in *biodiverse plantings* of the following approved plants:

- a. Qualified trees from the Office of the City Forester approved street tree list for Denver's public rights-of-way.
- b. Drought-tolerant groundcover, shrubs, and Xeric Grasses included in one of the following resources:
 1. "Plant Select" qualified plants.
 2. "Low-Water Native Plants for Colorado Gardens" as published by the Colorado Native Plant Society.
 3. Xeric grasses that appear in the most recent version of the *Urban Storm Drainage Criteria Manual* as published by Urban Drainage and Flood Control District.

Exceptions:

1. The area of dedicated athletic fields, golf courses, driving ranges, and areas dedicated for production of food for human consump-

tion, shall be excluded from the calculation of the *improved landscape* for schools, *residential* common areas, or public recreational facilities.

2. Landscape areas irrigated solely with *alternate on-site sources of water* shall be exempt from these requirements.

601.3.1.2 (6.3.1.2) Irrigation. Not greater than one-third of *improved landscape* area shall be irrigated with *potable water*. All other irrigation shall be provided from *alternate on-site sources of water* or municipally reclaimed water.

Exceptions:

1. For golf courses and driving ranges within 0.25 miles (402.3 m) of Denver Water's recycled water system, only municipally reclaimed water or *alternate on-site sources of water* shall be used to irrigate the landscape.
2. The area of dedicated athletic fields shall be excluded from the calculation of the *improved landscape* for schools, *residential* common areas and public recreational facilities.
3. *Potable water* is allowed to be temporarily used on such newly installed landscape for the *landscape establishment period*. The amount of *potable water* allowed to be applied to the newly planted areas during the temporary *landscape establishment period* shall not exceed 70% of ET_o for *turfgrass* and 55% of ET_o for other plantings. Where municipally reclaimed water is available at a water main within 0.25 miles (402.3 m) of the project *site*, such water shall be used instead of *potable water* during the *landscape establishment period*. After the *landscape establishment period* has expired, all irrigation water use shall comply with the requirements established elsewhere in this code.

601.3.1.2.1 (6.3.1.2.1) Irrigation System Design.

The design of the irrigation system shall be performed by a Certified Landscape Irrigation Auditor (CLIA), Qualified Water Efficient Landscaper (QWEL) or other accredited or certified irrigation professional and shall be in accordance with the following:

- a. Irrigation systems:
 1. Shall be based on *hydrozones*. *Turfgrass* areas shall be on their own *irrigation zones*.
 2. Shall have a master valve on municipally supplied water sources that allows pressurization of the irrigation mainline only when irrigation is scheduled.

3. Shall have a flow sensor and monitoring equipment that will shut off the control valve if the flow exceeds normal flow from an *irrigation station*.
 4. Shall prevent piping from draining between irrigation events.
- b. Irrigation emission devices shall comply with ASABE/ICC 802, *Landscape Irrigation Sprinkler and Emitter Standard*.
- c. Irrigation sprinklers:
1. Shall not spray water directly on buildings or *hardscape* area.
 2. Shall have matched precipitation rate nozzles within an *irrigation station*.
 3. Shall be prohibited on landscape areas having any dimension less than 4 ft (1220 mm).
 4. Shall have an application rate less than or equal to 0.75 in. (19 mm) per hour on slopes greater than 1 unit vertical in 4 units horizontal.
 5. Shall be limited to use with *turfgrass* or *ground cover* areas with vegetation maintained at 8 in. (203 mm) or less in height.
 6. Where of the pop-up configuration, shall have a pop-up height of not less than 4 in (100 mm).
- d. Microirrigation zones:
1. Shall be equipped with pressure regulators, filters, and flush assemblies.
 2. Shall have indicators that allow confirmation of operation by visual inspection.

601.3.1.2.2 (6.3.1.2.2) Controls. Where any irrigation system for the project *site* uses an *automatic* controller, the system shall be controlled by a qualifying *smart controller* that uses *evapotranspiration (ET)* and weather data to adjust irrigation schedules and that complies with the minimum requirements. The system shall be controlled by weather-based data or soil moisture sensor that automatically shuts off the system after a predetermined amount of rainfall or sensed moisture in the soil. Qualifying *smart controllers* shall be labeled according to USEPA WaterSense Specification for Weather-Based Irrigation Controllers or tested in accordance with Irrigation Association SWAT Climatologically Based Controllers, 8th Testing Protocol. *Smart controllers* that use *ET* data shall provide the following irrigation amounts:

- a. *Irrigation adequacy*—80% minimum *ET_c*.
- b. *Irrigation excess*—not to exceed 10% of *ET_c*.

Exception: A temporary irrigation system used exclusively for the establishment of new

landscape shall be exempt from this requirement. Temporary irrigation systems shall be removed or permanently disabled at such time as the *landscape establishment period* has expired.

601.3.1.2.2.1 (6.3.1.2.2.1). The following settings and schedule for the irrigation control system shall be posted on or adjacent to the controller:

- a. Precipitation rate of each *irrigation station*.
- b. *Plant* factors for each *hydrozone*.
- c. Soil type.
- d. Rain sensor settings.
- e. Soil moisture sensor settings, where installed.
- f. Peak demand schedule, including run times, cycle starts, and soak times.
- g. Maximum runtimes to prevent water runoff.

601.3.1.2.3 (6.3.1.2.3) Use of Potable Water (Project Elective). The use of *potable water* or *reclaimed water* for irrigation of native and *adapted plants* shall be limited to temporary use on newly installed landscape for the *landscape establishment period*. Irrigation should be completed by the end of the third growing season and irrigation system for affected areas should be permanently disconnected and dismantled without unduly damaging plant material or root zone.

Exceptions:

1. Irrigation of *drought-tolerant plants* as specified by Section 601.3.1.1 (6.3.1.1), item ‘b’. Irrigation shall be from one or more of the following systems:
 - a. On-site reclaimed water treatment systems complying with Section 601.3.7.
 - b. Above-ground irrigation systems
2. Irrigation of plants that are used on green roofs and other similar applications.

601.3.2 (6.3.2) Building Water Use Reduction (Mandatory).

601.3.2.1 (6.3.2.1) Plumbing Fixtures and Fittings. Plumbing fixtures (water closets and urinals) and fittings (faucets and showerheads) shall comply with the following requirements, as shown in Table 601.3.2.1 (6.3.2.1):

- a. **Water closets (toilets)—flushometer valve type.** For single-flush, maximum flush volume shall be determined in accordance with ASME A112.19.2/CSA B45.1 and shall not exceed 1.1 gal. For dual-flush, the full-flush volume shall not exceed 1.1 gal per flush. Dual-flush fixtures shall also comply with the provisions of ASME A112.19.14.

- b. **Water closets (toilets)—tank-type.** Tank-type water closets shall be certified to the performance criteria of the USEPA WaterSense Tank-Type High-Efficiency Toilet Specification and shall have a maximum full-flush volume of 1.1 gal. Dual-flush fixtures shall also comply with the provisions of ASME A112.19.14.
- c. **Urinals.** Maximum flush volume, when determined in accordance with ASME A112.19.2/CSA B45.1, shall not exceed 0.125 gal. Flushing urinals shall comply with the performance criteria of the USEPA WaterSense Specification for Flushing Urinals. Nonwater urinals shall comply with ASME A112.19.19 (vitreous china) or IAPMO Z124.9 (plastic) as appropriate.
- d. **Public lavatory faucets.** Maximum flow rate shall not exceed 0.25 gpm when tested in accordance with ASME A112.18.1/CSA B125.1.
- e. **Public metering self-closing faucet.** Maximum water use shall not exceed 0.25 gal (1.0 L) per metering cycle when tested in accordance with ASME A112.18.1/CSA B125.1.
- f. **Residential bathroom lavatory sink faucets.** Maximum flow rate shall not exceed 1.2 gpm when tested in accordance with ASME A112.18.1/CSA B125.1. *Residential* bathroom lavatory sink faucets shall comply with the performance criteria of the USEPA WaterSense High-Efficiency Lavatory Faucet Specification.
- g. **Residential kitchen faucets.** Maximum flow rate shall not exceed 1.8 gpm (6.8 L/min) when tested in accordance with ASME A112.18.1/CSA B125.1. Kitchen faucets shall be permitted to temporarily increase the flow greater than 1.8 gpm (6.8 L/min) but shall not exceed 2.2 gpm (8.3 L/min) and must automatically revert to the established maximum flow rate of 1.8 gpm (6.8

L/min) upon physical release of the activation mechanism or closure of the faucet valve.

- h. **Residential showerheads.** Maximum flow rate shall not exceed 1.8 gpm when tested in accordance with ASME A112.18.1/CSA B125.1. *Residential* showerheads shall comply with the performance requirements of the USEPA WaterSense Specification for Showerheads.

- i. **Residential shower compartment (stall) in dwelling units and guest rooms.** The allowable flow rate from all shower outlets (including rain systems, waterfalls, bodysprays, and jets) that can operate simultaneously shall be limited to a total of 1.8 gpm.

Exception: Where the area of a shower compartment exceeds 2600 in.² (1.7 m²), an additional flow of 1.8 gpm shall be permitted for each multiple of 2600 in.² (1.7 m²) of floor area or fraction thereof.

- j. **Water-bottle filling stations.** *Water-bottle filling stations* shall be an integral part of, or shall be installed adjacent to, not less than 50% of all drinking fountains installed indoors on the premises.

601.3.2.2 (6.3.2.2) Appliances.

- a. *Clothes washers* and *dishwashers* installed within *dwelling units* shall comply with the ENERGY STAR[®] Program Requirements for Clothes Washers and ENERGY STAR Program Requirements for Dishwashers. Maximum water use shall be as follows:

- 1. *Clothes washers*—Maximum *water factor (WF)* of 5.4 gal/ft³ of drum capacity (0.72 L/L of drum capacity) with load sensing capability.

**TABLE 601.3.2.1 (TABLE 6.3.2.1)
PLUMBING FIXTURES AND FITTINGS REQUIREMENTS**

PLUMBING FIXTURE	MAXIMUM
Water closets (toilets)—flushometer single-flush valve type	Single-flush volume of 1.1 gal.
Water closets (toilets)—flushometer dual-flush valve type	Full-flush volume of 1.1 gal.
Water closets (toilets)—single-flush tank-type	Single-flush volume of 1.1 gal.
Water closets (toilets)—dual-flush tank-type	Full-flush volume of 1.1 gal.
Urinals	Flush volume 0.125 gal.
Public lavatory faucets	Flow rate—0.5 gpm (1.9 L/min)
Public metering self-closing faucet	0.25 gal (1.0 L) per metering cycle
<i>Residential</i> bathroom lavatory sink faucets	Flow rate—1.2 gpm.
<i>Residential</i> kitchen faucets	Flow rate—1.8 gpm (6.8 L/min) ^a
<i>Residential</i> showerheads	Flow rate—1.8 gpm.
<i>Residential</i> shower compartment (stall) in <i>dwelling units</i> and guest rooms	Flow rate from all shower outlets total of 1.8 gpm.

a. With provision for a temporary override to 2.2 gpm (8.3 L/min) as specified in Section 601.3.2(g) [6.3.2.1(g)].

2. Dishwashers—Standard-size dishwashers shall have a maximum *WF* of 3.5 gal/full operating cycle. Compact sizes shall have a maximum *WF* of 3.5 gal/full operating cycle (13.2 L/full operating cycle). Standard and compact size shall be defined by ENERGY STAR criteria.

[See also the energy efficiency requirements in Section 701.4.7.3 (7.4.7.3).]

- b. Clothes washers installed in publicly accessible spaces (**Informative Note:** e.g., multifamily and hotel common areas), and coin- and card-operated clothes washers of any size used in laundromats, shall have a maximum *WF* of 4.0 gal/ft³ of drum capacity normal cycle (0.53 L/L of drum capacity normal cycle). [See also the energy efficiency requirements in Sections 701.4.7.3 (7.4.7.3).]
- c. Commercial dishwashers in commercial food-service facilities shall meet all ENERGY STAR requirements as listed in the ENERGY STAR Program Requirements for Commercial Dishwashers, Version 2.0.

601.3.2.3 (6.3.2.3) HVAC Systems and Equipment.

- a. *Once-through cooling with potable water* is prohibited.
- b. The water being discharged from cooling towers for air-conditioning systems such as chilled-water systems shall be limited in accordance with method (1) or (2):
 - 1. For makeup waters having less than 200 ppm (200 mg/L) of total hardness expressed as calcium carbonate, by achieving a minimum of 5 *cycles of concentration*.
 - 2. For makeup waters with more than 200 ppm (200 mg/L) of total hardness expressed as calcium carbonate, by achieving a minimum of 3.5 *cycles of concentration*.

Exception: Where the total dissolved solids concentration of the discharge water exceeds 1500 mg (1500 ppm/L) or the silica exceeds 150 ppm (150 mg/L) measured as silicon dioxide before the above *cycles of concentration* are reached.

- c. Cooling towers and evaporative coolers shall be equipped with makeup and blowdown meters, conductivity controllers, and overflow alarms in accordance with the thresholds listed in Table 601.3.4.1B (6.3.4.1B). Cooling towers shall be equipped with efficient drift eliminators that achieve drift reduction to a maximum of 0.002% of the recirculated water volume for counterflow towers and 0.005% of the recirculated water flow for cross-flow towers.

601.3.2.4 (6.3.2.4) Roofs.

- a. The use of *potable water or reclaimed water* for roof spray systems to thermally condition the roof shall be prohibited.
- b. In-ground irrigation systems on vegetated roofs using potable or off-site treated *reclaimed water* shall not exceed 10 gallons per square foot of vegetated roof area per year and shall be either a drip or spray type irrigation system.

601.3.2.5 (6.3.2.5) Commercial Food Service Operations. Commercial food service operations (**Informative Note:** e.g., restaurants, cafeterias, food preparation kitchens, caterers, etc.):

- a. Shall use high-efficiency prerinse spray valves (i.e., valves that function at 1.3 gpm [4.9 L/min] or less and comply with a 26 second performance requirement when tested in accordance with ASTM F2324),
- b. Shall use dishwashers that comply with the requirements of the ENERGY STAR Program for Commercial Dishwashers,
- c. Shall use boilerless/connectionless food steamers that consume no more than 2.0 gal/h (7.5 L/h) in the full operational mode,
- d. Shall use combination ovens that consume not more than 10 gal/h (38 L/h) in the full operational mode,
- e. Shall use air-cooled ice machines that comply with the requirements of the ENERGY STAR Program for Commercial Ice Machines, and
- f. Shall use dipper wells equipped with an in-line flow restrictor limiting flow to 0.3 gpm.

601.3.2.6 (6.3.2.6) Medical and Laboratory Facilities. Medical and laboratory facilities, including clinics, hospitals, medical centers, physician and dental offices, and medical and nonmedical laboratories of all types shall:

- a. Use only water-efficient steam sterilizers equipped with (1) water-tempering devices that allow water to flow only when the discharge of condensate or hot water from the sterilizer exceeds 140°F (60°C) and (2) mechanical vacuum equipment in place of venturi-type vacuum systems for vacuum sterilizers.
- b. Use film processor water-recycling units where large-frame x-ray films of more than 6 in. (150 mm) in either length or width are processed. Small dental x-ray equipment is exempt from this requirement.
- c. Use digital imaging and radiography systems where the digital networks are installed.
- d. Use a dry-hood scrubber system or, if the applicant determines that a wet-hood scrubber system is required, the scrubber shall be equipped with a

water recirculation system. For perchlorate hoods and other applications where a hood wash-down system is required, the hood shall be equipped with self-closing valves on those wash-down systems.

- e. Use only dry vacuum pumps unless fire and safety codes (**Informative Note:** e.g., *International Fire Code*) for explosive, corrosive, or oxidative gases require a liquid ring pump.
- f. Use only efficient water treatment systems that comply with the following criteria:
 - 1. For all filtration processes, pressure gages shall determine and display when to backwash or change cartridges.
 - 2. For all ion exchange and softening processes, recharge cycles shall be set by volume of water treated or based on conductivity or hardness.
 - 3. For reverse osmosis and nanofiltration equipment with capacity greater than 27 gal/h (100 L/h), reject water shall not exceed 60% of the feed water and shall be used as scrubber feed water or for other beneficial uses on the project *site*.
 - 4. Simple distillation is not acceptable as a means of water purification.
- g. With regard to food service operations within medical facilities, comply with Section 601.3.2.5 (6.3.2.5).

601.3.3 (6.3.3) Special Water Features (Mandatory).

Water use shall comply with the following:

- a. Ornamental fountains and other ornamental water features shall be supplied either by *alternate on-site sources of water* or by municipally reclaimed water delivered by the local water utility acceptable to the *AHJ*. Fountains and other features equipped with *automatic* water refilling valves shall be equipped with (1) makeup water meters that are connected to a Building Management System (BMS) if such a system is included in the *building project* (2) leak detection devices that shut off water flow if a leak of more than 1.0 gal/h (3.8 L/h) is detected, and (3) equipment to recirculate, filter, and treat all water for reuse within the system.

Exception: Where *alternate on-site sources of water* or municipally reclaimed water are not available within 500 ft (150 m) of the *building project site*, *potable water* is allowed to be used for water features with less than 10,000 gal (38,000 L) capacity.

- b. Pools and spas:
 - 1. Recover filter backwash water for reuse on landscaping or other applications, or treat and reuse backwash water within the system.
 - 2. For filters with removable cartridges, only reusable cartridges and systems shall be used. For filters with backwash capability, use only pool filter equipment that includes a pressure

drop gage to determine when the filter needs to be backwashed and a sight glass enabling the operator to determine when to stop the backwash cycle.

- 3. Pool splash troughs, if provided, shall drain back into the pool system.

601.3.4 (6.3.4) Water Consumption Measurement (Project Elective).

601.3.4.1 (6.3.4.1) Consumption Management. Measurement devices with remote communication capability shall be provided to collect water consumption data for the domestic water supply to the building and on all water sources used in tenant spaces and any individual water end uses that represents 10% or more the total annual consumption of the tenant space. Both potable and *reclaimed water* entering the *building project* shall be monitored or submetered. In addition, for individual leased, rented, or other tenant or subtenant *space* within any building totaling in excess of 50,000 ft² (5000 m²), separate submeters shall be provided. For subsystems with multiple similar units, such as multicell cooling towers, only one measurement device is required for the subsystem. Any project or building, or tenant or subtenant *space* within a project or building, such as a commercial car wash or aquarium, shall be submetered where consumption is projected to exceed 1000 gal/day (3800 L/day).

Measurement devices with remote capability shall be provided to collect water use data for each water supply source (**Informative Note:** e.g., *potable water*, *reclaimed water*, *rainwater*) to the *building project* that exceeds the thresholds listed in Table 601.3.4.1A (6.3.4.1A). Utility company service entrance/interval meters are allowed to be used.

Provide submetering with remote communication measurement to collect water use data for each of the building subsystems if such subsystems are sized above the threshold levels listed in Table 601.3.4.1B (6.3.4.1B).

601.3.4.2 (6.3.4.2) Consumption Data Collection. All building measurement devices, monitoring systems, and submeters shall be permanently installed and comply with the threshold limits in Section 601.3.4.1 (6.3.4.1) shall be configured to communicate water consumption data to a meter data management system. At a minimum, meters shall provide daily data and shall record hourly consumption of water.

601.3.4.3 (6.3.4.3) Data Storage and Retrieval. The meter data management system shall be connected to a local area network capable of transmitting data to a remote location and of electronically storing water meter, monitoring systems, and submeter data for at least 36 months. The data management system shall be capable of and creating user reports showing calculated hourly, daily, monthly, and annual water consumption for each measurement device and submeter and provide alarm notification capabilities as needed to support the requirements of the water user efficiency plan for operation in Section 1001.3.2.1.2 (10.3.2.1.2).

WATER USE EFFICIENCY

**TABLE 601.3.4.1A (TABLE 6.3.4.1A)
WATER SUPPLY SOURCE MEASUREMENT THRESHOLDS**

WATER SOURCE	MAIN MEASUREMENT THRESHOLD
Potable water	1000 gal/day (3800 L/day)
Municipally <i>reclaimed water</i>	1000 gal/day (3800 L/day)
Alternate sources of water	500 gal/day (1900 L/day)

**TABLE 601.3.4.1B (TABLE 6.3.4.1B)
SUBSYSTEM WATER MEASUREMENT THRESHOLDS**

SUBSYSTEM	SUBMETERING THRESHOLD
Cooling towers (meter on makeup water and blowdown)	Cooling tower flow through tower > 500 gpm (30 L/s)
Evaporative coolers	Makeup water > 0.6 gpm (0.04 L/s)
Steam and hot-water boilers	> 500,000 Btu/h (150 kW) input
Total irrigated landscape area with controllers	> 25,000 ft ² (2500 m ²)
Separate campus or project buildings	Consumption > 1000 gal/day (3800 L/day)
Separately leased or rental <i>space</i>	Consumption > 1000 gal/day (3800 L/day)
Any large water-using process	Consumption > 1000 gal/day (3800 L/day)
Tenant spaces	Consumption > 10% of the total annual consumption of that space

601.3.5 (6.3.5) Reserved.

601.3.6 (6.3.6) Reverse Osmosis Water Treatment Systems (Project Elective). Reverse osmosis systems shall be equipped with an *automatic* shutoff valve that prevents the production of reject water when there is no demand for treated water. Point-of-use reverse osmosis treatment systems for drinking water shall be listed and labeled in accordance with NSF 58.

601.3.7 (6.3.7) On-Site Reclaimed Water Treatment Systems (Project Elective). On-site reclaimed water treatment systems, including grey water reuse treatment systems and waste water treatment systems, shall be used to produce *nonpotable water* for use in water closet and urinal flushing, surface irrigation, and similar applications. On-site reclaimed water treatment systems shall be listed and labeled in accordance with NSF 350.

601.3.8 (6.3.8) Dual Water Supply Plumbing (Project Elective).

601.3.8.1 (6.3.8.1) Where sufficient supply of *reclaimed water* or *alternate on-site sources of water* is within 0.25 miles of Denver Water’s recycle water system, or planned to be available, within five years of completed building construction, the water supply system within the building shall be installed to allow the supply of reclaimed or alternative water to all urinals and water closets pending a final review by Denver Water.

Exceptions:

1. Existing buildings under renovation, where the water supply to the urinals and water closets within the building is to remain intact, shall

not be required to supply *nonpotable water* to urinals and water closets.

2. Urinals and water closets designed to operate without the use of water shall not be required to have alternate or reclaimed water supply to the fixture.

CHAPTER 7

ENERGY EFFICIENCY

701.1 (7.1) Scope. This section specifies requirements for energy efficiency for buildings and appliances, for *on-site renewable energy systems*, and for energy measuring.

701.2 (7.2) Compliance. The energy systems shall comply with Mandatory Section 701.3 (7.3), and one of the following Project Electives:

- a. Section 701.4 (7.4), “Prescriptive Approach”
- b. Section 701.5 (7.5), “Performance Approach”
- c. Section 701.6 (7.6), “Zero Net Energy Approach”
- d. Section 701.7 (7.7), “Passive House Approach”

701.3 (7.3) Mandatory Provisions (Mandatory).

701.3.1 (7.3.1) General. *Building projects* shall be designed to comply with Sections C402.5, C403.2, C403.3 through C403.3.2, C403.4 through C403.4.2.3, C403.5.5, C403.7, C403.8.1 through C403.8.4, C403.10.1 through C403.10.3, C403.11, C403.12, C404, C405, C407 and C408 of the *International Energy Conservation Code (IECC)*.

701.3.1.1 (7.3.1.1) Continuous Air Barrier. Building envelope airtightness shall comply with IECC Section C402.5.1.2.3, with the following modifications and additions:

- 1. The measured air leakage rate of the building envelope shall not exceed 0.25 cfm/ft² under a pressure differential of 0.3 in. of water with this air leakage rate normalized by the sum of the above- and below-grade building envelope areas of the conditioned and semiheated space.
- 2. The exception to Section C402.5.1.2.3 is allowed where the measured air leakage rate exceeds 0.25 cfm/ft² but does not exceed 0.40 cfm/ft².

701.3.2 (7.3.2) 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 4.0 kBtu/ft² for single-story buildings and not less than 7.0 kBtu/ft² multiplied by the *gross roof area* in feet squared (metres squared) for all other buildings in addition to any *on-site renewable* production used to comply with Section C406 of the IECC.

Exceptions:

- 1. *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/ft²·day (4.0 kWh/m²·day), accounting for existing buildings, permanent infrastructure that is not part of the *building project*, topography, or trees.

- 2. *Building projects* that comply with Section 701.4.1.1 (7.4.1.1).

701.3.3 (7.3.3) Energy Consumption Management.

701.3.3.1 (7.3.3.1) 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 (7.3.3.1A). 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 (7.3.3.1A), 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 (7.3.3.1B).

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

**TABLE 701.3.3.1A (TABLE 7.3.3.1A)
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 (TABLE 7.3.3.1B)
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 (7.3.3.2) 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 (7.3.3.3) 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 (7.3.4) Demand Response.** *Building projects* shall contain 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 demand-response (DR) infrastructure capable of receiving DR requests from the utility, electrical system operator, or third-party DR program provider and implementing load adjustments to the HVAC and lighting systems.

701.3.4.1 (7.3.4.1) 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 adjust upward the zone operating cooling set points by a minimum of 3°F (1.7°C).
- > b. The controls shall be programmed to adjust downward the zone operating heating set points by a minimum of 3°F (1.7°C).
- > c. The controls shall be programmed to adjust downward the zone operating cooling set points by a minimum of 2°F (1.1°C).
- > d. The 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 (7.3.4.2) Variable-Speed Equipment.** For HVAC equipment with variable-speed control, the controls shall be programmed to allow adjustment of the maximum speed of the equipment to 90% of design speed during 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 (8.3.1.1), or that would cause adverse building pressurization.

701.3.4.3 (7.3.4.3) Lighting. For *building projects* with interior lighting control systems controlled at a central point, such systems shall be programmed to allow 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 (7.4.6.1.1). 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.
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) [7.4.6.1.1(f)].

701.4 (7.4) Prescriptive Approach (Project Elective).

701.4.1 (7.4.1) General Comprehensive Prescriptive Requirements. When a requirement is provided below, it supersedes the requirement in the *International Energy Conservation Code* (IECC). For all other criteria, the *building project* shall comply with the requirements of the *International Energy Conservation Code* (IECC).

701.4.1.1 (7.4.1.1) 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 4.0 kBtu/ft² multiplied by the horizontal projection of the *gross roof area* in feet squared (metres squared) for single-story buildings, and not less than 7.0 kBtu/ft² multiplied by the horizontal projection of the *gross roof area* in feet squared (metres 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*.

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/m²·day (1.2 kBtu/ft²/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 Green Energy National Standard for Renewable Electricity Products, of at least 7 kWh/ft² (75 kWh/m²) of *conditioned space* each year until the cumulative purchase totals 70 kWh/ft² (750 kWh/m²) of *conditioned space*.

701.4.1.2 (7.4.1.2) Reserved.

701.4.2 (7.4.2) Building Envelope. The *building envelope* shall comply with the requirements in 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 curtain walls, storefront and site-built fenestration products* and *skylights*, each U-factor in IECC Table C402.4 shall be reduced by 10%. For all other *vertical fenestration* and *skylights*, each U-factor in 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 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 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 IECC Table C402.4.
2. The *SHGC* shall not be modified where the *SHGC* requirement is designated as “NR” (no requirement) in IECC Table C402.4
3. *Spaces* that meet the requirements of Section 801.4.1 (8.4.1), 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 (5.3.5.3) of this code includes additional provisions related to *roofs*.

701.4.2.1 (7.4.2.1) Reserved.

701.4.2.2 (7.4.2.2) 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 IECC Tables C402.1.3 and C402.1.4.

701.4.2.3 (7.4.2.3) 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·ft²·°F (6.81 W/m²·K). Opening rate, closing rate, and average cycles per day shall be included in

construction drawings. IECC Table C402.1.3 shall not apply to *high-speed doors* complying with all criteria in this section.

701.4.2.4 (7.4.2.4) Reserved.

701.4.2.5 (7.4.2.5) Vertical Fenestration Area. *Vertical fenestration area* shall comply with IECC Sections C402.4.1 and C402.4.1.1.

701.4.2.6 (7.4.2.6) Reserved.

701.4.2.7 (7.4.2.7) SHGC of Vertical Fenestration. The SHGC of *vertical fenestration* shall comply with Table C402.4 provided the SHGC multipliers in Table 701.4.2.7 (Table 7.4.2.7) are used.

**TABLE 701.4.2.7 (TABLE 7.4.2.7)
SHGC MULTIPLIERS FOR PERMANENT PROJECTIONS**

SHGC MULTIPLIER	
(ALL OTHER ORIENTATIONS)	(NORTH-ORIENTED)
0.80	0.95

701.4.2.8 (7.4.2.8) Building Envelope Trade-Off Option. The *building envelope* component performance alternative of IECC Section C402.1.5 shall not be utilized unless the procedure incorporates the modifications and additions to IECC noted in Section 701.4.2 (7.4.2).

701.4.2.9 (7.4.2.9) 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 701.4.2.7 (7.4.2.7).

$SHGC_C$ = the *SHGC* criteria from Section 701.4.2 (7.4.2).

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 701.4.2.1 (7.4.2.1).

701.4.3 (7.4.3) Heating, Ventilating, and Air Conditioning. The heating, ventilating, and air conditioning shall comply with IECC Sections C301 and C403, with the following modifications and additions.

701.4.3.1 (7.4.3.1) Minimum Equipment Efficiencies. All *building projects* 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 (7.4.7.3.2). Where equipment efficiency is not defined/listed in Normative Appendix B or in Section 701.4.7.3.2 (7.4.7.3.2), 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 IEC 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).
- j. 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 (7.4.3.1.1) Water-Cooled Centrifugal Chiller Packages Efficiency Adjustment.

- a. **For Water-Cooled Centrifugal Units Rated per AHRI Standard 550/590 (I-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_{adj} = 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_{adj} = maximum *NPLV* rating, adjusted for nonstandard conditions.

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

$$B = 0.0015 \times \text{LvgEvap} + 0.934.$$

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

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

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

The FL_{adj} and PLV_{adj} 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°C leaving and 12.00°C entering chilled-fluid temperatures, and with 30.00°C entering and 35.00°C leaving condenser-fluid temperatures, shall have maximum full-load (FL) COP and part-load rating requirements adjusted using the following code:

$$FL_{adj} = FL \times K_{adj}$$

$$PLV_{adj} = IPLV \times K_{adj}$$

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

where:

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

FL_{adj} = 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_{adj} = minimum *NPLV* rating, adjusted for nonstandard conditions.

$$A = 0.00000153181 \times (\text{LIFT})^4 - 0.000202076 \times (\text{LIFT})^3 + 0.0101800 \times (\text{LIFT})^2 - 0.264958 \times \text{LIFT} + 3.93073.$$

$$B = 0.0027 \times \text{LvgEvap} + 0.982.$$

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

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

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

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

- 2.20°C ≤ LvgEvap ≤ 15.60°C.
- LvgCond ≤ 46.00°C.
- 11.00°C ≤ LIFT ≤ 44.00°C.

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

701.4.3.2 (7.4.3.2) Ventilation Controls for Densely Occupied Spaces. The requirements in this section supersede those in 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).

Exceptions:

1. Systems with exhaust air energy recovery complying with Section 701.4.3.7 (7.4.3.7).
2. Systems with a design outdoor airflow less than 750 cfm (375 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 listed in ANSI/ASHRAE Standard 62.1: cells in correctional facilities; day-care 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 CO₂ 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 CO₂ sensors or air-sampling probes leading to a central CO₂ monitoring station shall be provided with at least one sensor or probe for each 10,000 ft² (1000 m²) of floor *space*. Sensors or probes shall be installed between 3 and 6 ft (1 and 2 m) above the floor.
- b. *Outdoor air* CO₂ concentrations shall be determined by one of the following:
 1. *Outdoor air* CO₂ concentrations shall be dynamically measured using one or multiple CO₂ sensors. The CO₂ sensor locations shall be identified on the *construction documents*.
 2. When documented statistical data on the local ambient CO₂ concentrations are available, a fixed value typical of the location where the building is located shall be allowed in lieu of an outdoor sensor.
- c. Occupant CO₂ generation rate assumptions shall be shown in the design documents.

701.4.3.3 (7.4.3.3) 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 (7.4.3.4) Economizers. Systems shall include economizers meeting the requirements in 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 ANSI/ASHRAE/IES Standard 90.1, Section 6.5.3.1

- 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 the exceptions in IECC Section C403.5 shall apply except as modified by the following:

For water-cooled units with a capacity less than 54,000 Btu/h 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.

**TABLE 701.4.3.4 (TABLE 7.4.3.4)
MINIMUM SYSTEM SIZE FOR
WHICH AN ECONOMIZER IS REQUIRED**

CLIMATE ZONES	COOLING CAPACITY FOR WHICH AN ECONOMIZER IS REQUIRED ^a
5B	≥ 33,000 Btu/h (9.7 kW) ^a

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.

701.4.3.5 (7.4.3.5) Reserved.

701.4.3.6 (7.4.3.6) Fan System Power and Efficiency.

701.4.3.6.1 (7.4.3.6.1) Fan System Power Limitation. Systems shall have fan power limitations 10% below the limitations specified in IECC Table C403.8.1(1). This requirement supersedes the requirement in IECC Section C403.8 and IECC Table C403.8.1(2). All exceptions in IECC Section C403.8.3 shall apply.

701.4.3.6.2 (7.4.3.6.2) Fan Efficiency. The fan efficiency requirements defined in 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 IECC Section C403.8.3 shall apply.

**TABLE 701.4.3.6.2 (TABLE 7.4.3.6.2)
MECHANICAL VENTILATION SYSTEM FAN EFFICACY**

FAN LOCATION	MINIMUM EFFICACY (CFM/WATT)
HRV or ERV	1.2 cfm/watt
In-line fan	3.8 cfm/watt
Bathroom, utility room	6.0 cfm/watt

701.4.3.6.3 (7.4.3.6.3) Low Capacity Fans. The fan efficiency requirements defined in IECC Section C403.8.5 shall be used, except that Table C403.8.5 shall be superseded by the requirements in Table 701.4.3.6.

701.4.3.7 (7.4.3.7) Exhaust Air Energy Recovery. The exhaust air energy recovery shall comply with the requirements defined in 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.

701.4.3.8 (7.4.3.8) Kitchen Exhaust Systems. The requirements in IECC Section C403.7.5 shall apply, except as follows:

701.4.3.8.1 (7.4.3.8.1) 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 (7.4.3.8.1). 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 (7.4.3.8.1) 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 (7.4.3.8.2) Kitchen/dining facilities with a total kitchen hood exhaust airflow rate greater than 2000 cfm (950 L/s) shall comply with at least one of the following:

- a. At least 50% of all replacement air must be *transfer air* that would otherwise be exhausted.
- b. At least 75% of kitchen hood exhaust air shall be controlled by demand ventilation system, which shall:
 1. Be capable of reducing exhaust and replacement air system airflow rates by no more than the larger of:
 - i. 50% of total design exhaust and replacement air system airflow rate; or
 - ii. 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.
 2. 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;

- 3. Include controls that result in full flow when the demand ventilation systems fail to modulate airflow in response to appliance operation; and
 - 4. 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. 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 (7.4.3.9) 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 IECC Section C403.11.1.

701.4.3.10 (7.4.3.10) 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.

701.4.3.10.1 (7.4.3.10.1) 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 (7.4.3.10.2) 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 (7.4.3.10.3) 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 (3°C) from the occupant set

point in the cooling mode and automatically lowered by at least 5°F (3°C) 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 (27°C) or higher in the cooling mode and to 60°F (16°C) 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 (7.4.3.10.4) 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.

701.4.3.10.5 (7.4.3.10.5) Automatic Control. Captive keycard systems shall not be used to comply with Section 701.4.3.10 (7.4.3.10).

701.4.4 (7.4.4) Service Water Heating. The *service water heating* shall comply with IECC Section C404, with the following modifications and additions.

701.4.4.1 (7.4.4.1) Equipment Efficiency. All *building projects* shall comply with the applicable equipment efficiency requirements in Normative Appendix B, Table B101.8 (B-8), and with the applicable ENERGY STAR requirements in Section 701.4.7.3.2 (7.4.7.3.2). These requirements supersede the requirements in IECC Table C404.2.

**TABLE 701.4.3.8.1 (TABLE 7.4.3.8.1)
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 ^a	280	433	350	541	420	650	490	758
Double island (per side)	175	271	210	325	280	433	385	596
Eyebrow	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).

701.4.4.2 (7.4.4.2) Insulation for Spa Pools. Pools heated to more than 90°F (32°C) shall have side and bottom surfaces insulated on the exterior with a minimum insulation value of R-12 (R-2.1).

701.4.4.3 (7.4.4.3) High Output Service Water Heating Systems. These requirements shall supersede the requirements of IECC Section C404.2.1. Where *buildings* have a total service water heating load of 1,000,000 Btu/h or greater, the water heating equipment shall have a minimum rated efficiency of 0.95 Et, 0.95 AFUE, 2.4 UEF or 2.0 COP. **(Alternate version:** These requirements shall supersede the requirements of IECC Section C404.2.1. Where *buildings* have a total service water heating load of 1,000,000 Btu/h or greater provided by gas-fired equipment, the combined input-capacity-weighted-average thermal efficiency, Et, of all such equipment shall be not less than 95 percent.)

701.4.5 (7.4.5) Reserved.

701.4.6 (7.4.6) Lighting. The lighting shall comply with IECC Sections C405.2 through C405.4, with the following modifications and additions.

701.4.6.1 (7.4.6.1) Lighting Power Allowance

701.4.6.1.1 (7.4.6.1.1) Interior Lighting Power Densities (LPDs). The total connected interior lighting power calculated in accordance with Section C405.3.1 shall be less than 70 percent of the total lighting power allowance calculated in accordance with Section C405.3.2.

701.4.6.1.2 (7.4.6.1.2) Exterior LPDs. The exterior *lighting power allowance* shall be determined using IECC Section C405.4.1, with the following modification. The LPDs from IECC Table C405.4.2(2) shall be multiplied by the appropriate LPD factor from Table 701.4.6.1.2 (7.4.6.1.2).

701.4.6.1.3 (7.4.6.1.3) Horticulture Lighting. Not less than 95 percent of the permanently installed luminaires used for plant growth and maintenance shall have a photon efficiency of not less than 1.6 μmol/J rated in accordance with ANSI/ASABE S640.

701.4.6.2 (7.4.6.2) 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/ft² (8.6 W/m²) or less.

701.4.6.3 (7.4.6.3) 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/ft² (1 W/m²). 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 (7.4.6.4) Controls for 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 (7.4.6.4.1) or 701.4.6.4.2 (7.4.6.4.2).

Exceptions:

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

701.4.6.4.1 (7.4.6.4.1) 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 (7.4.6.4.2) 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*.

**TABLE 701.4.6.1.2 (TABLE 7.4.6.1.2)
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

701.4.6.5 (7.4.6.5) Parking and Outdoor Sales Lighting. This section supersedes IECC Section C405.4.2 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 *day-light 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 (7.3 m) 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 (7.4.7) Other Equipment. The other equipment shall comply with IECC Sections C405.5 through C405.9, with the following modifications and additions.

701.4.7.1 (7.4.7.1) Equipment Efficiency. All *building projects* 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 (7.4.7.3.2).

701.4.7.2 (7.4.7.2) Supermarket Heat Recovery. Supermarkets with a floor area of 25,000 ft² (2500 m²) 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 (3°C) and shall not impair other head pressure control/energy reduction strategies.

701.4.7.3 (7.4.7.3) ENERGY STAR Equipment. All *building projects* shall comply with the requirements in Section 701.4.7.3.1 (7.4.7.3.1) and Section 701.4.7.3.2 (7.4.7.3.2).

701.4.7.3.1 (7.4.7.3.1) 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 (6.3.2.5)].
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 (6.3.2.5)].

701.4.7.3.2 (7.4.7.3.2) ENERGY STAR Requirements for Equipment Covered by Federal Appliance Efficiency Regulations. All *building projects* 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 (6.3.2.2)].
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 (6.3.2.2)].
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 (7.4.1)].
2. *Residential* boilers: ENERGY STAR Program Requirements for Boilers [see also the energy efficiency requirements in Section 701.4.1 (7.4.1)].
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 (7.4.1)].
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 Sin-

gle-Voltage AC-DC and AC-AC Power Supplies.

3. Vending machines: ENERGY STAR Program Requirements for Refrigerated Beverage Vending Machines.

701.4.7.4 (7.4.7.4) 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 (7.4.7.5) Refrigerated Display Cases. All open refrigerated display cases shall be covered by using field-installed strips, curtains, or doors.

701.4.7.6 (7.4.7.6) Electric Vehicle Charging. The requirements of IECC Section C405.10 shall be superseded by Section 501.3.7.3.

701.4.8 (7.4.8) Energy Cost Budget. The Energy Cost Budget option in ANSI/ASHRAE/IES Standard 90.1, Section 11, shall not be used.

701.5 (7.5) Performance Approach (Project Elective). IECC Section C401.2, option 3 shall not be used. *Buildings* shall comply with IECC Section C401.2, option 1(c) with the following modifications.

701.5.1 (7.5.1) Annual Energy Cost. The Energy Cost Budget option IECC Section C401.2, option 1(c)(1) shall not be used.

701.5.2 (7.5.2) Annual Source Energy. For *buildings* that comply with IECC Section C401.2, option 1(c)(2), the Source Energy Index Target (SEIt) shall be calculated in accordance with the following:

$$SEIt = 0.77 \times [BBUSE + (BPF \times BBRSE)] / BBP$$

701.6 (7.6) Zero Net Energy Approach (Project Elective). Achieve and document Zero Net Energy performance where, on an annual basis, the energy consumed on site by the *building project* is less than the energy produced by an *on-site renewable energy system* in accordance with this section. Only all-electric buildings are eligible for this approach.

701.6.1 (7.6.1) Design. Prior to issuance of the *building permit*, submit documentation that the design is capable of achieving zero net energy performance as defined by this option.

701.6.2 (7.6.2) Documentation. Within 24 months of the issuance of the certificate of occupancy, provide documentation of a continuous 12-month period where the energy consumed on site by the *building project* is less than the energy produced by an *on-site renewable energy system*.

701.6.2.1 Occupancy. Documentation shall include the percentage of occupancy. Where the building has less than 100% occupancy during the compliance period, onsite renewable energy consumption shall be prorated by actual occupancy during the compliance period for the purposes of determining occupancy.

701.7 (7.7) Passive House Approach (Project Elective). *Buildings* shall achieve Passive House certification in accordance with Section 701.6.1 or 701.6.2

701.7.1 (7.6.1) Passive House Institute US (PHIUS) Certification. Achieve certification with the PHIUS+ 2018 Passive Building Standard and provide documentation in accordance with Section 701.6.2.1.

701.7.1.1 (7.6.1.1) Documentation. Provide documentation to the *building official* demonstrating the following.

1. Prior to the issuance of a building permit, documentation of a PHIUS+ 2018 Certification Contract from PHIUS and a list of compliance features.
2. Prior to the issuance of a certificate of occupancy, copy of the final report submitted on a form that is approved by PHIUS to document compliance with the PHIUS+ 2018 Standard

701.7.2 (7.7.2) Passive House Institute (PHI) Certification. Achieve certification with the PHI Passive House Standard provide documentation in accordance with Section 701.6.2.1.

701.7.2.1 (7.7.2.1) Documentation. Provide documentation to the *building official* demonstrating the following.

1. Prior to the issuance of a building permit, signed documentation from a PHI accredited Passive House Certifier of intent to certify building and a list of compliance features.
2. Prior to the issuance of a certificate of occupancy, a copy of the final report submitted on a form that is approved by PHI to document compliance with the Passive House Standard.

CHAPTER 8

INDOOR ENVIRONMENTAL QUALITY (IEQ)

801.1 (8.1) 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 (8.2) Compliance. *Building projects* shall comply with Section 801.3 (8.3) in accordance with Section 101.4.1

801.3 (8.3) Mandatory and Elective Provisions

801.3.1 (8.3.1) Indoor Air Quality (Mandatory). 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 (8.3.1.1) through 801.3.1.6 (8.3.1.6) supersede such requirements in the *International Mechanical Code*.

801.3.1.1 (8.3.1.1) Minimum Ventilation Rates (Mandatory). 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, the *International Mechanical Code* shall be used to determine minimum zone and intake outdoor airflow rates.

801.3.1.2 (8.3.1.2) Outdoor Air Delivery Monitoring (Mandatory).

801.3.1.2.1 (8.3.1.2.1) 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 (8.3.1.2.2).

801.3.1.2.2 (8.3.1.2.2) 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 (8.3.1.3) Filtration and Air Cleaner Requirements (Project Elective).

- 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 (PM10).** 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 (PM2.5).** 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 (8.3.1.3), 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 (8.3.1.4) Building Pressure (Project Elective). The requirements in Section 801.3.1.4 (8.3.1.4) 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 (8.3.1.4.1) Mechanical Exhaust. Mechanical systems shall include controls capable of disabling exhaust fans and closing exhaust dampers whenever mechanical intake airflow is discontinued.

Exception: Buildings requiring smoke control in accordance with IFC Section 909 as amended by the City of Denver.

801.3.1.5 (8.3.1.5) Reserved.

801.3.1.6 (8.3.1.6) Humidity Control (Project Elective). 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 Section 801.3.1.4.1 (8.3.1.4.1), 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 (8.3.1.6.1) Reserved.

801.3.1.6.2 (8.3.1.6.2) 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.

801.3.1.7 (8.3.1.7) Reserved.

801.3.1.8 (8.3.1.8) Building Entrances (Project Elective). All *building entrances* shall employ a permanent entryway system at least 10 feet long in the primary direction of travel at regularly used exterior entrances. The entryway system shall be a permanently installed grate, grille, slotted system that allows for cleaning underneath, rollout mat, or any other material manufactured as an entryway system with equivalent or better performance.

801.3.2 (8.3.2) Thermal Environmental Conditions for Human Occupancy (Mandatory). 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 (8.3.3) Acoustical Control (Mandatory). 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.

801.3.3.1 (8.3.3.1) 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 noncom-

pliance 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.

801.3.4 (8.3.4) Soil-Gas Control (Mandatory). Soil-gas entry into *enclosed spaces* that are immediately above crawlspaces, slabs-on-grade, and basement slabs shall be controlled in accordance with the *International Building Code* and Sections 801.3.4.1 (8.3.4.1) or 801.3.4.2 (8.3.4.2).

Exceptions:

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

801.3.4.1 (8.3.4.1) Soil-Gas Control Systems.

801.3.4.1.1 (8.3.4.1.1) Soil-Gas Barriers. Soil-gas retarder systems shall be provided and shall comply with all of the following:

- a. 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 (8.3.4.1.2). 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.
- b. 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.
- c. 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.
- d. 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.

e. Hollow masonry unit *walls* shall be designed and constructed as follows:

1. The first course of masonry units bearing on a footing shall be laid with a full mortar bedding and shall be solid units or fully grouted masonry units.
2. 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.

801.3.4.1.2 (8.3.4.1.2) 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, geotextile 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 (8.3.4.1.3). The gas-permeable layer and soil-gas conveyance pipe shall comply with Table 801.3.4.1.2 (8.3.4.1.2) 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. (0.1 m) 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 (8.3.4.1.2).
- b. **Small Stone, Sand, and Soil.** The gas-permeable layer shall be a uniform layer not less than 4 in. (0.10 m) in depth that consists of any of the following:

1. Small stone aggregates classified in ASTM C33 as size numbers 467, 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 (6 m) apart and not farther than 10 ft

(3 m) away from foundation *walls* or other surfaces that surround the gas-permeable layer. Perforated pipe shall be surrounded by not less than 4 in. (0.10 m) 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 (8.3.4.1.2).

- c. **Crawlspace Membranes.** Perforated pipe or equivalent material not less than 10 ft (3 m) in length and 3 in. (0.08 m) in nominal diameter shall be provided under the membrane. The configuration shall allow air movement under the entire area of the membrane.

**TABLE 801.3.4.1.2 (TABLE 8.3.4.1.2)
SOIL-GAS CONVEYANCE COMPONENTS**

SYSTEM VENT PIPE NOMINAL DIAMETER	MINIMUM DIAMETER OF PITS ^a	MINIMUM LENGTH OF PERFORATED PIPE OR GEOTEXTILE MATTING ^b
3 in. (0.08 m)	12 in. (0.30 m) diameter pit	18 ft (5.4 m)
4 in. (0.10 m)	16 in. (0.40 m) diameter pit	32 ft (10 m)
6 in. (0.15 m)	24 in. (0.60 m) diameter pit	71 ft (22 m)

- a. Pits shall not be less than 4 in. (0.10 m) in depth.
- b. Openings in perforated pipe and geotextile matting shall not be less than 1.0 in.²/ft (21 cm²/m) of pipe or matting length.

801.3.4.1.2.1 (8.3.4.1.2.1) Soil-Gas Conveyance Clearance and Dimension. Geotextile mats and perforated pipe shall not be less than 12 in. (0.3 m) and not farther than 10 ft (3 m) 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.²/ft (21 cm²/m) of length. The airway path within geotextile mats and perforated pipe shall not be less than the nominal equivalent area of 3 in. (0.08 cm) pipe inner diameter. Pipe materials below slabs and membranes shall be configured to drain collected water within piping.

801.3.4.1.2.2 (8.3.4.1.2.2) Connections to Exhaust Vent Pipes. Exhaust vent piping, as specified in Section 801.3.4.1.3 (8.3.4.1.3), 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.

801.3.4.1.3 (8.3.4.1.3) 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 (8.3.4.1.3).
- 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. (1.2 m) and a diameter of not less than 21 in. (0.53 m) 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 (1.8 m) 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 (8.3.4.1.3).

Exception: Where inspections verify compliance with Sections 801.3.4.1.1 (8.3.4.1.1) through 801.3.4.1.3 (8.3.4.1.3), the maximum vented area per vent pipe indicated in Table 801.3.4.1 (8.3.4.1) 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 (TABLE 8.3.4.1.3)
VENT PIPE DIAMETER PER VENTED AREA**

VENT PIPE DIAMETER	MAXIMUM VENTED AREA PER VENT PIPE
3 in. (0.08 m)	2500 ft ² (230 m ²)
4 in. (0.10 m)	4500 ft ² (420 m ²)
6 in. (0.15 m)	10,000 ft ² (1000 m ²)

801.3.4.2 (8.3.4.2) 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 (8.3.5) Lighting Quality (Mandatory). The interior lighting and lighting controls shall be installed to meet the requirements of Sections 801.3.5.1 (8.3.5.1) and 801.3.5.2 (8.3.5.2). Lamps for other than decorative lighting shall have a CRI no less than 80 and a minimum rated life of 24,000.

801.3.5.1 (8.3.5.1) Enclosed Office Spaces. Lighting for at least 90% of enclosed office *spaces* with less than 250 ft² (23.3 m²) 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 (8.3.5.2) 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 (8.3.6) Moisture Control (Project Elective). 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 (8.3.6.1) and 801.3.6.2 (8.3.6.2), shall be performed on above-grade portions of the *building envelope* and on interior partitions as described in Section 801.3.6.2 (8.3.6.2). 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 (8.3.6.1) 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 (8.3.6.2) Humid Spaces. A separate analysis shall be performed in *spaces* where process or occu-

pancy 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, spaces for indoor horticulture and exhibit areas in museums.

801.3.6.2.1 (8.3.6.2.1) For exterior *building envelope* components of humid *spaces*, the analysis shall use the *outdoor air* temperature conditions described in Section 801.3.6.1 (8.3.6.1).

801.3.6.2.2 (8.3.6.2.2) 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 (8.3.6.3) Reserved.

801.3.7 (8.3.7) Glare Control (Project Elective). *View fenestration* for the *spaces* listed in Table 801.4.1.2A (8.4.1.2A) 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 (1000 lux) of direct sunlight illumination for more than 250 hours per year for less than 3% of the floor area.

801.3.8 (8.3.8) Automatic Glare Control (Project Elective). Glare control provided to comply with Section 801.3.7 shall be *automatic*. Occupants shall have the capability to temporarily override *automatic* methods of glare control for periods not exceeding two hours.

801.3.9 (8.4.2) Materials (Mandatory). 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.

801.3.9.1 (8.4.2.1) 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 801.3.9.1.1 (8.4.2.1.1) or 801.3.9.1.2 (8.4.2.1.2).

801.3.9.1.1 (8.4.2.1.1) 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.

801.3.9.1.2 (8.4.2.1.2) 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 (4.5°C).

801.3.9.2 (8.4.2.2) 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 top-coats, 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, undercoaters, 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 801.3.9.2.1 (8.4.2.2.1) or 801.3.9.2.2 (8.4.2.2.2).

801.3.9.2.1 (8.4.2.2.1) 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/IEC 17065 and have the relevant certification program in the scope of accreditation.

801.3.9.2.2 (8.4.2.2.2) 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 coatings, 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.

801.3.9.3 (8.4.2.3) 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/IEC 17065 and have the relevant certification program in the scope of accreditation.

801.3.9.3.1 (8.4.2.3.1) Deemed to Comply. Floor covering materials that are composed of materials listed in Table 801.3.9.3.1 (8.4.2.3.1) shall be deemed to comply with the requirements of Section 801.3.9.3 (8.4.2.3). 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 801.3.9 (8.4.2).

**TABLE 801.3.9.3.1 (TABLE 8.4.2.3.1)
FLOOR COVERING DEEMED TO COMPLY
WITH VOC EMISSION LIMITS**

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

801.3.9.4 (8.4.2.4) 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.

801.3.10 Daylighting (Mandatory). Daylighting shall be provided and shall comply with one of the following Sections:

- a. Section 801.4, “Prescriptive Requirements”
- b. Section 801.5, “Performance Requirements”

801.4 (8.4) Prescriptive Requirements.

801.4.1 (8.4.1) Daylighting.

801.4.1.1 (8.4.1.1) 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 (8.4.1.1.1, 8.4.1.1.2 and 8.4.1.1.3):

- a. The *space* is in a building with three stories or fewer above grade.
- b. The *space* area is greater than 2500 ft² (232 m²).
- c. The *space* is located directly under a *roof* and average ceiling heights are greater than 15 ft (4.6 m).

Exceptions:

- 1. Auditoria, motion picture theaters, performing arts theaters, museums, places of worship, and refrigerated warehouses.
- 2. *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 (8.4.1.1.1) Minimum Daylight Area.

Not less than 50% of the floor area shall be in the *daylight area* as defined in Chapter 3 (Section 3). For the purposes of Section 801.4.1.1.1 (8.4.1.1.1), 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*, under tubular daylight devices, 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 *sidelighting effective aperture* of not less than 0.15.
- e. *Secondary sidelighted areas* shall have a *sidelighting effective aperture* of not less than 0.30.
- f. The combined area of tubular daylight devices within the *space* shall be not less than 0.5% nor more than 2.0% of the calculated daylight area under tubular daylight devices.

801.4.1.1.2 (8.4.1.1.2) 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 (8.4.1.1.1) shall not be less than 0.15 nor higher than 0.65. 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 (8.4.1.1.3) Skylight Optical Diffusion Characteristics.

Skylights used to comply with Section 801.4.1.1.1 (8.4.1.1.1) 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 (8.4.1.2) Minimum Sidelighting Effective Aperture. The *spaces* listed in Table 801.4.1.2A (8.4.1.2A) 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 (8.4.1.2B).
- 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. (1.5 m), 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.

**TABLE 801.4.1.2A (TABLE 8.4.1.2A)
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 (TABLE 8.4.1.2B)
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

801.4.1.3 (8.4.1.3) Shading for Offices. For office *spaces* 80 ft² and larger, each façade shall be designed with a shading *projection factor (PF)*. 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. 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.
- 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 (2.5 m) 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 (7.4.2.5).
5. *Vertical fenestration* with automatically controlled *dynamic glazing* in compliance with Exception (3) of Section 701.4.2.5 (7.4.2.5).
6. Existing buildings undergoing alteration, repair, relocation, or a change in occupancy.

|| **801.4.2 (8.4.2) Reserved.**

801.4.3 (8.4.3) Lighting for Presentations. Luminaires that are located entirely or partially within 3 ft (0.9 m) 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 (0.9 m) horizontally of each *permanently installed* whiteboard, blackboard, or chalkboard that is not self-illuminated.

|| **801.5 (8.5) Performance Requirements.**

801.5.1 (8.5.1) Daylight Simulation. For the *spaces* listed in Table 801.4.1.2A (8.4.1.2A), and any *spaces* required to

have daylighting in accordance with Section 801.4.1.1 (8.4.1.1), 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 (8.5.1.1) and 801.5.1.2 (8.5.1.2) 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 (8.5.1.1) and *annual sunlight exposure (ASE)* calculations in Section 801.5.1.2 (8.5.1.2).

801.5.1.1 (8.5.1.1) 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 (150 lux): health-care patient rooms, post-office sorting areas, gymnasia, 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 (8.5.1.2) Excessive Sunlight. The *ASE*, calculated with a threshold of 93 fc (1000 lux) and 250 hours, shall not exceed 20% of the floor area.

Exceptions:

1. Spaces less than 250 ft² (23 m²).
2. *Vertical fenestration* with automatically controlled shading devices in compliance with Section 701.4.2.5 (7.4.2.5), Exception (2).
3. *Vertical fenestration* with automatically controlled *dynamic glazing* in compliance with Section 701.4.2.5 (7.4.2.5), Exception (3).

801.5.2 (8.5.2) 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

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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 (8.5.3) 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 (300 lux) 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 (50 lux) 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 (150 lux) 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 (9.1) 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 (9.2) Compliance. *Building projects* shall comply with Section 901.3 (9.3) in accordance with Section 101.4.1

901.3 (9.3) Mandatory Provisions.

901.3.1 (9.3.1) Construction Waste Management (Mandatory).

901.3.1.1 (9.3.1.1) Diversion. A minimum of 50% of nonhazardous construction and demolition waste material generated prior to the issuance of the final certificate of occupancy shall be diverted from disposal in landfills and incinerators by reuse, recycling, repurposing, and/or composting. Excavated soil and land-clearing debris shall not be included in the waste diversion calculation. *Alternative daily cover* and waste-to-energy incineration shall not be included as diverted material. All diversion calculations shall be based on either weight or volume, but not both, throughout the construction process.

Informative Note: Reuse includes donation of materials to charitable organizations; salvage of existing materials on-site; reclamation of products by manufacturers; and return of packaging materials to the manufacturer, shipper, or other source for reuse as packaging in future shipments.

901.3.1.2 (9.3.1.2) Reserved.

901.3.1.3 (9.3.1.3) Construction Waste Management Plan. Prior to issuance of a demolition or building permit, a preconstruction waste management plan shall be submitted to the *owner*. The plan shall:

- a. identify the construction and demolition waste materials expected to be diverted,
- b. determine whether construction and demolition waste materials are to be source-separated or commingled,
- c. identify service providers and designate destination facilities for construction and demolition waste materials generated at the job *site*,
- d. identify the average diversion rate for facilities that accept or process commingled construction and demolition materials. Separate average percentages shall be included for those materials collected by construction and demolition materials processing facilities that end up as *alternative daily cover* and incineration,
- e. Signage in English and Spanish, and
- f. Training for all employees on proper disposal of materials.

901.3.1.4 (9.3.1.4) Construction Waste Documentation. The following documentation of disposal shall be provided:

- a. A spreadsheet documenting the weight of each material diverted from the landfill and the overall diversion rate filled out by the waste hauler.
- b. Photos of all dumpsters.

901.3.2 (9.3.2) Reserved.

901.3.3 (9.3.3) Refrigerants (Mandatory). Chlorofluorocarbon (CFC) and hydrochlorofluorocarbons (HCFC) based refrigerants in HVAC&R systems shall not be used. Fire suppression systems shall not contain ozone-depleting substances (CFCs, hydrochlorofluorocarbons [HCFCs], or halons). For existing buildings with HVAC&R systems containing CFCs or HCFCs, a plan shall be submitted to the *building official* for phasing out all CFC and HCFC usage in the building.

901.3.4 (9.3.4) Areas for Storage and Collection of Recyclables and Discarded Goods (Mandatory).

901.3.4.1 (9.3.4.1) 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 (9.3.4.2) Reserved.

901.3.4.3 (9.3.4.3) Reserved.

901.3.4.4 (9.3.4.4) Reserved.

901.3.5 (9.3.5) Mercury Content Levels of Lamps (Mandatory). 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 (9.3.5).

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. (32 mm) 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.
9. LED lamps.

901.3.6 Building Materials (Mandatory). Environmental impact from building materials shall comply with one of the following sections:

- a. Section 901.4, “Prescriptive Requirements”
- b. Section 901.5, “Performance Requirements”

901.4 (9.4) Prescriptive Requirements.

901.4.1 (9.4.1) 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 (9.4.1.1, 9.4.1.2, 9.4.1.3, or 9.4.1.4). 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 (9.4.1.1) 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 (9.4.1.1.1) 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 (9.4.1.1.2) 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 (9.4.1.2) Regional Materials. A minimum of 10% of building materials or products used, based on cost, shall be regionally extracted/harvested/recovered or manufactured within a radius of 600 miles 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 600 miles.

901.4.1.3 (9.4.1.3) Biobased Products. A minimum of 5% of building materials used, based on cost, shall be *biobased products*. *Biobased products* shall:

- a. comply with the minimum biobased contents of the USDA’s BioPreferred Program;
- b. contain the “USDA Certified *Biobased Product*” label; or
- c. 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 (9.4.1.3.1) 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

**TABLE 901.3.5 (TABLE 9.3.5)
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 ^a	3 mg
Straight fluorescent T8 normal lifetime lamps ^a	4 mg
Straight fluorescent T5 and T8 long lifetime lamps ^b	5 mg
T12 eight-foot straight fluorescent lamps	15 mg

a. 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.
 b. 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.

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 (9.4.1.4) 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.

901.4.1.4.1 (9.4.1.4.1) Industry-Wide Declaration. A Type III 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 industry-wide. 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 (9.4.1.4).

901.4.1.4.2 (9.4.1.4.2) 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 (9.4.1.4).

901.4.1.4.3 (9.4.1.4.3) 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 (9.4.1.4).

- 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 (9.4.1.4.4) 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 (9.4.1.4).

901.5 (9.5) Performance Requirements.

901.5.1 (9.5.1) 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 (9.5.1.1) 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 (9.5.1.3): land use, resource use, global warming, ozone layer depletion, human health effects, ecotoxicity, smog, acidification, and eutrophication.

901.5.1.2 (9.5.1.2) 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. Reserved.
- 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.

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901.5.1.3 (9.5.1.3) 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 (10.1) 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 (10.2) Compliance. *Building projects* shall comply with Section 1001.3 in accordance with Section 101.4.1.

1001.3 (10.3) Mandatory and Elective Provisions.

1001.3.1 (10.3.1) Construction.

1001.3.1.1 (10.3.1.1) Building Systems FPT (Mandatory). *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 (10.3.1.1.1) FPT Requirements (Mandatory). 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 (53,000 W) for cooling, 300,000 Btu/h (88,000 W) for heating, or 10,000 cfm (5000 L/s) 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 (15,000 W).
- d. Water pumping and mixing systems over 5 hp (4 kW).
- e. Irrigation systems that use more than 220,000 gal per irrigation season.

1001.3.1.1.1.1 (10.3.1.1.1.1) 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 (10.3.1.1.1), *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 (10.3.1.1.1.2) 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 building *owner* and facility manager.

1001.3.1.1.1.3 (10.3.1.1.1.3) Documentation. The completed project design and *FPT* documentation shall be provided to the *owner* and shall be retained with the project records.

1001.3.1.1.2 (10.3.1.1.2) Acoustical Control (Project Elective).

1001.3.1.1.2.1 (10.3.1.1.2.1) Acoustical Field Measurement. Where required by Chapter 8 (Section 8), the *FPT* specified in Sections 1001.3.1.1.2.1.1 (10.3.1.1.2.1.1) through 1001.3.1.1.2.1.2 (10.3.1.1.2.1.2) shall be completed.

1001.3.1.1.2.1.1 (10.3.1.1.2.1.1) Reserved.

1001.3.1.1.2.1.2 (10.3.1.1.2.1.2) Interior Sound Transmission. The testing of interior sound transmission shall be in accordance with ASTM E336 with respect to noise isolation class (NIC) and ASTM E1007 with respect to impact sound rating (ISR).

1001.3.1.1.2.1.3 (10.3.1.1.2.1.3) Property Line Sound. Testing shall be performed at the locations and times of day or night that are estimated to most likely result in failure and shall be performed with all equipment operating under normal 100% load operation. The testing shall be in accordance with ANSI/ASA S1.13. At the discretion of the *AHJ*, noise that is not created on the source property need not be included in the reported test results.

1001.3.1.2 (10.3.1.2) Building Project Commissioning (Cx) Process (Mandatory). 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 (10.3.1.2.1) Systems to be Commissioned. For buildings that exceed 10,000 ft² (1000 m²) 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) [7.4.6.1.1(f)].
- d. Domestic hot-water systems and controls.
- e. Water pumping and mixing systems over 5 hp (4kW) and purification systems.

- f. Irrigation system performance that uses more than 1000 gal (4000 L) per day.
- g. Renewable energy systems and energy storage systems.
- h. Energy and building management and demand-control systems.

1001.3.1.2.2 (10.3.1.2.2) 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 (10.3.1.2.3) 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 (10.3.1.2.4) 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 (10.3.1.3) Project Cx Documents (Mandatory).

1001.3.1.3.1 (10.3.1.3.1) 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 (10.3.1.3.2) 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 (10.3.1.3.3) 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 (10.3.1.3.4) 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 (10.3.1.3.5) Reserved.

1001.3.1.3.6 (10.3.1.3.6) Documentation. *Owner* shall retain the systems manual and final Cx report.

1001.3.1.4 (10.3.1.4) Erosion and Sedimentation Control (ESC) (Mandatory). Develop and implement an ESC plan for all construction activities. The ESC plan shall conform to the erosion and sedimentation

control requirements of the most current version of the USEPA NPDES General Permit for Stormwater Discharges from Construction Activities, or local erosion and sedimentation control standards and codes, whichever is more stringent, and regardless of size of project.

1001.3.1.5 (10.3.1.5) IAQ Construction Management (Project Elective). 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 postconstruction, preoccupancy building flush-out as described under Section 1001.3.1.5(b)(1) [10.3.1.5(b)(1)], or postconstruction, preoccupancy baseline IAQ monitoring as described under Section 1001.3.1.5(b)(2) [10.3.1.5(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 10-1 shall be supplied while maintaining an internal temperature of a minimum of 60°F (15°C) 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 (8.3.1.3) 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 (8.3.1.1).
- ii. **Continuous postconstruction, preoccupancy/postoccupancy 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 ft² (1.5 L/s per m²) of *outdoor air*, or the outdoor airflow rate deter-

mined in Section 801.3.1.1 (8.3.1.1), 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.

$$\text{TAC} = V_{ot} \times \frac{1}{A} \times \frac{1}{H} \times 60 \text{ min/h} \\ \times 24 \text{ h/day} \times 14 \text{ days (I-P)}$$

$$\text{TAC} = V_{ot} \times \frac{1 \text{ m}^3}{1000\text{L}} \times \frac{1}{A} \times \frac{1}{H} \times 3600 \text{ s/h} \\ \times 24 \text{ h/day} \times 14 \text{ days (SI)}$$

(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, ft² (m²).

H = ceiling height, ft (m).

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 (10.3.1.5) 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 (10.3.1.5) are not exceeded in the larger of the following number of locations: (i) no fewer than one location per 25,000 ft² (2500 m²) or (ii) in each contiguous floor area. For each sampling point where the maximum concentra-

tion 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 (10.3.1.6) Moisture Control (Project Elective). 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*.

1001.3.1.7 (10.3.1.7) Construction Activity Pollution Prevention: Idling of Construction Vehicles (Project Elective). Construction-related vehicles shall not idle on the construction *site* for more than five minutes in any 60-minute period, except where necessary to perform their construction-related function. Signage shall be posted at vehicle entrances to the *building project* providing notice of this requirement.

1001.3.1.8 (10.3.1.8) Construction Activity Pollution Prevention: Protection of Occupied Areas (Project Elective). 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 (11 m) 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.

1001.3.1.9 (10.3.1.9) Soil-Gas Control (Project Elective). The building shall be tested, postconstruction, for radon in accordance with ANSI/AARST MALB. The indoor radon concentration shall be below 2.7 pCi/L (100 Bq/m³). Where radon testing indicates that the indoor radon concentration is 2.7 pCi/L (100 Bq/m³) or greater, radon mitigation shall be conducted in accordance with ANSI/AARST RMS-LB, and the building shall be retested to verify that the radon concentration is below 2.7 pCi/L (100 Bq/m³).

1001.3.1.10 (10.3.1.10) Construction Waste Management (Project Elective).

1001.3.1.10.1 (10.3.1.10.1) Collection. Specific areas on the construction *site* shall be designated for collection of recyclable and reusable materials. Alternatively, off-site storage and sorting of materi-

als shall be permitted. Diversion efforts shall be tracked throughout the construction process.

1001.3.1.10.2 (10.3.1.10.2) Documentation. Prior to issuance of the final certificate of occupancy, a final construction waste management report documenting compliance with Section 901.3.1 (9.3.1) shall be submitted to the *owner* and *AHJ*.

1001.3.2 (10.3.2) Plans for Operation (Project Elective). 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 (10.3.2.1) 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 (10.3.2.1.1) through 1001.3.2.1.4 (10.3.2.1.4).

1001.3.2.1.1 (10.3.2.1.1) Reserved.

1001.3.2.1.2 (10.3.2.1.2) Water Use Efficiency. The plan for operation shall specify water use *verification* activities for *building projects* to track and assess building water consumption. The plan shall describe the procedures needed to comply with the requirements outlined below.

1001.3.2.1.2.1 (10.3.2.1.2.1) Initial M&V. Use the water measurement devices and collection/storage infrastructure specified in Section 601.3.3 (6.3.3) to collect and store water use data for each device, starting no later than after building acceptance testing has been completed and certificate of occupancy has been issued.

1001.3.2.1.2.2 (10.3.2.1.2.2) Track and Assess Water Use. The plan shall specify the procedures for tracking and assessing the *building project* water use and the frequency for benchmark comparisons. The initial assessment shall be completed after 12 months but no later than 18 months after a certificate of occupancy has been issued. Ongoing assessments shall be completed at least every three years. The plan shall include the following:

- a. **Water use reports.** Develop a plan for collecting *building project* water use data for water sources and subsystems measured in Section 601.3.3 (6.3.3).
- b. **Benchmark water performance.** Develop a plan to enter building operating characteristics and water use data into the ENERGY STAR Portfolio Manager. For building parameter inputs into Portfolio Manager (*Informative Note:* e.g., number of occupants, hours of operation, etc.), use actual average values.
- c. **Assess water use performance.** Develop a plan to assess *building project* water use efficiency.

**TABLE 1001.3.1.5 (TABLE 10.3.1.5)
MAXIMUM CONCENTRATION OF
AIR POLLUTANTS RELEVANT TO IAQ**

CONTAMINANT	MAXIMUM CONCENTRATION, µg/m³ (UNLESS OTHERWISE NOTED)
Nonvolatile Organic Compounds	
Carbon monoxide (CO)	9 ppm 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)
Volatile Organic Compounds	
Acetaldehyde	140
Acrylonitrile	5
Benzene	60
1,3-butadiene	20
t-butyl methyl ether (methyl-t-butyl ether)	8000
Carbon disulfide	800
Caprolactam ^a	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 ^a	25
n-Hexane	7000
1-methyl-2-pyrrolidinone ^a	160
Naphthalene	9
Nonanal ^a	13
Octanal ^a	7.2
Phenol	200
4-phenylcyclohexene (4 PCH) ^a	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)	— ^b

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.

1001.3.2.1.2.3 (10.3.2.1.2.3) Documentation of Water Use. All documents associated with the M&V of the building’s water use shall be retained by the *owner* for a minimum of three years.

1001.3.2.1.3 (10.3.2.1.3) Energy Efficiency. The plan for operation shall specify energy performance *verification* activities for *building projects* to track and assess building energy performance. The plan shall describe the procedures needed to comply with the requirements outlined in the following subsections.

1001.3.2.1.3.1 (10.3.2.1.3.1) Initial M&V. Use the energy measurement devices and collection/storage infrastructure specified in Section 701.3.3 (7.3.3) to collect and store energy data for each device, starting no later than after acceptance testing has been completed and certificate of occupancy has been issued.

1001.3.2.1.3.2 (10.3.2.1.3.2) Track and Assess Energy Consumption. The plan for operation shall specify the procedures for tracking and assessing the *building project* energy performance and the frequency for benchmark comparisons. The initial assessment shall be completed after 12 months but no later than 18 months after a certificate of occupancy has been issued. Ongoing assessments shall be completed at least every three years. The plan shall include the following:

- a. **Energy use reports.** Develop a plan for collecting *building project* energy data for energy sources and system energy loads measured in Section 701.3.3 (7.3.3). The reports shall include the following, as a minimum:
 - 1. Hourly load profile for each day;
 - 2. Monthly average daily load profile;
 - 3. Monthly and annual energy use; and
 - 4. Monthly and annual peak demand.
- b. **Track energy performance.** Develop a plan to enter building operating characteristics and energy consumption data into the ENERGY STAR Portfolio Manager for those building types addressed by this program to track building performance. For building parameter inputs into Portfolio Manager (*Informative Note:* e.g., number of occupants, hours of operation, number of PCs, etc.), use actual average values.
- c. **Assess energy performance.** Develop a plan to assess *building project* energy performance.

1001.3.2.1.3.3 (10.3.2.1.3.3) Documentation of Energy Efficiency. All documents associated with the M&V of the building’s energy efficiency shall be retained by *owner*.

1001.3.2.1.4 (10.3.2.1.4) For Buildings Located in Nonattainments Areas for Ozone. For buildings located in nonattainments areas for ozone, as defined by the USEPA, air cleaning equipment, as defined in Section 801.3.1.3(b) [8.3.1.3(b)], shall be operated continuously during occupied hours during the local summer and fall season or when the USEPA Air Quality Index exceeds 100 or equivalent designations by the local authorities for ozone.

Exception: Spaces without mechanical ventilation.

1001.3.2.2 (10.3.2.2) 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 (8.3.1.2) 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 (1000 L/s) 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 (10.3.2.3) Reserved.

1001.3.2.4 Reserved.

|| **1001.3.3 (10.3.2.4) Transportation Management Plan (Mandatory).** A transportation management plan shall be developed compliant with the following requirements. *Owner* shall retain a copy of the transportation management plan.

|| **Exception:** *Residential buildings.*

|| **1001.3.3.1 (10.3.2.4.1) All Building Projects.** The plan shall include the following:

- || a. Preferred parking for carpools and vanpools within parking facilities.
- || b. A plan for bicycle transportation.

|| **1001.3.3.2 (10.3.2.4.2) Owner-Occupied Building Projects.** For *owner*-occupied buildings, the building *owner* shall offer at least one of the following primary benefits to the *owner*'s employees employed on-site:

- || a. Incentivize employees to commute using mass transit, vanpool, carpool, or nonmotorized forms of transportation.
- || b. Initiate a telework or flexible work schedule program that reduces by at least 5% the number of commuting trips by the *owner*'s employees.
- || c. Initiate a ridesharing or carpool matching program, either in-house or through an outside organization.

> In addition, the *owner* shall provide all of the following to the *owner*'s employees employed on-site:

- || a. Access to an *emergency ride home* for employees, either provided in-house or by an outside organization.
- || b. A central point of contact in charge of commuter benefits.
- || c. Maintenance of commuter benefits in a centralized location.
- || d. Active promotion of commuter benefits to employees.

|| **1001.3.3.3 (10.3.2.4.3) Building Tenant.** The building *owner*

- || a. shall provide a copy of the plan to tenants within the building; and
- || b. shall not include parking fees in lease rates, or shall identify the value of parking in the lease.

CHAPTER 11

NORMATIVE REFERENCES

Section numbers indicate where the reference occurs in this document.

AARST

American Association of Radon Scientists and Technologists
475 South Church Street, Suite 600
Hendersonville, NC 28792

ANSI/AARST RMS-LB-2014: Radon Mitigation Standards for Schools and Large Buildings
1001.3.1.9 (10.3.1.9)

ANSI/AARST MALB-2014: Protocols for Measuring Radon and Radon Decay Products in School and Large Buildings
1001.3.1.9 (10.3.1.9)

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

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 (I-P): 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/AHRI 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

ANSI

American National Standards Institute
25 West 43rd 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 Z21.47-2012: Gas-Fired Central Furnaces
Appendix B

ANSI Z83.8-2013: Gas Unit Heaters, Gas Packaged Heaters, Gas Utility Heaters, and Gas-Fired Duct Furnaces
Appendix B

NORMATIVE REFERENCES

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 (10.3.1.1.2)

ANSI/ASA S1.4-2014: Sound Level Meters

1001.3.1.1.2 (10.3.1.1.2)

ANSI/ASA S12.60-2009: Acoustical Performance Criteria, Design Requirements, and Guidelines for Schools, Part 2: Relocatable Classroom Factors

801.3.3 (8.3.3)

ANSI/ASA S12.60-2010: Acoustical Performance Criteria, Design Requirements, and Guidelines for Schools, Part 1: Permanent Schools

801.3.3 (8.3.3)

ANSI/ASA 12.72-2015: Measuring the Ambient Noise Level in a Room

1001.3.1.1.2 (10.3.1.1.2)

ASABE

American Society of Agricultural and Biological Engineers
2950 Niles Road
Saint Joseph, MI 49085

ASABE/ICC 802-2014: Landscape Irrigation Sprinkler and Emitter Standard

601.3.1.2.1 (6.3.1.2.1)

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 (8.3.3)

2014 FGI Guidelines: Residential Health, Care and Support Facilities: Guidelines for Design and Construction of Residential Health, Care, and Support Facilities

801.3.3 (8.3.3)

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 (8.3.1.3)

ANSI/ASHRAE Standard 55-2017: Thermal Environmental Conditions for Human Occupancy

801.3.2 (8.3.2)

ANSI/ASHRAE Standard 62.1-2016: Ventilation for Acceptable Indoor Air Quality

301.2 (3.2), 701.4.3.2 (7.4.3.2), 701.4.3.8 (7.4.3.8), 801.3 (8.3), 1001.3.1.5 (10.3.1.5), 1001.3.2.1.4 (10.3.2.1.4)

ANSI/ASHRAE Standard 62.2-2016: Ventilation and Acceptable Indoor Air Quality in Residential Buildings

801.3.1 (8.3.1), 801.3.1.1 (8.3.1.1)

> **ANSI/ASHRAE/IES Standard 90.1-2016: Energy Standard for Buildings Except Low-Rise Residential Buildings**

> 301.1 (3.1), 301.2 (3.2), 501.3.6 (5.3.6), 701.3.1 (7.3.1), 701.4.1 (7.4.1), 701.4.2 (7.4.2), 701.4.3 (7.4.3), 701.4.4 (7.4.4), 701.4.6 (7.4.6), 701.4.7 (7.4.7), 701.4.8 (7.4.8), 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 (8.3.1.2.2), 1001.3.2.1.4 (10.3.2.1.4)

ANSI/ASHRAE Standard 146-2011: Method of Testing and Rating Pool Heaters

Appendix B

ASHRAE—continued

- ANSI/ASHRAE Standard 154-2011: Ventilation for Commercial Cooking Operations**
701.4.3.8.1 (7.4.3.8.1)
- ANSI/ASHRAE Standard 160-2016: Criteria for Moisture-Control Design Analysis in Buildings**
801.3.6 (8.3.6)
- 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 (8.3.1)
- ANSI/ASHRAE/ACCA Standard 180-2012: Standard Practice for Inspection and Maintenance of Commercial Building HVAC Systems**
301.2 (3.2), 1001.3.2.2 (10.3.2.2)
- ANSI/ASHRAE/IES Standard 202-2013: Commissioning Process for Buildings and Systems**
1001.3.1.2 (10.3.1.2), 1001.3.1.3 (10.3.1.3)

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 (6.3.2.1)
- ASME A112.19.2-2013/CSA B45.1-13: Ceramic Plumbing Fixtures**
601.3.2.1 (6.3.2.1)
- ASME A112.19.14-2013: Six-Liter Water Closets Equipped with a Dual Flushing Device**
601.3.2.1 (6.3.2.1)
- ASME A112.19.19-2006: Vitreous China Nonwater Urinals**
601.3.2.1 (6.3.2.1)

ASTM

ASTM International
100 Barr Harbor Dr.
West Conshohocken, PA 19428-2959

- ASTM C33: Standard Specification for Concrete Aggregates**
801.3.4.1.2 (8.3.4.1.2)
- ASTM C518-15: Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus**
Appendix A
- ASTM C920-14: Standard Specification for Elastomeric Joint Sealants**
801.3.4.1.1 (8.3.4.1.1)
- ASTM C1371-15: Standard Test Method for Determination of Emittance of Materials Near Room Temperature Using Portable Emissometers**
501.3.5.4 (5.3.5.4)
- ASTM C1549-09(2014): Standard Test Method for Determination of Solar Reflectance Near Ambient Temperature Using a Portable Solar Reflectometer**
501.3.5.4 (5.3.5.4)
- ASTM D1003-13: Standard Test Method for Haze and Luminous Transmittance of Transparent Plastics**
301.2 (3.2), 801.4 (8.4), 801.4.1.1.3 (8.4.1.1.3), 801.4.1.3 (8.4.1.3)
- ASTM D1785-15: Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120**
801.3.4.1.3 (8.3.4.1.3)
- ASTM D5197-09e1: Standard Test Method for Determination of Formaldehyde and Other Carbonyl Compounds in Air (Active Sampler Methodology)**
801.3.9 (8.4.2), 1001.3.1.5 (10.3.1.5)

NORMATIVE REFERENCES

ASTM—continued

- ASTM E336-14: Standard Test Method for Measurement of Airborne Sound Attenuation Between Rooms in Buildings
1001.3.1.1.5.1.2 (10.3.1.1.5.1.2)
- ASTM E408-13: Standard Test Methods for Total Normal Emittance of Surfaces Using Inspection-Meter Techniques
501.3.5.4 (5.3.5.4)
- > ASTM E972-96 (2013): Standard Test Method for Solar Photometric Transmittance of Sheet Materials Using Sunlight
301.2 (3.2)
- > 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 (8.3.4.1.1)
- 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 (8.3.4.1.1)
- > ASTM E1903-11: Standard Practice for Environmental Site Assessments: Phase II Environmental Site Assessment Process
301.2 (3.2)
- ASTM E1918-06(2015): Standard Test Method for Measuring Solar Reflectance of Horizontal and Low-Sloped Surfaces in the Field
501.3.5.4 (5.3.5.4)
- ASTM E1980-11: Standard Practice for Calculating Solar Reflectance Index of Horizontal and Low-Sloped Opaque Surfaces
501.3.5.4 (5.3.5.4)
- ASTM E2399-11: Standard Test Method for Maximum Media Density for Dead Load Analysis of Vegetative (Green) Roof Systems
501.3.5.5 (5.3.5.5)
- 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 (9.5.1)

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
901.4.1.4.3 (9.4.1.4.3)

ANSI/BIFMA M7.1-2011 (R2016): Standard Test Method For Determining VOC Emissions From Office Furniture Systems, Components and Seating
801.5.2 (8.5.2)

>

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
801.3.9.2.2 (8.4.2.2.2)

|| 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
|| 801.3.9.2.4 (8.4.2.4)

CDPH

California Department of Public Health
Indoor Air Quality Section
850 Marina Bay Parkway
Richmond, CA 94804

|| 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
|| 801.3.9 (8.4.2), 801.5.2 (8.5.2), Table 1001.3.1.5 (Table 10.3.1.5), Appendix D

CEN

European Committee for Standardization
Avenue Marnix 17—B-1000
Brussels, Belgium

EN14500:2008: Blinds and shutters—Thermal and visual comfort—Test and calculation methods
801.3.8 (8.3.8)

CRRC

Cooling Roof Rating Council
449 15th Street, Suite 400
Oakland, CA 94612

ANSI/CRRC S100-2016: Standard Test Methods for Determining Radiative Properties of Materials
501.3.5.4 (5.3.5.4)

CTI

Cooling Technology Institute
PO Box 681807
Houston, TX 77268

CTI ATC-105 (00): Acceptance Test Code for Water Cooling Towers
Appendix B

CTI ATC-105S (11): Acceptance Test Code for Closed-Circuit Cooling Towers
Appendix B

CTI ATC-106 (11): Acceptance Test Code for Mechanical Draft Evaporative Vapor Condensers
Appendix B

CTI STD-201RS (15): Standard for the Certification of Water Cooling Tower Thermal Performance
Appendix B

Green-e

Green-e
c/o Center for Resource Solutions
1012 Torney Ave., Second Floor
San Francisco, CA 94129

Version 2.8, April 1, 2016: Green-e Energy National Standard for Renewable Electricity Products
701.4.1.1.1 (7.4.1.1.1)

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 (3.2), 601.3.1.2.2 (6.3.1.2.2)

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 (6.3.2.1)

NORMATIVE REFERENCES

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 (5.3.5.5)
- 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 (2.2), 102.4
- 2018 ICC PC: Performance Code for Buildings and Facilities®**
102.4

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 (5.3.6.2)
- LM-83-12: Approved Method: IES Spatial Daylight Autonomy (sDA) and Annual Sunlight Exposure (ASE)**
301.2 (3.2), 801.5.1 (8.5.1)

ISO

International Organization for Standardization
ISO Central Secretariat, 1 rue de Varembe, Case postale 56
CH-1211 Geneva 20, Switzerland

- 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 (9.4.1.4)
- ISO 14040-2006: Environmental Management—Life Cycle Assessment—Principles and Framework**
901.4.1.4 (9.4.1.4)
- ISO 14044-2006: Environmental Management—Life Cycle Assessment— Requirements and Guidelines**
901.5.1 (9.5.1), 901.5.1.2 (9.5.1.2)
- ISO 21930-2007: Sustainability in Building Construction—Environmental Declaration of Building Products**
901.4.1.4 (9.4.1.4)
- ISO/IEC-17025-2005 (Reviewed 2010): General Requirements for the Competence of Testing and Calibration Laboratories**
801.3.9 (8.4.2)
- ISO/IEC 17065-2012: Conformity Assessment—Requirements for Bodies Certifying Products, Processes, and Services**
801.3.9 (8.4.2)
- ISO/IEC Guide 59-1994: Code of Good Practice for Standardization**
901.4.1.3.1 (9.4.1.3.1)

NEMA

National Electrical Manufacturers Association
1300 North 17th Street, Suite 900
Rosslyn, VA 22209

ANSI/NEMA MG 1-2009: Motors and Generators
701.4.3.1 (7.4.3.1)

NEMA DC 3, Annex A-2013: Energy-Efficiency Requirements for Programmable Thermostats
701.4.7.4 (7.4.7.4)

NFPA

National Fire Protection Association
1 Battery March Park
Quincy, MA 02169-7471

NFPA 70-2014: National Electrical Code
501.3.6.3 (5.3.6.3)

NFRC

National Fenestration Rating Council
6305 Ivy Lane, Suite 140
Greenbelt, MD 20770-6323

ANSI/NFRC 200-2014: Procedure for Determining Fenestration Product Solar Heat Gain Coefficients and Visible Transmittance at Normal Incidence
301.2 (3.2)

NSC

Natural Stone Council
P.O. Box 539
Hollis, NH 03049

NSC 373-2013: Sustainable Production of Natural Dimension Stone
901.4.1.4 (9.4.1.4)

NSF

NSF International
789 Dixboro Road
Ann Arbor, MI 48105

NSF/ANSI 58-2016: Reverse Osmosis Drinking Water Treatment Systems
601.3.6 (6.3.6)

NSF/ANSI 140-2015: Sustainability Assessment for Carpet
901.4.1.4 (9.4.1.4)

NSF/ANSI 332-2015: Sustainability Assessment for Resilient Floor Coverings
901.4.1.4 (9.4.1.4)

NSF/ANSI 336-2011: Sustainability Assessment for Commercial Furnishings Fabric
901.4.1.4 (9.4.1.4)

NSF/ANSI 342-2014: Sustainability Assessment for Wallcovering Products
901.4.1.4 (9.4.1.4)

NSF/ANSI 347-2012: Sustainability Assessment for Single Ply Roofing Membranes
901.4.1.4 (9.4.1.4)

NSF/ANSI 350-2017: On-Site Residential and Commercial Water Reuse Systems
601.3.7 (6.3.7)

NORMATIVE REFERENCES

PHIUS

Passive House Institute US
116 West Illinois Street
Suite 5E
Chicago, IL 60605

PHIUS+ 2018 Passive Building Standard
701.7.1.1

TCNA

Tile Council of North America
100 Clemson Research Boulevard
Anderson, SC 29625

ANSI A138.1-2011: Standard Specifications for Sustainable Ceramic Tiles, Glass Tiles, and Tile Installation Materials
901.4.1.4 (9.4.1.4)

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 (9.4.1.4)

UL 102-2012: Standard for Sustainability for Door Leafs
901.4.1.4 (9.4.1.4)

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

EPA Act 2005 HR6 Public Law 109-58: The Energy Policy Act (EPA Act) of 2005
701.4.7.3 (7.4.7.3)

EISA 2007 HR6 Public Law 110-140: The Energy Independence and Security Act of 2007
701.4.7 (7.4.7)

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 (9.4.1.3)

USDOE

United States 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
Appendix B

USEPA

United States 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 (8.3.1.3)

EPA 420-F-07-063, November 2007: Green Vehicle Guide: Consider a SmartWay Vehicle Program—Requirements for Certified Passenger Vehicles

501.3.7 (5.3.7)

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 (10.3.1.5)

February 16, 2012: NPDES General Permit for Stormwater Discharges From Construction Activities

1001.3.1.4 (10.3.1.4)

USEPA Method TO-17 (1999): Determination of Volatile Organic Compounds in Ambient Air Using Active Sampling Onto Sorbent Tubes

801.3.9 (8.4.2)

Version 1.0, August 1, 2012: ENERGY STAR Program Requirements for Uninterruptible Power Supplies

701.4.7 (7.4.7)

Version 1.0, August 14, 2009: WaterSense Specification for Flushing Urinals

601.3.2.1 (6.3.2.1)

Version 1.0, March 4, 2010: WaterSense Specification for Showerheads

601.3.2.1 (6.3.2.1)

Version 1.0, October 1, 2007: WaterSense Tank-Type High-Efficiency Lavatory Faucet Specification

601.3.2.1 (6.3.2.1)

Version 1.0, November 3, 2011: WaterSense Specification for Weather-Based Irrigation Controllers

601.3.1.2 (6.3.1.2)

Version 1.2, August 1, 2003: ENERGY STAR Program Requirements for Commercial Steam Cookers

701.4.7 (7.4.7)

Version 1.2, July 1, 2004: ENERGY STAR Program Requirements for Room Air Cleaners

701.4.7 (7.4.7)

Version 1.2, June 2, 2014: WaterSense Tank-Type High-Efficiency Toilet Specification

601.3.2.1 (6.3.2.1)

Version 1.2, May 8, 2009: ENERGY STAR Program Requirements for Commercial Griddles

701.4.7 (7.4.7)

Version 2.0, April 22, 2011: ENERGY STAR Program Requirements for Commercial Fryers

701.4.7 (7.4.7)

Version 2.0 December 31, 2015: ENERGY STAR Program Requirements for Lamps (Light Bulbs)

701.4.7 (7.4.7)

Version 2.0, February 1, 2013: ENERGY STAR Program Requirements for Commercial Ice Makers

601.3.2.5 (6.3.2.5), 701.4.7 (7.4.7)

Version 2.0, June 25, 2012: ENERGY STAR Program Requirements for Commercial Dishwashers

601.3.2.5 (6.3.2.5), 701.4.7 (7.4.7)

Version 2.0, June 26, 2013: ENERGY STAR Program Requirements for Imaging Equipment

701.4.7 (7.4.7)

Version 2.0, May 9, 2013: ENERGY STAR Program Requirements for Water Coolers

701.4.7 (7.4.7)

Version 2.0, May 29, 2015: ENERGY STAR Program Requirements for Luminaires

701.4.7.3 (7.4.7.3)

Version 2.0, October 1, 2011: ENERGY STAR Program Requirements for Hot Food Holding Cabinets

701.4.7 (7.4.7)

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- Version 2.2, October 7, 2015: ENERGY STAR Program Requirements for Commercial Ovens**
701.4.7 (7.4.7)
- Version 3.0, April 1, 2012: ENERGY STAR Program Requirements for Residential Ceiling Fans**
701.4.7 (7.4.7)
- Version 3.0, December 20, 2013: ENERGY STAR Program Requirements for Boilers**
701.4.7 (7.4.7)
- Version 3.0, July 18, 2014: ENERGY STAR Program Requirements for Residential Water Heaters**
701.4.7 (7.4.7)
- Version 3.0, May 1, 2013: ENERGY STAR Program Requirements for Audio and Video**
701.4.7 (7.4.7)
- Version 3.0, October 1, 2012: ENERGY STAR Program Requirements for Dehumidifiers**
701.4.7 (7.4.7)
- Version 3.0, October 1, 2014: ENERGY STAR Program Requirements for Commercial Refrigerators and Freezers**
701.4.7 (7.4.7)
- Version 3.0, October 1, 2014: ENERGY STAR Program Requirements for Telephony**
701.4.7 (7.4.7)
- Version 3.1, January 1, 2012: ENERGY STAR Program Requirements for Geothermal Heat Pumps**
701.4.7 (7.4.7)
- Version 3.1, March 1, 2013: ENERGY STAR Program Requirements for Refrigerated Beverage Vending Machines**
701.4.7 (7.4.7)
- Version 3.2, April 1, 2012: ENERGY STAR Program Requirements for Residential Ventilating Fans**
701.4.7 (7.4.7)
- Version 4.0, February 20, 2015: ENERGY STAR Program Requirements and Criteria for Room Air Conditioners**
701.4.7 (7.4.7)
- Version 4.0, June 13, 2011: ENERGY STAR Program Requirements for Furnaces**
701.4.7 (7.4.7)
- Version 5.0, May 13, 2016: ENERGY STAR Program Requirements for Set-Top Boxes**
701.4.7 (7.4.7)
- Version 5.0, September 15, 2014: ENERGY STAR Program Requirements for Refrigerators and Freezers**
701.4.7 (7.4.7)
- Version 5.0, September 15, 2015: ENERGY STAR Program Requirements for ASHPs and Central Air Conditioners**
701.4.7 (7.4.7)
- Version 6.0, April 29, 2015: ENERGY STAR Program Requirements Product Specification for Residential Dishwashers**
601.3.2.2 (6.3.2.2), 701.4.7 (7.4.7)
- Version 6.1, August 12, 2014: ENERGY STAR Program Requirements for Computers**
701.4.7 (7.4.7)
- Version 7.0, May 2016: ENERGY STAR Program Requirements for Displays**
701.4.7 (7.4.7)
- Version 7.0, October 30, 2015: ENERGY STAR Program Requirements for Televisions**
701.4.7 (7.4.7)
- Version 7.1, May 20, 2015: ENERGY STAR Program Requirements for Clothes Washers**
601.3.2.2 (6.3.2.2), 701.4.7 (7.4.7)

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 (9.4.1.3.1)

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/ASHRAE/IES 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 (TABLE A-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 + R15 ci U-0.020	R-38 + R15 ci U-0.020	R-38 U-0.029

TABLE A101.2 (TABLE A-2)
(SUPERSEDES TABLE 6.8.2 IN ANSI/ASHRAE/IES STANDARD 90.1)
MINIMUM DUCT INSULATION R-VALUE^a 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 ^a	UNCONDITIONED SPACE ^b	INDIRECTLY CONDITIONED SPACE ^c	BURIED
Heating-Only Ducts							
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-6
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
Cooling-Only Ducts							
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
Return Ducts							
0 to 8	R-6	R-6	R-6	None	None	None	None

a. Insulation R-values, measured in (h·ft²·°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 A101.3 (TABLE A-3)
(SUPERSEDES TABLE 6.8.2 IN ANSI/ASHRAE/IES STANDARD 90.1)
MINIMUM DUCT INSULATION R-VALUE^a 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 ^a	UNCONDITIONED SPACE ^b	INDIRECTLY CONDITIONED SPACE ^c	BURIED
Supply Ducts							
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	R11	R11	R-3.5	R-8	None	R-8
Return Ducts							
0 to 8	R-6	R-6	R-6	None	None	None	None

- a. Insulation R-values, measured in (h·ft²·°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 non-ventilated.
- c. Includes return air plenums with or without exposed roofs above.

TABLE A101.1 (TABLE A-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 (TABLE A-2)
(SUPERSEDES TABLE 6.8.2 IN ANSI/ASHRAE/IES STANDARD 90.1)
MINIMUM DUCT INSULATION R-VALUE^a 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 ^a	UNCONDITIONED SPACE ^b	INDIRECTLY CONDITIONED SPACE ^c	BURIED
Heating-Only Ducts							
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
Cooling-Only Ducts							
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
Return Ducts							
0 to 8	R-1.06	R-1.06	R-1.06	None	None	None	None

- a. Insulation R-values, measured in m²·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 (TABLE A-3)
(SUPERSEDES TABLE 6.8.2 IN ANSI/ASHRAE/IES STANDARD 90.1)
MINIMUM DUCT INSULATION R-VALUE^a 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 ^a	UNCONDITIONED SPACE ^b	INDIRECTLY CONDITIONED SPACE ^c	BURIED
Supply Ducts							
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
Return Ducts							
0 to 8	R-1.06	R-1.06	R-1.06	None	None	None	None

- a. Insulation R-values, measured in m²·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 INCREASED EQUIPMENT EFFICIENCY APPROACH

(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 B101.1 (TABLE B-1)
(SUPERSEDES TABLE 6.8.1-1 IN ANSI/ASHRAE/IES 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 ^a
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	< 3 0,000 Btu/h	All	Split systems	12.0 SEER	AHRI 210/240
			Single packaged	12.0 SEER	
Small duct, high velocity, air cooled	< 65,000 Btu/h (one phase)	All	Split systems	12.0 SEER	AHRI 210/240
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	12.2 EER 14.0 IEER	AHRI 340/360
		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	12.2 EER 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	

a. Chapter 11 (Section 11) contains a details on the referenced test procedures, including year and version of the test procedure.

(continued)

**TABLE B101.1 (TABLE B-1)
(SUPERSEDES TABLE 6.8.1-1 IN ANSI/ASHRAE/IES 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 ^a
Air conditioners, water cooled	< 65,000 Btu/h	All	Split systems and single package	14.0 EER	AHRI 210/240
				15.3 IEER	
	≥ 65,000 Btu/h and < 135,000 Btu/h	Electric resistance (or none)	Split systems and single package	14.0 EER	AHRI 340/360
				15.3 IEER	
	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 IEER	
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			
Air conditioners, evaporatively cooled	< 65,000 Btu/h	All	Split systems and single package	14.0 EER	AHRI 210/240
				15.3 IEER	
	≥ 65,000 Btu/h and < 135,000 Btu/h	Electric resistance (or none)	Split systems and single package	14.0 EER	AHRI 340/360
				15.3 IEER	
	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 IEER	
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
				Not applicable match with indoor coil	
Condensing, water or evaporatively cooled	≥ 135,000 Btu/h			Not applicable match with indoor coil	
				Not applicable match with indoor coil	

a. Chapter 11 (Section 11) contains a details on the referenced test procedures, including year and version of the test procedure.

(continued)

TABLE B101.2 (TABLE B-2)
(SUPERSEDES TABLE 6.8.1-2 IN ANSI/ASHRAE/IES 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 ^a
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	AHRI 210/240
			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 210/240
	< 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	AHRI 340/360
		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	ISO-13256-1
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	

a. Chapter 11 (Section 11) contains details on the referenced test procedures, including year and version of the test procedure.

(continued)

TABLE B101.2 (TABLE B-2)
(SUPERSEDES TABLE 6.8.1-2 IN ANSI/ASHRAE/IES 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 ^a
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	
			Single packaged	8.50 HSPF	
Through-the-wall, air cooled (heating mode)	< 30,000 Btu/h (cooling capacity)	All	Split systems	7.40 HSPF	
			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	AHRI 210/240
	< 65,000 Btu/h (cooling capacity) (three phase)	All	Split systems	7.20 HSPF	
Air cooled (heating mode)	≥ 65,000 Btu/h and < 135,000 Btu/h (cooling capacity)		47°F db/43°F wb outdoor air	3.40 COP _H	AHRI 340/360
			17°F db/15°F wb outdoor air	2.40 COP _H	
	≥ 135,000 Btu/h (cooling capacity)		47°F db/43°F wb outdoor air	3.20 COP _H	
			17°F db/15°F wb outdoor air	2.10 COP _H	
Water-to-air water loop (heating mode)	< 135,000 Btu/h (cooling capacity)		68°F entering water	4.60 COP _H	ISO-13256-1
Water-to-air groundwater (heating mode)	< 135,000 Btu/h (cooling capacity)		50°F entering water	3.70 COP _H	
Brine-to-air ground loop (heating mode)	< 135,000 Btu/h (cooling capacity)		32°F entering fluid	3.20 COP _H	
Water-to-water water loop (heating mode)	< 135,000 Btu/h (cooling capacity)		68°F entering water	3.70 COP _H	ISO-13256-2
Water-to-water groundwater (heating mode)	< 135,000 Btu/h (cooling capacity)		50°F entering water	3.10 COP _H	
Brine-to-water ground loop (heating mode)	< 135,000 Btu/h (cooling capacity)		32°F entering fluid	2.50 COP _H	

a. Chapter 11 (Section 11) contains details on the referenced test procedures, including year and version of the test procedure.

TABLE B101.3 (TABLE B-3)
(SUPERSEDES TABLE 6.8.1-4 IN ANSI/ASHRAE/IES 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 CONDITION	MINIMUM EFFICIENCY	TEST PROCEDURE ^a
PTAC (cooling mode) standard size	All capacities	95°F db <i>outdoor air</i>	14.4 – (0.300 × Cap/1000) ^c EER	AHRI 310/380
PTAC (cooling mode) nonstandard size ^b	All capacities	95°F db <i>outdoor air</i>	10.9 – (0.213 × Cap/1000) ^c EER	AHRI 310/380
PTHP (cooling mode) standard size	All capacities	95°F db <i>outdoor air</i>	14.4 – (0.300 × Cap/1000) ^c EER	ARI 310/380
PTHP (cooling mode) nonstandard size ^b	< 7000 Btu/h	95°F db <i>outdoor air</i>	10.8 – (0.213 × Cap/1000) ^c 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 × Cap/1000) ^c COP _H	ARI 310/380
PTHP (heating mode) nonstandard size ^b	All capacities	47°F db/43°F wb <i>outdoor air</i>	2.9 – (0.026 × Cap/1000) ^c COP _H	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.².
- 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 (TABLE B-4)
(SUPERSEDES TABLE 6.8.1-4 IN ANSI/ASHRAE/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 (I-P)

EQUIPMENT TYPE	SIZE CATEGORY (INPUT)	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY BASE	MINIMUM EFFICIENCY CONNECTED ^b	TEST PROCEDURE ^a
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 _H		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 _H		
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 (TABLE B-5)
(SUPERSEDES TABLE 6.8.1-5 IN ANSI/ASHRAE/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 (I-P)

EQUIPMENT TYPE	SIZE CATEGORY (INPUT)	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY	TEST PROCEDURE ^a
Warm-air furnace, gas fired (weatherized)	< 225,000 Btu/h	Maximum capacity ^c	81% AFUE ^b	DOE 10 CFR Part 430 or Section 2.39, Thermal Efficiency, ANSI Z21.47
	≥ 225,000 Btu/h		80% E_t ^d	Section 2.39, Thermal Efficiency, ANSI Z21.47
Warm-air furnace, gas fired (nonweatherized)	< 225,000 Btu/h	Maximum capacity ^c	90% AFUE or 92% E_t ^{b,d}	DOE 10 CFR Part 430 or Section 2.39, Thermal Efficiency, ANSI Z21.47
	≥ 225,000 Btu/h		92% E_t ^d	Section 2.39, Thermal Efficiency, ANSI Z21.47
Warm-air furnace, oil fired (weatherized)	< 225,000 Btu/h	Maximum capacity ^c	78% AFUE ^{b,d}	DOE 10 CFR Part 430 or Section 42, Combustion, UL 727
	> 225,000 Btu/h		81% E_t ^d	Section 42, Combustion, UL 727
Warm-air furnaces, oil fired (nonweatherized)	< 225,000 Btu/h	Maximum capacity ^c	85% AFUE or 87% E_t ^{b,d}	DOE 10 CFR Part 430 or Section 42, Combustion, UL 727
	≥ 225,000 Btu/h		87% E_t ^d	Section 42, Combustion, UL 727
Warm-air duct furnace, gas fired (weatherized)	All capacities	Maximum capacity ^c	80% E_c ^e	Section 2.10, Efficiency, ANSI Z83.8
Warm-air duct furnace, gas fired (nonweatherized)	All capacities	Maximum capacity ^c	90% E_c ^e	Section 2.10, Efficiency, ANSI Z83.8
Warm-air unit heater, gas fired (nonweatherized)	All capacities	Maximum capacity ^c	80% E_c ^{e,f}	Section 2.10, Efficiency, ANSI Z83.8
Warm-air unit heater, oil fired (weatherized)	All capacities	Maximum capacity ^c	90% E_c ^{e,f}	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_t = 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 a flue damper. A vent damper is an acceptable alternative to a flue damper for those furnaces where combustion air is drawn from the conditioned space.
- e. E_c = 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 (TABLE B-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 ^a	SUBCATEGORY OR RATING CONDITION	SIZE CATEGORY (INPUT)	MINIMUM EFFICIENCY ^{b,c}	TEST PROCEDURE ^g
Boilers, hot water	Gas fired	< 300,000 Btu/h ^{hi}	89% AFUE ^h	10 CFR Part 430
		≥ 300,000 Btu/h and ≤ 2,500,000 Btu/h ^d	89% E_t^f	10 CFR Part 431
		> 2,500,000 Btu/h ^a	91% E_c^f	
	Oil fired ^e	< 300,000 Btu/h	89% AFUE ^f	10 CFR Part 430
		≥ 300,000 Btu/h and ≤ 2,500,000 Btu/h ^d	85% E_t^f	10 CFR Part 431
		> 2,500,000 Btu/h ^a	86% E_c^f	
Boilers, steam	Gas fired	< 300,000 Btu/h ⁱ	80% AFUE	10 CFR Part 430
	Gas fired all except natural draft	≥ 300,000 Btu/h and ≤ 2,500,000 Btu/h ^d	79% E_t	10 CFR Part 431
		> 2,500,000 Btu/h ^a	79% E_t	
	Gas fired natural draft	≥ 300,000 Btu/h and ≤ 2,500,000 Btu/h ^d	77% E_t	
		> 2,500,000 Btu/h ^a	77% E_t	
	Oil fired ^e	< 300,000 Btu/h	82% AFUE	10 CFR Part 430
		≥ 300,000 Btu/h and ≤ 2,500,000 Btu/h ^d	81% E_t	10 CFR Part 431
		> 2,500,000 Btu/h ^a	81% E_t	

- a. These requirements apply to boilers with rated input of 8,000,000 Btu/h or less that are not packaged boilers and to all packaged boilers. Minimum efficiency requirements for boilers cover all capacities of packaged boilers.
- b. E_c = thermal efficiency (100% less flue losses). See reference document for detailed information.
- c. E_t = thermal efficiency. See reference document for detailed information.
- d. Maximum capacity—minimum and maximum ratings as provided for and allowed by the unit's controls.
- e. Includes oil fired (residual).
- f. 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.
- g. Chapter 11 (Section 11) contains details for the referenced test procedure, including the referenced year version of the test procedure.
- h. 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.
- i. Boilers shall not be equipped with a continuous pilot ignition system.

**TABLE B101.7 (TABLE B-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 ^a	PERFORMANCE REQUIRED ^{a,b,c,d,e,f,i}	TEST PROCEDURE ^b
Propeller or axial fan open-circuit cooling towers	All	95°F entering water 85°F leaving water 75°F 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 (TABLE B-8)
(SUPERSEDES TABLE 7.8 IN ANSI/ASHRAE/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 ^a	TEST PROCEDURE ^b
Electric table-top water heaters ^c	≤ 12 kW	≥ 20 gal and ≤ 120 gal	Very small	UEF ≥ 0.6323 – 0.0058 <i>V</i>	DOE 10 CFR Part 430
			Low	UEF ≥ 0.9188 – 0.0031 <i>V</i>	
			Medium	UEF ≥ 0.9577 – 0.0023 <i>V</i>	
			High	UEF ≥ 0.9844 – 0.0016 <i>V</i>	
Electric resistance storage water heaters		≥ 20 gal and ≤ 55 gal	Very small	UEF ≥ 0.8808 – 0.0008 <i>V</i>	DOE 10 CFR Part 430
			Low	UEF ≥ 0.9254 – 0.0003 <i>V</i>	
			Medium	UEF ≥ 0.9307 – 0.0002 <i>V</i>	
			High	UEF ≥ 0.9349 – 0.0001 <i>V</i>	
		> 55 gal		Must use heat-pump water heater	
Electric resistance grid-enabled water heaters		> 75 gal	Very small	UEF ≥ 1.0136 – 0.0028 <i>V</i>	DOE 10 CFR Part 430
			Low	UEF ≥ 0.09984 – 0.0014 <i>V</i>	
			Medium	UEF ≥ 0.9853 – 0.0010 <i>V</i>	
			High	UEF ≥ 0.9720 – 0.0007 <i>V</i>	
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
	> 75,000 Btu/h	> 55 gal		EF ≥ 0.77, FHR ≥ 67 gal	
Gas instantaneous water heaters	> 50,000 Btu/h and < 200,000 Btu/h ^d	≥ 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 ^c	≤ 140 gal and ≥ 4,000 (Btu/h)/gal		$E_t \geq 0.94$ or $EF \geq 0.93$ $SL \leq 0.84 \times (Q/800 + 110\sqrt{V})$, Btu/h	ANSI Z21.10.3
Oil storage water heaters	≤ 105,000 Btu/h	≤ 50 gal	Very small	EF = 0.2509 – 0.0012 <i>V</i>	DOE 10 CFR Part 430
			Low	EF = 0.5330 – 0.0016 <i>V</i>	
			Medium	EF = 0.6078 – 0.0016 <i>V</i>	
			High	EF = 0.6815 – 0.0014 <i>V</i>	
	> 105,000 Btu/h	< 4,000 (Btu/h)/gal		$E_t \geq 80\%$ and $SL \leq (Q/800 + 110\sqrt{V})$, Btu/h	ANSI Z21.10.3
Oil instantaneous water heaters	≤ 210,000 Btu/h	≤ 50 gal		EF ≥ 0.59 – 0.0019 <i>V</i>	DOE 10 CFR Part 430
	> 210,000 Btu/h	≥ 4,000 (Btu/h)/gal and < 10 gal		$E_t \geq 80\%$	ANSI Z21.10.3
	> 210,000 Btu/h	≥ 4,000 (Btu/h)/gal and ≥ 10 gal		$E_t \geq 78\%$ and $SL \leq (Q/800 + 110\sqrt{V})$, 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		$E_t \geq 80\%$	ANSI Z21.10.3
Hot-water supply boilers, gas		≥ 4,000 (Btu/h)/gal and ≥ 10 gal		$E_t \geq 80\%$ $SL \leq (Q/800 + 110\sqrt{V})$, Btu/h	ANSI Z21.10.3

a. Energy factor (EF) and thermal efficiency (E_t) 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.

(continued)

TABLE B101.8 (TABLE B-8)
(SUPERSEDES TABLE 7.8 IN ANSI/ASHRAE/IES STANDARD 90.1)
PERFORMANCE REQUIREMENTS FOR SERVICE WATER HEATING EQUIPMENT (I-P) (Continued)

EQUIPMENT TYPE	SIZE CATEGORY (INPUT)	RATED STORAGE VOLUME AND INPUT RATING (IF APPLICABLE)	DRAW PATTERN	PERFORMANCE REQUIRED ^a	TEST PROCEDURE ^b
Hot-water supply boilers, oil		≥ 4,000 (Btu/h)/gal and ≥ 10 gal		$E_t \geq 78\%$ $SL \leq (Q/800 + 110\sqrt{V}), \text{ Btu/h}$	
Pool heaters, gas	All sizes			$E_t \geq 82\%$	ASHRAE 146
Pool heaters, oil	All sizes			$E_t \geq 78\%$	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_t) 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 (TABLE B-9)
COMMERCIAL CLOTHES WASHERS (I-P)

PRODUCT	MEF ^a	WF ^b , gal/ft ³
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/ft³).

TABLE B101.10 (TABLE B-10)
(SUPERSEDES TABLE 6.8.1-9 IN ANSI/ASHRAE/IES 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 ^a
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 (TABLE B-11)
(SUPERSEDES TABLE 6.8.1-10 IN ANSI/ASHRAE/IES 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 ^a
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	
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 ground source (cooling mode)	< 135,000 Btu/h	All	VRF multisplit system 77°F entering water	13.4 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	

a. Chapter 11 (Section 11) contains details for the referenced test procedure, including year version of the test procedure.

(continued)

TABLE B101.11 (TABLE B-11)
(SUPERSEDES TABLE 6.8.1-10 IN ANSI/ASHRAE/IES 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 ^a
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 _H	
			VRF multisplit system 17°F db/15°F wb <i>outdoor air</i>	2.40 COP _H	
	≥ 135,000 Btu/h (cooling capacity)		VRF multisplit system 47°F db/43°F wb <i>outdoor air</i>	3.20 COP _H	
VRF multisplit system 17°F db/15°F wb <i>outdoor air</i>			2.10 COP _H		
VRF water source (heating mode)	< 135,000 Btu/h (cooling capacity)		VRF multisplit system 68°F entering water	4.60 COP _H	AHRI 1230
	≥ 135,000 Btu/h (cooling capacity)		VRF multisplit system 68°F entering water	4.20 COP _H	
VRF groundwater source (heating mode)	< 135,000 Btu/h (cooling capacity)		VRF multisplit system 50°F entering water	3.60 COP _H	AHRI 1230
	≥ 135,000 Btu/h (cooling capacity)		VRF multisplit system 50°F entering water	3.30 COP _H	
VRF ground source (heating mode)	< 135,000 Btu/h (cooling capacity)		VRF multisplit system 32°F entering fluid	3.10 COP _H	AHRI 1230
	≥ 135,000 Btu/h (cooling capacity)		VRF multisplit system 32°F entering fluid	2.80 COP _H	

a. Chapter 11 (Section 11) contains details for the referenced test procedure, including year version of the test procedure.

TABLE B101.1 (TABLE B-1)
(SUPERSEDES TABLE 6.8.1-1 IN ANSI/ASHRAE/IES 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 CONDITIONS	MINIMUM EFFICIENCY	TEST PROCEDURE ^a
Air conditioners, air cooled	< 19 kW (one phase)	All	Split systems	4.40 SCOP _C 3.66 COP _C	AHRI 210/240
			Single packaged	4.40 SCOP _C 3.52 COP _C	
	< 19 kW (three phase)	All	Split systems	4.40 SCOP _C 3.52 COP _C	
			Single packaged	4.10 SCOP _C 3.40 COP _C	
Through-the-wall, air cooled	< 9 kW	All	Split systems	3.52 SCOP _C	
			Single packaged	3.52 SCOP _C	
Small duct, high velocity, air cooled	< 19 kW (one phase)	All	Split systems	3.52 SCOP _C	
	< 19 kW (three phase)	All	Split systems	3.52 SCOP _C	
Air conditioners air cooled	≥ 19 kW and < 40 kW	Electric resistance (or none)	Split systems and single package	3.58 COP _C 4.10 ICOP _C	ARI 340/360
		All other	Split systems and single package	3.52 COP _C 4.04 ICOP _C	
	≥ 40 kW and < 70 kW	Electric resistance (or none)	Split systems and single package	3.58 COP _C 3.87 ICOP _C	
		All other	Split systems and single package	3.52 COP _C 3.81 ICOP _C	
	≥ 70 kW and < 223 kW	Electric resistance (or none)	Split systems and single package	3.17 COP _C 3.60 ICOP _C	
		All other	Split systems and single package	3.11 COP _C 3.55 ICOP _C	
	≥ 223 kW	Electric resistance (or none)	Split systems and single package	3.05 COP _C 3.40 ICOP _C	
		All other	Split systems and single package	2.99 COP _C 3.34 ICOP _C	

a. Chapter 11 (Section 11) contains a details on the referenced test procedures, including year and version of the test procedure.

(continued)

TABLE B101.1 (TABLE B-1)
(SUPERSEDES TABLE 6.8.1-1 IN ANSI/ASHRAE/IES 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 CONDITIONS	MINIMUM EFFICIENCY	TEST PROCEDURE ^a	
Air conditioners, water cooled	< 19 kW	All	Split systems and single package	4.10 COP _c	AHRI 210/240	
			Split systems and single package	4.48 ICOP _c		
	≥ 19 kW and < 140 kW	Electric resistance (or none)	Split systems and single package	4.10 COP _c 4.48 ICOP _c	AHRI 340/360	
		All other	Split systems and single package	4.04 COP _c 4.43 ICOP _c		
	≥ 40 kW and < 70 kW	Electric resistance (or none)	Split systems and single package	4.10 COP _c 4.34 ICOP _c		
		All other	Split systems and single package	4.04 COP _c 4.28 ICOP _c		
	≥ 70 kW and < 223 kW	Electric resistance (or none)	Split systems and single package	4.10 COP _c 4.34 ICOP _c		
		All other	Split systems and single package	3.99 COP _c 4.28 ICOP _c		
	≥ 223 kW	Electric resistance (or none)	Split systems and single package	4.10 COP _c 4.34 ICOP _c		
		All other	Split systems and single package	4.04 COP _c 4.28 ICOP _c		
	Air conditioners, evaporatively cooled	< 19 kW	All	Split systems and single package	4.10 COP _c 4.48 ICOP _c	AHRI 210/240
		≥ 19 kW and < 140 kW	Electric resistance (or none)	Split systems and single package	4.10 COP _c 4.48 ICOP _c	AHRI 340/360
All other			Split systems and single package	4.04 COP _c 4.43 ICOP _c		
≥ 40 kW and < 70 kW		Electric resistance (or none)	Split systems and single package	3.96 COP _c 4.19 ICOP _c		
		All other	Split systems and single package	3.90 COP _c 4.13 ICOP _c		
≥ 70 kW and < 223 kW		Electric resistance (or none)	Split systems and single package	3.96 COP _c 4.19 ICOP _c		
		All other	Split systems and single package	3.90 COP _c 4.13 ICOP _c		
≥ 223 kW		Electric resistance (or none)	Split systems and single package	3.96 COP _c 4.19 ICOP _c		
		All other	Split systems and single package	3.90 COP _c 4.13 ICOP _c		
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 a details on the referenced test procedures, including year and version of the test procedure.

TABLE B101.2 (TABLE B-2)
(SUPERSEDES TABLE 6.8.1-2 IN ANSI/ASHRAE/IES STANDARD 90.1)
ELECTRICALLY OPERATED UNITARY AND APPLIED HEAT PUMPS—MINIMUM EFFICIENCY REQUIREMENTS (SI)

EQUIPMENT TYPE	SIZE CATEGORY	HEATING SECTION TYPE	SUBCATEGORY OR RATING CONDITIONS	MINIMUM EFFICIENCY	TEST PROCEDURE ^a
Air conditioners, air cooled (cooling mode)	< 19 kW (one phase)	All	Split systems	4.40 SCOP _C 3.66 COP _C	AHRI 210/240
			Single packaged	4.40 SCOP _C 3.52 COP _C	
	< 19 kW (three phase)	All	Split systems	4.40 SCOP _C 3.66 COP _C	
			Single packaged	4.40 SCOP _C 3.52 COP _C	
Through-the-wall, air cooled (cooling mode)	< 9 kW	All	Split systems	3.52 SCOP _C	
			Single packaged	3.52 SCOP _C	
Small duct high velocity, air cooled (cooling mode)	< 19 kW (one phase)	All	Split systems	3.52 SCOP _C	
	< 19 kW (three phase)	All	Split systems	3.52 SCOP _C	
Air conditioners, air cooled (cooling mode)	≥ 19 kW and < 40 kW	Electric resistance (or none)	Split systems and single package	3.31 COP _C 3.60 ICOP _C	AHRI 340/360
		All other	Split systems and single package	3.25 COP _C 3.55 ICOP _C	
	≥ 40 kW and < 70 kW	Electric resistance (or none)	Split systems and single package	3.19 COP _C 3.40 ICOP _C	
		All other	Split systems and single package	3.14 COP _C 3.34 ICOP _C	
	≥ 70 kW	Electric resistance (or none)	Split systems and single package	3.02 COP _C 3.11 ICOP _C	
		All other	Split systems and single package	2.96 COP _C 3.05 ICOP _C	
Water-to-air water loop (cooling mode)	< 5 kW	All	30°C entering water	4.10 COP _C	ISO-13256-1
	≥ 5 kW and < 19kW	All	30°C entering water	4.10 COP _C	
	> 19kW and < 40 kW	All	30°C entering water	4.10 COP _C	
Water-to-air ground water (cooling mode)	< 40 kW	All	15°C entering water	5.28 COP _C	
Water-to-air ground loop (cooling mode)	< 40 kW	All	25°C entering water	4.13 COP _C	
Water-to-water water loop (cooling mode)	< 40 kW	All	30°C entering water	3.11 COP _C	
Water-to-water groundwater (cooling mode)	< 40 kW	All	15°C entering water	4.78 COP _C	
Brine-to-water ground loop (cooling mode)	< 40 kW	All	30° C entering water	3.55 COP _C	
Air conditioners, air cooled (heating mode)	< 19kW (cooling capacity) (one phase)	All	Split systems	2.49 COP _H	AHRI 210/240
			Single packaged	2.40 COP _H	
	< 19kW (cooling capacity) (three phase)	All	Split systems	2.49 COP _H	
			Single packaged	2.40 COP _H	

a. Chapter 11 (Section 11) contains details on the referenced test procedures, including year and version of the test procedure.

(continued)

TABLE B101.2 (TABLE B-2)
(SUPERSEDES TABLE 6.8.1-2 IN ANSI/ASHRAE/IES 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 CONDITIONS	MINIMUM EFFICIENCY	TEST PROCEDURE ^a
Through-the-wall, air cooled (heating mode)	< 9 kW (cooling capacity)	All	Split systems	2.17 COP _H	AHRI 210/240
			Single packaged	2.17 COP _H	
Small-duct high velocity, air cooled (heating mode)	< 19kW (cooling capacity) (one phase)	All	Split systems	2.11 COP _H	AHRI 210/240
	< 19kW (cooling capacity) (three phase)	All	Split systems	2.11 COP _H	
Air cooled (heating mode)	≥ 19kW and < 40 kW (cooling capacity)		8.3°C db/6.1°C wb outdoor air	3.40 COP _H	AHRI 340/360
			-8.3°C db/9.4°C wb outdoor air	2.40 COP _H	
	≥ 40 kW (cooling capacity)	8.3°C db/6.1°C wb outdoor air	3.20 COP _H		
		-8.3°C db/9.4°C wb outdoor air	2.10 COP _H		
Water-to-air water loop (heating mode)	< 40 kW (cooling capacity)		20°C entering water	4.60 COP _H	ISO-1356-1
Water-to-air groundwater (heating mode)	< 40 kW (cooling capacity)		10°C entering water	3.70 COP _H	
Brine-to-air ground loop (heating mode)	< 40 kW (cooling capacity)		0°C entering fluid	3.20 COP _H	
Water-to-water water loop (heating mode)	< 40 kW (cooling capacity)		20°C entering water	3.70 COP _H	ISO-13256-2
Water-to-water groundwater (heating mode)	< 40 kW (cooling capacity)		10°C entering water	3.10 COP _H	
Brine-to-water ground loop (heating mode)	< 40 kW (cooling capacity)		0°C entering fluid	2.50 COP _H	

a. Chapter 11 (Section 11) contains details on the referenced test procedures, including year and version of the test procedure.

TABLE B101.3 (TABLE B-3)
(SUPERSEDES TABLE 6.8.1-4 IN ANSI/ASHRAE/IES 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 ^a
PTAC (cooling mode) standard size	All capacities	35°C db <i>outdoor air</i>	$4.22 - (0.300 \times \text{Cap}/1000)^c \text{COP}_C$	AHRI 310/380
PTAC (cooling mode) nonstandard size ^b	All capacities	35°C db <i>outdoor air</i>	$3.19 - (0.213 \times \text{Cap}/1000)^c \text{COP}_C$	AHRI 310/380
PTHP (cooling mode) standard size	All capacities	35°C db <i>outdoor air</i>	$4.22 - (0.300 \times \text{Cap}/1000)^c \text{COP}_C$	ARI 310/380
PTHP (cooling mode) nonstandard size ^b	< 7,000 Btu/h	35°C db <i>outdoor air</i>	$3.16 - (0.213 \times \text{Cap}/1000)^c \text{COP}_C$	ARI 310/380
PTHP (heating mode) new constructions	All capacities	8.3°C db/6.1°C wb <i>outdoor air</i>	$3.7 - (0.052 \times \text{Cap}/1000)^c \text{COP}_H$	ARI 310/380
PTHP (heating mode) nonstandard size ^b	All capacities	8.3°C db/6.1°C wb <i>outdoor air</i>	$2.9 - (0.026 \times \text{Cap}/1000)^c \text{COP}_H$	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 m².
- 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 (TABLE B-4)
(SUPERSEDES TABLE 6.8.1-4 IN ANSI/ASHRAE/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 ^b	TEST PROCEDURE ^a	
SPVAC (cooling mode)	< 19 kW	35°C db/23.9°C wb outdoor air	4.10 SCOP _C		AHRI 210/240	
	≥ 19 kW and < 40 kW	35°C db/23.9°C wb outdoor air	3.28 COP _C 3.78 ICOP _C		AHRI 340/360	
	≥ 40 kW and < 70 kW	35°C db/23.9°C wb outdoor air	3.22 COP _C 3.63 ICOP _C			
SPVHP (cooling mode)	< 19 kW	35°C db/23.9°C wb outdoor air	4.10 SCOP _C		AHRI 210/240	
	≥ 19 kW and < 40 kW	35°C db/23.9°C wb outdoor air	3.22 COP _C 3.58 ICOP _C		AHRI 340/360	
	≥ 40 kW and < 70 kW	35°C db/23.9°C wb outdoor air	3.11 COP _C 3.40 ICOP _C			
SPVHP (heating mode)	< 19 kW	8.3°C db/6.1°C wb outdoor air	2.34 SCOP _H		AHRI 210/240	
	≥ 19 kW and < 40 kW	8.3°C db/6.1°C wb outdoor air	3.30 COP _H		AHRI 340/360	
	≥ 40 kW and < 70 kW	8.3°C db/6.1°C wb outdoor air	3.2 COP _H			
Room air conditioners, with louvered sides	< 1.8 kW		3.55 CCOP _C		3.37 CCOP _C	ANSI/AHAM RAC-1
	≥ 1.8 kW and < 2.3 kW		3.55 CCOP _C		3.37 CCOP _C	
	≥ 2.3 kW and < 4.1 kW		3.52 CCOP _C		3.37 CCOP _C	
	≥ 4.1 kW and < 5.9 kW		3.46 CCOP _C	3.28 CCOP _C		
	≥ 5.9 kW and < 8.2 kW		3.02 CCOP _C	2.87 CCOP _C		
	≥ 8.2 kW		2.90 CCOP _C	2.75 CCOP _C		
Room air conditioners, without louvered sides	< 1.8 kW		3.22 CCOP _C	3.08 CCOP _C		
	≥ 1.8 kW and < 2.3 kW		3.22 CCOP _C	3.08 CCOP _C		
	≥ 2.3 kW and < 3.2 kW		3.11 CCOP _C	2.96 CCOP _C		
	≥ 3.2 kW and < 4.1 kW		3.08 CCOP _C	2.93 CCOP _C		
	≥ 4.1 kW and < 5.9 kW		2.99 CCOP _C	2.84 CCOP _C		
	≥ 5.9 kW		3.02 CCOP _C	2.87 CCOP _C		
Room air conditioner heat pump, with louvered sides	< 5.9 kW	3.17 CCOP _C	3.02 CCOP _C			
	≥ 5.9 kW	2.99 CCOP _C	2.84 CCOP _C			
Room air conditioner heat pump, without louvered sides	< 4.1 kW	2.99 CCOP _C	2.84 CCOP _C			
	≥ 4.1 kW	2.81 CCOP _C	2.67 CCOP _C			
Room air conditioner, casement only	All capacities	3.08 CCOP _C	2.93 CCOP _C			
Room air conditioner, casement-slider	All capacities	3.34 CCOP _C	3.17 CCOP _C			

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 (TABLE B-5)
(SUPERSEDES TABLE 6.8.1-5 IN ANSI/ASHRAE/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 ^a
Warm-air furnace, gas fired (weatherized)	< 65.9 kW	Maximum capacity ^c	78% AFUE or 80% E_t ^{b,d}	DOE 10 CFR Part 430 or Section 2.39, Thermal Efficiency, ANSI Z21.47
	≥ 65.9 kW		80% E_t ^d	Section 2.39, Thermal Efficiency, ANSI Z21.47
Warm-air furnace, gas fired (nonweatherized)	< 65.9 kW	Maximum capacity ^c	90% AFUE or 92% E_t ^{b,d}	DOE 10 CFR Part 430 or Section 2.39, Thermal Efficiency, ANSI Z21.47
	≥ 65.9 kW		92% E_t ^d	Section 2.39, Thermal Efficiency, ANSI Z21.47
Warm-air furnace, oil fired (weatherized)	< 65.9 kW	Maximum capacity ^c	78% AFUE or 80% E_t ^{b,d}	DOE 10 CFR Part 430 or Section 42, Combustion, UL 727
	> 65.9 kW		81% E_t ^d	Section 42, Combustion, UL 727
Warm-air furnace, oil fired (nonweatherized)	< 65.9 kW	Maximum capacity ^c	85% AFUE or 87% E_t ^{b,d}	DOE 10 CFR Part 430 or Section 42, Combustion, UL 727
	≥ 65.9 kW		87% E_t ^d	Section 42, Combustion, UL 727
Warm-air duct furnaces, gas fired (weatherized)	All capacities	Maximum capacity ^c	80% E_c ^e	Section 2.10, Efficiency, ANSI Z83.8
Warm-air duct furnaces, gas fired (nonweatherized)	All capacities	Maximum capacity ^c	90% E_c ^e	Section 2.10, Efficiency, ANSI Z83.8
Warm-air unit heaters, gas fired (nonweatherized)	All capacities	Maximum capacity ^c	80% E_c ^{e,f}	Section 2.10, Efficiency, ANSI Z83.8
Warm-air unit heaters, oil fired (weatherized)	All capacities	Maximum capacity ^c	90% E_c ^{e,f}	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_t = 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 a *flue damper*. A *vent damper* is an acceptable alternative to a *flue damper* for those furnaces where combustion air is drawn from the *conditioned space*.
- e. E_c = 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 (TABLE B-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 ^a	SUBCATEGORY OR RATING CONDITION	SIZE CATEGORY (INPUT)	MINIMUM EFFICIENCY ^{b,c}	TEST PROCEDURE ^g
Boilers, hot water	Gas fired	< 87.9 kW ^{h,i}	89% AFUE ^f	10 CFR Part 430
		≥ 87.9 kW and < 732.7 kW ^d	89% E_t ^f	10 CFR Part 431
		≥ 732.7 kW ^a	91% E_c ^f	
	Oil fired ^e	< 87.9 kW	89% AFUE ^f	10 CFR Part 430
		≥ 87.9 kW and < 732.7 kW ^d	85% E_t ^f	10 CFR Part 431
		≥ 732.7 kW ^a	86% E_c ^f	
Boilers, steam	Gas fired	< 87.9 kW ⁱ	80% AFUE	10 CFR Part 430
	Gas fired all except natural draft	≥ 87.9 kW and < 732.7 kW ^d	79% E_t	10 CFR Part 431
		≥ 732.7 kW ^a	79% E_t	
	Gas fired natural draft	≥ 87.9 kW and < 732.7 kW ^d	77% E_t	
		≥ 732.7 kW ^a	77% E_t	
	Oil fired ^e	< 87.9 kW	82% AFUE	10 CFR Part 430
		≥ 87.9 kW and < 732.7 kW ^d	81% E_t	10 CFR Part 431
≥ 732.7 kW ^a		81% E_t		

- a. 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.
- b. E_c = thermal efficiency (100% less flue losses). See reference document for detailed information.
- c. E_t = thermal efficiency. See reference document for detailed information.
- d. Maximum capacity—minimum and maximum ratings as provided for and allowed by the unit’s controls.
- e. Includes oil fired (residual).
- f. 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.
- g. Chapter 11 (Section 11) contains details for the referenced test procedure, including the referenced year version of the test procedure.
- h. 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.
- i. Boilers shall not be equipped with a continuous pilot ignition system.

**TABLE B101.7 (TABLE B-7)
(SUPERSEDES TABLE 6.8.1-7 IN ANSI/ASHRAE/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 ^a	PERFORMANCE REQUIRED ^{a,b,c,d,e,fi}	TEST PROCEDURE ^h
Propeller or axial fan open-circuit cooling towers	All	35.0°C entering water 29.4°C leaving water 23.9°C entering wb	≥ 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	≥ 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	≥ 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	≥ 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	≥ 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	≥ 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	≥ 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	≥ 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	≥ 69 COP	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 B101.8 (B-8) 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 B101.8 (B-8) 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 (TABLE B-8)
(SUPERSEDES TABLE 7.8 IN ANSI/ASHRAE/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 ^{a, d}	TEST PROCEDURE ^b
Electric table-top water heaters ^c	≤ 12 kW	≥ 75.7 L and ≤ 454 L	Very small	UEF ≥ 0.6323 – 0.0015 <i>V</i>	DOE 10 CFR Part 430
			Low	UEF ≥ 0.9188 – 0.00082 <i>V</i>	
			Medium	UEF ≥ 0.9577 – 0.00061 <i>V</i>	
			High	UEF ≥ 0.9844 – 0.00042 <i>V</i>	
Electric resistance storage water heaters		≥ 75.7 L and ≤ 208 L	Very small	UEF ≥ 0.8808 – 0.00021 <i>V</i>	DOE 10 CFR Part 430
			Low	UEF ≥ 0.9254 – 0.000079 <i>V</i>	
			Medium	UEF ≥ 0.9307 – 0.000053 <i>V</i>	
			High	UEF ≥ 0.9349 – 0.000026 <i>V</i>	
		> 208 L		Must use heat-pump water heater	
Electric resistance grid-enabled water heaters		≥ 284 L	Very small	UEF ≥ 1.0136 – 0.00074 <i>V</i>	DOE 10 CFR Part 430
			Low	UEF ≥ 0.09984 – 0.00037 <i>V</i>	
			Medium	UEF ≥ 0.9853 – 0.00026 <i>V</i>	
			High	UEF ≥ 0.9720 – 0.00018 <i>V</i>	
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	≤ 22.0 kW	≤ 208 L		EF ≥ 0.67, FHR ≥ 250 L	DOE 10 CFR Part 430
	> 22.0 kWh	> 208 L		EF ≥ 0.77, FHR ≥ 250 L	
Gas instantaneous water heaters	> 14.6 kW and < 58.6 kW	≥ 309.7W/L and < 7.6 L		EF ≥ 0.90 and GPM ≥ 2.5 over a 25°C rise	DOE 10 CFR Part 430
	≥ 22.0 kW	≤ 530 L and ≥ 309.7W/L		$E_t \geq 0.94$ or $EF \geq 0.93$ $SL \leq 0.84 \times (Q/234 + 56.5\sqrt{V}), W$	ANSI Z21.10.3
Oil storage water heaters	≤ 30.7 kW	≤ 190 L	Very small	EF = 0.2509 – 0.00032 <i>V</i>	DOE 10 CFR Part 430
			Low	EF = 0.5330 – 0.00042 <i>V</i>	
			Medium	EF = 0.6078 – 0.00042 <i>V</i>	
			High	EF = 0.6815 – 0.00037 <i>V</i>	
> 30.7 kW	< 309.7 W/L		$E_t \geq 80\%$ and $SL \leq (Q/234 + 56.5\sqrt{V}), W$	ANSI Z21.10.3	
Oil instantaneous water heaters	≤ 61.5 kW	≤ 190 L		EF ≥ 0.59 – 0.00050 <i>V</i>	DOE 10 CFR Part 430
	> 61.5 kW	≥ 309.7 W/L and < 38 L		$E_t \geq 80\%$	ANSI Z21.10.3
	> 61.5 kW	≥ 309.7W/L and ≥ 30 L		$E_t \geq 78\%$ and $SL \leq (Q/234 + 56.5\sqrt{V}), W$	
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 ≤ 3660 kW	≥ 309.7 W/L and < 30 L		$E_t \geq 80\%$	ANSI Z21.10.3
Hot-water supply boilers, gas		≥ 309.7 W/L and ≥ 30 L		$E_t \geq 80\%$ $SL \leq (Q/234 + 56.5\sqrt{V}), W$	ANSI Z21.10.3

- a. Energy factor (EF) and thermal efficiency (E_t) 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 B101.8 (TABLE B-8)
(SUPERSEDES TABLE 7.8 IN ANSI/ASHRAE/IES STANDARD 90.1)
PERFORMANCE REQUIREMENTS FOR SERVICE WATER HEATING EQUIPMENT (SI) (Continued)

EQUIPMENT TYPE	SIZE CATEGORY (INPUT)	RATED STORAGE VOLUME AND INPUT RATING (IF APPLICABLE)	DRAW PATTERN	PERFORMANCE REQUIRED ^{a, d}	TEST PROCEDURE ^b
Hot-water supply boilers, oil		≥ 309.7 W/L and ≥ 30 L		$E_t \geq 78\%$ $SL \leq (Q/234 + 56.5\sqrt{V}), W$	ANSI Z21.10.3
Pool heaters, gas	All sizes			$E_t \geq 82\%$	ASHRAE 146
Pool heaters, oil	All sizes			$E_t \geq 78\%$	ASHRAE 146
Heat-pump pool heaters	All sizes	10°C db 6.8°C wb <i>outdoor air</i> 26.7°C entering water		≥4.0 COP	ASHRAE 146
Unfired storage tanks	All sizes			≥ R-2.2°C • m ² /W	None

- a. Energy factor (EF) and thermal efficiency (E_t) 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 (TABLE B-9)
COMMERCIAL CLOTHES WASHERS (SI)

PRODUCT	MEF ^a	WF ^b , 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 (TABLE B-10)
(SUPERSEDES TABLE 6.8.1-9 IN ANSI/ASHRAE/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 ^a
VRF air conditioners, air cooled	< 19 kW	All	VRF multisplit system	4.40 SCOP _C 3.36 COP _C	AHRI 1230
	≥ 19 kW and < 40 kW	Electric resistance (or none)	VRF multisplit system	3.43 COP _C 4.37 ICOP _C	
	≥ 40 kW and < 70 kW	Electric resistance (or none)	VRF multisplit system	3.43 COP _C 4.22 ICOP _C	
	≥ 70 kW	Electric resistance (or none)	VRF multisplit system	3.08 COP _C 3.81 ICOP _C	

- a. Chapter 11 (Section 11) contains details for the referenced test procedure, including year version of the test procedure.

TABLE B101.11 (TABLE B-11)
(SUPERSEDES TABLE 6.8.1-10 IN ANSI/ASHRAE/IES STANDARD 90.1)
ELECTRICALLY OPERATED VARIABLE-REFRIGERANT-FLOW AND APPLIED
HEAT PUMP—MINIMUM EFFICIENCY REQUIREMENTS (SI)

EQUIPMENT TYPE	SIZE CATEGORY	HEATING SECTION TYPE	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY	TEST PROCEDURE ^a
VRF air cooled (cooling mode)	< 19 kW	All	VRF multisplit system	4.40 SCOP _C 3.66 COP _C	AHRI 1230
	≥ 19 kW and < 40 kW	Electric resistance (or none)	VRF multisplit system	3.31 COP _C 4.28 ICOP _C	
	≥ 19 kW and < 40 kW	Electric resistance (or none)	VRF multisplit system with heat recovery	3.25 COP _C 4.22 ICOP _C	
	≥ 40 kW and < 70 kW	Electric resistance (or none)	VRF multisplit system	3.19 COP _C 4.07 ICOP _C	
	≥ 40 kW and < 70 kW	Electric resistance (or none)	VRF multisplit system with heat recovery	3.14 COP _C 4.02 ICOP _C	
	≥ 70 kW	Electric resistance (or none)	VRF multisplit system	3.02 COP _C 4.02 ICOP _C	
	≥ 70 kW	Electric resistance (or none)	VRF multisplit system with heat recovery	2.96 COP _C 3.66 ICOP _C	
VRF water source (cooling mode)	< 19 kW	All	VRF multisplit systems 30°C entering water	4.10 COP _C 4.69 ICOP _C	AHRI 1230
	< 19 kW	All	VRF multisplit systems with heat recovery 30°C entering water	4.04 COP _C 4.63 ICOP _C	
	≥ 19 kW and < 40 kW	All	VRF multisplit system 30°C entering water	4.10 COP _C 4.69 ICOP _C	
	≥ 19 kW and < 40 kW	All	VRF multisplit system with heat recovery 30°C entering water	4.04 COP _C 4.63 ICOP _C	
	≥ 40 kW	All	VRF multisplit system 30°C entering water	3.40 COP _C 4.10 ICOP _C	
	≥ 40 kW	All	VRF multisplit system with heat recovery 30°C entering water	3.28 COP _C 4.04 ICOP _C	
VRF groundwater source (cooling mode)	< 40 kW	All	VRF multisplit system 15°C entering water	4.75 COP _C	AHRI 1230
	< 40 kW	All	VRF multisplit system with heat recovery 15°C entering water	4.69 COP _C	
	≥ 40 kW	All	VRF multisplit system 15°C entering water	4.04 COP _C	
	≥ 40 kW	All	VRF multisplit system with heat recovery 15°C entering	3.99 COP _C	

a. Chapter 11 (Section 11) contains a complete specification of the reference test procedure, including year version of the test procedure.

(continued)

TABLE B101.11 (TABLE B-11)
(SUPERSEDES TABLE 6.8.1-10 IN ANSI/ASHRAE/IES 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 ^a
VRF ground source (cooling mode)	< 40 kW	All	VRF multisplit system 25°C entering water	3.93 COP _C	AHRI 1230
	< 40 kW	All	VRF multisplit system with heat recovery 25°C entering water	3.87 COP _C	
	≥ 40 kW	All	VRF multisplit system 25°C entering water	3.22 COP _C	
	≥ 40 kW	All	VRF multisplit system with heat recovery 25°C entering water	3.17 COP _C	
VRF air cooled (heating mode)	< 19 kW (cooling capacity)		VRF multisplit system	2.49 SCOP _H	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 _H	
			-8.3°C db/-9.4°C wb <i>outdoor air</i>	2.40 COP _H	
	≥ 40 kW (cooling capacity)		VRF multisplit system 8.3°C db/6.1°C wb <i>outdoor air</i>	3.20 COP _H	
		-8.3°C db/-9.4°C wb <i>outdoor air</i>	2.10 COP _H		
VRF water source (heating mode)	< 40 kW (cooling capacity)		VRF multisplit system 20°C entering water	4.60 COP _H	AHRI 1230
	≥ 40 kW (cooling capacity)		VRF multisplit system 20°C entering water	4.20 COP _H	
VRF groundwater source (heating mode)	< 40 kW (cooling capacity)		VRF multisplit system 10°C entering water	3.60 COP _H	AHRI 1230
	≥ 40 kW (cooling capacity)		VRF multisplit system 10°C entering water	3.30 COP _H	
VRF ground source (heating mode)	< 40 kW (cooling capacity)		VRF multisplit system 0°C entering fluid	3.10 COP _H	AHRI 1230
	≥ 40 kW (cooling capacity)		VRF multisplit system 0°C entering fluid	2.80 COP _H	

a. Chapter 11 (Section 11) contains a complete specification of the reference test procedure, including year version of the test procedure.

NORMATIVE APPENDIX C
RESERVED



NORMATIVE APPENDIX D

BUILDING CONCENTRATIONS

(This is a normative appendix and is part of this code.)

SECTION D101 (D1.) 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, m^2 .

V_B = building volume, m^3 .

a_B = average weekly minimum air change rate, 1/h.

**INFORMATIVE APPENDIX E
RESERVED**

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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 (F1) 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 (F1.1) 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 (F1.1.1) 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 (F1.1.2) 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	IEQ	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 #2—without Atrium, three-story, minimum exposure on the south and west side.

BUILDING SYSTEM	HIGH-PERFORMANCE CRITERIA						
	SITE	IAQ	IEQ	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 objectors 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.

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

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 (9.4.1.1)

ASHRAE

1791 Tullie Circle NE
Atlanta, GA 30329

ASHRAE Guideline 0-2013: The Commissioning Process
1001.3.1.1 (10.3.1.1)

ASHRAE Guideline 1.1-2007 : HVAC&R Technical Requirements for the Commissioning Process
1001.3.1.1 (10.3.1.1)

ASHRAE Guideline 4-2008 (RA 2013): Preparation of Operating and Maintenance Documentation for Building Systems
1001.3.1.1 (10.3.1.1)

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 (10.3.1.4)

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 (5.3.7.2)

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 (8.3.6)

ASTM E1331-15: Standard Test Method for Reflectance Factor and Color by Spectrophotometry Using Hemispherical Geometry

801.4.1 (8.4.1)

ASTM E1477 - 98a (2013): Standard Test Method for Luminous Reflectance Factor of Acoustical Materials by Use of Integrating-Sphere Reflectometers

801.4.1 (8.4.1)

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 (8.4.1)

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

801.3.9 (8.4.2), 801.5.2 (8.5.2)

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 (9.4.1)

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

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: Minimal Risk Levels (MRLs)

Table 1001.3.1.5 (10.3.1.5)

EPA

United States Environmental Protection Agency
1200 Pennsylvania Ave NW
Washington, DC 20460

Portfolio Manager

1001.3.2.1.3.2 (10.3.2.1.3.2)

FSC

Forest Stewardship Council
1155 30th Street NW, Suite 300
Washington, DC 20007

901.4.1.3.1 (9.4.1.3.1)

GSA

United States General Services Administration
1800 F Street, NW
Washington, DC 20405

U.S. GSA-2005: The Building Commissioning Guide

1001.3.1 (10.3.1)

ICC

International Code Council
500 New Jersey Ave NW # 300
Washington, DC 20001

IBC-2018: International Building Code®

106.1, 801.3.1.8 (8.3.1.8), I201.1 (I2.1)

IECC-2018: International Energy Conservation Code®

Appendix H

IFC-2018: International Fire Code®

601.3.2.6 (6.3.2.6)

IPC-2018: International Plumbing Code®

601.3.1.2.1 (6.3.1.2.1)

ICC/ASHRAE 700–2015: National Green Building Standard

J101.1.1, J101.1.2, J101.1.3, J101.1.4, J101.1.5

IES

Illuminating Engineering Society
120 Wall Street, Floor 17
New York, NY 10005-4001

IDA/IES Model Lighting Ordinance: Model Lighting Ordinance (MLO)

501.3.6 (5.3.6)

ITE

Institute of Transportation Engineers
1627 Eye Street, NW, Suite 600
Washington, DC 20006

4th Edition, 2004: Parking Generation

1001.3.2.4 (10.3.2.4)

MTS

The Institute for Market Transformation to Sustainability
1511 Wisconsin Avenue, N.W.
Washington, D.C. 20007

MTS 1.0 WSIP Guide-2007: Whole Systems Integrated Process Guide for Sustainable Buildings and Communities

Appendix F

NREL

National Renewable Energy Laboratory
1617 Cole Blvd.
Golden, CO 80401-3393

NREL/TP-550-38617: Source Energy and Emissions Factors for Energy Use in Buildings

Table 701.5.2B (7.5.2B)

SFI

Sustainable Forestry Initiative, Inc.
1600 Wilson Blvd, Suite 810
Arlington, VA 22209

901.4.1.3.1 (9.4.1.3.1)

SMACNA

Sheet Metal and Air Conditioning Contractors National Association
4201 Lafayette Center Drive
Chantilly, VA 20151

ANSI/SMACNA 008-2008: IAQ Guidelines for Occupied Buildings under Construction, Second Edition

1001.3.1.5 (10.3.1.5)

SRI

Steel Recycling Institute
680 Andersen Drive
Pittsburgh, PA 15220

Brochure: Steel Takes LEED® With Recycled Content

901.4.1.1 (9.4.1.1)

>

UL

UL Environment
2211 Newmarket Parkway, #110
Marietta, GA 30067

UL2818-2013: Greenguard Certification Program for Chemical Emissions for Building Materials, Finishes and Furnishing

801.3.9 (8.4.2), 801.5.2 (8.5.2)

||

UL2821-2013: Greenguard Certification Program Method for Measuring and Evaluating Chemical Emissions from Building Materials, Finishes and Furnishings

801.3.9 (8.4.2), 801.5.2 (8.5.2)

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**INFORMATIVE APPENDIX H
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INFORMATIVE APPENDIX I

ADDITIONAL GUIDANCE FOR FUNCTIONAL AND PERFORMANCE TESTING (FPT) AND THE COMMISSIONING (Cx) PROCESS

(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.)

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 (10.3.1.1).

SECTION I101 (I1.) PROVIDER QUALIFICATIONS

I101.1 (I1.1) 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.

I101.2 (I1.2) Overview of the Cx Process. Table I101.2 (I1.2) provides an overview of activities, documentation, and responsibilities that should be included in the *Cx process*.

SECTION I201 (I2.) Cx DOCUMENTATION

The *Cx process* should result in the following deliverables.

I201.1 (I2.1) 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 (TABLE I1.2)
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 <i>Cx</i> 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 <i>Cx</i> requirements	<i>Cx</i> specifications	Design team and <i>Cx provider</i>
5	Design review	<i>Cx</i> 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 <i>Cx</i> report	Preliminary <i>Cx</i> report	<i>Cx provider</i>
12	<i>Cx</i> activities during occupancy	Additional information and updates to reports	<i>Cx provider</i> and building operations
13	Final <i>Cx</i> report	Final <i>Cx</i> report	<i>Cx provider</i>

I201.2 (I2.2) 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 (I2.3) 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 (I2.4) 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 (I2.5) 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 (I2.6) 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 docu-

ments 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 (I2.7) 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 (I2.8) 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 (I2.9) 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
RESERVED

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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.)

ANSI/ASHRAE/ICC/USGBC/IES Standard 189.1-2017 incorporates ANSI/ASHRAE/USGBC/IES Standard 189.1-2014 and Addenda a, b, c, d, e, f, g, i, j, k, l, m, n, o, p, q, r, s, t, u, v, w, x, y, z, aa, ab, ac, ad, ae, ag, ah, ai, aj, ak, al, am, ap, aq, as, au, av, aw, ax, ay, az, ba, bb, bd, be, bh, bi, bj, bk, bl, bn, bo, bp, bq, br, bs, bt, bu, bv, bw, bx, by, bz, cd, ce, cf, cg, ch, cj, and cl to ANSI/ASHRAE/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 ANSI/ASHRAE/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 ₂ 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)	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	Section 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
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

* These descriptions may not be complete and are provided for information only.

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TABLE K101.1 (TABLE J-1)
ADDENDA TO ANSI/ASHRAE/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
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
q	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, 2013	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
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

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TABLE K101.1 (TABLE J-1)
ADDENDA TO ANSI/ASHRAE/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
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) and 1001.3.2.1.5 (10.3.2.1.5); Appendix G	This addendum adds a requirement for an Indoor Environmental Quality (IEQ) occupant satisfaction survey to be included in the postoccupancy 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 (8.4.1.3)	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
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

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TABLE K101.1 (TABLE J-1)
ADDENDA TO ANSI/ASHRAE/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
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 façade and landscape 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
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

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TABLE K101.1 (TABLE J-1)
ADDENDA TO ANSI/ASHRAE/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
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
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

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TABLE K101.1 (TABLE J-1)
ADDENDA TO ANSI/ASHRAE/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
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
bo	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 801.3.9.2.1 (8.3.9.2.1) 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	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	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
bs	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

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TABLE K101.1 (TABLE J-1)
ADDENDA TO ANSI/ASHRAE/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
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
bv	Appendix B; Table B101.3 (B-3)	This addendum updates the centrifugal chiller requirement for K_{adj} , 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
ce	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

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TABLE K101.1 (TABLE J-1)
ADDENDA TO ANSI/ASHRAE/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
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 (IECC)</i> .	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

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NOTE: Referenced sections that are "Reserved" by Denver do not apply.

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>.

ANNEX 1

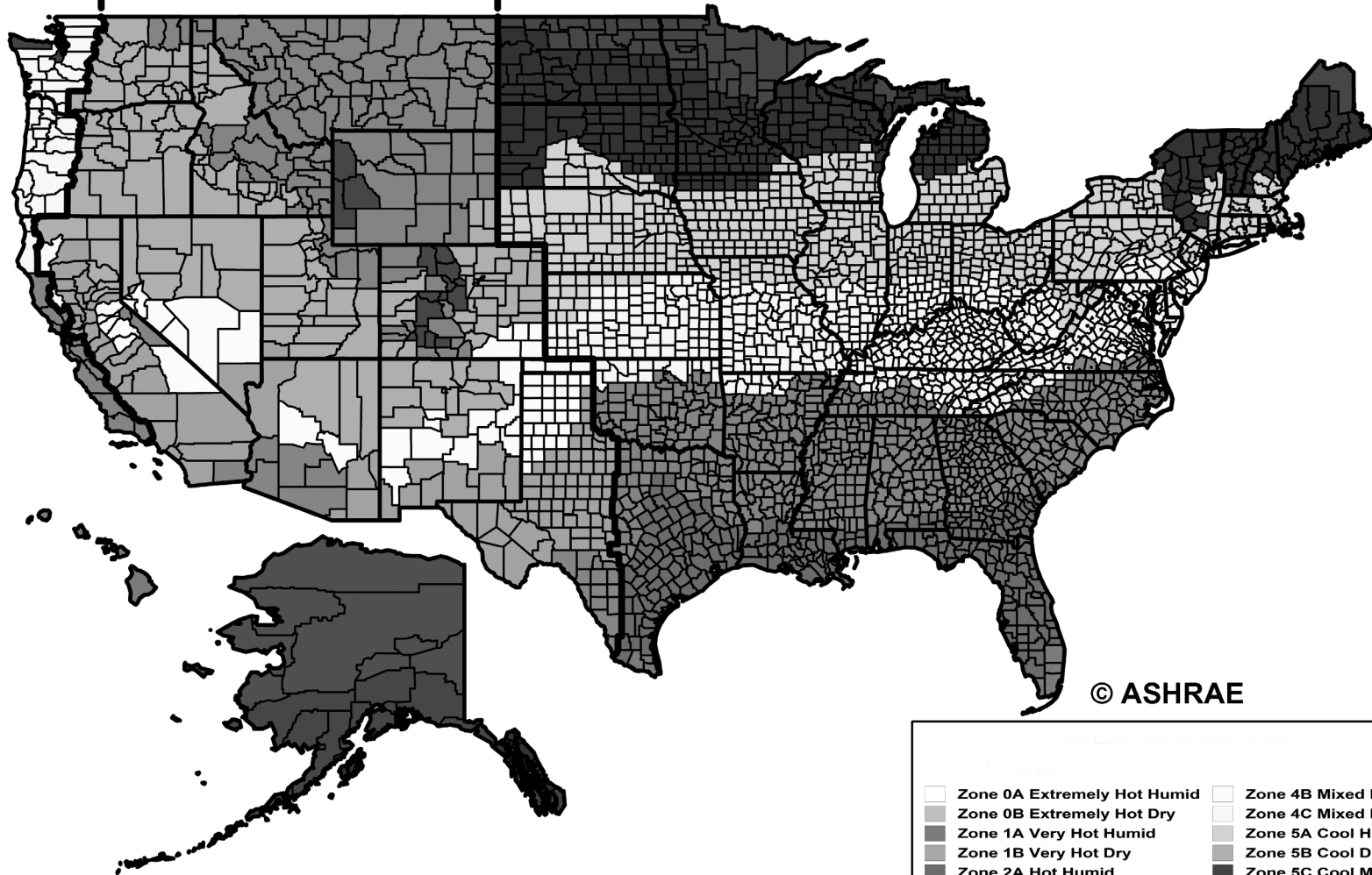
REFERENCED STANDARD REPRODUCTION ANNEX ASHRAE STANDARD 169

(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 Annex1-1	Figure B-1, Climate Zones for United States Counties	Informative
Appendix A	Section Annex1-1	Section A3 Climate Zone Definitions	Normative
Appendix A	Table Annex1-1	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.



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Zone 0A Extremely Hot Humid	Zone 4B Mixed Dry
Zone 0B Extremely Hot Dry	Zone 4C Mixed Marine
Zone 1A Very Hot Humid	Zone 5A Cool Humid
Zone 1B Very Hot Dry	Zone 5B Cool Dry
Zone 2A Hot Humid	Zone 5C Cool Marine
Zone 2B Hot Dry	Zone 6A Cold Humid
Zone 3A Warm Humid	Zone 6B Cold Dry
Zone 3B Warm Dry	Zone 7 Very Cold
Zone 3C Warm Marine	Zone 8 Subarctic
Zone 4A Mixed Humid	

FIGURE ANNEX 101.1 (FIGURE ANNEX 1-1)
 ASHRAE STANDARD 169-2013, FIGURE B-1: CLIMATE ZONES FOR UNITED STATES COUNTIES.

**SECTION ANNEX 101 (SECTION ANNEX 1-1)
ASHRAE STANDARD 169-2013, SECTION A3:
CLIMATE ZONE DEFINITIONS**

**SECTION A301 (A3.)
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:

$$P < 0.44 \times (T - 7) \quad (\text{I-P})$$

$$P < 20.0 \times (T + 14) \quad (\text{SI})$$

- c. If between 30% and 70% of the precipitation, P , occurs during the high sun period, then the dry/humid threshold is:

$$P < 0.44 \times (T - 19.5) \quad (\text{I-P})$$

$$P < 20.0 \times (T + 7) \quad (\text{SI})$$

- d. If 30% or less of the precipitation, P , occurs during the high sun period, then the dry/humid threshold is:

$$P < 0.44 \times (T - 32) \quad (\text{I-P})$$

$$P < 20 \times T \quad (\text{SI})$$

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 (TABLE ANNEX1-1)
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	$12600 < \text{HDD}_{65^{\circ}\text{F}}$	$7000 < \text{HDD}_{18^{\circ}\text{C}}$

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